2007 MINNESOTA FIRE WEATHER OPERATING PLAN
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FIRE WEATHER OPERATING PLAN FOR MINNESOTA
NATIONAL WEATHER SERVICE - FEBRUARY, 2007

INTRODUCTION

This document serves as the Minnesota Fire Weather Operating Plan (AOP) for the National Weather Service (NWS) and the interagency fire management community with fire management responsibility in Minnesota. The relationship between the NWS and land management agencies is established in the following documents:

- Interagency Agreement for Meteorological Services (National Agreement). See Appendix G.
- NWS Directive NWSI 10-4; Fire Weather http://www.weather.gov/directives
- Eastern Area Mobilization Guide

This AOP provides specific policy and procedure information used to provide forecast service to the fire management community in the State of Minnesota. In support of the Eastern Area Coordination Center, the EACC meteorologist will act as a liaison between the interagency fire management community and the NWS.

This Operating Plan is updated annually, and is reviewed by representatives of the NWS and each user agency prior to the onset of the spring fire season. All parties should have a copy of this plan available for reference purposes. Each fire management agency receiving this plan will be responsible for duplicating and distributing this plan to field offices which require NWS forecasts. The Operating Plan is also available in the Fire Weather section of NWS web sites.

SUMMARY OF CHANGES FOR 2007

1) Additional point forecasts will be added for Litchfield. (214501) by NWS Chanhassen, Rice Lake (211703) by NWS Duluth, and Big Stone (213501) by NWS Aberdeen.
2) If a Fire Weather Watch has been coordinated with land management officials, and land managers state that the fuels component is sufficient to justify a Watch, no further coordination is required if the Watch needs to be upgraded to warning for the same area. This would occur primarily with the Warning issuance on a mid shift.
3) The Haines Index and Smoke Management parameters will be included on all Fire Weather Planning Forecasts rather than ceasing on June 1st for southern Minnesota. .
4) The DirecWay satellite system in the AMRS has been decommissioned and replaced with INMARSAT for Incident Meteorologist (IMET) data receipt while on dispatch duties.

I. SERVICE AREA AND ORGANIZATIONAL DIRECTORY

A. NWS OFFICES SERVING MINNESOTA, POINTS OF CONTACT, AND BACKUP

The following NWS offices provide fire weather forecast service to the State of Minnesota: Duluth, Twin Cities/Chanhassen, Grand Forks, Aberdeen, Sioux Falls, La Crosse. See page 5 for a map of NWS forecast areas in Minnesota.

TWIN CITIES/CHANHASSEN NWS Forecast Office
1733 Lake Drive West
Chanhassen, MN 55317-8581
Phone 952-361-6708
Web Address http://www.crh.noaa.gov/mpx
Backup office: NWS Duluth

Byron Paulson	Fire Weather Focal Point/IMET	byron.paulson@noaa.gov
Todd Krause	Assistant F/W Focal Point	todd.krause@noaa.gov
Dan Luna	Acting Meteorologist-in-Charge	Daniel.luna@noaa.gov

DULUTH NWS Forecast Office
5027 Miller Trunk Highway
Duluth, MN 55811-1442
Phone 218-729-6697
Web Address http://www.crh.noaa.gov/dlh
Backup office: NWS Twin Cities/Chanhassen

Roman Berdes	Fire Weather Focal Point	roman.berdes@noaa.gov
Vacant	Assistant F/W Focal Point	
Michael Stewart	Meteorologist-in-Charge	michael.stewart@noaa.gov

GRAND FORKS NWS Forecast Office
4797 Technology Circle
Grand Forks, ND 58203-0600
Phone 701-795-5198
Web Address http://www.crh.noaa.gov/fgf
Backup office Bismark, ND

Al Voelker	Fire Weather Focal Point	al.voelker@noaa.gov
Vacant	Assistant F/W Focal Point	
David McShane	Meteorologist-in-Charge	david.mcshane@noaa.gov

LA CROSSE NWS Forecast Office
N2788 County Road
La Crosse, WI 54601-3038
Phone 608-784-8275
Web Address http://www.crh.noaa.gov/arx
Backup Office Des Moines, IA

Dave Schmidt	Fire Weather Focal Point	dave.schmidt@noaa.gov
Rod Swerman	Assistant F/W Focal Point	rod.swerman@noaa.gov
Glenn Lussky	Meteorologist-in-Charge	glenn.lussky@noaa/gov

SIOUX FALLS NWS Forecast Office
26 Weather Lane
Sioux Falls, SD 57104-0198
Phone 605-330-4247
Web Address http://www.crh.noaa.gov/fsd
Backup Office Aberdeen, SD

Mike Fuhs	Fire Weather Focal Point	michael.fuhs@noaa.gov
Jeff Chapman	Assistant F/W Focal Point	jeffery.chapman@noaa.gov
Greg Harmon	Meteorologist-in-Charge	greg.harmon@noaa.gov

ABERDEEN NWS Forecast Office
824 Brown County 14 South
Aberdeen, SD 57401
Phone 605-225-0519
Web Address http://www.crh.noaa.gov/abr
Backup Office Sioux Falls, SD

Stanley Keefe	Fire Weather Program Leader	stanley.keefe@noaa.gov
Amy Parkin	Assistant F/W Program Leader	amy.parkin@noaa.gov
James Scarlett	Meteorologist-in-Charge	james.scarlett@noaa.gov

OTHER IMPORTANT NWS CONTACTS
Larry Van Bussum, Natl F/W Ops Coord (NFWOC)
National Interagency Fire Center (NIFC)
3833 South Development Avenue, Bldg 3807
Boise, ID 83705-5354
e-mail larry.vanbussum@noaa.gov

Gary Schmeling
Regional Operational Services Meteorologist (ROSM)
National Weather Service,
Central Region Headquarters
7220 NW 101st Terrace
Kansas City, MO 64153
email gary.schmeling@noaa.gov
Central Region web site http://www.crh.noaa.gov

Heath Hockenberry
National Fire Weather Program Leader
National Weather Service
3833 South Development Ave.
Boise, ID 83705
email heath.hockenberry@noaa.gov

National Fire Weather web page http://fire.boi.noaa.gov

B. PARTICIPATING AGENCIES

1. DOC/NOAA - National Weather Service (offices listed in part I.A above.)
2. USDA Forest Service - Region 9 (Superior National Forest, Chippewa National Forest)
3. DOI National Park Service
4. DOI US Fish and Wildlife Service
5. DOI Bureau of Indian Affairs.
6. Minnesota Department of Natural Resources MNDNR

See Appendix A for a full listing of agency contacts, addresses, and phone numbers.

II. SERVICES PROVIDED BY THE NATIONAL WEATHER SERVICE

A. BASIC SERVICES - This section describes the fire weather products and services provided by the NWS as described in National Weather Service Directive NWSI 10-401. Significant changes to the services provided in Minnesota are generally coordinated at the annual Minnesota State Fire Weather Meeting. Since there are no full-time forecasters devoted solely to fire weather, these duties are scheduled among other warning and forecast responsibilities. However, spot forecasts for wildfires are treated with a high priority.

1. ROUTINE FIRE WEATHER FORECASTS

a) Issuance - Forecasts usually begin in early April in southern Minnesota, but have begun as early as mid March. Forecasts are initiated farther north as the snow melts. User agencies are responsible for requesting NWS offices serving their area to begin forecast service. See Figure 1 for the NWS offices and their areas of forecast responsibility. Fire season generally ends across Minnesota in November, but has been extended as late as mid December. User agencies will coordinate with the appropriate NWS office to determine when forecasts are no longer needed in their areas.

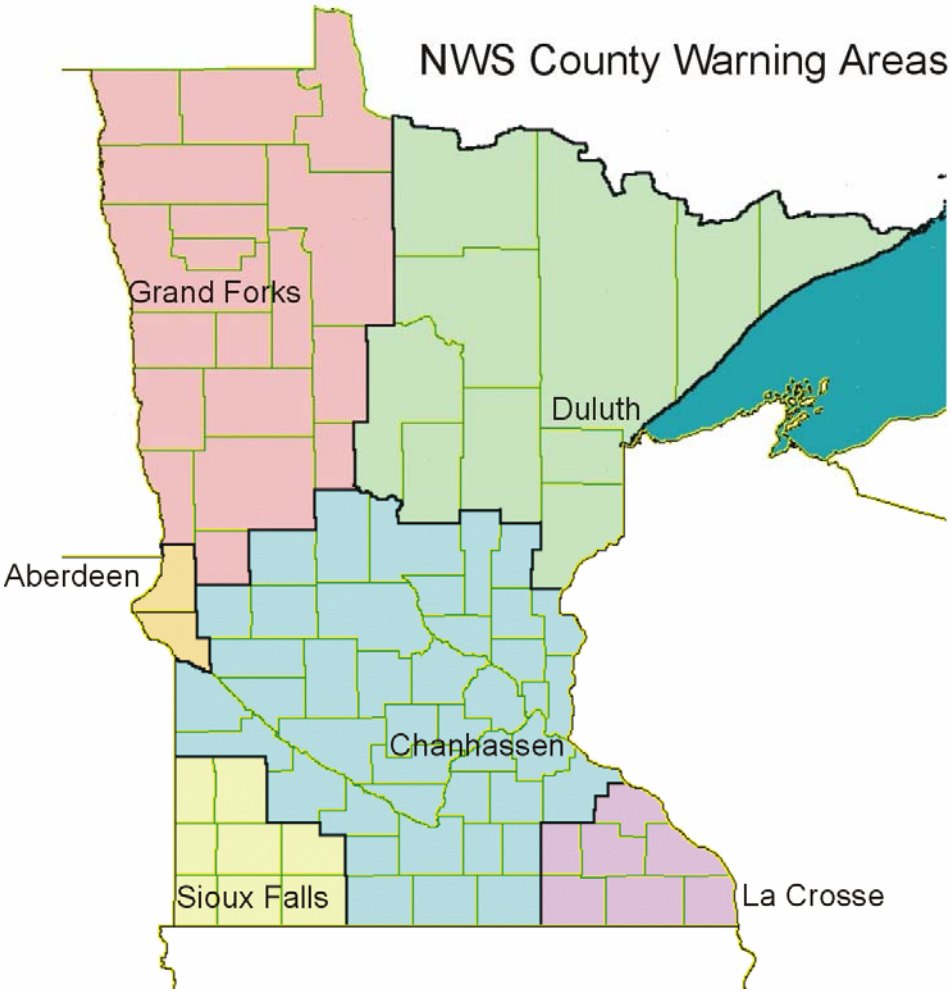

Figure 1 County Warning Areas (CWA) for NWS offices serving Minnesota.

During fire season, Fire Weather Planning Forecasts are issued twice daily - once by 0700 and again by 1530. Forecasts are updated if a Fire Weather Watch or Red Flag Warning is issued or cancelled, or the current forecast does not adequately describe expected weather conditions. If forecasts are updated, a call must be make to MIFC Dispatch
or Doug Miedtke, MN DNR (218-327-4445). Over about the southern half of the state, (See figure 2) forecasts are discontinued on June 1st, unless customers request that they continue or resume again at a later date. Point forecasts are issued for a number of NFDRS sites by 1530. Spot forecasts are issued upon request.

b) Access to Forecasts - Forecasts are transmitted through the NWS AWIPS computer system. They are then available to customers via WIMS, NWS office web sites, or on sites maintained by Predictive Services web sites at the GACCs. NWS web sites are listed in part I.A. General weather forecasts, hourly weather conditions, weather warnings, climate data and other weather information are available via continuous broadcast on NOAA weather Radio network broadcast by the NWS. See Appendix F.

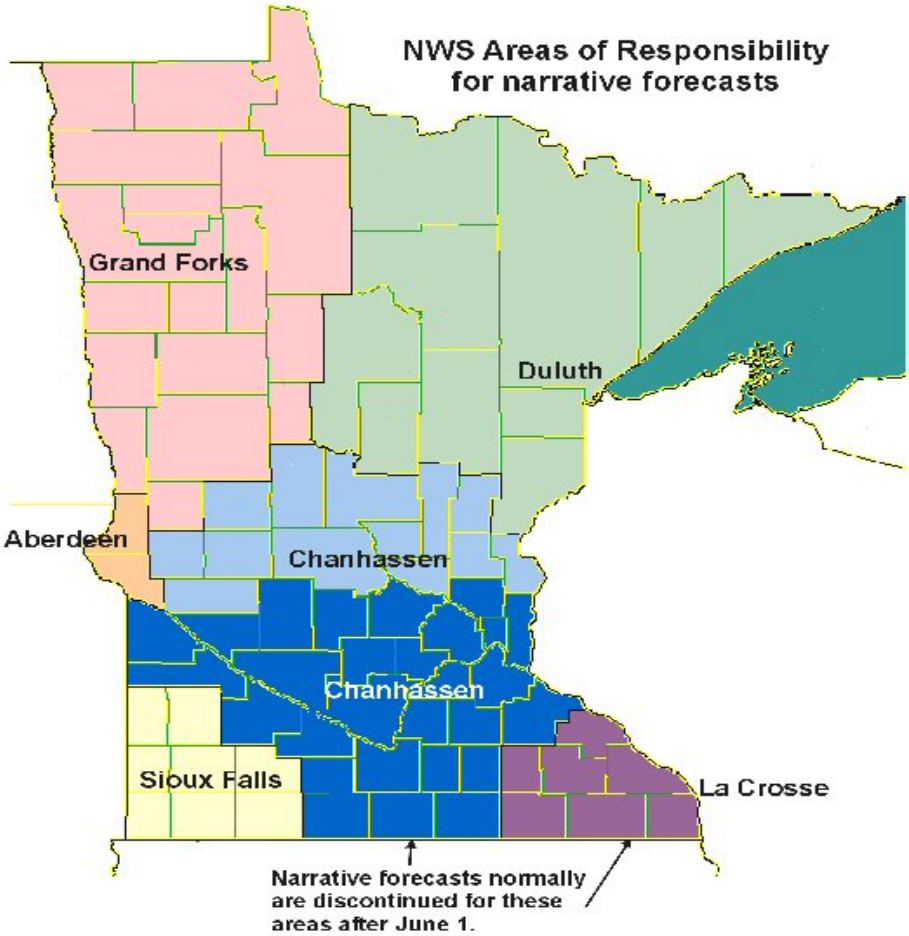

Figure 2. Narrative forecasts for much of southern Minnesota will normally be discontinued by NWS Twin Cities/Chanhassen and NWS La Crosse on June 1 as depicted.

c) Types of Forecasts, Format and Content

1) Fire Weather Planning Forecasts are issued for 98 fire weather zones. These zones, shown in Figure 3 generally follow county lines. Some of the larger counties may be subdivided into smaller zones. Appendix E has a list of zone numbers, county and key city names, as well as weather reporting stations.

Morning narrative forecasts are written for three forecast periods (TODAY, TONIGHT, TOMORROW). Afternoon narrative forecasts are written for (TONIGHT, TOMORROW, TOMORROW NIGHT, NEXT DAY). A forecast for days 3 through 7 is appended at the end of each forecast groups. A wind forecast is included through day 7.

