FIGURE 4.—Flood-damaged concrete bridge across the East Fork Carson River on Nevada State Highway 56, south of Gardnerville, Nev. Photograph by Nevada State Highway Department.

The broad overflow areas in lower Carson Valley reduced the flood peak, but even with this attenuation the peak discharge at the gaging station below Carson Valley was nearly double that of the 1950 flood. Cradlebaugh Bridge in lower Carson Valley was covered to a depth of about 4 feet but escaped major damage; all other bridges crossing the Carson River between Carson City and Weeks were destroyed. At Weeks Crossing the highway approaches to the bridge were washed out. Travel and communications in the entire area above Lahonton Reservoir were seriously disrupted, as every major road and highway was severed or inundated by the floodwaters.

Lahonton Reservoir, which was at low level prior to the floods, was able to contain the floodflows, and thus provided adequate protection for the city of Fallon and the highly developed irrigated areas in that vicinity. Part of the stored water was released at a later date to prepare for heavy flows during the spring runoff.

Discharge hydrographs for East Fork Carson River near Gardnerville, Nev., and Carson River near Carson City, Nev., are included on figure 3.

TRUCKEE RIVER BASIN

The Truckee River basin and its urban communities attracted the most attention in western Nevada. The peak discharge of the December 1955 flood at Reno, Nev., slightly exceeded that of November

1950; however, damage to establishments adjacent to the Truckee River was not as severe as that inflicted by the 1950 flood. Forewarned residents had limited opportunity to move perishable merchandise, and strategic use of sandbag barriers also helped to avert some losses. For instance, the Riverside and the Mapes Hotels on the banks of the Truckee River escaped practically unscathed behind sandbag dikes supplemented by pumping. Many other business establishments and homes adjacent to the river, however, were severely damaged by the floodwaters which spilled over into the streets for several blocks on each side of the river front. As in past floods the low bridges spanning the river in Reno were jammed with debris which reduced the effective carrying capacity of the river channel.

Floodwaters from tributary streams draining the area surrounding the cities of Reno and Sparks inflicted severe damage on private and public property in areas far removed from the river front, as streams and ditches were swelled to overflowing from local rains. The Reno airport was flooded to a depth of about 4 feet by waters from surrounding drainages and from waters impounded in the broad Truckee Meadows just downstream from Sparks. Peavine Creek in northwest Reno caused its usual destruction and there were many other places throughout the area where local flooding added to the disaster.

Air, rail, and automotive travel in the area came to a halt. U.S. Highways 40, 50, and 395 were blocked by washouts and landslides; inundated subgrades in Truckee Meadows and landslides in the Sierra Nevada passes halted rail traffic; and Reno airport was out of operation for several days until the water had drained from the landing field. Probably the greatest single loss in the Reno-Sparks area was the destruction of the nearly completed Kietske Lane bridge across the Truckee River between Reno and Sparks. Workmen poured the bridge floor just prior to the flood to provide sufficient weight and stability for the structure to withstand the surging river. However, the structure collapsed and was almost a complete loss.

Upstream from Reno the flood damage inflicted by the Truckee River was not as severe as that of the 1950 flood, but areas downstream from the city were damaged extensively as the flood was swelled by the inflow of small tributaries. The reefs at Vista, which form a natural barrier, limited the Truckee River flow and afforded some protection to downstream areas; but the retardation caused the inundation of the Truckee Meadows area east of Sparks.

Boca Reservoir, at the mouth of the Little Truckee River, had a major role in reducing the flood peak; capacity of the reservoir was sufficient to retain the floodflows of the Little Truckee River for a relatively short but very critical period. During the 1950 flood, Boca Reservoir was full before the peak flow of the Little Truckee

River No. 3 powerplant were damaged, a fish hatchery was flooded and its stock of fish washed away, and a Forest Service camp and the Kernville picnic grounds were flooded.

TULARE LAKE BASIN

The peak discharge at the Tule River station near Porterville (above the South Fork) was only slightly less than the previous maximum during the November 1950 flood. At the South Fork station near Success, the peak discharge from the storm of January 25–27 exceeded the peak of December but was less than half the record peak established by the flood of November 1950.

