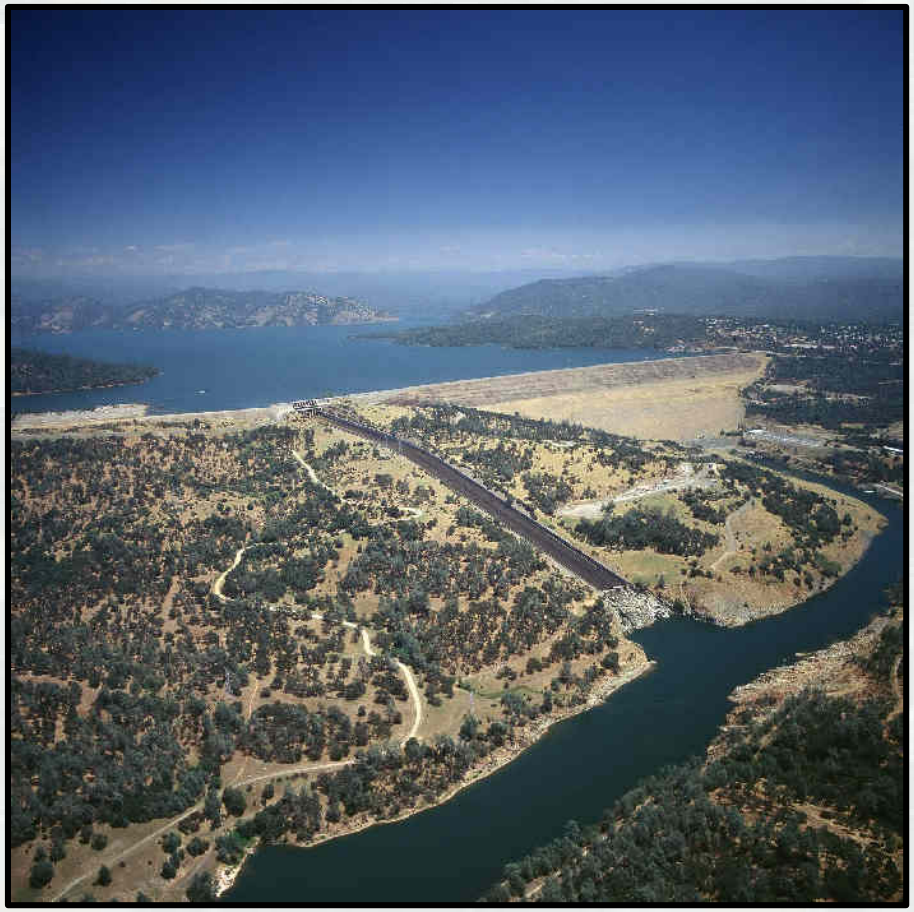
Water Control Diagram Example

Oroville Dam and Reservoir

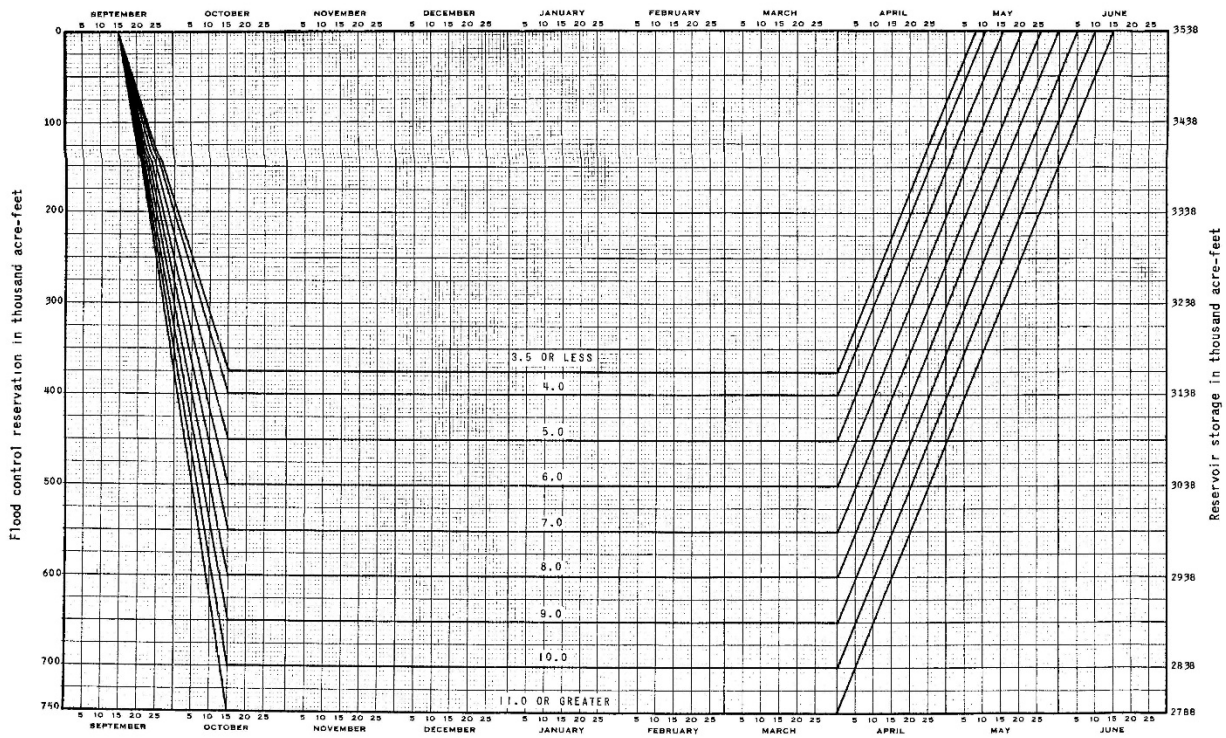


Flood control space varies by:

- **Date**
- **Basin wetness parameter**

Water Control Diagram Example

Oroville Dam and Reservoir



USE OF DIAGRAM

1. Parameters are computed daily from the weighted accumulation of seasonal basin mean precipitation by multiplying the preceding day's parameter by 0.97 and adding the current day's precipitation in inches.

2. Except when releases are governed by the emergency spillway release diagram currently in force (File No. 4-13-586), water stored in the flood control reservation, defined hereon, shall be released as rapidly as possible, subject to the following conditions:

   a. That releases are made according to the release schedule hereon.

   b. That flows in Feather River above Yuba River do not exceed 180,000 c.f.s.

   c. That flows in Feather River below Yuba River do not exceed 300,000 c.f.s.

   d. That flows in Feather River below Bear River do not exceed 320,000 c.f.s. insofar as possible.

   e. That releases are not increased more than 10,000 c.f.s. or decreased more than 5,000 c.f.s. in any 2 hour period.

RELEASE SCHEDULE

ACTUAL OR FORECAST INFLOW (WHICHEVER IS GREATER)	FLOOD CONTROL SPACE USED	REQUIRED RELEASES
c.f.s.	ac-ft	c.f.s.
0 - 15,000	0 - 5,000	Power Demand
0 - 15,000	Greater Than 5,000	Inflow
15,000 - 30,000	0 - 30,000	Lesser of 15,000 or maximum inflow
0 - 30,000	Greater Than 30,000	Maximum inflow for flood
30,000 - 120,000	- - - - - - - -	Lesser of maximum inflow or 60,000 c.f.s.
120,000 - 175,000	- - - - - - - -	Lesser of maximum inflow or 100,000 c.f.s.
Greater Than - 175,000	- - - - - - - -	Lesser of maximum inflow or 150,000 c.f.s.

