TIN CUP CREEK
INUNDATION STUDY FOR
THE AREA EAST OF "REACH 8"

September 7, 2001

GENERAL SCOPE:

The purpose of this study is to produce an inundation map for the lower reaches of Tin Cup Creek that will delineate an estimate of the outer perimeter of the area that would be impacted by a "Clear Weather" breach of Tin Cup Dam. Tin Cup Dam is located approximately 13 miles upstream from the study area.

Prior to this study a breach analysis for Tin Cup Dam was concluded by Laurence Siroky, P.E. of the Montana Department of Natural Resources and Conservation. This DNRC study developed breach flows for the dam and modeled the flood flows from the dam to a point on Tin Cup Creek identified as "Reach 8", which is just upstream from an existing bridge on Highway 93 near the town of Darby. Our study is limited to the area east of "Reach 8" of the DNRC model and extends to the Bitterroot River, which is the terminus of Tin Cup Creek. As directed by the USFS and the Tin Cup Water District we have taken the breach flows for our analysis directly from the DNRC report . Our study does not attempt to validate the DNRC model but simply considers the affects of the predetermined breach flows on the study area.

HYDRAULIC STUDY:

I. General

Two general breach scenarios were considered for this study. The first case was to consider breach flows with the dam at normal full pool elevation, approximately equal to the top of the existing spillway, which is elevation 6284.3. The flow at "Reach 8" taken from the DNRC model for this scenario is 5,255 cfs. The second case represented a breach of the dam while a temporary dike was in place raising the dam pool elevation to 6286.3. The DNRC model flow at "Reach 8" for this stage was given as 6,326 cfs.

II. Site Survey

Six cross sections were surveyed between "Reach 8" of the DNRC analysis and the Bitterroot river. The locations of these sections are shown on Exhibit A of this report. All sections were tied to USGS NAVD 88 datum.

III. HEC-RAS Analysis

A HEC-RAS computer model was developed for the lower reaches of Tin Cup Creek using the surveyed data and flows provided by the DNRC. As a method of calibration, water surface profiles were computed using the flows for the 2 year (Q2) and the 100 year (Q100) reoccurrence intervals. The computed water surface elevations and stream depths for the Q2 event were compared to the "bank full" widths and channel depths from the surveyed cross sections and for the Q100 event the computed water surface at the Highway 93 crossing was compared to the elevation for the same flow computed by the Montana Transportation Department as shown on the bridge plans (Federal Aid Project No. RTF-BRF 7-1(36)23, dated 5-19-92). Both computed profiles produced favorable results and our model was assumed valid for the purpose of this study.

DISCUSSION:

The HEC-RAS analysis highlighted two major points of constriction to the anticipated breach flows, the first being the Highway 93 bridge over Tin Cup Creek and the second consisting of two existing adjacent bridges over Tin Cup Creek located on Water Street approximately 1,000 feet downstream from the Highway 93 crossing. Inundation areas were developed assuming that these structures, as well as the roadbed, remain in place during a flood event.

In determining the inundation area we assumed that the sharp bend the natural channel makes just before reaching Highway 93 directly east of "Reach 8" will act to dissipate some of the energy and velocity of the breach flows. For this reason we believe it is possible that flows will back up behind the bridge and would not cross over the highway in any significant amount before filling all low lying areas west of Highway 93. We have calculated that approximately 3,500 cfs can pass through the existing bridge opening at the Highway 93 crossing before overtopping the roadway. The most significant difference between the two breach flow cases considered (Case 1- Pool at the spillway crest and Case 2- Pool 2' above the spillway crest) would be the depth of water impounded in the area west of Highway 93. We estimated that the larger flow associated with the higher pool elevation will result in approximately 40% more water being impounded behind the Highway 93 bridge than for the smaller flow associated with the normal full pool elevation. This larger volume of stored water increases the probability that some localized flow across Highway 93 may occur at the existing low point in the road near the present Sinclar gas station at the south edge of Darby.

The restriction of the two downstream Water Street structures is much more significant than that of the Highway 93 bridge. These bridges only have capacity to carry approximately one fourth of the anticipated breach flows (1,350 cfs) before overtopping the roadway. The area between Highway 93 and these structures is a broad flood plain. Once flows exceed the capacity of the natural channel and water overtops the existing creek banks east of Highway 93 we anticipate that water would travel overland as sheet flow and follow the natural downhill grade to the river.

In addition to the area that would be directly affected by the flooding mechanism outlined above we have also considered the possible impact from the breach flows exiting the natural, relatively narrow, constriction of the canyon just upstream from "Reach 8". It is our opinion that a strong "surge" flow would hit the highway before making the existing 90 degree river bend sending a percentage of the flow over Highway 93 at this point. As can be seen in the attached aerial photo (Exhibit A) the direct distance from the mouth of the canyon near "Reach 8" east to the Bitterroot River is approximately 1400 feet, this is compared to the 5000 feet which is the distance traveled along the current creek channel to the Bitterroot River. Highway 93 is the only barrier preventing the breach flows from taking this direct line to the river making it very probable that some water will cross the highway at least for a short period of time. This would also be a likely location for debris being carried by the breach flows to be deposited, possibly altering the course of the flow, and would be another reason to include this area in the inundation map.

CONCLUSION:

Due to the numerous man-made impediments to the natural course of Tin Cup Creek, such as, the Highway 93 road fill, bridges, buildings, etc., and the accompanying potential for drastic impacts of debris to the possible course the flood flows take, it is difficult to use only conventional modeling approaches to determine the boundary of the inundation area for a "Clear Weather" breach of Tin Cup Dam. It is our opinion that the inundation area we have shown (Exhibit B) provides a reasonable estimate of the area that could be impacted by breach flows and can be used as a guide to develop evacuation and warning plans and procedures.

In determining the inundation area no attempt has been made to differentiate between areas of severe flooding (greater than 2' in depth) and minor flooding (6" or less in depth) but only to delineate an estimate of the outer perimeter of the area that would expect to be flooded by a "Clear Weather" breach of the dam.

