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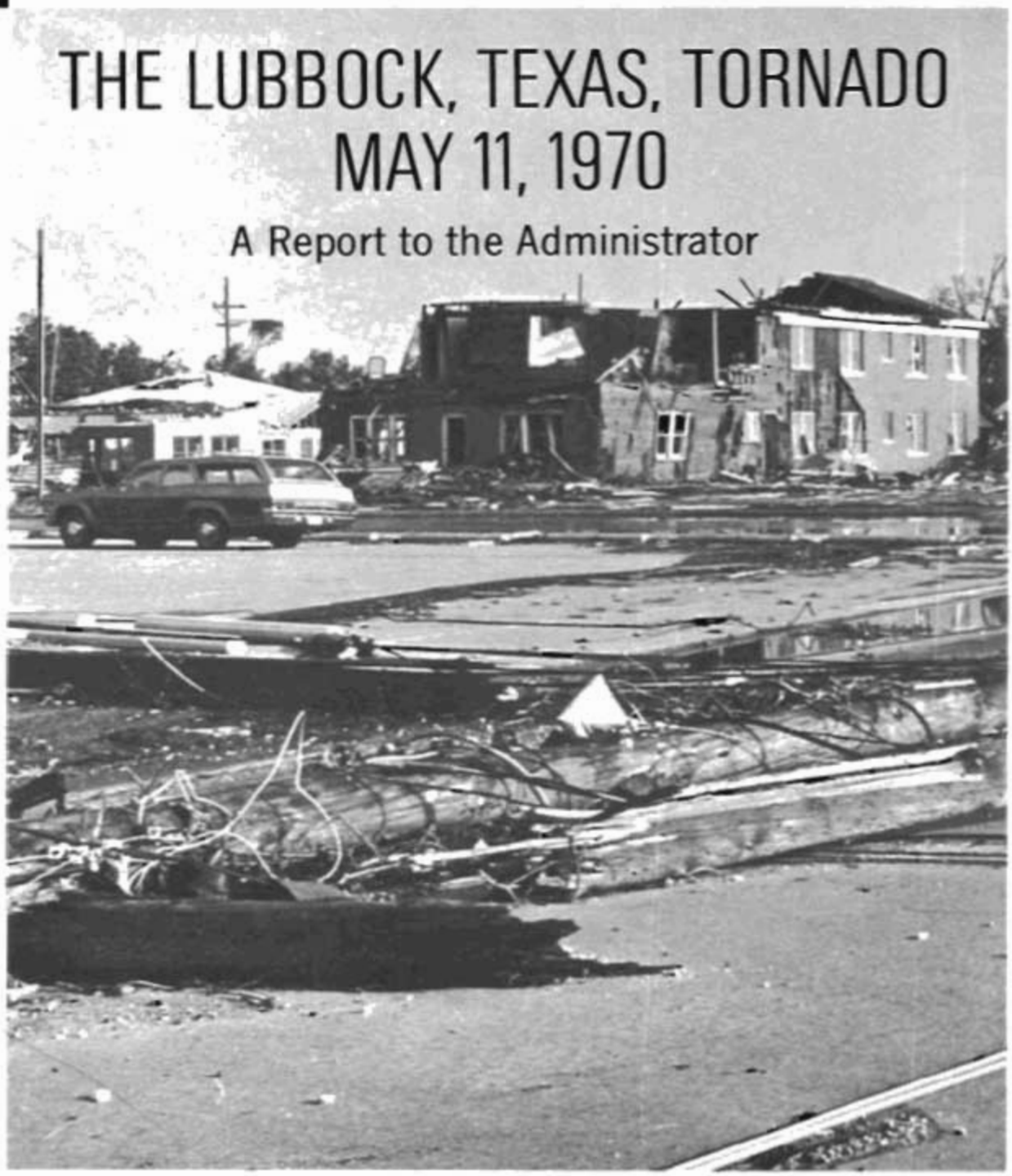
Natural Disaster Survey Report 70–1

U.S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration

THE LUBBOCK, TEXAS, TORNADO MAY 11, 1970

A Report to the Administrator



ROCKVILLE, MD.
JULY 1970

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
Robert M. White, Administrator

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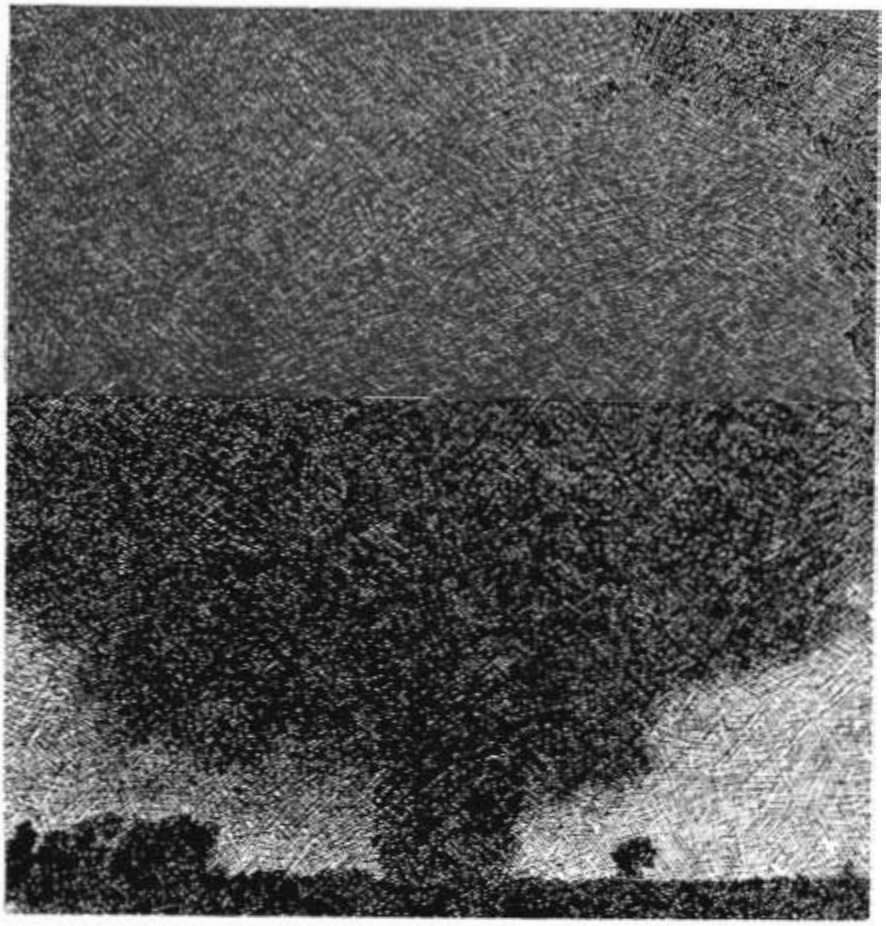


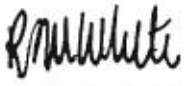
"You just can't get to people when they aren't listening."

Robert H. Bean
Judge, 140th District Court
Lubbock, Tex.
May 13, 1970

FOREWORD

On May 12, 1970, I requested Donald C. House, Chief, Atmospheric Science Services Division, ESSA Office of Plans and Programs, to form a survey team and undertake a review of the effectiveness of the ESSA tornado warning system preceding and during the time of the devastating tornado which struck Lubbock, Tex., on May 11, 1970.

The enclosed report by Mr. House and his survey team presents their findings. The report clearly reveals that the tornado warning system performed in an outstanding manner. It also describes how effective community preparedness action can make possible significant savings in lives even under the most difficult of warning situations. It clearly points out the importance of cooperative actions of Federal and local authorities and the news media.



Robert M. White, Administrator,
Environmental Science Services Administration

PREFACE

The survey team included Mr. D. C. House, Chief, Atmospheric Science Services Division, Office of Plans and Programs, ESSA; Mr. Robert E. Beck, Deputy Chief, Telecommunications and Space Services Division, Office of Plans and Programs, ESSA; Mr. Herbert Lieb, Deputy Director, Office of Public Information, ESSA; Mr. Samuel O. Grimm, Jr., Chief, Emergency Warnings Section, Weather Analysis and Prediction Division, Office of Meteorological Operations, Weather Bureau; Mr. Harold S. McCrabb, Service Operations Evaluation Meteorologist, Operations Division, Weather Bureau Southern Region; and Mr. Joseph M. Sassman, Aviation Services Operations Meteorologist, Operations Division, Weather Bureau Southern Region.

The team assembled in Lubbock, Tex., Weather Bureau Office early Wednesday morning May 13, 1970, to accomplish its assessment of the functioning of the ESSA tornado warning system prior to and during the tornado disaster which occurred on the evening of Monday, May 11, 1970. The survey team concentrated its efforts upon understanding the Lubbock warning system and its interface with the ESSA tornado warning system, how it functioned, and most importantly upon the question how lessons learned could be utilized to improve the overall warning system.

This survey team is indebted to numerous individuals within ESSA, other Federal agencies, officials of the State of Texas, city of Lubbock, and representatives of the news media for their contributions to this report. The survey would not have been successful without their cooperation and assistance. The survey team is particularly indebted to the Office of Emergency Preparedness and National Aeronautics and Space Administration for arranging an aerial photographic mission over the area on May 12, 1970, flown by NASA aircraft from Manned Spacecraft Center, Houston; Dr. T. T. Fujita of the University of Chicago for providing the team with his preliminary analysis of the meteorology of the storm; and to Dr. Norman Somes, Building Research Division, the National Bureau of Standards for an assessment of the structural damage suffered from the storm.

D. C. House, Chief,
Atmospheric Science Services Division

EXECUTIVE SUMMARY

INTRODUCTION

No area is more favorable to the formation of tornadoes than the midcontinent of North America. While no month is free of these violent storms, the number of torandoes reaches its peak in May.

On the evening of May 11, 1970, tornadoes were occurring in Wisconsin, Iowa, Kansas, Ohio, and Texas, with the most massive tornado forming and touching down over the heart of Lubbock, Tex.

In the few moments between 9:35 p.m. and the time the funnel lifted into the clouds, the tornado devastated the community along an 8½-mile path. It wrought havoc along a track that was 1½ miles wide in downtown Lubbock to one-fourth mile wide as it passed over the ESSA Weather Bureau Office located at the Lubbock Airport.

The tornado killed 26 persons and injured 1,500 more. More than 1,000 family units were totally destroyed and about 9,000 more damaged. Property damage was estimated at more than $125 million. The total in human suffering and sorrow is, of course, incalculable.

Although the total Weather Bureau Community Warning System worked most effectively, the survey team tried to determine whether the Lubbock tornado had lessons for Federal, State, and local governments, and for the public.

Following are the survey team's findings and recommendations:

Findings

—Prompt, professional interpretation of the storm echoes on radar at the Lubbock Weather Bureau Office was the primary basis for the lifesaving warnings issued to Lubbock officials and citizens.

—The existing surface and upper air observing network in the vicinity of Lubbock was adequate to support the local warning function and performed well. There were some delays in relaying spotter reports from the Civil Defense Emergency Operation Center (EOC) to the Lubbock Weather Bureau Office, but the mass media were able to obtain these reports through their representatives in the EOC and thereby kept the public continually alerted.

—The use of the ESSA Weather Wire Service as a technique for delivering hazard warnings to news media proved invaluable. It was the primary factor in alerting the population to the impending disaster. The performance of this Service could be improved only through wide use of positive alerting devices at the terminals to assure that critical information is brought to the attention of responsible personnel without delay.

—All communication systems performed adequately until they were disrupted by the tornado at about 9:49 p.m. on May 11. The total loss of communications did not adversely affect the warning given of the tornado, but the fact that officials and public could not reliably obtain authoritative information was a cause of great concern in the period immediately following the disaster.

—After the storm severed normal communication links, the ESSA Weather Bureau Office at Lubbock was out of contact with the rest of the national weather system and found it difficult to contact the Civil Defense EOC and the mass media. The initiative of personnel at station KCBD-TV, the Lubbock Fire Department, and the ESSA Weather Bureau Offices at Lubbock and Amarillo, Tex., minimized the effect of the communication loss and are deserving of the highest praise.

—The ESSA Weather Bureau Office staff at Lubbock was continuously on top of the situation, having the tools (radar and an action plan) and the professional competence to recognize a developing hazardous situation. The staff exercised outstanding skill and judgment in its warnings and statements. In the opinion of the survey team, the Lubbock staff could have done no more to help safeguard the city.

—The warning and statements issued by the ESSA Weather Bureau Office at Lubbock were given prompt emergency broadcast service by radio station KFYO; other local stations also broadcast information available from the ESSA Weather Wire Service and their representatives in the EOC.

—The sirens used to warn of the approach of the tornado were of mixed effectiveness. The survey

team feels that because sirens are used daily, they probably do not convey the unique meaning necessary to tell people to take shelter immediately. Civil Defense sirens require a power source; when the tornado disrupts that power, the warning signal cannot be heard. Finally, sirens are tested for hearing patterns, usually on clear days under optimum conditions; but to be effective, they must be heard through the noise of howling winds, driving rain, and often hail. In other tornado situations, however, sirens have been extremely effective.

Recommendations

—Local use radar information proved its great value in this tornado warning situation. However, the Lubbock WSR–1 local use weather radar should be replaced with modern equipment at an early date. A review of the *Federal Plan for Weather Radars and Remote Displays* should be made to insure that metropolitan areas within tornado-prone regions are adequately served by weather radar. The most effective alternative, local use radar or radar remote, should be available to each Weather Bureau Office responsible for providing the warnings. Finally, for locations that cannot be adequately served by radar remoting equipment, new local use radars should be procured. If it is ascertained that the development, procurement, and installation of new local use radars cannot be completed before the WSR–1 becomes unusable, consideration should be given to employing commercially available C–band radars derived from weather avoidance radar systems used on the current generation of commercial aircraft. Availability, low unit costs, and wide usage in the aircraft industry warrant a close investigation by ESSA to determine if this type of radar is an acceptable replacement for the obsolete WSR–1's.

