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MEMORANDUM

TO: Charles Morrill, WDFW

FROM: Michele Dehart

DATE: August 29, 2011

RE: 2009 Acoustic Tag Study at Little Goose Dam

In response to your request the FPC staff reviewed the study, "Approach, Passage, and Survival of Juvenile Salmonids at Little Goose Dam, Washington: post-Construction Evaluation of a Temporary Spillway Weir, 2009" (Beeman et al., 2010). In accord with your request, we reviewed the study relative to the Action Agencies use of these study results as a basis for their decision to reject System Operation Request #2011-3 that was submitted on July 19, 2011. The SOR requested spill to the 115/120% gas cap at Little Goose Dam during nighttime hours, during periods of Lower Granite pool operation above MOP for navigation safety issues. The COE decided not to implement the request based on information in the subject 2009 evaluation of the TWS operation. The objective of the 2009 study was to evaluate TWS operation at Little Goose Dam.

Following on the basis of our review of the 2009 study, are the FPC conclusions regarding the applicability of the subject study results to the denial of SOR #2011-3.

- The results from the 2009 study have limited applicability and do not support the decision against implementation of SOR#2011-3, for Little Goose Dam night time operations when the Biological Opinion MOP elevations are not implemented.
- The low spillway survival estimate in 2009 is inconsistent with the observations obtained from past acoustic-tag studies.
- The 2009 subyearling Chinook study was conducted only under the "low crest" weir elevation, while the implementation of the SOR would have been under the "high crest"

weir elevation. The "high crest" elevation is specifically implemented to address tailrace eddy formation.

- The flows under which the study was conducted, as well as the time of the year when the study was conducted, suggest the results were not applicable to the decision made relative to SOR # 2011-3.
- The spill pattern used for the 2009 test was changed in 2011, specifically to address concern regarding the tailrace eddy formation. The mean tailrace egress time for the spillway group was much longer than for the TSW group.
- A greater percentage of subyearling juveniles passed via the turbine during nighttime hours. Increasing nighttime spill would have increased overall survival by diverting fish from the turbines, a route associated with the lowest survival probability.
- Forebay residence times were much reduced for spillway routes.

Survival Estimates

The 2009 LGS study (Beeman et al. 2010) presents an overall estimate for spillway survival of 0.852 (s.e 0.044) and a nighttime spill survival of 0.880 (s.e. 0.062) (Table 1). The precision on the spillway survival estimate was relatively low in 2009 because few tagged fish passed via this route. This estimate is low when compared to spillway survival estimates collected in past years' with similar spill volumes.

Table 1. Estimates of subyearling Chinook spillway survival (at night) from 2006, 2007, and 2009 Little Goose Dam studies. 2006 study was conducted under uniform and bulk spill operations. Average spill proportions for study period are provided.

Year	Spill Survival night(se)	Spill Prop
2006	**0.942 (0.025) Uniform** **0.894 (0.041) Bulk**	**0.582** **0.512**
2007	**1.148 (0.169)**	**0.202**
2009	**0.880 (0.062)**	**0.097**

Spillway Weir Elevation

The TSW at Little Goose Dam was specifically designed to operate in either of two elevations, low crest or high crest. This capability was developed so that the TSW could be operated during periods of lower discharge, mostly summer, with less flow over the TSW leaving more water to pass over other conventional spillbays to control tailrace conditions. This operation with less flow over the TSW is called the "high crest" elevation. Due to higher flows during the time period in 2009 when the test was conducted, the weir was operated in the "low crest" elevation. The "high crest" operation began on July 7, while the summer test ended on July 6, 2011. Therefore, the operation of the TSW was not representative of what would have occurred in 2011 under the proposed, and denied, SOR. The "high crest" weir position is implemented when flows are below 85 Kcfs. The SOR was submitted on July 19, 2011, and flows were below the

85 Kcfs criteria, so it was expected that the project would be operating with the TSW in the "high crest" weir position in a matter of days.

