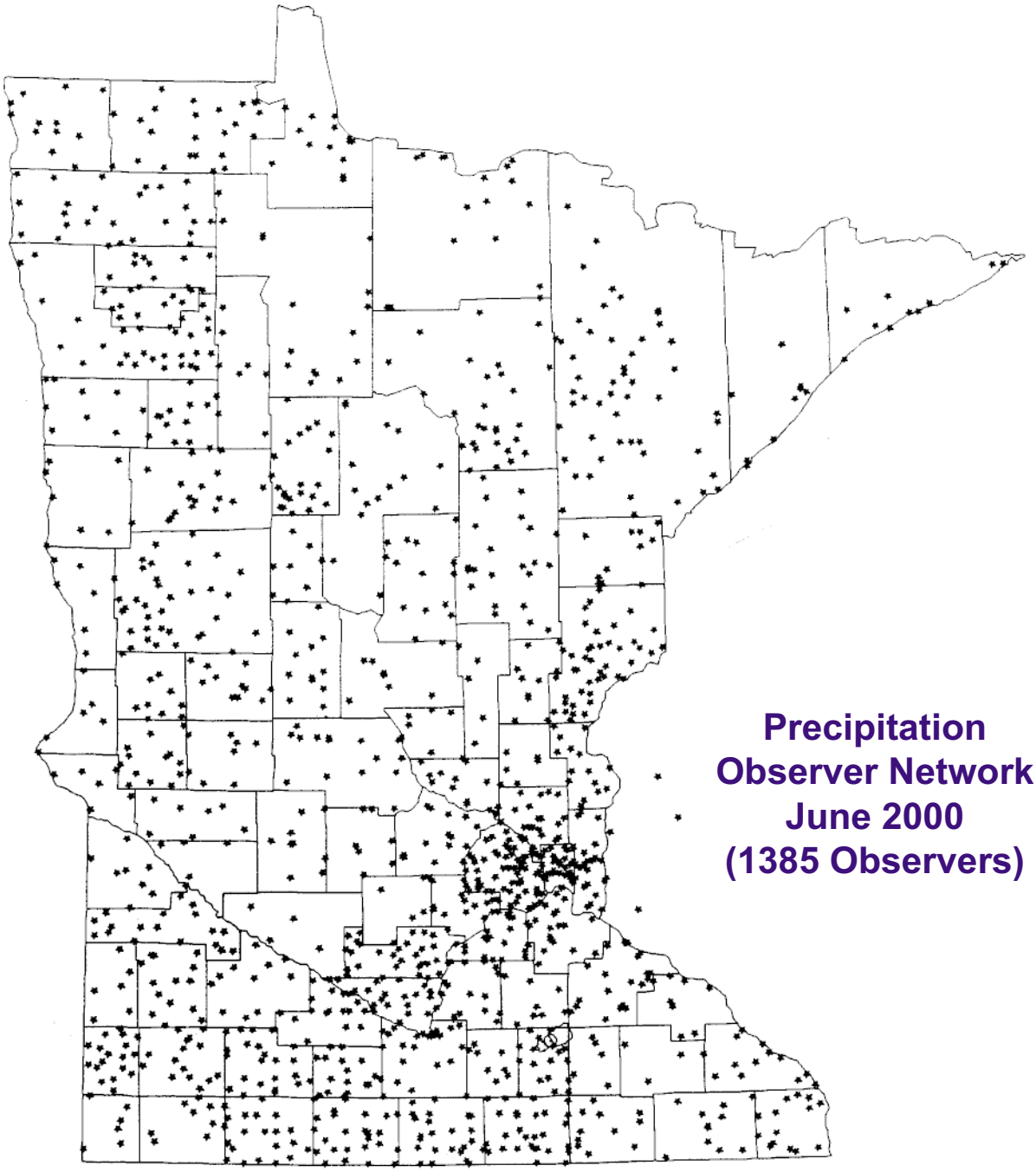
Chapter One CLIMATOLOGY



Precipitation Observer Network June 2000 (1385 Observers)

Introduction

The State Climatology Office exists to gather and analyze climate data for the benefit of the State of Minnesota and its citizens. A variety of organizations and individuals provide climate data. These organizations rely primary on the efforts of volunteer observers. The data are consolidated into a unified data base and climate information is distributed to many users.

A review of climate information can assist in explaining a prior event or condition. Climate information aids long-range planning efforts by characterizing what is typical or extreme, likely or unlikely. Users of climate information include government agencies (local, state, federal), academic institutions, media, private sector professionals and the general public. Specifically, engineers use temperature and precipitation data to design roads and storm sewers. Wildlife managers use temperature and snow depth information to identify survival conditions for wildlife. Foresters use temperature, humidity and wind data to identify fire danger conditions. Agricultural specialists use temperature and precipitation data to determine the types of crops that will grow in Minnesota. Others relying upon climate information include hydrologists, foresters, meteorologists, attorneys, insurance adjusters, journalists and recreation managers.

Climate Data Sources:

Soil and Water Conservation Districts
National Weather Service
University of Minnesota
Department of Natural Resources
Twin Cities Area Volunteer Observers (Backyard Network)
Metropolitan Mosquito Control District
Minnesota Association of Watershed Districts
Metropolitan Waste Control Commission
Deep Portage Conservation Reserve
Minnesota Power and Light Company
Emergency Management
Citizen Volunteers

"Normal"

The word 'normal' in this chapter refers to a 30-year mathematical average of measurements made over the period 1961-1990. In the year 2001, this averaging period will transition to 1971-2000 according to standards adopted by climatologists around the world. Many individuals tend to (erroneously) perceive "normal" weather as what they should expect. Dr. Helmut E. Landsberg, former Director of Climatology of the U.S. Weather Bureau, summarized this misconception as follows: "The layman is often misled by the word. In his every-day language the word normal means something ordinary or frequent...When (the meteorologist) talks about 'normal', it has nothing to do with a common event...For the meteorologist the 'normal' is simply a point of departure or index which is convenient for keeping track of weather statistics."