Mike Jensen, P.E.
Montana P.E. No. 13098PE

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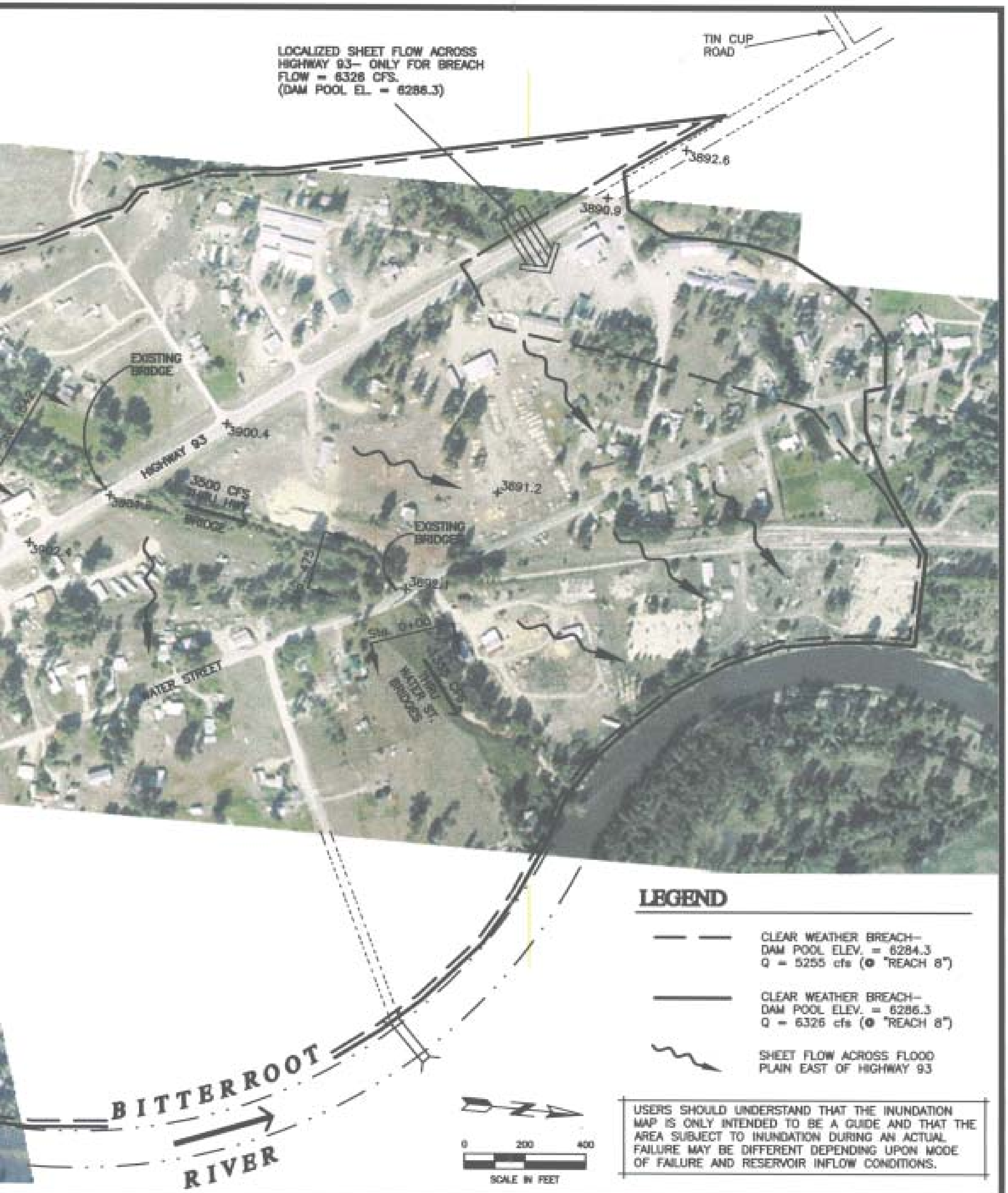
CONSULTING ENGINEERS & LAND SURVEYORS



TIN CUP CREEK AT HIGHWAY 93 DARBY, MONTANA	EXHIBIT A "CLEAR WEATHER" BREACH STUDY AREA & SUMMARY OF ANALYSIS	SHEET 1 OF 1