OROVILLE DAM AND RESERVOIR
FEATHER RIVER, CALIFORNIA

FLOOD CONTROL DIAGRAM

Prepared Pursuant to Flood Control Regulations
For Oroville Dam and Reservoir

APPROVED: F P Koisch
Major General, USA, Director of Civil Works

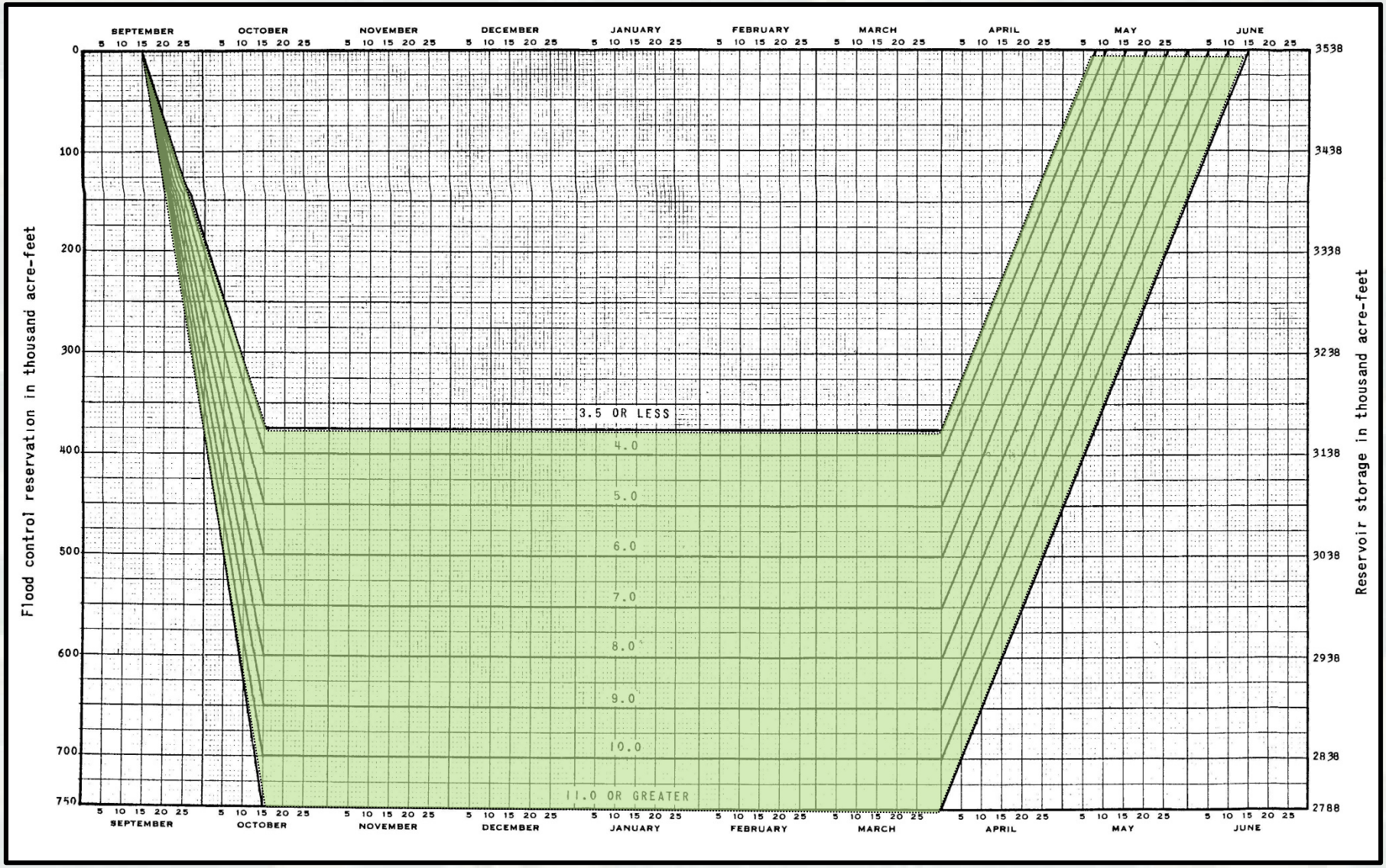
APPROVED: W R Gianelli
Director, Department of Water Resources

Effective Date: [illegible] File No.: 4-13-585

CHART A-1

Water Control Diagram Example

Oroville Dam and Reservoir



Water Control Diagram Example

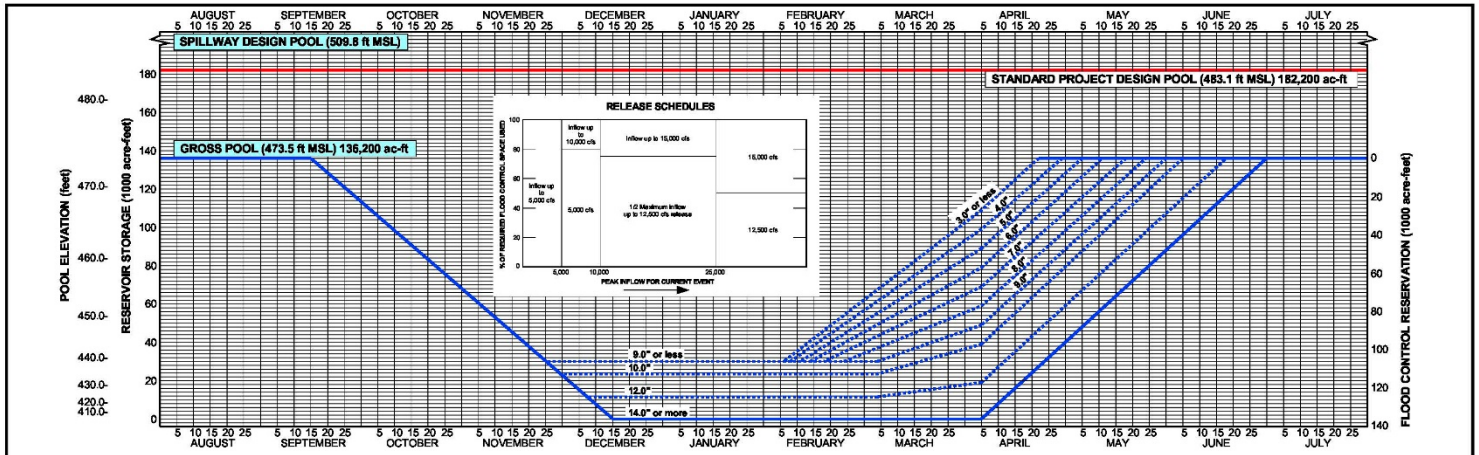
Black Butte Dam and Lake

Flood control space varies by:

- **Date**
- **Upstream storage credit**
- **Basin wetness parameter**

Water Control Diagram Example

Black Butte Dam and Lake



USE OF DIAGRAM

1. Rain flood parameters define the gross flood control reservation required on any given day and are computed daily from the weighted accumulation of the seasonal basin mean precipitation by adding the current day's precipitation in inches to 97 percent of the parameter computed by the preceding day. Sample calculation of required space is shown below.
2. Required gross flood control reservation in Black Butte Lake may be reduced by creditable flood control space known to exist in East Park and Stony Gorge Reservoirs.
3. Creditable transfer flood control space for East Park and Stony Gorge Reservoirs is determined as follows:
   a. The amount of creditable transfer flood control space for East Park Reservoir is computed by taking the smaller of:
      (1) 48,200 acre-feet minus the present storage at East Park or
      (2) 10,000 acre-feet
   b. The amount of creditable transfer flood control space for Stony Gorge Reservoir is computed by the following:
      (1) Between 1 September and 1 February - 28,400 acre-feet (storage at spillway crest) minus the present storage at Stony Gorge.
      (2) Remainder of flood control season - 28,400 acre-feet minus the present storage at Stony Gorge, but not less than zero.
   c. Total creditable transfer space is equal to the summation of Items 3a and 3b but not to exceed 40,000 acre-feet.
4. The flood control requirement in Black Butte Reservoir is equal to the gross flood control reservation minus the total creditable transfer space.
5. When space available for flood control is less than required, as determined above, water shall be released from Black Butte Lake as rapidly as possible, subject to the following conditions:
   a. That releases are made according to the RELEASE SCHEDULE hereon.
   b. That flows in Stony Creek below Black Butte Dam do not exceed 15,000 cfs.
   c. When Sacramento River flows at the latitude of Ord Ferry are forecasted to exceed 130,000 cfs (a stage of 116.2 feet at the Ord Ferry gage), releases from Black Butte should not be greater than inflow.
   d. That no level of release above 1,000 cfs shall be held for more than 18 hours.
   e. That rate of change for flood releases shall not be more than as follows:

Flow Range - increasing (cfs)	Max Rate (cfs/hr)
minimum - <1,000	
0 to <25% encroachment	250
25% to <50% encroachment	500
50% to 100% encroachment	1,000
1,000 - 15,000	1,000

Flow Range - decreasing (cfs)	Max Rate (cfs/hr)
15,000 - 5,000	500
<5,000 - 500	250
<500 - 100	*30
less than 100	10

*limited to 250 cfs/day

SAMPLE COMPUTATION OF REQUIRED FLOOD CONTROL SPACE

1. Computation of today's basin precipitation (P) for Black Butte Lake:

PRECIPITATION STATIONS	NORMAL ANNUAL PRECIPITATION	PRECIPITATION TODAY (P)
Black Butte Dam	17.0"	0.99"
Log Springs	34.0"	3.00"
Trough Springs	49.0"	5.10"
Noel Springs	42.0"	1.40"
Alder Springs	34.0"	4.00"
Total	176.0" (SNAP)	14.49" (STAP)

Basin Normal Annual Precipitation (BNAP) = 32.0"

Basin precipitation computation for today:

P = (BNAP / SNAP) x STAP = (32.0 / 176.0) x 14.49

P = 2.63"

2. Parameter and required flood control space computation:

PAR is today's parameter — PAR = P + (0.97 PAR^1)
PAR^1 is yesterday's parameter
P is today's basin precipitation

MONTH	DAY	P	PAR^1	PAR	REQUIRED FLOOD CONTROL SPACE*
OCT	4	-	-	0.00"	50,300 (ac-ft)
	5	1.78"	0.00"	1.78"	51,800
	6	1.20"	1.78"	2.93"	53,300
	7	0.00"	2.93"	2.84"	54,800
DEC	19	-	-	2.49"	106,400
	20	0.45"	2.49"	2.87"	106,400
	21	1.39"	2.87"	4.17"	106,400
	22	3.83"	4.17"	7.88"	106,400
	23	2.96"	7.88"	10.60"	116,200
	24	0.80"	10.60"	11.06"	119,200

*Determined from flood control diagram

NOTES

1. Black Butte Lake shall be operated for flood control in accordance with this Water Control Diagram.
2. Flood control reservation increases uniformly from a zero requirement on 15 September up to a maximum reservation of 136,200 acre-feet by 15 December (a minimum reservation of 106,400 acre-feet is required from 25 November to 6 February). Conditional flood control reservation up to a maximum of 136,200 acre-feet from 15 December to 5 April, decreasing again to zero on 30 June. The required reservation is determined by use of a ground wetness index during this period.
3. Gross flood control reservation is the total storage required for flood control operations within the Stony Creek Basin reservoir system.
4. Transferable space is that amount of space the required flood control reservation can be reduced by available space in upstream reservoirs, East Park and Stony Gorge. The amount of available space that can be credited to transferable space is discussed in the USE OF DIAGRAM.