The data from the 2009 test are not specifically applicable to subyearling Chinook survival in 2011, since the actual weir elevation under which the test was performed was not optimal for subyearling survival, and are not representative of what would have occurred during the 2011 SOR operation period.

Spill Patterns

The spill patterns used in the 2009 LGS study (Beeman et al. 2010) were very different than what was implemented in 2011. First, only the low crest configuration was used in the summer study period in the 2009 LGS study. The high crest configuration was only implemented near the end of the summer study period, and any study fish that were detected at LGS during the high crest configuration were removed from the analyses presented in the report. However, in 2011 when the SOR was submitted, the TSW at LGS was planned to end low crest operation within a matter of days (July 26) as daily average discharge at LGS dropped below 85 Kcfs.

Not only do the 2009 study operations and the 2011 actual operations differ in their crest configurations, but also in the spill patterns, particularly at the river flows that were expected over the rest of summer 2011. Table 2 provides the spill patterns that were used for the summer period of the 2009 LGS study, along with the spill patterns that were planned for 2011, under the flow conditions that could be anticipated during the period covered by SOR 2011-3.

During the summer period of the 2009 LGS study, spill (under the low crest configuration) was concentrated on the south end of the spillway, close to the TSW. For example, the spill pattern used during the 2009 study called for bays 2, 3, 4, 5, 6, 7, and 8 to be opened to one stop, consecutively, as flows increased (Table 2). Once all of the spill bays were opened to one stop, bay 2 was then to be opened to 2 stops, followed by the rest of the bays, in sequence. Results from the 2009 study revealed that this spill pattern may have contributed to the formation of an eddy on the north end of the spill way. Given this, the salmon managers and action agencies developed a new spill pattern at LGS in an attempt to minimize this eddy formation. This new pattern prioritizes north end spill sooner than the 2009 pattern. For example, the 2011 FPP (high crest configuration) calls for bay 8 (north end) to be opened to one stop first, followed by bay 2. At flows at or above 42 Kcfs, bay 8 is to be opened to two stops. As flows continue to increase, spill bays 4 and 6 are opened to 1 stop. Only after flows are above 59 Kcfs are bays 2, 5, and 7 opened, each to one stop (Table 2).

The spill patterns used in the 2006 and 2007 studies are also not comparable to that planned for 2011. The summer portion of the 2006 LGS study (Beeman et al. 2008a) included two different spill patterns, uniform and bulk. Under the uniform spill pattern, spill was provided in spill bays 1 through 7, with highest priority given to bays 2 and 3 (Table 3). The bulk pattern used in the 2006 LGS study was similar to the uniform, except that spill in bays 2 and 3 was higher, with these bays being opened to up to 5 stops (at flows up to ~125 Kcfs) (Table 3). The summer portion of the 2007 LGS study (Beeman et al. 2008b) also included two different spill patterns, tapered bulk and uniform. Under the tapered bulk pattern, spill was only provided in spill bays 1

through 4 only, with bays 2 and 3 having highest priority (Table 4). Under the uniform pattern, spill was provided in spill bays 2 through 7. For example, spill bays 2, 3, 4, 5, 6, and 7 were to be opened to one stop, consecutively, as flows increased (Table 4). Once all of the spill bays were opened to one stop, bay 2 was then to be opened to 2 stops, followed by the rest of the bays, in sequence. This is similar to what was used in the 2009 LGS study (Beeman et al. 2010).

Table 2. Spill patterns used during summer portion of 2009 LGS Study (shaded area) (data from Table D-1 of Beeman et al. 2010) and anticipated spill patterns for summer 2011 (data from Table LGS-12 of 2011 FPP) given expected river flow conditions.

