VIII - EFFECT OF WATER CONTROL PLAN

8-01. General

The sole purpose of Brea Dam is flood control, and by far the greatest effect and benefit of the dam is the protection of life and property downstream of the facility. The major aspects of flood control at Brea Dam for both the reservoir and spillway design floods, as well as several major historical floods, are discussed in section 8-02.

8-02. Flood Control

a. Spillway Design Flood. The spillway of the dam is designed to pass, without danger to the dam or threat of overtopping the dam, the greatest rate of discharge that could be expected from the most severe combination of rainfall and runoff conditions that could reasonably occur.

(1) Original Criteria. The spillway at Brea Dam was designed in 1939 for a peak outflow of 14,500 cfs, having a surcharge of 8.7 feet above the ogee spillway (with crest elev. at 279 feet). An additional 7 feet of freeboard set the top of the dam at elevation 295 feet.

This spillway design resulted from a hypothetical 24-hour storm that produced 10. 14 inches of rain during the 24 hours, as averaged over the drainage area above Brea Dam. Such a storm would result in a peak inflow of 16,800 cfs and a maximum impoundment level of 287.7 feet.

(2) Revised Criteria. In a subsequent 1969 study, the adequacy of the Brea Dam spillway was reviewed under revised criteria. Estimates of Probable Maximum Precipitation (PMP) for the basins in the Los Angeles area were furnished by the Hydrometeorological Section of the U.S. Weather Bureau in October 1968. The report indicated that the highest rate of discharge from the drainage area for the Brea Dam would result from a 6-hour convective-type storm.

The 1/2-, 1-, 3-, and 6-hour precipitation during the Probable Maximum Storm resulted in 3.1, 4.5, 6.4 and 7.5 inches, respectively. A minimum loss rate of 0.10 inch per hour was assumed to prevail throughout the probable maximum storm. In the development of the Probable Maximum Flood (PMF), 40 percent of the area was considered impervious. In this area, base flow would be only a nominal addition to a flood of probable maximum magnitude. The PMF peak inflow for Brea Dam is 37,000 cfs, and the hydrograph is shown on plate 8-01.

The PMF was routed through the spillway assuming the outlet gates were closed and inoperative and the pool level was at spillway crest at the start of the routing. The peak outflow was 27,000 cfs and the maximum pool elevation would be 292.16 feet.

b. Standard Project Flood. The Standard Project Flood (SPF) represents the runoff event that would result from the most severe combination of rainfall and watershed conditions that are considered reasonably characteristic for the region in question. The Corps of Engineers has replaced the Standard Project Flood in favor of the National Economic Development (NED) Criteria for formulating water control plans. Nevertheless, the Standard Project Flood was examined in the development of the Brea Dam Water Control Plan. The resultant level of flood protection was equal to that which would have been developed under NED Criteria.

For the rainfall to be used in the determination of the SPF at a given site, a Standard Project Storm is selected as the most severe reasonably characteristic storm of record within a climatically homogeneous region surrounding the site, and is then transposed to the drainage area upstream of the target site.

The storm of 30 December 1933-1 January 1934, which was centered over the La Cresenta area north of Los Angeles was transposed over the Brea Dam drainage area. The isopercentual lines (expressing precipitation depths in percent of mean seasonal precipitation) were superimposed over the area in such a way as to produce the greatest project storm rainfall amounts that would be consistent with reasonable assumptions concerning the causative meteorological situation. The maximum l-, 6-, 24- And 42-hour (total storm) average precipitation over the area was 0.86, 3.65, 10.00, and 10.95 inches respectively. A variable loss rate with an average of 0.20 inch per hour and a minimum of 0.10 inch per hour was assumed for Tonner and Brea Canyons. An average constant rate of 0.20 inch per hour was considered applicable for the valley areas. In the development of the SPF, 40 percent of the valley areas was considered all impervious. Runoff was computed by a synthetic unit hydrograph determined by the use of the lag curve, using average n-values ranging from 0.02 to 0.03 and the average Fullerton and San Jose S-graph, both of which were derived from data developed in studies of comparable drainage areas in southern California. The SPF peak inflow computed for Brea Dam is 8,000 cfs; the hydrograph is shown on plate 8-02.

c. n-Year Flood. The n-year flood is a flood that has a 1/n probability of being equaled or exceeded in any one given year. The discharge frequency relationship for inflow to Brea Dam was determined by statistical analyses (log Pearson Type III distribution) of historical inflows to the Brea Reservoir. Plate 8-03 shows the inflow frequency curves for 0- (i.e., instantaneous), l-, 3-, 6-, 12-, 24-, and 48-hour durations.

