SUMMARY REPORT
31 DECEMBER VARIABLE FLOOD CONTROL DRAFT FOR LIBBY RESERVOIR

Prepared by

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Northwestern Division
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for

The United States and Canadian Entities
Columbia River Treaty

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EXECUTIVE SUMMARY

This study evaluates the feasibility of relaxing the end-of-December flood control draft requirement at Libby Dam. The study was conducted in response to requirements set forth in the December 2000 Biological Opinions (BiOps) of the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). Both BiOps require the Corps to develop and, if feasible, implement a revised storage reservation diagram (SRD) for Libby Reservoir that replaces the existing fixed draft of 2.0 million acre-feet (maf) with a variable draft for the 31 December target. This measure, recommended by both NMFS and USFWS, is intended to improve the likelihood of refill at Lake Koocanusa during low flow or drought years.

Based on the analyses performed for this study, relaxation of the 31 December draft requirement at Libby should not be permitted for Standard flood control. A 2.0 maf draft should still be required at the end of December, corresponding to a reservoir elevation of 2411.0 ft. However, relaxation of the 31 December draft requirement at Libby is permissible for VARQ flood control. The maximum permissible relaxation is 600 kaf, reducing the end-of-December draft requirement to1.4 maf, which corresponds to a reservoir elevation of 2426.7 ft. The VARQ flood control procedure is currently used at Libby Dam, and will continue to be implemented on an interim basis until the Upper Columbia Alternative Flood Control and Fish Operations Environmental Impact Statement (EIS) is completed in 2005, at which point a decision will be made regarding long-term implementation of VARQ flood control.

Daily hydro-regulations with a relaxed end-of-December draft requirement were performed using the Corps SSARR and AUTOREG programs. These hydro-regulations were used to evaluate flood control impacts in the Kootenai basin during the 31

December -31 March time period. The simulations led to the following guidelines for relaxing the 31 December draft at Libby Dam under VARQ flood control:

- If 1 Dec forecast >= 5900 kaf (94% of normal), no relaxation
- If 1 Dec forecast <= 5500 kaf (88% of normal), relax draft by 600 kaf
- For 5500 kaf < 1 Dec forecast < 5900 kaf, relax draft by interpolating between 600 and 0 kaf.

These guidelines are depicted on the revised VARQ SRD (Figure 1) at the end of this report. Using these guidelines, years with a 1 December forecast that is 94% of normal or less would have a relaxed flood control draft requirement. For this study, 14 of the 54 years considered (1949-2002) would have a relaxed end-of-December draft requirement.

The recommended new SRD for VARQ flood control may improve refill reliability at Lake Koocanusa during years of low flow or drought years, and thereby facilitate flow augmentations requested by USFWS and NMFS for listed fish species downstream.

II. HISTORICAL PERSPECTIVE

As a necessary supplement for evaluation of variable drafts, both NMFS (RPA Number 36) and USFWS (RPA 8.1.i) recommend development of a revised methodology to forecast runoff volume for Libby Project based in part on climatic variables such as El Nino Southern Oscillation Index (SOI). Whereas the existing procedure (Morrow-Wortman, 1986) forecasts the April-August seasonal volume runoff once each month for the six-month period extending from 1 January to 1 June, the revised forecast methodology based on principal components regression would also include early-season forecast equations for 1 November and 1 December. The 1 December forecast is especially important because it would be used to calculate variable draft for the 31 December target. The Corps of Engineers recently completed a new forecasting methodology for Libby Reservoir (Wortman, 2003) that meets this requirement as outlined in RPA Number 36. The new forecasting methodology includes use of an SOI variable as a climatic component, which provides a marginal benefit to the early season equations before the first snow measurements are available on 1 January. The newly developed 1 December forecasts based on principal components regression (PCREG) are directly incorporated into the calculations for this report.

