

UNUSUAL AND NOTEWORTHY METEOROLOGICAL EVENTS AT WASHINGTON, D.C.

*Revised and updated from the original 1945 edition
of the Climatic Handbook for Washington, D.C.*

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TEMPERATURE

LOW TEMPERATURES

During the many winters that records have been kept in the Nation's Capital, temperatures of zero or below have occurred on 37 days. Only 19 winters have had days this cold; one winter, that of 1898-99, had 5 days with a temperature at zero or below. The earliest date of occurrence of zero or below was December 30, 1880 and again in 1917, and the latest was February 28, 1934. The three coldest spells saw low temperatures of -14°, -15°, and -13°. The next coldest temperature was -6°, which has been recorded four times.

The following is a chronological list of these cold spells:

<i>Winter</i>	<i>Month</i>	<i>Duration days</i>	<i>Lowest temperature</i>
1872-73	January	1	-6
1874-75	January	1	-3
1874-75	February	1	-2
1876-77	January	3	-3
1877-78	January	1	0
1878-79	January	1	0
1880-81	December	3	-14
1885-86	January	2	-1
1885-86	February	1	-2
1892-93	January	1	-5
1892-93	January	1	-6
1894-95	February	1	0
1894-95	February	1	0
1898-99	January	1	-1
1898-99	February	3	-15
1898-99	February	1	-6
1904-05	January	1	-2
1911-12	January	2	-13
1913-14	February	1	-1
1917-18	December	1	-3
1917-18	February	1	-2
1933-34	February	1	-6
1933-34	February	1	-1
1934-35	January	1	-2
1935-36	January	1	0
1981-82	January	1	-5
1984-85	January	2	-4
1993-94	January	1	-4

The cold spell of 1880-81. The coldest weather during this spell was from December 30, 1880, to January 1, 1881. The morning minimum temperatures during these days were -7°, -11°, and -14°, respectively, and the afternoon maximum temperatures were 9°, 13°, and 19°. The highest barometer reading was 30.51" at 11 AM on December 31. The first two days of this cold spell were cloudless until noon on January 1, but by 9 PM it was overcast. This cold spell was preceded by several snowstorms during which rain and sleet also fell. The following table summarizes these storms:

Dates	Precipitation	Duration (hours)
December 18	0.04	4
December 20-21	0.93	30
December 23-24	0.09	18
December 25-26	0.83	27
December 28-29	0.17	24

Records of the amount of unmelted snow or of the depth of snow on the ground were not kept by the Weather Bureau at this time. An examination of the U.S. Naval Observatory record shows that 18.5 inches of snow fell from December 18-29. It is noteworthy that this amount exceeds any *monthly* total for December since snowfall records have been kept by the Weather Bureau. The following description appeared in the *Monthly Weather Review*:

Monthly snowfalls for December: Philadelphia, 22"; Cumberland, MD, 22"; Loudoun County, VA, 24". Snow on ground at end of month: Washington, D.C., 14"; Brownsville, TX., 1". Minimum temperatures for December: Emmitsburg, MD, -19; Baltimore, -3; Washington, D.C. Distributing Reservoir, -15; Dover, VA, -34. Minimum temperatures for January: Woodstock, MD, -17; Baltimore, -6; Sandy Spring, MD, January 1 marked the end of the coldest 3-day period ever known here, minimum temperature at station -10, and -24 in a low valley a half-mile distant. Petersburg, VA, -4, coldest in past 25 years, birds frozen to death in the fields; Fredericksburg, VA, -22, much suffering among the people, cattle, and game frozen to death.

The cold spell of February 5-15, 1899. At midnight on February 4-5, 1899, the temperature fell below freezing. It did not rise above the freezing point until the afternoon of February 15, over 10 days later. While this, in itself, is not a record, several other records were established during this cold spell.

From February 5 to the 8th there were four separate snowstorms. Snow began at 4 AM February 5; there was snow during 6 hours on the 5th, 16 hours on the 6th; 14 hours on the 7th and 6 hours on the 8th. The accumulations of snow on the ground were as follows: on the 5th, 5.5 inches; 6th, 9.5 inches; 7th, 12.7 inches and the 8th, 13.7 inches. The morning minimum temperatures on the 9th, 10th, and 11th were -7°, -8°, and -15°, respectively. The minimum temperature on the 11th of 15° below zero is the lowest temperature of record at this location.

Snow began again at 3:30 PM February 11 and continued without interruption until 11 PM of the 13th. During this period 20.5 inches of snow fell and there was a total accumulation on the ground of 34.2 inches at the end of this snowstorm. This was the greatest depth of snow on the ground during the period of meteorological records in

Washington. This storm is commonly referred to as Washington's worst blizzard. Most snow fell, and the wind blew hardest, on the 13th, the final day of the storm. During the 24-hour period beginning at midnight of the 12th the total wind movement was 571 miles and the "extreme speed" was 40 miles per hour. On the morning of February 15 the temperature was again below zero, the fourth time for the month and the only month with four below-zero days.

While the lowest temperature at 24th and M Streets was on the 11th, many stations in central and eastern Maryland reported the lowest temperature on the 10th. The lowest at Laurel, MD was -18°; at Manassas, VA, -21°; at Fredericksburg, VA, -21° and at Quantico, VA, -20°. At the Naval Observatory on Massachusetts Avenue the lowest temperature was only -10°.

The meteorological conditions which caused this weather at Washington were most unusual. In the Monthly Weather Review for February 1899 the cold weather is mentioned in nearly all stations of the United States, and this was the only time in history that below-zero temperatures were recorded in all 48 states. Ice floes were observed at New Orleans, LA and were later spotted flowing into the Gulf of Mexico; the only previous time this had occurred was in 1780. The absolute lowest temperature in the United States during this cold period was -61° at Fort Logan, Montana.

The cold spell of January 13-14, 1912. The temperatures at 24th and M Streets NW remained below freezing from the afternoon of January 10 until the evening of the 17th; the two coldest days during this period were the 13th and 14th when the morning minima were 0° and -13° respectively and the afternoon maxima were 8° and 20°. The ground was covered with snow from January 3-20 but the greatest depth was only 6.5" on January 12. The highest pressure during this period was 30.68" at 10:30 AM on January 13. Minimum temperatures were reported as follows on January 14, 1912 at nearby stations:

College Park, MD	-26
Frederick, MD	-21
Great Falls, MD	-21
Laurel, MD	-19
Culpeper, VA	-20
Fredericksburg, VA	-11
Lincoln, VA	-25
Quantico, VA	-16

The cold spell of January 20-23, 1985. At 1 PM on January 19 the mercury stood at 40° at National Airport. Temperatures dropped to 23° by 1 AM on the 20th and continued to plunge throughout the day. At 1 PM the mercury read 10° and it dropped to 0° by 10 PM that evening and to -2° by midnight. The lowest temperature on the 21st was -4°, giving the Nation's Capital two consecutive zero days for the first time since 1912. The high temperature on January 20 was 27° and on the 21st it was 17°. Although this cold snap was accompanied by strong, bitter winds, the barometric pressure did not rise above 31.00 inches. The cold weather completely disrupted the Inaugural Ceremony and Parade planned for the 21st and most activities were moved indoors to avoid the dangerous conditions.

HIGH TEMPERATURES

Since records have been kept in Washington, D.C. temperatures of 100° or higher have occurred on 102 days. Only 49 summers have had days with temperatures so high. One summer, that of 1930, had 11 days with a temperature of 100° or above. The summer of 1988 had 7 days with such temperatures. The earliest date of occurrence was June 5, 1925 and the latest was September 8, 1939. Several of these hot spells have been selected for discussion.

The hot spell of August 5-9, 1918. One of Washington's worst hot spells occurred on these dates and its intensity felt worse because July and the first four days of August were relatively cool. The average maximum for these 5 days was 99.6°; the average minimum was 76.4°; and the average dew point was 72.3°. The highest temperature was 106° on the 6th and the highest dew point was 82° on the 8th. This latter mark remains the highest ever recorded in Washington, D.C., with the second-highest being the 80° dew point measured on August 13, 2002.

The hourly average temperature on August 5 was 85.7°; on the 6th, 91.3°; and on the 7th, 87.3°. The daily mean temperatures on these three days were respectively 86°, 92°, and 88°. The highest pressure during this heat wave was 30.15" at 11 PM on August 7 and the lowest 29.82" at 6 PM on August 5. The following is copied from the Daily Record:

August 5: Temperature rose rapidly today, reaching a maximum of 98 about 3 PM. Humidity high during the day, adding materially to uncomfortable conditions.

August 6: Intensely hot weather continued today with a maximum temperature of 105.5, which is the highest ever recorded at the station. Many prostrations have been reported in the newspapers.

August 7: The heat wave continued today with a maximum temperature of 104.5. A thunderstorm developed at 5 PM, causing a drop in temperature from 102 at 5 PM to 73 at 8:30 PM. This storm afforded great relief, and the night was cool and comfortable. A vivid display of atmospheric electricity occurred between 7 and 9 PM. First thunder heard at 5:12 PM, last heard at 11:35 PM. Preceding the storm, about 5 PM, a remarkable formation of Mammatocumulus clouds was observed in the north and northwest.

August 8: Excessive heat prevailed again today, although less intense than yesterday. Highest temperature today, 96.

August 9: Hot weather continued today, but was somewhat moderated by fresh northwest winds during the day. Very sultry at night, on account of increased humidity. Maximum temperature 94.

The highest temperatures recorded in the United States east of the Rocky Mountains during August 1918 were 115° at Searcy, AR; Minneapolis, KS; and Freemont, NE.

The hot spell of July 18-22, 1930. A noteworthy hot spell took place during July 18-22, 1930. The average maximum temperature during these five days was 101.2°; the average minimum was 75.2°. Thus the average temperature during these five days was 0.2° higher than during the hot spell of August 5-9, 1918. However, the average dew point from July 18-22, 1930 was only 65.9° while in 1918 it was 72.3°. The average daily temperature on the 19th was 87.7°; on the 20th, 89.9°; and on the 21st, 90.0°. Notes appear in the Daily Record as follows:

July 18: High temperature prevailed today, with a maximum of 95.
July 19: Unusually hot weather continued today, maximum 102.
July 20: Extreme heat continued today, with a maximum of 105.6, breaking all previous records for high temperature.
July 21: Heat wave continues unbroken, maximum temperature 103 at 4 PM.
July 22: Extreme heat wave broken in afternoon by a series of light thunderstorms, maximum temperature of 100 at 12:30 PM. During the progress of one of these squalls, at 3:20 PM, the wind reached an extreme gust velocity of 36 mph, northwest. First thunder, 12:40 PM, two more thunderstorms at 2:18 PM and 3:05 PM; last thunder heard at 4:50 PM.

The highest temperature for the United States east of the Rocky Mountains during July 1930 was 115° at Rison, AR, and Holly Springs, MS.

The hot spell of July 8-12, 1936. The third hottest five-day period at 24th and M Streets was from July 8-12, 1936. The average temperature for these five days was 87.5° and the average dew point was 67.4°. The hottest day was the 10th when the maximum temperature was 105° and the daily average was 89.9°. July 1936 was recognized as an unusually hot month over much of the United States. Although the hottest weather was not reached in all places during this five-day period, maximum temperatures were recorded for places east of the Rocky Mountains as follows:

Cumberland and Frederick, MD	109
Lincoln, VA	109
Runyon, NJ	110
Phoenixville, PA	111
Martinsburg, WV	112
Mio, MI	112
Wisconsin Dells, WI	114
Plain Dealing, LA	114
Greenville, IL	115
Collegeville, IN	116
Logan, IA	117
Goodland, MO	118
Minden, NE	118
Seymour, TX	120
Gann Valley, SD	120
Smithville, OK	120
Steele, ND	121

Many of these state record high temperatures still stand today. The summer of 1936 was probably the hottest ever known east of the Rocky Mountains.

The hot spell of July and August, 1980. The two months of July and August, 1980 were the hottest known in Washington, D.C. The average temperature for July was 82.3°, the highest for any calendar month and the warmest since July 1955. Remarkably, August 1980 averaged 82.8°, breaking July's short-lived record. There were 21 90° days during July, the most in any month, but this record was also broken in August when 22 90° days were recorded. The summer average (June, July, and August) for 1980 was 80.0°, the warmest in history. Five days exceeded 100°, fewer than 1930, but there were 67 days

during the summer with temperatures of 90° or higher, the greatest number ever. The hottest five-day period was from August 7-11, when temperatures averaged 87.5°. The average high during this spell was 97.4° and the average low was 77.6°; the average dew point temperature was 73.6°. High temperatures of 90° or more were recorded from July 25 to August 15, a stretch of 21 days. This record was later tied during the summer of 1988.

The hot spell of July 7-11, 1993. The month of July 1993 was the hottest ever recorded in the Nation's Capital with an average of 83.1°. During the five-day period from July 7 to July 11 the average high temperature was 99.2° and the average low was 77.8°, giving an average daily mean of 88.5°. This exceeded the record set during July 1930 by 0.3°. The highest temperature during this hot spell was 100° which occurred on three consecutive days. The dew point temperature averaged 72.6°, a mark that was higher than that of August 1918. The extremely oppressive heat and humidity caused record demands on the electrical power system that served the region.

