Natural Disaster Survey Report

NORTHERN CALIFORNIA FLOODS

GB
1399.4
.C2
N38
1995

JANUARY 7 - 15, 1995

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Western Region
Salt Lake City, Utah

July 1995

Table of Contents

Table of Contents i

List of Figures ii

List of Tables iii

List of Abbreviations and Acronyms iv

Preface . . . . . Page 1

Executive Summary . . . . . Page 3

Findings and Recommendations . . . . . .Page 4

Part I - Description and Impact of the Flood Event . . . .Page 16

Part II - Summary of Warning and Forecast Services . . . Page 35

Part III - New Technology and Data Sets . . . . . Page 43

Part IV - Dissemination . . . . . Page 53

Part V - Customer Response . . . . . Page 57

Appendix A - Sequence of Public Products Issued A-1

Appendix B - Flood Stage Report - Central Valley HSA, CNRFC . B-1

Appendix C - Flood Stage Report - NWSFO Monterey's HSA C-1

Appendix D - Flood Stage Report - NWSO Eureka's HSA D-1

Appendix E - OES Weather Distribution System E-1

Appendix F - City of Roseville Briefing Packet F-1

LIBRARY

OCT 10 2008

National Oceanic &
Atmospheric Administration
U.S. Dept. of Commerce

GB
1399.4
.C2
N38
1995

List of Figures

Figure 1 - Northern Hemisphere 500 MB Height Field at 00Z for Jan 4, 9, 11, and 15, 1995.

Figure 2 - 500 MB Vertical Velocity and Wind Field for 12Z, Jan 3, 1995; 500 MB Vertical Velocity and Wind Field for 12Z, Jan 4, 1995.

Figure 3 - Forecast Fields from ETA, January 6, 1995, 12Z.

Figure 4 - Infrared 2 mile Resolution Satellite Image at 0730Z for Jan 8, 1995.

Figure 5 - Vertical Motion and Wind Fields at 1200Z for Jan 9, 1995.

Figure 6 - Infrared 2 mile Resolution Satellite Image at 2130Z for Jan 8, 1995.

Figure 7 - Infrared 2 mile Resolution Satellite Image at 1630Z for Jan 10, 1995.

Figure 8 - Base Velocity Field from Monterey, CA, WSR88D at 0618Z Jan 7, 1995.

Figure 9 - Wind Profile on January 10, 1995 at 0216Z.

Figure 10 - Convective Precipitation Band over Merced County.

Figure 11 - Three Hour Precipitation Estimate Ending at 15Z, Jan 10, 1995.

Figure 12 - Storm Total Precipitation Estimate from Sacramento Radar Jan 2-10, 1995.

Figure 13 - Three hour Precipitation Estimate Ending at 17Z Jan 8, 1995.

Figure 14 - NOAA 12 Polar Orbiter Satellite Imagery at 1539Z for 1995.

List of Tables

Table 1 - Precipitation Totals for Northern California, Jan 7-15, 1995.

Table 2 - San Francisco Bay Area Storm Damage.

Table 3 - Preliminary Property Damage Estimates by County.

Abbreviations and Acronyms

AFOS	-	Automation of Field Operations and Services
ALERT	-	Automated Local Evaluation in Real Time
AMS	-	American Meteorological Society
AP	-	Associated Press
AVHRR	-	Advanced Very High Resolution Radiometer
BAPSU	-	Bay Area Public Service Unit
CALTRANS	-	California Transportation
CDEC	-	California Data Exchange System
CDF	-	California Department of Forestry
CDWR	-	California Department of Water Resources
CHP	-	California Highway Patrol
CLETS	-	California Law Enforcement Telecommunication System
CNRFC	-	California - Nevada River Forecast Center
CPCS	-	Common Program Control Station
DWR	-	Department of Water Resources
EBS	-	Emergency Broadcast System
EDIS	-	Emergency Digital Information System
EKA	-	NWSO Eureka, CA.
EOC	-	Emergency Operations Center
ESF	-	Flood Potential Outlook
ETA	-	Designation for NMC Mesoscale Model
FAT	-	NWSO Fresno, CA.
FFA	-	Flash Flood Watch
FFS	-	Flash Flood Statement or Urban and Small Stream Advisory
FFW	-	Flash Flood Warning
FLS	-	Flood Statement
FLW	-	Flood Warning
FPUS3	-	State Forecast Discussion (AFOS Product)
GOES	-	Geostationary Operational Environmental Satellite
HAS	-	Hydrometeorological Analysis and Support
HIC	-	Hydrologist-In-Charge
HIPS	-	High Resolution Picture Transmission Image Processing
HSA	-	Hydrologic Services Area
HYDROMET	-	Hydrometeorological Data Collection and Display Systems
KMUX	-	Identifier for Monterey Radar
KT	-	Knot
mb	-	Millibar
MOU	-	Memorandum of Understanding
MPH	-	Miles Per Hour
MRF	-	Designation for NMC's Medium Range Forecast Model
NAS	-	Naval Air Station
NAWAS	-	National Warning System
NEXRAD	-	Next Generation Weather Radar (WSR88D)

NIDS	-	NEXRAD Information Dissemination System
NMC	-	National Meteorological Center
NOAA	-	National Oceanic and Atmospheric Administration
NR	-	Near
NSSFC	-	National Severe Storms Forecast Center
NWR	-	NOAA Weather Radio
NWS	-	National Weather Service
NWSFO	-	NEXRAD Weather Service Forecast Office
NWSO	-	NEXRAD Weather Service Office
NWWS	-	NOAA Weather Wire Service
OASIS	-	Operational Area Satellite Information System
OES	-	Office of Emergency Services
PC	-	Personal Computer
QPF	-	Quantitative Precipitation Forecast
RDA	-	Radar Data Acquisition
RDD	-	WSO Redding, CA.
RFC	-	River Forecast Center
RIV	-	River
RVA	-	River Summary
RVR	-	River
RVS	-	River Statement
SAC	-	NSWO Sacramento, CA.
SFO	-	NWSFO San Francisco at Monterey, CA.
SP	-	State Park
SPS	-	Special Weather Statement or Urban and Small Stream Flood Advisory
SSD	-	Scientific Services Division
STP	-	State Temperature and Precipitation Summary
USGS	-	United States Geologic Survey
UCT	-	Universal Coordinated Time
VIL	-	Vertically Integrated Liquid
WCM	-	Warning Coordination Meteorologist
WFO	-	Weather Forecast Office
WRH	-	Western Region Headquarters
WSI	-	Weather Services, Inc.
WSO	-	Weather Service Office
WSR88D	-	Weather Surveillance Radar, 1988, Doppler (NEXRAD)
WSW	-	Winter Storm Warning

Preface

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, Western Region Headquarters, assembled two Regional Survey Teams following the record heavy rain, river flooding, flash flooding, and mudslides that occurred during January 4-15 1995, in California. The purpose of these surveys is to review the quality of services provided by the NWS prior to and during these record breaking events and to examine ways, if any, that services can be improved. The floods, flash floods, and mudslides in California were a major hydrometeorological event which resulted in loss of life and a large loss of property. When a severe event such as this occurs, it is NWS policy to conduct a survey to ensure the best service possible.

This report was filed by the team assigned to review the products and services issued for Northern California January 7-15, 1995, by NWSFO San Francisco at Monterey, California; NWSO Sacramento, California; NWSO Eureka, California; WSO Redding, California; WSO Fresno, California; and the California-Nevada River Forecast Center (CNRFC). The team consisted of Robert Tibi, Chief, Hydrologic Services Division (team leader), Western Region Headquarters (WRH); Thomas Ainsworth, WRH Meteorological Services Division; Ted Buehner, Warning Coordination Meteorologist (WCM), NWSFO Seattle; Mary Mellema, Service Hydrologist, NWSFO Boise; and Glen Sampson, Meteorologist (WRH) Scientific Services Division (SSD). A second survey team was assigned to review NWS products and services for Southern California (Jan 4-11, 1995), and has prepared a separate survey report. The meteorological analysis was prepared by Glen Sampson, Meteorologist in the SSD, WRH, which addresses weather conditions which affected all of California. The same analysis is included in the survey reports of both teams.

The Northern California team assembled in Monterey the morning of January 17, to review the event and discuss survey strategy. After the survey team meeting the team split into three groups on January 17 and 18 with one team travelling to the Bay area to meet with media representatives and emergency services directors, a second team travelling to the Napa and Russian River basins to meet with hydrologic users, and a third team remaining at the NWSFO to meet with forecasters and review internal operations. On January 19 and 20th, all team members travelled to the Sacramento area where the team split again with a group focusing on media and user contacts/visits, NWSO Sacramento activities, and CNRFC and California Department of Water Resources (CDWR) activities. Outgoing briefings were provided by the team leader to the Area Manager for Northern California and the Hydrologist-In-Charge (HIC)

of the CNRFC. In addition, the survey team leader visited NWSO Eureka on March 21 and 22, 1995, to discuss both the January flooding and the later record flooding of March which will be addressed in a separate survey report.

The flood survey team expresses its appreciation to the staffs of the NWSFO, RFC, NWSOs, and WSOs visited for their cooperation and support during the period while the survey team was on site, and for the assistance the NWSFO, CNRFC, and DWR provided in preparing information necessary for this survey.

Executive Summary

From Saturday, January 7, 1995, through Sunday January 15, 1995, a series of Pacific storms brought unusually heavy rains to Northern California. These same storm systems produced heavy rains in Southern California through the early morning hours of Wednesday, January 11, 1995. The heavy rains and runoff resulted in extensive, severe flooding to homes, businesses, agricultural land and roadways throughout the state of California. In addition to flooding, the storms also brought high winds and caused numerous mud and rock slides. A total of 42 of California's 58 counties were declared federal disaster areas, 11 persons lost their lives due to the storm and storm damages throughout California has been estimated to be $1.337 billion. The hardest hit areas in Northern California were Gurneville in Sonoma County, Roseville in Placer County and Rio Linda in Sacramento County.

The period of heaviest rainfall in Northern California was January 9-10, resulting in both mainstream river flooding and severe urban, small stream and flash flooding. Rivers throughout the area rose to near record levels. The Upper Sacramento River at Hamilton City came to within a half foot of the record level recorded prior to the completion of Shasta Dam in the mid 1930's. Urban and flash flooding in Roseville was the worst ever recorded, exceeding the severe flooding and devastation of February 1986, in that area. Heavy rains also fell over Southern California January 4 and again on January 9-10 with intermittent rain throughout the period from January 3 through 11. Flooding resulting from these storms in Southern California is described in a separate storm report.

The warning and forecast services provided by NWS offices in Northern California during this event were judged to have been excellent. Every watch, warning, and river bulletin issued for the flooding, both mainstream river flooding and "short fused" flashy flooding, verified. In every interview that the survey team conducted with emergency service agencies, county flood control agencies, the media, federal and state hydrologic users and the Governor's office, the message was the same: the NWS provided advanced notice of the storms and their impacts, and provided timely, accurate warnings and forecasts throughout the event. All customers of NWS services were kept well informed of current and forecast conditions and had sufficient lead-time to take actions necessary to mitigate property damage and loss of life due to the record flooding. The NWS's most noteworthy accomplishments of this event can be characterized as early recognition of the flood potential, long-lead times and accurate forecasts which provided the essential items for the public, emergency services, and hydrologic agencies (ie., flood control districts) to take actions necessary to prepare for and fight the flood. Lead-times for mainstream flooding and long-fuse events of several days were provided. Lead-times for "short fused", flashy events of 3-12 hours

were common. The following are some examples of the early recognition by NWS offices of the event:

The potential for heavy precipitation in Northern and Central California was recognized by the NWSFO and highlighted in public products starting at 3:00 AM, January 4; flash flood watches were issued at 4:30 PM, January 4; the first significant rains in the Coastal Mountains occurred on January 6.

The first RFC bulletin for significant mainstream river flooding was issued on January 7, at 7:30 AM; onset of river flooding was January 8 at 8:45 AM in reaches of the Napa and Russian Rivers.

The survey team submits the following findings and recommendations as a means to highlight the strength of the forecast and warning system in Northern California and to identify areas where improvements are needed and possible:

Findings and Recommendations:

1. **Finding:** Overall, the public forecast and warning services provided by the NWS offices (NWSOs, WSOs, RFC) in Northern California were excellent. Emergency service officials, hydrologic agencies (flood control districts), the media (television, radio, newspapers), Federal and State government agencies, and the public were kept well informed with timely and accurate forecasts, warnings and statements. Early recognition and long lead times were common during the event.

2. **Finding:** The California/Nevada River Forecast Center/California Department of Water Resources (CNRFC/DWR) joint operation during the flood event functioned just as designed in the Federal/State MOU for joint operations of a flood center and provided excellent service to their customers. NWS and DWR hydrologic forecasters worked extended hours of operations during the period and provided timely and accurate forecasts.

3. **Finding:** Quantitative Precipitation Forecasts (QPFs) provided by NWSFO forecasters for the first six hour period were occasionally altered higher or lower by the HAS Forecasters at the CNRFC before being input to the hydrologic models. California DWR has means of disseminating the altered QPFs over various communications networks used by emergency management personnel (i.e., CLETS, EDIS,

OASIS). Although the NWSFO QPF is not intended to be a public product, it never the less is disseminated outside the NWS. Users with access to both the NWSFO QPF and the altered QPF from CNRFC and DWR, could have inconsistent data from two NWS sources.

Recommendation: HAS Forecasters should coordinate any adjustments to the NWSFO QPF with the Lead Forecaster. If the NWSFO QPF product is modified, it should by reissued as an amended forecast so that the latest available QPF corresponds with information provided by the RFC HAS Forecaster.

4. **Finding:** Normally the CNRFC operates eight to twelve hours per day, 365 days per year. Emergency management centers began 24 hour coverage by the time River Flood Warnings were in effect on January 7, 1995. During the flooding, CNRFC increased daily operating hour to an average 20 hours per day. The longest period of continuous coverage at CNRFC was 22.5 hours on Monday, January 9. There were some isolated times when the NWSFO forecaster was not able to reach the hydrologic forecaster during the event. Also, some NWSFO forecasters were not aware of the RFC's extended hours of operation.

Recommendation: During major flood events, the RFC should operate 24 hours per day. This will enhance forecast coordination between the RFC and the NWSFO/NWSOs. The RFC should let all offices know what their hours of operations will be during flood events. All NWSFOs/NWSOs should ensure they have correct telephone numbers for all available telephone lines into the RFC and the flood center.

5. **Finding:** This was the first major flood since the HAS function was added to the CNRFC. Having the HAS forecasters take a detailed look at QPF forecasts from the NWSFOs and doing analysis on their own proved to be very valuable. They had the time to analyze the situation and develop quality QPF numbers for input into the RFC hydrologic model. Although there was a coordination call with the NWSFO every morning between 10:00 AM and noon, most of the QPF values were already entered for the hydrologic model runs. More coordination

should be taking place between the NWSFOs and the HAS forecasters to develop a coordinated QPF before putting the values into the Hydrologic Model. The HAS function greatly improved the lead time on the hydrologic forecasts by freeing up the RFC hydrologic forecasters to work on the hydrologic model.

Recommendation: Since the HAS function proved to be very valuable during this event, the role of the HAS forecaster should be widely publicized to all NWS offices. Also, the CNRFC should develop an outline of HAS duties based on experiences from the 1995 floods for use in training the staffs at NWSFOs, spinup NWSOs, and other RFCs on the HAS function.

6. **Finding:** The flooding problems associated with this storm were widespread. There was long term main stem river flooding and flash flooding in steep terrain. Small streams overflowed their banks and roadways and pastures became submerged. By definition, public notification of flooding (forecast or occurring) on waterways that are ungaged is accomplished by releasing a statement titled "Urban and Small Stream Flood Advisory". This NWS product is most often used when brief periods of very heavy rains overwhelm urban water drainage systems, cause a rapid increase to the water level and rate of flow in small streams, and cause water to pond on roadways. The Urban and Small Stream Flood Advisory product was the correct product to issue to describe the conditions occurring in January but the "advisory" language was interpreted by the users as understating the magnitude of the problem since flooded roads made parts of some Northern California counties unaccessible for several days.

Recommendation: NWS offices with flash flood warning responsibility should be allowed to change the wording of the advisory product to be titled "Urban and Small Stream Flood Warning" if significant flooding of city intersections, roadways, and pastures is occurring or is imminent, and the conditions are forecast to persist for more than (6) hours before receding. The Small Stream Flood Warning phrasing should be used to imply enough water accumulation to cause damage to

property or structures built along ungaged waterways or requiring traffic detours around water covered sections of the road. The Urban and Small Stream Flood Warning would be considered intermediate between a Urban and Small Stream Flood Advisory and Flood/Flash Flood Warning.

7. **Finding:** Staff members at the NWSFO and NWSO Sacramento, who had access to WSR-88D data, found the radar's areal depiction of precipitation was excellent. The reflectivity data was especially helpful in deciding where to issue Flood and Flash Flood Warnings, especially in the Central Valley.

8. **Finding:** The NWSFO and NWSO Sacramento considered the WSR-88D velocity data to be very helpful in deciding whether wind warnings were necessary. Several High Wind Warnings were issued during the week based on the WSR-88D velocity data and they all verified.

9. **Finding:** Storm total precipitation algorithms using KMUX (Monterey) WSR-88D radar data woefully underestimated precipitation amounts. It was not uncommon for the algorithm to generate only 10% of the actual precipitation observed. However, NWSFO forecasters did not always solicit satellite precipitation estimates from the National Meteorological Center's (NMC) Heavy Precipitation Branch.

Recommendation: Forecasters are reminded to utilize the services available from the national centers, such as the Heavy Precipitation Branch at NMC and the National Severe Storms Forecast Center.

10. **Finding:** The NWSFO developed a "Watch/Warning Flow Chart" several years ago. It is displayed at the forecaster's work stations. The chart facilitates the forecaster's decision making process as to which warning or advisory product should be issued and precludes frequent references to the station duty manual. NWSFO forecasters agreed the chart saved them a significant amount of time in preparing their products.

11. **Finding:** When the NWSFO and the Bay Area Public Service Unit (BAPSU) were located in

Redwood City, BAPSU was responsible for producing and disseminating short fused warning products (i.e., Flash Flood, Severe Thunderstorm, Tornado). Since the office move to Monterey in September 1994, the BAPSU no longer issues the short fused warnings. The Lead Forecasters and Service Hydrologist are now responsible for producing and disseminating the short fused warnings, as well as the longer lead warnings. This added responsibility on the Lead Forecasters and Service Hydrologist resulted in a significant increase in workload for them.

Recommendation: Prompt training of the BAPSU's "new staff" will resolve this issue.

12. **Finding:** The Northern California Area Manager cited benefits of participating in the Sierra Winter Workshops the past few years. These workshops, held annually at Lake Tahoe, NV, are designed to sensitize various groups to each others needs and abilities. Participants in the Sierra Winter Workshops come from both California and Nevada and include the NWS, Emergency Management, State Police and Highway Patrol, and ski resort personnel. Call-to-action statements within Winter Storm Warnings issued during this period included suggestions made at the workshops by the users of NWS products.

13. **Finding:** Coordination between the RFC and NWSFO was much better than in the past but still needs to be improved. There was a QPF coordination call between the RFC and the NWSFO every morning at 11 AM. Although there was coordination, there was no mechanism for coming to an agreement or providing feedback on later adjustments by the RFC.

Recommendation: The RFC and NWSFO must establish formal procedures for coordinating and agreeing on QPF information and for providing feedback to the NWSFO on what QPF was input to the RFC modelling process. Also, a QPF verification scheme should be developed to provide feedback to the forecasters.

14. **Finding:** The Redding and Sacramento NWS offices sent out mainstream river flood statements unaltered from the bulletins issued

by the RFC. The NWSFO also sent out several of these bulletins unaltered to the public under the Flood Statement (FLS) headers. The CNRFC and California Department of Water Resources (CDWR) have an agreement (MOU) that the moment the RFC sends out the joint RFC/DWR bulletin, it is also disseminated on the California Data Exchange System (CDEC) which is available to flood control districts, Office of Emergency Services and others. These are generally water control type agencies which understand the implications of damage expected at certain levels. The users of the NWSFO and NWSO products could be anyone, including local people who do not understand what kind of damage a forecast water level could cause. When NWSFO/NWSO/WSOs send out a bulletin unaltered from the RFC there is no additional information such as damage potential associated with a forecast river level or how it compares to past flooding. This kind of information could be essential for local agencies making emergency decisions. The NWSFO included this information on most of the warnings and statements that were issued.

Recommendation: Offices with Hydrological Service Area (HSA) responsibility should ensure that additional, meaningful "added value" information is included in public products in a timely manner. Information such as damage expected from a forecast stage, how a river level compares to past flooding, and call to action statements can be essential to private citizens and local agencies in making emergency decisions. In addition, the NWS and DWR need to coordinate E-19 information to ensure that the "value added" information from the offices with HSA responsibility is consistent with information provided by the Flood Center.

15. **Finding:** HSA responsibility for the Central Valley is assigned to the CNRFC. During this flood event the RFC HSA function was included in the State-Federal Flood Center Operation. Feedback from customers indicated that this arrangement was a success. The CNRFC Service Hydrologist was assigned to work in the Flood Center which in reality functions as an HSA for the major rivers of Northern California. This is an important function in flood

operations in California because this is how many customers get the information they need for emergency response activities. The best flood forecast is of little value without an effective user service function. Some important lessons learned from Flood Center Operations were:

A. Most agencies that deal with river flooding on the Russian, Napa, Salinas, and Pajaro Rivers get their warning calls from the Flood Center and their forecasts from CDEC. Coordination of forecasts and flooding is generally between the county agencies and the Flood Center.

B. The media, (TV, Radio, and Newspapers) were getting their information on Russian and Napa River flooding from the Flood Center.

C. Forecasts for the Napa, Russian, Salinas, and Pajaro Rivers were in the hands of users before warnings and/or statements were available through other channels, often by as much as an hour.

D. The Flood Center was staffed with engineers and hydrologists who could handle matters requiring technical expertise in hydrology.

Recommendation: WR HSD needs to further clarify HSA boundaries and Service Hydrologist's roles in California to ensure the best possible service to users and cooperators.

16. **Finding:** Some of the local users of the flood warnings were having a hard time receiving the information through the normal communication channels. The service hydrologist at the NWSFO had to FAX many of the warnings to local officials. This turned out to be a coordination problem, and an excessive added workload at the NWSFO.

Recommendation: The WCM and Service Hydrologist need to work with the State OES to make sure their communications channels are working correctly to get warnings to the local, county, and city levels.

17. **Finding:** California DWR indicated that they did not like to see a flood warning cancelled when a river fell below flood stage but remained above the warning stage in a continuing event. This problem needs to be clarified so that the NWSFO/NWSO's products are consistent with the RFC/DWR products.

Recommendation: The NWS should work with the CDWR to clarify the difference between use of "Warning" and "Flood Stage" terminology to eliminate confusion with NWS terminology.

18. **Finding:** There was some confusion within the NWS offices on what product to use for small stream flooding after the event was no longer a short-term flash flood event. Small stream flood statements were sent out under various product headers and AFOS keys from different offices because of this confusion. Guidelines need to be developed for how to handle long-term small stream flood events.

Recommendation: Develop a product specifically for small stream flooding during a long-term event. Some guidelines for this new product need to be spelled out. An Urban/Small Stream Flood Advisory does not fill this function and flash flood products are for short fused events.

19. **Finding:** Several customers surveyed indicated that they did not use NOAA Weather Radio (NWR) during the event because the length of the broadcasts was much too long and they had to listen through a lot of unrelated material to get warning information and/or the particular weather information they needed. Also, there were frequent warning alarms for events not affecting their county or area.

Recommendation: Some NWR stations are providing information for many different interests (e.g. marine, public, mountain). As a result, the cycle time is very long. A separate NWR frequency for marine information would reduce the cycle time on these stations and focus warning alarm activation to the area of interest. Also, offices programming NWR need to ensure warning alarm activation is used only for the NWR station's listening area.

20. **Finding:** Several customers surveyed indicated that they don't normally use NWR or were unaware of NWR.

Recommendation: The NWSFO and NWSOs need to enhance NWR awareness. Individual NWR station pamphlets should be prepared and distributed. Dennis Cain of NWSO Hanford has a template format being used in Washington state that can be used in California.

21. **Finding:** Dissemination of weather messages in California is complex. Despite all the different dissemination systems in the state, not one system currently reaches all users in a timely manner.

Recommendation: The best overall system would combine OASIS (when completed), NAWAS, and NWR. OASIS offers reliable satellite-based communication, even when other land-based systems may fail. However, OASIS is a menu-driven system and not an event driven system. Hence, a user alert mechanism is required before OASIS can be effectively used. The blend of NAWAS and NWR would provide an initial alert capability.

After OASIS is in place, NAWAS and or NWR, can alert the target user to the weather message available on OASIS. From there, the user could maintain their "weather watch" on OASIS, with NAWAS and/or NWR as a supplement.

Ideally, the OASIS system should have a user alert capability, signalling users that an important message is on the system and should immediately be interrogated.

22. **Finding:** Terminology in forecast bulletins seems to have caused some uncertainty with respect to the "rise to" statement with the storm still in progress.

Recommendation: The CNRFC needs to take steps to clarify "rise to" forecasts when rises are expected to continue.

23. **Finding:** The RFC had some problems meeting scheduled release times for forecasts during the early part of the event. Adjustments were

made to prevent this during the latter part of the storm period.

24. **Finding:** Problems were experienced with USGS gaging station malfunctions in the system and loss of telemetry from the Russian and Napa Rivers for an 18 hour period due to an earthquake knocking out the Mt. St. Helena repeater. Data sent via FAX from Sonoma and Napa Counties helped throughout this period. The California DWR took emergency action and obtained funding for replacements for the telemetry system and has also redesigned the system to eliminate any single point of failure.

25. **Finding:** The CNRFC Service Hydrologist is the Central Valley HSA program manager and is responsible for training NWSO Sacramento, as well as other NWSOs within the HSA, in their flash flood and small stream watch and warning programs. However, during a potential or actual flood event, operational responsibilities for the Watch Warning program are a station function not a service hydrologist function. That is, all operational staff must be capable of handling the event. During this event, the NWSO staff felt they were without advice for flash flood, small stream and urban flooding since the Service Hydrologist was located in the CNRFC (Flood Center).

Recommendation: The Service Hydrologist must work with both the CNRFC and NWSO Sacramento to ensure an effective hydrologic program for both mainstream river flooding and flooding on the smaller tributaries. This includes making sure that the staffs of all offices with hydrologic responsibilities in the HSA are fully trained and have sufficient resources (E-19s, hydrologic tables, etc.) to fulfill their operational responsibilities. In addition, a copy of the Hydrologic Services Manual should be available in the NWSOs.

Establishment and training of a hydrologic focal point at the NWSOs would provide additional hydrologic support for the office. Also, office managers should ensure that hydrology is a "station" function and that all staff members are aware of their

responsibilities and have been adequately trained.

26. **Finding:** The Hydromet software, ALERT computer, and data from the ALERT system were among the most valuable resources during the flood event. The NWSFO service hydrologist consistently monitored the system during the event and used the capabilities of the HYDROMET software to graph various river stages that provided the critical information to issue timely watches and warnings. Although, no data was lost during the event, the ALERT Computer (386) was maxed out. Also, ALERT data could not be received from some areas.

Recommendation: The Alert computer should be upgraded and a back-up system should be provided to ensure the availability of this critical information. In addition, additional repeaters should be installed to provide availability of all data. (All items have been ordered by WRH.)

27. **Finding:** There were several equipment outages during the event. Of particular concern was loss of power to MT. Umunhum which affected the RDA site on MCQueen Ridge and NWR transmitter on Tomita Hill.

Recommendation: Remote reboot capability for the WSR-88D would save critical time (several hours) when restoring service after an outage.

28. **Finding:** The director of the CPCS-1 (EBS) radio station, KCBS-AM, indicated that when products were issued requesting EBS activation, the NWSFO did not call KCBS as required.

Recommendation: Offices issuing products requesting EBS activation must inform the CPCS-1 station as required in the instructions in the NWSFO's "EBS Book".

29. **Finding:** Several news media representations commented that there were too many NWS products (watches, warnings, statements, etc.) for them to compile a synopsis of events and present then within a limited air-time.

Recommendation: NWS Offices should issue periodic summaries of watches/warnings and advisories in effect to meet needs of the media.

30. **Finding:** Precipitation totals in the State temperature and precipitation summary (STP) products were doubled or tripled a few times. Although corrections were issued, they were after the media aired the erroneous values.

Recommendation: Offices need to ensure that products contain correct information before dissemination.

In addition to these findings and recommendations identified by the survey team, several suggestions made by various users are listed in Part V, User Response.