Water Year 1999

October 1, 1998 – September 30, 1999

Highlights

- Mild Autumn, 1998
- Mild Winter, 1998 – 1999
- Wet Spring, 1999
- BWCA Superstorm – July 4, 1999
- Dry Spell Begins in Southwest Minnesota – Summer 1999

Autumn 1998

In late summer/early autumn of 1998, the northwest and southeast parts of Minnesota were quite wet, while the northeast and southwest were dry. As autumn progressed, the northeast received much needed rains while the southeast experienced dry conditions over a region that had a damp growing season (Figure 1).

The statewide average temperature was two to four degrees above normal during October and November, continuing a year-long trend of warmth. A November 10 storm brought heavy snow, damaging winds and record-breaking low temperatures to many locations, however, the end of November was extraordinarily warm.

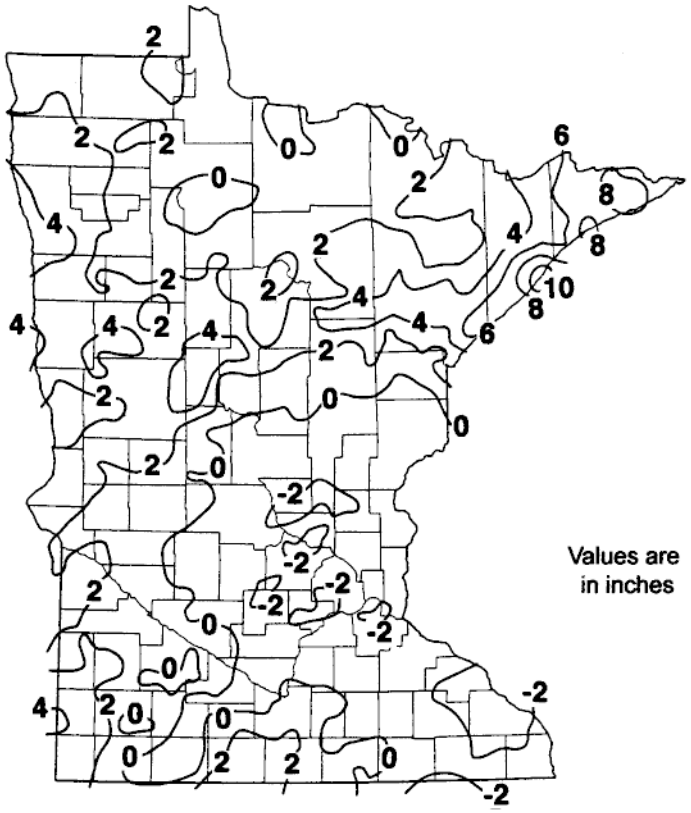
Winter 1998-1999

Many high-temperature records were broken during the first half of December, when statewide temperatures were 15 to 20 degrees above normal. The balmy weather led to unusually high December flows in many streams. Although precipitation was light, mild temperatures allowed tributaries to continue flowing when they would otherwise be ice-bound in a more typical year. Temperatures dropped below normal by mid-month, rapidly freezing the snow-free landscape. Historical ice-in records for lakes are sketchy, however, many lakes experienced very late freeze-up.

January 1999 brought frequent snowfalls to much of western and southern Minnesota. While no single event made headlines, the accumulation was above the median, except in some north central and northeastern parts of the state. Temperatures started out cold, but moderated by late month, resulting in a monthly mean near normal.

Figure 1

Departure from Normal Precipitation
September - November 1998



Spring 1999

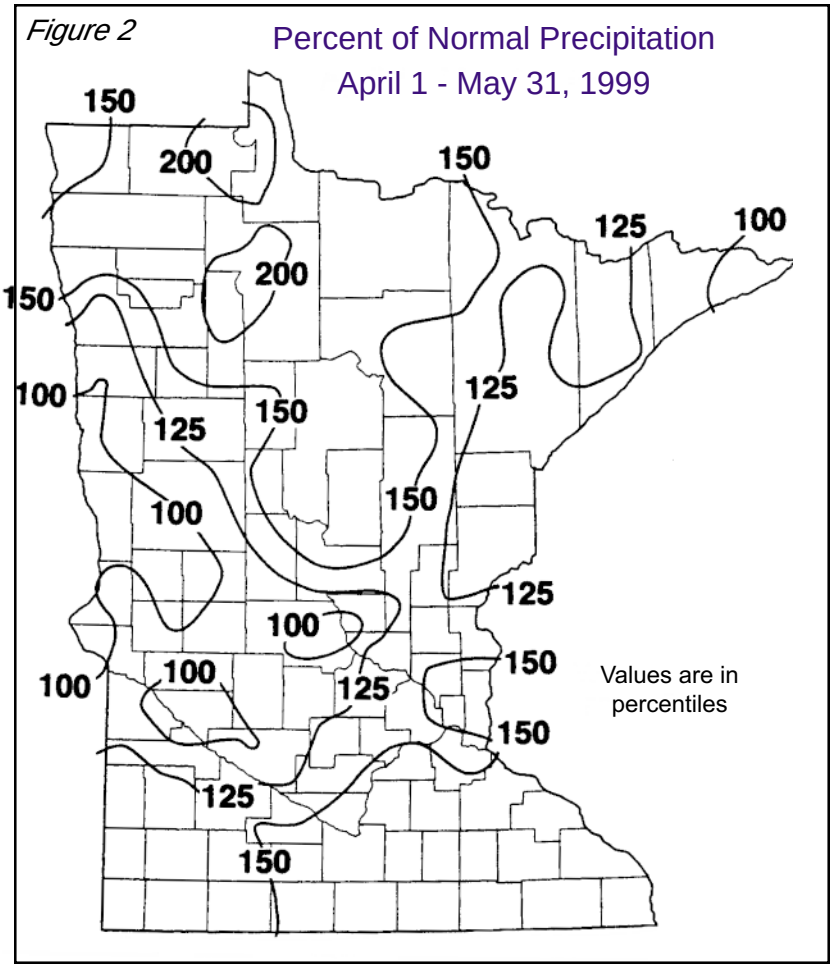
Much of Minnesota experienced temperatures eight to ten degrees above normal during February. Warm weather and a lack of snowfall diminished the snow pack, and the threat of spring snowmelt flooding in all but the lower (northerly) reaches of the Red River of the North. By month's end, only parts of the northeast and northwest reported snow depths greater than eight inches.