—Continuing emphasis should be given to research and development on techniques to identify positively tornadoes by such remote-sensing methods as conventional weather radar, Doppler radar, and passive electromagnetic monitors.

—Public education on the implications of ESSA Weather Bureau watches and warnings must be continued and intensified, not only by ESSA but by other agencies involved in natural hazards warnings.

—Procedures for relaying spotter reports from the EOC to the Weather Bureau Office and radar and spotter reports from the Weather Bureau Office to the ESSA Weather Wire Service should be reviewed to insure that these reports which are so vital to the assessment of the situation and subsequent specific warnings can be relayed without delay.

—All subscribers to the ESSA Weather Wire Service should be urged to install positive alerting devices to insure that information critical to public safety is neither overlooked nor delayed in reaching the public.

—All broadcast media should be continually reinformed of their right to remain on the air past specified closing hours in times of emergency

—ESSA should obtain several mobile single-sideband transceivers and antennas to serve as emergency voice links to Weather Bureau Offices whose warning capability have been degraded by loss of communications. Equipment should be held in readiness at Weather Bureau Regional Headquarters for immediate deployment, along with qualified operators.

—ESSA and Civil Defense officials, as a matter of urgency, should explore the possibility of an alternative means of warning the public to take shelter from an approaching tornado. The system should have these characteristics:

- A unique sound used for no other purpose.
- Minimum attenuation for natural obstacles and manmade structures.
- Maximum ability to be heard under storm conditions.
- A self-contained power source sufficient for at least an initial warning.

In this connection, the survey team noted the long-term success of lower frequency systems such as fog horns and diesel horns used as alerting devices under adverse conditions.

CONTENTS

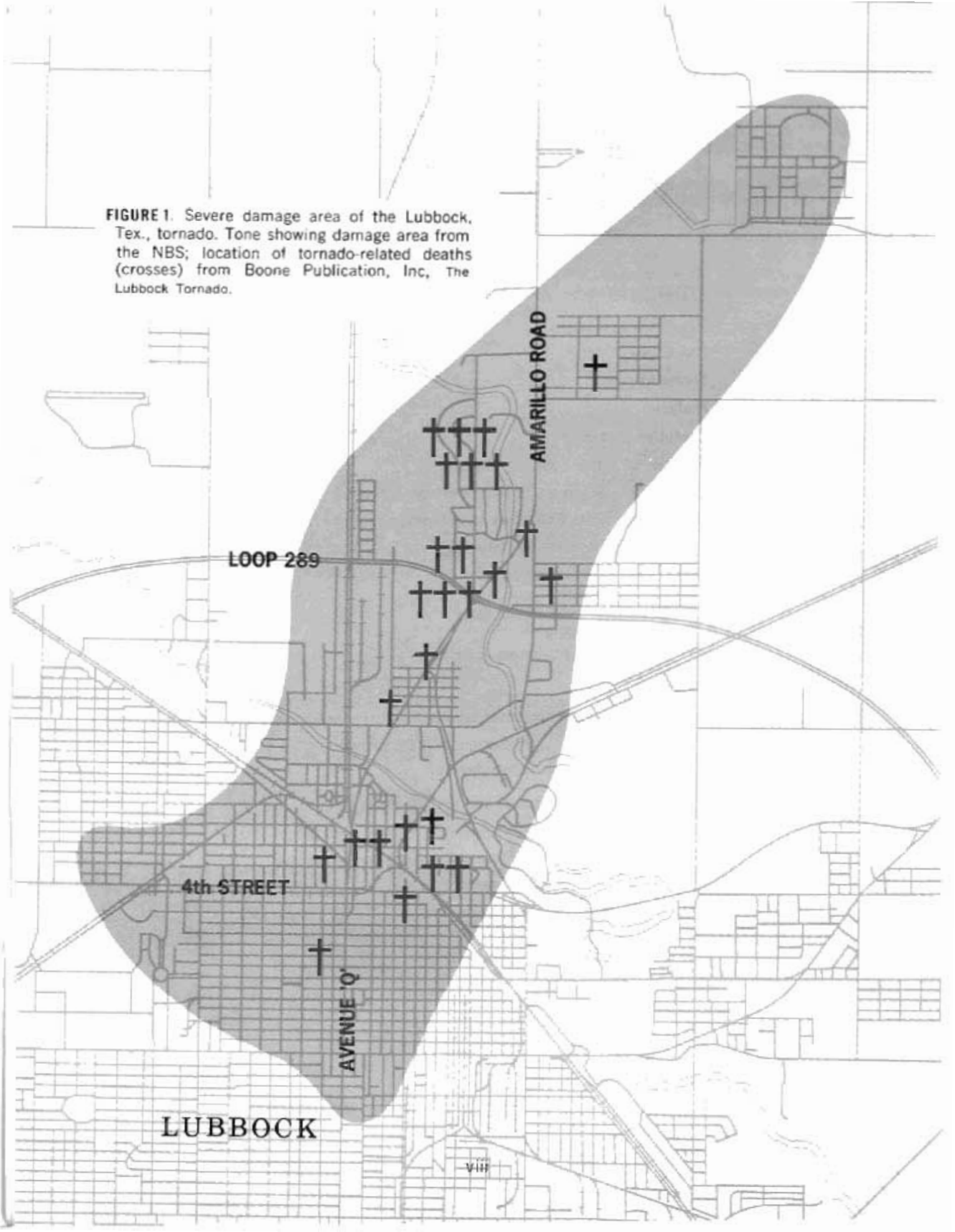


FIGURE 1. Severe damage area of the Lubbock, Tex., tornado. Tone showing damage area from the NBS; location of tornado-related deaths (crosses) from Boone Publication, Inc, The Lubbock Tornado.

CHAPTER 1

The Lubbock Tornado

Dawn broke clear and cold over the eastern slopes of the central and southern Rockies, the high plains of western Kansas, and the Texas and Oklahoma Panhandles on May 11, 1970. It was 37° in Cheyenne, Wyo., 36° in Denver, Colo., 39° in Goodland, Kans., 40° in Trinidad, Colo., 55° in Amarillo, Tex. Farther west in the intermountain region of Utah, Nevada, and western Wyoming, early morning temperatures were in the 20's.

By late afternoon, influenced by southerly winds, temperatures were in the 90's in eastern New Mexico and the Texas Panhandle. Thunderstorms were forming.

It was a typical spring day. The stage was set for a violent assault by the atmosphere.

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During the preceding months, winter's cold air had been challenged many times by warm, spring-like breezes, but winter easily won these skirmishes. By April, the warm air usually gains reinforcements from the Gulf of Mexico; and these warmer winds, aided by a warmer sun, probe continually at the front line of winter's cold mass. They find weak spots, and soon they split the winds of winter with a frontal assault. Winter, however, dies hard; it marshals its forces and starts a flanking maneuver of its own.

Snowstorms and blizzards, the weapons of winter, and thunderstorms and tornadoes, the weapons of spring, battle it out. Finally, as the sun melts the snowfields, winter is robbed of its power and retreats to await another season. But before winter loses and spring wins this fierce annual war, man is sure to have been scarred by both.

☆ ☆ ☆

The plains area of America is the principal battleground for these opposing natural forces. And so it was on May 11, 1970. During that evening, tornadoes appeared in Wisconsin, Iowa, Kansas, Ohio, and Texas, but the most massive tornado formed and touched down over the heart of the city of Lubbock, Tex.

In the few moments between 9:35 p.m. and the time when the funnel lifted back into the clouds, the tornado devastated the community along its 8½-mile path, causing havoc along a track ranging from 1½ miles wide in downtown Lubbock to one-fourth mile wide as it passed over the ESSA Weather Bureau Office at the Lubbock Airport.

The tornado killed 26 persons and injured 1,500. It wiped out 1,040 family units and damaged 8,876 more. Property damage is believed to have exceeded $125 million[1]. The toll in human suffering and sorrow is, of course, incalculable.

Figure 1 shows a shaded area[2] within which the occurrence of tornado damage was sufficiently severe to require competent professional help to restore the property to its former use. Crosses indicate the number of tornado-related deaths at that particular site.

"It's a miracle that 500 weren't killed," said Robert Snyder, station manager of KCBD-TV. This same remark was repeated in one form or another many times after the tragedy. The reasons will become apparent in this report. They are distilled, however, in a statement by Dr. James Granberry, Mayor of Lubbock:

"Without the timely and coordinated actions of the ESSA Weather Bureau, City, and Civil Defense officials, in concert with the responsiveness of the radio and television interests, many more lives would have been lost."

[1] As of May 22, 1970, information from various sources.

[2] Based upon information provided by the NBS's Building Research Division.

CHAPTER 2

Summary of Preparedness Action

When a tornado strikes, human life depends almost as much upon a prepared populace as upon the warning itself. Planning for effective community—and individual—action in such an emergency is a major concern of ESSA Weather Bureau Offices throughout every tornado-prone area of the Nation.

Before the start of the season, officials in charge of those ESSA Weather Bureau Offices which are responsible for relaying tornado watches and issuing warnings hold preparedness sessions with local offi-

FIGURE 2.
LUBBOCK WEATHER BUREAU OFFICES
COUNTY AREA OF RESPONSIBILITY.

cials to map or update plans for community preparedness. These meetings are attended by such persons as mayors; civil defense; law enforcement; utility and engineering officials; superintendents of schools and hospitals; State governmental departments and local public works; radio, television, and newspaper officials; and others.

For the 17-county area of responsibility of the Lubbock Weather Bureau Office, public education in tornado preparedness is a continuing process. The educational process is designed to encourage the organization of Community Warning Centers (where they are not already established), to assure strong cooperative storm reporting networks, and to develop networks where they do not exist, using fully the best available communications facilities.

Help and encouragement in community preparedness planning by the ESSA Weather Bureau Office at Lubbock for its 17-county area of responsibility (fig. 2) are furnished primarily through periodic and special visits and meetings with the news media, ESSA Weather Wire Service subscribers, and public officials. More than a score of such efforts have been made by this Office over the past 16 months (for details, see Attachment B).

In Lubbock itself, warnings are issued through an excellent Civil Defense organization from an Emergency Operations Center (EOC) in the City Hall basement. When the ESSA Weather Bureau confirms a severe weather warning by telephone to Mr. Bill Payne, the Civil Defense Director, he and his staff through a downward pyramiding of telephone calls arrange to man the Center. Within 5 to 10 minutes, essential personnel are on duty. The City Manager, Mr. Bill Blackwell, is in charge. The crew includes Mr. Hershel Sharpe, the Fire Chief; Mr. J. T. Alley, the Chief of Police; Mayor Granberry, the City Council, utility company officials, and newsmen.

The EOC is in radio contact with a spotter network surrounding the city, consisting mainly of police mobile units and supported by the ESSA Weather Bureau's spotter network which reports directly to the Bureau. Should a EOC network member see a tornado or another severe storm event, such as hail or high winds, immediate contact is made with the EOC which, in turn, relays it to the Weather Bureau Office. The EOC, simultaneously, reports the observations directly to the news media, the final vital link to the public. Spotter reports received from the ESSA Weather Bureau network are transmitted as quickly as possible to everybody concerned. The City Manager receiving a valid report from either network determines whether to sound the city siren(s).

The residents and officials of Lubbock are weather conscious and well informed. They are no strangers to tornadoes; they learn about them and how to protect against them from the first grade on. In this effort, the ESSA Weather Bureau and public safety officials have potent and willing allies in the news media.

All nine radio and four television stations subscribe to the ESSA Weather Wire Service, as do the *Avalanche-Journal*, the city's only newspaper, and the Civil Defense EOC. All agree it was a key factor in moving the warning to the public.

"It's our lifeline of weather information," said Tom Allen of KLBK-TV. And Frank Lee, of KCBD-TV, termed it "vital to our operation." Radio and television stations monitor the wire continuously, and one-third of them had positive alert devices on the night of May 11. Two television stations also have their own radar, but they make no effort to rely on this alone for information; they rely on the ESSA Weather Bureau.

All the Lubbock media are heavy users of ESSA tornado safety education materials. The *Avalanche-Journal* consistently carries tornado features and ESSA's safety rules. The radio stations air the ESSA safety announcement discs frequently through the season. The television stations have broadcast the ESSA film "Tornado!"

ESSA Weather Bureau and Civil Defense officials share with the media the effort to educate the public. They distribute many copies of tornado safety literature to the public annually. They give many talks to schools, civic and service organizations on the subject. By freakish coincidence, Mr. Payne was at a meeting of the Optimist Club on the night of May 11, preparing to show "Tornado!," when the word came: this is the real thing.

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No better testimony to the efficacy of this preparation could be found than the scene at Lubbock after the tornado: more than 8 miles of utter devastation—flattened homes, apartments, mobile homes, business establishments, and motels. Along this 8-mile path of horror, people ran for cover, took shelter in basements or inside rooms, got under tables, beds, or desks, and pulled mattresses over themselves.

And in this city of 150,000, only 26 persons died.

CHAPTER 3

Data Collection and Communications

SURFACE OBSERVATION NETWORKS

Surface observation networks and their data collection systems provide basic information for many uses, immediate and long range. In the Lubbock tornado, this network operated effectively until the storm killed communications with the ESSA Weather Bureau Office at about 9:49 p.m.