The hot spell of July 4-8, 1999. The average high temperature during this five-day heat wave was 98.2°, somewhat lower than those that occurred in earlier years, but the average nighttime low temperature was 78.6°, the highest of any hot spell considered in this study. The five-day mean was 88.4°, only 0.1° cooler than the record set in July 1993, and the average dew point temperature was 70.8°. On July 6, 1999 the high temperature was 103° and the low was 83°, giving an average daily mean of 93°. This was therefore the hottest day in Washington's meteorological history and it broke the record set on August 6, 1918. The low of 83° was only one degree short of the all-time highest low temperature ever recorded, a mark of 84° that occurred on July 16, 1983. The month of July 1999 averaged 83.0°, only 0.1° cooler than July 1993. A table of Washington's hottest five-day periods follows:

Year	Dates	Avg. High	Avg. Low	Mean	Maximum
1918	August 5-9	99.6	76.4	88.0	106
1930	July 18-22	101.2	75.2	88.2	106
1980	July 15-19	97.4	75.6	86.5	103
1980	August 7-11	97.4	77.6	87.5	100
1988	July 13-17	99.4	76.4	87.9	103
1993	July 7-11	99.2	77.8	88.5	100
1997	July 14-18	98.8	75.8	87.3	100
1999	July 4-8	98.2	78.6	88.4	103
2006	July 30-August 3	97.6	79.0	88.3	101

UNSEASONABLE TEMPERATURES

Low temperatures during Washington's hot summer months are comparatively rare. For example, during the entire period of record the temperature in August has fallen below 50° only three times. These low temperatures occurred on August 24, 1890; August 31, 1934; and August 29, 1986. In each case the low temperature was 49°.

The cold afternoon temperature of July 8, 1891. In July 1891, the lowest temperature for the month was 54° and this occurred on the 8th at 4 PM. A temperature of 55° or below has been recorded 24 times during July since official records began. A list of these unseasonable temperatures appears below:

<u>Year</u>	<u>Day</u>	<u>Temperature</u>
1890	20	53
1890	22	53
1891	8	54
1891	9	55
1892	8	54
1892	18	55
1894	10	54
1895	12	53
1895	31	52
1898	11	54
1899	1	54
1907	4	52
1909	5	53
1909	8	55
1918	3	53
1920	26	54
1920	27	55
1923	1	54
1925	1	54
1929	20	55
1933	4	52
1940	2	55
1945	12	55
1988	1	54

In all of the cases these low temperatures occurred near the time of sunrise when the night had been clear. On July 8, 1891, however, the sky was overcast and rain fell. The hourly temperature, wind, and rainfall data for July 8, 1891 are tabulated as follows:

Hour	AM hourly data for July 8, 1891											
	1	2	3	4	5	6	7	8	9	10	11	Noon
Temperature	76	75	72	69	68	65	62	60	60	60	57	57
Rainfall	---	---	0.05	T	T	0.02	0.03	0.14	0.12	0.06	0.06	0.17
Wind	SW	SW	SW	NW	NW	N	N	N	N	N	NE	NE

Hour	PM hourly data for July 8, 1891											
	1	2	3	4	5	6	7	8	9	10	11	Mid
Temperature	56	56	55	54	55	56	56	56	56	57	57	57
Rainfall	0.17	0.06	0.06	0.35	0.18	0.06	0.06	0.01	---	---	---	---
Wind	NE	NE	NE	NE	NE	N	N	N	N	N	N	N

There was no thunderstorm on July 8, 1891, and the lowest pressure was 29.75" at 2 AM; this was also the lowest pressure during that month. July 1891 was the coldest July of record in the Nation's Capital. On July 7-8, 1891, a low pressure center moved from near Memphis, Tennessee eastward across North Carolina and out over the Atlantic. On

the morning of the 8th a high pressure area was centered over southern Minnesota and a damaging frost was reported as far south as Fond du Lac, Wisconsin.

The cold weather of September 23, 1904. On September 23, 1904, a minimum temperature of 36° was recorded at 24th and M Streets, the lowest temperature ever recorded in September at this location. The next lowest temperature recorded during September was 38° in 1942, but it occurred at a later time of the month: the 30th. On this morning, a temperature of 30° was recorded at College Park, MD, in the metropolitan area of Washington. Frost of varying intensities was reported in 15 of the 23 counties of Maryland and in 12 counties of Virginia—in fact, light frost was reported in Surry County, VA, which lies south of the James River in the Tidewater section. The lowest temperature reported from a Maryland station was 27° at Grantsville (elev. 2,400 ft.) and from Virginia a temperature of 30° was reported from Lincoln (Loudoun County, elev. 500 ft.). The pressure was 30.59" on September 23, 1904 at 9 AM. On the preceding day at 9 AM it was 30.64", which is the highest September pressure of record.

The cold weather of May 11, 1906. On May 11, 1906, a temperature of 33° was recorded at 24th and M Streets, which is the lowest temperature ever recorded in May. Other low May temperatures were 35° on May 2, 1945 and 34° on May 1, 1876; there is evidence that the temperature fell to freezing or below on May 8, 1803, when snow flurries were recorded in the District of Columbia. On May 11, 1906, the following temperatures were recorded in Maryland and Virginia: 27° in College Park and Laurel, both in Prince Georges County, MD; 27° at Lincoln, Loudoun County, VA; 28° at Quantico, VA; and 29° at Petersburg, VA. It is worth comparing this low temperature in the late spring with that of May 12, 1913. On this last date the minimum temperature at 24th and M Streets was 37°. The temperature at cooperative stations was as follows: College Park 27°, Laurel 30°, Lincoln 29°, and Quantico 30°.

The pressures which accompanied these cold mornings in May were not especially high. On May 11, 1906, the highest pressure reading at Washington was 30.33" and on May 12, 1913 it was 30.34".

Warm January temperatures. Readings above 65° in January are uncommon, but show a marked increase in number from 1950 onward. Temperatures above 65° have occurred 101 times since 1871, with 59 of these readings being recorded since 1950. The month with the most such temperatures was January 1950, which was the warmest January in Washington's history and averaged 48.0°. This mark is a full 2.2° warmer than the next warmest January, that of 1932. The highest temperature in January 1950 was 79° on the 26th, which was also the all-time record for any January.

Temperatures above 75° in January are still very rare. The following list shows all these high January temperatures.

<i>Year</i>	<i>Day</i>	<i>Temperature</i>
1890	12	76
1907	7	76
1927	22	76
1932	13	75
1932	14	76
1932	15	77
1937	9	76

<i>Year</i>	<i>Day</i>	<i>Temperature</i>
1950	25	75
1950	26	79
1974	27	75
1975	11	75
1975	29	76
2002	30	77

The warm temperature during the night of January 18, 1929. The high temperature that occurred at 2 AM January 19, 1929 was preceded on January 14 by cold weather. The high on the 14th was 27° and the low was 8°. The next two days were seasonable with lows at or below freezing. On the 18th the temperature rose steadily from a minimum of 38° at midnight to a maximum of 67° the following midnight, while the wind was southerly. A high temperature of 69° was recorded on the 19th during the first two hours after midnight. At 2 AM on the 19th the wind shifted to the north and the temperature fell.

The warm temperature during the night of January 14-15, 1937. The wind was southerly from 10 AM, January 13 until 6:30 AM, January 15, when it shifted to the northwest. The minimum temperature in the morning of January 13 was 39° and of the 14th, 46°. The mercury rose to 67° by 1 AM of the 15th and to 69° at 2 AM, and remained at this temperature until the wind shifted. The sky remained overcast throughout each of these three days.

TEMPERATURE CHANGES

The following table shows the extreme differences in mean monthly temperatures between two consecutive months:

Month warmer (or slightly cooler) than preceding month

<i>Month</i>	<i>January</i>	<i>February</i>	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>
Year	1990	1977	1979	1960	1911	1925
Difference	15.8	13.4	23.1	25.6	18.8	16.8

<i>Month</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>October</i>	<i>November</i>	<i>December</i>
Year	1955	1895	1921	1879	1909	1923
Difference	11.9	4.4	1.6	-2.4	-2.4	-0.1

Month cooler (or slightly warmer) than preceding month

<i>Month</i>	<i>January</i>	<i>February</i>	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>
Year	1912	1934	1932	1907	1994	1918
Difference	-16.0	-14.4	-2.9	-0.4	1.1	1.2

<i>Month</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>October</i>	<i>November</i>	<i>December</i>
Year	1895	1887	1871	1925	1995	1989
Difference	-1.8	-7.3	-14.5	-20.8	-19.2	-20.2

The weather of March-April 1907. The year 1907 is the only one of record when April was cooler than March; the average temperature for these months being 48.8° for March and 48.4° for April. This anomaly was brought about by the weather prevailing during the last ten days of March when the average temperature was 62.3° and that prevailing during the first twenty days of April when the average temperature was 44.0°. On March 22, 23, and 29 the maximum temperature was 90° or higher (on March 29 it was 93°) and these days are the only ones in March when a maximum temperature of 90° or higher was recorded in Washington. The lowest temperature in April was 23° on the morning of the 2nd. On March 22 another record was set at 24th and M Streets, when the temperature rose from 40° at 7 AM to 90° at 3 PM. This was the greatest rise in temperature within a 24-hour period. At College Park, MD, on this day the temperature rose from 34° in the morning to 88° in the afternoon.

In connection with the temperature of 23° on April 2, 1907, it is worth pointing out that only twice during the period of record has a temperature this low been reached in April: on April 19, 1875, it was 22° and on April 1, 1923 it was 15°.

Some of the pressure readings associated with these temperature changes were as follows: on March 22 at 6 PM the lowest pressure was 29.75", on March 24 at 4 PM it was 29.67". On April 1 and again on the 2nd at 6 AM it was 30.33".

The temperature warmed up somewhat from April 21-30. The average temperature for these 10 days was 57.2°. However, May 1907 was the coldest May of record (average temperature 59.2°) and June 1907 was the coolest June of record. The average temperature for June was 65.9°; the average temperature for the first 20 days of June was 61.8°.

The cold wave of March 29, 1921. The month of March 1921 was the second warmest March since 1871, exceeded only by March 1945. Moreover, the first 28 days of March 1921 averaged warmer than the same period of March 1945. The coldest temperature of March 1921, 26°, occurred on the 29th. This temperature coming after a period of unseasonably warm weather caused great damage to fruit blossoms and ruined much of the fruit crop in nearby Maryland and Virginia.

The maximum temperature on March 28 was 82° at noon and the minimum on the 29th was 26° at 5 AM. This fall in temperature of 56° was the greatest of record in 24 hours or less during the period of record. The lowest pressure on March 28 was 29.76" at 3 PM and the highest on March 29 was 30.46" at 11 AM. On March 30 the pressure was 30.48" at 8 AM.

At College Park, the highest temperature on March 28 was 83° and the lowest on the 29th was 25°. On the morning of the 30th when the wind had subsided the lowest temperature at 24th and M Streets was 27° and at College Park it was 20°. The following note appears in the Daily Local Record on the 30th:

Killing frost this morning. Heavy damage to fruit reported from neighboring districts of Maryland and Virginia. The loss of peaches is estimated at 50%, apples at 25%, and the strawberry crop was badly damaged through Northern Virginia. Montgomery County, MD reports about 90% of the cherries and plums have been killed.

The winter of 1931-32. There have been three winter seasons since 1871 when March was the coldest month. These were the winters of 1889-90, 1931-32, and 1959-60. In the first two cases each of the three months, December to February, inclusive, was unusually

warm. December 1889 was the warmest of record (December 1984 later tied this record) and February 1890 was the warmest February of record (this mark has been broken many times since). November 1889 was about average in temperature. November 1931 was the warmest of record (this mark has been broken four times) and January 1932 was the warmest of record (see January 1950, above). March 1889 had an average temperature of 41.4° and March 1932 had only 40.0°. The winter of 1959-60 saw a warm December (average 42.0°), but January was only 2.4° above normal and February was actually 0.7° below normal. March 1960 averaged 35.6°, well below either March 1890 or March 1932; it was the coldest since 1885 and the third coldest ever known in Washington. The mercury never topped 40° during the first two weeks of March 1960; in fact, there were seven days when it never rose above freezing. These two weeks deserve a closer look:

<u>Day</u>	<u>High</u>	<u>Low</u>	<u>Avg.</u>	<u>Snow</u>
1	35	22	29	
2	34	22	28	0.8
3	26	21	24	7.1
4	29	19	24	Trace
5	27	20	24	
6	33	19	26	
7	30	18	24	Trace
8	31	16	24	
9	31	18	25	3.2
10	33	23	28	2.6
11	31	15	23	
12	36	21	29	
13	35	20	28	
14	39	34	37	
Totals	32.1	20.5	26.3	13.7

The average temperature for this period was much colder than a typical January; in fact, the average of 26.3° would place it *sixth* among all previous Januaries. The snowfall of 17.1 inches was equal to an entire winter's average for the Nation's Capital.