PART I

DESCRIPTION AND IMPACT OF THE FLOOD EVENT

HYDROMETEOROLOGICAL DISCUSSION

1. Antecedent Conditions

The first three months of water year 1995 began with a generally wet trend in Northern California. October 1994 received 70 to 90 percent of average precipitation and November received greater that 130 percent of average precipitation. This above normal precipitation began to bring the soils antecedent moisture conditions to moist levels. December was not as wet as November; precipitation amounts were around 70 to 90 percent of average. These three months, and especially November, caused the soils in Northern California to be in a moist state by January 1st. Preceding the flood event which began around January 6th, there were 17 consecutive days of precipitation. Soils had reached a saturated state and conditions were ideal for mud slides, debris flows and instantaneous runoff.

2. Description of Meteorological Features

The large scale pattern from January 3-12, 1995, consisted of a progressive broad long wave trough in the eastern and central Pacific (see the MRF 500 mb height analyses in Figure 1). This trough in combination with an upper latitude blocking ridge in the Gulf of Alaska developed a warm type conveyor belt of tropical moisture into California. Likewise a series of short waves moving through this long wave trough position continued to batter the state through this period. Precipitation amounts from orographic forcing alone would have been substantial, but combined with strong dynamical forcing produced record rainfall rates at many locations.

From January 12-15, 1995, the large scale pattern was undergoing some adjustments as the broad long wave trough consolidated into a smaller trough at 130W (Figure 1). This change broke the tropical moisture connection, but still provided one last precipitation episode in California Friday night and Saturday (13th

and 14th). The daily details throughout this storm period are described below.

Tuesday,January 3: The first short wave undercut the Gulf of Alaska Ridge and began to affect California by providing widespread rain over the state. This first system saturated most of the river basins while not causing extensive flooding (Figure 2a and b). A 55 kt jet at 500 mb entered Southern California providing upper level support and moisture for this storm. Downtown Santa Barbara recorded 0.98 inches of rain in 30 minutes during the morning. Winds in the East Santa Barbara Channel were sustained at 40 mph over several hours.

Wednesday, January 4: Another system quickly approached the CA coast with the primary track over Southern CA. This storm was noticeably stronger than the one on Tuesday with larger vertical motion fields and a stronger upper level jet (Figure 2b and c). Due to these differences, winds were substantially stronger with gusts of 52 mph at San Diego, 77 mph at Sudden Peak, and 90 mph at the Wheeler Ridge Pumping Station in the south end of the San Joaquin Valley. Precipitation amounts were also substantially greater than the previous day: Palos Verdes Peninsula 5.75", Gibraltar Dam 3.39", Santa Barbara 2.40" and Santa Maria 1.94". South coast sites generally reported between 2 to 4 inches. The maximum precipitation in the northern end of the state was 1.29 inches in west Fresno County and over 5.00" in Monterey County. Further north in the state, precipitation was light.

Thursday, January 5: Transition period as the Gulf of Alaska ridge began to retrograde from 130 W to 150 W. Winds continue to be in the 25 to 50 mph range with surfs 8-10 feet. Precipitation was light across the state.

Friday, January 6: A series of systems were lined up across the Pacific. The strong upper level jet shifted northward toward the San Francisco Bay Area. Warm air advection-induced precipitation and precipitation bands occurred over the northern portions of the state. Rainfall accumulations were light during the day with heavier amounts towards evening as

impulses moved rapidly through Central CA producing scattered areas of heavy rain and winds up to 60 mph in valley locations.

Figure 3 illustrates the significant weather forecast near the San Francisco Bay Area for the next 48 hours beginning the morning of January 6. Notice the strong vertical motion field (Omega), the complete saturation of the atmosphere (RH field) late Friday night, and the veering of winds with height indicative of the moist warm air advection.

Saturday,January 7: Strong moist flow was still entering CA with the 500 mb jet axis entering the state over San Luis Obispo. Morning showers lingered in the Northern CA mountains as a weakening frontal boundary moved into Southern CA through mid-day. Winds subsided in the north, although they remained gusty near convection in the south. Stations in Santa Barbara County reported precipitation amounts of 1-2 inches by morning.

Another storm rushed from the Pacific towards Northern CA by evening. The majority of the energy from this system struck Northern CA on Sunday. Winds again jumped up to 55 mph before midnight. Previous rains in Northern CA have now saturated the ground.

Sunday,January 8: Figure 4 emphasizes the amount of tropical moisture entering the state in the early morning hours. Heaviest precipitation started in the coastal range near the Russian River and the Napa Valley. Coastal range rainfall rates were up to 3.0" in a 6 hour period during the morning. By afternoon this system moved into the North Bay Area with similar rainfall rates of 2-3" in 6 hours. Later in the evening gale force winds occurred near the Golden Gate Bridge along with swells of 14 to 20 feet. The major precipitation areas in the evening moved to Mount Shasta and Siskiyou County. Twenty four hour rainfall rates ranged from 3 to 6 inches. All of this precipitation resulted in runoff, since soils were saturated from previous rains.

Monday,January 9: Figure 5 depicts the atmospheric vertical motion and speed for the

moist air mass over California. The winds were close to 100 knots at 500 mb, which caused 40 to 70 mph surface winds throughout the day in the valleys and mountain winds close to 110 mph. Intense one inch per hour rainfall rates were observed in much of Northern and Central California. Two exceptional rainfall rates, resulting from convective bands embedded in the widespread precipitation, were: downtown Colusa with 2" of rain in 30 minutes and Sacramento 1.29" in 30 minutes. Satellite imagery from Monday afternoon (figure 6) depicted the massive amount of low level moisture moving into the state. Notice the blocking of this moisture by the Sierra Nevada and Cascade mountain ranges.

As Figure 6 shows, moisture did move into Southern California, although precipitation rates were not as dramatic as those observed up north. Rainfall rates were less since the dynamics (vertical motion) associated with this phase of the storm were weaker over Southern California. Rainfall measurements before midnight were generally less than 0.5 inches.

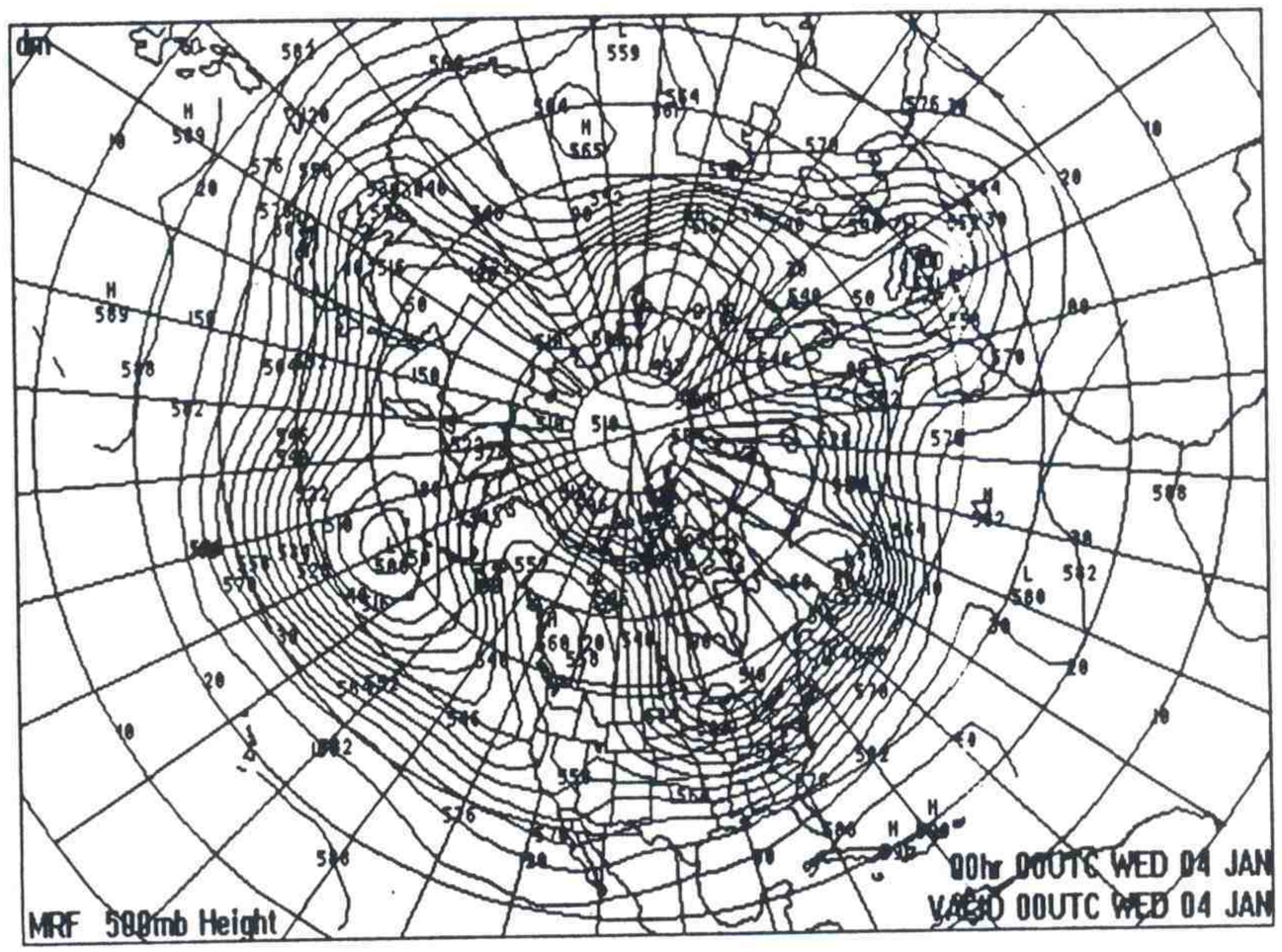
Tuesday,January 10: The system which affected the state on Monday continued to move slowly eastward and south. As this system departed early Wednesday morning, the tropical moisture feed was broken. Significant rainfall rates in the north (1" per hour over 3 hours) occurred on the morning in the western valleys and Sierra Foothills. Severe thunderstorms, with possible tornadic activity, were observed in the Sacramento and San Joaquin Valleys during the afternoon, which illustrated the instability of the atmosphere in the north.

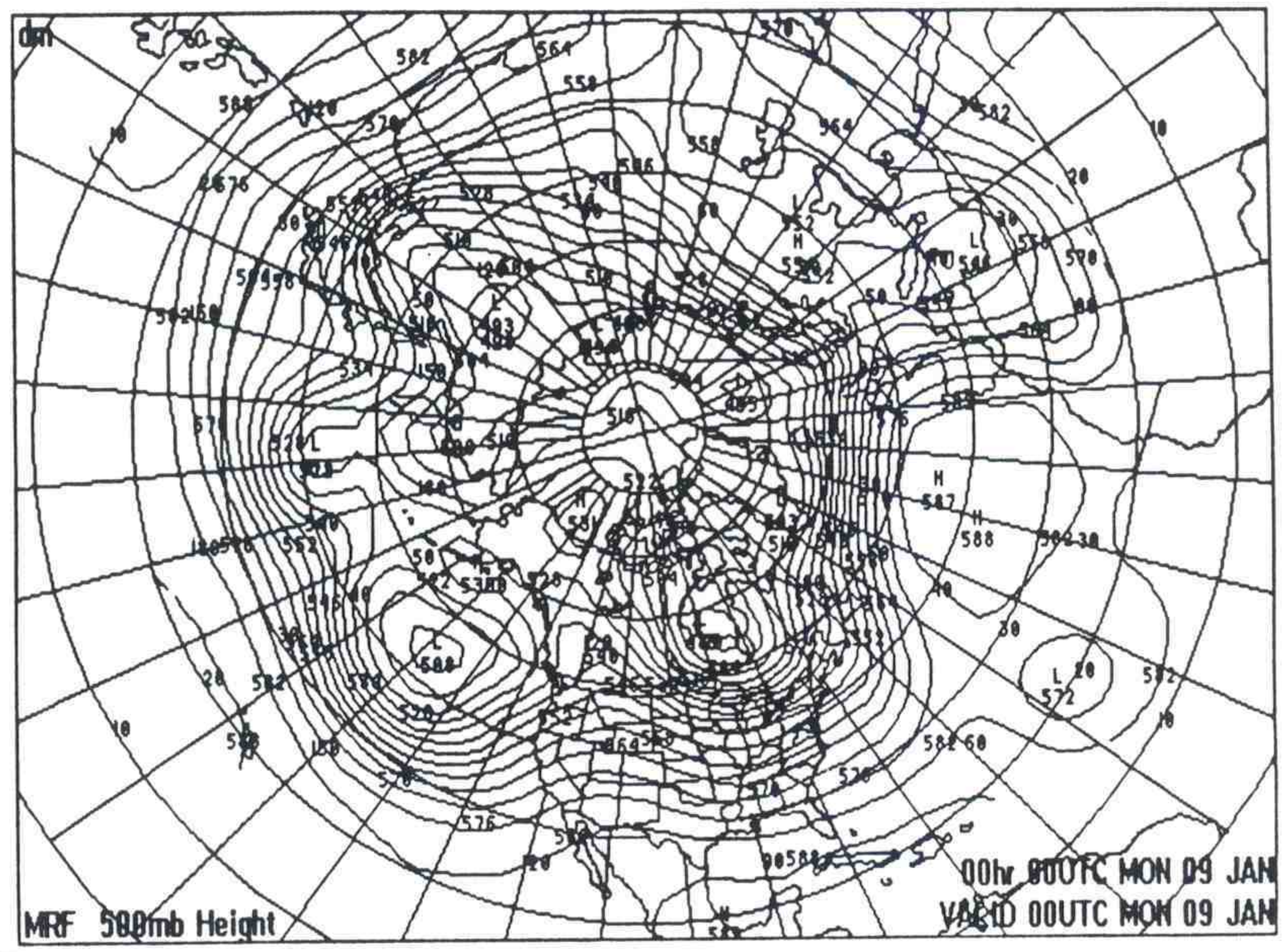
The tropical moisture and greatest vertical motion fields shifted to the south as heavy precipitation amounts were reported in Santa Barbara, Orange and Los Angeles Counties. Satellite imagery (Figure 7) depicts the last areas of tropical moisture in Southern CA before the storm leaves the state.

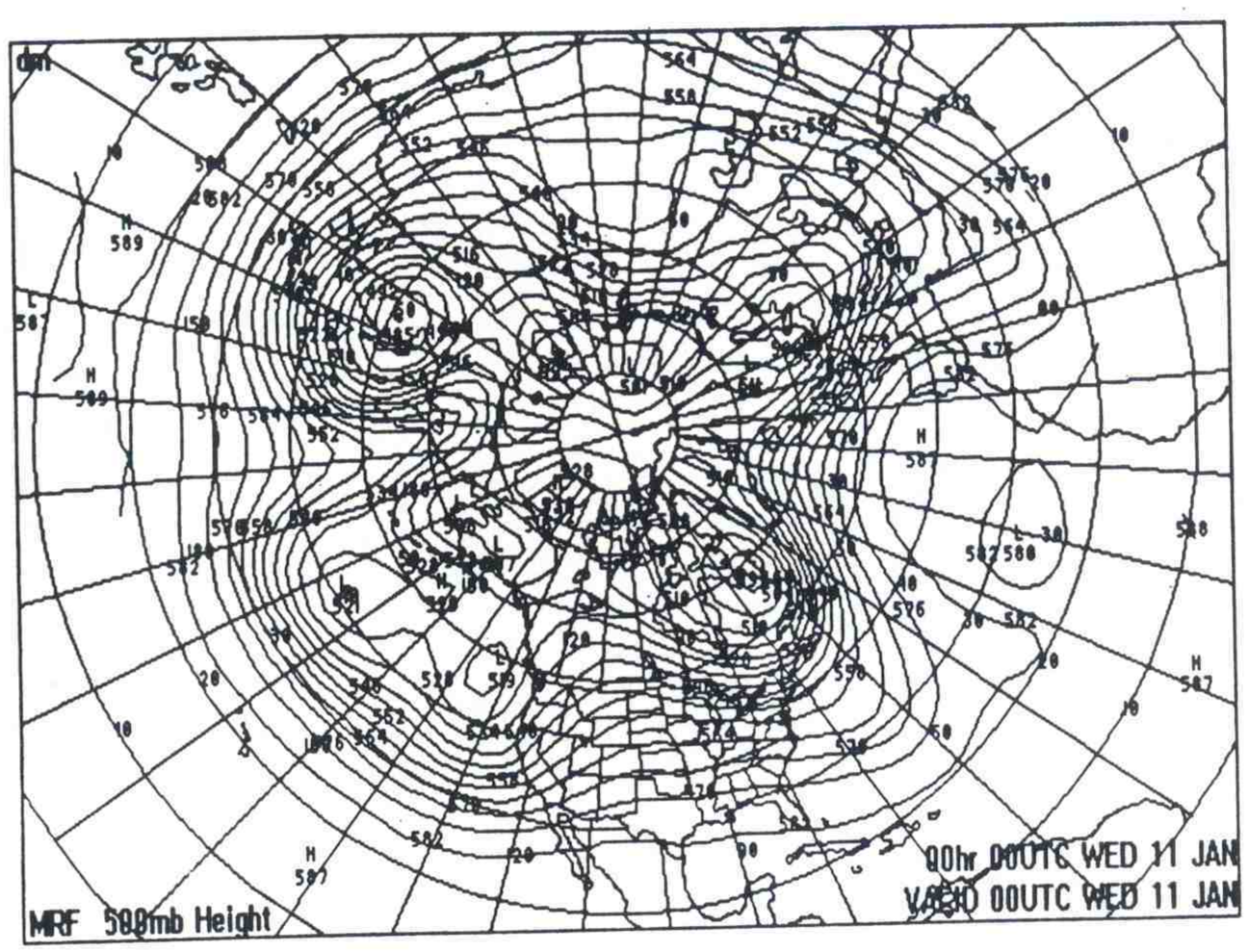
January 11-15: Although showers lingered in Southern CA early Wednesday, the tropical moisture connection was broken. A ridge built over the state late Wednesday and Thursday and

provided pleasant weather. A "normal" storm system moved into the state Friday afternoon (1/13) and Saturday (1/14) and provided some warm air advection precipitation. Amounts were relatively light, in comparison to the previous week, with maximum amounts near 2 inches in a 24 hour period.

In summary, these storms provided the heaviest precipitation in Southern California on Wednesday January 4, and in the northern portion of the state on Monday January 9.







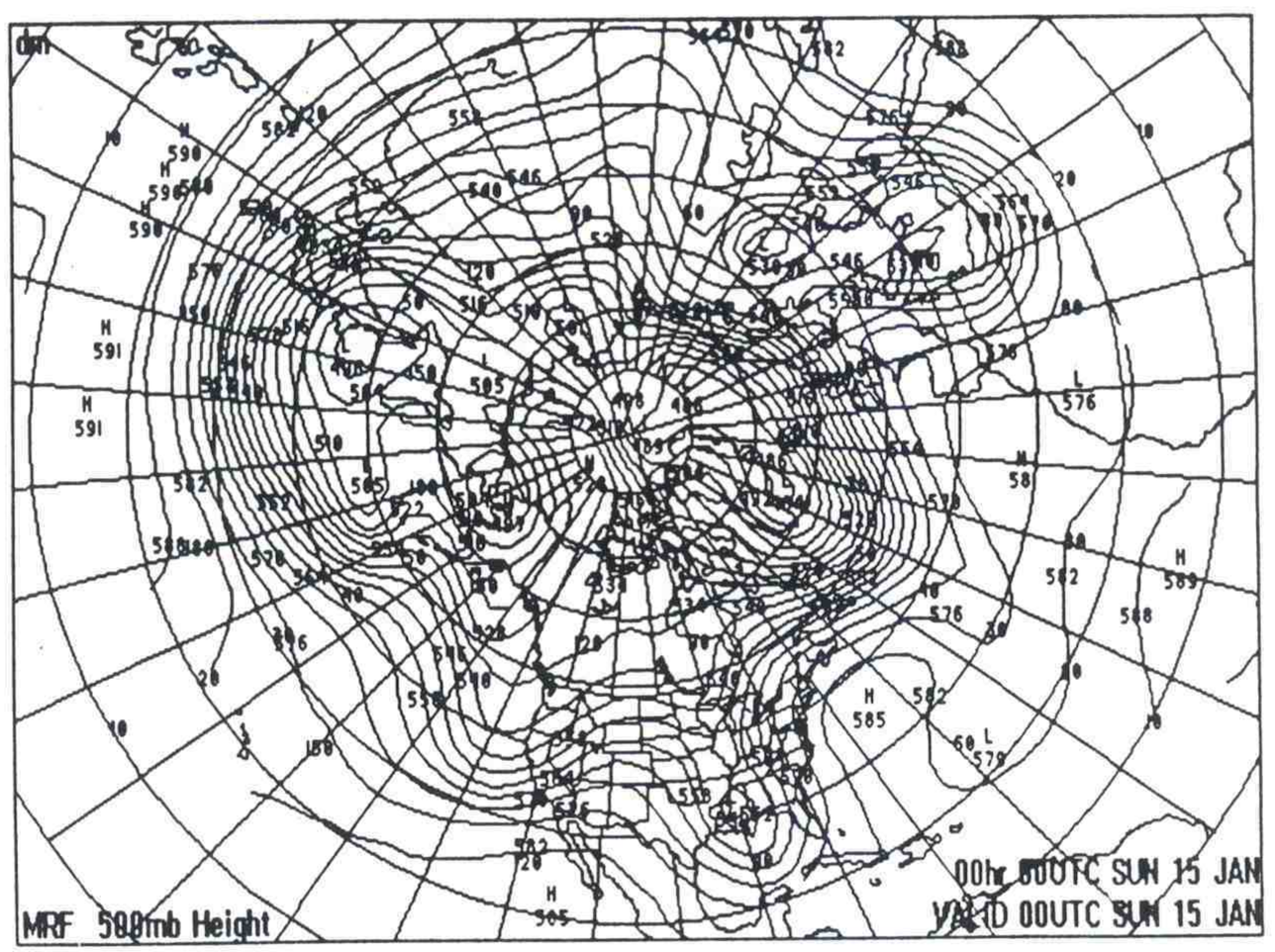
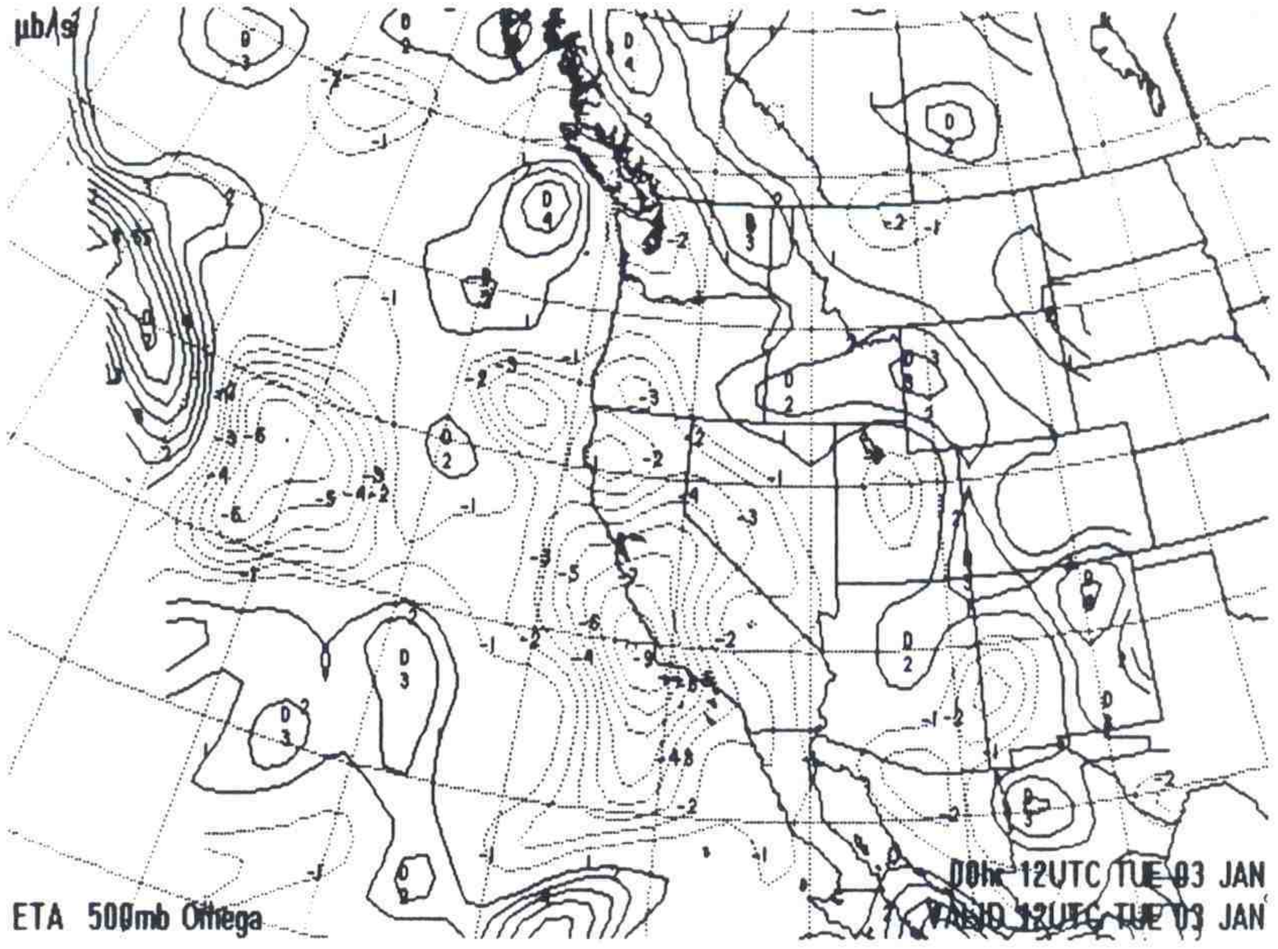
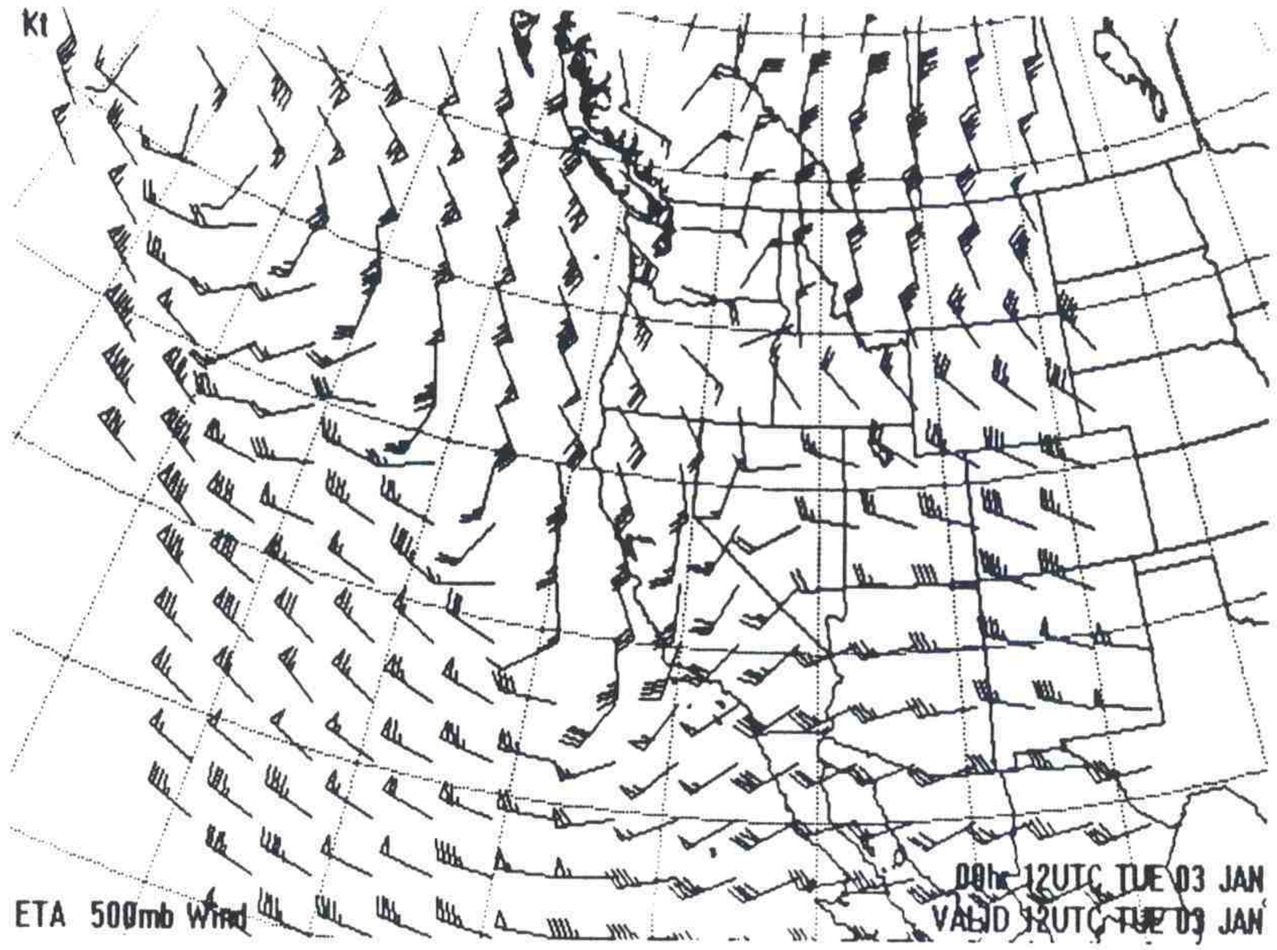


Figure 1 - Northern hemisphere 500 mb height fields at 00 UCT for January 4, 9, 11 and 15, 1995.

