Appendix D-2

Forest Service Instream Flow Upstream Flow Analysis

May 2003

Forest Service Instream Flow Upstream Flow Analysis

The hydrologic analysis provided by PG&E to Gallo et al for the economic analysis assessed flow losses to upstream users by determining an average value of lost flow due to increased instream flow and assumed that same amount of flow would be lost every year. The analysis assumed there were on average 39 days available every year for diversion under the existing instream flow requirement. It further assumed that the Forest Service increased instream flow requirement would reduce the number of days available for diversion to only 27 or a loss of 12 days per year. This was translated into a 43,000 ac-ft loss per year in agricultural water. PG&E's hydrologic analysis assumed that irrigation diversions could occur only when Lake Britton spilled implying that flows to the Pit 3 powerhouse intake in Lake Britton exceeded 3300 cfs. PG&E used the flow data from the USGS gage below the Pit 1 powerhouse outflow as a surrogate for the Pit 3 powerhouse inflow and assumed that if the flow at the Pit 1 gage exceeded 3000 cfs, than Lake Britton would spill.

Due to the wide range of flows possible in any given year and since PG&E provided a synthetic 30 year average daily flow data set for inflows to the Pit 3 powerhouse as part of the relicensing package, the FS conducted an analysis to determine the accuracy of the hydrologic data provided for the economic analysis.

The FS analysis focused on the **difference** in the number of days that upstream diversion could occur. The analysis first determined how many days the flow in the synthetic record for Pit 3 exceeded 3300 cfs in Water Years 1970 through 1987 and exceed 3450 cfs in Water Years 1988 through 1999. (reflecting the increased instream flow of 150 cfs imposed by FERC in 1988). Then the data were reexamined to determine how many days the flow in the synthetic record for Pit 3 exceeded 3700 cfs, reflecting an increase in instream flow to 400 cfs. The set of tables below provide this information by water year. It was assumed that the diversion season lasted from November 15th to April 30th.

Table Set 1. Number of days that Pit 3 flow exceeds 3300 or 3450 cfs; the number of days the Pit 3 flow exceeds 3700 cfs; and the difference between the two values.

Water Year	***70***	***71***	***72***	***73***	***74***	***75***	***76***	***77***	***78***
#days flow > 3300 cfs	86	111	87	24	122	75	7	0	81
#days flow > 3700 cfs	77	84	46	14	99	66	4	0	66
Difference in days	**9**	**27**	**39**	**10**	**23**	**9**	**3**	**0**	**15**

Water Year	***79***	***80***	***81***	***82***	***83***	***84***	***85***	***86***	***87***
#days flow > 3300 cfs	21	100	9	134	122	147	77	103	16
#days flow > 3700 cfs	15	67	4	114	107	117	19	81	11
Difference in days	**6**	**33**	**5**	**20**	**15**	**30**	**58**	**22**	**5**

Water Year	***88***	***89***	***90***	***91***	***92***	***93***	***94***	***95***	***96***	***97***	***98***	***99***
#days flow > 3450	0	52	3	4	0	71	0	106	97	110	110	125
#days flow > 3700	0	48	3	3	0	66	0	100	92	88	109	118
Difference in days	**0**	**4**	**0**	**1**	**0**	**5**	**0**	**6**	**5**	**22**	**1**	**7**

A summary of this data shows that in four out of 30 years (1977, 1988, 1992 and 1994), the flow into the Pit 3 powerhouse never exceeded 3300 cfs during the diversion season; hence no diversion days were available. In four other years (1976, 1981, 1990, and 1991) Pit 3 flow was greater than 3300 cfs for fewer than 10 days. Thus in 8 out of 30 years or about 25% of the time, flows to the Pit 3 powerhouse were never high enough to allow upstream diversion. In three other years (1973, 1979, and 1987), Pit 3 powerhouse flows were greater than 3300 cfs for fewer than 25 days. In these three years, the increased instream flow requirement resulted in an average reduction of 7 days of diversion. These 11 years are representative of dry to below normal precipitation years and represent about 35 percent of the record analyzed. In these eleven years, an increased instream flow requirement in the Pit 3 reach below Lake Britton would primarily affect PG&E operations, rather than irrigators since few days are available for diversion.

