TULARE
COUNTY
FLOOD
CONTROL
DISTRICT

FLOOD CONTROL MASTER PLAN

HYDROLOGY APPENDIX

Revised Edition June 1973

MURRAY, BURNS & KIENLEN Consulting Civil Engineers June 1971

THE SPINK CORPORATION Sacramento, California

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HYDROLOGY APPENDIX

This Hydrology Appendix presents detailed supporting data for the Flood Control Master Plan for the County of Tulare, dated June 4, 1971, including geography, normal annual precipitation, storm systems, flood runoff, and procedures for developing the flood hydrology of streams in the area.

GEOGRAPHY

Tulare County encompasses an area of approximately 5,000 square miles. The eastern two-thirds of the County consists of part of the Sierra Nevada and adjacent foothills; the western one-third is valley-floor land. The County contains some of the loftiest peaks of the Sierra Nevada, including Mount Whitney, which has an elevation of 14,496 feet. West of the Sierra Nevada are dissected uplands which extend to the foothill line at an elevation of approximately 500 feet. Low alluvial plains and fans extend westward to the bottom lands of Tulare Lakebed. The western border of the County is at an elevation of approximately 200 feet.

Geology

The Sierra Nevada were formed primarily from a single gigantic block of crystalline rock which has been uplifted on the eastern edge along a fault zone, forming a steep eastern escarpment. The westward tilting of the top of the block resulted in gentler slopes toward the west. Major rivers have incised deep canyons into this western slope. Soils are typically shallow throughout the area.

The dissected uplands east and south of Porterville and between Orange Cove and Woodlake include deeply weathered, eroded and uplifted alluvial deposits. Weathering has produced dark reddish-brown soils; erosion has resulted in gullies as much as 50 feet deep.

West of the foothill line the valley proper is a broad plain of low relief. The plain consists of the three large coalescing alluvial fans of the Kings, Kaweah and Tule Rivers. The Kings River alluvial fan, the largest, is separated in the upper portion from the Kaweah River alluvial fan by the Cottonwood Creek interfan and Cross Creek. The Kaweah River alluvial fan is separated in the upper portion from the Tule River alluvial fan by Lewis Creek interfan area and Elk-Bayou. South of the Tule River fan are smaller fans created by Deer Creek and White River with intervening fans from smaller stream channels. The soils of the fans are generally sandy, permeable and fertile, although hardpan is present in some areas. In the interfan areas the soils are somewhat alkaline and less fertile. The plains and fans form the largest part of the valley floor, presently a highly developed agricultural area.

Overflow lands and lake bottoms -- which are flat, nearly featureless areas -- are located in the western part of the County. These lands were formerly inundated during flood stages of Tulare Lake and supported growth of marsh and tule vegetation. The soils generally have limited permeability, but are fertile and mostly free from alkaline.

Drainage Areas

The eastern one-third of the County is drained by the Kern River system, which flows in a southerly direction to a point east of the City of Bakersfield, thence westerly through Kern County to Bakersfield where it discharges onto the floor of the San Joaquin Valley. Buena Vista Lake and Tulare Lake are the terminal points for Kern River water. Almost all of the lands drained by the Kern River stream system within Tulare County are located within the Sequoia National Forest.

The northeastern portion of the County is located within the drainage area of the Kings River. All of the tributary streams in this area flow in a generally northerly direction through Kings Canyon National Park. The Kings River flows onto the valley floor in a southerly direction and enters Tulare County to the west of Dinuba. It flows through Tulare County for approximately six miles and continues westward to a bifurcation from which the waters flow either southward into Tulare Lake or northward to the San Joaquin River.

The remaining portion of the County is drained by stream systems which flow to the west and discharge onto the floor of the San Joaquin Valley. The two largest stream systems which drain these western slopes are the Kaweah and Tule Rivers. In addition to these two major river systems, approximately 34 smaller drainage areas discharge water onto the valley floor within Tulare County. Another six drainage areas discharge water onto the valley floor outside the Tulare County boundaries; however, resulting flood flows may enter the County. All 40 drainage areas are identified on Plate I and are listed in Table 1, which also gives the area in square miles for each drainage. Also shown on Plate I and listed in Table 1 are those drainage areas in Kings and Kern Counties whose runoff has some effect on Tulare County. Brief descriptions of some of the watersheds which discharge onto the valley floor are contained in the following paragraphs.

Citrus Cove Drainage (Drainage Area 3). Citrus Cove drainage encompasses the area between Wahtoke Creek and Granite Hill. The maximum elevation in the drainage area is 1,500 feet and the elevation at the Friant-Kern Canal crossing is about 440 feet. Between Friant-Kern Canal and the Alta East Branch Canal the channel is known as Navelencia Creek. Water from Navelencia Creek is distributed by Alta East Canal into the canal system of the Alta Irrigation District. The drainage area above Friant-Kern Canal is 8.3 square miles.

Hills Valley Creek (Drainage Area 6). Hills Valley Creek heads on Bear Mountain at elevation 3,355 feet and flows southerly about six miles to Friant-Kern Canal. The elevation at the Friant-Kern Canal crossing is approximately 440 feet. In the lower reaches the stream channel has been realigned by recent land development. The drainage area of Hills Valley Creek at Friant-Kern Canal is 10.7 miles.

Wooten Creek (Drainage Area 7). Wooten Creek rises in Fresno County immediately north of the Tulare County line. It flows in a generally southwesterly direction into Tulare County in the vicinity of Orange Cove. East of Friant-Kern Canal, Wooten Creek has been realigned during land development and west of Friant-Kern Canal it is channelized from the Canal to the Alta East Branch Canal about one and one-half miles west of Orange Cove. The drainage area at Friant-Kern Canal is 11.3 square miles and ranges in elevation from 1,945 feet to 440 feet in the vicinity of Orange Cove.

Sand Creek (Drainage Areas 9 and 10). Sand Creek rises on the northern slopes of Goldstein Peak (elevation 2,814 feet). From its origin Sand Creek flows in a northwesterly direction about five miles, then turns and flows southwest about eight miles to discharge onto the floor of the valley between Primero and Curtis Mountains at an elevation of approximately 430 feet. From this point Sand Creek is channelized between Orosi and Cutler to the vicinity of Cottonwood Creek about six miles southeast of Dinuba. The drainage area at Friant-Kern Canal is 38.8 square miles. The Soil Conservation Service classifies runoff from the drainage basin as rapid.

Long Creek (Drainage Area 14). Long Creek drainage to Friant-Kern Canal is a relatively narrow 11.2 square mile area draining Long Valley, which is located between Tucker Mountain and Sawyer Peak. Elevations at these two locations are 2,603 feet and 2,403 feet, respectively. Story Creek, a principal tributary, joins Long Creek about one mile east of the Friant-Kern Canal at an elevation of approximately 450 feet. Long Creek channel west of the Friant-Kern Canal has been obliterated by land development. Runoff from the drainage area is classified as medium to rapid.

Cottonwood Creek (Drainage Areas 22, 23 and 24). Cottonwood Creek drainage is bounded on the north by a ridge containing Mitchell Peak (elevation 3,574 feet). Several tributaries flow south from this ridge and join in the vicinity of Cottonwood School to form Cottonwood Creek. Below this point Cottonwood Creek flows in a generally southerly direction about 14 miles to the south end of Colvin Mountain. It then turns west and flows across the floor of the San Joaquin Valley to its confluence with St. Johns River near U. S. Highway 99. The waters of Cottonwood Creek and St. Johns River are conveyed by the Cross Creek system southerly to Tulare Lake. The area drained by Cottonwood Creek ranges from a maximum elevation of 4,124 feet at Bear Mountain to about 430 feet at the south end of Colvin Mountain. The total area drained by Cottonwood Creek above Friant-Kern Canal is 88.1 Square miles. Runoff from the northerly half of the drainage area above Friant-Kern Canal is classified as rapid and from the southerly half as medium to rapid.

Antelope Creek (Drainage Area 25). Antelope Creek rises on the western slopes of Long Mountain and flows southerly about five miles to the vicinity of Woodlake. The watershed ranges in elevation from 2,516 feet to approximately 430 feet. The drainage area above Woodlake is 20.7 square miles. The natural terminal point for Antelope Creek water is the St. Johns River near the Friant-Kern Canal. Runoff from the drainage area is classified as medium to rapid.

Dry Creek (Drainage Area 27). Dry Creek, also known as Limekiln Creek, rises on the southern slopes of Park Ridge about one mile south of the Fresno-Tulare County Line. It flows in a generally southerly direction about 24 miles, discharging into the Kaweah River approximately one mile below Terminus Dam. The total drainage area at its mouth is approximately 82 square miles. The basin varies in elevation from a maximum of 7,540 feet to about 490 feet at the Kaweah River. Runoff from the drainage area is classified as rapid.

Kaweah River (Drainage Area 28). The source of the Kaweah River is a group of glacial lakes near Triple Divide Peak. The main stream is formed by the confluence of the middle and East Forks approximately five miles northeast of Three Rivers. Between this point and Terminus Dam the North and South Forks discharge into the main stream. The total watershed above Terminus Dam is 561 square miles. Elevations in the watershed range from a maximum of 12,634 feet to about 500 feet at the foothill line. Those portions of the watershed above 10,000 feet in elevation are characterized by mountain peaks and ridges having either a very thin mantle of soil or exposed brush.

Mehrten Creek (Drainage Area 29). Mehrten Creek flows generally in a northwesterly direction. The drainage area at its crossing with Foothill Ditch and Highway 198 is 19 square miles. From the Foothill Ditch crossing, Mehrten Creek water flows in a relatively undefined channel to Yokohl Creek near the latter's confluence with Consolidated Peoples Ditch. The maximum elevation in the watershed is 2,432 feet and the elevation at Foothill Ditch is approximately 460 feet. Runoff from the drainage area is classified as medium to rapid.

Yokohl Creek (Drainage Area 30). Yokohl Creek rises on the western slope of Blue Ridge and flows in a generally northwesterly direction about 16 miles to where it discharges onto the valley floor at a point about four miles northeast of Exeter. Yokohl Creek continues in a northwesterly direction approximately 3.5 miles to its confluence with Consolidated Peoples Ditch. The watershed contains approximately 71 square miles and ranges in elevation from 5,733 feet to approximately 460 feet at the foothill line. Runoff from the drainage area is classified as medium to rapid.

Lewis Creek (Drainage Areas 31 and 32). Lewis Creek rises on the southern slopes of Blue Ridge and flows through the foothills in a generally westerly direction for about eight miles. It then flows for about four miles along the foothill line to the Friant-Kern Canal immediately east of Lindsay. From this point Lewis Creek flows northerly around Lindsay then westerly to the vicinity of Outside Creek. Round Valley runoff enters Lewis Creek about one mile east of the Friant-Kern Canal. The Lewis Creek drainage area, including Round Valley, is approximately 32 square miles and ranges in elevation from a maximum of 2,901 feet to about 420 feet. Runoff from the eastern portion of the drainage area is classified as rapid and in the Round Valley area as medium to rapid.

Frazier Creek (Drainage Area 33). Frazier Creek rises at an elevation of approximately 1,500 feet in the foothills northeast of Porterville. It flows in a generally westerly direction about five miles to discharge onto the floor of the valley.

The watershed above a location one-half mile east of Road 256 contains 18.1 square miles and ranges in elevation from 2,308 feet to approximately 480 feet. West of Road 256 agricultural development has obliterated the Frazier Creek channel. Runoff from the watershed is classified as slow to medium.

Tule River (Drainage Area 36). The main stream of the Tule River is formed by the junction of the North and Middle Forks at a point about one mile northeast of Springville. Below this junction the Tule flows in a generally southwesterly direction about seven miles to Success Dam. Tule River channels continue westerly and terminate in Tulare Lake about four miles south of Corcoran in Kings County. The watershed above the dam contains 393 square miles and ranges in elevation from a maximum of 10,042 feet to approximately 500 feet at the dam.

Deer Creek (Drainage Areas 37 and 38). Deer Creek rises on the western slopes of Greenhorn Mountains and flows in a generally northwesterly direction about 27 miles to where it discharges onto the valley floor. Deer Creek channel terminates at the Homeland Canal about 10 miles west of Pixley. The watershed above Hungry Hollow Damsite contains approximately 124 square miles and ranges in elevation from a maximum of 8,284 feet to about 500 feet. Runoff from the basin is classified as medium to rapid.

Fountain Springs Gulch (Drainage Area 39). Fountain Springs Gulch rises on Galley Mountain at elevation 2,852 feet and flows westerly about eight miles. It then flows northwesterly in an entrenched channel past Terra Bella to its confluence with Deer Creek at an elevation of approximately 450 feet. The drainage area contains 35 square miles. Runoff from the drainage area to the north of the community of Fountain Springs is classified as medium to rapid, and to the east as rapid.

White River (Drainage Areas 43 and 44). White River rises on the western slopes of Bull Run Peak in the Greenhorn Mountains and flows in a generally westerly direction about 29 miles before discharging onto the valley floor. White River channel essentially disappears about five miles west of Earlimart. The watershed above State Highway 65 near Vestal contains approximately 120 square miles and ranges in elevation from 8,284 feet to approximately 500 feet. Runoff east of the White River near Ducor stream gaging station is classified as rapid and to the west as slow to medium.

Rag Gulch (Drainage Areas 49 and 50). Rag Gulch heads in Kern County on Blue Mountain (elevation 4,356). It flows westerly for about 20 miles at an elevation of about 500 feet to the Tulare-Kern County Line at Richgrove. Five Dog Creek, a major tributary, joins Rag Gulch about five miles southeast of Richgrove. From Richgrove westward to the Friant-Kern Canal, the Rag Gulch channel has been almost obliterated by land development. Rag Gulch drainage area contains 138 square miles at the SPRR tracks at Richgrove.

Between the major watersheds described above are smaller tributary areas which contribute significant stormflow to lands on the valley floor. These areas are also identified on Plate I and listed in Table 1. Runoff characteristics for these smaller tributaries can be generalized as follows: north of Kaweah River - medium to rapid; Porterville area (Drainage Areas 34 and 35) - rapid on the steep upper slopes and slow to medium on the moderate slopes; foothill areas between Terra Bella and Richgrove - slow to medium.

NORMAL ANNUAL PRECIPITATION

Normal annual precipitation within Tulare County ranges from about seven inches in the southwest corner of the County to over 50 inches in the northeast. Precipitation generally falls in the form of rain below the 5,000-foot elevation and as snow above this elevation. However, infrequent warm storms can produce rainfall at higher elevations near the crest of the Sierra with consequent high rates of runoff from the upper basins.

Precipitation stations in Tulare County and in immediately adjacent areas are listed in Table 2 and located on Plate II. Table 2 lists the station number assigned by the California Department of Water Resources, source of record, period of record, station elevation and normal annual precipitation for the periods 1911-60 and 1911-70 for those stations for which the normals have been computed. The normal annual precipitation values for the 1911-60 period have been developed by the California Department of Water Resources as described in "Precipitation in the Central Valley, Office Report, Coordinated Statewide Planning Program, Sacramento District, August 1966".

For purposes of this study, the 1911-60 normal annual precipitation amounts for 21 long-record stations in Tulare County and adjacent areas were updated to 1970. The additional 10 years of record changed the normal annual precipitation amounts for these stations by less than one percent on the average. For all practical purposes, precipitation amounts for Tulare County stations for the 1911-70 period are the same as the precipitation amounts for the 1911-60 period.

Precipitation, whether in the form of rain or snow, is measured as depth in inches of water that falls at a given location. At higher elevations where much of the precipitation is in the form of snow, it is difficult -- if not impossible -- to "catch" the true amounts of precipitation in rain gages. Therefore, rain gage data in these areas are supplemented with snow course measurements of water content in the snowpack. Snow courses and aerial markers in Tulare County and in immediately adjacent areas are listed in Table 3 and their locations depicted on Plate II.

Distribution of precipitation over an area is depicted by an isohyetal map -- a map showing lines of equal precipitation amounts. The isohyets are developed from point precipitation amounts and knowledge of the orographic effects on precipitation distribution. The normal annual isohyetal map of Tulare County for the base period 1911-70 is shown on Plates II and III. In addition to the isohyetal lines, drainage area boundaries are shown on Plate III. Isohyetal maps and data from the Sacramento District, U. S. Corps of Engineers, and the California Department of Water Resources were utilized in developing the isohyetal map for Tulare County.

STORM SYSTEMS

The storm systems that produce flood runoff in Tulare County are significant to an understanding of the flood hydrology of the area. Fall rains usually begin in November in the San Joaquin Valley. However, in some seasons the fall rains begin in September or October; in some years they are delayed until December. Large storms are most likely to occur in the months from November to April, although the predominant flood-producing period is the two-month period December and January. Recently major storms resulting in severe floods were experienced in 1966-67 and 1969.

The onset of fall and winter precipitation occurs with the southward migration of the polar jet stream, which is the maximum westerly wind in the upper levels of the atmosphere. In September the wind maximum is located near Latitude 50 degrees North (about the latitude of Vancouver, B. C.), but by mid-November it reaches Latitude 42 degrees North (about the latitude of the California-Oregon border). This southward swing of the westerlies causes the storm track to also move southward, bringing weather fronts into the San Joaquin Valley. The stronger fronts produce precipitation, the weaker ones only cloudiness.

Pacific storm systems usually involve classic cold and warm fronts and occlusions. Occluded fronts result when a cold front overtakes a warm front in a wave cyclone. Stronger fronts bring period of precipitation which can be as brief as six hours for a fast-moving front or as long as 24 hours for a slow-moving front. Periods of prolonged precipitation usually occur when cold fronts become quasi-stationary in a region. A stationary front lying parallel to a strong upper-level wind flow will frequently develop waves (undulations) which move along the front producing intense bursts of rain. This wave mechanism, in combination with orographic lifting of moist air, is the optimum condition for producing substantial precipitation amounts. (Frontal lifting is a mechanism of the storm itself; orographic lifting is caused by the flow of air over topographic barriers.) In all major flood-producing storms affecting Tulare County in the past, orographic precipitation has been quite significant.

December 1966 Storm

In the early part of December 1966 the polar jet stream shifted southward over the eastern Pacific Ocean. The storm track also moved southward along with the southward shift of the jet stream. In California the series of storms began on December 1 with the movement of a cold front into the State. This front reached Tulare County on December 2, producing generally light precipitation.