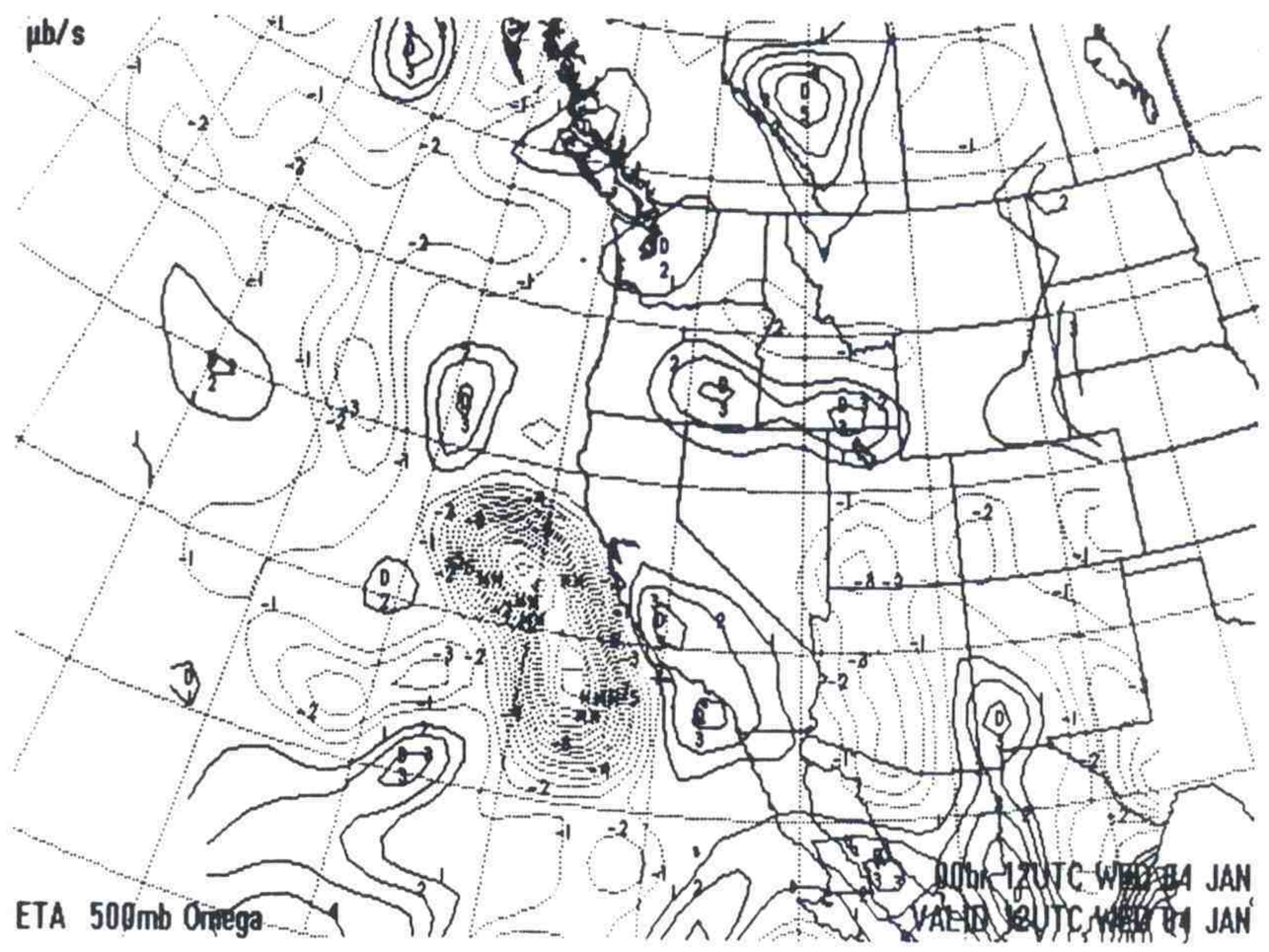
(a)



(b)



(c)



(d)

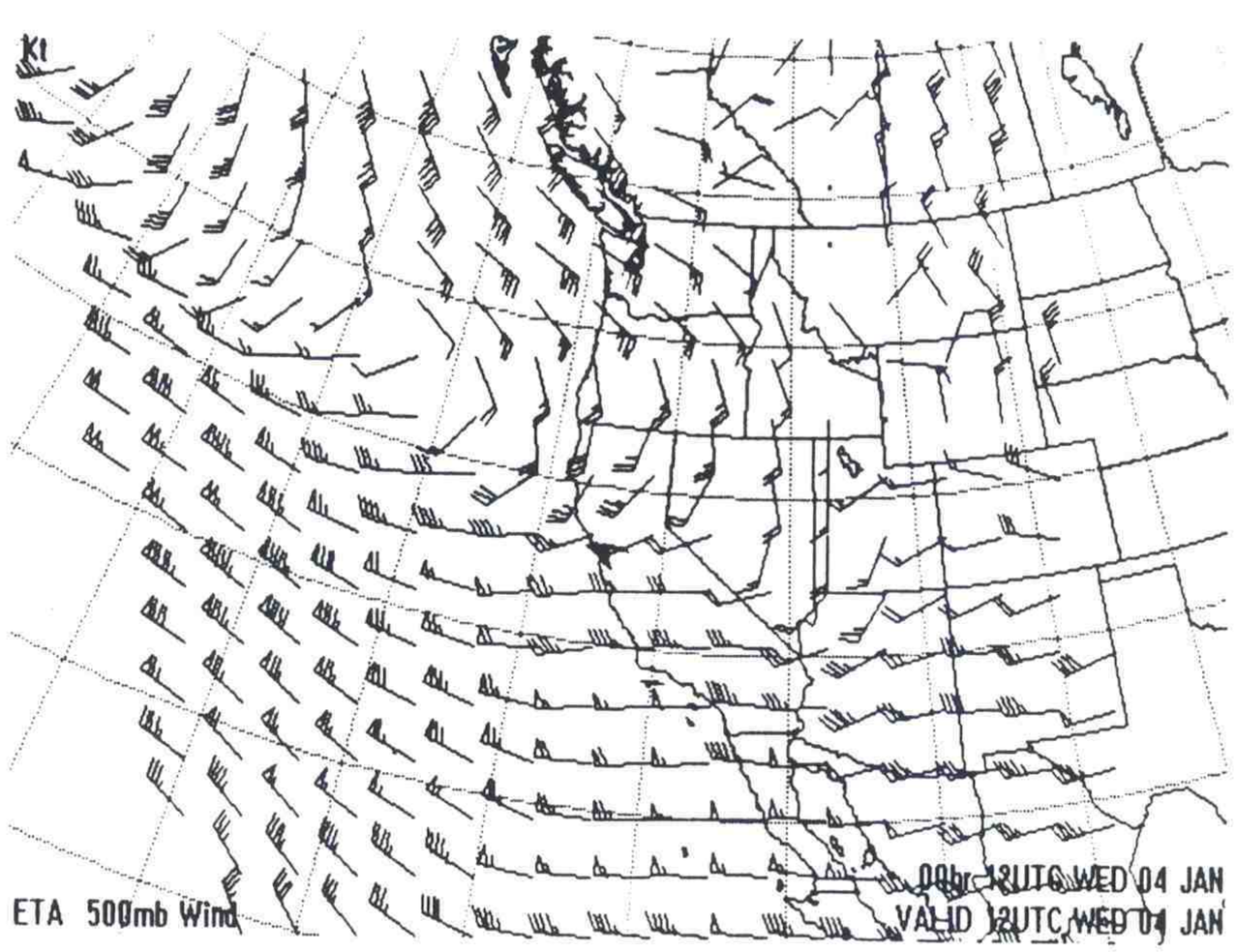
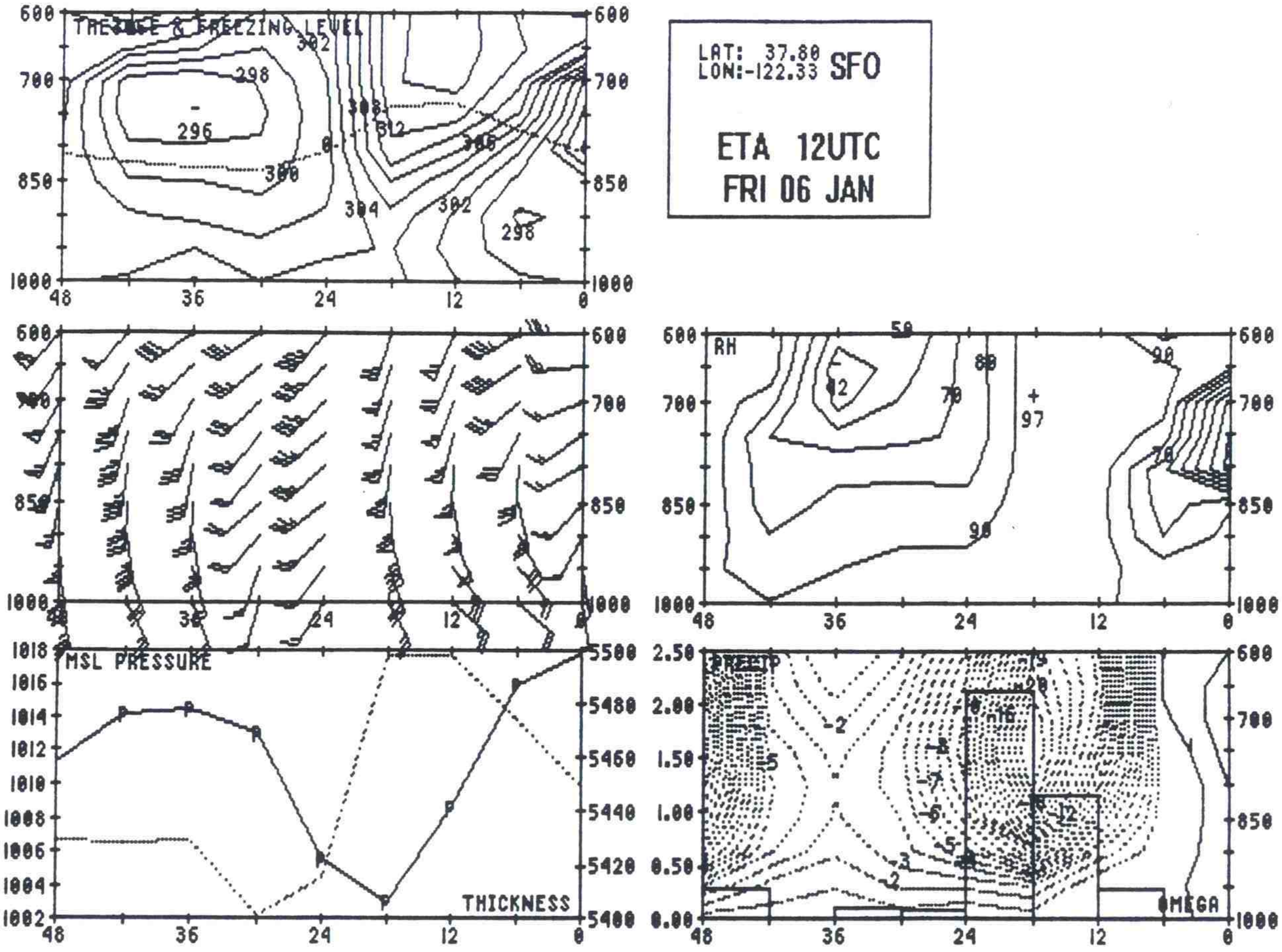


Figure 2 - (a) 500 mb vertical velocity and (b) wind field for 12Z January 3. (c) 500 mb vertical velocity and (d) wind field for 12Z January 4.

(a)

(b)

(c)



(d)

(e)

Figure 3 - Forecast fields from the ETA model run on January 6 at 12Z: (a) theta-e and freezing level, (b) winds, (c) sea-level pressure and thickness, (d) relative humidity, and (e) vertical motion and precipitation.

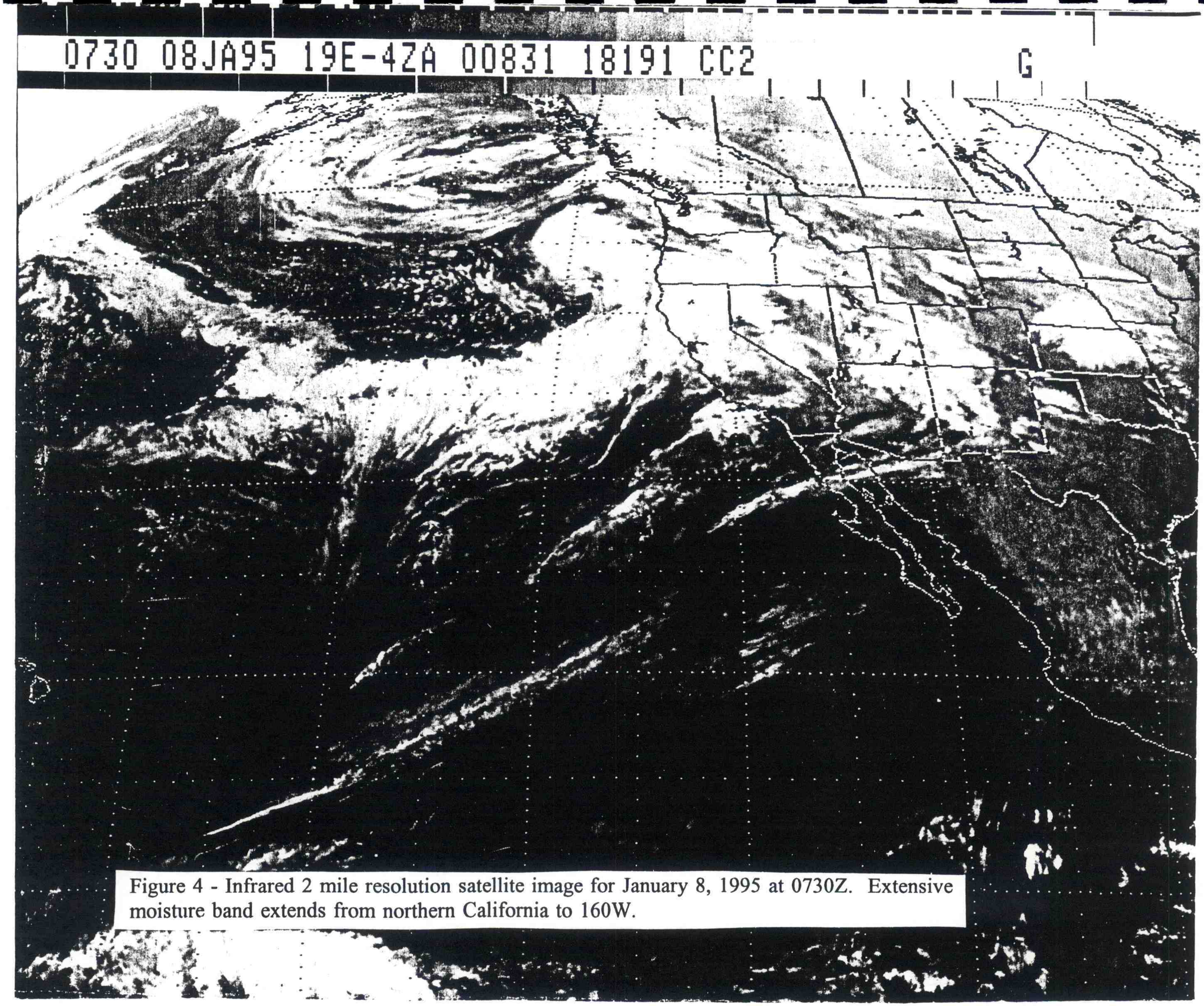


Figure 4 - Infrared 2 mile resolution satellite image for January 8, 1995 at 0730Z. Extensive moisture band extends from northern California to 160W.

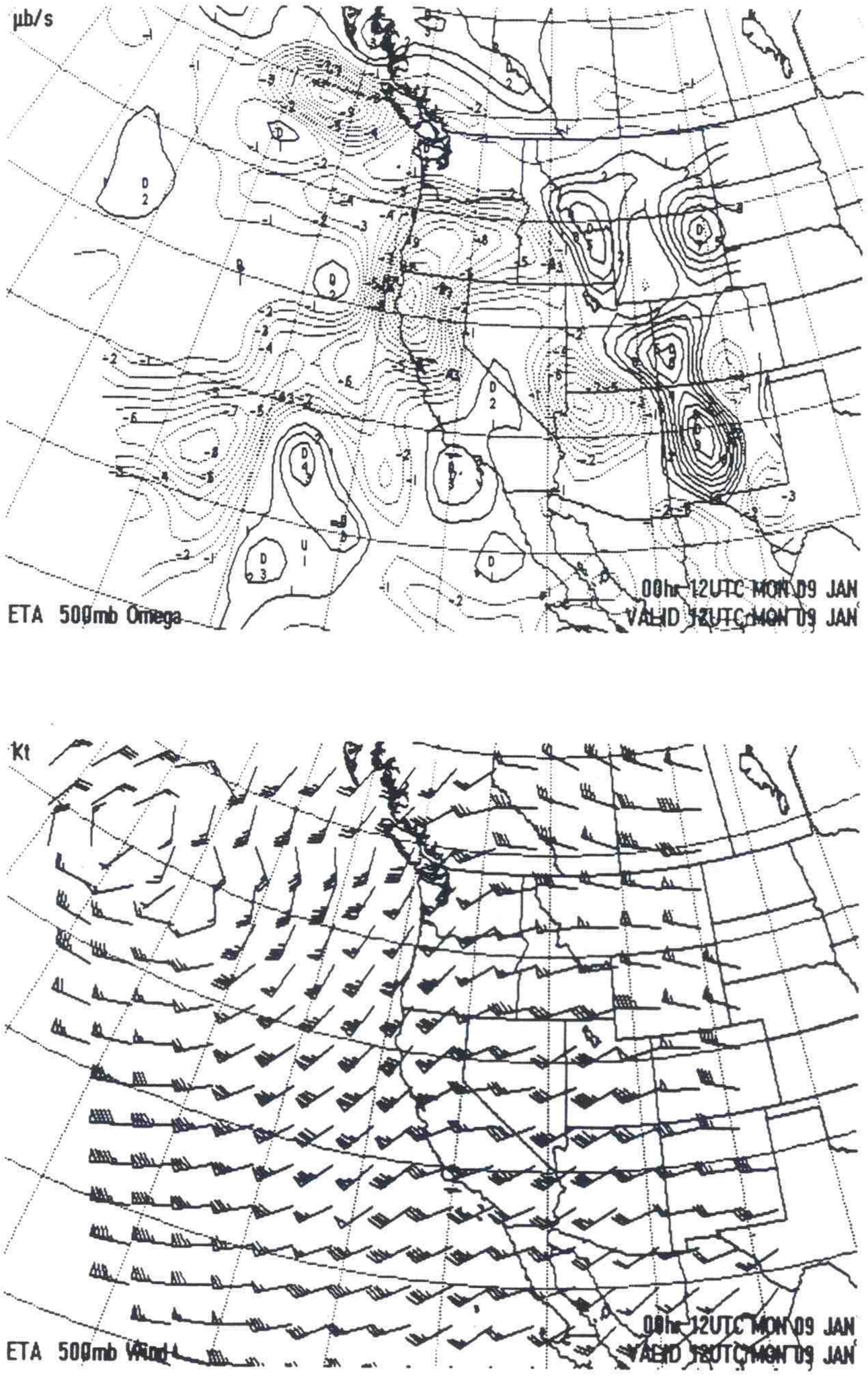


Figure 5 - Vertical motion and wind fields for Monday January 9 at 12Z.

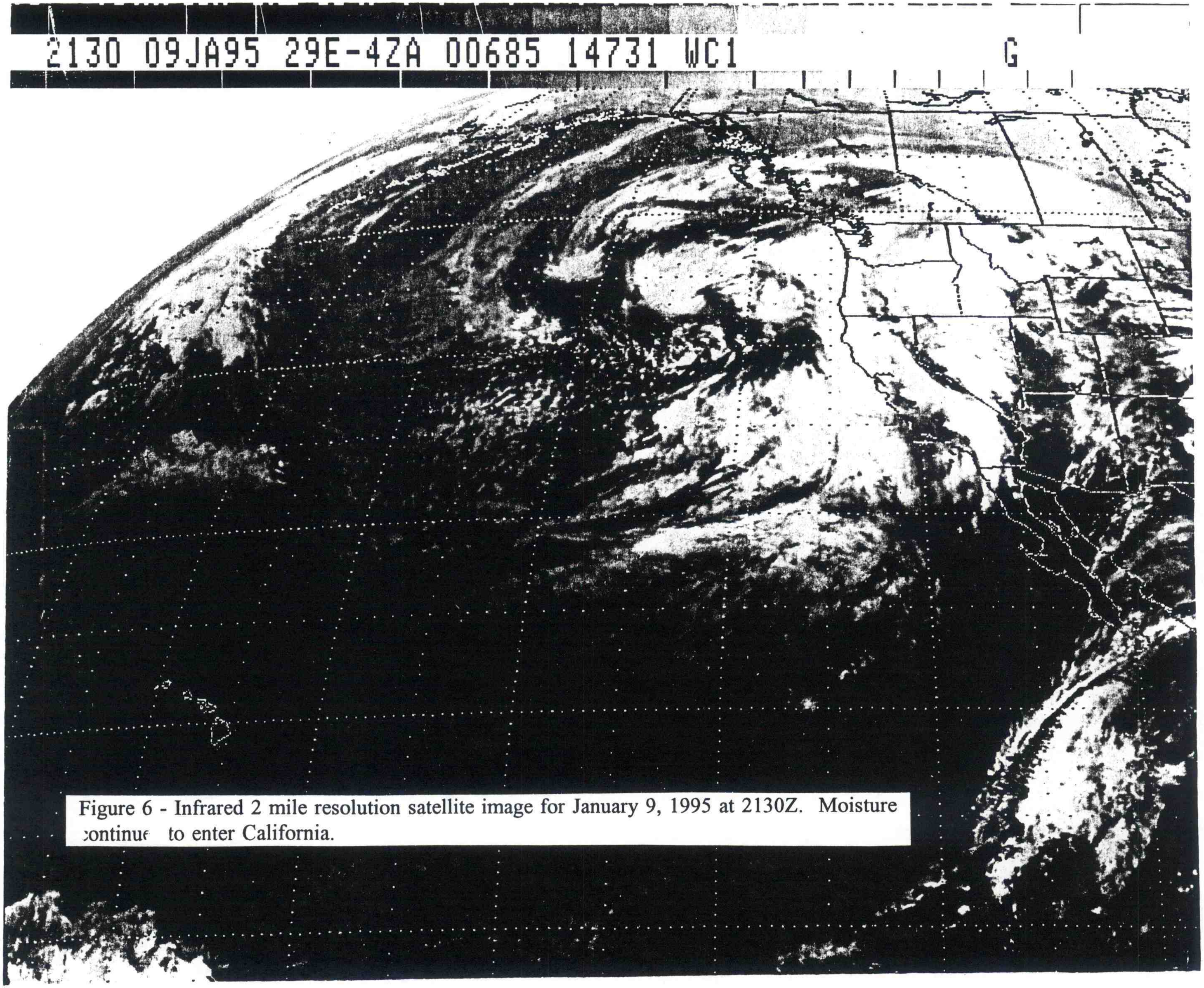


Figure 6 - Infrared 2 mile resolution satellite image for January 9, 1995 at 2130Z. Moisture continue to enter California.

630 10JA95 29E-4ZA 00634 14781 WC1 G

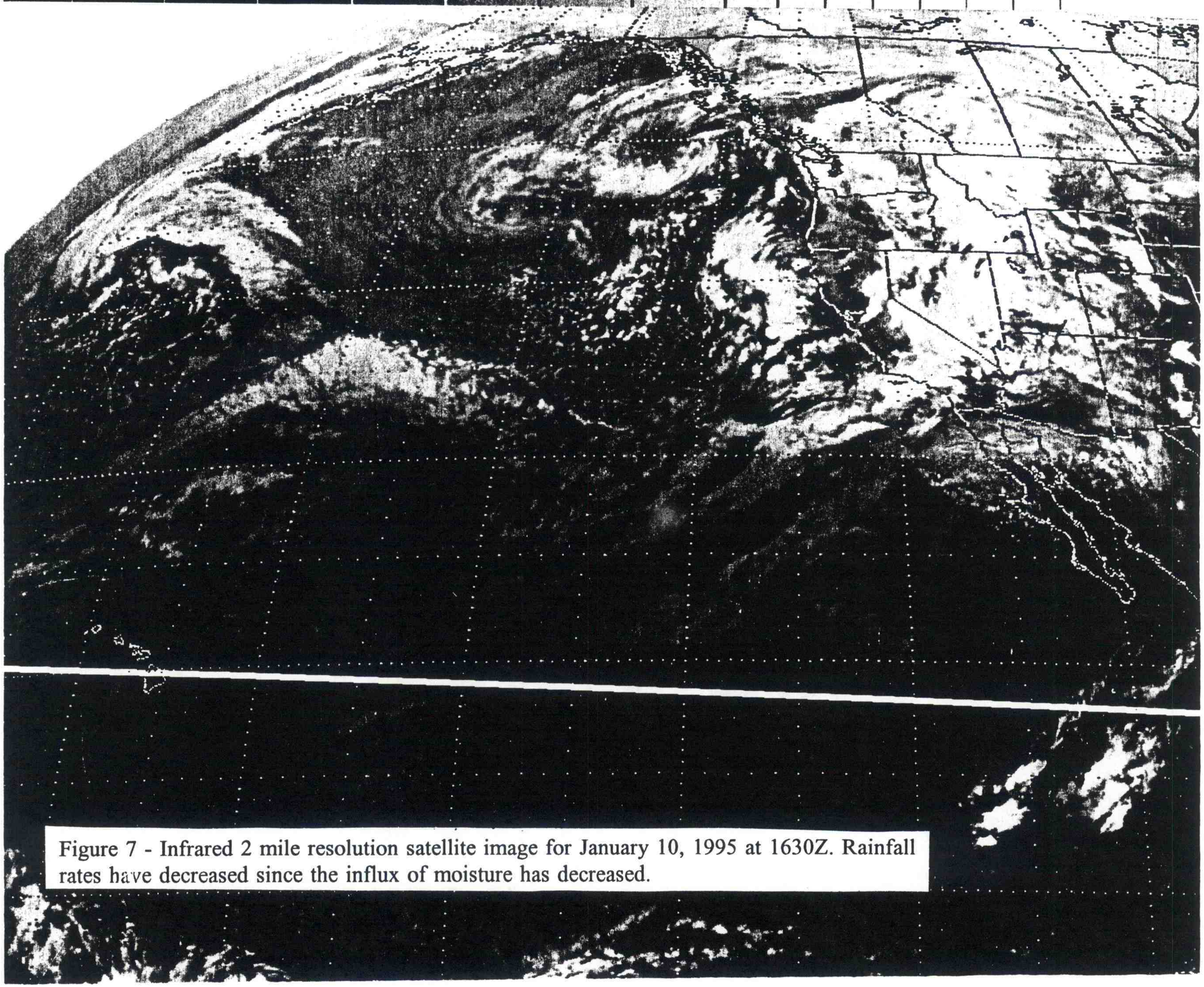


Figure 7 - Infrared 2 mile resolution satellite image for January 10, 1995 at 1630Z. Rainfall rates have decreased since the influx of moisture has decreased.

3. Summary of Northern California Precipitation

The synoptic pattern responsible for producing the heavy rains over most of California during the first 10 days of January was typical of historical flood patterns such as December, 1955; December, 1964; January, 1982; and February, 1986. This pattern is represented by a high latitude blocking ridge that is located over either western Canada or Alaska. The flow over the northern Pacific is usually a low amplitude zonal flow that splits just before reaching the latitude of the block. A portion of the flow moves north over the block and a portion undercuts the block through California. The flood pattern develops when the northern track is strong enough to move over the block and then cut back underneath the block and form a long southwesterly fetch into California. A second scenario is that the southerly flow is strong enough to simply undercut the ridge and develop a continuous westerly storm track from Japan to California. This is what occurred in early January, 1995, in California.

During the latter portion of December the southern storm track was relatively weak. As the new year started, the flow under the block became the dominant storm track with the first major shortwave moving under the block on January 4. This brought widespread heavy rains to most of California and was responsible for saturating most of the river basins after precipitation had already been above normal during the first part of the rainy season. The second in what was to be a long series of storms moved through on Friday January 6. This storm was expected to cause widespread heavy precipitation and last well into the 7th but it moved through the state in about 4 to 6 hours. This indicated the westerlies were well established between 35 and 40 degrees north latitude into California and storms would be strong and frequent. The storm that occurred on Sunday the 8th produced flooding on the Napa and Russian Rivers. Strong veering winds with height was indicative of the warm type conveyor belt which developed ahead of a surface cold front. Several waves moved along the front and slowed the eastward and southern movement of the warm conveyor belt. This

caused heavy rain to remain concentrated near the Russian and Napa Rivers for almost 24 hrs.

