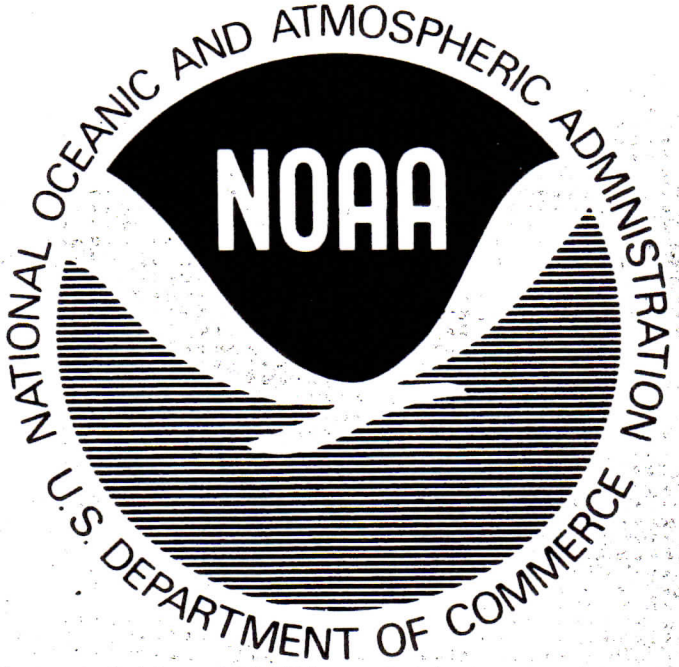
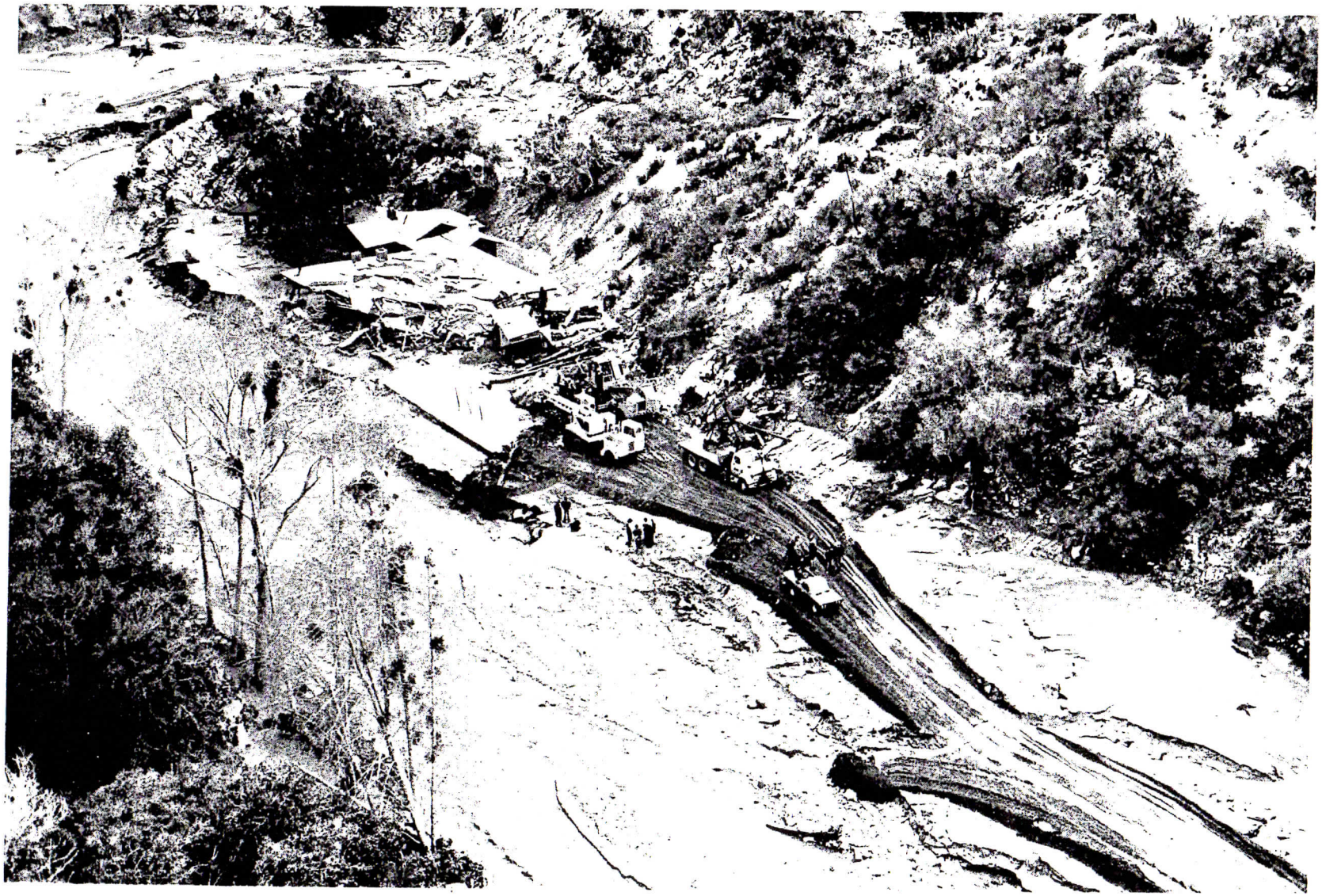
REPORT ON THE SOUTHERN CALIFORNIA FLOODS, FLASH FLOODS AND MUD SLIDES OF FEBRUARY 8-10, 1978



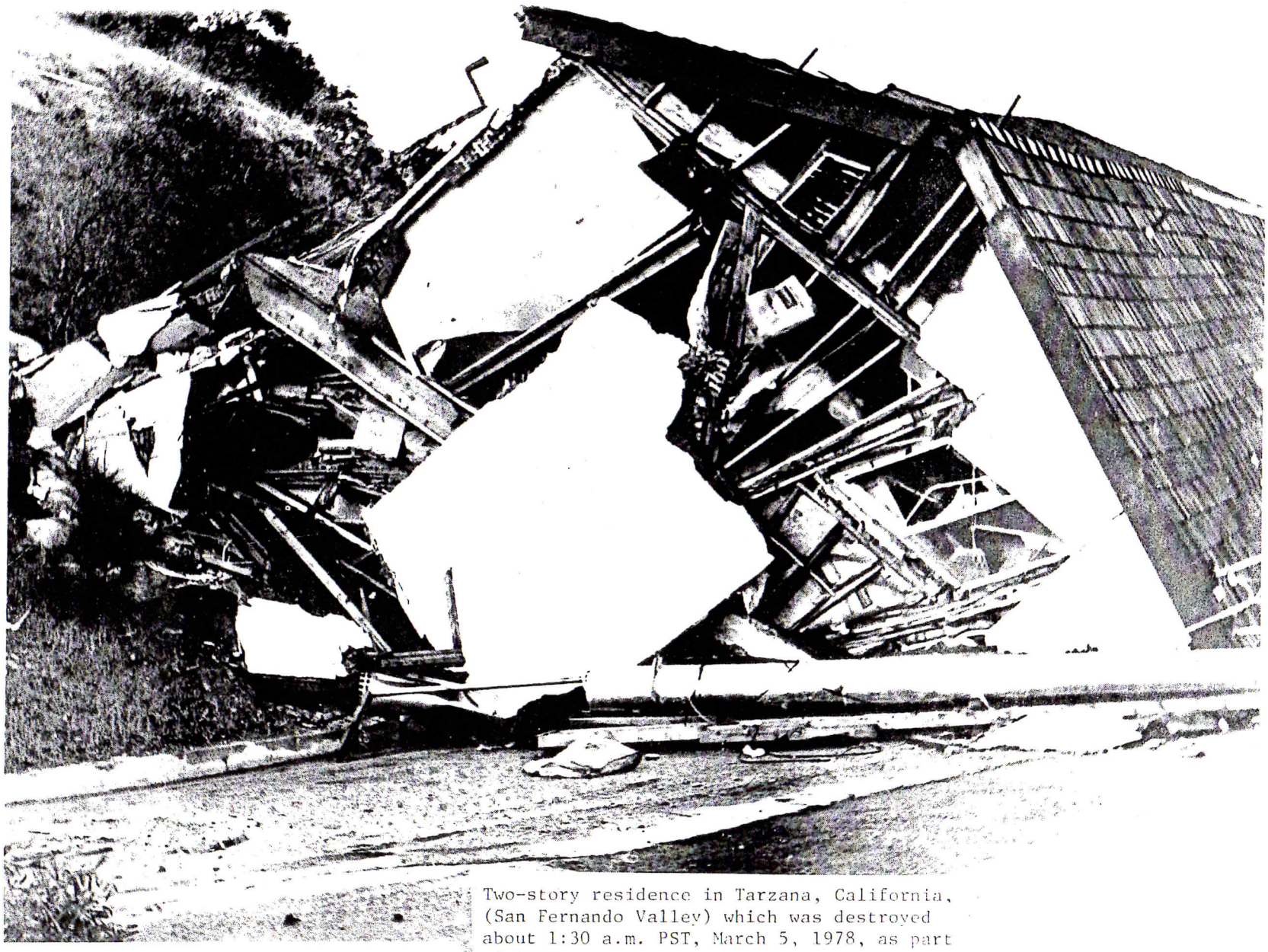
PREPARED BY:

WESTERN REGION HEADQUARTERS
NATIONAL WEATHER SERVICE
SALT LAKE CITY, UTAH

DECEMBER 8, 1978



Damage from February 9-10, 1978 Flash Flood
at Hidden Springs on Mill Creek, San Gabriel
Mountains, Los Angeles County, CA.
(Los Angeles Times Photo)



Two-story residence in Tarzana, California, (San Fernando Valley) which was destroyed about 1:30 a.m. PST, March 5, 1978, as part of hill to rear gave way due to prolonged rains.

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PREFACE

The NWS survey team that reviewed the southern California flash floods of February 8-10, 1978, consisted of P. Williams, Chief, MSD, WRH and R. J. Hutcheon, MSD, WRH; D. E. Colton, Flash Flood Hydrologist, RFC, Sacramento; three members of Los Angeles WSFO staff: R. H. Reece, MIC; A. G. Lessard, PA; and C. L. Conway, WSEO; and E. T. Riddiough, MIC, Bakersfield. Messrs. Hutcheon and Riddiough confined their fact-finding to Kern County--other team members to Los Angeles County. The survey team's findings and recommendations are included in this report.

The survey team thanks all who furnished information to them. Special thanks go to the Los Angeles Times for furnishing photographs and to KABC-TV, Los Angeles, for supplying video tapes of storm damage.

News reports during the week following the flood in the Tujunga watershed on the morning of February 10 indicated there had been cloud seeding in the Los Angeles area prior to the flood occurrence. To assist the survey team, personnel from the Office of Weather Modification, Environmental Research Laboratories, made a thorough and complete investigation and evaluation of the cloud seeding operations that took place during the initial period of rainfall. It was concluded that the cloud seeding by a contractor for the Los Angeles County Flood Control District did not contribute directly to the flood in Tujunga Canyon on February 10, 1978. Any contribution to pre-flood soil saturation of the watershed prior to the heaviest rainfall was trivial compared to the total precipitation during that period.

FOREWARD

After a significant weather-related disaster such as the southern California floods, flash floods, and mud slides of February 8-10, 1978, it is customary for a NOAA/NWS team to evaluate the effectiveness of the total weather warning system. This requires visiting sites of heaviest damage; interviewing survivors and learning what actions, if any, they took in response to our forecasts and warnings; and evaluating accuracy and timeliness of advisories and the means and efficiency by which these were disseminated.

Unlike other recent flash flood disasters that resulted from exceptionally heavy rainfall triggered by mesoscale features, this was a synoptic scale storm lasting one to two days, resulting in general rainfall and some embedded areas of very heavy rain. The most disastrous flash flooding was presumably caused by the release of a debris dam on rain swollen Mill Creek above the community of Hidden Springs.

On balance, prediction of this storm and issuance of advisories (e.g., forecasts, watches, warnings) were handled very well by the affected California NWS offices. Watches on the storm were issued more than 12 hours before the deaths occurred at Hidden Springs. Radar information from the Palmdale office was timely, well utilized, and outlined well the areas of heaviest rainfall. Satellite data from GOES was available at WSFO, Los Angeles during this event and played a significant role in helping to assess movement and location of significant rainfall.

Overall, field offices functioned in a manner commensurate with the state of the science, but, as usual, there were lessons to be learned. These included the need for more detailed rainfall and river data in real time, an improved capability for forecasting rainfall amounts, and improved interoffice coordination.

Since this storm, a WSR-74C radar with VIP capability has been installed at WSFO Los Angeles. This new radar will provide finer detail of rainfall patterns, and, hopefully, will be able to locate rainfall in the proper drainage basin. Further, southern California field offices have undertaken an effort to increase the number of river and rainfall reports they receive in real time. The RFC in Sacramento has continued its efforts to use and expand the use of self-initiating event-reporting rain gages in flood-prone basins.

Public response to watches and warnings continues to be mixed. While some people took life-saving actions, many others did not. The NWS and other preparedness organizations at the Federal, state, and local levels must continue to educate the public to the dangers of flash flooding. NWS issuances must be written well and spur people to take appropriate actions, too. The rarity of flash flooding at any single location and widespread public complacency must be considered in any public awareness program.

H. H. Bedke, Director
Western Region
National Weather Service

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SOUTHERN CALIFORNIA FLOODS, FLASH FLOODS, AND MUDSLIDES OF FEBRUARY 8-10, 1978 - EXECUTIVE SUMMARY

During February 8-10, 1978, heavy rains fell on the southern San Joaquin Valley and Los Angeles Basin and surrounding mountains. The resultant flooding, flash flooding, and mudslides caused widespread damage and 20 deaths. Thirteen people drowned in the little mountain resort of Hidden Springs, 20 miles north of downtown Los Angeles. Property damage from the storm totaled approximately $43 million in the Los Angeles area and approximately $40 million in the southern San Joaquin Valley--the latter mostly due to flooding of agricultural lands. Eight counties were declared Federal disaster areas (Figure 1).

Rainfall totals during the storm period exceeded 12 inches at several mountain stations. An all-time rainfall record, 3 inches in 24 hours, was set at Bakersfield. Gale winds caused extensive damage along the coasts. Whereas many episodes of rain and flooding have occurred in southern California in the past 100 years, this was one of the most severe from the point of view of loss of life and property damage. Heavy rains during the preceding 2 months saturated the soil, setting the stage for the flash floods of February 8-10. Another disastrous flash flood event occurred in early March. This is addressed in Appendix C.

A Western Region disaster team surveyed much of the damaged area and reviewed forecasts and warnings issued by WSFO's Los Angeles and San Francisco, and WSO's Bakersfield, Fresno, and Santa Maria. This report considers hydrometeorological conditions which contributed to the disaster, data acquisition, dissemination of forecasts and warnings, public response to these, evaluation of the adequacy and effectiveness of services provided by NWS, and recommendations for improvements. Some of the principal findings are:

FINDING 1:

Overall performance by NWS field offices was excellent. For example, WSFO Los Angeles issued a total of 14 watches, warnings, and special statements. These began with a special weather statement about the storm at 6 a.m., Wednesday, February 8, followed by a forecast of heavy rain at 5 p.m., Wednesday. A flash flood watch was issued at 1 p.m., Thursday, February 9, which continued in effect until the afternoon of Friday the 10th. The most serious flash flooding occurred around 2 a.m. on February 10.

WSFO San Francisco issued a flash flood watch for the San Joaquin Valley and adjacent Sierra Nevada at 9:30 a.m., February 9, and for San Luis Obispo and Monterey Counties and northern Santa Barbara County at 11 a.m. These watches were continued in effect until the morning of the 10th. WSO Palmdale provided useful radar information.

Although no flash flood warnings for specific areas were issued, the situation was well covered by flash flood watches, special weather statements and warnings of heavy rains by the WSFO's. These undoubtedly helped prevent greater loss of life and property damage. Especially notable were

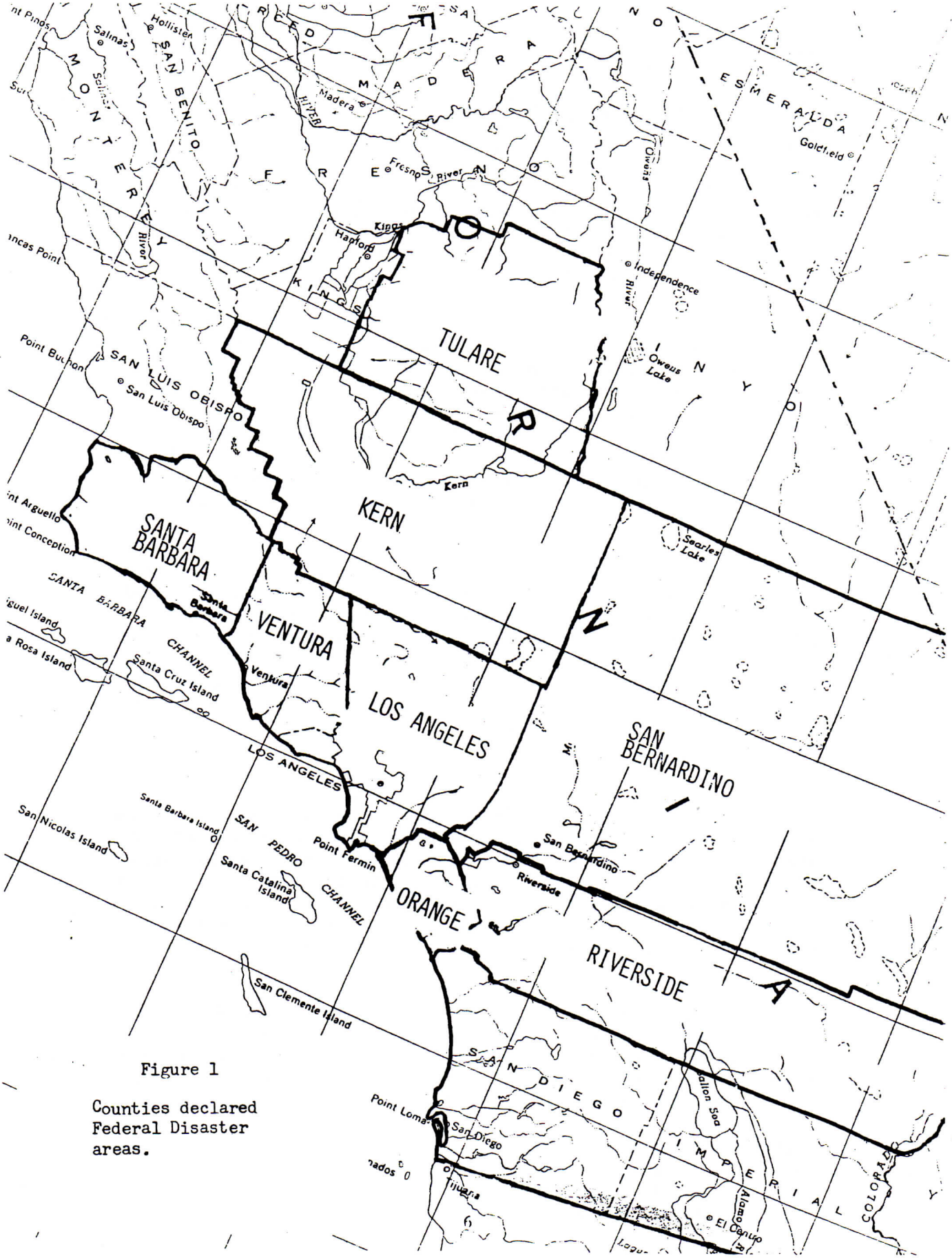


Figure 1

Counties declared Federal Disaster areas.

"call to action" statements appended to several of the special weather statements and the strong language contained in some of the releases.

RECOMMENDATION:

Appropriate field offices should be commended for their performances during this storm and the March 1978 storm (Appendix C).

FINDING 2:

Throughout the storm period, nearly all existing communication channels, including NAWAS and NOAA Weather Radio (NWR), were working at full performance. In addition, no evidence could be found of any significant equipment failure.

FINDING 3:

There is a need for more real time rainfall and river reports. Real time rainfall reports collected by the Los Angeles County Flood Control District Headquarters were not available to the Los Angeles WSFO. A method of obtaining this data had not been established.

RECOMMENDATION:

WSFO Los Angeles should promptly make arrangements to secure more real time, reliable data from Governmental agencies and others. Event reporting rain gages, flash flood alarms, and manually collected data should all be considered as part of a total local rainfall and river reporting system. Use of radios (amateur and reliable/organized CB groups) for collective data should be explored.

FINDING 4:

There were some people in exposed areas who either failed to receive the watches and warnings or ignored them. A number of survivors in the Hidden Springs area of greatest destruction said they had been through several previous flooding episodes and saw no need to evacuate in this case. This is a typical reaction by people in such situations.

RECOMMENDATION:

Through a more vigorous Disaster Preparedness Program (talks, dissemination of flash flood literature, etc.), NWS and other concerned government agencies should educate people about the need for proper action when watches/warnings are received. Closer coordination with law enforcement, sheriff, state and local police, and OES personnel are needed in some areas.

FINDING 5:

WSO's Bakersfield and Santa Maria are part-time offices (6 a.m. to 10 p.m.). Santa Maria closed at 10 p.m. and Bakersfield at 10:30 p.m., Thursday, February 9, while the storm was still in progress. Santa Maria opened as usual at 6 a.m., Friday, and Bakersfield at 4:30 a.m., 1 1/2 hours early.

