CHAPTER 2

HISTORY OF FLOODING AND FLOOD PROTECTION

US Army Corps of Engineers
Sacramento District

Post-Flood Assessment for 1983, 1986, 1995, and 1997
Central Valley, California

CHAPTER 2

HISTORY OF FLOODING AND FLOOD PROTECTION

INTRODUCTION

The climate and geography of the Central Valley have combined to produce an area where regular flooding is natural. In the early 1800's, settlers and Indians described the Sacramento and San Joaquin rivers as "miles wide" during flooding. Initially, flood protection in the Central Valley developed in a piecemeal fashion with the construction of levees to protect local areas from flooding. Levees were typically constructed in response to a past flood, with little or no coordination between different localities.

By the late 1800's, floods were magnified by the billions of tons of hydraulic mining debris washed down tributaries from the Sierra Nevada. In 1893, the California Debris Commission (CDC) was created to regulate hydraulic mining so that mining would not infringe on navigation and agricultural development in the Central Valley. The current flood protection system evolved from the CDC's plan for flood management in the Sacramento and San Joaquin Valleys, also known as "The Jackson Report."

This chapter describes the historical setting and development of flood protection in the Central Valley. The chapter begins with a description of early development and the need for flood protection, accompanied by early flood protection planning efforts. Major floods through the 1970's are summarized. The floods of 1983, 1986, 1995, and 1997 are discussed in detail in Chapter 5. Finally, the development of the current flood management system is described.

EARLY HISTORY OF FLOOD MANAGEMENT IN THE CENTRAL VALLEY

NATURAL CONDITIONS

Under natural conditions, the channels of the Sacramento and San Joaquin rivers in the Central Valley had insufficient capacity to carry the heavy winter and spring flows generated by wet season precipitation and/or snowmelt. Once flows exceeded channel capacity, the channels overflowed onto the surrounding countryside. The flow velocity in the overbank areas would be greatly reduced from that in the channel. Thus, the sediment-carrying capacity would also be reduced, allowing much of the material naturally eroded from mountain and foothill areas and carried in the streams to drop out of suspension. In this way, over many years, the Sacramento and San Joaquin rivers built up their beds and formed natural levees composed of the heavier, coarser material carried by the floodflows each year. The finer material stayed in suspension much longer and would drop out when the overflow water ponded in the basins that developed to the east and west of the rivers. The higher elevation land formed by the natural levees attracted the first settlements in the Central Valley.

IMPACTS OF MINING AND EARLY DEVELOPMENT

On January 24, 1848, James W. Marshall discovered gold at Coloma on the South Fork of the American River, marking the beginning of the California Gold Rush. Over the following years, thousands of people were drawn to California to try their hand at gold mining. Initially, mining activities were concentrated in streambeds or close to streams. It was soon discovered, however, that the gold found in the present canyons came from ancient gravel deposits in the ridges and hilltops between the canyons.

At the headwaters of the Yuba and Bear rivers in 1856, one of the most productive yet environmentally damaging mining methods was initiated—hydraulic mining. The hydraulic mining process is relatively simple. Streams of water from large nozzles called hydraulic monitors washed gravel down from the hilltops and through sluice boxes where the gold was caught by riffles. Over a period of two decades, the process was improved and developed to such an extent that by 1879 an estimated 53 million cubic yards of material were being washed annually into the streams and canyons tributary to the Sacramento and San Joaquin rivers. This vast amount of material reduced channel capacity downstream, resulting in increased flooding of the lower lying areas.

With the great influx of people into the State, the demand for goods grew tremendously. This demand included agricultural goods, which prompted the agricultural development of portions of the Central Valley. Before agricultural development, considerable portions of the valley floor were vast wetlands covered by a dense growth of tule. Surrounding the tule lands lay belts of higher and more fertile lands called rimlands. The rimlands were the first to be settled and to come under cultivation, since they were flooded less often and were still accessible to water transportation. As the cultivation of rich agricultural lands in the Central Valley increased, the damages caused by floods became increasingly more extensive.

Flood management in the Central Valley had its inception in the construction of levees to reclaim fertile tule lands and to provide protection against out-of-bank flows. No sooner had development begun than landowners began to build low levees along the riverbanks to protect their newly developed land. As the private levee system developed, with each levee intended to protect a different tract of land, the protection afforded by the individual levees decreased due to the increased heights of the floodwaters constrained between the levees. The increased flood danger led to competition between landowners to continually raise and strengthen levees piecemeal so that any overflow would flood somebody else’s land.

Continued levee construction by landowners, however, was not adequate to protect agricultural lands from the effects of hydraulic mining debris. By the mid-1870's, agricultural lands were being flooded and covered with mining debris to such an extent that agricultural interests filed a suit against the mining companies. The resulting Sawyer Decision, rendered on January 7, 1884, virtually stopped all hydraulic mining. Although levees were intermittently spaced prior to 1850, by 1894 many miles of levees had been constructed along the rivers, and some entities surrounded by levees had formed districts to provide flood protection. Figure 2-1 shows a time line of flood protection development in the Sacramento and San Joaquin River basins.

EARLY PLANNING REPORTS

During the first two decades of the 20th century, several studies were made by State and Federal interests to develop options for alleviating the damage from hydraulic mining and for providing additional flood protection. Generally, two types of flood management systems were proposed. The first system would widen and deepen the natural river channels and confine the floodflows to those channels through the construction of high levees along the banks. The second system combined natural channels with a system of bypasses. Under this system, the natural channels would only be slightly improved, but would be confined narrowly by levees. Protection from major floodflows would be accomplished by routing water away from the main channels through leveed bypasses constructed in the overflow basins next to the river. Weirs would be incorporated into the system to allow excess floodwater to spill into the bypasses and overflow areas. Navigation interests favored this latter plan of a confined river maintained to sufficient depth for shipping and with summer velocities high enough to keep the mining debris scoured from the channels.

CALIFORNIA DEBRIS COMMISSION

The California Debris Commission was established by Congress on March 1, 1893, and abolished by an act of Congress on November 17, 1986. Mining interests had appealed the "Sawyer Decision" to the Federal Government, until Congress modified the court ruling by passing the Caminetti Act in 1893. The Caminetti Act authorized the creation of the CDC as a Federal agency. On May 3, 1893, President Grover Cleveland appointed three Corps officers as members of the CDC. The primary duties of the CDC included the protection of rivers and the supervision of all hydraulic mining in watersheds of the Sacramento and San Joaquin rivers. Purposes of the CDC were to regulate hydraulic mining so that mining might be carried on without injury to navigation and agricultural lands; to improve the navigability of the rivers with a view to restoring, as nearly as practicable, the conditions existing in 1860; and to afford relief from flooding. The CDC was also authorized to carry out extensive research of the hydraulic mining industry and, where possible and practicable, build large, high debris dams. In turn, miners who were permitted to mine and dump tailings into streams behind the debris barriers would be required to reimburse the Government for this construction by paying a 3 percent tax on the gross proceeds. The CDC was also responsible for the inspection and regulation of gold dredging, which had begun to flourish as an industry following the elimination of hydraulic mining.