Developed by PEP - Prepared by JSM

BLACK BUTTE DAM AND LAKE
STONY CREEK, CALIFORNIA

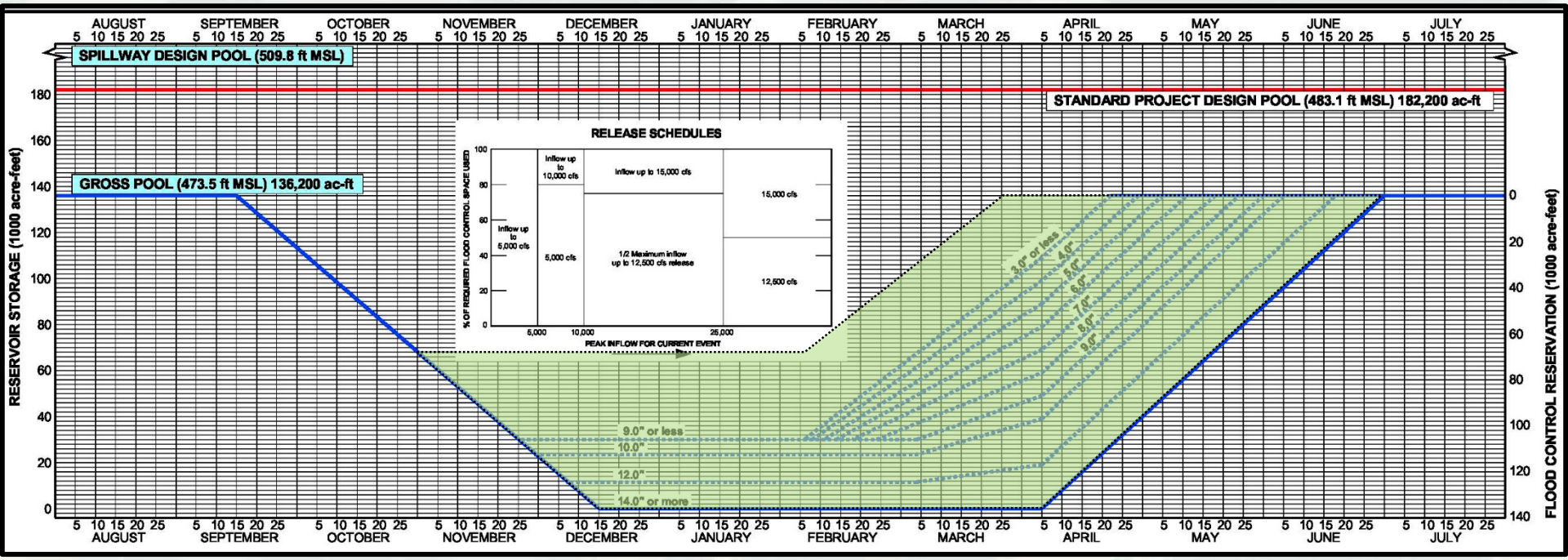
WATER CONTROL DIAGRAM (INTERIM)

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Revised Feb 2005 PLATE A-8

Water Control Diagram Example

Black Butte Dam and Lake



BUILDING STRONG®

Water Control Diagram Example

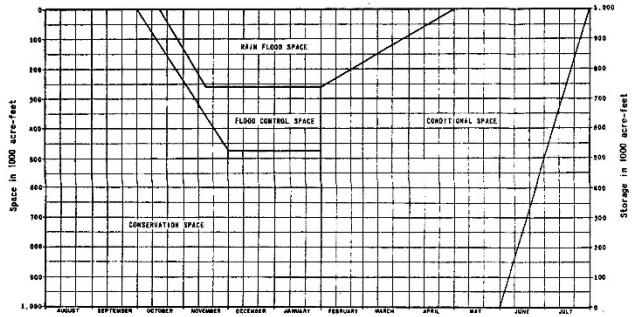
Pine Flat Dam and Reservoir

Flood control space varies by:

- **Date**
- **Upstream storage credit**
- **Snowmelt parameter**

Water Control Diagram Example

Pine Flat Dam and Lake



USE OF DIAGRAM

1. When the storage level is in the range of Conservation Space, flood releases are not required.
2. Water stored in Flood Control Space shall be released as rapidly as possible without exceeding 6,750 c.f.s. below Crescent Weir or causing flood flows to Kings River South. The Flood Control Space shall be decreased by the space available in Wishon and Courtright Reservoirs less 20,000 acre-feet.
3. When water is stored in Rain Flood Space, releases shall be increased to maximum channel capacity to Kings River North and up to maximum channel capacity to Kings River South as necessary to evacuate the Rain Flood Space within 10 days. The Rain Flood Space shall not be reduced by space in upstream reservoirs.
4. When water is stored in the portion of the Conditional Space required for flood control, a supplemental release in addition to irrigation demand must be made. The amount of Conditional Space required for flood control, on a given date, is determined from the forecasted full natural runoff into Pine Flat Lake and the forecasted irrigation demand from that date to 10 June (after 26 May use the forecasted irrigation demand for the next 15 days or until 31 July, whichever is less) using the adjacent diagram. The adjacent diagram is also used to compute the supplemental release.