The coldest ten-day period in March 1890 occurred from March 1-10 and the temperature averaged 30.4°; that in 1932 was March 6-15 with an average temperature of 26.9°. The comparable period March 1-10, 1960 averaged 25.4°.

The coldest temperature of the entire winter season of 1931-32 was 14° on March 10; no other months saw the mercury fall below 24°. Similarly, the coldest temperature of 1959-60 was the 15° recorded on March 11, 1960, although the temperature dropped to 18° in December 1959. The cold weather of March 6-15, 1932 was brought on by one of the most intense storms ever to strike the District of Columbia. The lowest pressure reading of record for 24th and M Streets occurred at 2 PM March 6 when the barometer read 28.67". At Norfolk, Virginia, the pressure fell to 28.35" on this day, and Cape Henry recorded 28.32". The lowest pressure on record at these places and at Baltimore, Richmond, and Philadelphia occurred on this day. All of these records were later broken by the severe storm of March 13, 1993.

The following is copied from the Maryland section of *Climatological Data*:

THE STORMS OF MARCH 1932

Following what was, at Baltimore, the warmest winter in over 114 years, a series of low pressure systems developed over the Gulf of Mexico, moved northeast with increase in force, and gave Maryland, Delaware, and adjacent ocean regions gales, rain, sleet, and snow. The storm of March 6-7 caused the most damage in this section, the gales, particularly in the western portion of Maryland, being accompanied by rain, sleet, and snow, that intensified their effect. At Baltimore, the barometer reached the lowest point in over 62 years of record, being 28.68 inches at 2 PM, March 6.

The damage to communication lines alone was extensive and quite unusual in amount, exceeding \$1 million, while the grand total of damage from storms during the month is probably in excess of \$2 million. (Note: \$30 million in 2000 dollars) March 6-7: Rain set in over the section in the morning of the 6th, as the storm approached from the southwest, accompanied by increasing northeast winds, which reached gale force at times. With backing of the wind into the northwest, as the storm passed over the section, lowered temperatures resulted, the rain changed to sleet and then to snow, the snow ending during the night. The northwest winds increased to a gale in the afternoon and continued at gale force through the night and on the 7th. The rain was heavy, except in the Allegheny Mountain region, while the snow was light, except moderate to heavy over the western portion of Maryland with depths 3 to 7 inches in the Allegheny Mountain region, 6 to 9 inches in the Blue Ridge Mountain region, and 3 to 6 inches between the two mountain regions. Under the northwest gales the snow drifted badly, to heights of 5 feet or more in the Blue Ridge region, where hundreds of motorists were marooned and general traffic was interrupted.

Frederick County and adjacent portions of neighboring counties were isolated by the general prostration of communication lines, under the weight of accumulated snow upon the wires and the pressure of the gales against the poles; power lines were also prostrated. Several days to a week or more passed before restoration of service was possible in some districts.

Approximately \$1 million will be expended by the C&P Telephone Co. for extraordinary repairs, including a wide area of Maryland, Virginia, and West Virginia, necessitating replacement of 21,400 poles, 10,000 miles of open wire lines, and 60 miles of cable. On the 6th the weather was unusually stormy on the Chesapeake Bay. Hundreds of small vessels at anchorage were driven ashore by high tide and gale; wharves were also damaged. Five steamers, moored for scrapping at Fairfield near Baltimore, broke away; four were recovered and one sank. Grounding of a steamer at Sandy Point resulted in loss of the entire cargo of bananas. The severe cold wave of the 7th to 10th, the only one of the season, that followed in the wake of the snow, caused the death of 10 persons. March 22: Two workmen were killed at Baltimore when a piece of sheet metal on a tank, on which they were standing, was lifted by a westerly gust of gale force, throwing them to the ground 30 feet below. Slight property damage resulted locally over the section. March 27-28: High winds and a heavy fall of wet snow in Garrett and Allegany Counties during the night caused a general prostration of communication lines, resulting in a loss of \$500,000. One hundred telephone poles were leveled and roads were blocked by snowdrifts of 7 to 8 feet.

The high northwest winds on the 28th damaged some dwellings and barns, uprooted some trees, and felled some poles in Anne Arundel, Queen Annes, and Kent Counties in Maryland.

The following is copied from the Virginia section:

During March 6 and the forenoon of the 7th, a severe wind, rain, sleet, and snow storm caused two fatalities in Virginia and a property loss of \$555,000. The greatest property loss occurred in northern counties and throughout the Great Valley, where the damage, particularly to overhead wire systems, was severe. Heavy losses were also reported in the vicinity of Norfolk and around Chesapeake Bay, and minor damage occurred throughout the state. Some strawberries and tender truck, and the buds of peaches, pears, and plums were damaged severely by the low temperatures of the 8th to 10th. Apples escaped serious injury.

The cold wave of January 29, 1934. Since 1905 there have been only four occasions when the temperature fell 50° or more in 24 hours or less. These occasions were: March 29, 1921, which has been referred to above; February 9, 1933, when there was a fall of 52° from the preceding day; January 29, 1934, when there was a fall of 55°, and March 19, 1934, when the temperature fell 50° from the previous day. From this viewpoint the cold wave of January 29, 1934 was the second greatest for the period of record.

On the morning of January 28 the lowest temperature was 45°, and the wind was from the south and southwest. The temperature rose to a maximum of 65° from the hours of 2 to 4 PM. At 4 PM rain began and the lowest barometer reading of 29.16" was reached at 4:15 PM. At 5 PM the wind shifted to the northwest. The rain stopped at 5:40 PM and there had been a fall of only 0.03 inches. The minimum temperature on the morning of the 29th was 10°. The speed of the wind for the 12 hours following the shift on the 28th averaged 22.8 mph and for the 24 hours following it 22 mph. The barometer reading at 8 AM on the 29th was 29.96". The barometer continued to rise until 8 AM of the 31st when it read 30.45".

This cold wave is most noteworthy because of the persistence of the cold weather which it brought in. February 1934 was the coldest February on record at Washington. The average temperature for the first 28 days of January 1934 was 41.2° while the average temperature for the period January 29-February 28 was 24.0°.

The only similar temperature drop since the 1930s occurred on January 16-17, 1982. The high temperature on January 16 was 42° and the low temperature on January 17 was -5°, a fall of 47° in less than 24 hours. The reading of -5° was the lowest temperature since 1934 in Washington and the lowest of record at National Airport.

PRECIPITATION

SNOW

The greatest accumulation of snow in December has already been mentioned above in connection with the cold spell of December 1880-January 1881. The greatest 24-hour snowfall and the greatest accumulation of snow on the ground for February were likewise mentioned above in connection with the cold spell of February 5-15, 1899. Some additional noteworthy snowstorms are treated below.

The snowstorm of February 16-17, 1900. Snow began to fall at 7 AM February 16, when the temperature was 28°; it continued without interruption until 11 PM February 17. The total depth was 14.3 inches and the melted amount was 1.03 inches. This was the 10th greatest snowstorm on record.

The snowstorm of January 27-29, 1922. The greatest snowstorm in the meteorological history of Washington took place from January 27-29, 1922. Notes from the Daily Record appear below:

January 27: Snow beginning at 4:20 PM was exceedingly light and dry, and had attained a depth of about 9.0 inches at midnight.

January 28: Heavy snowfall continued throughout the day and until after midnight. There was approximately 18 inches of snow on the ground at 8 AM. Great confusion in traffic conditions existed through the day, increasing at night. Practically all traffic confined to street railway tracks, which were kept open through the day, but the car service was finally abandoned at 7 PM. The depth of snow at 2 PM was 25 inches, and 26 inches at 7:30 PM; it measured 28 inches at midnight. During this storm there occurred a great disaster, about 9 PM, when the roof of the Knickerbocker Theater at 18th Street and Columbia Road collapsed, killing 98 people and injuring more than 100 others.

January 29: The snowstorm abated materially after 9 PM of the 28th, but continued as light snow until 12:30 AM on the 29th. The total fall of snow for the storm was 28 inches, which is the greatest of record for this station. The water equivalent was 3.02 inches. An average of about 30 measurements, made in an open field on the Virginia side of the river at Ft. Myer, by Mr. H. Lyman, indicated a fall of 30 inches. Other measurements, taken in the vicinity of the Zoological Park, averaged about 30 inches, running as high as 36 inches in some places. Traffic conditions still in great confusion. 500 Marines were employed today clearing the tracks at the Washington Terminal Station.

January 30: The tracks of the Capital Traction Co. were cleared yesterday (Sunday), from Georgetown to the Union Station, although many suburban lines are still unable to operate, which is causing great inconvenience to a considerable portion of the population. Traffic conditions were very bad, confined chiefly to the car tracks on principal thoroughfares. All side streets practically blocked with deep snow, except to heaviest motorcars.

January 31: Considerable progress made today in clearing principal thoroughfares of snow. Side streets still badly blocked. Mild weather today melted snow quite rapidly.

This snowstorm is commonly referred to as the “Knickerbocker Storm” because of the disaster connected with it. The behavior of the wind and pressure deserves special note. From 10 PM, January 22 until 6 AM, January 30, a period of 176 hours, the wind blew from the east for 6 hours, from the northeast 50 hours, and from the north 20 hours. The lowest pressure was 29.93” at 1 PM, January 28, and the highest was 30.73” at 9AM on January 25. After January 28 the pressure rose to a high reading of 30.61” at 10:30 AM on January 30. During the 7-day period of north and northwest winds the average pressure was 30.41”. During the 32-hour period while snow was falling the average pressure was 30.10”.

The snowstorm of February 7, 1936. Snow began falling at 11:55 PM on February 6 with a temperature of 25° and continued falling until 4:45 PM of the 7th. During this period of slightly less than 17 hours 14.4 inches of snow fell; the melted amount was 1.01 inches. This was the seventh greatest snowfall of record.

The snowstorm of November 24-25, 1938. The snow of November 24-25, 1938 was the second heaviest ever recorded in November, but it is not the earliest ever recorded in the season for on October 19, 1940 there was a fall of 1.5 inches and on October 30, 1925 there was a fall of 2.2 inches. The earliest measurable snowfalls occurred on October 10, 1895 (1.5 inches) and October 10, 1979 (0.3 inches). The snow of 1938 did not entirely melt until December 1 and this established a record for the number of days with snow on the ground for November. The following notes are copied from the Daily Local Record:

November 24, 1938: Seven inches of snow fell on the 24th-25th, breaking all previous Weather Bureau records for November for 24-hour snowfall and for total monthly November snowfall. This storm began as rain at 9:30 AM on the 24th, turning to sleet and rain at 11:20 AM, at which time it began to freeze on autos and other cold surfaces. The pavements did not become slippery until about 6:30 PM. Snow (mixed with sleet) began at 7 PM, 24th, the sleet continuing until 9:30 PM and the snow until 4 AM of the 25th. During the evening and night of the 24th, slippery streets caused much trouble to traffic. Streetcars, autos, and busses stalled, causing many traffic jams.

November 25, 1938: Snow on ground at 9 AM, 7.0 inches. Pavements and sidewalks remained slippery until past midnight. The frozen snow and ice melted somewhat from middle forenoon, resulting in a slushy condition. Extreme wind velocity 29 mph NW at 1:10 AM. The total fall of sleet during this storm was 0.6 inch and the total of snow 6.4 inches. The snow did not completely melt until December 1.

Virginia reported that “snowfall was the greatest ever recorded in November and was seven times the normal snowfall.” The state average for November was 4.2 inches.

The following is copied from the Maryland and Delaware section:

The change to much colder weather on Thanksgiving Day was attended by heavy snow during the 24th and at night of the 24-25th in western Maryland and by light rain and light sleet during the 24th followed by moderate to heavy snow at night of the 24-25th in the central and eastern divisions. This snowfall was the heaviest of record in November.

Snow depths of the 24-25th increased from 2.5 inches in extreme southern Somerset County northward to 8 to 12 inches over the northern half of the section. Snow flurries occurred in north-central Maryland and light snow fell in southern Maryland and on the Eastern Shore during the night of the 26-27th. Light snow fell on the 27th and snow

flurries occurred on the 28th in the Allegheny Mountain region. The monthly average snowfall for this section, 8.3 inches, is 7.1 inches above normal.