The CDC was an extremely powerful body and was the supreme authority in all matters relating to hydraulic mining. The three officers of the U.S. Army Corps of Engineers were empowered to establish their own operating procedures and to interpret them as they deemed appropriate. In the authorizing legislation, the CDC was "granted the right to use any of the public lands of the United States, or any rock, stone, timber trees, brush, or material thereon or therein, for any of the purposes of this [Caminetti] act . . . " Few groups in history have been afforded such absolute authority over a private commercial sector of society as was given the CDC.

The CDC began surveys of Sacramento Valley streams in July 1905 and developed a flood management plan based on the surveys and data from the flood of March 1907, which was the largest general flood in the valley for which measurements are recorded. The plan sent to Congress in 1910, known as the "Jackson Report," proposed a comprehensive project to improve navigation and flood management on the rivers. Under the Jackson Plan, normal flows would be confined to the river channels, and a series of bypasses and overflow basins would be used to direct high flows away from developed areas during major flooding. Specifically, the Jackson Plan included the following components:

- the construction and enlargement of levees along the riverbanks
- the construction of levees to create artificial channels, called "bypasses," that would convey the floodwater greater than the river's capacity
- the construction of weirs to discharge floodwaters from the river into the bypasses
- the enlargement, by dredging, of the channel of the Sacramento River from Cache Slough to Suisun Bay

In the plan, it was estimated that 90 percent of all levee construction could be done using clamshell dredges. The balance would be done with teams of horses and scrapers.

The CDC also suggested a plan to manage the Sacramento River by coordinating the operation of storage reservoirs for flood management. After examinations and surveys of reservoir sites in both the Coast Ranges and the Sierra Nevada, however, the CDC determined that construction of dams for flood management would not be economically feasible. In the Jackson Report, the CDC stated that construction of dams for flood management should be deferred until these reservoirs proved desirable for power and irrigation purposes.

CHRONOLOGY OF MAJOR FLOODS IN THE CENTRAL VALLEY

This section describes major floods in the Central Valley from the earliest reported floods through to the present day. During the past 150 years, flood protection facilities were developed in response to many of these events. Figure 2-1 shows a time line of major floods and milestones in the development of flood protection facilities in the Sacramento and San Joaquin River basins. Floods described in this section are specified based on the year in which they occurred. Often, floods in the Central Valley begin in December and continue through to the new year. In those cases, the flood is designated by the latter year.

MAJOR FLOODS PRIOR TO 1850

Information is very meager about floods in the Sacramento and San Joaquin River basins prior to the 1850s. The primary sources for information during this period are histories of the early settlements that include eyewitness accounts from Indians and the pioneer settlers. According to the early settlement histories, the Indians had knowledge of a great flood that supposedly

occurred at the beginning of the 19th century in the Sacramento River Basin. This great flood caused thousands of deaths. Also, prior to the 1850s, floods in the Sacramento River Basin occurred in 1826, 1840, and 1847. The Indians recalled the flood of 1826 as a devastating one. John A. Sutter described the area near the present city of Sacramento in the flood of 1840 as a vast expanse of water. However, since levees had not yet been constructed, even minor floods would have spread far beyond the channel of the lower Sacramento River.

The earliest flood mentioned in historical accounts of the settlement of the San Joaquin River Basin is that of January 1847. It was reported that the Stanislaus River, at a point about 1.5 miles upstream from its mouth, overflowed the country for miles beyond its channel and that the San Joaquin River was about 3 miles wide at the crest of the flood. As in the Sacramento River Basin, the extent of the overflow in the lower reaches of these rivers in the early days scarcely gives any indication of the discharge, as the minor floods would have spread, in many places, beyond the normal channels almost as far as the major floods.

MAJOR FLOODS 1850 TO 1900

Extensive settlement in the State began around 1850 following the discovery of gold. Around this time, systematic records of streamflow began. Between 1850 and 1900, a number of great floods occurred in the Sacramento and San Joaquin River basins. With respect to these floods, authentic data are available on the rainfall conditions and crest stages in some localities. These data are supplemented by accounts in local histories and newspapers. Large floods occurred in the Sacramento River Basin in 1850, 1852, 1853, 1861, 1862, 1867, 1868, 1878, 1881, 1886, 1889, 1890, and 1891. Large floods occurred in the San Joaquin River Basin in 1852, 1861, 1862, 1867, 1868, 1869, 1871, 1872, 1878, 1881, 1884, 1886, 1889, 1890, 1892, and 1893. The four largest floods during this period are discussed below.

Floods of 1862

December 1861 to January 1862 constitute one of the greatest flood periods in the history of California. The floods of 1862 were remarkable for the exceptionally high stages reached on nearly every stream, for repeated large floods, and for the prolonged and widespread inundation in the Sacramento and San Joaquin River basins. Rainstorms were heavy in the lower elevations and snowfall continuous in the upper elevations throughout the two basins.

Many reports published during this period describe the lower Sacramento River Basin as one vast sea of water. In this basin, overflow from the American River flooded the city of Sacramento, causing loss of life and destruction of property. The lower Sacramento River flooded considerable areas in the lowlands downstream from Colusa. Thousands of cattle drowned or died of starvation in the flooded regions, and many ranch buildings were destroyed. The levees protecting the city of Sacramento were raised after the flood of 1862, and the city has not been seriously flooded since.

In the San Joaquin River Basin, the city of Stockton and the surrounding country were inundated for many miles. Also in this basin, the Merced River, downstream from the mouth of its canyon,

flooded the town of Snelling. The flood widened and changed the course of the Merced River channel. Reports state that the whole country surrounding lower Mariposa Creek and the Fresno and Chowchilla rivers, as seen from the foothills, was one vast sheet of water. The Stanislaus River at Knights Ferry flooded that city twice during the winter season. During the second flood, the city was destroyed. The floods destroyed nearly all the bridges, mills, and other structures along the channels of the San Joaquin River and the major tributaries.

In the Tulare Lake Basin, reports state that a damaging flood on the Tule River overflowed farms to a depth of several feet. The town of Visalia, an early settlement, was flooded twice. The lowlands along the tributaries of Tulare Lake were probably flooded continuously from the middle to the end of January. A settlement known as Scottsburg on the Kings River was flooded. During the floods, the Tule River changed its channel for a considerable distance downstream from the foothills. From the number of large trees washed down from the mountains by the floods on the Kings, Kaweah, Tule, and White rivers, the settlers inferred that this was the greatest flood for many years.

Floods of 1867

In December 1867, the lower Sacramento River Basin was assailed by extremely heavy precipitation followed by excessive runoff. High stages were observed several times during December 1867 on the foothill streams of the Sierra Nevada, and moderate or large floods occurred during the latter part of this month on streams in the Sacramento River Basin.