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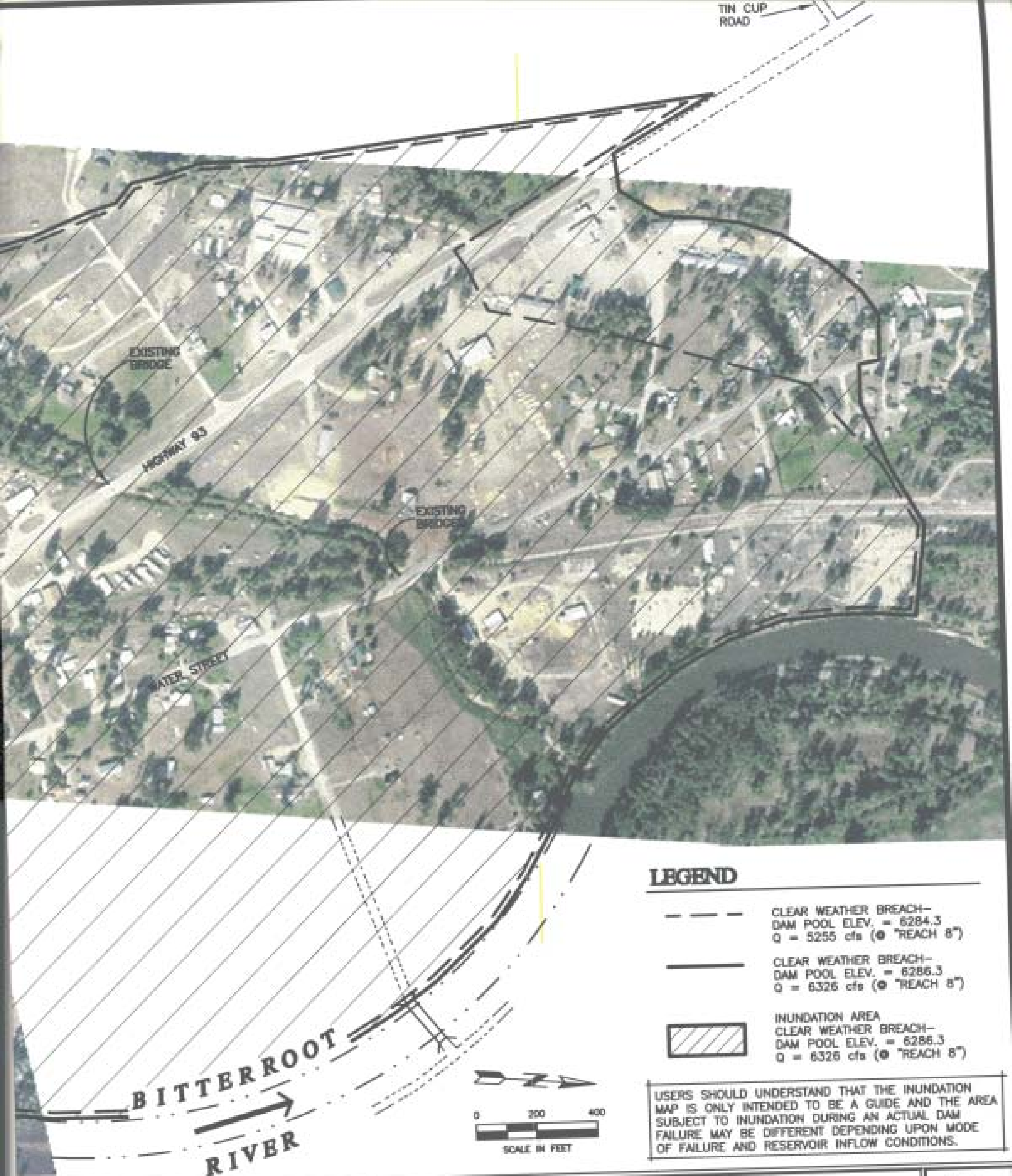
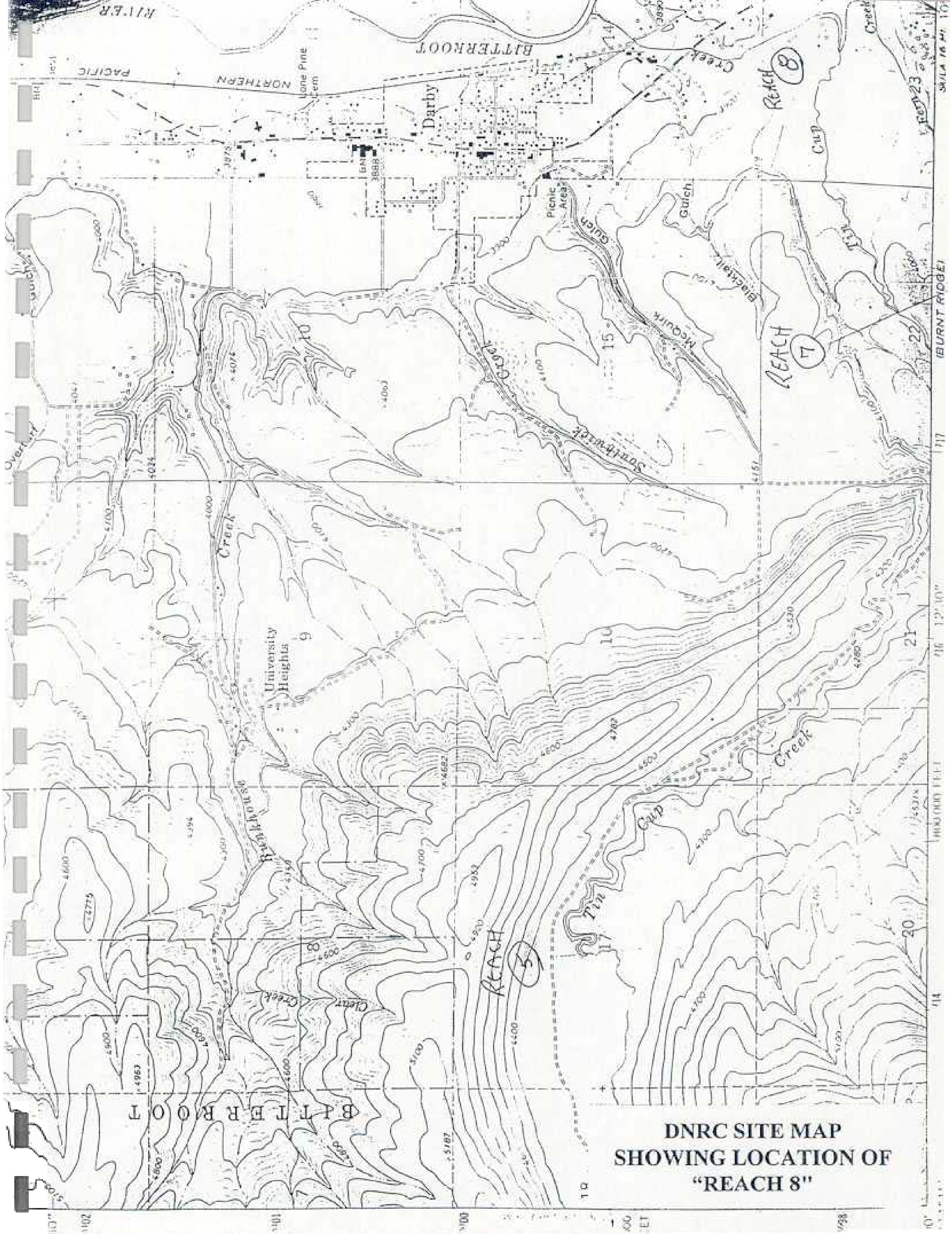
CONSULTING ENGINEERS & LAND SURVEYORS



TIN CUP CREEK AT HIGHWAY 93 DARBY, MONTANA	EXHIBIT B "CLEAR WEATHER" BREACH INUNDATION AREA EAST OF "REACH 8"	SHEET 1 OF 1

BREACH ANALYSIS
TIN CUP DAM
APRIL 2000
DNRC
L. SIROKY

NORMAL RESERVOIR ELEVATION	BREACH WIDTH (FEET)	BREACH TIME (HR)	BREACH FLOW @ DAM	BREACH FLOW @ REACH 8	BREACH ELEVATION @ REACH 8	FILE REFERENCE NAME
6283.3	25	.3	2453	**1847**	3893.8	TIN8325.HOU
6283.3	50	.3	4319	**3041**	3895.3	TIN8350.HOU
6283.3	75	.3	6144	**4082**	3896.3	TIN83[illegible].HOU
6284.3	75	.3	7353	**5255**	3897.5	TIN847[illegible].HOU
6285.3	75	.3	8663	**5529**	3897.7	TIN85.HOU
6286.3	75	.3	10049	**6326**	3898.4	TIN86.HOU
6287.3	75	.3	11473	**7208**	3899.0	TIN87.HOU
6288.3	75	.3	12432	**7712**	3899.5	TIN8875.HOU
6288.3	75	.5	11914	**7652**	3899.4	TIN8875.HOU
6288.3	150	.4	21275	**11193**	3901.7	TIN88.HOU
6293.3	75	.5	18565	**12028**	3902.2	TIN9375.HOU
6293.3	252	.5	42797	**21010**	3906.2	TIN93.HOU
6295.3	75	.5	21611	**14230**	3905.8	TIN9575.HOU
6295.3	300	.5	52951	**25412**	3907.7	TIN95.HOU