This study is one of several that the Corps of Engineers has conducted to review relaxation of flood control requirements in the Columbia River basin. In 1991, the Columbia River and Tributaries Study, CRT-63, examined relaxation of flood control throughout the Columbia basin. During the 1995 System Operation Review, VARQ was identified as a potential flood control procedure that could reduce flood control draft requirements at Libby and Hungry Horse Dams in many years. In 1999, a status report documenting the work to date in developing VARQ flood control was released. Subsequently, an Environmental Assessment with a Finding of No Significance was

prepared in 2002, leading to implementation of VARQ flood control at Libby Dam on an interim basis. At the present time, additional studies relating to VARQ are being conducted for inclusion in an Environmental Impact Statement that is scheduled for completion in early 2005. The Environmental Impact Statement will be used to make a decision regarding long-term implementation of VARQ flood control.

RPA #22 recommended that both the Corps and Bureau of Reclamation (USBR) should implement VARQ flood control operations for Libby and Hungry Horse Projects. By the end of 2002, the Corps and USBR had implemented VARQ flood control operations on an interim basis for their respective projects. For this report, relaxation of the 31 December draft requirement at Libby was considered for both Standard FC and VARQ FC. For VARQ FC, relaxation of the 31 December draft was found be permissible in many years without compromising the ability to meet flood control targets in subsequent months. However, For Standard FC, any relaxation of the 31 December draft requirement was found to compromise the ability to meet draft requirements in subsequent months. Thus, the Libby SRD for VARQ FC has been modified to show a variable end-of-December draft requirement based on the new PCREG forecasting equation for 1 December. No modifications have been made to the SRD for Standard FC.

Figure 1 denotes the proposed new SRD for VARQ FC with variable draft for the 31 December target. The proposed new SRD would replace the current SRD for VARQ FC that is based on fixed draft for the end-of-December target.

The study procedure is a two-step process used to evaluate each type of flood control (Standard FC, VARQ FC). First, the maximum draft relaxation allowed for the 31 December target was determined such that the authorized purpose of flood control for Libby Project is fully maintained. The second step involved an analysis of forecasted runoff volumes and modeling to determine the threshold PCREG forecasted 1 December runoff volume that would trigger this relaxation of draft for the 31 December target.

III. ANALYSIS PROCEDURE

a. Determination of Maximum Permissible Relaxation for the 31 December Flood Control Draft Target

If the 31 December draft requirement is relaxed, the revised target elevation for 31 December must continue to meet downstream flood control requirements for both local and system flood control. For local flood control requirements, the proposed relaxation must not violate the International Joint Commission (IJC) Order of Approval of 11 November 1938 for operation of Kootenay[1] Lake. That order includes maximum specified elevations for Kootenay Lake as measured at Queens Bay, British Columbia, for four winter and spring dates including 07 January, 31 January, 28 February, and 31 March. After 31 March, the lake is held below El. 1739.32 ft until it is forced above by

[1] Canadian spelling

rising inflows that signal the start of the spring freshet. Due to changing hydro-meteorological conditions from year to year, the official date for spring rise may vary from late March to early May. Therefore, the relaxation in the 31 December flood control requirement must be designed so that Libby is still capable of drafting all the way to its flood control target by the end of March. For this analysis, it was assumed that the ability to draft is constrained by the turbine capacity at Libby Project. It is currently set at five (5) units with a total hydraulic capacity of about 25,000 cfs.

The period of record from 1949-2002 was examined to determine the maximum allowable relaxation of the 31 December flood control target. Based on the requirement to be fully drafted by the end of March, each year's permissible relaxation amount was calculated. This was done in three steps.

- First, each year's January-March inflow volume was added to the volume of water in the reservoir contained between El. 2411 ft (the current 31 December target) and El. 2287 ft (the maximum draft requirement on 31 March). This represents the total amount of water that must come out of Libby Dam during this time period.
- Next, Libby Dam was assumed to operate with all five units running (assumed hydraulic capacity of 25,000 cfs). This was converted to a volume, which represents the most water that could possibly be released from Libby Dam during this time period.
- Finally, the first number (representing the existing required outflow volume from the project) was subtracted from the second number (representing the maximum possible outflow volume) to determine a potential relaxation volume for each year.

