

APPENDIX D
Testimony of Robert C. Wagner, P.E.

Comparative Analysis of Bloods Creek Watershed Runoff Potential
Prepared July 11, 2008
by
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Precipitation data measured at the Calaveras Big Trees station was assumed to be indicative of the pattern of expected precipitation in the Bear Valley area because a long term record for the Bear Valley area was not available to us at the time the hydrologic analysis for the hearing was prepared. Calaveras Big Trees precipitation station has a long period of record (water years 1948 through 2008) and, due to its lower elevation (about 4,700 feet), is assumed to be a conservative estimate of precipitation in the Bear Valley area (about 7,200 feet). Subsequent to our submittal of testimony we obtained snowfall data at Bear Valley was obtained from Mr. Jim Gentling of the Bear Valley Ski Resort. The snowfall data was compared to precipitation, snow depth and snowpack water content measurements taken at the USBR's Bloods Creek station. Our analysis of the additional data supports our previous estimates of runoff potential, and thus discharges estimates, of Bear Creek and Blood's Creek.

The snowfall was measured by the Bear Valley Ski Resort from water year 1969 through present. Snow depth and snowpack water content measured by USBR at the Bloods Creek station is available water years 1979 through present. The precipitation measurements recorded by USBR at the Bloods Creek station span a relatively short period of record (water years 1989 through present). Due to the shorter period of record at the Bloods Creek precipitation station, the rainfall and snowfall was analyzed from 1989 through present.

As shown on Table 1, the average annual rainfall measured at Calaveras Big Trees is 54 inches from 1989 through present. For the same period, the average reported rainfall at Bloods Creek (Table 2) is slightly less at about 50 inches, which appears to be an anomaly due to the large difference in elevation. We would normally expect precipitation in a watershed to increase with elevation. The precipitation measured at the Bloods Creek station may or may not include snowfall. Table 3 shows the total snowfall from October through May measured by Bear Valley Ski Resort. The average annual snowfall measured at the resort is about 377 inches.

Table 4 shows the reported snow depth measured at the Bloods Creek station. The corresponding snowpack water content is shown on Table 5. In an average year the water content of the snowpack accumulates from 20.2 inches to a maximum in February of 31.8 inches in April and then decreases to 20.8 in May and disappears by June. Accordingly,

a maximum accumulated snowpack water content of about 32 inches will run off in an average year.

Potential average annual runoff at Bloods Creek can be estimated using the Rational Method $Q = CIA$, where Q is the average runoff flow, C is the soil runoff coefficient calculated as described in the CALTRANS Highway Design Manual, I is the average rainfall and snowfall, and A is the drainage area upstream of Bloods Creek at the confluence with Bear Creek.

C = Runoff Coefficient

Relief (Extreme, slopes above 30%)	0.35
Soil Infiltration (Extreme, mostly rock outcropping)	0.16
Vegetal Cover (High, poor to fair cover)	0.10
Surface Storage (Extreme no flood plain storage)	<u>0.11</u>
	0.72

I = 50 inches rainfall (assuming this total includes snowfall)

A = Bloods Creek watershed above Bear Creek = 2,001 acres

$Q = CIA = 0.72 \times (50 \text{ in} / 12 \text{ in/ft}) \times 2,001 \text{ acres} = 6,003 \text{ acre-feet}$

Alternatively, if the reported precipitation at Bloods Creek does not include snowfall:

$I = 50 \text{ inches rainfall} + 32 \text{ inches snowpack melt} = 82 \text{ inches}$

$Q = 0.72 \times (82 \text{ in} / 12 \text{ in/ft}) \times 2,001 \text{ acres} = 9,845 \text{ acre-feet}$

The runoff of Bloods Creek above Bear Creek based on a correlation with the Merced River was estimated to be about 6,600 acre-feet for the season of October through July and about 6,800 acre-feet annually. The Merced River station used in the correlation has a period of record from water years 1917 through 2007. The estimate of Bloods Creek flow based on the Merced River is reasonably close to the estimate of flow based on the analysis above. Thus we conclude that the estimate of flow in Bloods Creek, and therefore Bear Creek, is reasonable. The table below summarizes the estimates of runoff potential:

Method	Potential Annual Runoff (acre-feet)
Correlation with Merced River	6,800
Rational Method Using Bloods Ck Precipitation	6,003
Rational Method Using Bloods Ck Precipitation Assuming Snowfall is Not Included in Reported Values	9,845

TABLE 1
Lake Alpine Water Company
Calaveras Big Trees, CA

Water Year 1989 Through 2008 Monthly Total Precipitation (inches)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc.,

z = 26 or more days missing, A = Accumulations present

Long-term means based on columns; thus, the monthly row may not

sum (or average) to the long-term annual value.

MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5

Individual Months not used for annual or monthly statistics if more than 5 days are missing.

Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Seasonal Total	Annual Total
1989	0.04	8.48	7.51	2.29	3.99	14.34	1.94	1.06	0	0	0.1	4.58	39.65	44.33
1990	9.15	4.19	0	6.14	5.6	4.41	2.37	5.7	0	0.19	0.2	0.31	37.75	38.26
1991	0.7	1.91	1.59	0.65	2.45	19.25	2.02	2.97	1.58	0	0.05	0.46	33.12	33.63
1992	6.09	2.63	2.9	2.11	10.76	6.3	0.66	0.17	1.68	2.47	0.03	0.06	35.77	35.86
1993	5.7	0.64	18.46	20.96	13.3	7.59	2.54	1.88	3.51	0	0	0	74.58	74.58
1994	2.2	2.92	3.34	4.04	10.71	0.87	5.36	1.81	0	0	0	0.71	31.25	31.96
1995	1.98	11.37	6.25	25.07	1.7	25.31	10.01	8.45	1.99	0	0	0	92.13	92.13
1996	0	0.43	11.89	15.24 b	15.37	6.97	5.28	4.94	1.18	0	0.01	0.3	61.3	61.61
1997	2.93	8.05	23.56 a	28.09	1.13	0.55	1.27	0.8	2.21	0.25	0.01	0.27	68.84	69.12
1998	2.31	7.56	5.42	18.99	22.14	7.6	6.97	7.22	1.16	0	0	2.1	79.37	81.47
1999	0.64	7.01	5.49	13.65	17.35 a	5.25	4.86	1.73	0.98	0	0.09	0.06	56.96	57.11
2000	1.9	4.24	0.98	20.9	19.44	3.74	3.31	5.02	0.85	0	0.04	1.94	60.38	62.36
2001	5.12	1.95	2.06	7.25	9.24	3.96 b	7.47	0	0.15	0.1	0	0.72	37.3	38.02
2002	1.37	9.65	14.02	3.6	4.43	8.7	2.76	2.78	0	0	0	0	47.31	47.31
2003	0	6.96	14.72	1.71	4.34	4.45	12.79	0 z	0	0	1.32	0	-	-
2004	0.04	4.46	17.25 a	3.97 a	10.57 a	1.95	0.58 a	0.59	0	0	0	0	39.41	39.41
2005	9.22	3.2	12.42	14.53	7.52	11.48	3.52	5.89	1.85 a	0	0	1.42 f	69.63	-
2006	1.34	4.17	21.67	11.36	6.38 a	16.04 a	12.71 a	2.55	0	0	0	0	76.22	76.22
2007	1.71	4.41	6.85	2.2	15.39	0.39	3.38	1.88	0.34	0	0	0.31	36.55	36.86
2008	2.2 b	1.42	0 z										-	-
Average	2.7	4.8	9.3	10.7	9.6	7.9	4.7	3.1	0.9	0.2	0.1	0.7	54.31	54.13
No. Years	20	20	19	19	19	19	19	18	19	19	19	18	18	17

Source: Western Regional Climate Center (<http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca1277>), accessed 6/19/2008.

TABLE 2
Lake Alpine Water Company
Bloods Creek Precipitation
USBR Weather Station

Source: DWR CDEC Website <http://cdec.water.ca.gov/> accessed July 2008

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1989					4.52	66.37	1.41	0.78	1.18	0	0	0.67	74.93
1990	4.13	2.68	0	0.75	3.89	4.29	0.47	3.6	0	0	0	3.38	23.19
1991	7.92	3.5	2.4	0.44	0.94	23.11	2.24	2.52	0.43	0.08	2.44	3.61	49.63
1992	5.63	2.99	2.52	2.21	8.74	2.52	0.87	0.51	1.66	2.83	1.03	0.04	31.55
1993	0.04	0	14.14	1.77	6.89	49.53	10.27	3.43	4.47	0.16	2.94	0	93.64
1994	2.68	3.8	8.24	0	17.38	4.87	4.66	2.16	0.08	0	5.6	7.33	56.8
1995	2.59	3.7	0.91	19.42	0	0	0.01	0	0	0	0	0	26.63
1996	0	0.62	10.48	0		1.29	4.54	5.91	9.73	1.49	0.09	1.09	35.24
1997	2.28	0.76			0	0.47	1.17	0	0	0	0	7.02	11.7
1998	0.81	0	6.18	6.45	15.6	7.04	0.15	0	0	0	0	1.29	37.52
1999	1.09	9.77	3.6	13.29	14.23	4.35	4.5	1.69	0	0.52	1.14	0.29	54.47
2000	1.76	3.89	0.67	8.05	9.6	0.35	4.37	3.73	1.29	0.08	0.24	2.15	36.18
2001	3.97	2.93	2.59	6.3	9.37	3.86	7.68	0.9	0.08	0.62	0.61	1.09	40
2002	1.43	9.54	14.65	4	4.09	7.93	3.63	2.31	0	0	0.08	0.35	48.01
2003	0	8.82	15.92	2	3.34	4.31	13.4	4.06	0.01	1.02	1.61	0.12	54.61
2004	0.43	4.15	17.29	5.16	11.19	1.75	1.82	1	0.14	0.34	0	0.48	43.75
2005	9.98	3.25	10.53	10.71	8.06	11.38	3.72	7.13	1.92	0.14	0.15	0.86	67.83
2006	1.81	4.95	23.5	10.41	8	15.71	16.56	1.76	0.15	0.71	0	0.67	84.23
2007	0.6	6.1	6.77	2.08	14.84	4.26	3.38	1.54	1.34	0.83	0.58	0.78	43.1
2008	1.54	1.16	7.69	14.33	9.31	1.38	0.8	2.52	0.15	0			38.88
Average	2.56	3.82	8.23	5.97	7.89	10.74	4.28	2.28	1.13	0.44	0.87	1.64	49.85

