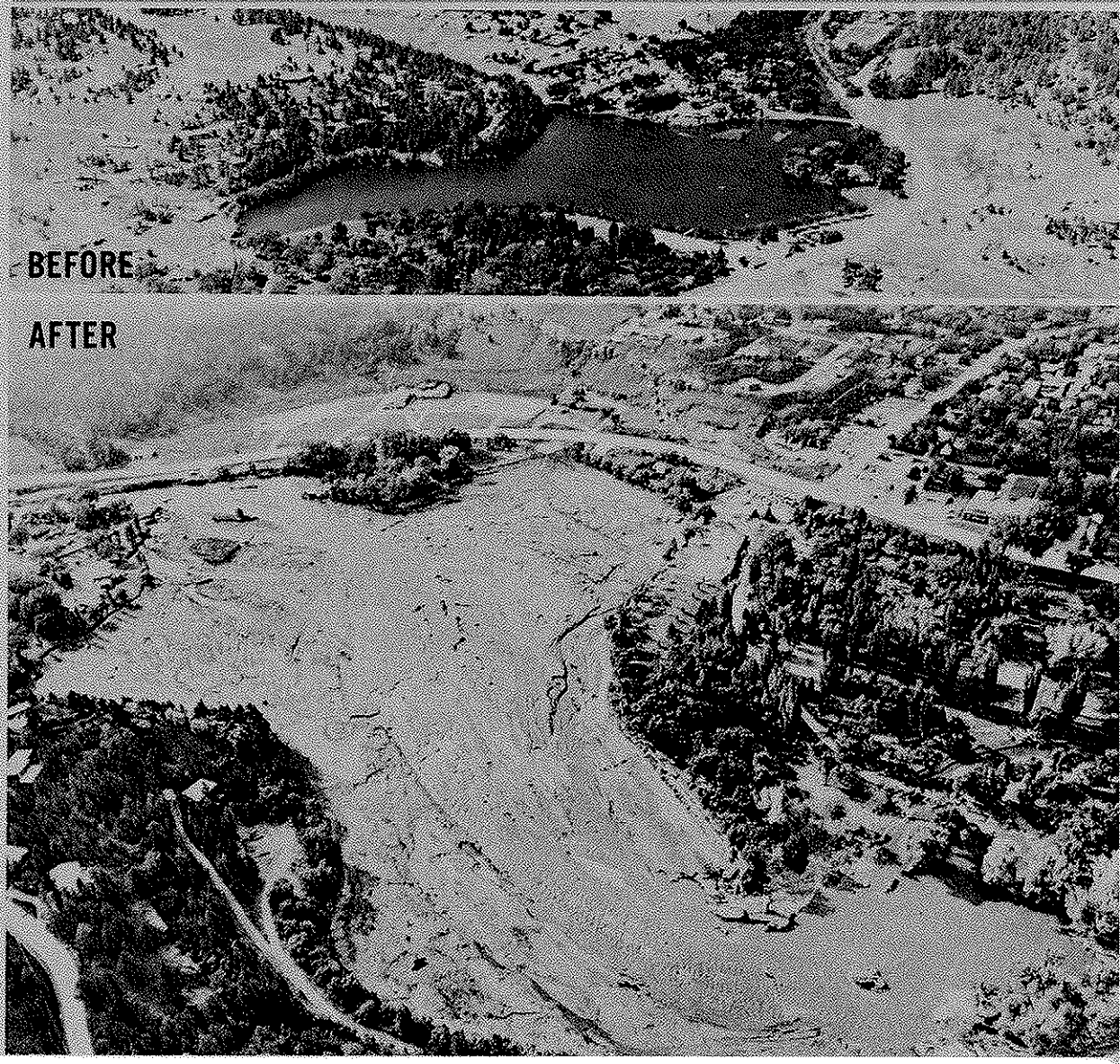
NOAA NDSR 72-1

# NATURAL DISASTER SURVEY REPORT 72-1

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

# BLACK HILLS FLOOD OF JUNE 9, 1972

A Report to the Administrator




ROCKVILLE, MD.
AUGUST 1972

U.S. DEPARTMENT OF COMMERCE
Peter G. Peterson, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

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## FOREWORD

The morning after the disastrous flood swept through the canyons and valleys of the Black Hills of South Dakota, a survey team was dispatched to the devastated area to review the effectiveness of NOAA's warning service and to identify weaknesses that require remedy. This report—The Black Hills Flood of June 9, 1972—presents the findings and recommendations of the Survey Team.

**D. C. House,** Chief,
Meteorological and Hydrological Services

## PREFACE

A survey team composed of Joseph A. Strahl, Chief, Operations Branch, Office of Hydrology; Herbert Lieb, Deputy Director, Office of Public Affairs; Lawrence Longsdorf, Hydrologist, Kansas City River Forecast Center, and D. C. House, Meteorological and Hydrological Services, reviewed the National Weather Service system performance related to the disastrous flooding of the Black Hills of South Dakota during the evening of June 9, 1972.

This team began its fact-finding in Rapid City late in the evening of June 10, 1972. Except for the laborious task of completing the rainfall survey, the essential facts were developed by June 14 at which time the team left Rapid City, leaving Lawrence Longsdorf in Rapid City to complete the rainfall survey.

Contributing to this report were numerous individuals within NOAA, other Federal agencies, officials of the State of South Dakota, Pennington County, and the City of Rapid City, and the representatives of the news media. The survey would not have been successful without their cooperation and assistance.

## EXECUTIVE SUMMARY

### INTRODUCTION

In a few hours during the late afternoon and evening of June 9, 1972, a record rain fell on the Black Hills of South Dakota. A stationary group of thunderstorms over the Central Hills dumped as much as 15 inches of rain in some locations in less than 6 hours.

The rains resulted in record-breaking floods on streams draining the eastern slopes of the Black Hills. At least 236 people are known dead and property damage exceeded $100 million in Rapid City and the surrounding recreational areas.

The Survey Team tried to determine whether the observation-warning-dissemination system worked as effectively as it could have, and whether the Rapid City flood would have lessons and applications to broader regional and National plans and programs as well. The team's major findings and recommendations follow.

### FINDINGS

- Flash flood warnings issued by the National Weather Service Office (WSO) at Rapid City, S.Dak., were timely and useful. Prompt action by State, city, and county officials, and the Rapid City radio and TV stations undoubtedly saved a great number of lives.
- While WSO Rapid City was fortunate in receiving radar reports by telephone from a research team at the South Dakota School of Mines and Technology, the primary radar coverage for Rapid City is a military radar at Ellsworth Air Force Base (AFB) with a remoting system at the WSO. This system was inoperable during the Rapid City flood.
- The staff on duty at the Rapid City WSO the night of the flood did receive significant reports of rainfall at strategic locations in the Hills. These few rainfall reports together with radar reports were instrumental in the issuance of the timely warning. However, at the time of the flood there was no organized real-time reporting system for river flow and rainfall that was able to provide essential information.
- The prime means for the exchange and coordination of critical radar and severe weather information between NWS stations is an internal teletypewriter network known as the Radar Report and Warning Coordination Circuit (RAWARC). The WSO at Rapid City is one of the 33 NWS offices with local warning responsibility that do not have a RAWARC circuit.
- A one-way hot-line telephone is the primary means of transmitting routine or emergency weather and hydrologic information to the news media in Rapid City. No teletypewriter circuits service the news media, and the State has no NOAA Weather Wire. The one-way hot-line telephone permits WSO to reach the radio and television stations in Rapid City, but the broadcasters' only way to call NWS is by a publicly listed commercial telephone.
- The telephone is also the principal means of calling other NWS stations. The NAWAS system is used to contact State Radio. No backup communications or emergency power are available.
- The Black Hills have several population centers exposed to some possibility of flooding. Nationwide, thousands of other population centers are also subject to flash flooding. The survey team notes that initial planning and some implementation of regional flash flood programs have been accomplished.
- The Black Hills attracts many campers and visitors, and it was difficult to warn those people in the more remote canyons and valleys. This is a National problem, as an ever-increasing number of people visit mountainous regions prone to flash floods.
- The Rapid City area has a nucleus for the organiation of an effective community action program; however, there was not a complete exchange of information between the WSO, news media, and local disaster officials.
- The basic observation network of surface, upper air, and radar observations is about 50 percent complete in South Dakota.
- The survey team found that two short visits had been made by the Regional Office to the station since the present MIC had been assigned one and a half years ago. The station's ability to carry its assigned program responsibilities were discussed, but

not in detail, during that visit. Although recent governmental personnel constraints have resulted in reductions in regional office staffs, the span of control of this regional office with some 73 Weather Service and Forecast Offices makes it difficult for higher echelons to monitor the activities of stations, and for the station itself to obtain assistance. In any event, it is clear that there is a need for closer relationships between the station and the next level of authority.