Balanced hydrographs for 500-, 200-, 100-, 50-, 25-, and 10-year floods were derived b using the Standard Project Storm pattern and, by trial and error, matching the n-year peak of the Brea Dam inflow discharge frequency curve for various durations. A constant loss rate of 0.20 in/hr was adopted. The discharge values for 0-, l-, 3-, 6-, 12-, 24-, and 48-hour duration of each frequency of flood are tabulated in table 8-01.

Table 8-01

Inflow Frequency Values for Various Durations

Return Period (Year)	500	200	100	50	25	10	5	2
0-hr	13500	10400	8210	6230	4480	2540	410	380
1-hr	11400	8890	7080	5370	3820	2080	1080	237
3-hr	9080	7090	5660	4300	3070	1680	880	196
6-hr	7510	5870	4680	3560	2540	1390	726	161
12-hr	5610	4390	3520	2680	1920	1060	555	125
24-hr	3910	3060	2440	1860	1330	732	384	86
48-hr	2470	1950	1560	1200	860	479	254	59

Note: 1. All values are in cfs.

2. Values are determined by statistical analyses of historical inflows to the Brea Dam.

3. Values are plotted on plate 8-03.

The 500-, 200-, 100-, 50-, 25-, and 10-year floods are routed through the reservoir using previous (table 7-01) and current operation plans. Inflow and outflow hydrographs at the dam for both plans are shown on plates 8-04 through 809, and the peak outflows and maximum pool elevations are tabulated in table 802. Plates 8-04 through 8-09 also show results of routing using the backup plan. The outflow and water surface elevation frequency curves computed for the current regulation schedule are shown on plate 8-10 and 8-11, respectively.

Table 8-02.

Outflow and Elevation Frequency Values

Return Period Year	500	200	100	50	25	10
Outflow (cfs)	5644	1500	1486	1500	1500	1351
Maximum Elevation (ft., NGVD)	283.5	277.9	268.9	257.7	245.07	230.5

Note: These values were obtained from the reservoir routing using the current operation plan and they are plotted on plates 8-10 and 8-11.

d. Historical Storms and Floods. Most of the major inflow and impoundment events in the history of Brea Dam have been the result of general winter storms, but several local thunderstorms have produced significant peak inflows.

Prior to the construction of the dam, there were a number of major storms and floods on southern California streams, including those of January 1862, February and March 1884, February 1891, January and February 1914, January 1916, December 1921, April 1926, February 1927, December 1933-January 1934, October 1934, February 1937, and February-March 1938. There was also a significant late summer tropical storm in September 1939; and shortly before Brea Dam was placed in operation, a heavy local thunderstorm struck the watershed in March 1941.

Since the dam was completed, there have been several major storms and inflows, including those of January 1943, January and March 1952, January 1956, January and February 1969, December 1974, February 1978, February-March 1978, January 1979, January-February 1979, January and February 1980, and February-March 1983.

Several of the more significant storms and floods are discussed below:

(1) Storms of January 1916. Two major series of general winter storms hit southern California during January 1916, as intense cold fronts dropped down the coast from the north, then turned inland. The first series occurred 14-20 January and dropped about 6-7 inches over Fullerton and vicinity. Yorba Linda measured 6.38 inches for the storm period, including 3.52 inches on 17 January. The second storm series occurred 24-30 January and was generally somewhat less heavy; but ground conditions, saturated from the first storm, were more favorable for runoff. About 4 inches fell in the vicinity of Fullerton. Yorba Linda measured 3.98 inches, including 3.01 inches on 27 January. No discharge values or dates are available for Brea Creek.

