

September 1997

# NATIONAL WEATHER SERVICE

## Modernization Activities Affecting Northwestern Pennsylvania



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**United States  
General Accounting Office  
Washington, D.C. 20548**

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**Accounting and Information  
Management Division**

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The Honorable F. James Sensenbrenner, Jr.  
Chairman, Committee on Science  
House of Representatives

The Honorable Phil English  
House of Representatives

As you know, the National Weather Service (NWS) has been modernizing its systems and work processes since the 1980s to enable it to provide better weather services to users. This effort is one of the larger systems modernization programs within the federal government, projected to cost about \$4.5 billion. The modernization is vital to NWS streamlining and downsizing and includes cutting its number of field offices by over half. Before any weather service office is closed, the Secretary of Commerce must certify that the affected geographic areas will not experience a degradation of weather service.<sup>1</sup>

In your March 5, 1997, letter, you expressed concerns about radar coverage and weather services provided to northwestern Pennsylvania, an area that had been served by the Erie weather service office (WSO). This office is slated for closure and has therefore been spun down operationally (i.e., it is no longer providing operational services to the public).<sup>2</sup> However, data from the Erie radar have been used by one of the three NWS offices now providing services to northwestern Pennsylvania. These offices are weather forecast offices (WFOS) in Pittsburgh and State College, Pennsylvania, and Cleveland, Ohio. NWS has not officially closed the Erie office, however, because of ongoing concerns regarding services to the Erie area. NWS officials said they will not close the office until they have addressed all concerns about possible degradation of service, including those regarding adequate radar coverage.

As agreed with your offices, we examined how NWS had implemented modernization and restructuring activities in this area. Specifically, our objectives were to identify (1) why the Erie, Pennsylvania, WSO was spun down prior to the Department of Commerce's October 1995 report on 32

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<sup>1</sup>This certification is required by the Weather Service Modernization Act, Public Law 102-567, Sec. 706(b), 106 Stat. 4306 (1992).

<sup>2</sup>Spin-down is a term used by NWS to describe the actions taken at a weather office slated for closure. It includes transferring weather service responsibilities to other offices and reducing staff.

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areas of concern,<sup>3</sup> (2) what types of services were provided to the counties served by the Erie office before and after office spin-down, as well as what public concerns have been raised, and how NWS responded to them, (3) what safety concerns have been raised relating to weather services at the Erie airport and to the timeliness of small-craft advisories for Lake Erie, including how NWS responded to public concerns about these issues, and (4) whether any reliable statistical or other evidence exists that addresses whether a degradation of service in the Erie area has occurred as a result of the modernization and office restructuring.

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## Scope and Methodology

To determine why the Erie wso was spun down before completion of the Secretary of Commerce's report on 32 areas of concern, we analyzed documents that described the spin-down and reviewed the Secretary's report. We also discussed the timeline of these events with NWS officials.

To determine what weather services were provided before and after the Erie office was spun down, we reviewed NWS site implementation plans for the Cleveland, Pittsburgh, and Central Pennsylvania weather offices, and interviewed former employees of the Erie wso and officials at each of the three wfos. We also discussed the services provided and concerns raised about the quality and types of services with (1) members of Save Our Station, a group dedicated to saving the Erie wso, (2) Erie television station meteorologists, (3) the National Air Traffic Controllers Association safety representative at Erie International Airport, (4) officials at Presque Isle State Park, Erie, (5) the officer in charge of the U.S. Coast Guard Station in Erie, and (6) emergency management officials and representatives of emergency volunteer organizations, such as Skywarn, in each of the nine counties that constituted the Erie wso warning area.<sup>4</sup> We reviewed NWS' responses to concerns raised.

We identified safety concerns raised regarding the weather services provided at the Erie airport and obtained NWS' responses to these concerns through interviews with the National Air Traffic Controllers Association safety representative at Erie International Airport, the manager of the Aviation Weather Requirements Division, the Federal Aviation Administration (FAA), and NWS officials. To identify concerns raised about

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<sup>3</sup>This report was required by a joint agreement between the Department and concerned members of the Congress. It assessed the possibility of degradation of service in areas of concern identified by the public primarily because of planned office closures. Northwestern Pennsylvania was identified as an area of concern.

<sup>4</sup>Counties in the Erie WSO warning area were Cameron, Crawford, Elk, Erie, Forest, McKean, Potter, Venango, and Warren.

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small-craft advisories on Lake Erie, we interviewed (1) officials at Presque Isle State Park, (2) the officer in charge of the U.S. Coast Guard station in Erie, (3) the commander of the Greater Erie Boating Association, and (4) members of Save Our Station. We reviewed NWS documents relating to aviation weather and the small-craft advisories on Lake Erie and obtained NWS' responses to safety concerns.

To determine if reliable statistical or other evidence existed that addressed degradation of service, we reviewed NWS verification statistics for severe weather events in the nine counties included in the Erie WSO county warning area prior to and after spin-down of the Erie office. We discussed the methodology and process used to develop these statistics, and their reliability, with NWS officials. In addition, we discussed NWS verification statistics and studies with a professor emeritus and an associate professor of meteorology at Pennsylvania State University and also with the chairperson of the Modernization Transition Committee. Further, we reviewed available NWS lake-effect snow study reports.<sup>5</sup> We interviewed the NWS Eastern region team responsible for the lake-effect snow study and the director of the Office of Meteorology at NWS headquarters. In discussions with representatives of Save Our Station, county emergency management directors, and volunteer organizations, we obtained specific examples of weather events that these individuals believed demonstrated evidence of degradation of service.

In addition, we reviewed the National Research Council (NRC) report on NWS modernization and the Secretary's report on 32 areas of concern, with specific reference to radar coverage. To understand the ability of NWS' new radars and other data tools available to forecasters to provide adequate coverage for severe weather event warnings and lake-effect snow, we discussed this topic with NWS officials and the study director of NRC, the chairperson of the Modernization Transition Committee, a member of the Secretary's report team who was the acknowledged expert on NWS radar, the former chairperson of NRC's Modernization Committee (who is also a professor emeritus of meteorology), and an associate professor of meteorology at Pennsylvania State University.

We performed our work at NWS headquarters in Silver Spring, Maryland; at the NWS Eastern region in Bohemia, New York; at the Cleveland, Pittsburgh, and Central Pennsylvania WFOS; and at the Erie WSO. In addition, we conducted telephone interviews with emergency

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<sup>5</sup>Lake-effect snow is localized snow that occurs over and along the shoreline of lakes. It is caused by the flow of relatively cold air over warm water, such as that occurring along the southern and eastern shores of the Great Lakes during outbreaks of arctic cold air.

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management officials and emergency volunteers in the Erie WSO county warning area.

We performed our work from April to August 1997, in accordance with generally accepted government auditing standards. As agreed with your offices, we did not assess the adequacy of the NWS responses to identified concerns, and we did not assess the adequacy of reports discussed in this report. The Secretary of Commerce provided written comments on a draft of this report. These comments are discussed at the end of this report and are reprinted in appendix II.

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## Results in Brief

NWS started spinning down the Erie WSO by transferring warning responsibilities to the three assuming WFOs in August 1994 before the Department of Commerce began its review of the 32 areas of concern in June 1995. Concerns about the Erie office closure, however, were made known as early as June 1994. NWS continued with its plans to spin down the office because officials believed they would be providing the best service to the area by relying on modernized radars in other offices.

