

The High-Impact Extreme Weather Outbreak of July 1, 1997

Summary, Discussion and Analysis

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6/27/2014

This report summarizes and describes an intense, widespread, and well-distributed severe weather outbreak over much of Minnesota and the Twin Cities Metropolitan Area on July 1, 1997

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Overview

On the afternoon of July 01, 1997, a complex of severe thunderstorms moved out of South Dakota, intensified, and caused significant damage from tornadoes, straight-line winds, and excessive rainfall—from western and central Minnesota through the Twin Cities Metropolitan Area.

Snapshot

Overall	Intense, long-lasting outbreak of tornadoes, straight-line winds, excessive rainfall, and even hail. Damage estimate statewide approx \$235 Million (2014), with \$147 M in Wright County alone. Considered the worst disaster in the history of Wright-Hennepin Cooperative Electric
Tornadoes	At least 18 reported in Minnesota, with the strongest at EF-3 in Wright County
Winds	Numerous reports and estimates of winds greatly exceeding hurricane-force, especially west and north Hennepin County (and points north/west)
Rainfall/flooding	1-hr rainfall rates exceeded 100-year thresholds over central and eastern Hennepin County
Impacts	<ul style="list-style-type: none"> • Severe structural damage • Trees/powerlines down • Power outages • Agricultural losses • Flooded roads and basements
Frequency/Recurrence	High-end multi-mode events recur approximately every 10 years within some part of Twin Cities
Forecast Situation	SPC high risk (SPC was National Severe Storms Forecast Center)
Considerations and Recommendations	Significantly affected most municipalities in Hennepin County. Downed trees, structural damage, and flooded streets, highways and interstates, hampering response efforts. HCEM should prepare for a distributed, multifaceted outbreak of this sort, on the order of once per decade. (Similar to 9/21/2005)

Event Synopsis

Meteorological Conditions

A strong and energetic low pressure system emerged from High Plains early on July 1 and intensified throughout the day (see Fig 1). The combination of strengthening and veering winds aloft with the strong warm and cold fronts generated by the system, set the stage for explosive severe storm development over the Upper-Midwest. The Storm Prediction Center placed much of southern

Minnesota in a rare “high risk” for severe weather, and by late morning, storms in South Dakota were organizing and becoming severe. ^{i ii iii} Over the next several hours, these storms would congeal into a powerful mesoscale convective system that would spawn new storms and go on to produce extensive damage throughout Minnesota.

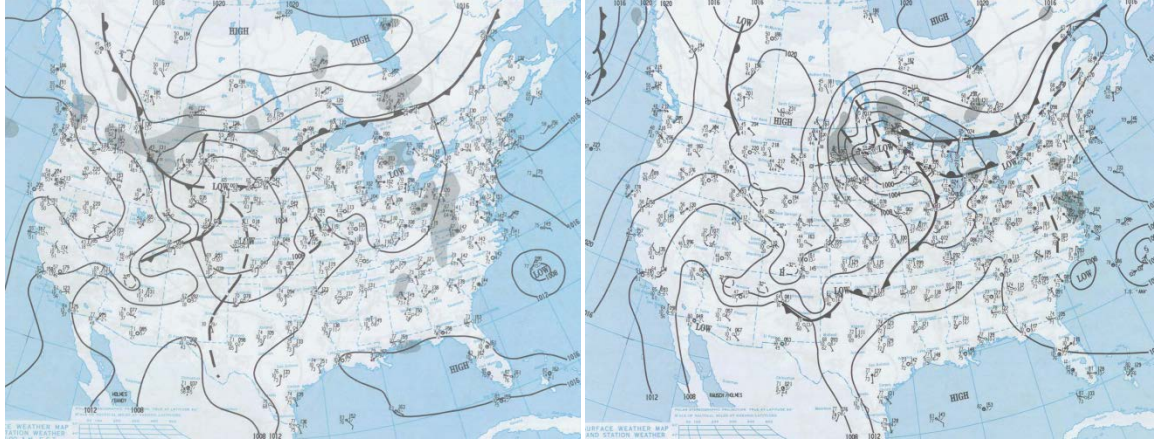


Fig 1. Basic surface weather maps at 7 AM EST on Tuesday July 1, 1997 (left) and Wednesday July 2, 1997. Note increased number of isobars on second image, suggestive of intensifying weather system.

