Appendix D – Upper Drum-Spaulding & Lower Drum Hydraulic Modeling Assessment

PG&E's Upper Drum-Spaulding Hydroelectric Project (FERC No. 2310) and Lower Drum Hydroelectric Project (FERC No. 14531)

Nevada and Placer Counties, California

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Prepared for:

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1 Hydraulic Modeling Assessment

This hydraulic modeling assessment was performed by Megan Lionberger, P.E., on February 7, 2020.

Pacific, Gas and Electric (PG&E) and Nevada Irrigation District (NID) operate hydroelectric projects in the Yuba and Bear River watersheds. These projects share water conveyances and operate together under a coordinated operations agreement. As part of the joint Federal Energy Regulatory Commission (FERC) relicensing process of PG&E's Drum-Spaulding Hydroelectric Project and NID's Yuba-Bear Hydroelectric Project, several modeling tools were developed to assess impacts of proposed changes to operations of the two projects. These same tools were used to support the CEQA analysis for the Proposed Upper Drum-Spaulding Project and Proposed Lower Drum Project (collectively Proposed Projects).

Since its application, PG&E has divided the Drum-Spaulding Project into three projects: Upper-Drum Spaulding, Lower Drum, and Deer Creek. A reservoir operations model was developed using HEC-ResSim with a time step of one day to simulate operations of the combined 40-plus reservoirs used by the projects. Development of the operations model included developing synthetic unimpaired hydrology for water years 1976 through 2008, and water supply demands for water users in the basin. The operations model prioritizes releases for environmental flow requirements, followed by discretionary releases for water supply and hydropower generation. Output generated by the model includes reservoir storage, tributary flows downstream of reservoirs, and water delivery volumes. A water rights post-processor was developed in Microsoft Excel to post-process HEC-ResSim output to quantify water supply availability and to track water delivery deficits to NID and the Placer County Water Agency (PCWA). The modeling period of record, 1976 through 2008, covers a diverse range of hydrologic conditions including extreme drought, moderate extended drought, and large flood events.

The modeling tools were used to simulate the operations of the Proposed Projects under existing FERC license conditions and under proposed license conditions as described in PG&E's Amended Application for New License and FERC's Final Environmental Impact Statement. The following summarizes substantial differences between the two scenarios as they relate to the volume and timing of flows:

- Environmental flow requirements increase under projected license conditions and are expanded to include additional Project-affected reaches.
- Spill cessation is included under proposed license conditions below several dams to minimize short-term, high-flow fluctuations in downstream reaches.

- Reservoir storage is drawn down more under proposed license conditions to meet higher environmental flow requirements while maintaining water supply deliveries. This is offset somewhat in drier water years by the need for a larger environmental flow reserve pool. Table D-1 and Table D-2 compares water levels in Upper-Drum Spaulding Reservoirs between proposed license conditions and existing license conditions.

The onset of spill releases from Proposed Projects' reservoirs tend to be delayed under proposed license conditions because reservoirs are operating at lower storage levels than under existing license conditions when reservoirs are not spilling. Once reservoirs fill, spill releases are the same under both scenarios. No new flooding occurs in downstream reaches relative to existing license conditions. Consequently, channel velocities will not increase, resulting in new or additional channel erosion.

Tables of modeled annual NID and PCWA water delivery deficits based on existing (water year 2001 to 2009 average) water supply demands are presented in Table D-3 and Table D-4. Water deliveries to PCWA reported in these tables were provided exclusively by PG&E. Deficits were limited to water years 1977 and 1978 under existing FERC license conditions. Water year 1977 is the driest year on record, even compared with the recent 2012 to 2015 drought. Deficits in 1978 result from the carryover of dry conditions from water year 1977. Under proposed license conditions, deficits increased in 1977 and were approximately the same 1978. There was also an additional small deficit in water year 1976 for NID, the second driest year in the period of record. Overall, there was relatively little change to water supply reliability except in the driest of years, when water supply was already affected. The annual demands used in the model were the full demands, and do not include demand reduction resulting from drought contingency plans. NID and PCWA user demands would likely have been reduced in 1976 and 1977 based on pre-determined drought plans and agreements once water deficits were anticipated. Therefore, the deficits in both the existing and proposed license conditions are conservatively high.

