

**Attachment 5**

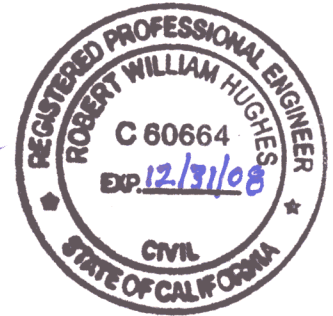
**Fish Screen and Ladder Cost Memo**

See appended: May 2, 2007, Robert W. Hughes, P.E.  
Memorandum in reference to  
“Review of PG&E’s Fish Screen and Fish Ladder Cost Estimates Supplemental Initial Study  
Report, January 16, 2007”

## M E M O R A N D U M

To: MaryLisa Lynch  
Senior Environmental Scientist  
North Central Region

From: Robert W. Hughes, P.E.  
Associate Hydraulic Engineer  
Fisheries Engineering Team



Date: May 2, 2007

Re: DeSabra-Centerville Project  
Review of PG&E's Fish Screen and Fish Ladder Cost Estimates  
Supplemental Initial Study Report, January 16, 2007

I have reviewed the fishway cost estimates presented by Pacific Gas and Electric Company (PG&E) in their Supplemental Initial Study Report (SISR), dated January 16, 2007. PG&E states that they based their *fish screen* cost estimates on the Philadelphia South Fork Stanislaus fish screens (at \$20,000 per cfs) and the Potter Valley fish screens (at \$50,000 per cfs). No information was included to support the dollar per cfs factors identified by PG&E. PG&E then separated the cost factors into three ranges: low-cost at \$20,000 to \$35,000 per cfs; medium cost at \$35,000 to \$50,000 per cfs; and high-cost at \$50,000 to \$70,000 per cfs. Again, no detail was provided to further support these cost range estimates.

PG&E's *fish ladder* cost estimates assume the use of multiple Denil or Alaska steep-pass fish ladders with intermediate resting pools. Cost factors were again separated into several ranges for the ladders and for the resting pools as follows:

Table 1. PG&E Fish Ladder Cost Basis

	Denil Fish Ladders	Resting Pools
Low Level	\$10,000/ft to \$20,000/ft	\$100,000/pool to \$300,000/pool
Medium Level	\$20,000/ft to \$30,000/ft	\$200,000/pool to \$400,000/pool
High Level	\$30,000/ft to \$50,000/ft	\$300,000/pool to \$450,000/pool
Special High Level I (Round Valley Dam only)	n/a	\$500,000/pool to \$800,000/pool
Special High Level II (Philbrook Dam only)	n/a	\$500,000/pool to \$1,000,000/pool

PG&E's cost estimates appear to be high – perhaps by an order of magnitude. For comparison purposes, I have prepared estimates of the range of costs for fish ladders and

fish screens at each of the facilities using the same approach that I used to evaluate fishway costs on PacifiCorp's Klamath River project. With regard to fish ladder cost estimates, I do not have ready access to data on the cost of Denil fish ladders or the cost of resting pools. Therefore, I compared PG&E's fish ladder cost estimates to the costs for standard concrete pool and weir fish ladders<sup>1</sup>.

When developing the cost estimates for fish ladders, I relied upon the cost guidelines presented by Charles H. Clay in "Design of Fishways and Other Fish Facilities, Second Edition." In this reference, the author suggests basing the cost of fish ladders on the volume of the structure. Clay suggests an approximate cost of between \$20 per cubic foot and \$40 per cubic foot (1987 dollars). Using typical fishway dimensions suggested by Milo Bell in "The Fisheries Handbook of Engineering Requirements and Biological Criteria," I estimated the fishway volume for a given fishway height. The volume was then multiplied by the cost range presented by Clay to estimate the fishway costs in 1987 dollars. I then researched the average annual change in the Consumer Price Index between 1987 and 2007 (3.1%) and used this value to convert the 1987 cost estimates to 2007 dollars.

When developing the cost estimates for fish screens, I relied upon information compiled by the Washington Department of Fish and Wildlife (WDFW) regarding the range of costs per cfs for screens constructed in the Pacific Northwest. The average costs range from \$9,216 per cfs for screens less than 10 cfs to \$4,537 per cfs for screens greater than 1,000 cfs (1999 dollars). The required screen size was determined by dividing the diversion rate by the allowable approach velocity<sup>2</sup>. The range of screening costs was estimated by multiplying the diversion rate by the applicable WDFW cost range in 1999 dollars. For consistency, I converted the 1999 estimates to 2007 dollars using the same average annual change in the Consumer Price Index (3.1%).