Timeline

2-3 PM

The Storm Prediction Center issued a PDS (Particularly Dangerous Situation) Tornado Watch for the southern ½ of Minnesota, right up to the western TC area.

BULLETIN - IMMEDIATE BROADCAST REQUESTED

TORNADO WATCH NUMBER 548

STORM PREDICTION CENTER NORMAN OK

222 PM CDT TUE JUL 1 1997

THE STORM PREDICTION CENTER HAS ISSUED A

TORNADO WATCH FOR PORTIONS OF CENTRAL AND SOUTHERN MINNESOTA

EFFECTIVE THIS TUESDAY AFTERNOON AND EVENING FROM 300 PM UNTIL 900 PM CDT.

THIS IS A PARTICULARLY DANGEROUS SITUATION WITH THE POSSIBILITY OF

VERY DAMAGING TORNADOES. ALSO...LARGE HAIL TO 2 1/2 INCHES IN DIAMETER...THUNDERSTORM WIND GUSTS TO 85 MPH...AND DANGEROUS LIGHTNING ARE POSSIBLE IN THESE AREAS. (Watch Message truncated)

3-4 PM

Severe storms entered far western Minnesota. No significant damage reported during this timeframe.

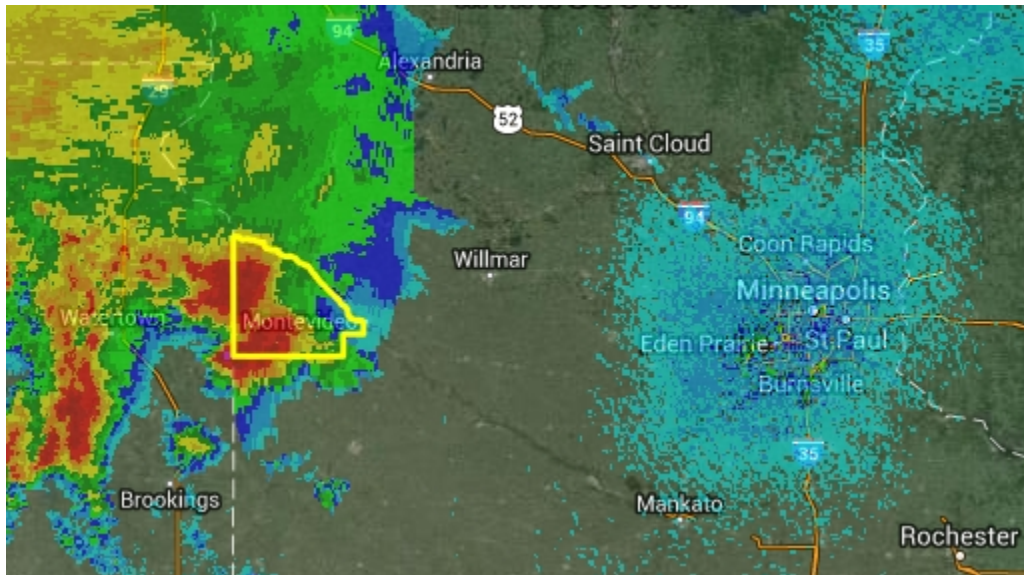


Fig 2. Composite radar image at 3:15 PM CDT, showing severe storms entering Minnesota.

4-5 PM

Storms becoming better organized, with reports of tornadoes, hail, and wind received in western Minnesota. Damage to a turkey barn, livestock exchange, two grain bins, and an ethanol plant reported.

5-6 PM

Storms expanded and intensified at this time, and the number of reports greatly increased. Of note:, Willmar had two tornadoes, destroying a warehouse, several cabins and boat docks. Additionally, the Willmar airport measured 78 mph wind gust, with residential roof damage, power poles blown down, and a semitrailer truck blown over.