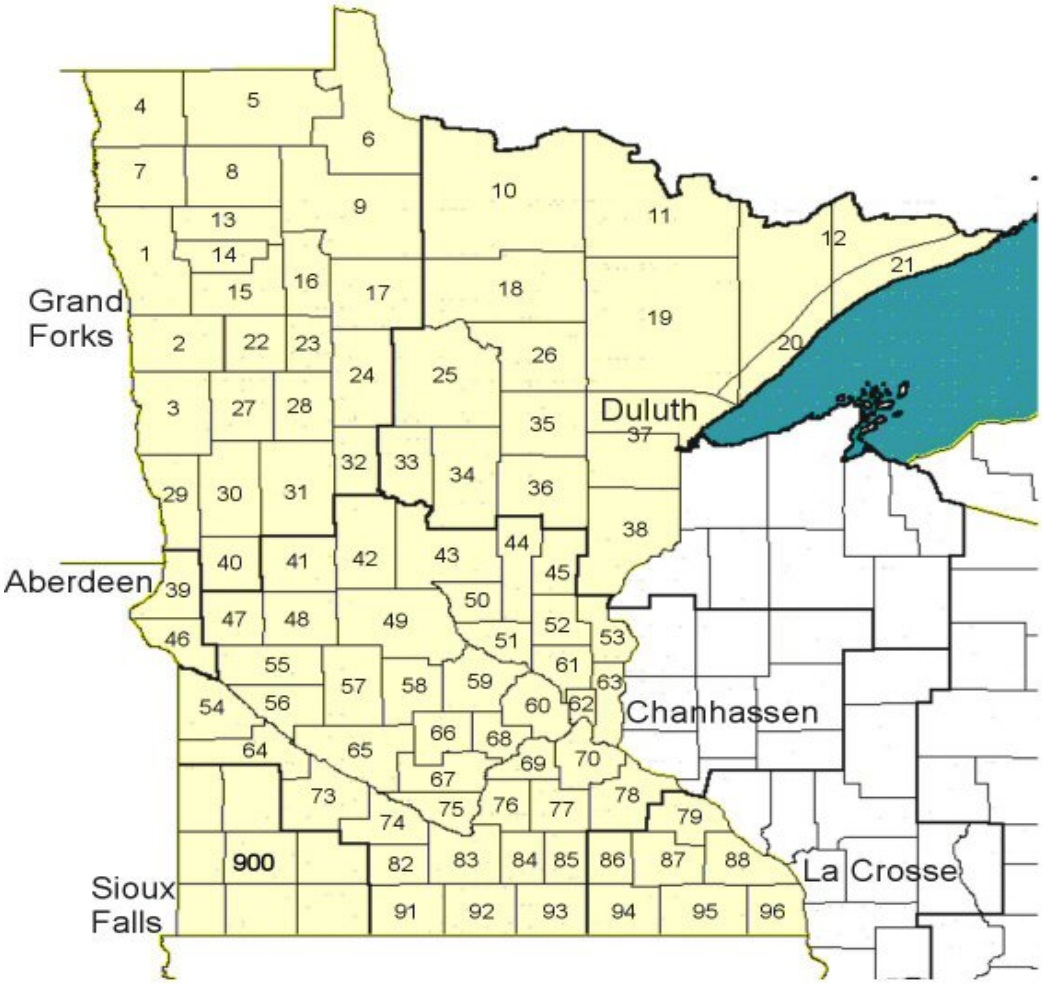

Figure 3. Forecast zone structure for NWS fire weather narrative products. Some zones are subdivisions of larger counties. Thick, black lines show the boundaries or the County Warning Areas (CWA) or each NWS office.

The elements in the narrative forecast are:

Headline (Required for Red Flag Warnings and Fire Weather Watches)
- encouraged to add headlines for other significant weather concerns or changes.

Discussion
- written with enough detail to give users knowledge of weather causes during the forecast period.
- provides frontal positions, movements and timing..
- serves as a vehicle to discuss reasoning for headlines or expected changes in critical parameters such as temperature, humidity, and wind

Sky/Weather
- sky and general weather conditions including trends
- as specific as possible on timing, duration and coverage of precipitation
- as specific as possible on cloud coverage, type, and trends

High and low temperature
- temperature ranges kept as small as possible, 5 degrees or less

Relative humidity
- forecast daytime minimum and nighttime maximum
- humidity ranges of 5 percent when RH is 40 percent or less;
- a maximum range of 10% can be used for RH greater than 40 percent

20 ft. wind speed (mph) and direction
- as specific as possible on timing of significant speed and directional changes
- given in ranges of 5 mph or less and includes gusts
- forecast direction to nearest 8 cardinal compass points (northwest, north, southeast)

Other elements included:

Haines Index
- determined for the 850 - 700 MB level (about 5,000 ft to 10,000 ft.)
- attached to "TODAY" and "NEXT DAY" on the morning narrative
- attached to the "TOMORROW" period on the afternoon forecast
- provided by throughout the fire season when narrative forecast available.

Smoke Management parameters
- depth of mixing layer (feet agl). The average mixing height from 12 to 18 hours local time.
- attached to "TODAY" and "NEXT DAY" on the morning narrative
- attached to the "TOMORROW" period on the afternoon forecast
- transport winds (speed (mph) and direction) in the mixing layer
  dispersion index consisting of a number and a text ranking of poor, fair, good, or excellent (Appendix C explains the terms used in smoke management)
- provided throughout the fire season when narrative forecast available.

Hours of sunshine

- important for assessing probability of ignition of fine fuels (strong insolation can make them more likely to ignite)

Precipitation amount

- average areal amount.

Extended forecasts

- added after each forecast group providing forecasts for the 3-7 day period .
- included are: sky/weather, temperature, with a wind forecast thru Day 7.

**Optional elements in narrative forecasts may vary slightly between NWS offices

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FIRE WEATHER PLANNING FORECAST FOR CENTRAL AND MOST OFSOUTHERN MN AND WC WISCONSIN NATIONAL WEATHER SERVICE CHANHASSEN/TWIN CITIES MN
700 AM CDT WEDMAY 10 2007

.DISCUSSION...AT DAYBREAK A COLD FRONT WAS MOVING INTO THE WESTERN DAKOTAS. WARMER AIR WILL PUSH INTO MINNESOTA AND WISCONSIN AHEAD OF THE FRONT. EXPECT SOUTHERLY SURFACE WINDS TO INCREASE AS THE FRONT APPROACHES. THESE WINDS WILL IMPORT MORE HUMID AIR INTO THE REGION. BY SUNSET THE FRONT WILL PUSH ACROSS THE WESTERN BORDER OF MINNESOTA ARRIVING IN EASTERN MINNESOTA EARLY THURSDAY MORNING. SCATTERED SHOWERS AND THUNDERSTORMS WILL ACCOMPANY THE FRONT. HIGH PRESSURE WILL THEN BUILD INTO THE AREA FOR THE NEXT SEVERAL DAYS BRINGING COOLER AND DRIER WEATHER.

MN039-041-046>048-054>056-064-102130-
TRAVERSE-DOUGLAS-BIG STONE-STEVENS-POPE-SWIFT-LAC QUI PARLE-CHIPPEWA-YELLOW MEDICINE-
INCLUDING THE CITIES OF ALEXANDRIA...MONTEVIDEO
700 AM CDT WED MAY 10 2007

.TODAY...
SKY/WEATHER.....SUNNY AND WARM.
MAX TEMPERATURE.....80 TO 85.
MIN HUMIDITY.....35 TO 40 PERCENT.
20-FOOT WINDS.....SOUTHWEST 10 MPH INCREASING TO 15 MPH BY NOON.
HAINES INDEX.....4 OR LOW.
HOURS OF SUN.....7 TO 9 HOURS.
PRECIPITATION.....NONE.
MIXING HEIGHT.....AROUND 5000 FT AGL (AVE 12-6 PM).
TRANSPORT WINDS.....SOUTHWEST 10 MPH (AVE 12-6 PM).
SMOKE DISPERSAL.....AROUND 50000 OR GOOD (AVE 12-6 PM).

.TONIGHT...
SKY/WEATHER.....MOSTLY CLOUDY. A 40 PERCENT CHANCE OF EVENING THUNDERSTORMS.
MIN TEMPERATURE…..55 TO 60.
MAX HUMIDITY.....85 TO 95 PERCENT.
20-FOOT WINDS.....SOUTHWEST 10 TO 15 MPH BECOMING WEST AFTER MIDNIGHT.
PRECIPITATION.....SCATTERED 0.10 to 0.20 INCH AMOUNTS.

.THURSDAY...
SKY/WEATHER.....PARTLY CLOUDY...BREEZY AND COOLER. A BRIEF AFTERNOON SHOWER
POSSIBLE. PRECIPITATION CHANCE IS 20 PERCENT.
MAX TEMPERATURE....73 TO 77.
MIN HUMIDITY.....35 TO 40 PERCENT.
20-FOOT WINDS.....NORTHWEST 10 TO 15 MPH INCREASING LATE MORNING TO 15 TO 20 MPH.
HAINES INDEX.....4 OR LOW.
HOURS OF SUN.....7 TO 9 HOURS.
PRECIPITATION.....ISOLATED 0.02 TO 0.05 INCH AMOUNTS.
MIXING HEIGHT..... AROUND 4000 FT AGL (AVE 12-6 PM).
TRANSPORT WINDS....SOUTHWEST 20 MPH (AVE 12-6 PM).
SMOKE DISPERSAL.....AROUND 80000 OR EXCELLENT (AVE 12- PM).

.FORECAST DAYS 3 THROUGH 7....
.THURSDAY NIGHT…PARTLY CLOUDY. LOWS IN THE UPPER 40S. WIND NORTHWEST 10 MPH.
.FRIDAY…PARTLY CLOUDY. HIGHS IN THE LOWER 70S. WIND NORTHWEST 10 TO 15 MPH.
.FRIDAY NIGHT…PARTLY CLOUDY. LOWS IN THE LOWER 50S. WIND WEST 5 TO 10 MPH.
.SATURDAY…MOSTLY SUNNY. HIGHS IN THE MID 70S. WIND WEST 15 MPH.
.SATURDAY NIGHT…MOSTLY CLEAR. LOWS IN THE LOWER 50S. WIND SOUTHWEST 5 TO 10 MPH.
.SUNDAY.....PARTLY CLOUDY. WARMER. HIGHS IN THE UPPER 70S. SOUTHWEST WINDS 15 MPH.
.SUNDAY NIGHT…A CHANCE OF SHOWERS. LOWS IN THE UPPER 50S. WIND SOUTHWEST 10 MPH. CHANCE OF RAIN 30 PERCENT.
.MONDAY…A CHANCE OF THUNDERSTORMS. HIGHS AROUND 80. WIND SOUTHWEST 15 TO 20 MPH. CHANCE OF RAIN 40 PERCENT.
.MONDAY NIGHT…PARTLY CLOUDY. COOLER. LOWS IN THE LOWER 50S. WIND NORTHWEST 10 MPH.
.TUESDAY...PARTLY CLOUDY. HIGHS IN THE LOWER 70S. WIND NORTHWEST 15 TO 20 MPH.
$$
OTHER ZONE GROUPINGS TO FOLLOW

Figure 4. Example of a morning narrative forecast for part of central Minnesota

FIRE WEATHER PLANNING FORECAST FOR E NORTH DAKOTA AND NW AND WC MINNESOTA
NATIONAL WEATHER SERVICE EASTERN NORTH DAKOTA/GRAND FORKS ND
300 PM CDT SAT JUN 3 2007

.DISCUSSION...GUSTY NORTHWEST WINDS AND COOLER TEMPERATURES WILL FOLLOW A COLD FRONT WHICH MOVED OUT OF THE AREA EARLIER TODAY. HIGH PRESSURE WILL PUSH INTO WESTERN MINNESOTA LATE SUNDAY BRINGING LESS WIND BUT CONTINUED COOL TEMPERATURES. A WARMING TREND WILL BEGIN ON TUESDAY AHEAD OF AN APPROACHING TROUGH OF LOW PRESSURE. THE APPROACH OF THE TROUGH WILL BRING A CHANCE OF SHOWERS BY THURSDAY NIGHT.

MN001>009-013>016-041200-
W POLK-NORMAN-CLAY-KITSON-ROSEAU-LAKE OF THE WOODS-W MARSHALL-E MARSHALL-N
BELTRAMI-PENNINGTON-RED LAKE-E POLK-N CLEARWATER-
INCLUDING THE CITIES OF ROSEAU...THIEF RIVER FALLS
300 PM CDT SAT JUN 3 2007

.TONIGHT...
SKY/WEATHER.....PARTLY CLOUDY AND COOL. BREEZY.
MIN TEMPERATURE.....45 TO 50.
MAX HUMIDITY.....90 TO 95 PERCENT.
20-FOOT WIND.....NORTHWEST 15 TO 20 MPH DIMINISHING TO 10 TO 15 MPH AFTER SUNSET.
PRECIPITATION.....NONE.

.SUNDAY...
SKY/WEATHER.....PARTLY CLOUDY...WINDY AND COOLER.
MAX TEMPERATURE.....60 TO 65.
MIN HUMIDITY.....35 TO 40 PERCENT.
20-FOOT WIND.....NORTHWEST 20 TO 25 MPH DECREASING TO 10 TO 15 MPH TOWARD SUNSET.
HAINES INDEX.....4 OR LOW.
HOURS OF SUN.....7 TO 9 HOURS.
PRECIPITATION.....NONE.
MIXING HEIGHT..... AROUND 4000 FT AGL (AVE 12-6 PM).
TRANSPORT WINDS.....NORTHWEST 25 MPH (AVE 12-6 PM).
SMOKE DISPERSAL.....AROUND 100000 OR EXCELLENT (AVE 12-6 PM).

.SUNDAY NIGHT...
SKY/WEATHER.....PARTLY CLOUDY.
MIN TEMPERATURE.....40 TO 45.
MAXIMUM HUMIDITY....90 TO 95 PERCENT.
20-FOOT WIND.....NORTHWEST 10 TO 15 MPH.
PRECIPITATION.....NONE.

.MONDAY...
SKY/WEATHER.....SUNNY.
MAX TEMPERATURE.....62 TO 66.
MIN HUMIDITY.....35 TO 40 PERCENT.
20-FOOT WIND.....NORTHWEST 10 TO 15 MPH.
HAINES INDEX.....4 OR LOW.
HOURS OF SUN.....7 TO 9 HOURS.
PRECIPITATION.....NONE.
MIXING HEIGHT.....AROUND 5000 FT AGL (AVE NOON-6 PM).
TRANSPORT WINDS.....SOUTHWEST 10 MPH. (AVE NOON-6 PM).
SMOKE DISPERSAL.....AROUND 50000 …GOOD (AVE NOON-6 PM).

.FORECAST DAYS 3 THROUGH 7....
.MONDAY NIGHT…MOSTLY CLEAR. LOWS IN THE LOWER 50S. WIND NORTHWEST 5 TO 10 MPH.
.TUESDAY…SUNNY. HIGHS AROUND 70. WIND NORTHWEST 10 TO 15 MPH.
.TUESDAY NIGHT….CLEAR. LOWS IN THE LOWER 50S. WIND WEST 5 MPH.
.WEDNESDAY…SUNNY. HIGHS IN THE LOWER 70S. WIND SOUTHWEST 10 MPH.
.WEDNESDAY NIGHT…PARTLY CLOUDY. LOWS IN THE MID 50S. WIND SOUTHWEST 10 MPH.
.THURSDAY…PARTLY CLOUDY. HIGHS IN THE MID 70S. WIND SOUTHWEST 10 TO 15 MPH.
.THURSDAY NIGHT… CHANCE OF SHOWERS. LOWS MID 50S. WIND SOUTHWEST 10 MPH. CHANCE OF RAIN 30 PERCENT.
.FRIDAY…A CHANCE OF THUNDERSTORMS. HIGHS IN THE MID 70S. WIND SOUTHWEST 15 TO 20 MPH. CHANCE OF RAIN 40 PERCENT.
.FRIDAY NIGHT…A CHANCE OF THUNDERSTORMS. LOWS IN THE MID 50S. WIND SOUTHWEST 10 MPH. CHANCE OF RAIN 40 PERCENT.
.SATURDAY...A CHANCE OF SHOWERS. HIGHS IN THE LOWER 70S. WIND WEST 10 TO 15 MPH. CHANCE OF RAIN 30 PERCENT.
$$
OTHER ZONE GROUPINGS TO FOLLOW

Figure 5. Example of an afternoon narrative forecast, for a portion of northwest Minnesota.