The following tables compare my cost estimates to those prepared by PG&E,

Table 2. Comparison of Fish Ladder Cost Estimates – DeSabra-Centerville Project

Fish Ladder Cost Estimates	<b>Butte Ck Dam</b>	<b>Hendricks Dam</b>	<b>Lower Centerville Dam</b>	<b>Round Valley Dam</b>	<b>Phillbrook Dam</b>
DFG Cost Range	\$702,000 to \$1,405,000	\$144,000 to \$287,000	\$192,000 to \$383,000	\$511,000 to \$1,022,000	\$1,389,000 to \$2,778,000
PG&E Cost Range	\$4,200,000 to \$6,400,000	\$900,000 to \$2,400,000	\$2,800,000 to \$5,600,000	\$1,400,000 to \$2,300,000	\$1,900,000 to \$13,000,000

<sup>1</sup> To allow more of an apples-to-apples comparison with PG&E's estimate, the cost of auxiliary water supply systems was not factored into my cost estimates. Depending on the fish ladder design selected, an auxiliary water supply system may need to be included as an element of the design.

<sup>2</sup> In the SISR, PG&E suggested that fish screens at the Inskip, Kelsey, Cunningham, and Little West Fork diversions would not be self-cleaning. Therefore, as specified in the Department's Fish Screening Criteria (June 2000), the fish screen size is assumed to be four times that of a self-cleaning fish screen.

Table 3. Comparison of Self-Cleaning Fish Screen Costs – DeSabra Centerville Project

Fish Screen Cost Estimates	<b>Butte Ck Dam</b>	<b>Clear Ck Diversion</b>	<b>Hendricks Dam</b>	<b>Long Ravine Diversion</b>	<b>Lower Centerville Dam</b>
DFG Cost Range	\$454,000 to \$1,135,000	\$192,000 to \$849,000	\$376,000 to \$1,117,000	\$391,000 to \$1,162,000	\$550,000 to \$1,635,000
PG&E Cost Range	\$4,500,000 to \$6,200,000	\$1,000,000 to \$1,400,000	\$2,400,000 to \$4,200,000	\$6,000,000 to \$8,400,000	\$6,300,000 to \$9,000,000

Table 4. Comparison of Non Self-Cleaning Fish Screen Costs – DeSabra Centerville

Fish Screen Cost Estimates	<b>Inskip Diversion</b>	<b>Kelsey Diversion</b>	<b>Cunningham Diversion</b>	<b>Little West Fork Diversion</b>
DFG Cost Range	\$299,000 to \$748,000	\$37,000 to \$182,000	\$96,000 to \$424,000	\$96,000 to \$424,000
PG&E Cost Range	\$3,000,000 to \$4,200,000	\$400,000 to \$560,000	\$1,000,000 to \$1,400,000	\$1,000,000 to \$1,400,000

As is evident after reviewing these tables, PG&E's cost estimates are consistently higher than my estimates – up to an order of magnitude or more. While I understand that the remoteness and complexity of the sites may contribute to higher than normal construction costs, I believe that a more thorough analysis is needed to better understand the costs of fish screens and fish ladders at project facilities.

I recommend that the collaborative group select a diversion site (e.g. the Hendricks Diversion), and that PG&E convene a small technical group to prepare a more detailed cost analysis for this site. The technical group could visit the site, identify one or more fish screen and fish ladder designs, and then prepare cost estimates for each specific design element. I am available to participate in this process.

Please let me know if there are any questions.

#### Attachments

- Fish Screen Cost Analysis Spreadsheet
- Fish Ladder Cost Analysis Spreadsheet

**Fish Ladder Cost Estimates**

	Butte Ck Dam	Hendricks Dam	Lower Centerville Dam	Round Valley Dam	Philbrook Dam
Elevation Gain (ft)	Step-Pool 44	Step-Pool 9	Step-Pool 12	Step-Pool 32	Step-Pool 87
Number of Pools (ft)	44	9	12	32	87
Pool Length (ft - assumed)	8	8	8	8	8
Width (ft - assumed)	6	6	6	6	6
Depth (ft - assumed)	7	7	7	7	7
Fishway Volume (cu ft)	14,784	3,024	4,032	10,752	29,232
Cost of Basic Structure @ \$20/cu ft	\$295,680	\$60,480	\$80,640	\$215,040	\$584,640
Cost of Misc Items (29%)	\$85,747	\$17,539	\$23,386	\$62,362	\$169,546
Subtotal - Fishway 1987 Dollars	\$381,427	\$78,019	\$104,026	\$277,402	\$754,186
Subtotal - Fishway 2007 Dollars	<b>\$702,401</b>	<b>\$143,673</b>	<b>\$191,564</b>	<b>\$510,837</b>	<b>\$1,388,838</b>
Cost of Basic Structure @ \$40/cu ft	\$591,360	\$120,960	\$161,280	\$430,080	\$1,169,280
Cost of Misc Items (29%)	\$171,494	\$35,078	\$46,771	\$124,723	\$339,091
Subtotal - Fishway 1987 Dollars	\$762,854	\$156,038	\$208,051	\$554,803	\$1,508,371
Subtotal - Fishway 2007 Dollars	<b>\$1,404,801</b>	<b>\$287,346</b>	<b>\$383,128</b>	<b>\$1,021,674</b>	<b>\$2,777,676</b>