RECOMMENDATION:

Part-time WSO's should extend hours of operation during severe weather. Parent WSFO's should advise and ensure that part-time WSO's in their forecast area stay open under these conditions.

FINDING 6:

Santa Maria failed to receive the flash flood watch issued at 1 p.m., February 9, by Los Angeles WSFO. This watch included southern Santa Barbara County, which is in Santa Maria's warning area. Staff at Los Angeles tried unsuccessfully for 2 1/2 hours to telephone Santa Maria with the watch but were unable to reach them because the telephone at Santa Maria was busy.

RECOMMENDATION:

Arrangements should be made promptly to extend Los Angeles NOAA Weather Wire to Santa Maria. If this is not possible, Santa Maria should obtain an unlisted telephone. It is imperative that watches and warnings issued by WSFO's are communicated immediately to affected WSO's. Los Angeles NOAA Weather Wire should also be extended to Bakersfield since part of Kern County is in Los Angeles' forecast district.

FINDING 7:

WSFO Los Angeles had frequent contact with WSO Palmdale and SFSS San Francisco. There was at least one case in which a significant misunderstanding ensued. This misunderstanding occurred between San Francisco WSFO and Santa Maria WSO and resulted in the watch for San Luis Obispo County and northern Santa Barbara County being incorrectly cancelled by WSO Santa Maria on the evening of February 9. The WSS on duty at Santa Maria WSO was told in a telephone conversation with the forecaster that the flash flood watch was to be cancelled. He coordinated with his OIC, got the word out to the media and closed the station at 10 p.m. Later information caused the WSFO forecaster to continue the flash flood watch. When the WSO opened the next morning, it was learned that the flash flood watch had been continued through the night.

RECOMMENDATION:

NWS and NESS field offices should be encouraged to develop a year-round coordination program. There is obvious need for frequent and close coordination between WSFO's and WSO's in watch/warning situations. The WSFO, San Francisco forecaster tried to call WSO, Santa Maria, but the station was closed. He should have called the OIC, Santa Maria, at his home and informed him of this decision. In the future watches should be cancelled only on receipt of a hardcopy message on NWWS.

FINDING 8:

The broadcast media disseminated watches/warnings and special weather statements in a timely, effective manner. Some local communities took effective life-saving actions before serious flooding occurred.

RECOMMENDATION:

NWS should congratulate the broadcast media and these local communities on their performance during the storm period. The importance of the media role in warning dissemination should be emphasized.

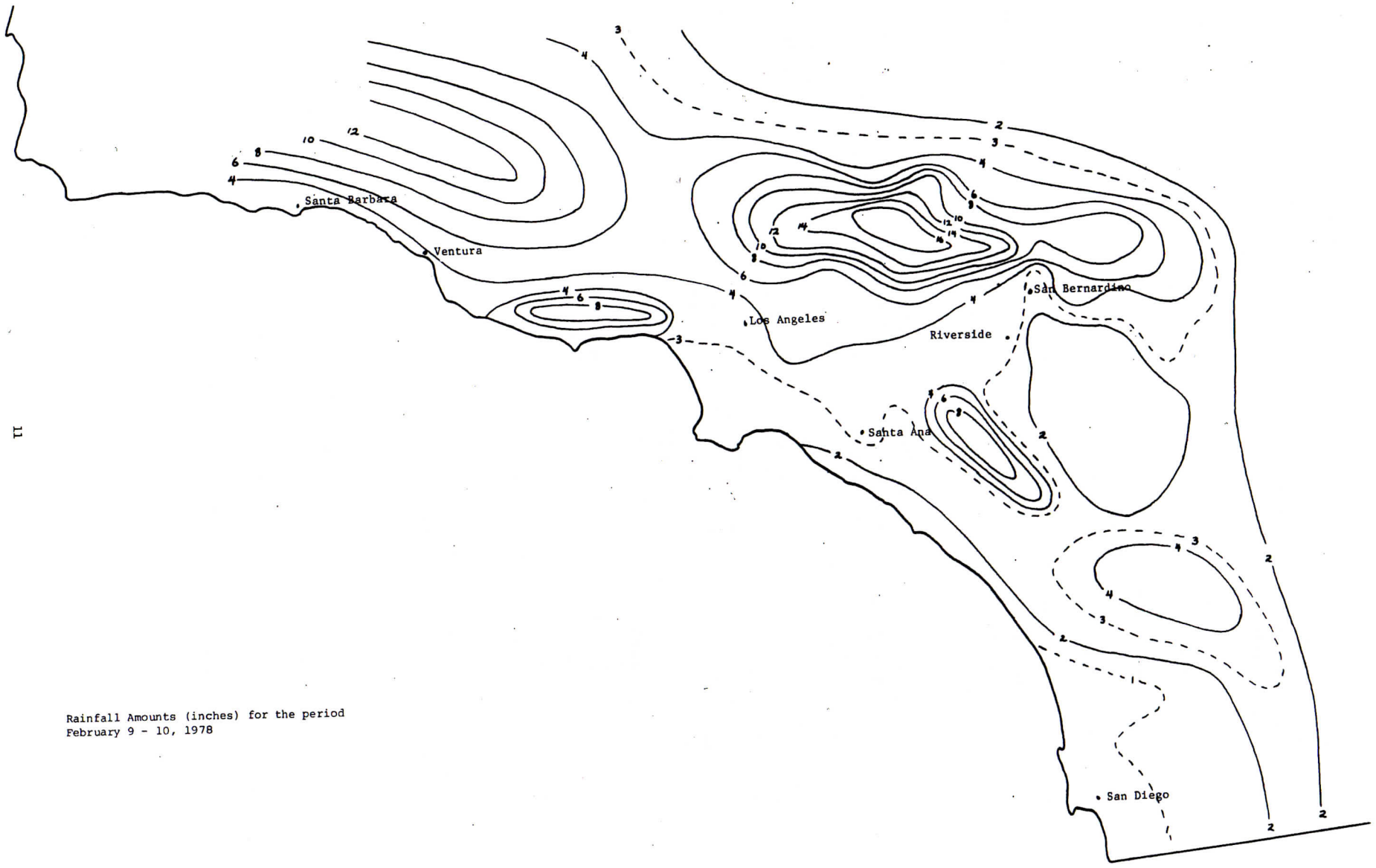
SOUTHERN CALIFORNIA FLOODS, FLASH FLOODS, AND MUDSLIDES OF FEBRUARY 8-10, 1978

CHAPTER 1 - DESCRIPTION OF EVENT

A monstrous storm, one of the worst in recent southern California history, brought death and destruction to the Los Angeles area and neighboring counties on February 8-10, 1978. Flash floods swept cars off highways, freed three dangerous lions from their cages (later shot by Sheriff's deputies), and washed at least 30 corpses from their graves near the City of Tujunga. Mudslides damaged homes and cabins, and strong winds uprooted hundreds of trees. Four coastal marinas were reduced to shambles and the Los Angeles and Long Beach Harbors were closed by gale winds.

An estimated 700 persons were driven from their homes throughout southern California. At least 100 houses were damaged by mud and rock slides in the Sunland area alone. Entire neighborhoods were isolated by either road closures or floods, several bridges were washed out, and dozens of schools were closed. Power outages affected more than 500,000 people. Twenty lives were lost. Damage exceeded $83 million ($43 million in the Los Angeles area and another $40 million in the southern San Joaquin Valley). Much of the loss in the San Joaquin Valley was agricultural. Eight counties were declared Federal disaster areas (Figure 1).

Late on Wednesday, February 8, heavy rains began over the Los Angeles Basin and adjacent counties to the north and continued until the morning of Friday, the 10th. Nearly 4 inches fell at Los Angeles Civic Center, but much heavier amounts fell in surrounding hills and mountains. Mt. Wilson, Lake Arrowhead, and Tujunga Canyon reported as much as 12-16 inches (see Isohyetal Map, Figure 2). Although the ground was saturated and reservoirs were full from earlier rains (Los Angeles had received 16 inches of rain for the winter season up to February 7, double the normal for the date and greater than the seasonal normal of 14 inches), the key to the flooding was the extremely heavy, short duration of rainfall on February 10. For example, Haines Canyon in the Tujunga Drainage recorded 1.4 inches in 30 minutes in the early morning of the 10th. Glendale recorded 0.48 inches in 5 minutes at 1:30 a.m. on the 10th. Bakersfield received 3.00 inches in 24 hours--the greatest such total in the 100-year record. As a result, there was widespread flooding, some flash flooding, and mudslides. However, most of the rainfall amounts were at or below those associated with the "10-year storm." Even the 9-inch 24-hour, the 3.90-inch 6-hour, and 1.6-inch 1-hour rainfalls near Hidden Springs were within the limits of the expected 10-year storm. This means that, given the proper antecedent conditions, similar flooding could be expected several times during an average lifetime.



Rainfall Amounts (inches) for the period
February 9 - 10, 1978

Hardest hit was the tiny community of Hidden Springs about 20 miles north of downtown Los Angeles in a canyon of the San Gabriel Mountains. Hidden Springs is a resort/fishing village located on Mill Creek. At 2 a.m. on Friday the 10th (all times PST except as noted in Chapter 3), a 15-foot wall of water described as a "big wave" swept over the community carrying 13 residents to their death. Ten of these died when the wave hit their lodge located on Mill Creek. A fire had broken out in the lodge and the volunteer fire department, consisting of several men and a pumper, were fighting the fire when the "big wave" hit. The pumper was found four miles downstream several days later. Three people were swept to their death when a nearby triplex was hit by the wave.

To indicate the short duration of the wave, one man who was trapped in the wreckage of the lodge was not drowned. Survivors indicated the wave rose in seconds and subsided in seconds sweeping everything before it--houses, cars, trucks and people. They said they had never seen Mill Creek rise so fast.

The sudden onslaught of this "big wave" suggests temporary damming upstream by debris which suddenly washed away. A half mile upstream from Hidden Springs at the confluence of Middle Fork and Mill Creek, Middle Fork flows through two culverts under the Angeles Forest Highway before joining Mill Creek. Local residents indicated one culvert and a section of road were washed out as water flooded over the highway, possibly contributing to the "big wave" that surged down Mill Creek. The watershed above Middle Fork had been extensively burned the previous August and most likely this led to the rapid runoff and accumulation of debris beyond the culvert. It is also possible, of course, that debris dams formed on Mill Creek above Middle Fork, although there did not appear to be any damage a short distance above the junction. Another factor contributing to the damage was altering of the Mill Creek streambed. The stream meanders a bit in the canyon bottom and had been "bowed out" in some places to make more level ground available for building. Of course, when the flood came the stream tended to follow the more direct path, destroying manmade objects in its way.

Flash flooding from breaking of debris dams as noted above cannot, of course, be pinpointed by NWS flash flood warnings. As described more fully later, the "big wave" also coincided with a heavy burst of rainfall associated with passage of a cold front through the area. ARTCC radar reports clearly indicated the front.

Several motorists in communities near Los Angeles were drowned when roads were washed away under their vehicles. Especially hard-hit were the cities of Sunland and Tujunga. Flash floods rolled down several small canyons overwhelming debris dams and destroying several homes, about two dozen autos and several bridges. Damage was considerable in Laurel Canyon in the Santa Monica Mountains just north of Hollywood where

50 automobiles were washed down the canyon. Flash flooding destroyed homes and trailers in Caliente and Loraine, small communities in the southern Sierra Nevada Mountains of eastern Kern County. It took weeks to repair all of the damaged roads and bridges.

The storm was sufficiently severe that on February 15 President Carter declared Los Angeles, Orange, Ventura, Santa Barbara, Riverside, San Bernardino, Tulare, and Kern Counties Federal disaster areas. (See Figure 1.)

CHAPTER 2 -- DATA ACQUISITION

WSFO, LOS ANGELES, DATA AND GUIDANCE ACQUISITION

In general, during the entire storm period of February 5 through 10, data and guidance acquisition systems at WSFO, Los Angeles, performed reliably. The rainfall reporting systems, particularly during the period leading up to the killer flash flood at Hidden Springs, indicate that there was not sufficient real time precipitation data to assess localized intense rainfall and to issue flash flood warnings for specific areas.

A. Data and Guidance Acquisition

Numerous channels for receiving operational data and guidance products at Los Angeles WSFO are available. These are Service A, Service C, Local Circuit (NOAA Weather Wire Service), Press Circuit, Coast Guard Circuit, RAWARC Circuit, Request/Reply Circuit, KCRT system, NAFAX, FOFAX, RAFAX, GOES Recorder, telephones, telemetered rain gages, and Fire Weather AFFIRMS system. A complete description of these systems is contained in Appendix B. Radio (amateur and CB) is not used to collect rainfall data.

The only outages during this storm period were as follows:

NAFAX - During the evening of February 9, from about 6:30 p.m. to 9:30 p.m., the circuit was down due to line problems. Missed guidance included the Barotropic and LFM Prog Packages. Although WSO Palmdale sent the LFM progs to WSFO, Los Angeles (in between scheduled radar charts) on the RAFAX circuit, these were of poor quality. In the opinion of the Lead Forecaster on duty and the survey team, the missing and late poor-quality guidance charts did not affect the quality of forecasts and warnings issued.

RAFAX - Because WSO Palmdale transmitted the LFM charts, both before and after the complete NAFAX failure, WSFO Los Angeles failed to receive 6 of the radar charts. This loss was not critical because of frequent telephone discussions between WSFO Los Angeles and WSO Palmdale. However, the quality of the NAFAX charts was so poor that it was necessary to switch the fax receiver normally used for RAFAX over to NAFAX.

B. Rainfall Reports

As can be seen from Tables 1A to 1C, very few precipitation reports were received in real time, and only two were received hourly - downtown Los Angeles and Sandberg. The vast majority of reports were either 24-hour amounts received once daily (Table 1D), or reports received after the storm period by telephone or mail from other agencies (Table 1E). Table 2 lists 6-hour and 12-hour amounts during the period of heaviest rainfall, the evening of the 9th and early morning of the 10th. Several of these reports were received at 3 or 6 hourly intervals, but only Mount Wilson is located in the San Gabriel Mountains.

Table 3 lists maximum short duration rainfall amounts from the Los Angeles County Flood Control gages. Although the Los Angeles County Flood Control District Center has automatic gage readouts, these reports were not available in real time at Los Angeles WSFO.

C. Weather Radar

Hourly ARTCC radar reports were received at Los Angeles WSFO from WSO Palmdale (see figures 3 through 11). In addition, there was frequent coordination between the two offices. Radar indicated echoes moving rapidly eastward at the time of heaviest rainfall. Throughout the storm period echo intensities were subjectively indicated as strong. No radar cloud tops are available, of course, from FAA radars and there were only a few PIREPs of cloud tops. Commercial aircraft in the Los Angeles Basin are usually descending on approach or climbing after take-off, do not top storm clouds, and hence they are rarely able to provide top reports over Los Angeles.

D. Satellite

Although WSFO Los Angeles made maximum use of satellite imagery in determining the synoptic situation, the imagery was not used to estimate rainfall amounts. Further, echo motion, moisture inflow and other information were difficult to determine from single photo imagery.

WSFO Los Angeles and the San Francisco Satellite Field Services Station discussed the situation frequently; at least 9 coordination calls were made. The forecasters relied heavily upon the NESS Satellite meteorologists' interpretation in issuing forecasts and warnings.

WSFO SAN FRANCISCO DATA AND GUIDANCE ACQUISITION

In general WSFO, San Francisco, has the same teletype and facsimile circuits as WSFO, Los Angeles. However, there are a few significant differences. Although each WSFO has a NOAA Weather Wire Service (NWWS) connecting it to its WSOs, there is no overlay connecting the northern

Preliminary 24-hour precipitation amounts (inches)
and
Availability of data at WSFO LAX (Feb 1978)

Station	24 hrs ending	8th	9th	10th	Total
Table 1A	Data available hourly				
Downtown Los Angeles	16P	.23	2.17	1.36	3.76
Sandberg	16P	0	2.08	2.52	4.60
Table 1B	Data available every 3 hours				
Los Angeles Airport	16P	.19	1.35	1.09	2.63
Long Beach	16P	.68	1.85	.98	3.51
Bakersfield	16P	T	1.12	2.68	3.80
Table 1C	Data available every 6 hours				
Santa Barbara	16P	1.91	2.68	1.16	5.75
Ontario	16P	.82	2.21	1.97	5.00
Mt. Wilson	16P	.95	5.27	7.82	14.83
Table 1D	Data available every 24 hours				
Lake Arrowhead	16P	.37	7.61	5.66	13.64
Northridge	16P	.06	2.52	2.03	4.61
Pasadena	16P	.12	3.05	1.52	4.69
San Gabriel	16P	.21	3.31	2.65	6.17
Santa Monica	16P	.10	1.98	1.08	3.16
Simi	16P	.18	3.76	2.44	6.38
Wrightwood	16P	.31	5.66	6.00	11.97
Lytle Creek	13P	.58	9.20	6.62	16.40
Devore	13P	.76	5.65	4.75	11.15
Big Bear FS	13P	.29	2.00	2.50	4.79

Table 1E — Data not available operationally

Station	24 hrs ending	8th	9th	10th	Total
Crestline	8AM	.51	.11	7.88	8.50
Crystal Lake	8AM	M	4.98	11.55	16.53+
Big Pines	8AM	.50	3.30	7.10	10.90
Red Box	8AM	M	M	9.55	9.55+
Monte Cristo	8AM	.61	2.00	8.93	11.54
Big Tujunga Dam (Los Angeles County Flood Control-Fischer Porter gage, about 4.5 miles downstream from Hidden Springs)	8AM	(M)-2.6-(M)		9.0	11.6
Santa Ana	8AM	0.82	1.39	1.62	3.83
Santiago Peak	8AM	1.2	5.4	3.8	10.40
Summit Upper Ojai		0.73	2.32	8.88	11.93
Matilija Dam		0.84	3.24	7.93	12.01
Ventura		1.31	2.20	2.34	5.85
Oxnard		1.07	3.20	1.65	5.92
Santa Paula		0.80	2.16	2.59	5.55
Fillmore		0.63	2.22	4.07	6.92
Piru		0.68	1.97	3.50	6.15
Thousand Oaks		0.82	1.62	3.20	5.54

M = Missing or not available

TABLE 2

Selected 6-hour and 12-hour rainfall amounts (inches)
2/9/16P - 2/10/4P/78

STATION	6-hour 9/16P -9/22P	6-hour 9/22P -10/04P	12-hour 9/16P -10/04P
Downtown Los Angeles	.31	1.00	1.31
Los Angeles Airport	.08	1.01	1.09
Ontario	.88	1.04	1.92
Sandberg	1.10	1.07	2.17
Mount Wilson	2.01	2.92	4.93
CORPS OF ENGINEERS TELEMETERED DATA			
Chatsworth	1.36	.98	2.34
Chilao	2.16	2.86	5.02
Crystal Lake	2.62	3.34	5.96
Santa Ana Flood Control District	.51	1.04	1.55
Sierra Madre	.91	1.68	2.59
San Antonio	1.42	1.44	2.86
Sepulveda	.47	.95	1.42
Whittier Narrows (Rio Hondo)	.49	1.24	1.73
Hansen	.40	1.54	1.94
Haines Canyon-Upper Prado	.92	1.38	2.30
Big Tujunga Dam (LA CO FC - FP gage about 4.5 miles downstream from Hidden Springs)	2.3	3.9	6.2

TABLE 3

Selected maximum short-duration rainfall amounts (inches)
2/9 and 2/10/78

STATION	DT/TIME (PST)	AMOUNT	DURATION (min)
Downtown Los Angeles	10/0200	.35	60
Los Angeles Airport	10/0000	.15	5
Glendale (LA CO. F.C. co-op #1081B)	10/0133	.48	5
CORPS OF ENGINEERS TELEMETED DATA			
Chatsworth	9/0111	.22	30
Chilao	10/0135	.42	30
Crystal Lake	10/0136	.43	30
Santa Ana Flood Control District	9/1805	.14	30
Sierra Madre	9/2302	.19	24
San Antonio	10/0304	.53	30
Sepulveda	10/0105	.21	30
Whittier Narrows	9/2101	.14	18
(Rio Hondo)	10/0137	.20	30
Hansen	9/2304	.30	24
	10/0005	.27	24
	10/0106	.23	30
	10/0138	.44	30
	(total 1.43 in 2 hr/58 min 2240-0138)		
Haines Canyon-Upper	10th	1.4	30
Prado	10/0305	.77	30