The flood of 1867 was one of major importance throughout the San Joaquin River Basin. Floods of great magnitude occurred on the main tributaries of the lower San Joaquin River. The San Joaquin River at Friant exceeded the flood of 1862, and caused many buildings to be washed away. The Mokelumne River overflowed its banks near Woodbridge and reached a stage near that of 1862. In the foothills, the flood on the San Joaquin River exceeded considerably any other known flood and was probably higher than any known flood at all points upstream from the mouth of the Merced River. However, the San Joaquin River stages downstream from the mouth of the Stanislaus River were not as high in 1867 as in 1862.

During recorded history, the flood of 1867 was one of the greatest in the Tulare Lake Basin. The floods were especially severe on Sierra Nevada streams tributary to the southern part of the Central Valley. Peak stages in this region during December 24 and 25 were the highest of record. Major floods occurred on all the main tributaries in the Tulare Lake Basin. The town of Visalia was partly flooded by waters from the Kaweah River. The settlement of Scottsburg on the Kings River, which had been flooded in 1862, rebuilt on a new site and was destroyed by the flood of 1867. A memorable characteristic of the flood of 1867 on the Kings and Kaweah rivers was the tremendous quantity of timber brought down from the Sierra and deposited on the plains. In the flood of 1867, the Tulare Lake overflowed to the north into the San Joaquin River.

Floods of 1881

In 1881, floods of considerable magnitude occurred throughout the Sacramento River Basin. The prolonged high stage period preceding the peaks, which distinguish these events, were primarily due to the changed channel conditions that resulted from mining activities and reclamation work. A storm over the Sacramento River Basin in the middle of January caused high stages in the lower Sacramento River and resulted in numerous levee breaks. At the end of the month, back-to-back storms caused additional flooding in the basin. During this second flood in January, levees again broke on both sides of the Sacramento River downstream from the City of Sacramento. Railroad tracks were submerged and washed out at several locations. Early in February, the Sacramento River upstream from Cow Creek reached one of the highest stages of record. The high stages on Cow Creek washed out bridges and roads. The Feather, Yuba, and American rivers all reached high stages. In fact, the stages for the Feather and Yuba rivers had risen higher than ever known. Floods were also notable in the San Joaquin River Basin.

Floods of 1890

The winter of the 1890 water year was remarkable for the exceptionally heavy and widespread precipitation that produced floods of considerable magnitude throughout northern California in January and February 1890 and moderate floods at other times from December 1889 through May 1890. The winter season of 1889 to 1890 featured an exceptionally heavy snowfall in the mountains, and the snow runoff period was one of the heaviest and longest of record. Lowlands in the lower Sacramento River Basin were flooded for many weeks. In December 1889, the Sacramento River reached flood stages from Tehama to Sacramento. The peak stages on the river at Colusa and Sacramento were the highest yet observed. However, these high stages were primarily due to reclamation work along the river. There were many breaks in the levees from Colusa downstream, and considerable damage was done to grain lands. A large break on the right bank levee of the Sacramento River below Sacramento helped to reduce subsequent flood stages. In January 1890, the tributaries of the Sacramento River were again at high stages. Stony and Putah creeks were reported to have been at the highest stages known to local residents. Considerable overflow from Cache Creek near Yolo flooded farms and caused washouts along the railroad. In February 1890, a flood occurred on the upper Sacramento River. The Sacramento River at Redding washed out part of a bridge.

Large floods occurred throughout the San Joaquin River Basin during the latter part of January 1890. The upper San Joaquin River possibly reached an extremely high stage. The Merced, Stanislaus, Tuolumne, and Mokelumne rivers were at dangerously high stages, and some of the foothill tributaries of these rivers were reported to have been at the highest known stages to date. Several towns were flooded and railroad and highway structures washed out. The maximum stage of the season, however, was reached, at least on the lower San Joaquin River, during the snow runoff period in May 1890. There were floods in the northern part of the Tulare Lake Basin at the end of January 1890. Overflow from the Kaweah River caused damage in Visalia, where it was reported that boats were used on Main Street. Railroad tracks were washed out near Visalia.

MAJOR FLOODS AFTER 1900

Flood of 1904

The upper Sacramento River reached peak stages that were the highest yet observed. These peaks occurred at Kennett and Red Bluff. Cottonwood and Clear creeks were also reported to have been at stages higher than ever observed. From the middle of February to the end of March, flooding was almost continuous in the lower Sacramento River Basin. Also during this time, there was a severe flood on the Pit River at Alturas, where it was reported that boats were rowed through the main part of town. In general, the flood of 1904 was considered to have been the most destructive flood in the history of the lower Sacramento Valley up to that time. However, the peak discharge of the lower Sacramento River was believed to have been greater during the flood of 1862.

Flood of 1907

In March 1907, a very destructive flood occurred in the Sacramento River Basin. The flood was caused by a severe rain from March 16 to 20 followed by a period of comparatively high runoff. Stages were exceptionally high throughout the basin. On the Feather River at Oroville, the flood height was the greatest ever observed, although it was believed that the river profile at that location had been raised since 1862 by deposition of mining debris.

This flood was also significant in the San Joaquin River Basin. Only a moderate rise on the upper San Joaquin River was observed during this flood, but there were exceptionally high stages on the large tributaries in the lower part of the basin. From the Merced River to the Mokelumne River, stages peaked on March 19, 1907, and were followed by high stages for several days. The San Joaquin River downstream from Mendota was at or above flood stage from the middle to the end of March.

Flood of 1909

The flood of 1909, is believed to have been as great as that of 1907. During January 1909, flooding occurred at several places in the Sacramento River Valley from Red Bluff to the mouth of the Sacramento River. The Sacramento River had reached high stages at Red Bluff in January and continued to rise into the beginning of February. The Sacramento River at Red Bluff reached a peak stage that was the highest yet observed. The lower river at Sacramento reached the maximum stage of record in the middle of January, and exceptionally high stages were recorded on nearly all the main tributaries to the river. Flood conditions prevailed in the lower basin through the end of the month. However, damaging floods occurred again in the beginning of February. The floods of 1909 were the most disastrous of any for which there is an authentic account, although it is believed that the flood discharge from the Sacramento River Basin in 1862 was probably far greater than discharge from the floods of 1907 or 1909.

Flood of 1911

The flood of 1911 was one of the greatest floods this century in the lower San Joaquin Valley. During this flood, the upper San Joaquin River near Friant reached high stages at the end of January 1911. The flood was higher downstream; near Newman at the mouth of the Merced River, the peak stage of 1911 set a record. High stages were also reached on the Calaveras, Mokelumne, Stanislaus, Tuolumne, and Merced rivers. The floods on these tributaries combined to raise the San Joaquin River to a record-breaking stage. Reports estimated that 75,000 acres of land were flooded from the overflow of the San Joaquin, Mokelumne, and Calaveras rivers. Extensive reclamation works and other improvements affecting the capacity of the channel since then make it impossible to estimate from the flood heights the relative magnitude of the floodflows in the lower San Joaquin River Basin.