Based on these calculations, the average permissible relaxation volume is about 500 kaf if all years are considered. If one is restricted to considering only below-average water years, the average permissible relaxation increases. It was found that for years with PCREG 1 December forecasts less than 6000 kaf, the permissible relaxation is 600 kaf. A 600 kaf relaxation makes the end-of-December draft requirement 1400 kaf, which corresponds to a flood control target of El. 2426.7 ft. The current fixed draft requirement for Libby at the end of December is 2000 kaf, which corresponds to a flood control target of El. 2411.0 ft.

There are several significant assumptions in this process that should be considered. First, it is assumed that all five units are fully operational during the period when Libby is drafting. In reality, it is possible that one or more units may be out of service when drafting is necessary. Furthermore, the hydraulic capacity at Libby Dam is not always 25,000 cfs. The hydraulic capacity typically varies between 27,600 cfs and 19,000 cfs, depending on the reservoir elevation behind Libby Dam. Second, no consideration is given to drastic forecast changes that may occur in January, February, or March, which could result in an inability to reach the end of March flood control target. Finally, the ability to draft Libby is sometimes restricted in order to comply with the 1938 IJC Order on Kootenay Lake.

The outflows from both Libby Project and Duncan Project affect the level of Kootenay Lake. The maximum allowable lake level is dictated by the 1938 IJC Order on Kootenay Lake, as discussed in Section III.a. The evacuation of storage as required by each project's SRD could result in a violation of the Order on allowable lake levels. If this occurs, the outflows at either Libby or Duncan, or both, must be reduced to preclude such a violation.[2] At times, this may require Libby or Duncan, or both, to reduce outflows to match reservoir inflow and can result in not reaching the flood control draft requirement by the end of the evacuation period, thus trapping storage above the flood control rule curve. (When a project stores water above its targeted flood control elevation, it is said to have "trapped storage", meaning that water is trapped in the space that should be empty to provide flood protection.)

Given these considerations, the second step in this analysis was to test the 600 kaf relaxation in the end-of-December draft requirement for both Standard FC and VARQ FC. To do this, simulated daily hydro-regulations were performed using the Corps SSARR and AUTOREG programs. These hydro-regulations were limited to the Kootenai Basin, and only evaluated flood control impacts occurring between 31 December and 31 March. These simulations were deemed necessary in order to evaluate the significance of varying hydraulic capacity, intra-seasonal forecast variability, and possible draft restrictions due to the 1938 IJC order on Kootenay Lake. Results of these simulations are discussed in Section III.c.

b. Description of Forecasted Seasonal Volumes used to Trigger Relaxation

A compilation and sorting of the PCREG 1 December forecast runoff volumes for April-August was completed to help determine the threshold 1 December forecast that would trigger relaxation of the 31 December draft requirement. Table 1 compiles both the observed runoff volume and PCREG 1 December forecast volume for water years 1949 through 2002. For years prior to 1949, no data were available to compute the PCREG 1 December forecasts. The data are sorted in ascending order by each year's PCREG 1 December forecast. An average runoff volume of 6248 kaf for the April-August period (POR: 1971 - 2000)[3] was used to compute the percent of normal for both the observed and forecasted runoff volumes, as shown in the fourth and fifth columns. The percent error for each year's 1 December forecast is given in the last column of the table, and demonstrates that both over-forecasted and under-forecasted years will be considered as candidates for relaxation. Negative percent error values indicate that the runoff was under-predicted and positive values indicate that the runoff was over-predicted.

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[2] The Columbia River Treaty does not elaborate on how to prioritize the draft of Libby and Duncan during trapped storage conditions. When flood control evacuation requirements are not met and trapped storage conditions exist at either Libby or Duncan, outflows higher than those originally anticipated for the ensuing flood season may need to be released during the Flood Control Refill Period to avoid filling the reservoirs too early. The Flood Control Refill Period pertains to that portion of the flood control season following project evacuation when the projects are refilled to prevent downstream local and system flooding.