Year	River Flow (Kcfs)	PH Flow (Kcfs)	Spill (Kcfs)	Percent Spill	Spillway Flow (stops)								Total Stops
					TSW	2	3	4	5	6	7	8	
2009	39.6	27.3	12.3	31.1	Low								0
2009	44.0	31.7	12.3	28.0	Low								0
2009	44.1	30.0	14.1	31.9	Low	1							1
2009	49.0	34.9	14.1	28.7	Low	1							1
2009	49.0	34.3	14.7	30.0	Low	1	1						2
2009	55.1	38.6	16.5	29.9	Low	1	1	1					3
2009	60.7	42.5	18.2	30.0	Low	1	1	1	1				4
2009	66.6	46.6	20.0	30.0	Low	1	1	1	1	1			5
2009	72.3	50.6	21.7	30.0	Low	1	1	1	1	1	1		6
2009	78.2	54.7	23.5	30.0	Low	1	1	1	1	1	1	1	7
2009	84.4	59.1	25.3	30.0	Low	2	1	1	1	1	1	1	8
2009	90.7	63.5	27.2	30.0	Low	2	1	2	1	1	1	1	9
2009	97.9	67.9	29.1	30.0	Low	2	1	2	1	2	1	1	10
2009	103.4	72.4	31.0	30.0	Low	2	1	2	1	2	1	2	11
2009	109.7	76.8	32.9	30.0	Low	2	2	2	1	2	1	2	12
2009	116.0	81.2	34.8	30.0	Low	2	2	2	2	2	1	2	13
2009	122.3	85.6	36.7	30.0	Low	2	2	2	2	2	2	2	14
2009	128.9	90.2	38.7	30.0	Low	3	2	2	2	2	2	2	15
2009	135.6	94.9	40.7	30.0	Low	3	3	2	2	2	2	2	16
2009	142.2	99.5	42.7	30.0	Low	3	3	3	2	2	2	2	17
2009	148.8	104.2	44.6	30.0	Low	3	3	3	3	2	2	2	18
2009	155.4	108.8	46.6	30.0	Low	3	3	3	3	3	2	2	19
2009	157.8	109.2	48.6	30.8	Low	3	3	3	3	3	3	2	20
2009	159.8	109.2	50.6	31.7	Low	3	3	3	3	3	3	3	21
2011	23.9	16.7	7.2	30.0	High								0
2011	26.4	17.5	8.9	33.7	High							1	1
2011	31.5	22.6	8.9	28.3	High							1	1
2011	35.0	24.3	10.7	30.5	High	1						1	2
2011	35.6	24.9	10.7	30.0	High	1						1	2
2011	38.0	27.3	10.7	28.1	High	1						1	2
2011	41.9	29.3	12.6	30.0	High	1						2	3
2011	47.7	33.4	14.3	30.0	High	1		1				2	4
2011	51.1	35.0	16.1	31.5	High	1		1		1		2	5
2011	54.7	38.6	16.1	29.4	High	1		1		1		2	5
2011	59.6	41.7	17.9	30.0	High	1	1	1		1		2	6
2011	65.4	45.8	19.6	30.0	High	1	1	1		1	1	2	7
2011	71.3	49.9	21.4	30.0	High	1	1	1	1	1	1	2	8
2011	73.9	52.5	21.4	28.9	High	1	1	1	1	1	1	2	8
2011	77.6	52.5	21.4	28.9	High	1	1	1	1	1	1	2	8

Table 3. Spill patterns for uniform and bulk spill treatments for summer portion of 2006 LGS Study (Beeman et al. 2008a). Only those flows levels that were experienced during the summer study period are presented. Data for spill patterns treatment taken from Table A-1 (uniform) and A-2 (bulk) of Beeman et al. 2008a.