Of particular interest is the extremely convective nature and intense rain which occurred on the evening of the 9th and during the day on the 10th over the central part of the state. This precipitation produced destructive flooding in Monterey County, the Sierra Nevada Foothills in Placer County, and in Southern California.

During the early morning hours, convective trains were observed over the Sierra Nevada Foothills. These trains are formed when the wind profile shows very little speed or directional shear and tend to be focused by the terrain. The terrain around Auburn and Roseville, Ca is very conducive to the development of this type of feature as the steep American River Canyon helps to focus the surface convergence necessary to initiate these. Later in the day this same type of feature was observed to develop in Merced County. A break in the precipitation occurred in most of California on the 11th through the 13th except in the Shasta-Trinity Basin and in the Feather River Basins where strong orographic enhancement produced 24 hour rainfalls of 2 to 3 inches per day with few areas receiving 5 to 6 inches in a 24 hour period. This rain produced significant inflows into Shasta and Oroville Reservoirs.

Table 1 shows storm totals for the nine day period ending at 4:00 AM PST on January 11 and for the 72 hour period from January 8-11.

TABLE 1

Precipitation Totals for Northern and Central California from 4 PM on January 3 to 4 PM on January 11.

SAN FRANCISCO BAY AREA	Jan 3-11	Jan 8-11
San Rafael	12.92	7.85
Santa Rosa	9.01	6.34
San Jose	5.14	3.80
Oakland Museum	4.85	2.89
SFO Airport	4.80	2.63
Redwood City	4.50	2.79
Fremont	4.10	2.65
San Francisco Mission Dolores	3.92	2.06
MONTEREY BAY AREA		
Santa Cruz	7.11	3.18
Watsonville	5.30 (JAN 4-11)	2.90
Monterey	4.48	2.69
Hollister	4.37	2.03
Salinas	3.19	1.38
CENTRAL COAST MOUNTAINS		
Three Peaks (Monterey Co)		14.84
Venado (Sonoma Co., Russian River Drainage)		12.48
Mining Ridge (Monterey Co.)		12.32
Mt. Umunhum (Santa Clara Co.)		11.46
Ventana Cone (Monterey Co.)		10.71
Angwin (Napa Co., Napa River Drainage)		10.48
NORTHWEST CALIFORNIA		
Whispering Pines		11.45
Dr. Fine Bridge		8.12
Leggett		7.92
Ft. Seward		7.76
Crescent City	7.99	7.16
Ft. Bragg	7.79	5.17
Eureka	4.62	3.42

MT. SHASTA/SISKIYOU REGION

12 MI North of Lakehead (Unofficial Spotter)	33.05	(Jan 7-11)
LakeShore		15.36
Slate Creek		14.29
Shasta Dam		14.26
Mt. Shasta City	15.96	13.03

NORTHERN SIERRA NEVADA

Humbug Summit		17.36
Rattlesnake		15.64
Strawberry		14.28
Four Trees		13.44
Blue Canyon	14.72	9.70

SACRAMENTO VALLEY

Redding Fire Station		9.02
Roseville WTP		8.90
Redding Airport	10.62	7.08
Auburn Dam Ridge		7.36
Rancho Cordova		6.62
Oroville		6.36
Red Bluff	9.27	5.91
Sacramento Downtown	8.34	5.67

SAN JOAQUIN VALLEY

Fresno	2.68	0.94
Lemoore NAS	2.49	1.14
Bakersfield	1.40	0.40

4. Description of Damages

There were no final dollar estimates at the time of publication for total damages from the flooding. In addition, to flooding, many mudslides were reported in Marin, Sonoma, Alameda, San Mateo, Santa Cruz and Santa Clara Counties. Some of these slides caused extensive property damage. Preliminary estimates for the entire state of California for severe winter storms (excessive precipitation and flooding), mud and rock slides, and high winds place damage estimates at $1.337 Billion. An estimated 370 homes were totally destroyed and another 1887 received major damage while 4179 received minor damage. Tables 2 and 3 provide preliminary damage information for Northern California counties.

Numerous residents were evacuated along the small rivers in the Bay Area counties during the night of January 9. Large evacuations occurred along the Russian and Napa Rivers. The American Red Cross reported 3696 persons were sheltered statewide at 80 locations. According to the Red Cross, their shelter figures represent approximately 10 percent of the total number of evacuees for a related disaster.

Two deaths occurred in Sonoma County that were considered flood related as follows:

1. Randy B. Moore, Male, 39, died 1/10/95 at 7:47 AM in Sonoma County near Santa Rosa, CA. Circumstances: The truck he was driving was crushed by a tree that was unstable due to heavy rain and blown over by wind onto the cab as he drove by.

2. Ronald Highby, Male, 83, found 1/11/95 at 9:30 AM. Time of death could have been any time between 1/8/95 and the time he was found near Sebastapol in Sonoma County, CA. Circumstances: Apparently his vehicle was stranded by road flooding. It is believed that he tried to wade out of the water and had cardiac failure.

Table 2
Bay Area Storm Damage

BAY AREA STORM DAMAGE

California's damage tally is expected to continue climbing because many of the hardest-hit counties have yet to figure out the total costs of the storm. Also, storms forecast to hit the state this weekend could further increase the toll.

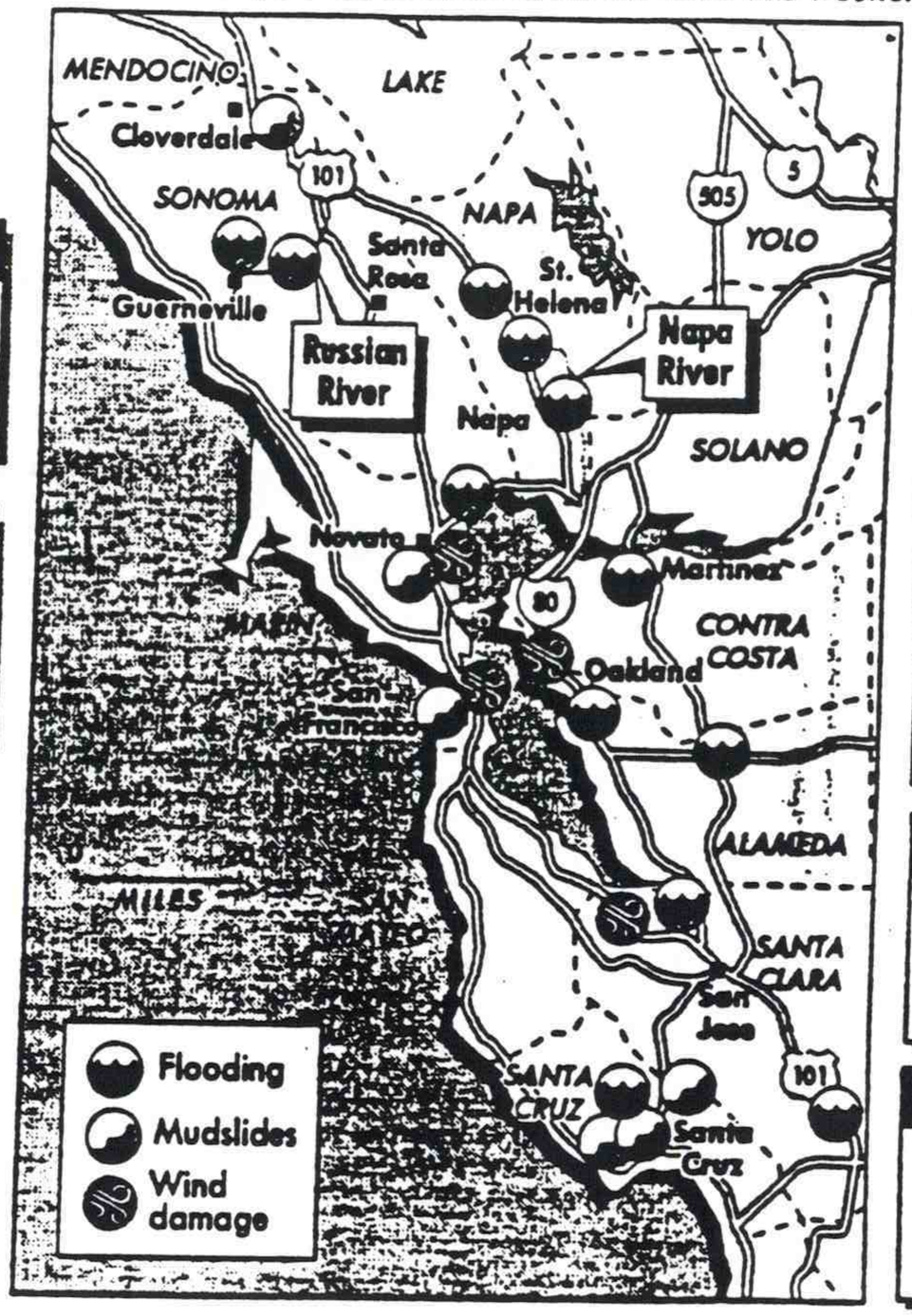
No deaths were recorded in San Francisco and Solano counties.

Bay Area:
- More than 5,000 customers in the Bay Area are still without power.

Sonoma County:
- Deaths: 2
- Property damage: $21,000,000

Marin County:
- Deaths: None
- Property damage: No estimates yet

San Mateo County:
- Deaths: None
- Property damage: $3,100,000



Napa County:
- Deaths: None
- Property damage: $5,100,000

Contra Costa County:
- Deaths: None
- Property damage: $4,500,000

Alameda County:
- Deaths: None
- Property damage: $8,000,000

Santa Clara County:
- Deaths: None
- Property damage: $3,000,000

Santa Cruz County:
- Deaths: None
- Property damage: $2,200,000

CHRONICLE GRAPHIC

TABLE 3 - STATEWIDE PROPERTY DAMAGE
BY COUNTY

COUNTY	PRIVATE	PUBLIC	PRELIM. TOTAL
Alameda	$1,591,000	$5,293,700	$6,884,700
Amador	$245,500	$85,300	$330,800
Butte	$4,064,000	$3,243,000	$7,307,000
Colusa	$5,925,000	$1,116,000	$7,041,000
Contra Costa	$2,114,000	$4,115,300	$6,229,300
Del Norte	$69,000	$2,337,400	$2,406,400
Glenn	$49,000	$1,018,000	$1,067,000
Humboldt	$24,600	$4,232,100	$4,256,700
Kern	$12,500	$1,887,000	$1,899,500
Lake	$523,900	$6,008,200	$6,532,100
Lassen	$314,000	$3,400,000	$3,714,000
Los Angeles	$19,075,400	$40,390,000	$59,465,400
Madera	$167,000		$167,000
Marin	$188,000	$4,100,900	$4,288,900
Mendocino	$263,000	$3,153,800	$3,416,800
Modoc		$7,613,700	$7,613,700
Monterey	$8,649,960	$770,000	$9,419,960
Napa	$460,000	$5,739,500	$6,199,500
Nevada	$276,000	$567,400	$843,400
Orange	$14,089,000	$42,020,000	$56,109,000
Placer	$75,590,200	$11,143,300	$86,733,500
Plumas	$303,000	$283,500	$586,500
Riverside	$268,972	$7,992,000	$8,260,972
Sacramento	$10,974,200	$7,482,700	$18,456,900
San Bernardino	$557,000	$4,343,000	$4,900,000
San Diego	$3,676,500	$3,094,000	$6,770,500
San Louis Obispo	$2,213,200	$794,000	$3,007,200
San Mateo	$55,000	$1,119,500	$1,174,500
Santa Barbara	$17,000,513	$57,308,000	$74,308,513
Santa Clara,	$180,000	$3,920,500	$4,100,500
Santa Cruz	$720,200	$4,197,800	$4,918,000
Shasta	$37,000	$5,270,700	$5,307,700
Sonoma	$32,075,000	$8,616,100	$40,691,100
Sutter	$162,000	$10,881,500	$11,043,500
Ventura	$2,050,200	$17,585,000	$19,635,200
Tehema	$390,000	$2,759,000	$3,149,000
Trinity		$954,500	$954,500
Yolo	$200,000	$6,561,400	$6,761,400
Yuba	$320,000	$2,903,000	$3,223,000
TOTAL	**$204,873,845**	**$221,174,800**	**$426,048,645**

These numbers are based on preliminary damage assessments of property inspected. A few caveats to remember: Federal property is not included, structures (such as many highways and levees) which receive aid from Federal agencies other than FEMA are excluded, and many owners of property which was fully insured against the hazards involved would not have registered with FEMA.

Part II

Summary of Warning and Forecast Services

Introduction: This is a summary of warning services provided by the National Meteorological Center (NMC) and the Northern California NWS offices during a period of widespread flooding in January 1995. These offices include the San Francisco Bay Area NEXRAD Weather Service Forecast Office (NWSFO) Monterey, the California-Nevada River Forecast Center (CNRFC), NEXRAD Weather Service Office (NWSO) Sacramento, NEXRAD Weather Service Office (NWSO) Eureka, and Weather Service Office (WSO) Redding. Warning actions by NWS personnel in these offices are reviewed along with the response taken by principal disseminators and users of the information; the media (television, radio, and newspaper) and emergency managers. Recommendations on how or where services may be improved are included.

Briefly, the NWS offices involved provided a high level of beneficial service to Northern California during this flood event. Bay Area NWSFO forecasters issued statements several days before the rain started that forewarned of heavy precipitation, mountain snows, high winds, and probable low elevation flooding. Forecast coordination between Bay Area NWSFO, other Northern California WSOs and the CNRFC took place regularly and frequently. NMC, Heavy Precipitation Branch, produced short term quantitative precipitation forecast estimates derived from satellite imagery analysis. Dissemination of warnings, forecasts, and statements was thorough and kept citizens, the media, and emergency responders across Northern California well informed. There were a total of 1,100 public warnings, forecasts, and statements issued via NOAA Weather Wire between January 7 and January 15. There were 400-500 telephone calls to the Bay Area Public Service Unit (BAPSU). Each of the Northern California NWS offices provided weather briefings, media interviews, and participated in forecast coordination teleconference calls.

PRINCIPAL PARTICIPATING OFFICES & AGENCIES: A number of federal state, and local groups were involved in helping to prepare forecast guidance products and disseminate those products to the customers during this flood event. A list of the principal participants and their roles are described here.

> **The San Francisco Bay Area NWSFO, located in Monterey, CA.** The NWSFO is responsible for overseeing that the NWS mission is carried out in Northern California. The mission of the NWS is to protect against the loss of life and property from dangerous weather conditions through timely issuance of weather warnings and forecasts. In this capacity, the NWSFO also produces forecast guidance products for other NWS offices within its area of responsibility.

The California-Nevada River Forecast Center (CNRFC). The CNRFC, collocated with NWSO Sacramento, and the California Department of Water Resources is the first echelon office for the development and distribution of necessary river forecasts, flash flood guidance, and water supply forecasts for California and Nevada. The CNRFC is staffed with both hydrologists and meteorologists (Hydrometeorological Analysis and Support (HAS) Forecasters). The CNRFC works jointly with the California Department of Water Resources (DWR) as a joint state federal flood forecast office. The CNRFC has responsibility for the Central Valley hydrologic service area (HSA).

NWSO Sacramento. NWSO Sacramento has county warning and forecast responsibility (including flash flood warnings) for a large portion of Central California. This area of responsibility lies between those of the Bay Area NWSFO and the Reno, NV, NWSFO. Forecast coordination between all three of these offices for their bordering areas of warning responsibility, together with CNRFC guidance, is crucial to providing consistent information to users.

NWSO Eureka. NWSO Eureka has warning and forecast responsibility for four counties in extreme northwest California, including Mendocino County. This area is bordered by the warning areas of responsibility of WSO Redding (to the east), NWSO Sacramento (southeast) and NWSFO Bay Area (south). Construction of the Eureka WSR-88D had just finished it had not been accepted yet. Limited data from the radar was made available to the NWSO by UNISYS as frequently as possible. Although limited, the data benefited NWSO Eureka's ability to positively locate areas of heavy precipitation and high wind.

WSO Redding. WSO Redding has county warning and forecast responsibility for the inland areas of Northern California. Its area of warning responsibility borders on those of the Reno, NV, NWSFO, and the Sacramento and Eureka NWSOs. Unlike all the other offices listed here, WSO Redding does not have direct access to any radar data. Through telemetered data and voice communications, WSO Redding provided ground truth information to the other offices.

National Meteorological Center (NMC). NMC provides weather analysis and forecast guidance for use by National Weather Service forecasters nationwide. Forecast guidance products cover a very broad spectrum of

time, ranging from the very near future (less than 12 hours) to much longer ranges (beyond 10 days). Output from numerical weather prediction models is generated and distributed in graphical, statistical, and text formats. NMC guidance products were key in prompting NWSFO Bay Area (Monterey) forecaster's to issue Special Weather Statements advertising a spell of very wet weather some 48 hours before it occurred. During the period of heaviest precipitation, NWS offices in Northern California relied heavily on NMC guidance for forecasting the onset and duration of precipitation as well as the amount. Specialized NMC guidance, such as mesoscale precipitation estimates, were utilized by NWSFO Bay Area forecasters during the initial stages of this event. Over the course of time, this type of information from NMC was obtained less often, due primarily to forecaster's reliance on data available from WSR-88D's, ASOS, and mesonets which provided precipitation data in real time.

BACKGROUND: The weather pattern over the eastern Pacific ocean and western United states in early January 1995 was recognized by forecasters as one of several patterns that can potentially produce heavy precipitation and floods. The general pattern persisted throughout the week-long rain event. Storm total precipitation in some river drainages in Northern California were in the 30-40 inch range. Several 24 hour rain totals were between 17 inches and 22 inches. Up to ten feet of new snow fell in the Sierra Nevada Range during the week. There were storm related deaths and forty-two counties statewide were eventually declared disaster areas by the President.

CHRONOLOGY OF BAY AREA NWSFO (and CNRFC) WARNING SERVICES JANUARY 4-11,1995: Early recognition of flood potential of the event by the NWSFO occurred by Wednesday, January 4th. Based upon NMC products, NWSFO forecasters issued statements highlighting the potential for heavy precipitation in Northern and Central California by 3:00 AM on Wednesday. A Winter Storm Watch & High Wind Advisory were issued and verified. Flash Flood Watches, Warnings and Urban/Small Stream Flood Advisories were issued January 4 by all Northern California offices calling for heavy rainfall amounts and the potential for rising small streams and rivers. On Friday, January 6, a Winter Storm Watch was issued for the mountainous northeastern one-third of California.

The Winter Storm Watch was upgraded to a warning at 3:30 PM, Friday. A frontal system moved through the area and caused two to three inches of rain in the coastal mountains of Northern California, two to four feet of

snow and blizzard conditions in the Sierra Nevada, and generally saturated the ground. Several statements were issued drawing attention to the heavy rainfall potential over the upcoming weekend. The possibility of mud and debris flows were also discussed.

On Saturday, January 7, 12:15 AM, the NWSFO issued a Small Stream Flood Advisory for local mud and debris flows and ponding water on roadways. At 3:00 AM, January 7, forecasters in Monterey issued an advisory valid during the daytime on Saturday for the Mt. Shasta/Siskyou region in the north and the Sierra Nevada in the east. The same area was put under a Winter Storm Watch for Saturday night. CNRFC issued its first North Bay River Forecast at 7:30 AM on the 7th indicating that all rivers were expected to remain below warning and flood levels. Wind Advisories (forecast 50 to 65 MPH), based on WSR-88D velocity data, were issued at 10:15 PM and 11:30 PM on the 7th for parts of Central California.

During the day on Saturday heavy rain fell over the Russian and Napa River Basins. This prompted a Bay Bulletin to be issued at 2:00 PM by CNRFC. The Russian River at Healdsburg was forecast to rise to the warning stage. On Saturday evening heavy rain had caused rapid rises on the Russian and Napa Rivers. At 9:45 PM a Bay Bulletin was issued calling for the Napa River at St. Helena to go above flood stage and the Russian and lower reaches of the Napa to reach warning stages. A Flood Warning was issued by the NWSFO at 11:15 PM unaltered from the Bay Bulletin format.

In response to the significant rains and the potential for additional rain in the Northern San Francisco Bay Area Counties of Sonoma and Napa on Sunday, January 8 at 3:00 AM, a Small Stream Flood Advisory was issued for the San Francisco Bay Region for possible mud and debris flows on steep terrain. Winter Storm Warnings were issued at 6:15 AM Sunday for the higher elevations of Northern and Eastern California (north of Kings Canyon). High Wind Warnings and Advisories covered the northern half of California as well. CNRFC issued a bulletin at 8:45 AM forecasting major rises in the Napa and Russian Rivers. Rises above Flood Stage were forecast at Healdsburg, Gurneville, and near St. Helena. The NWSFO followed at 10:15 AM with the first mainstream River Flood Warning for the Napa River (Napa County) and the Russian River (Sonoma and Mendocino Counties). " Significant" flooding was forecast through the next day, Monday. At 2:00 PM, the Bay Area NWSFO, in coordination with the USGS, issued a Mudslide/Debris Flow Watch and a Flash Flood Watch for Marin, Napa, and Sonoma Counties in the north portion of

the Bay Area. The Flood Warnings for the Napa River near Napa and the Russian River near Hopland were cancelled at 2:45 PM but major flooding was now being forecast at Gurneville that would affect buildings and roads. Also at 2:45 PM, CNRFC issued a bulletin forecasting flood stages on the Upper Sacramento River along with a forecast of major rises and flooding expected in Tehama County. A statement continuing the Winter Storm Warning for the Sierra Nevada north of Kings Canyon, the Northeast Plateau, and the Mt. Shasta/Siskyou region was issued at 3:00 PM by the NWSFO. A forecast of locally heavy rain for the lower elevations of Northern California was included in this 3:00 PM statement. Also at 3:00 PM, the CNRFC issued a bulletin addressing the North Coast Rivers.

The NWSFO, at 4:18 PM, issued a Flash Flood Warning for Marin, Napa, and Sonoma Counties. Twenty four hour rain totals had exceeded five inches. At 4:30 PM CNRFC issued the North Bay River Forecast for the flooding occurring on the Napa and Russian Rivers. At 5:30 PM Sunday, January 8, a Flood Warning, effective through Monday, was issued for the Napa River in Napa County and the Russian River in Sonoma County. The warning product said "disastrous flooding" is expected and "much of Gurneville would be flooded." At 9:00 PM, the Winter Storm Warning for the Sierra Nevada north of Kings Canyon was issued and this time included a High Wind Warning through Monday (9th) for the Northern Sacramento Valley. Heavy precipitation was still occurring, mainly over Northwest California north of the Bay Area. At 10:00 PM a Flash Flood Statement was issued by the NWSFO for Napa, Sonoma, and Marin Counties. At 10:45 PM CNRFC forecast the Russian River to rise to 48 feet at Gurneville Monday (9th) afternoon; a near record flood.

Forecasters in Monterey updated the Flood Warning for the Napa and Russian Rivers at 12:00 AM Monday, January 9th, to include the Russian River in Mendocino County. At 3:30 AM the Flash Flood Warning for Napa, Sonoma, and Marin Counties was cancelled and a Small Stream Flood Advisory was issued for Napa and Sonoma Counties. Mud slides and debris flows continued to threaten the northern counties of the Bay Area. Also at 3:30 AM, Winter Storm Warnings were updated for the mountains of Northern and Eastern California north of Kings Canyon. High Wind Warnings and/or Advisories were also in effect for much of Northern California, including the Northern Sacramento Valley and the San Francisco Bay Area.

CNRFC issued an updated North Bay River Forecast at 8:00 AM stating the Russian River at Gurneville would crest at

45.5 feet Monday morning. At 10:30 AM. A Mud/Debris Flow Warning was issued for part of San Luis Obispo County previously burned over by a wildfire. At 4:25 PM, the NWSFO coordinated with the USGS and issued a Mud/Debris Flow Watch and a Flash Flood Watch valid until midnight for Marin, Napa and Sonoma Counties. A rain gauge near Healdsburg measured 5.56 inches of rain in the past two hours. An Urban and Small Stream Flood Advisory for the Central California Coast, including San Francisco and Contra Costa Counties and the Salinas Valley, was issued at 4:45 PM. The NWSFO extended the Flood Warning for the Napa River in Napa County and the Russian River in Sonoma and Mendocino Counties through Tuesday morning (10th). The area of torrential rain continued to slide southward. Monday evening (9th) at 7:40 PM a Mud/Debris Flow Watch was issued for the entire San Francisco Bay Area, including Marin, Napa, Sonoma, San Francisco, San Mateo, Santa Cruz, Santa Clara, Alameda and Contra Costa Counties.

At 8:00 PM a Small Stream Flood Advisory was issued by the NWSFO for the entire Bay Area and Monterey County. A Flash Flood Warning for Santa Cruz County was issued at 8:58 PM. A detailed statement was issued by the NWSFO at 9:00 PM updating the information about the Winter Storm Warning for the Sierra Nevada north of Kings Canyon, a Snow Advisory for the Sierra south of Kings Canyon, a Wind Advisory for the Central Coast, Salinas Valley, and Northern San Joaquin Valley. Two day storm total precipitation reports of 12 inches were common and flooding was widespread from Santa Cruz County northward. A Flash Flood Statement was used to update ongoing flood conditions in Santa Cruz County at 9:30 PM.

A Flash Flood Statement was issued at 3:30 AM Tuesday, January 10, to cancel the Flash Flood Warning in effect for Santa Cruz County, and to cancel the Mud/Debris Flow Watch and Flash Flood Watch in effect for the entire San Francisco Bay Area. A Small Stream Flood Advisory remained in effect for the Bay Area. A new Flood Warning was issued at 3:30 AM for the Carmel River and was updated at 5:00 AM. Also at 5:00 AM, the Winter Storm Warning was updated for the Sierra Nevada north of Kings Canyon and the Snow Advisory was updated for the Sierra Nevada south of Kings Canyon. A Wind Advisory now covered Northwest California, the San Francisco Bay Area, and the Sacramento Valley. The 8:00 AM North Bay River Forecast from CNRFC indicated the Russian River at Healdsburg and Gurneville was above flood stage, as was the Napa River at Napa.

The Flood Warning for the Carmel River was cancelled at 9:00 AM. At 1:46 PM on Tuesday (10th) the National Severe Storms Forecast Center (NSSFC) issued a Severe Thunderstorm Watch for a "large part of Central and Northern California and adjacent coastal waters" (The Watch was valid 70 miles either side of a line from 45 miles west of Red Bluff to 60 miles southwest of Fresno). Another NWSFO/USGS coordinated Mud/Debris Flow Watch and Flash Flood Watch was disseminated at 3:00 PM for the entire San Francisco Bay Area, including San Benito County. The NWSFO issued a River Statement at 3:15 PM declaring the Salinas River near Bradley will be near flood stage late Tuesday evening (10th) and major rises should be expected on the Pajaro River Tuesday night. The WSR-88D and satellite imagery was showing the heaviest precipitation moving south and east of the Bay Area late Tuesday afternoon. The Mud/Debris Flow Watch and Flash Flood Watch for the San Francisco Bay Area was cancelled at 5:15 PM but a Small Stream Flood Advisory was issued for Monterey and San Luis Obispo Counties at the same time. At 6:30 PM, the NWSFO canceled the Debris Flow watch for Monterey and San Benito Counties.

CNRFC issued a bulletin at 8:15 PM Tuesday for the Central Coast and stated the Salinas River was at flood stage near Bradley and at warning stage near Spreckles. At 9:00 PM, the NWSFO followed with the Flood Warning for the Salinas River near Bradley and noted significant rises on the Pajaro River. Also at 9:00 PM, the NWSFO cancelled the Small Stream Flood Advisory for the San Francisco Bay Area but let it continue for Monterey County. The Winter Storm Warning was updated at 9:15 PM to include the Sierra Nevada north of Yosemite until midnight, and from Yosemite to Kings Canyon all night. A Snow Advisory remained in effect for the Sierra Nevada south of Kings Canyon.

The NWSFO cancelled the Small Stream Flood Advisory for Monterey County at 4:00 AM Wednesday, January 11. At the same time, it changed the Winter Storm Warning for the Sierra Nevada north of Kings Canyon to a Winter Weather Advisory. The Snow Advisory south of Kings Canyon was cancelled. At 8:30 AM the CNRFC issued a bulletin stating the Russian River at the Gurneville Bridge was forecast to recede to 33 feet by Thursday morning (12th) and to below 32 feet by late Thursday. A statement at 9:00 AM continued the Winter Weather Advisory for the Sierra Nevada for the remainder of the day.

<u>Summary:</u> Overall, the warning services provided by the National Weather Service Offices in Northern California were excellent. Emergency Services Offices, Flood Control

Districts, Corps of Engineers, Bureau of Reclamation, State Office of Emergency Services were kept well informed of warnings and statements. A Complete sequence of public products can be found in appendix A. Appendices B, C, and D contain flood stage and crest reports for Northern California river forecast points.

