MEMORANDUM REPORT

FLOOD HYDROLOGY

FOR THE DECOMMISSIONING OF HUMBOLDT BAY POWER PLANT UNIT NO. 3

Civil Engineering Department
Pacific Gas and Electric Company
San Francisco, California

June 1985

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UNIT NO. 3

CIVIL ENGINEERING DEPARTMENT

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

JUNE 1985

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1 INTRODUCTION

1.1 <u>Purpose and Scope:</u> This memorandum report was prepared to assemble the various hydrologic data and information necessary for evaluation of the structural and functional adequacy of any structure on the plant site containing radioactive material (i.e. spent fuel pool, storage pits, tanks, etc). It presents basic hydrologic data concerning the powerplant located near the shores of Humboldt Bay; describes (a) the derivation of the probable maximum flood, (b) the determination of the flood levels, and (c) maximum wind and wave data, (d) plantsite drainage, and (e) various tsunami levels at the bay near the plantsite.

1.2 <u>Authorization:</u> The hydrologic analysis and subsequent preparation of this report was initiated upon the request from Mr. J. C. Carroll of the Nuclear Plant Operations dated March 1, 1985. The request addressed to Mr. R. V. Bettinger, was for Mr. C. B. Cecilio of the Civil Engineering Department to assist in responding to several questions asked by the Nuclear Regulatory Commission. (NRC). These questions deal with hydrologic issues pertaining to the decommissioning of Unit 3 at the Humboldt Bay Power Plant. This report responds to one of the NRC questions.

1.3 <u>Methods of Investigation:</u> Estimation of hypothetical

floods such as the probable maximum flood (PMF) requires the determination of the hydrologic response (losses, base flow, routing and runoff model) of the watershed to intense rainfall, verification based on historical storm and runoff data (flood hydrograph analysis), the most severe precipitation reasonably possible (PMP), minimum losses, base flow, channel and reservoir routing. The hydrologic response characteristics of the basin to precipitation, such as the unit hydrograph, is determined and verified from historical floods using the computer simulation program HEC-1 developed by the U.S. Army Corps of Engineers (1). The probable maximum precipitation (PMP) is derived in accordance with the criteria from U.S. National Weather Service (formerly U.S. Weather Bureau) Hydrometeorological Report Nos. 36 and 49 (2,3).

Wind generated waves and runup are calculated using a computer program developed by Noble Software Incorporated called WRUP(4). This program develops the wave runup using the procedure from the U.S. Army Corps of Engineers, Shore Protection Manual (5).

Evaluation of tsunami levels was based on three sources of documents, references 15-17.

1.4 Location of Powerplant: The Humboldt Bay Power Plant is located in Humboldt County, California, approximately 4 miles southwest of the city of Eureka. The site consists of approximately 143 acres located on the mainland shore of Humboldt Bay, 1.5 miles

opposite the Bay entrance (See Figure 1).

The plant is located on the Buhne Point, 3 miles south and 2 1/2 miles west of Eureka between the Northwestern Pacific Railroad tracks and the north shoreline of Buhne Point.

2 DESCRIPTIVE HYDROLOGY

2.1 <u>watershed Characteristics:</u> Four major creeks drain into Humboldt Bay, these are Salmon Creek, Elk River, Freshwater Creek and Jacoby Creek. Several smaller tributaries also drain into the bay. Figure 1 shows the drainages of these creeks.

Salmon Creek drains a total area of 28.30 square miles. It rises in the central part of T.3N., R.1E., Humboldt base and meridian. It flows north of west 9 miles, then somewhat west of north about 4 miles to the western part of T.4N., R.1W., where it enters the south end of Humboldt Bay. The lower course of the creek is marshy.

Elk River drains an area of 51.3 square miles. It rises in the central part of T.3N., R.1E; flows northwestward and discharges into Humboldt Bay near the town of Elk River. The river has a length of 12 miles with North and South Forks as principal tributaries.

Freshwater Creek drains an area of 61.73 square miles. It rises in the north-central part of T.4N., R.2E; flows in general somewhat south of west 5 miles, then northwestward into Humboldt Bay. The creek has a length of 13 miles.

Jacoby Creek drains an area of 16.40 square miles. It rises in the northern part of T.4N., R.2E; flows northwestward to the

northern part of T.5N., R.1E., where it enters Humboldt Bay. The creek has a length of about 8 miles.

Other small tributaries in the watershed that drain into the bay are called sloughs.

2.2 <u>Climate:</u> The climate of the basin, characteristic of most of California, is divided into a wet and a dry season. Most of the rainfall occurs from storms during the wet season which extends from November through March. During this period 75% of the average annual precipitation falls on the basin. The dry season extends from May through September and only 10% of the average annual precipitation is contributed during this period. The rest of the annual precipitation is contributed during the transitional months of October and April.

The mean annual precipitation in the plant site is 36 inches. In the basin contributing runoff to the bay, the mean annual precipitation is shown in Figure 2. The normal and monthly precipitation data at Eureka WSO as published by the National Climatic Center (6) are shown in Table 1.

Temperatures in the plant site, according to the Environmental Report (7), has a minimal diurnal and seasonal range. It averages 52 degrees (F) annually, 46 degrees (F) in winter and 56 degrees (F) in the summer. Table 1 shows average temperatures at the Eureka WSO gage as reported by the National Climatic Center.

TABLE 1

NORMAL ANNUAL PRECIPITATION AND TEMPERATURES
AT
EUREKA WSO (No. 04-2910)
LATITUDE 40° 48'N LONGITUDE 124 10'W
ELEVATION 43 FEET (NGVD)

MONTH	PRECIPITATION (In)	TEMPERATURE (°F)
JAN	7.42	47.3
FEB	5.15	48.4
MAR	4.83	48.3
APR	2.95	49.7
MAY	2.11	52.5
JUN	0.66	55.2
JUL	0.14	56.3
AUG	0.27	57.0
SEP	0.65	56.6
OCT	3.23	54.4
NOV	5.77	51.7
DEC	5.58	48.6
ANNUAL	39.76	52.2

2.3 <u>Flood Characteristics:</u> The known large floods in the study area have all occurred during the winter months. These floods occur as a combination of rainfloods and high tides.

The rainfloods have sharp high peaks and are usually of short duration and comparatively small volume. Because of the relatively low elevation of the area, snowfall and snowmelt are not considerations for flooding in the area.

Table 2 shows annual instantaneous peak flows measured at two stream gages in the basin for rainfloods.

Tidal flooding occurs at the northern part of the plant site where the area is mostly marsh lands. No tidal flooding has ever been observed at the Humboldt Bay Power Plant site itself. Table 3 shows highest tide observed annually in Humboldt Bay as adjusted to the plant site vicinity.

2.4 <u>Upstream Regulation:</u> There are no known reservoirs within the watershed under study or above the powerplant site.

TABLE 2

ANNUAL MAXIMUM PEAK DISCHARGES

WATER YEAR	11-4797 ELK RIVER NEAR FALK DATE	11-4797 ELK RIVER NEAR FALK DISCHARGES (cfs)	11-4800 JACOBY CREEK NEAR FRESHWATER DATE	11-4800 JACOBY CREEK NEAR FRESHWATER DISCHARGES (cfs)
1955			12/30/54	1,670
1956			12/21/55	1,490
1957			12/11/56	516
1958	2/12/58	2,790	11/13/57	729
1959	2/14/59	3,220	2/14/59	749
1960	2/8/60	2,090	2/8/60	644
1961	2/11/61	2,160	2/11/61	276
1962	1/19/62	2,120	1/19/61	389
1963	4/12/63	2,220	12/2/62	446
1964	1/20/64	2,950	1/6/64	563
1965	12/22/65	3,430	12/22/64*	1,530
1966	1/4/66	3,270		
1967	12/5//66	3,110		
1968	Record Discontinued		1/15/68	380
1969			1/13/69	626
1970			1/23/70	897
1971			11/24/70	936
1972			3/2/72	2,510
1973				
1974			1/16/74	1,170

*Station converted to a crest-stage partial-record station.

TABLE 3

ANNUAL HIGHEST TIDE LEVEL

YEAR	DATE	HIGHEST TIDE (M.L.L.W)	TIDE STATION	ADJUSTED TIDE ELEV. AT POWERPLANT VICINITY
1920	12/25	8.1	SOUTH JETTY	8.2
1932	12/26&11/28	8.2	"	8.3
1933	12/17	8.1	"	8.2
1934	12/8	7.8	"	7.9
1935	12/9	7.8	"	7.9
1936	12/27	7.9	"	8.0
1937	12/17	8.2	"	8.3
1939	12/10	7.6	"	7.7
1940	12/27	7.6	"	7.7
1941	12/17	8.0	"	8.1
1942	12/8	7.9	"	8.0
1943	12/27	7.7	"	7.8
1944	11/29	7.8	"	7.9
1945	12/18	8.1	"	8.2
1946	12/9	8.1	"	8.2
1947	12/27	8.1	"	8.2
1948	12/28,12/17	7.5	"	7.6
	11/29		"	
1949	12/18	7.9	"	8.0
1950	12/9	8.1	"	8.2
1977	12/11	8.87*	NORTH SPIT	
1978	12/28	8.33*	"	
1979	12/30	8.86	"	
1980	12/21	8.81	"	
1981	11/27	12.46	"	
1982	11/30	9.69	"	
1983	1/26	9.96	"	
			"	

*Record not complete for the year, but values used here are for December when highest tides usually occur.

NOTE: According to the correction table of the "Official Tide Table for Humboldt Bay and Vicinity", tides at Fields Landing are 0.3 ft. higher than South Jetty Landing. Since the powerplant site is located about 1/3 of the distance between South Jetty Landing and Fields Landing, 0.1 ft. is used for correcting tides recorded at South Jetty Landing for the plantsite. No correction is assumed needed for tides recorded at North Spit.

3 HYDROLOGIC ANALYSIS

3.1 Rainfall-Runoff Study: Two USGS streamflow gaging stations were evaluated for historical flood hydrographs. These are the Elk River near Falk gage (11-4797) and the Jacoby Creek near freshwater gage (11-4800). A hydrograph for the December 21-23, 1964 flood was the only one that could be obtained for the Elk River gage. At the Jacoby Creek gage, the hydrograph for the December 21-23, 1955 was the only one available.

The two flood hydrographs were reconstituted with the aid of the computer program HEC-1 for unit hydrograph derivation. Of the two hydrographs only the December 1955 flood came out with the best reconstitution. Therefore, it was concluded that the unit hydrograph obtained from this flood should be used for the study area. Figure 3 shows the reconstituted flood hydrograph at the gage Jacoby Creek near Freshwater (11-4800).

3.2 Precipitation: Basin precipitation for the 1955 storm were determined by relating the point rainfall values at Kneeland 10 SSE (NWS No. 4587) weather station to the basin near precipitation. This procedure assumes that the ratio of precipitation increments at the two sites equals the ratio of the mean annual precipitation at those sites.

The hourly time sequence of storms were based on the pattern of the same recording precipitation.

3.3 <u>Precipitation Losses:</u> Studies relating basin-average rainfall amounts for short intervals in a storm to observed runoff indicate a distinctly nonlinear relationship between basin-mean rainfall intensity and basin-mean rainfall intensity and basin-mean infiltration rate. This is due to the heterogeneity of soils, vegetation, and precipitation throughout the drainage basin. To model this relationship, the U.S. Army Corps of Engineers (1) uses the following relationship, with a constraint that loss does not exceed precipitation for each time interval.

$$L = KP^{E}$$

where: L = loss rate in inches per hour.

K = coefficient decreasing with increased ground wetness.

P = rainfall rate in inches per hour.

E = exponent between zero and 1.0, depending on the variation of factors within the basin.

The above relationship was used in deriving the loss rate function for the gaged basins during the historical floods that were reconstituted.

3.4 <u>Unit Hydrograph:</u> A unit hydrograph for the basin Jacoby Creek near Freshwater, was obtained from the rainfall-runoff study of the 1955 storm.

A Clark's time of concentration (Tc) of 2.14 hours and a storage coefficient (R) of 4.64 hours were obtained from the optimization.

4 PROBABLE MAXIMUM FLOOD (PMF)

4.1 General: The term probable maximum flood (PMF) as used in the official documents of the Corps of Engineers identifies estimates of hypothetical flood characteristics (peak discharge, volume and hydrograph shape) that are considered to be the most severe "reasonably possible" at a particular location, based on relatively comprehensive hydrometeorological analyses of critical runoff producing precipitation (and snowmelt, if pertinent) and hydrologic factors favorable for maximum flood runoff (10). This type of flood is generally used as a spillway design flood for reservoirs impounding large quantities of water and is constructed above a populated community and when failure from overtopping cannot be tolerated. It has also been used as a design basis flood for nuclear generating plants. The criteria for the determination of the probable maximum flood is discussed in detail in the American National Standard, "Determining Design Basis Flooding at Power Reactor Sites" (11).

The PMF determination for the basin was prepared by estimating the areal distribution of the probable maximum precipitation (PMP) over the drainage basins shown in Figure 1. Excess runoff from the critically arranged precipitation was modeled by the unit hydrograph to produce the PMF inflow into the bay.

4.2 Probable Maximum Precipitation (PMP): The probable maximum precipitaton is the theoretically greatest depth of

precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of the year. (This definition is a 1982 revision and results from mutual agreement among the National Weather Service, the U.S. Army Corps of Engineers, and the Bureau of Reclamation) (12). No recurrence interval is assigned to the PMP. For California, PMP estimates are of two types. One is the general winter storm and the other is the convective type or local type thunderstorm.

4.2.1 General Type PMP: Basin mean PMP estimates for long duration cool-season storms for each sub-basin are calculated in accordance with the procedures in the U.S. Weather Bureau Hydrometeorological Report No. 36 (2). The critical storm has a 72-hour duration with the daily 6-hour and hourly precipitation amounts specified in the procedure. The PMP estimates consist of two meteorologic processes called orographic and convergence precipitation. They are calculated separately and then added together. The frontal type cool-season PMP is calculated for the months of October, November, December, January-February, March and April. The combined orographic and restricted convergence type storm produced the highest precipitation for all the sub-basins.

Figures 4 and 5 show the orographic and convergence index lines used for the calculations superimposed on the basins. Table 4 shows the total combined orographic and restricted convergence PMP for the fifteen sub-basins in the study area.

To produce a reasonably critical flood hydrograph from the probable maximum precipitation, it is necessary to specify the time sequence of the precipitation. HMR 36 presents several methods of arranging the 6-hour increments in a critical pattern. However, based on several historical storm pattern in the area, the adopted time distribution is similar to the sequence shown in Figure 7-3(c) of HMR 36. The maximum one hour precipitation occurs in the 40th hour and the maximum 6-hour precipitation from the 37th to the 42nd hour.

TABLE 4

TOTAL OROGRAPHIC-RESTRICTED CONVERGENCE PMP
(DEPTHS IN INCHES)

SUB-BASIN NO.	OCT.	NOV.	DEC.	JAN.-FEB.	MAR.	APR.
1	21.07	21.64	22.03	22.35	21.67	20.49
2	17.70	18.20	18.43	18.71	18.20	17.37
3	16.11	16.57	16.72	16.96	16.51	15.83
4	22.85	23.46	23.94	24.34	23.48	22.20
5	24.89	25.51	26.09	26.49	25.56	24.06
6	19.01	19.54	19.82	20.13	19.51	18.57
7	25.64	26.31	2[illegible].92	27.38	27.04	24.77
8	22.01	22.60	22.99	23.40	22.64	21.40
9	19.05	19.58	19.86	20.17	19.55	18.61
10	26.53	27.18	27.81	28.29	27.31	25.68
11	24.03	24.67	25.18	25.59	24.69	23.31
12	20.81	21.38	21.71	22.02	21.37	20.28
13	21.75	22.30	22.71	23.08	22.30	21.12
14	19.93	20.48	20.77	21.06	20.49	19.44
15	16.73	17.21	17.38	17.64	17.15	16.42

4.2.2 Local PMP: Intense local thunderstorms can produce short duration rains for small basins. Such storms, while producing the most intense point rainfalls of record, characteristically show a rapid decrease in rainfall with increase in area. The National Weather Service Hydrometeorological Report No. 49 (3) presents criteria to estimate thunderstorm PMP in terms of a one-hour, one-square mile isohyetal map. Reductions for areal variation are given for areas up to a maximum of 500 square miles. For storms less than one hour, areal reductions are only given for areas up to 200 square miles. The point values of the thunderstorm PMP at the plant site is presented as a depth-duration table in Table 5. The storm has a maximum duration of six hours. For this study, no flood hydrograph determination was necessary. The point value of the peak rainfall was utilized to determine peak instantaneous flows within the plantsite.

TABLE 5

DEPTH-DURATION TABLE
THUNDERSTORM PMP ESTIMATE

DURATION (HRS.)	1/4	1/2	1	2	3	4	5	6
DEPTH (IN.)	2.15	3.50	5.00	6.30	7.05	7.50	7.90	8.25

4.3 Unit Hydrograph: The unit hydrograph for each sub-basin was obtained by synthetically relating the unit hydrograph obtained by optimization at the Jacoby Creek gage. A relationship with the basin characteristics, L, Lca, and S was developed to obtain the

Clark's time of concentration, Tc, and storage coefficient, R for each of the sub-basin. After several trials an empirical relationship was calibrated with the unit hydrograph obtained at the Elk River gage from the 1964 flood. The final equations found applicable to determine the unit hydrograph for the sub-basins are:

$$Tc = 3.160\ (LLca/S^{1/2})^{1/2} \quad (1)$$

$$R = 5.293\ (LLca/S^{1/2})^{1/3} \quad (2)$$

where:

- Tc = Clark's time of concentration.
- R = Clark's storage coefficient.
- L = Length of the longest watercourse from the point of interest to the watershed divide in miles.
- Lca = Length of the watercourse from the point of interest to the intersection of the perpendicular from the centroid of the basin to the stream alignment in miles.
- S = Overall slope of the longest watercourse in feet per mile.

Table 6 shows the sub-basin characteristics with their corresponding Clark's unit hydrograph parameters. "A" unit hydrographs for sub-basins 3, 14, and 15 were considered to be a single-ordinate unit hydrograph for each sub-basin. This method was utilized because the sub-basins are large bodies of water where

runoff is considered 100% and instantaneous.

4.4 Loss Rates: Loss rates for each of the sub-basin were based on the loss rates exhibited at the Jacoby Creek during the December 1955 flood. It was assumed that the saturated condition during the historical rainflood would represent the general-type PMF loss rates.

The following loss rate parameters were used:

STRKR = 0.02

DLTKR = 1.73

RTIOL = 10.13

ERAIN = 0.43

The above parameters are defined as follows:

STRKR = The starting value of loss coefficient on exponential recession curve for rain losses.

DLTKR = The amount of initial accumulated rain loss during which the loss rate coefficient is increased. This parameter is considered to be a function primarily of antecedent soil moisture deficiency and is usually dependent.

RTIOL = The ratio of rain loss coefficient on exponential loss curve to that corresponding to 10 inches more

of accumulated loss.

ERAIN = The exponent of precipitation for rain function that reflects the influence of precipitation rate on basin -average loss characteristics.

4.5 <u>Flood Hydrograph Computation:</u> The PMF inflow hydrographs to the power plant site were derived with the aid of the computer program HEC-1, using the estimated storms, unit hydrograph and loss rates as input.

In routing the flood that would affect the plantsite, the basin modeling and combining options in HEC-1 were used. The flood flows from sub-basins 1, 2, and 3 were routed and combined at an arbitrary point SB shown in Figure 1. The flood flows from sub-basins 4, 5, 6, and 9 were routed and combined at a point called MB. The flood flows from sub-basins 7, 8, 12, 10, 11, 13, and 14 were routed and combined at a point called NB. The combined flow at NB was routed with and through sub-basin 15 to a point near the plant. Then all four hydrographs were combined at the plantsite.

Sub-basin 15 was considered to be a large channel. Storage and discharge relationships were developed for this sub-basin in order to utilize the storage routing technique called "Modified Puls."

Table 7 shows a summary of peak inflows and 5-day volumes of probable maximum flood at the plant site.

Figures 6 through 11 show the hydrograph of the different cool-season PMF.

4.6 <u>Flood Elevations:</u> Water surface profiles were run through sub-basin 15 to determine the elevations under various conditions of

the PMF. To provide a very conservative analysis, the flood profiles were run through the bay under the mean high high water (MHHW) level of 6.7 ft. The U.S. Army Corps of Engineers computer program, HEC-2 (13) was used to develop the profiles.

Table 7 shows the water surface elevation at the bay near the plantsite during the various probable maximum floods. It can be seen that the increase in water levels are insignificant.