2. Point Forecasts are issued by 1530 local time for the following NFDRS locations.

Duluth		Grand Forks		Minneapolis	
Cass Lake	211604	Baudette	210301	Sherburne	214001
Ely	210509	Detroit Lakes	212201	Litchfield	214501
Seagull	210709				
Hibbing	210512			Aberdeen	
Moose Lake	211803			Big Stone	213501
Brainerd	212601				
Rice Lake	211703				

The National Fire Danger Rating System (NFDRS) is designed to represent the fire potential at the "worst time of day" over a large area, generally in excess of 100,000 acres. The output from the NFDRS serves to indicate the levels of fire danger. From this, resource allocation and staffing are determined by the land management agencies.

Each afternoon by 1530 local time, the forecaster will enter all point forecasts into the USFS Weather Information Management System (WIMS) for stations at which reliable and timely observations are available on that day. During April and May, when necessary, and as forecast duties allow, the forecaster may update the NFDRS point forecasts issued from the previous afternoon if significant changes have occurred. These updates will be available by 7:00 a.m.

On June 1st, point forecasts will be continued only for Ely, Seagull, Hibbing and Cass Lake which are in the Superior and Chippewa National Forests. Point forecasts in the remainder of the state may be continued past June 1st, or may be resumed again later in the fire season upon request of land managers. Lightning Activity Level (LAL) is not forecast for any Minnesota NFDRS site.

NWS offices are encouraged to verify NFDRS forecasts and share results with State and Federal users.

NWS product ID's for each NWS office are:

MSPFWMMPX	NWS Minneapolis/Chanhassen
MSPFWMDLH	NWS Duluth
BISFWMFGF	NWS Grand Forks
FSDFWMABR	NWS Aberdeen
	NWS Sioux Falls does not issue point forecasts
	NWS La Crosse does not issue point forecasts for Minnesota stations

The format is: (commas but NO spaces)

FCST,SSCCNN,YYMMDD,VT,W,TT,RH,L1,L2,DD,VV,M,TM,TN,HM,HN,P1,P2,WF

STN # code SSCCNN where SS = State (21 is MN) CC = County NN = station

SSCCNN - 6 digit station number from above
YYMMDD - valid day of fcst - year/month/day The forecast made on April 10, 2007 for the 11th would be 070411
VT - Valid time. always a 13 for 1300 CST (2pm CDT)
W - State of the weather at 1300 CST tomorrow as shown below

0	= less than 1/8 clouds	4 = fog	7 = snow/sleet
1	= 1/8 to 4/8 opaque clouds	5 = drizzle	8 = showers
2	= 5/8 to 7/8 opaque clouds	6 = rain	9 = thunderstorms
3	= cloudy	(*Note: categories 5, 6, or 7 set NFDRS indecies to zero*)	

TT = temperature for 1300 CST tomorrow
RH = relative humidity for 1300 CST tomorrow
* L1 = lightning activity level (1400 CST today until 2300 CST). Always a "1" in Minnesota
* L2 = lightning activity level (2300 CST today until 2300 CST tomorrow). Always a "1" in Minnesota
DD = wind direction at 1300 CST tomorrow (8 point compass)
VV = 20 ft wind speed in mph at 1300 CST tomorrow
M = 10 hr fuel moisture (input by the users and left blank by the forecaster). Two commas will be noted next to each other
TM = maximum temperature from ***1300 CST to 1300 CST***
TN = minimum temperature from 1300 CST to 1300 CST
HM = maximum humidity in percent from 1300 CST to 1300 CST
HN = minimum humidity in percent from ***1300 CST to 1300 CST***
P1 = pcpn duration in hours from 1300 CST today till 0500 CST tomorrow
P2 = pcpn duration in hours from 0500 CST tomorrow till 1300 CST tomorrow
WF = Wet Flag. A Y or N. It is used to indicate if fuels will be wet at 1300 CST. All indices will be forced to zero if a Y used.
* For stations at Seagull, Ely, and Cass Lake, precipitation amounts of 0.15" or more from 1300 CST today to 1300 CST tomorrow will turn "Wet Flag "to Yes.

* The L1 and L2 values can range from 1 to 6. The higher the number, the greater the risk of lightning. LALs correspond roughly to categories of thunderstorm density:
1 = none, 2 = isolated, 3 = few, 4 = scattered, 5 = numerous. An LAL of 6 is generally reserved for the west where dry lightning is a problem.
At the request of user agencies in Minnesota, the *LAL forecast will always be set to 1 (none).*

Figure 6. Point Forecast coding and interpretation.

3. Spot Forecasts

a) Criteria - Spot forecasts are **site specific forecasts** in support of wildfire suppression and natural resource management. Spot forecasts for a wildfire will be treated with a priority similar to that of severe weather warnings. It is the responsibility of the requestor to indicate that the request is for wildfire suppression. At the 2005 Minnesota State Fire Weather Meeting is was agreed that the NWS would attempt to process all Spot Forecast requests within 40 minutes whenever possible.

In accordance with NWS Directive NWSI-401:

NWS offices will provide spot forecasts upon request of any federal, state, tribal, or local official who represents the spot forecast is required to support a wildfire.

For non-wildfire purposes, resources permitting, NWS offices will provide spot forecast service under the following circumstances and conditions:

a. Upon request of any federal official who represents that the spot forecast is required under the terms of the Interagency Agreement for Meteorological Services.
b. Upon request of any state, tribal, or local official who represents that the spot forecast is required to carry out their wildland fire management responsibilities in coordination with any federal land management agency participating in the Interagency Agreement.
c. Upon request of any public safety official who represents the spot forecast is essential to public safety, e.g.due to the proximity of population centers or critical infrastructure. A "public safety official" is an employee or contract agent of a government agency at any level (federal, state, local, tribal, etc) charged with protecting the public from hazards including wildland fires of whatever origin and/or other hazards influenced by weather conditions such as hazardous material releases.

NWS offices will not provide spot forecasts to private citizens or commercial entities not acting as an agent of a government agency.

Requestor Identification - The requestor for each spot forecast must provide the following information before a spot forecast can be issued.

a. Name
b. Government agency
c. Address and phone number
d. Representation as to the reason for the spot forecast, which must be one of the reasons indicated above.

A current on-site weather observation should accompany the forecast request. The requestor should specify how the wind measurement was obtained (20 foot or eye-level). In the case of a wildfire or prolonged prescribed burn, updated observations should be provided during the course of the event. Land management personnel should contact the servicing NWS office for an update if forecast conditions appear unrepresentative of actual weather

conditions. Spot forecasts should be considered one-time requests, and are not routinely monitored nor updated. Spot forecasts may be updated when representative observations are
available to the forecaster, he/she deems the current forecast does not adequately represent current or expected weather conditions, and emergency contact information is available to disseminate the update. If an update is made, the forecaster must call the emergency contact number listed on the spot forecast request. Feedback from land management personnel is also encouraged during or after the burn.

Users are asked to read the narrative fire weather forecast before making a spot forecast request. To hold the number of spot forecasts to a manageable level, internal coordination and planning should be done by user agencies making forecast requests.

b) Content and Format - The standard format for wildfire spots includes: headlines (mandatory when Red Flag Warning or Fire Weather Watch in effect), discussion, sky/weather, temperature, relative humidity, and wind. Optional elements may also be provided. See example below.

The content of non-wildfire spots should conform to the standard format for wildfire spots, though the content and number of forecast periods may be different, as determined by the requestor. Users should be as specific as possible when making a forecast request.

SPOT FORECAST FOR CRAZY LAKE FIRE
ISSUED BY NATIONAL WEATHER SERVICE DULUTH, MN
11 AM CDT SUNDAY MAY 14 2007

IF CONDITIONS BECOME UNREPRESENTATIVE CONTACT THE NWS

...INCREASING WINDS THIS AFTERNOON... *(headline required for Red Flag Warnings and Fire Weather Watches and recommended for every issuance.)*

.DISCUSSION...SOUTHWEST WINDS WILL INCREASE AHEAD OF AN APPROACHING COLD FRONT. THE FRONT WILL REACH THE BURN AREA BETWEEN 4 PM AND 6 PM THIS EVENING. WINDS WILL RAPIDLY BECOME NORTHWEST AND REMAIN GUSTY UNTIL DARK. AN ISOLATED THUNDERSTORM MAY FORM NEAR THE COLD FRONT.

.REST OF TODAY...
SKY/WEATHER.....MOSTLY SUNNY AND DRY. GUSTY WINDS. AN ISOLATED
THUNDERSTORM POSSIBLE BETWEEN 4 AND 7 PM.
TEMPERATURE.....82 TO 86
HUMIDITY.....32 TO 36 PERCENT
20-FOOT WIND.....SOUTHWEST 15 TO 20 MPH WITH GUSTS TO 25 MPH. WINDS
BECOMING NORTHWEST AFTER 4 PM.
HAINES INDEX.....5 OR MODERATE

.TONIGHT...
SKY/WEATHER..... MOSTLY CLEAR WITH DECEASING WINDS
MIN TEMPERATURE...55 TO 60
MAX HUMIDITY.....80 TO 85 PERCENT
20-FOOT WIND.....NORTHWEST 10 TO 15 MPH.

.MONDAY...
SKY/WEATHER.....PARTLY CLOUDY. BECOMING BREZZY.
HIGH TEMPERATURE....77 TO 81
MIN HUMIDITY.....34 TO 38 PERCENT
20-FOOT WIND.....NORTHWEST 8 TO 12 MPH INCREASING TO 15 TO 20
MPH AFTER 11 AM.
$$
(Optional elements may be added at request of user)

Figure 7. Example of a Standardized Spot Weather Forecast for a wildfire.

c. Procedures - An Internet-based program, NWS Spot, is the national standard for requesting, issuing, and retrieving spot forecasters. This program is available on NWS web sites. Spot forecasts can also be requested by phone or fax if NWS Spot is inoperative or if a discussion is needed with a forecaster. A phone call must accompany a fax request so the forecaster is aware of the request.

The requesting agency should provide information about the location, topography, fuel type(s), size, ignition time, and a contact and telephone number of the responsible land management official. When possible, a representative weather observation should accompany the request. As indicated above in section 3.a, requestor information justifying the spot forecast request must also be provided for the forecast request to be honored.

Feedback to the NWS providing the spot forecast is highly encouraged.

4. Fire Weather Watches and Red Flag Warnings

a) Criteria - NWS offices will issue Fire Weather Watches and Red Flag Warnings when the combination of dry fuels and weather conditions support extreme fire danger and/or fire behavior. Primary user agencies (USFS and MN DNR) are responsible for keeping the NWS aware of fuel conditions which could lead to extreme fire danger. The NWS will coordinate with user agencies prior to issuing Fire Weather Watches and Red Flag Warnings. However, if a Fire Weather Watch is currently in effect, it means that weather and fuels conditions have already been coordinated with land managers. In this case, no further coordination is required, if a Red Flag Warning is subsequently issued for the same time period and area. See call list under 4.c. - Procedures. Any National Forests affected will be specified in the Watch or Warning. During situations of borderline criteria for a Fire Weather Watch or Red Flag Warnings terminology such as SEVERE FIRE WEATHER CONDITIONS MAY OCCUR MONDAY AFTERNOON is encouraged in the synopsis portion of the routine narrative forecast. A Fire Weather Watch/Red Flag Warning checklist is shown in Figure 10.

The issuance of these products in typically a two stage process. A **Fire Weather Watch** is issued when there is a reasonable level of confidence that **ALL THREE** of the following weather conditions could be met within12 to 72 hours, after consultation with appropriate land managers. A **Red Flag Warning** will be issued immediately, after consultation with land managers, if these conditions are observed or there is a high confidence that they will be met within the next 24 hours. *Land managers could request that a Red Flag Warning be issued with weather criteria not meeting these values if fuels are critically dry.*

1. Sustained one-minute winds at standard 20 foot level are at or above 20 mph. However, in the Red River Valley of northwest Minnesota and in the southwest corner of the state sustained winds must be at or above 25 mph. See the map depicting these areas in Figure 9.
2. Minimum relative humidity at or less than 25 percent.
3. Temperatures at or greater than 75 degrees F.

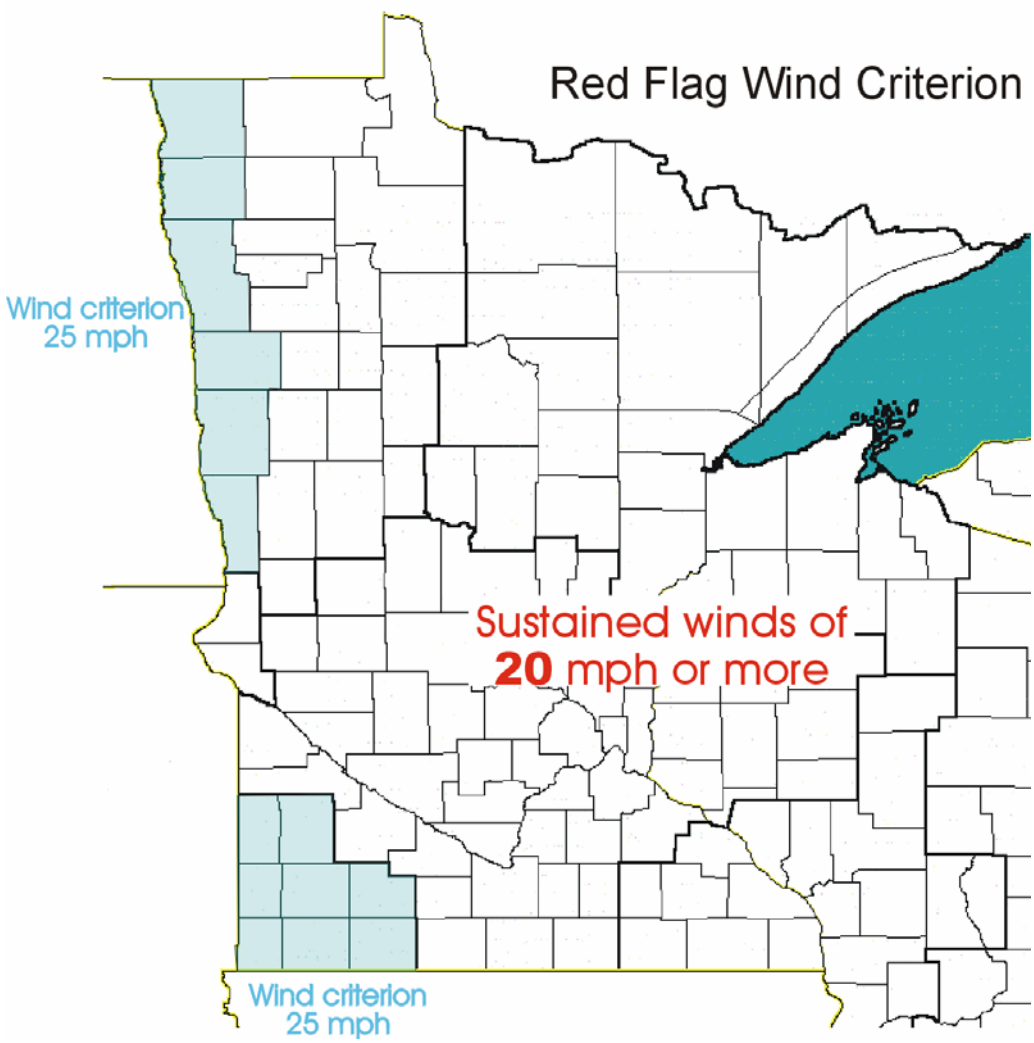

Figure 8. Wind criteria for Fire Weather Watch and Red Flag Warnings. The 2-minute, 33 foot wind threshold is 20 mph over Minnesota except for the Red River Valley in the northwest and the high terrain area in the southwest corner of the state.