The warmth of December and February, combined with a near-normal January, produced a second consecutive mild winter in Minnesota. March was generally mild and dry, with the exception of a notable snowfall event that affected the central and southern reaches of the state on March 8-9. 16 inches of snow were measured at the Twin Cities International Airport, which ties for eighth place among historical 24-hour snowfall amounts.

April brought heavy precipitation in the north which, combined with snowmelt, led to moderate to major flooding in the lower Red River and its tributaries. As the moisture moved south, many southern communities recorded three inches of rain for the second week of April. The second half of April was dry except for the extreme southeast. A combination of sunny skies, strong winds and low relative humidity increased the potential for wildfires.

The wildfire threat ended in the first half of May when precipitation amounts of four to six inches led to minor flooding and delayed agricultural field work. Much of Minnesota received over 200 percent of normal precipitation for the April-May period (Figure 2), with some communities reporting near record totals. Near to above average winter and spring temperatures produced lake ice-out dates of approximately one to two weeks ahead of average.

Figure 2



Summer 1999

Wet conditions continued into June which featured highly variable temperatures and precipitation amounts at or above normal. The heat and humidity of early July fueled a complex of severe thunderstorms in northern Minnesota on July 4-5. The storms spawned damaging winds that downed millions of trees in the Boundary Waters Canoe Area Wilderness and dropped very heavy rains (Figure 3), leading to significant flooding in parts of St. Louis, Lake and Cook Counties.

July also brought moisture to southeastern Minnesota, with some communities reporting over nine inches for the month. July 29 and 30, 1999 will be remembered as two of the most humid days in state history. Dew points in the mid to upper 70's were common with some southern locations reaching 80. On July 30, the dew point reached a record 81 degrees at Twin Cities International Airport.

August – September temperatures were unremarkable, averaging near the historical norm. Precipitation was a mosaic of dry and wet except in the southwest where a pattern of dryness developed that would last well into April, 2000. September brought heavy precipitation to the northern part of Minnesota.

Figure 3

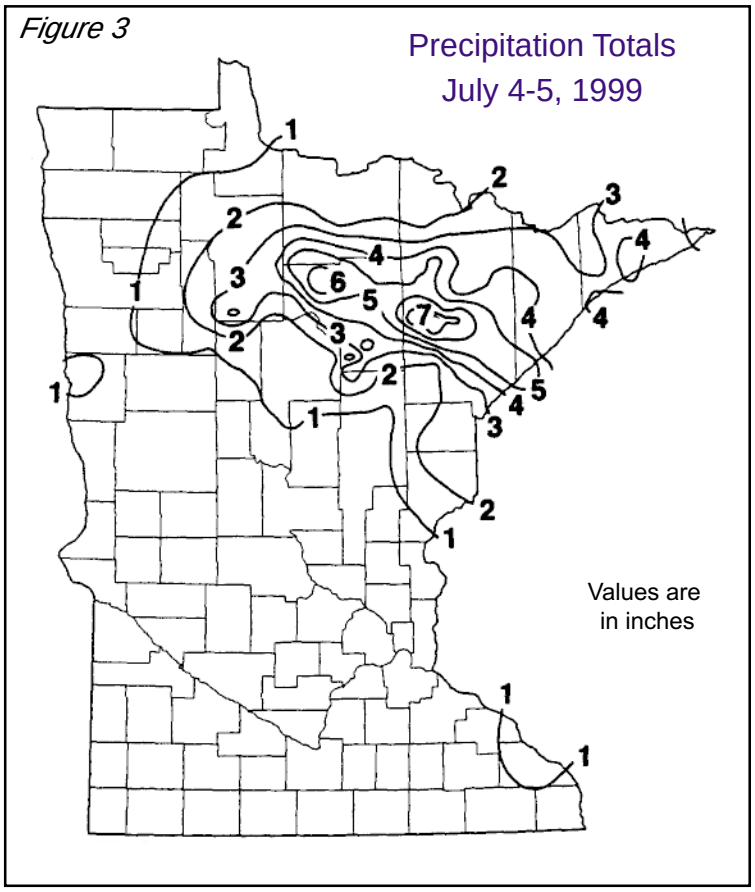
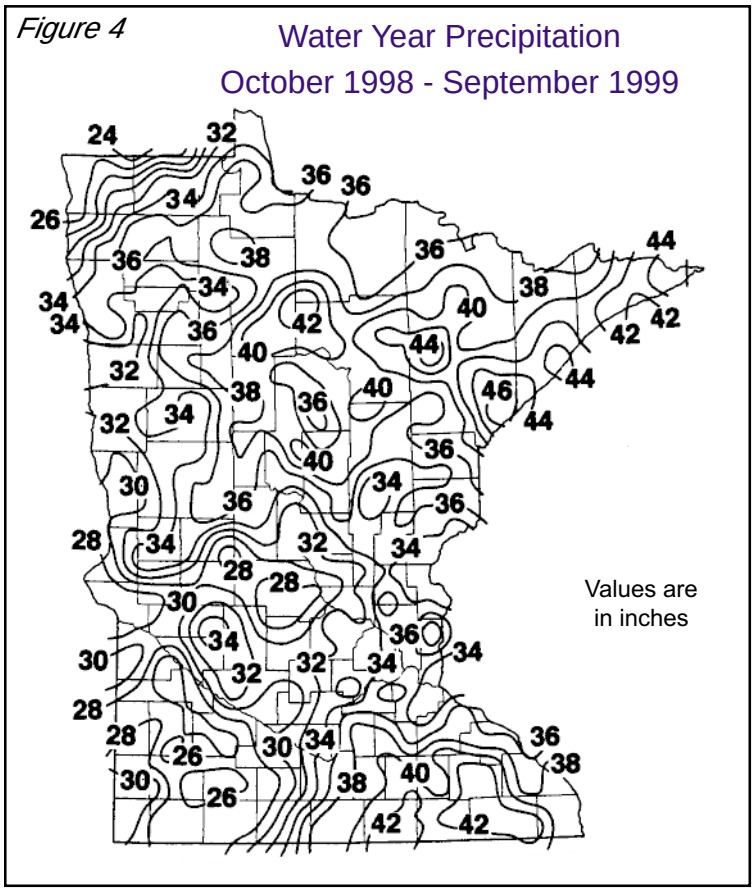