The snowstorm of March 28-29, 1942. Rain began on March 28 at about 4 AM and lasted, except for a brief interruption, until 8:30 PM when it changed to rain and snow mixed and at 10 PM the precipitation turned to pure snow. The snow ended shortly before 5 PM on the 29th. The total duration of precipitation was 36 hours and the fall 2.05 inches. The duration of snow was about 19 hours and the melted amount 1.58 inches. The snowstorm of March 28-29, 1942 was not the greatest one in March as it was exceeded by the one of March 26-28, 1891, when the fall was 12.0 inches in a storm that lasted 41 hours and had a total melted amount of 2.44 inches. Nevertheless the snowstorm of March 28-29, 1942 was a heavy snowstorm for Washington as it has been equaled or exceeded only by 15 others since 1871. Notable snowstorms later than the one of March 28-29, 1942 have been recorded as follows: April 6, 1889, with 4.0 inches; April 11-12, 1894, with 2.0 inches; April 3, 1915, with 3.5 inches; April 11-12, 1918, with 3.0 inches; and April 1, 1924, with 5.5 inches. The snowstorm of 1942 is notable not only for being the second heaviest in March but also as the heaviest fall so late in the season and the greatest fall in 24 hours in March. The following notes are copied from the Daily Local Record:

March 29: The total snowfall for the 28th-29th, 11.5 inches, was the greatest 24-hour fall recorded in March since 1888. The wet snow accumulated to unusual depths on power lines and limbs of trees, causing considerable damage. Many suburban districts were without electric current all day Sunday and for some time Monday. The streets in Washington and vicinity were littered with fallen tree branches and there were many cases in which electric power lines sagged dangerously near the ground. Street car traffic was not much impeded and relatively few accidents were reported. By early afternoon many of the streets had been made quite passable.

March 30: Because of wet, packed snow many pavements and sidewalks were quite slippery in places in the early morning. By the middle of the afternoon and continuing throughout the day, pavements and sidewalks where the snow had not been removed were covered with slush.

The following is copied from the Maryland and Delaware section of *Climatological Data*:

The feature of the month was the phenomenal heavy snowfall of Sunday, the 29th. Heavy rain and light snow fell over the eastern half of the Eastern Shore, heavy rain and heavy snow over the western half of the Eastern Shore and over southern Maryland, very heavy snow over north-central Maryland and Washington County, moderate rain and light snow in Allegheny County, and light snow in Garrett County. The depths over the extensive area of heavy snowfall increased westward from 5 to 10 inches along the western boundary of Delaware, northward from extreme southern Maryland, and eastward from extreme western Washington County to above 20 inches in northern Anne Arundel, Howard, Baltimore, Carroll, eastern Frederick, and northern Washington Counties, with maximum depths of 31 inches at Clear Spring, 32 inches at Westminister, 30 to 36 inches at State Sanatorium, and 36 inches at Edgemont. It was a record snowstorm for March and for so late in the season; the maximum depths were the greatest of record within a 24-hour period. Under the weight of the very heavy snow some

branches and limbs were broken from trees and shrubbery was damaged. Some minor property damage resulted in Baltimore.

The snowstorm of February 16-17, 1958. This snowstorm, known as "The Blizzard of '58", was the biggest storm of one of the stormiest winters of the past fifty years in the northeastern United States. The snow occurred during a very cold ten-day period. The storm began as a low pressure area moved across the Gulf of Mexico from Texas on February 15. A very strong anticyclone pushed its way down from Canada, supplying a reservoir of cold air for the growing storm. The following is copied from news reports:

Snow began in Washington at 9 AM and within a day 14.4 inches had piled up. A 50-mile wide band of 15 to 20 inches of snow fell from Washington, D.C. northeast through Baltimore County, with Baltimore recording 15.5 inches. The Mt. Washington section of Baltimore received 24 to 30 inches of snow, and in Mount Airy 33 inches was measured, with a melted amount of 4.03 inches. Hagerstown saw 16 inches, and the Eastern Shore received 3 inches, but areas to the north got 13 inches. The powerful north winds blew at 25 mph with gusts to 35 mph, creating blizzard conditions and subzero wind chills. Coastal areas saw high tides and flooding as winds increased to 45 mph on the 16th. The additional blowing and severe drifting of snow paralyzed all transportation by land, air, rail and highway. Some drifts were 5 to 6 feet deep, and the strong winds continued through the day of February 17. More than five thousand people were stranded at Bowie Racetrack, leaving the parking lot littered with abandoned vehicles. Rescue trains evacuated most of the refugees, but more than five hundred people spent the night at the track. President Eisenhower was trapped by the deep snows while vacationing in Georgia. Severe thunderstorms were reported all along the path of the intense nor'easter. Annapolis reported lightning and a wind gust of 58 mph; lightning was also reported at Takoma Park. Wind damage was considerable in Talbot and Dorchester Counties on the Eastern Shore. Many trees were blown down, creating severe disruption of telephone and electrical service. Up to a million homes lost phone service as thousands of utility poles fell. The communities of Frederick, Annapolis, Aberdeen, Bel Air, and Havre De Grace lost power entirely and it was over a week before service was fully restored. Some 300,000 customers lost electric power at the storm's height, and Baltimore Gas and Electric estimated the storm damage to be three times greater than that of Hurricane Hazel in 1954. Damages totaled \$500 million in Maryland, Delaware, and Washington, D.C., with a total of 18 dead in the metropolitan area. Very cold air followed in the wake of the storm. Baltimore fell to 3°, and DCA reported a low of 5°, the lowest temperature since 1942. Schools remained closed until the 24th in some areas.

The snowstorm of January 29-30, 1966. January 1966 was the snowiest January since 1935. A snowstorm had left 6.9 inches on the ground on January 26 and temperatures remained below freezing prior to the arrival of this major weather event. On January 29, a low pressure system developed over Texas and moved eastward in advance of a record-setting cold air mass dropping down from Canada. Once the cyclone center reached the Carolinas, it deepened explosively, eventually bottoming out at 28.64 inches as it passed over Vermont on the 31st. The storm was the first true blizzard to strike the city since 1948 (a blizzard is defined as a snowstorm with winds of 35 mph or greater, temperatures below 20°, and visibility of one-quarter mile or less). The following is copied from news reports:

Washington was struck by a combination of high winds, heavy snow, and bitter cold as the storm moved past, paralyzing the city. The winds grew stronger as the storm wore on, peaking with a gust of 54 mph on the 30th. The total snowfall of 13.8 inches was the sixth greatest for Washington as of that date, but the howling winds created the worst problems, blowing the snow into ten-foot drifts. All highway, rail, and air traffic was halted and hundreds of motorists were marooned; many were rescued from their cars and led to shelter. Several people became disoriented in the whiteout conditions and were later found frozen to death, a very unusual occurrence in this area. Twelve deaths were blamed on the storm in the vicinity of Washington. The Skyline Drive in the Blue Ridge Mountains received 36 inches of snow; Baltimore, 12.1 inches; Dover, 12.0 inches; and Charlottesville, 24.0 inches. Another inch of snow fell on February 1, the first day that the Federal Government was able to reopen.

The Snowstorm of February 18-19, 1979. February 1979 was the coldest since 1934 and the snowiest single month at Washington since January 1922, the month of the "Knickerbocker Storm." Very cold air moved over the region in the wake of the first major snowstorm of the month which occurred on the 7th. This storm dropped 5.6 inches of snow and initiated a cold regime during which the temperature remained below freezing for 7 days. The temperature fell below 32° at 4 PM on February 8 and did not rise above freezing until noon on February 16. Another heavy snow, amounting to 5.6 inches, fell during this period, namely on the 12th. Temperatures again fell into the single digits following this storm and an estimated 6 inches of snow lay on the ground on the 18th when the great snowstorm commenced. The following is copied from news reports:

The temperature was 12° and the wind was 10 mph from the northeast when the first snowflakes started to fall at 4 PM. This was a cold storm, with the temperature remaining below 20° throughout; the high temperature on the 18th was 15° and the low was 6°, which was also the lowest of the entire month. Snowfall was continuous until 11 AM on the 19th, a period of 19 hours. For the two-hour period from 6 to 8 AM on February 19, snow fell at an estimated rate of 2-3 inches per hour and amounted to a total of 14.0 inches for that calendar day. The snowfall for February 18 was 4.7 inches at National Airport, giving a 19-hour storm total of 18.7 inches. This was the highest total of any snowstorm since January 1922 and ranked third on the all-time list (see above for the storm of February 11, 1899).

All transportation was crippled by the deep snow and the Federal Government remained closed for two days. A large group of farmers, in town to protest agricultural policies, earned the appreciation of local residents by using their tractors to pull trapped autos from the deep snowdrifts. Following the storm, there was severe criticism of local weather forecasters who had not foreseen the intensity of this tempest.

No further snow fell during February 1979 and the month ended with an accumulation of 30.6 inches, the most since January 1922 and the third greatest total of any month. It is interesting to note that during the ten years from 1972 to 1982 the temperature in Washington dipped into the single digits on only eleven occasions; six of these occurred in the month of February 1979.

The snowstorm of February 11-12, 1983. Since meteorological records have been kept in Washington, there have been snowstorms of 12 inches or more on 16 occasions. The average recurrence period for such a storm is therefore 12 years. Only four years after

the heavy snow of February 18-19, 1979, another deep snowfall hit the Nation's Capital. The following is copied from Weather Service reports:

Snowfall began between 9 and 10 PM in Washington and fell without a break for the next 30 hours. Light snow and northeast winds of 10-15 mph prevailed over the entire area by midnight of the 10th. The large ridge of arctic high pressure over Quebec prevented the low pressure system from moving northward, allowing tremendous amounts of snow to accumulate from Georgia to Maine. Snowfall in Washington increased after 7 AM on February 11th and thunderstorms were reported over a wide area throughout the morning hours. This convection caused the winds to increase, leading to blizzard conditions and zero visibility; winds of 80 mph were reported from the New Jersey coast. At 3 PM, the height of the storm, the temperature was 22°, winds were 20 mph from the north, and snow was falling at the incredible rate of 3 inches per hour. At this time all major airports from Virginia to New England were shut down; this entire area received 20 inches or more of snow. Rail and road travel was severely disrupted by the deep drifts and blowing snow; many motorists were stranded. The total snowfall from the storm amounted to 16.6 inches in Washington; this was the fourth greatest amount measured since records began in 1871. The melted equivalent of snowfall measured 1.94 inches, which set a February 24-hour record for the National Airport site. Exceptionally heavy snow, amounting to 30-38 inches, fell along the Blue Ridge. Two feet of snow lay in a band across Washington, Frederick, Montgomery, Carroll, Howard and Baltimore Counties in Maryland. The storm set a new 24-hour snowfall record at Baltimore with 22.8 inches. Parts of Northern Virginia and western Maryland measured as much as 30 inches on the ground; Hagerstown, MD reported 25 inches of snow, a new record.

The snowstorm of November 11, 1987. This was the greatest November snow in Washington history and broke all records set during the storm of November 1938. The following is copied from Weather Service reports:

Forecasts had called for only an inch or so of snow, expecting temperatures to be warm enough to melt most of the snow as it fell on ground that had been saturated with over an inch of rain on the previous day. But the precipitation was heavier and the temperatures colder than anticipated. Rain turned to freezing rain and sleet in the northern and western suburbs before midnight on the 10th, and elsewhere on the morning of the 11th. The snow, mixed with some sleet, fell throughout the day of the 11th and ended at 4:30 PM when a total of 11.5 inches had accumulated at National Airport. This broke the former November record of 7.0 inches set in 1938. Parts of Southeast Washington received 14 inches and a small portion of Prince Georges County, MD was buried by 17 inches. The melted equivalent of the snow at National Airport was 1.46 inches. An interesting aspect of this storm was the prevalence of thunder and lightning; thunder was reported from 9:25 AM and continued intermittently until 4 PM. Many observers commented on the spectacular greenish displays of lightning that occurred during the storm. Excessive snow, amounting to 15 inches, blockaded the Wilson Bridge and many motorists were marooned on the bridge for the night. The high temperature for November 11 was 35° and the low was 29°.

The snowstorm of January 6-8, 1996. This was the biggest snowstorm of the snowiest January since 1935. The following is copied from Weather Service reports and local news reports:

January 6: This blizzard was forecast at least a day in advance. Snow began falling in Washington between 7 and 10 PM on January 6, becoming very heavy overnight.

January 7: Snow continued throughout the day on January 7, accompanied by strong winds which reduced visibility to almost zero. The high temperature on this day was 23° and the low was 17°. Winds were northerly, averaging 19.7 mph, but gusts reached 37 mph. Total daily snowfall is 13.0 inches. The cold temperatures, heavy snow, and strong winds resulted in brief periods when true blizzard conditions existed in Washington, a rare occurrence.

January 8: Light snow and brisk northerly winds continued until 10 AM. The blowing snow has drifted badly, completely blocking all highways and bridges; all major airports have been shut down and the Federal Government is closed for the day. Snowfall for the day is 1.7 inches.

January 9: Additional snow flurries continued off and on, dropping an additional 2.6 inches of snow.

