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REPORT
ON
NOVEMBER-DECEMBER 1950 FLOODS

SACRAMENTO-SAN JOAQUIN RIVER BASINS, CALIFORNIA
&
TRUCKEE, CARSON & WALKER RIVERS, CALIFORNIA & NEVADA

MARCH 1951

SACRAMENTO DISTRICT
CORPS OF ENGINEERS - U.S. ARMY
SACRAMENTO, CALIFORNIA

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Report on November-December 1950 Floods

SACRAMENTO-SAN JOAQUIN RIVER BASINS, CALIFORNIA AND TRUCKEE, CARSON, AND WALKER RIVERS, CALIFORNIA AND NEVADA

March 1951

REPORT ON NOVEMBER-DECEMBER 1950 FLOODS
SACRAMENTO-SAN JOAQUIN RIVER BASINS, CALIFORNIA
AND TRUCKEE, CARSON, AND WALKER RIVERS, CALIFORNIA AND NEVADA

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1. Introduction. - This is a report on the severe and widespread floods which occurred throughout the Sacramento and San Joaquin River Basins in California and Truckee, Carson, and Walker River Basins in California and Nevada during the latter part of November and the early part of December 1950. These floods were remarkable in extent, severity, and duration, and at many localities were the most destructive experienced over the 40 or 50-year period of record. The purpose of this report is to present information which has been gathered on the floods, including rainfall, run-off, and damage data, and to examine the effects of existing and proposed improvements on flood flows and damages. In order that a discussion of the principal features and effects of the floods may not be made too lengthy by the inclusion of the voluminous, detailed data which were collected for record purposes, such data have been eliminated from the main report and assembled separately in appendix A, entitled "Detailed Supporting Data." The authority for the preparation of this report is contained in paragraph 4223.05d of Orders and Regulations. The November-December 1950 floods are classed as category A floods (major floods, over wide areas, causing extensive property damage).

2. Description of area. - The Sacramento-San Joaquin Basins of California comprise a mountain-inclosed basin some 500 miles in length and 120 miles in width, consisting of the combined watersheds of the Sacramento and San Joaquin River systems and comprising more than one-third of the total area of the State. The two rivers join near the middle of the valley and drain westward through a common estuary to the Pacific Ocean, via San Francisco Bay. At this junction the rivers have formed a low-lying delta which is crossed by a maze of winding, sluggish channels and sloughs, and tidal influence extends through this delta area. The Sacramento River rises in the vicinity of Mount Shasta and flows south and southwest to the delta. In its upper course it is a swift-flowing mountain stream inclosed by steep walls, but north of Red Bluff it breaks out onto the valley floor and proceeds southward in a meandering course. Numerous tributaries from both the Sierra Nevada and Coast Range Mountains enter the river, the most important of which are the Feather River system, including the Yuba and Bear Rivers, and the American River from the east, and Stony, Cache, and Putah Creeks from the west. The Sacramento River drains a total area of about 26,000 square miles. The San Joaquin River rises in the Sierras northeast of Fresno, flows westward to the center of the valley floor, and there turns northwest to the delta. The Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus Rivers are the principal tributaries draining the Sierra Nevada. Three other streams from the Sierras--the Calaveras, Mokelumne, and Cosumnes Rivers--enter the delta directly.

The total drainage area of the San Joaquin Basin is about 20,000 square miles.

3. The southern end of the San Joaquin Valley is normally a closed basin, comprising some 13,000 square miles. This area, commonly referred to as the Tulare Basin, is drained principally by the Kings, Kaweah, Tule, and Kern Rivers which discharge into the sump of Tulare Lake. During years of normal run-off, all the water supply is used for irrigation within the basin, and only during wet periods does water from one of these streams - the Kings River - enter the San Joaquin River, via Kings River North.

4. The great floods of 1950 extended to the western Nevada area, drained by the Truckee, Carson, and Walker Rivers. Each of these streams rises on the eastern slopes of the Sierra Nevada in California and terminates in land-locked evaporation sumps on the great plateau of Nevada. The three rivers, including their terminal sumps, have a combined drainage area of about 11,000 square miles.

5. The streams under consideration in this report are shown on plate I.

6. The economy of the Sacramento and San Joaquin Basins of California is dominated by agriculture. The area is one of the world's choice agricultural regions, and the large acreages of deep, smooth alluvial soils have been used effectively for the production of many diversified, high-value crops. Most of the manufacturing activities of the area are related to agriculture, including the processing of foods and the manufacture of agricultural machinery. The climate of the area is characterized by wet winters, during which almost all of the seasonal precipitation falls, and dry, hot summers. Average seasonal precipitation varies from only 5 to 10 inches in the southern portion of the valley floor to over 100 inches in the northern, mountainous portions. Elevations vary from sea level to over 14,000 feet. A considerable portion of the precipitation at high elevations occurs as snow. The region supports a rapidly increasing population of nearly 2,000,000 people, about 40 percent of which reside in the important cities of Chico, Marysville-Yuba City, Sacramento, Stockton, Modesto, Merced, Fresno, and Bakersfield. The largest city is Sacramento, the State capital, with a population of about 150,000.

7. The western Nevada area, all of which lies above the 4,000-foot elevation, is also predominantly an agricultural area; however, winters are longer and colder, and summers shorter than in the Sacramento and San Joaquin Basins; crops are therefore less diversified, consisting mainly of forage crops for livestock. The total population in the drainage basins of the Truckee, Carson, and Walker Rivers is about 66,000, and the only large city in the area is Reno with a population of about 32,000.

8. Mainly because of the general lack of rainfall during the summer, extensive storage developments have taken place on many of the streams in the Sacramento and San Joaquin Basins of California and to a lesser extent in the western Nevada area. These reservoirs retain winter run-off for irrigation use later in the year and many of them have power plants which operate in conjunction with the irrigation function. Some of the reservoirs have specific flood-control functions, and almost all of the remainder effect incidental flood control for the downstream areas. Other existing flood-control improvements consist of many miles of levees along the lower reaches of the various streams, some of which were built by the Federal Government and some by local interests. The most extensive levee system exists on the Sacramento River and along the lower reaches of its important tributaries. The existing reservoirs and levee and channel improvements and their effect on flood flows and damages are described more fully in subsequent paragraphs. Plate I is a general map of the entire area covered by this report and shows the principal stream systems, flooded areas, and existing and proposed improvements. Detailed descriptive data for each individual stream is given in appendix A.

9. Storm pattern and precipitation data. - The Sacramento and San Joaquin Basins in California and the western Nevada area are subject at intervals to widespread storms during the winter wet season from November through March. These winter storms account for about 80 percent of the annual precipitation of this region. The storms originate over the North Pacific Ocean and push large volumes of moist ocean air inland against the mountain barriers. Usually this moist air is relatively cool and deposits rain over the Coast Ranges and below 5,000 feet on the Sierra Nevada, with snow at higher elevations. Typical storms may last for 2 to 5 days and may cover a 200-mile-wide strip. Rainfall intensities are usually moderate but rainfall is of long duration; up to 30 percent of the annual precipitation may fall in a single storm period. Above 5,000 feet on the Sierra Nevada, the snow usually accumulates into a deep snow pack, 5 to 20 feet deep, which will not melt until the next summer. Occasionally, the incoming ocean air is sufficiently warm to cause rainfall as high as 9,000 feet which may melt some of the accumulated snow pack. At other times the snow may fall as low as 1,000 feet. A typical 3-day storm may deposit 5 inches of rain on the seaward face of the Coast Ranges, 2 inches over the valley area, and 10 inches on the seaward face of the Sierra Nevada. Some precipitation may be carried over the crest of the Sierra Nevada and fall on the steep eastern face either as rain or snow. November or December storms rarely produce floods because of the usual dry condition of the mountain watersheds after the long summer drought.

10. The series of meteorological events which culminated in the great floods of November and December 1950, began in the last days of October when a general storm caused heavy rain over the northern end

of the Sacramento Basin and extended as far south as American River. This storm wet the mountain watersheds and laid down a shallow snow pack at higher elevations. During 13-15 November a cool storm of moderate intensity caused 1 to 3 inches of mixed rain and snow to fall from Yuba River south to Kern River. About 1/2 inch of rain fell on the eastern slope of the Sierra Nevada in the basins of the Truckee, Carson, and Walker Rivers. At the end of this storm a shallow blanket of snow extended down the Sierra Nevada slopes to about 4,000 feet in the Sacramento Basin, 6,000 feet in the San Joaquin Basin, 7,000 feet in the Tulare Basin, and 6,000 feet in the western Nevada area.

11. The region was then invaded by a storm of record-breaking magnitude which brought extremely warm air inland against the entire range of the Sierra Nevada and caused very intense rainfall to extremely high elevations. On 16-18 November an average of about 11 inches of rain fell on all the mountain watersheds from Yuba River in the north to Kern River in the south with some basins receiving as much as 13 inches. At several stations as much as 10 inches of rain fell in 12 hours. North of Yuba River, the rainfall was more moderate and averaged between 4 and 5 inches. East of the mountains the Truckee, Carson, and Walker Basins received about 7 inches of warm rain in 24 hours. This warm rain melted away most of the shallow snow cover that had accumulated on the mountain slopes and produced record-breaking flood peaks on almost all the mountain streams from Yuba River south to Kern River. By the end of this storm the mountain watersheds were extremely wet and stripped of their protective pack of snow.

12. On 19 November another wave of the storm caused renewed intense rainfall over the southern portion of the Sacramento Basin and the northern portion of the San Joaquin Basin. Warm rainfall also occurred on the eastern slopes of the Sierra Nevada. This intense rain, falling on already saturated watersheds, caused still higher peaks to occur on the Yuba, Bear, American, Mokelumne, Truckee, Carson, and Walker Rivers.

13. From 20 November to 1 December there was no further rainfall, but the weather remained warm and moist and there was very little opportunity for the watersheds to dry out. On 2-3 December another warm storm invaded the region and laid down from 3 to 6 inches of rain over the same region from Yuba River south to Kern River, with 2 to 3 inches of rain on the eastern slopes of the Sierra Nevada. In addition, about 5-1/2 inches of rain fell in the Coast Ranges near Clear Lake and caused minor tributaries of that lake to rise to moderate peaks. In the Sierra Nevada new floods occurred, but the peaks were generally less than were observed during the November floods. Again on 6-8 December another warm storm occurred which laid down 4 to 5 inches over the southern Sacramento Basin, from 2 to 3 inches over the San Joaquin Basin, and

about 1 inch over the Tulare Basin. On the eastern slope about 2 inches of rain fell. This finally brought the storm series to an end and very little rain fell during the remainder of December. During the entire storm series, about 15 inches of rain fell in the northern Sacramento Basin, about 30 inches over the Yuba and American Basins, about 25 inches over the San Joaquin Basin, and from 15 to 20 inches over the Tulare Basin. On the eastern side of the Sierra Nevada, the total rainfall reached from about 20 inches over the Truckee Basin to 16 inches over the Walker Basin. Chart I shows the geographical distribution of rainfall throughout the region for each of the component storms during the series. Table I has been compiled to show the approximate mean precipitation over various sub-basins during the storm period together with similar data for the December 1937 storm, which generally was the maximum of record prior to November 1950.

14. The storm series described above was unusually severe on several counts. First, was its unusually early date. November storms in this region are usually small in magnitude and almost never produce floods because of the dry conditions of the watersheds at this time of year. Second, the extremely warm temperature of the incoming air caused rain to fall at unusually high elevations in the mountains and melted away most of the snow which had already accumulated. Third, this storm series had an unusually wide areal extent causing flood-producing precipitation over almost the entire length of the Sierra Nevada and on both the eastern and western slopes. Finally, it was unusual in the short interval between the component storms so that the watersheds had no opportunity to dry out between storms.