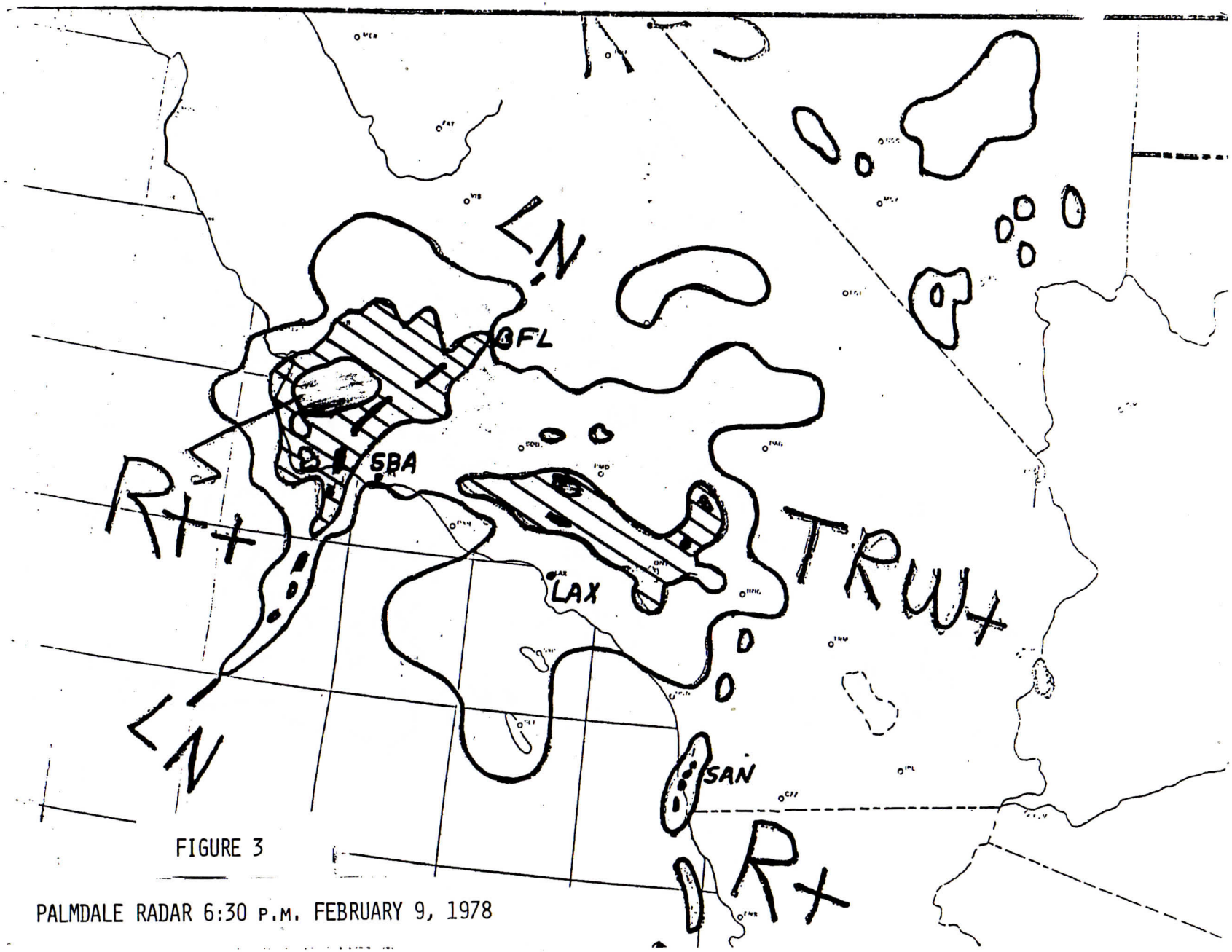


FIGURE 3

PALMDALE RADAR 6:30 P.M. FEBRUARY 9, 1978

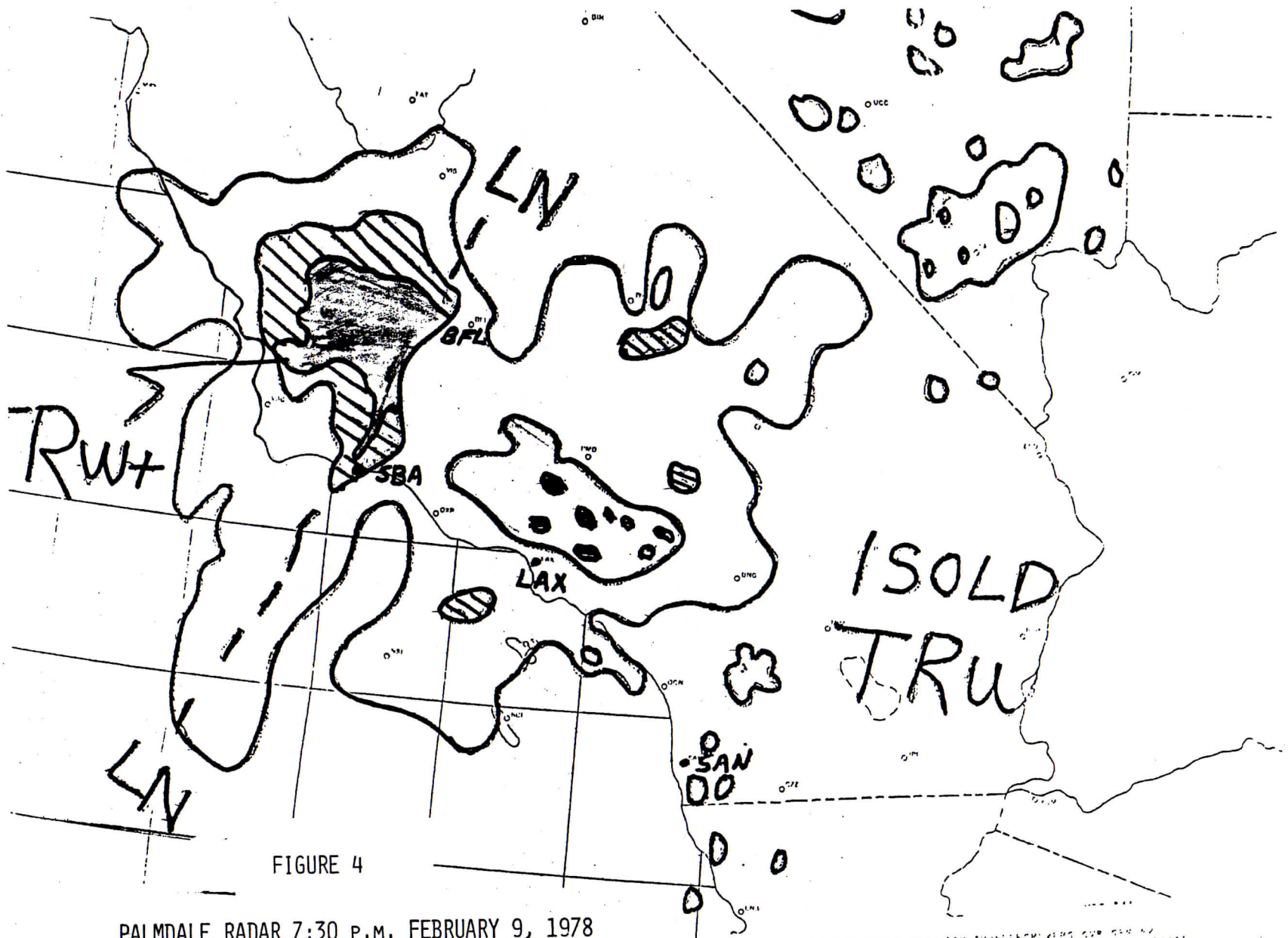


FIGURE 4

PALMDALE RADAR 7:30 P.M. FEBRUARY 9, 1978

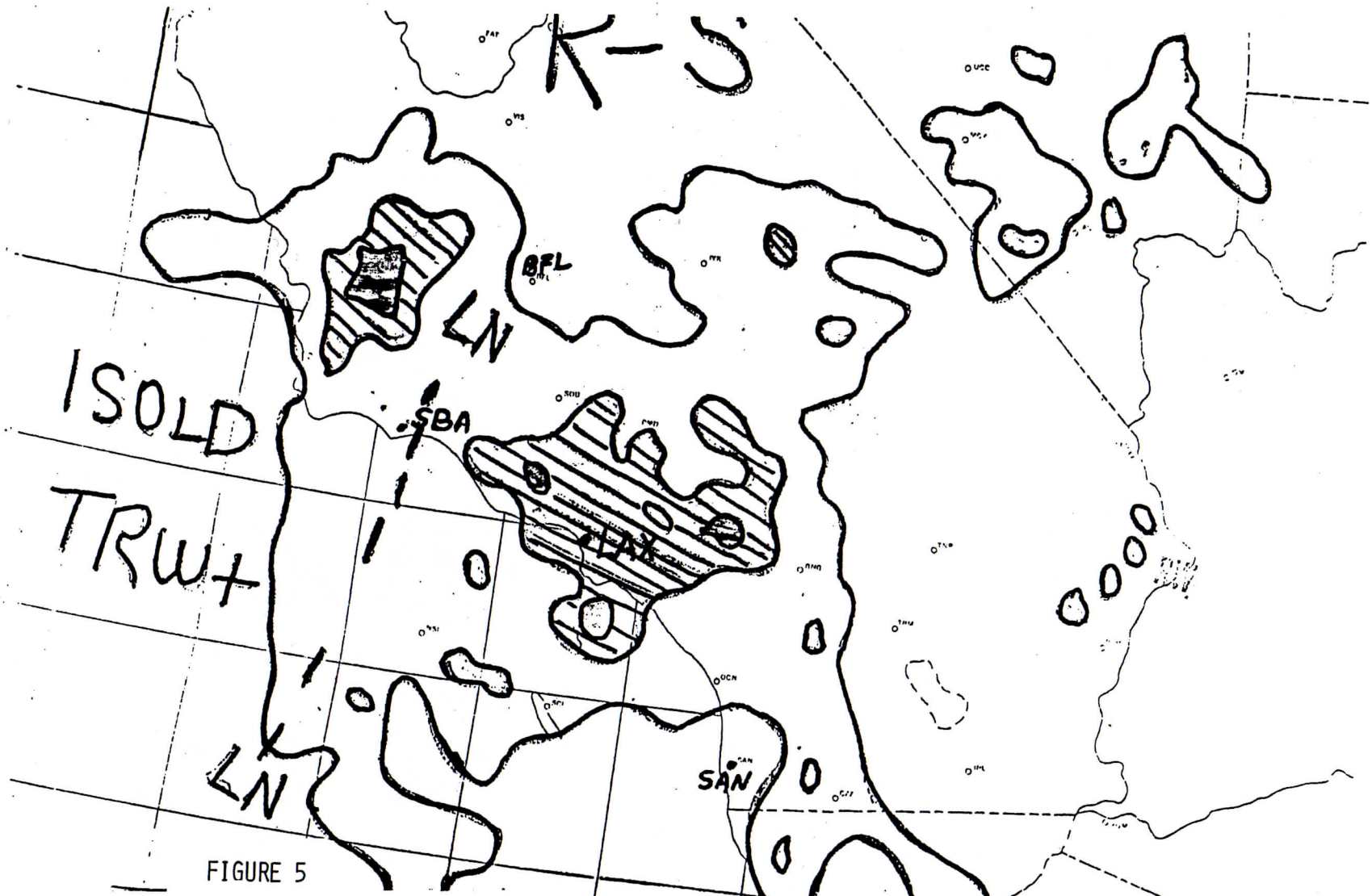


FIGURE 5

PALMDALE RADAR 8:30 P.M. FEBRUARY 9, 1978

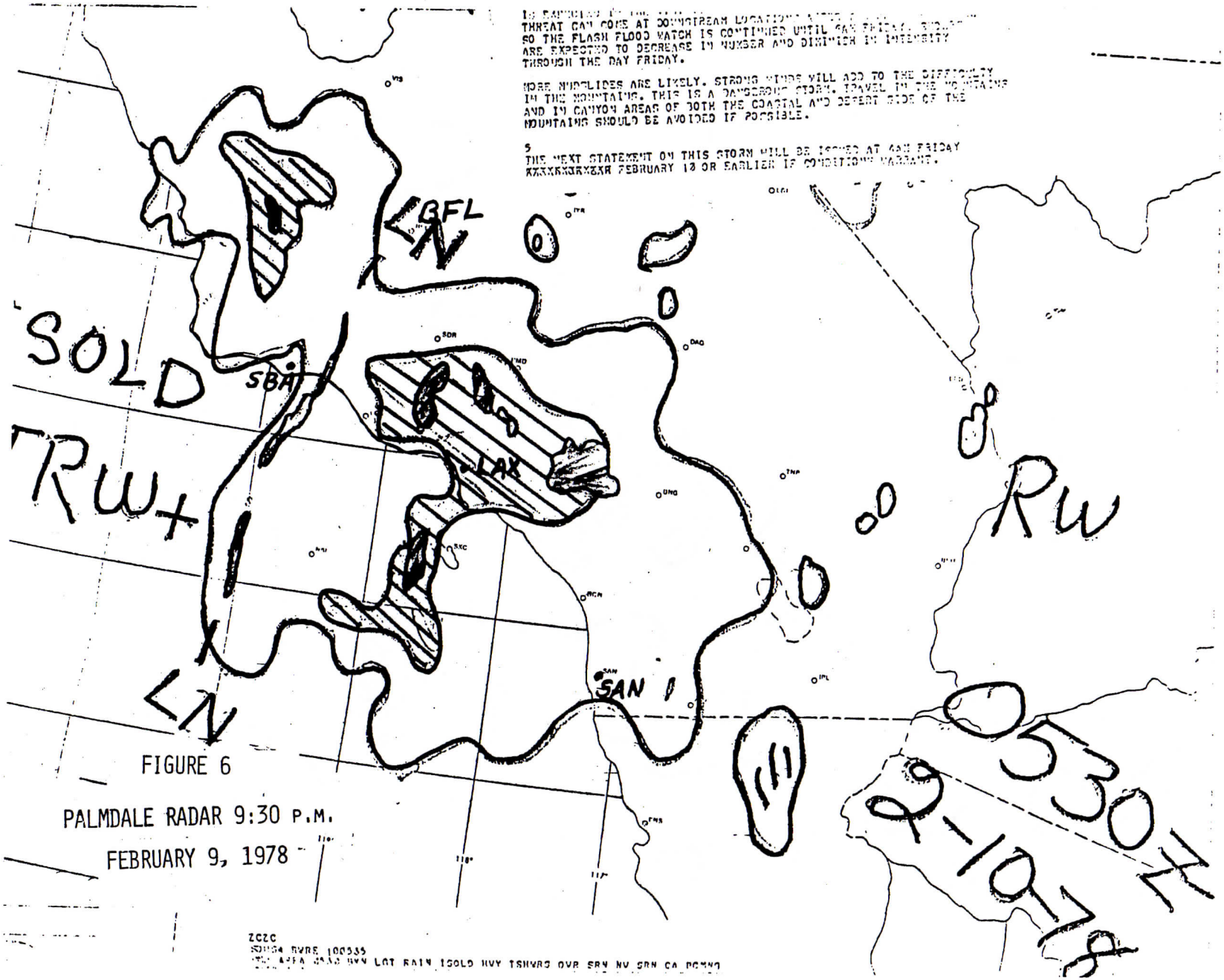


FIGURE 6

PALMDALE RADAR 9:30 P.M.

FEBRUARY 9, 1978

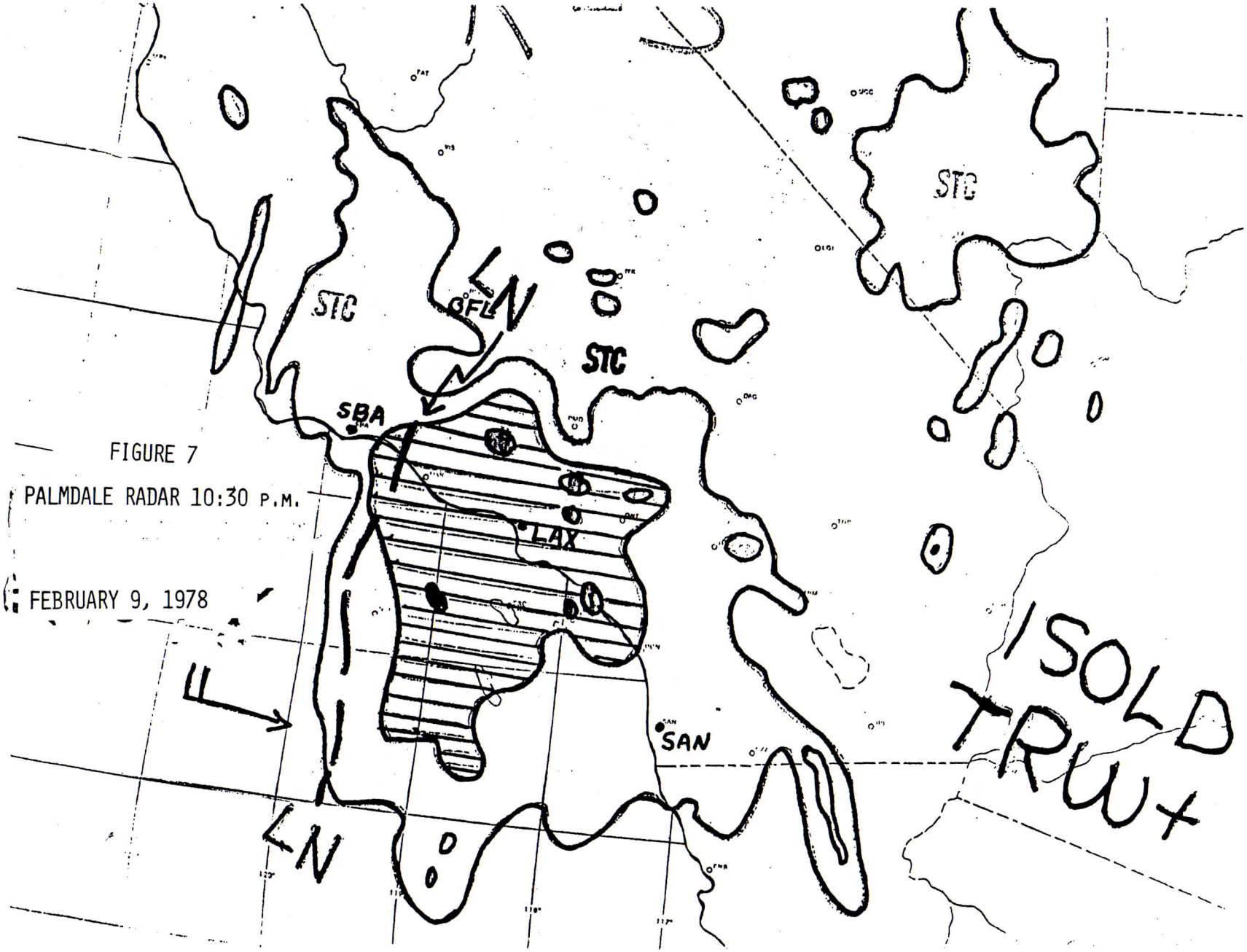


FIGURE 7

PALMDALE RADAR 10:30 P.M.

FEBRUARY 9, 1978

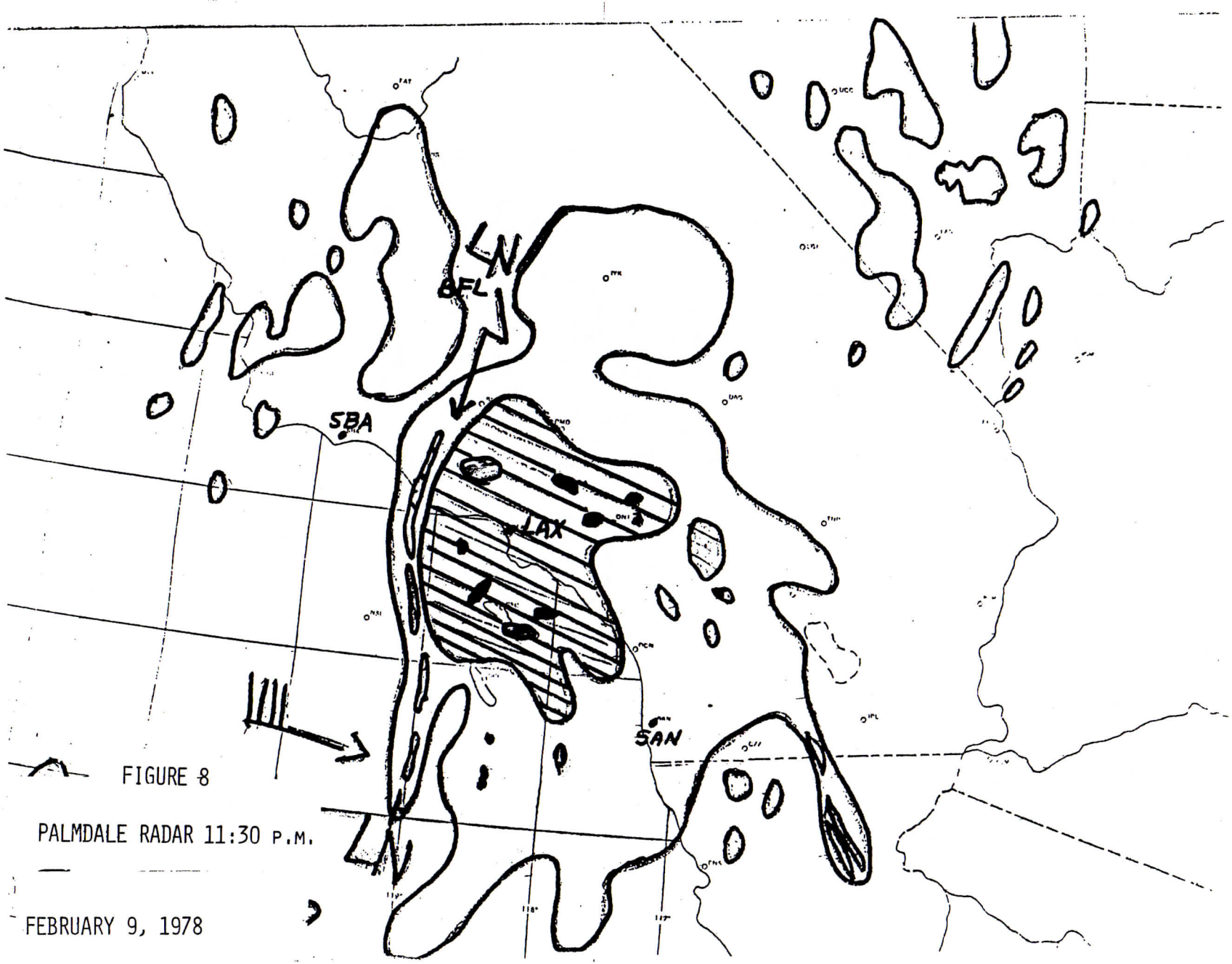


FIGURE 8

PALMDALE RADAR 11:30 P.M.