The three WFOs that assumed responsibility for the counties formerly served by the Erie WSO provide generally the same types of services that the Erie office had provided, with the exception of the general public's local or toll-free telephone access to NWS personnel. These ongoing services include issuing public forecasts, marine and aviation forecasts and warnings, and severe weather warnings, and conducting warning preparedness activities. The major concerns surrounding the transfer of responsibilities relate to whether radar coverage over the counties formerly served by Erie would be adequate, and whether forecasts and warnings are at least equal in accuracy and timeliness to those previously issued by Erie. NWS responses to such concerns include analyzing its ability to detect severe weather phenomena over northwestern Pennsylvania, as well as providing data on how well the assuming offices are issuing forecasts and warnings.

A few concerns also have been raised regarding NWS' service to the Erie airport and the timeliness of small-craft advisories for Lake Erie. The most commonly voiced concern regarded an automated surface observing system (ASOS) and requirements for air traffic controllers to augment it

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with human observations.<sup>6</sup> While FAA accepted responsibility for the Erie system from NWS in October 1996, concerns about using air traffic controllers to augment ASOS are not limited to the Erie airport. Consequently, FAA has sponsored a study of the impact of its augmentation responsibilities at airports such as Erie and will be issuing a report in the fall of 1997.

Several studies present evidence that a degradation in service has not occurred in northwestern Pennsylvania; however, the ability to detect and predict lake-effect snow remains a concern. Studies by NRC and the Department of Commerce show that the assuming WFOS have the ability to detect most weather phenomena in the areas formerly served by Erie as well as or better than that office. NWS is completing a lake-effect snow study to determine the effectiveness of the modernized weather system in detecting and predicting this phenomena in the Erie area. Preliminary conclusions indicate that service has not been degraded in detecting and forecasting lake-effect snow; however, the service being provided to Erie is not as good as the service provided to other lake communities whose service has improved as a result of the NWS modernization. The director of NWS' Office of Meteorology told us that as a result, he will recommend a radar for the Erie area. However, NWS has not yet taken a position on the need for a radar, and the Secretary of Commerce is scheduled to make the final decision on any action to be taken in northwestern Pennsylvania.

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## Background

NWS began a nationwide modernization program in the 1980s to upgrade observing systems, such as satellites and radars, and design and develop advanced forecaster computer workstations. The goals of the modernization are to achieve more uniform weather services across the nation, improve forecasts, provide better detection and prediction of severe weather and flooding, permit more cost-effective operations through staff and office reductions, and achieve higher productivity. As part of its modernization program, NWS plans to shift its field office structure from 52 Weather Service Forecast Offices and 204 WSOS, to one with 119 WFOS.<sup>7</sup>

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<sup>6</sup>ASOS was implemented during modernization to replace human observation of many elements, such as wind speed and direction, and visibility. However, because the system cannot detect all elements that were historically reported through human observation, such as thunderstorms, tornadoes, and cloud layers above 12,000 feet, system augmentation is needed to report these elements.

<sup>7</sup>This discussion of field offices does not include river forecast centers because the role of these offices was not changed by the modernization and restructuring.

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NWS field offices provide basic weather services such as forecasts, severe weather warnings, warning preparedness, and—where applicable—aviation and marine forecasts. Warnings include “short-fused”—events such as tornadoes, flash floods, and severe storms—and “long-fused”—events such as gales and heavy snow. NWS broadcasts forecasts and warnings over the National Oceanic and Atmospheric Administration’s (NOAA) Weather Radio. NWS offices transmit hourly weather updates and severe weather warnings as they are issued on hundreds of NOAA Weather Radio stations around the country. Warning preparedness includes coordinating with local emergency management, law enforcement agencies, and the media on notification of and response to severe weather events, and training volunteer weather observers to collect and report data under a program commonly called Skywarn. NWS relies heavily on supplemental data provided by Skywarn volunteers’ reports on severe weather events.

Under NWS’ restructuring plan, the Erie WSO is slated for closure and has been spun down operationally. When fully functioning, this office’s primary role was to provide severe weather warnings to nine counties in northwestern Pennsylvania, operate an on-site radar, and take surface-condition weather observations. Under the NWS field office restructuring, responsibility for Erie’s nine counties is divided among three WFOS: Erie and Crawford counties are served by the Cleveland WFO; Venango and Forest counties are served by the Pittsburgh WFO; and Cameron, Elk, McKean, Potter, and Warren counties are served by the Central Pennsylvania WFO (located at State College, Pennsylvania).<sup>8</sup> Figures 1 and 2 present maps of the premodernized and modernized office structures for the northwestern Pennsylvania area.

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<sup>8</sup>The Central Pennsylvania office is not fully staffed and, therefore, has not yet accepted its full responsibilities for the five former Erie counties. Long-fused forecasting services for these counties are still provided by the Pittsburgh office. NWS plans to fully staff this office in fiscal year 1998.