ADDITIONAL CONSIDERATIONS

1. Reservoir releases will be determined by the instructions hereon unless larger releases are required by the Emergency Spillway Release Diagram (Chart A-7).
2. The Corps of Engineers may direct flood releases to be increased or decreased when deviation from the computed release is warranted by existing conditions.
3. Insofar as possible, the release from Pine Flat shall not cause the flow in any reach of Kings River or Kings River distributaries to exceed the safe channel capacity as determined by the Corps of Engineers at the time of occurrence.
4. The Corps of Engineers may increase or decrease the 20,000 acre-foot adjustment to space transferals from Wishon and Courtright reservoirs based on forecasted runoff and reservoir operation.
5. When the San Joaquin River below Mendota is at flood stage the releases to Kings River North shall not be greater than pre-project flow.

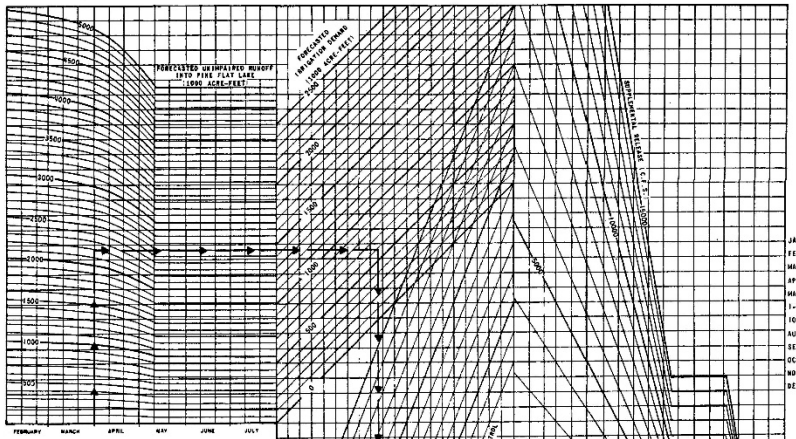
CONDITIONAL SPACE REQUIRED FOR FLOOD CONTROL COMPUTATION

1. Enter margin "A" for the date the required space is being computed, and move upward vertically to the Forecasted Unimpaired Runoff into Pine Flat Lake parameter, which indicates the runoff from that date through 31 July.
2. Move horizontally from the forecasted unimpaired runoff into Pine Flat Lake to the forecasted irrigation Demand from that given date to 10 June* (after 26 May use the Forecasted Irrigation Demand for the next 15 days or until 31 July, whichever is less).
3. Move vertically downward from the forecasted irrigation Demand to margin "B" to obtain Total Space Required for Flood Control. Decrease this volume by the space available in Wishon and Courtright Reservoirs (less 20,000 acre-feet) to obtain the Conditional Space required for flood control in Pine Flat Lake.

* Irrigation Demands shall be the amount of water determined by the Kings River Watermaster to satisfy diversion requirements, channel losses, spreading, sinking, and other uses.

SUPPLEMENTAL RELEASE COMPUTATION

1. Perform Steps 1 and 2 above using the date for which the release is being computed.
2. Move vertically downward from the Forecasted Irrigation Demand to the Total Space Available for Flood Control on the given date which is the total space available in Pine Flat Lake and Courtright and Wishon Reservoirs (less 20,000 acre-feet).
3. Move horizontally from the Total Space Available for Flood Control to the point directly above the given date on margin "C" to obtain the Supplemental Release (interpolate as required). The Supplemental release must be added to the irrigation demand to obtain the total release.



A

SAMPLE COMPUTATION

GIVEN DATA:

Date	1 April
Forecasted runoff from date to 31 July	2,200,000 ac-ft
Forecasted irrigation demand from date through 9 June	590,000 ac-ft
Requested irrigation release on 1 April	3,000 cfs
Space available in Pine Flat Lake	350,000
Space available in Wishon Reservoir	100,000
Space available in Courtright Reservoir	82,000

COMPUTATION OF CONDITIONAL SPACE REQUIRED FOR FLOOD CONTROL:

Total space required for flood control (from diagram) . . . . . 865,000 ac-ft

Conditional Reservation Required for Flood control in Pine Flat Lake:

865,000 - (100,000 + 82,000 - 20,000 = 703,000 ac-ft

COMPUTATION OF TOTAL RELEASE FROM PINE FLAT LAKE:

Total space available for flood control . . . .