Flood of 1928

In March 1928, flooding was severe in the Feather and American River basins and moderate throughout the Sacramento River Basin. A notable feature of the flood of 1928 was that it occurred during a relatively dry season and was followed by comparatively low stages, whereas most of the important floods in this basin have occurred during seasons of heavy precipitation. The flood of 1928 occurred during a period of heavy precipitation in the Sierra Nevada. Temperatures were unusually high, and the rainfall was especially heavy at altitudes up to 7,000 feet. The American River at Fair Oaks equaled its maximum recorded discharge of March 1907, and the Feather River at Oroville was exceptionally high. The greatest damage during the flood of 1928 was from overflow of the American River near Sacramento. Several thousand acres, including the town of North Sacramento, were flooded.

Flood of 1955

The December 1955 flood brought large flows to many locations in the Sacramento River Basin. A levee break on the Feather River caused severe flooding in the Yuba City area. The flow in the American River at Fair Oaks was controlled to 70,000 cfs because Folsom Reservoir was nearly empty at the beginning of the event. Had Folsom been up to allowable storage capacity, the project would have exceeded its design outflow and the flow at Fair Oaks probably would have been more than 115,000 cfs. At the Sacramento Weir, 30 gates were opened, and the peak flow reached 48,800 cfs. The peak flow in the Sacramento River at I Street was about 95,000 cfs. Total flow at the latitude of Sacramento, including the Yolo Bypass, was about 380,000 cfs.

Floods in the San Joaquin River Basin reflected those in the Sacramento River Basin. Flows on the San Joaquin River were completely controlled by Friant Dam. Prior to the December 1955 flood, Millerton Reservoir was well below flood management space. If storage had been at allowable flood management levels, uncontrolled flows would have exceeded 37,100 cfs and resulted in extensive damage between Friant Dam and the mouth of the Merced River. The peak flow of 62,500 cfs was a record on the Stanislaus River at Ripon, while the Middle Fork of the Tuolumne River at Oakland Recreation Camp reached a record flow of 4,920 cfs. During the 1955 floods, two of the three forks of the Tuolumne River reached record flows.

Flood of 1964

This was the first large flood after the devastating 1955 flood. The main center of precipitation was in the Feather, Yuba, and American River basins. Rainfall was heaviest December 22 and 23, 1964. Runoff from streams of the Coast Ranges, almost without exception, produced peak stages and peak flows that exceeded previous records. Runoff from the Sierra into the Feather, Yuba, and American rivers surpassed all previous records. Based on the flood control diagram for Folsom Reservoir, the storage in Folsom was below allowable flood management levels at the beginning of the flood. During the storm, inflow volume was sufficiently high, partly due to failure of Hell Hole Dam, to result in design capacity releases of 115,000 cfs from Nimbus Dam. Therefore, the peak flow in the American River at Fair Oaks, controlled by Folsom Dam, reached 115,000 cfs. In the remaining watersheds of the Sacramento Valley, peak stages and flows tended to equal those experienced in 1955. At the Sacramento Weir, all 48 gates were opened, and the peak flow reached 84,000 cfs. The peak flow in the Sacramento River at I Street was about 100,000 cfs. Total peak flow at the latitude of Sacramento, including the Sacramento River and the Yolo Bypass, was about 475,000 cfs.

Flood of 1967

Three major storm periods between December 1966 and March 1967 deposited above normal precipitation in the Sacramento River Basin, flooding 219,000 acres, primarily to agricultural property on the valley floor. The Sacramento River at the I Street gage in Sacramento reached a peak flow of about 78,000 cfs during early December. January 1967 precipitation ranged as high as 170 percent of normal. Runoff from the above normal precipitation, although moderately high, was controlled by major reservoirs and flood channels in the Sacramento River Basin. Folsom Reservoir experienced a maximum mean daily inflow of some 36,100 cfs as flood management releases were made in late January. All releases from Folsom Dam were well below project design flows.

Continuously above normal precipitation from December 1966 through March 1967 resulted in the flooding of 35,000 acres of the San Joaquin River Basin. A record-breaking storm in early December 1966 resulted in very high runoff from the San Joaquin River. The San Joaquin River above Millerton Lake experienced high runoff during early December. A maximum mean daily inflow of 18,450 cfs was recorded at Friant Dam. However, releases of only 52 cfs were made to the San Joaquin River. A vast amount of snowmelt from April to July compounded the flood damage experienced. The San Joaquin River Basin experienced a snowmelt volume of 7,800,000 acre-feet to the valley floor. Significant flooding also occurred along the Cosumnes River, in the Morrison Creek and Beach-Stone Lake areas, and in Madera County streams in the lower portions of the Fresno and Chowchilla rivers. Nearly all of the flooded areas were cropland, improved pasture, or grazing land.

The Tulare Lake Basin experienced dry weather in the fall of 1966. However, by early December a storm series caused outstanding flood peaks to occur on many streams. Specifically, unprecedented floods occurred on the Kaweah, Tule, and Kern rivers. A record peak discharge of 13,000 cfs was measured at the east fork of the Kaweah River near Three Rivers. Due to

flood inflow into Success Reservoir, eventual maximum outflow reached 8,300 cfs, exceeding channel capacity through agricultural areas. Significant amounts of flooding occurred in both mountain areas and the valley floor. A total of 141,800 acres flooded, including 122,400 acres of valley floor and 19,400 acres in mountain and foothill areas. These record-breaking floods inundated parts of the towns of Kernville, Springville, Three Rivers, Lindsay, and Lamont. Snow-melt in early spring contributed some 3,900,000 acre-feet of water to flooding already occurring in the valley floor.

Flood of 1969

In the Sacramento Valley, floodwaters produced by the January 1969 storms were largely controlled by major reservoirs, flood channels, and the bypass system. As a result, flows in the mainstem of the Sacramento River and its major tributaries remained well below project design flows. However, several unimproved valley and foothill streams overflowed their banks and caused local flooding. At the Sacramento Weir, 16 gates were opened, and the peak flow reached 30,000 cfs. The peak flow in the American River at Fair Oaks was 73,400 cfs. The peak flow in the Sacramento River at I Street was 95,500 cfs. Peak flow at the latitude of Sacramento was approximately 250,000 cfs.

Flood of 1970

The January 1970 flood was centered mainly on the mainstem of the Sacramento River. The Sacramento River near Bend Bridge, at Vina Bridge, at Ord Ferry, and opposite the Moulton Weir, and the Sutter Bypass at Long Bridge, experienced record flows. At the Sacramento Weir, 8 of 48 gates were opened with the peak flow reaching 25,200 cfs. The peak flow in the American River at Fair Oaks was 56,700 cfs. The Sacramento River at I Street peaked at 94,100 cfs. The total peak flow at the latitude of Sacramento was about 340,000 cfs.