TABLE 7

PROBABLE MAXIMUM FLOOD PEAKS AND LEVELS

HUMBOLDT BAY PLANT UNIT 3

PMP EVENT	PMP INFLOW (cfs)	5-DAY VOLUME (ac-ft.)	BAY W.S. ELEV[1] (ft.)	FREEBOARD[2] (ft.)
OCT.	108,070	256,150	6.79	5.21
NOV.	103,920	262,350	6.79	5.21
DEC.	99,460	267,060	6.78	5.22
JAN.-FEB.	97,670	270,940	6.77	5.23
MAR.	97,490	263,180	6.77	5.23
APR.	96,030	248,280	6.77	5.23

NOTES: 1. Elevation is based on National Ocean Survey Datum of Mean Lower Low Water level of zero at North Spit tidal gage and transposed to the plant site. Antecedent bay level was assumed equal to 6.7 feet above mean lower low water.

2. Freeboard is reckoned from the plant yard elevation of 12 feet MLLW.

5 WIND AND WAVE ACTION

5.1 General: The estimated maximum surcharge level that might be attained during the probable maximum flood represents the maximum stillwater level that would be considered for freeboard requirement. However, because of wind movement, determination of wave heights and runup on the embankment along the shoreline are usually a concern in connection with evaluating freeboard allowances.

5.2 PMP Wind: During the probable maximum flood condition, the U.S. Weather Bureau (2) presents estimates of wind velocities that would prevail during the probable maximum precipitation. Because the wind in the PMP procedure is generally used for optimum snowmelt calculation, the time distribution sequence is the same as that of the precipitation and temperature. In other words, the maximum wind velocity occurs on the 40th hour together with the maximum precipitation. Velocity-duration decay function was based on Figure 5-25 of HMR 36 (2).

The criteria for estimating the PMP thunderstorm does not include a method for determining the coincident wind velocities. However, U.S. Weather Bureau study (16) states that "in the local thunderstorm situation, the prevailing surface wind is only approximately in the direction of the storm's movement. Before the thunderstorm reaches a particular locality the prevailing wind slackens almost to a calm, changes direction to flow toward the storm, and freshens and the storm approaches. Just before the rain

starts, the wind shifts abruptly to blow in violent gusts outward from the rain area, reaching its maximum velocities during or just before the period of heavy rain, which occurs in the early portion of the storm. As the rain subsides, the wind also diminishes and resumes its prevailing direction."

In view of the short duration of the thunderstorm and the minimal effect of the wind to generate extreme waves, no calculation for thunderstorm wave runup was made. The volume of the 6-hour thunderstorm would not raise the bay to any significant level as to be of concern to plant safety.

5.3 Windstorm: The Department of Water Resources of the State of California published recorded windstorms in California (15). According to the report, the maximum fastest mile wind recorded at Eureka for 66 years of record has a speed of 56 miles per hour coming from the southwest. In the same report, a 100-year wind is estimated to have a speed of 62 miles per hour.

5.4 Tornado: The same report of the Department of Water Resources (15) indicated that a tornado occurred at McKinleyville on March 28, 1958 at 1340 hours. McKinleyville is about 15 miles northeast of the plantsite at latitude 40 degrees 55 minutes, longitude 124 degrees 7 mintues. The length of the tornado was 1610 metres and a width of 183 metres and covered an area of 0.29 square kilometers.

5.5 <u>Tropical Storms:</u> Tropical Pacific storms off the west coast of Mexico are a potential source of high winds. However, extreme winds from tropical storms have not been recorded in the Eureka area.

5.6 <u>Effective Fetch:</u> Fetch is the continuous area of water over which the wind blows in an essentially constant direction (sometimes used synonymously with fetch length); it is also termed the generating area. Fetch length is the horizontal distance (in the direction of the wind) over which the wind blows.

The Environmental Report (7) indicates that the prevailing wind at the site is from the north. This direction happens to be the one with the longest fetch towards the plant.

Figure 12 shows the effective fetches analyzed in the study.

5.7 <u>Wave Analysis:</u> Runup was determined with the aid of the micro-computer program WRUP developed by Noble Software, Inc. (4). Set-up was calculated by the modified Zuider Zee formula. Table 8 shows a summary of the wave runup and setup analysis for the revetment with a 2:1 slope.

Fetch A which is 2.63 miles was found to be the most critical. However, since it is 22.5 degrees from the perpendicular to the revetment, it was adjusted by the cosine of the angle.

TABLE 8

ESTIMATES OF WAVE RUNUP

PMF MONTH	DESIGN WIND (mph) OVERLAND	OVERWATER	PERIOD (sec)	RUNUP (ft.)	SETUP (ft.)	TOTAL RUNUP ABOVE MLLW (ft.)	FREEBOARD*
OCT.	27	33	2.5	1.6	0.3	8.7	7.3
NOV.	31	38	2.3	1.6	0.4	8.8	7.2
DEC.	36	45	2.5	1.9	0.5	9.2	6.8
JAN.-FEB.	40	49	2.6	2.0	0.6	9.4	6.6
MAR.	36	45	2.5	1.9	0.5	9.2	6.8
APR.	31	38	2.3	1.6	0.4	8.8	7.2
WINDSTORM	56	69	2.9	2.7	1.2	10.7	5.3
100-YEAR	62	77	3.0	3.0	1.5	11.3	4.7
ARBITRARY	100	124	3.5	4.9	4.0	14.7	1.3

* Reckoned from the top of the revetment which is at Elev.16 above MLLW using PG&E survey data dated January 12, 1983.

6 PLANTSITE DRAINAGE

6.1 General: Potential flooding of the plantsite from the probable maximum precipitation was investigated. Because of the small drainage area of the plant yard, only point values of the PMP were used.

6.2 Peak Flows: Table 9 shows a tabulation of the peak flows from the PMP of different months. Point values based on the time of concentration of 15 minutes calculated by the Kerby formula, were used with the "rational" formula, $Q = CiA$. Q is the peak instantaneous flow; C is the runoff coefficient which was assumed equal to 1; i is the intensity of rainfall and A is the plantsite drainage area of 53.2 acres.

6.3 Plant Yard Flooding: No specific flood routing was done through the plant yard drainage. Instead it was assumed that the total 72-hour PMP would fall directly into the total drainage. The volume of the 72-hour PMP was estimated to inundate the areas less than Elevation 9 feet (MLLW). Figure 13 shows the flood plain map from the October PMF. Figure 14 shows the flood plain map from the thunderstorm PMF.

TABLE 9

PLANTSITE DRAINAGE

PMF PEAK FLOWS AND RUNOFF VOLUME

PMF MONTH	15-MINUTE RAINFALL INTENSITY (in./hr.)	72-HOUR PMP (in.)	TOTAL RUNOFF VOLUME (cu.ft.)	PEAK DISCHARGE (cfs)
OCT.	6.9	17.70	3,417,000	367
NOV.	6.2	18.20	3,513,000	330
DEC.	5.5	18.42	3,556,000	293
JAN.-FEB.	5.2	18.69	3,608,000	277
MAR.	5.4	18.17	3,507,000	287
APR.	5.5	17.40	3,359,000	293
THUNDERSTORM PMP *	8.60	8.25	1,592,000	458

* 6-hr. duration only.

7 TSUNAMI

7.1 General: The incidence of tsunami waves in Humboldt Bay at the powerplant site was evaluated using three sources of documents. These documents which are references 16, 17, and 18 are as follows:

(a) Tsunamis at the Site of the Pacific Gas and Electric Company Power Plant at Buhne Point, Humboldt Bay, California by R.L. Wiegel, October 1965.

(b) "Tsunami Atlas for the Coasts of the United States," NUREG/CR-1106, TC-486, November 1979.

(c) "Type 16 Flood Insurance Study: Tsunami Predictions for the West Coast of the Continental United States," Technical Report H-78-26, December 1978

7.2 Wiegel Report: This report, presented information on the probabilities of tsunamis of various heights that could occur at Buhne Point in Humboldt Bay. Professor Wiegel indicated that a "probable tsunami" at the site would have a 63% chance of occurrence relative to the life of the plant. From a statistical method using Poisson's distribution , the report made the following findings:

(a) If the plant life is assumed equal to 50 years, the probable tsunami would have a wave height of 8

feet (trough to crest). It would have a runup of +7 feet above mean lower low water (MLLW). Such a tsunami, which has a return interval of 47 years, would not exceed the plant yard elevation of +12 feet above MLLW and would have no effect on the Unit.

(b) A probable tsunami with a return interval of 170 years and still has a 63 percent of occurrence, would have a wave height of 15 feet and a runup of +10.5 feet above MLLW. Such a runup would approach yard elevation but still below the revetments near the shores of the bay.

(c) A tsunami with a wave height of 34 feet (runup elevation of +20 feet above MLLW) has a return interval of 5,000 years (63 percent risk). A tsunami of this magnitude would flood the plant site 8 feet above yard grade.

7.3 Probable Highest Tsunami: A study done for the Nuclear Regulatory Commission by Tetratech, Inc. (NUREG/CR-1106, TC-486) presented the results to determine the distribution of offshore wave heights and time histories for coastal segments of the United due to distantly generated tsunamis. The hypothetical tsunamis addressed in the report are considered generated by vertical displacement of the sea floor with very large earthquakes. (17)

The study does not consider the effects of locally generated major tsunamis since the local bathymetry and the small scale features of bottom displacement are very important in these cases.

Instead the study shows wave histories at offshore stations in water of moderate depth (600 feet). In regions of simple bathymetry, this depth corresponds to the edge of the continental shelf. The wave history for the station off Eureka is shown in Figure 15.

According to the Atlas, the upper bound of the wave displacement generated by the tsunami is about 5.2 feet from the still water level at the station offshore of Eureka. From the figure, the period of the maximum wave is taken as 3,100 seconds, or about 1.03 hours.

As the tsunami propagates to the shore, its amplitude increases due to friction of the ocean bottom, wave refraction, and shoaling effects. Reference 18 is used to predict the wave displacement at the mouth of Humboldt Bay with the following assumptions:

(a) The smallest depth at the entrance to Humboldt Bay is 12.4 feet

(b) Energy is conserved between the station with water depth of 600 feet and the shore line for an unrefracted tsunami. As a result, Equation 49 of reference 18 is used to relate wave height and water depth between the two stations, as follows:

$$\frac{H_2}{H_1} = \left(\frac{d_1}{d_2}\right)^{\frac{1}{4}}$$

where: H = wave height measured from trough to crest

d = water depth

(c) Bay water is at mean sea level during the arrival of the probable highest tsunami.

From Figure 15, the wave height of the probable highest tsunami is:

$$H = 4.4 + 5.2$$
$$= 9.6 \text{ ft.}$$

The wave height at the shore depth of 12.4 feet is:

$$\frac{H_2}{H_1} = \left(\frac{d_1}{d_2}\right)^{\frac{1}{4}}$$

$$H_2 = H_1 \left(\frac{d_1}{d_2}\right)^{\frac{1}{4}}$$

$$= (9.6) \left(\frac{600}{12.4}\right)^{\frac{1}{4}}$$

$$= 25.32 \text{ feet}$$

Assuming a still water at mean sea level (3.39 feet) and wave displacements above and below stillwater are equal, (runup = drawdown) the crest of the tsunami is at:

$$\text{Elev.} = 1/2\ (25.32) + 3.39$$

$$= 16.1 \text{ ft. above MLLW.}$$

Once the probable highest tsunami passes through the mouth of the Bay, its amplitude would probably decrease due to the divergence effects as the wave propagates north and south.

The 1983 survey along the crest of the revetment near the power plant indicates that the average crest elevation is 16 feet above MLLW. Therefore, even if the probable highest tsunami retains its magnitude traveling to the revetment, the amount of overtopping insignificant.

7.4 100-and 500-year Tsunami: Reference 19 was prepared for the Federal Insurance Administration by the Corps of Engineers for use in flood insurance rate calculations. From this publication the following wave runups were estimated at the plant site:

100 -yr. tsunami = 10.6 ft. (MLLW).

500 -yr. tsunami = 20.7 ft. (MLLW).

The above values include the effects of astronomical tides. They were obtained from Figure 16.

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2. U.S. Weather Bureau, "Interim Report, Probable Maximum Precipitation in California," Hydrometeorological Report No. 36, Washington, D.C., October 1961 with revisions dated October 1969.

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17. Brandsma, M., Divoky, D. and Hwang, L., "Tsunami Atlas for the Coasts of the United States ," NUREG/CR-1106, TC-486, Prepared by Tetra Tech, Inc. for the U.S. Nuclear Regulatory Commission, November 1979.

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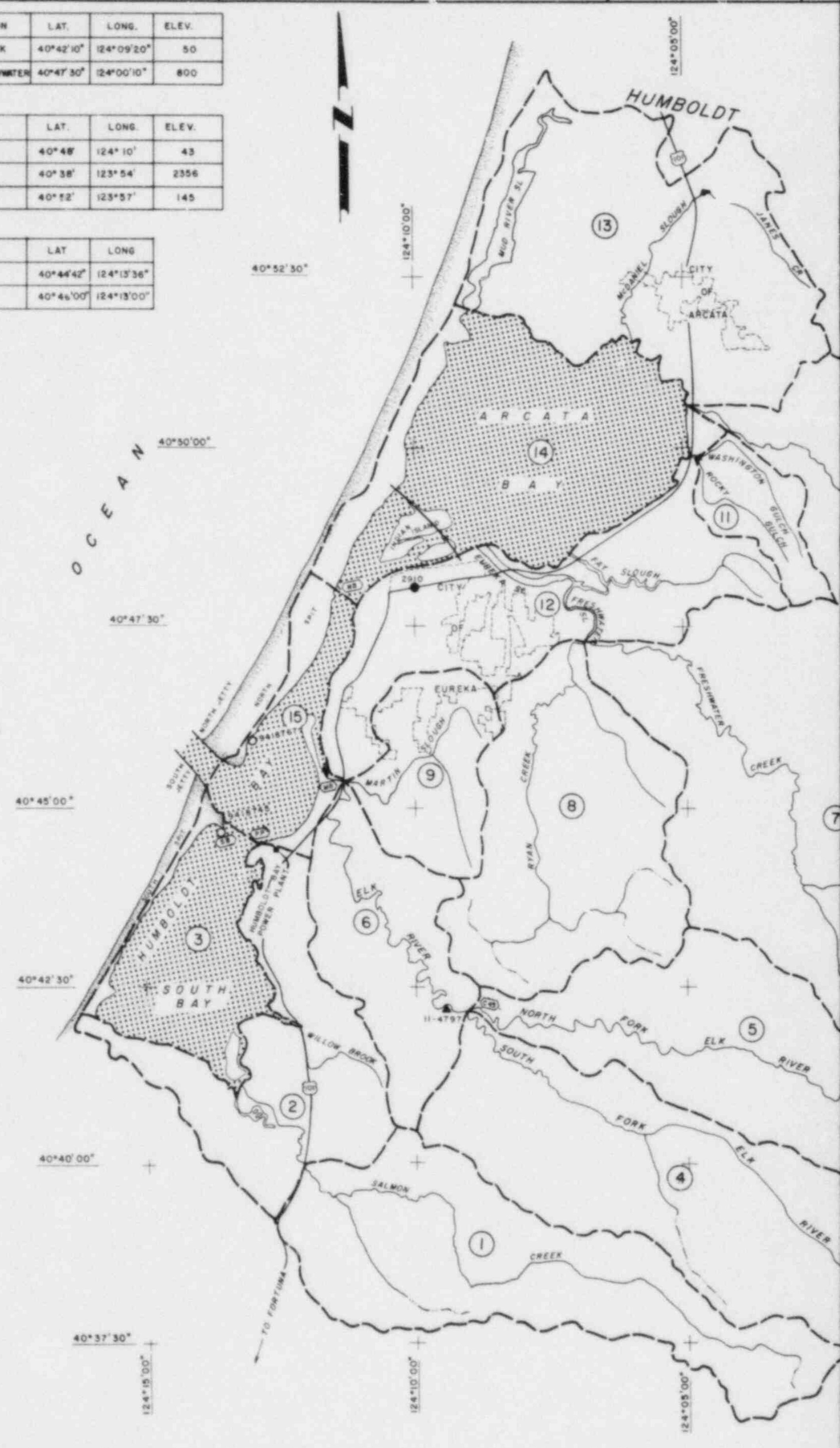
19. Houston, J.R. and Garcia, A. W., "Type 16 Flood Insurance Study: Tsunami Predictions for the West Coast of the Continental United States," Technical Report H-78-26, U.S. Army Engineer Waterways Experiment Station, Vickburg, Mississippi, December 1978.

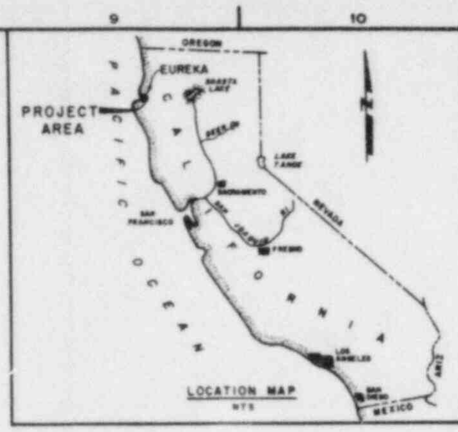
STA. NO.	STREAM GAGING STATION	LAT.	LONG.	ELEV.
11-4797	ELK RIVER NEAR FALK	40°42'10"	124°09'20"	50
11-4800	JACOBY CREEK NEAR FRESHWATER	40°47'30"	124°00'10"	800

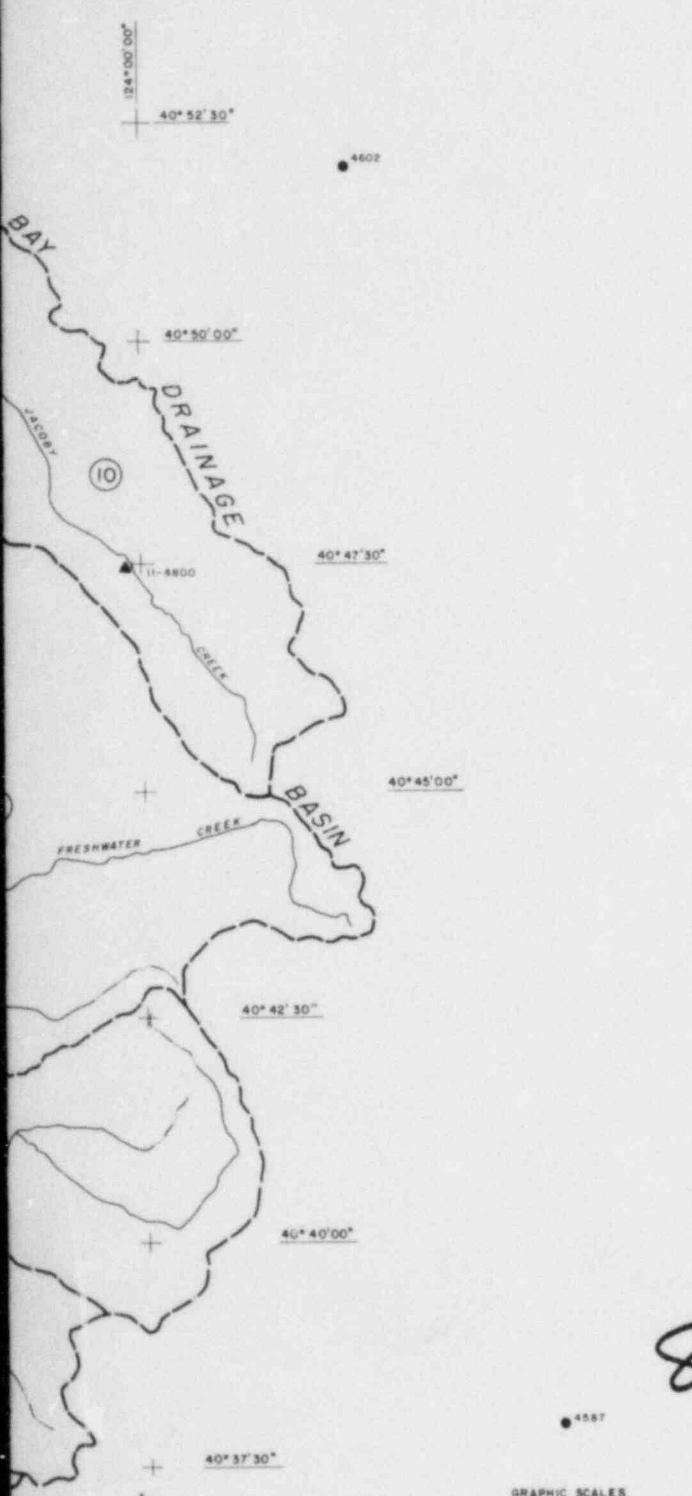
STA. NO.	WEATHER STATION	LAT.	LONG.	ELEV.
2910	EUREKA W.B. CITY	40°48'	124°10'	43
4587	KNEELAND 10 SSE	40°38'	123°54'	2356
4602	KORBEL	40°52'	123°57'	145

STA. NO.	TIDE STATION	LAT	LONG
9418745	SOUTH JETTY	40°44'42"	124°13'36"
9418767	NORTH SPIT	40°46'00"	124°13'00"



NO.	DATE	DESCRIPTION					NO.	DATE	DESCRIPTION
REVISIONS									





LEGEND

- DRAINAGE BASIN BOUNDARY
- RIVERS OR CREEKS
- EPHEMERAL CREEKS
- 101 ROADS
- 1 BASIN NUMBER
- 11-4800 U.S.G.S. STREAM GAGE / I.D. NUMBER
- 2910 WEATHER STATION / I.D. NUMBER
- 9418765 TIDE STATION / I.D. NUMBER
- H8 HYDROGRAPHS COMBINING STATIONS
- CITY LIMITS

NOTES:

1. THE BASE MAP IS TRACED AND REDUCED FROM U.S.G.S. QUADRANGLES 1:24 000 TO 1:48 000.

   ARCATA NORTH 1959, PR. 1972.
   ARCATA SOUTH 1959, PR. 1972.
   CANNIBAL ISLAND 1959, PR. 1972.
   EUREKA 1958, PR. 1972.
   FIELDS LANDING 1959, PR. 1972.
   HYDESVILLE 1979.
   IAQUA BUTTES 1979.
   KORBEL 1972.
   McWHINNEY CREEK 1979.
   TYEE CITY 1959, PR. 1972.