300,000 + (100,000 + 82,000 - 20,000 = 462,000

Supplemental release (from diagram) . . . . . 2,900 cfs

Total release . . . . . 3,000 + 2,900 = 5,900 cfs

Total space required for flood control (1000 acre-feet)

B

C

NORMAL IRRIGATION DEMAND

	(1000 A.F.)	(MEAN C.F.S.)
JANUARY	23	374
FEBRUARY	78	1350
MARCH	122	1960
APRIL	170	2860
MAY	257	4180
1-9 JUNE	104	5630
10 JUNE-31 JULY	565	6450
AUGUST	188	3060
SEPTEMBER	133	2240
OCTOBER	18	293
NOVEMBER	5	84
DECEMBER	19	309

PINE FLAT LAKE
KINGS RIVER, CALIFORNIA

FLOOD CONTROL DIAGRAM

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

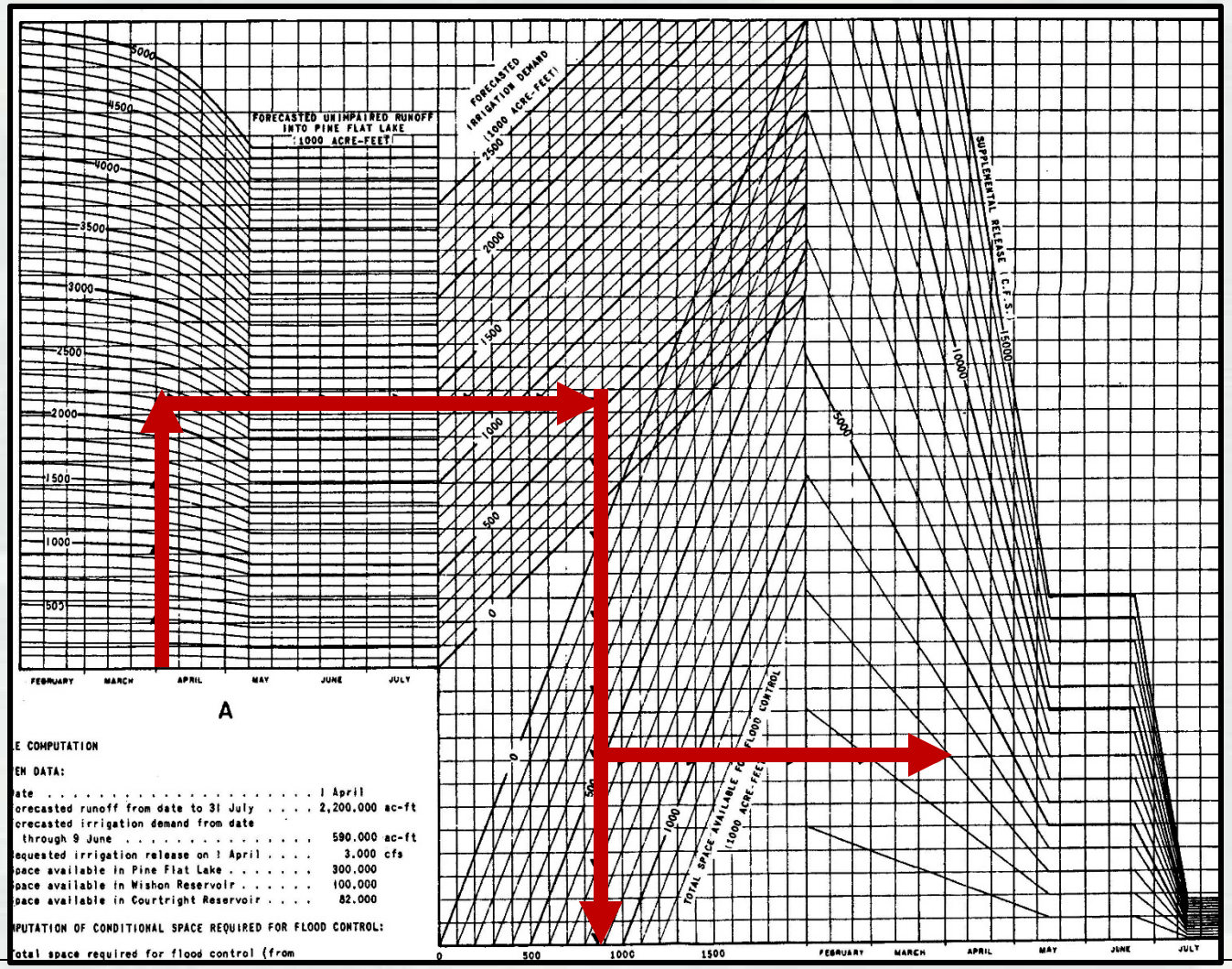
Prepared: H.T.M. Date: MARCH 1979
Drawn: L.H.C.