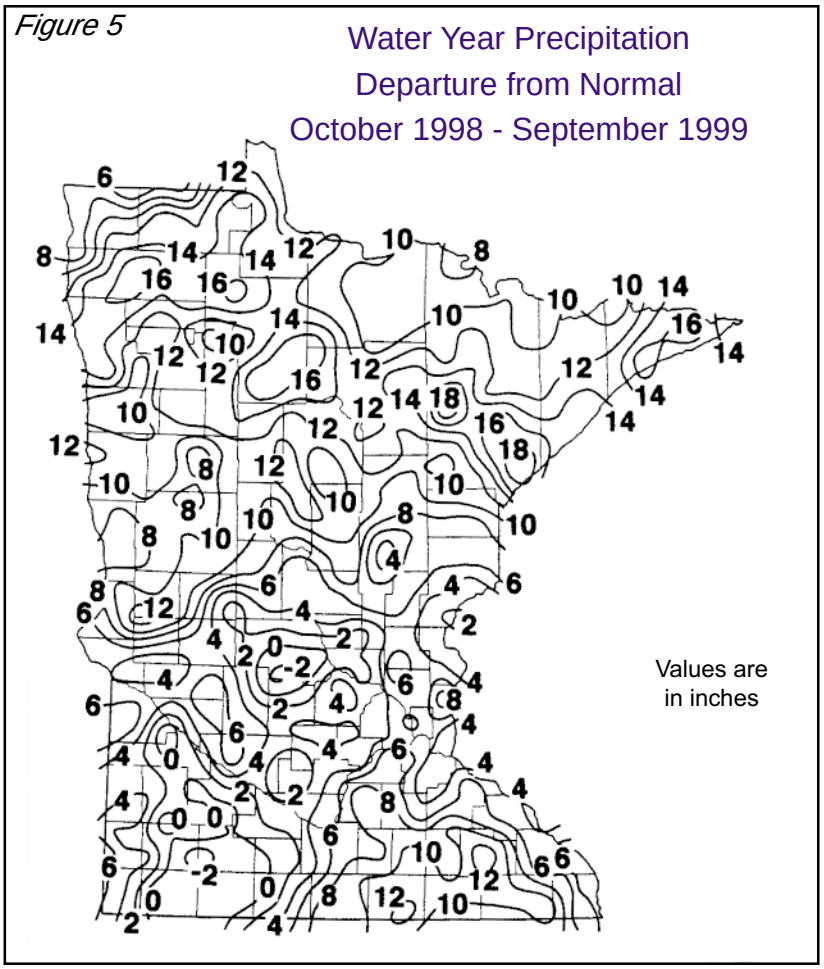
Figure 4



Water Year 1999

Precipitation totals exceeded 40 inches in some northern and southern counties during the water year (Figure 4). Totals topped historical averages by more than 10 inches in some areas and by more than 16 inches in others (Figure 5). These conditions were a continuation of unusually heavy, statewide precipitation during the 1990's, especially in northwestern Minnesota (see sidebar on page 6). In contrast, southwestern and central Minnesota finished the water year near the historical average, hinting at dry conditions that would follow.