PART III

NEW TECHNOLOGY and DATA SETS

INTRODUCTION: To provide a complete picture of the activities and processes used during the event to produce the forecasts and warnings, the survey team looked at the internal and external products available from the new technologies and data sets. The following sections are a discussion of the impacts and contributions of these technologies and data sets.

Doppler Radar:
The Monterey and Sacramento Doppler radars provided data superior to previous NWS radars; thus, enabling the National Weather Service to issue timely and accurate watches and warnings.

The information provided by the Monterey and Sacramento WSR-88Ds was instrumental in issuing watches and warnings. Specific areas where WSR-88D performance excelled were: (1) evaluating the magnitude and extent of low level jets for high wind advisories and warnings,(2) monitoring areas of strong convection and persistent high reflectivities associated with heavy rain, (3) identifying storms with possible hail through the WSR-88D Vertically Integrated Liquid (VIL) product, and (4) monitoring internal storm circulations through base velocity fields and the mesocyclone algorithm to identify potential tornadic activity. The doppler radars greatly enhanced the products issued during these precipitation events for both timeliness and accuracy.

The WSR-88Ds provided excellent wind information as shown in Figures 8 and 9. Figure 8 is the base velocity field associated with a frontal band as it moves on shore. Green colors represent inbound winds with respect to the radar, and red colors represent outbound. Thus, a strong southerly wind was present over the San Francisco Bay Area. Wind speeds exceeded 64 knots in this area. Figure 9 illustrates the vertical wind profile available from the WSR-88D for January 10. As shown, winds are 50 knots or greater at all levels.

The monitoring of convective bands far surpassed previous technology as illustrated in Figures 10 and 11. Figure 10 shows the composite reflectivity for one of these bands along the Sierra Nevada Foothills. Since this type of product was available every 6 minutes, the tracking and monitoring of these features was performed throughout its duration. Figure 11 depicts the precipitation estimate available from the WSR-88D. Gage data values are plotted on top of these estimates to illustrate the accuracy of the product. The radar precipitation estimate correlates well with precipitation amounts observed on the ground; however, the precipitation algorithm did exhibit some problems during this episode.

Precipitation estimates from the Monterey WSR-88D were vastly underdone, so this product was not used by forecasters. Precipitation algorithm improvements are needed to resolve the problems seen in Monterey.

Sacramento Valley precipitation estimates were used routinely by forecasters. Generally few discrepancies were observed between gage data and radar estimates in valley locations; however, the precipitation estimates for mountain locations were always overdone.

Figures 11, 12, and 13 show examples of the WSR88D precipitation estimates. Figure 11 depicts a 3 hour precipitation estimate for valley and foothill locations, which correlate well to ground truth. Figure 12 shows a maximum storm total precipitation (second blue line) of 139.6 inches. Maximum gage amounts in the Northern Sierras were about 15 inches during this time period, so obviously this maximum value is in error. However, this graphic clearly depicts the extent of the precipitation estimate errors over the mountains. Figure 13 illustrates how the Monterey radar consistently underestimated the precipitation. Flooding in the Napa and Russian River Basins was beginning during the time of Figure 13. Rainfall rates were up to 0.5 inches per hour, but the radar precipitation estimate is generally less than 0.1 inches over 3 hours.

Polar Orbiter Satellite Imagery:
Two polar orbiter passes occurred daily providing high resolution AVHRR satellite imagery. This imagery is available at NWSFO Monterey through the HIPS system and provided detailed information when available. Figure 14 provides an example of this imagery depicting convective bands over Central California on January 10.

Model Gridded Data:
Access to model gridded data, including and the 6-hour QPFs it provided greatly helped forecasters serve customers needs. Users of NWS precipitation forecasts (e.g., the city of Sacramento or county emergency managers) need detailed information on rainfall amounts and timing. Therefore, the NMC 24 and 48 hour QPF products (94Q and 98Q on AFOS) had limited value for users or forecasters during these rainfall events in complex terrain. The 6 hour model QPFs are much closer to what is needed. Access to model gridded data also allows the forecaster to fully analyze the model's reasons for generating precipitation amounts. The availability of finer resolution models with shorter time steps will help everyone using QPFs in the future.

Significant regions of the rainfall were induced by the terrain as the saturated air mass moved across California. Fortunately, the NWSFO had access to a simple model from the California-Nevada RFC

(developed by Owen Rhea), which tracks precipitation due to air flow over topography. This model helped forecasters pinpoint areas with potentially large rainfall rates, and in several instances out performed all other model output. Given a saturated air mass and orographically induced precipitation, this model could be useful for other offices.

ALERT Gage Data:
The ALERT data was the most valuable data source during the flooding. The NWS offices constantly monitored this system for changes in precipitation amounts and stream stages.

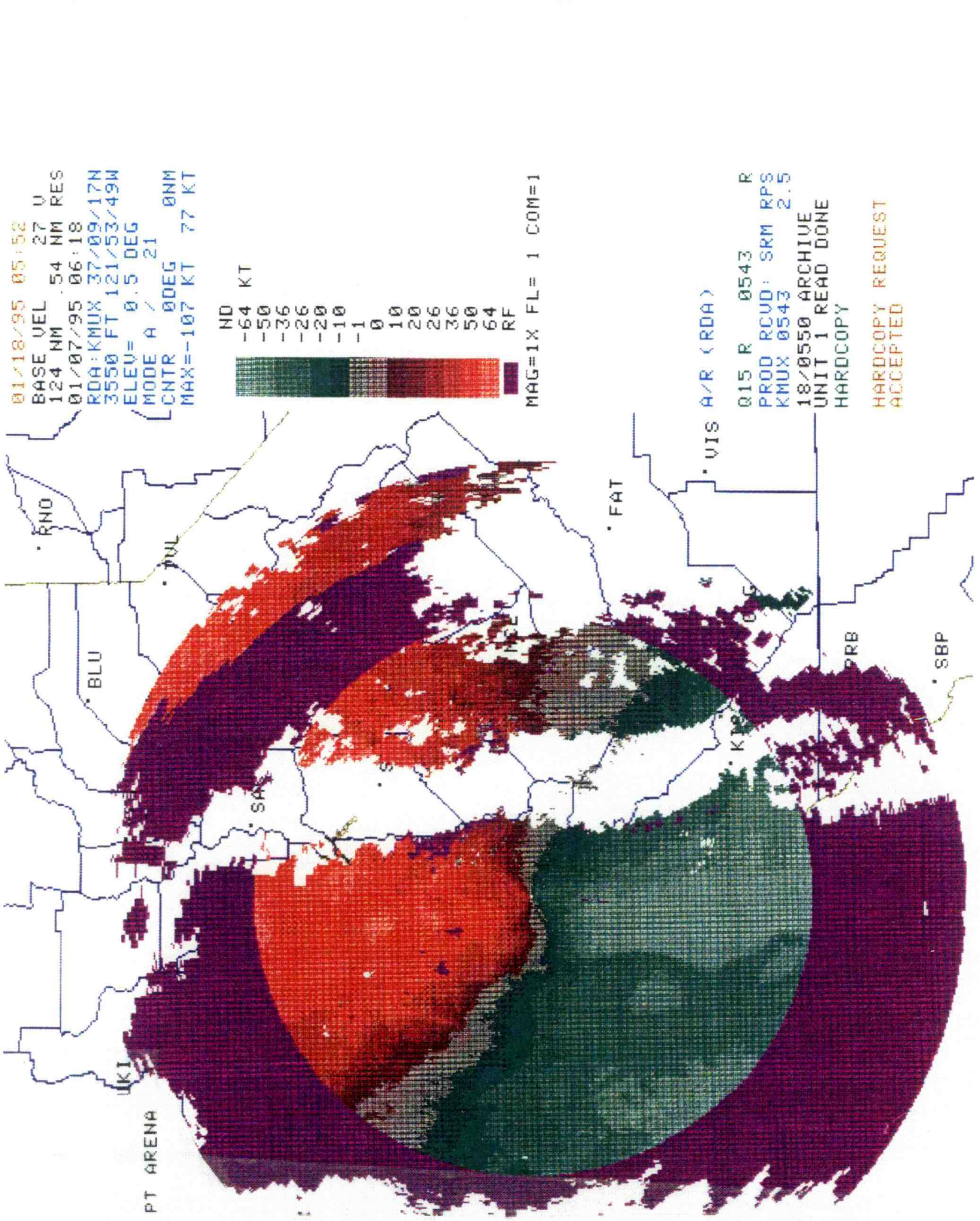


Figure 8 - Base velocity field from the Monterey, CA WSR-88D at 0.5 degrees on January 7, 1995 at 0618Z. Green colors represent inbound winds and reds outbounds, so a strong southerly wind exists at the surface.

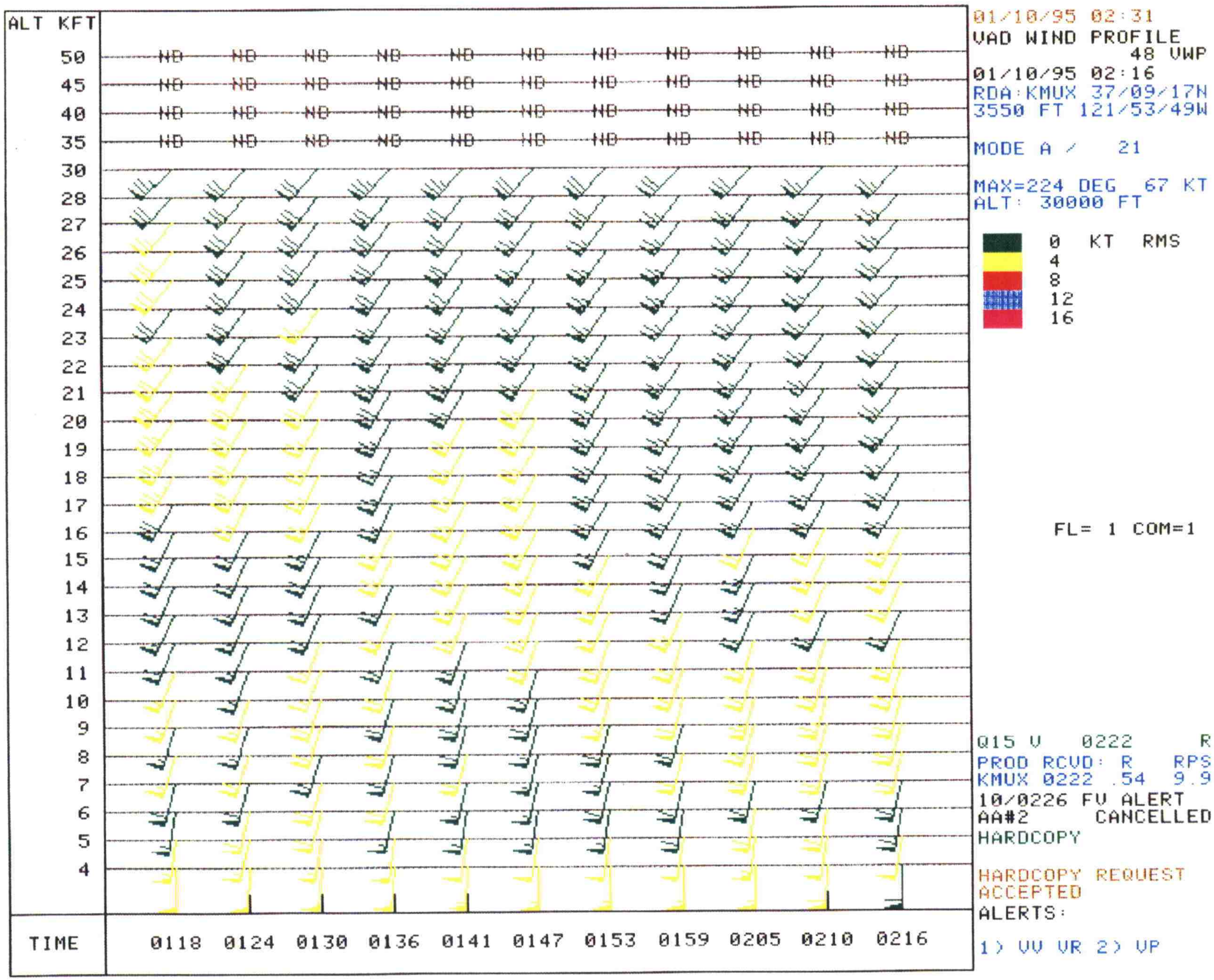


Figure 9 - Wind profile on January 10, 1995 at 0216Z from the Monterey, CA radar. Wind speeds of 50 knots or greater exist at all levels.

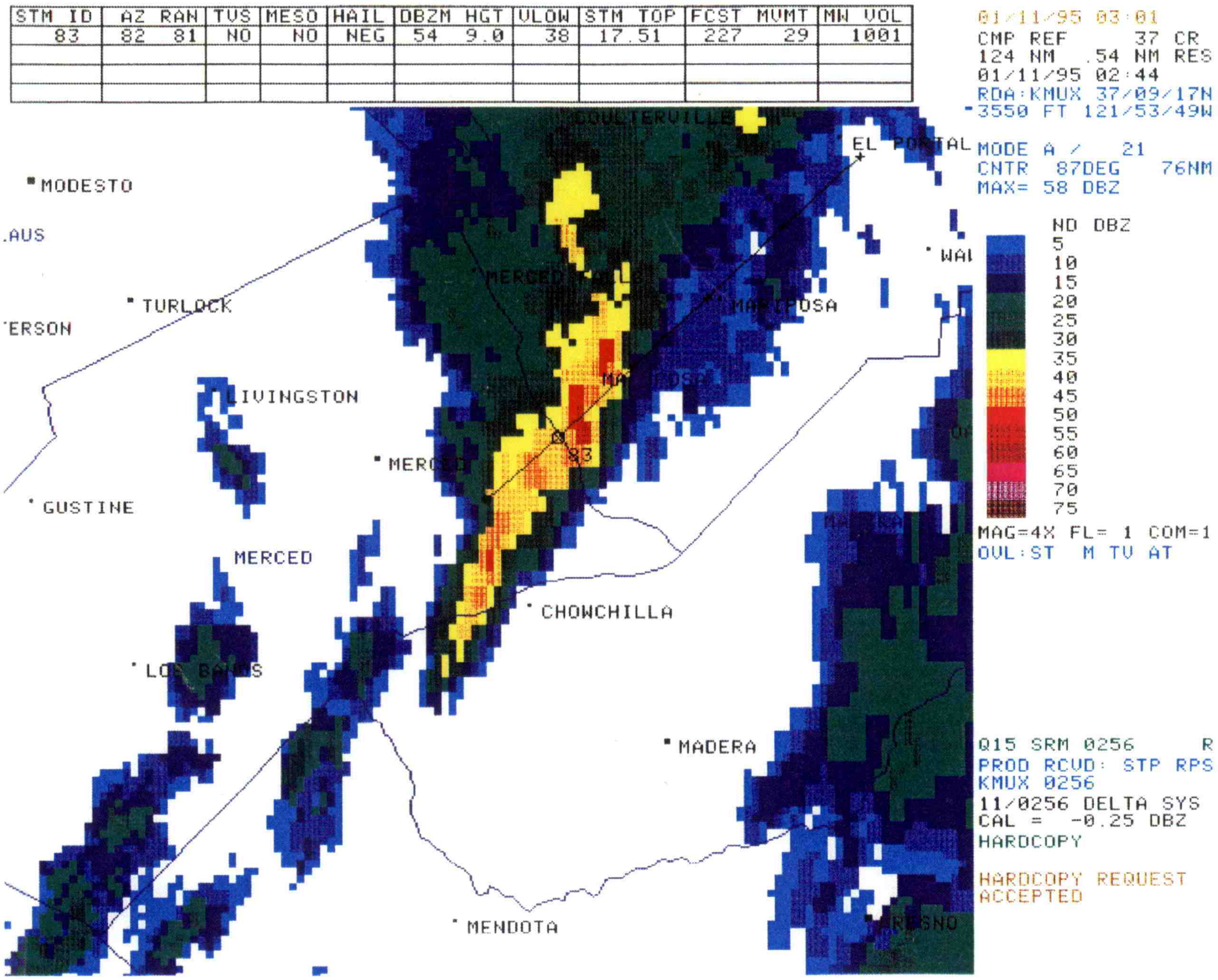


Figure 10 - Convective precipitation band over Merced county on January 11, 1995 at 0244Z. This band was observed from the Monterey, CA WSR-88D.

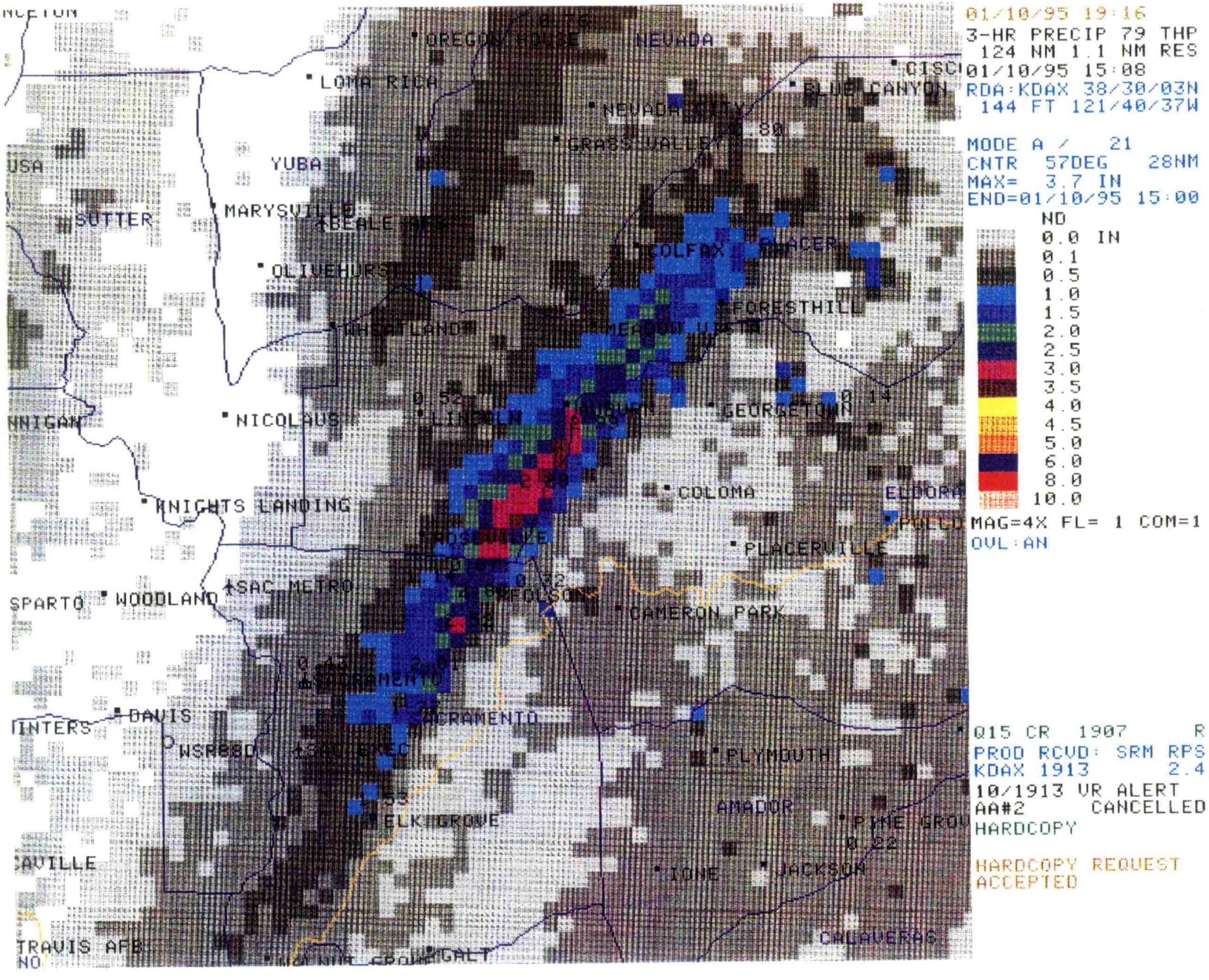


Figure 11 - Three hour precipitation estimate ending at 1500Z on January 10, 1995 from the Monterey, CA radar. The rain gage values shown correlate well with the precipitation estimates.

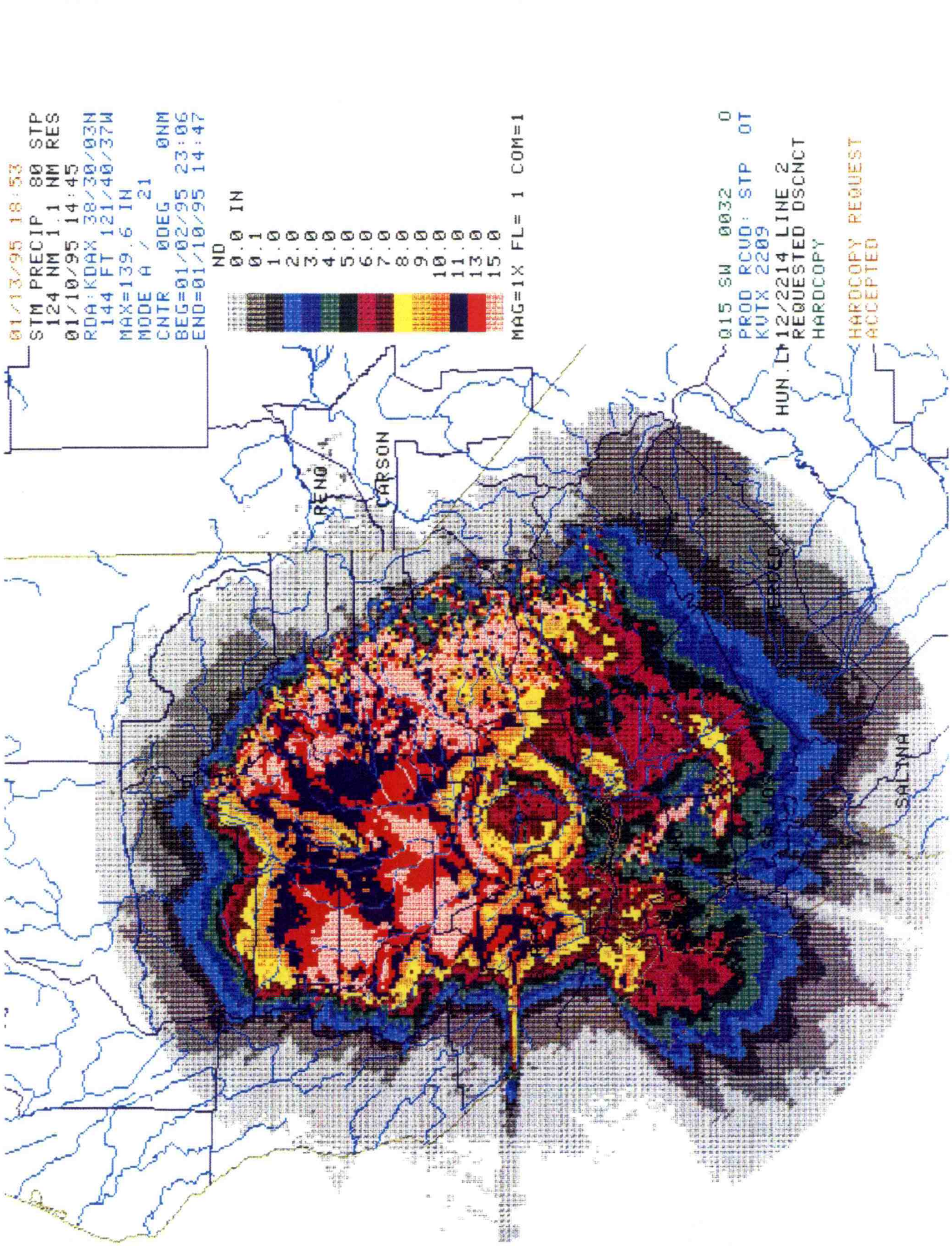


Figure 12 - Storm total precipitation estimates from the Sacramento, CA radar for January 2-10, 1995. This charts shows unusually large precipitation estimates (upto 139.6 inches) over the Sierra Nevada mountains.

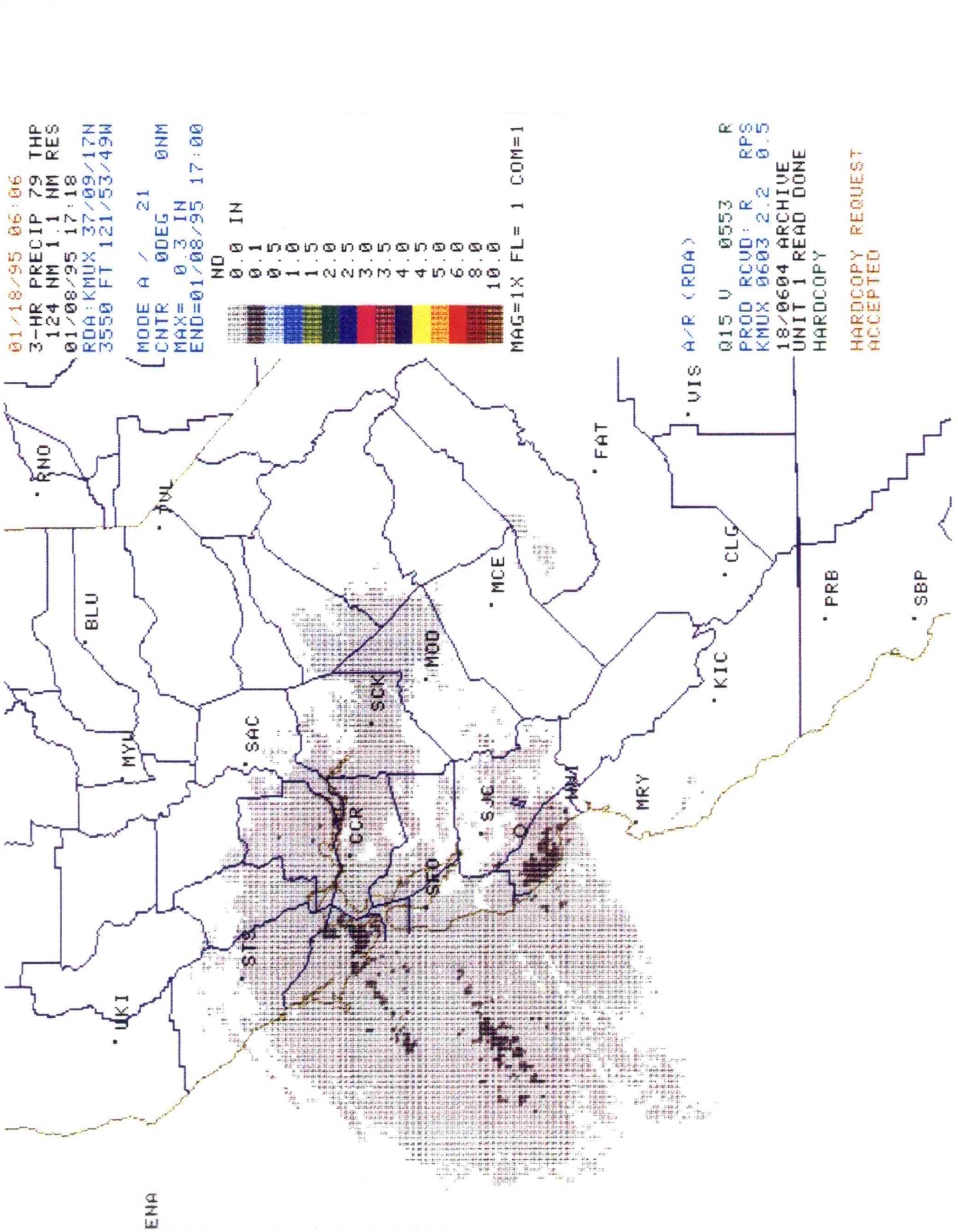


Figure 13 - Three hour precipitation estimate on January 8, 1995 at 1700Z for the San Francisco Bay Area. Flooding was starting in the Russian and Napa River Basins during this time , although radar estimates were only about 0.1 inches. Actual rainfall rates were about 1.25 inches.