CHART A-8

BUILDING STRONG®

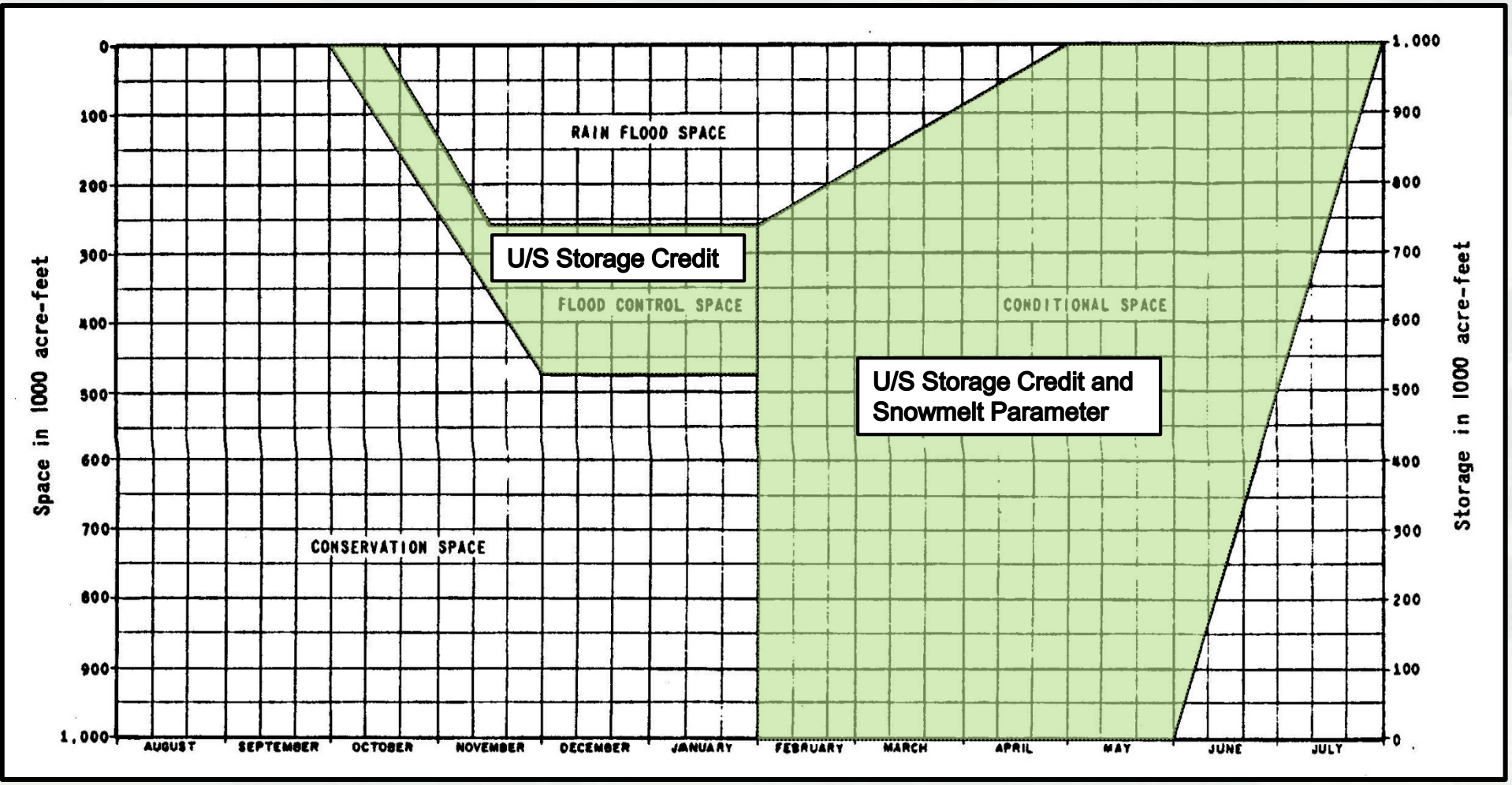
Water Control Diagram Example

Pine Flat Dam and Lake



Water Control Diagram Example

Pine Flat Dam and Lake



Summary

- There are several ways in which buffer zones can be implemented into water control diagrams

- Commonly, the shapes that buffer zones take are due to:
  - Upstream storage credit
  - Basin wetness parameters
  - Snowmelt parameters

- The difficulty of determining where the top of conservation fits inside the buffer zones can be easy (i.e. Oroville) or hard (i.e. Pine Flat)

Questions or Comments

Thank You