Figure 5

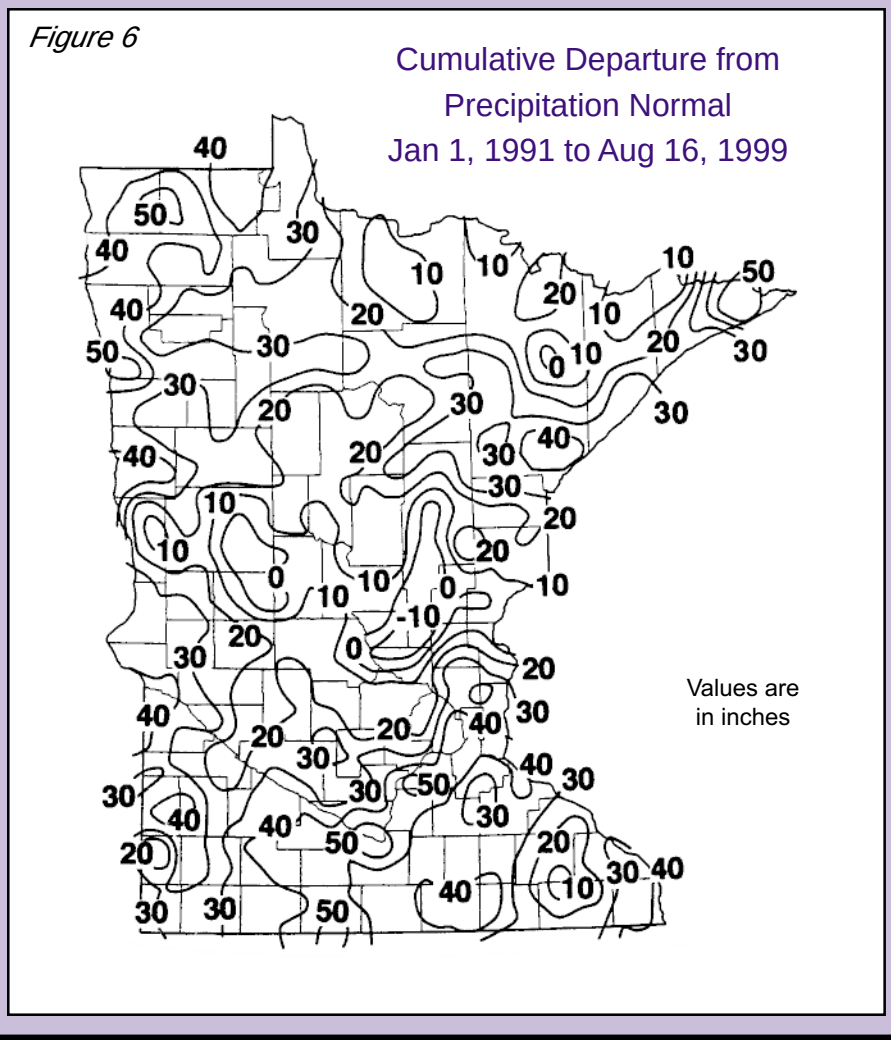


Minnesota's Precipitation Climate At the End of the 20th Century

For many regions, the decade of the 1990's was the wettest of the century. As a result, we began the 21st century with many of Minnesota's hydrologic systems at high levels, a considerable rebound from the drought of the late 1980's. In some areas, the heavy 1990's precipitation led to a welcome recovery from significant water deficits. For others, it led to high water levels and created serious problems. Across Minnesota, precipitation during the 1990's exceeded the climatological benchmark (1961-1990 normal) by a significant amount. Figure 6 shows that, for many areas, the cumulative precipitation departure from normal for January 1991 through mid-August 1999 exceeded the historical average by more than 30 inches. In some areas of northwestern, south central, and southeastern Minnesota, the aggregate departure exceeds 40 inches. A 40 inch positive departure in northwestern Minnesota is the equivalent of receiving an additional two years of annual average precipitation.

Climate extremes should not be considered aberrations, but rather treated as an inherent component of our continental climate. The present-day relative abundance of water is uncommon, but periods of wet weather are not without precedent. Nor is it without precedent for the state of the climate to change rapidly between wet and dry regimes.

Figure 6



Water Year 2000

October 1, 1999 - September 30, 2000

Highlights

- Dry Autumn, 1999
- Third Consecutive Mild Winter, 1999-2000
- Snow-Scarce Winter
- Late Spring/Early Summer Rains, 2000
- Summer Dryness - Southwest, Central, and Northeast, 2000

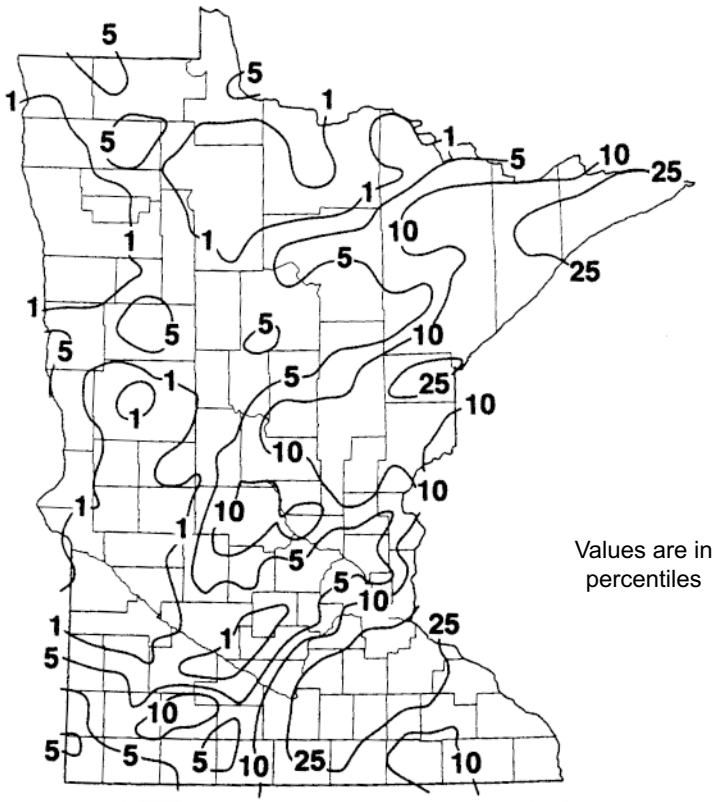
October temperatures began with record-breaking cold (and snow) in the extreme north and south, but finished the month quite mild. November was the warmest ever in some communities with statewide temperatures ranging from seven to nine degrees above the historical average. Numerous daily high temperature records were broken in mid-November.

Autumn 1999

The autumn and early winter of 1999 brought unusually dry conditions to much of Minnesota. Many western counties received less than one inch of precipitation from October through December. In some locations, precipitation totals were more than three inches below normal, and in the 5th percentile or less (Figure 7). The lack of precipitation created deficits in hydrologic systems that normally benefit from autumn replenishment. The northwest welcomed the dryer conditions after several years of high water problems. At the end of 1999, the Palmer Drought Severity Index (a measure of long-term meteorological conditions) indicated that southwest Minnesota was experiencing a "moderate drought". Autumn soil moisture was deficient throughout the rooting zone in the southwest, while topsoil moisture was generally short across the rest of the state.