## RECOMMENDATIONS

- The Federal Plan for Weather Radars and Remote Displays should be revised and an acceptable local use radar or a remote from a WSR-57 site be substituted for those locations with warning responsibility now scheduled to utilize remotes from Air Force FPS-77 Radars. The remoting criteria in the Plan should be reviewed and updated to provide definitive information for all types of radars, local warning requirements, and distance of the remote site from the master.
- Develop in cooperation with other agencies a plan for a long-term national flash flood warning program, including the programing of resources, and determine, on a priority basis, the population centers that are to be provided flash flood warning services.
- Action should be accelerated to determine the needs and to establish a river flow and rainfall reporting system suitable for use in the maintenance of the flash flood warning program. The survey team notes that the solution to the problem is not unique to the Black Hills area and urges that such a system be developed within the context of a National plan.
- The Radar Report and Warning Coordination Circuit (RAWARC) should be installed at Rapid City as soon as funds can be made available and at other NWS stations having warning responsibilities. The priorities for the installation of RAWARC should include the following criteria:
    1. Stations in areas prone to severe weather.
    2. Stations with warning responsibilities.
- A system should be implemented that will enable National Weather Service Offices to obtain, validate, and relay to officials responsible for community action timely information concerning critical weather and hydrologic events. The system should include a capability to deliver hard copy (teletypewriter circuits such as NOAA Weather Wire are suggested) while maintaining a two-way voice capability. Ideally the system should ensure that communications, including backup and emergency power, exist at all times to permit two-way exchange of information between the WSO, news media, Civil Defense, and other local officials.
- To help protect people in remote recreational areas, NOAA in consort with other Federal, State, and local agencies should develop and distribute sufficient educational materials to highlight man's exposure to potentially dangerous weather situations.
- Action should be taken to complete the basic observational network in South Dakota as soon as possible. By fiscal year 1974, the level of completeness should reach 75 percent, which is equivalent to that of the surrounding States.
- Every attempt should be made to use data available from weather satellites as a prediction and warning tool, and steps should be taken to staff the National Severe Storms Forecasting Center at Kansas City adequately to interpret the data.
- NOAA should also accelerate the implementation of its Plan to Improve Local Weather Forecasts and develop and carry out a program plan for improving knowledge of the physics of thunderstorms and related mesoscale weather phenomena.
- Steps should be taken to provide the Weather Service Offices a closer and more frequent working relationship with the next higher authority. This may require adjustments in regional office functions.

## CONTENTS

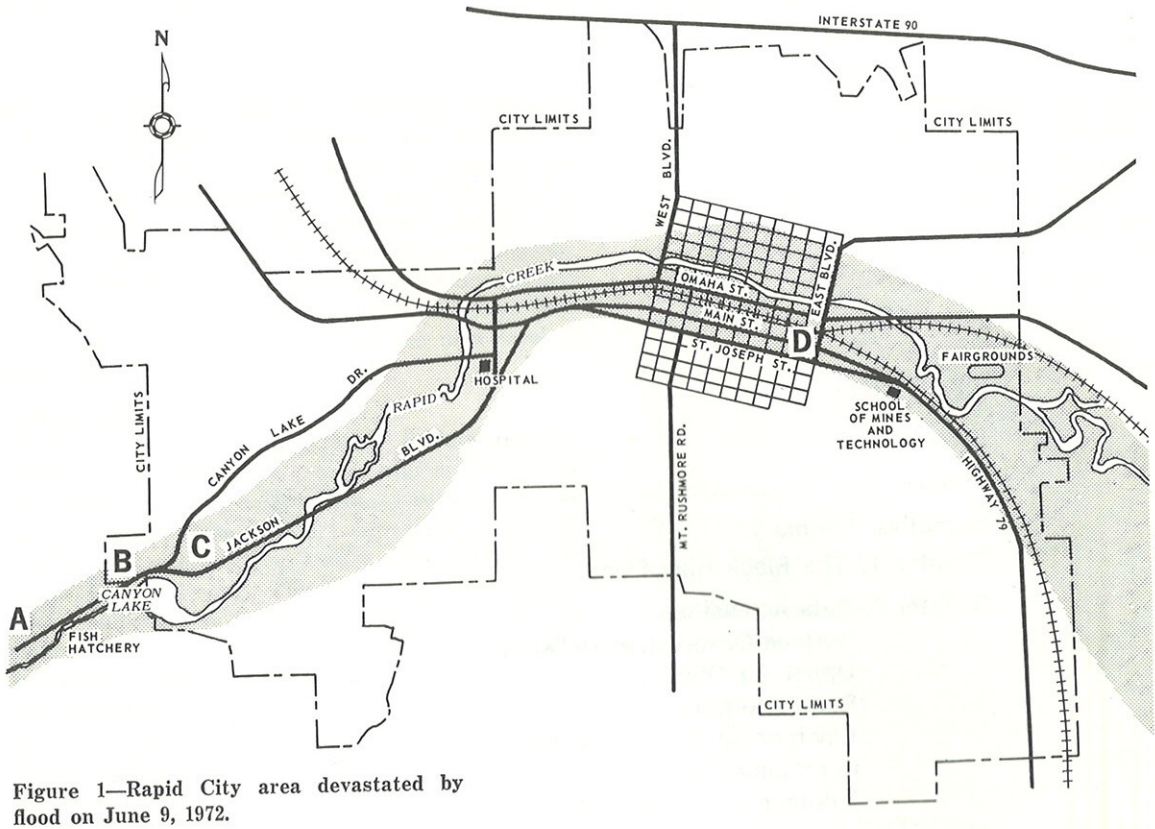
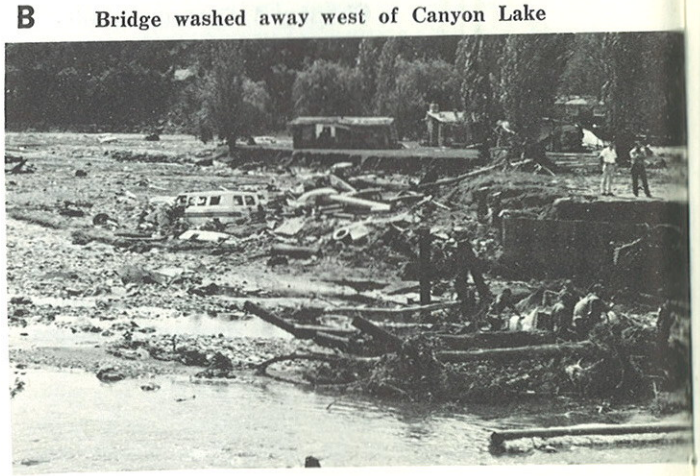



**Figure 1—Rapid City area devastated by flood on June 9, 1972.**

**A** Southwest of Rapid City

**B** Bridge washed away west of Canyon Lake



**C** Canyon Lake

**D** Rapid City

## CHAPTER 1

# The Black Hills Flood

Central to the Black Hills Flood of June 9, 1972, is Rapid City, S.Dak., population 43,836, located at about 3,000 feet above sea level. It is the gateway to the beautiful Black Hills, the summer playground of 2½ million tourists. Carrying in its legends the names of Custer, Wild Bill Hickok, Calamity Jane, Sitting Bull, and Crazy Horse, the Black Hills provide a mile-high backdrop for some of the West's most unusual attractions. Mt. Rushmore, Needles Highway, Custer State Park, Wind Cave, Crazy Horse Monument, and Spearfish Canyon are featured highlights of this unmatched family vacation land. Camping, fishing, sightseeing, skiing, and exploring are superb throughout the Black Hills. Abundant natural resources; fine automobile highways; prolific mines and forests and agricultural and grazing lands; beautiful wooded parks and flowered meadows with deer, elk, buffalo, mountain sheep, and beaver; trout-laden streams and waterfalls—all contribute to a complete relaxing environment. Here President Coolidge and his family spent a summer. Here Mount Rushmore National Monument has 60-foot-high granite images of Presidents Washington, Jefferson, Theodore Roosevelt, and Lincoln.

Rapid City takes its name from, and is divided by, Rapid Creek, a typical, boisterous mountain stream draining melted snow and rain waters from the rugged rocky crests and spruce-covered slopes of the central portion of the Black Hills. The creek has its headwaters near 7,140-foot Crooks Tower, just south of Cheyenne Crossing and 34 miles west of Rapid City. As its name suggests, its waters race 4,000 feet downhill to the city, controlled only by a dam at Pactola about midway between the city and the stream's origin. The rushing waters are only momentarily delayed as they pass through Canyon Lake at the western edge of the city. Then they accelerate as they race through the narrow gap, cut over the ages by the stream and framed by Dinosaur Hill on the right bank and "M" Hill on the left bank. The waters of the stream then flow along the main business district of the city on their way to join the Cheyenne River, 30 miles to the southeast on the prairie.

In his search for quality of life, man has attempted to utilize the natural beauty of Rapid Creek to provide him with a comforting backdrop for a more carefree life. It was in this setting that nature turned against him in a few short hours of one of its most violent rampages on June 9, 1972. Figure 1 shows the Rapid City area devastated by the flood.

The flooding was not restricted to Rapid Creek but was equally serious to the north on Box Elder Creek, and to the south on Spring and Battle Creeks, which also flow into the Cheyenne River. Fortunately, the latter two creeks do not travel through large population centers.

Fifteen inches of rain fell at Nemo on Box Elder Creek and 14.5 inches in about 5 hours near Sheridan Lake, located on the divide between Spring Creek and Rapid Creek, southwest of Rapid City. This set the stage for the great flood on Rapid Creek and the utter destruction of two-thirds of the city of Keystone on Battle Creek.

This deluge was the result of a meteorological condition consisting of a strong low-level easterly flow that forced the accompanying moist air up the Black Hills, causing it to cool and release its moisture. An important contributing factor was that the higher atmospheric levels had unusually light winds which did not disperse the moist air but allowed the storm to remain fixed over the central Black Hills.