TABLE 3
Lake Alpine Water Company
Bear Valley Midway Snowfall, Snow Survey (in inches)
Source: Jim Gentling, Bear Valley Ski Resort Manager

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
1989	0	70	77	30	67	87	18	0	349
1990	30	46	0	57	84	38	0	0	255
1991	0	0	42	5	17	217	16	0	297
1992	0	17	51	22	103	42	0	0	235
1993	0	5	136	131	103	42	0	0	417
1994	0	25	37	36	114	10	20	0	242
1995	18	86	72	190	12	179	63	24	644
1996	0	2	24	99	111	61	30	0	327
1997	21	25	156	133	13	6	6	0	360
1998	10	43	48	119	214	61	78	0	573
1999	6	48	57	78	124	51	67	12	443
2000	0	26	7	114	139	39	25	0	350
2001	18	32	17	69	111	33	80	0	360
2002	0	50	109	31	24	73	32	19	338
2003	0	21	150	10	28	26	125	33	393
2004	4	30	122	55	92	17	7	0	327
2005	54	24	92	118	75	89	36	25	513
2006	4	14	78	105	25	165	111	2	504
2007	3	14	48	16	136	22	33	11	283
2008	8	3	54	140	79	10			294
Average	8.80	29.05	68.85	77.90	83.55	63.40	39.32	6.63	377

TABLE 4
Lake Alpine Water Company
Bloods Creek Snow Depth
USBR Weather Station

Source: DWR CDEC Website <http://cdec.water.ca.gov/> accessed July 2008

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1989					54	51.9	59.5	21.7					187.1
1990				--	30.3	51.5	38.3	0	--	--			120.1
1991				--	14.7	39.5	87.7	36.6	--	--			178.5
1992				--	28.5	49.9	43.5	0	--	--			121.9
1993				--	100.7	153.7	117.2	72.1	--	--			443.7
1994				--	40.1	83	37	15.8	--	--			175.9
1995				--	106.2	87	147.3	112.8	--	--			453.3
1996				--	84	89.8	72.2	42.2	--	--			288.2
1997				--	116.4	98.2	71.5	23.2	--	--			309.3
1998				--	76.5	143.8	111	87.2	--	--			418.5
1999	--	--	--	--	70.2	115.6	96.1	77.6	--	--	--	--	359.5
2000	--	--	--	--	64.5	94.5	74.2	33	--	--	--	--	266.2
2001				--	47.6	79.4	43.2	27	--				197.2
2002				--	68	65.8	88.7	35.7	--				258.2
2003				--	51.1	53.9	49.5	64.9	--				219.4
2004				--	67.9	107	59	4.5	--				238.4
2005				--	99	107	119.5	93.5	--				419
2006				--	69	63	101.9	107	--				340.9
2007				--	28.3	83.8	39.9	18.5	--				170.5
2008				--	85	104.8	67.2	21.4	--				278.4
Average					65.10	86.16	76.22	44.74					272.21

TABLE 5
Lake Alpine Water Company
Bloods Creek Snow Water Content
USBR Weather Station

Source: DWR CDEC Website <http://cdec.water.ca.gov/> accessed July 2008

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1989					17.5	20.8	27.1	6.4					71.8
1990				--	8.8	16.5	15.8	0	--	--			41.1
1991				--	4.2	6.8	21	15.9	--	--			47.9
1992				--	9.2	17.9	17.6	0	--	--			44.7
1993				--	38.3	34.9	57.3	39.4	--	--			169.9
1994				--	10.3	20.8	15.9	5	--	--			52
1995				--	39.6	39.4	58.1	57.7	--	--			194.8
1996				--	22.7	27.9	34.6	21.9	--	--			107.1
1997				--	38.9	39.4	32	11	--	--			121.3
1998				--	24	48.9	48.2	45	--	--			166.1
1999	--	--	--	--	10.2	40.9	44.2	37.1	--	--	--	--	132.4
2000	--	--	--	--	15.5	28.7	32.9	12.7	--	--	--	--	89.8
2001				--	12	15.7	17.8	12.3	--	--			57.8
2002				--	23	26.2	33.2	15	--	--			97.4
2003				--	18.1	22.1	22.7	25.7	--	--			88.6
2004				--	22.8	31	26	2.4	--	--			82.2
2005				--	34	41	50	43.7	--	--			168.7
2006				--	21	22	37.9	46.7	--	--			127.6
2007				--	8.7	22	15.1	7.5	--	--			53.3
2008				--	25.1	34	29.4	10.9	--	--			99.4
Average					20.20	27.85	31.84	20.82					100.695