Figure 7

Precipitation Ranking
October - December 1999



Winter 1999 - 2000

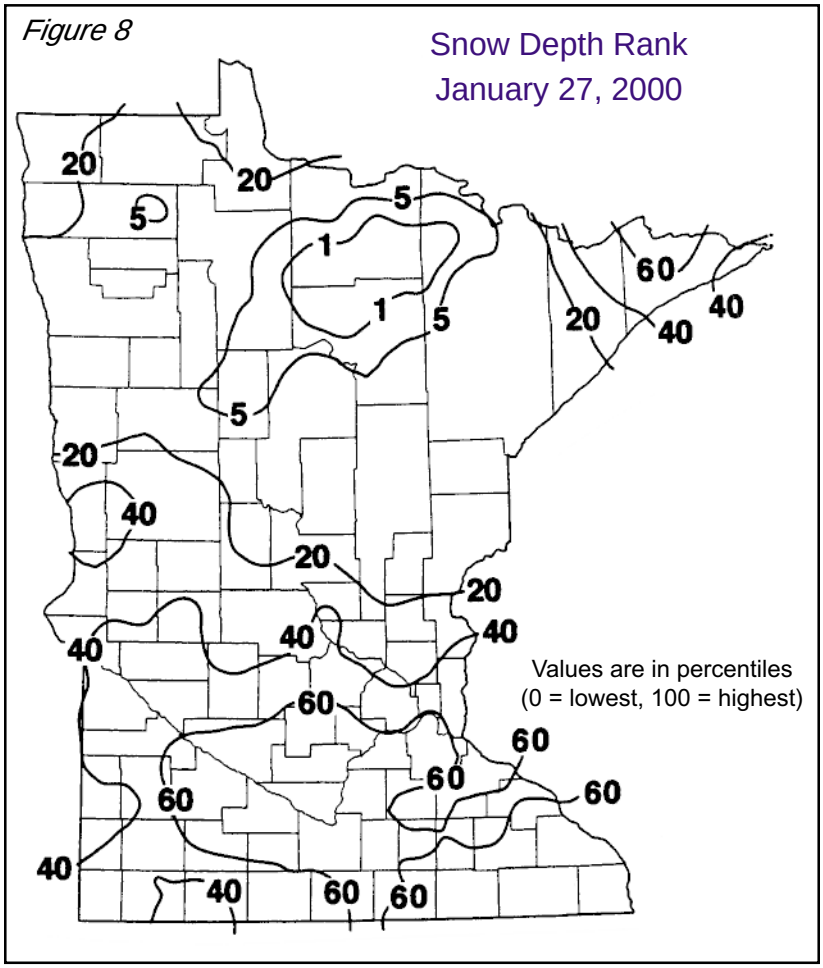
Temperatures ranged from seven to twelve degrees above normal in December, with many record highs observed on the 25th and 29th. Mild (or seasonally mild) temperatures and a lack of precipitation kept the southern two-thirds of Minnesota free of snow and significantly delayed lake ice formation.

Although three significant snowfall events affected parts of Minnesota in January, average temperatures for the month were three to five degrees above normal. Snow depths at month's end were generally less than eight inches across the state. The northern half of Minnesota was far below the median for snow depths in late January, while many areas were at or near record low snow depths for that point in the season (Figure 8). This was the third consecutive snow-deficient winter in northern Minnesota, creating economic hardships for those in snow dependent industries.

February precipitation was near to above normal across the state. An unusual thunderstorm passed over the region on February 23 which, along with warm temperatures, led to a rapid loss of snow cover. By the end of the month, nearly all of Minnesota was free of snow cover- a condition that is nearly without precedent in northern Minnesota. Temperatures were extraordinarily warm, averaging nine to twelve degrees above normal. Many daily records were broken, as were all-time monthly highs at some locations.

Temperatures soared into the 60's and 70's during the first week of March, breaking many maximum temperature records. Smaller lakes in southern Minnesota experienced ice-out three to five weeks ahead of average, and the earliest on record for some. The warm, dry weather also advanced the wildfire season by approximately one month.

Figure 8



Winter snowfall totals were light, roughly 50 to 75 percent of average, again creating deficits in surface hydrology. The situation was most acute in the southwest where precipitation totals in some communities were eight inches below normal for the nine-month period of July, 1999 to March, 2000. Two consecutive mild winters are rare in Minnesota, occurring only once before in the 20th century. The three consecutive mild winters of 1997-1998, 1998-1999 and 1999-2000 are without precedent in the climate record.

Spring 2000

Precipitation totals for April were generally below average across the state. Much of southwestern and central Minnesota received less than 60 percent of normal precipitation for the seven-month period of October, 1999 to April, 2000 (Figure 9). The extended dry spell manifested itself in lower lake levels, dry wetlands, reduced stream flow and dry soils. By late April, the National Drought Mitigation Center classified the southwest in the "severe drought" category and the remainder of southern Minnesota in the "first stage drought" category. Early spring lake levels, which typically rise significantly from autumn rains and spring snowmelt, rose very little from the previous autumn. Flows in southwest, central and north central streams fell below the 10th percentile in late April.

Figure 9

Percent of Normal Precipitation
October 1999 - April 2000

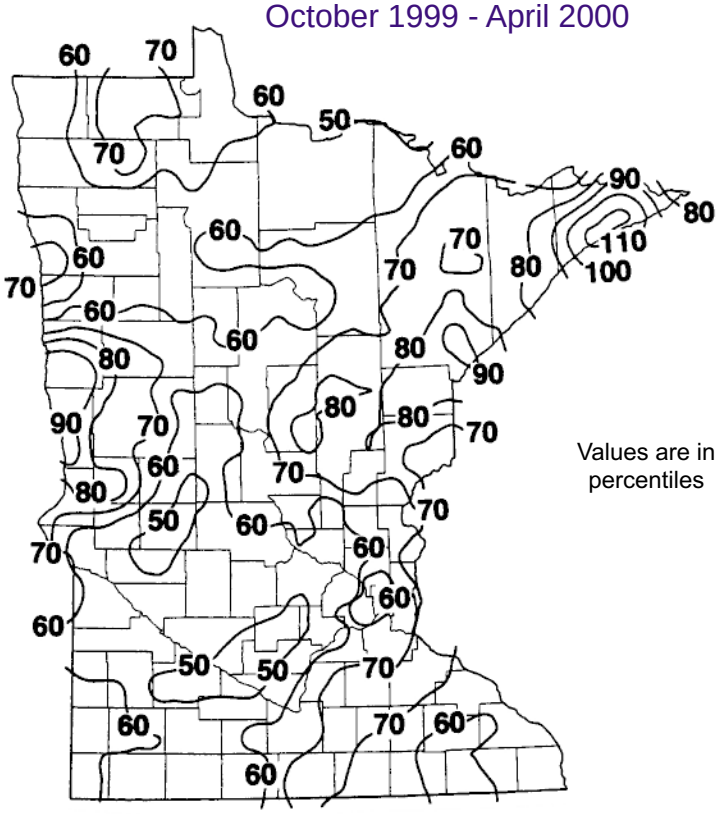
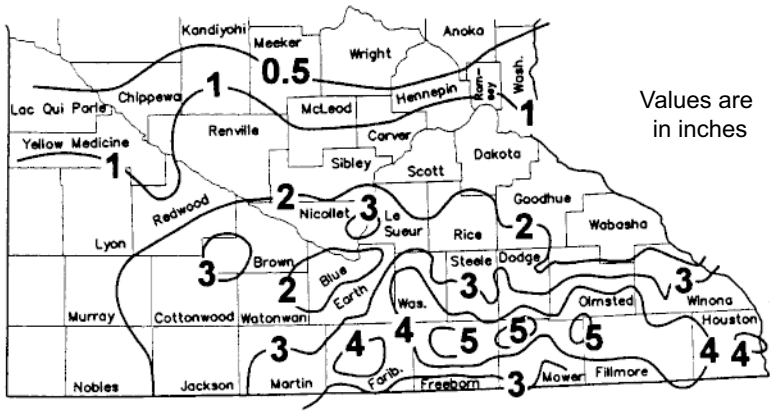