The network in the Lubbock vicinity is about average in terms of spacing between stations. (See fig. 3. Regular reporting stations are identified by a black circle; the substation network reporting to Lubbock by an open square.)

Weather Bureau Office personnel at Lubbock indicated that regular reporting stations were reliable in all respects, and that the substation network—composed principally of unpaid cooperative observers—was very effective in reporting both severe storm and conventional events.

The Lubbock Office accepts toll calls from the cooperative observers in the substation network, and often places calls to them to get on-the-spot evaluations of conditions indicated by its local use radar or by the WSR–57 network radar at Amarillo. The substation network is supplemented by more than 80 contact points such as police and fire stations

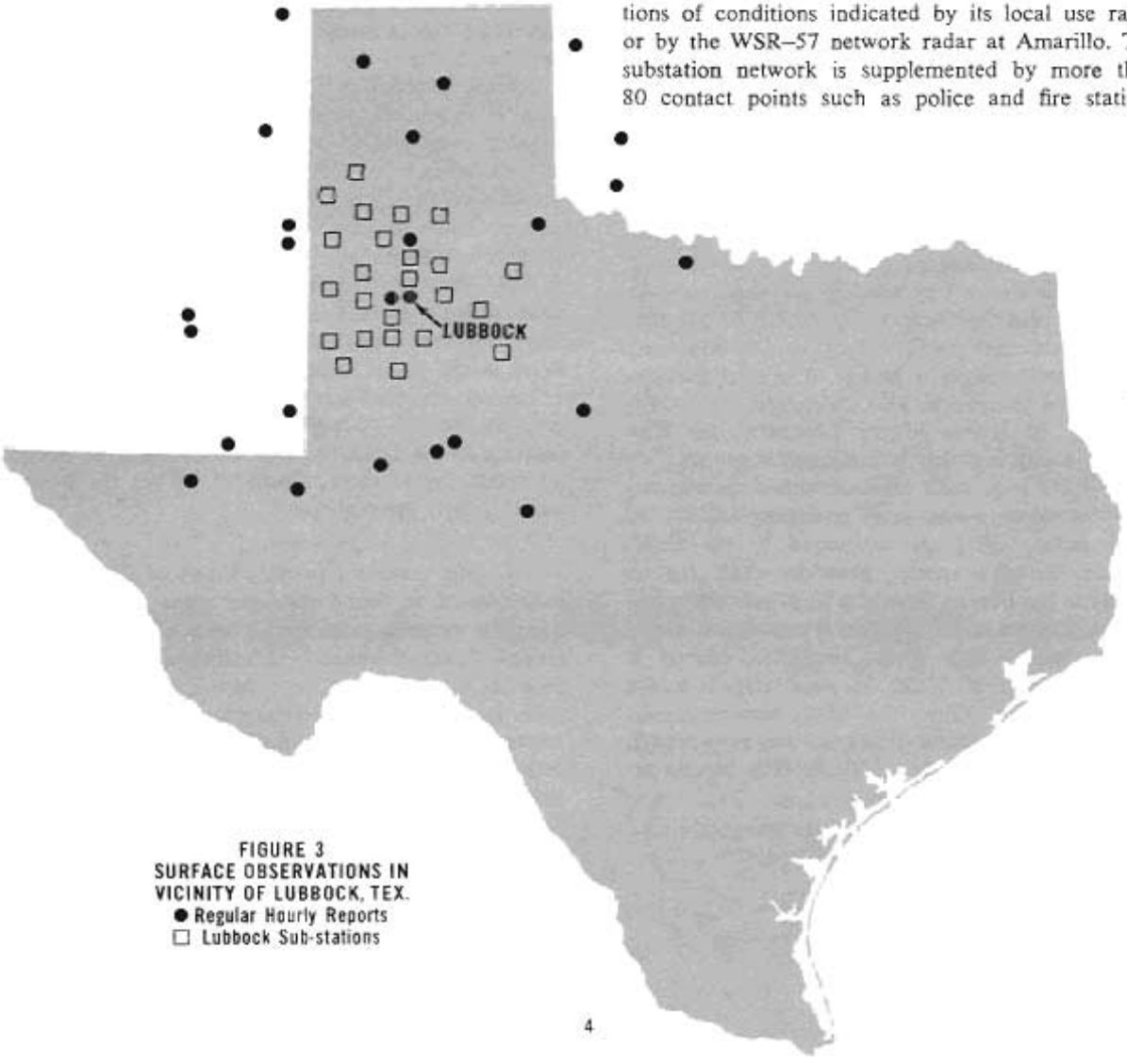

FIGURE 3
SURFACE OBSERVATIONS IN VICINITY OF LUBBOCK, TEX.
● Regular Hourly Reports
□ Lubbock Sub-stations

and sheriff offices throughout the 17 counties comprising the Lubbock area of responsibility. Watch-and-warning information are passed to these contact points; they furnish severe storm reports by commercial telephone and, when available, by means of the National Warning System (NAWAS). Funding has been adequate for this communication.

Additionally, severe storm reports are received from Civil Defense and the Texas Department of Public Safety (DPS), often from men in police cruisers. These Texas DPS reports normally are received very promptly through the NAWAS; Civil Defense reports received by commercial telephone from the Lubbock EOC may be delayed in reaching the Weather Bureau Office. However, they reach mass media outlets immediately through the media presence in the EOC.

UPPER AIR OBSERVATION

Upper air observations include rawinsondes—measurements of upper level winds, pressures, temperatures, and relative humidity—and pilot balloons which measure only upper level wind speeds and direction. The spacing of the upper air observation network in the Lubbock vicinity is about average in comparison with those in other tornado-prone areas of the Nation. Lubbock Weather Bureau Office personnel indicated that reports from these stations are received regularly and are of high quality. They routinely plot, analyze, and use the upper air pressure, temperature, and relative humidity information from surrounding stations. All scheduled upper air observations in the vicinity were received and used on May 11.

The upper air network in the Lubbock area is shown in figure 4. (Stations making rawinsonde observations twice daily at 0000 GMT and 1200 GMT (7 a.m. and 7 p.m. CDT) are shown as black circles; stations having only pilot balloon observations are shown as open squares.)

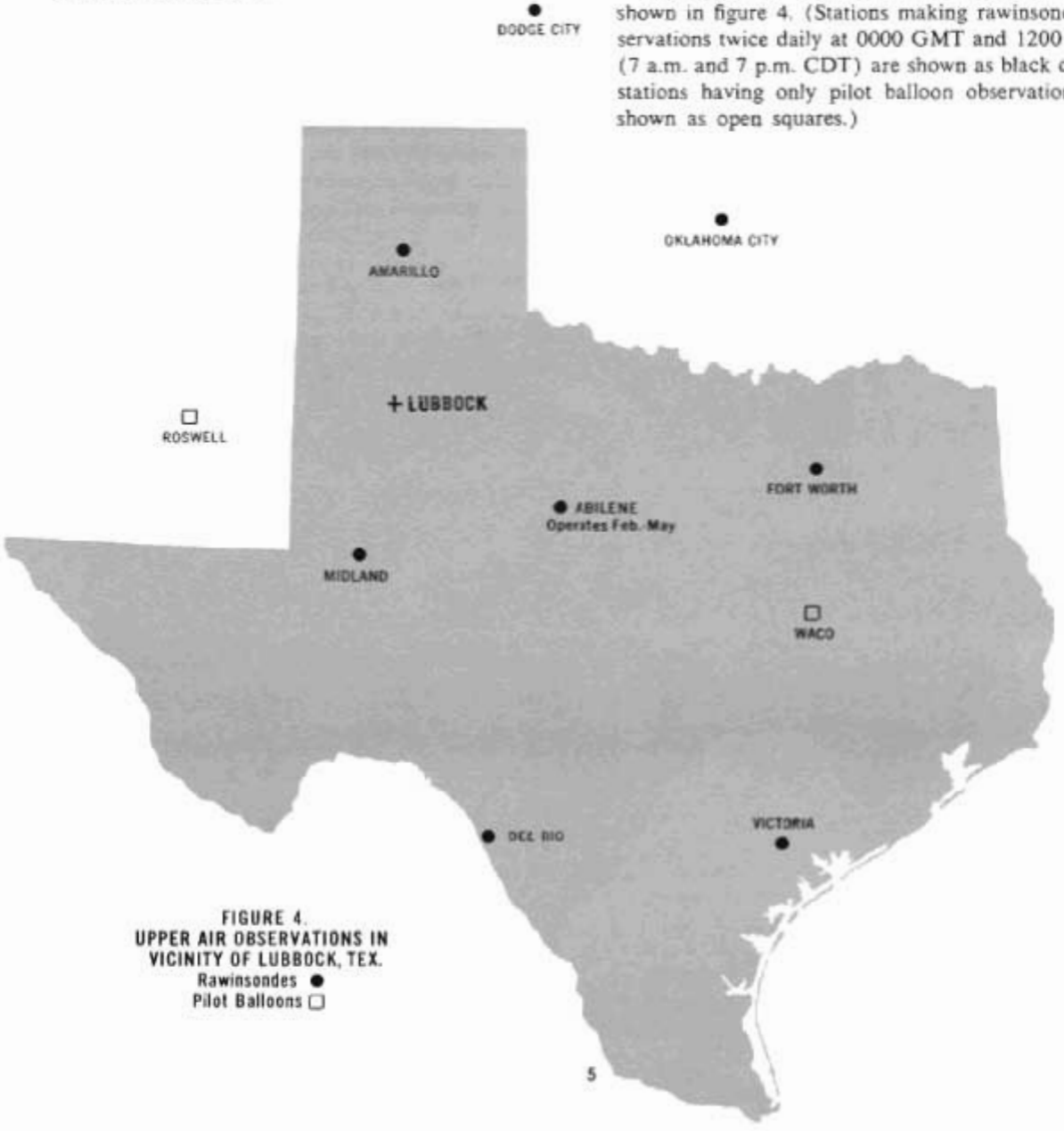

FIGURE 4.
UPPER AIR OBSERVATIONS IN VICINITY OF LUBBOCK, TEX.
Rawinsondes ●
Pilot Balloons □

RADAR NETWORK

Weather radar was the primary tool used to detect and warn of the severe thunderstorm and tornado activity in the area on the evening of May 11. The Lubbock tragedy starkly illustrates the necessity of adequate radar coverage if the ESSA Weather Bureau is to meet its public safety responsibilities.

Modern weather radars such as the WSR–57 in Amarillo, 100 miles from the scene of the tornado, detect precipitation and enable forecasters to estimate precipitation amounts as well as to identify and track squall lines, hurricanes, tornadoes, and other severe storms. They provide systematic observation of the location, height, and estimated intensity of precipitation. When precipitation is observed within about 125 miles of the radar, reports are made hourly; more frequently when conditions indicate severe storms or rapidly changing weather.

Local use radars, such as the WSR–1 in Lubbock, have shorter range. They provide information for short-period forecasts and for warnings in the immediate area. Locations of weather radars in the vicinity of Lubbock are shown in figure 5.

The Lubbock Weather Bureau Office is not a designated reporting station in the National Synoptic Weather Radar Network but its personnel are extremely well qualified in radar operation and interpretation. This was highlighted by their performance on May 14 during tornado activity, while the survey team was present. Significant radar reports are sent on the ESSA Weather Wire Service.

Both the ESSA Weather Bureau WSR–57 in Amarillo and the local use WSR–1 in Lubbock detected the initial development of a thunderstorm 15 miles south of Lubbock Airport between 6:45 and 6:55 p.m. Both monitored storm development and movement throughout the evening. Both agreed on location, movement, and intensity of echoes. The two