[3] This is the period of record used by the Northwest River Forecast Center to calculate average basin runoff volumes

c. Modeling Procedure to Test Relaxation

This section describes the rationale for selecting the forecast volume that would trigger relaxation of draft requirements for the 31 December target. For both Standard FC and VARQ FC, simulations for the 31 December – 31 March time period were performed. The years were simulated in the order shown in Table 1, beginning with the lowest PCREG 1 December forecast. Each year was tested with a 31 December target elevation of 2426.7 ft. (a 600 kaf relaxation) until a flood control violation occurred. The simulation results were then examined to determine the threshold at which flood control relaxation can occur, and years in excess of this threshold were not modeled. The simulations were performed for the local Kootenai basin, extending from Libby Dam to Kootenay Lake.

Table 1. Analysis of PCREG 1 Dec Fcsts WY 1949 - 2002

Sorted by Forecasted Apr-Aug Runoff Volume

Water Year	Observed (OBS) Apr-Aug (kaf)	PCREG 1-Dec Forecast (FCST) Apr-Aug (kaf)	Observed % of Normal	PCREG Forecast % of Normal	Percent Error (FCST - OBS) X 100 OBS
1953	6590	4410	105.5	70.6	-33
1988	4628	4786	74.1	76.6	3
2001	3175	5022	50.8	80.4	58
1977	3493	5026	55.9	80.4	44
1994	5213	5289	83.4	84.6	1
1980	5979	5323	95.7	85.2	-11
1973	5027	5327	80.5	85.3	6
1970	4654	5526	74.5	88.4	19
1979	4210	5676	67.4	90.8	35
1955	6612	5676	105.8	90.9	-14
1993	5474	5717	87.6	91.5	4
1992	4463	5869	71.4	93.9	32
1983	5925	5877	94.8	94.1	-1
1957	6027	5882	96.5	94.1	-2
1966	7183	5931	115.0	94.9	-17
1954	9143	5952	146.3	95.3	-35
1998	5819	5961	93.1	95.4	2
1949	5059	5979	81.0	95.7	18
1958	5731	6031	91.7	96.5	5
1981	7457	6086	119.4	97.4	-18
1978	6288	6128	100.6	98.1	-3
1971	7982	6163	127.8	98.6	-23
1982	6484	6227	103.8	99.7	-4
1987	4996	6289	80.0	100.7	26
2002	7098	6296	113.6	100.8	-11
1950	7396	6413	118.4	102.6	-13
1975	5980	6455	95.7	103.3	8
1995	6313	6464	101.0	103.5	2
1972	8869	6589	141.9	105.5	-26
1989	5558	6619	89.0	105.9	19
1962	5965	6619	95.5	105.9	11
1965	6964	6671	111.5	106.8	-4
1999	7149	6701	114.4	107.3	-6
1964	6938	6775	111.0	108.4	-2
1984	5073	6851	81.2	109.6	35
1969	8248	6882	132.0	110.2	-17
1986	6075	6883	97.2	110.2	13
1968	6240	6929	99.9	110.9	11
1952	6336	7024	101.4	112.4	11
2000	5296	7042	84.8	112.7	33
1985	4776	7079	76.4	113.3	48
1990	7558	7143	121.0	114.3	-5
1963	6440	7173	103.1	114.8	11
1976	7411	7304	118.6	116.9	-1
1961	7821	7508	125.2	120.2	-4
1959	8125	7526	130.0	120.5	-7
1967	8161	7675	130.6	122.8	-6
1997	7816	7698	125.1	123.2	-2
1956	8729	7716	139.7	123.5	-12
1960	6463	7754	103.4	124.1	20
1974	9215	7969	147.5	127.5	-14
1996	8350	8231	133.6	131.7	-1
1991	8466	8348	135.5	133.6	-1
1951	8529	8489	136.5	135.9	0