Flood of 1974

In 1974 two major floods occurred in the Sacramento Valley. The first occurred from January 11 through 19, 1974 and the second from March 28 through April 1, 1974. The peak flow in the Sacramento River at I Street was 159,000 cfs at Woodland in the Yolo Bypass on January 20 and 95,000 cfs on January 21. The Sacramento Weir gates were never opened. The Tisdale Weir overflowed continuously from November 12 through early February. Weirs overflowed into the Butte Basin causing stages to exceed the record 1970 floods. In the flood of January 1974, flood waters overtopped and broke through the Murphy Slough Plug, the Wright Levee probably was breached and the Parrot Plug area was again overtopped. Estimated instantaneous peak flows at the three gaging stations were: 158,000 cfs in the river at Hamilton City, 142,000 cfs at Ord Ferry, and 136,000 cfs at Butte City. After the 1974 flood, the Murphy Slough Plug was lengthened and strengthened by the Corps of Engineers.

Floods of 1983, 1986, 1995, and 1997

The floods of 1983, 1986, 1995, and 1997 are discussed in detail in Chapter 5 of this report, along with an evaluation of the flood management system for each of these storms, damages prevented, and damages sustained.

HISTORY OF FLOOD PROTECTION IN THE CENTRAL VALLEY

Prior to the development of the Jackson Report by the California Debris Commission, flood protection planning generally consisted of uncoordinated responses to the most recent flood. The Jackson Plan, completed in 1910, was the first comprehensive flood plan for the Central Valley. Over time, the recommendations of the Jackson Plan have been implemented and led to the current flood protection system.

Since 1850, the State of California and the Central Valley have experienced tremendous growth and periods of economic prosperity. The evolution of the Central Valley from a vast area of undeveloped and uncontrolled floodplain to an area of important agricultural production and diverse urban areas has been significantly driven by major Federal and State initiatives for water supply and flood protection development. The development of flood protection facilities in the Sacramento and San Joaquin River basins during the past 150 years can be summarized in five 30-year eras, as listed in Table 2-1.

The following sections describe major projects authorized for the development of flood protection in the Sacramento and San Joaquin River basins.

SACRAMENTO RIVER FLOOD CONTROL PROJECT

After modification in 1913, the CDC Jackson Plan was authorized in the Flood Control Act of 1917 for construction as the Sacramento River Flood Control Project. The plan was subsequently modified and extended by the Flood Control Act of 1928. The Act of 1928 specified that the Federal Government would pay for all channel work, all weirs, and half of all future levee construction, whereas the non-Federal interests would pay for all other features of the Project. This cost-sharing arrangement resulted in a one-third Federal, two-thirds non-Federal cost split. Pursuant to investigations authorized by the Flood Control Act of 1936, the requirements of local cooperation were reviewed as reported in House Document 205, and as subsequently authorized in the Flood Control Act of 1941. The 1941 act authorized Federal expenditures for completion of the project, with the following requirements placed upon local interests:

- Furnish all rights-of-way, including railway, highway, and all other utility modifications.
- Hold and save the United States free from damage claims.

- Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army.

Construction of the Sacramento River Flood Control Project began in 1918 and continued for many years. The plan for completing the project is presented in the November 30, 1953, "Memorandum of Understanding Respecting the Sacramento River Flood Control Project" (MOU) between the Corps and The Reclamation Board of the State of California. This MOU included levee construction standards for the river project levees and the bypass levees. There was no difference in levee standards for urban versus agricultural levees. Operation and maintenance regulations are presented in the Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project approved June 27, 1950. The State/Federal project legislation creates obligations on both the State and Federal Governments for the local cooperation and maintenance responsibilities. The State's authorities and responsibilities for fulfilling operation and maintenance are codified in the State Water Code, Sections 8350 through 9577 and Sections 12878 through 12878.45, inclusive.

TABLE 2-1

PERIODS OF FLOOD PROTECTION DEVELOPMENT

PERIOD	MAJOR DEVELOPMENTS
1850-1879	A series of floods and hydraulic mining caused many problems for the local economy. During this period, many local flood protection projects (usually levees) were constructed piecemeal.
1880-1909	The California Debris Commission was formed to control hydraulic mining. Major floods of 1907 and 1909 caused millions of dollars in damage. These floods served as the basis for the Sacramento River Flood Control Project's design. During this period, weak efforts at land control, uncoordinated levee construction, and attempted flood management solutions were ineffective.
1910-1939	The Jackson Report, as the basis for the Sacramento River Flood Control Project, starts the construction by local interests of many levees, weirs, and bypasses that were later updated by the Corps.
1940-1969	Major levees, bypasses, and dams, whose multipurpose storage included space for flood management, were constructed during this period. In addition to private developments, this period included development of major portions of the Central Valley Project (CVP), the State Water Project (SWP), and several Federal flood management projects in the San Joaquin Valley.
1970-1999	During these 30 years when extensive flood damage was experienced, almost all efforts for flood management were devoted to levee repairs and rehabilitation and mitigation for environmental impacts as required by Federal and State legislation. The development of new flood protection projects, or multipurpose projects with flood protection as a purpose, were limited in part by potential environmental impacts and extensive mitigation requirements.

The project comprises a comprehensive system of levees, overflow weirs, drainage pumping plants, and flood bypass channels, extending along the Sacramento River from Collinsville, near its mouth in Suisun Bay, upstream to Ord Bend, and along lower reaches of principal tributaries. In total, the Sacramento River Flood Control Project incorporates the following facilities:

- about 440 miles of river, canal, and stream channels;
- 1,000 miles of levees;
- five major weirs;
- two sets of outfall gates;
- three major drainage pumping plants;
- 95 miles of bypasses comprising areas aggregating 100,000 acres;
- five low-water check dams;
- 50 miles of drainage canals and seepage ditches;
- numerous appurtenant structures such as minor weirs and control structures, bridges, and gaging stations.

Specific major physical works of the Sacramento River Flood Control Project include:

- levees along the Sacramento River channel;
- leveed bypasses through the Sutter and Yolo Basins;
- levees along the Feather, Yuba, Bear, and American rivers, set back from the riverbanks to allow sufficient channel widths for the passage of floods;
- two relief bypasses from the Sacramento River to the Butte Basin, at the Moulton and Colusa Weirs;
- relief bypass from the Sacramento River at the Tisdale Weir to the Sutter Bypass;
- relief bypass from the Sacramento River at the Sacramento Weir to the Yolo Bypass;
- spillway structure or weir at each point where water is allowed to escape from a river channel;
- enlarged channel of the Sacramento River from Cache Slough to Collinsville.