2. STREAM GAGING STATION LOCATIONS ARE FROM THE U.S.G.S. SURFACE WATER SUPPLY RECORD, U.S. DEPARTMENT OF INTERIOR.
3. WEATHER STATION LOCATIONS ARE FROM THE NATIONAL CLIMATOLOGICAL DATA, DEPARTMENT OF COMMERCE.
4. TIDE STATION LOCATIONS ARE FROM THE U.S. NATIONAL OCEAN SURVEY, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE.

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GRAPHIC SCALES

1 0 1 2 3 4 MILES
4000 0 4000 8000 12000 16000 20000 FEET
1 0 1 2 3 4 5 6 KILOMETERS

FIGURE 1

CIVIL HYDROLOGIC ENGINEERING
WATERSHED MAP
HUMBOLDT BAY BASIN
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

NSHQ
SCALES AS SHOWN

1 | 6-28-85 | ISSUED FOR NRC

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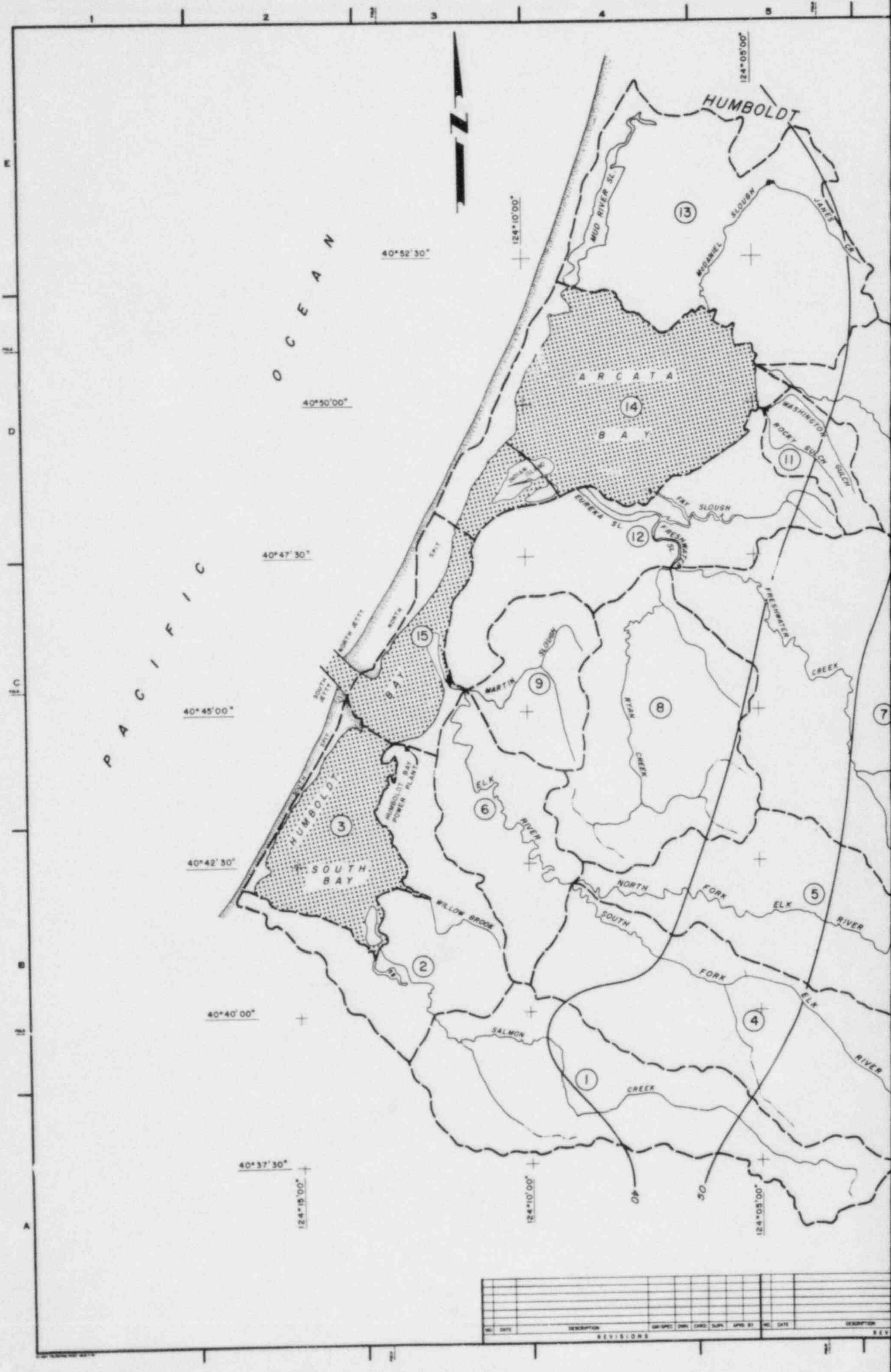
SHEET NO 473572
REV 1



PACIFIC OCEAN
HUMBOLDT
ARCATA BAY
HUMBOLDT SOUTH BAY
BAY
HUMBOLDT BAY POWER PLANT
MAD RIVER SL.
McDANIEL SLOUGH
JANES CR.
WASHINGTON
ROCKY GULCH
EUREKA SL.
FAY SLOUGH
FRESHWATER SL.
FRESHWATER CREEK
MARTIN SLOUGH
RYAN CREEK
ELK RIVER
NORTH FORK ELK RIVER
SOUTH FORK ELK RIVER
WILLOW BROOK
SALMON CREEK
NORTH JETTY
SOUTH JETTY
N
40°52'30"
40°50'00"
40°47'30"
40°45'00"
40°42'30"
40°40'00"
40°37'30"
124°15'00"
124°10'00"
124°05'00"
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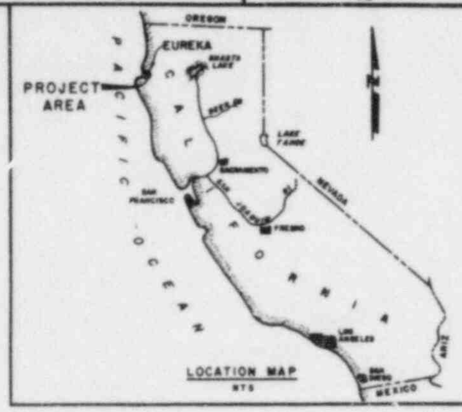
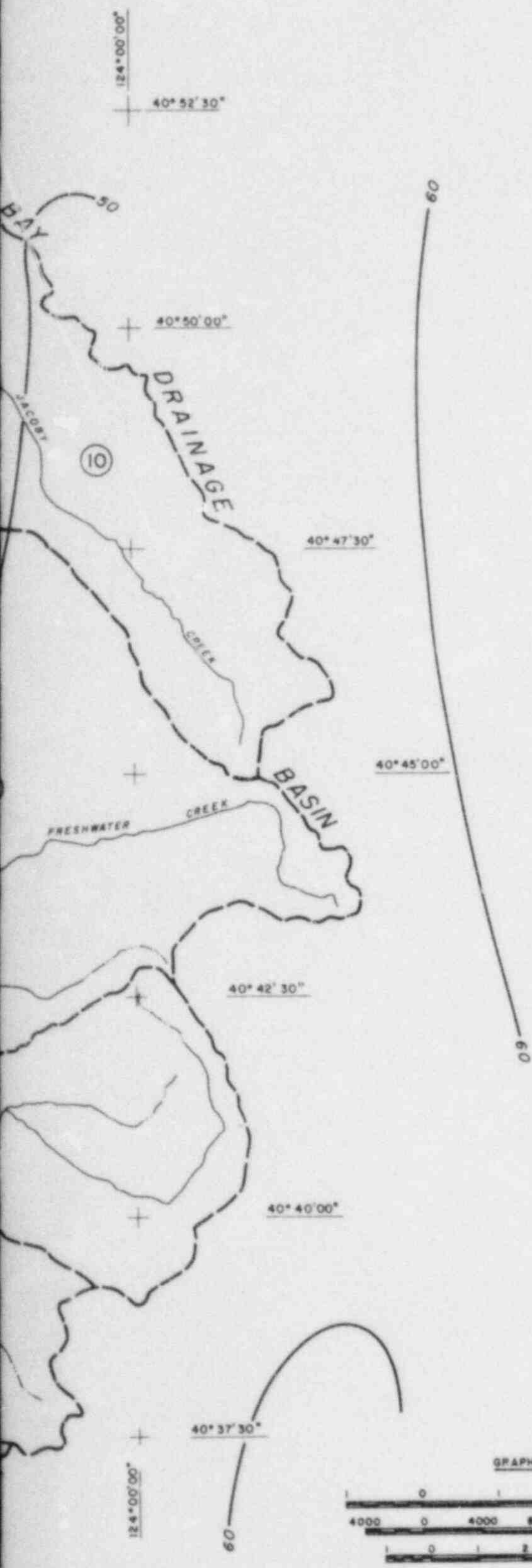
REVISIONS



LOCATION MAP
NTS



LEGEND

- DRAINAGE BASIN BOUNDARY
- RIVERS OR CREEKS
- EPHEMERAL CREEKS
- —60— ISOHYETAL LINES IN INCHES
- ◯ BASIN NUMBER

NOTES:

1. THE BASE MAP IS REDUCED AND TRACED FROM U.S.G.S. QUADRANGLES 1:24,000 TO 1:48,000
   - ARCATA NORTH 1959, PR. 1972.
   - ARCATA SOUTH 1959, PR. 1972.
   - CANNIBAL ISLAND 1959, PR. 1972.
   - EUREKA 1958, PR. 1972.
   - FIELDS LANDING 1959, PR. 1972.
   - HYDESVILLE 1979.
   - IAQUA BUTTES 1979.
   - KORBEL 1972.
   - McWHINNEY CREEK 1979.
   - TYEE CITY 1959, PR. 1972.
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GRAPHIC SCALES

1 0 1 2 3 4 MILES

4000 0 4000 8000 12000 16000 20000 FEET

1 0 1 2 3 4 5 6 KILOMETERS

8507250019-02

FIGURE 2

1 | 6-28-85 | ISSUED FOR NRC

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CIVIL HYDROLOGIC ENGINEERING

MEAN ANNUAL PRECIPITATION

HUMBOLDT BAY BASIN

DEPARTMENT OF ENGINEERING

PACIFIC GAS AND ELECTRIC COMPANY

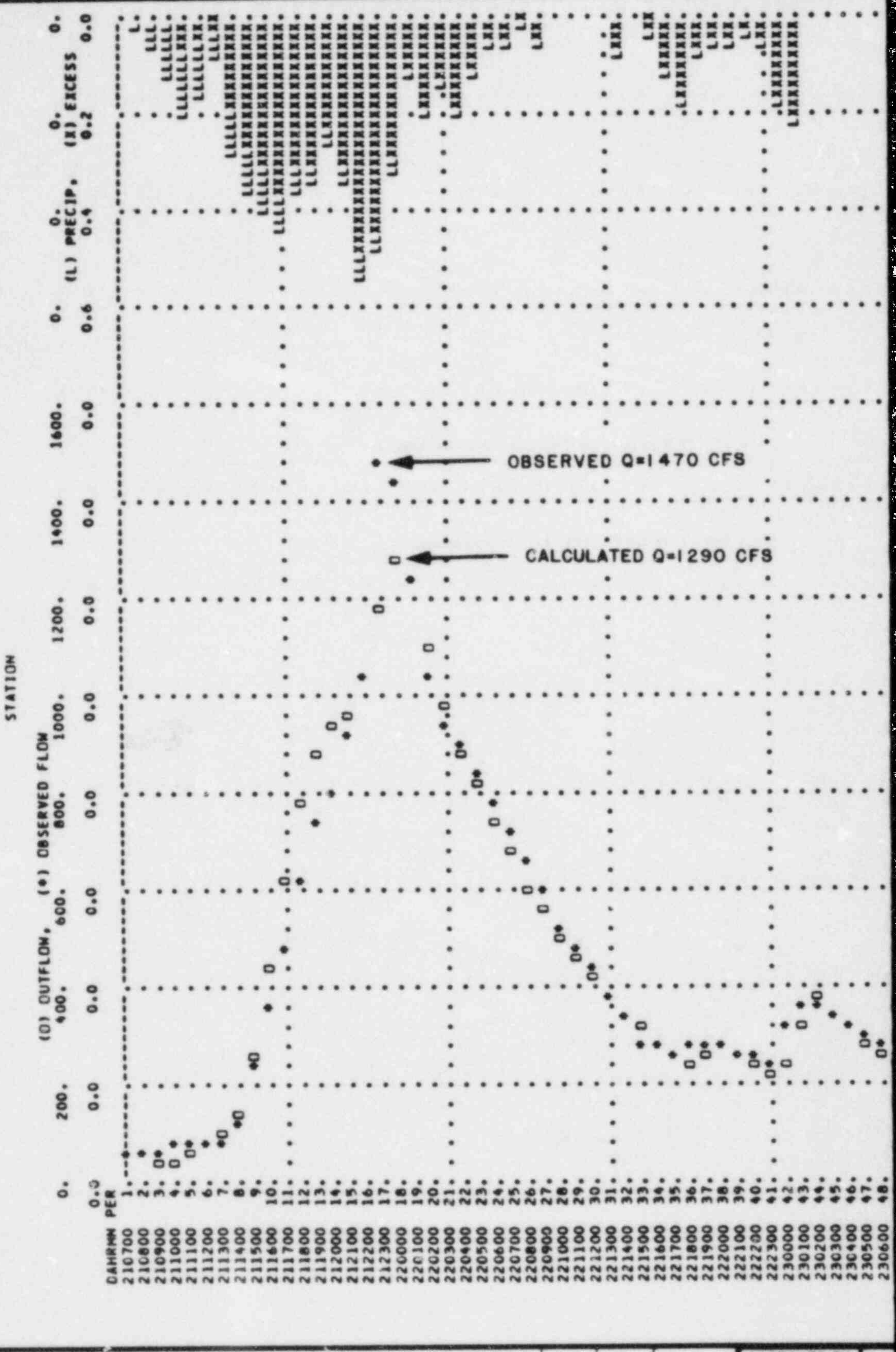
SAN FRANCISCO, CALIFORNIA

SCALES AS SHOWN

DIVISION HUMBOLDT

473573 | REV 1

106871



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1	7-3-85	ISSUED FOR NRC	T.L.	[illegible]	[illegible]

TABLE OF CHANGES

APPROVED BY

230700 49.
230800 50. .0*
230900 51. --------0-0---------: (-) LIMITS OF OPTIMIZATION

OBSERVED AND CALCULATED FLOWS IN
CUBIC FEET PER SECOND (CFS)
PRECIPITATION IN INCHES (IN)

DRAINAGE AREA . . . . 6.07 SQUARE MILES
RAIN . . . . .7.78 INCHES
RAIN EXCESS . . . . . . .5.41 INCHES

BASIN MEAN ANNUAL PRECIPITATION = 55.00 INCHES
PRECIPITATION PATTERN STATION = 4587, KNEELAND 10 SSE

NOTE:
RECONSTITUTION OF FLOOD PERFORMED WITH THE AID OF THE U.S. ARMY CORPS OF ENGINEERS, "FLOOD HYDROGRAPH PACKAGE," COMPUTER PROGRAM 723-X6-L2010, HEC-1, THE HYDROLOGIC ENGINEERING CENTER, DAVIS, CALIFORNIA, SEPTEMBER 1981.

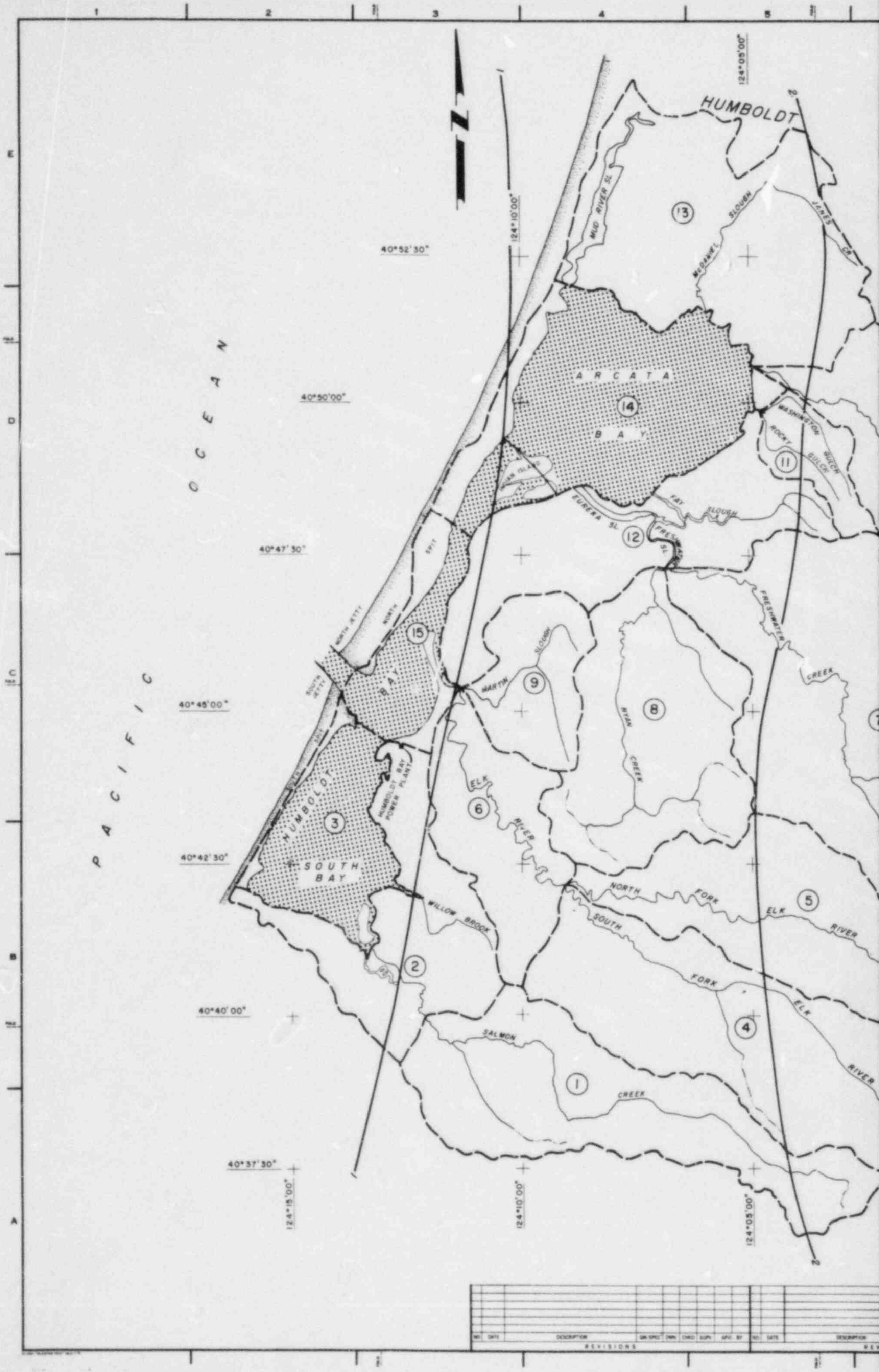
REGISTERED PROFESSIONAL ENGINEER
RICHARD V. BETTINGER
No. 7865
CIVIL
STATE OF CALIFORNIA