1. Standard Flood Control Simulations

Relaxation of the 31 December draft for Standard FC was tested first. The first year tested was 1953, which has a 1 December PCREG forecast of 4410 kaf (70.6% of normal). Due to a dramatic forecast increase between January and February and the need to reduce outflow to avoid an IJC violation on Kootenai Lake, the simulation shows that Libby is unable to meet its end-of-February and end-of-March flood control targets. Duncan, too, is unable to meet its end-of-February and end-of-March targets. Thus, both Libby and Duncan have trapped storage at the end of March. When 1953 is simulated without any relaxation of the 31 December draft target for Libby, there is still trapped storage at Libby and Duncan, but both projects have less than the previous scenario. The results for the 1953 Standard FC simulations are summarized in Table 2.

Table 2. 1953 Simulation Results – Standard FC

	LIBBY	**DUNCAN**
31 March FC target elev	2343.1 ft.	1817.4 ft
31 March simulated elev (600 kaf relaxation at Libby)	2354.58 ft	1847.91 ft
31 March simulated elev (no FC relaxation at Libby)	2349.63 ft	1845.51 ft
Trapped storage (600 kaf relaxation at Libby)	270 kaf	426 kaf
Trapped storage (no FC relaxation at Libby)	151 kaf	390 kaf

Because 1953 has the smallest 1 December PCREG forecast, it would be the first candidate year for a relaxed 31 December flood control target. However, simulation results reveal that when the 31 December flood control draft is reduced by 600 kaf, there is an increase in trapped storage at both Libby and Duncan. In fact, due to the nature of changing forecasts during this year and the IJC requirement to keep Kootenay Lake from exceeding its permissible elevation, *any* relaxation in the 31 December flood control draft at Libby would cause an increase in trapped storage at both Libby and Duncan. Thus, any relaxation of the 31 December flood control target at Libby would violate the flood control draft requirements under Standard FC. For this reason, no relaxation under Standard FC can be permitted, and the SRD for Standard FC should not be changed.

2. VARQ Flood Control Simulations

Relaxation of the 31 December draft for VARQ FC was tested next. The first year tested was 1953, with subsequent years tested in the order shown in Table 1. Because Libby's VARQ end-of-February and end-of-March target elevations in 1953 are higher than those for Standard FC, trapped storage was avoided at both Libby and Duncan for that year. The 600 kaf relaxation continued to be tested for the years in Table

1[4], with the first flood control violation occurring in 1954, which has a 1 December PCREG forecast of 5952 kaf (95.3% of normal). A flood control violation occurs for reasons similar to what was seen in 1953 with Standard FC. Dramatic forecast increases in January, February, and March, along with the need to reduce outflow to avoid an IJC violation on Kootenay Lake, result in trapped storage at both Libby and Duncan. When 1954 is simulated without any relaxation of the 31 December draft target for Libby, there is still trapped storage at Libby and Duncan, but both projects have less than the previous scenario. The results for the 1954 VARQ FC simulations are summarized in Table 3.

Table 3. 1954 Simulation Results – VARQ FC

	LIBBY	**DUNCAN**
31 March FC target elev	2287.00 ft.	1807.7 ft
31 March simulated elev (600 kaf relaxation at Libby)	2329.97 ft	1834.61 ft
31 March simulated elev (no FC relaxation at Libby)	2322.76 ft	1831.74 ft
Trapped storage (600 kaf relaxation at Libby)	772 kaf	345 kaf
Trapped storage (no FC relaxation at Libby)	624 kaf	304 kaf

Water year 1954 deserves examination, as it demonstrates how a relaxed December flood control target combined with increasing within-season forecast changes can compromise flood control. The water year begins with a below-normal 1 December forecast of 5952 kaf. However, the 1 January, 1 February, and 1 March forecasts rise sharply to 7099 kaf, 7924 kaf, and 8655 kaf, respectively. Moreover, these still under-predict the observed April-August runoff volume, which is 9138 kaf. The forecast error for 1954 is within the realm of what can be expected in the future, and clearly shows the impact that hydrologic uncertainty can have on flood control operations. Thus, 1954 was chosen as the threshold year where no relaxation in the 31 December draft requirement should be allowed for the VARQ SRD.