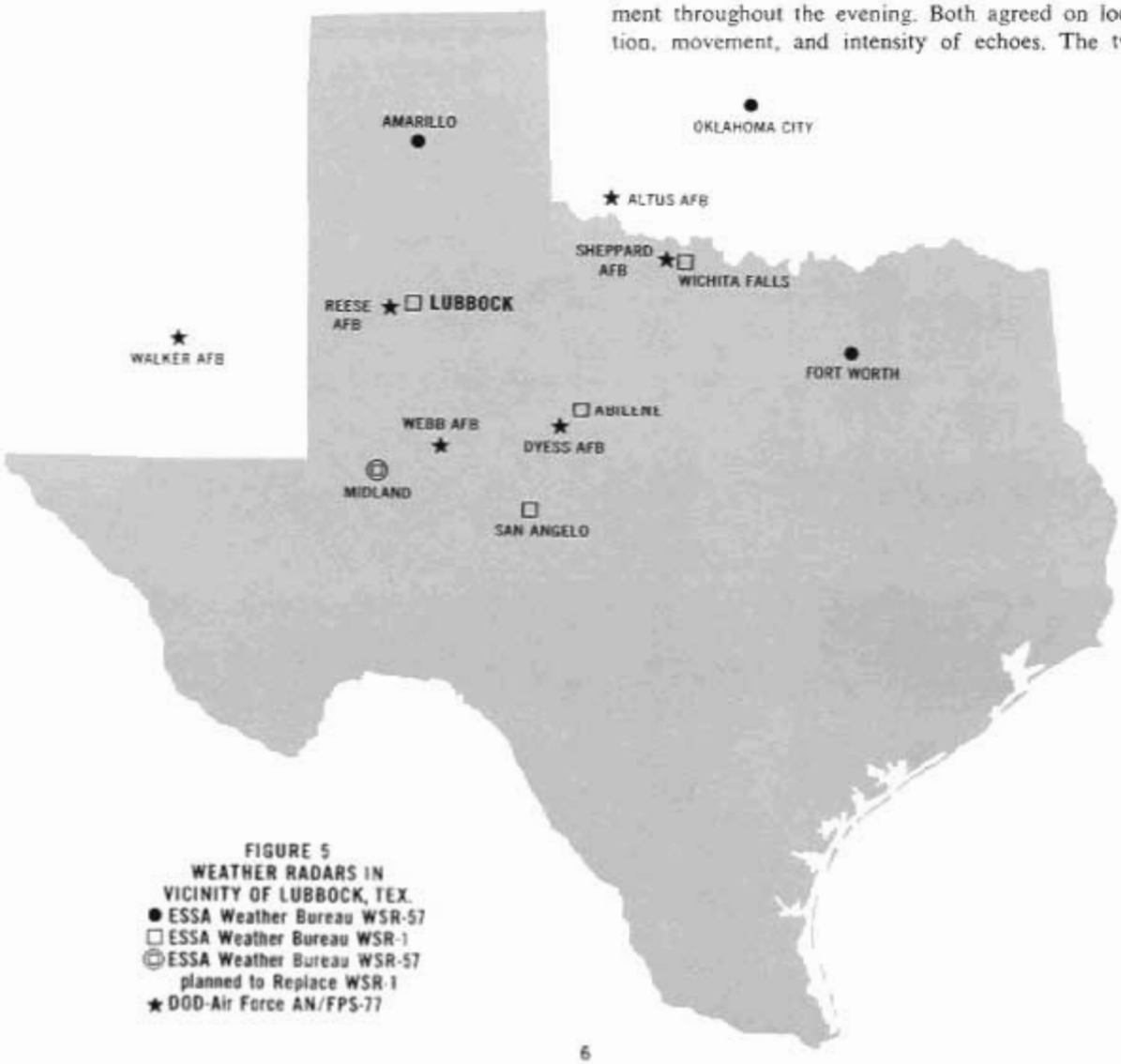

FIGURE 5
WEATHER RADARS IN VICINITY OF LUBBOCK, TEX.
● ESSA Weather Bureau WSR-57
□ ESSA Weather Bureau WSR-1
⊜ ESSA Weather Bureau WSR-57 planned to Replace WSR-1
★ DOD-Air Force AN/FPS-77

operations were outstandingly coordinated, with the Amarillo radar providing data on echo tops to supplement the limited height-finding capability of the Lubbock WSR–1. The exchange of information and support continued over the Federal Telecommunications Service (FTS) and NAWAS until the tornado passed over the Lubbock Weather Bureau Office and disrupted communications. Subsequently, the Amarillo Weather Bureau Office continued to monitor the Lubbock area of responsibility, filing reports and statements over the ESSA Weather Wire Service.

While the WSR–57 was able to detect the thunderstorms and furnish invaluable information on echo tops, the tornado-related hook echoes on which the Lubbock Weather Bureau Office personnel based the tornado warnings were not detected by the Amarillo radar. (It was viewing the echoes at a range of 100 to 110 miles; at this range, the diameter and height of the radar beam above the ground generally preclude the fine definition necessary to show hook-shaped echoes.)

The WSR–1 in Lubbock is a World War II military surplus radar modified by the ESSA Weather Bureau for storm detection work. Because of its age, spare parts are no longer available from commercial sources; radars being decommissioned and replaced by WSR–57's or the WBRR–68 remoting systems are cannibalized for spare parts to keep the remaining WSR–1's in operation. The electronics technician at the Lubbock Weather Bureau Office has done an outstanding job of maintaining the radar. On May 14, the set was operating as well as any WSR–1 the team has observed, and local ESSA Weather Bureau personnel were in unanimous agreement that this is usual. Personnel on duty during the evening of May 11 reported that the radar performed exceedingly well and that the only outage was for about 1 to 2 minutes, caused by switchover from commercial power to standby power earlier in the evening.

It should be noted that the standby power unit played an important role in the events of the evening of May 11, 1970, after the tornado destroyed the commercial power lines to the Weather Bureau Office. This unit allowed the Office to continue to utilize radar as a source of warning information for the remainder of that night, and at least through May 14 when the survey team departed.

Replacement of the WSR–1 at Lubbock will be necessary within a few years as the spare parts stock is exhausted. The *Federal Plan for Weather Radars and Remote Displays*, December 1969, states that remoting is feasible to as far as 75 to 85 miles from the prime radar. Lubbock is approximately 100 miles from the Amarillo WSR–57 and about the same distance from the WSR–57 planned for Midland, Tex. Both are beyond effective remoting distance. The fact that the WSR–57 at Amarillo did not detect the critical hook echoes on May 11 at ranges of 100 to 110 miles, but did detect hook echoes in a tornado situation northwest of Lubbock on May 14 at a range of about 75 miles, highlights this remoting limitation and rules out a remote from Amarillo or Midland as an acceptable replacement for the WSR–1 at Lubbock. The *Federal Plan for Weather Radars and Remote Displays* lists Lubbock for a WBRR-68 remote display from an AN/FPS–77 at Reese Air Force Base (AFB) which is about 10 miles southwest of the Weather Bureau Office. This may be an acceptable replacement for the WSR–1, provided certain conditions can be met since the Reese AFB radar did detect the hook echoes on May 11. It will be necessary that the Reese AFB radar be protected by an emergency power supply. The *Federal Plan* does not require the provision of such a safeguard. When commercial power is lost, as it was on the evening of May 11, the radar is out of operation and no local warning capability exists until commercial power is restored. The AN/FPS–77 at Reese AFB operated intermittently during the evening of May 11 because of repeated crystal failures resulting from power line voltage fluctuations—a common event during thunderstorm activity. Safeguards against such interruptions are essential.

Cooperation is effective between the Weather Bureau Office at Lubbock and the Weather Detachment at Reese AFB. Commercial telephone is used to discuss echoes on the radars; both Office and Detachment mutually support each other during equipment outages.

The success of Lubbock Weather Bureau Office personnel in detecting the hook-shaped echoes, relating them to ground truth reports from the spotter networks, and issuing the lifesaving warnings to the city is a tribute to the skill of the personnel involved. It must also be viewed as somewhat fortunate since there is no one-to-one relationship between hook-shaped echoes and tornadoes. Meaningful statistics are not available on this relationship, but the survey team estimates that not more than 5 percent of all tornadoes are accompanied by a unique radar signature—be it a hook, notch, or "blackhole" echo. The difficulty in using the radar identification is compounded by the fact that in many cases these signatures may appear on the radarscopes without a corresponding tornado. While there is a need for continuing research on means for uniquely identifying tornadoes by conventional and Doppler radar and by passive electromagnetic techniques, the fact remains that conventional weather radar, skillfully used in conjunction with spotter reports, is the only effective means available today for specific warnings of these destructive storms.

ENVIRONMENTAL SATELLITE DATA

Pictures from the ESSA spacecraft did not cover the severe thunderstorm and tornado activity in Lubbock. The ESSA 9 spacecraft passed over the area during the midafternoon and showed only cumulus and towering cumulus clouds typical of the area in this season. The pictures from NASA's Applications Technology Satellite (ATS) geostationary spacecraft were not available in real-time; use of the pictures from these spacecraft on a real-time operational basis began on May 18, 1970. Pictures taken at about one-half hour intervals during daylight hours are relayed to the National Severe Storms Forecast Center in Kansas City, Mo., where a team of specialists interprets them for applications in severe local storm forecasts. This operational use of ATS cloud pictures was planned by ESSA following hurricane Camille in August 1969.

A preliminary examination of cloud pictures NASA obtained from ATS–3 during the afternoon and evening of May 11, 1970, shows a rapid development of numerous severe thunderstorms in Kansas, with isolated thunderstorms about 500 miles southwestward in western Texas. The accompanying photograph from ATS–3 (fig. 6), taken at approximately 8:00 p.m. CDT, shows the cloud distribution about 10 minutes before the first radar indications of tornado activity in the Lubbock area. This photograph, taken just as darkness was moving into western Texas, shows an isolated group of large thunderstorms over Lubbock and a smaller, less intense thunderstorm between Lubbock and Amarillo. A large area of thunderstorm activity is visible over central Kansas with several prominent, bright tops indicative of the severe storm activity in that region.

The survey team understands that more than 60 ATS pictures were obtained by NASA on May 11, 1970, and are being processed for detailed study of the development of the severe thunderstorms and tornadoes that day. This study may reveal significant precursors of the isolated activity in western Texas not apparent from the limited examination by the survey team.

COMMUNICATIONS

Meteorological data are collected and distributed by a variety of communications systems, including teletypewriter, telephone, and facsimile. The following systems are in use at the ESSA Weather Bureau Office in Lubbock.

TELETYPEWRITER SYSTEMS

Meterological observations are transmitted and received on the Service A and Service C teletypewriter networks which provide fundamental surface and upper air data for the ESSA Weather Bureau functions.

The Weather Bureau's 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 Weather Bureau Offices; and such information as observations from substation networks and spotter report of severe local storms.

The ESSA Weather Wire Service teletypewriter system at the Lubbock Office is the primary means for disseminating meteorological information to local officials and the mass media. Because this is the primary means of contact, it has priority for transmission over all other teletypewriter systems. Routine information; severe thunderstorm and tornado

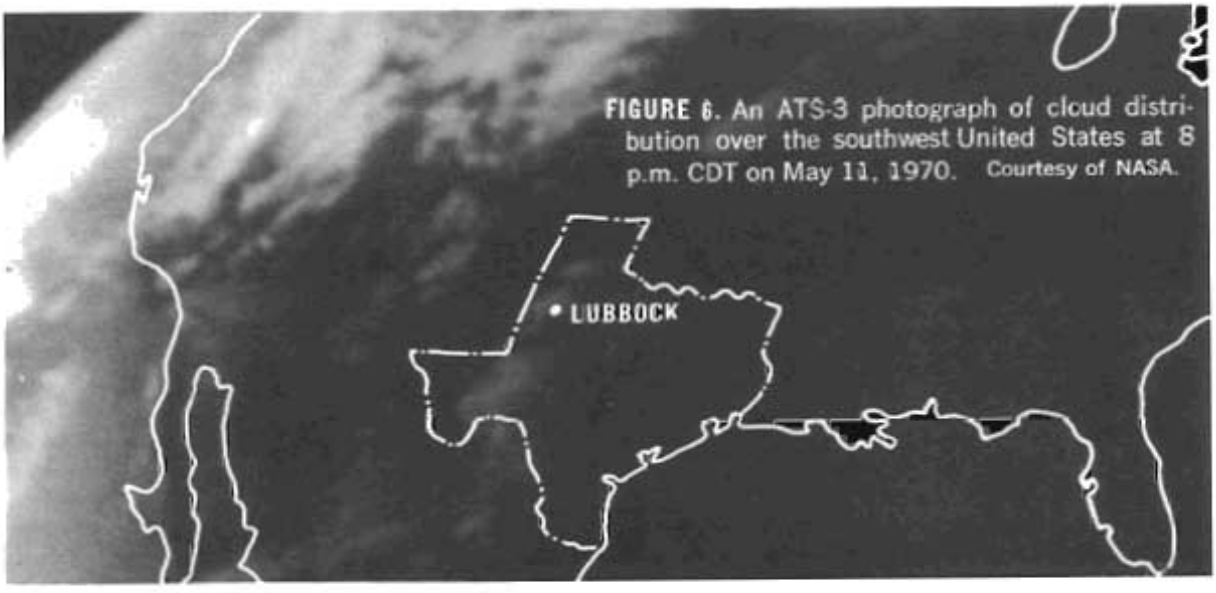

FIGURE 6. An ATS-3 photograph of cloud distribution over the southwest United States at 8 p.m. CDT on May 11, 1970. Courtesy of NASA.

watches, warnings, and statements; local radar reports; and spotter reports of severe storm activity are transmitted over the Service system to subscribers in the Lubbock Office's area of responsibility. (Attachment A lists the ESSA Weather Wire Service subscribers in the Lubbock area.)

As noted earlier, every news outlet in Lubbock is a subscriber to the ESSA Weather Wire Service. The survey teams knows of no other city where this laudable 100 percent participation has been achieved, and attributes it to the work of the local Meteorologist-in-Charge and his staff to impress upon news outlets the importance of the Weather Wire system. Only one-third of the subscribers, however, have positive alerting devices to assure that vital information is brought to the attention of responsible personnel without delay.

Managers of the two prime Lubbock television stations said ESSA Weather Wire Service could be improved by the elimination of delays in relaying radar observations. The survey team identified two causes for delays. First, a review of messages prepared between 7 and 10 p.m. showed that they required an estimated 40 man-minutes of tape-cutting time. This could be reduced substantially by the use of semiautomated equipment which would prepare the basic tapes according to standard formats, with the operator filling in the blanks as they appear. Delays also stem in part from ESSA Weather Bureau instructions for operating the ESSA Weather Wire Service. Transmission of Severe Storm and Tornado Watch and Warning Bulletins have first priority; lower precedence traffic may be pre-empted by local Weather Bureau Office personnel to send these messages. Radar reports and reports of severe storm events do not have this priority; their transmission, therefore, may be delayed until the circuit is free of traffic. This type of information is of great value because it adds to credibility of the warning and gives a greater sense of urgency to the public's need to prepare to seek safe shelter. The survey team does not believe that significant delays were experienced or degraded the warnings on the evening of May 11. However, it does believe the instructions should be revised to allow local Weather Bureau Office personnel to transmit as emergency traffic on ESSA Weather Wire Service any information which in their judgment would enhance the credibility and usefulness of the warnings.