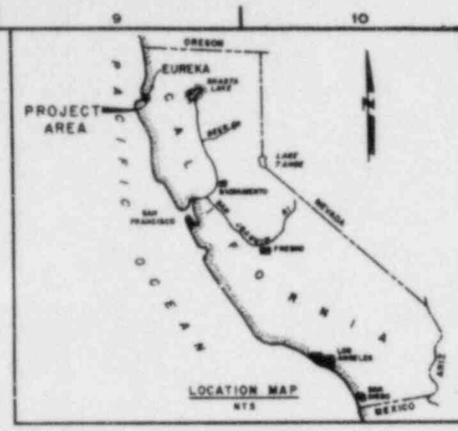
HUMBOLDT DIVISION

FIGURE 3

MICROFILM

NSHQ DRAWN MM CALLEJAS CHECKED S.C. LAU DESIGN T. LESOV APPROVED A. P. Urbina M.M. Callejas DATE 7-3-85 SCALE AS SHOWN	CIVIL-HYDROLOGIC ENGINEERING FLOOD HYDROGRAPH RECONSTITUTION DECEMBER 21-23, 1955 114800. JACOBY CREEK NEAR FRESHWATER DEPARTMENT OF ENGINEERING PACIFIC GAS AND ELECTRIC COMPANY SAN FRANCISCO, CALIFORNIA	BILL OF MATL DWG LIST SUPERSEDES SUPERSEDED BY SHEET NO. SHEETS DRAWING NUMBER 106871 CHANGE 1


HUMBOLDT
PACIFIC OCEAN
ARCATA BAY
14
13
MUD RIVER SL
McDANIEL SLOUGH
JANES CR
WASHINGTON GULCH
ROCKY GULCH
11
EUREKA SL
FAY SLOUGH
FRESHWATER SL
12
FRESHWATER
NORTH SPIT
NORTH JETTY
SOUTH JETTY
15
BAY
MARTIN SLOUGH
9
RYAN CREEK
8
CREEK
ELK RIVER
6
HUMBOLDT BAY POWER PLANT
HUMBOLDT SOUTH BAY
3
WILLOW BROOK
2
NORTH FORK ELK RIVER
5
SOUTH FORK ELK RIVER
4
SALMON CREEK
1
40°52'30"
40°50'00"
40°47'30"
40°45'00"
40°42'30"
40°40'00"
40°37'30"
124°15'00"
124°10'00"
124°05'00"
REVISIONS



LEGEND

- DRAINAGE BASIN BOUNDARY
- RIVERS OR CREEKS
- EPHEMERAL CREEKS
- 3 — ISOHYETAL LINES IN INCHES
- (1) BASIN NUMBER

NOTES:

1. THE BASE MAP IS TRACED AND REDUCED FROM U.S.G.S. QUADRANGLES 1:24 000 TO 1:48 000.
   - ARCATA NORTH 1959, PR 1972.
   - ARCATA SOUTH 1959, PR. 1972.
   - CANNIBAL ISLAND 1959, PR. 1972.
   - EUREKA 1958, PR. 1972.
   - FIELDS LANDING 1959, PR. 1972.
   - HYDESVILLE 1979.
   - IAQUA BUTTES 1979.
   - KORBEL 1972.
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GRAPHIC SCALES

1 0 1 2 3 4 MILES

4000 0 4000 8000 12000 16000 20000 FEET

1 0 1 2 3 4 5 6 KILOMETERS

FIGURE 4

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DATE 6-28-85
SCALES AS SHOWN

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OROGRAPHIC PMP INDEX

HUMBOLDT BAY BASIN

DEPARTMENT OF ENGINEERING

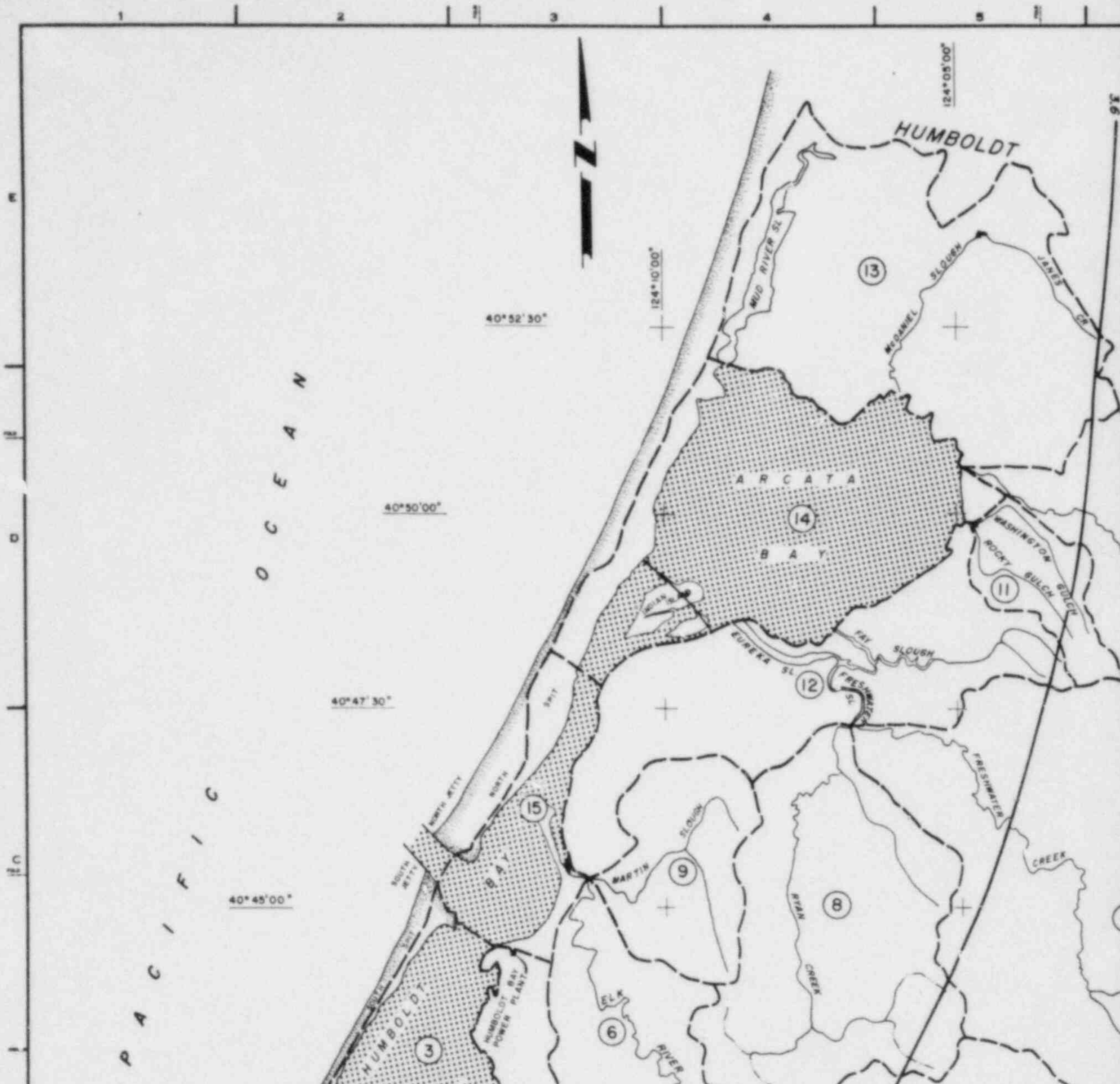
PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

MICROFILM

DIVISION HUMBOLDT

SHEET NO. 473574 REV 1



PACIFIC OCEAN
HUMBOLDT
MUD RIVER SL
13
McDANIEL SLOUGH
JANES CR
ARCATA BAY
14
WASHINGTON GULCH
ROCKY GULCH
11
FAY SLOUGH
EUREKA SL
12
FRESHWATER SL
FRESHWATER
CREEK
NORTH JETTY
SOUTH JETTY
NORTH SPIT
15
BAY
MARTIN SLOUGH
9
RYAN CREEK
8
ELK RIVER
6
HUMBOLDT BAY POWER PLANT
HUMBOLDT
3
SOUTH BAY
WILLOW BROOK
2
NORTH FORK ELK RIVER
5
SOUTH FORK ELK RIVER
4
SALMON
CREEK
1
40°52'30"
40°50'00"
40°47'30"
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40°42'30"
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40°37'30"
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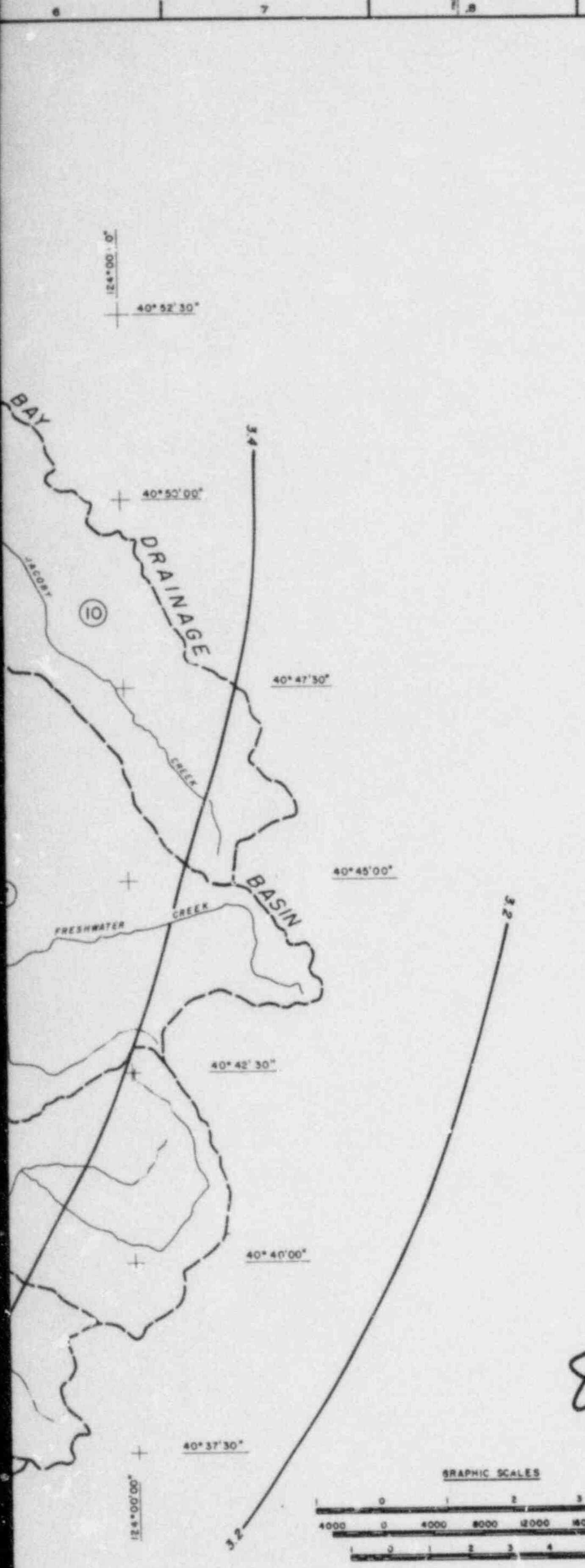
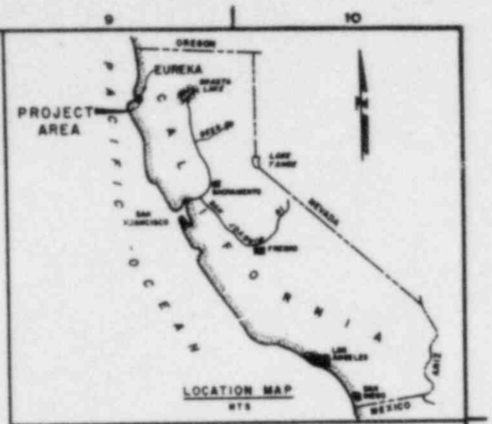
124°10'00"
124°05'00"
3.6
3.4
REVISIONS





LEGEND

- DRAINAGE BASIN BOUNDARY
- RIVERS OR CREEKS
- EPHEMERAL CREEKS
- 2 — ISOHYETAL LINES IN INCHES
- (1) BASIN NUMBER

NOTES:

1. THE BASE MAP IS TRACED AND REDUCED FROM U.S.G.S. QUADRANGLES 1:24 000 TO 1:48 000
   - ARCATA NORTH 1959, PR. 1972.
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   - EUREKA 1958, PR. 1972.
   - FIELDS LANDING 1959, PR. 1972.
   - HYDESVILLE 1979.
   - IAOUA BUTTES 1979.
   - KORBEL 1972.
   - McWHINNEY CREEK 1979.
   - TYEE CITY 1959, PR. 1972.
2. CONVERGENCE INDEX IS FROM U.S. WEATHER BUREAU "INTERIM REPORT PROBABLE MAXIMUM PRECIPITATION IN CALIFORNIA" HYDROMETEOROLOGICAL REPORT 36 WASHINGTON D.C., OCTOBER 1961 WITH REVISION OF 1969.

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FIGURE 5

CIV'L HYDROLOGIC ENGINEERING

CONVERGENCE PMP INDEX

HUMBOLDT BAY BASIN

DEPARTMENT OF ENGINEERING

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

DIVISION HUMBOLDT

SHEET NO 473575 REV 1

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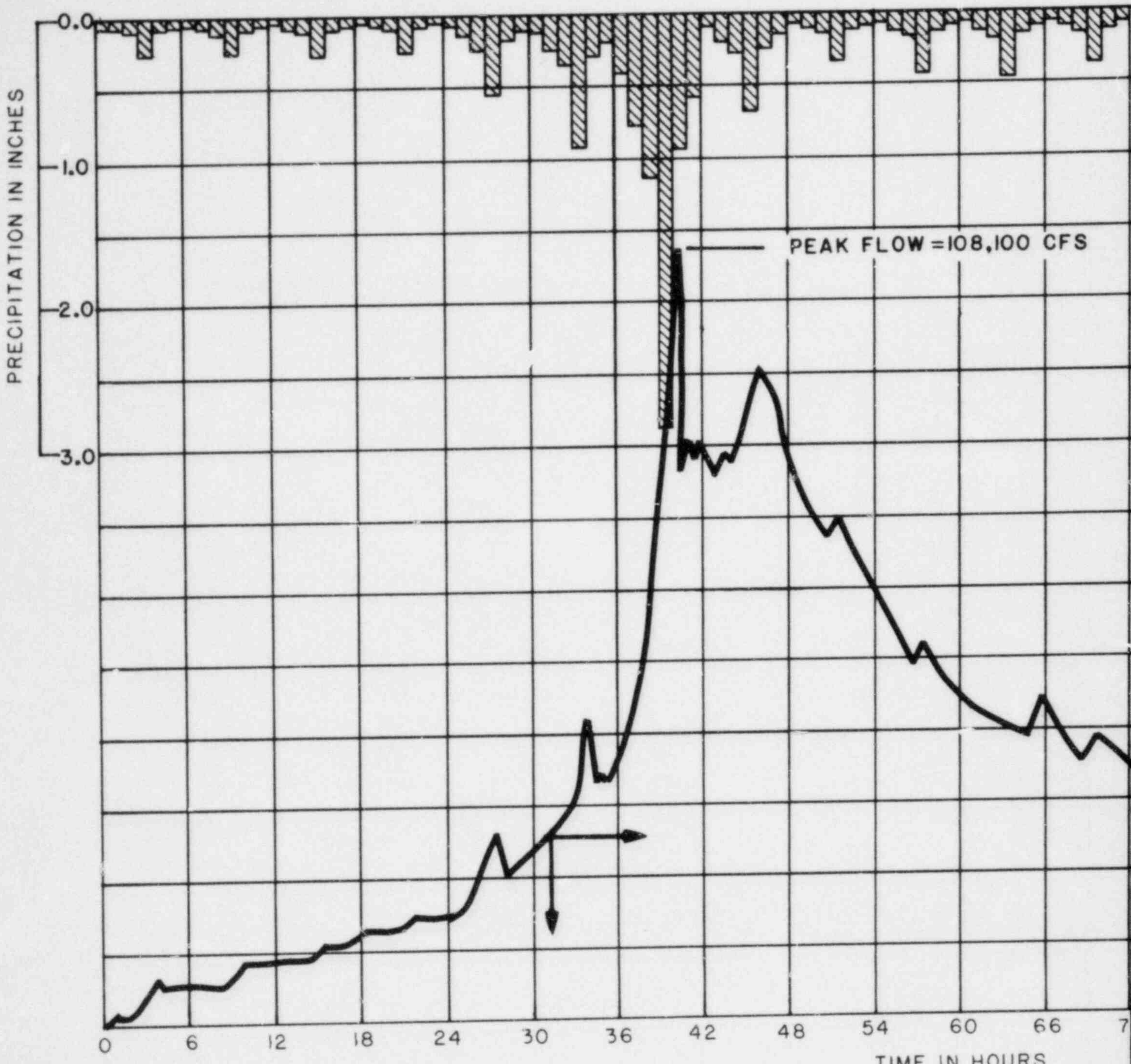
REVISIONS



NOTE
FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

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NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L		

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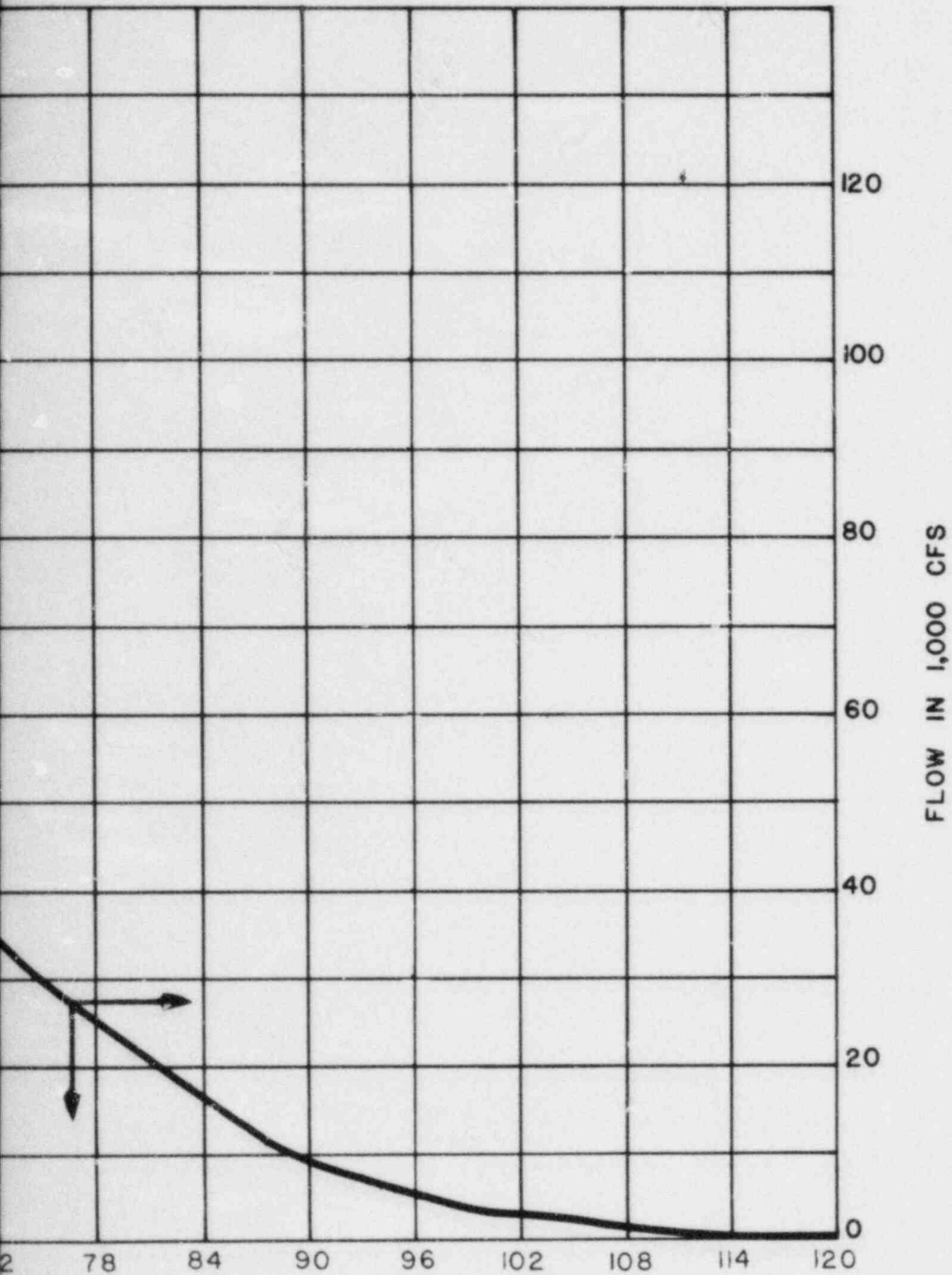