About 38,000 acres of agricultural land between the foothills and Tulare Lake were flooded in December; the January flood inundated about 27,000 acres, including much of the same land. Permanent plantings were damaged, growing crops were destroyed, and alfalfa and cotton stored in fields were severely damaged. Homes, farm buildings, farm equipment, highways, and bridges were damaged. The depth of flooding was about 3 feet for periods of 2 to 15 days. Above the foothills damage occurred to roads and bridges, a small dam on the North Fork, a powerplant intake structure, canal headworks, and summers cottages.

On the Kaweah River the flood of December 23 greatly exceeded the flood of November 1950 in both peak and volume, although in this respect the 1950 flood had been the largest since stream gaging was begun on that river in 1903. At the Three Rivers gaging station the flood volume of 186,600 acre-feet for December 1955 exceeded that for November 1950 by 106,800 acre-feet.

About 126,000 acres of land were flooded by the Kaweah River during the December and January storms. Most of the flooded area was along the river and its principal tributaries: the St. Johns River, Mill, Cameron, Packwood, and Cross Creeks, and Elk Bayou. The city of Visalia and the towns of Farmersville and Three Rivers were flooded. Most of the irrigation diversion structures on the river were washed out. Large quantities of debris accumulated against bridges and canal crossings and caused severe damage to most of these structures. Streambank erosion was severe, and great quantities of sand were deposited on farmlands adjacent to the streams. Nearly all roads in the area were flooded and damaged. In January, much of the area damaged by the December flood was re-flooded.

The McKay Point weirs, dividing the flow between the Kaweah and St. Johns rivers, were partly bypassed by severe bank erosion. A large part of the flow formed a new channel to the St. Johns River, but debris and sand later plugged this channel to direct the entire flow down the Kaweah channel. Water backed up against the

FIGURE 9.—Kaweah River flood at the Friant-Kern Canal crossing, California. The canal was breached by floodwaters in several places as shown in the upper part of the picture. Photograph by United Aerial Survey.

Friant-Kern Canal and overtopped and washed out large sections (fig. 9). Residences in the southern part of the town of Woodlake were flooded and damaged. More than half of the city of Visalia was flooded in December, and nearly a fourth of the city was reflooded in January. Several thousand people were forced to evacuate their homes. Damage was heavy in the business section and in a newer residential section in the southwestern part of the city where water in homes was as deep as 30 inches for about 6 days. The area flooded

places, and flooded about 1,700 acres of farmland. A nursery was severely damaged. On Pine, Rock, and Mud Creeks, levees were broken and about 3,100 acres farmland were flooded. About 60 pigs were drowned in one field. Big Chico Creek overflowed and inundated about 800 acres of farmland. Grain crops, farm buildings, irrigation systems, and roads were damaged. In the city of Chico, Bidwell Park and residences were flooded and eight persons were evacuated from their homes for 1 to 2 days. Little Chico Creek flooded about 500 acres of farmland, and 10 persons were evacuated from the area. On Butte Creek the levees were broken and about 10,000 acres of farmland were flooded to an average depth of 3 feet for about 2 weeks. Barley and oat crops were severely damaged, and levees and irrigation facilities were washed out. Flooding in the town of Durham was prevented by sandbagging of the levees, but 20 persons were evacuated from their homes for a few days.

FEATHER RIVER BASIN

In the Feather River basin the December flood peaks exceeded previous maxima of record at nearly all gaging stations on the North, Middle, and South Forks and the West Branch. At the main-stem station near Oroville a peak flow of 175,000 cfs on December 22 was followed by a peak of 203,000 cfs on December 23 which was less than the record established by the floods of March 1907. The December 23 flood peak was confined by levees along the river to the confluence with the Yuba River below Marysville; the peak reached that point at about 5:00 a.m. on December 24, about 4½ hours after the west levee broke at Shanghai Bend 3 miles south of Yuba City, and 5½ hours after the peak outflow from the Yuba River.

The most extensive flooding occurred as a result of the levee break at Shanghai Bend and a break in the east levee about 1 mile south of the town of Nicolaus. The areas flooded by the Feather River totaled about 100,000 acres.