All teletypewriter systems functioned normally until about 9:49 p.m. on the evening of May 11 when the tornado damaged communications and power lines, cutting all service until May 14. Limited contact with the ESSA Weather Bureau system was maintained through the Federal Aviation Administration Control Tower radio relays to Amarillo and other locations where observations could be placed on normal teletypewriter systems. No incoming data were available, however, and the Lubbock Office's capability to do its work was seriously degraded. Similarly, effective contact with local officials and the media was lost when the ESSA Weather Wire Service system and telephones were damaged by the tornado. The Lubbock Fire Department's radio channel to the EOC was of limited use because of antenna damage at the EOC. By the morning of May 12, this VHF-FM radio link was restored to full operation. It remained the sole means of contact with the EOC until telephone service was restored. Mass media outlets obtained information through their representatives at the EOC.

Station KCBD-TV (channel 11) placed a mobile radio-telephone and operator in the Weather Bureau Office on May 12, and used it to relay radar reports and weather information to the station for broadcast until the station's own radar was returned to operation.

TELEPHONES

The ESSA Weather Bureau Office at Lubbock has commercial telephones to conduct normal business, to contact its substation network, and to reach the cooperative contact points in the 17-county area of responsibility. ESSA Weather Wire Service to the Civil Defense EOC is supplemented by briefings over commercial telephone; spotter reports are relayed from the EOC to the Weather Bureau Office over the same lines. The commercial telephone system worked satisfactorily until the tornado interrupted the service. Service restoration began late on May 13; by May 14, the system was again fully operational.

An FTS access terminal is installed at the Lubbock Weather Bureau Office. It is used extensively for coordination with the Amarillo Weather Bureau Office. The FTS, similar to other telephone systems, failed when the tornado damaged the lines. Service was restored on May 14.

A terminal on the NAWAS telephone system is installed at the Lubbock Weather Bureau Office. Both a handset and speaker are available. The NAWAS is the principal means of contact with the Texas DPS and law enforcement offices in the 17-county area of responsibility to pass watch and warning information and to receive reports of severe storm activity. It is also used to coordinate radar information between Lubbock and Amarillo. The system failed when the tornado struck; service was restored on May 14.

The Lubbock Civil Defense officials and the ESSA Weather Bureau Office's Meteorologist-in-Charge had recognized the possibility of severe storms disrupting communications between the Weather Bureau Office and the Civil Defense EOC. Plans have been made

for a buried-cable telephone hot line connecting the two locations. The team understands that installation of this badly needed facility has been completed since the time of the survey.

FACSIMILE

Basic analysis and prognostic material are received in graphic format by the ESSA Weather Bureau Office at Lubbock over the National Facsimile System. The system operated satisfactorily until the communications circuits were damaged by the tornado. Service was restored on May 14.

FINDINGS AND RECOMMENDATIONS

The survey team concluded that:

(1) Prompt, professional interpretation of the storm echoes depicted by the WSR–1 (World War II model) local use radar at the Lubbock Weather Bureau Office was the primary basis for the lifesaving warnings issued to Lubbock officials and citizens. This vital part of the warning capability, near the end of its useful lifetime, will require replacement in a few years.

Recommendation:

The Lubbock WSR–1 local use weather radar should be replaced with modern equipment at an early date. A review of the Federal Plan for Weather Radars and Remote Displays *should be made to insure that metropolitan areas within tornado-prone regions are adequately served by weather radar. The most effective alternative, local use radar or radar remote, should be available to each Weather Bureau Office responsible for providing the warnings. Finally, for locations that cannot be adequately served by radar remoting equipment, new local use radars should be procured.*

If it is ascertained that the development, procurement, and installation of the local use radars cannot be completed before the WSR–1 becomes unusable, consideration should be given to employing commercially available C-band radars derived from weather avoidance radar systems used on the current generation of commercial aircraft. Availability, low unit costs, and wide usage in the aircraft industry warrant a close investigation by ESSA to determine if this type of radar is an acceptable replacement for the obsolete WSR–1's.

It is further recommended that continuing emphasis be given to research and development on techniques to identify positively tornadoes by such remote-sensing methods as conventional weather and Doppler radar, and passive electromagnetic monitors.

(2) The existing surface and upper air observing network in the vicinity of Lubbock was adequate to support the local warning functions; these networks performed satisfactorily on May 11, 1970. Local spotter networks were also adequate and performed very well. There were some delays in relaying spotter reports from the Civil Defense EOC to the Lubbock Weather Bureau Office, but the mass media were able to obtain these reports through their representatives in the EOC and thereby keep the public continually alerted. There were also some delays reported in the relaying of spotter sightings and radar reports on the ESSA Weather Wire Service. The survey team does not believe that significant delays were experienced or degraded the warnings.

Recommendation:

Procedures for relaying spotter reports from the EOC to the Weather Bureau Office and radar and spotter reports from the Weather Bureau Office to the ESSA Weather Wire Service be reviewed to assure that these reports which are so vital to the assessment of the situation and subsequent warnings can be relayed without delay.

(3) The outstanding coverage of mass media outlets by the ESSA Weather Wire Service was the primary factor in alerting the population to the impending disaster. The performance of the Service could be improved only through wider use of positive alerting devices at the terminals to assure that critical information is brought to the attention of responsible personnel without delay.

Recommendation:

All subscribers on the ESSA Weather Wire Service should be urged to install positive alerting devices to insure that information critical to public safety is neither overlooked nor delayed in reaching the public.

(4) All communications systems performed adequately until they were disrupted by the tornado at about 9:49 p.m. on May 11. Service restoration was as rapid as could reasonably be expected under the conditions that existed following the tornado. The total loss of communications did not adversely affect the warning service for the tornado, but the fact that officials and the

public could not reliably obtain authoritative information was the cause of great concern in the period immediately following the disaster.

Since the team departed Lubbock, the planned buried-cable telephone hot line between the Civil Defense EOC and the ESSA Weather Bureau Office in Lubbock has been installed. This will assure that warning information can reach responsible officials and be made available to mass media outlets for dissemination to the public.

(5) After the storm severed normal communication links, ESSA's Weather Bureau Office at Lubbock was out of contact with the rest of the national weather system and found it difficult to contact the Civil Defense EOC and the mass media. The initiative of personnel at station KCBD-TV, the Lubbock Fire Department, and the Weather Bureau Offices at Lubbock and Amarillo minimized the inherent dangers in this situation and are deserving of the highest praise.

Recommendation:

ESSA should obtain several mobile single-sideband transceivers and antennas to serve as emergency voice links to Weather Bureau Offices whose warning capability have been degraded by loss of communications. Equipment should be held in readiness at Weather Bureau Regional Headquarters for immediate deployment, along with qualified operators.

Courtesy of the Lubbock Avalanche-Journal.

CHAPTER 4

Analysis, Prediction, and Dissemination

In meeting its mission of furnishing authoritative warnings to local officials and the public in adequate time to save life and property, the ESSA Weather Bureau Tornado Warning Program employs three distinct levels for analysis, prediction, and dissemination: the National Meteorological Center (NMC) in Suitland, Md., the National Severe Storms Forecast Center (NSSFC) in Kansas City, Mo., and local Weather Bureau Offices, ESSA's most direct link to the public.

The state of the art for the prediction and warning of tornadoes dictates that for maximum effectiveness, the three-level warning system be redundant. This is so because at any given point in time, all required information in a usable form is not available at any one level. Time is of importance; consequently, the system permits but is not dependent upon the downward pyramiding of information from the highest to the lowest level. Consequently, the main line of defense must be set up by the local ESSA Weather Bureau Office.

The NMC, through largely computerized operations, provides a family of broad-scale analyses and predictions in graphic form covering the Northern Hemisphere.

Similar products with greater detail cover the conterminous States and surrounding waters. This basic guidance material, covering periods to 72 hours, is distributed to ESSA Weather Bureau Offices over the National Facsimile System.

Products issued by the NMC on May 11 satisfactorily depicted the significant large-scale features of the circulation. None of the applicable products indicated thunderstorm activity for western Texas. However, this had no direct bearing on forecasts and warnings applicable to the Lubbock tornado.

The NSSFC maintains 24-hour surveillance of the conterminous States to provide severe thunderstorm and tornado watches for public use, and aviation severe weather watches for that industry. Its bulletins outline areas of the greatest threat over periods of several hours after issuance and are distributed over national teletypewriter systems to local ESSA Weather Bureau Offices for public dissemination.

The Severe Local Storms (SELS) Unit of the NSSFC also provides daily outlooks assessing the possibility of severe local storm development over the next 24 hours. During the severe weather season (normally Feb. 1 to Aug. 31), the outlook is issued in graphic form on the National Facsimile System, and as required during the rest of the year.

The NSSFC convective outlook issued at 4:00 a.m. CDT on May 11 did not indicate the possibility of severe thunderstorm activity in western Texas during the ensuing 24 hours. It was amended at 10:00 a.m. CDT to add "also isolated thunderstorms with large hail expected High Plains of West Texas east of Pecos late afternoon or early evening." Again, at 1:25 p.m., NSSFC advised that local areas in the high country of western Texas should be monitored closely for the occurrence of severe thunderstorms.

The next NSSFC Bulletin, issued at 8:40 p.m. CDT, called for a severe thunderstorm watch in western Texas, including the city of Lubbock. This Bulletin was issued after the Lubbock Weather Bureau Office had issued a tornado warning for Lubbock and nearby counties.

Absence of Severe Thunderstorm Watch and Tornado Watch Area Bulletins by the NSSFC had no effect on the forecasts and warnings for the Lubbock area because the local ESSA Weather Bureau staff had recognized the threat and had issued local warnings.

The fact that the NSSFC did not issue a Severe Thunderstorm or Tornado Watch Area Bulletin for western Texas requires some explanation. Historically, NSSFC's tornado watches encompass slightly less than one-half of the tornadoes that occur each year. The state of the art in severe thunderstorm and tornado prediction, coupled with the relatively wide spacing of the upper air observation network, will not support attainment of a higher percentage without drastically over-warning large areas of the country day in and day out, an overkill which would destroy the value of the service.

ESSA Weather Bureau Offices, using the basic guidance from NMC, the Watch Bulletins from NSSFC, and local data from weather radar, substa-

tion and cooperative observers, and spotters constitute the focal point of the program. Local Weather Bureau Office personnel must maintain continuous surveillance of areas of responsibility often amounting to tens of thousands of square miles. Success or failure of the entire program depends on how well the small staffs at Weather Bureau Offices do their jobs of interpreting the mass of guidance from NMC and NSSFC, monitoring local conditions, and issuing warnings.

On May 11, the ESSA Weather Bureau Office at Lubbock maintained its usual careful watch.

The Meteorologist-in-Charge, recognizing that "tornadoes are a way of life at the Lubbock Weather Bureau Office," scheduled his personnel to have a professional meteorologist and two meteorological technicians on duty from midafternoon to midnight, the time of greatest danger. Increasing instability of the atmosphere was recognized and verified by development of towering cumulus clouds in the area by 6:00 p.m. CDT. At 6:55 p.m. CDT, the local use radar detected a moderate thunderstorm 5 miles south of the city. This information was disseminated over the ESSA Weather Wire Service system at 7:00 p.m. CDT. During the following hour, the radar was monitored continuously. This was the key action leading to the timeliness of the initial and subsequent warnings. At 7:47 p.m., a discussion was held with the ESSA Weather Bureau Office at Amarillo about the echo tops and the data from the 7:00 p.m. CDT rawinsonde observation. The Amarillo Office indicated cloud tops near 46,000 feet and increasing; the rawinsonde observation indicated that the tropopause had lifted 7,000 feet in the past 12 hours to 48,000 feet. Based on this information, a Severe Thunderstorm Warning Bulletin was transmitted at 7:50 p.m. CDT on the ESSA Weather Wire Service calling for severe thunderstorms in Lubbock, Crosby, Hale, and Floyd Counties until 9:00 p.m. CDT. Use of the Emergency Action Notification Signal (EANS) by radio and television was requested. Radio station KFYO complied at 7:59 p.m. CDT, and the station continued to broadcast without commercials until May 14. Other stations also picked up the warning and stepped up their broadcasts. Radio and television stations continually interrupted their regular programs to broadcast the ESSA Weather Bureau's warnings, statements outlining the current situation, and reports of funnel clouds, hail, and winds.

The ESSA Weather Wire Service message was supplemented with a telephone call to the Lubbock Civil Defense EOC, and the switchboard operator was requested to notify Mr. Payne, the Director of Civil Defense.

The initial warning was followed by a Severe Weather Statement transmitted on the ESSA Weather Wire Service at 8:08 p.m. CDT advising of reports of egg-size hail south of the city and reaffirming that the severe thunderstorm warning remained in effect. At 8:10 p.m., a similar Statement was transmitted advising of grapefruit-size hail 5 miles south of the city and again repeating the warning.

Further coordination with the Weather Bureau Office at Amarillo revealed that the storm cloud tops had reached 55,000 feet by 8:10 p.m. This information was followed immediately by a spotter report from an off-duty policeman to the Weather Bureau Office that he had sighted a funnel cloud 7 miles southeast of the Airport. A public report of baseball-size hail in southeastern Lubbock was received at 8:13 p.m.

A Tornado Warning Bulletin for Lubbock, western Crosby, eastern Hale, and Floyd Counties valid until 9:00 p.m. CDT was transmitted on the ESSA Weather Wire Service at 8:15 p.m. CDT, advising of the funnel cloud and noting that the radar was detecting a hook echo 7 miles southeast of the Airport moving northeastward. This warning was issued in "short form" to get the word out as quickly as possible. It was followed immediately by a "long-form" warning which added advice on preparations to seek a place of safety and instructions on how to report a sighting. Emergency broadcast was requested. Key radio station KFYO complied with this request; Mr. Payne, now at the Civil Defense EOC, was briefed on the situation.