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RICHARD V. BETTINGER
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STATE OF CALIFORNIA

HUMBOLDT DIVISION

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FIGURE 6

MICROFILM

NSHQ	
APV.	M.M.CALLEJAS
CALC.	S.C. LAU
DWN	T. LESOV
CKD	A.P. Urbina
	M.M. Callejas
DATE	7-3-85
SCALE	AS SHOWN

CIVIL-HYDROLOGIC ENGINEERING

OCTOBER PMF HYDROGRAPH

HUMBOLDT BAY P.P. NO.3

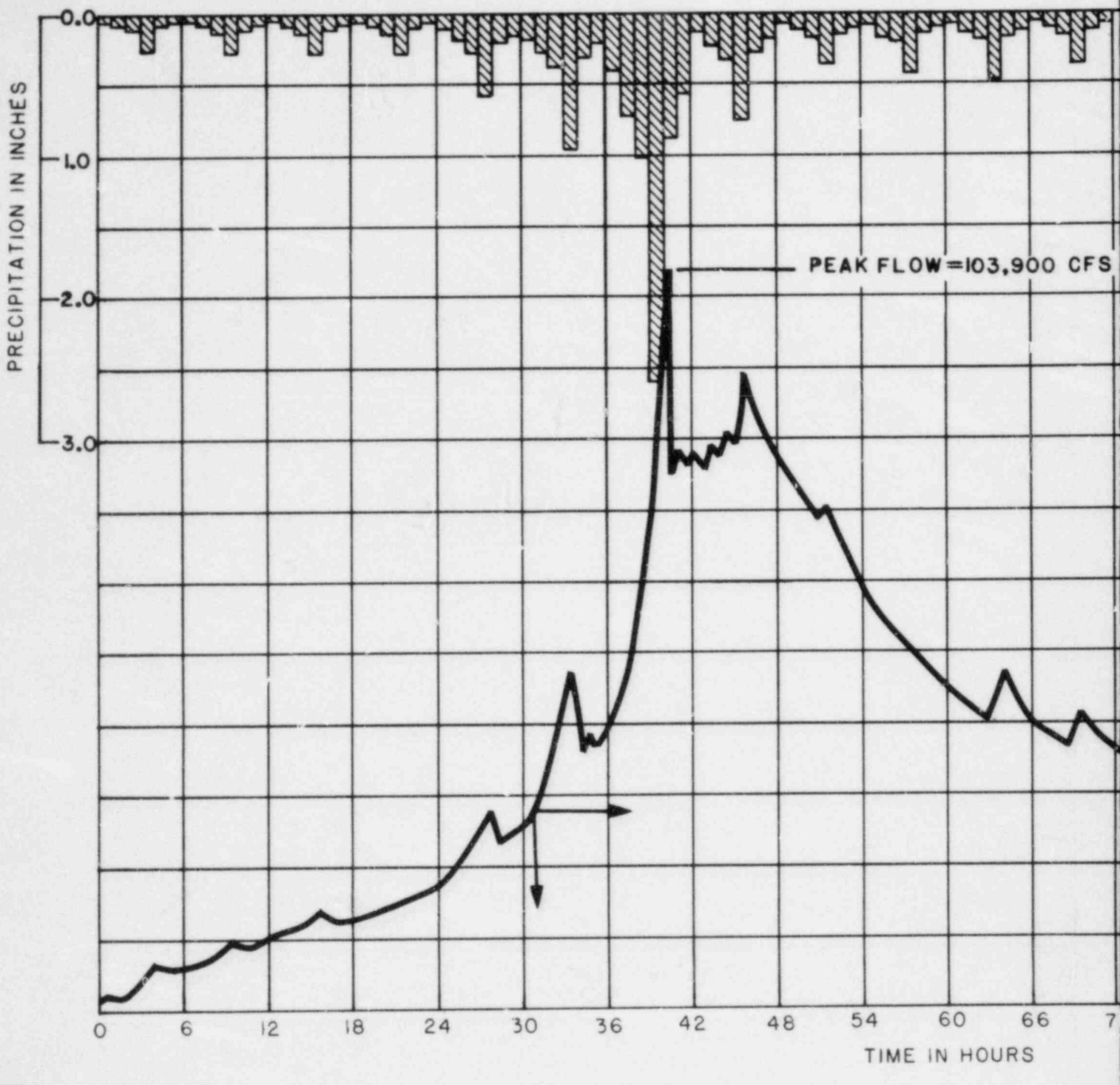
DEPARTMENT OF ENGINEERING

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

BILL OF MATL	
DWG LIST	
SUPERSEDES	
SUPERSEDED BY	
SHEET NO.	SHEETS
DRAWING NUMBER	CHANGE
106872	1

106873

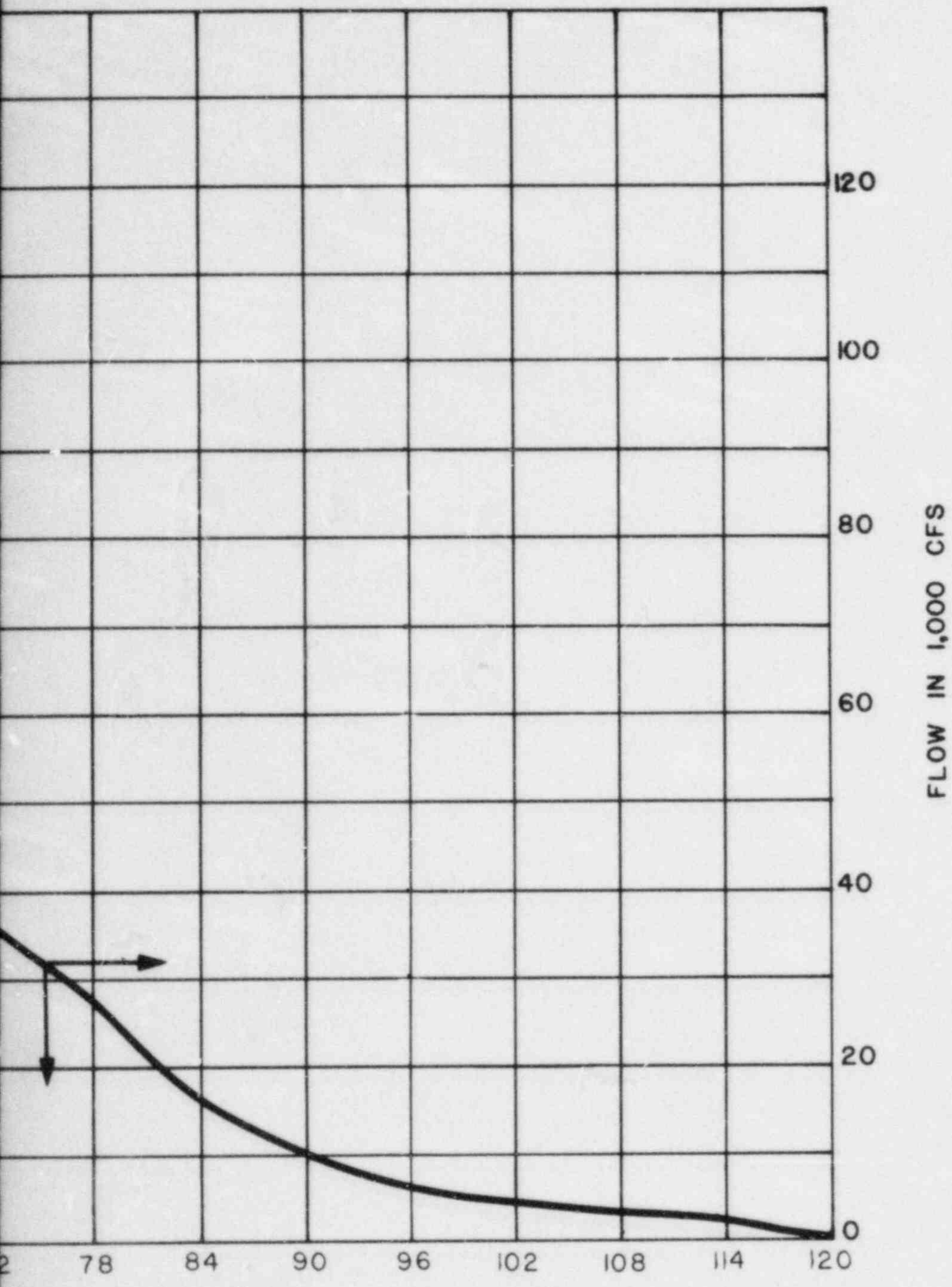


NOTE
FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.		

TABLE OF CHANGES

APPROVED BY



Also Available On Aperture Card

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REGISTERED PROFESSIONAL ENGINEER
RICHARD V. BETTINGER
No. 7866
CIVIL
STATE OF CALIFORNIA

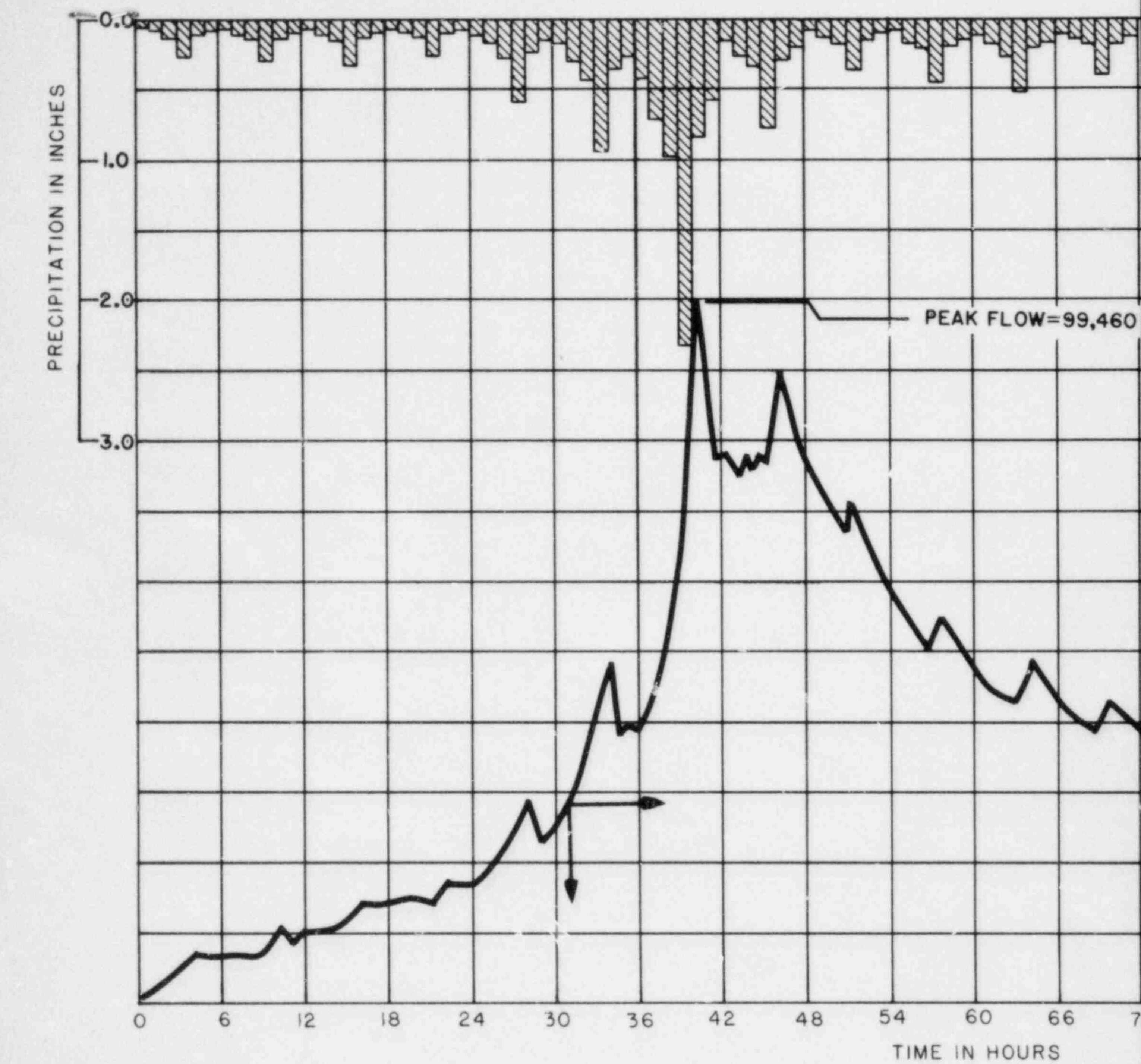
HUMBOLDT DIVISION

8507250019-07

FIGURE 7

MICROFILM

NSHQ	CIVIL-HYDROLOGIC ENGINEERING	BILL OF MATL	
...PV M.M.CALLEJAS	NOVEMBER PMF HYDROGRAPH	DWG LIST	
...LC. S.C. LAU	HUMBOLDT BAY P.P. NO.3	SUPERSEDES	
...N T. LESOV		SUPERSEDED BY	
...KD *A. P. Urbina*	DEPARTMENT OF ENGINEERING	SHEET NO.	SHEETS
M.M. Callejas	PACIFIC GAS AND ELECTRIC COMPANY	DRAWING NUMBER	CHANGE
...TE 7-3-85	SAN FRANCISCO, CALIFORNIA	106873	1
...LE ...S SHOWN			



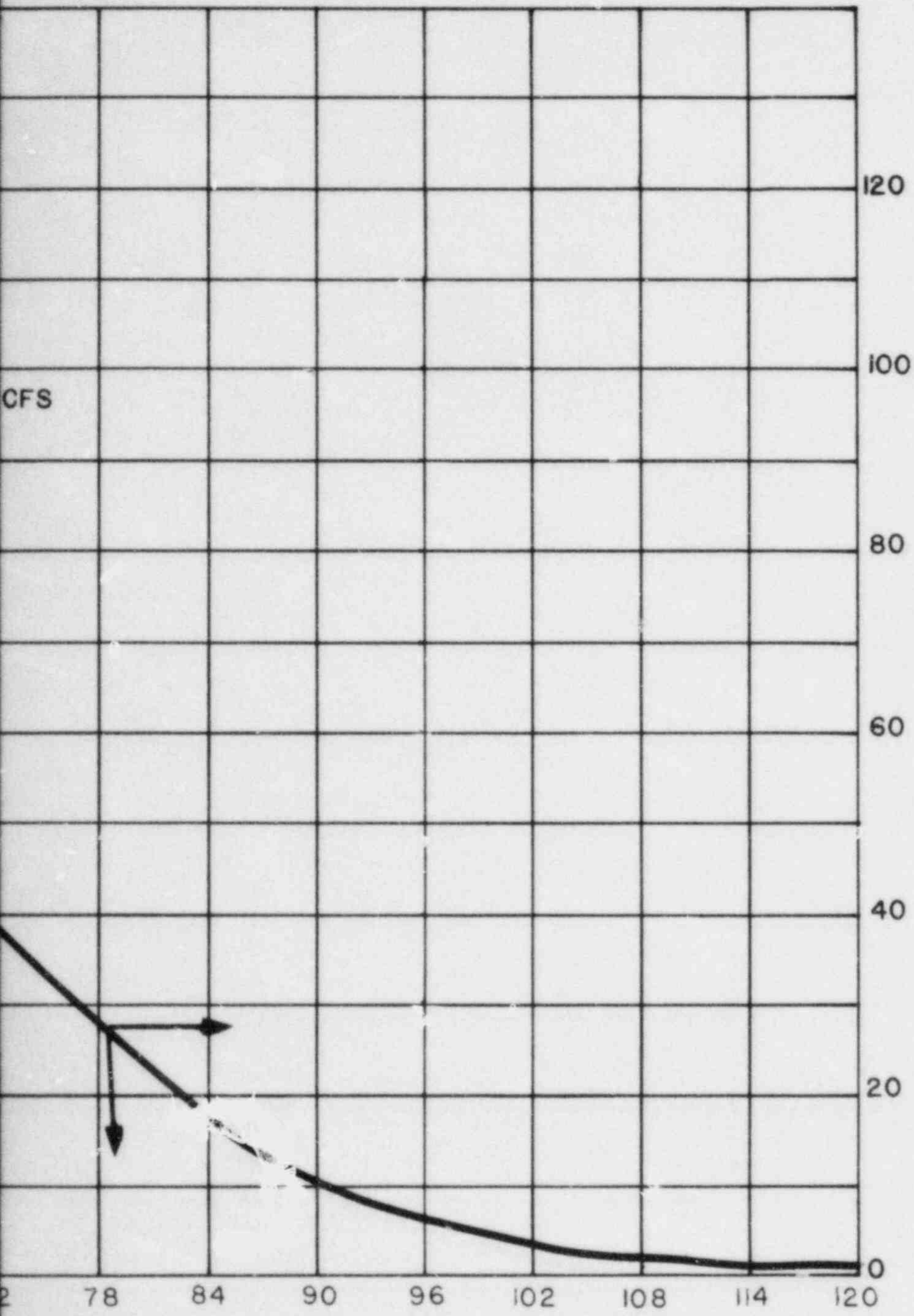
NOTE

FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.	[illegible]	[illegible]

TABLE OF CHANGES

APPROVED BY



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APERTURE
CARD

8507250019-08

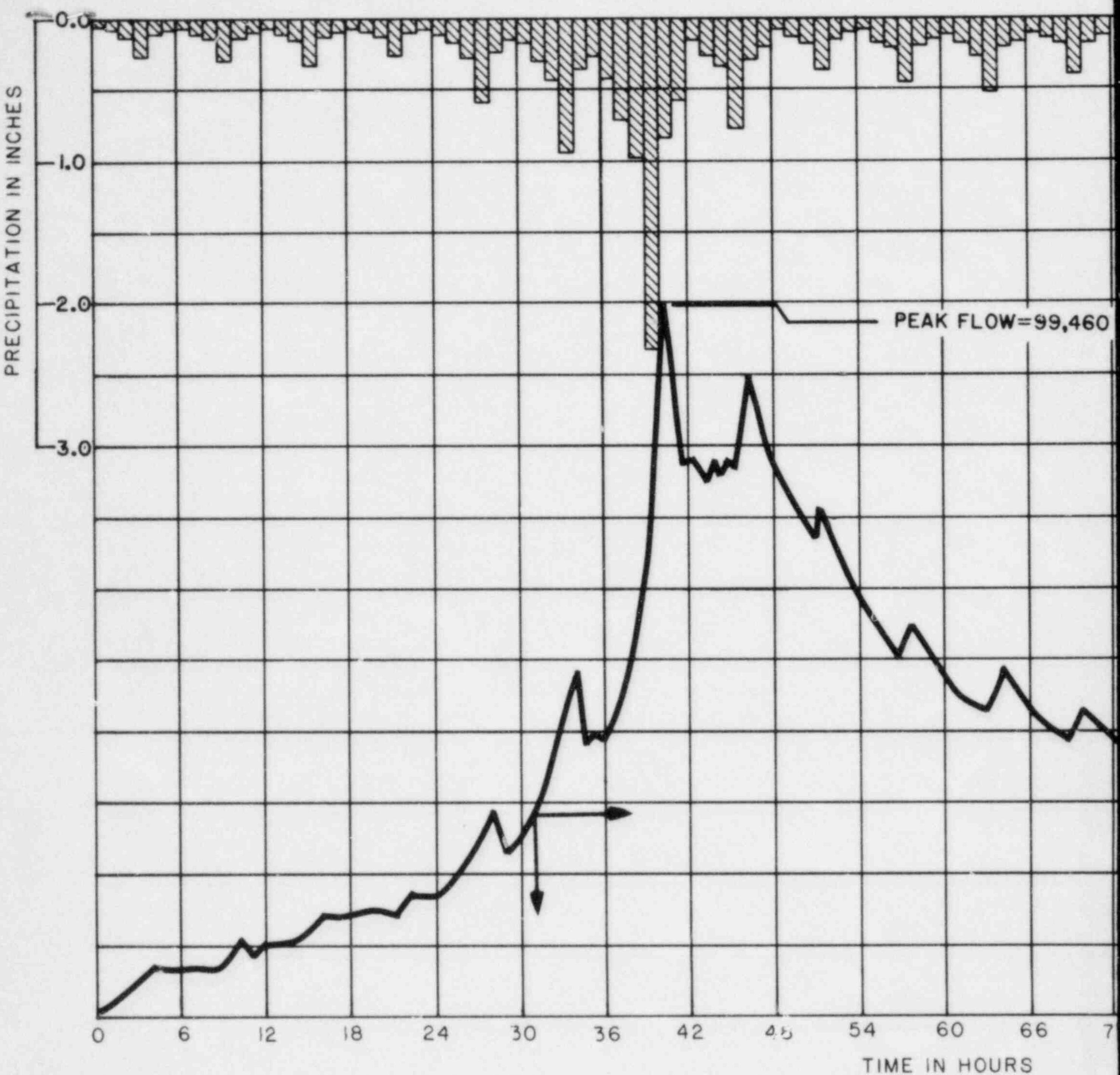
FIGURE 8

NSHQ	CIVIL-HYDROLOGIC ENGINEERING	BILL OF MATL
V. M.M.CALLEJAS	**DECEMBER PMF HYDROGRAPH**	DWG LIST
C. S.C. LAU	**HUMBOLDT BAY P.P. NO.3**	SUPERSEDES
N. T. LESOV	DEPARTMENT OF ENGINEERING	SUPERSEDED BY
D A. P. Urbina	PACIFIC GAS AND ELECTRIC COMPANY	SHEET NO. SHEETS
M.M. Callejas	SAN FRANCISCO, CALIFORNIA	DRAWING NUMBER 106874
E 7-3-85		CHANGE 1
ALE S SHOWN		