(2) Storm and Flood of 30 December 1933 - 1 January 1934. A slow-moving low latitude North Pacific storm moved directly into southern California at the end of 1933 and dropped record-setting 24- to 48-hour precipitation from Los Angeles northward through the San Gabriel Mountains. The center of the storm was in La Crescenta and vicinity (see section 8-02.b.). Heavy precipitation also fell in Orange County, with total rainfall in the vicinity of Fullerton generally between 5 and 6 inches. Yorba Linda measured 5.44 inches. More than half of this rain fell within 24 hours between approximately noon of 31 December and noon of 1 January. Very heavy rain fell near midnight at the turn of the year. The peak runoff of the 1933-34 season on Brea Creek occurred on 1 January.

(3) Storm and Flood of 27 February - 3 March 1938. The general winter storm of 27 January - 3 March 1938 resulted when high pressure over California and Nevada pushed northward and allowed a series of low-latitude Pacific storms to move into southern California from the west-southwest. These storms produced an average of about 10 inches of rainfall over the watershed above Brea Dam, with roughly 4.5 inches falling on 2 March, the day of the most intense cold front of the storm series. This 2 March rain, falling on saturated ground, caused severe flooding on most of the larger streams in southern California. On Brea Creek, a peak flow of about 2,000 cfs was measured at the USGS gauge downstream of the site of the reservoir.

(4) Storm and Flood of 14 March 1941. On the af ternoon of 14 March 1941, as part of a moderately heavy general winter storm, an intense local thunderstorm occurred in the vicinity of the City of Fullerton, producing more than two inches of rainfall in less than one hour. With ground saturated from months of heavy rain, the peak discharge from Brea Creek was 3,700 cfs at the USGS gauge downstream of the reservoir site.

(5) Storm and Flood of 16-18 January 1952. As the climax of a long series of winter storms that dropped southeastward from out of the Gulf of Alaska, a deep low and strong cold front moved slowly across southern California during mid January. Stations in the Fullerton-Yorba Linda area all measured totals around 6 inches for the three days. The heaviest rainfall came in bursts of about 1 inch in 2 hours early 16 January, about 0.6 inch in 1 hour mid-afternoon 17 January, and during the 8-hour period ending at 0600 hours 18 January, when 2.42 inches fell at Brea Dam and 1.98 inches at Fullerton Dam. By 18 January, most ground was highly saturated, and the maximum inflow to Brea Reservoir for that storm occurred on 18 January about 0300 hours, with a peak value of approximately 1,000 cfs.

(6) Storms and Floods of 19-27 January 1969. In January 1969 a storm track developed from the equatorial zone southeast of Hawaii all the way to southern California. As the result, four intense storms and several minor rain bands passed through southern California during a 9-day period. Although storm totals of 40- 50 inches in the San Gabriel Mountains resulted in severe flooding in many watersheds, only about 4.5 inches of rain fell on the Brea watershed, including 1.32 inches between 0600 and 1400 hours 25 January. Plate 8-12 depicts the hyetographs of hourly rainfall at Brea Dam and the inflow, outflow, and water surface elevation hydrographs for Brea Reservoir during the 24-26 January 1969 storm period. With ground saturated from a week of antecedent storminess, the 25 January rain generated a peak inflow to the reservoir of about 1,350 cfs (peak hourly 1,192 cfs) just before 1500 hours and a maximum water surface elevation of 245.3 feet at 2000 hours.

(7) Storms and Floods of 3-4 December 1974. A strong, slow-moving cold front passed through southern California during the night of 3-4 December 1974. Rain was especially heavy in the coastal sections of Orange County. A total of 2.75 inches of rain fell at Brea Dam between 1900 hours 3 December and 1200 hours 4 December, including 1.02 inches in 1 hour 0400-0500 4 December. Fullerton Dam and Orange County Reservoir recorded 0.90 and 0.78 inch respectively during the same hour. Relatively dry antecedent conditions limited the peak inflow to Brea Reservoir to approximately 2,150 cfs at 0645 hours 4 December.