Figure 10

Precipitation Totals
May 17 - 18, 2000



Although not universally distributed, rains abruptly eased or eliminated the concern for drought in May. Precipitation totals in southern Minnesota were three to five inches above normal during the month, with some southeastern communities receiving over twelve inches from mid-May to early June. A rainfall event on May 17-18 brought up to six inches to parts of Mower and Freeborn Counties (Figure 10). A second event on May 31-June 1 brought up to five additional inches of rain to some of the same communities as the earlier event, leading to significant urban and rural flooding and soil erosion. By late May, no region was classified in a drought category, however, the focus on dryness had shifted from the southwest to parts of east central Minnesota.

Summer 2000

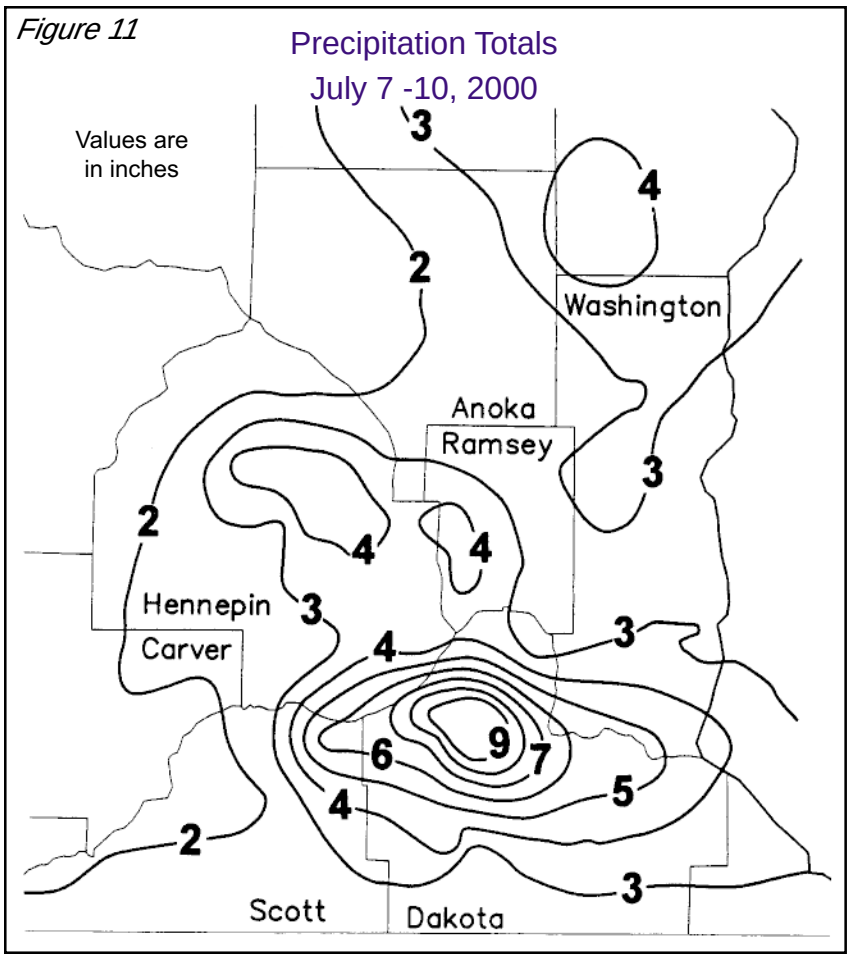
The wet weather of May continued into June, raising surface water levels that were lowered by precipitation shortfalls during the previous autumn, winter and early spring seasons. Rainfall totals in portions of southeastern, south central and northwestern Minnesota exceeded historical averages by more than ten inches for the season. Precipitation records for the month of June were set in Rochester (12.52 inches), Preston (11.86 inches) and Fargo/Moorhead (11.72 inches).

A major rainfall event soaked portions of Clay, Norman, Mahnomen and Becker Counties on June 19-20. Rain amounts exceeding six inches caused extensive urban flooding in Fargo/Moorhead, submerged large tracts of agricultural land and led to significant flooding on tributaries of the Red River. While most of the state received abundant to excessive spring and early summer precipitation, growing season totals for parts of central and east central Minnesota remained below normal. Scattered surface water levels remained below averages, still recovering from long term dryness.

June temperatures were generally below historical averages across Minnesota for the first time since October, 1999. Record cold temperatures were set on the morning of June 5, with many northern and eastern communities dropping below freezing. Three days later, 100-degree temperatures were observed in central and western Minnesota.

Precipitation patterns varied widely during the month of July. The northern third of the state was near to below normal for the month while the rest of Minnesota reported near to above normal precipitation. Some southern counties experienced heavy rainfalls during the first ten days of July. Heavy rains fell in the Twin Cities Metropolitan Area during the weekend of July 7-10. More than eight inches fell in three to five hours over a small area of northern Dakota County on July 7-8, with an additional two to three inches of rain later that weekend (Figure 11). South central and southeastern Minnesota received three to five inches of rain on July 9-10. During the afternoon of July 10, the Cedar River at Austin crested at a record level, affecting homes, businesses, bridges and streets. Nearly all of Minnesota experienced below normal precipitation during the second half of July. The City of Granite Falls was unfortunately in the path of a deadly and destructive tornado on July 25.