The heavy sustained rainfall for a period of 3 to 6 hours was centered just to the west and northwest of Rapid City as shown in figure 2. This precipitation averaged about four times the 6-hour amounts that are to be expected once every 100 years in the area. The resulting runoff produced record floods along Box Elder, Rapid, Spring, and Battle Creeks. Preliminary calculations by the U.S. Geological Sur-

vey indicate that Rapid Creek had a peak flow of about 31,200 cubic feet per second, 3 miles above Canyon Lake Dam at 10:45 p.m. and 50,600 cubic feet per second, more than 10 times the flow of any previous flood of record, in downtown Rapid City at 12:15 a.m. High-water marks have been used to establish a high stage of 15.5 feet at the Rapid City gage, which reads 9.0 feet when the creek is bank full.

It appears that the relatively small volume of water normally stored behind the Canyon Lake (about 192-acre-feet) would have contributed little to the downstream flooding. The flood waters above Canyon Lake Dam carried debris which clogged the spillway so that the reservoir pool temporarily became 11 to 12 feet deeper than normal. The total storage at this time was about 1,000 acre feet which is five times the normal capacity. Dam failure at 10:45 p.m. released this water causing a giant flood wave that devastated the urban area in its path and drowned more than 150 people during the next 2 hours.

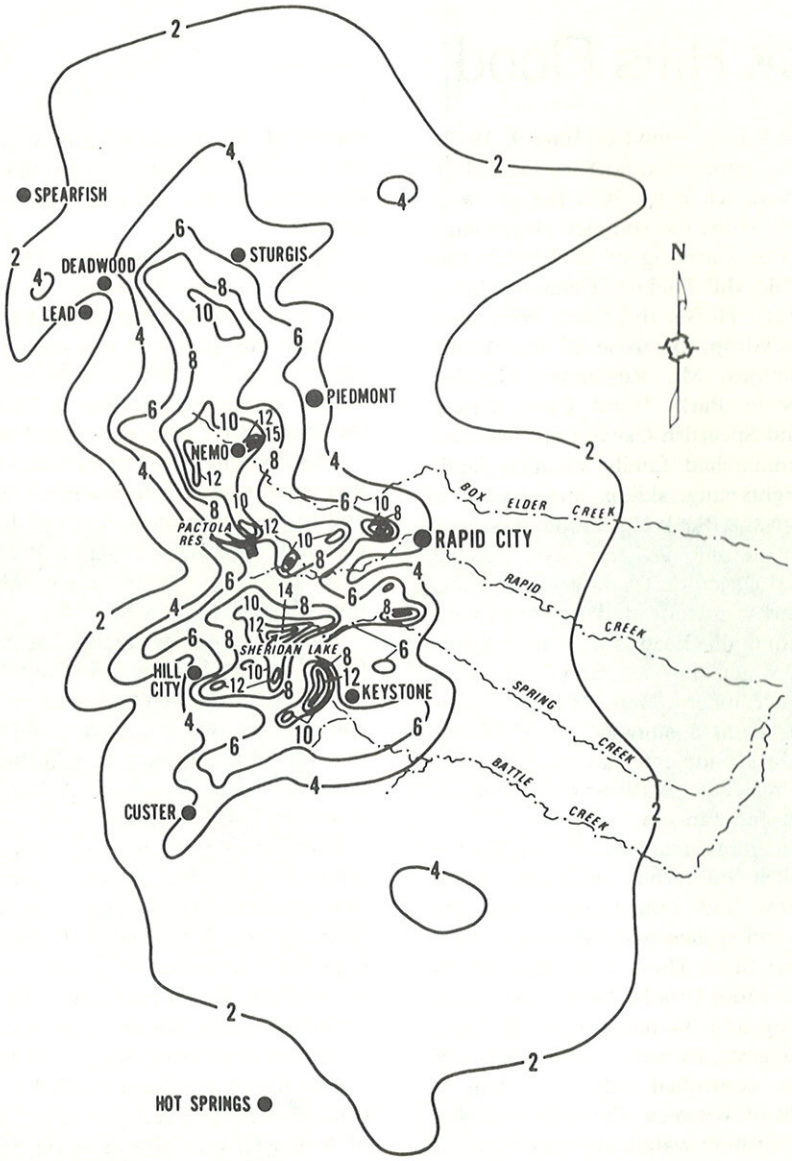



**Figure 2—Total rainfall during evening of June 9 into morning of June 10, 1972.**

Figure 3 shows a map of the Black Hills region and locates the places referred to in this report. The following chronology will provide the reader with a listing of key events and actions before and during the flood.

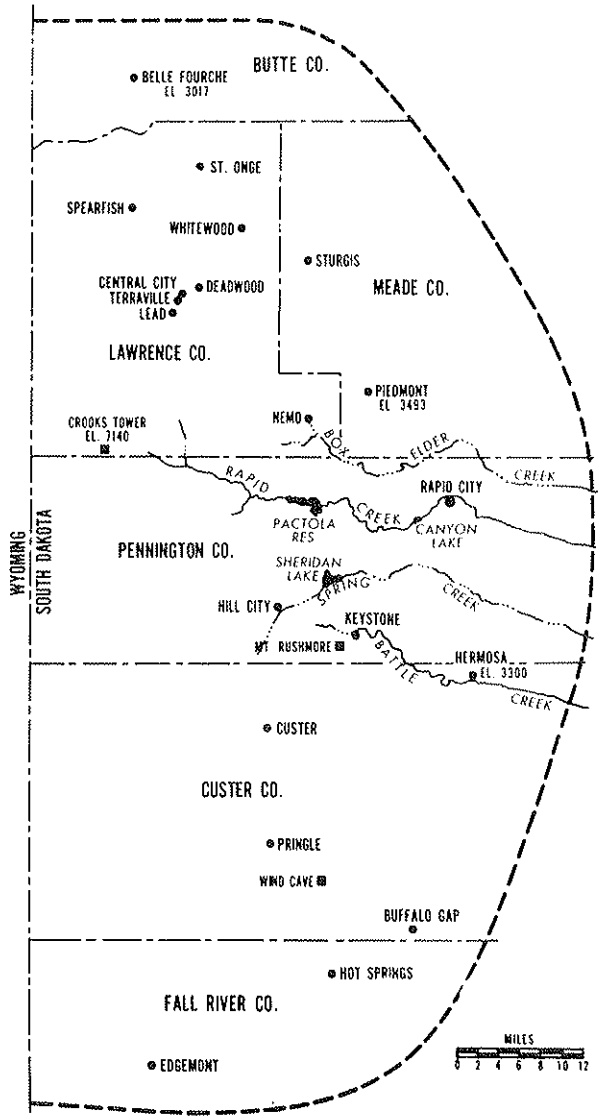



Figure 3—Black Hills Region.

## CHRONOLOGY OF KEY EVENTS

*June 9, 1972*

*9:00 AM** The National Severe Local Storm Forecast Center advised that isolated thunderstorms approaching severe limits were expected in Western South Dakota during the late afternoon and evening.

*Noon* The National Weather Service Office (WSO) at Rapid City predicted a few isolated thunderstorms approaching severe limits in the afternoon and evening in their release to the media.

*3:40 PM* Ellsworth AFB radar observer alerted NWS to the development of precipitation over the Black Hills.

*6:00 PM* State radio requested commercial radio and TV stations to announce that all motorists should avoid Boulder Canyon because of high water. KOTA and others made the announcement as early as 6:15 PM.

*6:15 PM* WSO Rapid City called the State radio dispatcher to obtain any information that office might have on rain in the Black Hills. WSO was advised of 12 inches of water over the highway west of Sturgis and some heavy rains in the Black Hills southwest of Rapid City.

*6:30 PM* Arnett Dennis of South Dakota School of Mines and Technology (SDSMT) radar advised NWS of strong thunderstorms in the Hermosa area.

*6:30 PM* Harold Irish, Civil Defense Director for Rapid City and Pennington County, was at Pactola Dam and called city police to report 3 inches of rain and Rapid Creek rising rapidly.

*6:45 PM* Commander of National Guard advised by Lawrence County sheriff that water was over the road in Boulder Canyon.

*6:50 PM* Alex Kocielski of SDSMT radar advised WSO of heavy rain from Piedmont northwestward through the Northern Hills. He advised that radar indicated that rain was falling at the rate of 2 inches per hour.

*7:00 PM* WSO received report from Galena of 4 inches of rain since 5:00 PM.

*7:10 PM* WSO Rapid City called River District Office in Sioux City to inform them of flash flood situation, to relay rainfall reports, and to request that office's advice and guidance.

*7:15 PM* NWS issued flash flood warning for Northern Hills.

*All times referred to in this report are Mountain Daylight Time.

*7:15 PM* Radio station in Sturgis received flash flood warning from NWS and advised NWS personnel of 6:00 PM report of flooding in Boulder Canyon.

*7:18 PM* Sioux City River District Office contacted the Hydrologist-in-Charge of River Forecast Center (RFC) at Kansas City to relay information concerning the flash flood situation in the Black Hills.

*7:30 PM* Mayor of Rapid City was advised of flood warning.

*7:30 PM* Off-duty guardsmen recalled to duty.

*7:30 PM* KOTA received call from dam tender at Pactola advising of rapid rises along several creeks.

*7:30* PM Hydrologist-in-Charge of RFC advised Sioux City River District Office that flash flood warnings should be expanded to the south and applicable creeks and canyons should be named.

*7:45 PM* The Sioux City River District Office advised WSO Rapid City of the advice received from RFC.

*About 7:45 PM* A person in Nemo advised NWS that Box Elder Creek was in flood, two dams upstream had broken, and low-lying areas in Nemo had been evacuated.

*8:00 PM* NWS revised flash flood warning and issued it to include Box Elder and Rapid Creek drainage.