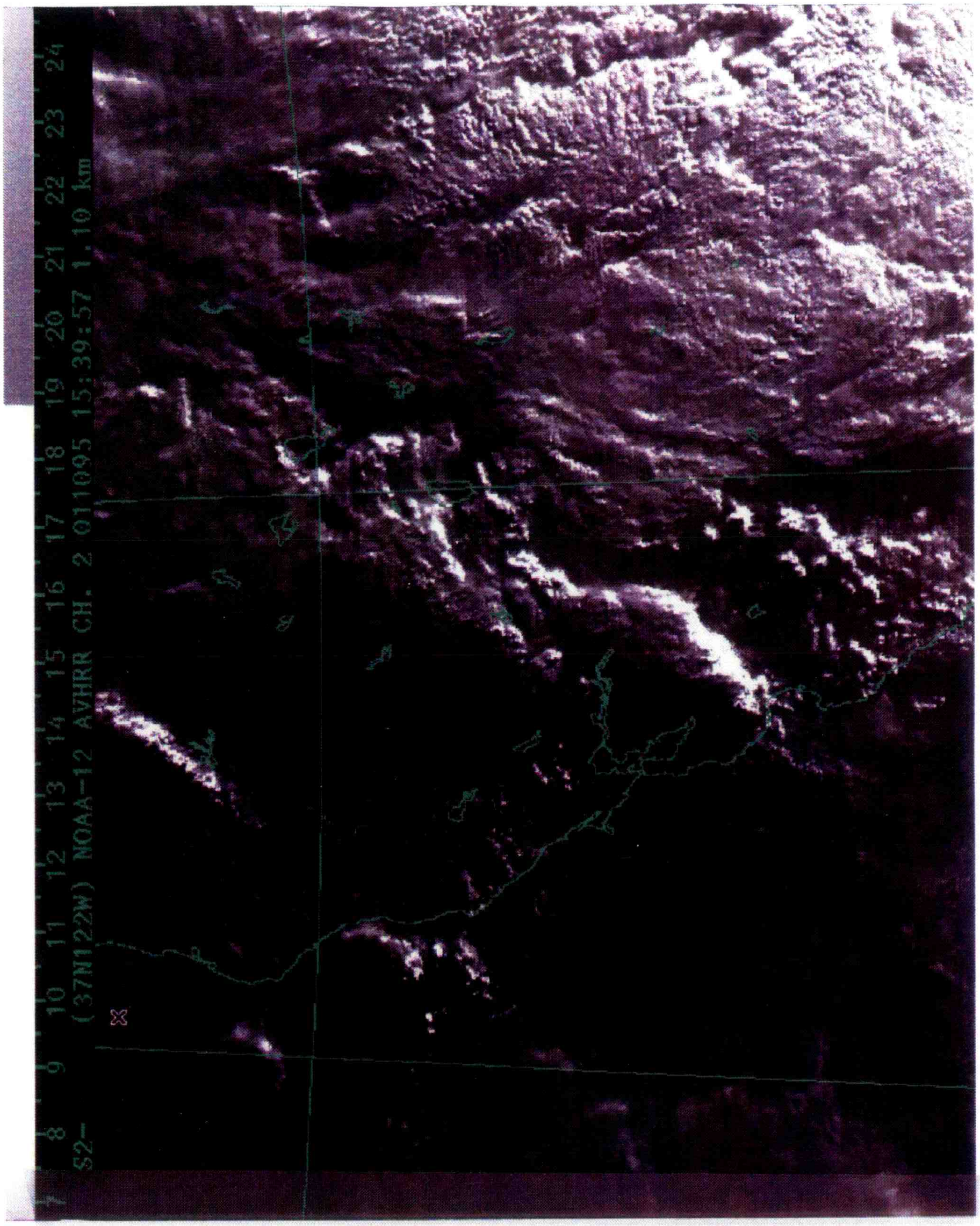


Figure 14 - NOAA-12 polar orbiter satellite imagery used to pinpoint convective precipitation bands on January 10, 1995 at 1539Z. Convection bands are the elongated, linear areas of white.

Part IV

Dissemination

NWS products were distributed to customers using a number of dissemination systems during the flood period. User groups included the general public, emergency response agencies, news media (television, radio, and newspaper), and other NWS offices. The dissemination systems are summarized below.

Dissemination Systems:

NOAA WEATHER RADIO (NWR): The Bay Area NWSFO operates three NWR transmitters: (1) Mt. Umunhum, (2) Mt. Pise (both of these are between San Francisco and Monterey), and (3) Cuesta Peak (near San Luis Obispo). The Mt. Pise and Cuesta Peak NWRs operated normally during the flood period. However, the Mt. Umunhum (Tomita Hill) NWR was off the air 19 hours when power to the mountain was lost from 8:50 PM Monday January 9, until 3:30 PM Tuesday, January 10. This period was during the onset of serious flooding north of the Bay Area.

NWSO Eureka also operates three NWR transmitters: (1) Eureka, (2) Point Arena, CA and (3) Brookings, OR. All three broadcasts continued normally during the flood period.

NWSO Sacramento and WSO Redding operated one NWR transmitter during the floods and they operated normally. (Since January, Sacramento began transmitting an identical broadcast to a second transmitter on Wolf Mountain.)

Regular NWR broadcast schedules may have been preempted at each site at some time during the floods in order to afford more time in the cycle for the increased number of flood warnings and statements. Each NWS office has a priority list of the order in which routine elements of their NWR broadcasts are preempted.

Several users indicated that they felt that the length of the broadcasts were much to long and they had to listen through a lot of material to get the information they needed. Several users also commented that there were frequent warning alarms for events (e.g. Marine) not affecting their area. In addition, several users surveyed didn't normally use NWR or were unaware of NWR.

NOAA Weather Wire Service (NWWS): All Northern California public flood warning products and statements were uplinked via satellite directly from NWSFO Monterey to the NWS's CONTEL contracted NOAA Weather Wire Service (NWWS). No known system outages occurred during the event. The state's complimentary NWWS drop from CONTEL is at the state Office of Emergency Service's (OES) Telecommunications Branch. Many local law enforcement agencies and emergency management offices receive a relay of NWS bulletins from

the State OES via the California Law Enforcement Telecommunication System (CLETS). Other media organizations receive NWS bulletins through other wire services such as AP or WSI. With the exception of CLETS, there did not appear to be any significant delays disseminating products via these alternative systems. Due to space limitations in the new NWS Forecast Office buildings, NWWS receivers are not located in the operations area. The NWWS receiver at the NWSFO is in the air conditioning room adjacent to the operations area.

NAWAS: The NAWAS system is operated from the State OES Telecommunications branch with drops into every county. Most county drops are located in dispatch centers, remote from county emergency management facilities. County or local emergency management personnel are then notified by phone, pager, radio or fax. Receipt of NWS bulletins was delayed at times because of this fanout system. There were no apparent NAWAS system outages during the event.

The NWS only had three NAWAS drops within the warned areas located at the forecast offices in Monterey, Reno, and Oxnard. The State OES would like to see NAWAS drops into all the WFO sites and for the NWS to use NAWAS much more. The NAWAS drop in the Monterey office was installed in November 1994. It was not used by the NWSFO staff to announce when new warning products were being issued. The NAWAS was primarily used to communicate weather and flood information back and forth to counties hard to reach by telephone.

OASIS : OASIS is a satellite based communication system being installed at emergency service facilities throughout California. Following the 1989 Loma Prieta earthquake, the system was designed to permit uninterrupted emergency communications via satellite rather than the usually disaster hampered land-line communication system. At the time of the flooding event less than 50% of the system had been installed at field sites. The installation process was expected to be completed near the end of 1995.

The system's satellite ground station and mainframe is located at the state OES telecommunications branch. The UNIX-based system has three processors and plenty of built-in backup capability. Each installed jurisdiction has eight channels which include 2-way data, voice, and control transmission. OASIS also functions as the communications switch for NWS NWWS messages to EDIS, CALTRANS, California Department of Forestry (CDF), CLETS, and other internal communication systems (appendix E).

OASIS is a menu-driven system and not an event-driven system. Hence, unless system users are notified that a NWS bulletin is in the system, they will not be immediately aware of the message. During this event, this system worked well for those that had the system installed.

EDIS : The state's Emergency Digital Information Service (EDIS) provides a means for authorized official agencies to deliver emergency public information and advisories directly to the media. The system is packet radio technology with transmitters covering only the Bay Area, Los Angeles Basin, and Sacramento Area. All emergency messages in California, including NWS bulletins, are transmitted on EDIS. The volume of messages during this event was heavy, yet the system performed well.

Users would prefer messages be directed to specific regions in order to avoid the heavy volume of message traffic on EDIS. In addition, typographical errors in the message header will prevent the message from being transmitted.

CLETS : The main communication switch for the California Law Enforcement Telecommunication System (CLETS) is located at the Department of Justice in Sacramento with field outlets at state, county, and municipal law enforcement offices. NWS messages are put into the system from the State OES telecommunications branch via the OASIS switch. Based on NWS message headers, CLETS software transmits messages to specific regions of the state.

During this event, CLETS was down for close to 14 hours because of the overwhelming "flood" of information on the system, according to California OES telecommunication officials. However, the OES Warning Controller communication log indicated the total outage time was closer to eight hours during the event, though there were admittedly a few unlogged outage times. The longest logged outage was 7 hours and 15 minutes from Jan 10 at 0350 UTC to Jan 10 at 1105 UTC.

CLETS main purpose is for dissemination and exchange of law enforcement information. Weather is permitted to transmit on the system as a courtesy because of the prominent numbers of field outlets around the state. During the flood event, some users asked to have weather "turned off" at times, since the system was "saturated" by weather messages and was disrupting law enforcement activities.

Television/Radio : There are some 60 television and radio stations in the Bay Area. There were no live interviews by Bay Area television stations with NWSFO personnel during the flood episode. This is presumably due to the distance between the stations and the NWSFO (100 miles). Several television interviews did originate from NWSO Sacramento. "Sensationalized" news broadcasts in Sacramento stated heavy rains would continue during one particular 24 hour period, despite NWS forecasts to the contrary. The media was less aggressive in the days following when NWS offices forecast the return of heavy precipitation and flooding.

Participation in the EBS system is lacking by the San Francisco Bay Area media outlets. A number of station managers interviewed by the

Survey Team believe the NWSFO "cries wolf" with too many weather warnings. Station managers cited the following example. The wording in the first weather and flood warnings (which requested EBS activation) was nearly identical to the earlier Special Weather Statements and weather and flood watch products, issued some 24 hours prior. Because the information in the initial weather and flood warnings had already received thorough dissemination, the EBS was not activated for the warnings.

AFOS/PC: The ALERT computer worked hard and alarmed steady, especially during the onset of the heaviest precipitation. NWSFO Service Hydrologist Tracy Cox deemed the ALERT data absolutely essential. GOES data carried on AFOS was used less by forecasters. AFOS worked without interruption, due in part to the newly installed HAWK hard drives. CNRFC River Forecast products intended for the NWSFO were also distributed over CDEC which has wide dissemination capabilities to emergency managers. Hence, river level forecasts by CNRFC were available to those with CDEC before the predictions were officially disseminated in NWS Flood Warning products from the NWSFO Bay Area.

Facsimile: The facsimile was the primary means which the NWSFO used to disseminate hard copies of initial flood warnings. While this was an effective method of broadcasting the information, placing over 50 separate calls made it the least efficient method. After the first surge of warning products, the facsimile was relied on less and more traditional dissemination methods were used (NWWS, NWR, AFOS, etc.)

Telephone: Telephone traffic was very high during the flood episode. The Bay Area Public Service Unit (BAPSU) alone answered 400-500 telephone calls. Callers to NWS offices included emergency service responders, severe weather spotters, HAM radio operators, and the media. Ed Cavagnaro, News Director at CPCS-1 radio station KCBS-AM said the service during the floods was very good except that the NWSFO did not call his station when EBS activation was requested. Informing the CPCS-1 station of warnings being released that request EBS activation is a requirement documented in the instructions within the NWSFO's "EBS BOOK" located in the forecast area. Coordination telephone calls between NWS offices (WSOs, NWSOs, CNRFC) were frequent. Coordination telephone calls were also carried out with state emergency management agencies and the media on a regular basis as well.

Part V

Customer Response

Overall, all customers surveyed felt the NWS did an outstanding job and were pleased with the timeliness and quality of NWS warning and forecast services prior to and during the event. Following are summaries of persons contacted and their comments:

1. Bob Fields, Manager of Santa Clara County Office of Emergency Services:

   Mr. Fields stated he received plenty of advance notification prior to the event through NWS statements, viewing weather satellite imagery via the media, and using his past experience of heavy precipitation weather patterns.

   During business or emergency operation hours, his facility receives NWS messages via EDIS. During remaining hours, a county 911 dispatch center located 10 miles from the EOC contacts him either by phone or pager after receiving notification through CLETS and NAWAS. One of the problems with EDIS though, is that the system has no means to address messages to specific sites or even regions. Thus all messages transmitted statewide on EDIS are received. Mr. Fields pointed out a stack of EDIS messages 4 1/2" thick received from January 1-17, the bulk being NWS messages from around the state. During the event, he and his staff had to sift through many NWS messages to find the one(s) that applied to their county.

   The EOC received NWR, but has not used it in quite some time since the warning alarm was always going off for marine warnings and the cycle time was much too long. When he needed it during the event, he called and got excellent support from the NWSFO in Monterey.

   Mr. Fields noted many personnel who normally do not use NWS messages become involved in EOC operations during an event. He suggested each NWS statement clearly list which county(s) is involved to ease proper handling, especially by those not proficient with these messages. He also suggested that during an event, a separate product be transmitted which clearly describes what a warning, watch, or advisory is, again to help those not proficient.

2. L "Pete" Peterka, Acting Sonoma County Emergency Manager:

   Mr. Peterka was the county's emergency manager before retiring in the mid 1980s. With a vacancy since December,

The county asked him to fill in until a permanent replacement is hired. Because of the length of his break in service, he was admittedly not completely current on all OES operations.

He stated NWS service was great. He had plenty of advance notification and service during the event. He noted some people ignored the warnings. Approximately 1500 people had to be evacuated by helicopter over a period of four days.

The EOC receives NWS messages via CLETS located in the county's 911 dispatch center next door. NAWAS was operational in the OES when he worked there years ago, but was not functional during the event. He was unsure if the NAWAS drop had been moved to the dispatch center. They do not have a weather radio receiver in the EOC, though they are aware of NWR.

He had only a few observations. The volume of messages made it difficult to determine which one(s) applied to his county. He indicated it would be helpful to list specific county(s) in NWS messages to help identify which messages apply to their county. Fresh NWS flood messages around 7:00 AM would have been more helpful prior to their morning county staff briefings. He also noted flood information was coming from more than one source and confusing matters for a while early in the event. The sources were the NWS, and his own county water/public works agency, (an internal matter) .

3. John Volpi, Part-Time Manager of Napa County Office of Emergency Services:

Mr. Volpi is a retired county sheriff department staff member and has been the emergency manager for only about a year. He received fine service from the NWS. He had advance notification of the event form the NWS and local sources. County personnel were ready with sandbags, supplies, and personnel.

He received NWS messages via CLETS, located in the sheriff's office elsewhere in the building. There were times when some products did not arrive on CLETS and he had to ask state OES to fax products to him. These products were then received as much as 1 hour and 45 minutes after NWS issuance.

NAWAS is located in the 911 central city dispatch center located elsewhere in town. Dispatch personnel contact him by phone when necessary. OASIS has arrived, but not all the hardware and modems have been installed and tested. He did use NWR a little during the event.

4. Brian Hackney and Tim Somers, KGO-TV Meteorologists:

KGO TV receives their weather information from WSI, including WSR-88D data. Mr. Hackney and Mr. Sumers felt the WSR-88D provided splendid data during the event and both were amazed by the high wind warning issued for the coast based on Doppler velocity signatures that later verified.

KGO-TV weatherman Pete Giddings was attending the national AMS conference in Dallas, Texas, during our visit. At the AMS conference, Mr. Giddings voiced some dissatisfaction with NWS services as a result of the forecast office's recent move to Monterey. He claimed to have documented examples. However, Mr. Hackney and Mr. Somers were unaware of Mr. Giddings' dissatisfaction and were unable to locate any such documentation. Mr. Hackney and Mr. Somers did not have any need to contact the NWS directly during the event. The new forecast office in Monterey is not too far away to do remote broadcasts, but during this event, all of the station's remote teams were busy covering local field stories.

Mr. Hackney and Mr. Somers suggested the following to enhance service to the media:

1) Too many warning/watch/advisory products at once to examine and compile for limited air time pieces. Periodically, would like a message which provides a summary of all warnings/watches/advisories in effect.

2) Too many terms used in warning and advisory names for use during limited air time.

3) Need to more clearly define the difference between a small stream flood warning and a flash flood warning.

4) There were a few times when the FPUS3 list of warnings did not match with current warnings. Also, comments in FPUS3 are seen and potentially used by the media. Example given was the "storm of the decade" FPUS3 remark later used by the media.

5) Precipitation totals in the state temperature/precipitation summary (STP) came out doubled or even tripled a few times. Corrections came to late before being aired.

5. Brian Sussmann, KPIX-TV Weatherman:

Because the survey team arrived within an hour of his 5 PM broadcast, Brian had little time to talk. KPIX TV receives their weather information from WSI, including WSR-88D data. Mr. Sussmann expressed nothing but praise for the job the NWS did prior to and during the event. His only negative comments were that a few FPUS3's were delayed or missing, and there were a few occasions when the STP product had precipitation amounts that were doubled or even tripled. STP corrections were made, but too late for broadcast since the incorrect totals were already aired.

6. Management and staff members, Coastal Region of the California State Office of Emergency Services:

The survey team interviewed four members of the Coastal Region, all of whom were very complimentary of NWS products and services during the event. Advance NWS notification of flood potential and the daily 2 PM briefings were invaluable to them, and permited adequate staff planning for the event. The group was unaware that they could call the NWS any time for additional briefings. Also, they would like to obtain WSR-88D data, which currently is delivered to the CDWR from a NIDS vendor, but is not disseminated further throughout the state.

Weather information is received at the OES Command Center on NWWS from the state OES office via satellite. They noted their region's counties have varied resource capabilities and receive NWS messages on one or more mediums, including NAWAS, CLETS, NWR, OASIS, EDIS, telephone, fax, and CDEC. The counties are responsible for disseminating the information throughout their county. Some county emergency managers and flood control districts/water agencies did <u>not</u> coordinate flood and weather information well.

Our visit seemed to bring the NWS and OES Region Closer. Northern California NWS Area Manager offered a NWS meteorologist to assist with briefings on-site if necessary during such significant events, Mt. Umunhum tower space for a radio link between the NWS forecast office and the Region's planned Oakland facility within a year, and an invitation to future state WCM meetings. The Region offered NWS attendance at future table top exercises and state/regional OES quarterly meetings.

7. Tim Longdon, CALTRANS Headquarters Highway Commission Section:

Mr. Longdon felt NWS products and services prior to and during the event were "great". They receive their weather information through a 2400 baud modem from the state OES, which has the state NWWS drop. We discovered during our discussion that they were not receiving all NWWS products from the NWSFO's located in Monterey, Oxnard, and Reno. None of the missing products apparently involved warning messages. NWSO Sacramento WMC Roger Pappas planned to work with them to update their NWWS database.

NWWS information is dumped into a UNIX based AT&T computer which is programmed to send NWS products to selected CALTRANS and California Highway Patrol (CHP) sites throughout the state via telephone modem. During the summer of 1995, they expect to have a UNIX based 486 PC replace the aging AT&T system. The new system will also enable them to disseminate highway information on the Internet.

8. Lloyd Darrington, Director of the California State Office of Emergency Services and five staff members:

The group interviewed were all very complimentary of NWS products and services during the event. Advance NWS notification of the potential event and the daily 2 PM briefings during the event were invaluable to them, enabling proper staff planning for the event. They were reminded that they could call the NWS at any time for additional briefings and even request NWS on-site support. WSR-88D data would have been very helpful during the event. Unfortunately, the state's special NIDS subscriber status belongs to CDWR. State OES determined NIDS vendor subscriber costs were prohibitive.

The state OES acts as a clearing house for NWS weather products. The state's NWWS drop comes into their facility via satellite from Contel, dumped into OASIS, and then distributed on many different mediums (see appendix E), including EDIS, OASIS access, CLETS, CALTRANS, and CDF. They also operate the state NAWAS system. They noted they would prefer the NWS use NAWAS more and have NAWAS drops into the remaining NWS sites as soon as possible.

The group interviewed offered several suggestions to enhance service in the future:

1) During the event, the communication systems were "saturated". Too many "corrections" to NWS messages transmitted, aggravated the problem. In addition, many

NWSO and WSO statements following NWSFO statements repeated "nearly verbatim" the NWSFO statements.

2) NWS statements listing a number of different warnings and/or advisories made dissemination to the appropriate enties more complex as well as interpretation of which part of the message is intended for which county or area of the state.

3) They would like to obtain the QPF product via another medium, like the NWWS. Currently, they dial into a CNRFC computer and obtain it over a very slow 300 baud modem.

9. Rob Nelson, City of Roseville Flood ALERT Technician:

Mr. Nelson has worked with CNRFC and NWSO Sacramento for a number of years. He indicated he had "excellent" service and coordination with the NWS prior to and during the event. He stated "NEXRAD was a fantastic tool!"

Just days before our visit, President Clinton toured the flood ravaged area, including the city of Roseville. A briefing packet given to The President, describing the city's drainage basin and flood information, was provided to us and is in appendix F.

The city has been very progressive in its effort to reduce flood damage and loss of life. In a basin of only 80 square miles, they have established 3 automated weather stations, 14 precipitation gauges, and 12 stream flow gauges, all telemetered into Mr. Nelson's city office. The data is shared with the NWS and is available to local cable TV subscribers in an easy to read format.

Mr. Nelson has both Hydromet and Novalinks software for reviewing ALERT data. He also obtains WSR-88D data and satellite imagery from Paramax. He routinely dials into the CNRFC computer for NWS products and data, as well as CDEC for additional hydrologic information. During this event, access to the CNRFC was limited because the CNRFC line was often busy. Mr. Nelson indicated he needs another more reliable way to receive NWS data during such significant events.

10. Mr. Bob Cortelyou and Ms. Helena Arneson, Sonoma County Water Agency:

Bob Cortelyou said they dialed directly into the CNRFC via modem to get the latest bulletins for mainstream river forecasts. They stated that they would have liked access to the Flash Flood Warnings and Flash Flood

Watches which were issued by the NWSFOs and NWSOs. They called these the "early" warnings that they wished they would have had access to. They got this information through the local fire department during this event. They also mentioned that CDEC did not have the new and updated weather forecasts for the weekend. Mr. Cortelyou and Ms. Arneson stated that they felt the quality of the products issued by the NWS was good.

The Sonoma County Water Agency also disseminates warnings and forecasts using a phone recorder with four lines into their office. They updated this recording from the bulletins issued by the CNRFC and California DWR.

11. Mr. Bob Sorenson and Mr. Lance Heide, Napa County Department of Public Works:

Bob Sorenson and Lance Heide both were very satisfied with the forecasts and services provided by the NWS. They also directly accessed the bulletins provided by California DWR and CNRFC through CDEC. They felt the mainstream river forecasts were good and that CNRFC was very accessible by phone. They were confused about the differences between watches and warnings issued for the small streams and rivers from the NWSFOs and NWSOs/WSOs. They would like to see some clarification for these products. They received this information from the California Law Enforcement Teletype System (CLETS). They felt some of the statements used a little bit too "flowery" of language in the text. They generally got this information over CDEC but on the weekend the weather forecasts were not updated on this system.

Summary

In general all users that were interviewed by the survey team were complimentary of the service that was provided by the NWS. All users felt they received plenty of advance notice of the events and that forecasts and warnings were timely and accurate.

Appendix A

Sequence of Public Products

1/4/95. Wed. 3:00 am. FFASFO - Flash Flood Watch for San Luis Obispo Co. Heavy rains expected along the coast Thursday evening and over night. Amounts of 3 to 5 inches possible with flash flooding and potential mud slides.

1/4/95. Wed. 12:10 pm. FFSFAT - Urban and Small Stream Flood Advisory. Central San Joaquin Valley and Southern Sierra Nevada Foothills. Moderate rain falling in the Central San Joaquin Valley with moderate to heavy rain in the Southern Sierra Nevada. In effect until 8:00 pm.

1/4/95. Wed. 1:30 pm. FFSSFO - Flash Flood Statement. Cancel flash flood watch and mudslide watch for Hwy 41 burn area of San Luis Obispo Co.

1/4/95. Wed. 4:30 pm. FFSSFO - Flash Flood. Watch for Arroyo Seco drainage of Monterey Co until 9:00 pm. Heavy rains in the coastal mountains of Big Sur. Amounts over 5 inches in the last 6 hours. Rapid rises seen on the Arroyo Seco drainage.

1/4/95. Wed. 4:34 pm. Flash Flood Warning until 6:30 pm for people in western Fresno Co. Flooding reported near Panoche Creek and I-5.

1/4/95. Wed. 5:15 pm. FFSFAT - Urban and Small Stream Flood Advisory until 9:00 pm for the Central San Joaquin Valley. Flash Flood Warning for West Fresno Co until 6:30 pm.

1/4/95. Wed. 6:45 pm. FFSFAT - Flash Flood Warning for Fresno Co expired. Urban and Small Stream Flood Advisory in effect until 9:00 pm for Central and Southern San Joaquin Valley.

1/4/95. Wed. 7:00 pm. FFSSFO - Flash Flood Watch for the Arroyo Seco drainage cancelled.

1/4/95. Wed. 10:11 pm. FFSFAT - Urban Small Stream Flood Advisory expired.

1/6/95. Fri. 9:00 am. WSWSFO - Winter Storm Warning, Watch, Wind Warning and Wind Advisory. Mentioned Localized flooding and mud debris flows in the coastal mountains of Central California.

1/6/95. Fri. 10:30 am. SPSSAC - Special Weather Statement for Heavy rainfall potential the Lower Sacramento Valley and the foothills.

1/6/95. Fri. 3:00 pm. FFSSAC - Urban/Small Stream Flood Advisory for southern Sacramento and Northern San Joaquin Valleys and Sierra Nevada Foothills. The text mentions that flooding is a real possibility over the weekend.

1/6/95. Fri. 3:01 pm. FFSEKA - Urban/Small Stream Flood Advisory North California coast. Heavy rains to bring small stream flooding.

1/6/95. Fri. 3:30 pm. FFSSFO - Urban/Small Stream Flood Advisory. Flooding of Small streams, ponding of roadways, local mud or debris flows over steep terrain.

1/6/95. Fri. 3:30 pm. FFSRDD - Flood Statement. Urban/Small Stream Flood Advisory for tonight Sacramento Valley and the surrounding foothills. Minor flooding expected.

1/6/95. Fri. 4:00 pm. FFSFAT - Urban and Small Stream Flood Advisory for tonight and Sat. for the Central San Joaquin Valley and foothills.

1/6/95. Fri. 9:00 pm. WSWSFO - Winter Storm Warning/Watch, High Wind Warning/Advisory tonight and Saturday. Mentions rain with storm in coastal mountains of Central California with localized flooding and mud and debris flows possible.

1/6/95. Fri. 9:40 pm. FFSSAC - Urban/Small Stream Flood Advisory through Saturday for Lower Sacramento Valley, Northern San Joaquin Valley and the Mother Lode.

1/6/95. Fri. 9:00 pm. FFSEKA - Urban/Small Stream Flood Advisory for North California Coast tonight.

1/7/95. Sat. 12:15 am. FFSSFO - Urban/Small Stream Flood Advisory for tonight and Saturday for San Francisco Bay Region, Central Coast and the Salinas Valley environs. Local mud and debris flows in steep terrain.

1/7/95. Sat. 3:15 am. FFSSFO - Urban/Small Stream Flood Advisory Cancelled.

1/7/95. Sat. 3:30 am. FFSSAC - Urban/Small Stream Flood Advisory cancelled for Lower Sacramento and Northern San Joaquin Valley and the Mother Lode.

1/7/95. Sat. 4:08 am. FFSRDD - Cancel Urban/Small Stream Flood Advisory for Sacramento Valley and surrounding foothills.

1/7/95. Sat. 4:20 am. FFSFAT - Cancel Urban/Small Stream flood Advisory for Central San Jaoquin Valley and surrounding foothills.

1/7/95. Sat. 11:15 pm. FFSRDD - Urban/Small Stream Flood Advisory this afternoon and tonight for Upper Sacramento Valley.

1/7/95. Sat. 3:30 pm. FFSEKA - Urban/Small Stream Flood Advisory for all of Northwest California tonight.

1/7/95. Sat. 9:30 pm. FFSEKA - Urban/Small Stream Flood Advisory Update stating small stream flooding occurring, minor flooding expected during the night.

1/7/95. Sat. 10:30 pm. FFSRDD - Urban/Small Stream Flood Advisory for the Upper Sacramento Valley and surrounding foothills and lower elevations of Trinity and Siskiyou Counties.

1/7/95. Sat. 11:15 pm. FLSSFO - Flood Statement for Napa River near St. Helena. Calling for major rises on the Russian and Napa Rivers on Sunday. No other forecast points to be above flood stage. Format was unaltered Bay Bulletin format from the RFC.

1/8/95. Sun. 3:00 am. FFSSAC - Urban and Small Stream Flood Advisory for Lower Sacramento Valley and Mother Lode. An inch of rain expected in Lower Sacramento Valley, and 2 to 3 inches possible in foothills of the Mother Lode.

1/8/95. Sun. 3:00 am. FFSSFO - Urban/Small Stream Flood advisory for San Francisco Bay Region with local mud and debris flows possible in steep terrain.