HUMBOLDT DIVISION

MICROFILM

1068874

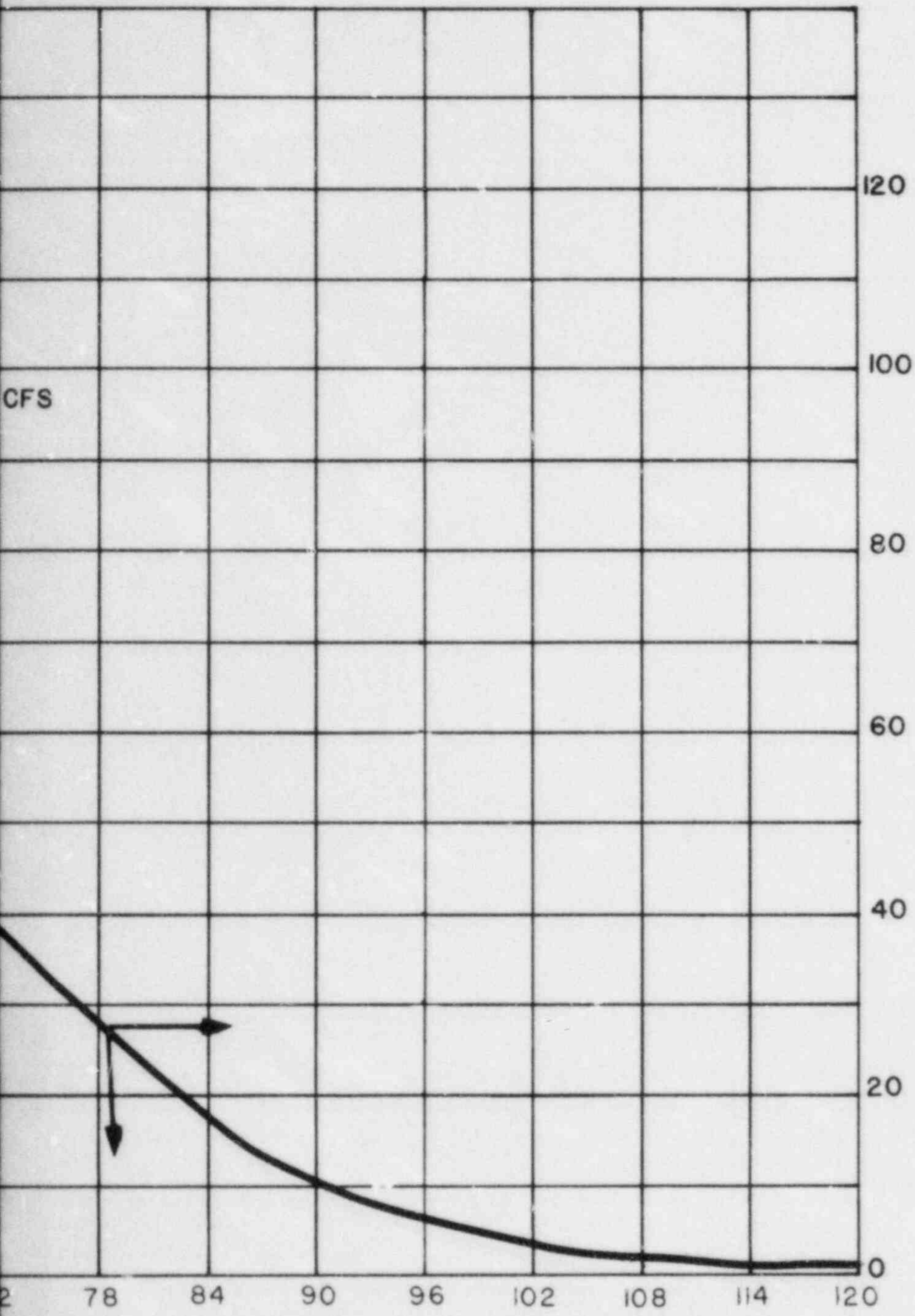


NOTE
FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

APPROVED BY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.		

TABLE OF CHANGES



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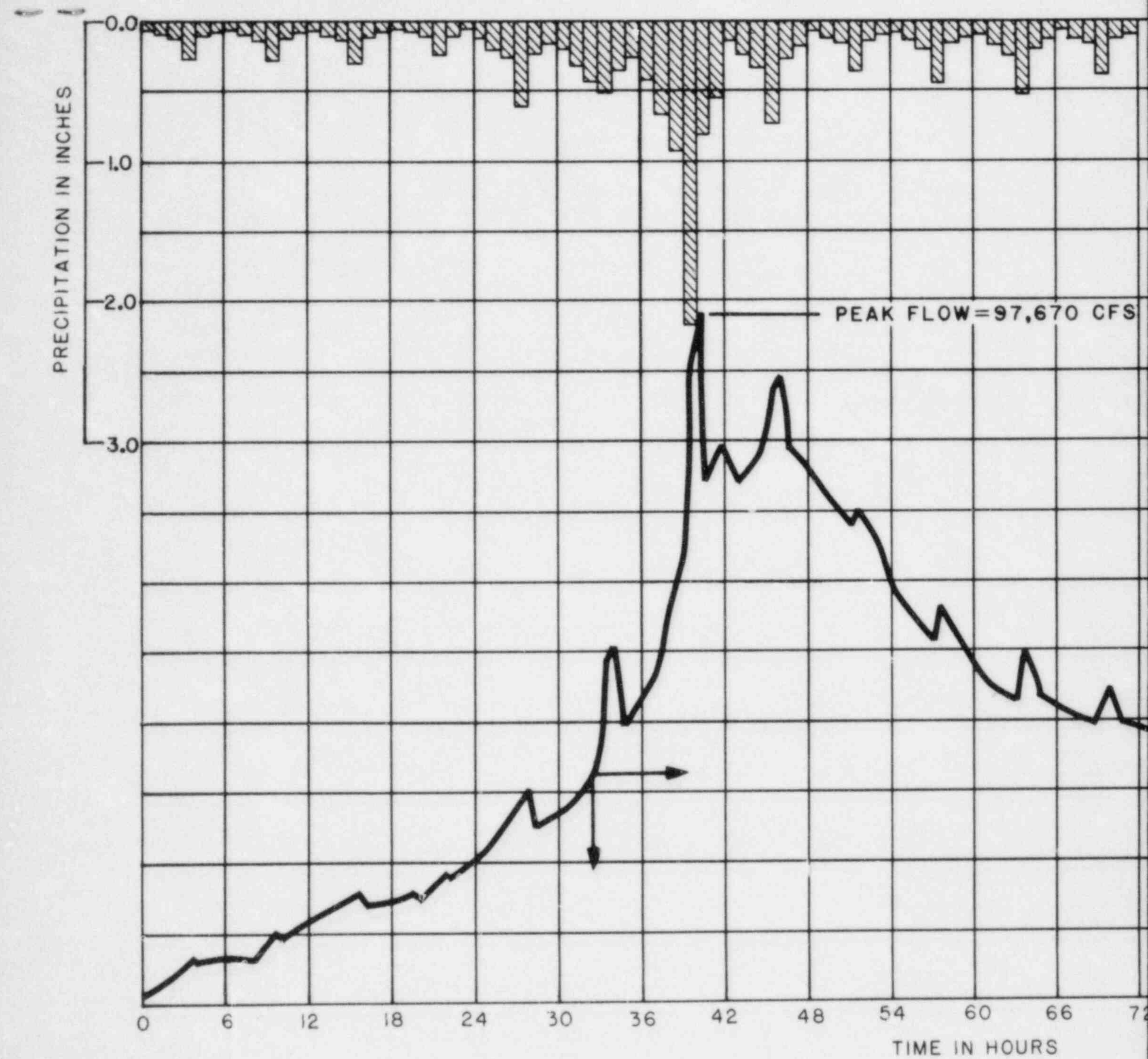
8507250019-08

FIGURE 8

MICROFILM

NSHQ	CIVIL-HYDROLOGIC ENGINEERING	BILL OF MATL	
...V. M.M.CALLEJAS	**DECEMBER PMF HYDROGRAPH**	DWG LIST	
...C. S.C. LAU	**HUMBOLDT BAY P.P. NO.3**	SUPERSEDES	
...N T. LESOV	DEPARTMENT OF ENGINEERING	SUPERSEDED BY	
...D A. P. Urbina	PACIFIC GAS AND ELECTRIC COMPANY	SHEET NO.	SHEETS
M.M. Callejas	SAN FRANCISCO, CALIFORNIA	DRAWING NUMBER	CHANGE
...TE 7-3-85		106874	1
...ALE ...S SHOWN			

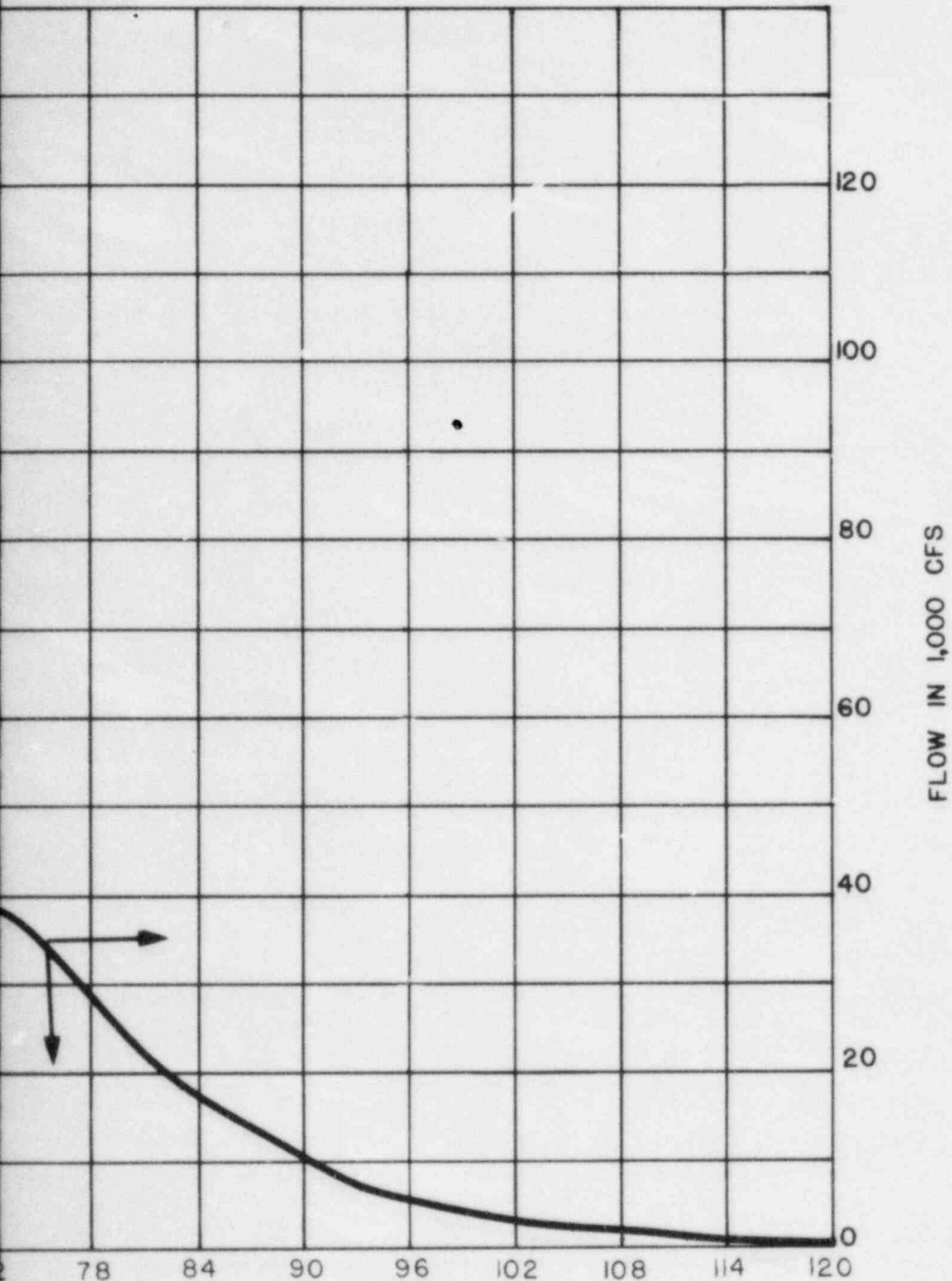


NOTE
FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.		

TABLE OF CHANGES

APPROVED BY



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CARD

REGISTERED PROFESSIONAL ENGINEER
RICHARD V. BETTINGER
No. 7866
CIVIL
STATE OF CALIFORNIA

HUMBOLDT DIVISION

8507250019-09

FIGURE 9

MICROFILM

NSHQ
M.M.CALLEJAS
SC. LAU
T. LESOV
A. P. Urbina
M.M. Callejas
7-3-85
AS SHOWN

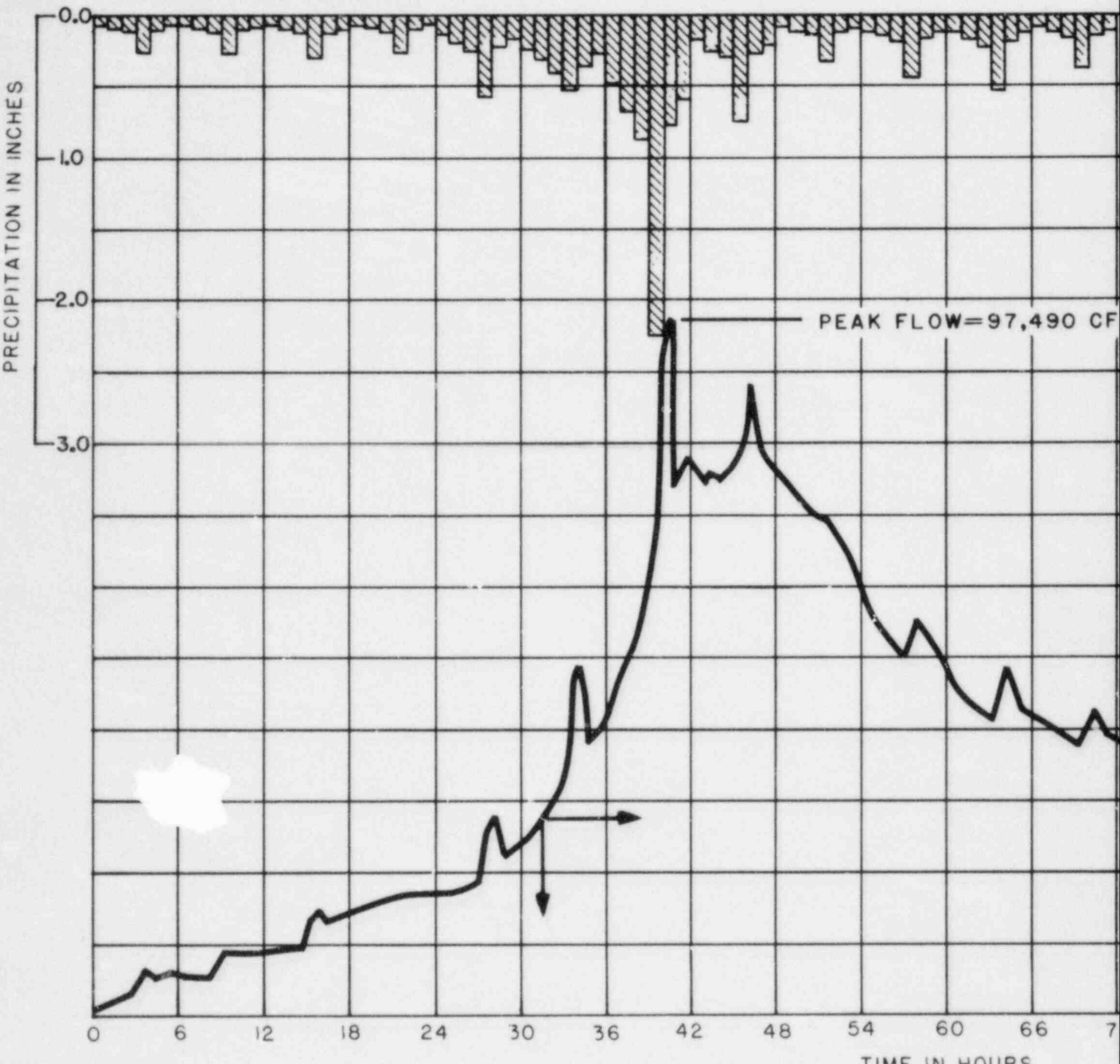
CIVIL-HYDROLOGIC ENGINEERING

JAN.-FEB. PMF HYDROGRAPH
HUMBOLDT BAY P.P. NO.3

DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL
DWG LIST
SUPERSEDES
SUPERSEDED BY
SHEET NO. SHEETS
DRAWING NUMBER 106875
CHANGE 1

106876



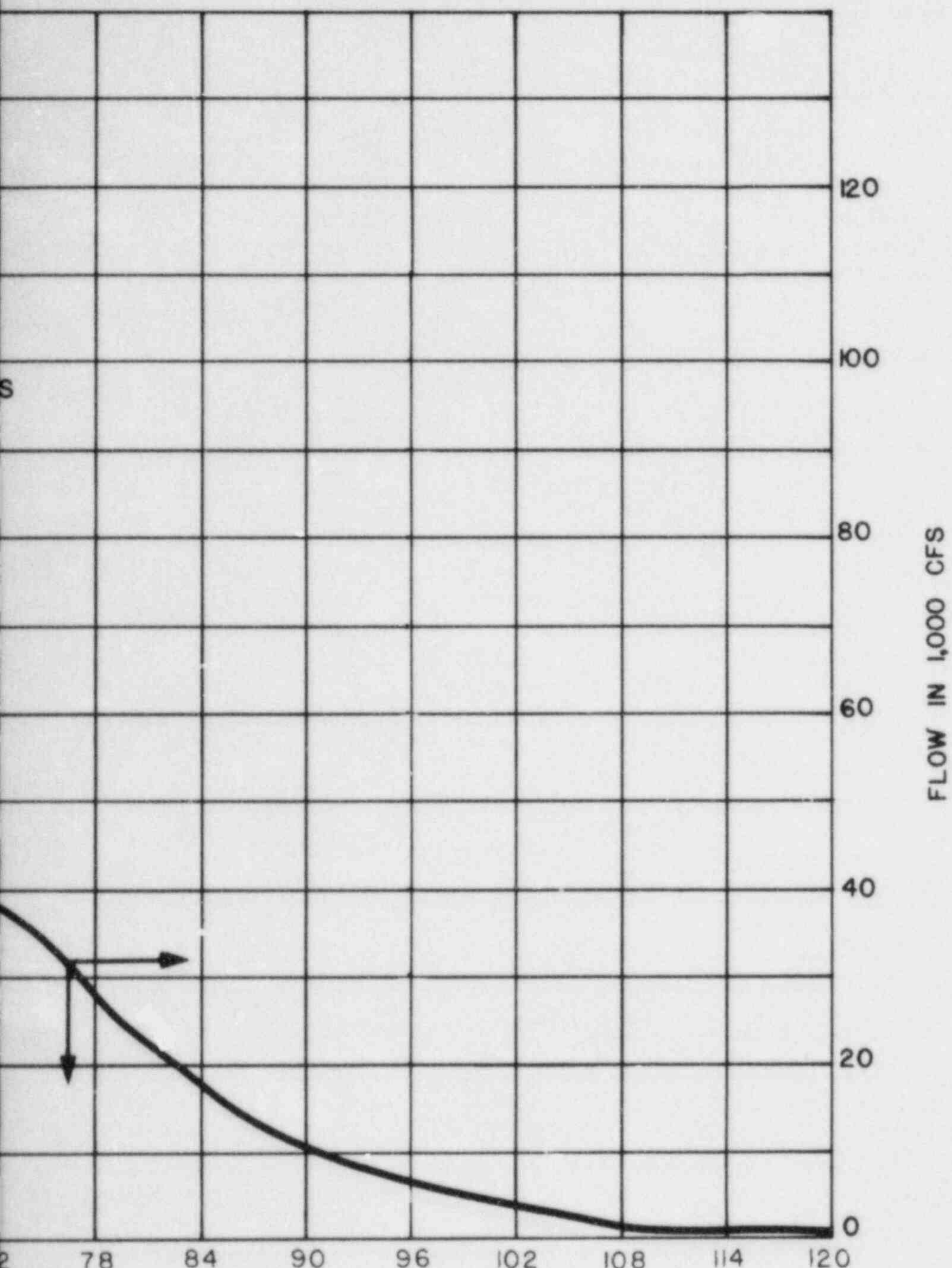
NOTE

FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

APPROVED BY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.		