On December 4 a stronger front moved into the State; precipitation began in Tulare County on the afternoon of the same day. On December 5 the front became stationary in the southern San Joaquin Valley; on the 6th the front surged northward as shown by the weather maps in Figure 1. During the three-day period from midday December 4 to the afternoon of the 6th, heavy rain fell in the southern San Joaquin Valley. In the Kaweah River Basin on the night of December 4-5, snowfall was reported at Grant Grove (elevation 6,600 feet), and the snow level (elevation where precipitation changes from rain to snow) was at approximately 6,000 feet. With the northward movement of the front on December 6, the snow level lifted to 9,000 feet, a relatively high snow level.

The time distribution of precipitation for December 2 through December 6 is illustrated in Figure 2 by the hyetograph (plot of hourly precipitation) for the Exeter Fauver Ranch station, which is at an elevation of 439 feet. Precipitation amounts at other representative stations for the period December 2-7, 1966, are given in Table 4. It should be noted that the observation time is not the same for all stations listed in Table 4.

Precipitation totals for the period December 2-7 ranged from about three inches in the Tulare Lake area and six inches at the foothill line to 30 inches in the headwaters of the Kaweah and Tule River Basins. Heavy precipitation at high elevations, combined with the wet antecedent ground conditions resulting from the rain of December 2, produced very heavy runoff; severe flood conditions in Tulare County resulted.

Snow Accumulation 1967

The December 1966 storm was followed by another unusual event -- the rest of the winter season and the spring were characterized by a record accumulation of snow in the southern Sierra Nevada. Heavy deposition of snow came in March and April 1967 when a series of cold storms brought heavy precipitation to the higher elevations. Because of relatively cold spring temperatures, snowmelt did not begin until the middle of May.

To illustrate the magnitude of the snow accumulation, the April-July 1967 volume of runoff on the Kings River Basin was

194 percent of normal, Kaweah River Basin 231 percent of normal, Tule River Basin 291 percent of normal and Kern River Basin 214 percent of normal.

January 1969 Storm

The airflow pattern over the Pacific Ocean during January 1969 is typical of many which have resulted in severe storms. The flow of cold air coming fron Alaska curves out over the Pacific in a cyclonic arc to meet an extended current of warm, moist air originating in the region of the Hawaiian Islands. This flow enters California as a strong southwest or west-southwest current and is heavily laden with moisture. As the air currents sweep up over the Coast Ranges and the Sierra Nevada copious precipitation can be produced. The areas crossed by this strong air current receive the highest precipitation. In the December 1955 and December 1964 storms the main current entered Northern California; in the January 1969 storm it crossed Southern California. Satellite pictures of the January 1969 storm clearly show a band of clouds stretching out over the Pacific for a distance of 2,000 miles.

In 1969 this typical confluent flow pattern began on January 15. Precipitation came in two waves or concentrations separated by one day; the first covered the period January 18-22 and the second January 24-28. The total 10-day precipitation in Tulare County ranged from about five inches in the Corcoran area and 10 inches in the foothills to 45 inches in the High Sierra. The weather map (Figure 1) shows streamlines of airflow for the northern hemisphere at approximately 10,000 feet for the period January 15-31, 1969. The time distribution of precipitation for January 18-28, 1969, is illustrated by the hyetograph (Figure 2) for Exeter Fauver Ranch station. Amounts of precipitation at other representative stations, both recording and non-recording, are given in Table 5.

February 1969 Storm

During the period February 21-28, 1969, the flow pattern consisted of a series of fronts moving over California from the northwest. These storms were colder than the storms in January, with snow levels about 4,500 feet in the Kaweah and Tule River basins. The cold front of February 24 was the most intense, bringing 2.33 inches of precipitation at Exeter Fauver Ranch in the 24-hour period ending at midnight February 24. Rainfall was not confined to the passage of the front, but lingered after the front because of the primary low pressure center remaining off the northern California coast. The four-day precipitation totals for the February 23-26 period varied from about two inches in the Corcoran area and five inches in the foothills to 20 inches in the high Sierra.

The time distribution of precipitation for February 22-26, 1969, is presented for the Exeter Fauver Ranch station in the hyetograph on Figure 2. Amounts of precipitation at other representative stations are given in Table 6.

Snow Accumulation 1969

The snow level varied during the period January 18-28, 1969, but remained at fairly high elevations during the times of heavy precipitation. In the Kaweah River Basin the snow level was about 6,000 feet during January 18-22. The station at Grant Grove reported the heaviest accumulation of snow from 8 a.m. on the 21st to 8 a.m. on the 22nd -- about 13 inches. Then a cold front moving through the State in the early morning of January 22 brought a cold air mass in its wake, temporarily ending precipitation. A significant renewal of the confluent flow pattern occurred on January 24 and the resulting warm air flow over the southern Sierra Nevada once again brought the snow level in the Kaweah River Basin to 7,000 feet during January 24-28.

More snow accumulated in the Kings, Kaweah, Tule and Kern Basins during February and, to a lesser extent, March and the first half of April, bringing the snowpack to record depths, exceeding even those recorded in 1967. For example, the station at Farewell Gap (elevation 9,000 feet) in the Kaweah River Basin reported a snow water content of 67.7 inches on February 4, 102 inches on March 4, 99.3 inches on April 7, 88.9 inches on April 26, and 67.6 inches on May 28. The April 7 reading of 99.3 inches is over three times the April 1 normal of 31.7 inches.

In the snowmelt period, the month of April 1969 differed from April 1967 in that the former had nearly normal temperatures, allowing the 1969 snowpack to ripen earlier and start an earlier melt. The volume of runoff for the April-July 1969 period on the Kings River was 277 percent of normal, Kaweah River Basin 309 percent of normal, Tule River Basin 399 percent of normal, and Kern River Basin 415 percent of normal.

FLOOD RUNOFF

A thorough search was made to obtain all streamflow data in the Tulare County area for flood periods. Federal, State and local agencies were canvassed and engineers active in the area were contacted to be sure all available data were obtained. Particular emphasis was placed on obtaining flood data for the smaller drainage areas located between the Kings, Kaweah, Tule and Kern River watersheds. Table 7 is a summary of stream gaging stations in the area that are pertinent to this study. The location of these stations is shown on Plate I. Station histories for the foothill gaging stations are presented on page 39.

The specific data required for development of rain-flood hydrology for an area are principally instantaneous peak flows during flood periods and records of runoff at sufficiently short intervals of time during flood periods to define the time distribution of runoff. The time distribution of runoff may be plotted as a continuous curve of discharge versus time, producing a "hydrograph", which pictorially describes the flood event.

Every effort was made to obtain sufficient detail to delineate hydrographs of runoff for each major rain-flood event. For a variety of reasons, these efforts produced a limited amount of usable data. While many years of streamflow records were available for some streams, the data consisted of mean daily or mean monthly flows suitable for water supply analysis; detailed data for flood periods frequently were not available.

In some instances, extreme floods of December 1966 and January-February 1969 washed out or badly damaged stream gaging station equipment. Other stations which had been operated by the U.S. Bureau of Reclamation were discontinued in 1967 and thus no record was obtained during the 1969 flood events. However, immediately following the January-February 1969 floods, the staff of the U. S. Geological Survey, Water Resources Division, developed -- by accepted indirect methods -- estimates of peak flows for many foothill drainage areas in Tulare County. Table 8 contains a summary of available peak flow data for Tulare County and adjacent streams for December 1966, January-February 1969 and for the maximum previously recorded. Note that the peak discharge sites are identified on Plate I.

The only hydrographs available for foothill streams for the December 1966 flood are Sand Creek near Orange Cove (Figure 3), Cottonwood Creek above Highway 65 (69) (Figure 4), Dry (Limekiln) Creek near Lemoncove (Figure 5); and for the January-February 1969 floods, Sand Creek near Orange Cove (Figure 3), Deer Creek near Fountain Springs (Figure 6) and White River near Ducor (Figure 7).

Snowmelt floods are characterized by an increase in runoff over a period of days or weeks rather than hours as in a rain-flood and by relatively low peak flows and large volumes of runoff. The many years of stream flow records collected on the larger streams in Tulare County for water supply purposes provide an adequate record for hydrologic analysis of snow-flood runoff.

HYDROLOGIC ANALYSES

The development of the flood control concepts presented in the Flood Control Master Plan required that runoff amounts, both peak flow and volume, be developed for each foothill drainage area. In addition, precipitation intensity-duration-frequency analysis and procedures were developed for use in studying small drainage areas in the foothills and on the valley floor.

Peak Flow and Volume Analysis

Estimates of maximum flood peak discharge and volume to be expected for given frequencies or "return periods" are essential for hydrologic design purposes and economic analyses. "Return period" is defined as the average interval of time within which a flood of a given magnitude will be equalled or exceeded once. Because of the short period of available record, caution should be exercised in using frequency or return periods to describe a given historical flood or storm event.

The basic flood hydrology data available were inadequate for a rigorous solution of discharge frequencies at each required location by standard methods. Very few of the stations had continuous records for long-term frequency analysis. Most records consisted only of peak flows and stages for one or two major floods. In order to estimate flood peaks and 1-day, 2-day, 3-day and 5-day flood volumes for the many drainage areas affecting Tulare County, a regional flood frequency analysis technique, based upon procedures described in USGS Water Supply Papers 1543-A and 1687, Vol. 2, was utilized. The objective of a regional flood frequency analysis is to establish the relationship between normal annual precipitation and physical characteristics of drainage areas, so that estimates of flood runoff -- both peak and volume for given return periods for any watershed in the study area -- can be made.

The drainage areas for which some runoff records were available and which were used in this regional analysis are:

Station No. Shown on Plate I	Stream Flow Station
1	Kings River above North Fork nr. Trimmer
2	Kings River at Piedra
3	Mill Creek near Piedra
4	Sand Creek near Orange Cove
6	Dry Creek near Lemoncove
7	Dry (Limekiln) Creek near Mouth
9	Middle Fork Kaweah River nr. Potwisha Camp
10	Marble Fork Kaweah River nr. Potwisha Camp
17	North Fork of Middle Fork Tule River nr. Springville
20	Tule River near Porterville
22	South Fork Tule River near Success
24	Deer Creek nr. Fountain Springs (Kilbreth)
26	White River near Ducor
27	Kern River near Kernville

Review of the records for these stream flow stations indicate that the period 1943-69 could be used as a base for frequency evaluation. The period of record includes 1943, 1950, 1955, 1966 and 1969, all of which were years of major flooding. The frequency evaluation was based on the maximum annual peak discharge for each year of record. Many of the stream gaging stations did not have continuous records during the base period. As a result, it was necessary to establish an order of magnitude, since specific values could not be obtained. Data for individual stations were ranked by size of flood and plotted on semi-log paper against "return period". Return period (T_p) was computed as follows:

$$T_p = \frac{(\text{years of record } +1)}{\text{rank}}$$

Individual magnitude-frequency relationships for the stream flow stations were then used to develop a regional frequency relationship. First, non-dimensional curves for each drainage area relating the 25- and 50-year floods to an index flood were developed. These non-dimensional plots were compared and an average relationship between the index flood event and the 25- and 50-year flood event was established for the region. Index floods were also used to establish the relationship between flood events and the physical characteristics of the drainage areas.

Many factors enter into the relationship between flood peaks, volumes, and physical characteristics of the basin; however, with limited data it is only possible to utilize a few factors. After studies of basin characteristics it was determined that flood peaks could be most effectively related to drainage area, elevation, basin orientation and normal annual precipitation; flood volumes (maximum daily volume) could be most effectively related to drainage area and normal annual precipitation. The physical characteristics of the basins (area, elevation and orientation) were taken from 1:250,000 topographical maps and USGS quadrangle sheets. Normal annual precipitation was taken from the isohyetal map shown in Plates II and III. In the development of the relationships it was assumed that the peak flows would be channelized to the locations for which flow estimates were required.

The runoff relationships presented here were adjusted to conform to the long-term frequency characteristics of the area. As previously noted, the 1943-69 period contained five major flood events, which is an exceptionally high number of flood events compared to runoff records in the area dating back to 1897. A study was made to determine the relationship between the 1943-69 period and longer periods of record. A frequency plot for the period 1911-69 was made for the South Fork Tule River near Success. The 25- and 50-year floods for the long-term period appeared to be about 70 percent of the flood estimates developed from the 1943-69 data. Similar but smaller differences were noted on other drainage areas for which long-term records were available. Therefore, the ratios of the 25- and 50-year floods to the index flood were adjusted to 85 percent of the plotted values in order to make allowance for length of record in the study period.

Peak Flow and Flood Volume Relationships

The charts expressing the relationship for peak index flood discharges are shown in Figures 8 and 9. The nomograph in Figure 8 is used to obtain the peak index flood discharge for (a) areas greater than 10 square miles, regardless of normal annual precipitation amount and (b) for areas less than 10 square miles with normal annual precipitation amounts greater than 16 inches. The relationships in Figure 9 are used to obtain the peak index flood discharge for areas under 10 square miles with normal annual precipitation 16 inches or less.

Nomographs and curves providing estimates of 1-day, 2-day, 3-day and 5-day flood volume indexes are shown on Figures 10 and 11. Figure 10 is used to obtain the maximum 1-day index flood for (a) areas greater than 10 square miles, regardless of normal annual precipitation amounts and (b) for areas less than 10 square miles with normal annual precipitation amounts greater than 16 inches. Figure 11 is used to obtain the 2-day, 3-day and 5-day index floods.

The maximum 1-day flood volume for areas under 10 square miles with normal annual precipitation of 16 inches for less is obtained by multiplying the peak flows derived from Figure 9 by the following percentages:

Drainage Area Normal Annual Precipitation	Percentage of Peak Flow for 1:25 year	1:50 year
12" - 16"	18%	19%
10" - 12"	16%	17%
Less than 10"	13%	14%

Procedures for the application of the peak flow and flood volume relationships and examples are presented below.

Procedure to Estimate Peak Flows for:

(a) Drainage areas greater than 10 square miles, regardless of normal annual precipitation amount.

(b) Drainage areas less than 10 square miles with normal annual precipitation amounts greater than 16 inches.

1. Determine drainage area parameters:
   a. Drainage area in square miles.
   b. Orientation of the principal axis of drainage basin from headwaters to outlet (for basin orientation factor see Figure 8).
   c. Elevation index, computed as the mean elevation of two points, one at 10% and the other at 85% of the channel length measured from the outflow point of the basin.
   d. Normal annual precipitation from isohyetal map (Plates II and III).

2. Using the parameters developed in 1, determine the peak index flood factor from the nomograph in Figure 8.

3. Multiply this peak index flood factor by the factor selected from the basin orientation diagram on Figure 8 to obtain the peak index flood discharge value.

4. Multiply the peak index flood discharge value by the following values to estimate the magnitude of the 25-, 50- or 100-year occurrences:

Index Flood	25-year	50-year	100-year
Peak Flow	4.2	6.0	8.0

EXAMPLE

Determine peak flows at Sand Creek near Orange Cove for return periods of 25, 50 and 100 years.

1. Drainage area parameters:
   a. Drainage area = 31.6 sq. mi. (Table 1).
   b. Basin orientation factor = 1.2 (Figure 8).
   c. Elevation index = 1,050 feet
   d. Normal annual precipitation = 18.2 inches (Plates II and III - Table 1).

2. Peak index flood factor = 530 cfs. (Figure 8).

3. Peak index flood discharge:
   530 cfs x 1.2 = 636 cfs.

4. Sand Creek near Orange Cove peak flows:
   1:25 yr. peak flow = 636 cfs x 4.2 = 2,671 cfs.
   1:50 yr. peak flow = 636 cfs x 6.0 = 3,816 cfs.
   1:100 yr. peak flow = 636 cfs x 8.0 = 5,088 cfs.

Procedure to Estimate Peak Flows For Drainage Areas Less than 10 Square Miles with Normal Annual Precipitation 16 Inches or Less

1. Determine drainage area parameters:
   a. Drainage area in square miles.
   b. Normal annual precipitation, from isohyetal map (Plates II and III.

2. Using the parameters developed in 1, determine the peak index flood discharge from Figure 9.

3. Multiply the peak index flood discharge value by the following values to estimate the magnitude of the 25-and 50-year peak flood occurrence:

Index Flood	25-year	50-year
Peak Flow	4.2	6.0

EXAMPLE

Determine peak flows for Granite Hill Drainage at Friant-Kern Canal (Area 4) for return periods of 25 and 50 years.

1. Drainage area parameters:
    a. Drainage area = 3.6 sq. mi. (Table 1)
    b. Normal annual precipitation = 13.8 inches (Plates II and III - Table 1).

2. Peak index flood discharge = 90 cfs. (Figure 9)

3. Granite Hill Drainage at Friant-Kern Canal peak flows:
    1:25 yr. peak flow = 90 cfs x 4.2 = 378 cfs.
    1:50 yr. peak flow = 90 cfs x 6.0 = 540 cfs.

Procedure to Estimate 1-, 2-, 3-, and 5-Day Flood Volumes for:

(a) Drainage areas greater than 10 square miles, regardless of normal annual precipitation amounts, and

(b) Drainage areas less than 10 square miles with normal annual precipitation amounts greater 16 inches.

1. Determine drainage area parameters:
   a. Drainage area in square miles.
   b. Normal annual precipitation, from isohyetal map (Plates II and III).
2. Using the parameters developed in 1, determine the maximum 1-day index flood from the nomograph in Figure 10.
3. Using the maximum 1-day index flood value from 2, determine the 2-day index flood value, 3-day index flood value, and 5-day index flood value from Figure 11.
4. Multiply the 1-day and multiple-day index flood values by the following figures to estimate the magnitude of the 25-year and 50-year occurrence.

Index Flood	25-year	50-year
1-day	3.5	5.2
2-day	3.4	4.8
3-day	3.3	4.6
5-day	3.3	4.6

5. The 1-day and multiple-day flood values are total volumes expressed in second-foot days. To obtain the volumes in acre feet, multiply the second-foot day values by 1.98.

EXAMPLE

Determine 1-day, 2-day, 3-day and 5-day flood volumes for Sand Creek near Orange Cove for 25- and 50-year return periods.