DNRC SITE MAP SHOWING LOCATION OF "REACH 8"

HEC-RAS Plan: w/ bridges 3 River: tin cup Reach: tincup

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width Act	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
tincup	4360	160.00	3908.47	3910.41	1.94	3910.41	3910.90	0.019023	5.64	28.38	29.59	1.01
tincup	4360	1355.00	3908.47	3913.41	4.94	3913.41	3914.87	0.010143	9.81	159.12	68.56	0.91
tincup	4360	2000.00	3908.47	3914.45	5.98	3914.45	3916.13	0.008722	10.77	237.76	88.31	0.88
tincup	4360	3500.00	3908.47	3915.51	7.04	3915.51	3915.75	0.002122	6.10	1529.58	479.36	0.45
tincup	4360	4082.00	3908.47	3915.51	7.04	3915.51	3915.84	0.002886	7.11	1529.58	479.36	0.53
tincup	4360	5529.00	3908.47	3915.51	7.04	3915.51	3916.11	0.005295	9.63	1529.58	479.36	0.71
tincup	4360	6326.00	3908.47	3915.51	7.04	3915.51	3916.30	0.006932	11.02	1529.58	479.36	0.81
tincup	4152	160.00	3905.60	3906.70	1.10		3906.87	0.005380	3.25	50.16	47.96	0.55
tincup	4152	1355.00	3905.60	3907.68	2.08	3908.64	3910.79	0.045994	14.21	105.16	132.19	1.79
tincup	4152	2000.00	3905.60	3908.05	2.45	3909.26	3912.22	0.052446	16.81	154.45	133.12	1.96
tincup	4152	3500.00	3905.60	3908.86	3.26	3910.34	3913.98	0.049842	19.55	262.88	135.14	1.99
tincup	4152	4082.00	3905.60	3909.32	3.72	3910.75	3913.90	0.039391	18.84	325.87	136.30	1.80
tincup	4152	5529.00	3905.60	3910.76	5.16	3911.67	3913.93	0.019010	16.27	535.60	170.17	1.32
tincup	4152	6326.00	3905.60	3911.67	6.07	3912.13	3914.22	0.012483	14.85	709.72	209.18	1.10
tincup	3854	160.00	3902.35	3903.65	1.30	3903.65	3904.07	0.019837	5.17	30.96	38.08	1.01
tincup	3854	1355.00	3902.35	3905.92	3.57	3905.92	3907.12	0.013639	8.79	154.10	67.31	1.00
tincup	3854	2000.00	3902.35	3906.90	4.55	3906.90	3907.91	0.008177	8.41	318.64	215.09	0.81
tincup	3854	3500.00	3902.35	3909.15	6.80		3909.57	0.002294	6.28	1085.58	396.87	0.47
tincup	3854	4082.00	3902.35	3909.78	7.43		3910.16	0.001875	6.10	1342.37	412.22	0.43
tincup	3854	5529.00	3902.35	3911.10	8.75		3911.44	0.001426	6.05	1907.85	447.46	0.39
tincup	3854	6326.00	3902.35	3911.71	9.36		3912.04	0.001310	6.11	2182.92	457.25	0.38
tincup	3623	160.00	3900.20	3901.47	1.27		3901.61	0.003936	3.00	53.41	44.05	0.48
tincup	3623	1355.00	3900.20	3904.53	4.33		3905.22	0.004456	6.67	203.20	53.80	0.60
tincup	3623	2000.00	3900.20	3905.56	5.36		3906.48	0.004657	7.69	260.11	57.07	0.63
tincup	3623	3500.00	3900.20	3907.19	6.99		3908.68	0.005625	9.79	357.49	62.27	0.72
tincup	3623	4082.00	3900.20	3907.62	7.42	3906.47	3909.32	0.005917	10.53	429.36	171.00	0.75
tincup	3623	5529.00	3900.20	3908.31	8.11	3908.31	3910.62	0.007145	12.43	548.63	171.00	0.84
tincup	3623	6326.00	3900.20	3908.84	8.64	3908.84	3911.25	0.006946	12.87	638.39	171.00	0.83
tincup	3415.5*	160.00	3899.43	3900.69	1.26		3900.82	0.003683	2.86	55.96	47.20	0.46
tincup	3415.5*	1355.00	3899.43	3903.66	4.23		3904.30	0.004276	6.47	209.46	56.48	0.59
tincup	3415.5*	2000.00	3899.43	3904.64	5.21		3905.51	0.004530	7.51	266.37	59.56	0.63
tincup	3415.5*	3500.00	3899.43	3905.86	6.43	3904.91	3907.44	0.006303	10.13	384.10	182.80	0.76
tincup	3415.5*	4082.00	3899.43	3906.18	6.75	3906.18	3908.00	0.006841	10.96	448.07	207.68	0.80
tincup	3415.5*	5529.00	3899.43	3907.13	7.70	3907.22	3909.11	0.006578	11.88	645.86	211.76	0.80
tincup	3415.5*	6326.00	3899.43	3907.22	7.79	3907.65	3909.70	0.008098	13.31	665.94	212.17	0.90