TABLE OF CHANGES



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REGISTERED PROFESSIONAL ENGINEER
RICHARD V. BETTINGER
No. 7868
CIVIL
STATE OF CALIFORNIA

HUMBOLDT DIVISION

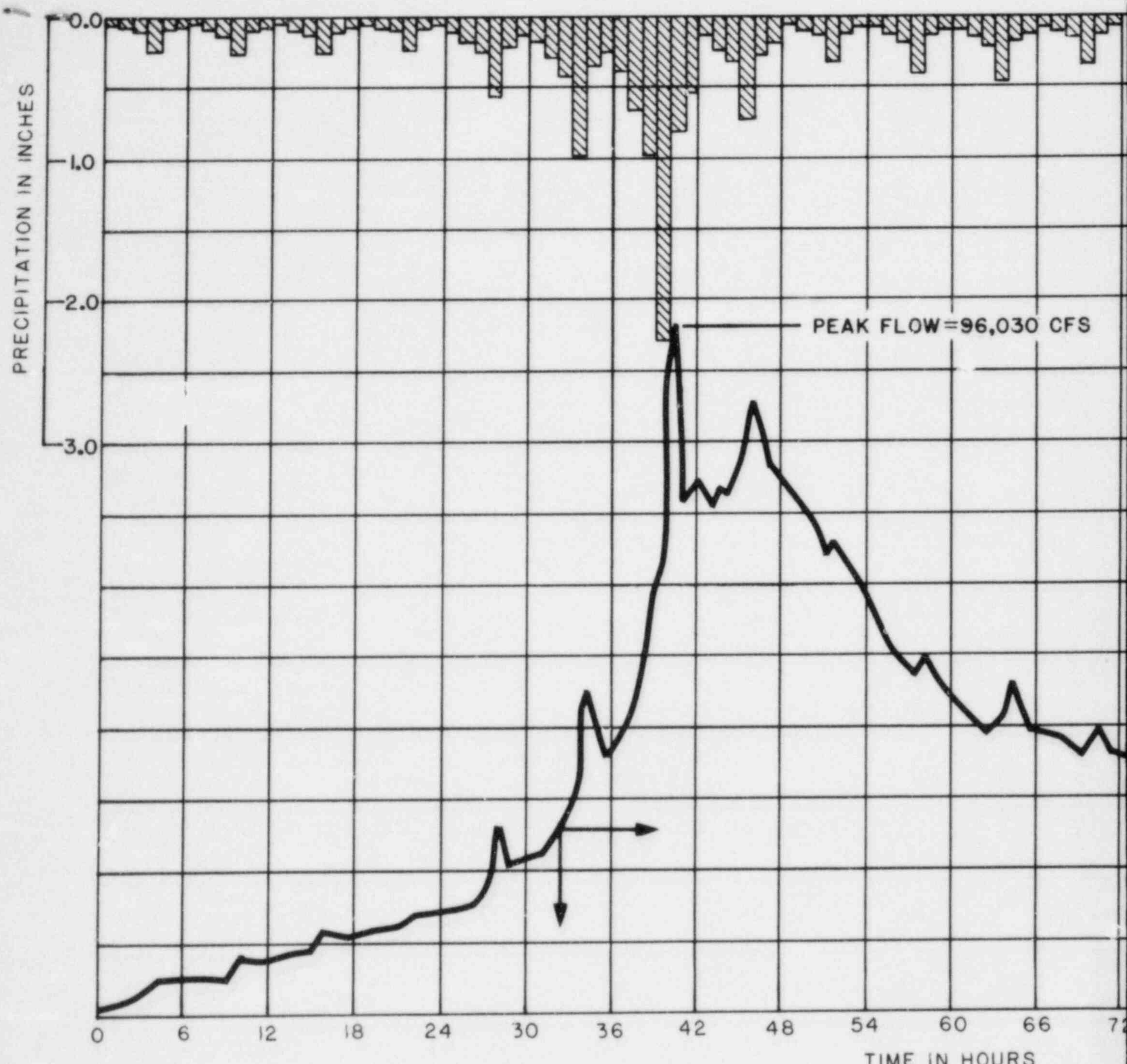
8507250019-10

FIGURE 10

MICROFILM

NSHQ	CIVIL-HYDROLOGIC ENGINEERING	BILL OF MATL	
APPV. M.M.CALLEJAS	**MARCH PMF HYDROGRAPH**	DWG LIST	
CALC. S.C. LAU	**HUMBOLDT BAY P.P. NO.3**	SUPERSEDES	
DRN T. LESOV	DEPARTMENT OF ENGINEERING	SUPERSEDED BY	
CHKD A. P. Urbina	PACIFIC GAS AND ELECTRIC COMPANY	SHEET NO.	SHEETS
M.M. Callejas	SAN FRANCISCO, CALIFORNIA	DRAWING NUMBER	CHANGE
DATE 7-3-85		106876	1
SCALE AS SHOWN			

106877

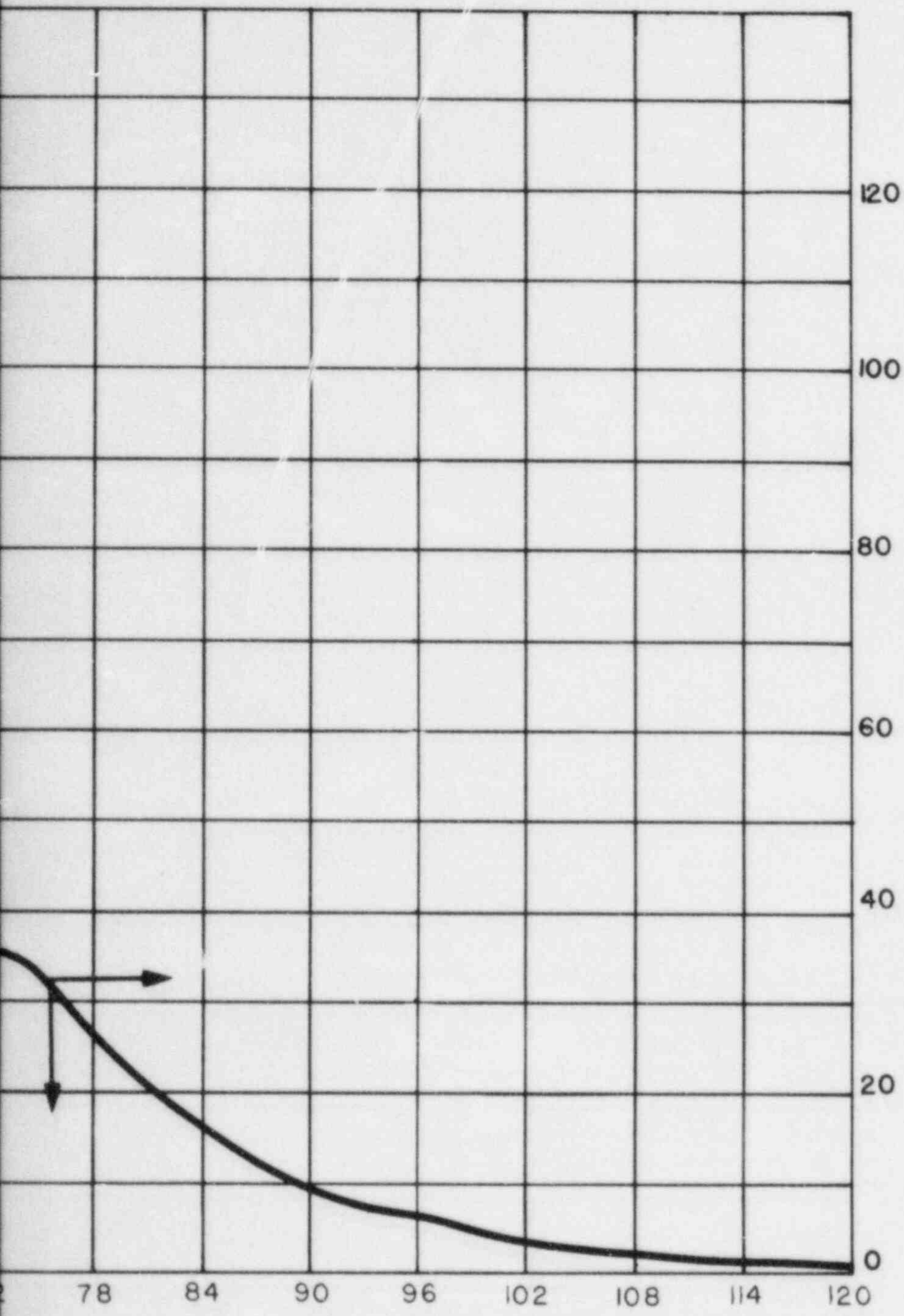


NOTE
FLOW IS TOTAL DISCHARGE AT MOUTH OF HUMBOLDT BAY

NO.	DATE	DESCRIPTION	BY	CH	APPR
1	7-3-85	ISSUED FOR NRC	T.L.	[illegible]	[illegible]

TABLE OF CHANGES

APPROVED BY



Also Available On Aperture Card

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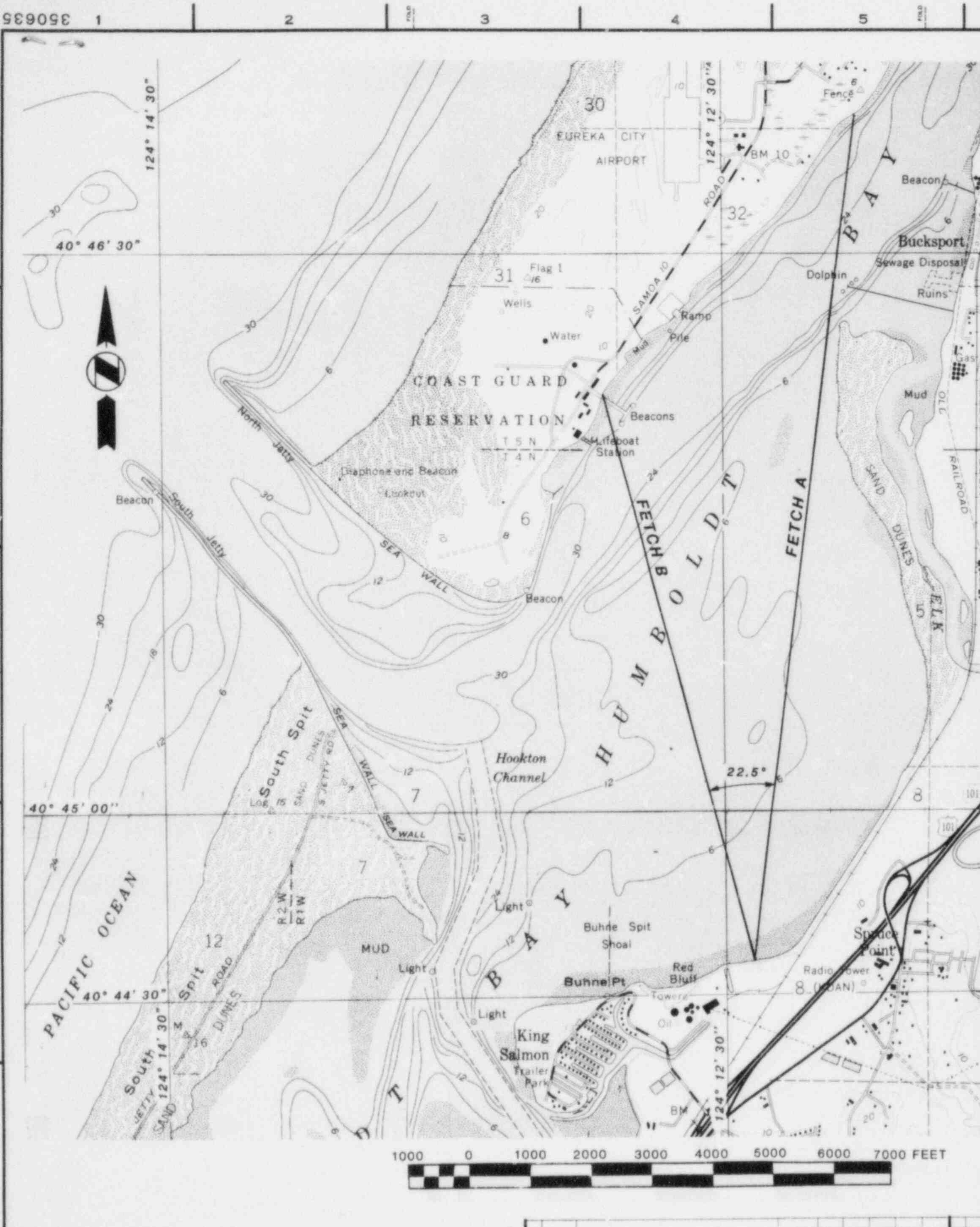
8507250019-11

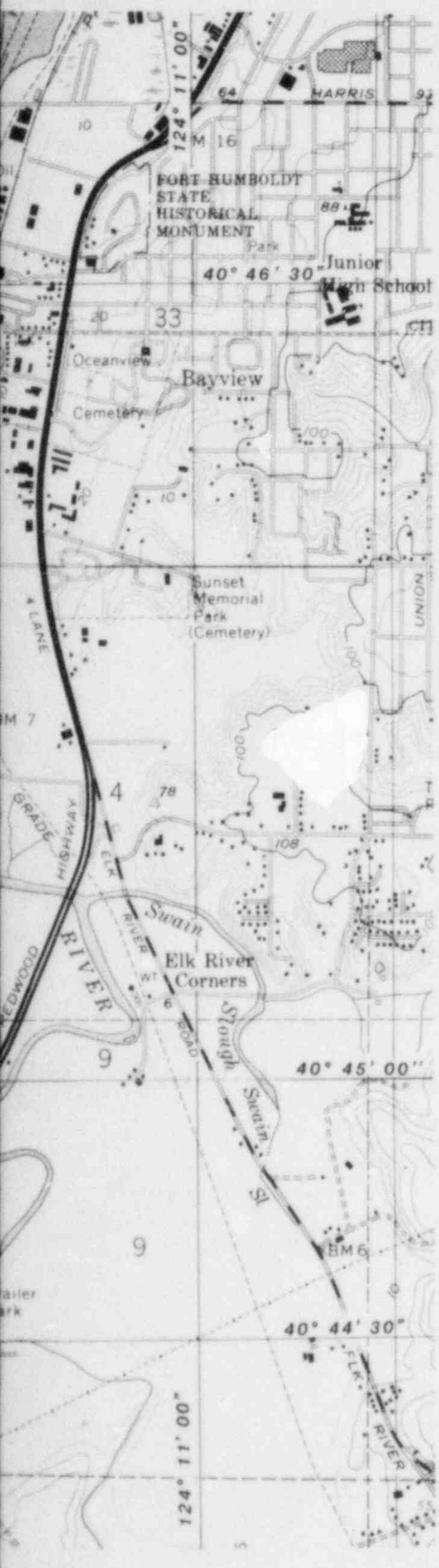
FIGURE 11

MICROFILM

NSHQ	CIVIL-HYDROLOGIC ENGINEERING	BILL OF MATL
M.M. CALLEJAS	**APRIL PMF HYDROGRAPH**	DWG LIST
S.C. LAU	**HUMBOLDT BAY P.P. NO.3**	SUPERSEDES
T. LESOV	DEPARTMENT OF ENGINEERING	SUPERSEDED BY
A.P. Urbine	PACIFIC GAS AND ELECTRIC COMPANY	SHEET NO. SHEETS
MM Callejas	SAN FRANCISCO, CALIFORNIA	DRAWING NUMBER 106877 CHANGE 1
7-3-85		
SHOWN		



350635
1
2
3
4
5
E
D
C
B
A
124° 14' 30"
124° 12' 30"
40° 46' 30"
40° 45' 00"
40° 44' 30"
EUREKA CITY
AIRPORT
BM 10
Fence
SAMOA
ROAD
Flag 1
Wells
Water
Ramp
Pile
Mud
COAST GUARD
RESERVATION
T 5 N
T 4 N
Beacons
Lifeboat
Station
Diaphone and Beacon
Lookout
Beacon
North Jetty
South Jetty
SEA WALL
FETCH B
FETCH A
HUMBOLDT
BAY
22.5°
Beacon
Bucksport
Sewage Disposal
Dolphin
Ruins
Gas
Mud
OIL
NORTHWESTERN
RAILROAD
SAND DUNES
ELK
Hookton
Channel
South Spit
SAND DUNES
S. JETTY ROAD
R2W
R1W
PACIFIC OCEAN
MUD
Light
Buhne Spit
Shoal
Red
Bluff
Buhne Pt
Towers
Oil
King
Salmon
Trailer
Park
BM
Spruce
Point
Radio Tower
(KOAN)
101
JETTY
SAND
ROAD
1000
0
1000
2000
3000
4000
5000
6000
7000 FEET
NO.
DATE
DESCRIPTION
APVD BY
REVISIONS



CALIFORNIA
LOCATION MAP
NOT TO SCALE

VICINITY MAP
NOT TO SCALE

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APERTURE
CARD

LEGEND

RIVERS AND CREEKS

U.S. ROUTE

LIGHT DUTY ROAD

MEDIUM DUTY ROAD

HEAVY DUTY ROAD

RAILROAD

NOTE:

1. THIS MAP WAS PHOTOGRAHICALLY REPRODUCED FROM U.S.G.S. QUADRANGLES, 1:24000 SCALE: EUREKA, CALIF. 1958 AND FIELDS LANDING, CALIF. 1959, BOTH PHOTOREVISED 1972, ENLARGED FROM 1" = 2000 FEET TO 1" = 1000 FEET.

2. DEPTH CURVES AND SOUNDINGS ARE IN FEET BELOW MLLW.

REFERENCE:

SHORE PROTECTION MANUAL, COASTAL ENGINEERING RESEARCH CENTER, U.S. ARMY CORPS OF ENGINEERS, 1984.