About 165 residences and 12 stores were flooded in the town of Chester, on the North Fork above Lake Almanor, and roads, bridges, railroads, and power facilities were washed out at scattered points along the river upstream from Oroville.

In the city of Oroville about 100 acres were flooded, including 36 homes and 15 commercial buildings. Below the city about 900 acres of agricultural land were flooded. Approximately 200 persons were evacuated from the flooded areas for 3 days.

High water in the Feather River prevented free runoff of Honcut Creek waters, and about 7,000 acres of farmland were flooded. Nearly 100 persons were evacuated from the area for 4 days.

Similarly, free runoff was prevented in the Jack Slough area north of Marysville, and about 6,800 acres of farmland were flooded east of Levee District 10. Eleven buildings were flooded and four were demolished. Twenty-eight persons were evacuated from the area.

Although the levees of District 10 held and that area was not flooded, 650 persons were evacuated for 3 or 4 days.

The failure of the west levee of the Feather River at Shanghai Bend occurred about 12:10 a.m. on December 24. Water from this break entered Yuba City and flooded about 95 percent of the city (fig. 12). The depth of flooding varied from a few inches on the north side to more than 12 feet in the low areas on the south. Because flooding occurred so quickly and in the middle of the night, practically none of the contents of homes and business buildings could be saved. Thirty-eight persons were reported to have lost their lives in this area as a result of the flood, and about 12,000 persons were evacuated for periods ranging from a few days to several months. A total of 3,134 homes was flooded, of which 31 were demolished and 45 were swept away completely. The business district was flooded in depths of 2 to 3 feet for 1 to 2 days, and very little merchandise, materials, or equipment could be removed. The Yuba City Union High School and three grade schools were flooded in depths of a few inches to 6

FIGURE 12.—Yuba City, Calif., under water as a result of Feather River levee failure. The city of Marysville is the "island" in the background surrounded by floodwaters of the Yuba and Feather Rivers. Photograph by Corps of Engineers.

feet over the floors. The 5th Street highway bridge and the Sacramento Northern Railroad bridge over the Feather River connecting Yuba City and Marysville were washed out, and one of the two trunk telephone lines serving the two cities was severed.

After the levee broke at Shanghai Bend, the entire agricultural area south of Yuba City was flooded rapidly, and floodwaters from the river continued to flow into the area for 2 weeks. By January 7 the levee break had been repaired sufficiently to shut off the flow; a second rise of the river in mid-January was barely prevented from overtopping the newly repaired levee by the heroic work of troops called out from Beale Air Force Base. The vast lake of floodwater became known locally as Tudor Lake, for the community of Tudor which it inundated. The Feather River levee was cut at the lower end of the lake to drain it. Drainage through the cut continued for more than a month; then the cut was closed and the remaining water was pumped out. About 57,000 acres were flooded in this area, including about 8,800 acres of peach orchards, 3,900 acres of prune orchards, 2,000 acres of almond and 1,700 acres of walnut trees, 1,700 acres of alfalfa, 4,200 acres of grain crops, and 26,700 acres of rice land. In areas near the levee break, trees were toppled and washed out, and in other places 2 to 3 feet of sand and silt were deposited in orchards. The floodwaters had a maximum depth of about 19 feet; the maximum duration of flooding was about 65 days. All homes and buildings in the area, including five public schools were flooded. Where water was deep, prolonged wave action demolished many buildings. The loss of livestock included 2,975 head of cattle, 2,500 sheep, 247 hogs, and 125 horses.

At Nicolaus part of the highway bridge across the Feather River was washed out, and the break in the east levee downstream from Nicolaus caused the flooding of about 24,600 acres of well-developed farmland (fig. 13). Two persons were reported to have lost their lives as a result of the flood in this area; approximately 98 farms and 12 nonfarm homes were flooded, and more than 400 persons were evacuated. The depth of floodwaters was 16 to 20 feet over most of the lower part of the area and 5 to 10 feet near Nicolaus. The levee was cut at the lower end to drain the floodwaters into the Sacramento River. Inflow through the Nicolaus break continued for 34 days until the gap was closed, and outflow through the lower cut continued for another 2 weeks. Then the cut was closed, and the remaining water was pumped out.