Figure 1: Premodernized NWS Office Structure for Northwestern Pennsylvania

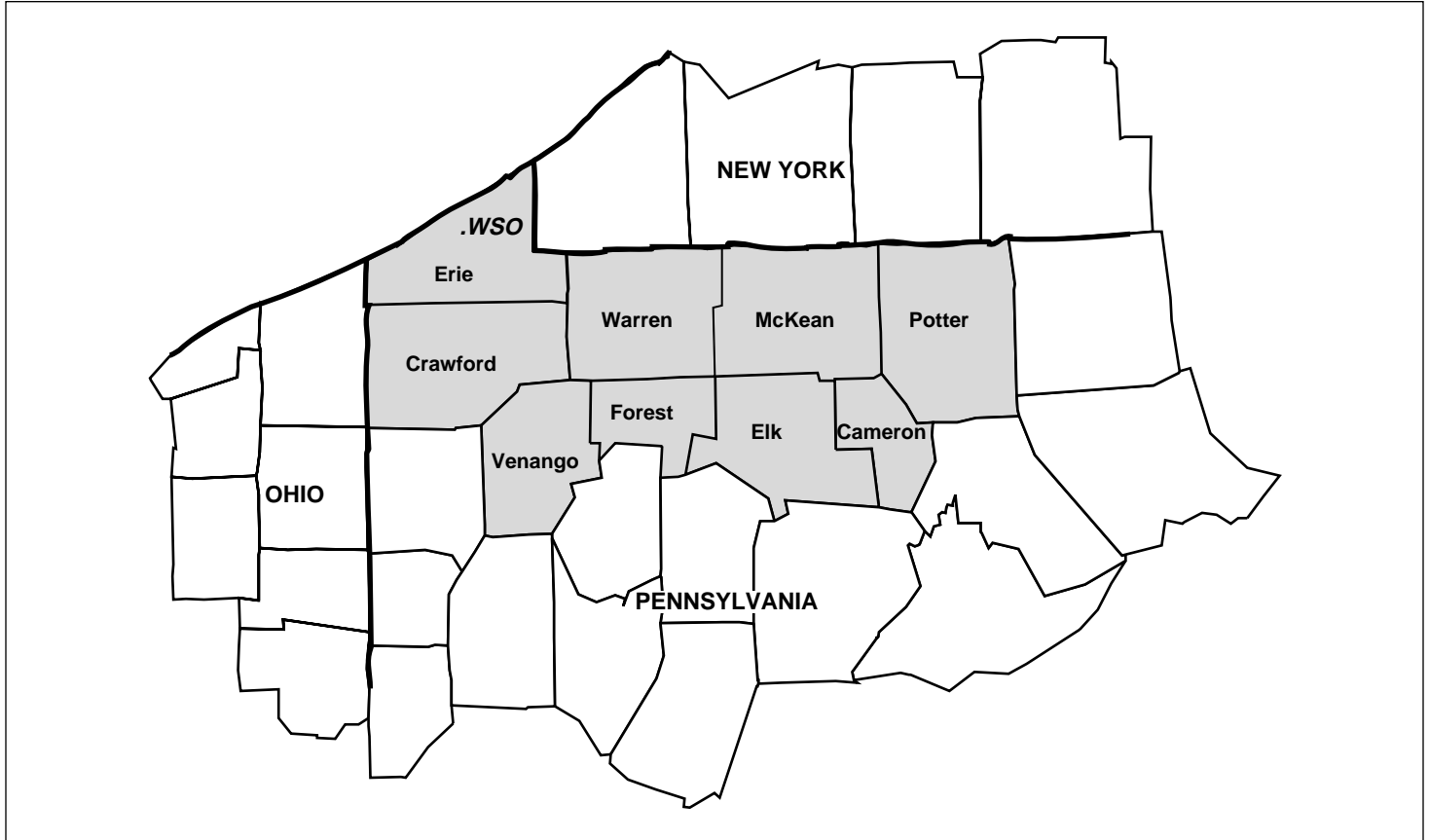
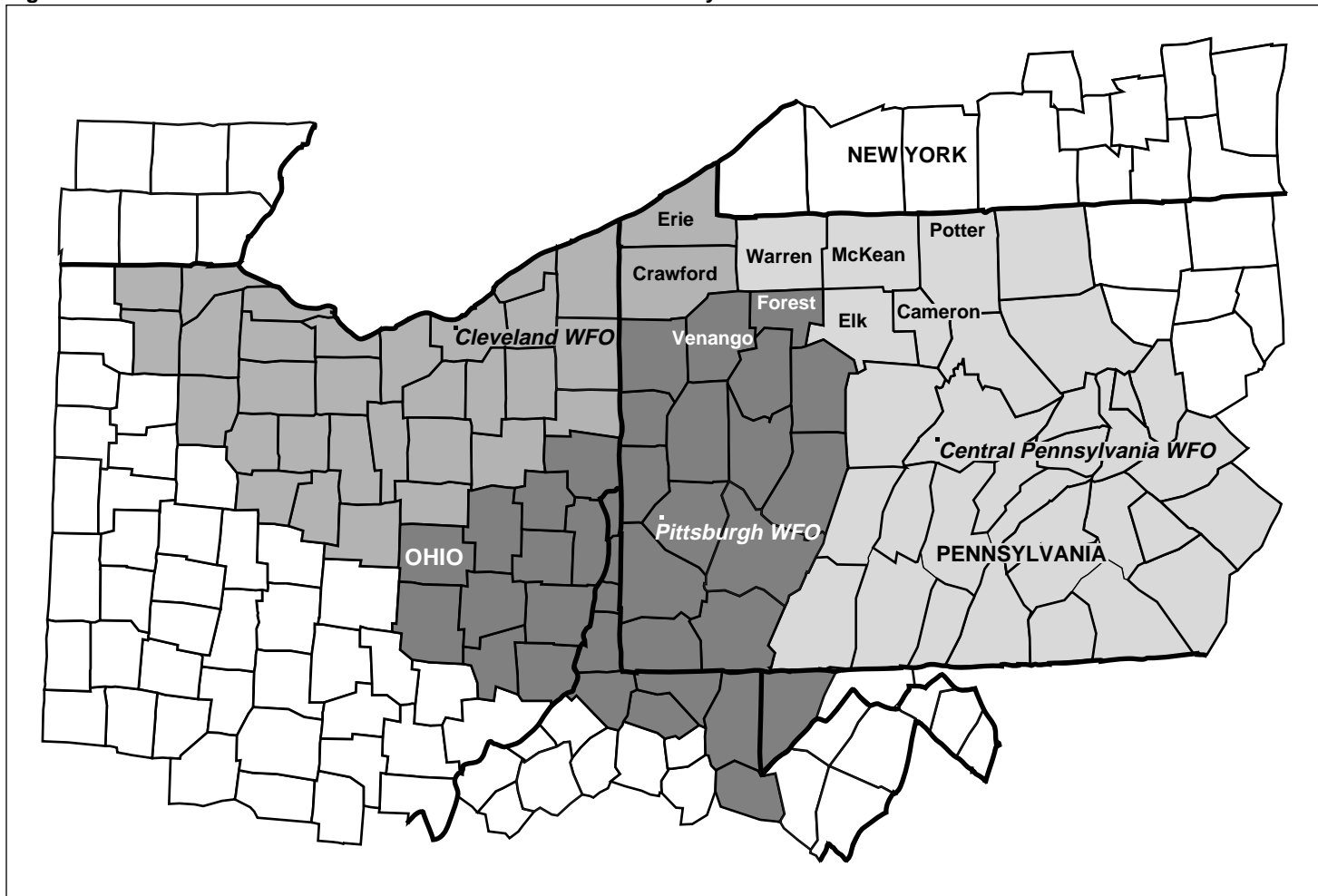


Figure 2: Modernized NWS Office Structure for Northwestern Pennsylvania



Under the field office restructuring, the three offices assuming coverage responsibility for Erie’s nine counties have been in the process of installing new systems and equipment, such as new radars, and training staff in using the new technologies. In addition, each office taking on part of Erie’s former responsibilities communicated modernization and restructuring changes with the newly-assumed counties’ emergency response community, volunteer weather observers, the media, and the public. Once sufficient systems and staff were in place, the three WFOs—Cleveland, Pittsburgh, and Central Pennsylvania—began assuming responsibility for their respective counties. Erie gradually phased out its

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routine radar operation; it was responsible for augmenting ASOS until October 1996 when FAA took over responsibility for this function.

Two other NWS changes affected the Erie area, but were not part of the spin-down or required for consideration in making an office closure certification; these changes affected the number and type of forecasts issued and the area covered by the forecasts. First, in both the premodernized and modernized environments, the 2-day forecast is broken into four 12-hour periods. However, with access to improved, real-time data from new technology—primarily the new radars implemented as part of the modernization—NWS in 1994 added a short-term forecast, called the Nowcast, which is a 6-hour forecast.

The second change NWS implemented during modernization was a reduction in the area covered by its zone forecast. Before modernization, forecast zones (i.e., the areas for which a particular forecast was issued) could include several counties as well as specific localized forecasts for high-population areas. In October 1993, NWS reduced the size of its zones to single counties to allow forecasters to take advantage of improved data and make more specific forecasts and warnings. Because of this ability to be more specific, most NWS areas discontinued the localized forecasts for high-population areas.

The Weather Service Modernization Act<sup>9</sup> requires that before any office may be closed, the Secretary of Commerce must certify to the Congress that closing the field office will not degrade service to the affected area. This certification must include (1) a description of local weather characteristics and weather-related concerns that affect the weather services provided within the service area, (2) a detailed comparison of the services provided within the service area and the services to be provided after such action, (3) a description of recent or expected modernization of NWS operations that will enhance services in the area, (4) identification of areas within a state that will not receive coverage (at an elevation of 10,000 feet or below) by the modernized radar network, (5) evidence, based upon a demonstration of modernized NWS operations, used to conclude that services will not be degraded from such action, and (6) any

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<sup>9</sup>Public Law 102-567, 106 Stat. 4303 (1992).