*8:00 PM* City and county Civil Defense emergency operations center opened.

*8:40 PM* Ellsworth AFB radar observer reported heavy precipitation over central portion of the Black Hills.

*9:00 PM* Commercial telephone service at the WSO became intermittent and unreliable.

*9:30 PM* NWS advised radio and TV stations that radar indications were that heavy rains would continue to fall until about midnight.

*10:10 PM* Rapid City police advised KOTA of evacuation of Brookdale.

*10:30 PM* In TV and radio broadcast, mayor of Rapid City urged immediate evacuation of low-lying areas.

*10:45 PM* Canyon Lake Dam ruptured.

*Midnight* NWS provided the State Civil Defense Director, at his request, with a summary of rainfall and river information as known to them at that hour.

*June 10 about 12:15 AM* Flood crest reached downtown Rapid City.

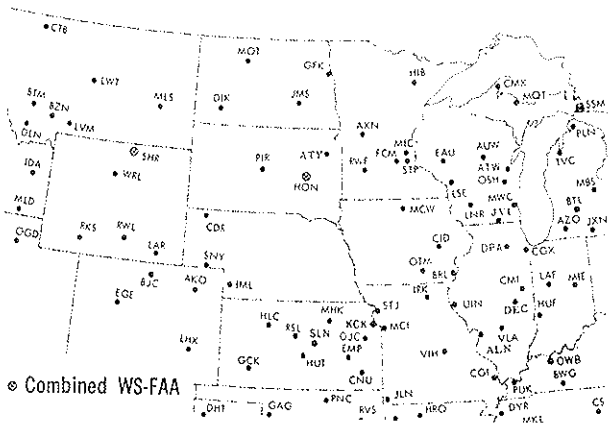
CHAPTER 2

# Data Acquisition

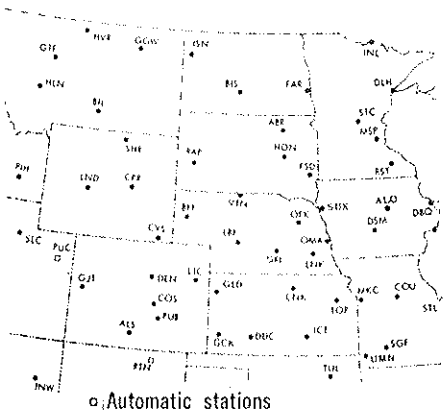
## SURFACE OBSERVATION NETWORKS

The surface observing networks provide basic data for many uses, and they include a variety of data collection systems which are, to the extent feasible, tailored to serve all appropriate uses. In general the networks are divided into two classes: (a) the stations that provide data for immediate use and for record purposes, and (b) the substations that provide data primarily for record purposes.

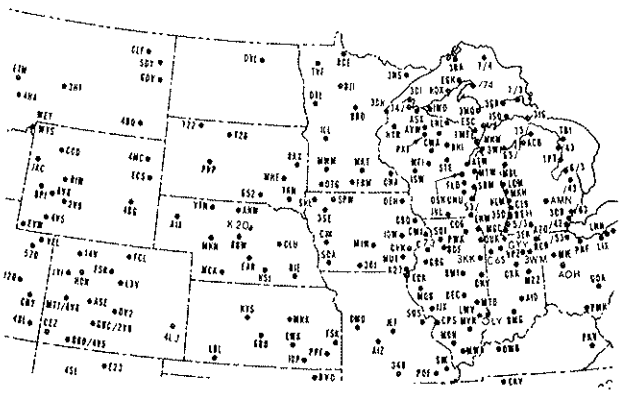
The network of reporting stations in the Rapid City area and surrounding States is shown in figure 4. These stations are manned to provide complete surface observational data on assigned schedules. Observations taken at these stations provide a data base for all weather analysis forecasting, warning, and weather service programs of the Nation and a significant input to the climatology of the Nation. At the present time the spacing between stations in this area averages about 100 to 200 miles. To describe adequately the phenomena of the severe weather type, the spacing between stations should be about 30 to 60 miles. This spacing would require the installation of nearly nine times as many surface observing facilities as now exist in that area. To achieve that density nationwide, about three times as many stations would be required for these purposes at a cost of $45 million.




FAA staffed stations




Weather Service staffed and automatic stations



Other stations

Figure 4—Surface observing stations.

A network designed to provide reports on river stages and rainfall during flash flood situations did not exist before June 9. There was a 16-station climatic network whose observers mailed in reports on a weekly basis. WSO called some of these observers during the evening of the flood to get additional information on rainfall.

Since the flood, a 30-station flash flood warning network has been established. The stations are instructed to call WSO each morning if the past 24 hours have had 1 inch or more of rain and at any time when 2 inches or more have fallen.

## UPPER AIR OBSERVATIONS

Upper air observations include measurements of pressure, temperature, water vapor, and wind direction and speed at various levels in the atmosphere from the surface up to about 100,000 feet. The primary type of upper air observation is the rawinsonde observation, which is taken at 94 NOAA ground stations.

In the Rapid City area and surrounding States, upper air stations are spaced at intervals of 250 to 300 miles. (See figure 5.) All upper air stations recorded and transmitted their scheduled observations. In addition, supplementary upper air wind information is obtained by tracking pilot balloons with theodolites. This information is used to supplement the observations obtained from the synoptic upper air network. Figure 6 shows the network of these stations in the north central United States. All pilot balloon observations were taken as scheduled and transmitted.

The present NWS Upper Air Plan calls for an upper air network spacing of about 250 miles between stations. This spacing is adequate to support data requirements for predictions of large-scale weather events. Experience in severe local thunderstorm forecasting indicates that the network is too gross for predicting phenomena indicative of heavy or excessive precipitation. On a nationwide basis the spacing between upper air stations would have to be reduced by half and the frequency of observations doubled if the density required for a significant improvement in predictions of such phenomena are to be realized. This improvement would cost about eight times that of the existing upper air observations network or $125 million. Because of the high costs of such a network, alternative means need to be used. Initial success in obtaining temperature soundings from satellites suggests a partial alternative for increasing network density. Use of this alternative source of data combined with radar and satellite cloud imagery coupled with the existing upper air observations may eventually permit the forecaster to observe the small details of structures needed for their prediction.

## RADAR NETWORK

Radar observations include the detection and measurement of precipitation, and identification and tracking of squall lines, hurricanes, tornadoes, and other severe storms. These observations provide almost continuous systematic measurements of location, height, and intensity of precipitation, and are reported hourly when precipitation is observed within the area and more frequently when conditions indicate severe storms or rapidly changing weather.

The nationwide radar network includes 88 NOAA stations, of which 38 are equipped with World War II surplus radars with limited capability (local use) and 50 are equipped with modern radars (WSR-57) specifically designed for weather surveillance. These modern radars are located mainly in the tornado belt of the Midwest and along the hurricane-vulner-

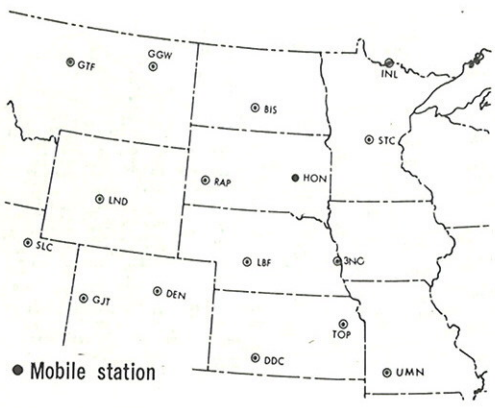



Figure 5—Rawinsonde network

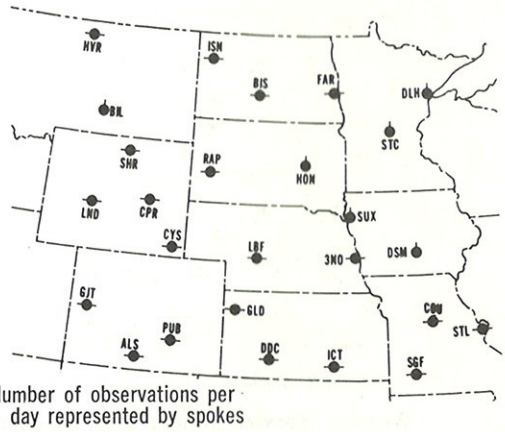



Figure 6—Pibal network.

able Gulf of Mexico and Atlantic coasts. NOAA's radar network is supplemented by observations from Air Force and Navy installations that participate in an interagency Federal network designed to provide 24-hour weather radar surveillance over critical areas of the Nation. Figure 7 depicts the radar coverage surrounding the Rapid City area.

There are two classes of radar uses—one for local warning purposes and the other as a network system. Local use radar provides information for short-period forecasts and warnings in the immediate area. The Federal Plan for Weather Radars and Remote Displays calls for a remoting system to be used to display the scope images via facsimile or slow scan television at locations distant from the primary radar set. This system is designed to permit the forecasters to make detailed analysis of precipitation patterns.

According to the Federal Plan, remote displays should be used to meet local use requirement when there is a suitable radar existing or planned within effective remoting distances and the local requirement does not demand a separate local use radar. NWS plans to install remoting equipment on all its WSR-57 radars to NWS offices within about 75 miles of the radar. Most offices are to be equipped with a remote display receiver with dial-call capability to permit receipt of radar data from any station within the area of forecast responsibility.

The primary radar coverage for Rapid City is the FPS-77 at Ellsworth AFB and a remoting system. The remote system equipment is at the NWS station. However, serious problems have existed with the system. It was not operating during the Rapid City disaster.