The four-day storm total was 19.7 inches and the depth of snow on the ground measured 20 inches, the greatest since January 1922. This blizzard was followed on January 12 by another storm that dropped 4.1 inches on National Airport. Snow depths for the week of January 8-14 averaged 17.1 inches at the official site, but they measured up to two feet in Fairfax County, VA and in Frederick County, MD. The following table gives the daily weather data for the storm:

Day	High	Low	Snow	Precip.	Wind
Jan 6	27	18	2.4	0.11	7.8 NE
Jan 7	23	17	13.0	1.19	19.4 N
Jan 8	30	20	1.7	0.16	19.9 N
Jan 9	27	15	2.6	0.26	2.9 SW
Jan 10	34	19	trace	0.01	11.4 NW

The month of January 1996 had a total snowfall of 23.8 inches, the most since January 1935. The floods that resulted from heavy rains and snowmelt later in the month are discussed under the section on Floods.

The snowstorm of February 15-18, 2003. This major snowstorm contributed to a monthly total of 28.7 inches of snow at National Airport, the fourth largest total of any calendar month since records began. A storm on February 6-7 had already dropped 6.6 inches on the Nation's Capital, though all of this had melted when the big storm began on February 14. The following is copied from Weather Service reports:

This storm was well forecast several days in advance, although its excessive amounts were underestimated. The storm began with rain at 10 PM on February 14 and snow commenced at about 7 AM on the 15th. Snow continued throughout the day on the 15th and 16th. Sleet and some freezing rain were reported during the afternoon of the 16th and on the 17th. The snow fell intermittently on the 17th and 18th but did not end until 7 AM on the 18th, when a total of 16.7 inches was measured at National Airport. Four-day totals at Dulles Airport and Baltimore were 22.4 inches and 28.2 inches, respectively. Both of these were single-storm records at these locations. This storm also broke the

January 1922 "Knickerbocker Storm" record at Baltimore. Two feet of snow was general over Montgomery County, MD and Carroll and Baltimore Counties; two feet was also measured in parts of Loudoun County, VA. The greatest measured total was in Berkeley Springs, WV, where 37 inches fell.

The storm was accompanied by winds averaging 16 mph for the three days February 15-17, which blew the snow into deep drifts. The entire region from Virginia to New England was paralyzed, closing airports and schools, shutting down the Federal Government for the first time since 1996, and creating great hardship. The monthly snowfall totals at Dulles Airport and Baltimore were the greatest ever recorded.

There are several items of interest associated with this storm. The snow melted fairly rapidly following the storm as temperatures rose into the 40s, but snow depths were still at 7 inches on February 21 when heavy rains and thunderstorms struck the area. On the 21st and 22nd, 2.56 inches of rain fell within 24 hours, setting a new February monthly record. These rains caused only moderate and local flooding, unlike those of January 1996. There were 10 days with snowfall at Washington during February 2003, the most since 1934. At National Airport, this was the coldest February since 1979 (33.7°) and the month was noteworthy for its lack of any mild weather. The warmest day was the 4th when the high was 54°.

SLEET AND GLAZE

Both sleet and glaze are common at Washington; outstanding cases are rare. Three are discussed below:

The sleet storm of February 19-20, 1927. On the night of February 19-20, 1927, 4.0 inches of sleet (ice pellets) fell. The sleet lasted almost exactly 12 hours. It was both preceded and followed by rain, the total duration of precipitation being 36 hours and 20 minutes; and the total fall of rain and melted sleet was 2.10 inches. This was the greatest sleet storm since the one of February 3-6, 1920, when 4.5 inches of sleet fell in a storm which lasted 61 hours. Notes appear in the Daily Local Record as follows:

February 19: Rain of this date changed to sleet at 4:15 PM, continued through the night, interfering very materially with street traffic. The ground was covered with about two inches at 8 PM and about 3 inches at midnight. Considerable melting in progress during the afternoon and evening.

February 20: Sleet continued until 4:10 AM of this date, then changing again to rain. The rain froze to trees and shrubbery, streets and walks, making unsafe and slippery conditions.

The pressure was 30.03" at 11:30 AM February 19, and fell more or less steadily to a low of 29.65" at 7 AM, February 20. The wind was mainly from the northeast. The following note from the Maryland and Delaware section is also of interest:

"Northeaster" of the 19th-20th. The high winds attending this storm were of gale force during the night of the 19th-20th over the eastern portion of the section. Extremely high tide resulted on the Atlantic coast. The tide was also high along the western shore of Chesapeake Bay. The storm produced heavy sleet and snow, 10 to 17 inches, in western Maryland; from the Blue Ridge Mountains eastward to the Atlantic coast heavy rain and heavy sleet fell in the northern and central portions of the section, and heavy rain in the

southern third. The fall of sleet in north-central Maryland was 3 to 7 inches; in southern Maryland and on the Eastern Shore, trace at the southern limit and 3 inches at the north. In western Maryland, train service was delayed by snowslides and drifts, roads were blocked, and 783 telephone poles were blown down. Along the Delaware coast, considerable damage was caused by the gale and the high tide as far north as Delaware City. The high water ranged from a 20-foot tide on the southern Delaware coast to 9.5 feet above mean low water at Delaware City. Some cottages were wrecked, some small bridges were floated, a part of Rehobeth pier was washed away, and small craft were beached. The new east entrance to the Chesapeake and Delaware Canal was damaged, and washouts occurred along the banks of the canal between Delaware City and St. George. At Delaware City and vicinity the damage was estimated at \$200,000. Elsewhere over the section, locally, some trees were uprooted and property was slightly damaged. The heavy fall of sleet on the 19th-20th disappeared on the 22nd on the Eastern Shore and in southern Maryland on the 23rd in north-central Maryland, except on the 26th in the Blue Ridge Mountain region. In western Maryland the fall of sleet and snow of the 19th-20th had not disappeared by the close of the month.

The ice storm of January 22-23, 1935. A notable instance of rain freezing as it fell (also termed "glaze" or "ice storm") was the one of the night of January 22-23, 1935. Precipitation began in the form of rain about 11 PM on January 21 when the temperature was 51°. Precipitation continued as rain until 12:40 PM, January 22, when it changed to rain mixed with sleet and the temperature had fallen to 34°. At 6:30 AM, January 23, the temperature was 28° and the rain and sleet turned to snow. The snow ended at 11:40 PM, January 23, with a temperature of 19°. During this 49-hour period the water equivalent of the rain, sleet, and snow which fell was 2.85 inches. The anemometer cups froze and the sunshine recorder failed due to being covered with ice. Notes appear as follows in the Daily Local Record:

January 22, 1935: Streets and walks slippery and dangerous at night, due to rain freezing as it fell.

January 23, 1935: Streets and roads in dangerous condition due to snow and ice. Great damage to telephones and wires in northern Virginia has been reported by Chesapeake & Potomac Telephone Co. In this section, about 2,500 poles were down. Gust velocity of wind, 37 mph N at 2:50 PM. Snow on ground:

9 AM,	1.0 inch
10:45 AM,	3.0 inches
Noon,	5.5 inches
1 PM,	6.5 inches
2:15 PM,	7.5 inches
4 PM,	8.0 inches
8 PM	11.0 inches
Midnight,	11.3 inches

More than 1,000 poles were felled on the Eastern Shore and several hundred poles were felled in southern Maryland under the weight of heavy glaze upon wires on the 22nd-23rd. The Virginia section mentions that three Norfolk, VA barges foundered in this storm with the loss of 13 men.

The sleet storm of February 8-13, 1994. The storm of February 10-11, 1994 was the worst to occur during one of Washington's iciest winters on record. Repeated storms

from January into early March produced between 19 and 23 days of icy precipitation over the region. A mixture of sleet and freezing rain began falling at 4 PM on February 8. The frozen precipitation continued, with some breaks, until 7 AM on February 13. The table below shows the temperature and precipitation for each day.

Day	High	Low	Precipitation	Sleet and ice
February 8	37	27	0.54	0.5
February 9	33	23	0.45	0.1
February 10	23	17	0.18	0.2
February 11	31	20	1.17	2.3
February 12	31	27	0.02	trace

The total fall of sleet amounted to 3.5 inches and was the most to accumulate in Washington since 1927. Precipitation ceased and the skies cleared at midnight, February 9, when much colder air moved in. This lull lasted until 10 PM February 10, when sleet and freezing rain again commenced, lasting until 4 PM on February 11. This is the period when the heaviest sleet fell. Freezing rain and drizzle then fell until the storm ended at 7 AM on February 13. The following is copied from local news reports:

Freezing rain caused a thick glaze of ice across trees, power and phone lines and roads. Travel was extremely hazardous. Trees and utility lines fell under the weight of the ice, leaving some customers without power and heat for up to two weeks due to the extent of the damage. This storm warranted a Presidential Disaster declaration for a swath of devastation from ice that stretched from Tennessee to Delaware. Damage to Maryland was estimated at over \$20 million. The ice storms left a coat of ice, one to three inches thick, across much of the area. Areas west of Frederick County, MD saw anywhere from five to nine inches of sleet accumulate. Toward the end of the storm, this area saw light freezing rain solidify the sleet on the ground. There were scattered outages and at least 75 ice-related injuries that were treated at area hospitals. Across central and northern Maryland, Northern Virginia, the Shenandoah Valley, and the central Piedmont of Virginia, about 4 to 7 inches of sleet fell. Again in this area, light freezing rain toward the end of the storm solidified the ice and coated everything.

The hardest hit area was Southern Maryland, Annapolis, the Eastern Shore, southwest across Fredericksburg and the Northern Neck area and down toward Lynchburg and Danville in Virginia. Here, the combination of the two storms left 3 to 5 inches of ice on surfaces. Some counties lost 10 percent of their trees. Fallen trees made roads impassable. It is estimated that 90 percent of the area was without power, some for as long as a week. A presidential disaster declaration was given for the counties affected in a 40 to 50 mile wide band all the way from Delaware southwest to Tennessee. Damages were estimated at \$100 million for the Virginia-Maryland area. There were hundreds of injuries from automobile accidents and people falling on ice.

PROTRACTED PRECIPITATION

Periods of precipitation lasting 48 hours or more are reasonably common, but most of the time there are interruptions with fair weather lasting several hours. The following list shows the cases of continuous precipitation of 48 hours or more for the period of record:

<u>Year</u>	<u>Date</u>	<u>Hours</u>
1889	April 25-27	56
1894	July 21-24	55
1899	February 11-13	56
1902	February 20-23	55
1903	April 13-15	48
1906	October 18-20	52
1907	January 15-17	48
1912	September 23-25	50
1914	December 5-8	59
1918	April 8-12	94
1920	February 3-6	61
1929	April 15-17	51
1935	January 21-23	48
1935	September 4-6	54
1937	April 24-27	57
1938	April 6-8	48
1940	November 13-15	54
1946	March 17-19	48
1952	April 24-28	114
1985	January 31-February 2	48
1985	October 20-23	77
1985	November 27-29	48
1985	November 29-December 1	50
1989	October 18-20	51
1992	December 10-12	49
1994	March 1-3	52
2002	October 29-31	48

The protracted precipitation of December 5-8, 1914. Rain began at 6 PM December 5, and continued without interruption until 4:25 AM of the 8th. Some sleet and snow was mixed with the rain on the 7th. The total precipitation during this 59-hour period was 1.64 inches.

No precipitation fell on December 3, nor until 11:50 PM of the 4th. Then there was precipitation each day through the 11th. The amounts and duration by days are given below:

<u>Day</u>	<u>Amount</u>	<u>Duration (hours)</u>
5	0.14	17
6	1.01	24
7	0.57	24
8	0.01	11
9	0.02	10
10	0.19	18
11	0.04	19

Each of these days was overcast and the wind was from a northerly direction.

The protracted precipitation of April 8-12, 1918. The longest duration of continuous precipitation at 24th and M Streets was from 5:15 PM, April 8, 1918, until 2:45 PM, April 12, 1918.

From the beginning of the rain until 1 AM, April 9, the wind was variable in direction and light. The next 5 hours it increased in speed and blew from the northwest. Then, from 6 AM, April 9, until 11 AM April 12, a period of 77 hours, the wind blew from the east 2 hours, from the northeast 37 hours, and from the north 38 hours. At 11 AM, April 12, it shifted to the northwest.

The daily maximum and minimum temperatures and amounts of precipitation are as follows:

<u>Day</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Precipitation</u>
April 8	61	45	0.22
April 9	53	37	1.44
April 10	42	38	1.57
April 11	38	32	0.46
April 12	38	32	0.35

On the 11th and 12th, 3 inches of snow fell as well as a trace of sleet. The highest pressure for the month was 30.50" at 10 AM on April 7. The pressure when precipitation began was 30.16" and the lowest pressure during the period was 29.81" at 2:30 PM on the 12th. The average pressure while precipitation was falling was 30.00".

The protracted precipitation of February 4-6, 1920. Rain began at 4:45 PM on February 3, and rain, sleet, or snow continued steadily until 5 AM February 6. There was some intermittent precipitation after this time on February 6. The wind blew from the northeast from noon February 3 to 7 AM, February 5, then from the north until 11 PM on the same day and then from the northwest until the end of the intermittent precipitation. The highest pressure for this month of February was 30.92" at 8 AM on the 1st. The pressure fell steadily until 8 PM of February 6 when it was 29.63". The following notes are from the Daily Local Record:

February 4: The fall of sleet, which continued throughout the day, after 9:15 AM, was about 3 inches deep at midnight causing some interference to traffic.