Preliminary fish ladder cost estimates based on cost criteria presented by Charles H. Clay in "Design of Fishways and Other Fish Facilities" 2nd Edition.  
 Note: Interest rate of 3.1% assumed based on the change in the Consumer Price Index between 1987 and 2007.

Fish Screen Cost Estimates

	Butte Ck Dam Self Cleaning	Inskip Div. Non Self Cleaning	Kelsey Div. Non Self Cleaning	Clear Ck Div Self Cleaning	Hendricks Head Dam Self Cleaning	Long Ravine Div. Self Cleaning	Cunningham Div. Non Self Cleaning	Little W. Fork Div. Non Self Cleaning	Lower Centerville Dam Self Cleaning
Approach Velocity (fps)	0.33	0.0825	0.0825	0.33	0.33	0.33	0.0825	0.0825	0.33
Hydraulic Capacity (cfs)	91	15 (60)	2 (8)	40	125	130	5 (20)	5 (20)	183
Screen Area (sq ft)	276	182	24	121	379	394	61	61	555
Minimum Cost per CFS (1999 Dollars)	\$3,905	\$3,905	\$3,600	\$3,757	\$2,354	\$2,354	\$3,757	\$3,757	\$2,354
Estimated Screen Cost 1999 Dollars	\$355,355	\$234,300	\$28,800	\$150,280	\$294,250	\$306,020	\$75,140	\$75,140	\$430,782
Estimated Min Screen Cost 2007 Dollars	<b>\$453,661</b>	<b>\$299,117</b>	<b>\$36,767</b>	<b>\$191,854</b>	<b>\$375,652</b>	<b>\$390,678</b>	<b>\$95,927</b>	<b>\$95,927</b>	<b>\$549,955</b>
Avg Cost per CFS (1999 Dollars)	\$5,837	\$5,837	\$9,216	\$9,199	\$4,550	\$4,550	\$9,199	\$9,199	\$4,550
Estimated Screen Cost 1999 Dollars	\$531,167	\$350,220	\$73,728	\$367,960	\$568,750	\$591,500	\$183,980	\$183,980	\$832,650
Estimated Avg Screen Cost 2007 Dollars	<b>\$678,110</b>	<b>\$447,106</b>	<b>\$94,124</b>	<b>\$469,753</b>	<b>\$726,090</b>	<b>\$755,134</b>	<b>\$234,877</b>	<b>\$234,877</b>	<b>\$1,062,996</b>
Maximum Cost per CFS (1999 Dollars)	\$9,766	\$9,766	\$17,790	\$16,617	\$7,000	\$7,000	\$16,617	\$16,617	\$7,000
Estimated Screen Cost 1999 Dollars	\$888,706	\$585,960	\$142,320	\$664,680	\$875,000	\$910,000	\$332,340	\$332,340	\$1,281,000
Estimated Max Screen Cost 2007 Dollars	<b>\$1,134,560</b>	<b>\$748,061</b>	<b>\$181,692</b>	<b>\$848,559</b>	<b>\$1,117,062</b>	<b>\$1,161,745</b>	<b>\$424,279</b>	<b>\$424,279</b>	<b>\$1,635,379</b>

	Min	Avg	Max
WDFW Screen Cost Estimates (1999 Dollars)	\$3,600	\$9,216	\$17,790
One to 10 CFS	\$3,757	\$9,199	\$16,617
Ten to 50 CFS	\$3,905	\$5,837	\$9,766
Fifty to 100 CFS	\$2,354	\$4,550	\$7,000
100 to 1,000 CFS	\$1,966	\$4,537	\$7,046
1,000+ CFS			

Note: For cost estimation purposes, the diversion rate for non-self cleaning fish screens is assumed to be four times higher than the actual diversion rate. The assumed diversion rate is noted in parentheses.

Submission Contents

Joint Agency response to PG&E's DeSabra-Centerville Draft License Application  
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