HEC-RAS Plan: w/ bridges 3 River: tin cup Reach: tincup (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Wdth Act	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
tincup	3208.*	160.00	3898.65	3899.96	1.31		3900.08	0.003461	2.73	58.52	50.45	0.45
tincup	3208.*	1355.00	3898.65	3902.78	4.13		3903.41	0.004266	6.36	213.19	59.11	0.59
tincup	3208.*	2000.00	3898.65	3903.71	5.06		3904.56	0.004544	7.42	276.41	148.78	0.63
tincup	3208.*	3500.00	3898.65	3904.65	6.00	3904.65	3906.08	0.006331	9.85	464.10	239.74	0.76
tincup	3208.*	4082.00	3898.65	3904.95	6.30	3905.16	3906.53	0.006689	10.62	540.22	264.75	0.79
tincup	3208.*	5529.00	3898.65	3905.33	6.68	3905.89	3907.53	0.008920	12.81	642.03	268.39	0.92
tincup	3208.*	6326.00	3898.65	3905.75	7.10	3906.21	3907.90	0.008342	12.96	755.68	269.80	0.90
tincup	3000.5*	160.00	3897.88	3899.30	1.42		3899.40	0.003061	2.57	62.32	53.88	0.42
tincup	3000.5*	1355.00	3897.88	3901.67	3.79		3902.39	0.005618	6.84	198.25	62.01	0.67
tincup	3000.5*	2000.00	3897.88	3902.05	4.17	3901.63	3903.28	0.008380	8.93	244.43	180.83	0.83
tincup	3000.5*	3500.00	3897.88	3903.06	5.18	3903.40	3904.56	0.008481	10.57	474.62	266.05	0.87
tincup	3000.5*	4082.00	3897.88	3903.31	5.43	3903.70	3904.94	0.008866	11.20	543.95	284.82	0.90
tincup	3000.5*	5529.00	3897.88	3904.04	6.16	3904.35	3905.62	0.007922	11.62	770.23	327.65	0.87
tincup	3000.5*	6326.00	3897.88	3904.59	6.71		3905.91	0.006260	10.99	950.91	329.32	0.78
tincup	2793	160.00	3897.10	3898.46	1.36		3898.60	0.005027	2.92	54.79	56.76	0.52
tincup	2793	1355.00	3897.10	3900.83	3.73		3901.30	0.004287	5.92	316.41	250.01	0.58
tincup	2793	2000.00	3897.10	3901.38	4.28		3901.88	0.004113	6.44	464.33	288.80	0.59
tincup	2793	3500.00	3897.10	3902.87	5.77		3903.20	0.002147	5.82	971.68	387.37	0.45
tincup	2793	4082.00	3897.10	3903.39	6.29		3903.68	0.001719	5.55	1176.36	388.88	0.41
tincup	2793	5529.00	3897.10	3904.18	7.08		3904.48	0.001611	5.85	1482.29	391.13	0.40
tincup	2793	6326.00	3897.10	3904.79	7.69		3905.08	0.001344	5.68	1723.28	392.89	0.37
tincup	2592.*	160.00	3896.20	3897.45	1.25		3897.58	0.005031	2.96	54.27	55.45	0.53
tincup	2592.*	1355.00	3896.20	3899.91	3.71		3900.43	0.004346	6.08	306.50	246.27	0.59
tincup	2592.*	2000.00	3896.20	3900.51	4.31		3901.04	0.004120	6.61	465.34	291.00	0.59
tincup	2592.*	3500.00	3896.20	3902.63	6.43		3902.84	0.001219	4.81	1188.42	354.86	0.35
tincup	2592.*	4082.00	3896.20	3903.18	6.98		3903.39	0.001056	4.75	1386.42	356.57	0.33
tincup	2592.*	5529.00	3896.20	3903.95	7.75		3904.20	0.001128	5.28	1660.67	358.91	0.34
tincup	2592.*	6326.00	3896.20	3904.59	8.39		3904.83	0.000993	5.24	1891.40	360.88	0.33
tincup	2391.*	160.00	3895.30	3896.48	1.18		3896.61	0.004784	2.93	54.63	54.25	0.51
tincup	2391.*	1355.00	3895.30	3899.00	3.70		3899.55	0.004372	6.20	297.64	246.03	0.59
tincup	2391.*	2000.00	3895.30	3899.56	4.26		3900.17	0.004488	6.95	446.93	292.15	0.62
tincup	2391.*	3500.00	3895.30	3902.48	7.18		3902.63	0.000758	4.14	1373.28	323.44	0.28
tincup	2391.*	4082.00	3895.30	3903.04	7.74		3903.20	0.000709	4.22	1556.46	325.35	0.27
tincup	2391.*	5529.00	3895.30	3903.78	8.48		3903.99	0.000848	4.91	1796.62	330.04	0.30

HEC-RAS Plan: w/ bridges 3 River: tin cup Reach: tincup (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Wdth Act	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
tincup	2391.*	6326.00	3895.30	3904.42	9.12		3904.64	0.000827	5.10	2016.09	353.30	0.30
tincup	2190.*	160.00	3894.40	3895.51	1.11		3895.65	0.004852	2.97	53.93	53.07	0.52
tincup	2190.*	1355.00	3894.40	3898.08	3.68		3898.66	0.004478	6.32	288.60	251.43	0.60
tincup	2190.*	2000.00	3894.40	3898.79	4.39		3899.33	0.003722	6.54	483.10	279.89	0.57
tincup	2190.*	3500.00	3894.40	3902.36	7.96		3902.50	0.000573	3.89	1537.52	341.00	0.25
tincup	2190.*	4082.00	3894.40	3902.93	8.53		3903.07	0.000556	4.01	1736.44	351.66	0.25
tincup	2190.*	5529.00	3894.40	3903.64	9.24		3903.83	0.000682	4.70	1987.51	353.90	0.28
tincup	2190.*	6326.00	3894.40	3904.29	9.90		3904.49	0.000639	4.77	2220.09	355.97	0.27
tincup	1989.*	160.00	3893.50	3894.65	1.15		3894.77	0.003918	2.80	57.15	52.20	0.47
tincup	1989.*	1355.00	3893.50	3897.56	4.06		3897.92	0.002581	5.19	382.88	245.55	0.47
tincup	1989.*	2000.00	3893.50	3898.37	4.87		3898.71	0.002161	5.39	582.64	251.80	0.44
tincup	1989.*	3500.00	3893.50	3902.30	8.80		3902.40	0.000346	3.24	1738.65	302.14	0.20
tincup	1989.*	4082.00	3893.50	3902.87	9.37		3902.97	0.000352	3.42	1909.86	302.14	0.20
tincup	1989.*	5529.00	3893.50	3903.55	10.05		3903.71	0.000470	4.14	2117.36	302.14	0.23
tincup	1989.*	6326.00	3893.50	3904.21	10.71		3904.37	0.000466	4.30	2314.68	302.14	0.23
tincup	1788	160.00	3892.60	3894.36	1.76		3894.41	0.000938	1.81	88.58	52.98	0.25
tincup	1788	1355.00	3892.60	3897.39	4.79		3897.55	0.001050	3.72	564.64	246.00	0.31
tincup	1788	2000.00	3892.60	3898.19	5.59		3898.37	0.001031	4.11	762.29	246.00	0.31
tincup	1788	3500.00	3892.60	3902.25	9.65		3902.33	0.000264	3.02	1759.87	246.00	0.17
tincup	1788	4082.00	3892.60	3902.81	10.21		3902.91	0.000285	3.26	1897.82	246.00	0.18
tincup	1788	5529.00	3892.60	3903.46	10.86		3903.62	0.000405	4.06	2050.44	246.00	0.22
tincup	1788	6326.00	3892.60	3904.11	11.51		3904.28	0.000421	4.30	2217.87	246.00	0.23
tincup	1542	160.00	3892.40	3893.64	1.24		3893.87	0.008392	3.83	41.80	42.47	0.68
tincup	1542	1355.00	3892.40	3896.86	4.46		3897.16	0.002355	4.98	480.76	255.78	0.45
tincup	1542	2000.00	3892.40	3897.72	5.32		3898.01	0.002018	5.27	759.79	342.90	0.43
tincup	1542	3500.00	3892.40	3902.19	9.79		3902.26	0.000280	3.07	2292.71	342.90	0.18
tincup	1542	4082.00	3892.40	3902.75	10.35		3902.83	0.000298	3.29	2484.17	342.90	0.19
tincup	1542	5529.00	3892.40	3903.38	10.98		3903.51	0.000422	4.09	2701.57	342.90	0.22
tincup	1542	6326.00	3892.40	3904.02	11.62		3904.17	0.000433	4.31	2922.67	342.90	0.23
tincup	1446.33*	160.00	3891.63	3892.82	1.19		3893.06	0.008364	3.95	40.52	39.09	0.68
tincup	1446.33*	1355.00	3891.63	3896.54	4.91		3896.92	0.002418	5.35	419.19	288.16	0.46
tincup	1446.33*	2000.00	3891.63	3897.52	5.89		3897.83	0.001774	5.26	703.86	291.93	0.41
tincup	1446.33*	3500.00	3891.63	3902.15	10.52		3902.23	0.000277	3.18	2054.96	291.93	0.18
tincup	1446.33*	4082.00	3891.63	3902.70	11.07		3902.80	0.000300	3.43	2216.60	291.93	0.19