6-7 PM

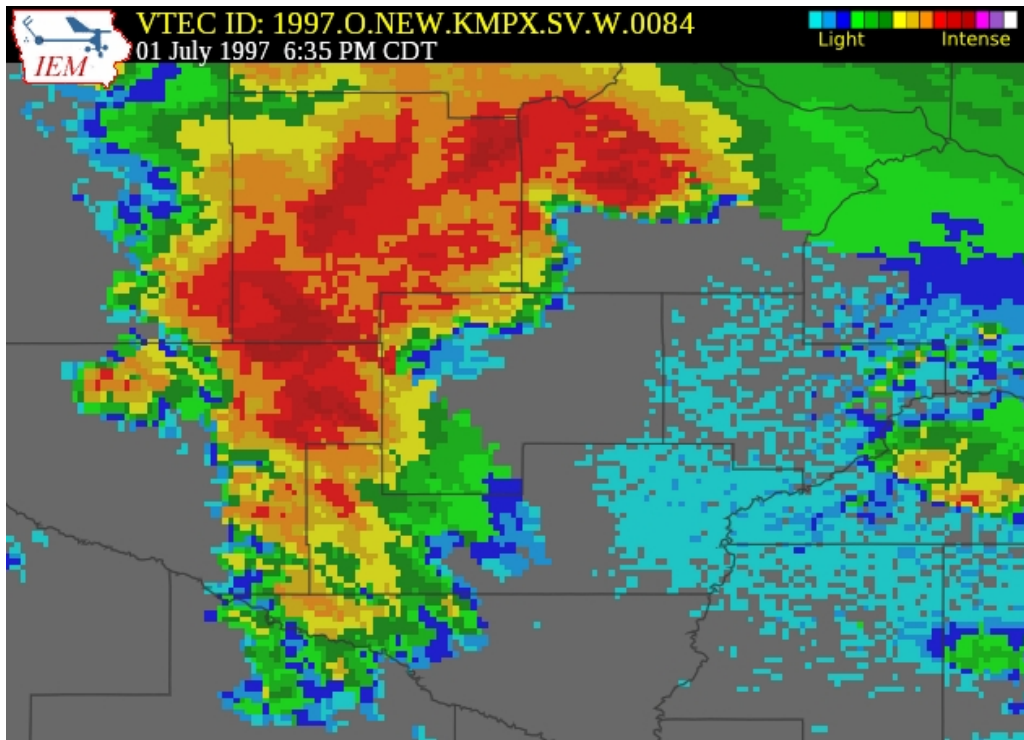


Fig 3. Composite radar image at 6:35 PM, CDT, showing severe thunderstorm complex entering Wright county and centered over Meeker county. System approx twice as large as in previous image (at 3:15 PM).

- Straight-line wind damage to trees and crops common throughout Meeker and McLeod counties.
- Two EF-0 tornadoes reported, along with a 2-inch hail report. Damage to trees, crops, grain bins, and barns reported.
- EF-3 tornado destroys house on Birch Lake in Wright county; other damage between Howard Lake and Buffalo.