Note: Operationally, the wind used in Red Flag criteria is actually a 33 foot wind. A dense network of airport observing sites across Minnesota provides wind reports at least hourly for the forecaster to use in making watch or warning decisions. Research has shown that the reduction from a 33 foot wind to a 20 foot wind is 10% or less for comparably sited instruments.

Other factors which must be considered:

4. WIMS categorical Fire Danger Index in the high to extreme category.
Source maps for the Fire Danger Rating are on the Minnesota DNR web page at http://www.dnr.state.mn.us/forestry/fire/
5. NFDRS output from the NWS product NMCFDICR product which provides information on the Burning Index (BI) and Energy Release Component (ERC). Generally, the BI should be above 4, and the ERC over 40 when a Watch or Warning is issued.

When Red Flag conditions have ended or are no longer expected, the Watch or Warning will be cancelled. This should be coordinated with user agencies.

b) Content/Format

The Watch or Warning headline will specify:

- The valid time, type of event, area affected, and critical weather elements causing the warning to be issued.

The following products will disseminate the Watch or Warning:

- A Fire Weather Watch Message (RFW) will carry the Watch or Warning Headline. The body of the product will describe the weather feature(s) responsible the event and provide detail as to the reason for the event.
- The Fire Weather Planning Forecast (FWF) will include the headline with the DISCUSSION. The headline will also be carried in the appropriate zone groupings.
- With Red Flag Warnings, the USFS and/or DNR may wish the NWS to distribute a public statement (RFD) to be distributed to the media. User agencies will provide guidance as to statement content and if they wish the Red Flag terminology to be used in the product.

User agencies will normally handle all public and media questions about fire potential and danger. The NWS will answer questions only about weather conditions, but should not comment on fire conditions

An example of a Red Flag Warning product is shown on the following page.

RED FLAG WARNING
NATIONAL WEATHER SERVICE EASTERN NORTH DAKOTA/GRAND FORKS ND
730 AM CDT SAT APR 15 2007

MN001>009-MN013>017-MN022 >024-MN027-MN028-160100-
VETEC CODING INFORMATION
W POLK-NORMAN-CLAY-KITTSON-ROSEAU-LAKE OF THE WOODS-W MARSHALL-
E MARSHALL-N BELTRAMI-PENNINGTON-RED LAKE-E POLK-N CLEARWATER-
MAHNOMEN-S CLEARWATER-HUBBARD-W BECKER-E BECKER-
INCLUDING THE CITIES OF ROSEAU-THIEF RIVER FALLS-(FOSSTON)-
(BAUDETTE)-DETROIT LAKES-
730 AM CDT SAT APR 16 2007

...RED FLAG WARNING IN EFFECT FROM 1 PM TO 8 PM CST THIS EVENING FOR NORTHWEST MINNESOTA FOR STRONG WINDS AND LOW HUMIDITY…

THE NATIONAL WEATHER SERVICE HAS ISSUED A RED FLAG WARNING FOR STRONG SOUTHWEST WINDS AND LOW HUMIDITY THIS AFTERNOON AND EARLY EVENING FOR THAT PORTION OF NORTHWEST MINNESOTA...WEST OF A LINE FROM BAUDETTE TO BEMIDJI TO PARK RAPIDS AND NORTH FROM PARK RAPIDS TO DETROIT LAKES

A STRONG AREA OF LOW PRESSURE WILL BE TRACKING ACROSS SOUTHERN MANITOBA THIS AFTERNOON. SOUTHWEST WINDS AHEAD OF THE LOW ARE EXPECTED TO INCREASE TO 25 TO 30 MPH WITH GUSTS OVER 35 MPH. HUMIDITY IS EXPECTED TO DROP TO 20 TO 25 PERCENT WITH TEMPERATURES CLIMBING TO NEAR 80 DEGREES.

A STRONG COLD FRONT WILL PUSH ACROSS THE NORTH DAKOTA BORDER AROUND 6PM AND SHOULD REACH THE BAUDETTE AND PARK RAPIDS AREA AROUND 10PM. WINDS WILL SHIFT TO THE NORTHWEST AT 20 TO 25 MPH. TEMPERATURES WILL FALL SHARPLY WITH HUMIDITY RECOVERING ABOVE 40 PERCENT AS THE FRONT PASSES. EXPECT SCATTERED SHOWERS AND SOME THUNDERSTORMS NEAR THE COLD FRONT WITH RAINFALL AMOUNTS AROUND .25.

PLEASE ADVISE THE APPROPRIATE OFFICIALS AND FIRE CREWS IN THE FIELD
OF THIS RED FLAG WARNING

$$

Figure 9. Example of a Red Flag Warning for a single segment event. Fire Weather Watches would follow the same format. This product could also be divided into multiple segments, especially in those cases where the watch or warning is for a large area.

FIRE WEATHER WATCH AND RED FLAG WARNING ACTION CHECKLIST

Issued		**Canceled**
Date_____	Fire Weather Watch _____	Date_____
Time_____	Red Flag Warning _____	Time_____
Forecaster_____		Forecaster_____

COORDINATION

WFO Minneapolis Time _____
WFO Grand Forks Time _____
WFO Green Bay Time_____
WFO Duluth Time_____
WFO La Crosse Time_____
WFO Sioux Falls Time_____
WFO Aberdeen Time _____

Make these CALLS prior to issuing the Watch or Warning

Minnesota Interagency Fire Center (MIFC)
MIFC Dispatch (24 hours) Time_____
Minnesota DNR, at MIFC
Doug Miedtke 218-327-4445 Time_____

(note: if coordination with one of the above, they may be able to contact the other party for you)

If a National Forest is affected also call:
Brad McKelvy, Forest Dispatcher 218-327-4176 Time_____

And when time permits call:
Eastern Area Interagency Coordination Center in Minneapolis / Duty Officer (24 Hour operation)
612-713-7300 Time_____

DISSEMINATION

RWF NWS office_____ Time_____
Added to regularly scheduled narrative forecast. a.m._____ p.m. _____
Updated narrative: Yes_____ Time_____ No_____
Public statement (coordinated with user agency) Time_____

Notes:_____
_____
_____

Figure 10. Fire Weather Watch and Red Flag Warning coordination checklist for NWS offices.

c. Procedures and Access - Prior to the issuance of Watches and Warnings, NWS offices will coordinate with the officials/agencies listed in the checklist above. When Fire Weather Watches and Red Flag Warnings are issued, they will be headlined in the products indicated in 4.b as well as in Spot Forecasts issued for the valid area. Fire Weather Watches and Red Flag Warnings will remain in effect through their expiration time, or until they are canceled or watches are upgraded to warnings. Red Flag Warnings and Fire Weather Watches are available soon after issuance via WIMS or on the web site of the NWS offices.

d. Verification - Fire weather program leaders will verify the Red Flag program. Results will be distributed the NWS Regional Fire Weather Program Managers as well as to the appropriate State and Federal user groups in Minnesota. Red Flag Warnings will be verified based on the Probability of Detection, False Alarm Rate, Critical Success Index, and Lead Time.

5. Participation in Interagency Groups - NWS offices providing fire weather services for Minnesota are expected to participate in the Annual State Fire Meeting. This meeting serves as a forum for interaction between NWS program leaders and their interagency users. It also provides an effective vehicle for discussions pertaining to changes to the AOP.

6. National Digital Forecast Database (NDFD) -

The NWS provides another forecast tool called the National Digital Forecast Database (NDFD). This database contains forecast weather parameters on a 2.5 to 5.0 kilometer grid. The NDFD runs through day 7, and is continually updated by NWS forecasters. Access to the NDFD is possible through NWS web pages by selecting GRAPHICAL from the dark blue menu bar on the left side of the NWS office homepage. Information on the NDFD can be found at the following link: http://www.weather.gov/ndfd/

B. SPECIAL SERVICES -The NWS provides a cadre of trained Incident Meteorologists (IMETs) who will provide on-site forecasting when requested by land management agencies. A certified IMET is on staff at the Minneapolis/Chanhassen NWS office. In addition to wildfires, IMETs may be dispatched to support:

- Large critical resource value prescribed burns. An example would be the Fuels Reduction Project in the Boundary Waters Area of Northeast Minnesota.
- Land management coordination and dispatch centers
- Hazardous substance release
- Any special projects or incidents which fall under the mandate of the NWS.

By Interagency Agreement, the NWS will support land management agency requests for on-site meteorological support for wildland fires through the IMET program. Other events listed above may be supported depending upon resource availability, if requested by federal fire agencies participating in the Interagency Agreement or if requested by public safety officials who represent such support as essential to public safety.

1) Only certified IMETS may be dispatched to support on-site service. The NWS is responsible for maintaining proficiency of designated IMETs.

2) An Atmospheric Theodolite Meteorological Unit (ATMU) is cached at the Region 9 Cache in Grand Rapids, MN. Land management agencies are responsible for transporting the ATMU to an incident. Helium will also be ordered for the ATMU upon request of the IMET.

3) IMET data needs will be obtained by one of four means:
   a) Incident provides communications through a LAN
   b) If incident does have communication, then use Verizon Wireless Cards.
   c) If no Verizon service in area, then use INMARSAT (satellite comms) at an estimated cost to the incident of around $500.00 per day.
   d) Another possible, but slow option, is via a phone modem connection.

4) The NWS is responsible for assembly and operation of this equipment, calibration of instruments, ordering contract repair, and, if necessary, scheduling training sessions.

5) Request and dispatch of IMETs and equipment is accomplished through the National Resource Coordination System. If the IMET in Minneapolis is unavailable, the request will be likely be sent to the Eastern Area Coordination Center (EACC). They will in turn forward the request to the NWS National Fire Weather Operations Coordinator (NFWOC) in Boise who will fill the order. If the Minneapolis IMET is not available, the Meteorologist-in-Charge will promptly notify the dispatch center that the order cannot be filled.

6) Incident Operations - The IMET must be provided a work area free from rain and wind as well as telephone access. The line is typically shared with the Fire Behavior Analyst (FBAN). A source of power is also necessary (generator is OK). The IMET will work the hours and perform the forecast tasks required by the Incident Management Team. When a fire is declared contained or controlled, the IMET will assess the time requirement for further support in conjunction with the FBAN and Plans Section Chief.

7) Reimbursement for Services Provided - The NWS will be reimbursed for all costs associated with on-site operation as set forth in the Interagency National Agreement. (viewed at http://www.weather.gov/directives). See Section 10 Operations and Services, NWSI 10-4. These include all overtime costs associated with the deployment, travel costs and per diem, telecommunication services, as well as costs incurred by the NWS IMET duty station such as covering shifts vacated by the IMET. After each deployment, the IMET will prepare a Report of Reimbursable Expenses. The NWS will recover costs based on this report.

C. TRAINING -

1. Forecaster training - Any NWS forecaster producing fire weather forecasts needs to be trained. Forecasters must fulfill the following requirements as set forth in NWSI 10-405:

a. Complete the NWS Fire Weather computer based learning module and S-290, Intermediate Wildland Fire Behavior (either by computer based training or residence training.)

b. Local training generally consists of review of the AOP, the Fire Weather Station Duty Manual and other station instructions, as well as training established by the Fire Weather Program Leader or land management personnel.

c. Forecasters must be familiar with NWS fire weather products and services and be proficient in their preparation and dissemination.

2. IMET Training and Certification requirements are detailed in NWSI 10-405.

3. NWS provided training to land management agencies - when NWS staff provide training to land management personnel, costs above planned salary and operating costs will be borne by benefiting agency(s). Billing procedures are described in the Interagency Agreement for Meteorological Services between the NWS and Land Management Agencies.

III. WILDLAND FIRE AGENCY SERVICES AND RESPONSIBILITIES

A. OPERATIONAL SUPPORT AND PREDICTIVE SERVICES - the GACC Meteorologist at the Eastern Area Coordination Center (EACC) at Fort Snelling, Minnesota combines forecast information from NWS offices and other sources into area-wide summaries and briefings. This meteorologist, along with Fire Intelligence forms the Predictive Services group which produces fire weather/fire danger assessments for USFS Region 9 which includes Minnesota. These value added products enhance short and long range forecasts issued by the NWS to assist land managers in allocating fire-fighting resources. Products issued by the EACC are available on line at:

http://www.fs.fed.us/eacc/predictive_services/index.shtml

Mailing address:

Eastern Area Coordination Center
1 Federal Drive PO Box 29
St. Paul, MN 55111-4080

Physical address:

Eastern Area Coordination Center
BHW Federal Building
1 Federal Drive G-20
Fort Snelling, MN 55111

Center Manager, Dave Boyd
Deputy Center Manager, Laura McIntyre-Kelly
Meteorologist, Stephen Marien 612-713-7315

B. AGENCY COMPUTER SYSTEMS - The communication system used to link the NWS with its users is the Weather Information and Management System (WIMS). The NWS receives user agency observations entered into WIMS via its Advanced Weather Interactive Processing System (AWIPS) computer system. Point and narrative forecasts are also sent to WIMS via this system. Observations and forecasts are exchanged between WIMS and AWIPS in the USFS Kansas City Computer Center.

C. FIRE WEATHER OBSERVATIONS - All fire weather observations in Minnesota are from automated sites and all have GOES antennas installed for data transmission. Station inspection and instrument maintenance are the responsibility of land management agencies. NWS forecasters may monitor data quality from observation sites. Any NWS travel expenses for equipment maintenance or station visitation will be reimbursed by the Wildland Fire Agency making the request. The NWS is, however, responsible for assigning station numbers to NFDRS weather sites.