The FPS-77 radar experienced intermittent problems during the late afternoon and evening of June 9. The times of outage were 4:40 p.m.-6:35 p.m.; 7:40 p.m.-8:40 p.m.; 9:40 p.m.-10:00 p.m. on June 9, and 3:30-4:30 a.m. on June 10. During periods that the radar was operational, the AF initiated a call at 3:40 p.m. to the NWS duty forecaster to alert him that heavy echoes existed over the Black Hills and also to check the status of the remote system. Further information was passed via telephone at 8:40 p.m. Telephone service was disrupted about 11:00 p.m. owing to flood conditions.

The FPS-77 and the remoting system have several critical limitations.

a. The information is made available insofar as it does not conflict with the primary military mission that the radar supports.

b. Resolution and distortion problems produced by the remoting system when utilized with the FPS-77 and/or the telephone lines linking the two make it difficult to interpret the remote "scope" effectively. The remote site must rely on the master for radar scope interpretation.

c. The remote readout operates only when the master radar of the FPS-77 is in automatic antenna rotation. The remote service will not be available when the master is operating manually so that the operator can study significant echoes in his own area.

d. Maintenance of the FPS-77 system is excessive.

e. The FPS-77 antenna cannot rotate 24 hours per day as required to serve the remote site effectively.

Nationally, the Federal Plan calls for the utilization of 20 FPS-77 radars with 30 remoting systems and 3 additional remoting systems are planned for future installation.

The operation of the FPS-77 system has been a continuing matter of concern between NWS and the Air Force. A recent letter to the Air Force pointed out that information from the Grand Forks

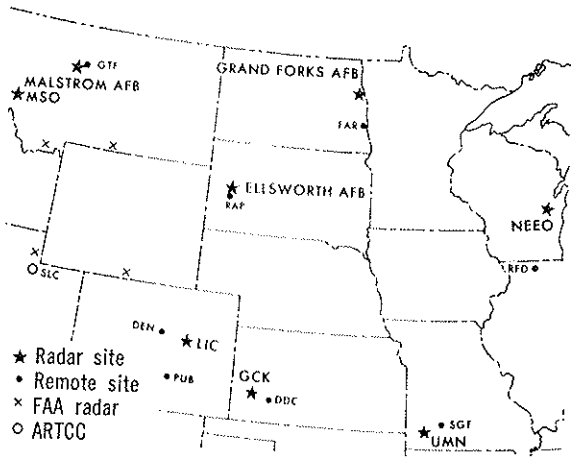
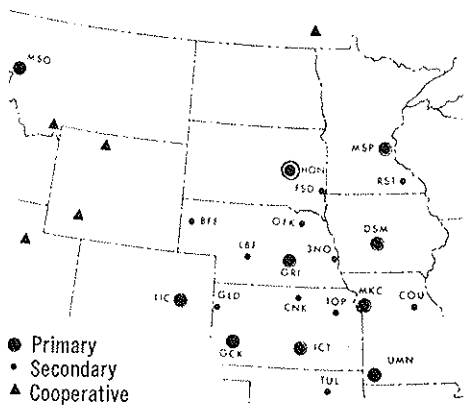



Figure 7—Radar stations. Radar remoting




Radar network

AFB FPS-77 was not available 41 percent of the time at Fargo during the period April 21, 1971, to October 19, 1971. A similar situation exists at Rapid City. The Air Force analyzed the problem and concluded that the FPS-77 antenna system was not designed to operate on a continuous or near-continuous rotation basis. The significant increases in antenna system failure at Ellsworth and Grand Forks are directly attributable to the demands of the local remoting systems for increased antenna rotation.

The Air Force concluded that antenna failures were causing degraded service for their operations as well as for NWS operations and that a solution had to be found. They proposed two alternatives: (1) upgrade the antenna systems at Grand Forks and Ellsworth at a cost of $50,000 per set or, (2) discontinue operations for the remote site.

NOAA responded to the AF letter on March 16, 1972, proposing a 5- to 6-minute transmission three times an hour during periods of significant weather until a suitable solution could be found to the problem.

At the time of the Rapid City disaster, the AF had not responded to the NOAA proposal.

In addition to the FPS-77 system the South Dakota School of Mines and Technology (SDSMT) provides radar information on a voluntary basis to the Rapid City WSO when field operations of its research programs are underway. According to information provided by the personnel of the SDSMT radar, they contacted the WSO between 5:00 p.m. and 6:00 p.m., at 6:30 p.m., and 6:50 p.m., giving information on the development of shower activity over the Black Hills. The WSO staff confirms receipt of information at the latter two times as shown in the Chronology in Chapter 1. None of the three persons; Newby, Behrens, and Deutscher, who were on duty at the WSO between 5:00 p.m. and 6:00 p.m., recalls the earlier contact.

Finally the Survey Team noted that the closest NWS radar is located at Huron, S.Dak., 200 miles to the east. A review of that record reveals that the Huron Radar detected the thunderstorms located over the Black Hills. The information was transmitted in the prescribed manner on the RAWARC circuit which is not available at WSO Rapid City. However, reporting procedures specify that the intensity of storms more than 125 miles away need not be indicated although their location must be reported. WSO Rapid City was unaware of the details of the Huron report.

### ENVIRONMENTAL SATELLITE DATA

Pictures from NOAA spacecraft did cover the severe thunderstorm activity at Rapid City. The pictures from the NASA's Applications Technology Satellites (ATS) were available until about 6:28 p.m. because pictures can be taken only in daytime. Earlier pictures taken from ATS-3 stationed over the Atlantic showed the Rapid City area having clear to scattered clouds. The last picture taken of the area at 3:00 p.m. from the ATS-3, from which a film loop was made by the staff assigned to Kansas City National Severe Storm Forecast Center (NSSFC), indicated possible thunderstorms in the Rapid City area. The information could not be effectively used, however, because the area was on the edge of the photos and there was no way of getting a clear definition of the activity or the intensity of the severe weather. ATS-1, on the other hand, stationed over the Pacific continued to take pictures of the area until the last usable light at 6:28 p.m. A film loop was made but was not available to operational personnel concerned with the flood situation. A later review by the National Environmental Sattelite Service of the 6:28 p.m. film loop and a comparison with earlier loops showed the development and growth of thunderstorm activity in the Rapid City area.

### COMMUNICATIONS

Meteorological data are collected and distributed by a variety of communications systems, including teletypewriter, telephone, and facsimile.

Meteorological observations are transmitted and received on the Service A and Service C teletypewriter networks that provide fundamental surface and upper air data for NWS functions. These circuits are available in the Rapid City WSO and, except for Service C, operated satisfactorily during the course of the disaster. Service C failed around 9:00 p.m., but it did not affect service.

The NWS Radar Report and Warning Coordination (RAWARC) teletypewriter network is used to collect and exchange weather radar reports; severe local storm and hurricane watches, warnings, and statements issued by local WSOs; and such information as observations from substation networks and spotter reports of severe local storms. This circuit had previously been installed in the Rapid City WSO, but was removed more than 10 years ago in an economy move. It is scheduled for implementation again in 1973. This system would have made available more detailed information reported by Huron radar concerning the precipitation pattern over the Black Hills, not otherwise available to the WSO. Nationwide, there are 33 WSOs with county warning responsibility that do not have access to RAWARC. These are planned to be installed by fiscal year 1974.

Basic analysis and prognostic material are received in graphic format by WSO at Rapid City over the National Facsimile System. The system operated satisfactorily during the duration of the disaster.

## FINDINGS AND RECOMMENDATIONS

The survey team concluded that:

**(1) Finding**

No organized real-time system for reporting river and rainfall data exists in the Black Hills area that is capable of providing essential information to assess flash flood potential. Consequently, in this emergency, the principal way to get critical information was through the placement of telephone calls to individuals at strategic locations.

**Recommendation**

Action should be accelerated to determine the needs and establish a river flow and rainfall reporting system suitable for use in the maintenance of the flash flood warning program. The survey team notes that the solution to the problem is not unique to the Black Hills area and urges that such a system be developed within the context of a National plan.

**(2) Finding**

The completeness of the basic observation network depends on the percent completeness of surface, upper air, and radar observations. According to NWS standards, the network in South Dakota is about 50 percent complete.

**Recommendation**

Take action to bring this capability to at least the 75 percent level (equivalent to that of surrounding States) by fiscal year 1974.

**(3) Finding**

The FPS-77 system has several critical limitations. It is doubtful that it would be cost-effective to modify the radar antenna so that it could operate continuously. In addition, the radar must be in automatic mode for remoting use. Military needs, however, preclude operation in this mode for any extended period of time. In addition, a rapid means of communicating with the remote site is needed to facilitate the exchange of information.

**Recommendation**

The Federal Plan for Weather Radars and Remote Displays should be revised and an acceptable radar or remote system be substituted for those locations with warning responsibility now scheduled to utilize remotes from Air Force FPS-77 Radars. The remoting criteria in the Plan is being reviewed and updated to provide definitive information for all types of radars, local warning requirements, and distance of the remote site from the master.

**(4) Finding**

The WSO staff at Rapid City does not include persons skilled in the application of radar to the warning problem.

**Recommendation**

The Rapid City staff as well as those from other radar remoting locations should receive appropriate training in the operation and utilization of data from modern radar systems.

**(5) Finding**

The pertinent hourly radar reports from Huron, S.Dak., suggested that a substantial amount of precipitation was falling into the Black Hills watershed. Information on this detail was not available at Rapid City.