FEBRUARY 9, 1978

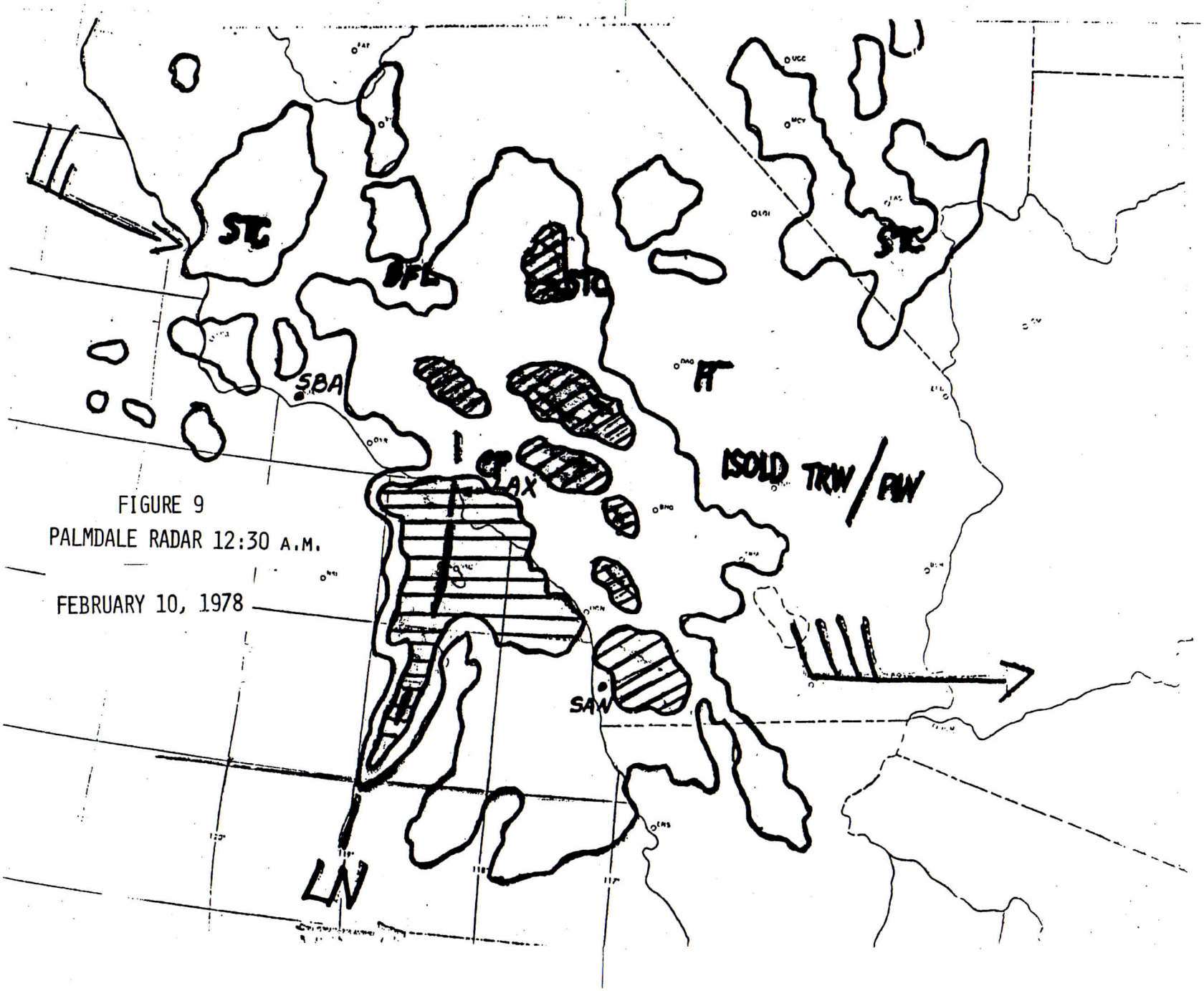


FIGURE 9
PALMDALE RADAR 12:30 A.M.

FEBRUARY 10, 1978

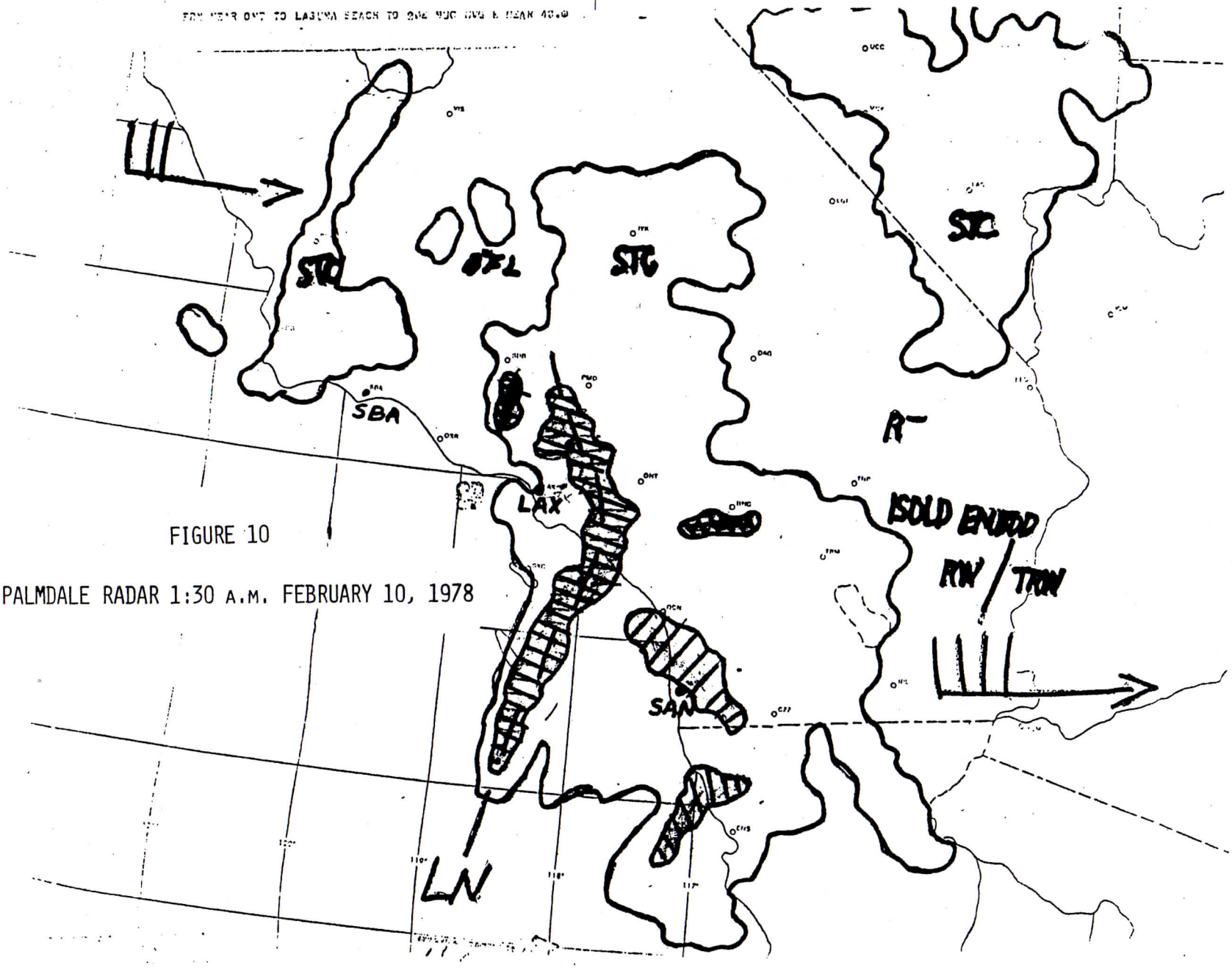


FIGURE 10

PALMDALE RADAR 1:30 A.M. FEBRUARY 10, 1978

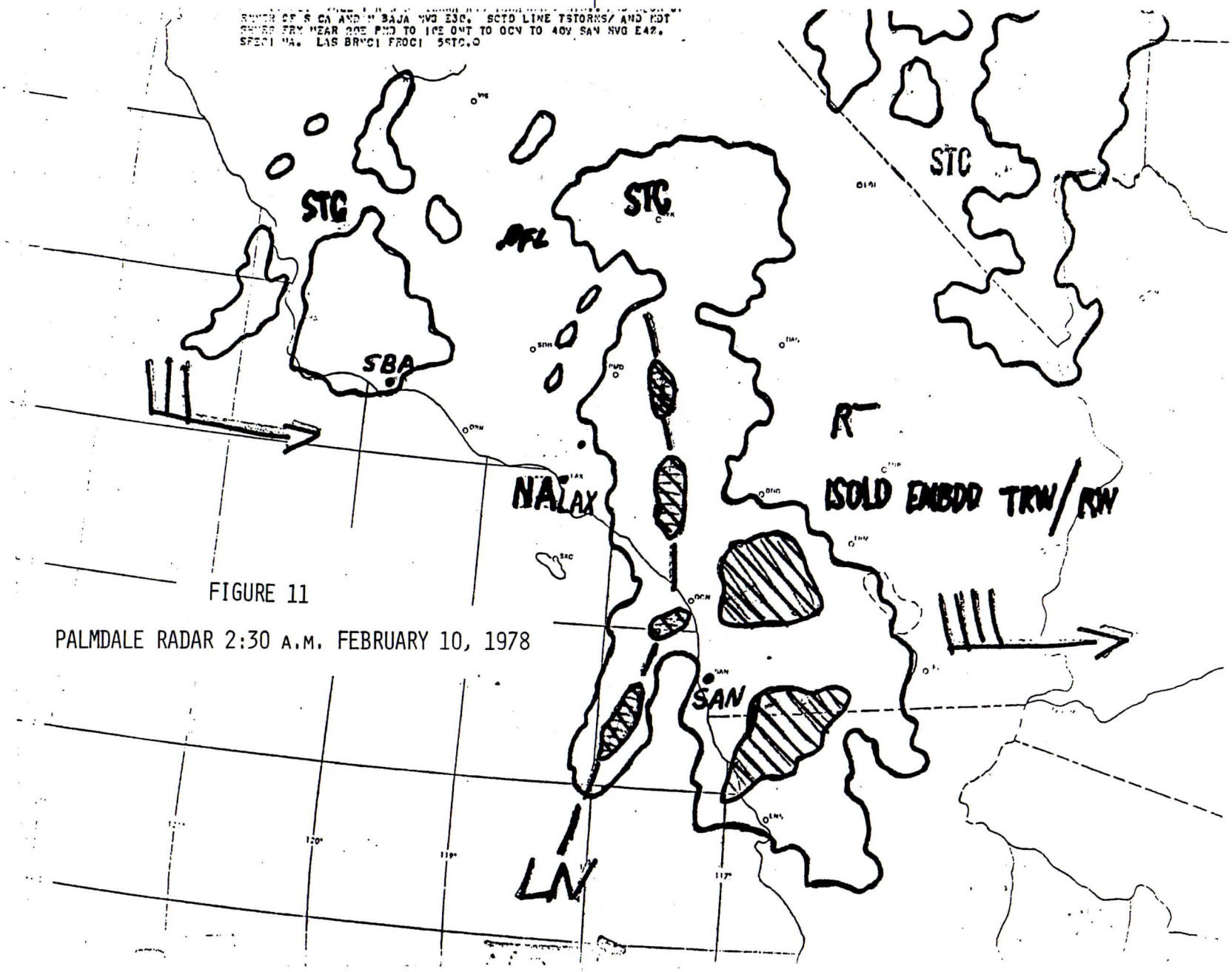


FIGURE 11

PALMDALE RADAR 2:30 A.M. FEBRUARY 10, 1978

California and southern California circuits. This poses some serious problems for WSOs, Bakersfield and Santa Maria, which are in the San Francisco forecast area, and thus on San Francisco NWWS, but have county warning responsibility extending into the Los Angeles forecast area.

WSFO, Los Angeles, receives its satellite data via GOES fax from San Francisco SFSS; the San Francisco WSFO is collocated with the latter, and has access to more sophisticated data, in particular satellite looping. San Francisco has no Fire Weather Program; thus, no AFFIRMS System. San Francisco received no telemetry from precipitation gages in the flood area under discussion.

All communication systems at WSFO San Francisco were operating normally during the storm period.

OTHER OFFICE DATA AND GUIDANCE ACQUISITION

RFC Sacramento has a considerable rainfall data base. In addition to using data collected through WSFO's and WSO's, RFC Sacramento collects rainfall data from a network of event reporting gages. One network has already been established (in cooperation with state and county offices) in the 1977 burn area of the Los Padres National Forest, south of Monterey. Work is progressing to expand the system to other areas of the state.

California WSO's have established lists of rainfall observers. However, only limited real-time rainfall data was received at the WSO's.

CHAPTER 3 - METEOROLOGICAL CONDITIONS

An anomalous large-scale flow pattern dominated southern California's weather during December and January. Normally, strong, upper-level westerly flow intrudes into the area periodically during winter months lasting only a few days at a time, but in the winter of 1977-78 westerlies remained unusually far south for weeks on end. The result was a southerly shift in the mean storm track and frequent bombardment of southern California with strong storms associated with copious rains during December and January. In addition, during the first eight days of February, more than 2 inches of precipitation fell on Los Angeles. Thus, the soil over the Los Angeles Basin was completely saturated by the end of the first week of February and conditions were dangerously close to criteria needed to precipitate mudslides.

The same type of flow pattern contributed to the unusually strong development of the February 8-10 storm. Figures 12-15 show development of the storm during the 36-hour period prior to landfall as seen by GOES satellite. It was a classic case of frontal wave development.