At 8:42 p.m., a Severe Weather Statement was sent on ESSA Weather Wire Service, advising that a severe thunderstorm over the southeastern part of the city was moving northeastward about 25 miles per hour with numerous reports of large hail and possibly a tornado. The Statement also advised that two additional, rapidly intensifying thunderstorms 8 miles southwest of the Airport were also moving northeastward at 25 miles per hour. The previously issued Tornado Warning Bulletin was reaffirmed.

Immediately following this statement, the NSSFC Severe Thunderstorm Watch Bulletin Number 225 issued at 8:40 p.m. CDT, was relayed on ESSA Weather Wire Service. The Weather Bureau Forecast Center at Ft. Worth, Tex.—the ESSA Weather Wire Service Relay Center—in keeping with standard practice, added a listing of the Texas counties included in the area mapped in Bulletin Number 225.

The Lubbock Weather Bureau Office issued a Tornado Warning Bulletin on the ESSA Weather Wire Service at 8:59 p.m. CDT extending the tornado warning for Lubbock, western Crosby, southern Floyd, and southern Hale Counties until 10:00 p.m. CDT. The Bulletin noted that the radar indicated a tornado—a funnel cloud had also been reported in the past 5 minutes—about 7 miles south-southeast of

the Airport moving northeastward 15 miles per hour. The Statement also indicated several other severe thunderstorms in the Lubbock vicinity and repeated the advice to be prepared to seek a place of safety. It concluded with the information that radar now was showing the hook echo along the eastern city limits moving northward at 15 miles per hour. Emergency broadcast action was requested.

Keeping well abreast of the rapidly developing situation, the Lubbock Weather Bureau Office issued a Bulletin on the ESSA Weather Wire Service at 9:14 p.m. advising of the current radar echo pattern (hook echo 6 miles south-southeast of the Airport with little movement), relaying numerous reports of large hail, and reaffirming the possibilty of a tornado until 10:00 p.m. CDT. The statement again repeated the warning to be prepared to move to a safe place. Emergency broadcast action was requested.

At 9:15 p.m. CDT, the Lubbock Weather Bureau Office advised the Texas DPS by means of NAWAS that the warning sirens should be sounded in the town of Idalou. The Fire Department in Shallowater was advised by telephone at 9:30 p.m. of the severe thunderstorm 5 miles south of the town.

The WSR-1 radar detected a new hook-shaped echo development at 9:35 p.m. about 7 miles south of the Airport (near 19th Street and Brownfield Highway.) This indication of a tornado was passed to the Lubbock Civil Defense EOC by telephone and by the two-way VHF-FM Fire Department radio link between the EOC and Lubbock Weather Bureau Office. The EOC simultaneously received a report of a funnel cloud in this area from one of its spotters and the decision was made to blow the warning sirens because the criterion for the action—positive identification by an EOC or Weather Bureau spotter—had been met.

Unfortunately, many of the sirens did not sound; the tornado had destroyed the power lines that operated them. Police cruisers also sounded their sirens and some people heard one or the other system, but many stated that they heard no sirens. Some of this latter group concluded that because they heard no siren, they had received no "warning."

At 9:47 p.m. CDT, the position of the tornado hook echo on radar (5 miles southwest of the Airport) was relayed to the EOC by telephone. The EOC had lost commercial power a minute or so before this contact. All communications (teletypewriters, telephones, and facsimiles) at the Lubbock Weather Bureau Office were lost at 9:49 p.m. CDT, and at 9:55 p.m. CDT, the ESSA Weather Bureau personnel took cover as the tornado approached and passed over the Office.

Using the Fire Department VHF-FM radio, tornado warnings were passed to the Abernathy, New Deal, and Petersburg areas, valid until 11:00 p.m. CDT. All warnings were cancelled by the Weather Bureau Office at Lubbock at 11:30 p.m. CDT using the Fire Department VHF-FM radio, the only link with the city and surrounding areas. (More specific actions taken on the evening of May 11 are detailed in the chronological resume of Attachment A.)

In summary, the "main line of defense" in the ESSA Weather Bureau system (in this case set up by the Lubbock Weather Bureau Office) held because the tools, professional competence, skill, and judgment necessary to handle the situation were present and properly used.

FINDINGS AND RECOMMENDATION

Findings:

(1) The NMC products satisfactorily depicted the major features of the significant large-scale characteristics of the circulation. Absence of thunderstorm forecasts for the area did not detract from the quality or timeliness of forecasts and warnings issued by the ESSA Weather Bureau Office at Lubbock.

(2) The NSSFC severe weather outlooks for May 11-12, 1970, issued at 10:00 a.m. and at 1:25 p.m. CDT, indicated the possibility of isolated severe thunderstorms in western Texas during the evening hours. Lack of a Tornado Watch Area Bulletin from NSSFC did not degrade the quality or timeliness of warnings for the city of Lubbock.

(3) The main line of the ESSA Weather Bureau defense held because the ESSA Weather Bureau Office staff at Lubbock had the tools (radar and an action plan) and the professional competence to recognize a developing hazardous situation. The staff exercised outstanding skill and judgment in its warnings and statements on the evening of May 11. The survey team could not identify any area in which the staff could have done more to help safeguard the city.

(4) The warnings and statements issued by the ESSA Weather Bureau Office at Lubbock were given prompt emergency broadcast service by radio station KFYO; other local stations also broadcast the information available from ESSA Weather Wire Service and their representatives in the EOC. Unfortunately, the Spanish-language station ceased operations at 8:00 p.m., terminating an important contact with a significant segment of the local population.

(5) Communications with local officials and the mass media were primarily by ESSA Weather Wire Service. The Service system operated very well until power and telephone lines were disrupted at 9:49 p.m. CDT. After this time, only very limited contacts were possible with the EOC through

the Fire Department VHF-FM radio link. Warnings and subsequent cancellations for other communities were passed through this system.

(6) There is some question in the minds of the survey team as to the effectiveness of sirens as a warning signal for tornadoes. Because sirens (police and fire) are used daily, they probably do not convey the unique meaning necessary to tell people to take shelter immediately. The Civil Defense sirens require a power source; when the tornado disrupted the power, the warning signal could not be sounded. Finally, sirens are tested for hearing patterns on clear days, usually under optimum conditions; but to be effective, they must be heard through the noise of howling winds, driving rain, and often hail. However, their use should be continued until something more effective is found.

Recommendation:

—ESSA and Civil Defense officials, as a matter of urgency, should explore the possibility of an alternative means of warning the public to take shelter from an approaching tornado. The system should have these characteristics:

- *A unique sound used for no other purpose.*
- *Minimum attenuation by natural obstacles and manmade structures.*
- *Maximum ability to be heard under storm conditions.*
- *A self-contained power source sufficient for at least an initial warning.*

In this connection, the survey team noted the long-term success of lower frequency systems such as fog horns and diesel horns used as alerting devices under adverse conditions.

Courtesy of the Lubbock Avalanche-Journal.

CHAPTER 5

User Response and Service Benefits

IN RETROSPECT

Early education and preparation were of excellent quality and scope. When the storm came, warnings were accurate, made quickly, and disseminated widely. The death toll was amazingly low.

But there is no room for complacency where disaster is involved. So the question must be asked, Does Lubbock's experience have lessons for Government and the public which may save more lives the next time a great funnel comes screaming down from the sky somewhere in America?

The team's recommendations for improvements in the ESSA system are contained elsewhere in this report.

This Chapter will deal with another facet of the tragedy.

Approximately one-half of the deaths in Lubbock were to the Spanish-speaking population. The tornado passed over the Guadelupe section of the city where the majority of these persons live. The one Spanish-language radio station, KLFB, goes off the air at 8:00 p.m. At that time, listeners are advised to tune to radio station KFYO, the city's key Emergency Action Notification Signal (EANS) station. While it cannot be determined that continued Spanish-language broadcasts as the threat grew more acute would have saved lives, it is logical that they would have been helpful. The team is led to believe that broadcast media should be continually reinformed of the Federal Communications Commission Regulations that permit stations to remain on the air past specified closing hours in times of major emergency.

Perhaps the greatest and most frustrating single problem in the Lubbock disaster was summed up by Judge Robert H. Bean, who made the statement, "You just can't get to people when they aren't listening."

Team members interviewed numerous people on the streets of the city to learn whether they had heard and understood the ESSA Weather Bureau warning. A significant number had indeed heard, but had not wholly understood. Many of them—people who have read ESSA safety literature, have viewed "Tornado!," and have gone through an extremely tornado-conscious school system—did not know the difference between a ESSA Weather Bureau watch and a warning. A significant number said they had not been warned of the onset of the tornado. Further questioning, however, revealed that most of them had heard the radio and television broadcasts which saturated the Lubbock air that night: they were using the word *warning* in a different sense.

To them, a warning was a specific command from somebody in authority to take cover, or was the sound of a siren. In general, they believe siren signals to be one of the most important of all "take-cover" types of warning. But, they said, it must be a distinctive sound or signal that means just one thing—TORNADO—if it is to be effective. And, they said, it must be audible (as the Lubbock sirens largely were not) through the storm.

One cannot debate the fact that an inaudible siren is valueless. (The team's recommendations on this matter are contained in Chapter 4.) The ESSA Weather Bureau has pressed continually, and nationally, for the use of ever-audible disaster signals; it should continue to do so. But such signals should be primarily for the benefit of those otherwise unwarned.

It is difficult to understand why anybody who has just heard an ESSA Weather Bureau tornado warning over the radio or television would wait to hear it sanctified by the sound of a siren, or by some other "take-cover" command. The ESSA Weather Bureau warnings were clear and simple indications that safe shelter should be sought immediately (see Attachment A); they were augmented by pleas from the broadcast media throughout the evening.

Again, one cannot determine to what degree the attitude existed that no compelling personal emergency was present in the absence of sirens or, assuming its existence, how this attitude contributed to death and injury. But it seems logical to believe that if many of the living felt that way, so may have some of those who died.

There is no easy answer to this problem. It is clear, however, that public education on the implications of ESSA Weather Bureau watches and warnings must be continued and intensified, not only by ESSA but by other agencies involved in natural hazards.

Finally, what did the warning system service accomplish in terms of lives saved? The benefits from this service are measurable only in such terms.

At best, only crude estimates can be made because of the variability of circumstances surrounding the event. The time of day, type of construction, frequency of occurrence, time interval since last incident, population density, and general public understanding of the phenomena are some of the important factors that must be considered. All of these vary with time.

The effectiveness of the warning system utilized in this storm can be inferred by comparison with storms that were "unwarned" by today's standards. To do so, one must go back to 1953, the year a concerted effort was begun to develop a tornado warning system on a national basis. During that year, tornadoes struck six large population centers that were not given adequate warning in advance. They were:

1. Warner Robins Air Force Base, Ga., Apr. 30, 1953, 18 killed, $15,000,000 damage.
2. San Angelo, Tex., May 11, 1953, 11 killed, $3,239,000 damage.
3. Waco, Tex., May 11, 1953, 114 killed, $41-150,000 damage.
4. Flint, Mich., June 8, 1953, 116 killed, $19,-000,000 damage.
5. Worcester, Mass., June 9, 1953, 90 killed, $52,193,000 damage.
6. Vicksburg, Miss., Dec. 5, 1953, 38 killed, $25,000,000 damage.

For these six storms, a total of 387 persons lost their lives and $155,582,000 property loss were sustained. This represents a ratio of one life lost for each $400,000 of property loss. Assuming that inflation over the 17-year period has resulted in a doubling of property values, the present-day ratio would become one life lost per $800,000 damage.

Comparisons can now be made with lives and property loss sustained in the Lubbock storm. Twenty-six lives were lost; and, it is estimated conservatively that $125,000,000 property damage was sustained on May 11, 1970, giving a ratio of loss of life to property damage of approximately one life per $5,000,000 of damage. The extrapolation of the 1953 experience to the present would indicate that 156 persons might have become fatalities, or that as many as 125 lives saved because of the effectiveness of the warning system. The survey team concludes that this estimate is conservative even though more than 1,000 family units were destroyed by the storm.

Courtesy of the Lubbock Avalanche-Journal.

ATTACHMENT A

Listing of Warnings and Information Service Issuance

I. Chronology of Events and Action Taken.

May 11, 1970

1. 10:00 a.m.*—The Severe Local Storms (SELS) Unit amended the convective outlook issued earlier to include "Isolated thunderstorms with large hail expected in High Plains of West Texas east of Pecos late afternoon and early evening."
2. 1:25 p.m.—The SELS Unit advised that the air mass in the high country of West Texas was unstable, isolated thunderstorms would be severe, and that "local areas should be monitored for this possibility."
3. 6:55 p.m.—The Lubbock radar detected a moderate thunderstorm 15 miles south of the Lubbock Airport or about 5 miles south of the Lubbock city limits near the community of Woodrow.

†4. 7:00 p.m.—Moderate thunderstorm with a diameter of 10 miles indicated by Lubbock radar at 6:55 p.m.

†5. 7:30 p.m.—Revised forecasts to include thunderstorm activity for Lubbock and vicinity—eastern half of Zone 21, Zone 22, and southeastern half of Zone 24.

6. 7:45 p.m.—The Lubbock radar detected a moderate thunderstorm 10 miles south of the Lubbock Airport near southern city limits; thunderstorm increasing in intensity.
7. 7:47 p.m.—Called Amarillo Weather Bureau Office (WBO) on the Federal Telecommunications Service (FTS) and talked to radar operator. Amarillo radar indicated cloud tops near 46,000 feet and increasing. The 7:00 p.m. rawinsonde observation at Amarillo indicated a tropopause of 48,000 feet, an increase of 7,000 feet since the 7:00 a.m. observation.