**Recommendation**

Take action to ensure that information of significance beyond 125-mile range be brought to the attention of responsible warning officials.

**(6) Finding**

Access to the Huron, S.Dak., radar reports were available to the Weather Service Forecast Office (WSFO) at Minneapolis and the WSO at Sioux Falls, yet neither station forwarded this information to Rapid City.

**Recommendation**

WSFO should establish procedures for utilizing radar information in issuing and monitoring flash flood alerts.

**(7) Finding**

Usable information indicating the development and growth of the thunderstorm activity in the Rapid City area was available from the ATS-1 and ATS-3 satellites. The use of the data was hampered by lack of personnel at the NSSFC in Kansas City to process the information; the need to use two satellites to obtain the information; and a daytime capability only on the geostationary ATS satellites.

**Recommendation**

Every attempt should be made to use data available from weather satellites as a tool in predicting and warning of severe weather, and steps should be taken to adequately man the NSSFC facility to interpret the satellite data.

**(8) Finding**

The Rapid City WSO does not have access to the prime NWS teletypewriter network known as the Radar Report and Warning Coordination (RAWARC) circuit utilized for the collection and distribution of radar information, severe storm warnings, and other severe weather and hydrologic information. The availability of this system would have provided the WSO with significant useful information during this emergency. Further, it is noted that there are 32 other NWS offices that do not have access to the RAWARC network.

**Recommendation**

That RAWARC be installed at those offices having warning responsibilities. The priorities for the installation of RAWARC should include the following criteria:

1. Stations in severe weather prone areas.
2. Stations with warning responsibilities.

**About ten miles south of Rapid City on Highway 16.**

## CHAPTER 3

# Analysis and Prediction

In fulfilling its responsibility for the prediction of phenomena associated with thunderstorms NWS has established two forecast echelons designed to help local NWS offices predict critical events.

On a national level the National Meteorological Center (NMC) in Suitland, Md., in conjunction with the National Severe Storms Forecast Center (NSSFC) in Kansas City, Mo., provide initial guidance on the location of impending severe thunderstorms. The Weather Service Forecast Office (WSFO) uses this guidance to make forecasts for its area of responsibility. The WSO uses the forecast issued by the WSFO, incorporates into it certain local details, and issues it to the public and specialized users.

NMC, a largely computerized facility, provides a variety of analyses and prediction products covering the Northern Hemisphere. Similar graphic displays with higher resolution cover the continental States and surrounding waters. This basic guidance material, covering a period up to 5 days, is distributed to WSOs over the National Facsimile Network (NAFAX).

Products issued by NMC on the morning of June 9 indicated scattered rain showers and thunderstorms throughout South Dakota and Eastern Wyoming with 30 to 35 percent chance of precipitation and an average of 0.25 inches of rain associated with the thunderstorms for the ensuing flood period.

NSSFC provides a continuous 24-hour surveillance of the development and prediction of severe thunderstorms for the continental States. Its bulletins outline areas and periods of potential severe thunderstorms and/or tornadoes and are distributed over the RAWARC and other national teletypewriter systems to local WSOs for public dissemination. The Severe Local Storms (SELS) Unit of NSSFC also provides a daily outlook indicating regions of possible severe local storm development over the next 24 hours which is transmitted over the teletypewriter system in addition to being transmitted graphically on NAFAX.

Initially, the NSSFC convective outlook issued at 5:05 a.m. on June 9 did not include Rapid City in the expected region of severe thunderstorms. However, at 9:00 a.m. SELS transmitted over Service A an updated outlook which indicated that isolated thunderstorms approaching severe limits were expected in the Rapid City area of responsibility during the late afternoon or evening.

Using the basic guidance from NMC, the NSSFC updated outlook, the South Dakota State forecast issued by WSFO at Minneapolis at 10:10 a.m. indicated scattered thunderstorms in central and western sections of South Dakota with accompanying showers or periods of light rain in the afternoon and evening of June 9. Indications of thunderstorm severity were not included in the forecast.

By early afternoon of June 9, a strong cold front extended through South Dakota from the northwest to the southeast just north of the Black Hills. In advance of the front was a generous supply of moist unstable air.

The potential for scattered thunderstorms in the area was apparent, and examination of the regional weather subsequent to the flood confirmed this forecast. Based upon these indications, Rapid City WSO included the following in their noon release:

> "A few isolated thunderstorms may approach severe limits late in the afternoon and evening over Eastern Montana, Northern Wyoming, and Western South Dakota."

The national guidance centers alerted the local WSO forecaster of the possibility of severe thunderstorms in his region. The capability of subsequently assessing a potentially dangerous mesoscale situation rests with the WSO Weather Service Specialist, who must depend upon local information. Under such circumstances, a localized approach that is

capable of considerable discrimination is necessary if warnings are to be adequate.

In this particular case, a mesoscale network with suitable digitized radar support could have been instrumental in observing and monitoring heavy precipitation and subsequently forecasting flash flooding. To support this proposition, we need only examine the hourly radar reports from Huron, S.Dak., (200 miles east of Rapid City) for this day, from 3:45 p.m. to 10:45 p.m. Nearly stationary radar echoes from thunderstorms were indicated to the west and northwest of Rapid City. That information coupled with locally observed rainfall rates and the known duration of the storm would have clearly indicated the extent and severity of the situation.

Essentially the NWS warning system consists of three parts designed to afford maximum effectiveness. The first part is the predictive part of the system which includes guidance issued by the national centers. Although not detailed it was generally good. Statewide forecast issued by the responsible WSFO at Minneapolis and the zone forecasts for South Dakota by the Sioux Falls WSO were as good as can be expected considering that the basic observational networks in that area were not designed to provide details important to the prediction of such localized phenomenon.

The second part of the system designed to provide details of the significant events occurring is the radar network. As noted, the radar system for Rapid City was not in working condition. A network station at Huron issued radar reports as required but, because of current operating instructions, intensities of thunderstorms over 125 miles from the station are not required to be transmitted even though the location of the thunderstorms is transmitted. However, detailed information reported by Huron radar was not available to Rapid City because RAWARC was not available and alternative means of providing it were not utilized. This was because the offices at Huron, Sioux Falls, and Minneapolis were not aware of the lack of detailed radar information at Rapid City. If it had been known, there seems little doubt that the radar operator at Huron, noting the intense thunderstorm over the Black Hills, would have taken steps to contact Rapid City WSO with the information.

The third part of the system designed to provide information for disasters of this type is a rainfall reporting network. Cooperative observers call rainfall reports into the local WSO when certain rainfall rates are observed. As already mentioned, no network of this type had been established in the Rapid City area.

When Allen Herbert of Galena at 7:00 p.m. voluntarily reported to the WSO that 4 inches of rain had fallen since 5:00 p.m., the WSO immediately contacted the NWS River District Office (RDO) in Sioux City to inform them that a flash flood warning was being released for the Northern Hills and asked for advice and guidance on the flash floods situation. RDO then contacted the Hydrologist-in-Charge (HIC) of the River Forecast Center at his home in Kansas City. After reviewing the situation, the HIC called RDO in Sioux City about 7:40 p.m. and suggested that WSO Rapid City should be advised to expand its warnings to include other drainages to the south. The Sioux City RDO passed this advice to WSO Rapid City about 7:45 p.m. As a consequence of this advice and additional reports from the concerned public which suggested that the center of heavy rains had shifted southward, the flash flood warning issued at 7:15 p.m. was revised at 8:00 p.m. to include the Rapid and Box Elder Creek drainages. This was more than 2 hours in advance of the onslaught of the death-dealing flood crest's arrival in Rapid City. The actions of Behrens and Newby of the WSO staff were prompt and responsive.

## FINDINGS AND RECOMMENDATIONS

**(1) Finding**

Despite the fact that limited knowledge of the physics of thunderstorms continues to hamper the prediction of heavy or excessive rainfall associated with them and that only a limited capability existed at Rapid City for its detection, the warnings of flash flooding were timely and useful. Much can be done, however, to improve capabilities both locally and nationally.

**Recommendation**

NOAA should accelerate the implementation of its Plan to Improve Local Weather Forecasts and develop and carry out a program plan for improving knowledge of the physics of thunderstorms and related mesoscale weather phenomena.

## CHAPTER 4
# Dissemination

### COMMUNITY PREPAREDNESS ACTION

The nucleus of an organization for an effective community action program in the event of natural disasters exists in Rapid City and vicinity. Responsibilities have been assigned, and the system is periodically revitalized.

Three weeks before the flash flood hit, Harold Irish, City and County Civil Defense Director, called a community preparedness meeting on severe local storms. The meeting was attended by representatives from NOAA; city, county, and State Civil Defense (CD) authorities; city, county, and State police; the Red Cross; the Forest Service; Ellsworth AFB; REACT (Radio Emergency Action Group—a local CD network of ham radio operators); hospitals; and the news media. These agencies represent the three functional components that compose the warning system: NOAA, the Federal agency responsible for providing the warnings; State and local civil agencies responsible for protective actions; and the radio and television stations that broadcast the vital information to the public. The principal emphasis at this meeting was directed toward the seasonal problem of warning against severe local thunderstorms and tornadoes. Don Halligan, MIC of the WSO, presented information on the NWS warning services and provided information concerning its interface with community preparedness. The problem of warning against flash flooding was not of prime concern at this meeting. However, the community preparedness plan is designed to function regardless of the type of event likely to produce a disaster.