Some Internet sites available to view fire weather observations include:
http://raws.wrh.noaa.gov/roman
http://www.wrcc.dri.edu/wraws/mnF.html
http://www.met.utah.edu/mesowest/ (this site contains a very useful interactive map)

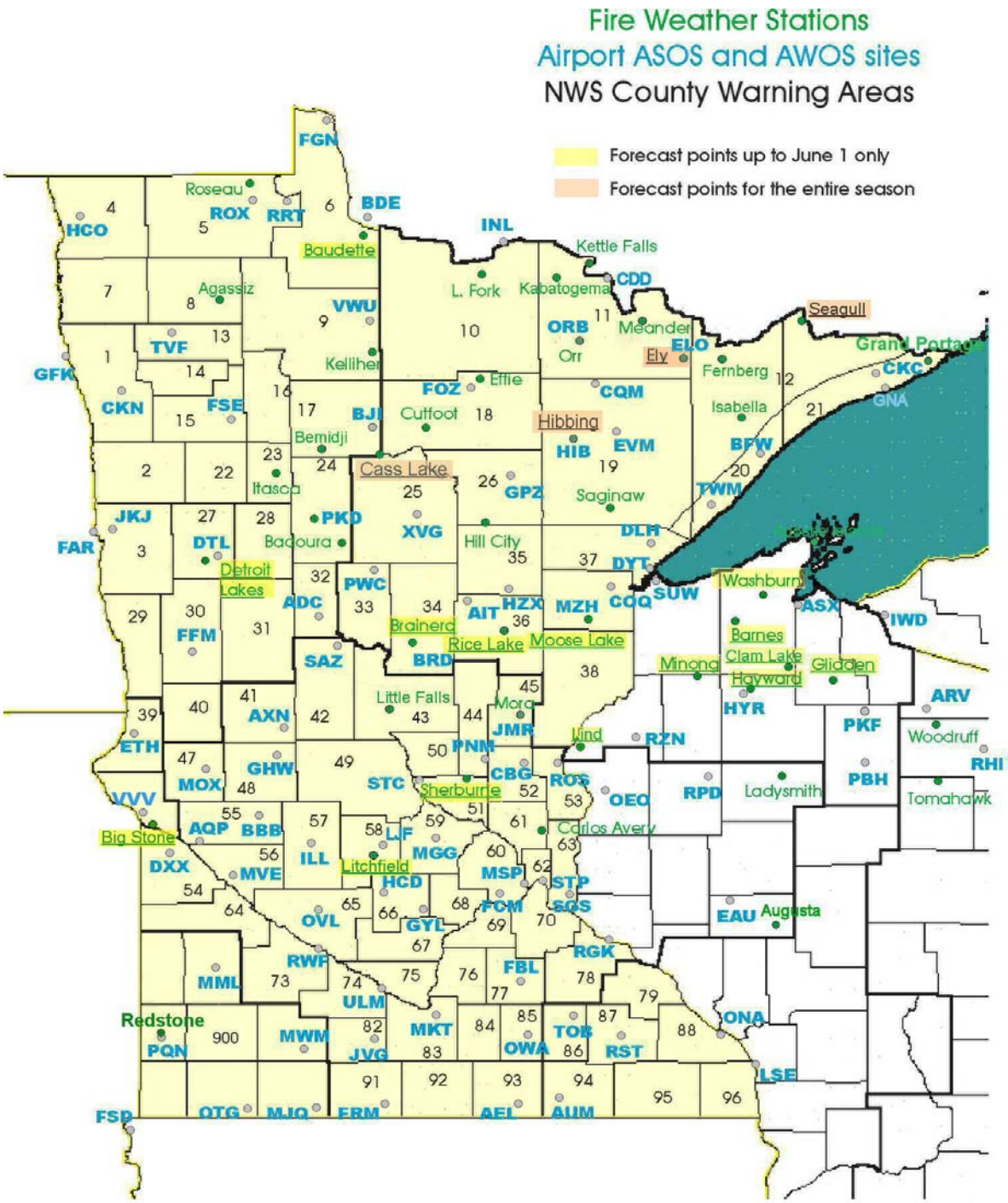

Figure 11. Locations of fire weather observation points and automated airport observing systems. The names shaded with yellow receive point forecasts prior to June 1st. Ely, Seagull, Hibbing and Cass Lake, shaded in red, receive point forecasts throughout the season.

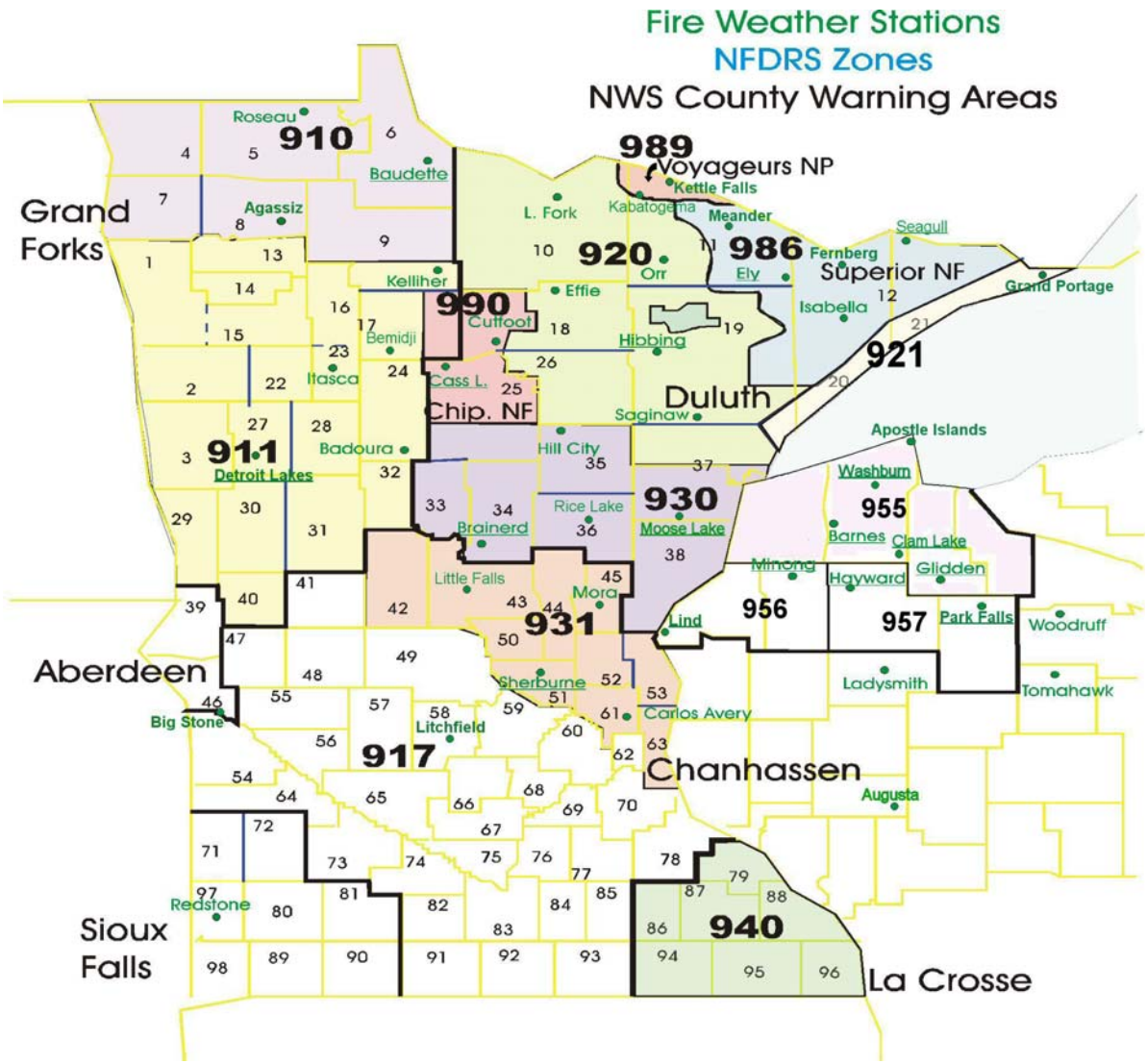

Figure 12 NFDRS zones and the agency observation points.

Automated Fire Weather Stations in Minnesota

Station name	Number	Zone	Lat	Lon	Elev
Minnesota DNR					
Baudette	210301	910	48.71	94.59	1083
Badoura	211502	911	46.92	95.06	1457
Bemidji	210901	911	47.40	94.93	1377
Brainerd	212601	930	46.34	94.22	1200
Carlos Avery	214201	931	45.30	93.10	900
Effie	211004	920	47.83	93.63	1436
Hibbing	210512	920	47.42	92.92	1450
Hill City	211702	930	46.99	93.59	1358
Saginaw	210511	920	46.50	92.27	1330
Roseau	210203	910	48.85	95.70	1047
Orr	210514	920	48.01	92.85	1309
Itasca	211401	911	47.21	95.16	1520
Kelliher	210902	911	47.94	94.45	1232
Littlefork	210405	920	48.39	93.55	1158
Moose Lake	211803	930	46.44	92.76	1062
Mora	213301	931	45.90	93.27	1000
Little Falls	213102	931	46.09	94.34	1150
U.S. Forest Service					
Meander	210503	986	48.11	92.02	1520
Cass Lake	211604	990	47.38	94.61	1320
Cutfoot	211005	990	47.53	94.07	1320

(26)

Station name	Number	Zone	Lat	Lon	Elev
Ely	210509	986	47.89	91.86	1470

Fernberg	210607	986	47.95	91.49	1700
U.S. Fish and Wildlife Service					
Seagull	210709	986	48.11	90.83	1480
Isabella	210602	986	47.50	91.30	1927
National Park Service					
Redstone	216901	917	44.03	96.27	1660
Kabetogema	210507	989	48.44	93.05	1200
Kettle Falls	210516	989	48.50	92.63	1160
Litchfield	214501917		45.07	94.53	1076
Rice Lake	211703	930	46.54	93.29	1185
Big Stone	213501	917	45.26	96.34	878
Detroit Lakes	212201	911	46.51	95.51	1385
Agassiz	210801	910	48.29	95.68	1174
Sherburne	214001	931	45.30	93.40	950
Grand Portage Agency					
Grand Portage	210703	921	47.95	89.78	1200

D. REIMBURSEMENT FOR NWS PROVIDED ON-SITE SUPPORT AND TRAINING -- **A**gencies will reimburse the NWS for all costs incurred for IMET support as well as for training assistance or station visitation.. Procedures are detailed in the Interagency National Agreement.

IV. JOINT RESPONSIBILITIES

A. Meteorological training can be provided either by NWS or the EACC meteorologist. Each NWS office has at least one person, typically the Fire Weather Program Leader, who is qualified to teach courses at least through Intermediate Fire Behavior (S-290). Requests for NWS training should be directed to that office's Fire Weather Program Leader or MIC Sufficient advance notice should be given to allow for preparation as well as scheduling. Costs incurred by the NWS will be reimbursed by the requesting agency.

B. NWS Fire Weather Program Leaders will participate in coordination conference calls, primarily in the spring fire season. This duty will be shared by the program leaders and the EACC Meteorologist. This representative should be prepared to provide a statewide briefing highlighting significant weather trends as well as possible critical fire weather situations. Participants are asked to keep their input brief and to the point, lasting less than 5 minutes. When calls are held twice-weekly, weather information should go out 5 days. When calls are held once-weekly, weather information should include the next 7 days.

V. EFFECTIVE DATES ON THE AOP

This document will be effective approximately from March 1, 2007 to March 1, 2008.

VI. AGENCY SIGNATURES

Daniel Luna, Acting MIC NWS Chanhassen _____/Signed/date
representing all NWS offices with fire weather forecast responsibility in Minnesota

Henry Goehle, USFS Fire Management Officer _____/Signed/date
_MNICS Task Force Chairperson
Signing for MN DNR and All Federal Land Managers
Management Agencies - USFS, BIA, NPS, USFWS

VII. APPENDICES

A. Address and Phone Directory
B. Glossary of Meteorological Terms
C. Smoke Management
D. Haines Index
E. Zones, Counties, Cities, and Weather Stations
F. NOAA Weather Radio Network
G. National Interagency Agreement for Meteorological Services

APPENDIX A

ADDRESS AND PHONE DIRECTORY

NATIONAL WEATHER SERVICE - U.S. Department of Commerce

Dan Luna Acting , MIC 952-361-6708
National Weather Service
1733 Lake Drive West
Chanhassen, MN 55317-8581

Byron Paulson, F/W Focal Point Internet Home Page
Todd Krause, Assistant F/W Focal Point http://www.crh.noaa.gov/mpx/

e-mail Daniel.luna@noaa.gov
byron.paulson@noaa.gov
todd.krause@noaa.gov

Michael R. Stewart, MIC 218-729-6697
National Weather Service
5027 Miller Trunk Highway
Duluth, MN 55811-1442

Roman Berdes, F/W Focal Point Internet Home Page
Vacant Assistant F/W Focal Point http://www.crh.noaa.gov/dlh/

e-mail michael.stewart@noaa.gov
roman.berdes@noaa.gov

David McShane, MIC 701-795-5198
National Weather Service
4797 Technology Circle
Grand Forks, ND 58203-0600

Al Voelker, F/W Focal Point Internet Home Page
Vacant Assistant F/W Focal Point http://www.crh.noaa.gov/fgf/

e-mail david.mcshane@noaa.gov
al.voelker@noaa.gov

NATIONAL WEATHER SERVICE - U.S. Department of Commerce (continued)

Glenn Lussky, MIC 608-784-8275
National Weather Service
N2788 County Road
La Crosse, WI 54601-3038

Dave Schmidt, F/W Focal Point Internet Home Page
Rod Swerman, Assistant F/W Focal Point http://www.crh.noaa.gov/arx/

e-mail glenn.lussky@noaa.gov
rod.swerman@noaa.gov
dave.schmidt@noaa.gov

Greg Harmon, MIC 605-330-4247
National Weather Service
26 Weather Lane
Sioux Falls, SD 57104-0198

Mike Fuhs, F/W Focal Point Internet Home Page
Jeff Chapman, backup http://www.crh.noaa.gov/fsd/

e-mail greg.harmon@noaa.gov
michael.fuhs@noaa.gov
jeffrey.chapman@noaa.gov

James Scarlett, MIC 605-225-0519
National Weather Service
825 Brown County 14
Aberdeen, SD 57401

Stanley Keefe, F/W Focal Point Internet Home Page
Jeff Chapman, backup http://www.crh.noaa.gov/abr/

e-mail Stanley.keefe@noaa.gov

Larry Van Bussum, Nat'l F/W Ops Coordinator
National Interagency Fire Center (NIFC)
3833 South Development Avenue, Bldg 3807
Boise, ID 83705-5354

e-mail larry.vanbussum@noaa.gov Internet Home Page
http://www.boi.noaa.gov/firewx.htm

U.S. FOREST SERVICE - U.S. Department of Agriculture

Minnesota Interagency Fire Center (MIFC)
402 11th Street SE
Grand Rapids, Minnesota 55744

Tom Fastland, MIFC Coordinator tom.fastland@dnr.state.mn.us

MIFC Dispatch (24 hours)
Superior & Chippwa National Forest

Brad McKelvy, Forest Dispatcher 218-327-4176 bmckelvy@fs.fed.us

Henry Goehle, USFS FMO 218-327-4462 hgoehle@fs.fed.us

Ellen Bogardus-Szymaniak, Fuels Specialist 218-327-4571 ebogardus@fs.fed.us

Fire Cache (Bob Behrner) 218-327-4578 rbehrner@fs.fed.us

Chippewa National Forest 218-335-8600
Route 3, Box 219
Cass Lake, MN 56633

All dispatching for the
Chippewa National Forest
is done at Superior Dispatch:

Eastern Area Interagency Coordination Center (EACC) (Multi-agency)
Mailing address
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APPENDIX B

Glossary of Meteorological Terms

A

ADDS - Automated Digital Data Service. An interactive web site at the NWS's Aviation Weather Center. Hourly surface maps are available which allow fire personnel to assess and track wind shifts, temperature, and dew points in a region.