Of the remaining 19 years analyzed, there were 12 years when the flow to the Pit 3 powerhouse exceeded 3300 cfs for more than 100 days and 7 years when the flow exceeded 3300 cfs for at least 70 days. In eight of these 19 years, the increased instream flow requirement resulted in a reduction of 9 or fewer days of diversion. Thus in 19 out of 30 years (65 percent of years) there were either no or few diversion days available (11 years) or the loss in the number of diversion days due to the increased instream flow requirement was small (8 years). This is contrasted to PG&E's assumption that there would be 39 days available for diversion every year and that the increased flow requirement would result in a loss of 12 days of diversion every year.

Another way to look at the loss of diversion is to use the flow at the Canby gage in the upper watershed as a surrogate to estimate the amount of water available in the upper watershed for diversion. On days when the average daily flow to the Pit 3 powerhouse exceeded 3300 cfs (3450 cfs in WY 1988 and beyond), the flow for that day at the Canby gage is assumed to be available for storage. Thus referring to the previous set of Tables, in water year 1979, the 21 days that the flow exceeded 3300 cfs at the Pit 3 powerhouse were assumed to be days that water passing by the Canby gage was available for storage. The amount of water available for storage was assumed to be the total volume of water recorded at the Canby gage (average daily cfs converted to acre-feet per day) on those days. The following set of tables shows that the volume of water available at the Canby gage over those 21 days in 1979 was 31,260 acre-feet. To determine the loss of the volume of water due to increased instream flow requirements, the same technique was applied. Thus in 1979, there were 15 days when the flow exceeded 3700 cfs and that correlated to a volume of 27,172 acre-feet of water available at the Canby gage. Thus there was a loss of 4,088 acre-feet of water available for diversion in 1979.

The PG&E hydrologic analysis states that approximately 145,000 acre-feet of storage is located in the upper watershed, more than half above Canby. Thus the flow that reaches the Canby gage may reflect net water available since irrigators upstream and "up-watershed" have already diverted the flow for their use. However in this example, once again the idea is to look at how much water would be "lost" to diverters if instream flows were increased.

The following tables illustrate the potential loss of water to diversion when flow requirements at the Pit 3 powerhouse are increased from 3300 to 3700 cfs. The tables are arranged in groups by the total volume of water lost for the diversion season due to the increased instream flow

requirement presented as acre-feet. Recall the PG&E analysis assumed that there would 43,000 acre-feet of water lost every year due to the increased instream flow requirement.

Table Set 2: Volumes of water (ac-ft per diversion season) passing the Canby gage when inflow to the Pit 3 powerhouse is greater than 3300 (3450) cfs; 3700 cfs; and the difference due to the increased instream flow requirement:

***a.* Loss less than 5000 ac-ft per season:**

Water Year	***76***	***77***	***79***	***81***	***87***	***88***	***89***	***90***
Canby flow volume (ac-ft) when Pit3 >3300 cfs	3,370	0	31,260	11,816	10,348	0	100,651	3,132
Canby flow volume (ac-ft) whenPit3 >=3700 cfs	2,017	0	27,172	8,305	8,255	0	96,966	3,132
Difference From 3300 (3450) to 3700 (ac-ft)	**1,353**	**0**	**4,088**	**3,511**	**2,093**	**0**	**3,685**	**0**