1/8/95. Sun. 3:30 am. FFSRDD - Urban/Small Stream Flood Advisory Northern Sacramento Valley and surrounding foothills and lower elevation of Trinity and Siskisyou Counties. Calling for a new storm with 1 to 3 inches of additional rain.

1/8/95. Sun. 3:30 am. FFSEKA - Urban/Small Stream Flood Advisory update. Second winter storm noted off coast of Northern California. Minor flooding occurring near the mouth of Eel river.

1/8/95. Sun. 6:30 am. FFSSFO - Urban/Small Stream Flood Advisory today for San Francisco Bay region. Mud and Debris flows possible in steep terrain.

1/8/95. Sun. 9:00 am. FFSSFO - Urban/Small Stream Flood Advisory for San Francisco Bay region. Local mud and debris flows in steep terrain. Reports include 3.00 inches in 6 hours at Venada (in the coast range near Russian River) and 1.8 inches at Angwin (Upper Napa River basin above St. Helena). Calling for similar amounts in the next 6 hours.

1/8/95. Sun. 10:00 am. FFSEKA - Urban/Small Stream Flood Advisory remains in effect for all of Northwest California. 1 to 4 inches has fallen, additional 1 to 3 inches possible from next storm tonight.

1/8/95. Sun. 10:00 am. FFWRDD - Small Stream Flood Warning for Northern Sacramento Valley and surrounding foothills and Lower elevations of Trinity and Siskiyou Counties. Heavy rain occurring and more expected will flood small streams.

1/8/95. Sun. 10:15 am. FLWSFO - Flood Warning for Russian and Napa Rivers. Significant flooding forecast to occur through at least Monday.

1/8/95. Sun. 11:10 am. FFSSAC - Urban/Small Stream Flood Advisory for Lower Sacramento Valley and Mother Lode. Rainfall amounts generally light but more expected.

1/8/95. Sun. 1:30 pm. FFSRDD - Small Stream Flood Statement for Northern Sacramento Valley and surrounding foothills and lower elevations of Trinity and Siskiyou Counties for Sunday afternoon and night.

1/8/95. Sun. 1:45 pm. FLWSFO - Flood Warning through Monday for the Napa River in Napa Co (St. Helena) and Russian River in Sonoma Co (At Healdsburg and Guerneville). Cancel Flood Warning for Napa River near Napa and Russian River near Hopland.

1/8/95. Sun. 2:00 pm. FFASFO - Flash Flood Watch and Mud/Debris Flow Watch effective until 2:00 am Monday for Marin, Napa and Sonoma Counties.

1/8/95. Sun. 2:45 pm. FLWRDD - Flood Warning for Sacramento River at many forecast points. Format was unaltered bulletin from the RFC.

1/8/95. Sun. 4:00 pm. FFSSAC - Urban/Small Stream Flood Advisory for Lower Sacramento Valley and Mother Lode.

1/8/95. Sun. 4:18 pm. FFWSFO - Flash Flood Warning in Marin, Napa, and Sonoma Counties. Heavy rains could trigger mudslides. Numerous roads closed in the Guernville area.

1/8/95. Sun. 4:25 pm. FFSEKA - Urban/Small Stream Flood Advisory remained in effect for all of Northwest California.

1/8/95. Sun. 3:25 pm. FFWSAC - Flash Flood Warning for Yolo and Colusa Counties. Road closure and evacuations were already taking place in these counties.

1/8/95. Sun. 5:30 pm. FLWSFO - Flood Warning for the Napa River in Napa Co. and Russian River in Sonoma Co. Near record flood forecast for the Russian River near Guerneville and the Napa River at St. Helena and Napa. Compared forecasted crests to the record events for each forecast point.

1/8/95. Sun. 6:00 pm. FFSRDD - Small Stream Flood Warning for the Northern Sacramento Valley and surrounding foothills and lower elevations of Trinity and Siskiyou Co. tonight. Current flood problems along small streams with rural road closures in Tehama, Butte and Glen Counties. Worst flooding in Tehama sandbagging and

evacuations have taken place. Sacramento River also forecast to reach or exceed above or to flood stage by Monday morning.

1/8/95. Sun. 7:25 pm. FFWSAC - Small River and Stream Flood Warning for Yolo and Colusa Counties. Serious flooding reported in these counties, roads closed, sandbagging and evacuations.

1/8/95. Sun. 8:30 pm. FFWEKA - Small River and Small Stream Flood Warning for Mendocino and Lake Counties.

1/8/95. Sun. 10:00 pm. FFSSFO - Flash Flood Statement. Flash Flood Warning continues until 4:00 am Monday for Napa, Sonoma and Marin Counties. Local mud and debris flows possible in steep terrain.

1/8/95. Sun. 9:45 pm. FLSRDD - Flood statement for warning points along the Sacramento River and warning levels for other points along the Sacramento River. Format unchanged from the Bulletin from the RFC.

1/8/95. Sun. 8:30 pm. FFWEKA - Small River and Small Stream Flood Warning for Mendocino and Lake Counties.

1/8/95. Sun. 10:00 pm. FFSSAC - Urban/Small Stream Flood Advisory for Yolo and Colusa Counties and Urban and Small Stream Flood Advisory for Lower Sacramento Valley and Mother Lode.

1/8/95. Sun. 10:19 pm. FFSEKA - Urban/Small Stream Flood Advisory remains in effect for all Northwest California tonight.

1/8/95. Sun. 11:30 pm. FFWRDD - Small Stream Flood Warning continues through tonight for the Northern Sacramento Valley and surrounding counties as well as lower elevations of Trinity and Siskiyou Counties. Mainstream Sacramento River flooding.

1/9/95. Mon. 12:00 am. FLWSFO - Flood Warning through Monday morning for Napa River and Russian River in Sonoma and Mendocino Counties. Near record flooding for Russian River near Guerneville. Mentioned that flooding will be similar to 1986 levels.

1/9/95. Mon. 12:37 am. FLWEKA - Flood Warning for Eel River at Fernbridge. Significant rises at Miranda on Eel River and Grizzley Creek State Park along Van Duzen River.

1/9/95. Mon. 2:51 am. FLWEKA - Flood Warning for Van Duzen River at Grizzly Creek State Park.

1/9/95. Mon. 3:45 am. FFSSAC - Flood Warning for small streams for Yolo and Colusa Counties extended until 10:00 am. Urban/Small Stream Flood Advisory remains in effect for remainder of Lower Sacramento Valley and Mother Lode through today.

1/9/95. Mon. 4:25 am. FFWEKA - Small River and Stream Warning for Lake and Mendocino Counties until 10:00 am.

1/9/95. Mon. 6:05 pm. FFWRDD - Small Stream Flood Warning continues in effect through this afternoon for the northern Sacramento Valley and surrounding foothills as well as the lower elevations of Trinity and Siskiyou Counties.

1/9/95. Mon. 8:27 pm. FLWEKA - Flood Warning continues for Eel and Van Duzen Rivers through Monday evening.

1/9/95. Mon. 6:00 am. FFSSFO - Small Stream Flood Warnings remain in effect through night for Napa, Sonoma and Marin Counties. Mud slides and debris flows continue to threaten northern counties of San Francisco Bay Region.

1/9/95. Mon. 9:00 am. FLSSFO - Flood Statement - Cresting now taking place on Russian and Napa Rivers. Warning remains in effect through Tuesday.

1/9/95. Mon. 9:00 am. FLWRDD - Sacramento River Forecasts. Upper sites of rivers well above flood stage, lower reaches at warning stage. Format unchanged from bulletin from RFC.

1/9/95. Mon. 9:26 am. FFWEKA - Small River and Stream Warning for Lake Co. and all of Mendocino Co.

1/9/95. Mon. 10:00 am. FLWEKA - Flood Warning with update and forecast for Fernbridge stage.

1/9/95. Mon. 10:00 am. FFWRDD - Small Stream Flood Warning continues through tonight for Northern Sacramento Valley and surrounding foothills and lower elevations of Trinity and Siskiyou Counties. Also includes Sacramento River forecasts.

1/9/95. Mon. 10:30 am. FFWSFO - Flash Flood Warning for mudslides/debris flow in San Luis Obispo County.

1/9/95. Mon. 10:50 am. FFSSAC - Urban/Small Stream Flood Advisory. Flood warning continued for small streams and low-lying areas for Yolo and Coulsa Counties today. Urban/Small Stream Flood Advisory for Lower Sacramento Valley and Mother Lode continued today.

1/9/95. Mon. 12:00 pm. FFSSFO - Small Stream Flood Warning remains in effect until midnight for Napa, Sonoma and Marin Counties. Mud slides and debris flows continue to threaten northern counties of San Francisco Bay Area.

1/9/95. Mon. 12:25 pm. FLSEKA - Small River and Stream Flood Warning continues for Mendocino and Lake Counties today.

1/9/95. Mon. 12:45 pm. FFSSFO - Urban/Small Stream Flood Advisory for San Francisco, Alameda, Contra Costa, San Mateo, Santa Clara, Santa Cruz, Monterey, San Benito and San Luis Obispo Counties until midnight.

1/9/95. Mon. 1:30 pm. FLWEKA - Flood warning for Eel River and Van Duzen River. Significant rises also on other stretches of the Eel and Van Duzen Rivers.

1/9/95. Mon. 3:10 pm. FFWEKA - Small River and Stream Flood Warning for Lake and Mendocino Counties.

1/9/95. Mon. 4:00 pm. FFSSAC - Urban/Small Stream Flood Advisory for Sacramento Valley.

1/9/95. Mon. 4:25 pm. FFASFO - Flash Flood Watch for Marin, Napa, and Sonoma Counties. Flash Flood Watch and mudslide/debris flow watch until midnight.

1/9/95. Mon. 4:45 pm. FFSSFO - Flash Flood and Mudslide/Debris Flow Watch until midnight for Napa, Sonoma, Marin Counties. Small Stream Flood Advisory until midnight for San Francisco Bay Area and central coast and Salinas Valley.

1/9/95. Mon. 5:30 pm. FLWSFO - Flood Warning through Tuesday morning for Napa River in Napa Co and Russian River in Sonoma and Mendocino Counties. Near record flooding for Russian River near Guerneville and Napa River at St. Helena.

1/9/95. Mon. 6:00 pm. FFSRDD - Small Stream Flood Statement for Northern Sacramento Valley and surrounding foothills and lower elevations of Trinity and Siskiyou Counties through tonight.

1/9/95. Mon. 6:22 pm. FFSSAC - Urban/Small Stream Flood Statement for north of Marysville to Antioch moving east over Woodland in Yolo County.

1/9/95. Mon. 6:45 pm. FLSRDD - Flood Warning for Sacramento River at numerous points. Format unaltered from bulletin issued by RFC.

1/9/95. Mon. 7:40 pm. FFASFO - Mudslide/Debris flow watch and flash flood watch for the San Francisco Bay Area until 4:00 am Monday.

1/9/95. Mon. 8:00 pm. FLWEKA - Flood Warning continues on Eel River at Fernbridge through Tuesday morning.

1/9/95. Mon. 8:00 pm. FFWSFO - Small Stream Flood Warning effective until 4:00 am Tuesday for Marin, Sonoma, Napa, San Francisco, Alameda, Contra Costa, San Mateo, Santa Clara, Santa Cruz, and Monterey Counties. One to two inches of rain in past 2 hours ending at 7:00 pm. More rain expected. Small creeks now rising.

1/9/95. Mon. 8:00 pm. FFSSAC - Urban/Small Stream Flood Advisory continues through the night for Yolo and Colusa Counties and Lower Sacramento Valley and Mother Lode.

1/9/95. Mon. 8:15 pm. FLSEKA - Flood Statement. Flood Warning cancelled on Eel River at Scotia and Miranda, and Van Duzen River at Grizzley Creek. Small River and Stream Warning continued for Lake and Mendocino Counties, and Flood Warning continues on Eel River at Fernbridge through Tuesday morning.

1/9/95. Mon. 9:00 pm. FFWRDD - Small Stream and River Flood Warning in effect through Tuesday afternoon for the Northern Sacramento Valley and surrounding foothills as well as in the lower elevations of Trinity and Siskiyou Counties, also in effect through Tuesday morning for lower elevations and valleys of Lassen and Plumas Counties.

1/9/95. Mon. 8:58 pm. FFWSFO - Flash Flood Warning until 4:00 am for Central California county of Santa Cruz.

1/9/95. Mon. 9:30 pm. FFSSFO - Flash Flood Statement. Update of river levels. Flash Flood warning until 4:00 am for Santa Cruz County. FFA and Mudslide/Debris Flow Watch until 4:00 am for San Francisco Bay Area. Small Stream Flood Warning until 4:00 am for San Francisco Bay Area and Monterey Counties.

1/9/95. Mon. 9:45 pm. FFWSAC - Small Stream Flood Warning until 12:45 am for Western Placer, Sacramento, Solano, Sutter, Yolo, Yuba, and Colusa Counties.

1/9/95. Mon. 11:00 pm. FLSEKA - Flood Statement. Small River and Stream Flood Warning continues for all of Lake and Mendocino Counties. Flood Warning continues on Eel River at Fernbridge.

1/10/95. Tue. 12:00 am. FLSSFO - Flood Statement. Flood Warning in effect through Tuesday for Napa River in Napa Counties and Russian River in Sonoma County. Near record flooding continues along Russian River near Guerneville. Flood Warning cancelled for Russian River near Hopland.

1/10/95. Tue. 12:40 am. FFSSAC - Small Stream Flood Statement extended through 9:00 am Tuesday for small streams and low-lying areas in Sacramento, Solano, Yolo, Sutter, Yuba, Colusa and Western Placer Counties. Small Stream Flood Advisory continues through morning for Mother Lode County in Nevada, El Dorado, Amador, and Calveras, Counties.

1/10/95. Tue. 2:30 am. FLSEKA - Flood Statement. Flood Warning continues on Eel River at Fernbridge through the morning.

1/10/95. Tue. 3:30 am. FFSSFO - Flash Flood Statement. Cancel Flash Flood Warning for Santa Cruz Co. Cancel Flash Flood and Mudslide/

Debris Flow Warning for San Francisco Bay Area. Small Stream Flood Warning remains in effect until midday for San Francisco Bay area. Small Stream Flood Advisory for Monterey and San Luis Obispo Counties.

1/10/95. Tue. 3:30 am. FLWSFO - Flood Warning until midmorning for the Upper Carmel River.

1/10/95. Tue. 5:00 am. FLWSFO - Flood Warning until midmorning for Upper Carmel River. Stage level at Rio Road Gage.

1/10/95. Tue. 5:17 am. FFWEKA - Small River and Stream Flood Warning continues for Lake and Mendocino Counties. Through midday.

1/10/95. Tue. 730 am. FFSSAC - Small Stream Flood Statement remains in effect until noon for small streams and creeks in Sacramento, Eastern Solano, Western El Dorado, Placer, Western Amador and Northern San Joaquin Counties. Very heavy rains continue.

1/10/95. Tue. 8:45 am. FLSEKA - Flood statement. Flood Warning continues on Eel River at Ferbridge through this evening.

1/10/95. Tue. 9:00 am. FLSSFO - Flood statement. Flood Warning still in effect through Tuesday for Napa River in Napa Co., Russian River in Sonoma Co. Near record flooding continues along the Russian River near Guerneville. Cancel flood warning for Napa River near St. Helena.

1/10/95. Tue. 9:00 am. FFSSFO - Flood Warning. Cancel Flood warning for the Upper Carmel River.

1/10/95. Tue. 9:30 am. FFSRDD - Small Stream Flood Statement. Cancel Warnings for the Northern Sacramento Valley and foothills and lower elevations of Trinity and Siskiyou Counties.

1/10/95. Tue. 9:15 am. FFSFAT - Urban and Small Stream Flood Advisory updated. In effect for Tuesday for the Central San Joaquin Valley and adjacent Sierra Nevada Foothills.

1/10/95. Tue. 9:15 am. FLSRDD - Sacramento River system forecast. Format unchanged from the bulletin issued by the RFC.

1/10/95. Tue. 11:01 am. FFWSAC - Flash Flood Warning until 3:00 pm. Northern San Joaquin, Western Amador, Western El Dorado, Placer, Sacramento, and Eastern Solano Counties.

1/10/95. Tue. 11:45 am. FFSSFO - Flash Flood Statement. Small Stream Flood Warning remains in effect until midday for San Francisco Bay area. Small Stream Flood Advisory for Monterey and San Luis Obispo Counties.

1/10/95. Tue. 12:15 pm. FFSSAC - Small Stream Flood Statement. Flash Flood Warning in effect for Southern Sacramento Co through evening. Small Stream Flood Warning remains in effect until evening for Sacramento, Solano, Western El Dorado, Placer, Western Amador, and San Joaquin Counties.

1/10/95. Tue. 3:00 pm. FFASFO - Flash Flood Statement. Small Stream Flood Warning remains in effect through tonight for San Francisco Bay Area. Small Stream Flood Advisory for Monterey and San Luis Obispo Counties through tonight.

1/10/95. Tue. 3:15 pm. FFSSAC - Small Stream Flood Warning remains in effect until 9:00 pm in Sacramento, Solano, Colusa, Yolo, Western El Dorado, Placer, Western Amador, San Joaquin, Colusa, Yolo Counties.

1/10/95. Tue. 3:16 pm. FFSFAT - Urban Small Stream Flood Advisory extended through tonight for Central San Joaquin Valley and Sierra Nevada foothills.

1/10/95. Tue. 3:45 pm. FFASFO - Flash Flood Watch for the Southern Sacramento Valley and surrounding foothills until 11:00 pm.

1/10/95. Tue. 4:00 pm. FLSEKA - Flood Warning cancelled for all rivers in Northwest California.

1/10/95. Tue. 5:00 pm. FLSSFO - Flood Statement. Flood Warning continued through Wednesday for Russian River in Sonoma Co. Cancel Flood warning for the Napa River near Napa and Russian River near Healdsburg.

1/10/95. Tue. 5:15 pm. FFSSFO - Flash Flood Statement. Mudslide/Debris Flow Watch and Flash Flood Watch cancelled for San Francisco Bay Area, Small Stream Flood Warning remains in effect for San Francisco Bay Area, Monterey and San Luis Obisop Counties tonight.

1/10/95. Tue. 6:00 pm FLSRDD - Flood Statement. Update on the Sacramento River stages. Format unchanged from bulletin issued from the RFC.

1/10/95. Tue. 6:30 pm. FFSSFO - Flash Flood Statement. Update to earlier FFSSFO but cancelling Mudslide/Debris Flow Watch and Flash Flood Watch for Monterey and San Benito Counties.

1/10/95. Tue. 8:00 pm. FFSFAT - Small Stream Flood Warning for tonight in the eastern Sierra Nevada foothills.

1/10/95. Tue. 9:00 pm. FFSSFO - Flash Flood Statement. Small Stream Flood Warning cancelled for San Francisco Bay Area, Small Stream Flood Advisory continues tonight for Monterey County.

1/10/95. Tue. 9:00 pm. FLWSFO - Flood Warning for the Salinas River near Bradley. Significant rise observed on the Pajaro River Tuesday afternoon.

1/10/95. Tue. 9:43 pm. FFSSAC - Small Stream Flood Statement. Small Stream Flood Warning remains in effect tonight for Lower Sacramento Valley, Small Stream Flood Advisory remains in effect for tonight for the foothills of the Sierra Nevada.

1/11/95. Wed. 3:00 am. FFSFAT - Small Stream Flood Warning for Southern Nevada foothills until midmorning.

1/11/95. Wed. 3:30 am. FFSSAC - Small Stream Flood Statement. Small Stream Flood Warning continues until midmorning for Eastern Sacramento and Western Placer Co. Cancel Small Stream Flood Warning for rest of Lower Sacramento Valley and Small Stream Flood Advisory for Sierra Nevada Foothills north of Sonora.

1/11/95. Wed. 4:00 am. FFSSFO - Flash Flood Statement. Cancel Small Stream Flood Advisory for Monterey Co.

1/11/95. Wed. 9:30 am. FLSSFO - Flood Statement. Russian River continue to recede. Flood warning continues through Thursday morning for Russian River in Sonoma Co.

1/11/95. Wed. 10:25 am. FFSSAC - Small Stream Flood Statement. Small Stream Flood Warning continues through noon for Eastern Sacramento and Western Placer Counties.

1/11/95. Wed. 10:30 am. FLSSFO - Flood Warning cancelled for Salinas River near Bradley.

1/11/95. Wed. 12:13 pm. FFSSAC - Small Stream Flood Statement. Small Stream flood Warning for Eastern Sacramento and Western Placer Counties cancelled. Urban/Small stream flood advisory issued for the Lower Sacramento Valley and Sierra Nevada foothills through 6:00 pm. Small Stream Flood Warning for Colusa Co. until 8:00 pm.

1/11/95. Wed. 5:00 pm. FLSSFO - Flood Statement. Flood Warning continues for Russian River at Guerneville. River receding slowly.

1/11/95. Wed. 6:15 pm. FFSSAC - Small Stream Flood Statement. Cancelled Urban/Small Stream Flood Advisory for Lower Sacramento Valley and Sierra Nevada foothills.

1/11/95. Wed. 8:22 pm. FFSSAC - Small Stream Flood Warning for Colusa Co. expired.

WS FORM E-3
(5-71)
(PRES. BY WSOM E-41)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RIVER DISTRICT OFFICE
Central Valley HSA - CNRFC

REPORT FOR:
MONTH January YEAR 1995

FLOOD STAGE REPORT

RIVER AND STATION	FLOOD STAGE (Feet)	ABOVE FLOOD STAGES (Dates) FROM	TO	CREST STAGE (Feet)	CREST DATE
Sacramento River					
Bend Bridge	27.0	1/9 1000	1/9 1600	27.79	1/9 1300
Tehama Bridge	213.0	1/8 1300	1/11 0500	221.1	1/9 2300
		1/13 1400	1/14 2300	218.6	1/14 0400
		1/23 0100	1/24 0100	216.6	1/23 1200
		1/28 1300	1/29 0400	213.7	1/28 1800
		1/30 1300	2/2 2400	216.95	2/1 1600
Vina Woodson Bridge	183.0	1/8 2400	1/10 2200	189.62	1/10 0200
		1/13 2200	1/14 1800	185.91	1/14 0800
Hamilton City	148.0	1/9 0900	1/11 0300	150.65	1/10 0700
Ord Ferry	114.0	1/9 0700	1/12 0300	118.99	1/10 1300
		1/14 0200	1/15 1800	116.39	1/14 2000
		1/23 2000	1/24 1400	114.82	1/24 0500
		1/31 1300	1/31 1700	114.10	1/31 1500

WS FORM E-3
(5-71)
(PRES. BY WSOM E-41)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RIVER DISTRICT OFFICE
Central Valley HSA - CNRFC

REPORT FOR:
MONTH January | YEAR 1995

FLOOD STAGE REPORT

RIVER AND STATION	FLOOD STAGE (Feet)	ABOVE FLOOD STAGES (Dates) FROM	ABOVE FLOOD STAGES (Dates) TO	CREST STAGE (Feet)	CREST DATE
ache Creek					
Rumsey Bridge	14.0	1/8 1500	1/8 1800	14.12	1/8 1700

WS FORM E-3

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RIVER DISTRICT OFFICE:

NWSFO Monterey HSA

REPORT FOR:

MONTH: January

YEAR: 1995

FLOOD STAGE REPORT

RIVER AND STATION	FLOOD STAGE (FEET)	ABOVE FLOOD STAGES (DATES) FROM:	TO:	CREST STAGE (FEET)	CREST DATE
Following are crests which occurred on mainstem river points in the MTR HSA during January, 1995. The times are in PST. Flows from the USGS or ratings in use. E: estimated U: unofficial. Data subject to revison by the USGS.					
Napa Rvr nr St. Helena	13.0	0030 8th	0930 9th	17.47	0015 9th 9080 cfs
		1630 9th	0330 10th	14.43	0000 10th 5820 cfs
		1900 13th	0700 14th	15.05	0130 14th 6310 cfs
Napa Rir nr Napa	25.0	2000 8th	0900 10th	26.96	2100 9th 22900 cfs
Russian Riv nr Hopland	21.0	0100 9th	1000 9th	22.40	0600 9th 31000 cfs
Russian Riv nr Healdsburg	19.0	1300 8th	1200 10th	26.23	0600 9th 73000 cfs
Russian Riv at Hacienda Bridge	34.0	0030 9th	0600 12th	48.01	0000 10th 93900 cfs
		2300 13th	1100 15th	38.33	1400 14th 58800 cfs
Russian Riv at Gurneville	32.0			E48.0	0200 10th
				E36.6	1600 14th
Pajaro Riv at Chittenden	32.0			20.62	1700 26th 5609 cfs
Salinas Riv nr Bradley	13.0	0000 25th	0800 25th	14.10	0400 25th 21220 cfs
Salinas Riv nr Spreckels	23.0			20.37	2000 27th 7950 cfs

WS FORM E-3

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RIVER DISTRICT OFFICE:

NWSFO Monterey HSA

REPORT FOR:

MONTH	YEAR
January	1995

FLOOD STAGE REPORT

RIVER AND STATION	FLOOD STAGE (FEET)	ABOVE FLOOD STAGES (DATES) FROM:	TO:	CREST STAGE (FEET)	CREST DATE
Following are crests which occurred on non-mainstem rivers in the MTR HSA in January, 199 All flood stages are unofficial. All data subject to revision by the USGS.					
Mendocino County:					
Navarro Riv nr Navarro				36.49	0700 9th 51500 cfs
Noyo Riv nr Ft. Bragg				23.93	0800 9th 17500 cfs
Marin County:					
Novato Ck at Novato	12.0			10.95	1600 9th 1820 cfs
San Mateo County:					
San Francisquito Ck	9.5			8.9	2000 9th 3265 cfs
Pescadero Creek nr Pescadero	12.0			17.2	2100 9th 6316 cfs
Santa Cruz County:					
San Lorenzo Riv. nr Big Trees/Felton	14.0			18.4	2200 9th 12400 cfs
Soquel Ck nr Soquel	14.5			17.9	2300 9th 12402 cfs
Corralitos Ck at Freedom	11.5			7.5	2300 9th 1427 cfs
Monterey County:					
Carmel Riv. at Robles del Rio	12.0			12.8	0400 10th
Big Sur Riv. nr Big Sur S.P.	10.0			12.2	0300 10th 6470 cfs
Arroyo Seco Riv. nr Greenfield	14.0			14.2	0200 10th 11078 cfs
Alameda County:					
Arroyo Valle Riv. nr Livermore	10.0			7.5	0400 24th 1800 cfs

US FORM E-3

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RIVER DISTRICT OFFICE:

NWSFO Monterey HSA

REPORT FOR:

MONTH	YEAR
January	1995

FLOOD STAGE REPORT

RIVER AND STATION	FLOOD STAGE (FEET)	ABOVE FLOOD STAGES (DATES) FROM:	TO:	CREST STAGE (FEET)	CREST DATE
Non-mainstem Rivers continued:					
Alameda County (cont):					
Arroyo De La Laguna nr Pleasanton	17.5			18.15	9th 1900 6300 cfs
Alameda creek nr Niles	11.5			11.20	10th 0100 10000 cfs
Santa Clara County:					

REPORT FOR: EUREKA, C

MONTH: Jan

YEAR: 1995

FLOOD STAGE REPORT

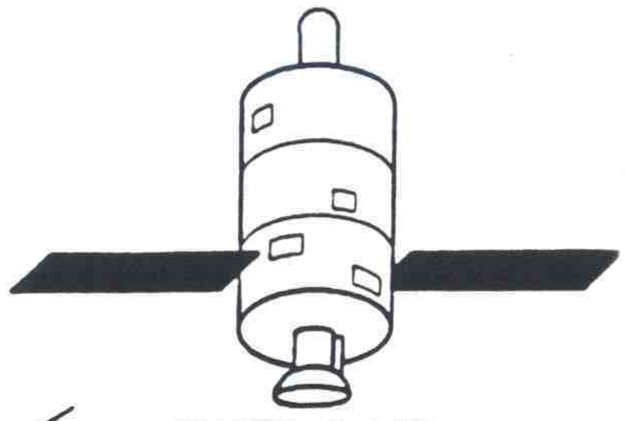
RIVER AND STATION	FLOOD STAGE (FEET)	ABOVE FLOOD STAGES (DATES) FROM:	TO:	CREST STAGE (FEET)	CREST DATE
Van Duzen Bridgeville	17	1/9/95 0200	1/9/95 1000	19.72	1/9/95 0600 pst
Eel Fernbridge	20	1/9/95 0330 pst	1/10/95 1430 pst	25.22	1/9/95 1400 pst
		1/14/95 0300 pst	1/14/95 2000 pst	21.79	1/14/95 1000 pst
Eel Scotia	51			49.8	1/10/95 2300 pst
Smith Jed Smith	26			25.58	1/9/95 1100 pst
Dr Finebridge	33			30.63	1/9/95 1300 pst
Klamath Terwer Creek	34			29.1	1/10/95 0700 pst
Mad River Arcata	24			20.29	1/9/95 1100 pst