The previously tested years with 1 December PCREG forecasts less that for 1954 (5952 kaf) were then examined to see if the full 600 kaf relaxation was actually contributing to increased likelihood of refill. In many years, the full 600 kaf relaxation was not needed, as the reservoir would still have to be drafted to meet flood control requirements in January, February, or March. The effectiveness of improving refill likelihood by relaxing the 31 December flood control is shown in Table 4.[5]

[4] Water year 2001 was not simulated due to unavailability of required data. The volume forecast from January onward was consistently less than 4000 kaf (64% of normal), and the observed April-August volume was just 3175 kaf (51% of normal). This was an extraordinarily low water year, and no flood control violation would be expected as a result of relaxing the 31 December draft requirement.

[5] Water year 2001 is not included in Table 4 because it was not simulated. It is expected that the full 600 kaf relaxation in water year 2001 would beneficially contribute to improving the likelihood of refill.

Table 4. Effectiveness of Relaxing 31 December Target – VARQ FC			
	1 Dec PCREG forecast (kaf)	**1 Dec PCREG forecast (% of normal)**	**Effectiveness**
1953	4410	70.6	No benefit from relaxation, the 28 Feb FC target governs
1988	4786	76.6	Full 600 kaf relaxation is beneficial
1977	5026	80.4	Full 600 kaf relaxation is beneficial
1994	5289	84.6	Full 600 kaf relaxation is beneficial
1980	5323	85.2	Partial relaxation beneficial, then 31 Jan FC target governs
1973	5327	85.3	No benefit from relaxation, the 31 Jan FC target governs
1970	5526	88.4	Full 600 kaf relaxation is beneficial
1979	5676	90.8	Partial relaxation beneficial, then 31 Jan FC target governs
1955	5676	90.9	Partial relaxation beneficial, then 31 Jan FC target governs
1993	5717	91.5	Partial relaxation beneficial, then 31 Jan FC target governs
1992	5869	93.9	Partial relaxation beneficial, then 31 Jan FC target governs
1983	5877	94.1	No benefit from relaxation, the 28 Feb FC target governs
1957	5882	94.1	No benefit from relaxation, the 15 March FC target governs
1966	5931	94.9	No benefit from relaxation, the 28 Feb FC target governs
1954	5952	95.3	Increased trapped storage from relaxation

Based on these results, the following guidelines for relaxation were developed:

- If 1 Dec forecast >= 5900 kaf (94% of normal), no relaxation
- If 1 Dec forecast <= 5500 kaf (88% of normal), relax draft by 600 kaf
- For 5500 kaf < 1 Dec forecast < 5900 kaf, relax draft by interpolating between 600 and 0 kaf.

Daily flood control simulations with these guidelines were performed. For the years where relaxation would be allowed, simulations demonstrated that the VARQ flood control draft requirements could still be achieved. The simulations provided a means for testing the relaxed December draft in conjunction with the 1938 IJC order on Kootenay Lake. For the simulated years where relaxation would be allowed, the simulations demonstrate that there are no years when trapped storage in the flood control space of Libby or Duncan would occur. Additionally, the stage at Bonners Ferry during the 31 December – 31 March time period remained well below the flood stage of El. 1764 ft for all simulated years where relaxation would be allowed.