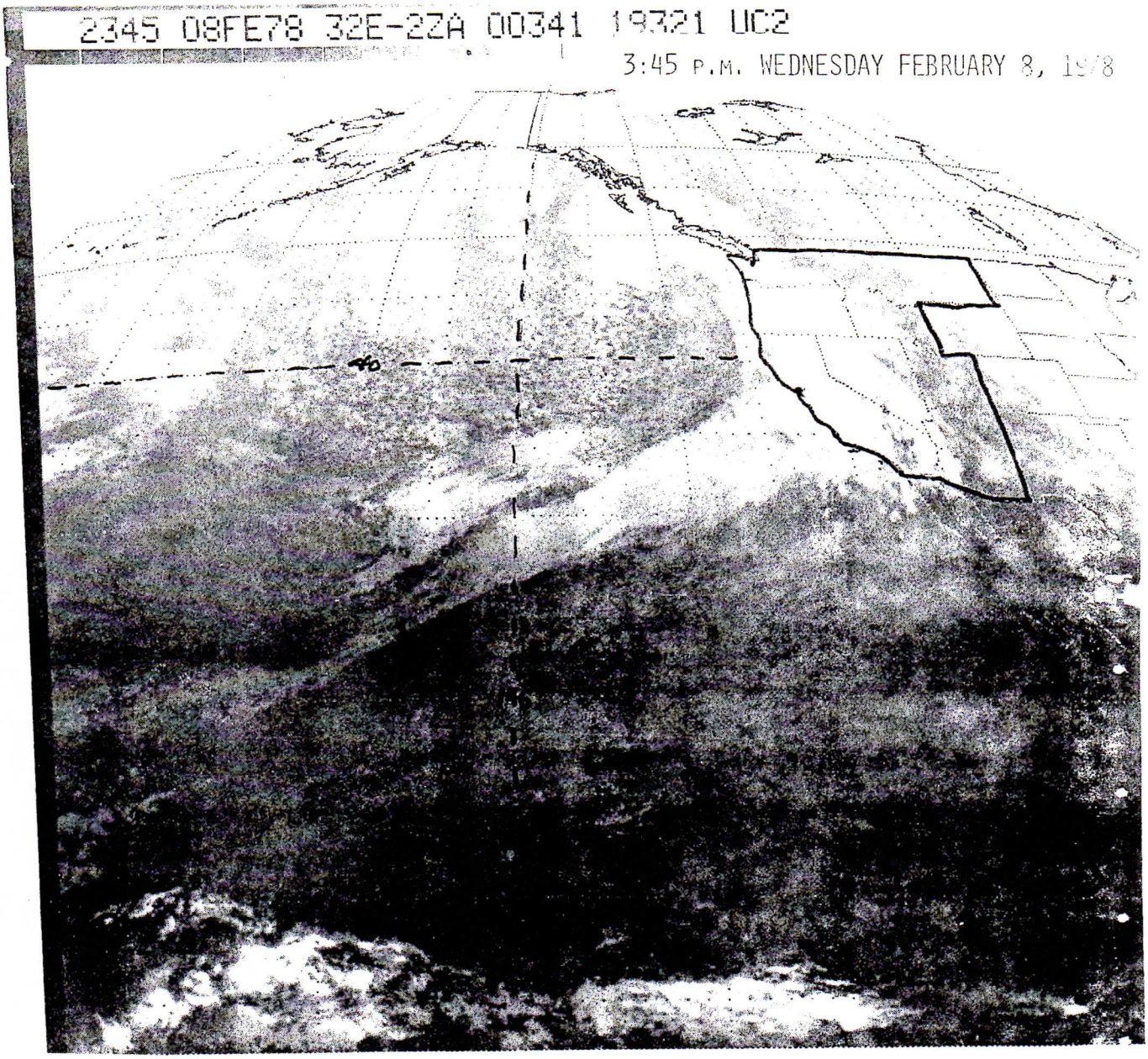

2345 08FE78 32E-22A 00341 19321 UC2
3:45 P.M. WEDNESDAY FEBRUARY 8, 1978

Figure 12

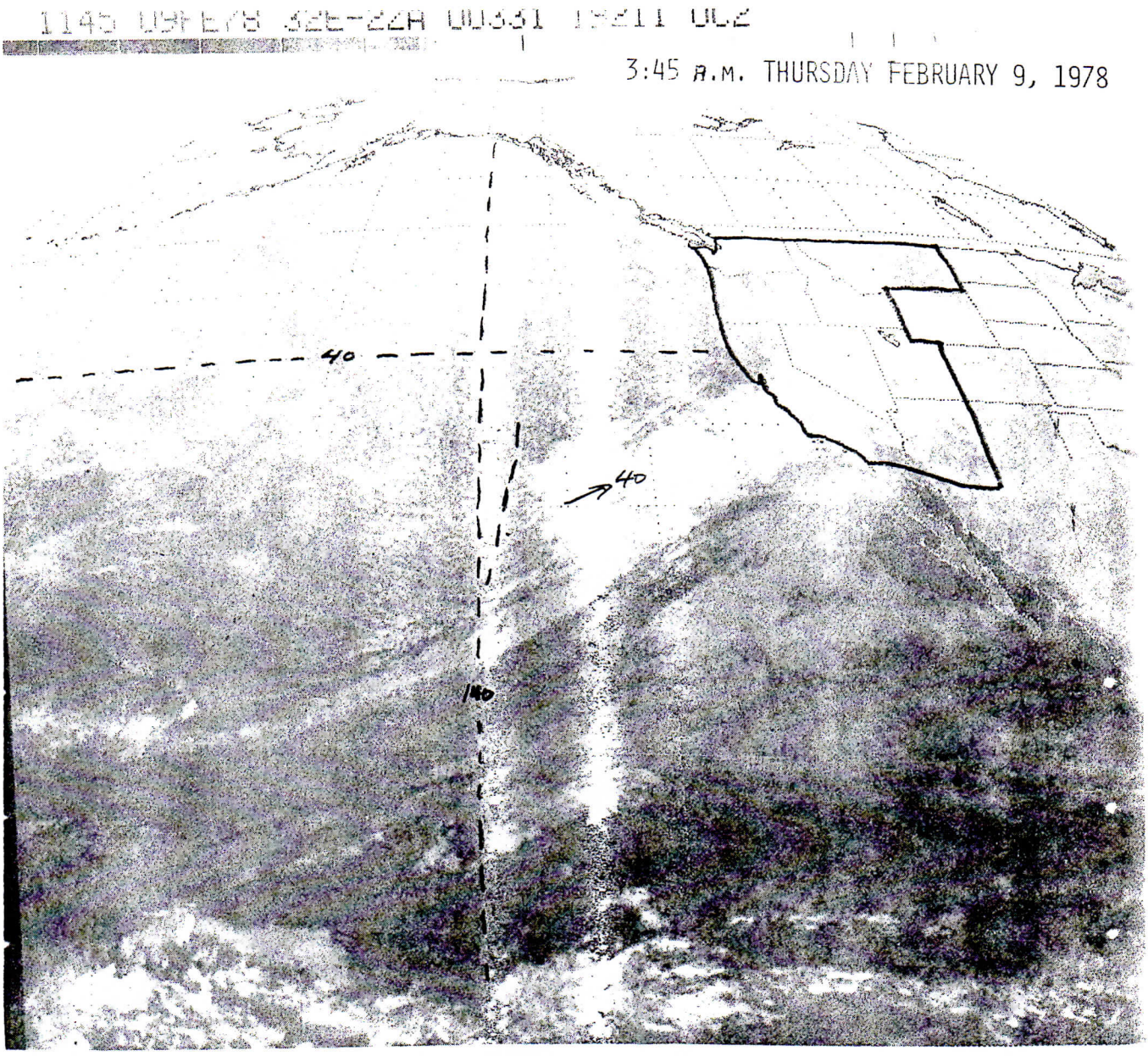


Figure 13

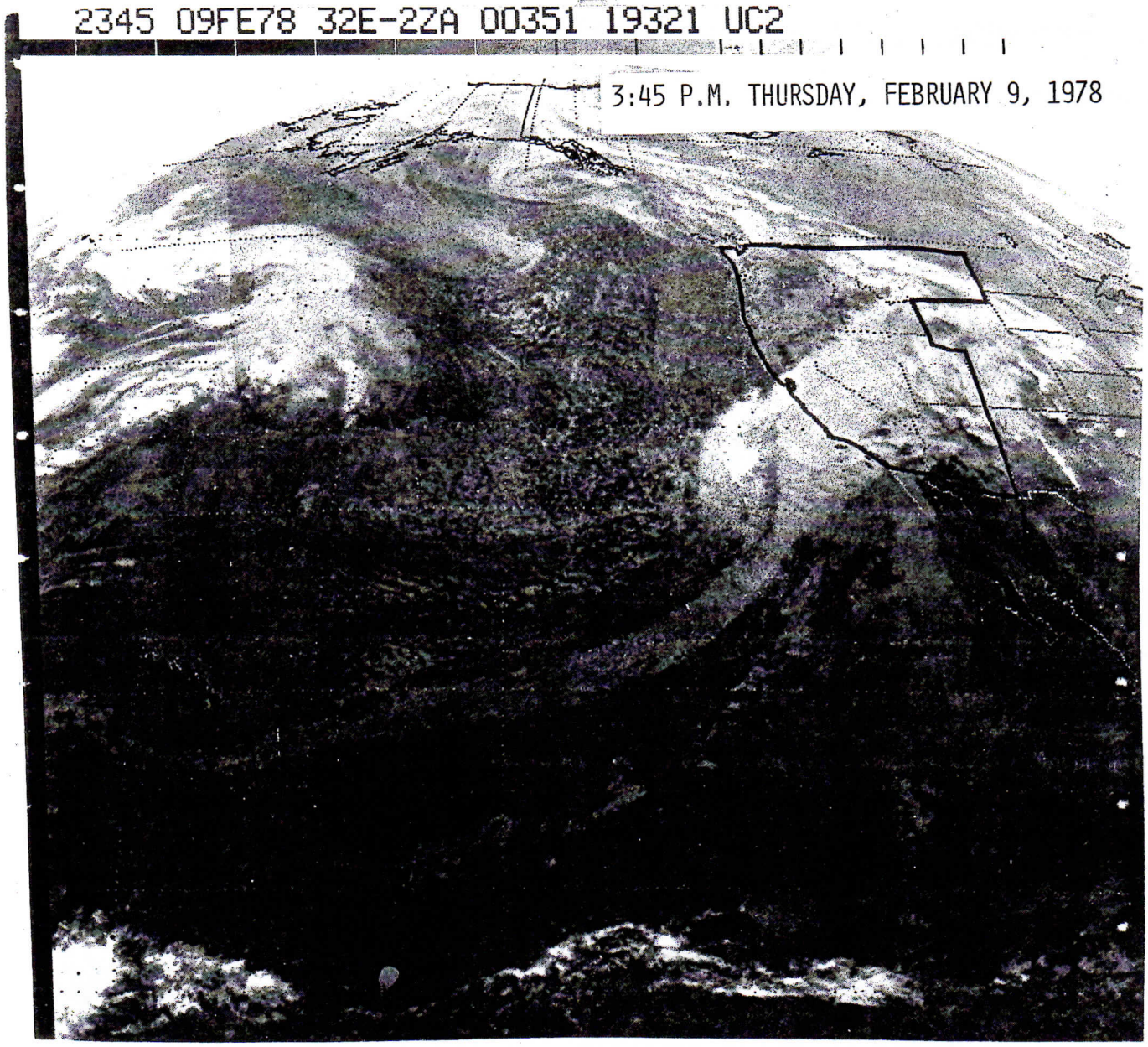

2345 09FE78 32E-2ZA 00351 19321 UC2
3:45 P.M. THURSDAY, FEBRUARY 9, 1978

Figure 14

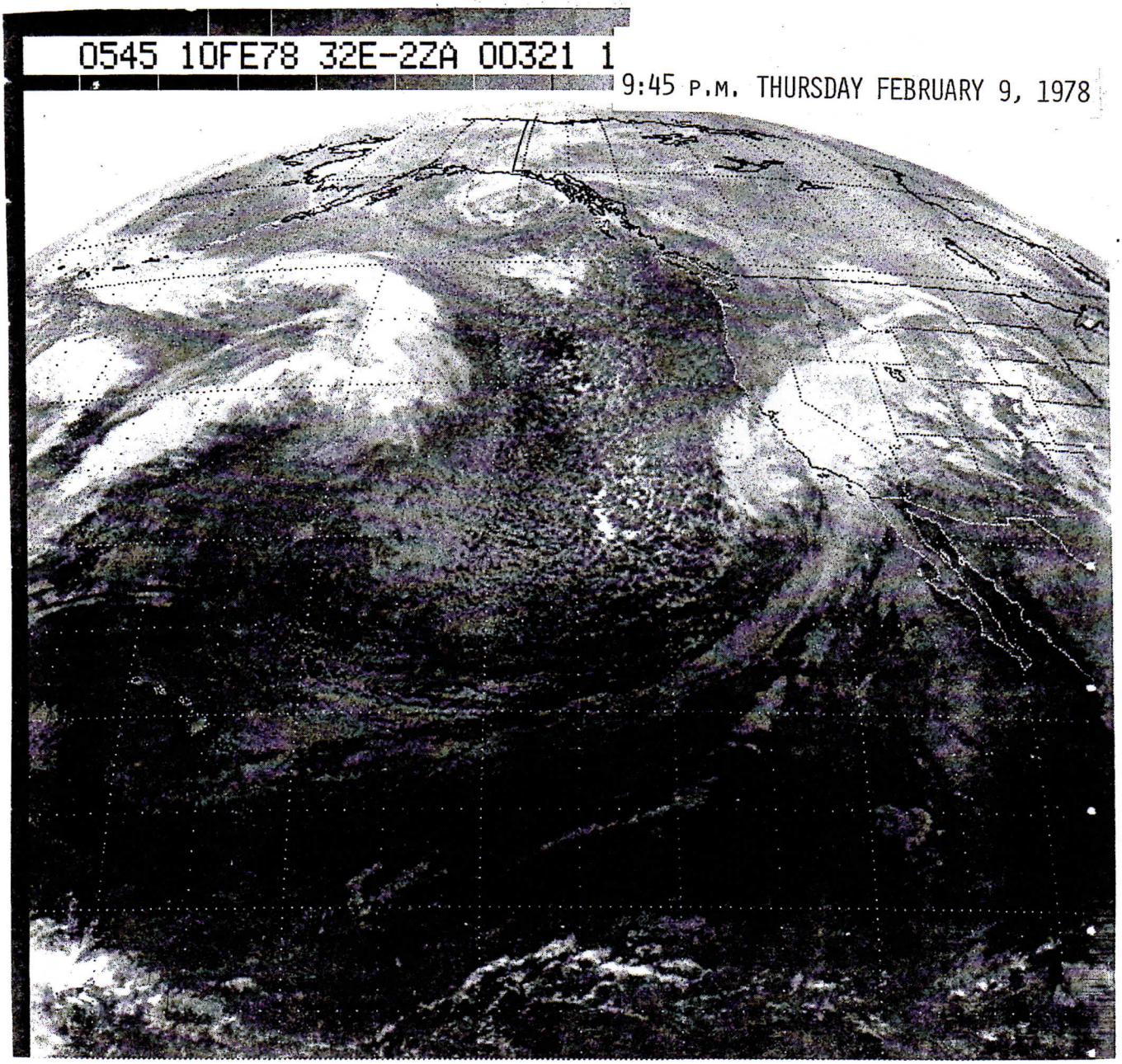


Figure 15

First evident about 600 miles northeast of Hawaii, the wave moved east-northeastward at 40 KT, intensifying slowly at first then more rapidly as it neared the coast. During the early morning hours of the 10th, the storm center moved onshore just north of Los Angeles. At 5:54 a.m. on the 10th, Los Angeles International Airport recorded a sea-level pressure of 993.7 mb, the lowest ever recorded at that office.

Frontal wave development of this type is not uncommon in the eastern Pacific but is rare at such low latitudes. Typically several storms each year move into southern California from the southwest, but they are usually cut-off upper-level cyclones that are weakening as they move inland. The extreme southern extension of the upper-level westerlies during the first part of February set up conditions that were more typical of the Washington/Oregon coasts than southern California.

There were several unique aspects of the February 8-10 storm that should be discussed:

a. If the storm had occurred farther north in the heavily forested Washington and Oregon area, it would not have been too unusual. But with 24-hour rainfall amounts of about 2 inches over the general area and about 15 inches in some mountain areas, it was enough to cause widespread mudslides and some flash flooding after the heavy rains during the previous week.

b. Although the estimated central pressure of the storm (992 mb) was not low compared to storms that occur in more northerly latitudes, the February 8-10 storm was, in general, of record intensity for the Los Angeles area. In addition to record sea-level pressure observed at Los Angeles International Airport, near-record low temperatures and heights at 500 mb and maximum winds were reported along the coast. Precipitation, however, did not generally exceed expected 10-year amounts mainly because of the rapid movement of the storm through the area.

A study of surface reports, upper air data, satellite pictures and radar shows that the front passed through the Los Angeles area between 0900Z and 1000Z (1 a.m. and 2 a.m. PST) on the 10th. A line of vigorous convection was associated with the frontal passage. The front was moving at about 30 knots. The vigor of this front is exemplified by the pressure tendency field at 0900Z (1 a.m. PST) on the 10th. Three-hour pressure falls as large as 5.8 mbs. were recorded just ahead of the front. The heaviest rains were associated with this frontal passage. The pressure trough and wind shift followed approximately 3 to 4 hours behind the front.

c. The 3-inch rainfall in 24 hours at Bakersfield needs further explanation. The expected 24-hour rainfall total for a 10-year storm at Bakersfield was only 1.4 inches due to its "protected" location. Bakersfield is in a valley and westerly or southwesterly flow aloft normally results in downslope conditions, therefore, precipitation amounts are usually much less there than in the mountains just to the east and west. Significant accumulations, however, are normally associated with cold fronts pushing rapidly through the area from the northwest.

The February 8-10 storm generated a rare flow regime over the Bakersfield area. Prior to the storm hitting the coast, cool air behind a weak cold front had worked its way into the southern San Joaquin Valley southward down to the northern slopes of the Tehachapi Mountains. As the developing storm approached the coast, warm, moist air ahead of the system began flowing northeastward, overrunning the cool air over Bakersfield, thereby negating the usual downslope effect of the terrain. This overrunning pattern continued until the low center passed over the Bakersfield area. As a result, rain fell for 46 continuous hours at Bakersfield. Nearly four inches fell during the period.

Forecast Guidance

In general, guidance from NMC was advertising a significant rain event, but none of the NMC products accurately forecast the intensity of the February 8-10 storm. The 36-hour LFM forecast computed from 09/00Z and valid at 10/12Z was exceptionally good as far as depicting the location of the surface low and upper-level trough. Although the surface low was underforecast, the 500 mb forecast showed a strong jet stream impinging on the southern California coast and a strong vorticity center just offshore. These features, at such a low latitude were rare. The NMC man/machine forecasts based on the 09/00Z forecast package accepted the LFM trend but further downplayed the intensity of the storm. The following LFM prognostic cycle at 09/12Z, backed off from its previous trend and showed the storm much weaker and well into Nevada by 10/12Z. Based on comparisons with satellite data, the poor prognoses generated from 09/12Z may have resulted from a poor initial analysis. The barotropic and PE progs fared no better. The barotropic grossly underestimated the intensity of the storm as would be expected in a strong developmental situation. The PE prognoses generally underestimated the intensity of the storm until the 10/00Z cycle, but by that time the storm was almost onshore. QPF forecasts from NMC generally paralleled the numerical guidance. A significant rain event (up to 2 inches) was forecast for the areas, but rainfall indicated for the mountain areas was underforecast.

Satellite imagery proved to be one of the most valuable tools to the Los Angeles forecasters. By analyzing pictures every 30 minutes, forecasters were able to monitor development of the storm system as it approached the coast. Analysis of the satellite data allowed adjustments to be made in the conventional surface analyses and initial analyses for individual NWP prognostic cycles. Without the satellite data, it is likely that watches and warnings issued by the Los Angeles office would not have been as accurate or timely.

CHAPTER 4 - WATCH AND WARNING DISSEMINATION AND USER REACTION

For the past several years, NWS Western Region has intensified activities in the area of Disaster Preparedness and Flash Flood Forecasting. Recent disaster preparedness actions by Western Region Headquarters included directives to all stations outlining the regional Disaster Preparedness Program in 1977. These emphasized conducting emergency warning drills, updating station duty manuals with respect to warning sections, and use of substation observers for severe weather reporting. Funding was also provided for disaster preparedness travel. On January 11, 1978, all offices were requested to review arrangements for obtaining rainfall reports from Federal and state agencies in their area of county warning responsibility. Thus, many steps have been taken during the past year to alert all stations to the tremendous importance of adequate preparation for flash flood events.

Disaster preparedness is an ongoing program at WSFO Los Angeles. It is particularly noteworthy that Los Angeles WSFO personnel met in May 1977 with County Flood Control people, California Highway Patrol and California State Emergency Services personnel to exchange information on available weather services relative to disaster preparedness programs for southern California. Six NWS employees from both WSFO, Los Angeles, and WSO, San Diego, explained terminology, forecast techniques and problems, and described services available from NWS. Several follow up meetings were held in the fall of 1977. In addition, staff from WSFO, Los Angeles, participated in 5 other committee and planning meetings with county officials. Three meetings were held with officials of Riverside County to assist in the establishment of a spotter network. Two meetings were held in the fall of 1977 with officials of San Bernardino County. These meetings addressed disaster preparedness for county officials.

As a result of these meetings, local officials had a better understanding of NWS products and NWS had a better understanding of the needs of users in the area.

FORECAST RESPONSIBILITY IN AREAS AFFECTED BY THE STORM

Forecast responsibility (Figure 16) for Tulare and San Luis Obispo Counties, the northwestern two-thirds of Kern County and the northwestern half of Santa Barbara County is assigned to San Francisco WSFO. WSO, Fresno, has county warning responsibility for Tulare County (and several others), Bakersfield WSO for Kern County, and Santa Maria WSO for San Luis Obispo and Santa Barbara Counties. Los Angeles WSFO has forecast and warning responsibility for all other counties (or portions of counties) affected by the storm. (The boundary between Los Angeles and San Francisco WSOs' forecast areas runs near the crest of the coast range, Tehachapi Mts. and southern Sierra Nevada.) Bakersfield and Santa Maria WSOs are 16-hour stations. Nighttime back-up warning responsibility for both stations at the time of the storm belonged to San Francisco WSFO since these stations are in San Francisco's forecast area. (On June 1, 1978, back-up warning responsibility was changed to coincide with WSFO forecast responsibility.)

FORECASTS: PREPARATION AND DISSEMINATION

WSFO, Los Angeles, forecasts are typed on an electronic cathode-ray tube (KCRT). When completed, forecasts are transmitted to a computer in Washington, then relayed to a distribution computer in Kansas City for transmission on designated teletypewriter circuits. The forecast office retrieves a paper tape and hard copy of the forecast and transmits the forecast to local area users on NOAA Weather Wire.

Urgent messages are not transmitted this way because of delays during time of heavy computer usage. Watches, warnings, advisories, and statements are prepared by typing a hard copy and simultaneously producing a paper tape. The tape is immediately taken to the communications room for transmission on one or more local-area teletypewriter circuits. These circuits are:

7GT75 (Flood): primarily flood-control users
7GS138 (Press): southern California Weather Wire Service
7GT175 (Aviation): primarily aviation interests
7GT331 (USCG): U.S. Coast Guard
RAWARC
Western Union Telegraph (to selected addressees).

In addition to circuits mentioned above, forecasts, watches, warnings, advisories, and weather statements are immediately broadcast by Los Angeles WSFO personnel on NOAA Weather Radio (KWO-37 (L.A.), 162.55 mHz and KIH-34 (Santa Barbara), 162.40 mHz). A warning alarm signal is activated for all warnings and short-fuse watches including flash

CALIFORNIA

Figure 16. County Warning Areas and Forecast Areas in California

U. S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
1960
Corrected as of April 1965

flood watches. Additionally, the California Office of Emergency Services (OES) in Sacramento is advised via the NAWAS hot line. It, in turn, immediately notifies public safety officials in the affected counties. A hard copy of the warning message is then transmitted to OES by telecopier. An example of the Los Angeles warning dissemination check list is given in Figure 17.

Two coordination calls were made by WSFO Los Angeles Forecasters to WSFO, San Francisco, during the storm. These were for the purpose of discussing the synoptic situation and to determine what action San Francisco was going to take.

WSFO, Los Angeles, relayed rainfall data to the RFC at Sacramento. However, since the RFC does not have flash flood watch or warning responsibility, Los Angeles forecasters made no further contacts.

WSFO LOS ANGELES WATCHES, WARNINGS, AND STATEMENTS

A summary of the principal Los Angeles releases and means of dissemination are given in Table 4. A more complete description follows (all times PST). NAWAS, NWR, NWWS, RAWARC, and Service "C" teletype were all operating and used as appropriate to disseminate watches, warnings, and weather statements during the entire flood period.

A local weather statement was issued at 6 a.m., Wednesday, February 8, indicating a Pacific storm would move into the Los Angeles area Wednesday night bringing expected 24-hour rainfall amounts of 1 1/4 inches in the coastal areas and up to 2-3 inches in the mountains with snow above 5,000 feet. This was followed up at 5 p.m. with a "rain warning" for coastal and mountain areas of southern California for Wednesday night and Thursday; 1-2 inches were expected on the coast and up to 4 inches in the mountains during the next 24 hours with possible local flooding and mudslides due to heavy rainfall on already wet ground. Extreme caution was urged for motorists. "Rain warnings" are a non-standard issuance peculiar to the Los Angeles office but have been used for years. They are issued when 1 to 1 1/2 inches of rain in coastal areas and/or 3 inches or more in the mountains are expected in 24 hours.

The "rain warning" was continued at 2 a.m., Thursday, February 9, keeping the precipitation at 1 1/2-3 inches in coastal areas and 3-6 inches in the mountains by noon Friday. A local weather statement, issued at 6 a.m., Thursday, indicated a slight break in and lessening of the heavy rain, but still with amounts of 1 1/2-2 inches in coastal areas and 3-5 inches in mountains by noon Friday. (Rain warnings have since been discontinued--situation is now covered by special weather statements, watches, or warnings as appropriate.)

Figure 17
WSFO, LOS ANGELES

WARNING DISSEMINATION CHECK-OFF SHEET

WARNING TYPE (Circle appropriate type) Date_____

LOCAL SMALL CRAFT ( ) Hoist ( ) Lower
SMALL CRAFT Hoist ( ) Lower
GALE ( ) Hoist ( ) Lower
STORM ( ) Hoist ( ) Lower
SPECIAL MARINE WARNING
HEAVY SURF ADVISORY
RAIN
SNOW
HEAVY SNOW
FREEZE/FROST
HIGH WIND
AVIATION WIND
DUSTSTORM
TRAVELERS ADVISORY
BLIZZARD

TORNADO ( ) Watch ( ) Warning
SEVERE THUNDERSTORM ( ) Watch ( ) Warning
FLASH FLOOD ( ) Watch ( ) Warning

TSUNAMI ( ) Watch ( ) Warning
AIR POLLUTION ( ) ASA ( ) DS
SPECIAL WEATHER STATEMENT

Distribution	Local Time (PDT) (PST)	Initials
( ) NAWAS	_____	_____
( ) RAWARC	_____	_____
( ) Local Circuit	_____	_____
( ) Press Circuit	_____	_____
( ) Flood Control	_____	_____
( ) Coast Guard	_____	_____
( ) Western Union	_____	_____
( ) VHF	_____	_____
( ) WSOs_____	_____	_____
( ) MIC	_____	_____
( ) WRH	_____	_____
( ) Special marine dissemination list	_____	_____

Forecaster will check appropriate distribution and give tape and check sheet to communicator. Communicator will enter time and initials and return sheet to forecaster.

At 11 a.m., Thursday, another special weather statement was issued indicating an additional 1 1/2-3 inches in coastal sections and 4-6 inches in mountains by noon Friday with some flooding likely. The statement also cautioned motorists about the flooding threat.

A flash flood watch was issued at 1 p.m., Thursday valid until 6 a.m., Friday, for the mountains, deserts and areas below canyons in southern California from Orange and Riverside Counties northward to the Inyo County line. This included Ventura, Riverside, San Bernardino and Orange Counties, southern Santa Barbara County and portions of Los Angeles County (see Figure 18). The "rain warning" was continued, and mentioned an additional 1 1/2-3 inches in coastal areas and 4-6 inches in the mountains by noon Friday. The flash flood watch and rain warning were distributed on NAWAS, RAWARC, press circuit, local circuit, flood control circuit, Coast Guard Circuit, and also to Palmdale and Santa Maria WSO's.