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report of the Modernization Transition Committee<sup>10</sup> that evaluates the proposed certification.

In response to concerns from members of the Congress, the Department of Commerce agreed to take several steps to identify community concerns regarding modernization changes, such as office closures, and study the potential for degradation of service. First, the Department published a notice in the Federal Register in November 1994, requesting comments on service areas where it was believed that premodernized weather services may be degraded with planned modernization changes. Next, the Department contracted with NRC to conduct an independent scientific assessment of proposed modernized radar coverage and consolidation of field offices in terms of the no degradation of service requirement. In addition, NRC established criteria for identifying service areas where the elimination of older radars could degrade services. Finally, the Secretary of Commerce applied the NRC criteria to identified areas of concern to determine whether a degradation of service is likely to occur. The resulting report, Secretary's Report to Congress on Adequacy of NEXRAD Coverage and Degradation of Weather Services Under National Weather Service Modernization for 32 Areas of Concern, was issued in October 1995.

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## Erie Spin-Down Began Prior to Initiation of Commerce Review

NWS started spinning down the Erie WSO by transferring warning responsibilities to the three assuming WFOS in August 1994 before the Department of Commerce began its review of areas of concern. However, Erie community members raised questions in June 1994, several months before Erie was identified as one of the areas of concern through the Federal Register process. NWS continued with its plans to spin down the office because officials believed they would be providing the best service to the area by relying on modernized radars in other offices. Erie continued surface observations and radar operations until October 1996 and March 1997, respectively.

The starting point for the Department of Commerce study of areas of concern was the November 1994 Federal Register announcement soliciting concerns about NWS modernization and restructuring plans. In

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<sup>10</sup>The Weather Service Modernization Act established this committee with representatives from NWS, FAA, the Department of Defense, the Federal Emergency Management Agency, civil defense and public safety organizations, news media, labor organizations, meteorological experts, and private sector users of weather information.

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February 1995, Erie was identified as 1 of 32 areas of concern.<sup>11</sup> The Department of Commerce reviewed the 32 areas between June and August 1995, and issued its report in October 1995. The report concluded that with the exception of lake-effect snow, the assuming WFOS will be able to detect severe weather phenomena over northwestern Pennsylvania. In addition, the report recommended that NWS (1) compare the adequacy of the assuming WFOS' new radars and other data sources with Erie's old radar in identifying lake-effect snow over a 2-year period and (2) transmit data from Erie's radar to nearby WFOS to support the lake-effect snow study and facilitate the continued spin-down of the Erie office.

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**Types of NWS Services Provided Before and After Spin-Down Are Generally the Same, but Concerns Exist Regarding NWS' Ability to Serve Distant Areas**

The three weather offices that assumed responsibility for the counties formerly served by the Erie WSO provide generally the same types of services that the Erie office had provided, with the exception of the general public's local or toll-free telephone access to NWS personnel. The general public in the nine counties must now call long-distance to contact the Cleveland, Central Pennsylvania, and Pittsburgh WFOS.

Services for Erie and Crawford counties are now provided entirely by the Cleveland WFO. There are few changes to the services that were provided by the Erie WSO. The primary changes are the discontinuance of the localized forecast for the city of Erie and the addition of the Nowcast. As noted before, localized forecasts were discontinued because of changes in the size and detail of zone forecasts. Another significant change is the transfer of ASOS augmentation to FAA. This relieves NWS of maintaining staff on-site to take observations. Table 1 presents a detailed comparison of the services provided to Erie and Crawford counties before and after spin-down.

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<sup>11</sup>Residents of northwestern Pennsylvania raised concerns that the Erie closure could result in a degradation of service. A list of all areas of concern was published in the Federal Register on February 23, 1995.

**Table 1: Services Provided to Erie and Crawford Counties Before and After Spin-Down**

<b>Service</b>	<b>Previously provided by</b>	<b>Now provided by</b>	<b>Date of change</b>
Short-fused warnings (including warnings for adjacent coastal waters)	Erie	Cleveland	8/94
Long-fused warnings	Pittsburgh	Cleveland	10/95
Forecasts	Pittsburgh	Cleveland (including individual county forecasts and Nowcasts)	10/95
	Erie modified Pittsburgh's first period forecast (hours 0-12) and issued as a local forecast for the city of Erie	Local forecast discontinued	9/94
Open-lake waters and near-shore forecasts, warnings, and advisories	Cleveland	Cleveland	N/A
Bay report (current wind and wave conditions)	Not an official NWS service before modernization	Cleveland	N/A
Aviation forecast for Erie International Airport	Pittsburgh	Cleveland	10/95
Warning preparedness	Erie	Cleveland	8/94
Surface observations	Erie	ASOS augmentation turned over to FAA	10/96
NOAA Weather Radio	Erie	Cleveland	8/94
Climatological services (daily and monthly messages)	Erie	Cleveland	10/95

The Pittsburgh WFO now provides all services to Venango and Forest counties with the exception of issuing NOAA weather radio reports and updates. Changes in services to these counties are minimal as Pittsburgh was already providing many services to these areas. The only significant change is the addition of the short-term forecast—the Nowcast—which was not provided in premodernization. Table 2 presents a detailed comparison of services provided before and after spin-down.

**Table 2: Services Provided to Venango and Forest Counties Before and After Spin-Down**

<b>Service</b>	<b>Previously provided by</b>	<b>Now provided by</b>	<b>Date of change</b>
Short-fused warnings	Erie	Pittsburgh	8/94
Long-fused warnings	Pittsburgh	Pittsburgh	N/A
Forecasts	Pittsburgh	Pittsburgh (including individual county forecasts and Nowcasts)	N/A
Warning preparedness	Erie	Pittsburgh	8/94
NOAA Weather Radio	Erie—however, existing transmitters did not serve all areas in these counties	Cleveland (providing same coverage as Erie)	8/94
Climatological services (daily and monthly messages)	Erie	Pittsburgh	10/95

Services for Cameron, Elk, McKean, Potter, and Warren counties are now provided mostly by the Central Pennsylvania WFO. Since this office is not yet fully staffed, forecasting and long-fused warning services are still provided by Pittsburgh. Again, with the exception of the Nowcast, no major changes have occurred for these counties. Since many of these counties are mountainous, NOAA Weather Radio service does not reach all areas. NWS believes service will be improved when additional transmitters are installed in fiscal year 1998. The Central Pennsylvania and Pittsburgh WFOs will program these transmitters. Table 3 presents a detailed comparison of services provided before and after spin-down.