SACRAMENTO RIVER MAJOR AND MINOR TRIBUTARIES PROJECT

The Sacramento River Major and Minor Tributaries Project was initially authorized by the Flood Control Act of 1944 (Public Law 534, December 22, 1944, 78th Congress, 2d Session), and was further amended by the Flood Control Act of 1950. The project was a modification and extension of the Sacramento River Flood Control Project and was to supplement reservoir storage of the comprehensive plan by providing flood protection to certain unprotected or partially protected areas along the Sacramento River. The area encompassed by the project included the Sacramento River and tributaries from Collinsville to Shasta Dam.

The project provided for levee construction and/or channel enlargement of the following minor tributaries of the Sacramento River: Chico and Mud creeks and Sandy Gulch; Butte and Little Chico creeks; Cherokee Canal; Elder Creek; and Deer Creek (Tehama County). In addition, the project also included revetment of levees for the Sutter, Tisdale, Sacramento, and Yolo Bypasses. Minor tributary improvements were to provide flood protection to about 80,000 acres of agricultural land important to the economy of the region and to the City of Chico and other smaller communities. Bypass levee revetment features of the project were to provide protection to floodplain lands adjacent to the bypasses and ideally would decrease requirements for levee repairs under emergency conditions.

SACRAMENTO RIVER BANK PROTECTION PROJECT

The Sacramento River Bank Protection Project was initially authorized by the Flood Control Act of 1960 (Public Law 86-645, July 14, 1960, 86th Congress, 2d Session). Authorization was continued by River Basin Monetary Authorization Act of 1974, further continuing Appropriation Act of 1983, and Water Resources Development Act of 1986. The project consisted of modifications to the Sacramento River Flood Control Project, including a long-range program for construction of bank erosion control works and setback levees within the limits of the existing levee system. The project authorized a total of 835,000 linear feet of bank protection in two phases. The First Phase of the bank protection project, from 1963 to 1974, was for rock revetment of 430,000 linear feet of levees and banks. The Second Phase, from 1975 to the present, has so far added another 405,000 linear feet.

The project was intended to maintain the integrity of the levee system of the Sacramento River Flood Control Project such that it would continue to furnish the degree of protection for which it was designed. The project was intended to reduce costs of emergency repairs and downstream dredging, reduce land losses caused by erosion, and provide boat launching facilities, parking, and picnic areas along the river at selected sites.

BUTTE BASIN PLAN OF FLOOD CONTROL

The objective of the Butte Basin Plan of Flood Control is to ensure a division of flows between the Sacramento River and Butte Basin. Ideally, the Butte Basin would provide relief from high riverflows, such that floodflows in the Sacramento River channel would not exceed the specified

channel capacity between project levees downstream. Failure of the downstream levees becomes more likely if the floodflows in the river channel exceed specified capacity values. The Butte Basin Overflow Project includes two basic elements: a bank protection element (river channel stabilization), consisting of about 31,500 linear feet of bank protection; and an overbank flow element, consisting of three designated overflow areas: one natural overflow site, and two flood relief structures.

LOWER SAN JOAQUIN RIVER AND TRIBUTARIES PROJECTS

In addition to projects in the Sacramento River Basin, the Flood Control Act of 1944 authorized the Lower San Joaquin River and Tributaries Project. The Lower San Joaquin River and Tributaries Project included construction of levees on the San Joaquin River below the Merced River, Stanislaus River, Old River, Paradise Cut, and Camp Slough. The project also included construction of New Hogan Dam on the Calaveras River, New Melones Dam on the Stanislaus River, and Don Pedro Dam on the Tuolumne River. New Melones Dam was later reauthorized for construction under the Flood Control Act of 1962. The Chowchilla and Eastside Bypasses were also constructed during this time period by the State as part of the project. Construction was initiated on the Lower San Joaquin River and Tributaries Project in 1956.

OTHER FLOOD MANAGEMENT PROJECTS

In addition to projects described above, several smaller flood control projects have been developed at low elevations in the Sierra Nevada foothills in the San Joaquin River Basin. These projects generally consist of dry dams constructed to protect downstream metropolitan areas and nearby agricultural lands. The Merced County Stream Group Project was constructed to restrict flood flows on several streams to nondamaging levels from the foothill line to the city of Merced. The Redbank and Fancher Creeks Project was constructed to provide flood protection to the Fresno-Clovis metropolitan area and nearby agricultural land. Farmington Dam, on Littlejohn Creek, provides flood protection for intensely developed agricultural lands below the dam, the city of Stockton, and the rural towns of Farmington and French Camp.

DEVELOPMENT OF MULTIPURPOSE PROJECTS

About the same time that the CDC began surveys of the Sacramento Valley streams for a proposed flood management project, Federal assistance to western irrigation planning was being authorized by Congress with the adoption of the Reclamation Act of 1902. The Reclamation Act created the Reclamation Service, which later became the U.S. Bureau of Reclamation (USBR). Federal involvement in the development of California water facilities focused on two fundamental goals: water conservation and flood management. The USBR was assigned responsibility for the development of water supply projects that would include mechanisms for repayment in accordance with Reclamation Law. The responsibility for navigation and flood management along major rivers in the Central Valley was assigned to the Corps. In recognition of the protective nature of flood management and navigation, project costs expended for these purposes are nonreimbursable Federal expenditures and do not require repayment. Because of the opportunity to accomplish water supply, flood management, and navigation benefits with

individual projects, the Federal Government coordinated the development of flood management and USBR projects to the greatest extent possible, and Federal reservoirs were designed to serve multiple purposes. During the early portion of this century, the Federal Government (USBR and Corps) and the State of California cooperated in surveys of the Central Valley to coordinate water supply planning activities.

Central Valley Project

In 1920, Colonel Robert Marshall, chief geographer for the United States Geological Service, proposed a major water storage and conveyance plan to transfer water from northern California to meet urban and agricultural needs of central and southern California. This plan ultimately provided the framework for development of the Central Valley Project (CVP). Under the Marshall Plan, a dam would be constructed on the San Joaquin River near Friant, and water would be diverted to areas north and south in the eastern portion of the San Joaquin Valley. The diverted water would provide a supplemental supply to relieve some of the dependency on groundwater that had led to overdraft in areas of the eastern San Joaquin Valley. In addition, surplus water in the Sacramento Valley would be collected, stored, and transferred to the San Joaquin Valley by a series of reservoirs, pumps, and canals. The main storage facility would be Shasta Dam on the Sacramento River at its confluence with the McCloud and Pit rivers. Hydroelectric power generated at Shasta Dam would provide the power to lift project water from the Delta to irrigated lands in the San Joaquin Valley. A portion of this water would be delivered to San Joaquin River water rights holders, in exchange for water diverted at Friant Dam.