†8. 7:50 p.m.—Severe Thunderstorm Warning Bulletin issued for Lubbock, Crosby, eastern Hale, and Floyd Counties, using a quick-action form. Emergency Action Notification Signal (EANS) requested. Long form of Severe Thunderstorm Warning Bulletin with specific details sent near 8:00 p.m. Also, Civil Defense was given warning by telephone. The switchboard operator was requested to notify Mr. Bill Payne, the Civil Defense Director.

9. 7:52 p.m.—The Texas Department of Public Safety (DPS) reported to the Lubbock WBO on marble-size hail in the 1300 block of 58th Street (this would be southeastern Lubbock).
10. 7:59 p.m.—Radio Station KFYO used EANS to alert other radio and television stations that a special warning message is coming over the network. No "commercials" given by KFYO from this time until 7:30 a.m., May 14.
11. 8:05 p.m.—Public reported golf ball-size hail 3 miles south of Lubbock city limits.

†12. 8:08 p.m.—A Severe Weather Statement was issued giving a report by the public of golf ball- to egg-size hail 3 miles south of Lubbock city limits at 8:05 p.m.

13. 8:10 p.m.—Golf ball- to grapefruit-size hail reported by public to Lubbock WBO at 8:10 p.m. in the vicinity of Lubbock Downs (about 2 to 3 miles south of city limits). Lubbock WBO checked with Amarillo radar personnel on severe storm just south of Lubbock and found that cloud tops had increased to 55,000 feet.

†14. 8:10 p.m.—Item #13 issued in a Severe Weather Statement. Severe thunderstorm warnings continued in effect for Lubbock, western Crosby, eastern Hale, and Floyd Counties until 9:00 p.m.

15. 8:10 p.m.—Funnel cloud 7 miles south of Lubbock Airport is reported by off-duty policeman to Lubbock WBO.
16. 8:13 p.m.—Public reported to Lubbock WBO of baseball-size hail in the southeastern part of the city of Lubbock.

†17. 8:15 p.m.—Tornado Warning Bulletin issued for Lubbock, western Crosby, eastern Hale, and Floyd Counties valid until 9:00 p.m. Quick warning form used. Item #16 included with additional note that a hook formation was indicated on the Lubbock WBO WSR–1 radar at about the same time 7 miles south of the Lubbock Airport apparently moving northeastward.

†18. 8:15 p.m.—Tornado Warning Bulletin, includ-

* Legal time is Central Daylight Time.

† Items transmitted on the ESSA Weather Wire Service by the Lubbock Weather Bureau Office.

ing additional details on long form, sent again by ESSA Weather Wire Service and relayed by telephone to Civil Defense Director, Mr. Bill Payne.

19. 8:33 p.m.—Public reported to Lubbock WBO of baseball-size hail about 5 miles south of the Airport.
20. 8:40 p.m.—Severe Thunderstorm Watch Bulletin Number 225 issued by the National Severe Storms Forecast Center (NSSFC) for all of the South Plains valid until 2:00 a.m. CDT Tuesday morning. Areal outline also listed.
†21. 8:42 p.m.—Severe Weather Statement issued by Lubbock WBO included numerous reports of large hail reported in Lubbock area in past 30 minutes. The WSR–1 radar indicated hook at 8:40 p.m., 5 miles south-southeast of Lubbock Airport.
22. 8:52 p.m. (approximate time)—The Texas DPS reported funnel cloud observed 3 miles east of Lubbock city limits on Buffalo Lake Road.
†23. 8:59 p.m.—Tornado Warning Bulletin continued for persons in Lubbock, western Crosby, southern Floyd, and southern Hale Counties valid until 10:00 p.m. CDT.
24. 9:05 p.m.—The Texas DPS informed Lubbock WBO of golf ball-size hail about 6 miles southeast of the Airport.
25. 9:08 p.m.—Public reported to Lubbock WBO of baseball-size hail at Holiday Inn East and Mackenzie State Park about 4 miles south of Airport.
†26. 9:14 p.m.—Bulletin issued advising of latest radar report and recent reports of large hail in the Lubbock area. Mention of tornado warning continuing in effect for Lubbock, western Crosby, southern Hale, and Floyd Counties included.
27. 9:15 p.m.—The Lubbock WBO advised the Texas DPS in Lubbock to notify Idalou police to sound tornado warning. Idalou is 10 miles northeast of Lubbock.
28. 9:30 p.m.—The Lubbock WBO advised the Shallowater Fire Department by telephone of severe storm 5 miles south of their area.
29. 9:35 p.m.—The Lubbock WBO WSR–1 radar indicated tornado about 7 miles southwest of the Lubbock Airport vicinity of 19th and Brownfield Highway. This information was relayed by two-way radio and telephone to Civil Defense. Sirens were sounded at 9:35 p.m. (this was the time that a patrolman reported a funnel in this part of city).
†30. 9:35 p.m.—Texas Zone Forecasts for Lubbock and Vicinity, Zone 21, and Zone 22 are issued which included severe thunderstorm watch; remainder of amended forecasts were to be issued after 10:00 p.m., but because of the tornado hitting downtown Lubbock, loss of communications at 9:49 p.m. prevented transmission.
31. 9:47 p.m.—The last communications between Lubbock WBO and Lubbock Civil Defense reported that "hooks" were indicated on radar about 9:45 p.m. about 5 miles southwest of Lubbock Airport.
32. 9:46 p.m.—Power failure at Civil Defense Headquarters.
33. 9:49 p.m.—The Lubbock WBO lost all communications.
34. 9:55 p.m.—The Lubbock WBO personnel abandoned the WBO to take cover from the approaching tornado.
35. 10:10 p.m.—The Lubbock WBO, using the two-way Lubbock Fire Department radio, relayed tornado warnings to the Abernathy, New Deal, and Petersburg areas. Sirens were sounded in Petersburg at an unknown time. Tornado warning was valid until 11:00 p.m. Message relayed by Mr. Tom Foster, Fire Department operator. Tornado warnings valid to 11:00 p.m. also included Lubbock, western Crosby, southern Hale, and southern Floyd Counties.
36. 11:30 p.m.—The Lubbock WBO relayed information to EOC by two-way radio that the tornado warnings were officially cancelled for all areas as storms had decreased to moderate intensity in the Lorenzo area.

Additional Information

1. Most of the initial severe weather reports and warnings were transmitted by the Radar Report and Warning Coordination Circuit (RAWARC).
2. During this same time period, many unrecorded contacts (unrecorded due to the press of severe weather) was made with the City of Lubbock, Civil Defense officials, and the Fire Department, answering their questions about the severe weather; also, contacts were made with the Texas DPS in Lubbock by the National Warning System (NAWAS), requesting information pertaining to damage reports of severe weather, etc.
3. By 1:15 a.m. on May 12, it became known that Lubbock WBO's only communications were by radio with the Lubbock Fire Department. Within 10 minutes, the Fort Worth Weather Bureau Forecast Office of the ESSA Weather Bureau had contacted the Amarillo WBO and made arrangements for that Office to assume responsibility for the area normally assumed by the Lubbock WBO.

II. Radio and Television Stations in Lubbock, Tex., *serviced by the ESSA Weather Wire Service.*

KYFO* ----------CBS affiliate.
KCBD and KCBD-TV --NBC "

* Emergency Action Notification Signal (EANS) station.

KSEL and KSEL-TV ---ABC affiliate.
KLBK-TV ----------CBS "
KLFB ----------Spanish-language radio station.
KDAV ----------Mutual Broadcasting System affiliate.
KLLL ----------Independent radio station.
KBFM ----------Independent radio station.
KKBC-TV ----------Independent television station.
KTXT and KTXT-TV ---Educational radio and television station.

Also Lubbock Cable Company's television weather with KCBD-TV channel 11 radar.

III. Messages Transmitted on ESSA Weather Wire Service by Lubbock WBO.

SEVERE THUNDERSTORM WARNING BULLETIN EANS REQUESTED . . . IMMEDIATE BROADCAST REQUESTED

WEATHER BUREAU LUBBOCK TEXAS

ISSUED 7/50 PM MAY 11 1970

A SEVERE THUNDERSTORM WARNING IS IN EFFECT UNTIL 9/00 PM FOR PERSONS IN LUBBOCK . . . CROSBY . . . EASTERN HALE . . . AND FLOYD COUNTIES.

A SEVERE THUNDERSTORM WAS INDICATED BY RADAR 10 MILES SOUTHEAST OF LUBBOCK ARPORT AT 7/50 PM. THE THUNDERSTORM IS MOVING TO THE NORTHNORTHEAST ABOUT 25 MPH. PEA SIZE HAIL REPORTED WITH THIS THUNDERSTORM BUT THUNDERSTORM IS INCREASING.

IF THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY TO REPORT LARGE HAIL OR DAMAGING WINDS . . . PLACE AN EMERGENCY CALL COLLECT TO THE LUBBOCK WEATHER BUREAU ON PO–25500 OR ASK THE NEAREST LAW ENFORCEMENT AGENCY TO RELAY YOUR REPORT TO THE WEATHER BUREAU.

SEVERE WEATHER STATEMENT
U S WEATHER BUREAU LUBBOCK TEXAS
ISSUED AT 8/08 PM CDT MAY 11 1970

PUBLIC REPORTS GOLF BALL TO EGG SIZE HAIL 3 MILES SOUTH OF THE LUBBOCK CITY LIMITS AT 8/05 PM IN THE SEVERE THUNDERSTORM THAT IS LOCATED ABOUT 8 MILES SOUTH OF THE LUBBOCK AIRPORT AT 8/05 PM . . . SEVERE THUNDERSTORM WARNING CONTINUES IN EFFECT FOR LUBBOCK . . WESTERN CROSBY . . . EASTERN HALE . . . AND FLOYD COUNTIES UNTIL 9 P . CDT . . .

SEVERE WEATHER STATEMENT
U S WEATHER BUREAU LUBBOCK TEXAS
ISSUED AT 8/10 PM CDT MAY 11 1970

PUBLIC REPORTS GOLF BALL TO GRAPEFRUIT SIZE HAIL 5 MILES SOUTH OF LUBBOCK PROPER AT 8/10 PM . . .

SEVERE THUNDERSTORM WARNING CONTINUES IN EFFECT FOR LUBBOCK . . . . WESTERN CROSBY . . . EASTERN HALE . . . AND FLOYD COUNTIES UNTIL 9 PM CDT . . .

TORNADO WARNING BULLETIN (short form)
EANS REQUESTED
WEATHER BUREAU LUBBOCK

ISSUED AT 8/15 PM CDT

A TORNADO WARNING IS IN EFFECT UNTIL 9 PM CDT FOR PERSONS IN LUBBOCK . . WESTERN CROSBY . . . EASTERN HALE . . . FLOYD COUNTIES

A FUNNEL CLOUD WAS SIGHTED BY OFF DUTY POLICEMAN AND RADAR INDICATED A HOOK FIGURATION AT 8/10 PM AT 7 MILES SOUTH OF LUBBOCK AIRPORT AND IS MOVING NORTHEAST.

TORNADO WARNING BULLETIN (long form)
EANS REQUESTED
WEATHER BUREAU LUBBOCK TEXAS
ISSUED AT 8/15 PM

A TORNADO WARNING IS IN EFFECT UNTIL 9/00 PM CDT FOR PERSONS IN LUBBOCK . . . WESTERN CROSBY . . . EASTERN HALE . . . FLOYD COUNTIES

A FUNNEL CLOUD WAS SIGHTED BY OFF DUTY POLICEMAN AT 8/10 PM AND RADAR AT WEATHER BUREAU INDICATED HOOK FIGURATION ALSO AT THAT TIME LOCATED AT 7 MILES SOUTH OF LUBBOCK AIRPORT AND MOVING NORTHEAST.

IF THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY TO REPORT A TORNADO OR OTHER SEVERE WEATHER. PLACE AN EMERGENCY COLLECT CALL TO THE LUBBOCK TEXAS WEATHER BUREAU ON PO–25500 OR ASK THE NEAREST LAW ENFORCEMENT AGENCY TO RELAY YOUR REPORT TO THE WEATHER BUREAU.

SEVERE THUNDERSTORM WATCH BULLETIN NUMBER 225.
ISSUED 840 PM CDT MAY 11 1970.

THE WEATHER BUREAU HAS ISSUED A SEVERE THUNDERSTORM WATCH FOR . . . PORTIONS OF WEST TEXAS AND
EXTREME SOUTHWEST OKLAHOMA.

THE THREAT OF SCATTERED SEVERE THUNDERSTORMS WITH LARGE HAIL AND DAMAGING WINDS WILL EXIST IN THESE AREAS FROM CURRENT TIME UNTIL 2 AM CDT THIS MONDAY NIGHT.

THE GREATEST THREAT OF SEVERE THUNDERSTORMS IS IN AN AREA ALONG AND 70 MILES EITHER SIDE OF A LINE FROM 70 MILES NORTHEAST OF AMARILLO TEXAS TO 100 MILES SOUTH SOUTHEAST OF WINK TEXAS.

PERSONS IN OR CLOSE TO THE SEVERE THUNDERSTORM WATCH AREA ARE ADVISED TO BE ON THE WATCH FOR LOCAL WEATHER DEVELOPMENTS AND FOR LATER STATEMENTS AND WARNINGS.