1. Drainage area parameters:

   a. Drainage area = 31.6 sq. mi. (Table 1)
   b. Normal annual precipitation = 18.2 inches (Plates II and III - Table 1)

2. Maximum 1-day index flood = 205 second-foot days (sfd)(Figure 10).

3. Multiple-day index flood values (Figure 11)

   2-day index flood = 270 sfd
   3-day index flood = 330 sfd
   5-day index flood = 400 sfd

4. Sand Creek near Orange Cove flood volumes (second-foot days):

   1:25 Year Flood Volume

   1-day flood volume (205 sfd) (3.5) = 718 sfd
   2-day flood volume (270 sfd) (3.4) = 918 sfd
   3-day flood volume (330 sfd) (3.3) = 1089 sfd
   5-day flood volume (400 sfd) (3.3) = 1320 sfd

   1:50 Year Flood Volume

   1-day flood volume (205 sfd) (5.2) = 1066 sfd
   2-day flood volume (270 sfd) (4.8) = 1296 sfd
   3-day flood volume (330 sfd) (4.6) = 1518 sfd
   5-day flood volume (400 sfd) (4.6) = 1840 sfd

5. Sand Creek near Orange Cove flood volumes (acre feet):

Flood Volume

	1:25 year	1:50 year
1-day	1,420 af	2,110 af
2-day	1,820 af	2,560 af
3-day	2,160 af	3,000 af
5-day	2,620 af	3,640 af

Procedure to Estimate Flood Volumes for Areas Less than 10 Square Miles with Normal Annual Precipitation 16 Inches or Less

1. Determine peak flow for the required return periods by following procedure on page 28.
2. Multiply the peak flows by the following percentages to obtain the maximum 1-day flood volume:

Drainage Area Normal Annual Precipitation	Percentage of Peak Flow For 1:25 year	1:50 year
12"-16"	18%	19%
10"-12"	16%	17%
Less than 10"	13%	14%

3. Maximum 1-day flood volumes from 2 are expressed in second-foot days. To obtain the volumes in acre feet, multiply the second-foot day values by 1.98.

EXAMPLE

Determine the 1-day flood volumes for Granite Hill Drainage at Friant-Kern Canal for 25- and 50-year return periods.

1. Peak flows (page 29)

   1:25 year = 378 cfs

   1:50 year = 540 cfs

2. Granite Hill Drainage at Friant-Kern Canal maximum 1-day flood volumes (second foot days)
   (Normal annual precipitation = 13.8")

   1:25 year = (378 cfs)(0.18) = 68 sfd

   1:50 year = (540 cfs)(0.19) =102 sfd

3. Granite Hill Drainage at Friant-Kern Canal maximum 1-day flood volumes (acre feet).

   1:25 year = (68 sfd)(1.98) = 135 af

   1:50 year = (102 sfd)(1.98)= 202 af

Precipitation Intensity - Duration - Frequency Relationship

Relationships for estimating precipitation intensities (Figures 12 and 13) for return periods of 2 to 100 years and duration of ten minutes to six hours in areas of Tulare County below elevation 2,000 feet were developed from hydrologic analysis of available data and studies of the U. S. Weather Bureau and the California Department of Water Resources.

Precipitation amounts derived from the intensity-duration-frequency relationship represent maximum hour amounts (as distinguished from clock-hour amounts) and a partial duration series (as distinguished from an annual series). The maximum hour is the maximum 60-minute period, rather than the single maximum clock hour of the 24-hour day. A partial duration series represents all events during the period of record; an annual series represents only the maximum event of each year. Although the relationships were developed from clock-hour and annual series data, they were adjusted to maximum hour and partial duration series through procedures described in U. S. Weather Bureau Technical Bulletins 24, 25 and 28.

Although the intensity - duration - frequency relationship presented here can be applied to larger drainage areas, its primary function is in the determination of flood runoff from drainage areas less than one square mile in size.

Procedure to Estimate Precipitation Intensities at Any Location for Return Period of 2 to 100 Years and Durations of 10 Minutes to 6 Hours

1. Determine normal annual precipitation at the site from isohyetal map (Plates II or III).

2. Using Figure 12 and the normal annual precipitation from 1, determine the one-hour precipitation intensity for the desired return period.

3. Using Figure 13, determine the intensity factor for the desired duration using the normal annual precipitation amount from 1.

4. Multiply the one-hour precipitation intensity value by the intensity factor from 3. The product is the precipitation rate in inches per hour for the desired frequency and duration.

5. To obtain total precipitation in inches, multiply the precipitation rate (from 4) by the duration in hours.

EXAMPLE

Determine for a location adjacent to McKays Point control structure the total rainfall that would be expected to occur for a duration of 30 minutes (1/2 hour) on the average of once in 25 years.

1. Normal annual precipitation = 13.1 inches (Plates II or III).

2. One-hour precipitation intensity for return period of once in 25 years = 0.96 inches per hour (Figure 12).

3. Intensity factor for 30 minutes (1/2 hour) = 1.55 (Figure 13)

4. Precipitation rate that is expected to occur for 30 minutes on the average of once in 25 years = 0.96" x 1.55 = 1.49 inches per hour.

5. Total precipitation expected to occur in 30 minutes on the average of once in 25 years = 1.49 in./hr. x 1/2 hr. = 0.75 inches.

STREAM GAGING STATION HISTORIES

The following are station histories for foothill gaging stations in Tulare County shown on Plate I. The stream gaging station numbers are those listed in Table 7.

Sand Creek nr. Orange Cove (Stream Gaging Station No. 4)

Location: NW¼ Section 15, T15S, R25E, MDB&M, on right bank 3.8 miles east of Orange Cove.

Drainage area: 31.6 square miles

Record: Station was installed by USBR in 1943. USGS operated station and published record 1944-1954. USBR operated 1954-1967; unpublished records available in USBR files. From 1968 to 1971 recorder operated by Kaweah Delta Water Conservation District (KDWCD); however, no analysis made of record. USGS reactivated station in February 1971 under a cooperative agreement with Tulare County.

Cottonwood Creek above Highway 65 (69)(Stream Gaging Station No. 5)

Location: NE¼ Section 14, T16S, R26E, MDB&M, on right bank about one mile upstream from bridge on Highway 69 (formerly 65) over Cottonwood Creek.

Drainage area: 52.2 square miles.

Record: Station installed in 1956 by USBR. Unpublished 1956-1967 records available in USBR files. From 1968-1971 recorder operated by KDWCD; however, no analysis made of record. USGS relocated station to Highway 69 bridge over Cottonwood Creek in February 1971 under a cooperative program with Tulare County.

Dry Creek nr. Lemoncove (Stream Gaging Station No. 6a)

Location: SE¼ Section 15, T17S, R27E, MDB&M, on right bank 0.5 mile downstream from Bequette Canyon and 4.4 miles north of Lemoncove.

Drainage area: 75.6 square miles.

Record: Station installed at present location in 1969. Gage previously installed in 1959 in NW¼ Section 26, T17S, R27E (Station No. 6); drainage area 80.4 square miles. USGS operates station and publishes record.

Dry (Limekiln) Creek nr. Mouth (Stream Gaging Station No. 7)

Location: SW¼ Section 26, T17S, R27E, MDB&M, on right bank approximately 4,500 feet upstream from confluence with Kaweah River.

Drainage area: 82 square miles.

Record: Station installed in 1943 by USBR. Unpublished records are available in USBR files for 1943-1954.

Yokohl Creek East of Exeter (Stream Gaging Station No. 8)

Location: NW¼ Section 23, T19S, R27E, MDB&M, on left bank approximately 8 miles east of Exeter at a point 200 feet upstream from County bridge.

Drainage area: 75 square miles.

Record: Station installed in 1962 by USBR. Unpublished records available in USBR files. Station destroyed by flood runoff on December 6, 1966.

Deer Creek nr. Fountain Springs (Kilbreth) (Stream Gaging Station No. 24)

Location: NE¼ Section 10, T23S, R29E, MDB&M, on left bank 1.0 mile upstream from Pothole Creek, 6.3 miles northeast of Fountain Springs.

Drainage area: 83.3 square miles.1/

Record: Station installed in 1919 for Terra Bella Irrigation District. Operated and record maintained for water supply purposes by Althouse-Strauss Engineering Services (and predecessors) until 1966. Peak flow data not available during period 1919-1966; however, maximum 1943 peak estimated by Althouse. USGS reactivated station in 1968.

Deer Creek at Hungry Hollow (Stream Gaging Station No. 25)

Location: NW¼ Section 22, T22S, R28E, MDB&M, on left bank 5 miles east and 2 miles north of Terra Bella.

Drainage area: 124 square miles

Record: Station installed in 1962 by USBR. Unpublished records 1962-1967 available in USBR files.

White River nr. Ducor (Stream Gaging Station No. 26)

Location: NE¼ Section 27, T24S, R28E, MDB&M, on right bank 500 feet downstream from bridge at Gilliam Ranch, 3 miles downstream from Coho Creek and 8 miles southeast of Ducor.

Drainage area: 92.9 square miles.

Record: Station established by USGS in 1942. USGS operated station and published record 1942-1953. Station operated during 1954 by USBR; unpublished record available in USBR files. Operated by Delano-Earlimart Irrigation District 1954-1958; recorder charts available in District's files; however, no analysis made of record by District. Operated by USBR 1959-1967; unpublished records available in USBR files. USGS reactivated station in February 1971 under a cooperative agreement with Tulare County. New station located approximately 300 feet upstream from old station.

1/ 67.0 square miles published by USGS in 1967-68 -- corrected in 1968-69 WSP.

ABBREVIATIONS USED IN APPENDIX

DEID	Delano Earlimart Irrigation District
DWR	California Department of Water Resources
JGB	J. G. Boswell Co.
KDWCD	Kaweah Delta Water Conservation District
KRWA	Kings River Water Association
PC	Private Cooperators
SCE	Southern California Edison Company
SDF	State Division of Forestry
UCF	University of California Forestry, Berkeley
USBR	U. S. Bureau of Reclamation
USCE	U. S. Corps of Engineers
USFS	U. S. Forest Service
USGS	U. S. Geological Survey
USWB	U. S. Weather Bureau

TABLE NO. 1

DRAINAGE AREAS and NORMAL ANNUAL PRECIPITATION AMOUNTS

No. Shown on Plate No. I	Drainage Area Designation	Drainage Area (Sq.Mi.)	Normal Annual Precipitation (Inches)
1	Mill Creek nr. Piedra	127	24.7
2	Wahtoke Creek at Friant-Kern Canal (FK)	21.5	15.4
3	Citrus Cove Drainage at FK	8.3	14.3
4	Granite Hill Drainage at FK	3.6	13.8
5	Surprise Creek at FK	2.3	13.8
6	Hills Valley Creek at FK	10.7	15.6
7	Wooten Creek at FK	11.3	15.2
8	Orange Cove Drainage at FK	3.7	13.7
9	Sand Creek at FK	38.8	17.4
10	Sand Creek nr. Orange Cove	31.6	18.2
11	Curtis Mtn. Drainage at FK	1.0	13.2
12	Negro Creek at FK	5.3	14.1
13	Avenue 424 Drainage at FK	0.7	13.3
14	Long Creek at FK	11.2	15.4
15	Avenue 416 Drainage at FK	8.4	13.5
16	Stokes Mountain-West Drainage at FK	1.3	12.4
17	Stokes Mountain-South Drainage into FK	1.8	12.6
18	Stone Corral Canyon Drainage at FK	2.7	13.4
19	Road 180 Drainage at FK	1.0	13.4
20	Avenue 384 Drainage at FK	2.3	13.2
21	Colvin Mountain Drainage into FK	2.4	12.4
22	Cottonwood Creek at FK	88.1	18.4
23	Cottonwood Creek at Elderwood	83.4	18.8
24	Cottonwood Creek above Highway 65 (69)	52.2	20.9
25	Antelope Creek at Woodlake	20.7	14.3
26	Antelope Mountain-Woodlake Drainage at Bravo Lake	3.0	13.2
27	Dry Creek nr. Lemoncove	80.4 1/	23.4
28	Kaweah River at Terminus Dam	561	36.7
29	Mehrten Creek at Foothill Ditch	19.0	13.8
30	Yokohl Creek at Hamilton Ranch	70.6	17.5

1/ Station moved upstream 1969, drainage area 75.6 sq. mi.

TABLE NO. 1 (Continued)

DRAINAGE AREAS
and
NORMAL ANNUAL PRECIPITATION AMOUNTS

No. Shown on Plate No. I	Drainage Area Designation	Drainage Area (Sq.Mi.)	Normal Annual Precipitation (Inches)
31	Lewis Creek nr. Strathmore	18.3	15.9
32	Lewis Creek at Road 236	32.1	14.7
33	Frazier Creek 1/2 mile East of Road 256	18.1	12.9
34	Lewis Hill Drainage at Porterville	3.6	10.8
35	Rocky Hill Drainage at Porter Slough	7.9	11.6
36	Tule River at Success Dam	391	28.4
37	Deer Creek at Hungry Hollow	124	22.2
38	Deer Creek nr. Fountain Springs (Kilbreth)	83.3	25.7
39	Fountain Springs North Drainage at Deer Creek	19.3	11.1
40	Fountain Springs Gulch at Deer Creek	35.0	11.8
41	Terra Bella-Ducor Drainage at FK	16.9	9.4
42	Ducor East Drainage at SPRR	13.9	9.9
43	White River nr. Vestal	120	15.1
44	White River nr. Ducor	92.9	16.5
45	Orris East Drainage at SPRR	1.8	8.9
46	Vestal East Drainage at SPRR	7.8	8.8
47	Vestal Southeast Drainage at SPRR	2.6	8.3
48	Richgrove East Drainage at SPRR	28.4	9.0
49	Rag Gulch at SPRR	138	11.4
50	Rag Gulch nr. Villard Ranch	71.2	12.4

TABLE NO. 2

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
			TULARE COUNTY				
1	Angiola	C0204	USWB	1899-	205	7.17	7.36
2	Ash Mountain	C0343	USWB	1925-	1708	25.2	25.4
3	Atwell	C0374	USWB	1948-	6400	38.0	
4	Badger	C0422	USWB	1940-	3030	25.5	
5	Beartrap Meadow	C0596	USWB	1959-	6800	47.7	
6	California Hot Springs R.S.	C1300	USWB	1907-1965	2950	23.5	
7	Camp Nelson	C1425	PC	1959-	4825	25.9	
8	Camp Wishon	C1470	USWB	1940-1961	3800	33.6	
9	Chagoopa	C1647	USCE	1964-	10390	-	
10	Crabtree Meadow	C2114	USWB	1948-	720	21.7	
11	Deer Creek Ranch	C2335	PC	1968-1969	950	-	
12	Dinuba	C2440	USWB	1893-1945	330	11.1	
13	Dinuba Alta I.D.	C2440	PC	1944-	334	10.7	
14	Doublebunk Meadow	C2492	USWB	1955-	6200	35.8	
15	Eagle Creek	C2591	USCE	1964-	6650	36.0	
16	East Vidette Meadow	C2653	USWB	1955-1964	400	20.8	
17	Exeter	C2921	USWB	1897-1929	391	-	
18	Exeter Fauver Ranch	C2922	USWB	1938-	439	11.2	
19	Fountain Springs F.S.	C3207	SDF	1965-	800	-	
20	Giant Forest	C3397	USWB	1921-	6412	42.4	

TABLE NO. 2 (Continued)

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
21	Goshen SPRR	C3514	USWB	1897-1918	286	-	
22	Grant Grove	C3551	USWB	1924-	6580	41.9	42.3
23	Hills Orchard	C3979	PC	1924-1948	700	-	
24	Hockett Meadows	C4012	USWB	1959-	8500	-	
25	Hossack	C4120	USWB	1959-	7100	40.1	
26	Ivanhoe I.D.	C4312	PC	1954-	370	-	
27	Johnsondale	C4389	USWB	1954-	4680	23.5	
28	Kaweah PH 3	C4452	SCE	1913-	1370	24.9	
29	Kern River Intake #3	C4518	USWB	1952-1966	3650	18.2	
30	Kern River Intake #3 SCE	C4519	SCE	1921-	3642	17.3	
31	Lemoncove	C4890	USWB	1899-	513	13.68	13.72
32	Lindsay	C4957	USWB	1913-	395	10.9	11.0
33	Lindsay Gov't. Camp	C4957	USBR	1952-1954	-	-	
34	Lodgepole	C5026	USWB	1968-	6735	-	
35	Lodgepole R.S.	C5028	USWB	1951-1956	6695	38.8	
36	Milo	C5668	USWB	1898-1922	1600	-	
37	Milo 5 NE	C5669	USWB	1957-	3400	28.7	
38	Mineral King	C5680	USWB	1956-1969	7975	32.6	
39	Monache Meadows	C5770	USWB	1940-	8000	14.5	
40	Moraine Creek	C5832	USBR	1964-	8840	24.3	
41	Mountain Home	C5883	USWB	1897-1911	6680	-	
42	Mountain Home 2	C5887	USCE	1962-	5360	-	
43	Old Porter Ranch	C6413	USWB	1947-1955	6470	8.3	
44	Pear Lake	C6767	USWB	1956-1969	9700	40.0	
45	Porterville R.S.	C7076	SDF	1945-1952	455	-	

TABLE NO. 2 (Continued)

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
46	Porterville	C7077	USWB	1893-	393	10.39	10.52
47	Porterville F.S.	C7078	SDF	1945-1952	455	-	
48	Porterville 3W	C7079	PC	1958-	413	8.3	
49	Portuguese Meadow	C7093	USWB	1953-	7000	44.2	
50	Portuguese Pass	C7094	USWB	1948-1953	7300	29.4	
51	Posey 4 ENE	C7095	USWB	1960-1962	5490	-	
52	Posey 3E	C7096	USWB	1954-	4920	29.0	
53	Quaking Aspen	C7179	USWB	1955-	7200	38.4	
54	Quinn R.S.	C7205	USWB	1948-1959	8300	35.0	
55	Rector	C7288	SCE	1888-	344	9.88	
56	Rogers Camp	C7529	USCE	1964-	6240	-	
57	Round Meadow	C7579	USWB	1947-	9000	36.5	
58	Sierra Vista Ranch	C8220	PC	1926-1948	404	-	
59	Springville	C8451	PC	1924-1944	4050	16.5	
60	Springville 3 ENE	C8453	USWB	1951-1953	1460	16.1	
61	Springville 7 ENE	C8455	USWB	1953-	2470	27.6	27.9
62	Springville R.S.	C8460	USWB	1924-	1050	18.2	
63	Springville Tule HDW	C8463	USWB	1907-	4070	35.79	
64	Stevenson Dist.Sec. 33	C8520	JGB	1951-1969	212	7.5	
65	Success Dam	C8620	USCE	1959-	590	14.0	
66	Success	C8622	USWB	1923-1928	600	-	
67	Taylor Meadow	C8790	USWB	1948-1955	7000	19.6	
68	Terminus Dam	C8868	USCE	1959-	965	-	
69	Terra Bella	C8876	PC	1924-1947	490	9.6	
70	Terra Bella 1E	C8876	PC	1919-1958	-	9.3	