(8) Storms and Floods of 28 February - 6 March 1978. In a pattern very similar to that of exactly 40 years earlier, a series of low-latitude Pacific storms moved into southern California at the end of February and beginning of March 1978. There were several major peaks of rainfall and inflow during the storm period (pl. 8-13), including 1 March (most rapid rise of inflow and water surface of the storm period), 4 March (greatest volume of rainfall and runoff), and 5 March (greatest short-term rainfall intensity). A total of about 8.5 inches of rain fell at Brea Dam during these storms, with an estimated 11 inches averaged over the watershed. Of this, 2.05 inches fell on 1 March, with 2.34 inches on 4 March. These rains, on ground saturated by a wet winter, produced peak inflow to the reservoir of approximately 2,200 cfs (peak hourly 1,727 cfs) on 4 March about 1900 hours, and a maximum water surface elevation of 231.4 feet on 4 March about 2030 hours.

(9) Storm and Flood of 5 January 1979. On 5 January 1979 a cold storm dropped rapidly southward from the Gulf of Alaska, spreading general moderate rain over most of southern California. Most of the rain had ended by mid-evening, but an intense post-frontal thunderstorm hit the Fullerton area just before midnight. Brea Dam recorded 1.30 inches between 2200 and 2400 hours, and Fullerton Dam recorded 1.35 inches between 2100 and 2300 hours. The storm totals ending early 6 January were 3.28 and 3.02 inches at the respective dams. This thunderstorm resulted in a very rapid rise in the inflow rate to Brea Reservoir, with a peak of about 2,300 cfs at 0015 hours 6 January and a maximum water surface elevation of 231.5 feet on 6 January at 0200 hours.

(10) Storm and Flood of 30 January - 2 February 1979. Near the end of January 1979 a cold cut-off low pressure center dropped southward off the coast of California and picked up moisture over the water west of southern California. Locally heavy rain developed during the afternoon of 30 January and became heavy during the early evening. Brea Dam measured 1.70 inches between 1900 and 2200 hours, while Fullerton Dam measured 1.61 inches between 1800 and 2100 hours. Brief heavy showers continued on 31 January, with light showers through 2 February. With the ground moderately saturated from preceding rains, the peak inflow to Brea Reservoir that occurred on 30 January at 2145 hours was approximately 1,600 cfs, and the peak water surface elevation of 31 January at 0100 hours-was 232.9 feet.

(11) Storm and Flood of 13-18 February 1980. From 13 through 21 February 1980 a series of intense, warm Pacific storms moved into southern California from out of the west-southwest, dropping a total of 10-13 inches of rain during the 6 days 13-18 February. The Yorba Linda station measured 11.69 inches for the period, including 2.50, 1.65, and 2.05 inches in the 24-hour periods ending at 1800 hours on 14, 16, and 18 February respectively. Although data from several northern Orange County recording rain gauges were not reported for February 1980, the rainfall intensities from stations a few miles away indicate up to 0.6 inch in 1 hour and up to 1.4 inches in 3 hours late 13 February and relatively high rates during other portions of the storm as well. Plate 8-14 shows four periods of rainfall and four corresponding major rises in inflow and water surface elevation at Brea Reservoir during the period. Although the 13 February rainfall was the heaviest, the progressive saturation of the ground led to higher runoff values during the latter two rainfall periods. The peak inflow to Brea Reservoir occurred about 1900 hours 16 February, with approximately 2,500 cfs (peak hourly 2,240 cfs), while the maximum water surface elevation of 246.0 feet occurred 18 February from 0800 to 0900 hours.

(12) Storm and Flood of 27 February - 3 March 1983. A low-latitude Pacific storm reminiscent of those of 5 and 45 years earlier moved into southern California at the end of February and first of March 1983, with 5-8 inches of rain over portions of Orange County. This storm was the climax of a pattern of such storms that had prevailed since mid-January. The heaviest rainfall of the season occurred with the passage of a strong occluded cold front during the late morning of 1 March, with peak intensities well in excess of 1 inch per hour.