February 5: Rain during the early morning froze the trees, fences, and other objects covering everything with a film of ice. The sleet on the ground owing to rain freezing on surface and crusted to a depth of about one-half inch. Traffic conditions bad on all streets.

February 6: From nine measurements of the depth of snow and sleet on the ground taken with a snow sampler, in the immediate vicinity of the Weather Bureau's Station, after the end of the snow this morning, the following results were shown:

Average depth on ground	6.0 inches
Average water equivalent	2.17 inches
Average density	.366

Traffic badly hampered on all streets today.

The protracted precipitation of April 23-28, 1952. This was the longest duration of continuous precipitation in Washington's history and it broke the mark set in April 1918. Rainfall was "almost continuous" for a period of 137 hours and it was absolutely continuous from April 24 through April 28, a period of 114 hours. The daily records for this period are shown below.

<u>Day</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Precipitation</u>
April 23	88	54	0.21
April 24	54	46	0.44
April 25	52	46	1.40
April 26	52	47	0.92
April 27	57	51	0.75
April 28	61	55	0.17

Relative humidity remained at or above 77% for the entire six-day period, and there were no thunderstorms recorded. Rainfall totaled 3.89 inches at the airport site, but Baltimore was drenched by over seven inches, and even greater totals fell upstream along the Potomac River. Roads in Arlington and Alexandria were flooded, and US 1 was completely underwater near Laurel, Maryland. The heavy rains caused numerous traffic accidents which resulted in one death.

The protracted precipitation of October 20-23, 1985. Rain began at 3 AM on October 20, 1985 and continued until 7 AM, October 23, a period of 77 consecutive hours. This represents the third longest duration of continuous precipitation at the official Washington site and the longest ever at National Airport. Winds throughout this period averaged 10 mph from the northeast until 10 AM on the 24th, when they shifted to the south.

The daily maximum and minimum temperatures and amounts of precipitation are as follows:

<u>Day</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Precipitation</u>
October 20	71	52	0.27
October 21	57	50	1.12
October 22	62	55	0.78
October 23	71	58	0.01
October 24	67	60	0.01

The heaviest rainfall occurred from 8 AM to 11 AM on October 21, when 0.55 inches fell. Much heavier amounts, ranging up to several inches, fell in the Potomac watershed to the west of the city. This four-day event was followed by a dry period of six days when no rainfall was measured at the Washington site. On October 31, Tropical Storm Juan made landfall along the Florida-Alabama border and tracked slowly northward, reaching the central Appalachians on November 1. The storm produced copious rains over the mountainous regions of Virginia and West Virginia as it stalled in this area for four days. Tremendously destructive floods occurred throughout this region when the heavy rains fell on ground saturated by the previous rainfall of autumn 1985. The flood crest on the Potomac River rose to 30.1 feet at Harpers Ferry, West Virginia, a mark 2.4 feet higher than the crest from Tropical Storm Agnes in June 1972. At Richmond, Virginia, the flood crest measured 31.5 feet, the second highest ever, and damage was extensive. On November 7, the crest at Chain Bridge measured 18.0 feet, and at Wisconsin Avenue it measured 11.8 feet, both these marks being lower than those of June 1972. They were, however, the fifth highest of record along the river. The destructive flooding in Virginia and West Virginia took the lives of 69 persons and caused over \$500 million in damages. The autumn of 1985 was the eighth wettest ever recorded at the Nation's Capital, with a total rainfall of 14.99 inches.

FLOODS

Washington is so situated that it is subject to floods of four different types. First, it is subject to local flooding by locally heavy rains as are all places over the earth, even deserts. Secondly, as it is on the Potomac River, it is subject to floods when the river overflows its banks. This happens when there have been generally heavy rains over the entire Potomac Basin. Third, as occasionally cold winters occur when ice forms on the Potomac River it is subject to floods caused by ice gorges when the ice breaks up. Fourth, while Washington is more than one hundred miles from the Atlantic Ocean by air, nevertheless the Potomac River at Washington is at tide water. The Potomac River is an estuary as far as Key Bridge and is therefore subject to tidal flooding by tropical storms and noreasters.

LOCAL FLOODING

Local flooding is liable to result whenever heavy rains fall in a short time. The following list includes all cases where more than two inches of rain fell in one hour at the official site since 1905.

Year	Date	Amount
1905	July 5	2.77
1906	August 24	2.48
1912	July 14	2.61
1917	June 14	2.48
1922	July 13	2.79
1922	September 2	2.38
1926	September 2	2.15
1934	September 12	3.42
1939	September 4	2.85
1940	July 23	2.23
1944	August 2	2.18
1951	August 3	2.73
1953	May 5	2.10
1955	August 14	2.12
1969	July 22	3.29
1970	July 9	2.96
1975	May 22	2.18
2001	August 11	*3.50
2006	June 25	2.07

* Unofficial, but based on rain gauge measurement

Rains of this type are usually caused by thunderstorms although that of August 1944 was caused by a tropical hurricane. The next list includes all cases where more than 4.00 inches fell in 24 hours.

Year	Date	Amount
1874	September 15	5.66
1878	July 29	5.80
1886	June 22	4.16
1904	September 14	5.00
1905	July 5	4.22

<i>Year</i>	<i>Date</i>	<i>Amount</i>
1922	September 2	5.16
1924	September 29	4.53
1928	August 11	7.31
1933	August 23	6.40
1934	September 12	4.25
1935	September 4	4.49
1939	September 4	4.49
1942	August 8	6.05
1944	August 2	6.15
1953	May 5	4.32
1955	August 12	6.38
1955	October 14	4.98
1963	August 20	6.28
1966	September 13	4.12
1969	July 22	4.38
1970	July 9	4.69
1972	June 22	7.19
1975	September 24	5.31
1976	September 16	4.76
1993	November 27	4.03
1999	September 15	4.09
2001	August 11*	7.25
2005	October 7-8	5.94
2006	June 25-26	7.94

* Unofficial, but based on rain gauge measurement

The rains of September 1924, August 1928, August 1933, September 1935, August 1944, August 1955, June 1972, September 1975, September 1999, and October 2005 were associated with tropical hurricanes; these will be treated elsewhere. The unusual rains of June 2006 were caused by a succession of thunderstorms that stalled over the city; the 7.94 inches that fell in 24 hours represents the all-time local record.

The thunderstorm and rain of July 5, 1905. The following is copied from the Daily Local Record:

Thunderstorm from the west; first thunder heard at 5:10 PM, last at 1 AM, 6th. Very heavy rain from 7:25 PM to 8:38 PM during which time 3.26 inches fell. From 7:29 PM to 8:29 PM, 2.77 inches fell. Streets much flooded; deposit of sand and mud on car tracks impeded traffic on streetcar lines. In the southern and eastern parts of the city the rain was light during the storm, only a trace having fallen in some sections until later in the night. Very dark clouds and a number of flashes of lightning accompanied by heavy peals of thunder.

The rains of August 11-12, 1928. Rain fell continuously from 6 AM, August 11, 1928, to 9:45 PM, August 12 (with the exception of 45 minutes on the afternoon of the 12th). The measured depth at 24th and M Streets was 5.97 inches on the 11th and 2.70 inches on the 12th, making a total of 8.67 inches in less than 40 hours. No other period of 72 hours or less had a rainfall amount exceeding this value until June 2006. The Daily Local Record has notes as follows:

August 11, 1928: Thunderstorm, southeast; first thunder, 5:35 PM, last heard, 7:45 PM.

August 12, 1928: The storm of August 11-12th was the heaviest on record, 8.67 inches falling between 6 AM of the 11th and 9:40 PM of the 12th. 7.31 inches fell in the 24-hour period from 6:15 PM, 11th to 6:15 PM, 12th. Streets were submerged and cellars flooded in all sections of the city. Scores of people were removed from houses in Congress Heights. Traffic was most seriously interrupted east and south of Washington due chiefly to the washout of bridges. Sixty persons were trapped at Waldorf, Maryland, being forced to spend the night in automobiles. Potomac Park was flooded in places to a depth of more than one foot. No fatalities reported.

The following is copied from the Maryland and Delaware section report:

Northeast Wind and Heavy Rainstorm of 11th-12th

A tropical storm passed inland on the east-central Florida coast on the 8th and moved northward over the South Atlantic States. It overspread the Maryland-Delaware section on the 11th and continued on the 12th, the center moving northeastward over extreme southern Maryland. The northeast wind reached gale force during the night of the 11th-12th over the Eastern Shore and Chesapeake Bay and was high between the Bay and the Blue Ridge Mountains. It caused high seas on the Chesapeake Bay and high tide along the western shore and low tide along the eastern shore of the Bay. Many small vessels were torn from their moorings; some were damaged, others were swamped. Two barges broke adrift in the Bay. A tug foundered in Delaware Bay, and two men were drowned. At Ocean City 500 feet of boardwalk was undermined and several hotels were slightly damaged. Uprooted trees, in falling, broke wires, interrupting telephone and electric-light services. Corn fields were flattened. The rainfall was exceptionally heavy in the District of Columbia and southern Maryland, and thence northeastward across the section. Over this area the totals were between 6 and 10 inches, except between 10 and 14 inches over the northern portion of southern Maryland. At Cheltenham, Prince Georges County, the total fall for the storm was 13.25 inches, with a maximum of 11.66 inches in 24 hours. This is next to the greatest 24-hour fall of record; namely, 14.75 inches on July 26-27, 1897, at Jewell, Anne Arundel County, during a local thunderstorm. The heavy rainfall caused streams to rise above their banks and many small bridges were washed away in southern Maryland and on the northern Eastern Shore. The bridge at Upper Marlboro, Prince Georges County, was washed away, and 18 bridges were washed away in Charles County. A dam gave way at Millington, Kent County and another at Wye Mills, Talbot County. Roads were damaged and washouts occurred along railroad beds in southern Maryland and on the northern Eastern Shore. In western Maryland the storm was but little felt. Loss by wind and rain estimated at about \$1 million.

This rain was preceded by clear or partly cloudy skies on the 8th, 9th, and 10th. The barometer was remarkably steady on these three days and also the morning of the 11th; the barogram shows the diurnal variation very clearly. The lowest pressure for the month was 29.66" on August 11 at 11 PM. This rain was associated with a tropical hurricane which moved across the Bahamas and Florida.

The wet weather of September 1934. September 1934 was the wettest month on record at 24th and M Streets. An interesting fact about this is that no other station in either Maryland or Virginia had as much rainfall as the station in Washington. While it was the wettest month, neither the 72-hour nor the 48-hour maximum precipitation record was established at this time. In fact the only other maximum precipitation records established this month were those for 1 hour and for 30-minute durations, and these were on the 12th during a thunderstorm. Except for its excessive precipitation the thunderstorm was not

unusual for no hail was observed and the highest wind was only 18 mph. Local flooding was caused by the heavy rainfall this day.

The wet weather of September 4-6, 1935. The section's heaviest rainfall in a 48-hour period at 24th and M Streets was from 6 AM, September 4, to 6 AM, September 5, 1935, and amounted to 6.70 inches. The third heaviest rainfall in a 72-hour period begins 24 hours earlier and amounts to 6.83 inches. This rain was caused by a tropical hurricane. The wind was relatively light in Washington. The extreme wind speed was 19 mph and this was at the time the rain stopped on the 6th; the average wind speed during the rain was less than 6 mph. No thunderstorm accompanied this hurricane. The following is copied from the Maryland and Delaware sectional report:

The excessive rain of September 4-6, 1935 in Maryland and Delaware. The Florida hurricane that developed southeast of the Bahamas August 30, 1935 recurved over the Matacumbe Keys, and after passing the Florida coast east of Apalachicola moved northeast over the Carolinas and Virginia, crossing the lower Chesapeake Bay north of the Virginia Capes the night of September 5. It lost most of its wind force in its course over land, so that unusual gales and very high tides did not occur. In Maryland and Delaware, on the coast, winds were estimated at 50 to 55 mph. Over the north Atlantic, winds of hurricane velocity were again attained. The disturbance was preceded by low pressure and unsettled, humid weather in the Atlantic States, with rains beginning as early as September 1 in the Middle Atlantic States. An unusual feature was a local tornado near Farmville, VA, on the 5th and another on the 5th in southern Maryland. Excessive rains attended the northwest quadrant of the disturbance, falling on the 4th to 6th in Virginia and Maryland, the estimated damage to crops (principally corn) in Virginia, being \$1.65 million, and to highways \$450,000. In Maryland and Delaware the damage was confined to the southern area comprising about two-thirds of Delaware and one-third of Maryland. The damage was especially heavy in Talbot, Caroline, and Dorchester Counties of Maryland, where rain of 15 to 16 inches occurred within a period of 52 hours. In Dorchester and Caroline Counties the damage to tomatoes alone is estimated at \$300,000. At Federalsburg, Caroline County, flood waters caused damage estimated at \$500,000 and many people were made homeless. The entire loss was so general and widespread in the counties affected that is impracticable to give a close estimate of it. It is probably around \$2 million (\$28 million in 2000 dollars). The rainfall was the greatest of record in any one storm in the following counties: Charles, St. Marys, Prince Georges, Calvert, Dorchester, Wicomico, Somerset, Talbot, Caroline, and Queen Annes in Maryland, and Sussex and Kent in Delaware. Some total amounts of rain in 51 to 52 hours were as follows: Easter, 16.63 inches; Cambridge, 15.15; Ridgely, 14.56; Salisbury, 12.10; Solomons, 11.39; Princess Anne, 12.10; Bridgeville, DE, 12.60; Milford, DE, 11.89.