The flash flood watch was followed up with a flash flood statement at 4:30 p.m., Thursday. This continued the watch and "rain warning" for areas noted above and also mentioned that there would be strong winds with gusts greater than 50 miles per hour as a cold front moved through the area during the late evening, tapering off by sunrise. Especially noteworthy is the following paragraph in the statement:

> "TRAVELERS SHOULD EXERCISE EXTREME CAUTION IN ALL PARTS OF SOUTHERN CA TONIGHT . . . ESPECIALLY IN AREAS NORMALLY SUBJECT TO MUD SLIDES OR HEAVY RUNOFF. TRAVEL TO MOUNTAIN AREAS SHOULD BE AVOIDED IF AT ALL POSSIBLE." (Appendix B contains examples of complete statements.)

Another flash flood statement was issued at 10 p.m., Thursday continuing the flash flood watch to 6 a.m., Friday and the "rain warning". Two to three inches were forecast for coastal areas and up to 6 inches in mountains by noon Friday. Radar indicated heavy thundershowers in the L.A. basin and hearby mountains. The front was expected to move through the area by 3 a.m., Friday, accompanied by the heaviest rainfall. A notable paragraph in this statement was:

> "MORE MUDSLIDES ARE LIKELY. STRONG WINDS WILL ADD TO THE DIFFICULTY IN THE MOUNTAINS. THIS IS A DANGEROUS STORM. TRAVEL IN THE MOUNTAINS AND IN CANYON AREAS OF BOTH THE COASTAL AND DESERT SIDE OF THE MOUNTAINS SHOULD BE AVOIDED IF POSSIBLE."

At 4:30 a.m., Friday, February 10, a flash flood statement was issued continuing the flash flood watch. A special weather statement at 5:40 a.m., Friday, stated that the flash flood watch and "rain warning" were still in effect until mid-morning, with rainfall in the afternoon expected to gradually diminish. Colder temperatures were forecast with snow level lowering in the mountains to 3,000 feet.

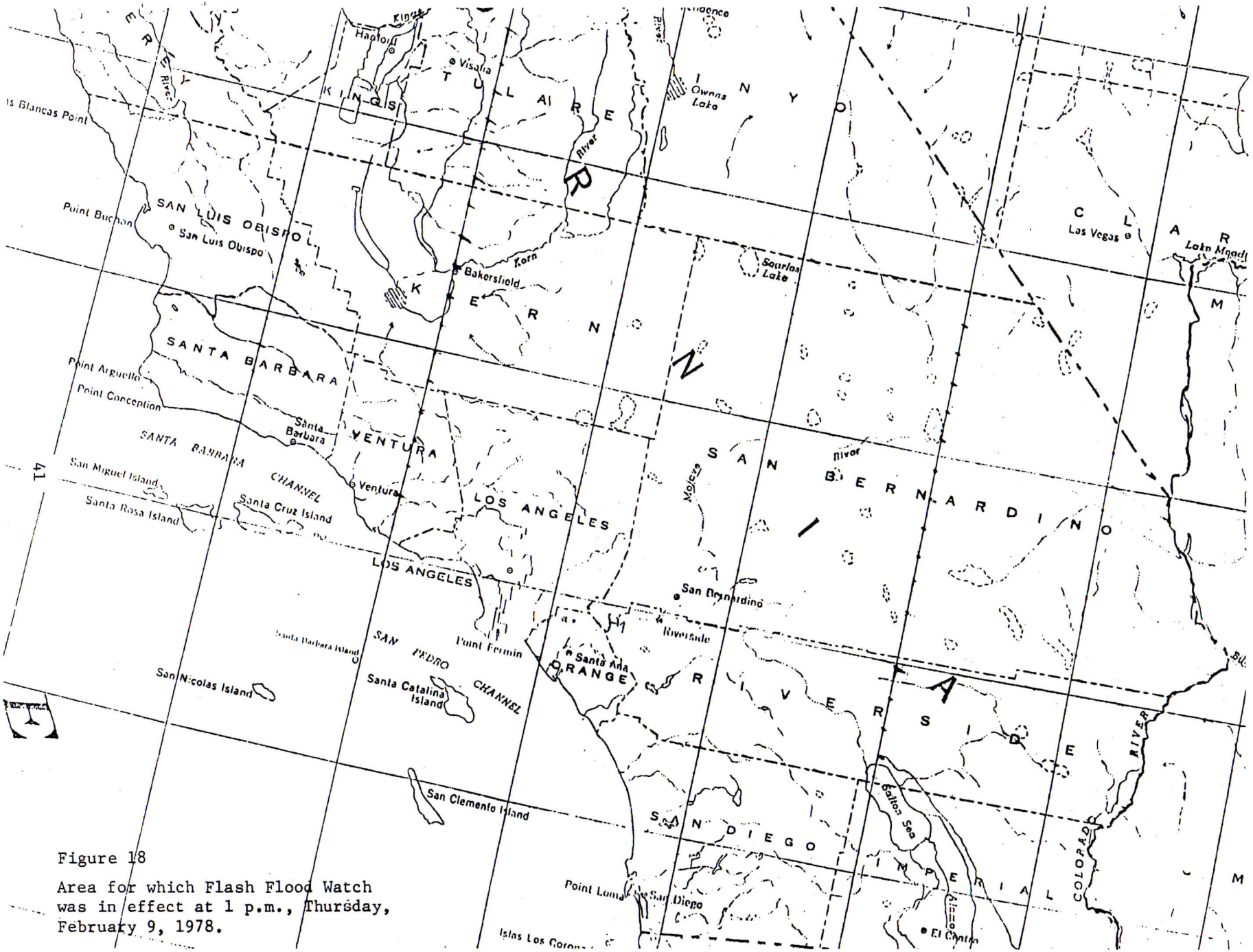


Figure 18

Area for which Flash Flood Watch was in effect at 1 p.m., Thursday, February 9, 1978.

Table 4

SEQUENCE OF SPECIAL ISSUANCES BY LOS ANGELES WEATHER SERVICE FORECAST OFFICE, FEB. 8-10, 1978
(Routine and updated forecasts not included)

TIME PST	DAY	TYPE OF MESSAGE	SUMMARY OF CONTENTS	DISTRIBUTION (See note*)								
				MARINE (Telephone)	NAWAS	AVIATION	PRESS	FLOOD	USCG	RAWARC	W.Union	NWR
6 am	Wed	Local Weather Statement	New storm threat;QPF 11/4"-3"/24 hrs.			X	X	X	X			X
445 pm	Wed	Small Craft Advisory	Southeast winds 18-30 knots	X		X	X	X	X	X		X
5 pm	Wed	Rain Warning	1"-2" coast;2-4" mountains per 24 hrs		X	X	X	X	X	X	X	X
2 am	Thur	Special Weather Statement	Increased QPF amounts per 24 hrs			X	X	X	X	X	X	X
6 am	Thur	Local Weather Statement	General Information and QPF			X	X	X	X			X
11 am	Thur	Special Weather Statement	Storm Progress and QPF			X	X	X		X		X
1 pm	Thur	Flash Flood Watch Bulletin	Heavy rain forecast. Defines areas		X	X	X	X	X	X		X
430 pm	Thur	Flash Flood Statement	Update on storm, watch and Rain Warning			X	X	X	X	X		X
10 pm	Thur	Flash Flood Statement	Information and update on storm			X	X	X	X	X		X
11 pm	Thur	Gale Warning	Entire coast,southwest winds 25-45 kts	X	X	X	X	X	X	X		X
430 am	Fri	Flash Flood Statement	Information and update on storm			X	X	X	X	X		X
540 am	Fri	Special Weather Statement	Storm progress, outlook and QPF			X	X	X	X	X		X
945 am	Fri	Flash Flood Statement	Storm progress. Rain Warning cancelled		X	X	X	X	X	X		X
130 pm	Fri	Flash Flood Statement	Storm progress. Cancel FF Watch northern counties		X	X	X	X	X	X		X
230 pm	Fri	Severe Thunderstorm Watch	Bulletin, defining statement		X	X	X	X	X	X		X
4 pm	Fri	Severe Weather Statement & Cancel Flash Flood Watch	Information on thunderstorms and FF Watch cancelled Orange to San Diego Cnty			X	X	X	X	X		X
5 pm	Fri	Bulletin, Svr Wx Statement	Cancel Thunderstorm Watch. Final Statement		X	X	X	X	X	X		X
730 pm	Fri	Cancel Gale Warning	Gale changed to Small Craft Advisory	X		X	X	X	X	X		X

(footnote)

*Distribution note: See paragraph, Forecasts: Preparation and dissemination for Circuit numbers and types of recipients. In addition there is NAWAS and NWR.

A flash flood statement issued at 9:45 a.m., February 10, continued the flash flood watch but cancelled the "rain warning" and mentioned that some local flooding and mudslides were expected during the day. The final flash flood statement at 1:30 p.m., Friday, continued the flash flood watch until 6 p.m. for portions of Orange, Riverside and San Diego Counties but cancelled the watch elsewhere.

In addition, NSSFC issued severe thunderstorm watch at 2 p.m., Friday. This was distributed and mentioned again in a 4 p.m. statement cancelling the flash flood watch. A severe weather statement, issued at 5:00 p.m., Friday, continued the severe thunderstorm watch for desert areas and carried a travelers' advisory for the mountains due to wind and snow. A small craft advisory was issued Wednesday afternoon for the coast from Pt. Conception to the Mexican Border. This was upgraded to a gale warning at 11 p.m., Thursday, and downgraded to a small craft advisory at 7 p.m., Friday.

Quantitative precipitation forecasts issued by Los Angeles WSFO underforecast amounts at the Los Angeles Civic Center by a small margin, and for Mount Wilson by a larger margin. An exception was an update issued Wednesday evening with initial issuance of the rain warning. Special Weather Statements were issued at frequent intervals throughout the storm, and these statements contained fairly accurate projections of expected rainfall for the following 24 hours. During the course of the storm, these statements implied storm totals of up to 5 inches in coastal areas and up to 12 inches in the mountains.

Overall, the Special Weather Statements issued by WSFO, Los Angeles, contained reasonably accurate quantitative precipitation forecasts. Amounts were based primarily on inferences made from satellite information. No coordination occurred between WSFO, Los Angeles, and NMC QPB during the storm.

WSFO, SAN FRANCISCO ACTIONS (SEE TABLE 5)

At 9:30 a.m., Thursday, February 9, San Francisco WSFO issued the following Flash Flood Watch:

> "THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH FOR THE SOUTHERN SIERRA NEVADA FROM THE MERCED RIVER DRAINAGE BASIN THROUGH THE KERN RIVER DRAINAGE BASIN. THIS INCLUDED THE COUNTIES OF KERN, TULARE, FRESNO, TUOLUMNE, MARIPOSA, AND MADERA. RAPID RISE OF LOCAL STREAMS IS EXPECTED. LOW LYING REGIONS AND CANYONS WILL BE SUBJECT TO FLOODING AS THE STORM CONTINUES."

At 11 a.m., February 9, San Francisco issued another Flash Flood Watch:

> "THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH FOR SAN LUIS OBISPO AND NORTHERN SANTA BARBARA COUNTIES CALIFORNIA FOR THIS AFTERNOON AND TONIGHT. ADDITIONAL HEAVY RAIN EXPECTED THIS AFTERNOON AND WILL ADD TO THE LOCALLY HEAVY RAIN WHICH FELL LAST NIGHT. RAPID RISE OF LOCAL STREAMS ESPECIALLY SAN LUIS CREEK AND SANTA YNEZ RIVER CAN BE EXPECTED. LOW LYING REGIONS AND CANYONS WILL BE SUBJECT TO FLOODING AS THE STORM CONTINUES."

This was continued at 3:30 a.m., February 10. Both watches were cancelled at 9 a.m., Friday, February 10. Zone forecasts for the San Joaquin Valley that were issued from 9 p.m., Wednesday, February 8, through 9 a.m., Friday, February 10, indicated "locally heavy rain with chance of thundershowers."

WSO FRESNO ACTIONS (SEE TABLE 6)

WSO, Fresno, highlighted travelers' advisories in forecast issuances throughout the storm. At 6:54 a.m. on the 9th a special broadcast statement by Fresno indicated the following:

> "FOOTHILL STREAMS CAN BE EXPECTED TO RISE SUBSTANTIALLY TODAY AND FLASH FLOODING BECOMES A REAL POSSIBILITY FOR TODAY AND TONIGHT."

At 9:30 a.m. on the 9th, Fresno promptly disseminated the applicable Flash Flood Watch issued by San Francisco.

At 10:30 a.m., February 10th, Fresno issued the following Special Weather Statement:

> "COPIOUS AMOUNTS OF PRECIPITATION IN THE PAST 48 HOURS HAVE BROUGHT EXTREMELY LARGE RISES IN ALL CREEKS AND SMALLER TRIBUTARY STREAMS TO THE MAJOR RIVERS OF THE SAN JOAQUIN VALLEY. FLOODING IS EXPECTED IN SOME AREAS ALONG THESE USUALLY SMALLER STREAMS. LOCAL PONDING IS ALSO TO BE EXPECTED IN THE USUAL LOW AREAS. THESE CONDITIONS WILL CONTINUE FOR THE NEXT 24 HOURS. RESIDENTS ALONG THE STREAMS FROM THE FRESNO RIVER DRAINAGE SOUTHWARDS TO THE TEHACHAPI MOUNTAINS SHOULD USE EXTREME CAUTION WHEN APPROACHING THE STREAMS. THEY SHOULD BE PREPARED TO MOVE TO HIGHER GROUND IF THE OCCASION APPEARS TO WARRANT. THE SHOWERS EXPECTED TODAY WILL NOT CONTRIBUTE MUCH ADDITIONAL WATER TO THAT ALREADY ON THE GROUND. THE STREAMS ARE EXPECTED TO BE RECEDING BY SATURDAY . . ."

WSO Fresno had several phone contacts with local officials during the storm. However, with the exception of local forecasts and relay of WSFO San Francisco watches, WSO Fresno issued only one weather statement.

WSO BAKERSFIELD ACTIONS (SEE TABLE 7)

WSO Bakersfield and the Kern County Office of Emergency Services acted in the following manner during the February 9-10 disaster. At 6 a.m., February 9, WSO, Bakersfield, issued a forecast calling for "Locally heavy rain, some flooding of low creeks and low spots on highways." At 8:30 a.m., San Francisco WSFO called Fresno WSO and discussed the flood situation. Fresno WSO then called Bakersfield WSO to discuss the flood situation and inform Bakersfield that San Francisco would issue a flash flood watch.

At 9:30 a.m., WSO, Bakersfield, received the Flash Flood Watch issued by WSFO, San Francisco, for the "Southern Sierra Nevada" from the Merced River Drainage Basin through the Kern River Drainage Basin as noted above. Office of Emergency Services entered the watch into the Kern Communications network, a radio network which goes to all fire houses, sheriffs' offices, city offices, and county agencies.

The Flash Flood Watch was continued at 4 p.m. San Francisco WSFO called Bakersfield WSO at 6 p.m., Thursday, to discuss flood situation. The flash flood watch was continued at 8 p.m. and included in Bakersfield's evening agricultural forecast discussion.

At 9:45 p.m., WSO, Bakersfield, called San Francisco WSFO to discuss the possibility of a flash flood warning. It was decided not to issue a warning. At 10:30 p.m., Thursday the 9th, the Bakersfield office was closed for the night, one-half hour later than normal.

At 4:30 a.m., the station was opened, 1 1/2 hours before normal opening. The 6:00 a.m., Bakersfield local forecast indicated heavy rains would be diminishing to a chance of thundershowers by afternoon. At 8 a.m., San Francisco called Bakersfield WSO to discuss the rain situation. At 10 a.m. WSO, Bakersfield, issued a Special Weather Statement indicating that "the worst of the storm was over".

WSO SANTA MARIA ACTIONS (SEE TABLE 8)

WSO Santa Maria relayed WSFO San Francisco releases and made numerous telephone calls to local officials. WSO Santa Maria did not issue any statements or warnings on teletype and due to a misunderstanding with WSFO San Francisco inadvertently cancelled the flash flood watch at 10 p.m. on February 9.

USER REACTION

There is, of course, a problem of reaching people in remote areas. Although the Los Angeles County Sheriff was notified on NAWAS of the flash flood watch and rain warnings, it appeared to be difficult for that office to get the information out to all deputies in the county. The Deputy Sheriff on patrol in Big Tujunga Canyon at the time of the flash flood barely escaped with his life. He had been fighting the fire in the lodge on Mill Creek at 2 a.m., Friday, when the flash flood struck. He had to hang onto a pickup truck that came swirling downstream in order to survive. (The truck was washed ashore in an eddy.) The survey team interviewed the deputy and he reported he did not hear or receive the flash flood watch. He said he did not have time to listen to commercial radio or TV Thursday although he was aware that heavy rain had been forecast and was occurring. A survivor of the triplex destroyed in Hidden Springs was also interviewed. He said he did not hear Weather Service warnings. Since he was a new resident of one month and old-time residents in the community did not evacuate, he saw no reason for alarm. He barely escaped with his life when the "big wave" came roaring through the community at 2 a.m., taking the lives of 3 others in the triplex. He did, however, tell his wife, who worked in Los Angeles not to return home Thursday evening. This action probably saved her life.

The deputy sheriff mentioned above said he had been patrolling the canyon for 18 years, had experienced several flooding situations, and he did not urge anyone to evacuate the canyon. Long-time residents apparently took no action to evacuate the Hidden Springs area. The fact that a number of people took refuge in a lodge by the creek instead of seeking higher ground indicated that these people tended to ignore danger even when imminent.

In general, the flash flood watch was communicated to the public in Kern County rapidly and effectively, well in advance of the flood. There were numerous cases of people taking positive actions based on the threat of flooding.

In Kern County, most police stations and fire houses received the flash flood watch shortly after it was relayed at 9:30 a.m., Thursday, February 9, from the Office of Emergency Services. An example of positive action was taken by the City of Arvin. Immediately after receiving the watch, the Arvin City Police Chief notified the four local radio stations and went on the air with a live broadcast. One station was a Spanish broadcasting station and the bi-lingual Police Chief broadcast the watch in Spanish. (Approximately 2/3 of the Arvin residents are Mexican/American.) Sand bags were obtained from the Department of Highways and crews set to work filling them.

The Fire Department in Caliente warned people of the possibility of flooding during the afternoon, 12 hours before flooding damaged homes in that community. During the evening, they were on hand to help evacuate people from threatened homes, six hours before water entered them.

Table 5

SEQUENCE OF ACTIONS BY WSFO SAN FRANCISCO

FEBRUARY 9-10, 1978

February 9 --	8:30 a.m.	RFC Sacramento called WSFO San Francisco and advised them of heavy overnight rainfall.
	8:30 a.m.	WSFO San Francisco called WSO, Fresno to discuss flash flood watch. Asked Fresno to relay to WSO Bakersfield that a watch would be issued.
	9:30 a.m.	Flash Flood Watch issued for "Southern Sierra Nevada from the Merced River drainage basin thru the Kern River Drainage Basin. This included the counties of Kern, Tulare, Fresno, Tuolumne, Mariposa, and Madera. Rapid rise of local streams is expected. Low-lying regions and canyons will be subject to flooding as the storm continues."
	10:15 a.m.	WSFO San Francisco contacted WSO Santa Maria to discuss flash flood watch.
	11:00 a.m.	WSFO San Francisco issued a flash flood watch for "San Luis Obispo and northern Santa Barbara Counties." ". . .low-lying regions and canyons will be subject to flooding as the storm continues."
	6:00 p.m.	WSFO San Francisco called WSO Bakersfield to discuss flood situation and continued watch.
	10:00 p.m.	WSFO San Francisco contacted WSO Santa Maria to discuss flash flood watch.
February 10 -	3:30 a.m.	WSFO San Francisco continued flash flood watch for "San Luis Obispo and northern Santa Barbara Counties. Locally heavy rain will add to the rains which fell last night. Rapid rise of local streams . . . can be expected. Low-lying regions and canyons will be subject to flooding as the storm continues."
	8:00 a.m.	WSFO San Francisco called WSO Bakersfield to discuss flood situation.
	9:00 a.m.	WSFO San Francisco cancelled flash flood watch.

Table 6

SEQUENCE OF ACTIONS BY WSO FRESNO

FEBRUARY 9-10, 1978

February 9 --	6:54 a.m.	The early morning broadcast script warned, "Foothill streams can be expected to rise sharply today and flash flooding becomes a real possibility for today and tonight."
	8:35 a.m.	WSO Fresno called WSO Bakersfield relaying message from WSFO San Francisco that Flash Flood Watch would be issued.
	9:30 a.m.	Flash Flood Watch is issued by WSFO San Francisco and disseminated immediately by WSO Fresno. The Flash Flood Watch was put on NWR and continued until cancellation.
	10:00 a.m.	WSO Fresno called WSFO San Francisco about flooding in coastal range.
	12:24 p.m.	On noon broadcast Flash Flood Watch updated: "rainfall amounts are becoming more than just generous or even copious. Reports have been coming in all morning--Grant Grove (5 inches), Lodge Pole (4.62), and many foothill stations between 2 and 3 inches with most streams running bankful." "Streams will be going over their banks in many areas tonight. Local flooding will occur in many areas and residents should take whatever precautions are necessary."
	3:00 p.m.	Local forecast "rain heavy at times tonight."
	8:30 p.m.	Local forecast "rain heavy at times tonight, diminishing Friday."
		Throughout the day the MIC had a number of contacts with Springville Fire Dept., Kernville Fire Dept., Tulare County OES, the Sheriff of Madera County and others, providing them with the latest information and receiving reports on river and stream conditions.
February 10 --	10:30 a.m.	WSO Fresno issued a Special Weather Statement warning residents to use extreme caution when approaching swollen streams and that the streams would recede by Saturday.