7-8 PM

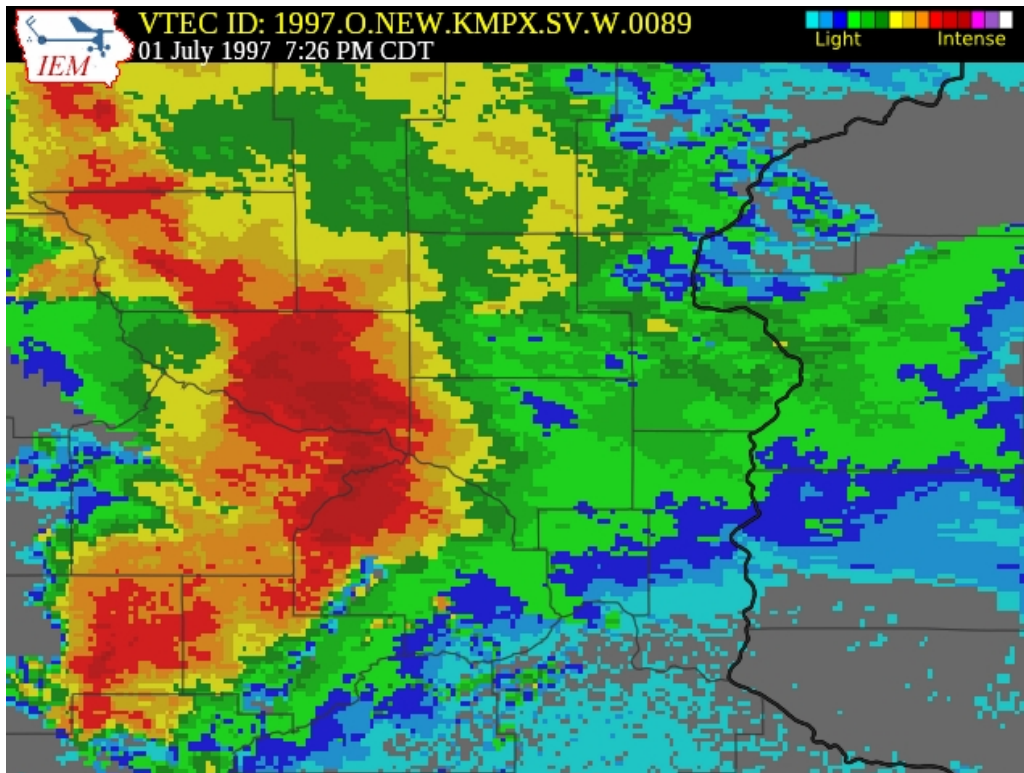


Fig 4. Composite radar image at 7:26 PM CDT, showing storm at peak intensity. Prominent balloon-shaped upper portion of main cell with pronounced bowing (bulging) on forward side frequently seen with other extreme downburst/straight-line wind events. At time of this image, storm was producing widespread damage associated from winds estimated well in excess of hurricane-force (75 mph).

The storms reached peak intensity during this timeframe. Five tornadoes were confirmed in Wright, Anoka, and Isanti counties. Additionally, extreme, non-tornadic downburst and straight-line winds were common in Wright, Sherburne, Hennepin, and Anoka counties. Some specifics include:

- **Waverly:** EF-1 tornado. Damage path 7 blocks long by 1 block wide (mostly tree, garage, roof damage)
- **Buffalo:** 80 mph winds estimated. Mobile home halved by fallen tree; one airplane overturned; roof over high school gymnasium partially destroyed
- **Maple Lake:** 100-105 mph winds estimated. Three airplanes and two hangars destroyed; Silo blown onto barn with two dozen cattle fatalities
- **Monticello:** Two EF-2 tornadoes. Prairie Acres housing development especially hard hit

- **Big Lake:** 110 mph winds estimated. Five airplanes overturned at local airport. Roof blown off lumberyard, injuring a motorist. Fire hall doors blown off. Hundreds of trees blown down. Roofs ripped off numerous structures including middle school, apartment building and hardware store. Traffic lights down. Restaurant destroyed. Police car blown off the road.
- **Monticello:** 110 mph winds estimated. Every tree in 4.2 acre Ellison Park damaged. Roof ripped off automobile dealership and flung into new car area, destroying 75 new cars and trucks. Numerous recreational vehicles at RV dealership totaled. Over 200 structures significantly damaged. 61 homes and apartment buildings declared uninhabitable. 30 factories closed. Northern States Power transmission towers blown down. 2500 trees lost. Air conditioning unit blown off high school roof. Parked truck blown two-thirds of a block.
- **Albertville, St Michael and Otsego:** 80 mph wind estimated. Numerous trees blown down. Scattered roof damage. Silos toppled and a mobile home destroyed. Roof damage. Several Otsego elementary schools experience roof damage.
- **Dayton:** 84 mph winds measured. 300 trees, many large, blown down.
- **Maple Grove:** trees blown down, boats capsized and sheds damaged
- **Hanover:** Fire dept. deployed to rescue and shelter motorists and nearby gas station patrons.
- **Ramsey:** 90-95 mph winds estimated. Gas station roof destroyed.
- **Coon Rapids:** 90-95 mph winds estimated. 200 trees blown down at Bunker Hills, where 20 corporate tents in preparation for upcoming PGA event destroyed.
- **Champlin, Brooklyn Park, Brooklyn Center, Fridley:** 75 mph winds estimated. Trees and power lines blown down.
- **St. Francis:** EF-1 tornado with 5-mile length. One barn destroyed.
- **Anoka:** 95-100 mph wind gusts estimated. Tree mortality in the thousands. Roof ripped off apartment building. Headstones blown over in cemetery.