On the Yuba River, the peak discharge of 148,000 cfs on December 23 at Englebright Dam plus the nearly simultaneous peak of 11,300 cfs on Deer Creek near Smartville, amounted to 159,000 cfs. This figure represents the peak discharge at the former gaging-station site

FIGURE 13.—Floodwaters of the Feather River at Nicolaus, Calif., on December 24. The break in the east levee is in the foreground. The Nicolaus gaging station is visible a short distance upstream from the break.

at Smartville, and compares with the previous maximum of 120,000 cfs at that site during the flood of March 1928. A combined peak of 114,000 cfs for the Englebright Dam and Deer Creek stations occurred during the November 1950 flood.

Upstream from Englebright Dam several areas on tributaries were flooded, and roads and power facilities were washed out. On the North Yuba River the flooding caused heavy damage in Downieville below the Downie River confluence.

On the valley floor the peak discharge was confined by the levees along the river to the confluence with the Feather River at Marysville. However, in the area east of Marysville, about 4,400 acres of orchard and farmland between the project levees were flooded to a maximum depth of 8 feet for 3 to 4 days. Roads, railroads, communication facilities, other utilities, and trailer courts, a hog farm, and a sand and gravel pit were flooded. Losses included 1,095 head of livestock. On December 23 about 8,500 persons were evacuated from the city of Marysville, but through the heroic efforts of the townspeople and and troops from Beale Air Force Base, the levees held and the city was not flooded.

SACRAMENTO RIVER BASIN BELOW FEATHER RIVER

The peak discharge of Bear River near Wheatland gaging station on December 22 exceeded the record peak of January 21, 1943, but

was to the lumber industry, as facilities were destroyed and large stocks of logs and finished lumber were swept away. Two lives were lost and 27 persons injured, but the toll of deaths and injuries would have been much higher had it not been for spectacular rescues by members of the Armed Forces, National Guard, Coast Guard, county employees, and volunteer workers.

FIGURE 16.—Eel River flood damage near Fernbridge, Calif. Undercutting is on downstream side of Fernbridge-Ferndale highway. Flood-damaged homes are in middleground. Photograph by Proctor's, Eureka, Calif.

Agricultural damage in the delta area was tremendous. Despite the efficacy of flood warnings, entire herds of valuable dairy stock, developed over many years of breeding, were lost. Numerous farm homes, out-buildings, and machinery were destroyed or damaged. The damage to highways and bridges throughout the basin isolated many communities for as long as several weeks (fig. 16). Slides, washouts, and trestle losses shut down the Northwestern Pacific Railroad for about 7 weeks. Communication lines and equipment were washed away or destroyed by slides throughout a large part of the basin. Long-distance trunk lines were inoperative for 1 to 2 weeks, except for intermittent operation for emergency calls.

Subsequent to the main rise of the river, lesser rises caused reflooding in the lower Eel River basin. Additional damage was light, except for bank erosion.

MAD RIVER BASIN

The flood in the Mad River basin on December 22 was the greatest of record, but other floods of this magnitude probably have occurred since the great flood of the winter of 1861-62. At the station at Kneeland 7 SSE, a 24-hour precipitation of 5.46 inches was recorded on December 21. The flood inundated 6,300 acres, of which 4,500 were agricultural and industrial land between the town of Blue Lake and the Pacific Ocean. U.S. Highway 101 was inundated and the north approach to the bridge over the Mad River was washed out. Damage to agricultural lands from erosion, scour, silt, and debris deposits was severe and loss of dairy cattle was high. Considerable damage was suffered by sawmills and wood-products mills. Sweesey Dam, which diverts domestic water supply for the city of Eureka, suffered minor damage. The peak stage of the Mad River reached the levee crest near the towns of Blue Lake and Korbel, but the river was contained there.