***a cont'd.* Loss less than 5000 ac-ft per season:**

Water Year	***91***	***92***	***93***	***94***	***95***	***96***	***98***	***99***
Canby flow volume (ac-ft) when Pit3 >3300 cfs	6,766	0	147,120	0	189,951	210,885	112,713	190,530
Canby flow volume (ac-ft) whenPit3 >=3700 cfs	6,766	0	144,173	0	186,307	206,313	112,193	186,036
Difference From 3300 (3450 to 3700 (ac-ft)	**0**	**0**	**2,947**	**0**	**3,644**	**4,572**	**520**	**4,495**

***b.* Loss between 5000 ac-ft and 7,600 ac- ft per season:**

Water Year	***70***	***73***	***75***	***78***	***82***	***83***
Canby flow volume (ac-ft) when Pit3 >3300 cfs	176,757	22,764	106,447	63,064	237,302	143,490
Canby flow volume (ac-ft) whenPit3 >=3700 cfs	171,523	15,164	100,742	57,562	229,912	137,145
Difference From 3300 (3450) to 3700 (ac-ft)	**5,234**	**7,601**	**5,704**	**5,502**	**7,390**	**6,345**
Percent loss	**3%**	**33%**	**5%**	**9%**	**3%**	**4%**

***c.* Loss greater than 10000 ac-ft per season:**

Water Year	***71***	***72***	***74***	***80***	***84***	***85***	***86***	***97***
Canby flow volume (ac-ft) when Pit3 >3300 cfs	250,088	190,191	168,789	150,008	220,447	60,625	273,408	194,083
Canby flow volume (ac-ft) whenPit3 >=3700 cfs	230,983	147,213	158,128	126,770	200,372	20,918	257,100	176,912
Difference From 3300 (3450) to 3700 (ac-ft)	**19,105**	**42,978**	**10,661**	**23,238**	**20,075**	**39,707**	**16,308**	**17,171**
Percent loss	**8%**	**23%**	**6%**	**15%**	**9%**	**65%**	**6%**	**9%**

The above set of Tables illustrate that in 16 out of 30 years (data in Tables 2.a.) the loss of water available for diversion when the flow requirement was increased to 3700 cfs was less than 5,000 acre-feet per season. These 16 years include the 11 years noted above in the Table 1 discussion when very few days were available for diversion. In another 6 years the volume lost was between 5,000 and 7,600 acre-feet per season and in the remaining eight years the loss was greater than 10,000 ac-ft per season. However, in theose14 years when the loss exceeded 5,000 acre-feet per season (Tables 2.b and 2.c), there were eight years when the volume of water available for diversion exceeded 140,000 acre-feet even when the downstream flow requirement for the inflow to the Pit 3 powerhouse was increased to 3700 cfs.

The PG&E analysis assumed that there would be at least 43,000 acre-feet of water not available for diversion every year if instream flow requirement were increased. This example shows that the loss is often less than 5,000 acre-feet and in years with more than a 5,000 ac-ft loss, only three years out of thirty had greater than a 20 percent loss in volume.

In summary, the above analysis illustrates that the hydrologic assumptions provided by PG&E for the economic analysis overstated the amount of water that would be unavailable for diversion if instream flows were increased as proposed in the Forest Service's 4(e) conditions. A loss of 43,000 acre-feet per season would be expected to rarely occur. The PG&E analysis also failed to account for the 35 percent of years when diversion may not be available or extremely limited based on the assertion that diversion may only occur when inflow to the Pit 3 powerhouse exceeds 3300 cfs.

As a side note, the FS analysis also looked at the correlation of the Pit 3 synthetic record to the Pit 1 gage data used by PG&E. PG&E assumed that a Pit 1 gage flow of 3000 cfs was comparable to the inflow to the Pit 3 powerhouse equaling 3300 cfs. A review of the Pit 3 synthetic data and the Pit 1 gage data suggests that the Pit 1 gage value that is equivalent to a flow rate of 3300 cfs at the Pit 3 powerhouse is closer to 2200 cfs. Thus by using 3000 cfs for the Pit 1 gage, the PG&E analysis underestimated the number of days available for diversion.