15. Run-off and stream flow data. - The results of the severe and intense storms during November and December were record-breaking flood flows on virtually every major stream of the Sacramento and San Joaquin Basins and of the western Nevada area. The only exceptions were streams of the northern Sacramento Valley and west-side tributaries draining the Coast Range Mountains. From the Yuba River south to the Mokelumne River, two major peaks occurred in November about 2 days apart. The second peak was in all cases larger than the first, and this second peak exceeded any previous flow of record, which in most cases represented a period of about 50 years. North of the Yuba River, the Feather and upper Sacramento Rivers did not approach previous record flows. From the Calaveras River south to the Kern River, the major peak resulted from the first storm, and in fact the second peak disappeared south of the San Joaquin River. New records were also established on virtually every stream of this group. The greatest relative flows were noted on those streams draining high areas. The western Nevada streams behaved in a similar manner to those of the Yuba to Mokelumne group. The Truckee, Carson, and Walker Rivers all showed two peaks, one on the 19th and one on the 21st of November, with the second peak the larger and again exceeding any previous flow of record by a substantial amount.

16. The additional rainfall which occurred during the two storms of early December caused flows on most of the streams to rise again, but in practically all cases the December peaks were of lesser magnitude than those which occurred in November. One notable exception was the lower San Joaquin River, which reached its greatest flow since 1907 on 10 December as a result of the combined contributions from the various east-side tributaries. The November peak on the lower San Joaquin was of lesser magnitude, principally because of the inhibiting effect of the many storage reservoirs on the tributaries; these reservoirs were in most cases full at the time of the December peaks and were generally ineffective in reducing flood flows in the lower reaches of the river system. The Sacramento River in its upper reaches also reached a greater flow in December than in November, but both peaks were far below previous records.

17. In general, the hydrographs of all the streams in the Sacramento and San Joaquin Basins and in the western Nevada area were characterized by sharp peaks of short duration, typical of rain floods in this region. The principal exception was the lower San Joaquin River which, because of the continuous contribution of various tributaries not necessarily synchronized as to time of peak, had a tremendous volume of flow, and the peak receded relatively slowly. These sustained high flows endangered levees in the delta area for several days, and high tides during the same period aggravated the condition. Charts II, III, IV, and V show hydrographs at key points on various streams throughout the area for which data are available at this time. The effect of existing reservoirs on some of these streams is shown in a very striking manner. Table II presents all available data on flood flows for the principal streams of the Sacramento and San Joaquin Basins and of western Nevada. The previous maximum flow of record on the stream is also shown for comparison.

18. Flooded areas. - As a result of the exceptionally large flows which occurred throughout the Sacramento-San Joaquin Basins and western Nevada areas, virtually every major stream overflowed its banks at some point, with the notable exception of the Sacramento River. Many levee breaks occurred during the floods. The most significant of these were on the south bank of the Yuba River in the vicinity of Hammonton, on the south bank of the Bear River below United States Highway No. 99E, on the north bank of the American River above the H Street Bridge, on the eastern tributaries of the San Joaquin River, and along the San Joaquin River proper. For the most part the areas inundated consisted of agricultural property, although many suburban areas and parts of some urban communities were flooded. Some areas were inundated as many as three and four times as a result of successive flood peaks. The total area flooded one or more times in the Sacramento-San Joaquin Basins and western Nevada areais estimated to be 710,000 acres. The location and extent of flooded areas are shown on plate I. Details of flooded areas in each stream basin and the type of property damage are given in appendix A.

19. In the Sacramento Basin, including the lower delta area, a total of 245,000 acres was flooded. The principal streams causing this overflow were the Yuba, Bear, and American Rivers. Although the Sacramento River was confined between its levees, overflow occurred at all of the relief weirs along the river, which are a part of the Sacramento River Flood Control Project, and the project floodways and natural storage basins, including Sutter, Tisdale, and Yolo Bypasses and Butte Basin, were flooded. For the most part, the inundated areas were devoted to agricultural activities; however, the overflows from the Yuba and American Rivers inundated a considerable area of suburban developments and there was severe damage to residential property. Olivehurst and Linda, suburban areas south of Marysville, and East Sacramento suffered the major portion of this damage. Many roads, railroads, bridges, levees, and other public properties were damaged. There was also considerable damage to commercial and industrial installations in the Sacramento Basin. A summary of the flooded areas for each of the streams in the Sacramento Basin, broken down into various reaches for some of the streams, is given in table III.

20. The overflow from streams in the San Joaquin Basin, including the upper delta area, inundated a total of 226,000 acres. Practically all of this area consisted of agricultural property. There was much less damage to residential property and to commercial and industrial facilities in the San Joaquin Basin as compared to the Sacramento Basin. A large portion of the city of Chowchilla and the outskirts of Modesto, Merced, Stockton, and Lodi were flooded. Damage to transportation systems, including highways, railroads, and bridges, and to other public utilities and institutions was particularly high in the San Joaquin Basin. Most of this type of damage occurred along the Merced and lower San Joaquin Rivers. Flooded areas for each stream, segregated into reaches, are given in table IV.

21. The total flooded area in the Tulare Basin amounted to 198,000 acres. Almost all of this area was agricultural land, and relatively minor areas of residential property were inundated. Areas in and adjacent to Porterville, Visalia, and Woodlake were flooded. There was considerable damage to transportation systems, levees, and other public utilities in the Tulare Basin. A summary of the flooded areas by stream reach is given in table V.

22. In the western Nevada area, the Truckee, Carson, and Walker Rivers flooded a total of 41,000 acres. Most of this area was agricultural property; however, the Truckee River inundated a considerable portion of the business district of the city of Reno and many commercial and industrial establishments as well as residences were flooded. Reno sustained by far the largest damage of any city affected by the flood, either in California or Nevada. Flooded areas are given for each stream reach in table VI.

23. As far as is known, only one life was lost which is directly attributable to the flood. This was a transient who was sleeping under a bridge on the Chowchilla River when the flood came. However, many residents throughout the region had narrow escapes. The remarkable record of only one life lost in such a widespread flood as this attests to the effectiveness of the flood warning and evacuation system during the flood period. Approximately 25,000 persons were evacuated from their homes during the entire flood period, 8,000 of which were from the Yuba River area. The American Red Cross estimates that it gave assistance to about 15,000 flood victims throughout the region.

24. Flood damages. - Immediately after the recession of flood flows below danger points, the Sacramento District instituted a region-wide detailed flood damage survey. This survey required approximately 3 months to complete and involved the personal interview of a large percentage of the property owners who suffered damage. Local organizations, public utilities, and private firms were contacted for losses to their property. In general, the degree of coverage is considered exceptionally complete. Examples of every type of damage were inspected in the field; in some cases damages of the same type were estimated on the basis of a sampling procedure. Only monetary losses or costs immediately attributable to the flood were included, and future costs or intangible losses were not included.

25. The total direct damage from the floods of November and December 1950, exclusive of damage to United States Forest Service property, amounted to $31,525,000 in the Sacramento and San Joaquin Basins and $4,360,000 in the western Nevada area. Damage to Forest Service property throughout both areas amounted to $1,465,000, making a grand total of $37,350,000. In the Sacramento and San Joaquin Basins the damages of $31,525,000 are further broken down as to major sub-basins, as follows:

Sacramento Basin, including lower delta area	$ 9,934,000
San Joaquin Basin, including upper delta area	12,241,000
Tulare Basin	9,350,000
Total	$31,525,000

Data on the breakdown of Forest Service damages by river basins are not available at this time.

26. In compiling flood damage data, streams were divided into various reaches, where pertinent, and damages were classified into five different categories. These categories, showing the percentage of the total damage, exclusive of damage to Forest Service property, for the Sacramento-San Joaquin Basins and western Nevada region in each category, are as follows:

Agricultural damage	38	percent
Residential damage	10	"
Commercial and industrial damage	11	"
Damage to public and private utilities and public institutions	39	"
Loss to traveling public	2	"
Total	100	"

Detailed damages in each category for the various stream reaches for the Sacramento Basin, including the lower delta area, are given in table III; for the San Joaquin Basin, including the upper delta area, in table IV; for the Tulare Basin, in table V; and for the western Nevada area, in table VI. Details of damage to United States Forest Service property are given in table VII.

27. Agricultural damage included damage to crops, farm improvements, and stored supplies; loss of livestock and poultry; and erosion of land and deposition of debris. The crops grown in the area are very diversified and include grain, orchard, vineyard, and truck crops and pasture. Residential damage involved mostly damage to foundations, floors, furnishings, and yards. Commercial and industrial establishments which were damaged included lumber mills, sand and gravel plants, wineries, oil field installations, stores, and others. Private and public utilities and public institutions which were damaged included highways, railroads, levee systems, telephone and power lines, power plants, water and sewer lines, schools, and numerous other public institutions. Included in this category are expenditures by the American Red Cross and by Federal, State, and local agencies for flood fighting activities, and the cost of emergency repairs to flood-control works and of flood damage surveys by the Corps of Engineers. Loss to the traveling public was estimated as the cost incurred by reason of the public being required to take a more circuitous route as a result of damaged highways.

28. Damage was very widespread throughout the Sacramento and San Joaquin Basins and western Nevada area. The largest damages occurred along the Yuba, American, Kings, San Joaquin, and Truckee Rivers, each of which caused damages in excess of $3,000,000. The largest single item of damage occurred at the site of Pine Flat Dam, which is under construction on the Kings River. Damage to the contractors' plant and Government facilities at this location including costs incurred as a result of construction delays, amounted to almost $900,000. The highest concentration of urban damage was in Reno on the Truckee River, where almost $2,000,000 damage occurred. Further details on damages are given in appendix A.

29. Effect of existing Corps of Engineers projects. - The Corps of Engineers has been involved in the construction of flood-control

improvements in the Sacramento and San Joaquin Basins for a number of years, and completed improvements performed effectively to reduce flood flows and damages during the November-December floods. There are no existing Corps of Engineers projects in the western Nevada area. The most extensive existing improvement is the Sacramento River Flood Control Project which consists of a comprehensive system of levees, overflow weirs, bypass channels, and pumping plants. Although some work remains to be done on this project, all functional parts such as weirs and bypasses were in operation at the time of the flood and provided adequate protection. The principal works of the project are levees and channel improvements along the Sacramento River from Chico Landing to its mouth and along the lower reaches of the principal tributaries; the Moulton, Colusa, Tisdale, Fremont, and Sacramento overflow weirs; and the Sutter and Yolo Bypasses. The total length of levees involved is over 1,100 miles. Other existing Corps of Engineers projects which were completed and in operation at the time of the flood are the Mariposa, Owens, and Burns Reservoirs of the Merced County Stream Group Project, and Big Dry Creek Reservoir on Big Dry Creek south of Fresno. Farmington Reservoir on Littlejohn Creek, although not entirely completed, functioned substantially as intended and provided effective flood control. On the Tuolumne River the existing Don Pedro Reservoir, constructed and operated by local interests, has been operated since December 1949 to provide 100,000 acre-feet of flood-control space as the first phase of the authorized joint Federal-local interests Tuolumne River Project. In addition to the above-described improvements, two major reservoirs constructed by the United States Bureau of Reclamation were operated to provide flood control during the flood period. These are the Shasta Reservoir on the Sacramento River and Friant Reservoir on the San Joaquin River, both of which are operated in accordance with flood-control criteria developed by the Corps of Engineers under provisions of Section 7 of the 1944 Flood Control Act. Pertinent descriptive data for all of the above-described reservoirs are as follows:

Reservoir	Stream	Drainage area controlled (sq. mi.)	Gross capacity (ac.-ft.)	Max. flood-control reservation (ac.-ft.)
Shasta	Sacramento R.	6,660	4,500,000	1,300,000
Farmington	Littlejohn Cr.	212	52,000	52,000
Don Pedro	Tuolumne R.	1,539	290,000	100,000
Burns	Burns Cr.	74	7,000	7,000
Owens	Owens Cr.	26	3,600	3,600
Mariposa	Mariposa Cr.	108	15,000	15,000
Big Dry	Big Dry Creek	86	15,500	15,500
Friant	San Joaquin R.	1,633	520,000	390,000
Total		10,338	5,403,100	1,883,100

30. All of the foregoing projects operated during the November-December flood period to provide effective flood control and prevented a considerable amount of damage which would otherwise have occurred. The Sacramento River Flood Control Project was by far the most spectacular as far as damages prevented. An example of the manner in which the project works functioned to reduce flood flows along the river is afforded in the situation which developed at Sacramento. As a result mainly of the record-breaking flow on the American River, the flood stage of the Sacramento River at Sacramento reached a record gage height of 30.15 feet, corresponding to a discharge of 102,000 cubic feet per second. At the same time, the upstream Fremont and Sacramento weirs were discharging a combined flow of 170,000 cubic feet per second into the Yolo Bypass, which obviously prevented serious damage in the vicinity of Sacramento. It is estimated that the entire Sacramento River Project prevented damages of about $75,000,000 during the flood period, based upon the present development in the area. However, such an estimate of prevented damages is somewhat unrealistic, since the present development would not have taken place without the project. Such important cities as Marysville, Yuba City, Sacramento, and North Sacramento could not have grown to their present size without protection of the communities and their trade areas from devastating floods of the Sacramento River system.

31. The effect of the reservoir projects in reducing flood flows and damages, although less spectacular, was nevertheless considerable. Farmington Reservoir on Littlejohn Creek reduced a peak inflow of more than 6,000 cubic feet per second to an outflow of 2,900 cubic feet per second and thereby prevented damages estimated at $100,000. Don Pedro Reservoir on the Tuolumne River would have effected substantially the same reduction in flows at downstream points during the November flood even if no allotment of flood-control space had been made, since this reservoir would normally be at a low level at this time of year and would have stored the same amount of inflow. However, by virtue of having evacuated the allotted 100,000 acre-feet of flood-control space after the November flood, the reservoir was able to reduce the first December peak inflow of 54,000 cubic feet per second to a nondamaging outflow of 9,000 cubic feet per second. It is estimated that without this project the outflow during this first December flood would have been in the order of 40,000 cubic feet per second. Furthermore, by the storage of 100,000 acre-feet of flood volume during the two December floods, the reservoir accomplished a reduction in the peak flow of the lower San Joaquin River. It is estimated that the operation of Don Pedro Reservoir as the first phase of the authorized Tuolumne River Project prevented damages of about $100,000 on the Tuolumne River and lower San Joaquin River.

32. Mariposa, Owens, and Burns Reservoirs on streams in Merced County effected similar reductions in downstream flows and prevented considerable damage. Burns Reservoir on Burns Creek by virtue of reducing a peak inflow of 8,000 cubic feet per second to an outflow of

1,700 cubic feet per second prevented the flooding of a considerable additional suburban area in eastern Merced and prevented damage estimated at $2,200,000. Mariposa and Owens Reservoirs also substantially reduced downstream flows and prevented damage estimated at $300,000. Mariposa Reservoir reduced a peak inflow of 18,600 cubic feet per second to a maximum outflow of 900 cubic feet per second, and Owens Reservoir reduced an inflow of 1,700 cubic feet per second to an outflow of 150 cubic feet per second. It is estimated that if the three reservoirs of the Merced County Stream Group Project had not been in existence, the flooded area in this vicinity would have been more than 40,000 acres instead of the 27,000 acres which were actually flooded. Big Dry Creek Reservoir on Big Dry Creek reduced a peak inflow of 1,500 cubic feet per second to an outflow of 50 cubic feet per second and thereby prevented flooding of the suburban Figarden area north of Fresno. The damage prevented by this project is estimated at $200,000.

33. Friant Reservoir on the San Joaquin River had a peak inflow during the flood period of 55,000 cubic feet per second, and the reservoir release never exceeded 500 cubic feet per second until 11 December when flood peaks began to recede on the lower San Joaquin River. The effect of this reduction in flow was felt all along the San Joaquin River, although the major effect was above the mouth of the Merced River. It is estimated that the flow at Newman on the San Joaquin River would have been increased from 17,000 cubic feet per second to about 25,000 cubic feet per second if Friant Reservoir had not been in existence and operated for flood control as it was. The total damage prevented by this project is estimated at $1,375,000. Shasta Reservoir on the Sacramento River had little effect on flood flows and damages because inflows to the reservoir never reached excessively large amounts. Although Shasta Reservoir stored a considerable amount of water during the main flood period, subsequent releases were almost as great as the peak inflow, and the peak flow of the Sacramento River at Red Bluff was not reached until 14 December. The magnitude and duration of the minor flood flows on the upper Sacramento River might have been somewhat greater without Shasta Reservoir, but the additional damage which would have resulted would have been negligible.

34. The functioning of these existing reservoirs during the flood period is summarized in table IX. A summary of the damages prevented by all of the existing Corps of Engineers projects, including nonproject reservoirs operated specifically for flood control, is given in the following tabulation:

Sacramento River Flood Control Project	$75,000,000 (a)
Shasta Reservoir	negligible
Farmington Reservoir	100,000
Don Pedro Reservoir	100,000 (b)
Burns Reservoir	2,200,000
Owens Reservoir	50,000
Mariposa Reservoir	250,000

Big Dry Reservoir	200,000
Friant Reservoir	1,375,000
Total	$79,275,000

(a) Based on present development.
(b) Refers to damage prevented by virtue of contract for 100,000 acre-feet of flood-control space and not to total damage prevented by reservoir.

35. Effect of other existing works. - In addition to the existing projects described in the preceding paragraphs, a number of other existing reservoirs and levees effectively reduced flood flows and flood damages. All of the reservoirs, with the exception of Hogan Reservoir on the Calaveras River, were constructed principally for irrigation, water supply, and/or power generation purposes and effected only incidental flood control. Hogan Reservoir is a flood-control project constructed by the city of Stockton. The structure has ungated outlets and operates automatically during a flood. This unit reduced a peak inflow of 21,000 cubic feet per second to a maximum outflow of 8,000 cubic feet per second and thereby prevented considerable additional flooding in the outskirts of Stockton. Damages prevented by this project have not been evaluated, but they were substantial. Other reservoirs, although providing only incidental flood control, also effected a considerable reduction in flood flows and damages downstream. The most important of these units are Melones Reservoir on the Stanislaus River, Pardee Reservoir on the Mokelumne River, and Exchequer Reservoir on the Merced River. Upstream power reservoirs on the Feather, Yuba, Mokelumne, and Tuolumne Rivers were also effective in reducing flood flows. On the Truckee River, Lake Tahoe and Boca Reservoir had little effect on downstream flows and damages although storing considerable water. The existing Bridgeport and Topaz Reservoirs on the Walker River and Lahontan Reservoir on the Carson River effected an appreciable reduction in downstream flood flows and damages. The functioning of these reservoirs during the flood period is summarized in table IX.

36. Many miles of levees along the lower reaches of the various streams in the Sacramento and San Joaquin Basins have been constructed by local interests. In general, these levees were inadequate to handle the excessively severe and repeated flood flows which passed down the streams, but in many specific cases these levees held and prevented in the aggregate a considerable amount of additional damage throughout the region.

37. Potential effect of authorized flood-control works. - The Corps of Engineers has been authorized to construct a number of projects for flood control and allied purposes throughout the Sacramento and San Joaquin Basins in California. There are no authorized projects in the western Nevada area. These authorized projects include multiple-purpose

reservoirs at the foothill line on many of the major streams, single-purpose flood-control reservoirs, and levee and channel improvement projects. All were authorized by Congress in the 1944 and 1950 Flood Control Acts. Many of these projects are presently under construction and scheduled for completion within the next few years.

38. The following tabulation gives pertinent descriptive data and the status of all authorized Corps of Engineers reservoir projects in the Sacramento and San Joaquin Basins exclusive of those described under existing projects:

Reservoir	Stream	Drainage area (sq. mi.)	Gross capacity (ac.-ft.)	Max. flood control reservation (ac.-ft.)	Primary uses
Black Butte	Stony Creek	712	160,000	130,000	Fl. contr. & irrigation
Iron Canyon	Sacramento R.	2,606	503,000	400,000	Fl. contr., power, & irrig.
Folsom (a)	American R.	1,875	1,000,000	400,000	ditto
Hogan	Calaveras R.	363	325,000	125,000	Fl. contr. & irrigation
New Melones	Stanislaus R	900	1,100,000	350,000	Fl. contr., power, & irrig.
New Don Pedro (b)	Tuolumne R.	1,539	-	340,000	ditto
Bear	Bear Cr.	72	7,700	7,700	Fl. control
Pine Flat(a)	Kings R.	1,542	1,000,000	1,000,000	Fl. contr. & irrigation
Terminus	Kaweah R.	560	100,000	100,000	ditto
Success	Tule R.	408	75,000	75,000	ditto
Isabella (a)	Kern R.	2,075	550,000	550,000	ditto
Total		12,652	4,820,700	3,477,700	

(a) Under construction (b) To be constructed by local interests.

39. The following tabulation gives pertinent descriptive data for the major authorized levee and channel improvement projects in the Sacramento and San Joaquin Basins, which are grouped in some cases for convenience:

Project and stream	Type of improvement	Approximate channel dist. (miles)
Sacramento R. major and minor tributaries (a)	New levees, levee extension and raising, channel improvements, bank protection, and diversion	270
Bear Creek (San Joaquin County)	Levees and channel improvement	30
Lower San Joaquin River	New levees, levee rebuilding, revetments, and flowage easements	260
Duck Creek (San Joaquin County)	Diversion and levees	1
Merced County Stream Group	Levees, channel improvement, and diversions	55
Kings, Kaweah, and Tule Rivers	Levees, channel improvements, and spreading works	37
Total		653

(a) Under construction.

40. The foregoing authorized projects have been designed to provide a relatively high degree of flood protection for the areas in which they are located, and their effect in reducing flood flows and damages from the November-December 1950 floods would have been very great. Table VIII shows that if these projects had been in operation at the time of the flood, the damage prevented would have amounted to $16,011,000 exclusive of $841,000 damage reduction in flowage easement areas. This represents a reduction of 83 percent in the total damage that occurred along streams on which major flood control projects have been authorized. Of the remaining 17 percent, about 14 percent occurred above project sites and in floodways and is considered nonpreventable on the basis of present economic conditions. The other 3 percent can be considered as residual damage on these streams. It can therefore be seen that the degree of protection to be provided by the authorized projects would have been remarkably high. Table VIII gives details of damages prevented by authorized projects on each stream, and plate I shows the location of these projects.