REDWOOD CREEK BASIN

Virtually all the damage from the flood of December 21–22 in the Redwood Creek basin occurred in the town of Orick and its environs. The maximum stage and discharge of the stream at Orick were identical to those of the flood of January 1953, and several other floods of this magnitude have probably occurred since the great floods of the winter of 1861–62.

The creek rose rapidly at Orick until water covered most of the area to a depth of about 4 feet; nearly every home and business establishment in the town was flooded. Residents were evacuated to higher ground and there was no loss of life. About 910 acres of agricultural land were inundated, and damage to roads and bridges was appreciable. During late December and January, further rises of Redwood Creek caused inundation of some areas, but the additional damage was light.

KLAMATH RIVER BASIN

The heavy December rains throughout the Klamath River basin culminated in a peak discharge of 425,000 cfs on December 22 at the gaging station near Klamath (fig. 15). This peak is the maximum of record, but it probably was equaled in the flood of February 1890 and exceeded in the floods of the winter of 1861–62.

Major damage occurred in the lower reaches of the basin where six persons lost their lives as a direct result of the floods. The greatest damage was in and near the town of Klamath and in Hoopa Valley. The town of Klamath and the community of Klamath Glen, about 3 miles upstream, were almost completely destroyed (fig. 17). Much

FIGURE 17.—Flooding in the town of Klamath, Calif., on the right bank of the Klamath River. Photograph by Proctor's, Eureka, Calif.

of the economy of the area is based on the production of lumber and lumber products, and several mills in the vicinity were severely damaged or demolished. Loss of stocks of finished lumber and logs was very high. In the delta area of the Klamath River about 700 acres of agricultural land were inundated. In Hoopa Valley on the Trinity River, several lumber mills were damaged but the principal losses involved very extensive damage to roads and bridges.

Because the Klamath River basin in California is very sparsely settled, there was only scattered damage to residential and commercial properties elsewhere in the basin. In the Scott River valley, however, approximately 6,300 acres of agricultural land were inundated. Throughout the entire basin and particularly in its interior, roads and communications were destroyed by the rains and high water. Slides and bridge and road washouts completely isolated large areas for weeks; during this time radio was the only means of communication.

In the upper Klamath River basin in Oregon, damage was negligible and was confined mainly to local flooding in the upper Sprague River drainage basin.

SMITH RIVER BASIN

The flood of December 22 in the Smith River basin was the maximum recorded since 1931, when the mainstem of the river was first gaged. During the storm of December 21–24, Gasquet Ranger Station received 12.03 inches of rain, two-thirds of which fell in 24 hours. As the Smith River rose, flood warnings for the delta area were issued by the Weather Bureau. These warnings were particularly effective in keeping cattle loss to a minimum. It is estimated that 7,600 acres of pasture and agricultural land in the delta area were inundated to an average depth of about 3 feet. Floodwaters from the Smith River flowed into Lake Earl Slough and raised the elevation of Lake Earl so that 3,200 acres of land bordering the lake were flooded. Agricultural damage consisted primarily of the scouring of pastureland and the deposition on the land of silt, gravel, and debris from timber operations. Damage to roads and bridges was severe as a result of the rain and high water, which caused slides and washouts. The principal industrial damage was the inundation of lumber mills and the attendant loss of finished lumber and logs.

WEST-CENTRAL IDAHO

A winter flood in central or southern Idaho is an extraordinary occurrence. In the lower valleys, early spring thaws commonly cause localized freshets on the smaller tributary streams. In the higher country most of the flood potential is due to heavy snow accumulations, and rivers usually remain low from November to March. Winter floods are more common in the Coeur d'Alene River drainage basin where an exceptionally high flood occurred in December 1933 as a result of warm rains on accumulated snow. A similar condition caused the December 1955 flood in west-central Idaho. Warm rains on snow generated record streamflows within a period of 48 to 72 hours. The Idaho flood was a product of a storm that caused simultaneous floods in northern California and southwestern Oregon. The broad path of the parent storm was marked by a number of spot reactions as it approached Idaho, namely, Satus Creek in the Yakima area, John Day River on the lower Snake River, and Asotin Creek and Palouse River in southeastern Washington and Idaho. In Idaho the flood was centered in the Weiser and Payette River basins which are flanked by the Little Salmon River on the north and the Boise River on the south (fig. 18). The locations of the sites, 481-566, at which streamflow data were collected, are shown on the map. Hydrographs illustrating the relative pattern and magnitude of discharge during December 1955 and January 1956 at selected gaging stations are shown in figure 19.