8-9 PM

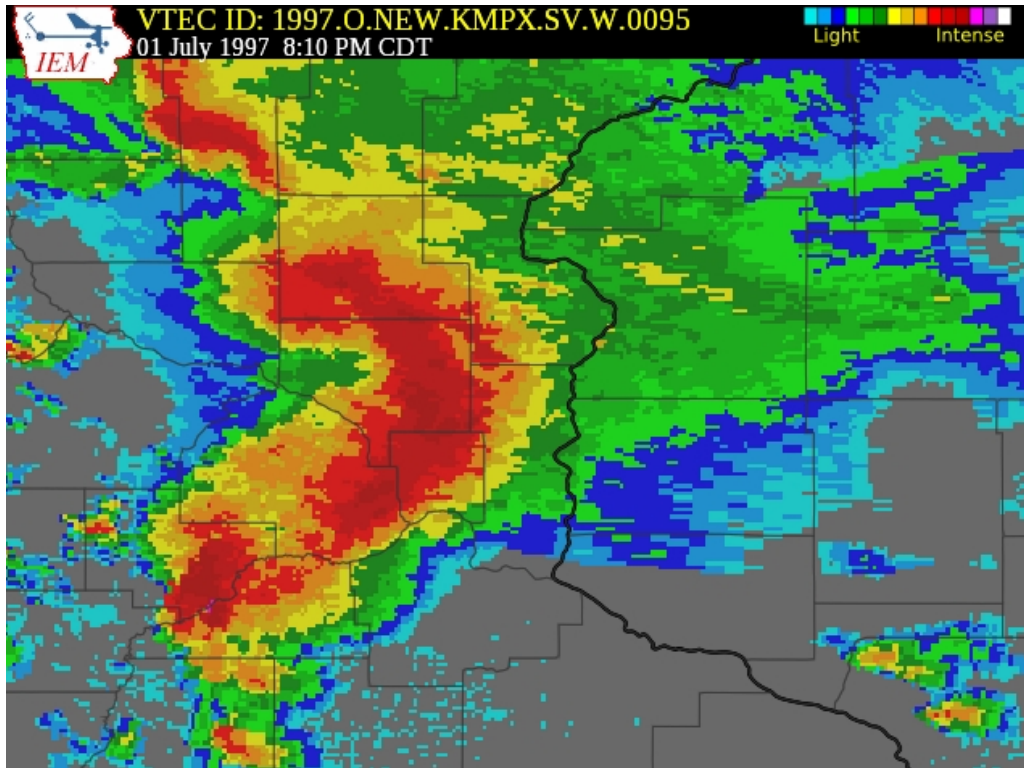


Fig 5. Composite radar image from 8:10 CDT. Bowing structure still apparent, but storm motions slowed appreciably. Extreme rains falling on much of central Twin Cities Metropolitan Area.

Despite one more tornado report near Forest Lake in Washington county, after 8 PM, the storms slowed down and the extreme nontornadic winds ceased. The storms were still at very high intensity, however, and the slower forward speed allowed excessive rainfall rates to be sustained for up to an hour in some places. Rainfall amounts in less than one hour included:

- 5.2 inches at Woodbury
- 4.5 inches at Brooklyn Center
- 3.5 inches at St. Louis Park
- 3.4 inches at Stillwater,
- 3.0 inches in Lauderdale
- 2.9 inches in Minneapolis

These rates exceeded the 100-year threshold for one-hour rainfall, and topped the greatest rate recorded at MSP during the July 23-24, 1987 Superstorm^{iv}. The resulting flash-flooding on July 1, 1997 was swift and significant. Known impacts include:

- **Minneapolis:** Portions of Interstates 94, and 35 flooded severely, with floating cars and stranded motorists. Residents deployed boats on 35 W between Diamond Lake Road and 36th St to assist with rescues. Abbott Northwestern hospital transformer shorted out due to basement flooding. Five million dollars damage done to Edison High School, where water to a

height of 6 feet caused basement walls to collapse, destroying classrooms, kitchen, boiler room, gymnasium and band instruments.



Fig 6. Cars floating and stranded on I 35-W in south Minneapolis, near Diamond Lake Road.

- **Bloomington:** 494 inundated with dozens of floating and stranded vehicles. Stores were flooded in the Mall of America.
- **St. Louis Park:** Severe basement and street flooding throughout city
- **Mound:** Minor basement and street flooding
- **Brooklyn Park:** Basement and street flooding
- **MSP airport:** closed for 90 minutes during height of storm, with flooding on tarmac and runways.
- **St. Paul:** 39 homes flooded along Hoyt Avenue; water levels reached 8 feet in some basements. 5 homes were condemned. Several streets collapsed. Apartment building roof collapsed, injuring one woman. Milton Square retail center flooded to height of 5 feet. Foot bridges washed away at Highland Golf Course.