41. Potential effect of recommended flood-control projects. - Even after completion of all of the authorized projects in the Sacramento and San Joaquin Basins, there would still remain a considerable area which would not have adequate flood protection and which sustained considerable damage during the 1950 floods. In recognition of this need for additional flood protection over and above that which would be provided by the authorized projects, a Comprehensive Report on Sacramento-San Joaquin Basin Streams was prepared in 1945 and brought up to date by a Supplement

in 1948. This report has been printed as House Document No. 367, Eighty-first Congress, first session. As a result of the studies and recommendations of the reporting officers, the Chief of Engineers recommended in this document the construction of certain additional works on streams of the Sacramento and San Joaquin Basins. There are no recommended projects on Nevada streams. The following tabulation gives pertinent descriptive data for the reservoir projects recommended by the Chief of Engineers:

Reservoir	Stream	Drainage area (sq mi)	Gross capacity (ac.-ft.)	Max. flood control reservation (ac.-ft.)	Primary uses
Oroville (a)	Feather R.	3,611	3,000,000	385,000	Fl. control, power, & irrigation
Indian Valley	Cache Cr.	121	250,000	30,000	Fl. contr. & irrigation
Buchanan	Chowchilla R.	234	70,000	60,000	ditto
Hidden	Fresno R.	236	90,000	80,000	ditto
Total		4,202	3,410,000	555,000	

(a) Alternate to previously recommended Bidwell Bar Reservoir.

42. The following tabulation gives pertinent descriptive data for recommended levee and channel improvement projects:

Project and stream	Type of improvement	Approximate channel dist. (miles)
American River	Extension of levees upstream	7
Clear Lake tributaries	Levees, channel improvement, and diversion	7
Deer Creek (Sacramento County)	Levees and diversion	1
Mormon Slough	Levees and diversion	5
Tulare Lake	Levees	61
Miscellaneous streams in Sacramento-San Joaquin Basins	Levees, bank protection and channel clearing	-
Total		81

43. The damages that would have been prevented by the projects listed in the previous two paragraphs, if they had been completed and in operation, are estimated at $628,000, excluding $35,000 damage reduction within floodway areas. The residual damage along streams on which the recommended projects are located would have amounted to $248,000, of which $236,000 represents residual damage to the American River levees. Table VIII gives the break-down of the damage figures and plate I shows the location of the recommended projects.

44. Potential effect of proposed flood-control projects. - In recognition of future additional needs for flood protection in the Sacramento and San Joaquin Basins, a number of projects in addition to those authorized and recommended were proposed by the Chief of Engineers in House Document No. 367. Subsequent studies since the date of the report contained in the cited document have indicated the need for further improvements on the Sacramento and San Joaquin Basins and western Nevada streams; however, reports on this additional group of proposed projects have not yet been submitted to Congress. The following tabulation lists projects proposed for construction on various streams in the Sacramento and San Joaquin Basins and in western Nevada together with pertinent descriptive data:

Stream	Type of improvement	Principal features
Yuba River	Multiple-purpose reservoir	675,000 ac.-ft. Bullards Bar Res.
Bear River	Multiple-purpose reservoir	200,000 ac.-ft. Garden Bar Res.
Putah Creek	Multiple-purpose reservoir	2,200,000 ac.-ft. Monticello Res.
Cosumnes River	Multiple-purpose reservoir	550,000 ac.-ft. Nashville Res.
Cache Creek	Multiple-purpose reservoir and channel improvements	40,000 ac.-ft. Kelseyville Res. and Clearlake outlet enlargement
Sacramento River	Levees and bank protection	60 miles of improvement on river and tributaries from Chico Landing to Red Bluff
Truckee River	Multiple-purpose reservoir and channel improvements	135,000 ac.-ft. Prosser Res. and 8 miles of channel improvement
Carson River	Multiple-purpose reservoir	50,000 ac.-ft. Watasheamu Res.
Walker River	Multiple-purpose reservoir	160,000 ac.-ft. Pickle Meadows Res.

45. The damage that would have been prevented by the proposed projects is estimated at $7,967,000, exclusive of $229,000 damage reduction within floodway areas. The residual damage along streams on which the proposed projects are located would have amounted to about 4 percent of the total, thus indicating a very high degree of protection. Table VIII gives the break-down of the prevented damage, and plate I shows the location of the proposed projects.

46. Potential effect of all authorized, recommended, and proposed projects. - Table VIII shows that if all authorized, recommended, and proposed projects had been completed and in operation they would have prevented damages estimated at $24,606,000, excluding $1,105,000 damage reduction within floodways and flowage easement areas. The residual damage below the projects and outside of floodways and flowage easement areas would have amounted to $3,397,000. This represents approximately 9 percent of the total damage caused by the floods. Of the $3,397,000 residual damage, $1,507,000 occurred along the Mokelumne River, which is presently being investigated to determine if flood protection works are justified in the light of current economic conditions.

47. Flood fighting and other activities. - During the progress of the floods of November-December 1950, the Corps of Engineers was engaged in flood fighting activities throughout the Sacramento-San Joaquin Basins and western Nevada area. A flood operations center was set up at District headquarters in Sacramento for the purpose of coordinating activities of the various field forces. This operation center received information on river stages, weather data, and critical conditions at various points, analyzed such information and data, and disseminated it to Corps of Engineers field personnel, as well as to other interested Federal, State, and local agencies. One of the principal functions of the flood operation center was to analyze weather reports and river flows in order to predict the development of critical situations. When critical stages were expected, all agencies were alerted by the United States Weather Bureau, the agency charged with this responsibility. In the field, Corps of Engineers personnel were involved in patrolling of levees, contacting responsible local interests to apprise them of dangerous conditions, assisting in the evacuation of personnel from danger areas, and assisting in operations to repair damaged levees and prevent failure. In the latter operation, a considerable amount of manpower, equipment, and material was made available to local interests. Flood fighting activities were accomplished in coordination with many Federal, State, and local agencies, and individuals, among which the cooperation was excellent. There is no doubt that these activities prevented many dollars in damage and quite possibly saved some lives.

48. In addition to the flood fighting activities described above, Corps of Engineers personnel were engaged in the collection of basic data during the flood period. Such data included observation

of gage heights, measurement of stream flows, fixing of high water marks, and general observations of the behavior of the streams during time of flood. An attempt was made to obtain complete aerial photographic coverage of the flooded areas at the height of the floods. In some cases, bad weather prevented this operation, but a fairly complete photographic record of the flood was obtained. As a result of the data collected by Corps of Engineers personnel and many others, the 1950 floods will be the best recorded in the history of California and Nevada floods.

49. Emergency repairs. - The record floods which occurred on virtually every stream in the Sacramento and San Joaquin Basins and in western Nevada caused widespread damage to existing levees and other flood-control works. At many locations levees were weakened and at many others were completely washed away. These conditions imposed the threat of a major disaster to many areas if another flood should occur, and, therefore, the Corps of Engineers undertook extensive emergency repairs throughout the region under the authority granted by the 1948 Flood Control Act. More than 100 requests for such emergency aid have been received to date, and repair work has been undertaken or scheduled at approximately 70 general locations. Emergency repair work will have been done on practically every major stream in the Sacramento and San Joaquin Basins by the time the program is completed. A total of $1,150,000 has been spent or obligated in connection with this work to date, and the work is not yet completed.

50. The floods also left many obstructions in various channels throughout the region which have seriously reduced carrying capacities. To correct this situation, the Sacramento District Engineer has recommended that clearing and snagging work be undertaken on some 8 streams in the Sacramento and San Joaquin Basins and in western Nevada. Some of this work is presently under way. It is estimated that the entire clearing and snagging program will involve a total expenditure of about $300,000. The effectiveness of such clearing and snagging work is demonstrated by the fact that work of this nature done on the Tule and Kaweah Rivers early in 1950 materially helped prevent serious flood damage to the cities of Porterville and Visalia, respectively.

51. Summary. - The flood events that have been described in this report were, in general, the largest and most destructive since the turn of the century. Over 700,000 acres of the best agricultural and suburban areas were flooded, causing damages in excess of $37,000,000. Fortunately the flood-control projects already completed prevented a further damage of some $80,000,000. The Corps of Engineers has developed a comprehensive plan for the prevention of damages from floods such as these, and to make beneficial use of the floodwaters. Some units of the comprehensive plan have already been authorized, some have been recommended for authorization, and others have been proposed for future authorization. If the units which have been authorized had been completed and in operation, they would have prevented nearly

one-half of the damage which actually occurred. Further, if the entire comprehensive plan had been completed and in operation, the total damage in areas other than headwaters, floodways, and flowage easements would have been reduced to less than $3,500,000. It is therefore evident that the degree of flood protection contemplated is relatively high.

52. Bibliography. - In addition to the data included in this report and accompanying appendix, the following data pertaining to the floods have been collected and are on file in the District Office:

a. Flood damage questionnaires.

b. Aerial and other photographs taken during flood.

c. Detailed maps showing flooded areas.

d. Stream flow measurements and gage heights.

e. Record of weather forecasts and precipitation data.

f. Record of permanent high water marks.

g. Record of emergency repairs.

h. Record of flood fight operations.

i. Record of activities of "Flood Operations Center".

j. Copy of pamphlet entitled "Reno Flood 1950", by the Reno, Nevada, Junior Chamber of Commerce.

k. Copy of report by the California State Division of Highways entitled "Report of 1950 Flood Damage to State Highways" dated December 14, 1950.

l. Copy of report by California State Division of Water Resources, entitled "Floods of 1950 in California" dated December 18, 1950.

m. Copy of report by United States Forest Service, Region 5, and California Forest & Range Experiment Station, entitled "Special Watershed Report, Flood of November 1950", dated December 11, 1950.

n. Miscellaneous flood and damage data furnished by various public and private agencies and individuals.

TABLE I.--Storm Precipitation by Basins

Basins	Nov-Dec 1950 Storm (a)			Dec 1937 Storm (b)	
	Total 13 Nov-8 Dec	Total 16 Nov-21 Nov	Max. 24 hr period	Total 9 Dec-11 Dec	Max 24 hr period
	(All quantities in inches)				
Sacramento					
Cache	15.0	7.5	3.2	11.1	7.0
Upper Sacramento	11.0	4.0	2.2	7.5	5.0
Feather	15.0	10.0	5.0	16.9	11.4
Yuba	32.0	20.5	6.8	12.0	6.6
Bear	25.5	16.5	6.1	8.5	4.0
American	29.5	20.0	6.5	12.5	6.2
San Joaquin					
Cosumnes-Mokelumne	25.0	16.0	8.1	8.9	4.2
Calaveras	19.0	12.0	5.8	6.6	3.8
Stanislaus	22.5	13.0	9.0	10.8	5.5
Tuolumne	21.0	12.5	7.1	11.6	5.2
Merced	19.5	12.0	9.8	15.1	7.0
San Joaquin	18.5	11.5	10.0	13.7	6.3
Tulare Lake					
Kings	16.5	10.5	10.0	10.6	4.8
Kaweah	18.5	13.5	11.0	14.5	7.5
Tule	16.0	11.0	9.7	10.5	5.7
Kern	13.5	9.0	8.1	5.3	3.1
Western Nevada					
Truckee	20.0	14.5	4.8	9.0	4.5
Carson	18.0	12.0	4.6	7.5	4.3
Walker	16.0	12.0	5.8	7.5	5.0

(a) Approximate data from preliminary storm study.
(b) From final storm study.