The storm extended from December 18 to 23, and at some points it was reported that the rain was nearly continuous. The Weather Bureau reported that eight of its stations within the primary flood area recorded more than 6 inches of precipitation during the week. This precipitation fell as snow at the highest altitudes; part of the precipitation, which fell as rain at medium altitudes was absorbed by

lumbering industry lost many logs stored in booming areas and recovered others only at large cost.

Because these streams are relatively short and steep and flood runoff was flashy, floodflows lasted for less than 2 days. There are no flood-control reservoirs in this area and natural flow occurred. Levees on the Nehalem, Nestucca, and Siuslaw Rivers were overtopped, and tide gates failed at several locations. On streams entering Tillamook Bay (Kilchis, Trask, Tillamook, Wilson, and Miami Creeks) levees were not overtopped, but some flooding occurred when water flanked these levees upstream.

UMPQUA RIVER BASIN

From December 18 to 27, precipitation generally averaged between 10 and 15 inches over the entire basin; a maximum 24-hour precipitation of 5.75 inches was recorded for December 25 at Reston in the South Umpqua River basin. At the headwaters of the North Umpqua River, much of the precipitation infiltrated the porous soils and ran off later. As a result peak runoff was less than in the South Umpqua River or in the lower North Umpqua River basin. The floods in December 1955 were double crested in the Umpqua River basin. On the main stream and larger tributaries the peaks that occurred late on December 21 or early December 22 were the maximums for the flood period and were the result of the heavy rains on December 18–22. On the smaller tributary streams, particularly near Roseburg, the peaks that occurred early on December 26 were the maximums for the flood period and were the result of rains of shorter duration but higher intensity on December 25–26.

According to a report by the Oregon State Civil Defense Agency, five lives were lost in the basin as a direct result of the floods. At Toketee Falls, in the headwaters of the North Umpqua River, about 200 families and 150 construction workers were isolated for several days. A small diversion dam on Fish Creek was washed out, and 3 feet of mud was deposited in the control station of the main powerhouse. The town of Myrtle Creek was without light and power, and communication lines were down. The town of Riddle was evacuated and later was completely surrounded by water. Pacific Highway between Dillard and Myrtle Creek was blocked by water, and the Drain to Reedsport highway was closed by slides. There was also considerable damage to the county road system (fig. 24). More than 300 families were evacuated from danger points in the basin. Damages were estimated at $2,143,000; the major types were agricultural (32 percent), residential (26 percent), and industrial (21 percent).

FIGURE 24.—Floodwaters over county road bridge across South Fork Umpqua River at Rice Creek, 2 miles upstream from Dillard, Oreg., at 11 a.m., December 22, 1955. Photograph by Dick Gilman, Roseburg, Oreg.

In general, streams were above bankfull stages for 1 to 2 days at the time of the December 21–22 peak and for less than 1 day at the time of the December 26 peak. There are no significant storage or flood-control reservoirs in the basin. All levees were overtopped except those protecting the towns of Reedsport and Gardiner, which proved adequate and prevented extensive damage.

COOS AND COQUILLE RIVER BASINS

The Coos and Coquille Rivers rise in the Coast Range, and are the principal streams in Coos County and the only large streams between the Umpqua and Rogue Rivers. Precipitation during December 18–27 was 16.47 inches at North Bend in the Coos River basin and about 20 inches for Powers and Sitkum in the Coquille River basin.

Maximum peaks of record did not occur except at gaging stations with short periods of record. However, peaks approached previous maximums at stations with 20 to 40 years of record. Although there is no gaging station on the main Coquille River, the lower Coquille River may have had the greatest discharge known. However, the tide is a major factor in the lower Coquille and all that is certain is that the stage was higher than ever before observed.

One person was drowned in the Coos River as a direct result of the