Table 7

SEQUENCE OF ACTIONS BY WSO BAKERSFIELD

FEBRUARY 9-10, 1978

February 9 --	6:00 a.m.	Local forecast issued calling for "locally heavy rain, some flooding of low creeks and low spots on highways."
	9:30 a.m.	WSFO San Francisco issued Flash Flood Watch for southern Sierra Nevada including Kern County. WSO Bakersfield disseminated watch immediately.
	12 noon	WSO Bakersfield included update of watch in noon forecast and broadcast.
	8:00 p.m.	Flash Flood Watch continued and included in the evening's agricultural forecast discussion.
	9:45 p.m.	WSO Bakersfield called WSFO San Francisco to discuss the possibility of a Flash Flood Warning. It was decided not to issue warning but to continue Flash Flood Watch.
	10:30 p.m.	WSO Bakersfield closed office for night, one-half hour later than normal.
February 10 --	4:30 a.m.	WSO Bakersfield opened office one and one-half hour earlier than the scheduled time.
	6:00 a.m.	WSO Bakersfield's local forecast called for diminishing heavy rain during day.
	10:00 a.m.	WSO Bakersfield issued Special Weather Statement that "worst of storm was over."

Table 8

SEQUENCE OF ACTIONS BY WSO SANTA MARIA

FEBRUARY 9-10, 1978

February 9 --	8:18 a.m.	WSO Santa Maria telephoned Rain Warning to agencies on Warning Call list, including San Luis Obispo disaster center, Santa Barbara Sheriff.
	8:29 a.m.	Made tape of Rain Warning for San Luis Obispo radio station KVEC and Lompoc radio station KNEZ.
	11:00 a.m.	WSFO San Francisco issued flash flood watch for San Luis Obispo and northern Santa Barbara Counties. WSO Santa Maria immediately disseminated watch to Santa Barbara County Flood Control, State Division of Highways, San Luis Obispo Disaster Center, and others.
	12:15 p.m.	Noon broadcast on KSMA - provided lengthy discussion of potential for flooding and included flash flood watch. During the afternoon, a number of calls were made and received from local users, county sheriffs, Disaster Center San Luis Obispo and Santa Barbara Counties and MND's.
	5:30 p.m.	Completed briefing 3 TV stations for their evening broadcasts. Flash Flood Watch and information about heavy rain emphasized.
	10:00 p.m.	WSO Santa Maria discussed flash flood situation with WSFO San Francisco. Due to misunderstanding, WSO Santa Maria canceled the Flash Flood Watch and closed the office for the night.
February 10 --	6:10 a.m.	WSO Santa Maria contacted WSFO San Francisco to clarify Flash Flood Watch.

FINDINGS AND RECOMMENDATIONS

FINDING 1:

Overall performance by NWS field offices was excellent. For example, WSFO Los Angeles issued a total of 14 watches, warnings, and special statements. These began with a special weather statement about the storm at 6 a.m., Wednesday, February 8, followed by a forecast of heavy rain at 5 p.m., Wednesday. A flash flood watch was issued at 1 p.m., Thursday, February 9, which continued in effect until the afternoon of Friday the 10th. Most of the flooding occurred around 2 a.m. on February 10.

WSFO San Francisco issued a flash flood watch for the San Joaquin Valley and adjacent Sierra Nevada at 9:30 a.m., February 9, and for San Luis Obispo and Monterey Counties and northern Santa Barbara County at 11 a.m. These watches were continued in effect until the morning of the 10th. WSO Palmdale provided useful radar information. Although no flash flood warnings for specific areas were issued, few were really needed. The situation was well covered by flash flood watches, special weather statements and warnings of heavy rains by the WSFO's. These undoubtedly helped prevent greater loss of life and property damage. Especially notable were "call to action" statements appended to several of the special weather statements and to the strong language contained in some of the releases.

RECOMMENDATION:

Appropriate field offices should be commended for their performances during this storm and the March 1978 storm (Appendix C).

FINDING 2:

Throughout the storm period, nearly all existing communication channels, including NAWAS and NOAA Weather Radio (NWR), were working at full performance. In addition, no evidence could be found of any significant equipment failure.

FINDING 3:

There is a need for more real time rainfall and river reports. Real time rainfall reports collected by the Los Angeles County Flood Control District Headquarters were not available to the Los Angeles WSFO. A method of obtaining this data had not been established.

RECOMMENDATION:

WSFO Los Angeles should make arrangements to secure more real time data from Governmental agencies and others. Event reporting rain gages, flash flood alarms, and manually collected data should all be considered as part of a total local rainfall and river reporting system. Use of radios (amateur and reliable/organized CB groups) for collective data should be explored.

FINDING 4:

There were some people in exposed areas who either failed to receive the watches and warnings or ignored them. A number of survivors in the Hidden Springs area of greatest destruction said they had been through several previous flooding episodes and saw no need to evacuate in this case. This is a typical reaction by people in such situations.

RECOMMENDATION:

Through a more vigorous Disaster Preparedness Program (talks, dissemination of flash flood literature, etc.), NWS and other government agencies should educate people about the need for proper action when watches/warnings are received. Closer coordination with law enforcement, sheriff, state and local police, and OES personnel are needed in some areas.

FINDING 5:

WSO's Bakersfield and Santa Maria are part-time offices (6 a.m. to 10 p.m.). Santa Maria closed at 10 p.m. and Bakersfield at 10:30 p.m., Thursday, February 9, while the storm was still in progress. Santa Maria opened as usual at 6 a.m., Friday, and Bakersfield at 4:30 a.m., 1 1/2 hours early.

RECOMMENDATION:

Part-time WSO's should extend hours of operation during severe weather. Parent WSFO's should ensure that part-time WSO's in their forecast area stay open under these conditions.

FINDING 6:

Santa Maria failed to receive the flash flood watch issued at 1 p.m., February 9, by Los Angeles WSFO. This watch included southern Santa Barbara County, which is in Santa Maria's warning area. Staff at Los Angeles tried unsuccessfully for 2 1/2 hours to telephone Santa Maria with the watch but were unable to reach them because the telephone at Santa Maria was busy.

RECOMMENDATION:

Arrangements should be made to extend Los Angeles NOAA Weather Wire to Santa Maria. If this is not possible, Santa Maria should obtain an unlisted telephone. It is imperative that watches and warnings issued by WSFO's are communicated immediately to affected WSO's. Los Angeles NOAA Weather Wire should also be extended to Bakersfield since part of Kern County is in Los Angeles' forecast district. (AFOS now installed at WSFOs, Los Angeles and San Francisco, and soon to be installed at WSOs, Bakersfield and Santa Maria will solve this communications problem.)

FINDING 7:

WSFO Los Angeles had frequent contact with WSO Palmdale and SFSS San Francisco. However, there was at least one case in which a significant misunderstanding ensued. This misunderstanding occurred between San Francisco WSFO and Santa Maria WSO and resulted in the watch for San Luis Obispo County and northern Santa Barbara County being incorrectly cancelled by WSO Santa Maria on the evening of February 9. The WSS on duty at Santa Maria WSO was told in a telephone conversation with the forecaster that the flash flood watch was to be cancelled. He coordinated with his OIC, got the word out to the media and closed the station at 10 p.m. Later information caused the WSFO forecaster to continue the flash flood watch. When the WSO opened the next morning, it was learned that the flash flood watch had been continued through the night.

RECOMMENDATION:

NWS and NESS field offices should be encouraged to develop a year-round coordination program. There is obvious need for frequent and close coordination between WSFO's and WSO's in watch/warning situations. The WSFO forecaster tried to call WSO, Santa Maria, but the station was closed. He should have called the OIC, Santa Maria, at his home and informed him of this decision. In the future, watches should be cancelled only on receipt of a hardcopy message on NWWS.

FINDING 8:

The broadcast media disseminated watches/warnings and special weather statements in a timely, effective manner. Some local communities took effective life-saving actions before serious flooding occurred.

RECOMMENDATION:

NWS should congratulate the broadcast media and these local communities on their performance during the storm period. The importance of the media role in warning dissemination should be emphasized.

FINDING 9:

Although WSO's made numerous telephone calls to local officials and relayed WSFO releases, they did not, in some cases, issue enough special weather statements to completely inform the public and the media in their local areas.

RECOMMENDATION:

Field offices should be reminded of the importance of keeping the public and media informed of local storm developments through the issuance of weather statements.

FINDING 10:

No adverse publicity concerning NOAA's services occurred as a result of this disaster. On the contrary, during the survey a number of very favorable comments were heard from the news media and others about services provided by the NWS. The Kern County Office of Emergency Services, in particular, was very pleased with the lead time provided by the Flash Flood Watch. Dr. George Fishbeck, KABC-TV (Channel 7), Los Angeles, Weathercaster, publicly complimented the NWS on at least two TV newscasts for its excellent forecasting during the storm.

FINDING 11:

All watches, warnings and statements were broadcast on NOAA Weather Radio. The warning alarm was activated according to instructions on the NOAA Weather Radios at Los Angeles, Fresno, and San Luis Obispo (the latter is remotely operated by WSFO San Francisco). However, it appears that little public response occurred because of the broadcast of the warning alarm.

RECOMMENDATION:

NOAA Weather Radio and the warning alarm feature needs to be publicized more widely.

FINDING 12:

Los Angeles WSFO issued non-standard warnings called "rain warnings" throughout the storm. While these are of long-standing custom and appear to be effective, they may be misunderstood by some people because of their non-standard nature.

RECOMMENDATION:

Issuance of "rain warnings" by Los Angeles WSFO have been discontinued. Instead, special weather statements indicating the intensity of the storm along with quantitative precipitation forecasts are now issued. If flash flooding or flooding is expected, watches and warnings, as appropriate, should be issued in addition to the statement.

APPENDIX A
WSFO LOS ANGELES
COMMUNICATION SYSTEMS

SYSTEM	RELEVANT FUNCTIONS
Teletypewriter Circuits	
Service A	Hourly and special aviation observations, including 3 or 6-hourly precipitation amounts from most NWS, military, and FAA stations. Radar narrative reports; SIGMETs, AIRMETs from WSFO, San Francisco; Aviation severe weather watches from SELS.
Service C	3 and 6-hourly synoptic observations and upper air data, NMC forecast discussions, NMC QPFs, FOUS bulletins, including boundary layer wind forecasts and QPFs for Los Angeles, San Francisco NESS satellite interpretation bulletins, severe weather watches from SELS.
Local Circuit	Aviation observations on-the-hour and special and local observations from stations in the Los Angeles Basin. Pilot reports as received at Los Angeles and Ontario FSSs.
Press Circuit	Several rainfall amounts for San Diego County, at 12-hour intervals. Also road condition reports are received from CALTRANS around noon.
Coast Guard Circuit	3-hourly MARS observations from coastal locations, mainly Coast Guard bases. Many of these stations do not report at night. Occasional reports of severe weather conditions from vessels underway, usually Coast Guard cutters.
RAWARC Circuit	San Francisco NESS satellite interpretation bulletins. Western U.S. radar observations. Severe weather watches and outlooks from SELS. MARS coastal observations from San Diego County twice a day.

SYSTEM	RELEVANT FUNCTIONS
Request/Reply Circuit	Capability to request data stored in FAA communications computer at Kansas City. Provides back-up, and in many cases more timely receipt of data and guidance normally received on Service A and Service C. NMC MOS products, including surface wind forecasts, POPs, and categorical QPF pop forecasts for Los Angeles, Long Beach, San Diego, and Daggett.
Miscellaneous Systems	
Telephones	Most 3-hourly MARS coastal reports and a few aviation observations are received by telephone. Also, most of the 24-hour rainfall amounts are collected by this means.
Telemetered Rain Gages	These are located in Santa Barbara, Ventura, southern Los Angeles, San Bernardino, Orange, and San Diego Counties. There is no capability for interrogating automatic gages located in northern Los Angeles County, which includes the San Gabriel Mountains, where the heaviest rainfall and most severe flood problems occurred during this storm.
Fire Weather AFFIRMS System	Observations collected from a few Fire Weather reporting sites once daily during the winter months. These include 24-hour rainfall amounts.

APPENDIX B

SAMPLE WSFO LOS ANGELES RELEASES

NNNN
ZCZC
RWUSA RWRE Ø921ØØ
LAX

BULLETIN
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE LOS ANGELES CA
1 PM PST THU FEB 9 1978

A FLASH FLOOD WATCH HAS BEEN ISSUED FOR MOUNTAINS...DESERTS...AND AREAS BELOW CANYONS IN SOUTHERN CALIFORNIA FROM ORANGE AND RIVERSIDE COUNTIES NORTHWARD TO THE INYO COUNTY LINE VALID UNTIL 6AM FRIDAY MORNING. THE WATCH AREA INCLUDES SOUTHERN SANTA BARBARA COUNTY...VENTURA SAN BERNARDINO RIVERSIDE AND ORANGE COUNTIES...EASTERN KERN COUNTY...AND PORTIONS OF LOS ANGELES COUNTY.

GENERAL HEAVY RAIN IS FORECAST TO SPREAD SOUTHWARD OVER COASTAL AND MOUNTAIN AREAS OF SOUTHERN CALIFORNIA LATE TODAY AND TONIGHT AS A VERY STRONG AND MOIST FRONT MOVES SLOWLY SOUTHWARD. LOCAL AREAS OF HEAVY RAIN ARE ALSO EXPECTED IN SOME NORTHERN DESERT AREAS.

ADDITIONALLY...A RAIN WARNING IS IN EFFECT FOR ALL COASTAL AND MOUNTAIN AREAS OF SOUTHERN CALIFORNIA...INCLUDING SAN DIEGO COUNTY. THE RAIN WARNING CALLS FOR AN ADDITIONAL 1 1/2 TO 3 INCHES IN COASTAL AREAS WITH 4 TO 6 INCHES IN THE MOUNTAINS BY NOON FRIDAY.

THE NEXT STATEMENT WILL BE ISSUED AT 4PM OR SOONER IF CONDITIONS WARRANT.

END DBH Ø921ØØ

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LJ
ZCZC
RWJSA RWRE 100030
-LAX

BULLETIN
FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE LOS ANGELES CA
4:30PM PST THU FEB 9 1978

A FLASH FLOOD WATCH CONTINUES IN EFFECT FOR THE MOUNTAINS... DESERTS...AND AREAS BELOW CANYONS IN SOUTHERN CALIFORNIA FROM ORANGE AND RIVERSIDE COUNTIES NORTH TO THE INYO COUNTY LINE VALID UNTIL 6AM FRIDAY MORNING.

THE FLASH FLOOD WATCH MEANS THAT FLASH FLOODING IS LIKELY WITHIN THE WATCH AREA IN AREAS NORMALLY SUBJECT TO FLASH FLOODING.

ADDITIONALLY...A RAIN WARNING IS IN EFFECT FOR ALL COASTAL AND MOUNTAIN AREAS OF SOUTHERN CALIFORNIA...INCLUDING SAN DIEGO COUNTY. AN ADDITIONAL 2 TO 3 INCHES OF RAINFALL IS EXPECTED IN COASTAL AREAS WITH 4 TO 6 INCHES IN THE MOUNTAINS BETWEEN 4PM THIS AFTERNOON AND NOON FRIDAY...MOST OF THIS RAIN WILL FALL TONIGHT.

VERY HEAVY RAIN HAS ALREADY BEEN REPORTED ALONG THE SOUTH SLOPES OF THE MOUNTAINS FROM LOS ANGELES NORTHWARD. LYTLE CREEK NEAR THE BASE OF THE SAN BERNARDINO MOUNTAINS HAS REPORTED OVER 9 INCHES /9.2/ IN THE LAST 24 HOURS. MOUNT WILSON REPORTED 5 AND 1/2 INCHES IN THE 24 HOURS ENDING AT 4PM THIS AFTERNOON...AND LAKE ARROWHEAD HAD ABOUT 7 AND 1/2 INCHES.

AT MID AFTERNOON TODAY...THE MAIN FRONTAL SYSTEM WAS STILL JUST WEST OF POINT CONCEPTION...AND WAS EXPECTED TO REACH THE LOS ANGELES AREA BY LATE EVENING. HEAVY RAIN WILL COVER ALL COASTAL AND MOUNTAIN AREAS BY LATE EVENING...TAPERING OFF SOME BY SUNRISE FRIDAY MORNING. STRONG WINDS ACCOMPANY THE STORM WITH WIND GUSTS WELL OVER 50 MPH IN THE MOUNTAINS...AND THE SNOW LEVEL WILL BE LOWERING RAPIDLY DURING THE NIGHT.

TRAVELERS SHOULD EXERCISE EXTREME CAUTION IN ALL PARTS OF SOUTHERN CALIFORNIA TONIGHT...ESPECIALLY IN AREAS NORMALLY SUBJECT TO MUDSLIDES OR HEAVY RUNOFF. TRAVEL TO MOUNTAIN AREAS SHOULD BE AVOIDED IF AT ALL POSSIBLE.

THE NEXT STATEMENT WILL BE ISSUED AT 10PM TONIGHT OR SOONER IF CONDITIONS WARRANT.

END DBH 100040

ZCZC
RWUS4 RWRE 1ØØ6ØØ
↑LAX

FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE LOS ANGELES CA
1Ø.ØØPM PST THU FEB 9 1978

A FLASH FLOOD WATCH CONTINUES IN EFFECT FOR THE MOUNTAINS...
DESERTS AND AREAS BELOW CANYONS IN SOUTHERN CALIFORNIA FROM
ORANGE AND RIVERSIDE COUNTIES NORTH TO THE INYO COUNTY LINE
VALID UNTIL 6AM FRIDAY MORNING.

A FLASH FLOOD WATCH MEANS THAT FLASH FLOODING IS LIKELY IN THE
WATCH AREA. LOW LYING AREAS AND STREAM BEDS NORMALLY SUBJECT TO
FLASH FLOODING SHOULD BE AVOIDED.

ADDITIONALLY A RAIN WARNING IS IN EFFECT FOR ALL COASTAL AND
MOUNTAIN AREAS OF SOUTHERN CALIFORNIA INCLUDING SAN DIEGO COUNTY.
AN ADDITIONAL 2 TO 3 INCHES OF RAINFALL IN THE COASTAL SECTIONS
AND UP TO 6 INCHES IN THE MOUNTAINS IS EXPECTED BY NOON FRIDAY.

RADAR REPORTS INDICATE THAT HEAVY SHOWERS AND THUNDERSTORMS
ARE OCCURRING IN THE LOS ANGELES BASIN AND NEARBY MOUNTAINS.

A FRONT EXTENDS FROM JUST WEST OF SANTA BARBARA SOUTHWARD AND
WILL BE MOVING THROUGH SOUTHERN CALIFORNIA COASTAL SECTIONS AND
BEYOND THE COASTAL MOUNTAINS BY ABOUT 3AM. THE HEAVIEST RAINFALL
IS EXPECTED IN THE VICINITY OF THE FRONT BUT THE FLASH FLOOD
THREAT CAN COME AT DOWNSTREAM LOCATIONS AFTER THE HEAVY RAINFALL
SO THE FLASH FLOOD WATCH IS CONTINUED UNTIL 6AM FRIDAY. RAIN SHOWERS
ARE EXPECTED TO DECREASE IN NUMBER AND DIMINISH IN INTENSITY
THROUGH THE DAY FRIDAY.

MORE MUDSLIDES ARE LIKELY. STRONG WINDS WILL ADD TO THE DIFFICULTY
IN THE MOUNTAINS. THIS IS A DANGEROUS STORM. TRAVEL IN THE MOUNTAINS
AND IN CANYON AREAS OF BOTH THE COASTAL AND DESERT SIDE OF THE
MOUNTAINS SHOULD BE AVOIDED IF POSSIBLE.

THE NEXT STATEMENT ON THIS STORM WILL BE ISSUED AT 4AM FRIDAY
FEBRUARY 10 OR EARLIER IF CONDITIONS WARRANT.

NNNN OEN 10PM PST THU FEB 9 1978

(Numerous garbles in the original message were corrected for purposes of this report.)

APPENDIX C

SOUTHERN CALIFORNIA FLOODS, FLASH FLOODS, AND MUDSLIDES OF MARCH 4-5, 1978

EXECUTIVE SUMMARY

On March 4, 1978, two or more inches of rain fell over the Los Angeles Basin and adjacent areas. During the week of February 28-March 5, six inches of rain fell at the Los Angeles International Airport and 24.16 inches fell at Mt. Wilson Observatory.

The intense rain of March 4, falling on the already soggy hills in the Los Angeles area resulted in massive mudslides. In addition, the heavy rain caused the already swollen rivers in the area to flood. Public Safety Officials estimate that the heavy rains of March 4, either directly or indirectly contributed to the deaths of 18 persons in Southern California. Most of the fatalities resulted from separate incidents. In addition, estimates of total property damage range as high as $120 million. At least 300 homes were reported damaged in Los Angeles County alone. Principal damage was caused by rain-soaked hillsides liquefying and sliding into homes and highways.

The National Weather Service offices with forecast and warning responsibility for the storm area all performed in a very good manner. WSFO, Los Angeles provided excellent forecasts and warnings before and during the storm. Twenty-six watches, warnings, special statements and advisories were issued from the afternoon of Friday, March 3, through Sunday, March 5. These timely statements kept the public well advised on a wide variety of weather-related phenomena; high surf, flash floods, gale force winds, mudslides, high river stages, heavy rain, and tornadoes. WSFO, Los Angeles was able to issue this large number of statements because they had anticipated the weekend storm two days in advance and had arranged for extra help to be on duty.