TABLE II.--Preliminary Estimate of Peak Flows During Period 18 November to 10 December 1950

Stream	Station	Peak flow or stage (a) 18 Nov. - 10 Dec. flood		Maximum previous peak (a)	
		Peak	Date	Peak	Date
Sacramento River	Inflow to Shasta Reservoir	43,000	16 Nov.	186,000	28 Feb. 1940
	At Ord Ferry	53,000	4 Dec.	370,000	28 Feb. 1940
	Over Fremont Weir	120,000	22 Nov.	332,000	20 Mar. 1907
	Over Sacramento Weir	81,000	21 Nov.	93,000	19 Mar. 1907
	At I Street Bridge	102,000	21 Nov.	91,000	19 Mar. 1907
	In Yolo Bypass	170,000	22 Nov.	438,000	21 Mar. 1907
Feather River	Near Oroville	87,000	21 Nov.	230,000	19 Mar. 1907
	Below Marysville	110,000	21 Nov.	295,000	20 Mar. 1907
Yuba River	At Englebright Dam	107,000	21 Nov.	105,000	26 Mar. 1928
	At Marysville	75,000	21 Nov.	120,000	20 Mar. 1907
Bear River	Near Wheatland	27,000	21 Nov.	31,300	21 Jan. 1943
American River	At Folsom	210,000	21 Nov.	150,000	25 Mar. 1928
	At H Street Bridge	45.75 ft.	21 Nov.	43.4 ft.	26 Mar. 1928
Clover Creek	Near Upper Lake	2,100	3 Dec.	3,500	11 Dec. 1937
Middle Creek	Near Upper Lake	6,000	3 Dec.	12,000	11 Dec. 1937
Scott Creek	Near Lakeport	7,000	3 Dec.	9,000	11 Dec. 1937
Kern River	At Isabella Dam site	39,000	19 Nov.	-	-
	Near Bakersfield	39,000	19 Nov.	22,000	9 Mar. 1943
Tule River	At Worth Bridge	28,000	19 Nov.	22,000	9 Mar. 1943
Kaweah River	At McKay Point	55,000	19 Nov.	35,000	11 Dec. 1937
Kings River	At Piedra	91,000	19 Nov.	80,000	11 Dec. 1937
Big Dry Creek	Above Big Dry Dam	1,500	19 Nov.	2,600	Mar. 1938
	In Big Dry Reservoir	,500 ac.-ft.	5 Dec.	-	-
San Joaquin River	Inflow to Friant Reservoir	55,000	19 Nov.	77,000	11 Dec. 1937
	Near Newman	17,000	12 Dec.	33,000	7 Mar. 1938
	At Hetch-Hetchy Crossing	60,000	9 Dec.	-	-
	Near Vernalis - flow	75,000	10 Dec.	51,000	16 Mar. 1938
	Near Vernalis - stage	27.9 ft.	9 Dec.	27.0 ft.	12 Feb. 1938
	At Mossdale - stage	24.75 ft.	10 Dec.	22.5 ft.	16 Mar. 1938
Fresno River	Near Knowles	8,800	19 Nov.	7,600	12 Mar. 1938
	Near Daulton	16,000	19 Nov.	8,100	2 Feb. 1945
Chowchilla River	At Buchanan Dam site	17,000	19 Nov.	19,000	2 Mar. 1938
Mariposa Creek	Mariposa Reservoir				
	Max. inflow	18,600	18 Nov.	7,900	2 Mar. 1938
	Max. storage	8,340 ac.-ft.	19 Nov.	-	-
	Max. stage	57.5 ft.	19 Nov.	-	-
	Max. release	900	19 Nov.	-	-
Owens Creek	Owens Reservoir				
	Max. inflow	1,700	18 Nov.	1,800	12 Feb. 1941
	Max. storage	950 ac.-ft.	19 Nov.	-	-
	Max. stage	40.6 ft.	19 Nov.	-	-
	Max. release	150	19 Nov.	-	-
Burns Creek	Burns Reservoir				
	Max. inflow	8,000	18 Nov.	5,000	2 Mar. 1938
	Max. storage	3,230 ac.-ft.	19 Nov.	-	-
	Max. stage	29.4 ft.	19 Nov.	-	-
	Max. release	1,700	19 Nov.	-	-
Bear Creek	Below Burns Creek	16,000	19 Nov.	9,800	6 Feb. 1937
Merced River	Exchequer Reservoir				
	Max. inflow	88,700	19 Nov.	59,000	11 Dec. 1937
	Max. outflow	38,000	4 Dec.	-	-
Cherry Creek	At Cherry Valley Dam site	15,000	19 Nov.	18,000	11 Dec. 1937
Tuolumne River	Don Pedro Reservoir				
	Max. inflow	90,000	19 Nov.	60,000	31 Jan. 1911
	Max. outflow	64,500	8 Dec.	-	-
Stanislaus River	Melones Reservoir				
	Max. inflow	90,000	19 Nov.	60,000	31 Jan. 1911
	Max. outflow	45,000	21 Nov.	-	-
Littlejohn Creek	Farmington Reservoir				
	Max. storage	8,000 ac.-ft.	8 Dec.	-	-
	Max. stage	141.0 ft.	8 Dec.	-	-
	Max. outflow	2,900	8 Dec.	9,000	11 Feb. 1938
Calaveras River	Hogan Reservoir				
	Max. inflow	21,000	19 Nov.	50,000	31 Jan. 1911
	Max. outflow	7,000	19 Nov.	-	-
Mokelumne River	Pardee Reservoir				
	Max. inflow	30,000	20 Nov.	27,300	25 Mar. 1928
	Max. outflow	28,000	21 Nov.	-	-
Dry Creek	Near Galt	9,000	20 Nov.	13,000	2 Feb. 1945
Cosumnes River	At Michigan Bar	27,000	21 Nov.	26,000	31 Mar. 1940
	At McConnells	22,000	21 Nov.	-	-
Truckee River	Near Truckee	6,500	20 Nov.	1,800	11 Dec. 1937
	At Reno	19,900	21 Nov.	16,000	11 Dec. 1937
West Carson River	Near Woodfords	4,100	20 Nov.	3,500	11 Dec. 1937
East Carson River	Near Gardnerville	12,10	21 Nov.	12,000	11 Dec. 1937
Carson River	Near Carson City	12,200	22 Nov.	12,000	18 Mar. 1907
West Walker River	Near Coleville	6,200	20 Nov.	5,800	11 Dec. 1937
	Near Hudson	1,700	8 Dec.	2,500	7 June 1922

(a) Units are c.f.s. unless otherwise noted.

TABLE III.--Flooded Areas and Flood Damages, Sacramento Basin, including Lower Delta
November and December 1950 Floods

Stream and reach	Flooded areas (acres)	Direct flood damage ($)						
		Agricultural	Residential	Commercial & industrial	Public institutions & utilities	Loss to traveling public	Total
Yuba River							
Above Englebright Dam	200	0	25,000	0	364,000	25,000	414,000
Below Englebright Dam	43,200	506,000	1,164,000	905,000	1,020,000	25,000	3,620,000
Total, Yuba River	43,400	506,000	1,189,000	905,000	1,384,000	50,000	4,034,000
Bear River							
Above foothill line	0	0	0	0	11,000	0	11,000
Below foothill line	16,700	130,000	0	0	137,000	0	267,000
Total, Bear River	16,700	130,000	0	0	148,000	0	278,000
American River							
Above Folsom Dam	300	2,000	45,000	14,000	395,000	28,000	484,000
Folsom Dam to North Sacramento Levee	5,000	487,000	1,104,000	300,000	602,000	125,000	2,618,000
Flowage easement area	1,400	0	0	51,000	34,000	0	85,000
Del Paso Heights backwater area	2,400	23,000	272,000	23,000	0	0	318,000
Total, American River	9,100	512,000	1,421,000	388,000	1,031,000	153,000	3,505,000
Streams on eastern slope of Coast Range							
Walnut Creek	1,300	32,000	49,000	12,000	20,000	11,000	124,000
Putah Creek	400	3,000	0	0	0	0	3,000
Cache Creek below Clear Lake	200	2,000	0	0	0	0	2,000
Willow Creek	200	1,000	0	0	1,000	0	2,000
Stony Creek	0	0	0	0	1,000	0	1,000
Thomes Creek	500	1,000	0	0	0	0	1,000
Miscellaneous eastern slope streams	10,200	2,000	0	0	14,000	0	16,000
Total, Streams on eastern Coast Range slopes	12,800	41,000	49,000	12,000	36,000	11,000	149,000
Clear Lake and tributaries							
Middle and Clover Creeks	1,400	4,000	7,000	6,000	1,000	0	18,000
Scott Creek	2,200	16,000	0	0	2,000	0	18,000
Kelsey Creek	100	0	0	5,000	1,000	0	6,000
Miscellaneous streams	2,000	10,000	1,000	0	1,000	0	12,000
Clear Lake rim	0	0	0	0	0	0	0
Total, Clear Lake and tributaries	5,700	30,000	8,000	11,000	5,000	0	54,000
Streams on western Sierra slopes							
Antelope, Deer, Pine, Rock and Mud Creeks	400	1,000	0	0	1,000	0	2,000
Chico Creek, Sandy Gulch, Little Chico Creek and Edgar Slough	0	0	0	0	1,000	0	1,000
Butte Creek	0	0	0	0	2,000	0	2,000
Cherokee Canal	5,700	14,000	0	0	1,000	0	15,000
Local to Cherokee Canal	2,000	10,000	0	0	0	0	10,000
Dry (Linda) Creek	400	4,000	0	0	0	0	4,000
Miscellaneous western slope streams	500	1,000	0	0	6,000	0	7,000
Total, Streams of western Sierra slopes	9,000	30,000	0	0	11,000	0	41,000
Feather River							
Above Oroville	1,000	10,000	0	0	41,000	0	51,000
Oroville to Honcut Creek	5,600	33,000	0	0	0	0	33,000
Honcut Creek to Marysville	11,000	30,000	0	0	54,000	0	84,000
Marysville to Nicolaus	1,000	3,000	0	0	102,000	0	105,000
Total, Feather River	18,600	76,000	0	0	197,000	0	273,000
Sacramento River and bypasses							
Above Shasta Dam	0	0	0	0	6,000	0	6,000
Shasta Dam to Red Bluff	0	0	0	0	2,000	0	2,000
Red Bluff to Chico Landing	0	0	0	0	3,000	0	3,000
Chico Landing to Colusa	0	0	0	0	7,000	0	7,000
Colusa to Collinsville	200	1,000	7,000	20,000	86,000	0	114,000
Sutter and Tisdale bypasses	21,300	35,000	0	0	2,000	0	37,000
Yolo and Sacramento bypasses	48,000	104,000	0	0	15,000	78,000	197,000
Colusa Basin	10,000	5,000	0	0	2,000	0	7,000
Butte Basin	32,200	42,000	0	0	13,000	0	55,000
Total, Sacramento River and bypasses	111,700	187,000	7,000	20,000	136,000	78,000	428,000
Lower Delta							
Little Holland Island	2,800	72,000	0	0	8,000	0	80,000
Prospect Island	2,300	10,000	0	0	15,000	0	25,000
Liberty Island	4,500	86,000	0	0	30,000	0	116,000
Venice Island	3,600	341,000	0	0	161,000	0	502,000
Miscellaneous Delta tracts	0	0	0	0	439,000	0	439,000
Suisun Bay	5,000	10,000	0	0	0	0	10,000
Total, Lower Delta	18,200	519,000	0	0	653,000	0	1,172,000
TOTAL SACRAMENTO BASIN, EXCLUDING LOWER DELTA	227,000	1,512,000	2,674,000	1,336,000	2,948,000	292,000	8,762,000
TOTAL SACRAMENTO BASIN, INCLUDING LOWER DELTA	245,200	2,031,000	2,674,000	1,336,000	3,601,000	292,000	9,934,000

TABLE IV.--Flooded Areas and Flood Damages, San Joaquin River Basin, including Upper Delta
November and December 1950 Floods