TABLE NO. 2 (Continued)

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
71	Terra Bella 5E	C8876	PC	1955-1958	-	12.3	
72	Three Rivers 6SE	C8912	USWB	1940-	2200	18.6	
73	Three Rivers PH #2	C8914	USWB	1909-	950	19.71	
74	Three Rivers PH #1	C8917	USWB	1940-	1140	19.9	
75	Traver SPRR	C9011	USWB	1885-1909	291	-	
76	Traver 4 ESE	C9011	DWR	1962-1965	283	-	
77	Trout Meadows	C9038	USWB	1948-1955	6250	18.8	
78	Tulare	C9051	SCE	1919-	293	9.1	
79	Tulare Tuohy	C9051	USWB	1874-1914	285	-	
80	Tulare Near	C9051	USWB	1893-1909	274	-	
81	Tulare SP Co	C9051	USWB	1906-1918	285	-	
82	Tulare Evap	C9051	USBR	1903-1905	287	-	
83	Tule River Intake	C9059	SCE	1910-	2450	26.0	
84	Tule River PH	C9060	SCE	1910-	1240	19.86	
85	Tunnel R.S.	C9061	USWB	1945-	8950	18.4	
86	Uhl R.S.	C9120	USWB	1965-	3680	-	
87	Vandalia I.D.	C9257	PC	1925-1959	-	11.2	
88	Vestal	C9304	SCE	1920-	500	8.1	
89	Visalia	C9367	USWB	1903-	354	9.40	9.46
90	Visalia 4E	C9369	PC	1959-	357	-	
91	Wet Meadow	C9602	USWB	1959-	8950	36.6	
92	Whitaker Forest	C9629	UCF	1966-	5360	-	
93	Windy Springs	C9731	PC	1929-1934	6500	10.4	

TABLE NO. 2 (Continued)

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
	FRESNO COUNTY						
94	Balch Powerhouse	C0449	USWB	1921-	1720	29.8	30.1
95	Benner Ranch	C0676	PC	1967-	3525	-	
96	Dunlap	C2557	USWB	1937-1955	1940	21.6	
97	Dunlap near	C2558	USWB	1911-1917	2800	26.0	
98	Five Points 5 SSW	C3083	USWB	1942-	276	6.4	6.5
99	Fresno WB AP	C3257	USWB	1899-	331	10.9	10.9
100	Kingsburg	C4564	USWB	1879-1918	301	-	
101	Miramonte Honor Camp	C5708	USWB	1958-	3005	23.4	
102	Orange Cove	C6476	USWB	1931-	431	12.9	12.9
103	Pine Flat Dam	C6896	USCE	1949-	615	18.7	18.7
104	Pinehurst	C6902	USFS	1954-	4050	31.9	
105	Reedley MVFD	C7354	PC	1962-	345	-	
106	Reedley SJVRR	C7355	USWB	1899-1923	347	11.5	
107	Sanger SPRR	C7800	USWB	1889-1918	371	10.6	
108	Sanger 1 NE	C7800	PC	1959-	375	-	
109	Sanger R.S.	C7800	SDF	1958-	375	-	
110	Schafer Ranch	C8036	PC	1959-1961	365	10.1	
111	Selma	C8086	USWB	1886-1918	311	9.2	
112	Westhaven	C9560	USWB	1925-	285	6.6	6.6

TABLE NO. 2 (Continued)

PRECIPITATION STATIONS

No. Shown on Plate No. II	Station Name	DWR Station No.	Source of Record	Period of Record	Elevation (Feet)	Normal Annual Precipitation 1911-60 (Inches)	Normal Annual Precipitation 1911-70 (Inches)
	KINGS COUNTY						
113	Corcoran	C2009	USWB	1940-1956	200	6.8	
114	Corcoran I.D.	C2012	USWB	1912-	200	6.8	6.8
115	Hanford	C3747	USWB	1899-	242	8.01	8.04
116	Hanford Refinery	C3749	PC	1964-	245	-	
117	Homeland Dist. Sec. 9	C4061	JGB	1952-	190	7.6	
118	Homeland Dist. Sec. 17	C4061	JGB	1952-1964	206	7.1	
119	Homeland Dist. Sec. 34	C4061	JGB	1951-1969	196	6.6	
120	Kingsburg 5S No. 1	C4564	DWR	1957-1958	276	-	
121	Kingsburg 5S No. 2	C4564	DWR	1958-1962	277	8.6	
122	Kingsburg near	C4564	USWB	1928-1932	309	8.6	
123	South Lake Farms Hdqtrs.	C8407	PC	1959	190	7.2	
	KERN COUNTY						
124	Delano	C2346	USWB	1876-	323	7.8	7.7
125	Glennville	C3463	USWB	1951-	3140	17.2	17.3
126	Kern River PH No. 3	C4523	USWB	1946-	2703	12.4	12.7
127	Wasco	C9452	USWB	1899-	333	6.32	6.43
128	Wofford Heights	C9754	USWB	1894-	2700	10.7	10.9

TABLE NO. 3

SNOW COURSES AND AERIAL MARKERS

No. Shown on Plate No.II	Station Name	Calif. No.	Period of Record	Elevation (Feet)	Average April 1 Water Content (Inches)
	KINGS RIVER DRAINAGE				
1	Charlotte Ridge	299[1]	1955-	10,700	35.1
2	Bullfrog Lake	307	1932-	10,650	33.5
3	State Lakes[2]	545[1]	1956-	10,300	
4	Copper Creek Summit	001	1931-1936	10,200	
5	Granite Basin	546	1953-	10,000	
6	Mitchell Meadow[2]	511[1]	1956-	9,900	
7	Scenic Meadow	512	1953-	9,650	
8	Vidette Meadow	309	1956-	9,500	21.8
9	Rowell Meadow	226[1]	1930-	8,850	27.5
10	Moraine Meadows	002	1929-1942	8,400	
11	Junction Meadow	231	1930-1963	8,250	17.8
12	Kennedy Meadow	003	1929-1942	7,600	
13	Big Meadows	236	1930-	7,600	25.9
14	Horse Corral Meadow	237[1]	1930-	7,600	17.6
15	Grant Grove	240	1930-	6,600	14.6

1/ Aerial snow depth marker located on or near course.

2/ Radio reporting gage.

TABLE NO. 3 (Continued)

SNOW COURSES AND AERIAL MARKERS

No. Shown on Plate No.II	Station Name	Calif. No.	Period of Record	Elevation (Feet)	Average April 1 Water Content (Inches)
	KAWEAH RIVER DRAINAGE				
16	White Chief	374	1970-	9,200	
17	Farewell Gap	292	1952-	9,000	35.9
18	Panther Meadow	243	1925-	8,600	36.8
19	Hockett Meadows	244	1930-	8,500	29.0
20	Mineral King	245	1948-	8,000	21.3
21	Giant Forest	568 1/	1970-	6,650	
22	Giant Forest 2/	246	1930-	6,400	16.6
	TULE RIVER DRAINAGE				
23	Quaking Aspen	247	1937-	7,000	13.3
24	Old Enterprise Mill	248	1937-	6,600	16.4
	DEER CREEK DRAINAGE				
25	Dead Horse Meadow	249	1937-	7,300	12.6
	KERN RIVER DRAINAGE				
26	Upper Tyndall Creek 2/	516 1/	1957-	11,450	
27	Bighorn Plateau	250 1/	1949-	11,350	23.4
28	Cottonwood Pass	251 1/	1948-	11,050	14.1
29	Siberian Pass	252 1/	1948-	10,900	18.9
30	Crabtree Meadow	253 1/	1949-	10,700	19.8

TABLE NO. 3 (Continued)

SNOW COURSES AND AERIAL MARKERS

No. Shown on Plate No.	Station Name	Calif. No.	Period of Record	Elevation (Feet)	Average April 1 Water Content (Inches)
	KERN RIVER (Continued)				
31	Guyot Flat	254[1/]	1949-	10,650	21.0
32	Sandy Meadows	275[1/]	1949-	10,650	19.0
33	Tyndall Creek	255[1/]	1949-	10,650	18.9
34	Shotgun Pass	517	1959-	10,400	
35	Chagoopa Plateau	514	1953-	10,300	
36	Big Whitney Meadow	257[1/]	1948-	9,750	17.6
37	Rock Creek	256[1/]	1949-	9,600	17.7
38	Round Meadow[2/]	258[1/]	1930-	9,000	25.6
39	Wet Meadow[2/]	518[1/]	1957-	8,950	
40	Ramshaw Meadows	259[1/]	1930-	8,700	11.5
41	Little Whitney Meadow	260[1/]	1930-	8,500	14.0
42	Casa Vieja Meadows	262[1/]	1930-	8,400	19.7
43	Quinn Ranger Station	264[1/]	1930-	8,350	20.4
44	Bonita Meadows	261[1/]	1930-	8,300	14.3
45	Monache Meadows	263[1/]	1931-	8,000	7.9
46	Beach Meadows	265[1/]	1930-	7,650	9.5
47	Cannel Meadows	004	1929-1944	7,500	
	OWENS RIVER DRAINAGE				
48	Kearsarge Pass	539	1954-	11,300	
49	Cottonwood Lakes	541	1954-	11,200	
50	Cottonwood Lakes 2	220	1926-	11,100	12.5

TABLE NO. 4

DAILY PRECIPITATION AMOUNTS
(Inches)

December 1966 Storm

No. Shown on Plate No.II	Station Name	Elevation (Feet)	Observation Time	Date 2	3	4	5	6	7	Storm Total
114	Corcoran I. D.	200	8 AM	.01	.70		.24	1.20	.80	2.95
89	Visalia	354	8 AM							1/
46	Porterville	393	8 AM	.03	.73		.50	2.34	1.95	5.55
32	Lindsay	395	7 PM	.13	.68	.13	1.00	3.57		5.51
102	Orange Cove	431	10 AM	.18	.99		1.25	2.62	.33	5.37
18	Exeter Fauver Ranch	439	Mid	.72		.24	2.09	1.90		4.95
31	Lemoncove	513	5 PM	.24	.51	.06	2.20	3.14		6.15
73	Three Rivers PH #2	950	2 PM	.34	1.41		2.03	7.90	.17	11.85
62	Springville R.S.	1050	Mid	1.66	.02	.21	5.04	3.85		10.78
74	Three Rivers PH #1	1140	Mid	1.65	.17	.59	5.69	4.06		12.16
72	Three Rivers 6SE	2200	Mid	1.46	.01	.35	5.84	5.05		12.71
4	Badger	3030	Mid	2.63	.18	.62	5.27	3.78	.05	12.53
63	Springville Tule HDW	4070	Mid	3.11	.38	1.38	1/	1/	1/	1/
52	Posey 3E	4920	7 AM	.21	1.60	3.22	6.89	3.53		15.45

1/ Missing record.

TABLE NO. 5

DAILY PRECIPITATION AMOUNTS
(Inches)
January 1969 Storm

No. Shown on Plate No.II	Station Name	Elevation (Feet)	Observation Time	Date 18	19	20	21	22	23	24	25	26	27	28	29	Storm Total
114	Corcoran I.D.	200	8 AM		.36	1.93	.63	.05		.26	1.02	.22	.08			4.55
89	Visalia	354	8 AM		.84	2.16	.72	.69		.10	1.42	.12	.02		.20	6.27
46	Porterville	393	8 AM		.97	1.82	1.02	.18	T	.18	1.55	.27	.16	.02	.64	6.81
32	Lindsay	395	7 PM	.40	2.47	.24	.94	.07	.05	.37	1.20	.26	.18	.20	.21	6.59
102	Orange Cove	431	10 AM		1.65	1.73	1.16	.91	.01	.28	1.75	.38	.04	.14	.16	8.21
18	Exeter Fauver Ranch	439	Mid	.99	2.40	.34	1.36		.03	.65	1.66	.35		.33		8.11
31	Lemoncove	513	5 PM	.54	2.90	.40	1.15	.65		.40	1.74	.47	.05	.28	.06	8.64
73	Three Rivers PH #2	950	2 PM	.05	4.93	1.42	1.49	1.05		.56	3.23	1.19	.04	.51	.25	14.72
62	Springville R.S.	1050	Mid	1.42	2.22	.34	1.08	.02	.07	.98	1.37	.53	.03	.70		8.76
74	Three Rivers PH #1	1140	Mid	2.73	3.44	.46	1.65	.38	.10	1.75	2.15	1.04	.07	.68		14.45
72	Three Rivers 6SE	2200	Mid	1.53	2.92	.39	2.16	.26	1/	1/	3.55	1.21	.06	.49	.03	12.60
4	Badger	3030	Mid	3.10	5.47	1.01	3.44	.76	.10	2.26	2.73	.89	.03	.93	.03	20.75
63	Springville Tule HDW	4070	Mid	3.03	4.71	1/	1/	1/	1/	1/	5.28	.90	.35	1.31		15.58
52	Posey 3E	4920	7 AM		2.62	2.00	.83	1.02	.16	.90	3.00	1.35	.72	.20	1.20	14.00

1/ Amount included in following measurement.

TABLE NO. 6

DAILY PRECIPITATION AMOUNTS
(Inches)
February 1969 Storm

No. Shown on Plate No.II	Station Name	Elevation (Feet)	Observation Time	Date 23	24	25	26	Storm Total
114	Corcoran I.D.	200	8 AM	.30	.04	1.50	.27	2.11
89	Visalia	354	8 AM	.19	.27	2.08	.11	2.65
46	Porterville	393	8 AM	.27	.19	2.72	.11	3.29
32	Lindsay	395	7 PM	.31	1.03	1.66	.09	3.09
102	Orange Cove	431	10 AM	.29	.59	2.43	.12	3.43
18	Exeter Fauver Ranch	439	Mid	.34	2.33	.40	.07	3.14
31	Lemoncove	513	5 PM	.39	1.33	1.85	.14	3.71
73	Three Rivers PH #2	950	2 PM	.44	.88	3.30	.38	5.00
62	Springville R.S.	1050	Mid	.65	2.62	.80	.31	4.38
74	Three Rivers PH #1	1140	Mid	.51	3.49	.61	.33	4.94
72	Three Rivers 6SE	2200	Mid	.46	3.54	.65	.27	4.92
4	Badger	3030	Mid	.77	1/	4.96	.26	5.99
63	Springville Tule HDW	4070	Mid	2/	4.00	.95	.44	5.39
52	Posey 3E	4920	7 AM	.22	1.25	3.63	.47	5.57

1/ Amount included in following measurement.
2/ Missing record.

TABLE NO. 7

STREAM GAGING STATIONS

No. Shown on Plate No. I	Station Name	Station No.	Source of Record	Period of Record	Drainage Area (Sq.Mi.)
1	Kings River above North Fork nr. Trimmer	11-2135	USGS	1931	952
2	Kings River at Piedra[1]	11-2220	USGS	1895-1959	1687
3	Mill Creek near Piedra		KRWA	1938-1960	127
		11-2217	USGS	1957-	
4	Sand Creek near Orange Cove	11-2120	USGS	1944-1954	31.6
			USBR[2]	1954-1967	
			KDWCD[2]	1968-1971	
		11-2120	USGS	1971-	
5	Cottonwood Creek above Hwy 65 (69)	-	USBR[2]	1956-1967	52.2
			KDWCD[2]	1968-1971	
5a	Cottonwood Creek nr. Elderwood	11-2117.9	USGS	1971-	60.4
6	Dry Creek nr. Lemoncove	11-2113	USGS	1959-1969	80.4
6a	Dry Creek nr. Lemoncove	11-2113	USGS	1969-	75.6
7	Dry (Limekiln) Creek nr. mouth	-	USBR[2]	1943-1954	82
8	Yokohl Creek east of Exeter	-	USBR[2]	1963-1966	75
9	Middle Fork Kaweah River nr. Potwisha Camp	11-2065	USGS	1949-	102
10	Marble Fork Kaweah River nr. Potwisha Camp	11-2080	USGS	1950-	51.4
11	East Fork Kaweah River nr. Three Rivers	11-2087.3	USGS	1952-	85.8
12	North Fork Kaweah River at Kaweah	11-2095	USGS	1910-1960[3]	128
13	Kaweah River at Three Rivers	11-2099	USGS	1958-	418
14	South Fork Kaweah River at Three Rivers	11-2101	USGS	1958-	86.7
15	Kaweah River nr. Three Rivers	11-2105	USGS	1903-1961	520

1/ Prior to Oct. 1, 1924, published as "near Sanger."

2/ Unpublished - records available in agency office.

3/ Operated as Crest gage 1966-67

TABLE NO. 7 (Continued)

STREAM GAGING STATIONS

No. Shown on Plate No. I	Station Name	Station No.	Source of Record	Period of Record	Drainage Area (Sq.Mi.)
16	Kaweah River Below Terminus Dam	11-2109.5	USGS	1961-	561
17	North Fork of Middle Fork Tule River nr. Springville	11-2020	USGS	1939-	39.5
18	North Fork Tule River at Springville	11-2031	USGS	1957-1966	97.9
19	Tule River nr. Springville	11-2032	USGS	1957-	229
20	Tule River nr. Porterville	11-2035	USGS	1901-1960	261
21	Tule River below Porterville	CO3169	DWR	1957-	-
22	South Fork Tule River nr. Success	11-2045	USGS	1930-	109
23	Tule River below Success Dam[4/]	11-2049	USGS	1953-	393
24	Deer Creek nr. Fountain Springs (Kilbreth)		TBID	1919-1966	83.3
		11-2008	USGS	1968-	83.3
25	Deer Creek at Hungry Hollow	-	USBR[2/]	1962-1967	124
26	White River nr. Ducor	11-1995	USGS	1942-1953	92.9
			USBR[2/]	1954	
			DEID[2/]	1955-1958	
			USBR[2/]	1959-1967	
			DEID[2/]	1968-1969	
		11-1995	USGS	1971	
27	Kern River nr. Kernville	11-1860	USGS	1912-	846
28	Poso Creek nr. Oildale	11-1978	USGS	1959-	230
29	Cross Creek below Lakeland Canal No. 2	CO2602	DWR	1921-	-
30	Tulare Lake	CO3110	DWR	1937-	-

4/ Prior to Oct. 1960, published as "at Worth Bridge nr. Porterville."