On June 9, from shortly after 7:00 p.m. to past midnight, a steady stream of flood information and advice spontaneously worked its way at least partially through the community system and some of it was broadcast over television and radio. A band concert before a packed house of 800 persons at Stevens High School was interrupted by an announcement by a police officer who reported that flooding was taking place and urged residents along the periled creeks to take appropriate action. Most of the actions were prompt, and there is little doubt that the quick response by State, city, county, NWS, and the radio television personnel saved a great number of lives. Yet 236 persons are known dead. Nearly 6 square miles within the city of Rapid City were devastated by flood waters causing more than $100 million in damages. About 70 percent of the deaths occurred along Rapid Creek below Canyon Lake Dam in the city while about 15 percent of the deaths occurred in the first 3 miles of Rapid Creek above the dam. Most of these deaths were between 10:30 p.m. and midnight. Some undoubtedly were asleep when the warnings were broadcast. Others were not watching or listening to radio and television. Still others just would not heed the warnings.

The mayor of the city of Rapid City, Donald Barnett, was informed of the developing situation beginning at 7:30 p.m. For the next 3 hours he used all resources at his command to confirm the seriousness of the flood potential and in a simultaneous TV and radio broadcast about 10:30 p.m. urged, in fact pleaded, with the people to evacuate low-lying areas adjacent to Rapid Creek. The city has provision to sound fixed sirens in such a situation. They did not that night. Sirens on patrol cars, however, were sounded in the affected area.

Major General Duane Corning, Commander of the National Guard and State Civil Defense Director, said that he first got word of trouble when he received a call from Sheriff Dick McGraff of Lawrence County at 6:45 p.m. McGraff told Corning that a wall of water was coming down Boulder Canyon and "we might need your help." Corning said that after 7:30 p.m. he recalled all off-duty Guardsmen who were attending annual summer encampment. General Corning, his deputy, Col. Lemaster, and Major Teske, all felt that the death-dealing waters came between 10:30 p.m. and 11:30

p.m. While the official directive ordering the National Guard into service came at 2:00 a.m. Saturday morning, the Guard spontaneously went into help and rescue work as early as 7:30 p.m., Friday, including assisting police in a door-to-door plea to evacuate.

A visit with Robb DeWall of KOTA, the newsman who stayed on duty for 28 hours during the crisis, provided information that was useful in the evaluation of the warning system. KOTA is the Emergency Broadcasting System station for Rapid City. It has a TV viewing audience of 24,000 families during prime time, according to the American Research Bureau ratings. DeWall's log indicates that the first word he received indicating some kind of trouble came from State police radio shortly after 6:00 p.m. State radio called asking him to announce that all motorists should stay away from Boulder Canyon because 8 to 12 inches of water, rocks, and debris were on the road at the east end of the golf course. DeWall broadcasted this over the radio about 6:15 p.m. and TV at 6:45 p.m. DeWall said that his next notification of any kind of threat was the NWS call initiated by Newby at 7:10 p.m., with the warning for the northern hills. KOTA radio and TV broadcasted this warning at 7:15 p.m. DeWall also verified receipt of the 8:00 p.m. NWS warning, extending the warning to include Box Elder and Rapid Creek. DeWall said it was the longest 45 minutes he had ever spent. After the 7:15 p.m. warning, he made repeated calls to get reports from outlying areas. At 7:30 p.m. DeWall got a call from the dam tender at Pactola Dam, who transmitted a report that the creek had risen 4 feet. This was aired by KOTA about 8:30 p.m. At 10:00 p.m. DeWall said that KOTA provided a summary of events. (This summary is reproduced and discussed later in this chapter.) At 10:10 p.m. he received a message from city police advising of evacuation underway at Brookdale. For the most part, KOTA did not interrupt their scheduled program to provide updated information on the flood's progress. Pertinent warnings and other information were transmitted in the form of a "crawl"—a written message which appeared at the bottom of the viewers' TV screen while the programing continues.

## COMMUNICATIONS

Facilities for the collection of special rainfall reports and dissemination of warnings and related information at WSO Rapid City consist of one voice circuit on the Federal Telephone System (FTS), one listed commercial telephone, one unlisted commercial telephone, one listed telephone with automatic answering device, a one-way hot-line interphone connecting WSO Rapid City with the Rapid City outlets of the news media, and an interconnection to the National Warning System. All of these systems are susceptible to outages during thunderstorms and floods.

Considering all the communications systems available for the dissemination of critical information, the Survey Team noted several deficiencies in the case of Rapid City. It was difficult to determine the role these deficiencies may have played in the assessment of the seriousness of the situation and warning of the flash flood. The deficiencies noted were as follows:

1. Neither NOAA Weather Wire facilities nor the Radar Warning and Coordination circuits are available at this office. A "hard copy" record of significant outgoing transmissions is difficult if not impossible to maintain during the stress of a warning situation. WSO Rapid City is isolated from communications with other WSOs and the responsible WSFO. Because time does not permit the routine transmission of information by voice circuits, the Minneapolis WSFO, charged with flash flood monitoring responsibilities, was unaware of Rapid City's problem and did not provide assistance at the critical time.
2. A *one-way* telephone hot-line links NWS to the news media in Rapid City. Other outlying radio stations are called on regular commercial telephone or FTS lines. The hot-line telephone system is used for the dissemination of all products issued by the WSO Rapid City. There is no audible or predetermined distinction made between a routine issuance and an emergency message. A flickering light in the control rooms of the radio and TV stations is the only signal that the WSO is transmitting a message. Often the signal is missed because of other events transpiring at the studio. There is no way for the Weather Service Specialist to know whether his message has been received.
3. WSO Rapid City has the capability of contacting all operating positions on the NAWAS system by a "party-line" system. During the early evening of June 9 this system was used effectively to contact State Radio position in Rapid City. Direct contact with city and county Civil Defense people was not made by the WSO at any time during the crisis. It is known that the city and county Emergency Operations Center was not opened until about 8:00 p.m. when Illa Cannon, the CD Operations Officer, came to the office. This was after the distribution of the 7:15 and 8:00 p.m. flash flood warnings.

4. Shortly after 9:00 p.m., the local commercial telephone service at the WSO became unreliable because of service disruptions and overloaded facilities. After that time, the only reliable voice circuit connecting the WSO with the flood-stricken area was the FTS. To complete a call anywhere into the Black Hills area the Weather Service Specialist would request the FTS operator in Aberdeen, S.Dak., to dial the desired number. This was the only reliable way that critical information could be collected and disseminated.
5. Because the radio and television broadcasters did not have access to the WSO unlisted telephone, they had no way to relay or confirm flood reports. To contact the WSO, they had to use the overloaded listed commercial telephone.

It is apparent that news media and others were receiving warnings issued by the WSO. Derry Newby and Leo Behrens, Weather Service Specialists, used the limited resources available to them to make a continual assessment of the situation and keep all interests informed. Lack of reliable two-way communications between NWS and others denied them timely access to key information. The Survey Team found that the media and others were receiving information before NWS. In some cases there was vital information received that never got into NWS channels.

In summary, available communications systems did not permit the rapid coordination and interchange of information among NWS personnel, State and local officials responsible for emergency action, and the news media. This lead, inevitably, to a situation where there was no single voice speaking authoritatively and no overall assessment of the extent of the flood.

## USER RESPONSE

Human behavior scientists who have studied disasters have pointed out that it is very difficult to warn people successfully against impending danger when they have not experienced the predicted danger in recent years, and when they cannot directly perceive the signs of danger.

The last significant flash flood experience Rapid City had was 10 years before—in June 1962. At that time fewer houses and people were exposed to the dangers of rapid rising creeks and the flow of water. Damage in the 1962 flood was confined to "a few wet basements and lawns." It is entirely possible that the memory of the mild 1962 flood lulled many residents into a false sense of security.

The first NWS flash flood warning was issued at 7:15 p.m. and emphasized flooding potential in the northern portion of the Black Hills. By 8:00 p.m. it was evident that the precipitation was heaviest in the central portion of the Black Hills. Its true intensities were not known. Nevertheless, the flash flood warning was shifted southward to cover the Box Elder and Rapid Creek drainages. It was never extended further southward to include the area drained by Spring Creek. Although these warnings were timely and useful in activating the system, they did not carry with them a sense of urgency because of the complete lack of knowledge concerning the incredible amount of rain that was falling. One person remarked that, "It (the first warning for Rapid Creek) was the kind of warning that suggested that I should bring in the lawn furniture." The following 10:00 p.m. news wrap-up by KOTA would indicate that the magnitude and seriousness of the flood was not realized at that time.

> "Torrential rains struck large areas of the Black Hills tonight—and a full emergency operation is underway at newstime tonight to determine the full extent of the flooding and to rescue persons stranded along swollen creeks.
>
> "All area National Guard units have been called out along with all other emergency personnel. Flash flooding hit Boulder Canyon between Deadwood and Sturgis—Little Elk Creek is causing severe flooding in the Nemo area—and Rapid Creek above Rapid City has risen at least four feet with the downpour—and it is still raining tonight—heavily —in the stricken areas.
>
> "Authorities are urging no travel in the Hills areas hard hit by rains. Bridges are reported washed-out or badly undercut in many spots. As the water has risen tonight in Rapid City—and as the rain continued—travel in western Rapid City was being restricted. Persons living along Rapid Creek are advised to be prepared for a further rise in the creek and more flooding as the water crest moves downstream and rains continue.
>
> "At newstime evacuation operations are under way at the danger points. As the flood story began unfolding this evening, there were many reports of dramatic close-calls to man and vehicles. At this hour, we have no reports of serious personal injuries. Livestock losses have been reported and some buildings are reported badly damaged in hard-hit areas.
>
> "Colonel Chalberg of the National Guard says the Boy Scouts in the Nemo area are safe. He believes the Girl Scouts—also at Camp—are safe, but word has not been received back from rescuers headed for the Girl Scout campsite.
>
> "Colonel Chalberg says "things are bad" west of Cleghorn Canyon . . . and all persons on or near

Rapid Creek should take all precautions against more flooding."