REGISTERED PROFESSIONAL ENGINEER
RICHARD Y. OETTINGER
No. 7665
CIVIL
STATE OF CALIFORNIA

HUMBOLDT DIVISION

8507225-0019-12

FIGURE 12

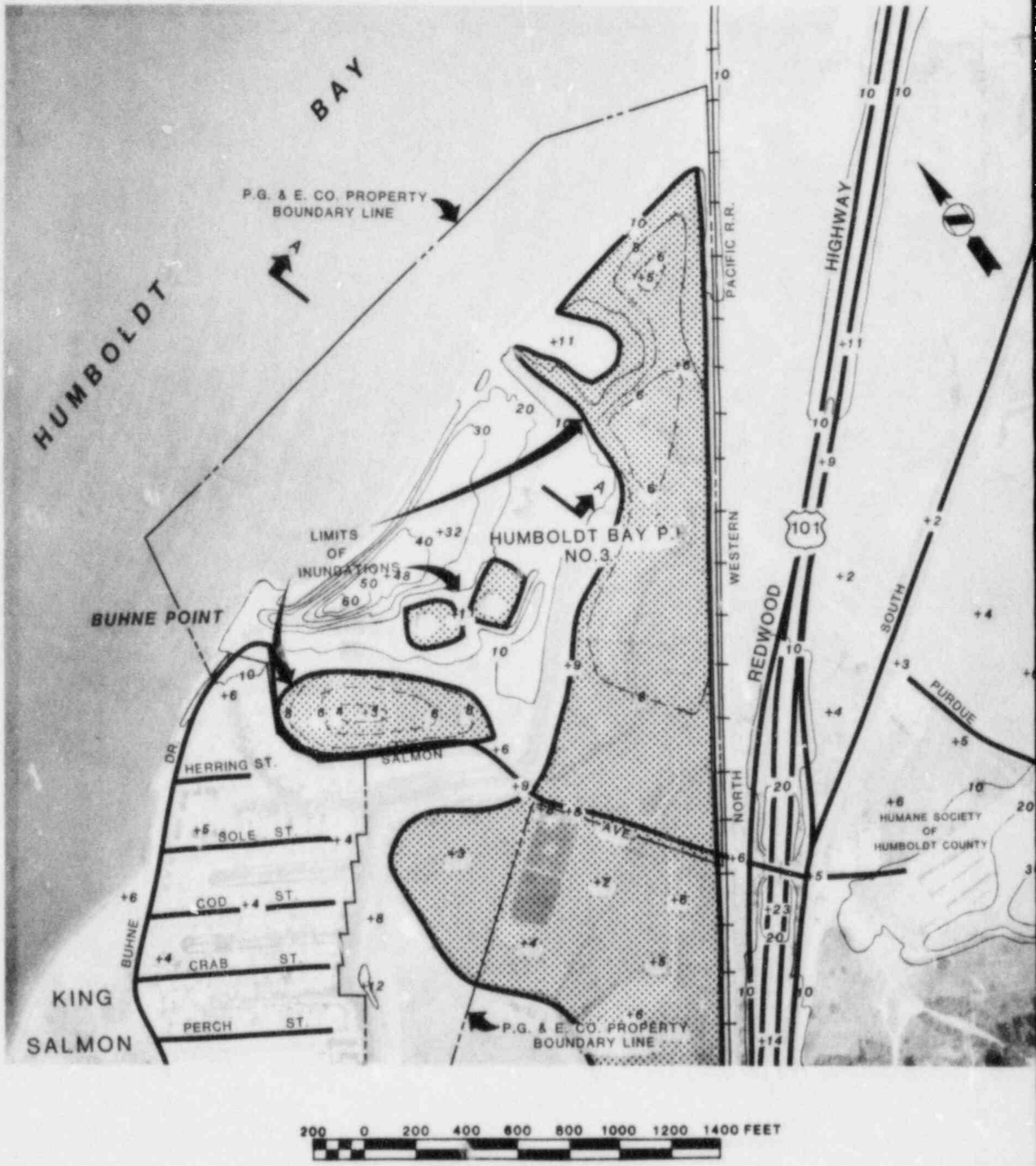
5	ISSUED FOR NRC	NSHQ					
	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV.	APVD. BY	
	REVISIONS						

APPROVED BY	NSHQ
SUPV	M.M.CALLEJAS
DSGN.	B.C.LAU
DWN	A.P.URBINA
CHKD	E.J.KAPPLER
O.K.	M.M. Callejas
DATE	7-3-85
SCALES	AS SHOWN

CIVIL-HYDROLOGIC ENGINEERING
EFFECTIVE FETCH MAP
HUMBOLDT BAY NO.3
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

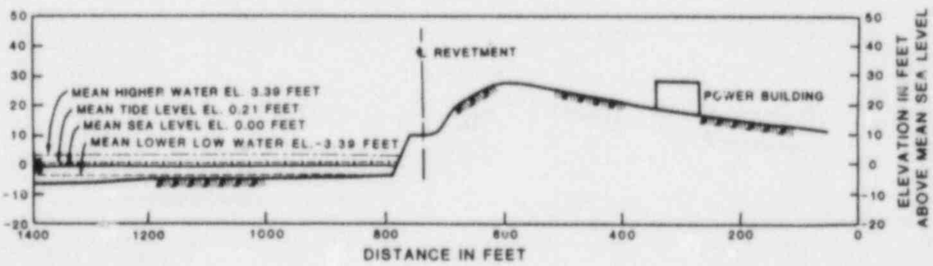
MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO.	SHEETS
350635	REV 1

473523



CONTOUR INTERVAL 10 FEET

DOTTED LINES REPRESENT 2-FOOT CONTOURS



SECTION A-A

1" = 100 FEET

CALIFORNIA
LOCATION MAP
NOT TO SCALE

VICINITY MAP
NOT TO SCALE

LEGEND

- LIMIT OF INUNDATION
- RIVERS AND CREEKS
- PROPERTY LINE
- INTERPOLATED CONTOUR LINE
- INDEX CONTOUR LINE
- +4 RANDOM ELEVATIONS
- IMPROVED ROADS
- RAILROAD
- 101 U.S. ROUTE

NOTES:

1. PHOTO CONTOUR MAP IS REPRODUCED FROM AERIAL SURVEY CONTRACT NUMBER 63-OIPC-1, SHEETS 3 AND 8, DIVISION OF HIGHWAYS, STATE OF CALIFORNIA, 1964.
2. DATUM FOR PHOTO CONTOUR MAP IS MEAN SEA LEVEL, 1929 ADJ.
3. MEAN SEA LEVEL IS 3.39 FEET ABOVE MEAN LOWER LOW WATER.
4. INUNDATED AREAS SHOWN ARE WEST OF WESTERN PACIFIC RAILROAD.

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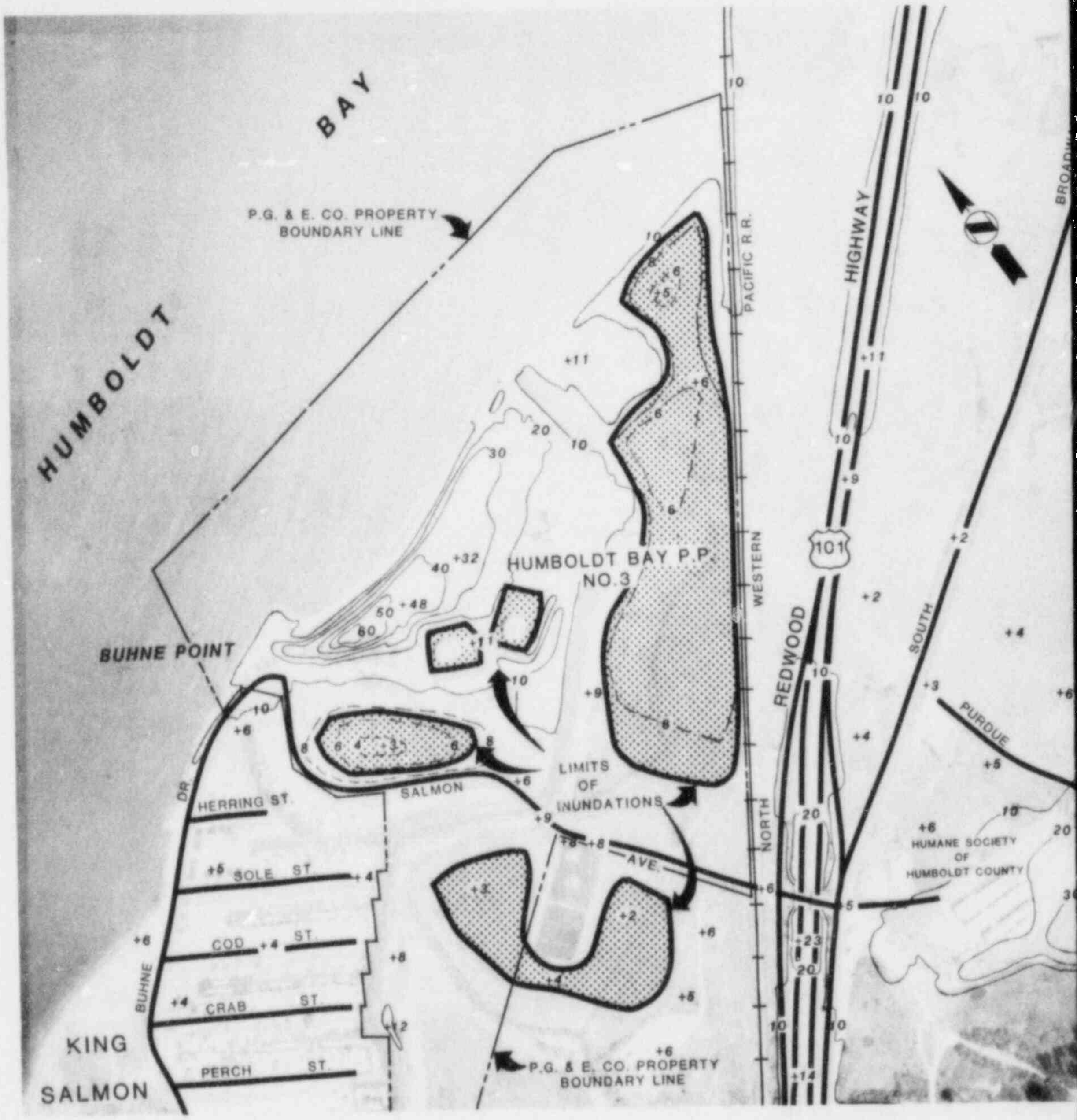
FIGURE 13

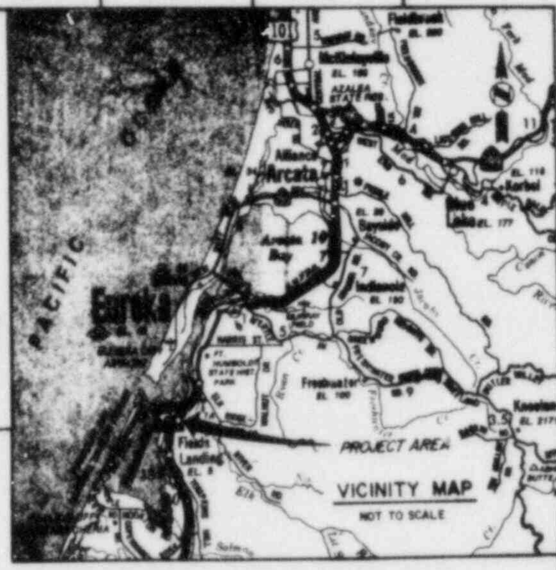
1 7-9-85 ISSUED FOR NRC

CIVIL-HYDROLOGIC ENGINEERING
FLOOD PLAIN MAP
JAN.-FEB. PMF
HUMBOLDT BAY P.P. NO.3
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

473523 1


HUMBOLDT
BAY
P.G. & E. CO. PROPERTY
BOUNDARY LINE
PACIFIC R.R.
WESTERN
NORTH
HIGHWAY
101
REDWOOD
SOUTH
BROADWAY
PURDUE
HUMBOLDT BAY P.P.
NO. 3
BUHNE POINT
LIMITS
OF
INUNDATIONS
SALMON
AVE.
HERRING ST.
SOLE ST.
COD ST.
CRAB ST.
PERCH ST.
BUHNE DR.
KING
SALMON
P.G. & E. CO. PROPERTY
BOUNDARY LINE
HUMANE SOCIETY
OF
HUMBOLDT COUNTY

CALIFORNIA
LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

LEGEND

	LIMIT OF INUNDATION
	RIVERS AND CREEKS
	PROPERTY LINE
6	INTERPOLATED CONTOUR LINE
10	INDEX CONTOUR LINE
+4	RANDOM ELEVATIONS
	IMPROVED ROADS
	RAILROAD
101	U.S. ROUTE

Also Available On Aperture Card

TI APERTURE CARD

NOTES:

1. PHOTO CONTOUR MAP IS REPRODUCED FROM AERIAL SURVEY CONTRACT NUMBER 63-OIPC-1, SHEETS 3 AND 8, DIVISION OF HIGHWAYS, STATE OF CALIFORNIA, 1964.
2. DATUM FOR PHOTO CONTOUR MAP IS MEAN SEA LEVEL, 1929 ADJ.
3. MEAN SEA LEVEL IS 3.39 FEET ABOVE MEAN LOWER LOW WATER.
4. INUNDATED AREAS SHOWN ARE WEST OF WESTERN PACIFIC RAILROAD.

8507250019-14

FIGURE 14

NSHQ

CIVIL-HYDROLOGIC ENGINEERING
FLOOD PLAIN MAP
THUNDERSTORM PMF
HUMBOLDT BAY P.P. NO.3
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO CALIFORNIA

ISSUED FOR NRC

SCALE AS SHOWN

MICROFILE
BILL OF MAT'L
DWG LIST
SUPSDS
SUPSD BY
SHEET NO.
473524

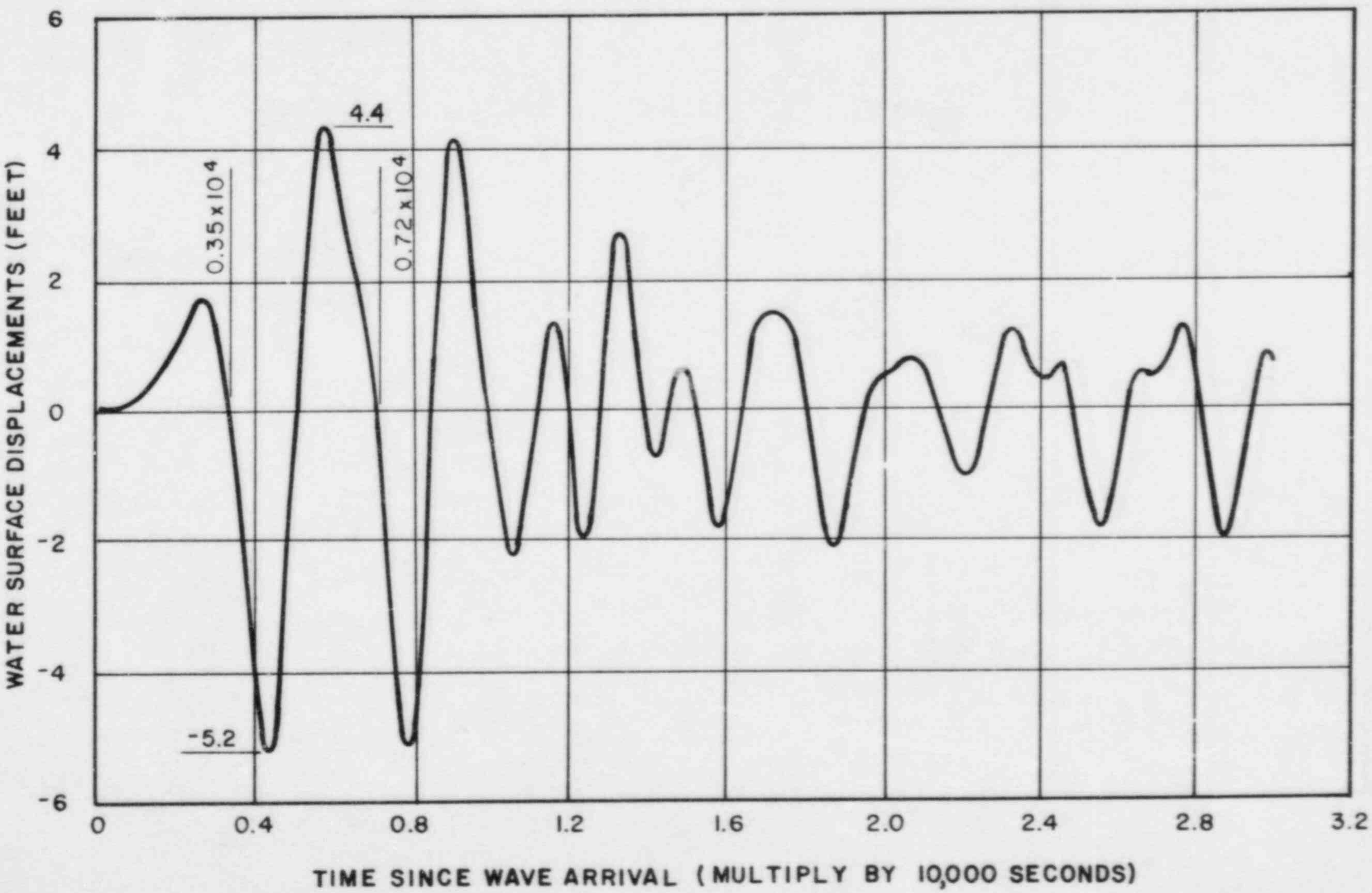


FIGURE 15. LARGEST TSUNAMI ARRIVING AT STATION 8 OFFSHORE EUREKA, CA

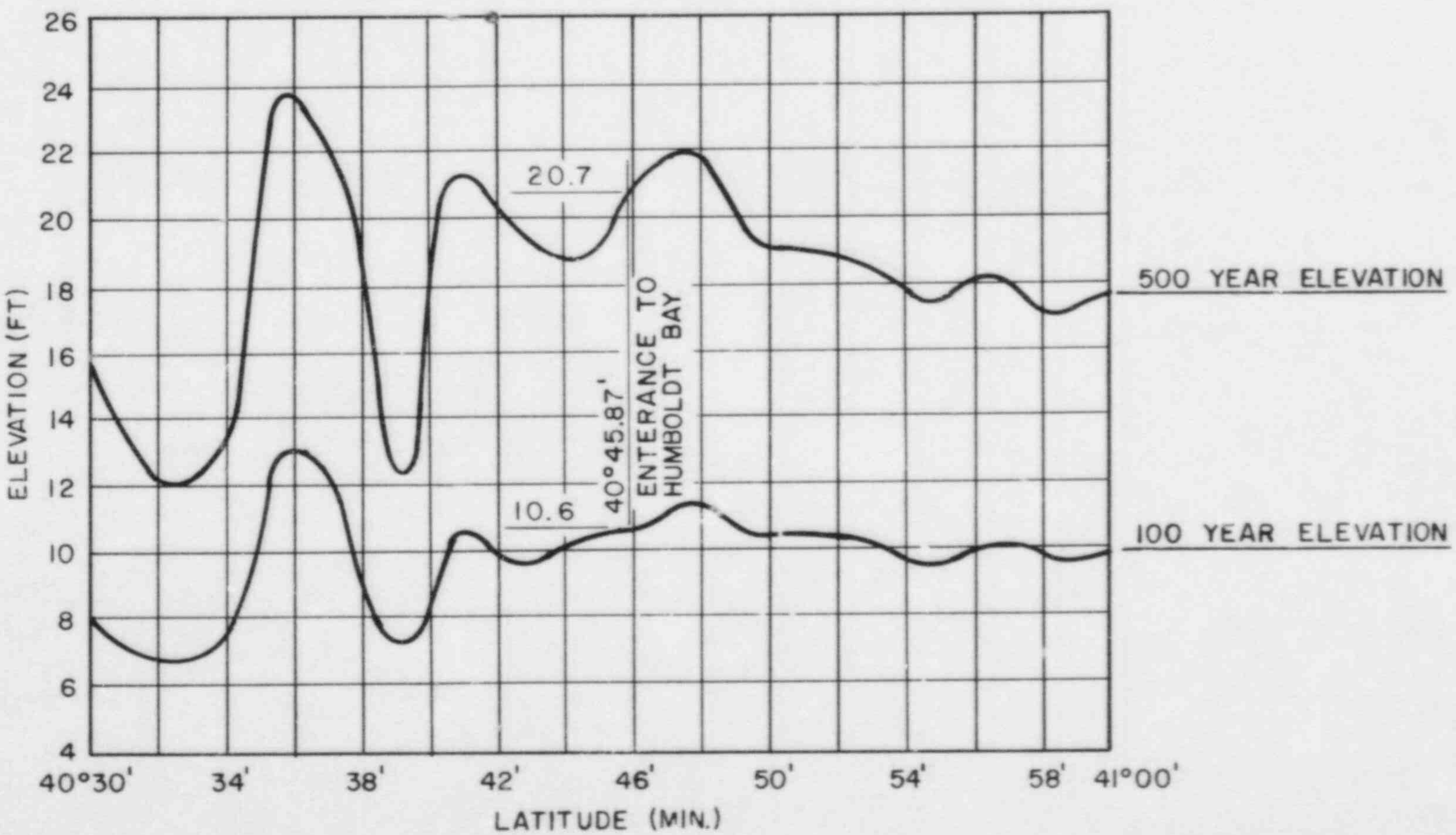


FIGURE 16. 100- AND 500-YEAR TSUNAMI ELEVATIONS LATITUDE 40°30' TO 41°00'.