IV. RESULTS AND RECOMMENDATIONS

Based on the analyses performed for this study, relaxation of the 31 December draft requirement at Libby should not be permitted for Standard FC. However, relaxation of the 31 December draft requirement at Libby is permissible for VARQ FC. Under VARQ FC, the threshold for requiring full draft of 2000 kaf for the 31 December target should be when the PCREG 1 December forecast volume equals or exceeds 5900 kaf

(94% of normal). For PCREG 1 December forecast volumes equal to or less than 5500 kaf (88% of normal), COE recommends a 600 kaf reduction to 1400 kaf for the end-of-December draft target. (See Paragraph III.a for explanation of 600-kaf reduction in draft). For intermediate PCREG 1 December forecast volumes between 5500 kaf and 5900 kaf, the total reduction in draft should be based on a simple linear interpolation between the two points. For example, a PCREG 1 December forecast volume of 5700 kaf for April-August would result in a draft reduction of 300 kaf for a total draft of 1700 kaf for the 31 December target.

These guidelines were used to develop the proposed new SRD for VARQ FC at Libby that is depicted in Figure 1. Using this proposed new SRD for the period of record 1949 to 2002, the variable draft for 31 December would have been implemented in the following 14 years: 1953, 1955, 1957, 1970, 1973, 1977, 1979, 1980, 1983, 1988, 1992, 1993, 1994, and 2001. Using the reduced 31 December draft requirement, simulations show that additional water would be stored behind Libby Dam at the end of the flood control draft period for many of the years listed above. The amount of additional water stored during each of these years is shown in Figure 2.[6]

V. SUMMARY

- The recommended new SRD for VARQ FC with variable draft for the 31 December target (Figure 1) maintains full downstream local and system flood control. As discussed in Section III.c.2, no trapped storage conditions should be caused by this procedure. The PCREG 1 December forecast volume must be used to determine the variable draft requirements for Libby Project for the 31 December target.

- The recommended new SRD for VARQ FC may improve refill reliability at Lake Koocanusa during years of low flow or drought years, and thereby facilitate flow augmentations requested by USFWS and NMFS for listed fish species downstream.

[6] Water year 2001 is not included in Figure 2 because it was not simulated. It is expected that an additional 600 kaf of water would have been stored in the reservoir on 31 March 2001 as a result of relaxing the 31 December draft requirement.

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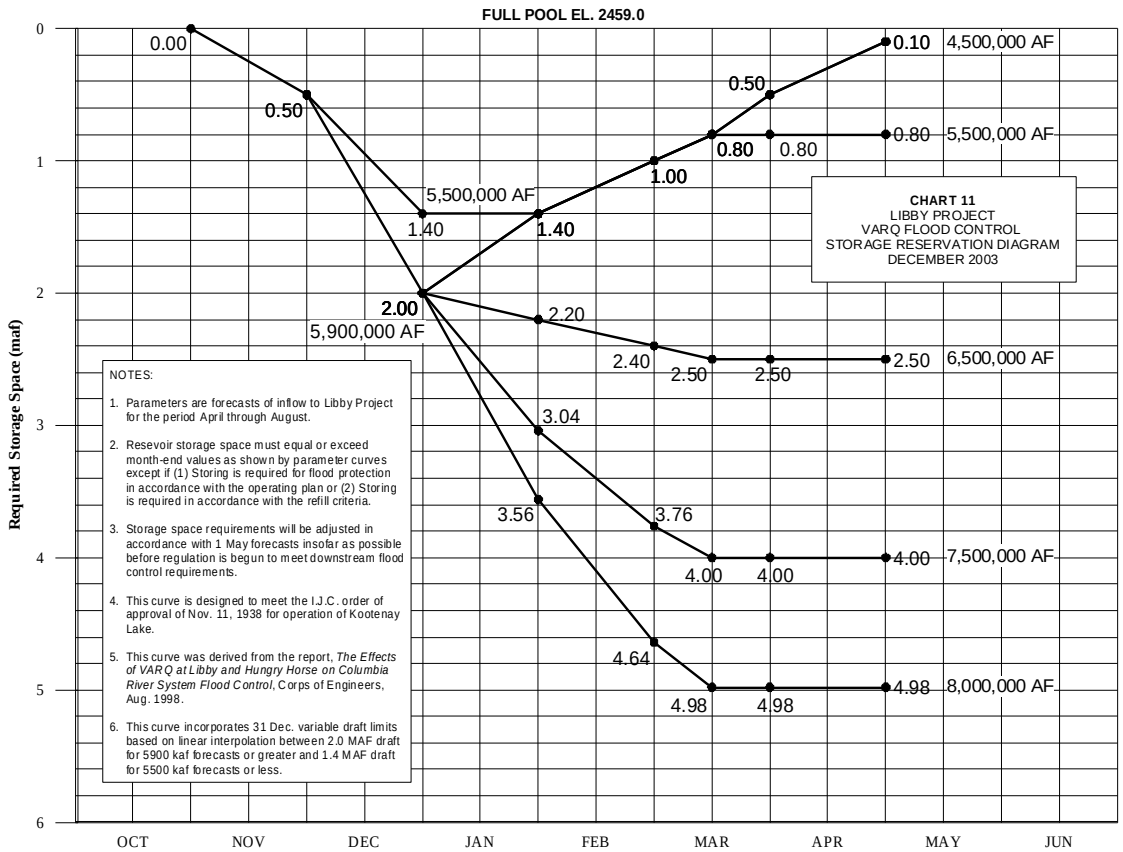