## FINDINGS AND RECOMMENDATIONS

**(1) Finding**

Neither NOAA Weather Wire nor RAWARC service are available in WSO Rapid City. A one-way hot-line telephone is the primary means of rapidly disseminating warnings to the news media. Telephone is the primary means of contacting other WSOs. Other methods such as VHF/FM and DIDS have been suggested as national solutions to the warning dissemination problems.

**Recommendation**

A system should be implemented that will enable NWS offices to obtain, validate, and relay to officials responsible for community action timely information concerning critical weather and hydrologic events. The system should include a capability to deliver hard copy (appropriate teletypewriter circuits such as NOAA Weather Wire) while maintaining a two-way voice capability which would enable users to verify receipt and exchange vital emergency information with NWS.

**(2) Finding**

There was not a complete exchange of information between WSOs, news media, and local disaster officials. Ideally, a community action program provides for a single command post, headed by a single responsible official, where all disaster agencies and news media are represented. The system should provide for hard copy of warnings received from WSO and permit essential coordination and feedback information to the WSO via appropriate communication facilities.

**Recommendation**

NOAA should work in cooperation with other agencies toward the organization of a community action program at Rapid City (and elsewhere) that will provide a single authoritative voice during periods of disaster emergencies.

**(3) Finding**

Emergency power, while not a critical deficiency in this instance, is not available at WSO Rapid City. Backup communications were not available and would have been helpful.

**Recommendation**

Action be taken to install emergency power and backup communication facilities.

## CHAPTER 5

# Program Responsibilities

NWS issues and maintains a program letter that outlines the responsibilities of each of its offices. The purpose of the program letter is to describe the field office operational functions; establish station responsibilities for programs, their products and services; and to provide guidance to the Meteorologist-in-Charge and his staff for the conduct of the program, including the establishment of standards for evaluation of quality and suitability of its output products and services. Such a letter was issued by the Director, Central Region, on April 14, 1972, to WSO Rapid City. It was used as the principal basis for this survey team's review of station performance.

WSO Rapid City is charged with the responsibility for assuring that the applicable NWS products and services are of top quality and are suitable, adequate and delivered in the most efficient manner possible. At the time of the flood, the authorized staff pattern consisted of two professional meteorologists (the Meteorologist-in-Charge and his principal assistant) and eight meteorological technicians. One of the latter positions was vacant. Although the MIC and his principal assistant are expected to perform operational shift duties, this vacancy required them to spend more time than normal on shift duties at the expense of carrying out their supervisory responsibilities and development of service programs at the station.

Specifically, the MIC's responsibilities include:

1. The preparation and dissemination of local and vicinity public forecasts and warnings.
2. The preparation and issuance of warnings to the general public of hazardous weather in the State's nine westernmost counties. (See figure 8.)
3. The impetus, organizational and educational assistance to establish the necessary trained spotter networks for both summer and winter storms, and assistance in the establishment of a community/county warning systems.

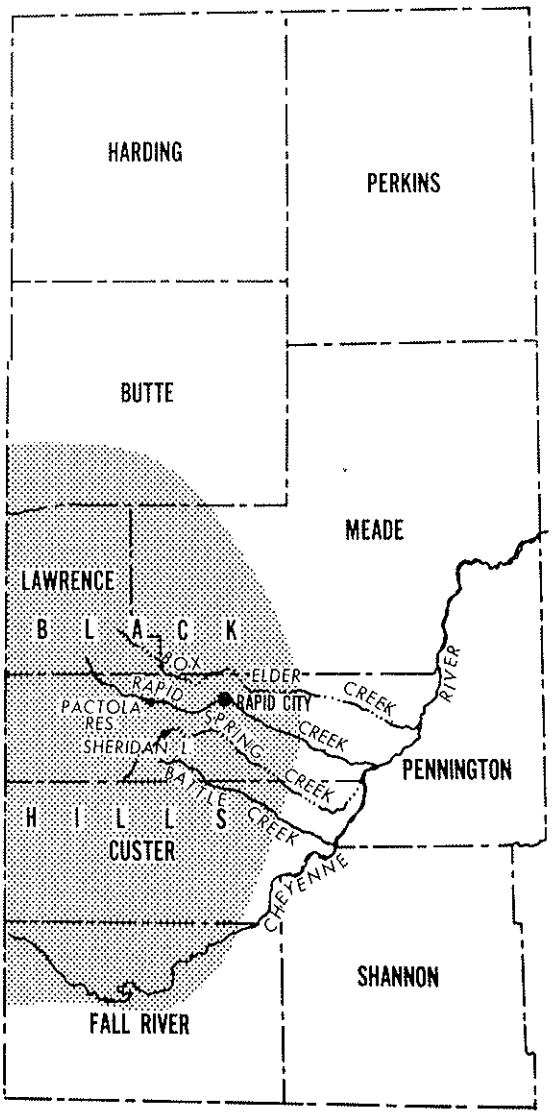



**Figure 8—Warning responsibility area of Weather Service Office, Rapid City, South Dakota.**

4. The observational program in support of the NWS nationwide observing and climatological networks as well as those needed to provide all data required by the local public.
5. The furnishing of weather briefing service and distribution of warnings to aviation interests.
6. The preparation of specialized forecasts of forest fire potential and related fire weather advice.

The program letter appropriately assigns top priority to the mass dissemination of emergency warnings. Second priority is given to the observational program in support of nationwide observing and climatological networks. All other station activities, including the organizational and educational assistance to establish trained spotter networks and community warning systems, are of lower priority.

While the wording of the program letter suggests that a responsibility exists for warnings of general and flash flooding, an explicit assignment of responsibilities is not included in the current letter but was to be forwarded at a later date. (It had not been received prior to the flood.) The NWS Operations Manual Chapter E-13 assigns the general responsibility for, and outlines the procedures for issuing Flash Flood Alerts, Watches and Warnings. Although the program letter makes occasional and casual references to "spring flooding" hazards, the degree to which appropriate warning networks should be developed and the methods of accomplishing the office's implied responsibilities are left to the judgment and innovation of station personnel.

The survey team examined the capabilities of the

**About one-quarter-mile from Keystone on Mt. Rushmore Road.**

station to carry out the work described in the program letter and found the station did not have the ability to meet its assigned responsibilities as thoroughly as could be desired.

As indicated previously, the Survey Team found critical deficiencies in the station's ability to obtain and use radar information; an extremely limited and failure-prone information collection and dissemination capability; a complete lack of supporting river and rainfall network; and manpower and other resource constraints that severely limited the development and conduct of an effective community flash flood warning system.

The development of a community warning system places a substantial workload on the station. The system must be tailored to the individual community, designed in cooperation with local officials, and should result in clear and recognizable channels of authority during disasters. In addition, it involves making arrangements for the acquisition of data through community actions to agument the information derived from other facilities such as radar and satellites.

Four criteria are suggested for establishing need and priority for installation of warning systems.

1. Frequency of critical flash flooding. The initial design should be based upon the provision of warnings specified for critical portions of any flood plain (including flood plains below established flood control dams) such as those portions between the high-water contours of the 5- and 50-year flood,
2. The number of persons inhabiting these critical flood plain areas,
3. The value of property within these contours that can be protected by warnings received 1 to 6 hours ahead of the event, and
4. Cost of warning system must be commensurate with the value of protection afforded.

While specifically applied, here, to the Black Hills, these criteria are equally applicable to the establishment of flash flood warning systems nationwide where there are several thousand places subject to flash flooding.

## FINDINGS AND RECOMMENDATIONS

**(1) Finding**

The survey team found two short visits had been made by the Regional Office to the station since the present MIC had been assigned one and a half years ago. The station's ability to carry its assigned program responsibilities were discussed, but not in detail, during either visit. Although recent governmental personnel constraints have resulted in reduction in regional office staffs, the span of control of this regional office with 73 Weather Service and Forecast Offices makes it difficult for higher echelons to monitor the activities of stations, and for the station itself to obtain assistance. In any event, it is clear that there is a need for closer relationships between the station and the next level of authority.

**Recommendation**

a. Periodical, in-depth program analyses of station activities, including the identification of

user requirements and the determination of unmet needs should be emphasized. The station's ability to perform the assigned responsibilities should be assessed, priorities determined, responsibilities confirmed, and resource allocation established accordingly.

b. Steps should be taken to provide the Weather Service Offices a closer and more frequent working relationship with the next higher authority. This may require adjustments in regional office functions.

**(2) Finding**

The nation contains thousands of population centers that are subject to flash flooding. The Survey Team notes that some initial planning and implementation of regional flash flood programs has been accomplished.

**Recommendation**

Develop in cooperation with other agencies a plan for a long-term national flash flood warning program including the programming of resources and determine, on a priority basis, the population centers that are to be provided flash flood warning services.

**(3) Finding**

Ever increasing numbers of people are attracted to picturesque flash flood prone canyons and valleys of mountainous regions for camping, recreation, etc. It is becoming increasingly difficult to ensure that those people be warned of severe weather and flash flooding.

**Recommendation**

Education materials must be developed in cooperation with other agencies and distributed to highlight man's exposure to potentially dangerous weather situations in remote areas.

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