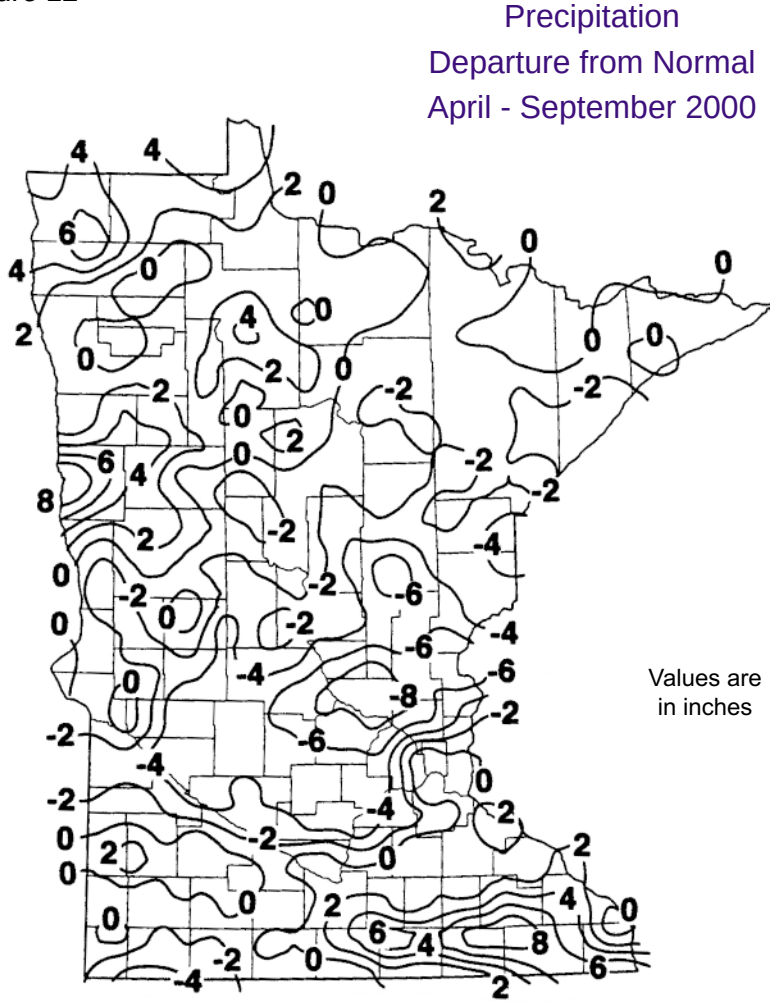
Figure 11



August precipitation was generally near to below normal, with a few exceptions. Some northwestern and north central counties reported rainfall amounts of an inch or more above normal, while isolated thunderstorms helped Rochester set a record for the four-month period of May through August (30.7 inches). In contrast, parts of central and east central Minnesota recorded growing season precipitation totals 30 percent below normal. Unlike the rest of the state, these areas did not recover from the precipitation deficits accrued during the previous autumn-winter-spring seasons. For example, the City of Santiago in Sherburne County was approximately nine inches of precipitation below normal for the year ending in August. Pockets of dryness also existed along the North Shore of Lake Superior, especially in Cook County. August temperatures were near average statewide, although dew point temperatures climbed into the 70's on six occasions during the month.

September precipitation was slightly above normal in some northwestern counties, but ranged from one to three inches below normal over the rest of the state. The dryness in central and east central Minnesota worsened as a result of the continued below-normal precipitation. Dry conditions could also be found in southwestern Minnesota and along the North Shore. Seasonal rainfall totals (April 1-September 30) in the dry areas were more than four inches below normal (Figure 12), ranking some communities in the lowest 10th percentile when compared with the historical climate record. Stream flows in these areas were very low, as were lake levels which had not been as low since the drought of the late 1980's. Wildfire potential was also very high.

Figure 12



A significant rainfall event occurred during the evening of September 2 in east central Minnesota. Heavy thunderstorms produced three to four inches of rainfall in less than three hours in parts of the eastern Twin Cities Metropolitan Area. Thereafter, precipitation for the Twin Cities was negligible for the remainder of the month. Late summer and early autumn rains pushed seasonal totals in the far northwest to 25 percent or more above the historical average. September temperatures were close to the historical average statewide.

Water Year 2000

The 2000 Water Year was highlighted by sharp geographical contrasts in precipitation across Minnesota. October 1999 through September 2000 precipitation totals were less than 18 inches in some western and central counties, while areas of the southeast reported total precipitation exceeding 36 inches (Figure 13). Water Year precipitation topped the historical average by more than six inches in some northwestern and southeastern communities, while a swath of central Minnesota fell short of the average by six inches or more (Figure 14).

Figure 13

Water Year Precipitation
October 1999 - September 2000

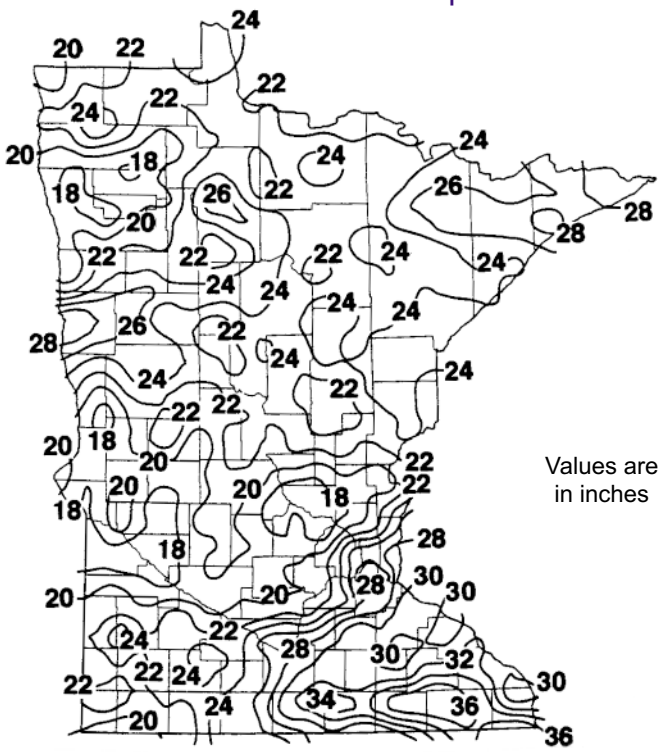


Figure 14

Water Year Precipitation
Departure from Normal
October 1999 - September 2000