Adiabatic Process - A thermodynamic process in the atmosphere involving warming or cooling of air normally when a parcel or layer of air moves up or down. Cooling of the air parcel occurs as the it moves up and expands. The parcel warms as it descends and as the surrounding air pressure increases. The dry lapse rate of 5.5^{o} F per 1000 feet of altitude describes how unsaturated air will cool. The moist adiabatic lapse rate of 3.0 ^{o} F per 1000 feet describes a saturated air parcel movement.

Advection - The horizontal movement of air or of a specific component of air. Warm air advection or moisture advection that occurs may change the fire behavior.

AFD - Area Forecast Discussion. An unscheduled product from the NWS used to describe the weather features and trends for a forecast period. Although somewhat technical, it does list the features which the forecaster is following. The AFD usually precedes the scheduled zone forecast product by about 2 hours.

Air Mass - An extensive body of air having the same properties of temperature and moisture in the horizontal plane.

Anemometer - An instrument for measuring wind speed.

Anticyclone - An area of high pressure with closed, clockwise circulation. Its common name is simply a High. It is designated on a surface weather chart as a blue H.

Area Forecast Discussion (AFD) - See AFD

Atmospheric Pressure - The force exerted per unit area by the weight of the air above.

ASOS - Automated Surface Observing System **-** An automated weather system deployed at airports nationwide. They provide hourly reports called METARs which are plotted on surface weather maps.. These systems are primarily owned by the NWS and the Federal Aviation Administration (FAA)...

ATMU – Atmospheric Theodolite Meteorological Unit – portable equipment used by NWS Incident Meteorologists (IMET) to measure wind speed and direction aloft.

AWIPS -Advanced Weather Interactive Processing System- A powerful weather processing workstation used by forecasters at NWS Weather Forecast Offices.

AWOS - **Automated Weather Observing System** An automated weather system deployed at airports nationwide. They provide hourly reports called METARs which are plotted on surface weather maps.. Most systems are owned by state agencies. They are similar to ASOSs.

B

Backing Winds - Winds that change direction in a counter clockwise direction with altitude in the vertical A south wind at the surface and an east wind at some point aloft would be an example of backing winds.

Barometer - An instrument for measuring atmospheric pressure.

Boundary Layer - The layer of air far enough above the surface to be free of frictional influences of the earth.

C

Chinook Wind - A foehn wind blowing down the eastern slopes of the Cascades, Rocky Mountains, and over the adjacent plains in the United States and Canada. In winter, this warm, dry wind causes snow to disappear with remarkable rapidity, and hence it has been nicknamed the “snow eater”. In hot dry weather, Chinook winds can quickly extend fire weather conditions to the ”extreme”.

Cirrus - A form of high cloud composed of ice crystals that do not obscure the sun to any great degree. They normally have a fibrous or wispy appearance.

Cold Front: The leading edge of a relatively cold air mass that displaces warmer air. The heavier cold air may cause some of the warm air to be lifted. If the lifted air contains enough moisture, the result may be cloudiness, precipitation, and thunderstorms. If both air masses are dry, no clouds may form. Following the passage of a cold front in the Northern Hemisphere, westerly or northwesterly winds of 15 to 30 or more miles per hour often continue for 12 to 24 hours.

Condensation - The atmospheric process by which water vapor changes into liquid form. This process releases heat.

Convection - As specialized in meteorology, atmospheric motions that are predominantly upward in the absence of wind (which distinguishes this process from advection), resulting in vertical mixing and transport of atmospheric properties. Convection is normally thought of as the process which initiates cumulus clouds and thunderstorms by heating the air from below.

Convergence - Net horizontal flow of air into an area associated with low pressure systems. If convergence occurs at the surface, upward vertical motion results. Consequently, areas of convergent winds are regions favorable to formation of clouds and development of rain.

Coriolis Force - An apparent force due to the rotation of the earth that causes a deflection of air to the right in the Northern Hemisphere as the air flows from high to low pressure. The Coriolis Force causes surface winds to flow across isobars at an angle. Aloft, the force results in winds flowing parallel to the lines on an upper air chart.

Cumulonimbus - The ultimate growth of a cumulus cloud into an anvil shape, with considerable vertical growth, usually fibrous ice crystal tops, and probably accompanied by lightning, thunder, hail, and strong winds.

Cumulus - A principal, low cloud type in the form of individual cauliflower-like cells of sharp nonfiberous outline and less vertical development than cumulonimbus.

Cyclone - An area of low atmospheric pressure that has closed counter clockwise circulation. Cyclones usually bring about marked changes of weather and temperature during their passage. Other name given to cyclones are “low” or “depression”.

D

Derecho - A downburst straight line wind event from a mesoscale convective systems that produces widespread damage. The Boundary Waters Canoe Area blowdown of July 4, 1999 was a derecho.

Dew Point - The temperature to which air must be cooled at constant pressure and moisture content for saturation to occur.

Dispersion - The decrease in concentration of airborne pollutants as they spread throughout an increasing volume of the atmosphere.

Dispersion Index - A numerical value computed by multiplying the transport wind times the mixing depth or height of the mixing layer. Ranges of index values are assigned descriptive terms indicating how well the atmosphere might function at spreading out or dispersing smoke. In Minnesota and Wisconsin the following values are used in the narrative fire weather forecasts.

<13,000	Poor
13,000 - 29,999	Fair
30,000 - 59,999	Good
60,000 or greater	Excellent

Diurnal - Daily, especially pertaining to cyclic actions that are completed within a 24 hour period and which recur every 24 hours. The daily high and low temperature range is a diurnal cycle.

Divergence - The condition that exists when the distribution of winds within a given volume results in a net horizontal flow of air outward from the region. In divergence at lower levels, the resulting deficit is compensated by a downward movement of air from aloft. Divergence in upper levels of the atmosphere is often mention in Area Forecast Discussion products (AFD). Divergence in the wind flow aloft produces a compensating area of convergence near the surface resulting in the formation of low pressure centers or troughs. Divergence aloft can lead to the development of precipitation.

Dry bulb - An ordinary thermometer used to determine the ambient or existing air temperature. In a psychrometer both a dry bulb thermometer and a wet bulb thermometer are read in order to determine the relative humidity.

Dry Lightning Storm - A thunderstorm that produces little if any precipitation. Often virga is seen along with the lightning.

Drought Index: A number representing net effect of evaporation, transpiration, and precipitation in producing cumulative moisture depletion in deep duff or upper soil layers.

E

El Nino' - An abnormal warming of the eastern Pacific Ocean along the west coast of South America. This pattern often disrupts normal weather cycle.

Evaporation - The transformation of a liquid into a gaseous state. Heat is lost by the liquid during the process.

F

Fire Weather - Weather conditions that influence fire ignition, behavior and suppression.

Fire Weather Watch: A term used by fire weather forecasters to notify land management agencies, usually 24 to 72 hours ahead of a situation where fire weather parameters would create dangerous fire conditions.

Foehn Wind - Pronounced "Fern" A type of general wind that occurs when stable, high pressure air is forced across and then down the lee slopes of a mountain range. The descending air is warmed and dried due to adiabatic compression. In that process, wind flowing down hill warms at the rate of 5.5^{o} per 1,000 feet. Some local names for a foehn wind are: Santa Ana, Chinook, or Mono.

Fog - A cloud at the earth's surface. Fog consists of numerous droplets of water which individually are so small that they cannot readily be distinguished by the naked eye. Three of the most common types of fog are: advection fog, radiation fog, and upslope fog.

Free Air - That portion of the atmosphere that is not modified by local surface frictional affects.

Friction Layer - The layer of the atmosphere in which the frictional force of the earth's surface exercises an appreciable influence on winds. This is generally the air within about 1500 feet of the ground.

Front - The transition zone between two air masses of different density and temperature. Fronts emerge from a low pressure center. A cold front is the lead edge for colder and more dense air. A warm front marks the northern or eastern edge of a warmer and less dense air mass. An occluded front develops usually north of the low pressure center where a cold front meets the warm front

Frontal Inversion - An increase in temperature with height, normally near and ahead of an advancing warm front. Warm, less dense air rides up and over the retreating colder air to the north.

G

General Winds - Large scale winds caused by the pressure gradient between high and low pressure systems but generally influenced and modified in the lower atmosphere by terrain.

GOES - Geostationary Operational Environmental Satellite. Weather satellites that remain at a fixed location 22,500 miles above the earth. East GOES is at 75° W, and West GOES is at 135° W GOES satellites provide a variety of weather imagery but also handle uplink and downlink communication with various observing technologies such as RAWS.

GPS Winds - Winds aloft measured by GPS navigation equipment in an aircraft. These winds offer an alternative to PIBAL balloon measurements when an IMET is not present on the fire.

Gradient - The change in a property between two locations. Pressure gradient is the difference in air pressure between areas of high and low pressure.

Gradient Winds - winds that flow parallel to the contours on upper air charts. This usually occurs above 1500 feet above ground level. Below that point winds cross the isobars at an angle.

Gust - A sudden, brief increase in the speed of the wind.

Gust Front - The leading edge of cold dense air flowing outward from a thunderstorm. The boundary is marked by rising air above it and downward motion behind it. Winds can be quite strong and gusty. Gust fronts are sometimes visible on Doppler radar as thin circular arcs around a thunderstorm cell or complex.

H

Haines Index: An atmospheric index used to indicate the potential for wildfire growth by measuring the stability and dryness of the air over a fire.

Hazardous Weather Outlook (HWO) - An alerting tool issued by the NWS at least every morning by 730 a.m. The HWO briefly explains potential weather hazards in the seven days ahead.

Heat Index - A discomfort index used to described the combined effects of temperature and humidity on the body's ability to cool itself.

High Clouds - Thin clouds, generally above 20,000 feet. The clouds are thin and wispy and comprised of ice crystals. Clouds in this ground include: cirrus, cirrostratus, and

cirrocumulus. They are often indications of an approaching low pressure area, particularly a warm front.

High Pressure (Ridge) - An area on the surface map where atmospheric pressure measured by barometers is higher than the surrounding air. High pressure results from air descending into a region. On weather maps, highs are designated with a blue H and have closed isobars surrounding them. High pressure ridges usually are areas of cooler, subsiding air associated with quiet weather. Circulation around a high is in a clockwise direction. Over time, a subsidence inversion often forms.

HPC - Hydrometeorological Prediction Center. A part of the National Center for Environmental Prediction.. The HPC is responsible for producing surface maps every three hours, forecast surface maps for every six hours, and the quantitative precipitation forecast (QPF).

Hudson Bay High - High Pressure centered near Hudson Bay, Canada. The Hudson Bay High is a contributor to fire weather problems. The air flowing clockwise around the high emerges from a cold region. As it moves south and warms, the relative humidity falls significantly. The resulting northeast winds that flow into Minnesota and Wisconsin are dry and can increase fire behavior.

Humidity - The measure of water vapor content in the air.

I

Infrared (IR) - Radiation emitted from objects in the spectrum between visible light and microwaves. Weather satellites detect levels of IR radiation and display the data in a manner such that darker grey shades represent warm temperatures and whiter colors represent cooler temperatures. In that way satellites can locate clouds and storms at various levels as well as lakes and rivers.

Insolation - Radiation received from the sun at the earth's surface.

Instability - The state of the atmosphere in which the vertical distribution of temperature is such that an independent air parcel rising through the surrounding air, will become warmer than the surrounding air and will continue to rise. Unstable air contributes to increased fire behavior and better smoke dispersion.

Inversion - A condition in the atmosphere where temperature increases with increasing altitude rather than decreasing like it normally does. Inversions are of four types: Subsidence, Frontal, Radiation (nighttime), and Marine**.** Inversions inhibit smoke dispersal if low enough, and can increase fire behavior when they dissipate.

Isobar - A line of equal pressure surrounding areas of high and low pressure.

J

Jet Stream - A narrow meandering stream of high speed winds embedded in the normal prevailing westerly wind flow aloft. The jet stream is normally at about 30,000 feet but varies with seasons. Diverging air at the jet stream level often results in converging air near the earth's surface, leading to upward motion, formation clouds, and possible precipitation. There are two jet streams that cross the U.S., the polar jet, near the Canadian border, and the subtropical jet that crosses the southern tier of states.

K

Keech Byram Drought Index (KBDI): Commonly-used drought index adapted for fire management applications, with a numerical range from 0 (no moisture deficiency) to 800 (maximum drought).

L

La Nina' - The opposite of El Nino' in which abnormally cold Pacific Ocean water exists

along the west coast of South America.
Lake Effect - Precipitation that occurs along the shores of the Great Lakes. The precipitation is not necessarily associated to a low pressure system but is produced by cold air moving across a relatively warmer and open lake. This unstable condition produces clouds over the relatively warmer open water. The instability can lead to precipitation, particularly snowfall.

Lapse Rate - The change of temperature with height. Normally temperature decreases with height, but it sometimes increases. This latter condition is called a temperature inversion. Lapse rates are normally expressed in negative values for temperatures that decrease with height and as positive values for inversions. The ambient lapse rate refers to the existing temperature structure of the atmosphere. The dry adiabatic lapse rate of -5.5^{o}F per 1,000 feet is the rate at which a rising parcel of air would cool if lifted. The moist adiabatic lapse rate of -3.0^{o}F per 1,000 feet is the rate at which a saturated air parcel would cool as it rises. The normal lapse rate of -3.5^{o}F per 1,000 feet is an average atmosphere lapse rate.
Lifted Index (LI) - An index used by the NWS to forecast thunderstorm development and severity.
Lightning - A sudden visible flash of energy and light caused by electrical discharges from thunderstorms**.**
Lightning Activity Level (LAL): A number, on a scale of 1 to 6, that reflects frequency and character of cloud-to-ground lightning. The scale is exponential, based on powers of 2 (i.e., LAL 3 indicates twice the lightning of LAL 2). An LAL of 6 refers to dry thunderstorms.
Local Winds - Small scale convective winds of local origin cause by temperature differences. Upslope winds during the day are examples of local winds.
Low Pressure Trough - An elongated area of relatively low atmospheric pressure, usually extending from the center of a low pressure system. Troughs are areas of converging and upward-moving air.

M

METAR- **Meteorological Terminal Air Report** - A coded weather report from ASOS and AWOS automated airport weather stations. Reports are sent at least every hour or more often if conditions change significantly. The reports are decoded and plotted on surface maps.
Middle Clouds - Clouds ranging in altitude from 6,500 to near 20,000 feet.
Miller-Holzworth Method - A technique involving the use of a thermodynamic diagram (SkewT or Stuve) to predict the height of the mid morning mixing height. The morning sounding is used. Five degrees C is added to the surface temperature. A line is extended upward, parallel to a dry adiabat. Where this line intersects the plotted sounding is the height (MSL) of the mid morning mixing height.
Millibar (Mb)- a unit of measure for atmospheric pressure. Multiplying millibars times 0.02953 yields inches of mercury. Multiplying inches of mercury times 33.86 yields millibars. Another more universal name for a millibar is a hectaPascal (HPa).
Mixed Layer - The lowest layer of the atmosphere from the surface to the base of any temperature inversion that may exist aloft. A well mixed layer has a lapse rate close to

the dry adiabatic lapse rate of -5.5^{o} F per 1,000 feet.
Mixing - The process of upward and downward motion in the atmosphere, particularly near the surface of the earth.
Mixing Height - The layer in the atmosphere from the surface to the first inversion layer. It is in this layer where vigorous mixing occurs due to convection.
NWS Spot - A web-based program for requesting and receiving spot weather forecasts.