The inflow to Brea Reservoir consisted of three broad periods from 27 February to 3 March (pl. 8-15), with the middle period of 1 March by far the most intense. The saturation of the ground by abundant antecedent precipitation helped push the maximum 15-minute peak inflow to 3,610 cfs (peak hourly 2,625 cfs) at 1315 hours 1 March and the maximum water surface elevation of the reservoir to 252.0 feet from 1630 to 1700 hours that day. These values represent the greatest inflow and water surface elevation ever recorded at Brea Dam. For comparison, the 3,700 cfs of 14 March 1941 was measured by the USGS gauge some distance downstream of the reservoir site.

e. Comparison of Floods. The current operation plan was used to route the following historical floods: January 1969, December 1974, March 1978, January 1979, and February 1980. Inflow hydrographs, outflows, and reservoir elevations resulting from these routings are shown on plates 8-16 through 8 - Plate 8-21 is a comparison of these five historical floods, the SPF, the PMF, and the 100-year flood; all of these floods were routed using the current operation plan. Plate 8-22 is a listing of flood magnitudes for the floods shown on plate 8-21. the four diagrams on plate 8-21 depict the maximum values of water surface elevation, reservoir contents, the mean hourly inflows and outflows for the five historical floods, the SPF, the 100-year flood, and the PMF.

8-03. Recreation

None of the recreational facilities in Brea Reservoir depend upon runoff water impounded behind the dam. Thus, there are no direct recreational benefits that result from the dam or its operation. The recreational facilities were constructed because the land within the reservoir could not be used for other purposes. Thus, there is an indirect benefit of the project upon recreation.

The effects of the dam and its operation upon the recreational facilities within the reservoir are by necessity all negative, that is, some of these facilities are occasionally flooded by the impoundment of water behind the dam for flood control. These recreational facilities were constructed and are operated with this understanding.

8-04. Water Quality

There are no benefits of Brea Dam to the water quality of Brea Creek. On the other hand, Brea Creek and its operation should not in any way contribute to the degradation of the water quality of the river. An oil spill has historically occurred; a contingency plan should be prepared jointly by the oil well owner and the U.S. Army Corps of Engineers to reduce the effects of such a spill in the case of its future occurrence.

8-05. Fish and Wildlife

The reservoir lands that constitute the Brea Flood Control Basin provide open space and some natural riparian habitat in the middle of an extensive urban area, thereby providing very important wildlife habitat. About 30 species of birds have been identified in the area. Five of those species being purely migratory, remain for only short periods.

Flooding within the reservoir basin is relatively uncommon (especially May-October) and is usually not prolonged, and therefore does not normally cause serious adverse impact upon biological resources within the basin, although some impacts are inevitable. Wildlife taking refuge in borrows, or slow-moving species might be trapped and killed by flooding.

Flooding within the reservoir basin also has a beneficial impact upon some wildlife. Large numbers of migratory waterfowl utilize low-lying flooded areas within the basin for wintering.

8-06. Frequencies

a. Peak Inflow and Outflow Probabilities. Plates 8-03 and 8-10 are graphs of the inflow and outflow frequencies at Brea Dam. The 0-, l-, 3-, 6-, 12-, 24-, and 48hour peak inflow frequency curves were plotted based on statistical analysis (log Pearson Type III distribution) of historical data.

The outflow curve of plate 8-10, reflects the Brea Dam Water Control Plan. The plate shows the current control plan conditions. A sharp break in the slope of the outflow frequency curve reflects the fact that outflow rate increases rapidly for any additional rise in the reservoir water surface elevation over the spillway crest elevation at 279 feet. A maximum reservoir release of 1,500 cfs is made for floods between the 10-year and 200-year frequencies, while the release is 5,644 cfs for the 500-year flood. Table 8-02 lists the outflow frequency values plotted on plate 8-10.

b. Pool Elevation Frequency. Plate 8-11 shows the reservoir elevation frequency curves for Brea Reservoir based on current water control plan conditions. The values of the curve at specific return periods are listed in table 8-02.

8-07. Other Studies

a. Flood Control Regulation. The "Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Prado, Brea, Fullerton, and Salinas Dams", dated November 1969, presents the derivation of the Probable Maximum and Standard Project Floods used in this manual. The report entitled "Coyote Creek Tributaries Santa Ana River Basin, Orange County, California, Interim 3, Hydrology Documentation", dated May 1984 was used as the basis for the hydrologic parameters used in this manual.

b. Channel and Floodway Improvements. The downstream channel from Brea Dam is maintained by the Orange County Environmental Management Agency (OCEMA). No floodplain management studies addressing the downstream channel have been conducted by the U.S. Army Corps of Engineers. A Flood Insurance Study has been completed by the Federal Emergency Management Agency (FEMA).