**Table 3: Services Provided to Cameron, Elk, McKean, Potter, and Warren Counties Before and After Spin-Down**

<b>Service</b>	<b>Previously provided by</b>	<b>Now provided by</b>	<b>Date of change</b>
Short-fused warnings	Erie	Central Pennsylvania	8/94
Long-fused warnings	Pittsburgh	Pittsburgh (will be provided by Central Pennsylvania once office is fully staffed)	N/A
Forecasts	Pittsburgh	Pittsburgh provides individual county forecasts; will be provided by Central Pennsylvania once office is fully staffed	N/A
		Central Pennsylvania provides Nowcasts	5/94
Warning preparedness	Erie	Central Pennsylvania	8/94
NOAA Weather Radio	Erie, Pittsburgh, and Williamsport WSO—however, existing transmitters did not serve all areas in these counties	Central Pennsylvania and Cleveland (providing same coverage as before)	8/94
Climatological services (daily and monthly messages)	Erie	Central Pennsylvania	10/95

### Concerns Raised About Services to Erie and Crawford Counties and NWS Responses

Many concerns have been raised about the specific services being provided by NWS as well as the quality of the service provided. Most concerns had been brought to NWS' attention and NWS provided responses to them. Other concerns brought to our attention either had not been reported to NWS or NWS had not officially responded. We discussed these concerns with NWS officials and received their responses. The most common concern—voiced by almost every individual we spoke with—was with the ability of distant radars to detect all types of weather phenomena. Table 4 presents concerns raised by users in Erie and Crawford counties and NWS' responses.



**Table 4: Concerns Raised About Services to Erie and Crawford Counties and NWS Responses**

Concern	NWS response
Cleveland WFO too far away to be able to forecast weather and issue severe weather warnings accurately and timely.	Modernized radars are very effective even at long ranges for most phenomena and provide improved service over older radars; verification statistics support this statement for northwestern Pennsylvania.
Gap in radar coverage will affect ability to detect lake-effect snow.	NRC and Commerce studies support this concern; NWS is completing a lake-effect snow study to determine NWS' ability to detect this phenomenon over northwestern Pennsylvania.
Verification statistics for the Erie area show warnings were more accurate when the Erie WSO was issuing warnings.	Statistics show the accuracy of warnings for the nine-county Erie area have improved overall. <sup>a</sup>
Cleveland staff are not familiar with terrain and weather experienced in northwestern Pennsylvania.	Terrain and weather are similar to that of northeastern Ohio, which are familiar to staff; several staff members have visited the area.
Lake-effect snow study data collection was inconsistent—too few data points and not always scientifically collected.	Data collection did change during the 3-year study as NWS attempted to enlist additional volunteers—the number of volunteers for Erie and Crawford counties changed each year during the 3-year study from 15, 13, to 22; volunteers were trained by NWS personnel in proper data collection procedures.
Erie WSO is providing no services, therefore the office should be considered closed; however, NWS has not yet completed a “no degradation of service” certification.	Erie WSO is not closed because operation of the Erie radar was required for the lake-effect snow study; NWS is awaiting the results of the study to determine if degradation exists and, if so, how to address the problem.
Public telephone service was discontinued in the Erie office in spring 1996; the community must now call Cleveland for information.	The Erie office does not have modernized equipment and therefore cannot provide the best weather information to the public; NWS wants communities to begin relying on their new weather offices.
There is no public toll-free telephone number for Cleveland.	Cleveland offers toll-free telephone numbers to emergency management and Skywarn; it also offered free telephone access to the public until February 1997, when budget cuts dictated that this service be eliminated.
The public telephone number for Cleveland is not answered 24 hours a day.	The public number is available during regular business hours—8:30 a.m. to 4:30 p.m.; 24-hour service is available to emergency management, state, county, and municipal officials, and Skywarn volunteers.
There is no forecast for Presque Isle Bay; the near-shore forecast does not specifically address the Bay.	Erie WSO never issued a separate Bay forecast; the near-shore forecast includes the Bay, which generally experiences less severe conditions than other waters in the near-shore forecast.
Wind reports and near-shore forecasts are inadequate.	Three additional wind sensors were installed along the shore to provide better information.
Sometimes there are missing wind sensor reports.	The missing reports are usually from the two sensors that are read by state officials who may not take observations if their workload does not permit it; the one automated sensor will always provide data unless the equipment is inoperable.
Proposed marine prediction unit cut in Cleveland will adversely affect Lake Erie service.	No changes yet; if a change is made, however, Cleveland will still issue near-shore forecasts—the marine prediction unit is responsible for ice and wind reports used primarily by commercial carriers.

(continued)

Concern	NWS response
Fear of untimely service of NOAA Weather Radio.	No problems reported; Cleveland focuses priority on quick service to northwestern Pennsylvania.
ASOS cannot adequately replace human observations of all critical weather conditions, such as tornadoes, blowing snow, and clouds above 12,000 feet.	ASOS was not designed to completely replace human observers and requires augmentation for certain observations; this is being provided by FAA for the ASOS unit at the Erie International Airport.
Reliance on ASOS will interrupt the historical climate record because it cannot report on all critical weather conditions.	The Erie ASOS is augmented by FAA for critical weather observations with the exception of snow depth—this is provided by volunteer observers for northwestern Pennsylvania.
Outreach on modernization and restructuring issues was insufficient.	Cleveland, Pittsburgh, Central Pennsylvania, region headquarters, and Erie personnel communicated with users and the community in over 100 instances, such as notification letters, briefings, and Skywarn training sessions.
NOAA Weather Radio updates are issued later than when issued by Erie.	Erie only had to issue updates for one station and therefore issued updates just a few minutes after the hour; with new responsibilities, Cleveland has to issue updates for four stations and, as a result, Erie's updates were issued later than normal; in response to concerns, Cleveland has begun issuing the Erie updates first.
Too few staff per shift will result in some areas getting degraded coverage if multiple severe events occur at the same time.	Cleveland is following NWS policy on the number of staff; during severe weather events staff will be supplemented with overtime employees, as needed.
Some severe weather events have been missed and some forecasts have been inaccurate.	Weather prediction and severe weather warning are never 100 percent accurate; some events inevitably are missed.
<p>Specifically:</p> <ul style="list-style-type: none"> <li>• A tornado in June 1994 was not detected on Cleveland's radar and a warning was not issued until after touch-down.</li> <li>• A funnel cloud in May 1996 was not detected by ASOS.</li> <li>• Severe flooding in September 1996 was not predicted and Cleveland radar could not see the intense rainfall.</li> </ul>	<ul style="list-style-type: none"> <li>• Erie WSO still had authority for issuing warnings; Cleveland's radar showed severe storm activity and staff were talking with Erie staff to determine whether a tornado was possible.</li> <li>• Cleveland issued a tornado warning 2 hours prior to detection; the funnel cloud was detected by ASOS augmentation.</li> <li>• The flood was a once-in-a-100 years event. Intense rainfall was generated by very low-topped clouds, which is an unusual cause for rainfall of this amount. Cleveland radar did not see this event because the weather pattern was so low and the Erie radar could not detect the intensity of the rainfall. However, after heavy rainfall started, Cleveland used rainfall and flood reports from volunteers to issue subsequent warnings.</li> </ul>

<sup>a</sup>See appendix I for NWS' verification statistics for this area.

## Concerns Raised About Services to Cameron, Elk, Forest, McKean, Potter, Venango, and Warren Counties and NWS Responses

The primary concern voiced from five of the seven counties now served by the Central Pennsylvania and Pittsburgh WFOS was the ability of distant radars to provide adequate coverage for severe weather phenomena in order to issue accurate and timely forecasts and warnings. Some users in counties at the fringes of radar coverage questioned NWS' ability to track approaching severe weather outside the range of an office's radar. NWS' responses to these concerns were to assure county officials and residents that the new radars and other components of the modernization, such as satellites and improved weather models, would enable NWS to provide better service to their areas. Furthermore, WFOS can access radar data from nearby WFOS. For example, if a severe storm was moving eastward into northwestern Pennsylvania, Central Pennsylvania and Pittsburgh staff would likely access data from Cleveland's radar to help determine the path and intensity of the event.