During the 1920's, the California State legislature commissioned a series of investigations to evaluate the Marshall Plan further and in 1933 approved the Central Valley Project Act. This act authorized the construction of initial features of the CVP, including Shasta Dam and powerplants on the Sacramento River; Friant Dam on the San Joaquin River; power transmission facilities from the Shasta Dam site to Tracy; and the Contra Costa, Madera, and Friant-Kern canals. The act authorized the sale of revenue bonds to construct the project, but during the Great Depression the bonds could not be sold. The State therefore appealed to the Federal Government for assistance in the construction of the CVP. With the passage of the Rivers and Harbors Act of 1935, Congress appropriated funds and authorized construction of the CVP by the Corps. When the act was reauthorized in 1937, the construction and operation of the CVP were assigned to the USBR, and the construction and operation of CVP became subject to Reclamation Law. Construction of the CVP began on October 19, 1937, with the Contra Costa Canal. Construction of Shasta Dam was begun in 1938.

By the late 1940's, it had become apparent that California's rapid urban, agricultural, and industrial growth would quickly increase demands for water and power to levels that exceeded the initial CVP system capacity. In response to this increase in projected demand, the Corps and USBR evaluated an enlargement of Folsom Dam and Reservoir (originally authorized for construction by the Corps as a flood management facility in 1944) to also provide water supply and hydroelectric power and be integrated into the CVP. In 1949, Congress passed the American River Act, which authorized the American River Division of the CVP and provided for the construction of Folsom and Nimbus dams, lakes, and powerplants. This action converted the

single-purpose authorization of a flood management reservoir into a substantially enlarged multiple-purpose project integrated into the CVP. The act authorized the financial integration of the American River Division into the CVP, enabling coordination of water releases between Shasta and Folsom for flood protection and water supply and the optimization of power production.

State Water Project

In addition to the expansion of the CVP, planning for the multipurpose State Water Project (SWP) also began shortly after World War II. In 1947, the State began an investigation of its water resources and needs and prepared The California Water Plan, which outlined preliminary plans to meet the State's anticipated water needs through development of the SWP. In 1960, California voters authorized construction of the SWP by ratifying the Burns-Porter Act. The plans recognized that there would be a gradual increase in water demand and that construction of some facilities would be deferred. Initial projects included Oroville Dam and Lake Oroville on the Feather River; San Luis Dam and Reservoir, which were constructed and are jointly operated with USBR; the North and South Bay aqueducts; and the California Aqueduct.

Other Multipurpose Projects

The Flood Control Act of 1944 also authorized construction of Isabella, Success, Terminus, and Pine Flat dams on rivers in the Tulare Lake Basin. Following major flooding in 1955, the construction of levees and bypasses on the San Joaquin River upstream from the Merced River was authorized. In 1962-63, Congress authorized the construction of Buchanan Dam on the Chowchilla River and Hidden Dam on the Fresno River and authorized Federal participation in the cost of New Exchequer Dam on the Merced River. All these reservoirs provide water supplies for urban and domestic uses and, in some cases, hydropower generation. In addition, recreation facilities were developed, and the dams are operated in part to meet downstream fish and wildlife requirements.

RECENT ACTIVITIES

Public Law 84-99

Public Law 84-99, Flood and Coastal Storm Emergencies, authorizes the Corps to provide emergency/disaster assistance. Under this law the Chief of Engineers is authorized to undertake specific activities including disaster preparedness, advance measures, emergency operations (Flood Response and Post-Flood Response), and rehabilitation of flood management works threatened or destroyed by floods.

In response to the 1997 flood and at the request of the Governor, the Corps' Sacramento District categorized levee rehabilitation into three phases (I, II, and III) to distinguish between complete levee rehabilitation and an interim (25-year) level of repair undertaken at that time to restore the system to a minimally-acceptable level as soon as possible. Phase I is referred to as 'emergency flood fight'. Emergency flood fight assistance can be extended to any situation that poses an

immediate danger to life or improved property. Assistance may be extended as long as the danger exists, but must end when the situation is stabilized. Phase II entails the repair of breached levees to correct immediate problems to regain a moderate level of flood protection. Phase III corresponds to repairs to levees damaged during floods that do not pose an immediate threat.

Phase III levee repair work has been extensive during the past several years. In response to the 1997 floods, over 600 levee sites were repaired through 59 projects authorized by the Corps. The 1998 floods resulted in 50 requests for levee repairs in the Sacramento River Basin and 11 requests in the San Joaquin River Basin.

Levee Restoration

Prompted by the 1986 flooding, a decade-long project was undertaken to restore the Sacramento River's aging flood management system and to enhance the level of protection in some critical areas. The project is overseen by the Corps and has several funding sources. The project includes restoring levees along the Feather, Yuba, and Sacramento rivers. Specific locations of levee restoration projects are summarized on Table 2-2.

TABLE 2-2

LEVEE RESTORATION PROJECTS

River	Location
Feather River	west bank near East Biggs
Feather River	east and west banks between Lomo and Tambo
Yuba River	south levee at Linda
Yuba River	north levee at Marysville
Feather River	west levee at convergence of Yuba River
Feather River	east levee at Arboga
Feather River	east levee south of Arboga
Sacramento River	west levee south of Knights Landing
Sutter Bypass	west levee near Verona
Sacramento River	east levee from Verona to Sacramento
Sacramento River	east levee from South Sacramento to Freeport
Sacramento River	west levee from South Sacramento to near Freeport

Folsom Reoperation Study

Sacramento Area Flood Control Agency and the USBR have agreed to modify the authorized operation of Folsom Dam and Reservoir to provide portions of the American River floodplain with as much immediate flood protection as possible with the existing flood management system. Through the agreement, the flood control diagram governing reservoir storage space allocations and outflows during flood management operation has been revised to reduce the probability of flooding in Sacramento to 1 chance in 100. This agreement has a 5-year term (until 1999) and is intended to be in place until a long-term flood management project is implemented in the basin.

The Corps was directed by the Defense Appropriations Act of 1993 to prepare a Special Evaluation Report regarding possible flood management features and operational procedures that should be implemented in a coordinated plan to increase the level of flood protection to Sacramento. Some of the measures being analyzed as feasible methods to increase flood protection include:

- improved operation response time
- lowered main spillway
- enlargement of existing river outlets
- new river outlets
- new tunnel outlets
- levee modifications
- flood detention dam
- modification of Folsom flood space
- credit surcharge storage for flood management

1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930

Gold Discovered (1848)

Hydraulic Mining underway (1856)

Hydraulic Mining underway (1856)

Major Flood (1862)

Major Flood (1867)

Major Flood (1881)

Sawyer Decision rendered (1884)

Major Flood (1890)

California Debris Commission established (1893)

Congress authorizes Yuba River debris control works (1896)

Congress reauthorizes Yuba River debris control works (1902)

Major Flood (1904)

Major Flood (1907)

Major Flood (1909)

Congress authorizes the Jackson Report (1910)

Major Flood (1911)

The State Reclamation Board is established (1911)

Reclamation Board given control of "pre-project" levees on Central Valley Streams (1913)