TABLE NO. 8

PEAK DISCHARGE

No. Shown on Plate No. I	Location	Station No.	Date and Peak Discharge: Dec. 1966 Date	Dec. 1966 cfs.	Jan.-Feb. 1969 Date	Jan.-Feb. 1969 cfs.	Max. Previous Date	Max. Previous cfs.
3	Mill Creek nr. Piedra	11-2217	6	11,000	1/25	9,860	12/23/55	6,000
					2/24	9,030		
31	Wahtoke Creek nr. Centerville				2/24	1,760		
32	Travers Creek nr. Reedley				2/24	1,130		
33	Wooten Creek nr. Orange Cove				2/24	264		
4	Sand Creek nr. Orange Cove	11-2120	6	2,100	1/25	2,900	12/23/55	1,320
					2/24	3,520		
34	Cottonwood Creek at Elderwood		6	4,650	2/24	4,670		
5	Cottonwood Creek above Hwy.65 (69)		6	5,700			3/ 3/58	2,460
35	Antelope Creek at Woodlake				2/24	1,050		
6	Dry Creek nr. Lemoncove	11-2113	6	14,500	1/25	5,710	12/23/55	6,070
					2/24	5,120		
9	Middle Fork Kaweah River nr. Potwisha Camp	11-2065	6	23,300	1/25	6,580	12/23/55	46,800
					2/24	1,270		
10	Marble Fork Kaweah River at Potwisha Camp	11-2080	6	6,400	1/25	2,610	12/23/55	12,500
					2/24	200		
11	East Fork Kaweah River nr. Three Rivers	11-2087.3	6	13,000	1/25	4,700	2/ 1/63	2,850
					2/24	1,590		
12	North Fork Kaweah River at Kaweah	11-2095	6	23,900			12/23/55	21,500
13	Kaweah River at Three Rivers	11-2099	5	73,000	1/25	24,200	12/23/55	71,000
					2/24	11,900		
14	South Fork Kaweah River at Three Rivers	11-2101	6	11,600	1/25	5,960	12/23/55	10,000
					2/24	6,360		
15	Kaweah River nr. Three Rivers	11-2105					12/23/55	80,700

Rev. 12/9/71

TABLE NO. 8 (Continued)

PEAK DISCHARGE

No. Shown on Plate No. I	Location	Station No.	Dec. 1966 Date	Dec. 1966 cfs.	Jan.-Feb. 1969 Date	Jan.-Feb. 1969 cfs.	Max. Previous Date	Max. Previous cfs.
16	Kaweah River below Terminus Dam	11-2109.5	8	5,740	1/30	4,250	1/31/63	5,080
36	Yokohl Creek nr. Exeter		5	3,400				
37	Lewis Creek nr. Strathmore				2/24	1,480		
38	Lewis Creek nr. Lindsay		6	1,900				
17	North Fork of Middle Fork Tule River nr. Springville	11-2020	6	16,900	1/25	5,080	12/23/55	12,400
18	North Fork Tule River at Springville	11-2031	5	24,200			1/31/63	4,600
19	Tule River nr. Springville	11-2032	6	49,600 1/	1/25	17,300	4/ 3/58	3,400
20	Tule River nr. Porterville	11-2035					11/19/50	25,500
22	South Fork Tule River nr. Success	11-2045	6	14,300	1/25 2/24	5,280 4,720	11/19/50	7,100
23	Tule River below Success Dam	11-2049	6	9,050	1/29 2/27	2,540 3,210	12/23/55 11/19/50	27,000 2/ 32,000 2/ 3/
21	Tule River below Porterville	CO 3169	7	8,850	1/27 2/27	2,034 4/ 2,904 4/	5/19/57	5,170
24	Deer Creek nr. Fountain Springs (Kilbreth)	11-2008	6	5,330	1/25 2/24	2,510 3,340	3/ 9/43	8,000
25	Deer Creek at Hungry Hollow		6	6,050				
39	Deer Creek at Trenton Weir		6	3,500				
40	Coho Creek nr. White River		6	221	1/25 2/24	155 564		

1/ At site 1.9 miles upstream.

2/ Prior to regulation by Lake Success

3/ At previous site.

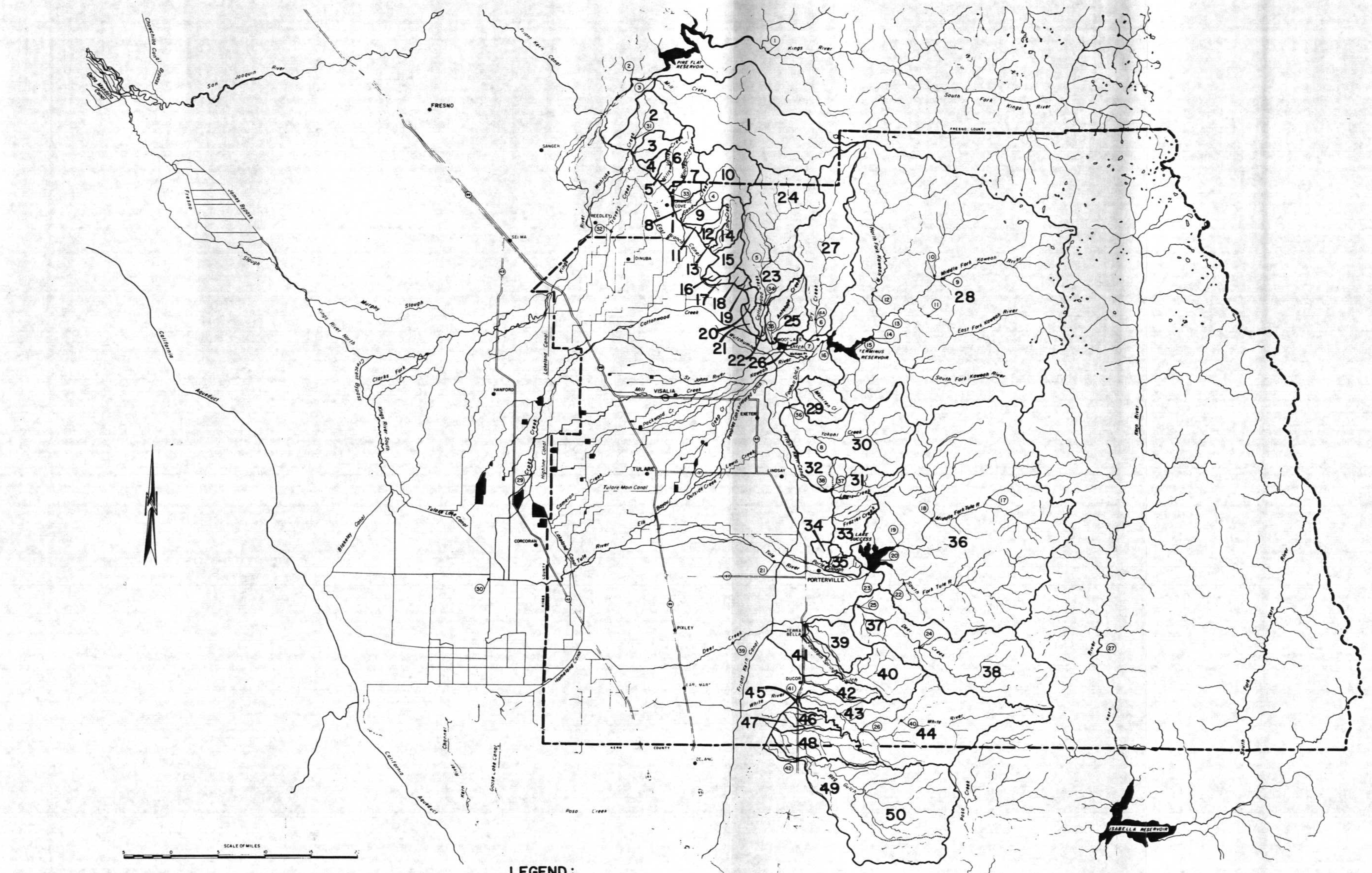
4/ Mean Daily Discharge.

TABLE NO. 8 (Continued)

PEAK DISCHARGE

No. Shown on Plate No. I	Location	Station No.	Dec. 1966 Date	Dec. 1966 cfs.	Jan. - Feb. 1969 Date	Jan. - Feb. 1969 cfs.	Max. Previous Date	Max. Previous cfs.
26	White River nr. Ducor	11-1995	6	1,204			3/ 9/43	2,300
41	White River nr. Vestal				2/24	4,560		
42	Rag Gulch nr. Richgrove				2/24	2,240		
28	Poso Creek nr. Oildale	11-1978	6	4,300	1/25	3,020	4/ 4/58	2,750
					2/25	6,700		
29	Cross Creek below Lakeland Canal No. 2	CO 2602	14	1,250 4/	1/29	2,625 4/	12/27/55	2,070 4/
					2/27	4,030 4/		

No. Shown on Plate No. I	Location	Station No.	Maximum Daily Gage Height 1966-67		1968-69		1940-41	
30	Tulare Lake	CO 3110	5/22	183.58	6/24	192.50	6/28	196.8



LEGEND:

(30) — NO. 1-30, STREAM GAGING STATIONS (TABLE NO. 7)

(42) — NO. 31-42, PEAK DISCHARGE SITES (TABLE NO. 8)

(35) DRAINAGE AREAS (TABLE NO. 1)

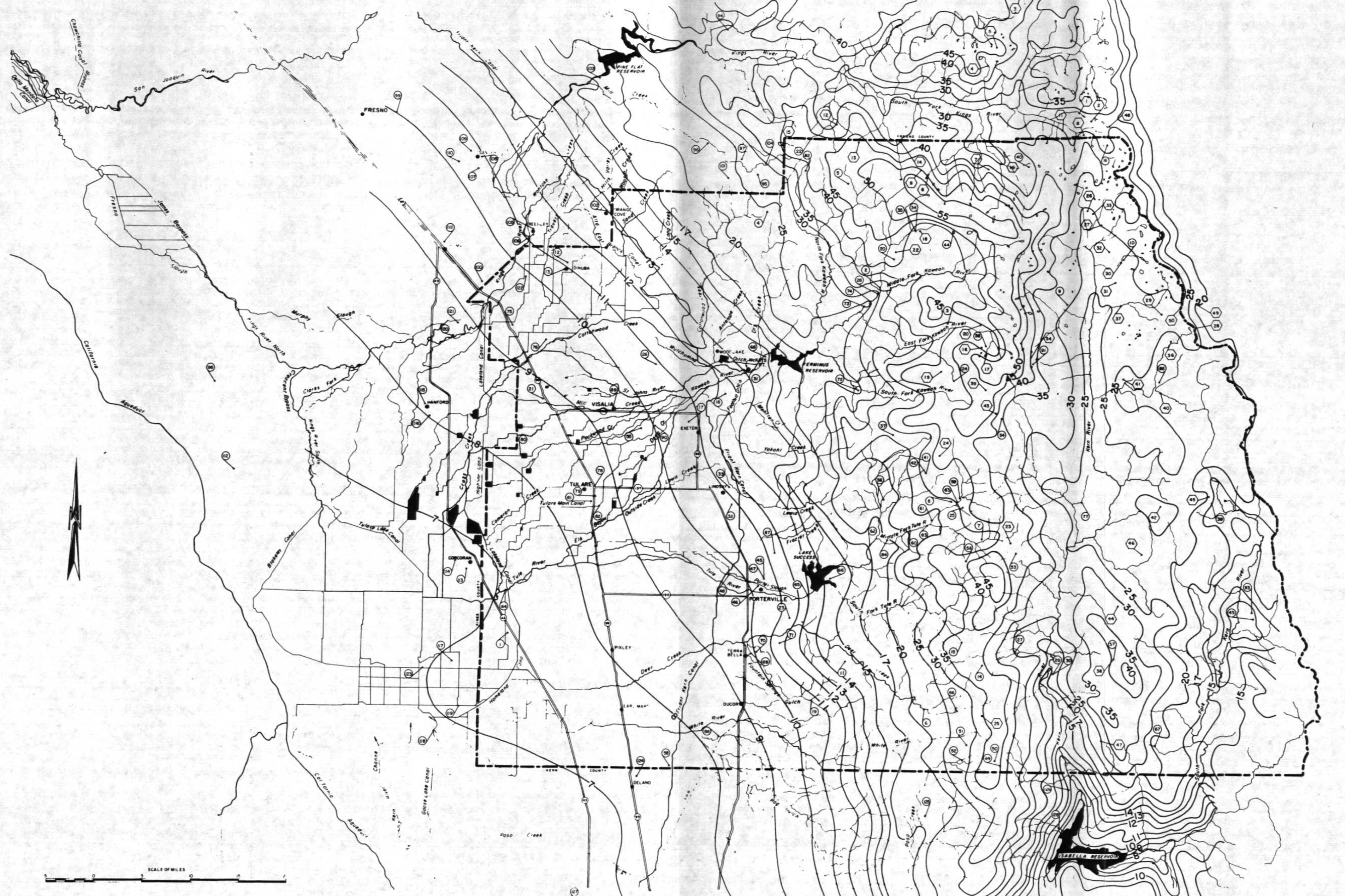
MURRAY, BURNS AND KIENLEN — CONSULTING CIVIL ENGINEERS
600 FORUM BUILDING

THE SPINK CORPORATION
720 F STREET — SACRAMENTO, CALIF.

TULARE COUNTY FLOOD CONTROL DISTRICT
FLOOD CONTROL MASTER PLAN — HYDROLOGY APPENDIX

DRAINAGE AREAS, STREAM GAGING STATIONS AND PEAK DISCHARGE SITES

APRIL, 1971 — PLATE I



LEGEND:

—12— NORMAL ANNUAL PRECIPITATION - INCHES

(12) PRECIPITATION STATIONS (TABLE NO. 2)

(31) SNOW COURSES AND AERIAL MARKERS (TABLE NO. 3)

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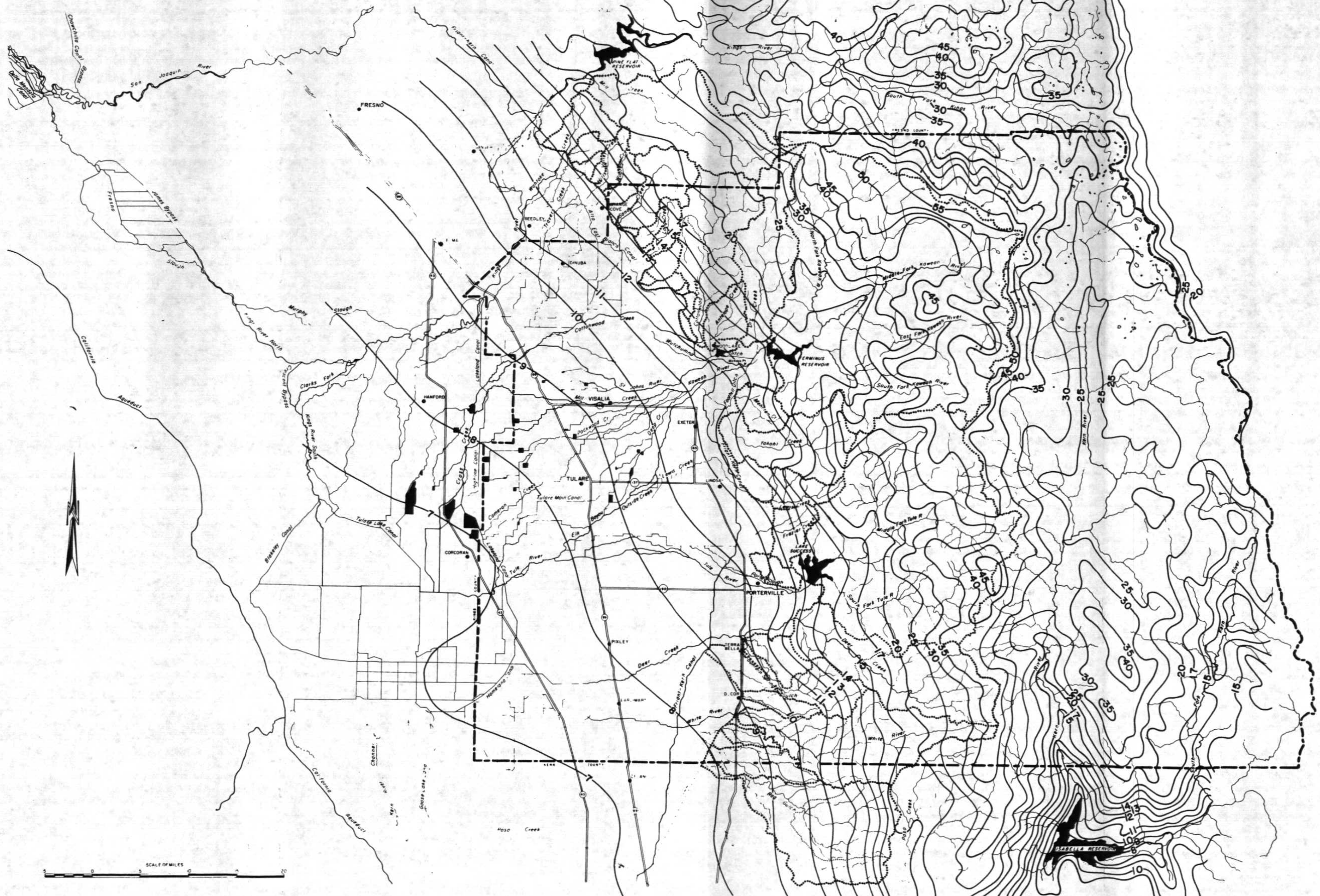
THE SPINK CORPORATION

TULARE COUNTY FLOOD CONTROL DISTRICT
FLOOD CONTROL MASTER PLAN HYDROLOGY APPENDIX

NORMAL ANNUAL PRECIPITATION (1911-1970)
PRECIPITATION STATIONS AND SNOW COURSES

APRIL, 1971

PLATE II



LEGEND:

—12— NORMAL ANNUAL PRECIPITATION - INCHES

DRAINAGE AREAS (SEE PLATE II)