One individual expressed concern that during severe weather events, there may not be sufficient staff to operate the amateur radio equipment, which is used to communicate with Skywarn volunteers. According to NWS, there are licensed amateur radio operators on staff. However, if licensed staff are not available during severe events, NWS can call on volunteers to help operate the equipment. These concerns seemed to have been allayed as most officials told us that service provided by the new offices is at least equal to the service provided before modernization.

## Concerns About Services at the Erie Airport and Timeliness of Lake Erie Small-Craft Advisories

A few concerns have been raised regarding weather services provided at the Erie International Airport and the timeliness of small-craft advisories for Lake Erie. The most commonly cited concern was with ASOS, which has been the subject of much scrutiny since its nationwide deployment. We reported on several ASOS issues in 1995,<sup>12</sup> such as specific sensor problems and the system's difficulty reporting actual, prevailing conditions in rapidly changing or patchy weather conditions. NWS has implemented modifications to address sensor problems and, in some places, including Erie, added sensors to better report representative observations. In addition, since ASOS does not replace all human observations, human observers must continue to take manual observations at airports such as Erie to supplement the system (this process is called augmentation) and correct the system when it is not accurately reporting current conditions.

<sup>12</sup>Weather Forecasting: Unmet Needs and Unknown Costs Warrant Reassessment of Observing System Plans (GAO/AIMD-95-81, April 21, 1995).

Under an NWS/FAA interagency agreement, FAA accepted augmentation responsibility for the Erie ASOS in October 1996. At that point, NWS weather observers were discontinued at Erie and air traffic controllers became responsible for augmenting ASOS observations and correcting the system when it reported inaccurate conditions. Concerns surround the issue of whether this ASOS augmentation responsibility is too much for air traffic controllers. FAA recognizes these concerns and has sponsored an independent study of the impact of ASOS augmentation. According to the manager of FAA's Aviation Weather Requirements Division, a report is expected in the fall of 1997. Table 5 presents specific safety concerns raised and NWS responses.

**Table 5: Concerns Raised About Safety at Erie International Airport and Timeliness of Small-Craft Advisories, and NWS Responses**

Concern	NWS response
FAA controllers must augment ASOS; this places too much work on controllers at the risk of safety.	FAA agreed to assume ASOS augmentation responsibilities; in response to concerns from controllers, FAA has sponsored a study of the impact of ASOS augmentation.
ASOS is unrepresentative of prevailing conditions; this can have safety implications for aircraft approach and landing.	A joint NWS/FAA/aviation industry study found that ASOS is representative 98 percent of the time; an additional sensor was installed apart from the ASOS sensor group to identify when visibility conditions are different from the official ASOS observation (i.e., to identify when the official ASOS observation may be unrepresentative of prevailing conditions).
Terminal forecasts are no longer sent directly to the Erie airport tower.	Cleveland is issuing terminal forecasts as required and disseminating them to FAA; the Erie WSO arrangement of sending forecasts directly to the airport tower was a favor.
Some severe weather on Presque Isle Bay and Lake Erie have occurred without warnings.	Weather prediction and severe weather warning are not 100 percent accurate; some events inevitably are missed.
Specifically: <ul style="list-style-type: none"> <li>• A high school rowing team was practicing on Presque Isle Bay when high winds capsized rowing shells; no severe weather warnings were issued.</li> </ul>	<ul style="list-style-type: none"> <li>• Cleveland office records show that NWS first issued a small-craft advisory the night before the incident and upgraded its advisory to gale warnings at 3:48 a.m. on the day of the incident; such warnings and advisories are included in NOAA Weather Radio updates and sent to local TV and radio stations via regular NWS dissemination avenues.</li> </ul>
<ul style="list-style-type: none"> <li>• Several waterspouts have occurred without warning.</li> </ul>	<ul style="list-style-type: none"> <li>• Waterspouts are not detectable with either the old or new radars although NWS will issue warnings when conditions look favorable for waterspout activity.</li> </ul>

## No Evidence of Service Degradation, but Detection of Lake-Effect Snow Remains a Concern

There are several sources of evidence that address whether a degradation of service has occurred in the Erie area. NWS' statistical verification program collects performance data on the issuance of forecasts and warnings and provides information necessary to compare "premodernized" and "modernized" performance. Overall, data for the former nine-county Erie WSO area show an improvement in service under the three WFOS.

Studies by NRC and the Department of Commerce analyzed the ability of the new radars and other components of the modernization to detect certain weather phenomena and assessed the potential for degradation of weather services in the Erie area. NRC concluded that the ability to detect three severe weather phenomena, including lake-effect snow, was questionable. The Department of Commerce's study expanded on NRC's work and concluded that lake-effect snow was the only phenomena that remained a concern. NWS is completing a 3-year study of its ability to detect and predict lake-effect snow in the Great Lakes area, which includes northwestern Pennsylvania.

## Accuracy and Timeliness of Warnings and Forecasts Show Overall Improvement

Since the 1980s, NWS has assessed the accuracy and timeliness of its severe weather warnings and public and aviation forecasts through a statistical verification program. The verification process includes determining the accuracy of the forecast elements of maximum and minimum temperature and probability of precipitation. Several elements of the aviation forecasts are likewise verified. Severe weather warnings are verified by determining whether an event for which a warning was issued occurred. The elements calculated for warning verification are probability of detection (i.e., NWS' ability to detect weather events—the higher the probability, the better the performance), false alarm rate, and lead time. If a warning was issued but a severe weather event did not occur, a higher false alarm rate results. If a severe weather event occurred without a warning, the probability of detection goes down.

Warning and forecast verification statistics historically have been used to help weather office managers determine trends in performance and identify areas needing improvement. With modernization, the statistics are included in the certification package as support either for or against a determination of degradation of service. NWS officials stressed, however, that verification statistics are not the most important component of the no-degradation assessment. Rather, they said, they rely most heavily on

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feedback from users to determine satisfaction with the level of service being provided and whether degradation has occurred.

The verification statistics for the nine former Erie office counties show an overall improvement to the area in warning service. Appendix I presents the warning verification data for the nine-county area. The statistics also show slight improvement for public forecast service. The aviation forecast verification statistics show a negligible decline from .33 to .32, on a scale from 0 to 1 with 1 being the best performance.

NWS officials cautioned that there are limitations to the verification program and resulting data. For example, since the number and type of weather events vary from year to year, it is impossible to directly compare performance from one year to another. In addition, it is more difficult to verify events in sparsely populated areas. Finally, NWS officials acknowledged that severe weather warning verification procedures vary across offices.

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## NRC Concluded That New Radars May Miss Three Key Weather Phenomena

In August 1994, the Department of Commerce contracted with NRC to study NWS' modernized radar network coverage and identify any gaps that could result in a degradation of weather service. In addition, NRC was to develop criteria for the Department to use in determining the potential for degradation of service in those areas of concern identified through the public comment process.

In June 1995, NRC issued its report, Toward a New National Weather Service: Assessment of NEXRAD Coverage and Associated Weather Services. Overall, NRC concluded that weather services on a national basis would be improved substantially under the new radar network. For example, compared with the old radar network, the modernized radar network will cover a much broader area of the contiguous United States and provide greater coverage for detecting specific severe weather phenomena, such as supercells, mini-supercells, and macrobursts.<sup>13</sup> NRC also noted that the new radars are just one element in a composite weather system that includes satellites, automated surface observing equipment, wind profilers, improved numerical forecast models, and cooperative networks of human observers and spotters.