SEVERE WEATHER STATEMENT
U S WEATHER BUREAU LUBBOCK TEXAS
ISSUED AT 8/42 PM CDT MAY 11 1970

RADAR AT THE LUBBOCK AIRPORT AT 8/41 PM SHOWS A LARGE SEVERE THUNDERSTORM LOCATED BETWEEN IDALOU AND REACHING TO THE SOUTHEAST PORTION OF LUBBOCK CITY . . . NUMEROUS REPORTS OF LARGE HAIL RANGING FROM GOLF BALL TO BASEBALL SIZE HAIL HAVE BEEN RECEIVED FROM THIS SEVERE STORM DURING THE PAST HALF HOUR WITH SOME GRAPEFRUIT SIZE HAIL ABOUT 3 OR 4 MILES SOUTH OF THE LUBBOCK CITY LIMITS ABOUT HALF HOUR AGO NEAR THE JOCKEY CLUB . . .

RADAR STILL INDICATED THE POSSIBILITY OF A TORNADO WITHIN THIS SEVERE STORM ABOUT 5 MILES SOUTH-SOUTHEAST OF THE AIRPORT AT 8/40 PM . . . THIS SEVERE STORM IS MOVING NORTH NORTHEAST ABOUT 25 MPH. TORNADO WARNING WAS ISSUED AT 8/15 PM CDT . . .

TWO OTHER THUNDERSTORMS INTENSIFYING RAPIDLY ABOUT 8 MILES SOUTHWEST OF THE LUBBOCK AIRPORT WITH APPARENT MOVEMENT TO THE NORTHEAST ABOUT 25 MPH . . . DIAMETER OF THESE THUNDERSTORMS ABOUT 4 MILES . . .

TORNADO WARNING BULLETIN
EANS REQUESTED
WEATHER BUREAU LUBBOCK TEXAS

ISSUED AT 8/59 PM CDT MAY 11 1970

A TORNADO WARNING IS IN EFFECT UNTIL 10 PM CDT TONIGHT MAY 11TH FOR PERSONS IN LUBBOCK . . . WESTERN CROSBY . . . SOUTHERN FLOYD AND SOUTHERN HALE COUNTIES . . .

A TORNADO WAS INDICATED BY RADAR AT 8/57 PM AND A FUNNEL CLOUD HAS BEEN OBSERVED IN THIS SAME AREA DURING THE PAST 5 MINUTES ABOUT 7 MILES SOUTH SOUTHEAST OF LUBBOCK AIRPORT . . . THIS SEVERE STORM IS MOVING TOWARDS THE NORTH NORTHEAST ABOUT 15 MPH . . . THE AREA WHERE RADAR SHOWS THIS POSSIBLE TORNADO IS IN THE BUFFALO SPRINGS LAKE AREA.

CORRECTION . . . THIS REPORT OF THE FUNNEL AND RADAR INDICATION IS 3 MILES EAST OF THE LUBBOCK CITY LIMITS ON THE BUFFALO SPRINGS LAKE ROAD . . .

LARGE SEVERE THUNDERSTORM IS CENTERED JUST SOUTHEAST OF THE LUBBOCK AIRPORT MOVING NORTH NORTHEAST ABOUT 15 MPH . . . LARGE HAIL AND DAMAGING WINDS ARE LIKELY WITH THIS SEVERE STORM UNTIL 10 PM .

IF THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY . . TO REPORT A TORNADO OR OTHER SEVERE WEATHER PLACE AN EMERGENCY COLLECT CALL TO THE LUBBOCK TEXAS WEATHER BUREAU AT PO 2-5500 OR ASK THE NEAREST LAW ENFORCEMENT AGENCY TO RELAY YOUR REPORT TO THE WEATHER BUREAU . . .

RADAR NOW AT 9/03 PM SHOWS THIS HOOK FORMATION TO BE ABOUT 6 MILES SOUTH SOUTHEAST OF THE LUBBOCK AIRPORT MOVING NORTH ABOUT 15 MPH . . . THIS LOCATION WOULD BE ALONG THE EASTERN CITY LIMITS OF LUBBOCK . . .

OTHER THUNDERSTORMS DEVELOPING TO THE WEST AND SOUTHWEST OF LUBBOCK . .

SEVERE THUNDERSTORM WARNING BULLETIN
EANS IMMEDIATE BROADCAST REQUESTED

WEATHER BUREAU LUBBOCK TEXAS
ISSUED AT 9/14 PM CDT MAY 11 1970

A LARGE SEVERE THUNDERSTORM ABOUT 10 TO 15 MILES FROM ABOUT 8 MILES WEST OF THE LUBBOCK AIRPORT TO THE LUBBOCK AIRPORT TO ABOUT 7 MILES EAST AND SOUTHEAST OF THE LUBBOCK AIRPORT WITH LITTLE MOVEMENT INDICATED . . . . RADAR INDICATES THIS TO BE A SEVERE HAILSTORM . .

SEVERAL REPORTS IN THE PAST 10 MINUTES INDICATE GOLF BALL TO BASEBALL SIZE HAIL IN THE VICINITY OF THE HOLIDAY INN EAST AND MACKENZIE STATE PARK WITH HAIL INCREASING AT THIS TIME . . . HAIL NOW ONE INCH IN DIAMETER HERE AT THE LUBBOCK AIRPORT . . .

TORNADO WARNING REMAINS IN EFFECT FOR LUBBOCK . . . WESTERN CROSBY . . FLOYD . . . AND SOUTHERN HALE COUNTIES UNTIL 10 PM TONIGHT . . . SEVERE THUNDERSTORMS WITH LARGE HAIL . . . DAMAGING WINDS AND POSSIBLY A TORNADO IN THESE AREAS UNTIL 10 PM . . . RADAR STILL INDICATES GOOD HOOK FORMATION ABOUT 6 MILES SOUTH SOUTHEAST OF THE LUBBOCK AIRPORT . . AND THIS LOCATION WOULD BE ON THE BUFFALO SPRINGS LAKE ROAD ABOUT 3 MILES EAST OF CITY OF LUBBOCK . . IDALOU SHOULD BE ON THE ALERT IN PARTICULAR FOR THIS SEVERE STORM AND POSSIBLE TORNADO . .

IF THREATENING CONDITIONS ARE SIGHTED . . . BE PREPARED TO MOVE TO A PLACE OF SAFETY TO REPORT LARGE HAIL OR DAMAGING WINDS . . . PLACE AN EMERGENCY COLLECT CALL TO THE LUBBOCK TEXAS WEATHER BUREAU AT PO 2-5500 OR THE NEAREST LAW ENFORCEMENT AGENCY TO RELAY YOUR REPORT TO THE WEATHER BUREAU . .

THE LAST REPORT OF THE BASEBALL SIZE HAIL WAS AT 9/08 PM IN THE HOLIDAY INN EAST AND MACKENZIE STATE PARK . . .

LUBBOCK AND VICINITY
9:35 PM CDT MAY 11, 1970
SEVERE THUNDERSTORM WATCH IN EFFECT UNTIL 2 AM TONIGHT . . .

CHANCE OF AFTERNOON AND NIGHT TIME THUNDERSTORMS THROUGH WEDNESDAY WITH THE POSSIBILITY OF A FEW LOCALLY SEVERE . . . CONTINUED WARM . . . LOW TONIGHT AND TUESDAY NIGHT . . . NEAR 60. HIGH TUESDAY . . . LOW 90S. HIGH WEDNESDAY . . . UPPER 80S. SOUTHERLY WINDS 10 TO 15 MPH TONIGHT INCREASING TO 15 TO 25 MPH TUESDAY . . . WINDS BRIEFLY STRONG AND GUSTY VICINITY THUNDERSTORMS . . . CHANCE OF RAIN 60 PER CENT TONIGHT AND 30 PER CENT TUESDAY AFTERNOON AND NIGHT . . .

ZONE 21
SEVERE THUNDERSTORM WATCH BULLETIN IN EFFECT UNTIL 2 AM CDT TONIGHT . . CHANCE OF AFTERNOON AND NIGHT-TIME THUNDERSTORMS THROUGH WEDNESDAY WITH THE POSSIBILITY OF A FEW LOCALLY SEVERE . . CONTINUED WARM THROUGH TUESDAY NIGHT. NOT QUITE SO WARM WEDNESDAY . . . LOW TONIGHT . . . NEAR 50 NORTHWEST TO UPPER 50S SOUTHEAST. HIGH TUESDAY . . . NEAR 90. LOW WEDNESDAY NIGHT . . LOW AND MIDDLE 50S. HIGH WEDNESDAY . . . IN THE 80S. SOUTHERLY AND SOUTHWESTERLY WINDS 10 TO 15 MPH TONIGHT INCREASING TO 15 TO 25 MPH TUESDAY . . . EXCEPT WINDS STRONG AND GUSTY VICINITY THUNDERSTORMS . . . . . CHANCE OF RAIN 40 PER CENT TONIGHT AND 30 PER CENT TUESDAY AFTERNOON AND NIGHT . . .

ZONE 22
SEVERE THUNDERSTORM WATCH IN EFFECT UNTIL 2 AM TONIGHT . . CHANCE OF AFTERNOON AND NIGHT-TIME THUNDERSTORMS THROUGH WEDNESDAY WITH THE POSSIBILITY OF A FEW LOCALLY SEVERE. CONTINUED WARM . . . LOW TONIGHT . . . . MIDDLE 60S. HIGH TUESDAY . . . MIDDLE 90S. LOW TUESDAY NIGHT . . . LOW AND MIDDLE 60S. HIGH WEDNESDAY . . LOW 90S. SOUTHERLY WINDS 10 TO Q15 MPH TONIGHT INCREASING TO 15 TO 25 MPH TUESDAY . . EXCEPT WINDS STRONG AND GUSTY VICINITY THUNDERSTORMS . . CHANCE OF RAIN 40 PER CENT TONIGHT . . . 30 PER CENT TUESDAY AND TUESDAY NIGHT . . REMAINDER OF AMMENDED FORECASTS WILL FOLLOW AFTER 10 PM CDT . . .

ATTACHMENT B

Preparedness Actions

The following meetings were held over a 16-month period in the Lubbock area to heighten community preparedness against tornadoes:

January 31, 1969
Plainview in Hale County—Mr. Curry, Civil Defense and Safety Director.
Lockney in Floyd County—Mr. Brown, Mayor.
Floydada in Floyd County—Mr. William A. Feuerbacher, City Manager.
Ralls in Crosby County—Mr. Pretty, Civil Defense.
Idalou in Lubbock County—Mr. Frank Guess, Mayor.

March 4, 1969
Levelland in Hockley County—Single sideband radio group.

March 25, 1969
Lubbock in Lubbock County—Area-wide meeting sponsored by the Texas Department of Public Safety (DPS); 100 in attendance.

April 10, 1969
Brownfield in Terry County—Mr. Simmonds, Civil Defense; City officials and local citizenry.

April 14, 1969
Hale Center in Hale County—Mr. Law, the Civil Defense Director; and local citizenry at radio and television center.

April 15, 1969
Floydada in Floyd County—Mr. Richard Thomas, Civil Air Patrol; at Group Center at radio station KFLD.

April 15, 1969
Springlake in Lamb County—Mr. Wisian, Civil Defense.
Olton in Lamb County—Mr. Wayne Cole, Civil Defense.

April 16, 1969
Littlefield in Lamb County—City Police, Fire Department, and County Sheriff.
Sudan in Lamb County—City Police and Fire Department.
Muleshoe in Bailey County—City citizen radio group and City Police.
Slaton in Lubbock County—Mr. Kendrick, Civil Defense; and citizen radio group.
Post in Garza County—Sheriff, City Police, Fire Department, and the Texas DPS.
Tahoka in Lynn County—County Sheriff, City Police, Auxiliary Police, and Fire Department with Civil Defense.

April 13, 1970
Lubbock in Lubbock County—Mr. Bill Payne, Civil Defense Director; Mr. Bill Blackwell, City Manager; Mr. Shannon, the Assistant Civil Defense Director; and representatives of six local radio and television stations and the local newspaper.

April 18, 1970
Plainview in Hale County—Preparedness planning meeting cancelled because of the tornado at Plainview on April 17, 1970.

May 14, 1970
Brownfield in Terry County—Area-wide tornado preparedness planning meeting at Civil Defense Headquarters which included Civil Defense directors, mayors, city managers, Texas DPS personnel, sheriffs, and radio personnel from Cochran, Hockley, Lubbock, Yoakum, Terry, Lynn, Gaines, and Dawson Counties; 41 in attendance.

At each of the above meetings public education material on severe thunderstorms and tornadoes prepared by the ESSA Weather Bureau were distributed; two color slide series "Tornadoes and Severe Local Storms—A Guide to Storm Identification" and "Skywarn—Severe Local Storms Spotter's Training Slide-Lecture Series," and the film "Tornado!" were shown and discussed. A listing of ESSA-produced materials applicable to severe local storms follows.

Courtesy of the Lubbock Avalanche-Journal.

PUBLIC EDUCATIONAL MATERIAL—SEVERE LOCAL STORMS

Booklets

Tornado Preparedness Planning

Weather Bureau Severe Local Storm Warning Service and Tornado Statistics, 1953–1968

Weather Bureau Spotter's Guide for Identifying and Reporting Severe Local Storms

Brochures

Lightning

Thunderstorms

Tornado

Cards and Decals

SKYWARN Spotter Decal

SKYWARN Spotter I.D. Card

Tips for Tornado Safety Card

Folders

In Your Keeping (SKYWARN 70)

SKYWARN

Posters

Severe Local Storm Spotter Reporting Procedures

Tornado Safety Rules

Series

Severe Local Storms Spotter's Training Slide-Lecture Series