WSOs, Santa Maria and San Diego both performed effectively during the storm, relaying WSFO, Los Angeles' issuances to the public in their areas of responsibility, and issuing more localized statements when necessary. In addition, Santa Maria, normally a 16-hour-a-day station, remained open 24 hours on March 4, because of seriousness of the storm.

No serious deficiencies were found in the performance on the National Weather Service offices during this disaster. A similar storm occurred in the same area in the previous month, and a detailed investigation of the performance of the NWS was done for this storm. The lessons learned from the first storm were applied to the second with good results.

Chapter 1

Description of Events

Intense rain fell in Southern California Saturday, March 4, 1978, causing many of the already soggy hills in the Los Angeles area to turn into massive mudslides. Saturated hillsides liquefied and flowed down on homes in many areas, either crushing them or filling them with mud.

Communities in the Ojai Valley along the Ventura River were evacuated as the river overflowed its banks. Considerable flooding occurred in the Fillmore area as the Sespe River on the west, and the Santa Clara River on the south overflowed their banks, inundating homes with as much as five feet of water and forcing many occupants to roofs to wait rescue by helicopter. A number of homes along the Pacific Coast Highway, undermined by high tides and heavy seas in combination with heavy rain, crashed into the sea.

Ventura County was virtually cut off late Saturday, as mudslides, rockslides and heavy rain forced closure of the Pacific Coast Highway from Point Mugu to Malibu. U.S. 101 was closed from east of Thousand Oaks to northwest of Ventura.

In Santa Paula, water and mud washed down gullies carved by earlier floods and inundated the west end of town. In the San Fernando Valley, widespread sheet flooding occurred.

The heavy rains throughout the area cut ditches beside many roads and undermined them in places. A section of the Queen of Angels Hospital parking lot in Los Angeles was undermined and fell onto the adjacent Hollywood Freeway.

From February 28 through March 5, rainfall amounts at the Los Angeles International Airport totaled 6.00 inches; at the L.A. Civic Center - 7.92 inches, and at 5700 feet on top of Mount Wilson, in the San Gabriel Mountains north of Los Angeles - 24.16 inches. During the 24 hours of March 4, 1.97 inches of rain were recorded at Los Angeles International Airport; 2.28 inches at the L.A. Civic Center; and 6.58 inches at Mount Wilson.

According to Public Safety officials, the heavy rains of March 4 contributed, either directly or indirectly, to the death of 18 persons in Southern California. Most of the fatalities resulted from separate incidents.

Two adults, one in Bel Air and the other in Woodland Hills, died when mudslides severely damaged or destroyed their residences. Two teenagers in the Greater Los Angeles area died in separate incidents when one fell into a flood control basin and another into a storm drain.

One prisoner was killed when a hill collapsed on Pacific Coast Highway in Los Angeles as he and others were working on the highway to clear it of a mudslide. The body of one man in Ventura County was found floating in the water at a marina. He had apparently gone aboard his boat to check the docking lines, fell overboard and drowned.

Another Ventura County man was reported missing and presumed dead after part of his house in Fillmore was destroyed by overflow from Sespe Creek. A man was killed in San Bernardino County when his sports car, stalled in a flooded street, was swept into a drainage ditch.

Another death was reported in San Diego County when a man was washed downstream as he attempted to rescue a friend caught in a swollen creek. One teenager drowned in San Gabriel River when a rubber raft he was riding overturned.

Two railroad employees were killed when a Santa Fe freight train derailed on rain-damaged tracks in San Bernardino County. One adult was drowned as he attempted to cross a stream on horseback in San Diego County. Three adults were killed when their pickup truck went out of control during heavy rain on a narrow mountain road in San Diego County. The body of one person was found in the Tijuana River south of San Diego on the U.S. side of the border.

Estimates of total property damage have ranged as high as $120 million. At least 300 homes were reported damaged, half of them severely, in Los Angeles County alone. Principal damage was caused by rain-soaked hillsides slipping and severely damaging or destroying homes built at the base of the hillsides.

Creeks and streams in the coastal mountains of Los Angeles, Ventura and Santa Barbara Counties overflowed in a few areas, causing local damage to homes and autos. Considerable street and urban flooding also occurred since many areas do not have storm drainage systems, thus streets became the flow channels for the high waters.

High surf and high tides combined to wreak additional havoc to beachfront residences in Malibu. In much of the area, the beach no longer exists.

The National Weather Service Forecast Office at Los Angeles provided excellent forecasts and warnings before and during the storm. Twenty-six watches, warnings, special statements and advisories were issued from the afternoon of Friday, March 3, through Sunday, March 5. These timely statements kept the public well advised on a wide variety of weather-related phenomena; high surf, flash floods, gale force winds, mudslides, river stages, heavy rain, and tornadoes. Two waterspouts off the Los Angeles coast and three funnel clouds (two in the Redondo Beach-Torrance area, and another near the El Toro Marine Base) were reported the morning of March 5.

There were no reports of damage resulting from the waterspouts or funnel clouds. WSO's, Santa Maria and San Diego both performed effectively during the storm, relaying WSFO, Los Angeles' issuances to the public in their areas of responsibility, and issuing more localized statements when necessary. Santa Maria extended their hours of operation because of the storm. WSFO, Los Angeles arranged ahead of time for extra people to be on duty over the weekend of March 4 and 5 in anticipation of the storm.

Chapter 2

Data Acquisition

During the storm period of March 3 through 5, the data acquisition systems at WSFO, Los Angeles performed reliably. A complete description of the Data Guidance Acquisition system is contained in Chapter 2 of the report on the Southern California storm of February 8-10, 1978.

Findings and recommendations contained in that report as to how the Data and Guidance Acquisition system should be improved also apply to this report.

Chapter 3

Meteorological Conditions and Forecasts

Synoptic Scale Features

During the latter part of February a blocking high developed over Northern British Columbia and by March 1, the block had retrograded to a position over Alaska resulting in a split in the westerlies across the Eastern Pacific. The jetstream associated with the southern branch was depressed far to the south--just below 30N from the dateline to the west coast--dipping to near 25N under a strong trough that was located just off the Southern California coast. Heavy rain fell in Southern California Tuesday night and Wednesday (Feb. 28 - March 1). By Wednesday evening, the main low had moved inland, but a new trough and surface low were developing off the Central California coast. This maintained a strong flow of moist air into Southern California from the westsouthwest and prolonged the heavy rain into Thursday morning.

At 12Z Thursday, March 2, the surface map showed a 988 mb surface low about 400 miles west of Monterey with a cold front approaching Southern California, and a wave was evident on the front near 25N/145W. Satellite imagery showed a wide band of clouds from the wave to Southern California.

On Thursday developments offshore in the vicinity of 25-35N/140-150W were quite complex with an apparent "instant occlusion" forming in the flow near 30N/140W. The Thursday evening 500 mb chart showed a quasistationary closed low centered about 300 miles west of Eureka with a strong short wave trough about to rotate underneath it--the jetstream was pointed directly at Southern California. There still seemed to be a weak wave near 30N/140W. On Friday morning, March 3, the flat wave was apparently outrunning the main center bringing only light rain in southern California during the day. The main surface frontal system, associated with a strong and slowly progressive upper low that had formed, was nearing 125W and the strong upper level support for the front was not yet close enough to be producing a good vertical motion field over the front. This was apparent by examining satellite IR pictures. No cold tops were associated with the front Friday morning.

The main front moved into Southern California Saturday morning, March 4, preceded and accompanied by heavy rain, thunderstorms, and gale winds. By Saturday afternoon a ridge was building in rapidly along 135W. This sharpened the trough and helped move it rapidly inland over California Sunday, March 5. The trough produced locally heavy showers, and some severe weather (waterspouts and funnel clouds).

Guidance Received at WSFO, Los Angeles

During nearly the entire episode of heavy rains of the first week of March, the new 7LPE was much superior to the LFM II.

The PE 500 millibar prog forecast the intense trough of March 1, quite well, but was poor on the following trough that evolved into a closed low off Northern California Thursday, causing the heavy rain of March 1 to linger into the morning of the 2nd (Thursday). The PE was consistently quite good with the movement of the next short wave trough headed toward Southern California from north of Hawaii, but it wasn't quite deep enough. This trough eventually caused heavy rain Friday night through Saturday night. However, there was one exception--the Wednesday evening package was much too fast and too weak on the system. Overall, the PE did quite well in forecasting the dynamics of this major storm development, including QPF.

LFM II was much less consistent on developments leading up to the storm of March 1-2 and was much too fast in moving the system eastward. LFM II then tended to build a significant ridge along 125-130W Thursday and Friday where only a very flat ridge was observed between the storm of March 1-2 and the one of March 3-5. While the rain slackened considerably between the systems, it never completely stopped. Initially, the LFM II moved the strong storm that hit Friday night too fast, and indicated very little amplitude and minimal rainfall. However, beginning with the Thursday evening package, the LFM began handling the system very well, and from then on was excellent on the movement and intensity of the low and trough, though slightly too strong and slow. Significant rainfall was indicated for Friday night and Saturday beginning with this package.

It appears that there are some problems with the new LFM, whether boundary problems or otherwise, when there is a strong jetstream across the Pacific in low latitudes. Overall, the PE was much superior to the LFM through the stormy period of the first week of March.

Forecasts and Warnings

WSFO, LAX issued the first Flash Flood Watch at 8:55 p.m., Friday, March 3, approximately 6 hours before the heaviest rains and damaging mudslides began. During the next 2 1/2 days, the WSFO issued 25 more statements warning of hazardous conditions.

Nearly all special statements and warnings contained "Call to Action" statements such as the following from the 8:55 p.m. Flash Flood Watch:

> "If you live in an area that is subject to flooding or mudslides and heavy rain is observed take quick action to move to a safe place immediately. Do not wait for a warning or actual flooding."

All flash flood statements and heavy rain warnings mentioned the likelihood of mudslides. While WSFOs normally do not forecast geological hazards, forecasters at WSFO, LAX were cognizant of the danger posed by mudslides. Based on their previous experience that heavy rain frequently caused mudslides in this area, and on the knowledge of the exceptional antecedent conditions, they were able to accurately warn of the numerous mudslides. During this storm mudslides were responsible for much of the damage and a number of deaths.

The sequence of weather bulletins issued by WSFO, LAX follows:

- 2:15 PM PST FRI MAR3
  High Surf Advisory - 5 to 8 ft breakers with occasional sets to 10 ft., from early Saturday through Sunday.

- 8:55 PM PST FRI MAR3
  Flash Flood Watch - for mountain areas and areas below canyons for Santa Barbara county and Ventura county; valid until 9 AM PST MAR 4.

- 12:05 AM PST SAT MAR 4
  Rain Warning - all southern California coastal and mountain areas for the following counties: Santa Barbara, Ventura, Orange, portions of Los Angeles, San Bernardino, Riverside, and San Diego; 1 1/2 to 3 inches in coastal areas and 3 to 6 inches in the mountains.

- 12:15 AM PST SAT MAR 4
  Flash Flood Watch - for all portions of the following counties: Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Riverside and San Diego.

- 12:35 AM PST SAT MAR 4
  Travelers Advisory - for coastal and intermediate valleys and Owens Valley for local flooding and mudslides in the canyons. (issued as part of FPI)

- 5:10 AM PST SAT MAR 4
  Flash Flood Statement - to continue Flash Flood Watch until noon Sat.

- 8:30 AM PST SAT MAR 4
  Flash Flood Statement - update on current conditions.

- 10 AM PST SAT MAR 4
  Special Weather Statement on River Stages

- 1 PM PST SAT MAR 4
  Flash Flood Statement - to extend Flash Flood Watch until 6 PM Sat.

- 2 PM PST SAT MAR 4
  Heavy Surf Statement - to continue High Surf Advisory into Monday.

- 2:15 PM PST SAT MAR 4
  Cancel Gale Warning

- 5:15 PM PST SAT MAR 4
  Special Weather Statement on River Stages

- 5:45 PM PST SAT MAR 4
  Flash Flood Statement - extending Flash Flood Watch until 10 PM Sat.

- 9:50 PM PST SAT MAR 4
  Flash Flood Statement - cancel Flash Flood Watch below coastal canyons and mountain sections.

- 12:15 AM PST SUN MAR 5
  Flash Flood Watch - reinstating Flash Flood Watch for mountains and foothills of Los Angeles and San Bernardino counties for Sun. morning.

- 3:10 AM PST SUN MAR 5
  Flash Flood Watch - watch extended to include mountains and coastal slopes of the following counties: Santa Barbara, Ventura, Los Angeles, Orange, San Diego, western portion of Riverside, and San Bernardino; valid through Sunday.

- 6:30 AM PST SUN MAR 5
  Flash Flood Statement - statement on current conditions.

- 9:25 AM PST SUN MAR 5
  Tornado Warning - for southwestern corner of Los Angeles county.

- 9:45 AM PST SUN MAR 5
  Special Weather Statement - statement on waterspout and funnel clouds.

- 10:13 AM PST SUN MAR 5
  Special Weather Statement - on funnel clouds.

- 11:02 AM PST SUN MAR 5
  Tornado Watch - Issued by SELS for small portion of southwestern Southern California and adjacent islands and coastal waters (Areal Outline).

- 12 PM PST SUN MAR 5
  Severe Weather Statement - cancelling the Tornado Watch.

- 1:55 PM PST SUN MAR 5
  Special Weather Statement on funnel clouds.

- 2:22 PM PST SUN MAR 5
  Special Weather Statement on funnel clouds

- 8:45 PM PST SUN MAR 5
  Flash Flood Statement - cancelling the Flash Flood Watch

WSO, San Diego, which has warning responsibility for San Diego and Imperial counties, assisted in providing a steady flow of warnings and statements from March 3 through 5. San Diego's weather synopsis given in the 4 p.m., Friday, March 3, issuance stated "Light rain has begun in the Santa Barbara area and is expected to move into San Diego County tonight with locally heavy amounts beginning after midnight and continuing Saturday." All watches and warnings issued by Los Angeles WSFO were received and disseminated in timely fashion. In addition, WSO, San Diego issued a Special Weather Statement at 10 a.m., Saturday, March 4, specifically advising residents of San Diego County of the threat of flooding and mudslides.

WSO, Santa Maria has warning responsibility for Santa Barbara and San Luis Obispo Counties. While there were some deficiencies in the communication system to Santa Maria during the period from March 3 through 5, Santa Maria received all watches and warnings issued by WSFO, LAX, and disseminated them to their area of responsibility.

Santa Maria is a 16-hour-a-day station. The Flash Flood Watch issued at 8:55 p.m., Friday, March 3, was telephoned to Santa Maria by WSFO, LAX. A discussion was held of the weather situation, and it was determined that because of the seriousness of the situation, Santa Maria would remain open all night, instead of closing at 10 p.m. as normal. Los Angeles called Santa Maria again at 12:30 a.m., March 4, with the Rain Warning and update of the Flash Flood Watch. By remaining open, Santa Maria was able to effectively disseminate watches and warnings to residents of Santa Barbara County.

FINDING 1: Performance by the National Weather Service during this disaster was excellent. WSFO, Los Angeles, and WSOs, San Diego and Santa Maria performed in a commendable manner. Particularly notable was: (1) WSFO, Los Angeles' arrangement in anticipation of the storm for extra people to be on duty over the weekend. Off-duty personnel were contacted Thursday, March 2, and Friday, March 3, and asked to work over the weekend; (2) the decision by WSFO, Los Angeles and WSO, Santa Maria that the latter should extend its hours and remain open all night; (3) the advance warning of the storm, and the steady flow of statements and warnings, during the storm by all three NWS offices keeping the public advised of the hazardous conditions.

FINDING 2: The broadcast media provided timely and effective broadcasts of the watches, warnings, and statements.

Recommendation: NWS should congratulate the broadcast media on its performance during this storm. The importance of their role in warning dissemination should be emphasized.

FINDING 3: Los Angeles WSFO continued to issue nonstandard "Rain Warnings" during the storm. These may be misunderstood by some people because of their use only in this area. WSFO, Los Angeles used Flash Flood Statements to extend watches several times.

As noted in main report, issuance of "Rain Warnings" by WSFO, Los Angeles has been discontinued.

FINDING 4: Coordination between WSFO, Los Angeles and WSOs, San Diego and Santa Maria was good, in general. However, because of time constraints Friday, March 3, on the WSFO, Los Angeles forecaster, a complete discussion of the weather situation with San Diego was not possible. WSO, San Diego went considerably stronger on precipitation in their local issuances than the Los Angeles guidance for the night of Friday, March 3, and Saturday, March 4.

Recommendation: The need is obvious for close coordination between WSFOs and WSOs in potentially severe weather situations. Forecast offices should make every effort to ensure that time is available for forecasters to coordinate with WSOs.

FINDING 5: WSFO, Los Angeles issued a "Rain Warning" and a "Flash Flood Watch" for all of Santa Barbara County. WSFO, San Francisco has forecast responsibility for the northern two-thirds of Santa Barbara County. The "Rain Warning" and "Flash Flood Watch" for that area should have originated at WSFO, San Francisco rather than WSFO, Los Angeles. It is the responsibility of WSFOs to issue appropriate watches and warnings of hazardous weather in their area of forecast responsibility. Watches and warnings should also be coordinated with forecast offices having adjacent areas of forecast responsibility.

Recommendation: WSFO, Los Angeles should coordinate watches/warnings for Santa Barbara County with WSFO, San Francisco.

FINDING 6: Apparently, very few deficiencies in NWS operations occurred during this storm. One reason for this was that a similar storm occurred in Southern California in the previous month. Performance of the NWS during the first storm was examined in detail. The lessons learned from the first disastrous storm were applied to the second with good results.

Recommendation: Unusual or severe storms should be examined in detail by the WSFOs and WSOs affected. Attempts should be made to recognize and correct deficiencies in operations. In addition, realistic station drills are necessary to stimulate severe weather situations which occur very infrequently. Performance during drills should be examined as critically as performance during actual weather, with the objective of recognizing and correcting deficiencies.

Chapter 4

Warning Dissemination and Public Response

WSFO, LAX has forecast and warning responsibility for the area south of a line which runs from Pt. Conception along the crest of the Coast Range, Tehachapi Mountains and southern Sierra Nevada. This includes, among others, the counties of Ventura, Los Angeles, Orange, Riverside and San Bernardino. WSO, San Diego has warning responsibility for the counties of San Diego and Imperial and WSO, Santa Maria has responsibility for Santa Barbara and San Luis Obispo counties. During the hours Santa Maria is closed, WSFO, LAX, has warning responsibility for the southeastern third of Santa Barbara County; WSFO, SFO has responsibility for the remainder.

AT WSFO, LAX, forecasts are typed on electronic cathod-ray tube (KCRT). When completed, they are transmitted to a computer in Washington, then relayed to a distribution computer in Kansas City for transmission on the proper teletypewriter circuit. The forecast office retrieves a paper tape and a hard copy of the forecast and transmits the forecast to local area users on NOAA Weather Wire.

Urgent messages are not transmitted this way because of delays during times of heavy computer usage. Watches, warnings, advisories and statements are prepared by typing a hard copy and simultaneously producing a paper tape. The tape is immediately taken to the communications room for transmission on one or more local-area teletypewriter circuits. These curcuits are described in Chapter 4 of the main report.

In addition, forecasts, watches, warnings, advisories, and weather statements are immediately broadcast by WSFO, LAX on NWR (KWO-37, 162.55 MHz; KIH-34, 162.40 MHz, Santa Barbara). A warning alarm signal is activated for all warnings and short-fuse watches such as flash flood watches. Also, the California Office of Emergency Services (OES) in Sacramento is advised via the NAWAS hot line. It, in turn, notifies public safety officials in the affected area.

The sequence of statements, watches and warnings described in Chapter 3 were disseminated in the manner described above. Of particular note is the use made of teletype circuit number 7GS138, the press circuit for Southern California. Many of the radio and TV stations in the Los Angeles and surrounding area have this circuit. The steady flow of weather statements and warnings issued by WSFO, LAX over the 2 1/2 days of the storm were fed directly and immediately by this circuit to many of the radio and TV stations in the area. The weather information received wide play by the media, and because of the number of issuances and the call to action statements contained in them, kept people generally alerted to the danger of the situation.

The timely and numerous statements issued by WSFO, LAX were the result of advance planning by the WSFO and anticipation of the weekend weather. On Thursday, March 2, and Friday, March 3, the WSFO anticipated that severe weather would occur over the weekend.

It is apparent that the public was warned of the hazard and kept informed of the progress of the storm. As in most disasters, public reaction varied. While most of the public acted with caution and responded to warnings and public safety official instructions, a few did not. Public safety officials had to arrest at least one resident when he refused to obey an evacuation order. (Officials were evacuating homes in an area threatened with destruction by mudslides.)

A response that is typical of many natural disaster survivors was made by a woman in the Baldwin Hills area, who nearly died when her house was destroyed by a mudslide: "I kept on hearing about the trouble at Malibu and in the canyons, but it never dawned on me it would happen right here."

FINDING 1: Public reaction to the warnings and the actual occurrence of hazardous conditions varied considerably. As in all disasters, a number of people failed to recognize the danger and take appropriate actions.

Recommendations: A more active disaster preparedness program is needed in the NWS and other government agencies to educate the populace of the proper action required in natural disaster situations.

Residents remove furniture across the roof of their home in La Crescenta, in the Los Angeles area, after the storm sent a wall of water and mud down Shields Canyon Road. What used to be the front yard of this home is now covered with mud and cars.
(Los Angeles Times Photo)

Damage from February 9-10, 1978 Flash Flood at Hidden Springs on Mill Creek, San Gabriel Mountains, Los Angeles County, CA. (Los Angeles Times Photo)