Stream and reach	Flooded area (acres)	Direct flood damage ($)					
		Agricultural	Residential	Commercial & industrial	Public institutions & utilities	Loss to traveling public	Total
Cosumnes River							
Above Nashville Dam site	0	0	0	0	0	0	0
Below Nashville Dam site	17,600	214,000	0	0	20,000	0	234,000
Total, Cosumnes River	17,600	214,000	0	0	20,000	0	234,000
Dry Creek							
Above Ione Dam site	100	0	0	0	0	0	0
Below Ione Dam site	3,800	11,000	0	0	0	0	11,000
Total, Dry Creek	3,900	11,000	0	0	0	0	11,000
Mokelumne River							
Above Pardee Reservoir	0	0	0	0	107,000	0	107,000
Pardee Reservoir to mouth of Dry Creek	13,400	603,000	33,000	149,000	548,000	0	1,333,000
Below mouth of Dry Creek	8,700	209,000	0	5,000	20,000	0	234,000
Total, Mokelumne River	22,100	812,000	33,000	154,000	675,000	0	1,674,000
Bear Creek (San Joaquin County)	2,100	79,000	0	0	35,000	0	114,000
Calaveras River							
Above Hogan Dam	0	0	0	0	0	0	0
Below Hogan Dam	3,000	180,000	6,000	1,000	65,000	0	252,000
Total, Calaveras River	3,000	180,000	6,000	1,000	65,000	0	252,000
Littlejohn Creek							
Littlejohn Cr. above Farmington Res.	0	0	0	0	0	0	0
Farmington Reservoir	0	0	0	0	6,000	0	6,000
Littlejohn Cr. below Farmington Res.	0	0	0	0	0	0	0
Duck Creek	2,500	46,000	43,000	9,000	0	0	98,000
Total, Littlejohn Creek	2,500	46,000	43,000	9,000	6,000	0	104,000
Stanislaus River							
Above New Melones Dam site	0	0	0	0	76,000	0	76,000
Below New Melones Dam site	15,000	883,000	10,000	48,000	120,000	0	1,061,000
Total, Stanislaus River	15,000	883,000	10,000	48,000	196,000	0	1,137,000
Tuolumne River							
Above New Don Pedro Dam site	100	0	0	0	17,000	0	17,000
Below New Don Pedro Dam site	8,000	296,000	224,000	76,000	37,000	0	633,000
Total, Tuolumne River	8,100	296,000	224,000	76,000	54,000	0	650,000
Merced River							
Above Exchequer Dam	200	0	0	0	1,786,000	30,000	1,816,000
Below Exchequer Dam	19,600	372,000	24,000	13,000	210,000	0	619,000
Total, Merced River	19,800	372,000	24,000	13,000	1,996,000	30,000	2,435,000
Merced County Stream Group							
Bear and Burns Creeks above dams	0	0	0	0	5,000	0	5,000
Bear, Burns & Bl. Rascal below dams	17,300	119,000	5,000	41,000	111,000	0	276,000
Owens and Mariposa Creeks above dams	0	0	0	0	82,000	0	82,000
Miles, Owens and Mariposa Creeks below dams	9,700	21,000	0	0	12,000	0	33,000
Total, Merced County Stream Group	27,000	140,000	5,000	41,000	210,000	0	396,000
Chowchilla River							
Above Buchanan Dam site	0	0	0	0	20,000	0	20,000
Below Buchanan Dam site	12,000	158,000	15,000	34,000	89,000	41,000	337,000
Total, Chowchilla River	12,000	158,000	15,000	34,000	109,000	41,000	357,000
Fresno River							
Above Hidden Dam site	0	0	0	0	3,000	0	3,000
Below Hidden Dam site	4,000	105,000	0	0	72,000	0	177,000
Cottonwood Creek	900	18,000	0	0	15,000	0	33,000
Total, Fresno River	4,900	123,000	0	0	90,000	0	213,000
Upper San Joaquin River							
Above Friant Dam	0	0	0	0	21,000	0	21,000
Mendota to Friant Dam	0	0	0	0	0	0	0
Total, Upper San Joaquin River	0	0	0	0	21,000	0	21,000
Lower San Joaquin River							
Mendota to Merced River	25,000	36,000	0	0	12,000	0	48,000
Merced River to Tuolumne River	10,700	175,000	0	0	0	0	175,000
Tuolumne River to Stanislaus River	12,200	251,000	0	0	8,000	0	259,000
Stanislaus River to Mossdale Bridge	21,000	858,000	60,000	1,000	547,000	0	1,466,000
Los Banos and San Luis Creeks	1,200	10,000	0	0	405,000	0	415,000
Other west side tributaries	300	10,000	0	0	2,000	0	12,000
Total, Lower San Joaquin River	70,400	1,340,000	60,000	1,000	974,000	0	2,375,000
Upper Delta (Mossdale Br. to tidal channels)							
Reclamation District No. 17	10,200	741,000	11,000	6,000	85,000	50,000	893,000
Reclamation District No. 2058	4,400	269,000	0	0	339,000	40,000	648,000
Reclamation District No. 2062	3,200	254,000	0	10,000	423,000	40,000	727,000
Total, Upper Delta	17,800	1,264,000	11,000	16,000	847,000	130,000	2,268,000
TOTAL, SAN JOAQUIN RIVER BASIN	226,200	5,918,000	431,000	393,000	5,298,000	201,000	12,241,000

TABLE V.--Flooded Areas and Flood Damages, Tulare Basin
November and December 1950 Floods

Stream and reach	Flooded areas (acres)	Direct flood damage ($)					
		Agri-cultural	Resi-dential	Commer-cial & indust-rial	Public in-stitutions & utili-ties	Loss to travel-ing public	Total
Kings River							
Above Pine Flat Reservoir	200	10,000	0	0	5,000	0	15,000
Pine Flat Reservoir	100	15,000	0	0	909,000	0	924,000
Pine Flat to Highway 99	17,000	1,185,000	20,000	180,000	396,000	0	1,781,000
Highway 99 to Highways 41 & 198	36,000	924,000	0	3,000	31,000	0	958,000
Highway 41 to Mendota	14,000	180,000	0	0	72,000	0	252,000
Highway 198 to Tulare Lake	2,000	0	0	0	17,000	0	17,000
Total, Kings River	69,300	2,314,000	20,000	183,000	1,430,000	0	3,947,000
Kaweah River							
Above Terminus Reservoir	600	18,000	35,000	14,000	167,000	0	234,000
Terminus Reservoir	0	0	0	0	0	0	0
Terminus Dam to Tulare Lake	47,000	352,000	54,000	134,000	559,000	0	1,099,000
Total, Kaweah River	47,600	370,000	89,000	148,000	726,000	0	1,333,000
Tule River							
Above Success Reservoir	300	30,000	15,000	11,000	82,000	0	138,000
Success Reservoir	100	7,000	0	0	3,000	0	10,000
Success Dam to Tulare Lake	32,000	507,000	46,000	238,000	265,000	0	1,056,000
Total, Tule River	32,400	544,000	61,000	249,000	350,000	0	1,204,000
Kern River							
Above Isabella Reservoir	400	0	2,000	18,000	151,000	0	171,000
Isabella Reservoir	1,600	73,000	19,000	16,000	118,000	0	226,000
Isabella Dam to Buena Vista Lake	10,500	92,000	5,000	145,000	501,000	35,000	778,000
Buena Vista Lake	6,300	404,000	0	0	0	0	404,000
Goose Lake Slough	18,500	388,000	0	0	30,000	0	418,000
B.V.F. Chan., Lake to Wasco Rd.	0	0	0	0	0	0	0
B.V.F. Chan., below Wasco Rd.	0	0	0	0	0	0	0
Total, Kern River	37,300	957,000	26,000	179,000	800,000	35,000	1,997,000
Tulare Lake	10,600	676,000	0	0	134,000	0	810,000
Minor Streams							
Deer Creek (Tulare County)	600	5,000	0	0	44,000	0	49,000
Poso Creek, White River, Big Dry Creek & Caliente Creek Group	200	0	0	0	10,000	0	10,000
Total, Minor streams	800	5,000	0	0	54,000	0	59,000
TOTAL, TULARE BASIN	198,000	4,866,000	196,000	759,000	3,494,000	35,000	9,350,000

TABLE VI.--Flooded Areas and Flood Damages, Western Nevada
November and December 1950 Floods

Stream and reach	Flooded areas (acres)	Direct flood damage ($)					
		Agricultural	Residential	Commercial & industrial	Public institutions & utilities	Loss to traveling public	Total
Truckee River							
Lake Tahoe shoreline	120	0	5,000	5,000	0	0	10,000
Lake Tahoe to Donner Creek	100	0	3,000	24,000	0	0	27,000
Donner Creek to Farad	200	0	0	0	103,000	0	103,000
Farad to Reno	500	23,000	13,000	9,000	435,000	66,000	546,000
Reno	200	0	136,000	1,580,000	256,000	10,000	1,982,000
Reno to Vista	3,800	220,000	0	0	89,000	6,000	315,000
Vista to Derby Dam	100	42,000	0	0	30,000	0	72,000
Derby Dam to Pyramid	1,250	37,000	0	0	61,000	0	98,000
Total, Truckee River	6,270	322,000	157,000	1,618,000	974,000	82,000	3,153,000
Carson River							
East Fork to Centerville	700	72,000	0	0	47,000	1,000	120,000
West Fork to Centerville	3,000	71,000	0	0	54,000	2,000	127,000
E. & W. Forks, Centerville to Carson	22,000	208,000	6,000	0	130,000	8,000	352,000
Main Carson, Carson to Lahontan	7,000	151,000	0	0	5,000	8,000	164,000
Main Carson, below Lahontan	300	35,000	0	0	26,000	1,000	62,000
Total, Carson River	33,000	537,000	6,000	0	262,000	20,000	825,000
Walker River	2,000	143,000	5,000	0	230,000	4,000	382,000
TOTAL, WESTERN NEVADA	41,270	1,002,000	168,000	1,618,000	1,466,000	106,000	4,360,000

TABLE VII.--Damage to Properties Maintained by Forest Service
Floods of November-December 1950

Physical property	Estimated damage, by forests						Total damage
	Plumas ($)	Tahoe ($)	Eldorado ($)	Stanislaus ($)	Sierra ($)	Sequoia ($)	($)
Bridges	100,000	97,100	204,800	60,700	59,000	93,200	614,800
Roads	53,500	156,800	49,000	52,200	104,600	60,800	476,900
Trails	1,000	23,800	12,200	18,400	10,000	47,800	113,200
Buildings	1,000	0	200	0	2,000	1,200	4,400
Communication systems	1,000	4,700	2,000	0	2,500	800	11,000
Recreation areas	300	20,600	58,000	5,000	6,600	34,600	125,100
Cable river crossings	0	0	0	0	0	600	600
Dams and reservoirs	0	0	300	0	0	1,100	1,400
Irrigation ditches	200	100	0	0	0	800	1,100
Range improvements, fences	500	1,000	200	0	0	100	1,800
Sanitation systems	1,000	0	0	0	500	0	1,500
Water systems	0	0	500	500	500	1,000	2,500
Mountain meadows, timber sale areas	0	0	0	0	110,000	1,200	111,200
Total	158,500	304,100	327,200	136,800	295,700	243,200	1,465,500

NOTE: Data for this table furnished by U. S. Forest Service. As of this writing sufficient information is not available to break the damage into river basins. Therefore damage reported herein is not included in Tables III through VI.

