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MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: March 10, 2009

RE: Libby End of December Draft

We are providing the following in response to your request (made at the Fish Passage Advisory Committee meeting on March 3, 2009) that we provide a technical review of the COE's 2004 study evaluating the flexibility of the Libby end of December Draft.

We believe that the analysis that established the relaxation of the December draft for only those years where the December Libby forecast is 5900 KAF or less, and the establishment of 600 KAF as the full relaxation volume, was conservative.

The risk of allowing Libby to draft to 2411 feet is placed on refill and spring and summer flows, whereas the potential risk of not being able to draft the reservoir is less defined. Given that the criteria for relaxing the December draft are conservative, more years could be included for implementation of relaxed December drafts.

The draft of Libby reservoir in December has a significant impact on the ability of operators to meet Flood Control elevations, spring flow targets, reservoir refill, and potentially summer flow augmentation volumes. The relaxation of the end of December flood control requirement at Libby Dam began implementation in 2003. The COE document "Summary Report 31 December Variable Flood Control Draft for Libby Reservoir" issued by the COE in January of 2004 and a COE PowerPoint presentation titled "31 December Variable Flood control Draft for Libby Reservoir" provide the COE analysis establishing 600 KAF relaxation volume and the 5900 KAF criteria for relaxation of the December draft at Libby¹. According to the COE documents,

¹ Documents can be found at:

http://www.nwd-wc.usace.army.mil/tmt/agendas/2008/1217_LibbyVariableDecember.pdf.

<http://www.jsao.atmos.washington.edu/cig/outreach/workshopfiles/portland2004water/fitzgerald.ppt>

approximately 25% of water years will have some relaxed flood control requirements or, conversely, in 75% of the years Libby will be drawn down to 2411 feet in December.

The relaxed flood control volume is based on a minimum end of December draft of 1.4 MAF in every year (as compared to the 2 MAF draft to 2411 feet). The COE estimates based on their analysis that a total of up to 600 KAF can be available for relaxation by the end of December at Libby Dam. The COE established the availability of the 600 KAF based on the following premise: the maximum volume that would be available for relaxation is determined by the maximum amount of water that could come out of the reservoir between January and March (based on hydraulic capacity without spill); subtracting from that the maximum volume of water that would have to come out of Libby in a high inflow year when the project has to be drafted to its empty elevation.

In equation form this is:

Max Relaxation Vol = Max Vol that could come out – Max Vol that would have to come out

$$\mathbf{600\ KAF} \quad = \quad \mathbf{25,000\ cfs \times 3\ months} \quad - \quad \mathbf{(Jan - Mar\ Inflow\ Volume + 2.98\ MAF)}$$

where:

**2.98 MAF is the volume of water between 2411 feet and the empty elevation of 2287 feet and,
Solving for the Jan – Mar inflow volume yields 875 KAF.**

This suggests that in years' when the Jan – Mar runoff volume is 875 KAF or greater, the reservoir cannot draft to the empty level at full powerhouse capacity if the full 600 KAF is kept above the 2411 feet elevation. The Jan-Mar runoff volume at Libby has only exceeded 875 KAF in one year of the 50-year GENESYS record for Libby stream flows 1929-1978. The highest Jan-Mar inflow in the GENESYS record was 1025 KAF. This inflow (based on operating Libby at full powerhouse January through March and using the equation above) would still result in a possible relaxation of Libby December elevation of approximately 450 KAF, and would allow the project to be empty on March 31. If the full 600 KAF was held in the reservoir with the 1025 KAF highest runoff volume in Jan-Mar, and the reservoir had to be drafted to its empty level for that years runoff volume, the only additional risk that would be incurred is that Libby would have to be drafted an additional 150 KAF, which spread over 3 months would result in a daily outflow of 25.8 Kcfs, or a daily spill of 0.8 Kcfs (COE assumed Powerhouse capacity of 25 Kcfs).