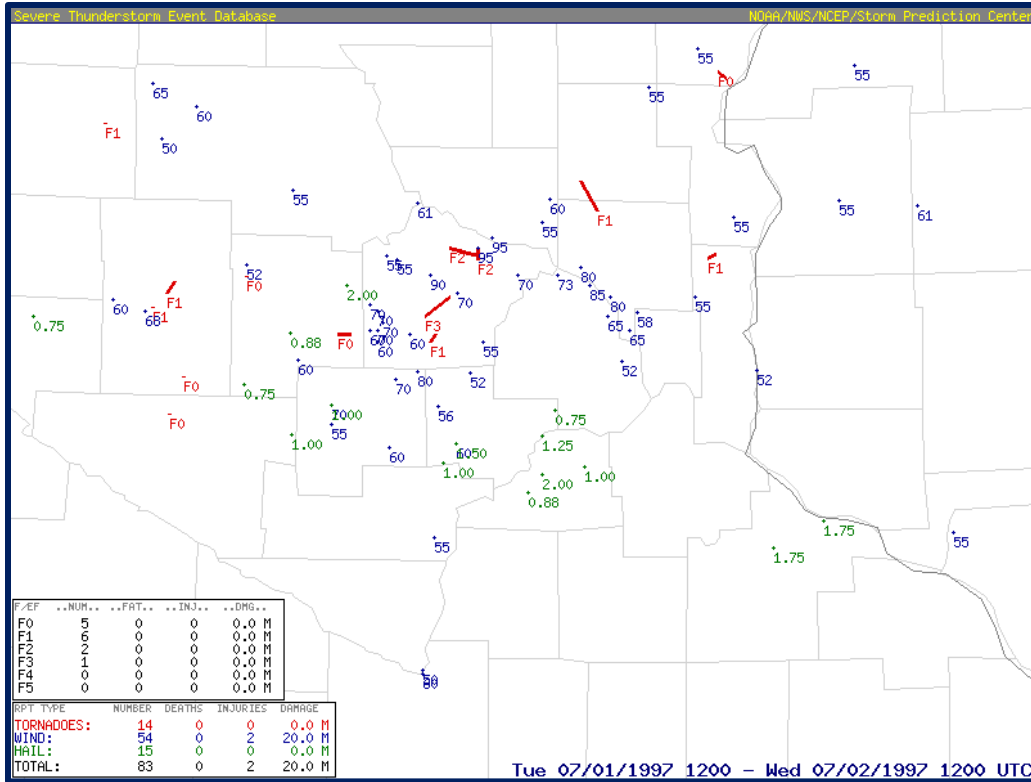


Fig 7. Map showing hail diameter (green), tornado F-rating (red), and wind speed report/estimates in knots (blue). Multiply knots by 1.15 to get mph. Generated from SVRLOT3 (<http://www.spc.noaa.gov/climo/online/sp3/plot.php>)

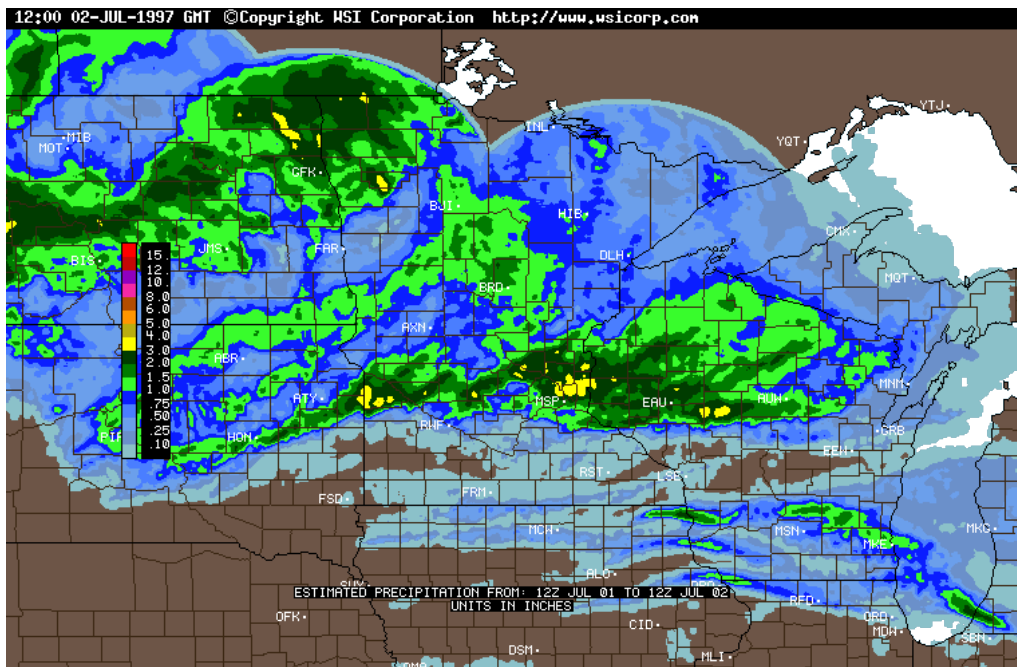


Fig 8. Radar-estimated precipitation from July 01,1997 event. Image hosted at climate.umn.edu, and prepared by WSI Corporation.