TABLE VIII.--Summary of Flood Damages Showing Reduction to be Effected by Completion of Corps of Engineers Authorized, Recommended, and Proposed Flood Control Projects

River basin	Total damage incurred	Damages above authorized, recommended & proposed projects (a)	Damages within floodways or on areas covered by existing authorized & proposed flowage easements	Residual damages outside floodways subject to prevention by projects (b)	Damage that would be prevented by completion of authorized projects	Additional damage that would be prevented by completion of recommended projects	Additional damage that would be prevented by completion of proposed projects	Residual damages not preventable by completion of the C. of E. comprehensive plan as now envisioned (c)
	($)	($)	($)	($)	($)	($)	($)	($)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sacramento Basin								
Yuba River	4,034,000	414,000	22,000	3,598,000	0	0	3,598,000(d)	0
Bear River	278,000	11,000	73,000	194,000	0	0	194,000(e)	0
American River	3,505,000	484,000	85,000	2,936,000	2,680,000	20,000	0	236,000(t)
Coast Range streams	149,000	0	8,000	141,000	0	0	0	141,000
Clear Lake & tributaries	54,000	18,000	6,000	30,000	0	18,000	0	12,000
Misc. western Sierra streams	41,000	0	3,000	38,000	15,000	0	2,000	21,000
Feather River	273,000	51,000	189,000	33,000	0	33,000(f)	0(g)	0
Sacramento River & bypasses	428,000	8,000	380,000	40,000	40,000(h)	0	0(i)	0
Little Holland Island	80,000	0	80,000	0	0(j)	0	0	0
Prospect Island	25,000	0	25,000	0	0(j)	0	0	0
Liberty Island	116,000	0	116,000	0	0(j)	0	0	0
Venice Island	502,000	0	502,000(s)	0	0	0	0	0
Misc. Delta tracts	439,000	0	439,000(k)	0	0	0	0	0
Suisun Bay	10,000	0	0	10,000	0	0	0	10,000
TOTAL	9,934,000	986,000	1,928,000	7,020,000	2,735,000	71,000	3,794,000	420,000
San Joaquin Basin								
Cosumnes River	234,000	0	0	234,000	0	0	234,000	0
Dry Creek	11,000	0	0	11,000	0	0	0	11,000
Mokelumne River	1,674,000	107,000(l)	0	1,567,000	0	0	60,000(m)	1,507,000(u)
Bear Creek	114,000	0	0	114,000	114,000	0	0	0
Calaveras River	252,000	0	0	252,000	242,000	10,000	0	0
Littlejohn Creek	104,000	6,000	0	98,000	98,000	0	0	0
Stanislaus River	1,137,000	76,000	0	1,061,000	1,061,000	0	0	0
Tuolumne River	650,000	17,000	0	633,000	633,000	0	0	0
Merced River	2,435,000	1,816,000(o)	0	619,000	0	0	0	619,000
Merced Co. stream group	396,000	87,000	0	309,000	309,000	0	0	0
Chowchilla River	357,000	20,000	0	337,000	0	337,000	0	0
Fresno River	213,000	3,000	0	210,000	0	210,000	0	0
Upper San Joaquin River	21,000	21,000(o)	0	0	0	0	0	0
Lower San Joaquin River	2,375,000	0	145,000	2,230,000	1,803,000	0	0	427,000(p)
Upper Delta	2,268,000	0	15,000	2,253,000	2,253,000	0	0	0
TOTAL	12,241,000	2,153,000	160,000	9,928,000	6,513,000	557,000	294,000	2,564,000
Tulare Basin								
Kings River	3,947,000	939,000	0	3,008,000	3,008,000	0	0	0
Kaweah River	1,333,000	234,000	0	1,099,000	1,099,000	0	0	0
Tule River	1,204,000	148,000	0	1,056,000	1,056,000	0	0	0
Kern River	1,997,000	397,000	0	1,600,000	1,600,000	0	0	0
Tulare Lake	810,000	0	810,000	0	0(r)	0	0	0
Minor streams	59,000	0	0	59,000	0	0	0	59,000
TOTAL	9,350,000	1,718,000	810,000	6,822,000	6,763,000	0	0	59,000
GRAND TOTAL, CALIFORNIA	31,525,000	4,857,000	2,898,000	23,770,000	16,011,000	628,000	4,088,000	3,043,000
Eastern Nevada								
Truckee River	3,153,000	0	0	3,153,000	0	0	2,865,000	288,000
Carson River	825,000	127,000	0	698,000	0	0	632,000	66,000
Walker River	382,000	0	0	382,000	0	0	382,000	0
TOTAL	4,360,000	127,000	0	4,233,000	0	0	3,879,000	354,000
National Forests								
Damage reported by Forest Service not allocated to the various river basins	1,465,000	1,465,000	0	0	0	0	0	0
GRAND TOTAL	37,350,000	6,449,000	2,898,000(q)	28,003,000	16,011,000	628,000	7,967,000	3,397,000

(a) Mainly damages in mountain areas due to bridge and road losses and damage to power generating facilities.
(b) Column 5 = col. 2 - col. 3 - col. 4.
(c) Column 9 = col. 5 - col. 6 - col. 7 - col. 8.
(d) In addition, damages of $22,000 which occurred within floodways would also have been prevented.
(e) In addition, damages of $73,000 which occurred within floodways would also have been prevented.
(f) In addition, $35,000 of the damage which occurred within floodways would also have been prevented.
(g) The proposed projects on the Yuba and Bear Rivers would have reduced the damage within the floodways of the Feather River by $104,000.
(h) In addition, the Folsom Project would have prevented $10,000 of the damage which occurred on Yolo Bypass.
(i) The proposed projects on the Yuba and Bear Rivers would have reduced by $30,000 the flood damages that occurred within the Sutter Bypass.
(j) The Folsom Project would have eliminated all the damage that occurred on Little Holland Island, Prospect Island, and Liberty Island, amounting to $221,000.
(k) This damage consists mainly of damage to local interests and reclamation districts' levees.
(l) Above existing Pardee Reservoir.
(m) This amount would have been prevented in the Cosumnes-Mokelumne pool area by the proposed Nashville Reservoir on Cosumnes River.
(n) Above existing Exchequer Reservoir.
(o) Above existing Friant Reservoir.
(p) This damage was caused primarily by Los Banos Creek to the Delta-Mendota Canal now under construction.
(q) Completion of the authorized projects would have reduced this damage by $841,000. Completion of the recommended projects would have effected a further reduction of $35,000. Completion of the proposed projects would have accomplished an additional reduction of $229,000.
(r) The authorized projects on Kings, Kaweah, and Tule Rivers would have prevented $610,000 of the damage which occurred in Tulare Lake sump.
(s) Venice Island was flooded basically because of unusually high tide and inadequate levees. Concurrent high river discharges may have aggravated the condition, but only to a minor extent.
(t) Consists mainly of residual damages to existing levees.
(u) An investigation is presently under way to determine feasibility of flood-control works on Mokelumne River.

TABLE IX.--Functioning of Principal Existing Reservoirs During November-December 1950 Floods

Reservoir	Stream	Operating agency	Purpose (a)	Reservoir capacity	Flood of 15-21 November 1950				Flood of 2-5 December 1950				Flood of 6-10 December 1950			
					Avail. space at beginning of flood	Maximum storage used	Peak inflow	Peak outflow	Avail. space at beginning of flood	Maximum storage used	Peak inflow	Peak outflow	Avail. space at beginning of flood	Maximum storage used	Peak inflow	Peak outflow
				(ac.-ft.)	(ac.-ft.)	(ac.-ft.)	(c.f.s.)	(c.f.s.)	(ac.-ft.)	(ac.-ft.)	(c.f.s.)	(c.f.s.)	(ac.-ft.)	(ac.-ft.)	(c.f.s.)	(c.f.s.)
Shasta	Sacramento R.	U.S.B.R.	F.C.I. & P.	4,493,000	1,354,000	145,000	43,000	8,000	1,160,000	61,000	20,000	6,700	1,099,000	131,000	35,000	12,000
Lake Almanor	Feather R.	P.G. & E.	P.	650,000	151,000	11,000	2,700(b)	40	107,000	9,000	1,800(b)	10	98,000	19,000	2,800(b)	10
Clear Lake	Cache Creek	Clear Lake Water Co.	I.	319,000(c)	303,000	35,000	-	0	255,000	38,000	-	0	201,000	25,000	-	0
Pardee	Mokelumne R.	East Bay Municipal U. Dist.	I.P., W.S.	210,000	45,000	55,000	30,000	28,000	36,000	39,000	25,000	5,500	0	10,000	30,000	27,000
Salt Springs	Mokelumne R.	P.G. & E.	P.	139,000	75,000	68,000	-	-	6,000	Full	-	-	0	Full	-	-
Hogan	Calaveras R.	City of Stockton	F.C. & I.	76,000	76,000	21,000	21,000	7,000	75,000	11,000	16,000	4,600	72,000	10,000	20,000	5,700
Farmington	Littlejohn Cr.	C. of E.	F.C. (f)	52,000	52,000	2,500	-	2,400	52,000	2,000	-	2,250	52,000	8,000	-	2,900
Melones	Stanislaus R.	Oakdale Irr. Dist.	P. & I.	112,000	87,000	89,000	90,000	45,000	16,000	16,000	52,000	42,000	13,000	11,000	43,000	39,000
Don Pedro	Tuolumne R.	Turlock & Modesto Irr. Dist.	F.C., P.&I.	290,000	191,000	190,000	90,000	29,000	101,000	87,000	64,000	9,000	16,000	20,000	69,000	64,500
Hetch Hetchy	Tuolumne R.	City of San Francisco	W. S. & P.	360,000	164,000	134,000	40,000	800	7,000	11,000	40,000	9,000	0	9,000	8,000(b)	9,000
Exchequer	Merced R.	Merced Irr. District	P. & I.	281,000	256,000	203,000	88,000	100	26,000	34,000	55,000	38,000	20,000	18,000	20,000	14,000
Burns	Burns Creek	C. of E.	F. C.	7,000	7,000	3,200	8,000	1,700	7,000	-	-	1,400	7,000	-	-	1,000
Owens	Owens Creek	C. of E.	F. C.	3,600	3,600	950	1,700	150	3,600	660	1,400	135	3,400	60	150	120
Mariposa	Mariposa Creek	C. of E.	F. C.	15,000	15,000	8,300	19,000	900	15,000	4,000	9,000	790	-	-	1,100	600
Friant	San Joaquin R.	U.S.B.R.	F.C. & I.	520,000	418,000	114,000	55,000	50	250,000	80,000	35,000	500	170,000	67,000	15,000	500
Big Dry Res.	Big Dry Creek	Fresno Irr. Dist.	F. C.	16,000	16,000	240	1,500	80	16,000	500	950	60	-	-	-	50
Lake Tahoe	Truckee River	Sierra Pac. Power Co.	P. & I.	757,000(d)	441,000	130,000	-	4	280,000	61,000	-	15	212,000	55,000	-	30
Donner Lake	Donner Creek	Sierra Pac. Power Co.	P. & I.	11,200	5,000	5,000	-	700(b)	4,000	4,000	-	400(b)	0	0	-	400(b)
Boca Res.	L. Truckee River	Truckee-Carson Irr. Dist.	P. & I.	40,900	8,000	8,000	7,000	5,000(b)	14,000	5,000	-	1,400(b)	10,000	4,000	-	2,400(b)
Lahontan	Carson River	Truckee-Carson Irr. Dist.	P. & I.	290,000	130,000	60,000	8,500	240	49,000	30,000	8,500	1,700	20,000	10,000	7,000	2,500
Topaz	W. Walker River	Walker River Irr. Dist.	I.	59,400	52,400	9,000	(e)	-	-	-	(e)	-	-	-	-	-
Bridgeport	E. Walker River	Walker River Irr. Dist.	I.	42,500	39,500	9,000	-	-	-	-	-	-	-	-	-	-

(a) F. C., Flood Control; I, Irrigation; P, Power; W.S., Domestic Water Supply.
(b) Mean daily flow.
(c) Storage between Rumsey Gage 0.00 feet and 7.56 feet.
(d) Storage between elevation 6,223.0 feet and 6,229.1 feet.
(e) Offstream storage reservoir. Intake destroyed during first flood.
(f) Interim operation with uncontrolled outlets.