HEC-RAS Plan: w/ bridges 3 River: tin cup Reach: tincup (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Wdth Act	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
tincup	1446.33*	5529.00	3891.63	3903.32	11.69		3903.47	0.000434	4.28	2395.35	291.93	0.23
tincup	1446.33*	6326.00	3891.63	3903.95	12.32		3904.12	0.000451	4.54	2582.02	291.93	0.23
tincup	1350.66*	160.00	3890.87	3892.12	1.25		3892.35	0.006680	3.78	42.28	36.55	0.62
tincup	1350.66*	1355.00	3890.87	3896.33	5.46		3896.71	0.002062	5.23	387.95	240.97	0.43
tincup	1350.66*	2000.00	3890.87	3897.34	6.47		3897.67	0.001613	5.27	630.75	240.97	0.39
tincup	1350.66*	3500.00	3890.87	3902.11	11.24		3902.21	0.000277	3.28	1779.42	240.97	0.18
tincup	1350.66*	4082.00	3890.87	3902.66	11.79		3902.77	0.000303	3.55	1911.49	240.97	0.19
tincup	1350.66*	5529.00	3890.87	3903.24	12.37		3903.42	0.000448	4.46	2052.92	240.97	0.23
tincup	1350.66*	6326.00	3890.87	3903.88	13.01		3904.07	0.000471	4.74	2205.35	240.97	0.24
tincup	1255	160.00	3890.10	3891.82	1.72	3891.05	3891.94	0.002545	2.86	55.85	35.05	0.40
tincup	1255	1355.00	3890.10	3895.89	5.79	3893.83	3896.46	0.002743	6.07	226.01	55.00	0.49
tincup	1255	2000.00	3890.10	3896.31	6.21	3894.85	3897.35	0.004499	8.22	249.04	55.00	0.63
tincup	1255	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
tincup	1255	4082.00	3890.10	3902.57	12.47							
tincup	1255	5529.00	3890.10	3903.10	13.00							
tincup	1255	6326.00	3890.10	3903.72	13.61	3902.01	3904.02	0.000638	5.56	1771.98	190.00	0.28
tincup	1185	Bridge	HIGHWAY 93 BRIDGE									
tincup	1100	160.00	3889.40	3891.17	1.77	3890.44	3891.33	0.003105	3.19	50.22		0.44
tincup	1100	1355.00		3895.44							156.00	
tincup	1100	2000.00		3895.95								
tincup	1100											
tincup	1100	4082.00	3889.40	3897.09	7.70	3896.55	3898.32	0.005002	10.38	633.47		
tincup	1100	5529.00	3889.40	3898.03	8.63	3898.01	3898.59	0.002646	8.23	1327.09		
tincup	1100	6326.00	3889.40	3898.40	9.00	3898.01	3899.01	0.002761	8.66	1434.66	291.60	
tincup	891.666*	160.00	3888.47	3890.61	2.14	3889.66	3890.76	0.002383	3.05	52.43	28.27	0.39
tincup	891.666*	1355.00	3888.47	3895.00	6.53	3892.92	3895.41	0.001976	5.61	368.70		
tincup	891.666*	2000.00	3888.47	3895.72	7.25	3894.58	3895.97	0.001408	5.14	827.68		
tincup	891.666*	3500.00	3888.47	3896.51	8.04	3895.51	3896.91	0.002123	6.84	1088.25	329.10	0.46
tincup	891.666*	4082.00	3888.47	3896.81	8.34	3895.73	3897.25	0.002280	7.29	1186.43	329.10	0.48
tincup	891.666*	5529.00	3888.47	3897.52	9.05	3896.24	3898.03	0.002527	8.16	1418.79	329.10	0.51
tincup	891.666*	6326.00	3888.47	3897.86	9.39	3896.46	3898.42	0.002644	8.59	1533.37	329.10	
tincup	683.333*	160.00	3887.53	3890.16	2.63	3889.01	3890.30	0.002014	3.00	53.36	25.86	0.37
tincup	683.333*	1355.00	3887.53	3894.68	7.15	3892.67	3895.00	0.001581	5.19	463.23	200.00	0.38