Oxnard Wx

Monterey Wx

Reno Wx

All U S Forcast Offices



CONTEL Satellite



CONTEL
Satellite Ground
Station



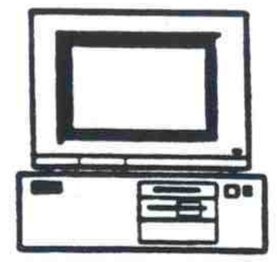
Sacramento
Radio Broadcast



Bay Area
Radio Broadcast

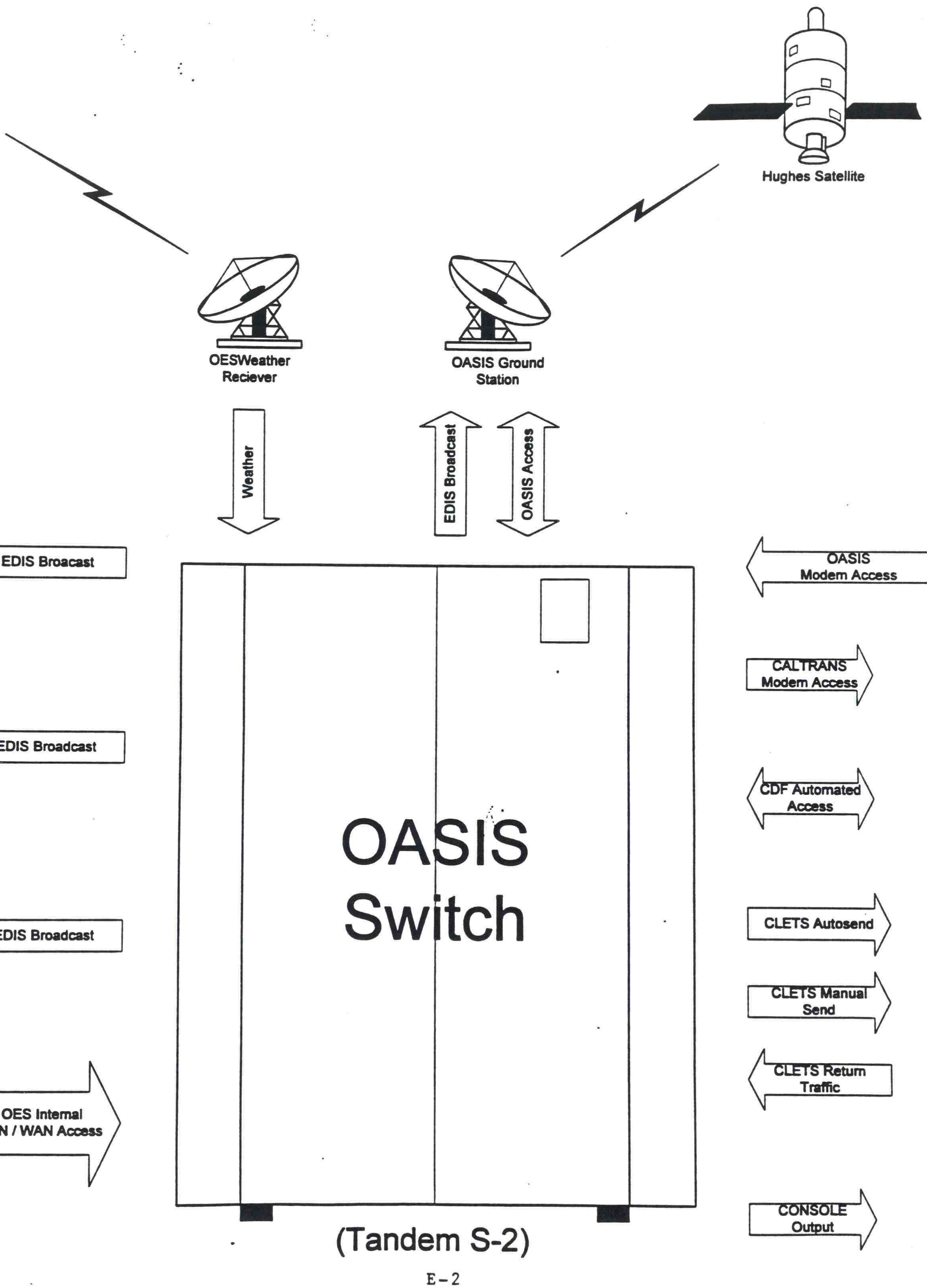


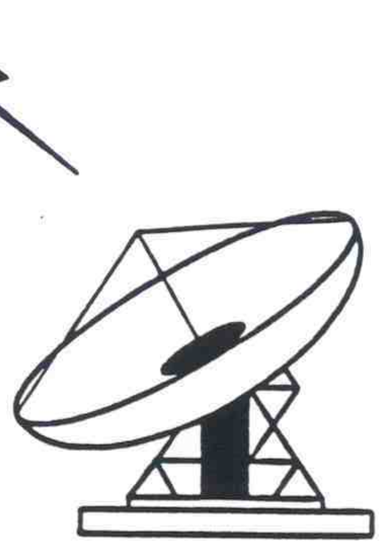
Los Angles
Radio Broadcast



Desktop computer

OES Weather Distribution System


Hughes Satellite
OESWeather
Reciever
OASIS Ground
Station
Weather
EDIS Broadcast
OASIS Access
EDIS Broacast
OASIS
Modem Access
CALTRANS
Modem Access
EDIS Broadcast
CDF Automated
Access
OASIS
Switch
EDIS Broadcast
CLETS Autosend
CLETS Manual
Send
CLETS Return
Traffic
OES Internal
LAN / WAN Access
CONSOLE
Output
(Tandem S-2)



OASIS Terminal

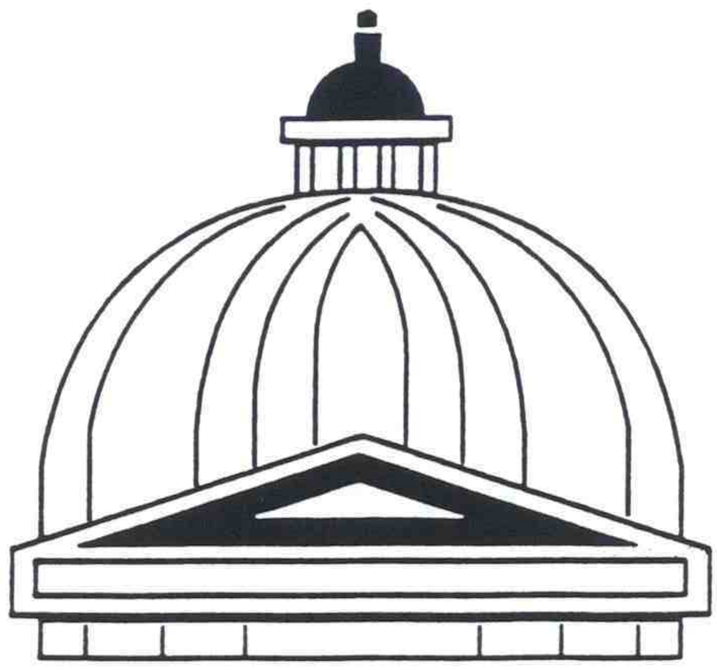


Voice

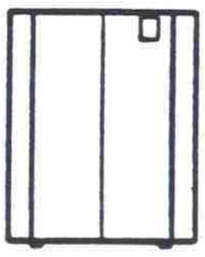
OASIS Access

EDIS Broadcast

OASIS Modem Access

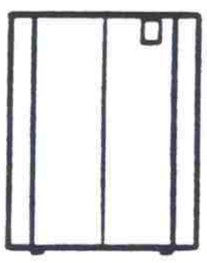


Operational Area
Local Government



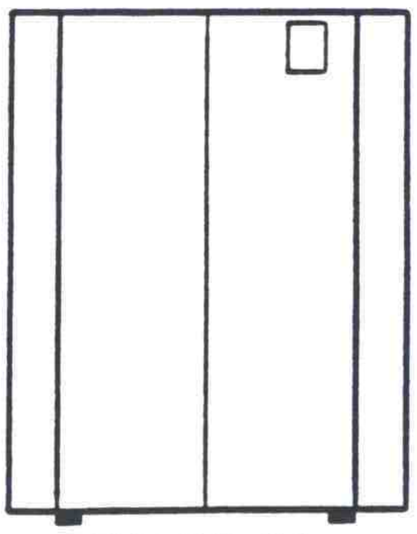
CALTRANS
Switch

CALTRANS Roadwire Network



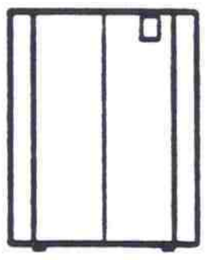
CDF Switch

CDF Network



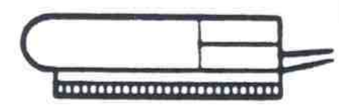
CLETS Switch
DOJ Sacramento

CLETS Network



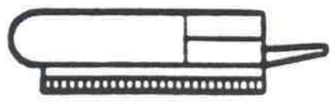
County or
City Switchs

Individual
Mnemonics

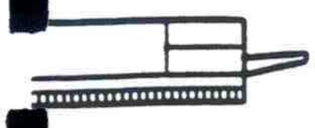


Printer

Individual
Mnemonics

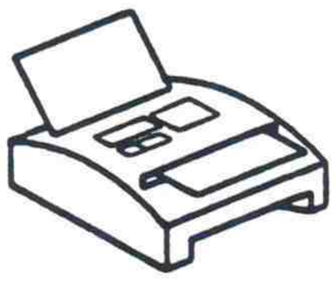


Printer



Printer

OES Fax
Capability



Statewide Fax
Network

Trip of The President to Northern California

City of Roseville
Tuesday, January 17, 1995

Councilmembers

Mel Hamel, Mayor
Pauline Roccucci, Mayor Pro Tempore
Harry Crabb, Jr., Councilmember
Claudia Gamar, Councilmember

Contacts

Allen E. Johnson
City Manager
(916) 774-5362

Marilyn Bartell
Public Information Officer
(916) 774-5201

Larry Pagel
Public Works Director
(916) 774-5331

Julia Burrows
Administrative Analyst II
(916) 774-5434

PUBLIC INFORMATION
CITY OF ROSEVILLE
TRADITION • PRIDE • PROGRESS

311 VERNON STREET, #200 • ROSEVILLE, CA 95678
(916) 774-5201 • TDD (916) 774-5220 • FAX (916) 786-9175

City of Roseville
Background Statistics

Location:	16 miles northeast of Sacramento, the State Capital, in California's Central Valley
County:	Placer County
Population:	58,000 residents
Dwelling Units:	21,000 residential units
Area:	31 square miles
Elevation:	165 feet above sea level
Major Transportation Routes:	Interstate 80 bisects Roseville. 30 minutes southwest of Roseville, Interstate 5 and Highway 99 intersect and state Highway 50 heads east out of Sacramento to the Sierra Nevadas.

Roseville is a full-service City providing water, sewer, and electric power to residents and businesses.

Major employers include Hewlett Packard (3500 employees), NEC (1900 employees), Southern Pacific Railroad (1600 employees), Roseville Hospital (1330 employees), PRIDE Industries (1130 employees) and the City of Roseville (670 employees).

City of Roseville
Description of Drainage Basin and January 10, 1995 Storm Event

Dry Creek Drainage Basin

The Dry Creek Drainage Basin is just under 80 square miles of which approximately 13 square miles or 18% of the watershed is within the Roseville city limits. The Dry Creek basin is comprised of seven streams:

* Dry Creek
* Cirby Creek
* Linda Creek
* Strap Ravine
* Miners Ravine
* Secret Ravine
* Antelope Creek

The Cirby Creek basin is a sub-basin of the Dry Creek basin and is comprised of three streams. The basin is 19.5 square miles of which approximately 6.3 square miles or 32% is within Roseville.

* Cirby Creek (flows into Dry Creek)
* Linda Creek (flows into Cirby Creek)
* Strap Ravine (flows into Linda Creek)

Roseville Flood Alert System

The "Roseville Flood Warning and Response System can be broken down into the following components: the Local Flood Warning System and the Local Response to a Forecasted Flood Threat. Roseville operates 11 stream flow stations, 14 precipitation stations, and three weather stations. These stations are in place to monitor the flood threat on seven streams in an 80-square-mile basin. Data is transmitted from the data collection stations by way of remote sensor antennas.

Flood information is distributed to the public through a public broadcasting system delivering stream flow data through a local cable television station (channel 11). The City of Roseville has a four-tier public notification plan: flood watch, flood threat warning, evacuation, and re-entry.

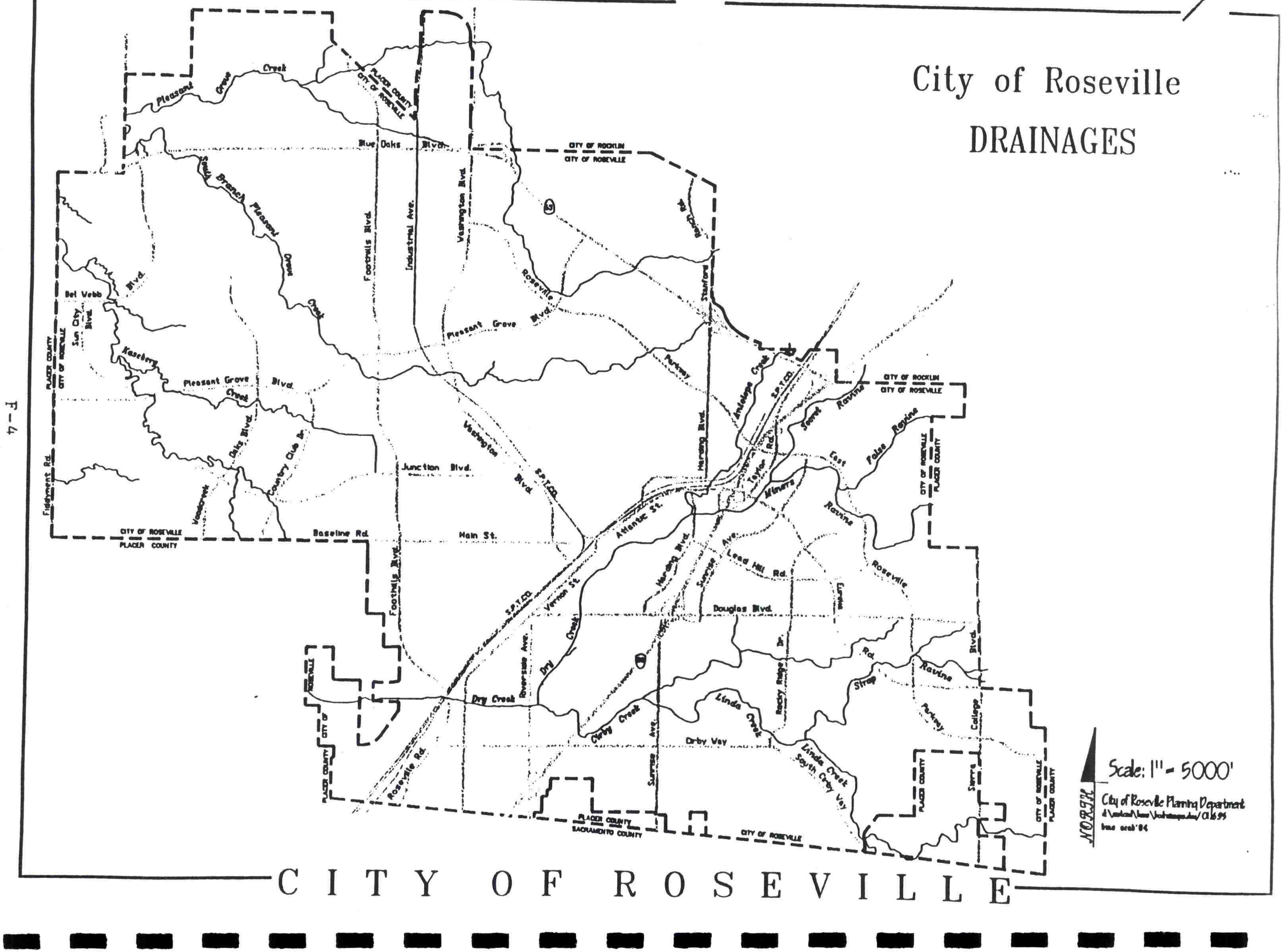
* "Flood watch" is a warning status which alerts Roseville staff and residents to weather conditions which may result in flooding. This level provides enough lead time for residents to prepare for floodproofing measures and evacuation.

* "Flood threat warning" is a situation which alerts Roseville staff and residents to current weather and basin conditions which will probably result in flooding and evacuation. This warning classification provides sufficient lead time for residents to prepare for evacuation.

* "Evacuation notice" is a warning and instruction to Roseville residents and City staff that current basin and weather conditions will result in flooding. Designation of this alarm level will initiate the evacuation and sheltering of those people whose homes and businesses are forecasted to flood.

* "Re-entry notice" serves to inform residents that designated areas are safe to re-enter after the flood threat has subsided.

City of Roseville
DRAINAGES



CITY OF ROSEVILLE

City of Roseville
Description of Drainage Basin and January 10, 1995 Storm Event cont'd.

Storm Event

The intense rainfall on January 9 and January 10, 1995 plus the already saturated ground from above average rainfall for November and December caused the 1995 flooding. Measured rainfall causing the streams to overflow showed intensities that exceed any estimation of "probable rainfall." At the Roseville Water Treatment Plant on Barton Road, the rain gage measured 4.21 inches in a four hour time period. This is more rain than received in 24 hours during the 1986 flooding. Prior to this storm, a rainfall intensity of 4.25 inches in 24 hours represented a 100 year storm event. Roseville had 7.56 inches in 24 hours at the Water Treatment Plant gage.

Stream Levels

Stream Elevations (measured in feet)
based on preliminary data from Flood Alert System gages.

Location	Minimum Elevations 9 Jan 95 (time of day)	Maximum Elevations 10 Jan 95 (time of day)	Difference
Dry Creek at Vernon Street	114.26 (7:02 p.m.)	132.17 (12:01 p.m.)	17.91
Linda Creek at Tina Way	124.64 (6:56 p.m.)	138.71 (11:12 a.m.)	14.07
Linda Creek at Oakridge Drive	132.67 (6:17 p.m.)	145.33 (10:20 a.m.)	12.66
Linda Creek at Champion Oaks Drive	147.19 (7:12 p.m.)	158.30 (9:20 a.m.)	11.11

Impacts of Development

Because the City only includes a small portion of the Dry Creek Basin, the effects of development within the City are negligible. A City flood control plan (the *Dry Creek Watershed Flood Control Plan*, dated March 1992) shows that over 75% of the flows for a future 100 year storm event will originate outside the Roseville city limits for the Dry Creek Basin. Approximately 80% of the flows for the Cirby Creek basin during a future 100 year storm event will originate outside the city limits. Increases in stream flows due to future development will vary between 10% and 20% overall. Roseville's portion of this increase varies from between less than 1% and 5%.

Roseville DOES NOT nor does the City have plans to divert stream flows to particular neighborhoods or areas of the City. The City's flood control program has been devised to mitigate drainage impacts to all affected areas of the City.

City of Roseville
1995 Flood Statistics

Public Safety
Injuries: None reported
Fatalities: None reported
Number Evacuated 10 Jan 95: 500+ residents
Number Rescued 10 Jan 95: 60-100 residents

Damage Estimates
Private Property: $3,735,000
Public Property: $4,386,100
Total Preliminary Damage Estimate: $8,121,100

Private Property Estimates*:

Homes:	319 homes with $2,859,000 in damage
Businesses:	25 in 11 buildings with $570,000 in damage
Apartment Complex:	31 units at Twin Creek Commons, 720 Sunrise Blvd. with $256,000 in damage
Churches:	First Southern Baptist Church, 1301 Coloma Way with $50,000 in damage
Total Private Property Damage:	**$3,735,000**

*Damage estimates are for structures only. Does not include fencing, personal belongings, or vehicles.

Public Property Damage Estimates:

Water/Sewer Infrastructure:	$2,104,000
Wastewater Treatment Plant:	$ 328,000
Streets/Engineering:	$1,149,100
Parks:	$ 750,000
Electric:	$ 50,000
Fire Apparatus:	$ 5,000
Total Public Property Damage:	**$4,386,100**

Major public infrastructure damages:
Old Auburn Road at S. Cirby Way $1,020,000
(bridge washed out, culvert, street repair)
Miner's Ravine Bike Trail $ 500,000
(7 bridges in need repair and pavement needs replacement)

Personnel (at height of flood recovery effort)
City of Roseville: 300 City staff
California Department of Forestry (CDF): 111 crew members with leadworkers
California Conservation Corps (CCC): 39 crew members with leadworkers
National Guard: 2 members
Volunteers: 20 average on weekdays, 250 on Saturday
Total Personnel: 443 full-time staff dedicated to flood recovery and storm preparation.

City of Roseville
1995 Flood Recovery Efforts

Flood recovery efforts began on January 10, 1995. Programs and activities in the City of Roseville include the following:

- Roseville Flood Assistance Program
- Neighborhood Assistance
- Creek Clearing
- Immediate Damage Assessment
- Utilities
- Security
- Public Safety during predicted 13 Jan 95 storm event
- Road Closure
- Volunteer Efforts
- Sandbags

Roseville Flood Assistance Program

Roseville's Flood Assistance Program consists of:

* $500 grants to help owners and renters repair their homes and replace personal belongings.
* $5,000 no-interest deferred loans to property owners for property repair.

City Council approved assistance at special meeting held January 16, 1995, and directed staff to begin distribution of grant checks on Tuesday, January 17, 1995.

Neighborhood Assistance

1. *Debris Clearing*. City crews, California Department of Forestry and Fire, California Conservation Corps, and community volunteers performed house-by-house clean-up in the affected neighborhoods. The crews were distributed to those areas hardest hit by the flood waters and assisted with debris removal from the homes, yards, and nearby creeks.
2. *Debris Removal*. Over 160 dumpsters (average = 1 for every 3 houses damaged) were distributed by the City of Roseville between 12 Jan 95 and 14 Jan 95. The dumpsters were emptied an average of 12 times per day. The Western Regional Landfill remained open after hours and City refuse workers worked overtime to remove the debris. Between 12 Jan 95 and 15 Jan 95, 772 tons of debris were collected and hauled to the landfill.
3. *Pumping of Individual Homes*. City water/sewer crews, Fire Department crews and crews from the California Conservation Corps pumped standing water from over 100 deluged residences.

Creek Clearing

In preparation for any future storm events and to protect the public safety, hundreds of staff-hours were spent clearing the creeks of debris from the January 10, 1995 storm. Nearly a dozen large trees were removed in addition to several tons of limbs, personal belongings, and household debris which had flowed into the City's streams. Over 150 workers, including City parks maintenance crews with the assistance of the California Department of Forestry and Fire crews, the California Conservation Corps, and volunteers, spent four days to clear the creeks.

City of Roseville
1995 Flood Recovery Efforts cont'd.

Immediate Damage Assessment

A total of 10 inspection teams consisting of one building inspector and one planner performed a structure-by-structure damage assessment on January 11, January 12 and January 13, 1995. Each structure had to be inspected prior to restoration of electricity, gas, cable television, and telephone service. The information collected will form the list of those to receive grants and loans from local and federal assistance programs. During the three day period, 319 single family homes, 25 businesses, 31 multi-family dwelling units, 1 elderly retirement apartment complex, two churches, and one elementary school were inspected. Reinspections to verify information will occur the week of January 16, 1995.

City employees are documenting all damage to public infrastructure from the winter storm disaster. The City is eligible for reimbursement for a percentage of the damage to public improvements from the Federal Emergency Management Agency.

Utilities

Electric. Electricity is provided by Roseville Electric Utility Department. Electricity was restored to all homes by January 13, 1995 with one exception. The property owners at 720 Sunrise Avenue (31 apartments were damaged) requested that the electricity be disconnected until an electrician could inspect the units.

Natural Gas. Natural gas is provided by Pacific Gas and Electric. Gas service restored to all areas by January 13, 1995. Individual service is not restored until PG&E inspects homes for safety reasons. Undetermined number of homes still without gas service.

Telephone Telephone service is provided by Roseville Telephone Company. Telephone service also restored on house-by-house basis. Telephone company employees continuing house-by-house reinstallation.

Cable Television. Cable television service provided by Jones Intercable. Cable TV service restored to all areas by January 13, 1995. Individual connections are dependent upon electricity and safety of individual appliances.

Security

Police officers were on-duty in the neighborhoods from January 10, 1995 through January 16, 1995. All traffic entering the six areas during daytime hours was monitored and through traffic was restricted. During night-time hours, all access was monitored with residents only being allowed into the areas. A total of two arrests for prowling were made during the six-day period.

Public Safety during 13 Jan 95 Storm Event

A second storm system was predicted for Friday, January 13, 1995. To keep those residents without electricity and/or access to the Channel 11 Flood Alert System informed, five city vehicles were posted in the neighborhoods and staffed by city employees. The city employees were in constant radio contact with the flood alert staff. Any and all neighborhood residents could come to the vehicles during the night and inquire about the stream level status. The City's presence was very well received by the neighborhoods, and fortunately, the streams did not reach alarm stage.

Volunteers

City residents and cleaning crews received assistance from numerous civic and religious organizations and area businesses. The major effort was on Saturday, January 14, when over 250 volunteers helped clean affected neighborhoods, clear gutters of debris to aid water flow, help residents load belongings into moving trucks, and clean public facilities.

A partial list of volunteer groups includes:

* Local clubs and associations including the Kiwanis, Rotary and Lions Clubs
* Roseville Telephone Company
* Church of Jesus Christ Latter Day Saints
* St. Rose Catholic Church
* Boy Scout Troop 1 of Roseville
* Bank of America, Roseville Main Branch
* Granite Springs Church, Rocklin
* Board of Realtors
* City employee volunteers
* Individual neighbors and citizens ranging in age from 8 to 75 years from the local area and outlying areas.

Sandbag Sites

The City maintained three locations for sandbag pick-up with the assistance of the California Department of Forestry crews, California Conservation Corps crews and volunteers:

1. Maidu Community Center
2. Fire Station No. 3, 1300 Cirby Way
3. Washington Boulevard across from the Placer County Fairgounds

Two private retail stores also offered sandbags to local residents and businesses:

1. Home Depot on North Sunrise Avenue
2. Lumberjack located on Riverside Avenue.

City of Roseville
1995 Flood Recovery Efforts cont'd.

Road Closure

The only road remaining closed is Old Auburn Road at South Cirby Way. The bridge and culvert washed out following the heavy rainfall. The Streets and Engineering Divisions have secured the road and installed a detour. Reconstruction of the roadway will be the Engineering Division's first priority in obtaining bids and negotiation of contracts.

Household Hazardous Waste

The City's hazardous materials team has responded to several calls for assistance with hazardous waste. For household hazardous waste, the City has placed a bin for paints and a bin for oil at the Sierra Gardens Elementary School, 711 Oakridge Drive.

Roseville Flood Work since 1986

1986 flood damage: $7.5 million

Notification:

Created superior flood alert warning system with over 30 rain gauges (14 in Roseville), 11 stream gauges, three weather stations and an extensive computer monitoring system that is constantly updated as weather conditions change. We have direct connection with Doplar radar in Sacramento and satellite imaging of incoming storms. System gives us information needed to provide MINIMUM two-hour notification to evacuate.

Annual Streambed Maintenance:

Extensive creek cleaning to prevent blockage of culverts and bridges by trees and debris.

Construction:

Between 1986 and Fall, 1993, city spent over $3.5 million on flood control projects.

1993 - Replaced Diamond Oaks culvert - brought all area homes out of 100-year floodplain - $500,000

1992 - Replaced Loretto Bridge and widened channel between Eich School and Sierra Gardens Boulevard - brought all area homes out of 100-year floodplain - $700,000

1990 - Enlarged culvert in Diamond Oaks Road to improve water-carrying capacity - protected 10 homes that flooded in 1986

1989-90 - Spent over $1 million for environmental document that prioritizes flood control projects citywide (document adopted 1991)

1988/89 - City of Roseville was one of the key players in creating the Placer County Flood Control District, which established standards and recommended fees for development and flood control within the entire watershed. Fees are being collected by agencies within the district to pay for flood control projects specified in several regional studies developed by the District.

1986 - Improved railyard culvert over Dry Creek to facilitate water flow downstream preventing backup at confluence of Cirby & Dry Creek to prevent flooding of Riverside Avenue and protect area properties

1986 - Culvert added at Champion Oaks Road across Linda Creek and channel improvements made upstream to increase channel capacity

1986 - Quadrupled size of culvert at Rocky Ridge to adequately handle 100-year flood

Roseville Flood Work since 1986 cont'd.

Summary of Measure C (flood control) - defeated by voters in 1993:

Project cost: $13.8 million
Annual property tax assessment: $34 per $100,000 assessed valuation

Project would have:

* Provided flood protection for 243 properties along Cirby, Linda & Dry Creeks between Vernon Street and Old Auburn Road

* Provide 100-year flood protection for major street crossings, ensuring that all neighborhoods would be accessible to emergency services

Measure C defeated by voters by a 2-1 margin.