CORPS OF ENGINEERS

U. S. ARMY

LEGEND

Flood control and multiple purpose improvements proposed by Corps of Engineers

- Reservoirs
- Levee and channel improvements
- (A) Completed improvements
- (B) Improvements under construction
- (C) Authorized improvements
- (D) Improvements recommended by Chief of Engineers
- (E) Future proposed improvements
- Area flooded 1950

CENTRAL VALLEY OF CALIFORNIA & WESTERN NEVADA

FLOODS OF NOVEMBER-DECEMBER 1950

GENERAL MAP & FLOODED AREAS

SCALE IN MILES 10 0 10 20 30 40 50

CORPS OF ENGINEERS, U.S. ARMY
SACRAMENTO DISTRICT, SACRAMENTO, CALIFORNIA, MARCH 1951

Prepared: Chief, Ins. & Rpts. Section

Recommended: Chief, Engineering Division

Submitted: Chief, Planning Branch

Approved: Col., Corps of Engrs., U.S.A. Dist. Engr.

To accompany report on Flood of Nov.-Dec. 1950 dated March 1951

Dr by: H.M. Tr. by: H.M. Csd. by: R.D.

FILE NO. SA-DT-20-56

SHEETS: 1 SHEET NO. 1

PLATE I

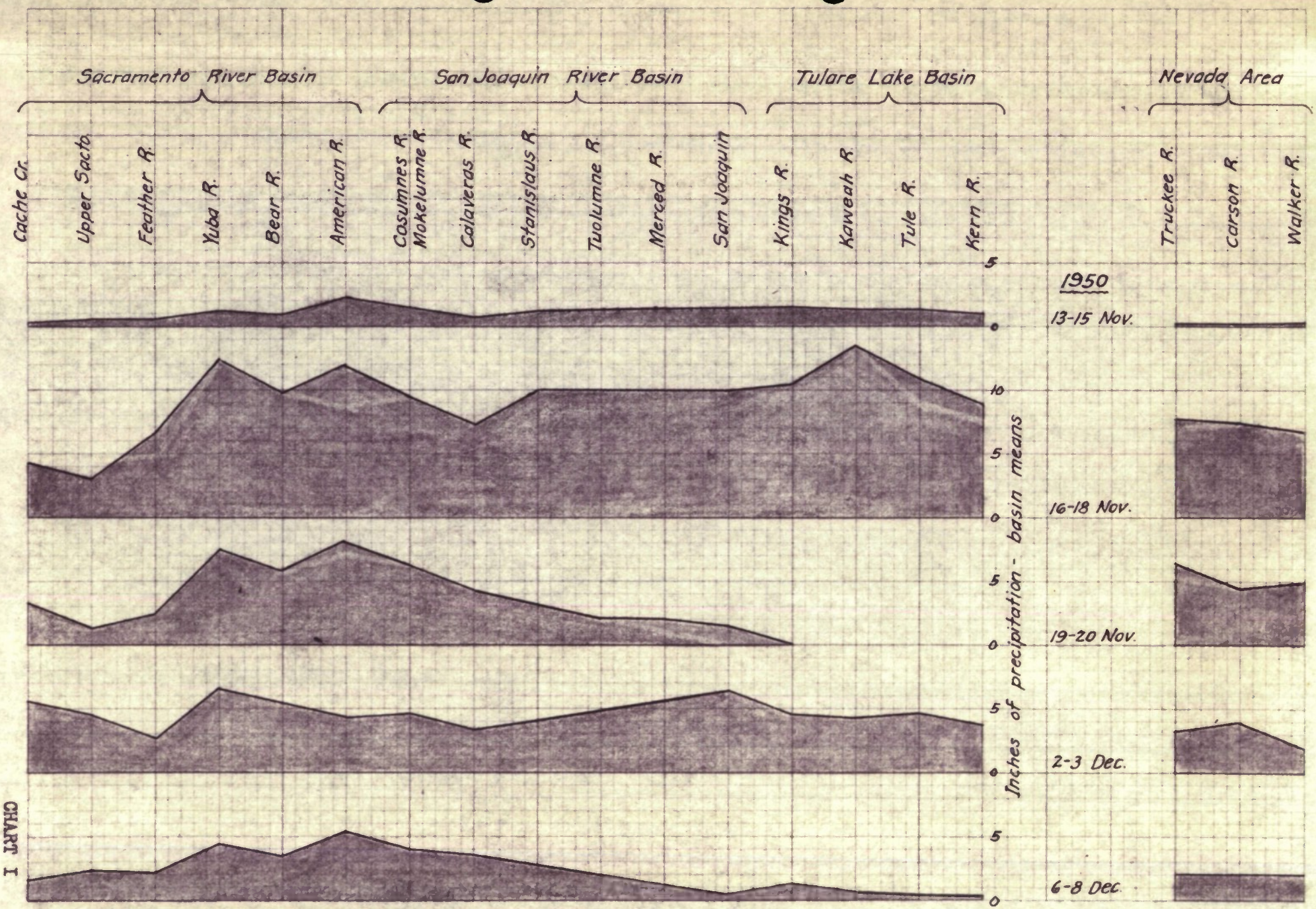

CHART I

STORM PRECIPITATION -- CHART I

Flow in 1000 c.f.s.

Stage in feet

Shasta Reservoir

Sacramento River at Iron Canyon (Red Bluff)

Ord Ferry

Feather River at Oroville

Yuba River at Englebright Dam

Yuba River at Marysville (stage in Feet)

Bear River at Wheatland

American River at Folsom

Yolo Bypass at Fremont Weir

" " " Lisbon

Sacramento Weir into Yolo Bypass

Sacramento River at I St Bridge

Nov. 1950

DEC. 1950

SACRAMENTO RIVER BASIN HYDROGRPAHS -- CHART II

Flow in 1000 c.f.s.

Stage in feet

55,000 Inflow / Outflow

35,000 — 500 c.f.s. — 15,000 — 5,000

San Joaquin River at Friant Reservoir

2400 — 3800

San Joaquin River near Mendota

(Newman) 3700 — (Patterson) 17,000

San Joaquin River near Newman & Patterson

31,000 — 60,000

San Joaquin River at Hatch Hetchy Crossing

37,000 — 75,000

San Joaquin River near Vernalis

15.5 — 24.75

San Joaquin River at Mossdale Bridge (Stage in Feet)

88,700 Inflow — 50 c.f.s. — 55,000 Inflow — 38,000 Outflow — 20,000 — 14,000

Merced River at Exchequer Res.

90,000 — 29,000 — 64,000 — 9,000 — 69,000 — 64,500

Tuolumne River at Don Pedro Res.

80,000 — 27,600 — 45,000 — 52,000 — 42,000 — 30,000 — 43,000 — 39,000

Stanislaus River at Melones Res.

21,000 — 7000 — 15,000 — 7000 — 16,000 — 4600 — 20,000 — 9700

Calaveras River at Hogan Res.

25,000 — 30,000 — 28,000 — 27,000 — 25,000 — 30,000 — 27,000 — 25,000 — 20,000

Mokelumne River at Pardee Res.

Cosumnes River at Michigan Bar

NOV. 1950 — DEC. 1950

16 17 18 19 20 21 22 23 24 — 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

SAN JOAQUIN RIVER BASIN HYDROGRAPHS -- CHART III

Flow in 1000 c.f.s.

100 50 0 50 0 50 0 50 0 50 0 50 0 50 0

91,000
39,000
10,000
Kings River at Piedra

10,000
10,000
Kings River at Lemoore Weir

5,000
5,000
4,000
Kings River at Crescent Weir

4150
Kings River at Fresno Slough

55,000
14,500
Kaweah River at McKay Point

28,000
7000
Tule River at Worth Bridge

39,000
1,000
Kern River at Isabella Damsite

39,000
8400
Kern River nr. Bakersfield

1,500
2,300
Kern River at 2nd Point

NOV 1950
16 17 18 19 20 21 22 23 24

DEC 1950
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

TULARE LAKE BASIN HYDROGRAPHS -- CHART IV

Flow in 1000 c.f.s.

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22 October 2008

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The enclosed documents from USACE Sacramento District are hereby submitted for inclusion in DTIC's technical reports database. The following is a list of documents included in this shipment:

ADB344304 • Lemon Reservoir Florida River, Colorado. Report on reservoir regulation for flood control, July 1974

ADB344333 • Reconnaissance report Sacramento Metropolitan Area, California, February 1989

ADB344346 • New Hogan Dam and Lake, Calaveras River, California. Water Control Manual Appendix III to Master Water Control Manual San Joaquin River Basin, California, July 1983

ADB344307 • Special Flood Hazard Study Nephi, Utah, November 1998 (cataloged)

ADB344344 • Special Study on the Lower American River, California, Prepared for US Bureau of Reclamation – Mid Pacific Region and California Dept. of Water Resources..., March 1987

ADB344313 • Transcript of public meeting Caliente Creek stream group investigation, California, held by, the Kern County Water Agency in Lamont, California, 9 July 1979

ADB344302 • Initial appraisal Sacramento River Flood control project (Glenn-Colusa), California, 10 February 1989

ADB344485 • Report on November-December 1950 floods Sacramento-San Joaquin river basins, California and Truckee, Carson, and Walker rivers, California and Nevada, March 1951

ADB344268 • Reexamination Little Dell Lake, Utah, February 1984

ADB344197 • Special report fish and wildlife plan Sacramento River bank protection project, California, first phase, July 1979

ADB344264 • Programmatic environmental impact statement/environmental impact report Sacramento River flood control system evaluation, phases II-V, May 1992

ADB344201 • Hydrology office report Kern river, California, January 1979

ADB344198 • Kern River – California aqueduct intertie, Kern county, California, environmental statement, February 1974

ADB344213 • Sacramento river Chico Landing to Red Bluff, California, bank protection project, final environmental statement, January 1975

ADB344265 • Cottonwood Creek, California, Information brochure on selected project plan, June 1982

ADB344261 • Sacramento river flood control project Colusa Trough Drainage Canal, California, office report, March 1993

ADB344343 • Detailed project report on Kern River-California aqueduct intertie, Kern County, California. February 1974

ADB344267 • Sacramento River Flood Control Project, California, Right Bank Yolo Bypass and Left Bank Cache Slough near Junction Yolo Bypass and Cache Slough, Levee construction, General Design, Supplement No. 1 to Design Memorandum #13, May 1986

ADB344246 • Redbank and Fancher Creeks, California, General Design Memorandum #1, February 1986

ADB344260 • Cache Creek Basin, California, Feasibility report and environmental statement for water resources development Lake and Yolo counties, California, February 1979

ADB344199 • Sacramento River Deep Water Ship channel, California, Feasibility report and environmental impact statement for navigation and related purposes, July 1980

ADB344263 • Sacramento River flood control project, California, Mid-Valley area, phase III, Design Memorandum, Vol. I or II, June 1986

ADB344262 • Marysville Lake, Yuba River, California, General Design Memorandum Phase I, Plan Formulation, Preliminary Report, Appendixes A-N, Design Memorandum #3, March 1977

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