River Flow (Kcfs)	PH Flow (Kcfs)	Spill (Kcfs)	Spill Pattern	Spillway Flow (stops)								Total Stops
				1	2	3	4	5	6	7	8	
18.93	13.25	5.68	Uniform		3							3
25.53	17.87	7.66	Uniform		4							4
31.43	22.00	9.43	Uniform	1	4							5
37.87	26.51	11.36	Uniform		3	3						6
43.77	30.64	13.13	Uniform	1	3	3						7
51.07	35.75	15.32	Uniform		4	4						8
56.80	39.76	17.04	Uniform		3	3	3					9
62.70	43.89	18.81	Uniform	1	3	3	3					10
68.60	48.02	20.58	Uniform	1	3	3	3	1				11
75.73	53.01	22.72	Uniform		3	3	3	3				12
81.63	57.14	24.49	Uniform	1	3	3	3	3				13
87.53	61.27	26.26	Uniform	1	3	3	3	3	1			14
94.67	66.27	28.40	Uniform		3	3	3	3	3			15
100.57	70.40	30.17	Uniform	1	3	3	3	3	3			16
106.47	74.53	31.94	Uniform	1	3	3	3	3	3	1		17
113.60	79.52	34.08	Uniform		3	3	3	3	3	3		18
119.50	83.65	35.85	Uniform	1	3	3	3	3	3	3		19
127.67	89.37	38.30	Uniform		4	4	4	4	4			20
18.93	13.25	5.68	Bulk		3							3
25.53	17.87	7.66	Bulk		4							4
31.43	22.00	9.43	Bulk	1	4							5
37.33	26.13	11.20	Bulk	1	4	1						6
43.93	30.75	13.18	Bulk	1	5	1						7
49.83	34.88	14.95	Bulk	1	5	1	1					8
55.73	39.01	16.72	Bulk	1	5	1	1	1				9
62.10	43.47	18.63	Bulk	1	5	2	1	1				10
68.47	47.93	20.54	Bulk	1	5	2	2	1				11
75.13	52.59	22.54	Bulk	1	5	3	2	1				12
81.73	57.21	24.52	Bulk	1	5	4	2	1				13
88.10	61.67	26.43	Bulk	1	5	4	2	2				14
94.00	65.80	28.20	Bulk	1	5	4	2	2	1			15
100.37	70.26	30.11	Bulk	1	5	4	2	2	2			16
106.97	74.88	32.09	Bulk	1	5	5	2	2	2			17
113.63	79.54	34.09	Bulk	1	5	5	3	2	2			18
120.23	84.16	36.07	Bulk	1	5	5	4	2	2			19
126.13	88.29	37.84	Bulk	1	5	5	4	2	2	1		20

Table 4. Spill patterns for tapered bulk and uniform spill treatments for summer portion of 2007 LGS Study (Beeman et al. 2008b). Only those flows levels that were experienced during the summer study period are presented. Data were taken from Table A3 of Beeman et al. 2008b.

River Flow (Kcfs)	PH Flow (Kcfs)	Spill (Kcfs)	Spill Pattern	Spillway Flow (stops)								Total Stops
				1	2	3	4	5	6	7	8	
18.9	13.3	5.7	Tapered Bulk		3							3
25.5	17.9	7.7	Tapered Bulk		4							4
31.4	22.0	9.4	Tapered Bulk		4	1						5
37.3	26.1	11.2	Tapered Bulk	1	4	1						6
43.7	30.6	13.1	Tapered Bulk	1	4	2						7
50.3	35.2	15.1	Tapered Bulk	1	5	2						8
57.0	39.9	17.1	Tapered Bulk	1	5	3						9
62.9	44.0	18.9	Tapered Bulk	1	5	3	1					10
69.5	48.6	20.8	Tapered Bulk	1	5	4	1					11
75.8	53.1	22.8	Tapered Bulk	1	5	4	2					12
		1.8	Uniform		1							1
		3.5	Uniform		1	1						2
		5.3	Uniform		1	1	1					3
		7.1	Uniform		1	1	1					4
		8.9	Uniform		1	1	1	1	1			5
		10.6	Uniform		1	1	1	1	1	1		6
		12.5	Uniform		2	1	1	1	1	1		7
		14.4	Uniform		2	2	1	1	1	1		8
		16.4	Uniform		2	2	2	1	1	1		9
		18.3	Uniform		2	2	2	2	1	1		10
		20.2	Uniform		2	2	2	2	2	1		11
		22.1	Uniform		2	2	2	2	2	2		12