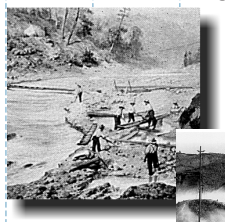
Debris Commission begins dredging Sacramento River (1913)

Sacramento River Flood Control Project authorized by Flood Control Act of 1917

Sacramento Weir completed on the Sacramento River (1918)

Fremont Weir completed on the Sacramento River (1924)

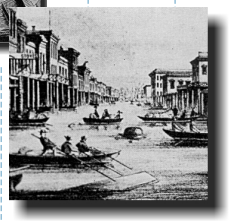
Major Flood (1928)

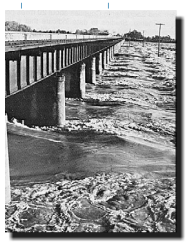


Gold Mining

Hydraulic Mining

Flooding in Downtown Sacramento





Sacramento Weir

Back to Text

- All Basins
- Sacramento River Basin
- San Joaquin River Basin
- Tulare Lake Basin

POST FLOOD ASSESSMENT FOR
1983, 1986, 1995, and 1997

FIGURE 2-1
CENTRAL VALLEY
FLOOD MANAGEMENT TIMELINE
1850 – 1930

US Army Corps of Engineers
Sacramento District

March 1999

1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930

1930 1935 1935 1940 1945 1950

- Moulton Weir completed on the Sacramento River (1932)
- Tisdale Weir completed on the Sacramento River (1932)
- Colusa Weir completed on the Sacramento River (1933)
- Central Valley Project authorized (1933)
- Sacramento River dredging completed from Cache slough to mouth (1934)

Moulton Weir

- Congress authorizes Narrows Dam for mining debris (1935)
- Congress authorizes North Fork Dam for mining debris (1935)
- Yuba River debris control works completed (1935)
- North Fork Dam completed on North Fork American River (1939)

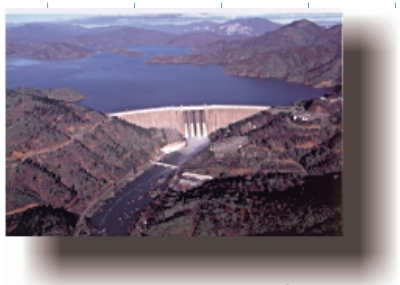
North Fork Dam

Narrows Dam

- Narrows Dam completed on the Yuba River (1941)
- Flood Control Act of 1944 assigns duty of flood control and navigation to the U.S. Army Corps of Engineers
- Sacramento River and Major & Minor Tributaries Project authorized by Flood Control Act of 1944

- Shasta Dam completed during war for interim operation (1945)
- Shasta Dam completed for full operation on the Sacramento River (1949)
- Friant Dam completed on the San Joaquin River (1949)

Friant Dam



Shasta Dam

All Basins
Sacramento River Basin
San Joaquin River Basin
Tulare Lake Basin

1930 1935 1935 1940 1945 1950

POST FLOOD ASSESSMENT FOR
1983, 1986, 1995, and 1997

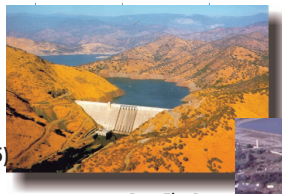
FIGURE 2-1
CENTRAL VALLEY
FLOOD MANAGEMENT TIMELINE
1930 – 1950

US Army Corps of Engineers
Sacramento District

March 1999

1950 1955 1960 1965

- Isabella Dam completed on the Kern River (1953)
- Pine Flat Dam completed on the Kings River (1954)
- Congress authorizes construction of levee on north bank of the American River (1954)
- Legislature authorizes levees, bypasses on the San Joaquin River above Merced River (1955)
- **Major Flood (1955)**
- Folsom Dam completed on the American River (1956)
- Construction initiated on Lower San Joaquin River and Tributaries Project (1956)
- Levee on north bank American River completed (1958)
- State Water Project authorized (1960)
- Congress authorizes Sacramento River Bank Protection Project (1960)
- Sacramento River Flood Control Project substantially completed (1961)
- Success Dam completed on the Tule river (1961)
- Terminus Dam completed on the Kaweah River (1961)
- Black Butte Dam completed on Stony Creek (1963)
- Camanche Dam completed on the Mokelumne River (1963)
- New Hogan Dam completed on the Calaveras River (1964)
- **Major Flood (1964)**

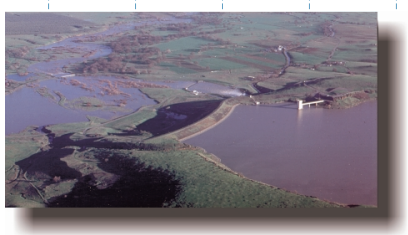


Pine Flat Dam

Folsom Dam

Success Dam

New Hogan Dam



Black Butte Dam

- All Basins
- Sacramento River Basin
- San Joaquin River Basin
- Tulare Lake Basin

POST FLOOD ASSESSMENT FOR
1983, 1986, 1995, and 1997

FIGURE 2-1
CENTRAL VALLEY
FLOOD MANAGEMENT TIMELINE
1950 – 1965

US Army Corps of Engineers
Sacramento District

March 1999

1950 1955 1960 1965

1965 1970 1975 1980 1985 1990 1995 2000

- Portions of Sacramento River and Major & Minor Tributaries Project completed (1965)
- **Major Flood (1967)**
- New Exchequer Dam completed on the Merced River (1967)
- Oroville Dam completed on the Feather River (1968)
- Lower San Joaquin River and Tributaries Project levees constructed (1968)
- **Major Flood (1969)**
- New Bullards Bar Dam completed on the Yuba River (1970)
- Don Pedro Dam completed on the Tuolumne River (1970)
- **Major Flood (1970)**
- Lower San Joaquin River and Tributaries Project completed (1972)
- **Major Flood (1974)**
- Hidden Dam completed on the Fresno River (1975)
- Buchanan Dam completed on the Chowchilla River (1975)
- Indian Valley Dam completed on Cache Creek (1976)
- New Melones Dam completed on the Stanislaus River (1978)
- **Major Flood (1983)**
- **Major Flood (1986)**
- Cache Creek Basin Project completed (1993)
- Redbank and Fancher Creeks Project (1993)
- **Major Flood (1995)**
- Sacramento River Bank Protection Project completed (1996)
- **Major Flood (1997)**
- **Major Flood (1998)**

New Exchequer Dam

Don Pedro Dam

New Melones Dam

Levee Break - Flood of '97

All Basins
Sacramento River Basin
San Joaquin River Basin
Tulare Lake Basin

POST FLOOD ASSESSMENT FOR
1983, 1986, 1995, and 1997

FIGURE 2-1
CENTRAL VALLEY
FLOOD MANAGEMENT TIMELINE
1965 – Present

US Army Corps of Engineers
Sacramento District

March 1999

1965 1970 1975 1980 1985 1990 1995 2000