The rain of August 8-9, 1942. This rain was not associated with any tropical hurricane and neither was any thunderstorm observed on these days. The following is copied from the Daily Record.

The almost continuous rainstorm that began 5:12 PM, August 7, and ended 2:50 PM August 9, was one of the heaviest August rainfalls at Washington since 1871, when the records began. 6.04 inches fell in the 24-hour period, 3:20 AM, 8th to 3:20 AM, 9th. This 24-hour rainfall was exceeded only once during previous Augusts, on August 11-12, 1928, when 7.31 inches fell. The heavy rain caused some damage to crops, inundated lower sections of the District, flooded many basements and blocked auto traffic on some streets. Light fog until 2:30 PM.

From the Maryland and Delaware section report:

Heavy rains of the 8th-9th yielded 3 to 6 inches in southern and north-central Maryland. Flood waters from the Anacostia River were 4 feet deep in the business section of Bladensburg and forced 30 families from their homes at Edmonston, west of Hyattsville. The highway near Upper Marlboro and the highway 6 miles west of La Plata were covered by 2 to 3 feet of water. Homes and the airport fields at Dundalk were flooded. Parkton was inundated by flood waters 10 feet deep; homes and buildings were flooded.

The rain of August 2-3, 1944. The following is copied from the Daily Local Record:

Firemen and sewer department employees today continued pumping water out of hundreds of basements flooded by yesterday's torrential downpour, the heaviest in 2 years, which forced approximately 450 persons from their homes, disrupted traffic, and marooned thousands in homes, offices, and stores. Several cars in Silver Spring were damaged when a brick wall at the Wolfe Motor Co. on East-West Highway was loosened by the rain and caved in, police reported. 35 families on Valley Street SE, near Anacostia High School, were removed to the school, while others were rescued from flooded houses in the 3300 block of Croffut Place SE. Streets here were converted into miniature canals by the driving rain. Government employees, many of them removing their shoes, sloshed through 2 feet of water at Constitution Avenue and 14th Street NW. At many intersections Constitution Avenue looked like a roaring stream during the downpour. The avenue was practically deserted of automobiles, except for taxicabs jammed by stranded persons going home. Elsewhere throughout the city bus and streetcar traffic was frequently tied up with passengers in many cases forced to wade in foot-deep water as they left the vehicles. Metropolitan police reported that the hardest-hit sections were the low-lying area around Gallinger Hospital on the Anacostia River, the municipal fish wharf where a storm sewer top was washed off as the water in it backed up, and the blocks in Half Street SW, between 700 and 1000. Throughout the night weary firemen answered emergency calls from householders whose basements had been flooded. By 9 AM today 200 complaints had been answered.

The thunderstorms and rain of August 19-20, 1963. Three waves of heavy thunderstorms moved slowly across Washington over a 24-hour period. The heaviest rains fell in the area of National Airport and Arlington, Virginia. The storm of the night of August 19 dropped 1.45 inches of rain and the two storms on the following day dropped a total of 4.83 inches of rain. The total 24-hour rainfall at National Airport was therefore 6.28 inches, an amount exceeded by only four other events in Washington's weather history, namely the tropical storms of August 1928, August 1933, June 1972, and August 1955. Many highways were flooded and the airport itself was swamped with several feet of water, which wrecked the electrical system and forced its closure. Flood waters 5 to 6 feet deep raged through the Arlandria section south of the airport and at least 100 persons were forced from their homes. One person was reported drowned in this area. The flood was gauged to be 10,000 cubic feet per second at the mouth of Four Mile Run at 9:35 PM on August 20, the greatest flow ever measured on the stream. This was almost three times the flow measured on May 5, 1953 after another torrential thunderstorm struck the area.

The thunderstorms and rain of July 22, 1969. A cluster of slow-moving thunderstorms passed across Washington during the evening hours of July 22, 1969. The storms approached from the northwest and moved southeast across the southern part of the city and into Maryland. A total rainfall of 4.38 inches was measured at National Airport, of which 3.29 inches fell in one hour. The following is copied from *Washington Weather*:

The flooding resulting from the thunderstorms of July 22, 1969 was particularly devastating in the Arlandria section, located along Four Mile Run between Arlington and Alexandria, Virginia. The water level was measured at 19 feet during the storm, breaking the record of 17 feet set in the flood of August 1963. The flooding was so severe that the 10-foot water gauges which measure flood levels around Route 1 and Mt. Vernon Avenue were completely submerged. A local shopping center suffered severe damage and broken windows, and the flood waters also swept several local automobile dealerships clean of their cars; twenty automobiles were later found in Four Mile Run after the flooding subsided. The storm also forced the cancellation of the All-Star baseball game at RFK Stadium in the District. President Richard Nixon and 40,000 other fans were caught in the sudden cloudburst, which filled the dugouts chest-deep with water. Even heavier rainfall was measured in southern Maryland when the storms passed through that section: Leonardtown, MD recorded 12.44 inches of rain that night.

The thunderstorm rains of August 11, 2001. Although rainfall from this storm amounted to only 0.92 inches at National Airport, this event is included for study because of its spectacular and damaging effects across a wide area of the District of Columbia. From 6 to 7 PM on August 10, thunderstorms struck an area from western Fairfax County, VA to northern Prince Georges County, MD. Maximum rainfall from these storms amounted to 2.60 inches in the northern parts of Arlington County and the District. The next day, August 11, a cold front approached the city from Pennsylvania and stalled near the border of Maryland. Moisture convergence to the south of this front led to some of the greatest short-term rainfalls ever measured in Washington, beginning at about 2:15 PM on the afternoon of August 11. The heaviest rainfall began at 3:30 PM and lasted for two hours, during which time over seven inches fell in portions of the District of Columbia. One rain gage totaled 6.06 inches between 3:30 and 5 PM; another gage overflowed after its capacity of 7.25 inches was reached. These maxima were recorded in Northwest Washington, west of Rock Creek Park and north of M Street NW. Roadways were completely flooded and several parked cars were moved by the rushing torrents. Rock Creek Parkway was completely under water and fish leapt from the water that covered the normally dry bike path. Hundreds of basements were flooded throughout Northwest Washington and power was cut off to thousands of customers, some for several days. The area received a presidential disaster declaration the next day, the first time this had ever occurred in the District of Columbia.

The thunderstorm rains of June 25-26, 2006. An entrenched trough of low pressure yielded five consecutive days of rain and thunderstorms in the Washington, D.C. area. The official total at DCA was 7.94 inches in 24 hours, the most in the city since Hurricane Agnes in June 1972 and the greatest in weather history. The all-time mark of 7.31 inches, set in August 1928, was broken by this event. Some rainfall totals from the area appear below.

Site	24-hour Rainfall
Washington National Airport	7.94
Dalecarlia Reservoir	5.73
National Arboretum	7.37
Columbia, Maryland	8.42
Potomac	6.50
Bethesda	4.90
Gaithersburg	4.48
Takoma Park	6.24

Oxon Hill	5.03
Manassas, Virginia	3.40
Herndon	6.57
Fairfax City	4.12

After a night of torrential rain, commuters face downed trees, closed highways, and flooded intersections; the Beltway was closed by a mud slide at Telegraph Road that dumped five feet of earth on the highway, and Metro service was disrupted by high water that flooded downtown stations. More than 30,000 homes were without power by Monday morning, and lightning strikes had cut electricity to a total of 100,000 over a three-day period. The unprecedented continuous thunder, lightning, and heavy downpours battered the entire region, and there were dozens of rescues of trapped motorists during the evening hours. Five people died in Frederick County, Maryland. The basement of the Internal Revenue Service Building, on Constitution Avenue, was inundated by five feet of water. Heavy rains from the same storm system, which ranged for hundreds of miles north and south along the East Coast, caused severe flooding in northern Dorchester and southern Caroline counties on Maryland's Eastern Shore, washing out roads and forcing some residents to be evacuated from their homes. The largest amount of rainfall was reported in Hyattsville, where 10.06 inches of rain fell over a 24-hour period. The official site at National Airport recorded the following totals from June 19-29:

<i>Date</i>	<i>Rainfall</i>
19	1.99
20	0.03
21	0.00
22	0.04
23	0.68
24	0.14
25	5.19
26	4.22
27	0.93
28	0.17
29	Trace

Total precipitation for this period amounted to 13.39 inches. June 2006 ended with 14.02 inches of rain, breaking the monthly record of 11.53 inches set in June 1972. In addition, the 10.34 inches of rain that fell in 72 hours shattered the old record of 8.72 inches set in August 1955 during Hurricane Connie. During the five hours from 8 PM June 25 to 1 AM June 26, 5.89 inches of rain fell. This was also the only time in weather history that Washington, D.C. recorded two consecutive days with rainfall exceeding 4 inches.

POTOMAC RIVER FLOODS

Since 1871 there have been nine major floods along the Potomac River that have affected Washington, D.C. Besides those mentioned here, notable floods took place in October 1896, April 1937, and March 1924.

The flood of May 31-June 1, 1889. The following note about this flood and the weather accompanying it are copied from the Daily Journal.

May 30, 1889: Cloudy, dense fog in morning. Fresh and brisk southeast winds.

Thunderstorm 3:20 to 6:45 PM moving from southeast to northwest. Wind before storm southeast, temperature 80.3°. Wind after storm southeast, temperature 70.5°. High wind reached velocity 28 miles, extreme velocity 30 miles. Rain excessive (1.42 inches) from 3:20 to 6:45 PM.

May 31, 1889: Cloudy. Excessive rain from midnight to midnight, amounting to 2.98 inches; cool. Great damage to the farming interests from heavy rains during the month in the vicinity of Washington.

June 1, 1889: Heavy rain during the night. Potomac River rising rapidly; great danger of high water. People preparing for it. Cleared away in the morning. Fresh northwest wind.

June 2, 1889: Cloudless. The river reached its highest point about the middle of the day. The water was about as high as ever before. Great damage along the river front and lower part of the city. A span out of the Long Bridge.

The flood crest at Georgetown reached 19.5 feet, the highest ever recorded in the Nation's Capital. Flood waters inundated the downtown sections of the city and reached as far as the Capitol Building, where the high water marks were chiseled into the gate posts.

It should be noted that the rainfall in the mountainous areas to the west was much higher than that of Washington during this period. Some parts of western Maryland and Pennsylvania received more than 8 inches of rain over a three-day period. These excessive rains led to the bursting of a dam which destroyed the city of Johnstown, PA on May 31, killing more than 2,200 persons.

The flood of May 13-14, 1924. The following is taken from the Daily Local Record, and from the Maryland and Delaware sectional report:

The second great flood of the Potomac River reached a crest stage of approximately 12.2 feet at high tide, 3:44 AM this date—the most destructive flood in the lower river since 1889. Heavy property losses were sustained at Cumberland, Harpers Ferry, Point of Rocks, and in the vicinity of Washington, and much damage was done to the C&O Canal. Total losses estimated at \$1 million, exclusive of damages to the canal. No loss of life has been reported. Crest stage at Cumberland, 13.8 feet, 3 PM, May 12. Crest stage at Harpers Ferry, 27.6 feet, 9 AM, May 13 (9.6 feet above flood stage).

As a result of moderate to heavy rains on May 7 and 8, over the Potomac and Shenandoah watersheds a moderate flood occurred at and immediately below Harpers Ferry, WV, during the night of May 9-10. Steady rain that set in again on May 11 over the now thoroughly saturated watersheds resulted in the most extensively destructive flood in the lower Potomac since 1889. Near 9 AM on May 12, Cumberland, MD reported a stage of 12 feet (4 feet above flood stage), with the Potomac rising and Wills Creek flooding a portion of the city, and at about the same hour reports from Riverton, VA, on the Shenandoah River indicated a considerable rise (though the flood stage was not yet reached) in that river. The crest occurred at Cumberland with 13.8 feet at 3 PM on May 12, and a slow recession of water began at that place. Rains stopped in the afternoon of the 12th, but a steady rise continued below Cumberland and in the Shenandoah at Riverton, finally reaching a stage of 34.0 feet (12 feet above flood stage) at the latter place at 8:30 PM of the 12th, and of 27.6 feet (9.6 feet above flood stage) at Harpers Ferry at 9 AM of the 13th. In the early morning of the 13th the flood stage of 8 feet was passed at Washington, where the rise continued steadily to a crest of

approximately 12.2 feet at high tide, 3:44 AM, May 14. No fatalities were reported, except one unconfirmed newspaper statement that the body of a man had been washed ashore at St. Johns Run, MD. Losses were approximately \$35,000 each for Cumberland and Harpers Ferry, and \$15,000 for Point of Rocks, MD. It is probable that \$1 million will cover the total damage of the flood, exclusive of that done the C & O Canal.