Higher Nighttime Turbine Passage

The assumption made in denying the SOR was that by increasing spill, the number of juveniles that avoided the bypass with a higher survival would be decreased to put fish over the spillway, with a lower associated survival. The survival data from the 2009 LGS study do not necessarily support this conclusion. Forebay residence time was longer during nighttime hours. The greatest rates of passage were through the bypass, the TSW, then the spillway. Turbine passage increased fourfold relative to the day and was 11.2% of the fish. Turbine survival was less than spill survival. Overall, there were more fish that could have been drawn over to the spillway side of the project and likely passage through the TSW would have increased as well.

The nighttime TSW passage proportion was only 0.361 versus a daytime TSW passage proportion of 0.646. It is highly likely, that even given the questionable spill survival estimate, a higher overall project survival may have occurred.

Literature Cited:

Beeman, J.W., A.C. Braatz, S.D. Fielding, J.M. Hardiman, C.E. Walker, A.C. Pope, T.S. Wilkerson, D.J. Shurtleff, R.W. Perry, and T.D. Counihan. 2008a. Passage, survival, and approach patterns of radio-tagged juvenile salmonids at Little Goose Dam, 2006. Final report of research by the U.S. Geological Survey, Cook, Washington, for the U.S. Army

Corps of Engineers, Walla Walla District, Washington, Contract W68SBV60317747. Submitted May 2008.

Beeman, J.W., A.C. Braatz, S.D. Fielding, H.C. Hansel, S.T. Brown, G.T. George, P.V. Haner, G.S. Hansen, and D.J. Shurtleff. 2008b. Approach, passage, and survival of juvenile salmonids at Little Goose Dam, 2007. Final report of research by the U.S. Geological Survey, Cook, Washington, for the U.S. Army Corps of Engineers, Walla Walla District, Washington, Contract W68SBV60317747. Submitted Novemner 2008.

Beeman, J.W., A.C. Braatz, H.C. Hansel, S.D. Fielding, P.V. Haner, G.S. Hansen, D.J. Shurtleff, J.M. Sprando, and D.W. Rondorff. 2010. Approach, passage, and survival of juvenile salmonids at Little Goose Dam, Washington: post-construction evaluation of a temporary spillway weir, 2009. U.S. Geological Survey Open-File Report 2010-1224, 100p.

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DATA REQUEST FORM

Request Taken By: M. Filardo **Date:** July 27, 2011

Data Requested By:
Name: Charles Morrill **Phone:**
Address: WDFW **Fax:**
Email: Charles.Morrill@dfw.wa.gov

Data Requested:
Review of 2009 LGS TSW study relative to SOR 2011-3.

Data Format: **Hardcopy** ☐ **Text** ☑ **Excel** ☐

Delivery: **Mail** ☐ **Email** ☑ **Fax** ☐ **Phone** ☐

Comments:

Data Compiled By: M. Filardo **Date:** 8/29/2011

Request # 70

Margaret Filardo

From: Morrill, Charles (DFW) [Charles.Morrill@dfw.wa.gov]

Sent: Wednesday, July 27, 2011 10:21 AM

To: Margaret Filardo; Michele Dehart

Cc: Paul.Wagner@noaa.gov; david_wills@fws.gov; Rick.Kruger@state.or.us; Daves@nezperce.org; Le Fleur, Cindy (DFW); lort@critfc.org; russ.kiefer@idfg.idaho.gov

Subject: FPC review of USGS 2009 study re: SOR 2011-1 discussed at todays TMT

Hi Margaret, Michele,

Would you please add this request to the Que ... we as managers have not had the opportunity to review and discuss the USGS study and although we did not object to the COE's action on SOR 2011-1 at todays TMT. .we did note that once we had reviewed the study and discussed it that we may desire to address this issue again with TMT members

FPC review and analysis would be valuable ..

thanks Margaret !

Charlie