These results represent a bookend analysis of impacts on water supply between the current conditions and the Proposed Projects. Assuming that the Yuba-Bear Project and Lower Drum Project operate under existing license conditions, impacts on water deliveries would go down for NID, but would be approximately the same for PCWA. The majority of unrecoverable increases in environmental flows, relative to existing conditions, is associated with the Upper Drum-Spaulding Project below Lake Spaulding.

Most PG&E reservoirs represented as the Drum-Spaulding Project are associated with the Upper Drum-Spaulding Project. The Lower Drum Project is operated, in part, to provide water to PCWA. Even without the Lower Drum Project, operation of the Upper

Drum-Spaulding Project would be relatively unchanged due to contractual requirements to provide water to in-basin users downstream of the Upper Drum-Spaulding Project. Therefore, the results of this assessment do not identify a need for additional modeling to assess the relative impacts of changes in operation of the Upper Drum-Spaulding Project to the Lower Drum Project.

Table D-1. Summary of Predicted Reservoir Elevation Impacts, by Water Year Type, of PG&E's Proposed Projects Coupled with Projected (**Year** 2062) Future Water Deliveries at Fordyce Lake

Fordyce Lake											
PG&E's Proposed Projects with 2062 Water Supply (Operations Model Scenario Name: L030311-P) Reservoir Elevation Differences (as compared to No-Action Alternative)											
Median Reservoir Level by Date and Water Year Type (feet)											
Water Year Type	**1-May**	**15-May**	**1-Jun**	**15-Jun**	**1-Jul**	**15-Jul**	**1-Aug**	**15-Aug**	**1-Sep**	**15-Sep**	**30-Sep**
Critically dry	-4.6	-5.1	-6.3	-8.7	-11.7	-14.4	-10.3	-11.3	-13.9	-16.9	-17.8
Dry	-1.5	-2.1	-0.6	-2.7	-4.9	-2.1	0.0	0.1	0.5	0.6	-0.8
Below normal	-0.9	-0.8	-0.3	0.0	-1.7	0.0	0.0	0.2	0.4	0.5	-1.4
Above normal	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	-0.1	-1.0
Wet	-0.5	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.3	-0.4	0.0

Table D-2. Summary of Predicted Reservoir Elevation Impacts, by Water Year Type, of PG&E's Proposed Projects Coupled with Projected (2062) Future Water Deliveries at Lake Spaulding

Lake Spaulding											
PG&E's Proposed Projects with 2062 Water Supply (Operations Model Scenario Name: L030311-P) Reservoir Elevation Differences (as compared to No-Action Alternative)											
Median Reservoir Level by Date and Water Year Type (feet)											
Water Year Type	**1-May**	**15-May**	**1-Jun**	**15-Jun**	**1-Jul**	**15-Jul**	**1-Aug**	**15-Aug**	**1-Sep**	**15-Sep**	**30-Sep**
Critically dry	0.2	1.0	5.3	10.3	7.3	7.7	-2.7	-2.7	-2.2	-2.2	-4.4
Dry	0.1	0.6	0.4	4.4	7.8	4.7	2.1	2.6	2.9	2.5	3.1
Below normal	-3.3	0.0	0.0	-0.1	1.9	0.0	0.3	0.6	0.6	0.6	0.9
Above normal	-2.5	-2.5	0.0	0.0	0.2	0.0	-0.7	-1.5	-2.6	-3.1	-3.9
Wet	0.0	0.0	0.0	0.0	0.0	0.1	-0.7	-1.3	-0.6	-0.6	-3.0

Table D-3. Percentage of Combined Yuba-Bear/Drum-Spaulding Water Deliveries Met, by Month and Year Base Case-EBF