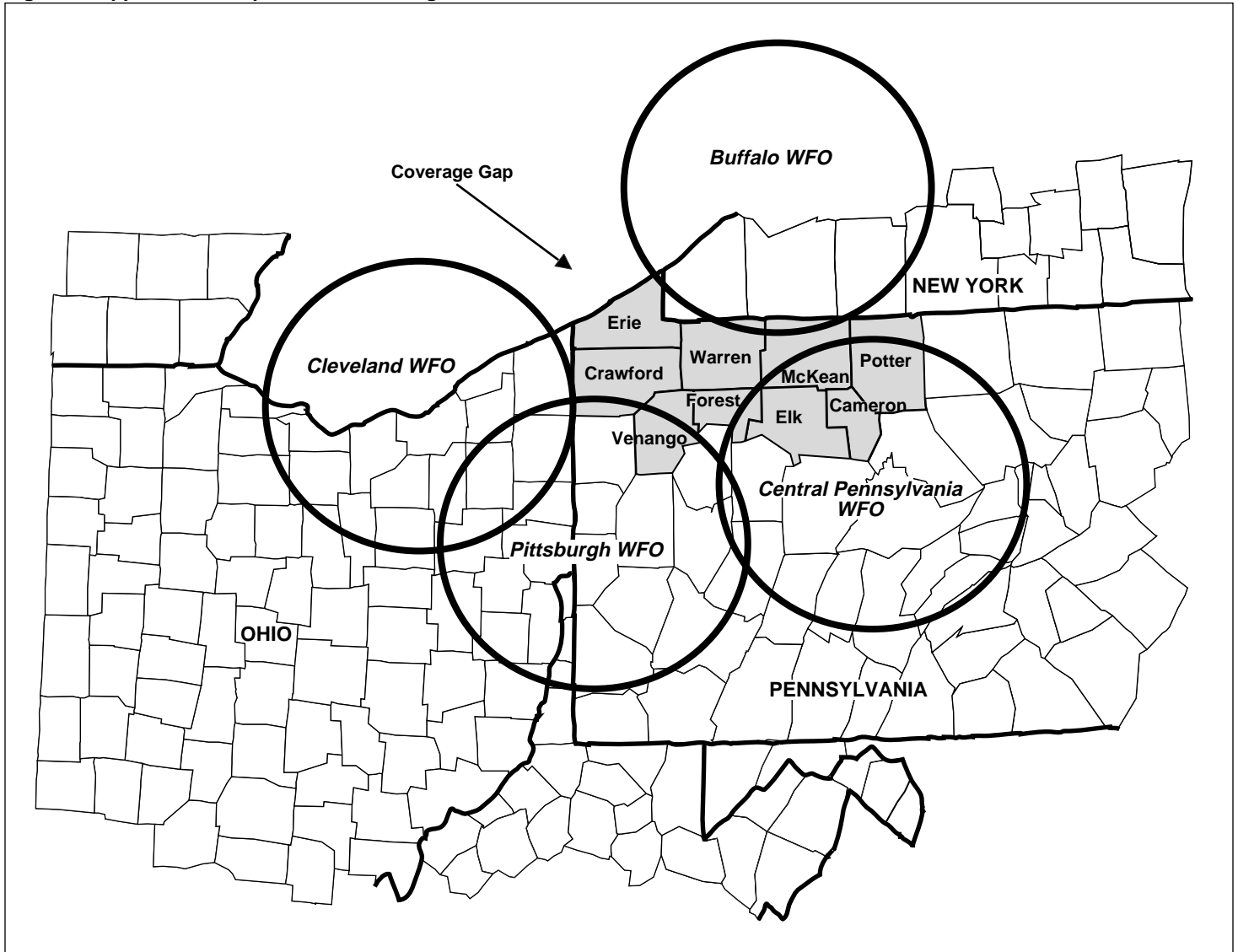
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<sup>13</sup>A supercell may produce high winds, large hail, and long-lived tornadoes, and may last several hours. A mini-supercell contains similar characteristics as a supercell but is significantly smaller. A macroburst—which is caused by a strong downdraft—is an outburst of damaging winds on or near the ground over an area greater than 2.5 miles.

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NRC cautioned, however, that at old radar sites where radar coverage is to be provided by a new radar some distance away, there is the potential for degradation in radar-detection coverage capability. In particular, northwestern Pennsylvania was one such area with degraded radar coverage for macrobursts, mini-supercells, and lake-effect snow. NRC recommended NWS study the area to determine whether the degraded radar coverage would result in a degradation of weather service. Figure 3 shows the approximate gap in radar coverage for lake-effect snow over northwestern Pennsylvania.

Figure 3: Approximate Gap in Radar Coverage for Lake-Effect Snow



Note: The shaded counties are those formerly served by the Erie WSO. The circles indicate radar coverage for lake-effect snow by the WFO indicated.

Source: National Research Council, 1995.



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## The Department of Commerce Concluded That New Radars May Miss Lake-Effect Snow

As agreed with concerned members of the Congress, the Department of Commerce used NRC's criteria to evaluate the potential for degradation in the 32 areas identified via the Federal Register process and assessed the potential for degradation of service for the radar gaps identified in NRC's report.<sup>14</sup> The Secretary's team conducted additional research into the capabilities of the new radars and found that the effective range of detection was greater than estimated by NRC. Specifically, the team concluded that the new radars serving the former Erie WSO area would be able to detect macrobursts and mini-supercells for northwestern Pennsylvania. It was still clear, however, that the radars could not adequately detect some lake-effect snow events in the Erie area. Therefore, the Secretary's team recommended that NWS compare the adequacy of the assuming WFOS' new radars and other data sources with Erie's old radar in identifying lake-effect snow over a 2-year period to determine how well the composite weather system could help detect and predict lake-effect snow over the area in question. In addition, the report recommended that NWS keep the Erie radar (an older vintage) operational until the results of the study were compiled, which was done.

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## Degradation of Lake-Effect Snow Detection Not Evident, but Service Not as Good as Elsewhere Along the Great Lakes

NWS began a lake-effect snow study in November 1994, 1 year before the Secretary's team recommended that a similar assessment be done. NWS initiated the study to improve its ability to detect and predict lake-effect snow, as well as in response to concerns raised by congressional staff and residents of northern Indiana and northwestern Pennsylvania; these areas were scheduled to lose old radars and, instead, receive coverage from more distant but modernized radars. The goal of the study was to find ways of improving the warning and forecast services associated with lake-effect snow events. In response to the Secretary's team's recommendation, however, another goal was added to this study—to determine whether lake-effect snow detection would be degraded over northwestern Pennsylvania, if the Erie radar and office were shut down.

Data on lake-effect snow were collected over the three winter seasons between 1994 and 1997. While the broad study area included all areas in New York, Pennsylvania, Ohio, and Indiana that experience lake-effect snow, a seven-county area was established surrounding Erie on which

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<sup>14</sup>The group that conducted this assessment, referred to as the "Secretary's Team," worked from June through August 1995. The report was issued on October 12, 1995.

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more specific analysis would be performed.<sup>15</sup> After each winter season, a data report was issued by NWS.