From the analysis conducted by the COE it appears that the 600 KAF relaxation volume is conservative. After establishing the relaxation volume at 600 KAF the COE then established the following criteria for determining when the project could adopt the relaxed flood control elevation at the end of December. The criteria was developed based on running a simulation of

projected forecasts and the ability to get the volume out of Libby without it being trapped in Libby and Duncan reservoirs, while not violating the 1938 IJC Order requirement to not exceed the permissible elevation of Kootenay Lake. Water years from 1949 to 2002 were tested in order of increasing December 1, Apr-Aug forecasts. The first time the IJC requirement was violated was when the Dec 1 forecast exceeded 5900 KAF. Consequently the criteria established were:

Relax 600 KAF if forecast is < 5500 KAF
No Relaxation if forecast is > 5900 KAF
Between 5500 KAF and 5900 KAF, interpolate to determine relaxation volume.

The established criteria for when the relaxation is implemented, as described above, only allow for relaxation of flood control in 25% of water years. The 5900 KAF criteria (no relaxation) occur in any year that is 94% of normal or above. Full relaxation only occurs in years that are less than 88% of normal, which in the water years tested resulted in full relaxation in approximately 13% of the years.

However, it is important to note that 1954 chosen as the threshold year where no relaxation in the December 31st draft requirement was allowed is somewhat of an anomaly. The December 1 forecast for 1954 was 5952 KAF whereas, the actual runoff volume in the same year was actually 9143 KAF (see Table 1 of COE Libby Variable December document cited in footnote 1). The COE theorized that this year should represent the threshold for the variable December draft, as this type of discrepancy between the forecast and actual runoff was within the possibility of what could be expected.

Using the year of 1954 to set the threshold for the end of December Draft at Libby Dam causes the relaxation operation, limited to the lowest 25% of years, to be extremely conservative. Considering the entire 54 year record used in Table 1 of the COE Variable December Draft document, 1954 contained the largest increase between December Apr-Aug forecast and actual Apr-Aug runoff volume at Libby. Also, the actual runoff volume in 1954 was 9143 KAF or 146% of normal, which was the second highest observed runoff of this record. According to the COE document the Apr-Aug forecast in 1954 was 5952 KAF in December, 7099 KAF in January, 7924 KAF in February, 8655 KAF in March, and ended with an actual runoff volume of 9143 KAF. In a year such as 1954, with a water supply that increased 3191 KAF throughout the year flood control elevations could not have been met regardless of where the reservoir was at on December 31st. According to Table 3 in the COE Libby Variable December document, for the simulated year 1954, trapped storage at Libby by March 31st would have been 772 KAF under a full 600 KAF relaxation by December 31st and 624 KAF of trapped storage by March 31st with no end of December relaxation at Libby. It is clear that in a year such as 1954, the management of Libby would have been extremely difficult **regardless** of whether the reservoir was at 2411 feet or somewhat higher by the end of December.

The use of 1954 as the threshold to set the December draft of Libby limits the number of years that the reservoir can be relaxed in December. The direct result of limiting the relaxation of the end of December draft at Libby to only 25% of years is that in 75% of years Libby will draft to 2411 feet by the end of December. The following table shows the December, January, February,

March, and April Apr-Aug forecasts at Libby from 2003 to present. From this table, in three of the seven years (2004, 2005, and 2009- highlighted yellow) the COE December forecast would have resulted in a draft to 2411 feet (forecast > than 5900 KAF), however later forecasts dropped to levels that would have set the December draft to approximate 2426.7 feet (forecast < 5500 KAF). In these types of years, the draft of Libby Dam to 2411 feet by the end of December puts Libby at a disadvantage with respect to meeting later flood control elevations. By failing to meet April 10th Flood Control elevations, operators are typically forced to refill aggressively during the spring flow period and/or not achieve a full reservoir elevation by the beginning of July which also limits the amount of flow augmentation available during the summer months.

Table 1. COE Apr-Aug forecasts for Libby from December through April from 2003 to present.

Libby Apr-Aug Forecast (KAF)					
	Dec	Jan	Feb	March	April
2003	4924	4861	4659	4181	4955
2004	6954	5708	5644	5359	5305
2005	6178	5786	5630	5371	5401
2006	6625	5487	6186	6350	6076
2007	7746	6955	6582	6516	6847
2008	6385	6282	6498	6435	6387
2009	5937	5526	5436		