O

Occluded Front - The front that is formed when and where a cold front overtakes a warm front or a stationary front.
Outflow - Cold, denser air thay descends from the base of a thunderstorm and then spreads out in all directions. Outflow can travel several miles ahead of the thunderstorm and create gusty erratic winds unexpectedly.
Outflow Boundary - The leading edge of thunderstorm outflow. If these boundaries meet boundaries from other thunderstorms, new thunderstorm development is possible. Outflow boundaries are sometimes visible on weather radar as thin, curved lines surrounding a thunderstorm.

P

Palmer Drought Severity Index - An index used to gage the severity of drought conditions by using a water balance equation to track water supply and demand. This index is calculated weekly by the NWS.
Pibal - Pilot balloon. A method used by an Incident Meteorologist (IMET) at a fire to measure the winds aloft. The IMET tracks the ascending balloon with a theodolite noting azimuth and elevation every few seconds. He later uses these angles to calculate the winds. Launched with equipment contained in the ATMU.
Pressure Gradient - The difference between the air pressure in one area and the air pressure in another. The difference between High and Low pressure areas can be very small and result in light winds. Or the air pressure differences can be large, resulting in strong winds flowing from the High to the Low.
Profiler - A sampling device used to measure wind speeds aloft. A network of profilers is in the Midwest. The most northern installation is at Wood Lake, Minnesota. Profiler data maps are available on the internet.

Q

QPF - Quantitative Precipitation Forecast - A forecast of the rainfall amount that would be measured in a rain gage randomly placed in an area.

R

Radiational Cooling - The net loss of heat due to infrared radiation. Radiational cooling cools the ground and the air immediately above. Over time, radiational cooling helps to develop a nocturnal inversion, and that leads to poor smoke dispersion.
Radiosonde - an instrument carried aloft by balloon and tracked by ground equipment. The instrument sends back temperature, humidity, and pressure. Ground equipment helps to calculate wind speeds.
RAOB - Radiosonde Observation. A collection of information sent back from a radiosonde instrument. The data are used to create a plotted sounding which shows the

temperature, humidity, and wind structure of the air aloft. RAOBs are used as basic information for the atmospheric forecast models and for determining smoke management parameters.

Red Flag Warning - Term used by fire weather forecasters to alert forecast users to an ongoing or imminent critical fire weather pattern.

Reflectivity - The ability of a radar target to return energy; used to estimate precipitation intensity and rainfall rates. Reflectivity imagery this that most often display on NWS web sites and on TV weathercasts. Cooler blue shades usually indicate light precipitation while warmer, red hues imply stronger thunderstorms.

Relative Humidity (RH) - The ratio of the amount of moisture in the air, to the maximum amount of moisture that air would contain if it were saturated. The ratio of the actual vapor pressure to the saturated vapor pressure.

Remote Automatic Weather Station (RAWS) - An apparatus that automatically acquires, processes, and stores local weather data for later transmission to the GOES Satellite, from which the data is re-transmitted to an earth-receiving station for use in the National Fire Danger Rating System.

Ridge - An elongated area of High Pressure.

Roll Cloud.- A horizontal, tubular cloud that may be seen on the leading edge of an outflow from a thunderstorm.

RUC - Rapid Update Cycle. A short term atmospheric forecast model that uses recent surface observations (METARs), satellite-calculated winds and temperatures, Doppler radar winds, and other information from commercial aircraft.

S

Severe Weather Statement (SVS) - A text product issued by the local NWS office during severe weather as an update to a Severe Thunderstorm Warning or Tornado Warning. The SVS gives detailed information about when the leading edge of severe weather, gusty winds, hail, and rain will pass designated locations.

Sea Breeze - A local wind that flows from a large body of water toward land. The sea breeze results from the land heating up, causing the air to rise convectively. As this happens, air from the cooler water flows inland. Sea breezes are often noted along Lake Superior, especially in the spring. Sea breezes can be opposite to the established flow in the area, or it can enhance the local wind if blowing in the same direction as the local winds.

Security Weather Watch - Observers are posted at one or more strategic locations in the proximity of a fire to detect critical weather changes that might significantly affect the fire and to report those changes to fire personnel.

Short Term Forecast - Sometimes called a NOWCAST. A short text product issued by the local NWS office to supply detail on weather such as non-severe thunderstorms that is or soon will be occurring at designated locations.

Short Wave - A kink in the broad scale upper flow. The east side of short waves area areas of rising motion, while the west side are areas of downward motion. Forecasters track short waves since short waves can often help to initiate or strengthen storms..

SkewT - A special graph for plotting upper air soundings or RAOBS. Forecasters use SkewTs to determine atmospheric instability as well as to calculate smoke management parameters. The temperature axis is shifted or skewed at an angle rather than being at

right angles to the other axis as is normally done. *See also Stuve.*
Slope Winds - Small scale convective winds that occur due to local heating and cooling of a natural incline of the ground.
Smoke Management: - Application of fire intensities and meteorological processes to minimize degradation of air quality during prescribed fires.
Sounding - See RAOB
SPC - Storm Prediction Center - The office that issues Severe Thunderstorm and Tornado Watches. SPC also issues a daily fire weather related message on the potential for severe fire weather conditions.

Spot Weather Forecast: - A special forecast issued to fit the time, topography, and weather of each specific fire. These forecasts are issued upon request of the user agency and are more detailed, timely, and specific than zone forecasts.
Squall line - Any non-frontal line or narrow band of active thunderstorms extending across the horizon. It is of importance to fire behavior due to accompanying strong gusty winds and the possibility of such a line passing between regular weather observation stations without being reported.
Stability - The state of the atmosphere in which the vertical distribution of temperature is such that an air parcel will resist vertical displacement from its level.
State of Weather - A brief description of current weather that expresses the amount of cloud cover, kind of precipitation, and/or restrictions to visibility being observed at a weather observation site.
Stratosphere - The layer of the atmosphere between the troposphere and the mesosphere where the air is usually stable.
Stuve Diagram - (Pronounced STOO vee) A type of graph used to plot upper air soundings or RAOBs and from which smoke management parameters can be calculated. *See also SkewT*.
Subsidence - An extensive sinking motion of air in the atmosphere, most frequently occurring in high pressure areas of polar origin. The subsiding air is warmed by compression and becomes more stable as a subsidence inversion develops. Of particular importance is the heating and drying of the air.
Subsidence Inversion - A temperature inversion that forms under high pressure. The inversion lowers with time.
Subtropical High - The semi-permanent area of high pressure centered in the south Atlantic and Caribbean areas.
Surface Wind - The wind measured at 20 feet above the average top of the local vegetation. It is often a combination of the local and general winds.

T

Thermal Belt - An area of mountainous slope (characteristically the middle third), where the top of the radiation inversion intersects the slope. That area typically experiences the least variation in diurnal temperature variation and has the highest average temperature, and thus the lowest relative humidity. Its presence is most evident during clear weather with light wind.
Thunderstorm - Localized storm characterized by one or more electrical discharges.
Transport Winds - The average wind speed and direction of the horizontal wind within the mixing layer.
Troposphere - The layer of the atmosphere from the earth's surface up to the

tropopause, characterized by decreasing temperature with height (except, perhaps in thin layers, called inversions), vertical wind motion, appreciable water vapor content, and sensible weather (clouds, rain, etc.)

Trough - An elongated area of low pressure. Troughs are regions of converging air at low levels which in turn results in upward vertical motion. See also Upper level disturbance, short wave.

Turbulence - Irregular motion of the atmosphere usually produced when air flows over a comparatively uneven surface such as the surface of the earth; or when two currents of air flow past or over each other in different directions or at different speeds.

U

Upper Level Disturbance - See Short Wave. A general term for any large scale or mesoscale disturbance capable of producing upward motion (lift) in the middle or upper parts of the atmosphere. Such disturbances can help initiate vertical motion or enhance existing vertical motion.

V

Vorticity - A measure of the local rotation in a fluid flow. In weather analysis and forecasting, it usually refers to the vertical component of rotation (i.e. rotation about a vertical axis) and is used most often in reference to synoptic scale or mesoscale weather systems. By convention, positive values indicate cyclonic rotation.

Veering Winds - Winds which shift in a clockwise direction with time at a given location (e.g. from southerly to westerly), or which change direction in a clockwise sense with height (e.g. southeasterly at the surface, turning to southwesterly aloft). The latter example is a form of directional shear which is important for tornado formation. Compare with backing winds.

Virga - Streaks or wisps of precipitation falling from a cloud but evaporating before reaching the ground. In certain cases, shafts of virga may precede a microburst. Virga may also be present in dry thunderstorms which produce “dry lightning”.

W

Warm Front - The leading edge of a relatively warm air mass which moves in such a way so that warm air displaces colder air. Winds associated with warm frontal activity are usually light, and mixing is limited. The atmosphere is relatively stable near a warm front when compared to the air near a cold front.

Weather Information and Management System (WIMS): An interactive computer system designed to accommodate the weather information needs of all federal and state natural resource management agencies. Provides timely access to weather forecasts, current and historical weather data, the National Fire Danger Rating System (NFDRS), and the National Interagency Fire Management Integrated Database (NIFMID).

Wet Bulb Depression - The difference between the wet-bulb and dry-bulb temperatures as measured by a psychrometer. The wet bulb depression is used in conjunction with the dry-bulb temperature and pyschrometric tables to calculate relative humidity.

Wet Bulb Temperature - The lowest temperature to which air can be cooled by

evaporating water into it at a constant pressure when the heat required for evaporation is supplied by the cooling of the air. It is measured by the wet-bulb temperature, which usually employs a wetted wick on the bulb as a cooling devise through the process of evaporation. The drier the air, the more evaporation from the wet bulb of a psychrometer can occur. The wet bulb temperature is an indicator of the water vapor in the air.

WSR-88D - The identifier for National Weather Service Doppler radar. Weather Surveillance Radar deployed in 1988 with Doppler capability.

APPENDIX C

SMOKE MANAGEMENT

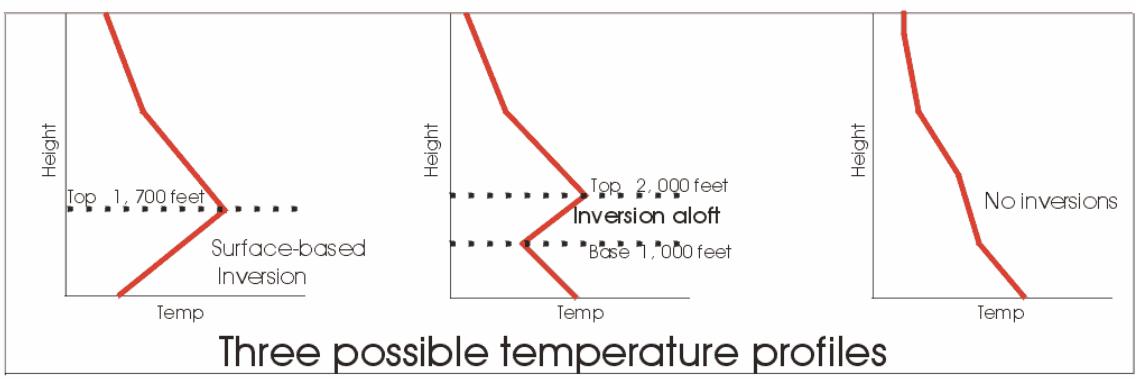
The Clean Air Act requires land management agencies to address the issue of smoke management in its prescribed burns. The goal is to burn in atmospheric conditions that would encourage smoke to rise to such a level that the smoke is dispersed as much as possible to reduce a number of health and safety risks near the fire.

A Minnesota Smoke Management Plan (SMP) was created in the year 2000 and should be considered the source document for any questions regarding the requirements or practices of smoke management in Minnesota.

The National Weather Service will support the smoke management efforts of federal, state, and local agencies as well as organizations involved in such burning. The NWS will provide three (3) parameters used in smoke management in its narrative forecast packages. The NWS will also include these parameters, upon request of the land agency, in spot forecasts.

The three weather parameters of smoke management forecasts are mixing layer (or depth), transport winds, and dispersion index. For smoke management purposes, the mixing layer is usually considered the lowest layers of the atmosphere bounded by the earth's surface and the bottom of any temperature inversion which may exist aloft. If a temperature inversion is based at the surface, then there is no mixing layer. A temperature inversion would serve to trap smoke at low levels or would prevent sufficient lofting of smoke to a level where winds would dilute or transport it away from the area. See Figure 16 below.

Figure 16. Three upper air temperature profiles which affect smoke dispersal differently.



a) a surface-based inversion is an absolutely stable condition that traps smoke and prevents lofting. b) An elevated inversion is unstable or neutral and allows limited smoke rise, but the smoke will stop rising at the base of the inversion aloft. c) When no inversions are present, smoke is free to rise. However, the existing (ambient) lapse rate will determine the rate of rise and the plume characteristics.

The transport wind is defined as the average wind speed and direction through the mixing layer.

In forecasts provided by the NWS, the transport wind will be provided in mph and the height of the mixed layer will be in feet agl.

The transport wind may suggest the need for surveillance or resource location at downstream areas for the purpose of minimizing the danger posed by spotting due to firebrands and to determine the impacts of smoke on a sensitive area.

The Dispersion Index is detailed in the Minnesota Smoke Management Plan (SMP) in section 4.2.2. The index is intended to serve as a single adjective index which describes how smoke will disperse on that day. The Dispersion Rate is given by the following formula as defined in the Minnesota Smoke Management Plan:

Dispersion Index = (Mixing Height in feet) x (Transport Wind in knots)

The Minnesota Smoke Management Plan (SMP) suggests the following interpretation of the values:

Dispersion Index	Dispersion Rate
< 13,000	Poor
13,000 - 29,999	Fair
30,000 - 59,999	Good
60,000 or greater	Excellent

The SMP contains guidelines for using the index and should be consulted for those details.

Smoke management data for the morning narrative forecast are obtained from the 7 a. m. (1200 UTC) morning upper air soundings taken at International Falls, MN, Chanhassen, MN and Green Bay, WI. Sounding data are normally available by 730 a.m. CDT.

Most smoke management inputs to software programs and nomograms are in metric units.
A table for conversion among various units is provided on the next page.

The National Weather Service uses a variety of units of measure for wind and height. To minimize confusion and to make the conversion of units easier, the following conversion factors will prove helpful.

Multiply	By	To get
Feet	0.308	Meters
Feet	0.0152	Chains
Statute Miles	1609.34	Meters
Statute Miles	1.60934	Kilometers
Statute Miles	0.8684	Nautical Miles
Statute Miles	80	Chains
Nautical Miles	0.6080	Feet
Nautical Miles	1.152	Statute Miles
Nautical Miles	1853.25	Meters
Nautical Miles	1.85325	Kilometers
Chains	66	Feet
Chains	20.12	Meters
Chains	0.0125	Statute Miles
Meters	3.281	Feet
Meters	0.0497	Chains
Meters	0.00062	Statute Miles
Meters	0.00054	Nautical Miles
Kilometers	3280.84	Feet
Kilometers	0.6214	Statute Miles
Kilometers	0.5396	Nautical Miles
Knots	1	Nautical Miles Per Hour
Knots	1.152	Statute MPH
Knots	1.689	Feet Per Second
Knots	0.515	Meters Per Second
Knots	1.853	Kilometers Per Hour
Statute MPH	0.868	Knots
Statute MPH	1.467	Feet Per Second
Statute MPH	0.447	Meters Per Second
Statute MPH	1.609	Kilometers Per Hour
Statute MPH	88	Feet Per Minute
Kilometers Per Hour	0.278	Meters Per Second
Kilometers Per Hour	0.540	Knots
Kilometers Per Hour	0.621	Miles Per Hour
Kilometers Per Hour	0.911	Feet Per Second
Meters Per Second	3.6	Kilometers Per Hour
Meters Per Second	1.943	Knots
Meters Per Second	2.237	Miles Per Hour
Meters Per Second	3.281	Feet Per Second
Meters Per Second	196.85	Feet Per Minute

APPENDIX D

HAINES INDEX

The NWS forecaster will calculate the Haines Index using upper air data taken at International Falls and Chanhassen, Minnesota, or at Green Bay, Wisconsin. The appropriate index will be included in the morning narrative forecast which will be available by 7:00 a.m.