SECTIONS GENERATED FROM FIELD MEASUREMENT OF STRUCTURE

HEC-RAS Plan: w/ bridges 3 River: tin cup Reach: tincup (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Wdth Act	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
tincup	683.333*	2000.00	3887.53	3894.88	7.35	3894.24	3895.47	0.002849	7.14	504.39	200.00	0.51
tincup	683.333*	3500.00	3887.53	3896.09	8.56	3895.13	3896.47	0.002041	6.82	1158.30	366.60	0.45
tincup	683.333*	4082.00	3887.53	3896.35	8.82	3895.34	3896.77	0.002238	7.32	1253.62	366.60	0.47
tincup	683.333*	5529.00	3887.53	3897.00	9.47	3895.82	3897.50	0.002511	8.20	1493.76	366.60	0.51
tincup	683.333*	6326.00	3887.53	3897.33	9.80	3896.08	3897.86	0.002635	8.62	1613.06	366.60	0.52
tincup	475	160.00	3886.60	3888.57	1.97	3888.57	3889.21	0.017564	6.43	24.87	19.70	1.01
tincup	475	1355.00	3886.60	3892.69	6.09	3892.69	3894.05	0.008072	9.62	180.74	113.63	0.81
tincup	475	2000.00	3886.60	3893.91	7.31	3893.91	3894.69	0.004345	8.33	528.35	355.76	0.62
tincup	475	3500.00	3886.60	3894.71	8.11	3894.71	3895.65	0.005383	10.13	827.08	394.70	0.71
tincup	475	4082.00	3886.60	3895.02	8.42	3895.02	3895.94	0.005275	10.36	952.56	404.10	0.71
tincup	475	5529.00	3886.60	3895.47	8.87	3895.47	3896.54	0.006189	11.72	1133.30	404.10	0.77
tincup	475	6326.00	3886.60	3895.68	9.08	3895.68	3896.84	0.006684	12.41	1217.75	404.10	0.81
tincup	181.7	160.00	3884.40	3886.81	2.41	3885.66	3886.94	0.001968	2.95	54.15	26.10	0.36
tincup	181.7	1355.00	3884.40	3892.10	7.70	3889.83	3892.20	0.000521	3.24	901.13	316.59	0.22
tincup	181.7	2000.00	3884.40	3892.84	8.44	3890.59	3892.96	0.000622	3.80	1139.17	327.00	0.25
tincup	181.7	3500.00	3884.40	3893.79	9.39	3891.47	3893.98	0.000966	5.13	1449.16	327.00	0.31
tincup	181.7	4082.00	3884.40	3894.08	9.69	3891.72	3894.31	0.001087	5.57	1546.56	327.00	0.33
tincup	181.7	5529.00	3884.40	3894.73	10.33	3892.32	3895.03	0.001369	6.55	1757.08	327.00	0.38
tincup	181.7	6326.00	3884.40	3895.04	10.64	3892.67	3895.39	0.001514	7.05	1859.19	327.00	0.40
tincup	154	Bridge	WATER STREET BRIDGES									
tincup	114	160.00	3884.40	3886.62	2.22		3886.78	0.002604	3.25	49.29	25.53	0.41
tincup	114	1355.00	3884.40	3890.42	6.02		3890.91	0.002918	6.31	398.69	272.50	0.50
tincup	114	2000.00	3884.40	3891.15	6.75		3891.63	0.002805	6.78	609.84	296.69	0.50
tincup	114	3500.00	3884.40	3892.24	7.84		3892.79	0.003103	8.01	943.60	319.39	0.54
tincup	114	4082.00	3884.40	3892.58	8.18		3893.17	0.003185	8.39	1055.74	326.66	0.55
tincup	114	5529.00	3884.40	3893.36	8.96		3893.99	0.003223	9.04	1309.37	327.00	0.57
tincup	114	6326.00	3884.40	3893.71	9.31		3894.38	0.003322	9.45	1423.53	327.00	0.58
tincup	000	160.00	3883.10	3886.14	3.03	3885.44	3886.39	0.004508	4.04	39.57	22.39	0.54
tincup	000	1355.00	3883.10	3889.79	6.69	3889.56	3890.48	0.004502	7.43	319.75	210.51	
tincup	000	2000.00	3883.10	3890.48	7.38	3890.20	3891.21	0.004501	8.18	486.25		
tincup	000	3500.00	3883.10	3891.58	8.48	3891.22	3892.36	0.004502	9.30	810.84		
tincup	000	4082.00	3883.10	3891.94	8.84	3891.48	3892.73	0.004501	9.64	919.92		
tincup	000	5529.00	3883.10	3892.70	9.60	3892.07	3893.55	0.004503	10.37	1165.99		
	000	6326.00	3883.10	3893.06	9.96	3892.34						

GENERATED FROM MEASUREMENT

REDUCED CROSS SECTION NOTES

Project Title: ______________

Engineer's Project No. ______________

Survey Date: ______________

TIN CUP - STREAM SECTIONS

STATION/ LOCATION																					
43+60	3947^{71}	26^{29}	26^{25}	11^{87}	14^{17}	14^{08}	12^{04}	10^{07}	9^{74}	9^{48}	8^{47}	9^{7}	3912^{0}	12^{16}	12^{43}	12^{0}	3913^{68}				EL.
SEC 1	0^{0}	32^{3}	42^{8}	IRR DITCH	70^{1}	80^{7}	91^{5}	93^{7}	97^{8}	107^{8}	115^{2}	120^{3}	128^{8}	152^{8}	280^{9}	526^{3}	541^{9}				DIST.
U/S SECTION				[illegible]	USE 65^{0}		TB						TB								DESC.
																					EL.
																					DIST.
																					DESC.
41+52	3907^{6}	07^{6}	05^{6}	05^{6}	12	3912^{4}															EL.
(Not Surveyed)	0	80	84	127	138	240															DIST.
		TB			TB																DESC.
																					EL.
																					DIST.
																					DESC.
38+54	3955^{7}	13^{34}	11^{24}	10^{63}	7^{64}	7^{27}	6^{17}	4^{21}	3^{32}	2^{76}	2^{35}	2^{64}	6^{24}	3905^{91}							EL.
SEC 2	0	73^{7}	93^{22}	117^{3}	189^{6}	308^{1}	387^{9}	410^{3}	420^{8}	427^{9}	440^{6}	445^{7}	453^{7}	514^{2}							DIST.
FIRST BEND							TB						TB								DESC.
																					EL.
																					DIST.
																					DESC.

REDUCED CROSS SECTION NOTES

Project Title: ____________
Engineer's Project No. ____________
Survey Date: ____________

TIN CUP - STREAM SECTIONS

STATION/ LOCATION						EL. / DIST. / DESC.
36+23	07^{2}	00^{2}	00^{2}	07^{2}	3907^{2}	EL.
	59^{2}	70	110	121^{5}	171	DIST.
	TB			TB		DESC.
SMALL WOOD BRIDGE						

STATION/ LOCATION										EL. / DIST. / DESC.
27+93	3918^{28}	11^{97}	11^{97}	09^{09}	--	97^{8}	97^{8}	97^{34}	3900^{4}	EL.
SEC 3	0	14	–	121^{5}		352^{3}	361^{9}	406^{5}	526^{7}	DIST.
								TB		DESC.