Figure 1 – Storage Reservation Diagram for VARQ Flood Control with variable draft for the 31 December target.

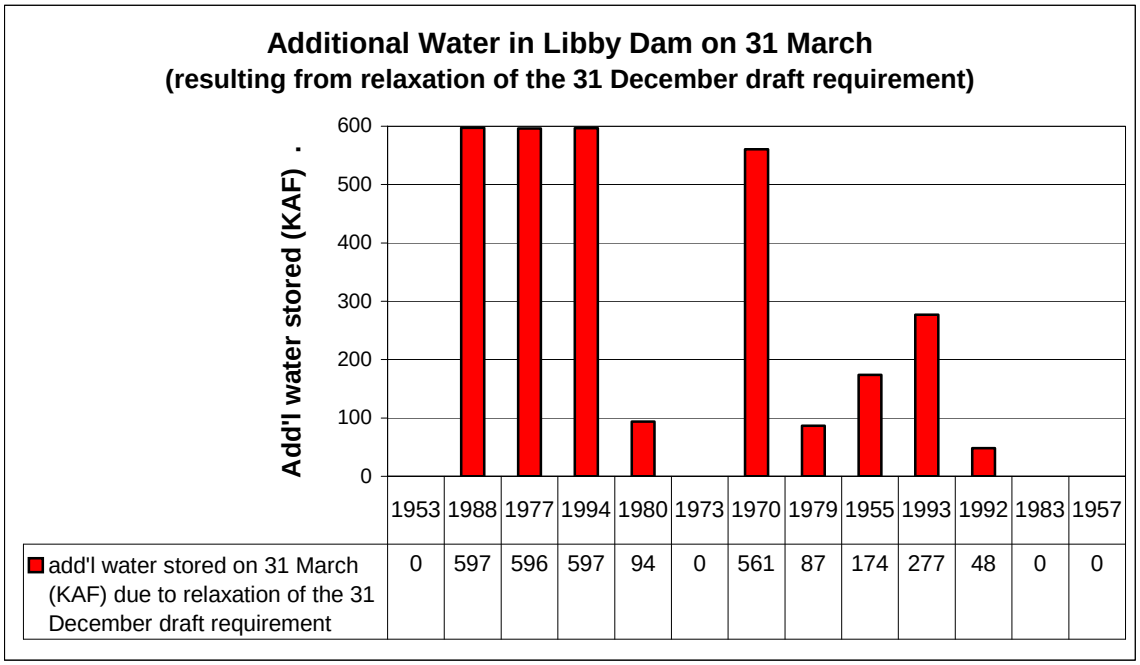

Figure 2 – Additional water stored at Libby Dam on 31 March due to relaxation of the 31 December draft requirement.