MURRAY, BURNS AND KIENLEN — CONSULTING CIVIL ENGINEERS
600 FORUM BUILDING

THE SPINK CORPORATION

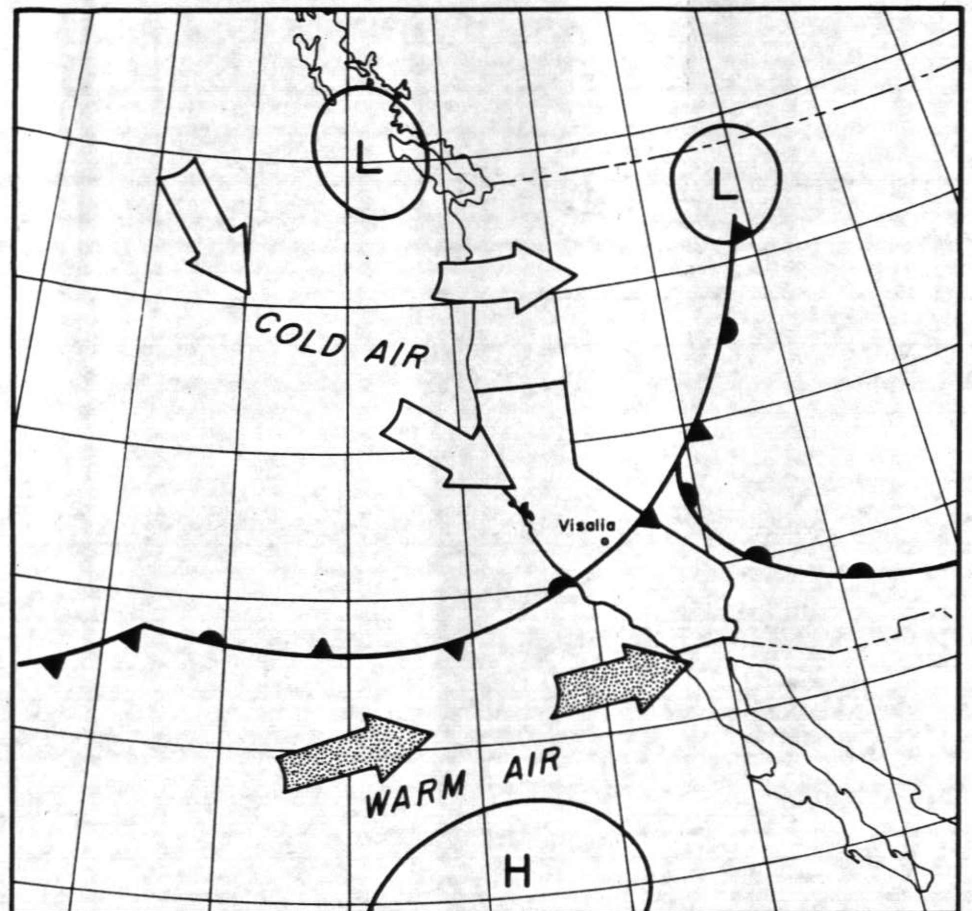
TULARE COUNTY FLOOD CONTROL DISTRICT
FLOOD CONTROL MASTER PLAN HYDROLOGY APPENDIX

DRAINAGE AREAS AND NORMAL ANNUAL PRECIPITATION

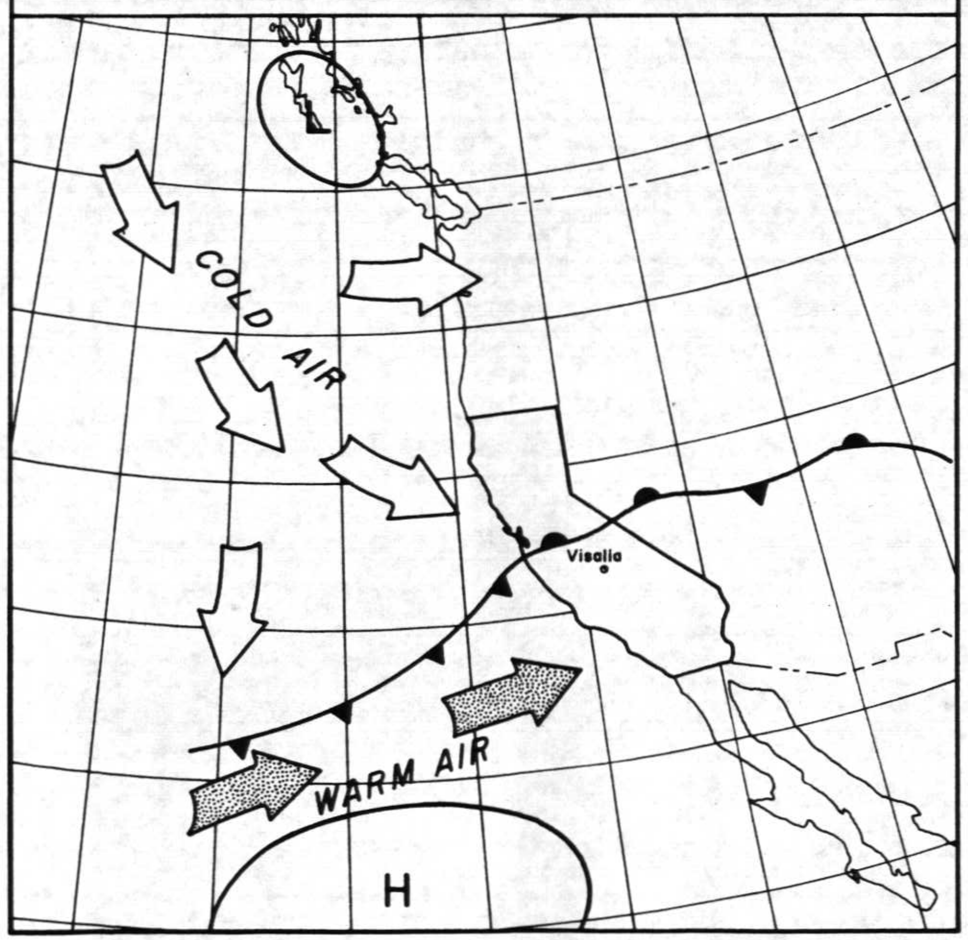
APRIL, 1971

PLATE III

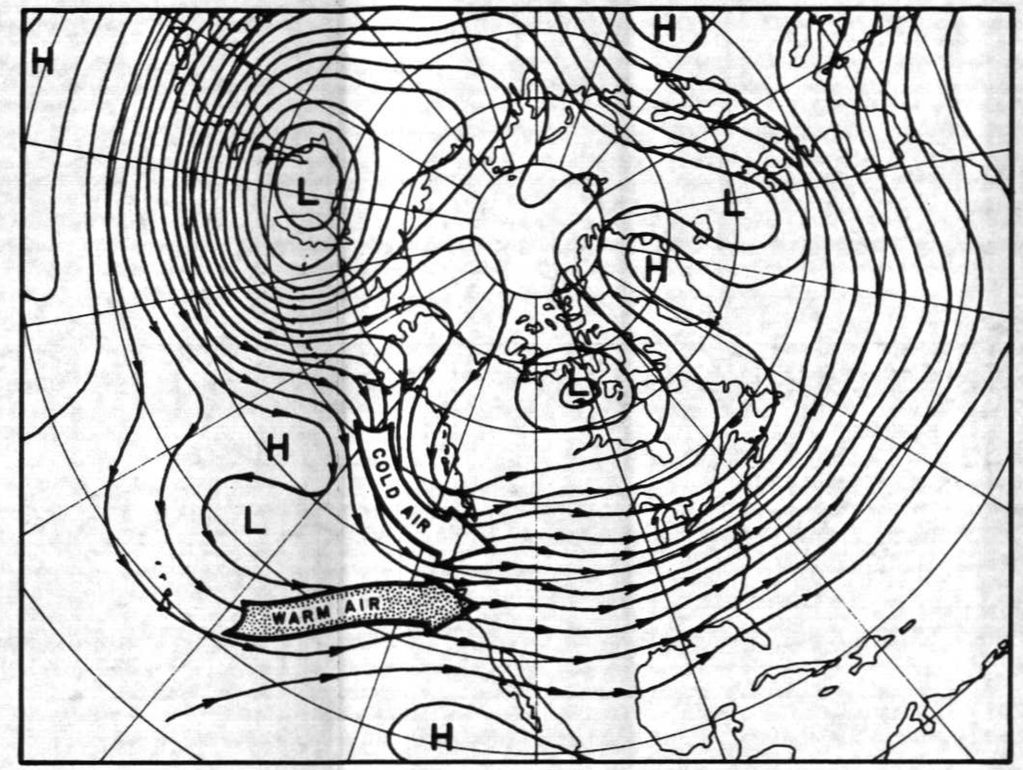
FIGURE 1



WEATHER MAP
AT 1000 PST
DECEMBER 5, 1966

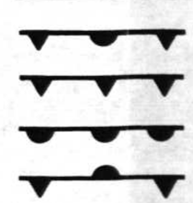


WEATHER MAP
AT 1000 PST
DECEMBER 6, 1966



STREAMLINES OF FLOW
AT APPROXIMATELY 10,000 FEET
JANUARY 15–31, 1969

LEGEND



- OCCLUSION
- COLD FRONT
- WARM FRONT
- STATIONARY FRONT

TULARE COUNTY FLOOD CONTROL DISTRICT

FLOOD CONTROL MASTER PLAN—HYDROLOGY APPENDIX

WEATHER MAPS DECEMBER 1966 AND JANUARY 1969

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FIGURE 2

TULARE COUNTY FLOOD CONTROL DISTRICT

FLOOD CONTROL MASTER PLAN—HYDROLOGY APPENDIX

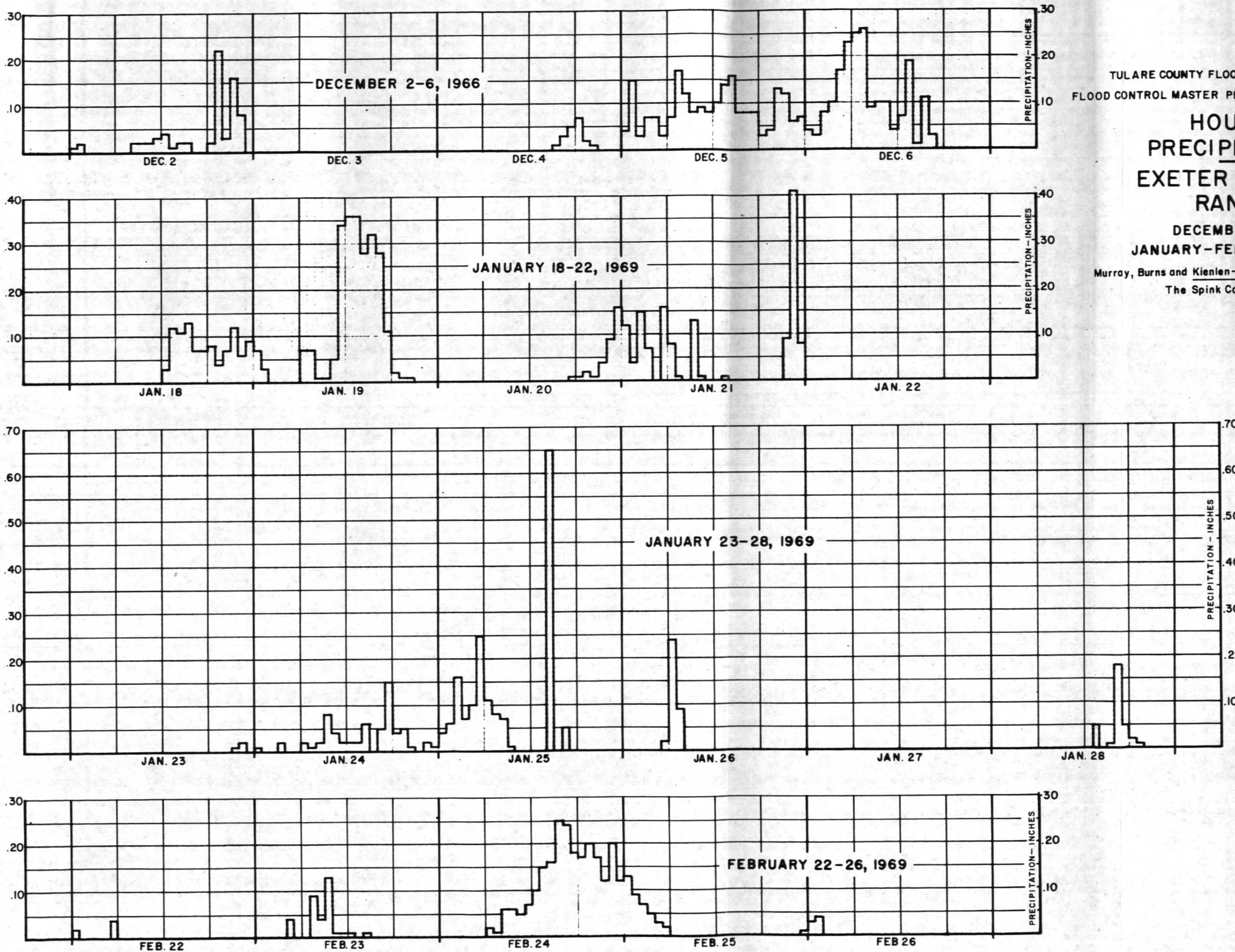
HOURLY PRECIPITATION EXETER FAUVER RANCH