These reports conclude that NWS has made significant progress in improving its ability to detect and forecast lake-effect snow, however, there are still questions about the level of this service being provided to northwestern Pennsylvania. For example, NWS' Eastern Region reported that for about 35 percent of lake-effect snow events, the composite weather system will be insufficient to compensate for the degradation in radar coverage over northwestern Pennsylvania.<sup>16</sup> In addition, this report stated that NWS is not able to provide detailed, short-term forecasts (Nowcasts) during lake-effect snow events like it can for other areas that have better radar coverage. The Eastern Region's report and the director of NWS' Office of Meteorology point out, however, that this problem does not constitute a degradation of service because the probability of detection for lake-effect snow in the seven-county study area has improved since 1993.

Even though degradation has not occurred, according to the Eastern Region report and the director, this level of service is still unacceptable because lake-effect snow is the Erie area's most severe weather condition and the community does not receive the same level of service that other lake communities receive. As a result, the Eastern Region report recommended that a radar be installed to provide better coverage for this severe weather phenomenon in northwestern Pennsylvania. The director of the Office of Meteorology agrees with this recommendation, but points out that since data from this new radar would be transmitted to existing WFOS, an additional weather office is not needed in the Erie area.

NWS' final report of the lake-effect snow study is expected this fall. Any conclusions and recommendations from the lake-effect snow study will be reviewed by the Secretary's team, which will make recommendations to the Secretary regarding specific actions to be taken. Once the results of the lake-effect snow study are finalized and actions taken to address degradation concerns, if any, NWS officials told us they will pursue closure certification for the Erie office.

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<sup>15</sup>These counties are Erie, Crawford, and Warren in Pennsylvania; Ashtabula and Trumbull in Ohio; and Chautauqua and Cattaraugus in New York. This area is covered by radars in the Buffalo, Central Pennsylvania, Cleveland, and Pittsburgh WFOS.

<sup>16</sup>A Review of the 1996-1997 Lake-Effect Snow Study in the Eastern Region of the National Weather Service, July 1997.

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## Agency Comments

In commenting on a draft of this report, the Department of Commerce took no exceptions to the information presented and acknowledged that we had conducted thorough work in researching the issues and preparing the report. The Department reiterated that, after NOAA presents the Secretary's team with the results of the lake-effect snow study, it will review and evaluate the findings, conclusions, and recommendations and determine the need for a radar in northwestern Pennsylvania. The Department's written response is reprinted in appendix II.

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As agreed with your offices, unless you publicly announce the contents of this report earlier, we will not distribute it until 10 days from the date of this letter. At that time we will send copies to the Ranking Minority Member, House Committee on Science, and the Chairmen and Ranking Minority Members of the Senate Committee on Commerce, Science, and Transportation; House and Senate Committees on Appropriations; House Committee on Government Reform and Oversight; and Senate Committee on Governmental Affairs; and to the Director, Office of Management and Budget. We are also sending copies to Senators Arlen Specter and Rick Santorum; Congressman John Peterson; the Secretary of Commerce; the Administrator, National Oceanic and Atmospheric Administration; and the Acting Director of the National Weather Service. Copies will be made available to others upon request.

Please contact me at (202) 512-6408 if you or your staffs have any questions concerning this report. I can also be reached by e-mail at [willemsenj.aimd@gao.gov](mailto:willemsenj.aimd@gao.gov). Major contributors to this report are listed in appendix III.



Joel C. Willemsen  
Director, Information Resources Management

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# Contents

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Letter		1
Appendix I Warning Verification Data for Erie's Nine-County Area		28
Appendix II Comments From the Department of Commerce		29
Appendix III Major Contributors to This Report		30
Tables		
	Table 1: Services Provided to Erie and Crawford Counties Before and After Spin-Down	12
	Table 2: Services Provided to Venango and Forest Counties Before and After Spin-Down	13
	Table 3: Services Provided to Cameron, Elk, McKean, Potter, and Warren Counties Before and After Spin-Down	14
	Table 4: Concerns Raised About Services to Erie and Crawford Counties and NWS Responses	15
	Table 5: Concerns Raised About Safety at Erie International Airport and Timeliness of Small-Craft Advisories, and NWS Responses	18
Figures		
	Figure 1: Premodernized NWS Office Structure for Northwestern Pennsylvania	7
	Figure 2: Modernized NWS Office Structure for Northwestern Pennsylvania	8
	Figure 3: Approximate Gap in Radar Coverage for Lake-Effect Snow	22

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**Contents**

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**Abbreviations**

ASOS	Automated Surface Observing System
FAA	Federal Aviation Administration
NEXRAD	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NWS	National Weather Service
WFO	weather forecast office
WSO	weather service office

# Warning Verification Data for Erie's Nine-County Area

<b>Tornadoes</b>	<b>Premodernized<sup>a</sup></b>	<b>Modernized<sup>b</sup></b>
Number of events	4	4
Probability of detection <sup>c</sup>	0.00	0.75
False alarm rate <sup>d</sup>	1.00	0.85
Lead-time (minutes)	N/A	14.3

<b>Severe local storms</b>	<b>Premodernized<sup>a</sup></b>	<b>Modernized<sup>b</sup></b>
Number of events	379	147
Probability of detection <sup>c</sup>	0.79	0.86
False alarm rate <sup>d</sup>	0.37	0.48
Lead-time (minutes)	21.7	23.5

<b>Flash floods</b>	<b>Premodernized<sup>a</sup></b>	<b>Modernized<sup>b</sup></b>
Number of events	72	85
Probability of detection <sup>c</sup>	0.57	0.81
False alarm rate <sup>d</sup>	0.67	0.46
Lead-time (minutes)	28.9	45.5

Note: NWS officials cautioned that there are limitations to the verification program and resulting data. For example, since the number and type of weather events vary from year to year, it is impossible to directly compare performance from one year to another. In addition, it is more difficult to verify events in sparsely populated areas. Finally, NWS officials acknowledged that severe weather warning verification procedures vary across offices.

<sup>a</sup>The premodernized period is January 1, 1986, through July 31, 1994.

<sup>b</sup>The modernized period is August 1, 1994, through December 31, 1996.

<sup>c</sup>Probability of detection is measured on a scale of 0 to 1 with 0 representing no detection of severe weather events and 1 representing complete detection of all severe weather events.

<sup>d</sup>The false alarm rate is measured on a scale of 0 to 1 with 0 representing no false alarms issued and 1 representing all warnings issued being false alarms.

Source: National Weather Service.

# Comments From the Department of Commerce



**THE SECRETARY OF COMMERCE**

Washington, D.C. 20230

SEP 16 1997

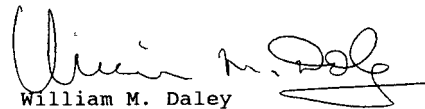
Mr. Gene L. Dodaro  
Assistant Comptroller General  
Accounting and Information  
Management Division  
General Accounting Office  
Washington, D.C. 20548

Dear Mr. Dodaro:

Thank you for the opportunity to review your draft report entitled, "National Weather Service: Modernization Activities Affecting Northwestern Pennsylvania, GAO/AIMD-97-156." As iterated, once the National Weather Service concludes its lake-effect snow study in the fall of 1997, and management officials of the National Oceanic and Atmospheric Administration present my team with the study results, we will review and evaluate the findings, conclusions, and recommendations and determine the need for a radar in northwestern Pennsylvania.

We would like to acknowledge the thorough work conducted by the General Accounting Office in researching the complex issues and preparing this comprehensive report.

Sincerely,

  
William M. Daley

# Major Contributors to This Report

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