Historical Context, Implications and Recommendations

In 1997 dollars, the damage in Wright county alone was estimated at \$100 million (\$147 M in 2014 dollars). Adding up agricultural losses, damages in other rural counties, and flood damage to not just the urban infrastructure, but also to personal and commercial property, the cost of this storm was in excess of \$160 million (1997) or \$235 million in 2014. Wright-Hennepin Electric considered this event to be the worst in its history, a distinction perhaps only challenged by June 21, 2013.

Though the region has a long, reasonably well-recorded history of severe weather, nothing in the record bears resemblance to July 01, 1997, which appears to have few if any peers, especially in the Twin Cities area. The event is notable for producing damage from all four major convective weather hazards: hail, wind, tornadoes, flooding. The wind damage northwest of Minneapolis alone is on the high end of the historical severe wind spectrum, putting the event in the same category as other famous “derecho” type events, like July 3 and 19, 1983, and May 15 and 30, 1998. Similarly, the 1-hour rainfall rates and resultant flash-flooding were in the far upper echelon of recorded severity.

This event stressed emergency response resources in ways infrequently experienced. Downed trees and power lines blocked several hundred roads and intersections through the area, and many of those roadways were significantly flooded and required watercraft for safe navigation. The widespread and extreme nature of the event was such that few communities had resources available to assist neighboring communities, let alone themselves. A 1200 square-mile area stretching from Buffalo to Minneapolis was at full capacity. It is known that a Presidential Disaster Declaration was issued for Anoka, Dakota, Hennepin, Ramsey and Washington counties.^v

The timeline of the event also posed special problems. Though the storms took several hours to intensify and gain momentum out in western and central Minnesota, the peak impacts occurred in a roughly 90-minute period between 7 and 8:30 PM CDT. Thus, damage in central and eastern Wright county was only being discovered as the flash-flooding was impacting highways in Minneapolis. In that sense, many of the impacts were realized simultaneously, across a large area.

Though this storm’s combined high-end hazards make it an outlier, wind events like it recur within the Twin Cities ever 5-10 years. Flooding of this sort recurs somewhere within the Twin Cities every 3-5 years. EF-3 tornadoes can be expected within the TCMA every 3-5 years. While it is difficult to estimate the return period of a carbon-copy of July 01, 1997, a system exerting similar multi-mode impacts can be expected within the Twin Cities area approximately every decade.^{vi} Thus, it is recommended that the July 01, 1997 event be treated as a rare but likely-to-recur event. EM departments should expect a widespread, resource-taxing convective weather event of this magnitude approximately every ten years.

Notes on Data Sources

Data and information for this report came from National Climatic Data Center publication, *Storm Data*, Vol 39, no. 7 (July 1997); the Minnesota State Climatology Office; the Midwest Regional Climate Center, The Storm Prediction Center’s historical archive of products and historical severe weather event plotting interface (SVRLOT 3); and the author’s personal notes from the event. Radar imagery was provided by the Iowa Environmental Mesonet.

References

ⁱ http://www.convectiveoutlook.com/highrisk/19801999/97070106_spc.htm

ⁱⁱ http://www.convectiveoutlook.com/highrisk/19801999/97070115_spc.htm

ⁱⁱⁱ http://www.convectiveoutlook.com/highrisk/19801999/97070119_spc.htm

^{iv} http://climate.umn.edu/doc/journal/flash_floods/ff970701.htm

^v <http://www.gpo.gov/fdsys/pkg/FR-1997-07-29/html/97-19824.htm>

^{vi} Blumenfeld, K.A. 2009. The Frequency of High-Impact Convective Weather Events in the Twin Cities Metropolitan Area, MN. *Journal of Applied Meteorology and Climatology*.
<http://journals.ametsoc.org/doi/full/10.1175/2009JAMC2223.1>