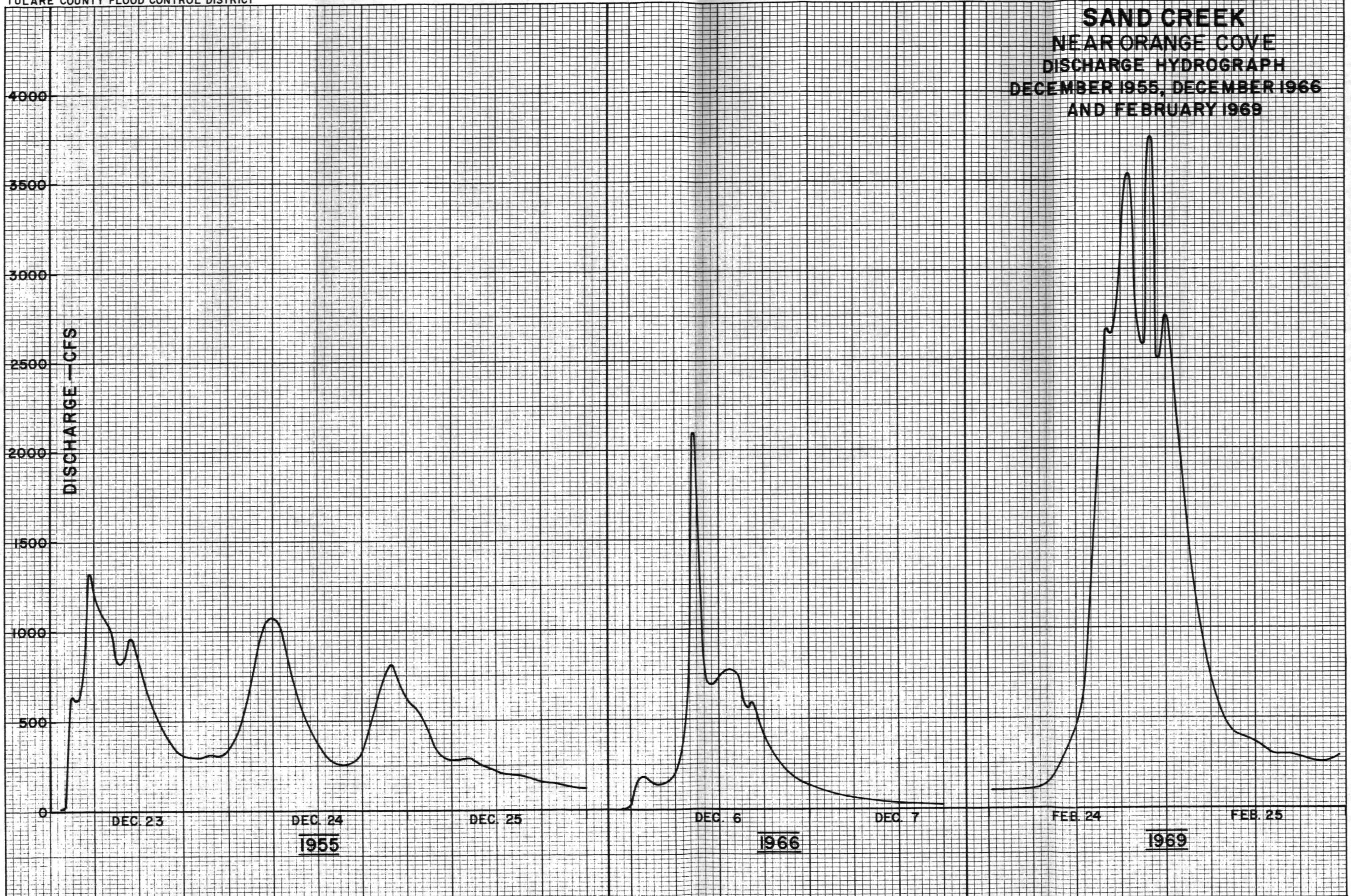
DECEMBER 1966

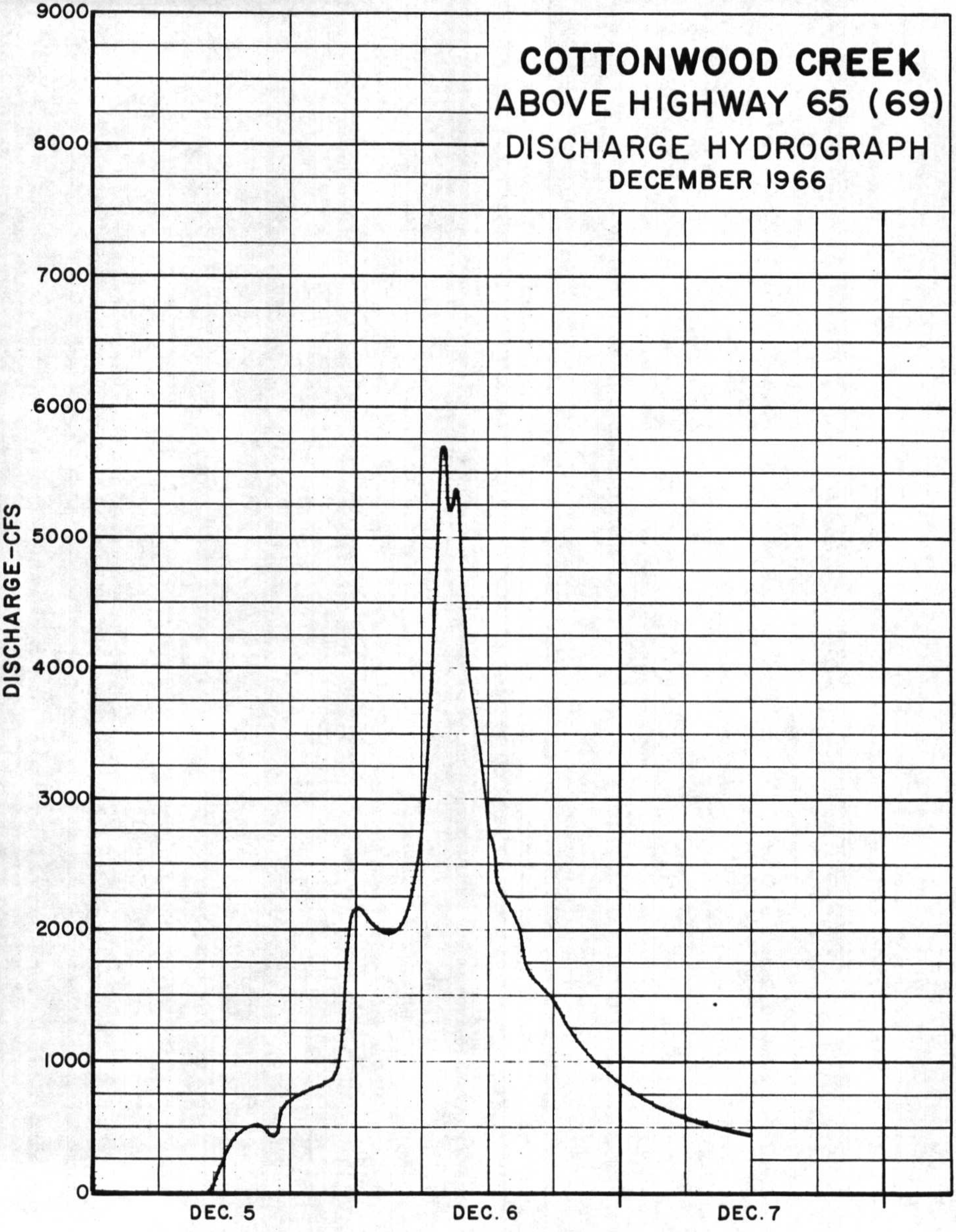
JANUARY–FEBRUARY 1969

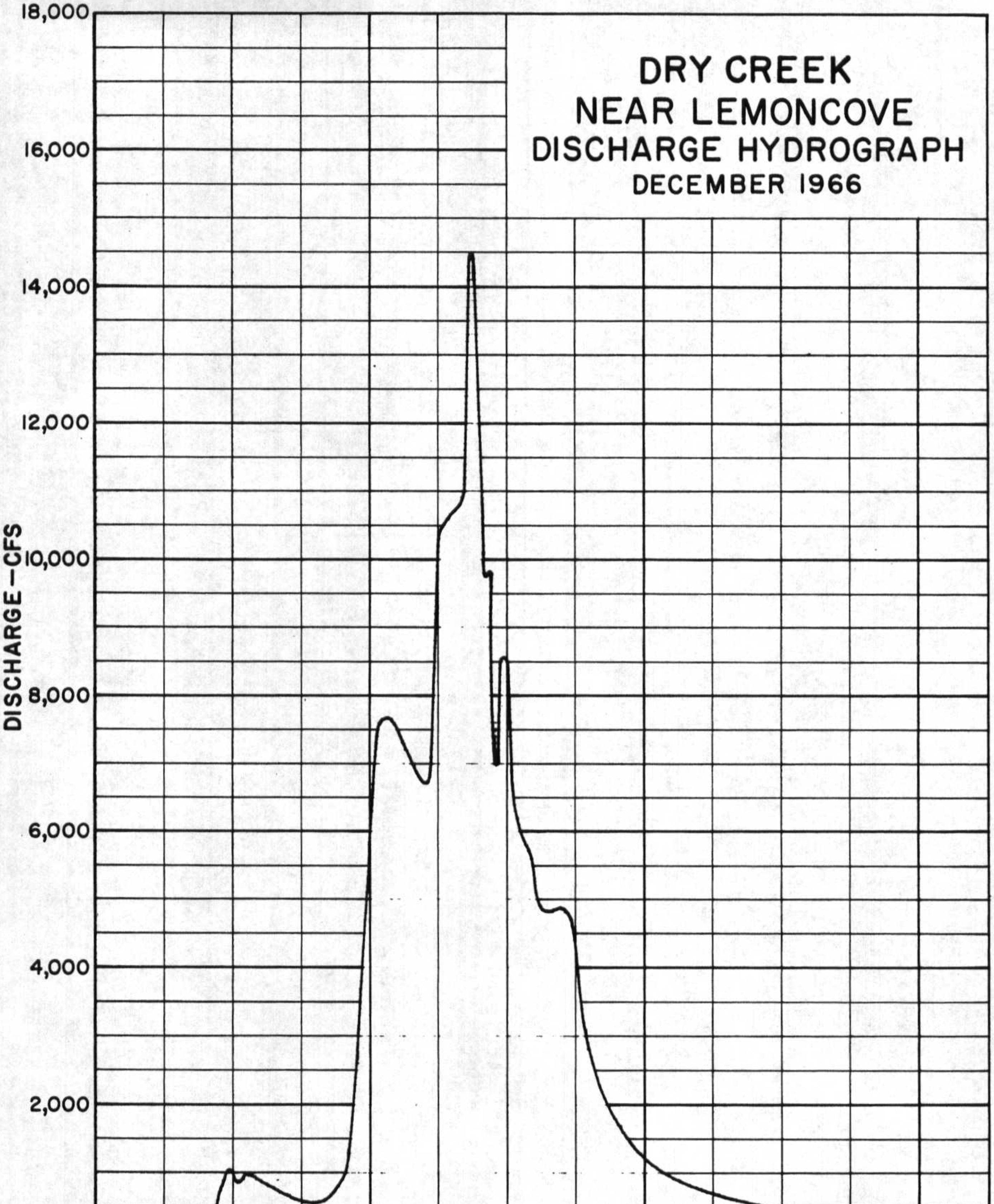
Murray, Burns and Kienlen—Consulting Civil Engineers

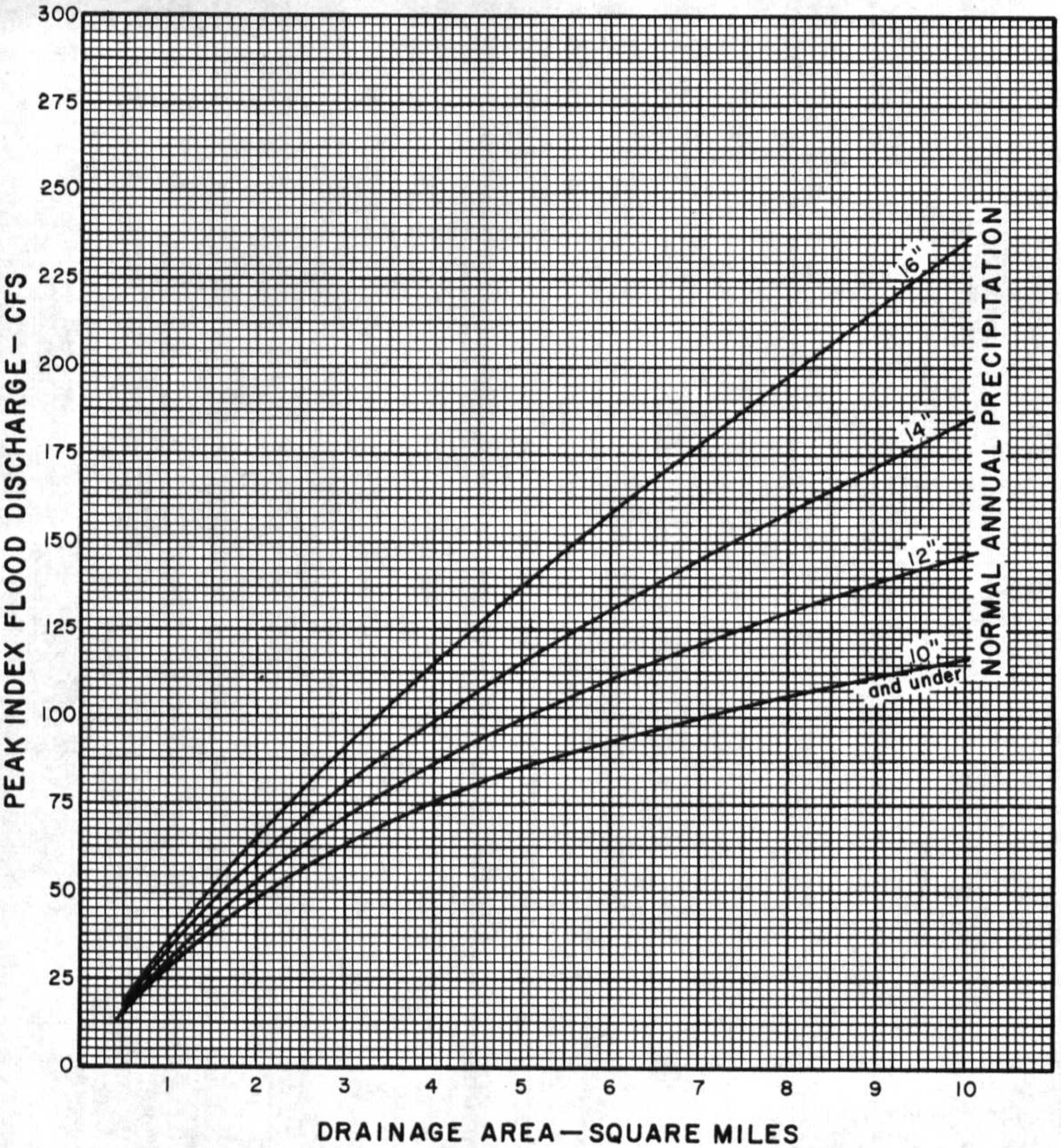
The Spink Corporation



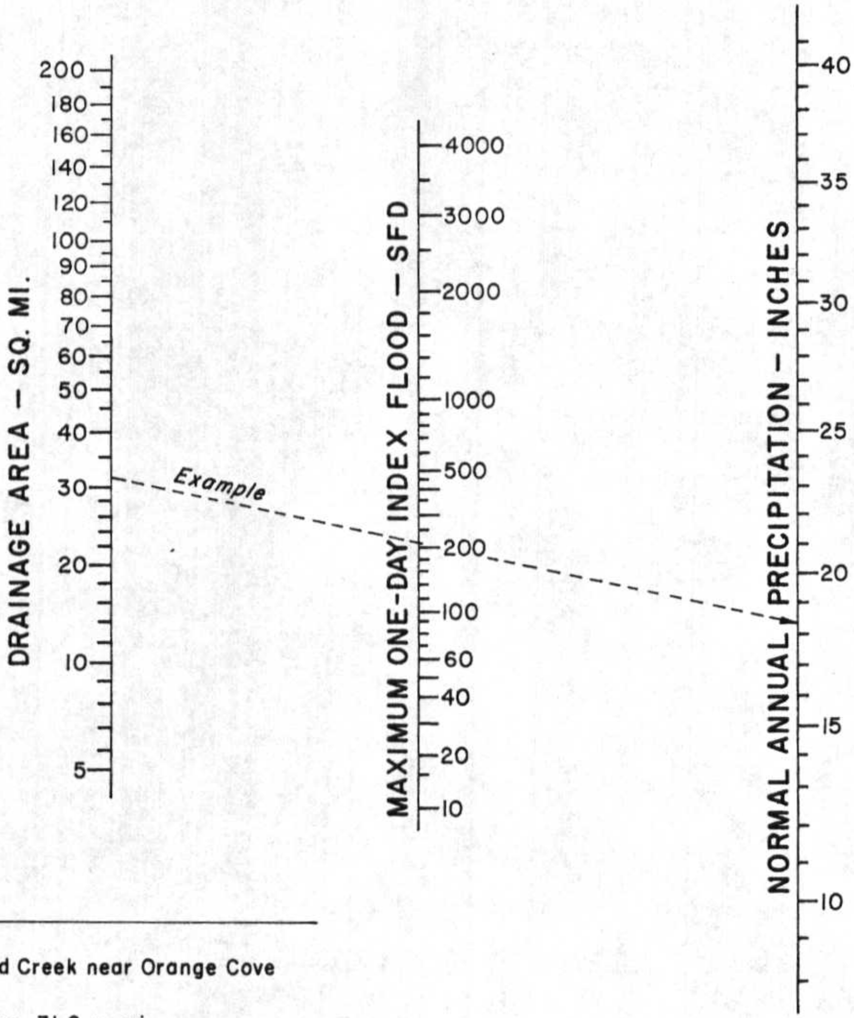

SAND CREEK
NEAR ORANGE COVE
DISCHARGE HYDROGRAPH
DECEMBER 1955, DECEMBER 1966
AND FEBRUARY 1969
DISCHARGE — CFS
4000
3500
3000
2500
2000
1500
1000
500
0
DEC. 23
DEC. 24
DEC. 25
1955
DEC. 6
DEC. 7
1966
FEB. 24
FEB. 25
1969


COTTONWOOD CREEK
ABOVE HIGHWAY 65 (69)
DISCHARGE HYDROGRAPH
DECEMBER 1966
DISCHARGE-CFS
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
DEC. 5
DEC. 6
DEC. 7


DRY CREEK
NEAR LEMONCOVE
DISCHARGE HYDROGRAPH
DECEMBER 1966
DISCHARGE—CFS
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
DEC. 5
DEC. 6
DEC. 7



PEAK INDEX FLOOD DISCHARGE
SMALL FOOTHILL DRAINAGE AREAS
Normal Annual Precipitation of 16 Inches or Less



EXAMPLE

Station: Sand Creek near Orange Cove

Drainage Area: 31.6 sq. mi.
Normal Annual Precipitation: 18.2 in.

From Nomograph:

Maximum One-Day Index Flood = 205 SFD

ONE-DAY INDEX FLOOD NOMOGRAPH

FIGURE 6

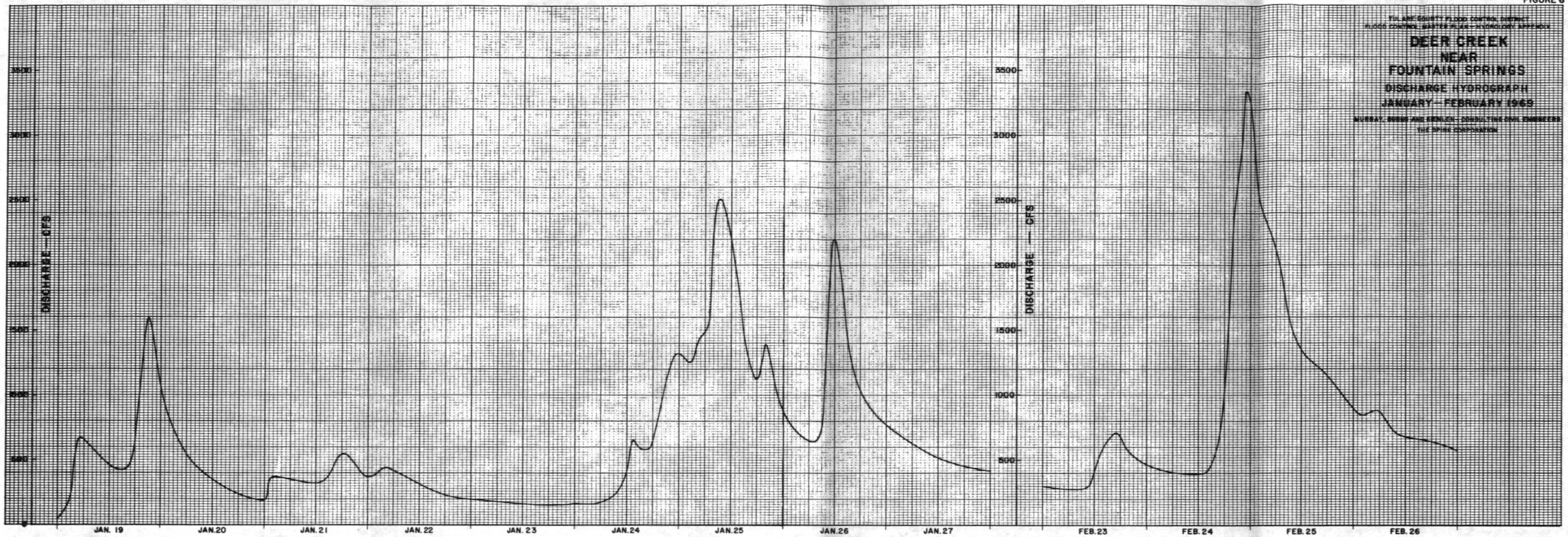


FIGURE 7

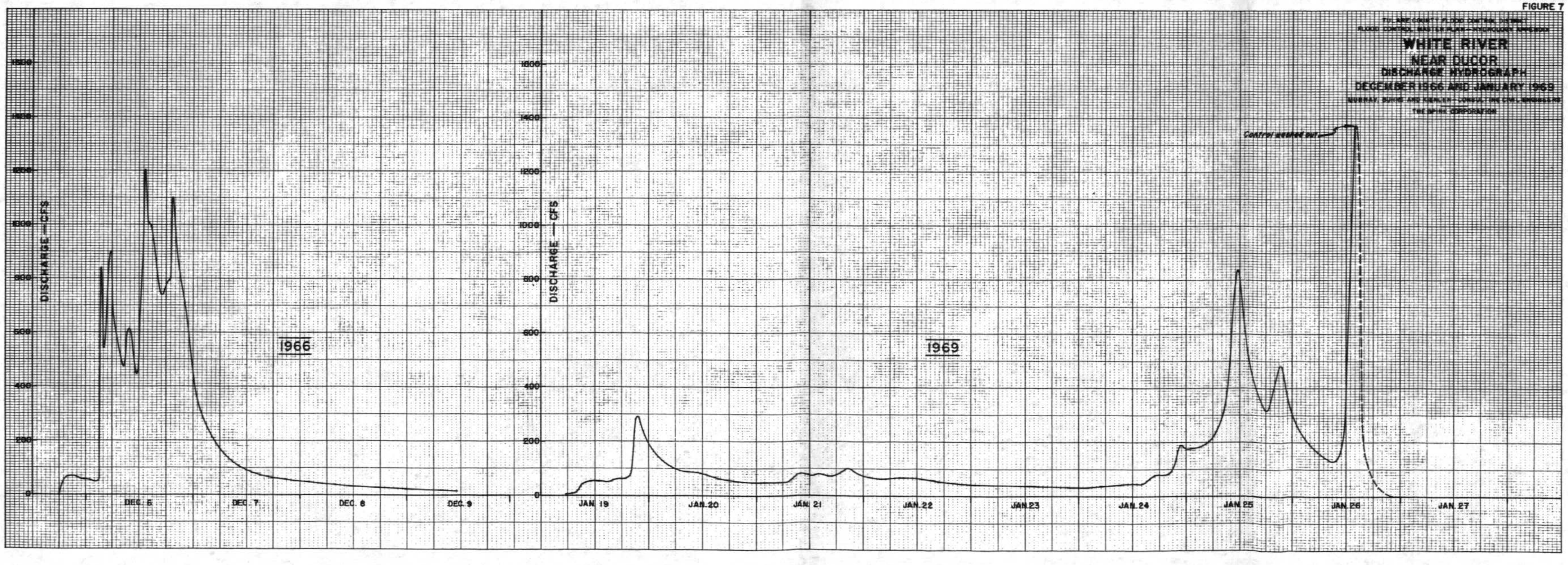
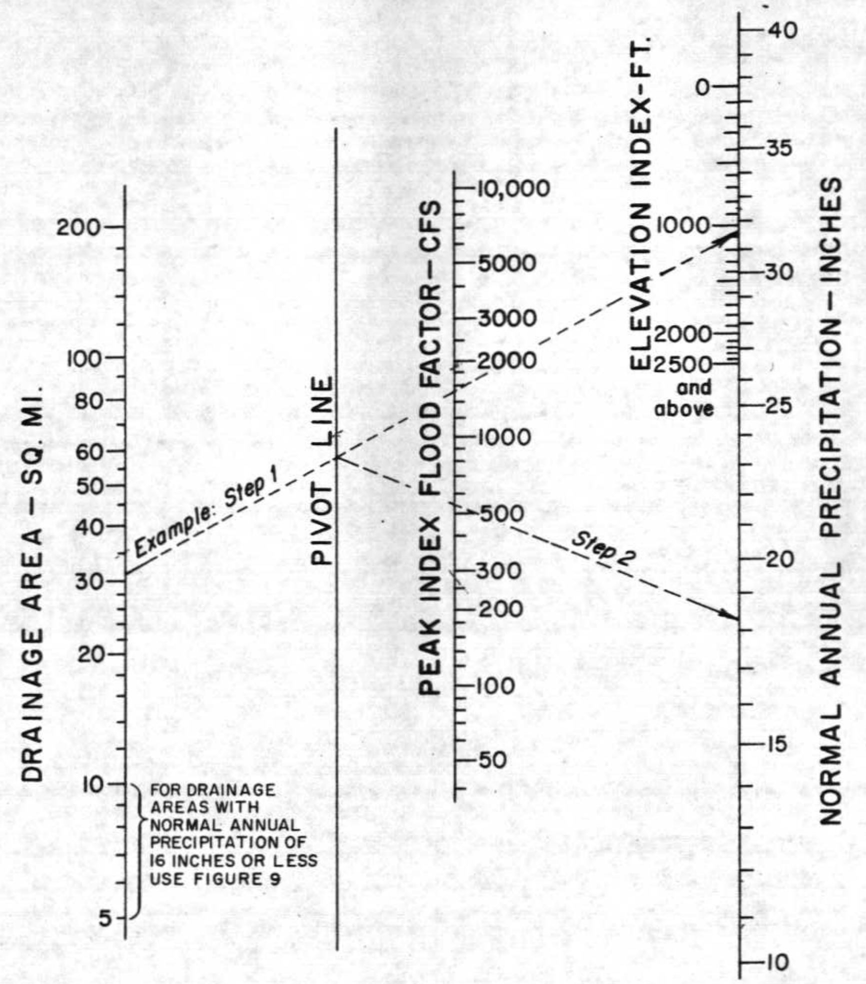
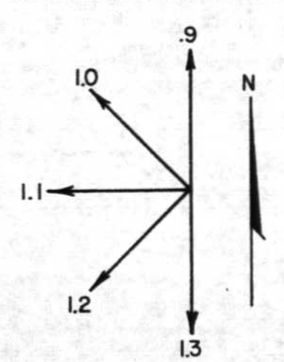


FIGURE 8



BASIN ORIENTATION DIAGRAM



Step 3

PEAK INDEX FLOOD DISCHARGE =

BASIN ORIENTATION FACTOR x PEAK INDEX FLOOD FACTOR
From diagram at left *From nomograph*

Step 4

Multiply PEAK INDEX FLOOD DISCHARGE *by the following values to estimate* 1:25 YEAR and 1:50 YEAR FLOOD PEAKS:

1:25 Year	4.2
1:50 Year	6.0
1:100 Year	8.0

EXAMPLE

STATION: SAND CREEK NEAR ORANGE COVE

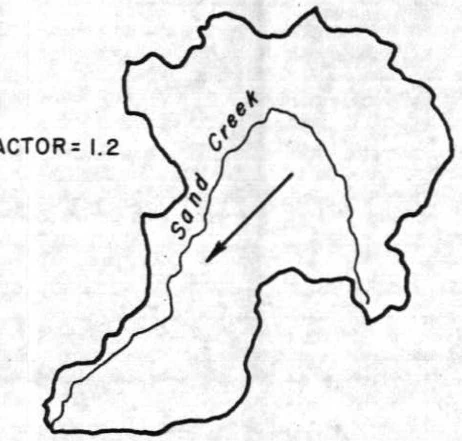
DRAINAGE AREA = 31.6 SQ. MI.
ELEVATION INDEX = 1050 FT.
NORMAL ANNUAL PRECIPITATION = 18.2 IN.

Steps 1 & 2 (Nomograph)

PEAK INDEX FLOOD FACTOR = 530 CFS

Step 3

BASIN ORIENTATION FACTOR = 1.2



PEAK INDEX FLOOD DISCHARGE =
BASIN ORIENTATION FACTOR x PEAK INDEX FLOOD FACTOR =
(530 cfs) x (1.2) = 636 cfs

Step 4

PEAK INDEX FLOOD DISCHARGE x 1:25 YEAR VALUE =
1:25 YEAR PEAK FLOW
(636 cfs) x (4.2) = 2671 cfs

TULARE COUNTY FLOOD CONTROL DISTRICT

FLOOD CONTROL MASTER PLAN–HYDROLOGY APPENDIX

PEAK INDEX FLOOD DISCHARGE NOMOGRAPH

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ONE-DAY VS MULTIPLE-DAY INDEX FLOODS

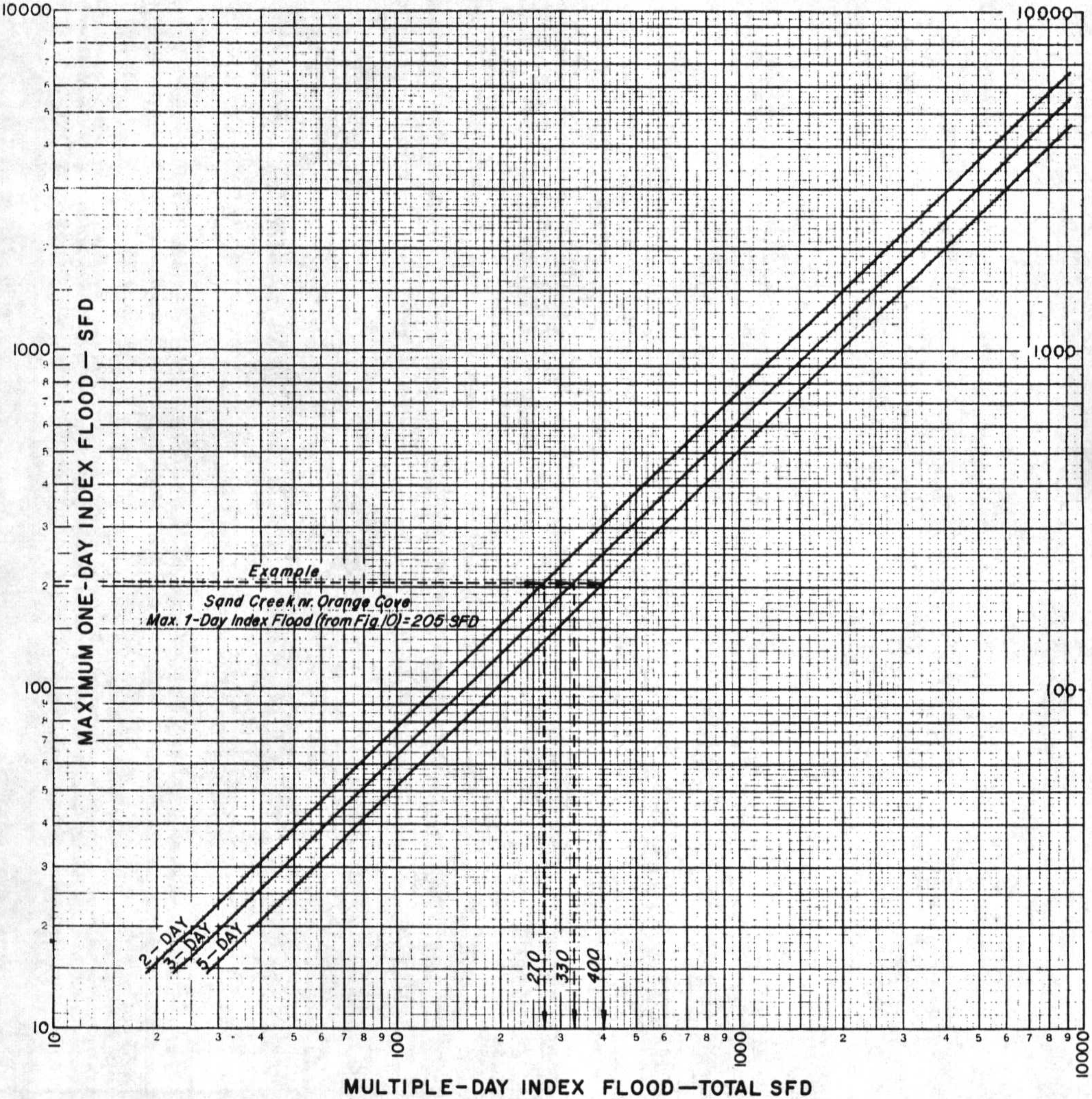


FIGURE 12

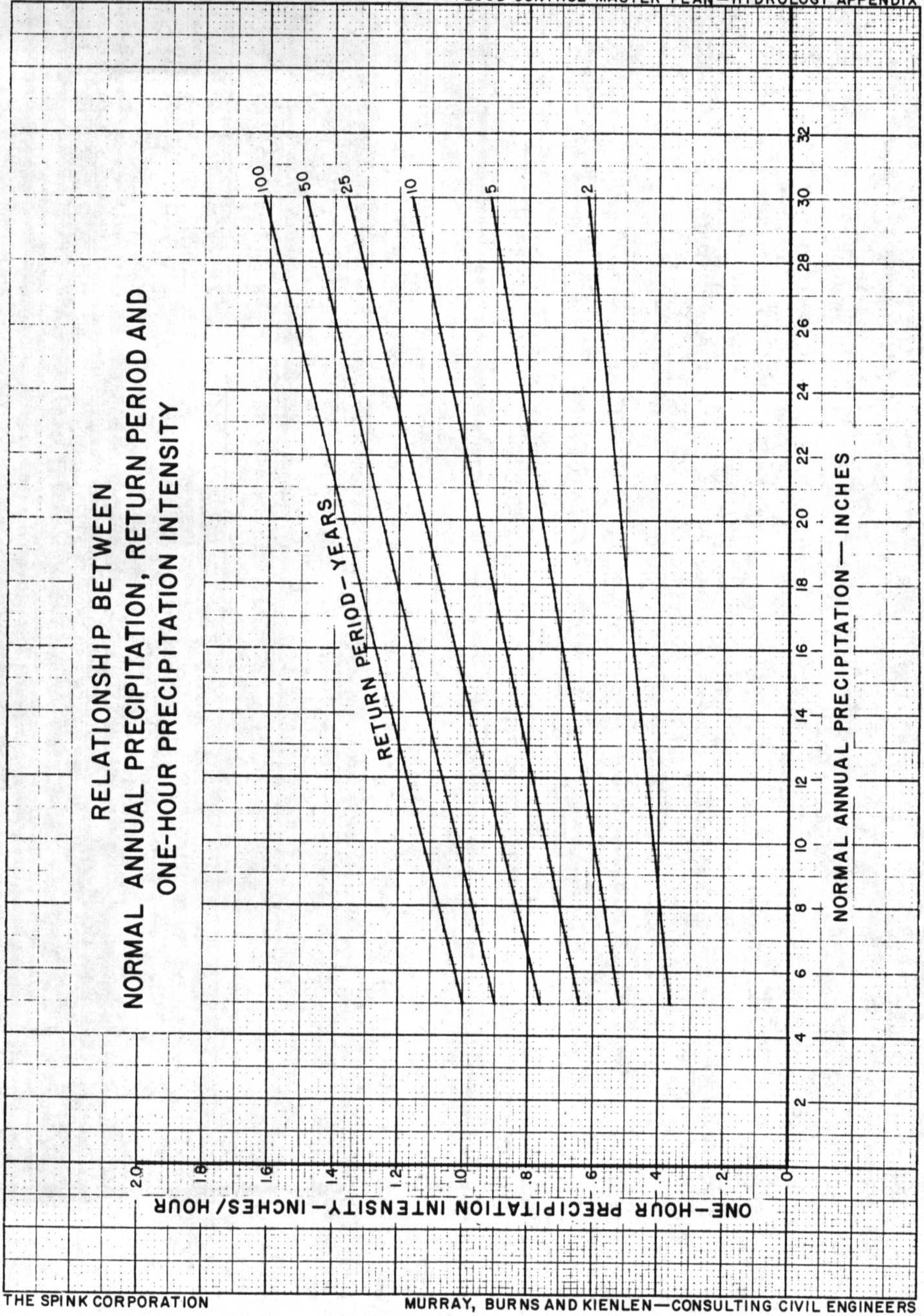
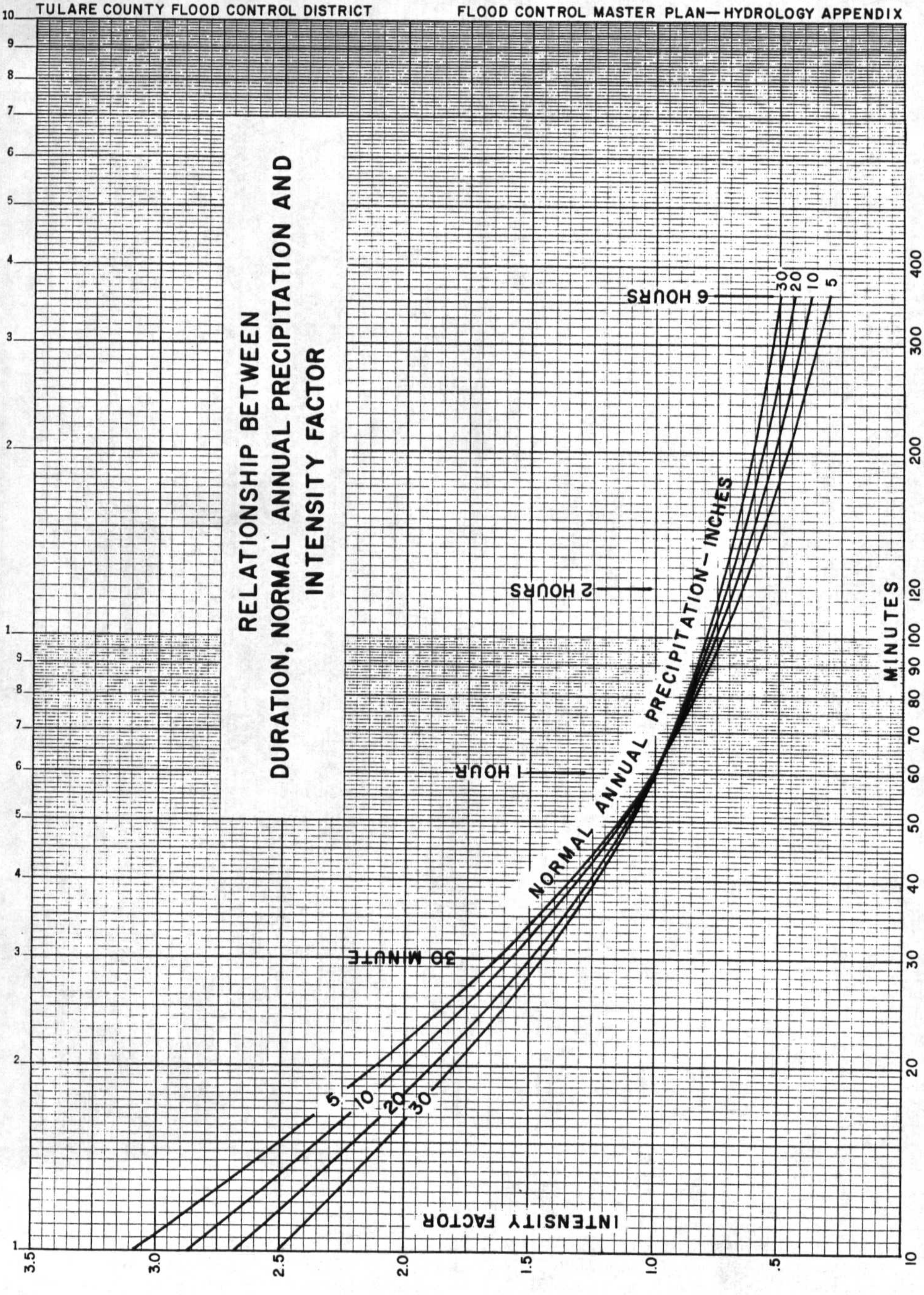

RELATIONSHIP BETWEEN
NORMAL ANNUAL PRECIPITATION, RETURN PERIOD AND
ONE-HOUR PRECIPITATION INTENSITY
RETURN PERIOD—YEARS
100
50
25
10
5
2
NORMAL ANNUAL PRECIPITATION — INCHES
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
ONE-HOUR PRECIPITATION INTENSITY-INCHES/HOUR
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0

FIGURE 13

TULARE COUNTY FLOOD CONTROL DISTRICT

FLOOD CONTROL MASTER PLAN— HYDROLOGY APPENDIX



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