What is the Haines Index?

The Haines Index combines the effects of dry air and instability to determine the potential for large fire growth. Its purpose is to identify weather conditions that may allow an existing fire to spread rapidly or exhibit extreme fire behavior. It should NOT be used to predict the potential or probability for wildfires to ignite. No such danger or wording will be conveyed in any NWS products. The Haines Index is most applicable to plume-dominated fires. The Haines Index does not account for wind.

The Haines Index contains two components, one to assess the dry air, and the other to measure the instability. Dry air affects fire behavior by lowering fuel moisture, which increases the amount of fuel available to the fire and enhances the probability of spotting. Instability is caused by warming the lower levels of the atmosphere, cooling the higher levels, or by a combination of the two processes. An unstable air mass promotes the formation of rising currents of air and thus increases the vertical extent of a smoke column. Wildfires that burn in a dry, unstable environment can become plume-dominated and are often able to generate their own strong surface winds. Ground elevation will determine which of three levels in the atmosphere will be used to compute the Haines Index. In Minnesota, the mid-level layer between 850 mb and 700 mb will be used.

Computing the Haines Index

Haines Index = Stability + Moisture = A + B

Stability Term = 850 MB Temperature - 700 MB Temperature
Let A equal the following values according to the temperature differences

A = 1 when stability term is 5 degrees C or less
A = 2 when stability term is 6 to 10 degrees C
A = 3 when stability term is 11 degrees C or more

Large positive values of the stability term indicate an unstable layer of the atmosphere near the earth's surface. Negative values indicate a temperature inversion.

Moisture Term = 850 MB Temperature - 850 MB Dew Point Temperature

B = 1 when moisture term is 5 degrees C or less
B = 2 when moisture term is 6 to 12 degrees C
B = 3 when moisture term is 13 degrees C or more
The value of the moisture term will always be positive. The greater the value of this term, the

drier the air is.

Significance of the Haines Index values

2 or 3	Very Low
4	Low
5	Moderate
6	High

An example calculation

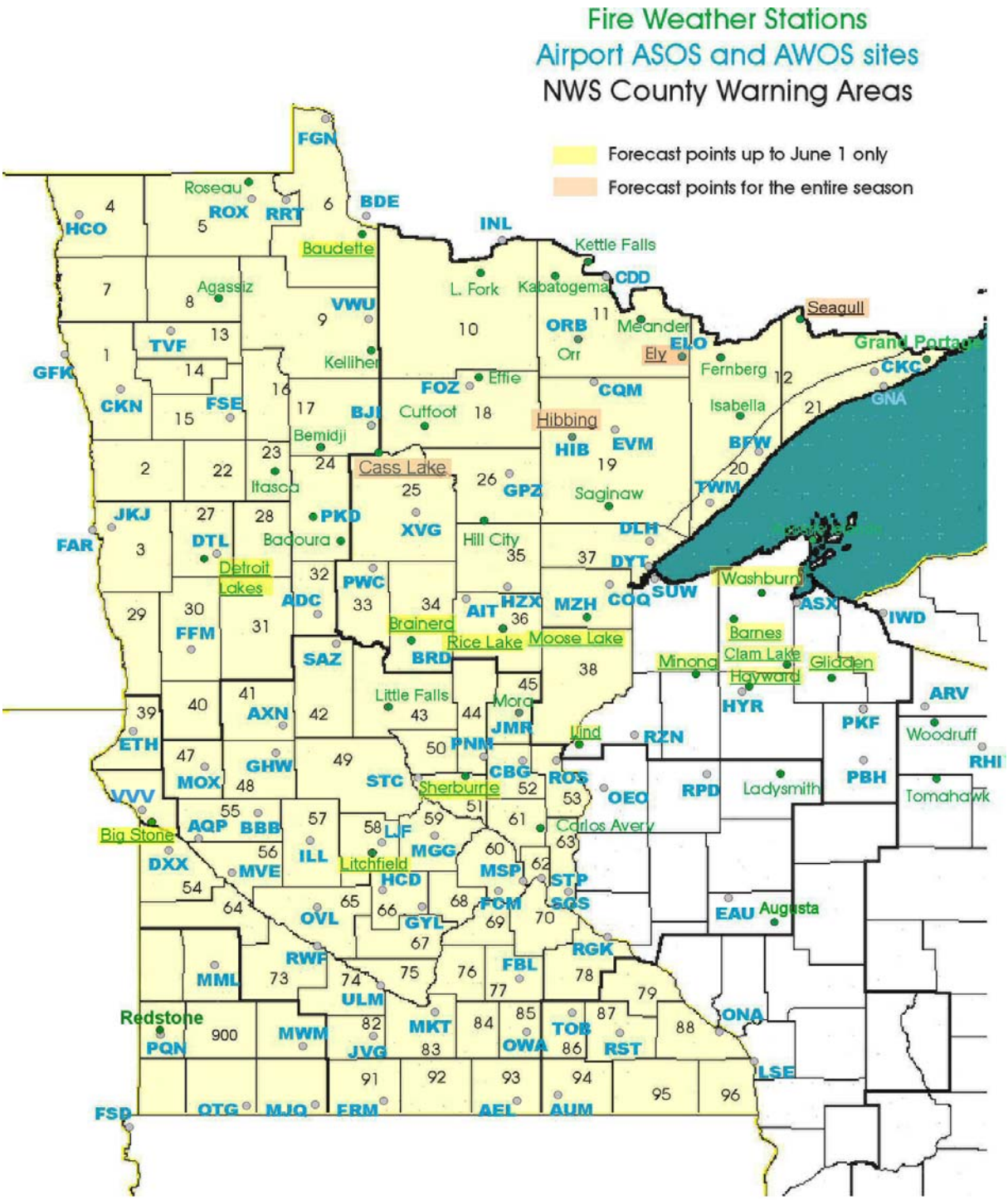
850 MB Temperature = 20 degrees C
850 MB Dew Point = 15 degrees C
700 MB Temperature = 12 degrees C
Haines Index = Stability (A) + Moisture (B)
From the tables above
850 MB Temp - 700 MB Temp = 20 - 12 = 8 Stability is between 6 and 10, so let A = 2
850 MB Temp - 850 MB Dew point = 20 - 15 = 5 Moisture is less than 6, so let B = 1

A + B = 2 + 1 = 3.

An Index value of 3 corresponds to a “Very Low” category. The conclusion is that extreme fire behavior would not be expected on this day.

APPENDIX E

Zones, Counties, Cities, and Weather Stations



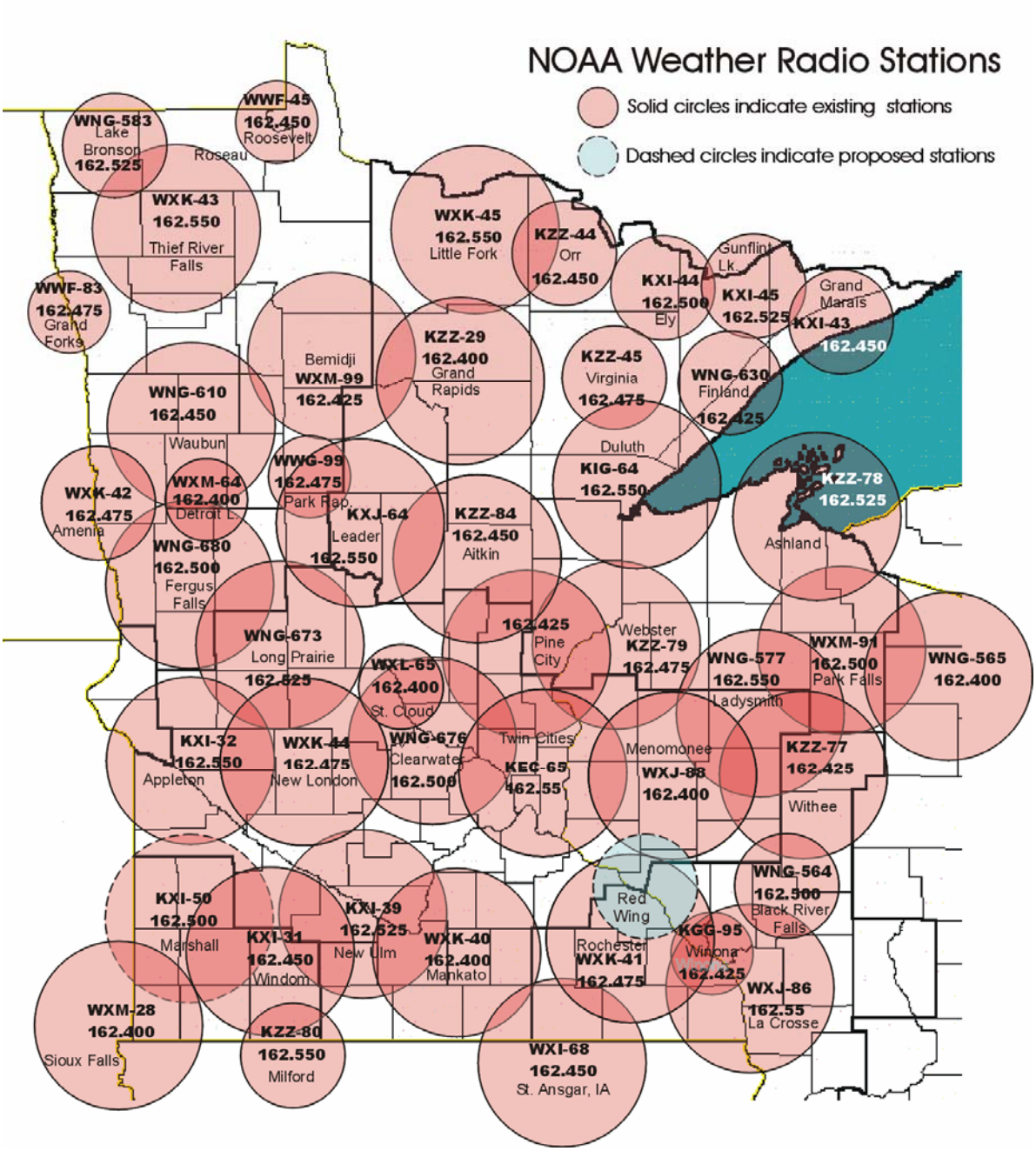
Zones, County Warning Areas, Fire Weather Stations and Airport ASOS and AWOS Weather Observation sites. A list of stations, zone names, and zone numbers is on the next page.

APPENDIX E

Zones, Counties, Cities, and Weather Stations

ZONE	City	Zone Name
1	Crookston	West Polk
2	Ada	Norman
3	Moorhead	Clay
4	Hallock	Kittson
5	Roseau/Greenbush	Roseau
6	Baudette	Lake of the Woods
7	Argyle	W. Marshall
8	Grygla	E. Marshall
9	Waskish	N. Beltrami
10	International Falls	Koochiching
11	Ely	N. St. Louis
12	BWCAW	N. Cook/Lake
13	Thief River Falls	Pennington
14	Red Lake Falls	Red Lake
15	Erskine	E. Polk
16	Clearbrook	N. Clearwater
17	Bemidji	S. Beltrami
18	Effie	N. Itasca
19	Hibbing	C. St. Louis
20	Finland/Two Harbors	Northshore/S. Lake
21	Grand Marais/ Grand Portage	Northshore/S. Cook
22	Mahnomen	Mahnomen
23	Bagley	S. Clearwater
24	Park Rapids	Hubbard
25	Cass Lake	N. Cass
26	Grand Rapids	S. Itasca
27	Detroit Lakes	W. Becker
28	Osage	E. Becker
29	Breckenridge	Wilkin
30	Fergus Falls	W. Otter Tail
31	Ottertail	E. Otter Tail
32	Wadena	Wadena
33	Leech Lake	S. Cass
34	Brainerd	Crow Wing
35	Hill City	N. Aitkin
36	Aitkin	S. Aitkin
37	Duluth/Cloquet	Carlton/S. St. Louis
38	Hinckley	Pine
39	Wheaton	Traverse
40	Elbow Lake	Grant
41	Alexandria	Douglas
42	Long Prairie	Todd
43	Little Falls	Morrison
44	Onamia	Mille Lacs
45	Mora	Kanabec
46	Ortonville	Big Stone
47	Morris	Stevens
48	Glenwood	Pope
49	St. Cloud	Stearns
50	Sauk Rapids	Benton
51	Elk River	Sherburne
52	Cambridge	Isanti
53	Taylors Falls	Chisago
54	Madison	Lac Qui Parle
55	Benson	Swift
56	Montevideo	Chippewa
57	Willmar	Kandiyohi
58	Litchfield	Meeker
59	Buffalo	Wright
60	Minneapolis	Hennepin
61	Anoka	Anoka
62	St. Paul	Ramsey
63	Stillwater	Washington
64	Granite Falls	Yellow Medicine
65	Renville	Renville
66	Glencoe	McLeod
67	Gaylord	Sibley
68	Waconia	Carver
69	Shakopee	Scott
70	Hastings	Dakota
71	Lake Benton	Lincoln
72	Marshall	Lyon
73	Redwood Falls	Redwood
74	New Ulm	Brown
75	St. Peter	Nicollet
76	Montgomery	Le Sueur
77	Faribault	Rice
78	Zumbrota	Goodhue
79	Wabasha	Wabasha
80	Slayton	Murray
81	Windom	Cottonwood
82	St. James	Watonwan
83	Mankato	Blue Earth
84	Waseca	Waseca
85	Owatonna	Steele
86	Dodge Center	Dodge
87	Rochester	Olmsted
88	Winona	Winona
89	Worthington	Nobles
90	Jackson	Jackson
91	Fairmont	Martin
92	Blue Earth	Faribault
93	Albert Lea	Freeborn
94	Austin	Mower
95	Preston	Fillmore
96	Caledonia	Houston
97	Pipestone	Pipestone
98	Luverne	Rock

APPENDIX F - NOAA WEATHER RADIO STATIONS



NOAA Weather Radio transmitter sites. The circles indicate a radius within which the tone alert should be available. Actual availability may vary due to terrain, weather conditions, or other reasons. Smaller circles indicate lower-powered transmitters. Red, or blue colored circles indicate existing stations or those which should be available in the near future. Frequencies are shown in megahertz.

APPENDIX G - Interagency Agreement for Meteorological Services Among the Bureau of Land Management, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, and National Park Service of the U.S. Department of Interior; the Forest Service of the U.S. Dept. of Agriculture; and the National Weather Service of the U.S. Dept. of Commerce. Can be viewed on-line at http://www.weather.gov/directives. See Section 10 – Operations and Services - NDS 10-4 Fire Weather Services.