3896^{2}	95^{4}	95^{4}	92^{6}	92^{6}	96^{5}	EL.
0^{0}	50	100	104^{1}	152	246	DIST.
		TB				DESC.

REDUCED CROSS SECTION NOTES

Project Title: ______

Engineer's Project No. ______

Survey Date: ______

STATION/ LOCATION																					
15+42	3897^{4}	95^{9}	95^{4}	95^{3}	92^{9}	92^{5}	92^{4}	92^{9}	95^{3}	94^{9}	96^{9}	3897^{1}									EL.
SEC 4	0^{0}	30^{5}	86^{1}	131^{0}	134^{1}	143^{2}	159^{5}	171^{7}	184^{4}	268^{4}	267^{0}	342^{9}									DIST.
				TB					TB												DESC.
																					EL.
																					DIST.
																					DESC.
12+55	3895^{4}	95^{4}	90^{1}	90^{1}	95^{4}	95^{4}															EL.
	0^{0}	90^{0}	98^{0}	128^{0}	136^{0}	190^{0}															DIST.
U/S AT Bridge - Hwy 93		TB			TB																DESC.
																					EL.
																					DIST.
																					DESC.
11+00	3893^{8}	93^{0}	89^{4}	89^{4}	89^{4}	92^{8}	92^{1}	3893^{5}													EL.
	0^{0}	156	167^{0}	172^{95}	191	196	269^{2}	291^{6}													DIST.
D/S AT BRIDGE																					DESC.
																					EL.
																					DIST.
																					DESC.

REDUCED CROSS SECTION NOTES

Project Title: ____________

Engineer's Project No. ____________

Survey Date: ____________

STATION/ LOCATION													
4+75 SEC 5	3893^{0}	93^{0}	92^{5}	87^{8}	86^{6}	87^{2}	91^{3}	92^{4}	92^{6}	94^{9}	93^{2}		EL.
	0^{0}	150^{0}	161^{1}	167^{6}	172^{95}	184^{5}	191^{7}	269^{2}	291^{6}	404^{1}	518^{0}		DIST.
											℄ WATER ST.		DESC.
1+81.7 U/S WATER STREET BRIDGES	3890^{5}	90^{2}	89^{5}	84^{4}	84^{4}	84^{4}	89	89	89	90^{6}	92^{6}		EL.
	0	50	89	96^{6}	100^{4}	115^{5}	122^{4}	206^{3}	242^{7}	285^{1}	327		DIST.
													DESC.
1+14 D/S WATER STREET BRIDGES	3890^{5}	90	89^{5}	84^{4}	84^{4}	84^{4}	89^{2}	89^{1}	89^{0}	90^{6}	92^{6}	94^{6}	EL.
	0	50	89	96^{6}	100^{4}	115^{5}	122^{4}	206^{3}	242^{7}	285^{1}	327	367	DIST.
													DESC.
													EL.
													DIST.
													DESC.
0+00 SEC 6	3890^{5}	90^{2}	88^{89}	85^{0}	83^{1}	85^{2}	89^{8}	88^{6}	90^{6}	92^{6}			EL.
	0	50	89^{0}	95^{3}	100^{4}	113	206^{3}	242^{7}	285^{1}	327^{0}			DIST.
													DESC.
													EL.
													DIST.
													DESC.

SPILLWAY WITH 2' RISE

Consider Breach Flows for Reservoir Elevation of 6286.3, Approx. Capacity of Reservoir = 1134 Acre-Ft.

Breach Flow @ Dam = 10049 cfs
Breach Flow @ Darby (Reach 8) = 6326 cfs
} From DNRC Model by L. Siroky

Time to Empty Reservoir

$$t_1 = \frac{1134 \text{ Acre-Ft} \times 43560 \text{ ft}^2/\text{acre}}{10049 \text{ ft}^3/\text{sec}}$$

$$t_1 = 4915.6 \text{ sec} \Rightarrow 82 \text{ min}$$

Because the Highway Bridge over Tin Cup Creek is not located directly in the path of the breach flow as it exits the confining valley just above Darby we assume that the highway bridge will remain in place and will be the controlling element in determining the inundation area U/S of Highway 93. From HEC-RAS Modelling the hydraulic capacity of the bridge is estimated to be 3500 cfs when depth of flow is restricted to just below the bridge finish grade elevation, i.e. structure and highway are not overtopped. To determine the inundation boundary U/S of the bridge we assume what does not pass thru the bridge must be stored in the flood plain above the structure

$$Q_{STORE} = 6326 \text{ cfs} - 3500 \text{ cfs}$$
$$= 2826 \text{ cfs}$$

$$Vol_{STORE} = 2826 \text{ cfs} \times 82 \text{ min} \times \frac{60 \text{ sec}}{1 \text{ min}}$$

$$Vol_{STORE} = 13{,}903{,}920 \text{ cf} \Rightarrow 319.2 \text{ acre-ft}$$

Job Title: Tin Cup Dam By Date Job No.

Subject: Inundation Study Checked Sheet of

V_{STORE} = 319.2 ACRE - FT

BASED ON CROSS SECTION DATA and FIELD REVIEW, INITIALLY ASSUME AN AVERAGE DEPTH OF 3'

$$A_{STORE} = \frac{319.2 \text{ Acre-Ft}}{3} = 106.4 \text{ Acres}$$

ESTIMATE ACTUAL SURFACE AREA WITHIN INUNDATION AREA TO BE APPROX 85 ACRES

$$d_{REQ'D} = \frac{319.2 \text{ Acre-Ft}}{85 \text{ Acre}} = 3.76$$

SPILLWAY WITHOUT 2' RISE (NORMAL FULL POOL)

CHECK FOR SMALLER FLOW WITH RESERVOIR ELEVATION OF 6284.3

TIME TO EMPTY RESERVOIR

$$t = \frac{940 \text{ ACRE-FT} \times 43560 \text{ ft}^2/\text{acre}}{7353 \text{ cfs}}$$

t = 5568.7 SEC ⇒ 93 min

Q_{STORE} = 5255 CFS − 3500 CFS
= 1755 CFS

V_{STORE} = 1755 CFS × 93 min × 60 SEC/min
= 9,792,900 cf
OR 224.8 acre-Ft.

(Approx 70% OF $V_{6286.3}$)