	Annual Totals (% of Target Delivery)		**Annual Totals (Delivery Deficit,** acre-feet**)**		**PG&E Water that** needed **to be purchased to Meet Min. Flow in Bear River Reach to Lake Combie (**acre-feet**)**
Water Year	**NID**	**PCWA**	**NID**	**PCWA**	
1976	100%	100%	0	0	0
1977	62%	76%	57,000	28,000	13,000
1978	93%	92%	11,000	9,000	4,000
1979	100%	100%	0	0	0
1980	100%	100%	0	0	0
1981	100%	100%	0	0	0
1982	100%	100%	0	0	0
1983	100%	100%	0	0	0
1984	100%	100%	0	0	0
1985	100%	100%	0	0	0
1986	100%	100%	0	0	0
1987	100%	100%	0	0	0
1988	100%	100%	0	0	0
1989	100%	100%	0	0	0
1990	100%	100%	0	0	0
1991	100%	100%	0	0	0
1992	100%	100%	0	0	0
1993	100%	100%	0	0	0
1994	100%	100%	0	0	0
1995	100%	100%	0	0	0
1996	100%	100%	0	0	0
1997	100%	100%	0	0	0
1998	100%	100%	0	0	0
1999	100%	100%	0	0	0
2000	100%	100%	0	0	0
2001	100%	100%	0	0	0
2002	100%	100%	0	0	0
2003	100%	100%	0	0	0
2004	100%	100%	0	0	0
2005	100%	100%	0	0	0
2006	100%	100%	0	0	0
2007	100%	100%	0	0	0
2008	100%	100%	0	0	0

Table D-4. Percentage of Combined Yuba-Bear/Drum-Spaulding Water Deliveries Met, by Month and Year in PG&E's Proposed Projects (L061812-EBFSC)

	Annual Totals (% of Target Delivery)		**Annual Totals (Delivery Deficit,** acre-feet**)**		**PG&E Water that** needed **to be purchased to Meet Min. Flow in Bear River Reach to Lake Combie** (acre-feet)
Water Year	**NID**	**PCWA**	**NID**	**PCWA**	
1976	99%	100%	2,000	0	0
1977	50%	66%	76,000	39,000	20,000
1978	92%	92%	12,000	9,000	2,000
1979	100%	100%	0	0	0
1980	100%	100%	0	0	0
1981	100%	100%	0	0	0
1982	100%	100%	0	0	0
1983	100%	100%	0	0	0
1984	100%	100%	0	0	0
1985	100%	100%	0	0	0
1986	100%	100%	0	0	0
1987	100%	100%	0	0	0
1988	100%	100%	0	0	0
1989	100%	100%	0	0	0
1990	100%	100%	0	0	0
1991	100%	100%	0	0	0
1992	100%	100%	0	0	0
1993	100%	100%	0	0	0
1994	100%	100%	0	0	0
1995	100%	100%	0	0	0
1996	100%	100%	0	0	0
1997	100%	100%	0	0	0
1998	100%	100%	0	0	0
1999	100%	100%	0	0	0
2000	100%	100%	0	0	0
2001	100%	100%	0	0	0
2002	100%	100%	0	0	0
2003	100%	100%	0	0	0
2004	100%	100%	0	0	0
2005	100%	100%	0	0	0
2006	100%	100%	0	0	0
2007	100%	100%	0	0	0
2008	100%	100%	0	0	0

As noted in the "General Assumptions" above, this model run does not include any block flows (as suggested by Foothill Water Network) or any Bureau of Reclamation demands below Newcastle Powerhouse. Also, the model run does not include agency-suggested spill cessation in the Upper Bear River, Drum Afterbay, and Rollins Dam. If these proposals were included, effects on power generation, water deliveries, hydrology, and reservoir elevations may change. Also, the model itself is being modified on a regular basis based on observations/requests by relicensing participants. Any future modifications to the model may also affect the results presented for this model run.

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