The flood of March 19, 1936. The highest water stage of record at the gauge on the Potomac River near Washington (above tide water) was on March 19, 1936. The following is copied from the Maryland and Delaware section of Climatological Data:

The River Floods of March 1936

The unusually cold winter of 1935-36 caused heavy ice in practically the entire Potomac River system; the streams were frozen, except the swiftly running water, over a period of several weeks in January and February. In addition to the heavy ice in the rivers the entire drainage basin was covered with snow averaging more than 15 inches in depth. Several days of mild weather and warm rains late in February and early in March of this year caused moderate rises and some gorging with the breakup of ice. Crest stages, due to this cause, were well below flood stage at all points, except at Sycamore Island, MD, where the crest was 1.4 feet above flood stage. Some damage occurred to bridges in the Shenandoah River from ice gorging, but elsewhere the damage was slight. By March 16 all streams were falling although the stages were several feet above normal. On March 17 a storm that originated in Texas two days before had moved to south-central North Carolina and was causing general rains over the Middle Atlantic seaboard and the upper Ohio Basin. These rains were unusually heavy in the upper portion of the Potomac Basin where amounts in excess of 4 inches occurred in less than 12 hours over a large area. The 48-hour amounts over the entire drainage basin of the Potomac ranged from slightly less than an inch over the lower reach to more than 5 inches over the headwaters. The occurrence of a period of mild thawing weather of several days duration just prior to the heavy rainfall left the soil in a well-saturated condition and the percentage of runoff was unusually high. This, coupled with the fact that the rivers were somewhat above normal stage when the heavy rainfall began, gave the most disastrous Potomac River flood since records began. From below Cumberland, MD to Washington, D.C., the gauge heights exceeded the flood of 1889. Practically all towns along the rivers suffered inundation to some extent. Numerous bridges were wrecked and carried away; many miles of highway and railroad tracks were washed out and badly damaged. The loss of life was not considered great, considering the magnitude of the flood.

The following table shows the flood crest heights, in feet, at various points along the Potomac; all of the crests remain the highest of record at each station.

Station	Flood Stage	1936 Flood Crest	Date
Cumberland, MD	17.0	29.1	March 18
Paw Paw, MD	25.0	54.0	March 18
Hancock, MD	30.0	47.6	March 18
Williamsport, MD	23.0	48.6	March 18
Harpers Ferry, WV	18.0	36.5	March 19
Point of Rocks, MD	16.0	41.0	March 19
Chain Bridge	10.0	28.1	March 19
Wisconsin Ave	7.0	19.8	March 19

The flood of October 17, 1942. On October 17, 1942, the second highest water stage of record was reached at the Wisconsin Avenue gauge on the Potomac River at Washington. The following table is copied from the *Monthly Weather Review*:

Station	Miles from Washington	October 1942 Stage	Date	Time
Cumberland, MD	196	24.1	October 15	4 PM
Shenandoah, Riverton, VA	118	46.0	October 16	4 AM
Potomac, Hancock, MD	127	36.6	October 16	3 PM
Williamsport, MD	98	36.1	October 16	7 PM
Harpers Ferry, WV	60	33.8	October 16	6 PM
Washington, Chain Bridge	6	26.9	October 17	5:45 AM
Washington, Wisconsin Ave	0	17.5	October 17	7 AM

The following is copied from the Maryland and Delaware sectional report:

The Potomac River Flood of October 15-17, 1942

The crest of this flood was several feet below the crests of the June 1889 and March 1936 floods, but several feet above the crest of the October 1937 flood. It reached Cumberland, MD at 6 PM of the 15th; Hancock at 5 PM; Williamsport at 8 PM; and Washington, D.C. at 8 AM of the 17th. At Cumberland downtown streets were covered with 3.5 feet of water; damage estimated at \$50,000. At Hancock the main business street was covered with 8 feet of water; damage estimated at \$10,000. At Williamsport the flood spread over the lowlands to a distance of 4 miles from the river; damage estimated at \$5,000. Two homes were carried away at Harpers Ferry, WV. At Point of Rocks several houses were lifted from their foundations. A number of waterfront shacks were destroyed at Brunswick. The water was 6 feet deep at Point of Rocks and 7 feet deep at Brunswick over the tracks of the B & O Railroad. The number of families forced from their homes by the flood were: Cumberland, 350; Ridgely, WV, 30; and Point of Rocks, 40. At Washington, D.C., 1.5 feet of water covered Maine Avenue along the waterfront for one hour, slight damage was caused at the Navy Yard and hundreds of homes in Georgetown were flooded. The B & O Railroad suffered property damage of \$52,000 and rolling-stock damage of \$24,000 in Maryland. Streams were in flood on the 16th in north-central and southern Maryland. The boulevard in Bladensburg was covered by 6 feet of water by the flood from the Anacostia River. Repairs to highways in Maryland cost \$86,000.

The following is copied from the Virginia section:

October 1942 was the fifth wettest of record, but the rainfall was unevenly distributed. At Fredericksburg, Manassas, Mt. Weather, Riverton, Winchester, and Woodstock, it was the wettest month of record, and at six other stations it was the wettest October. At Big Meadows, in Madison County, 12.30 inches of rain fell during the 24 hours ending at 4:30 PM on October 15. This is probably the greatest 24-hour rainfall ever recorded in Virginia. Torrential rains in central and northern Virginia from the 12th to the 16th caused one of the worst floods in the history of the state. Little damage occurred along the James except to crops in the river bottoms, but all of the streams north of the James reached stages not equaled for more than 50 years. Complete figures covering the damage are not yet available, but the total will be several millions of dollars. At Fredericksburg alone the damage was estimated at \$2 million. Numerous highway and railway bridges were washed away. County agricultural agents estimated that 1,000

miles of fence was destroyed. About 1,300 people were made homeless in Albemarle, Spotsylvania, Stafford, and Warren Counties. One death was caused by the flood. Traffic of all kinds was interrupted for 3 or more days. Crops were adversely affected and fall harvesting made little progress.

The meteorological conditions associated with the heavy rain which caused this flood are of special interest. The warmest temperature at 24th and M Streets for this month of October was 81°, on October 9. From 5 AM, October 10, to 10 PM, October 17, a period of 185 hours, the wind blew from the east 13 hours, from the north 27 hours, and from the northeast 145 hours. Rain initially began at 1:55 AM October 13, and finally ended at 7:50 AM, October 17. The number of hours with rain, the total amount of rain, and the mean temperature are given in the table below:

<i>Date</i>	<i>Duration (hours)</i>	<i>Amount (inches)</i>	<i>Mean temperature</i>
October 13	19	0.80	57.8
October 14	20	1.51	64.5
October 15	21	2.59	67.2
October 16	24	1.04	66.7
October 17	8	0.33	61.8

October 15 was the warmest day of the month as shown by the above table. The maximum temperature was 69° and the minimum 66°. The pressure was relatively high while the rain fell. The rainfall was the result of the slow-moving remnants of a tropical system that moved inland over North Carolina on the 12th.

The flood of August 20, 1955. The Potomac River flood of August 20, 1955 resulted from two separate tropical hurricanes that passed over, or close to, Washington, D.C. in a period of 5 days. The first hurricane, Connie, came ashore at Wilmington, NC on August 11 with sustained winds of 114 mph. Extensive damage occurred along the Outer Banks of North Carolina as the storm moved due northward. Connie's path led directly up the Chesapeake Bay and the storm center passed between Washington and Annapolis at 7:30 AM on August 12. This was the last time, as of this writing, that a tropical hurricane passed over the Nation's Capital. Strong winds, high tides, and excessive rainfall accompanied the storm, causing extensive damage to waterfront areas along the Potomac River and the Chesapeake Bay. National Airport totaled 6.38 inches of rain from the storm, the most in August since the 1933 hurricane and one of the greatest 24-hour rainfalls ever recorded. Many local streams flooded, streets were eroded in Bladensburg, and the Potomac River rose four feet. Four people drowned in Rock Creek when their car fell into the swollen stream near P Street in Georgetown. The hurricane's worst disaster occurred on the Chesapeake Bay that night when an excursion sailing ship capsized off Chesapeake Beach, drowning 14 persons.

On August 16, Hurricane Diane came ashore very near the same spot that Connie had struck five days earlier. The storm's path made a wide loop to the west and north of Washington, drenching the mountains of central Virginia and Maryland with more heavy rainfall. These rains, falling on saturated ground, led to severe flooding along much of the Potomac River. The table below shows the daily weather at National Airport:

Date	Rainfall (in.)	Wind (mph)	High temp	Low temp
August 12	5.44	58 NE	75	69
August 13	1.16	48 NE	80	71
August 14	2.12	28 SE	84	68
August 15	0.00	18 SE	86	73
August 16	0.27	30 S	86	74
August 17	0.40	40 E	81	74
August 18	1.08	40 S	79	74
<i>Total</i>	10.47		81.6	71.9

The Potomac River crested at 8.8 feet at Wisconsin Avenue on August 20. Four persons died in the immediate vicinity from the second hurricane's effects. Damages were estimated at \$80 million in Virginia, Maryland, and the District of Columbia. Far worse destruction occurred in Pennsylvania, New York, and New England, where 170 people died. Diane was termed "The Billion-dollar Hurricane" since it was the first tropical storm to exceed this level of damage. Thunderstorms were recorded at National Airport on August 14 and 16, but the storms of the 14th were associated with a cold front and not the first hurricane. Monthly rainfall at Washington totaled 14.31 inches, the fourth greatest of any calendar month and the most since 1934 in the city.

The floods of June 21-22, 1972. Hurricane Agnes, a minimal Category I storm, made landfall on Florida's Gulf Coast on June 19. It moved slowly northward, passing over Georgia and reaching South Carolina on the evening of the 20th. The storm intensified as it moved over the Carolinas and into the coastal waters east of the Chesapeake Bay. Gale-force winds extended outward two hundred miles from the storm center, with many areas experiencing sustained winds of 55 mph and gusts of 70 mph. Extraordinary rainfall, averaging between 8 and 10 inches, occurred over the river basins of Virginia, Maryland, Pennsylvania, and New York as the tropical storm moved northward. In Washington, precipitation amounted to 8.16 inches from the 20th to the 23rd. A total of 7.19 inches fell within 24 hours on June 21-22, which is the second greatest 24-hour fall of record in the city. The highest total in the immediate vicinity was 16 inches, recorded in Chantilly, Virginia, about 20 miles west of the city. The excessive rains on the Potomac watershed led to the worst flooding since 1936 in the region. The table below shows the flood crests from this storm compared to the record crests:

Station	Flood stage	June 1972 crest	1936 crest
Paw Paw	25.0	28.8	54.0
Hancock	30.0	30.8	47.6
Williamsport	23.0	34.0	48.6
Harpers Ferry	18.0	27.7	36.5
Point of Rocks	16.0	37.4	41.0
Chain Bridge	10.0	22.0	28.1
Wisconsin Ave	7.0	15.5	19.8

The following is copied from local news reports:

Extensive damage occurred along the Potomac, especially to the C & O Canal. Many bridges and railroad tracks were washed out and two motorists died in Montgomery County when their cars were swept away by the raging waters. Hundreds of families were evacuated from the flood-prone Four Mile Run area of Arlington. Police closed the P Street Bridge to all traffic when the roadway began to visibly undulate, leading to fears that the entire structure would collapse. The situation was even more serious in Northern Virginia, where thirteen people died. Trailer parks and entire subdivisions in Prince William County were inundated, forcing families to flee for their lives. Dozens of roads and bridges were washed out, blocking highways and isolating thousands of people. The most serious danger involved the many dams scattered throughout the Piedmont area in Virginia and Northern Maryland. The Lake Barcroft Dam was actually breached by the floodwaters, sending a thunderous torrent of water downstream into Holmes Run Valley. The main dam structure was saved when the breach reduced pressure on the dam. Over six thousand people lost electricity, and thousands more lost phone service, as Agnes' gusty winds toppled trees and poles throughout the region. To the south, Richmond's James River reached its highest crest in history, dating back over two hundred years. A 200-block area of downtown Richmond was inundated, and only one bridge over the river remained open, isolating large areas of the city. Water supply, sewage, and power plants were flooded in many towns, creating public health problems.

The floods of January and September, 1996. The Potomac River flood of November 1985 has already been discussed under the section on Protracted Precipitation. The next great flood to affect Washington occurred in January 1996. This was the snowiest month since February 1979, due mostly to the snowstorm of January 6-9 which is discussed above in the section on Snowstorms. A deep snow pack, similar to that of 1936, lay over the entire Potomac River Basin on January 17. Mild air moved in from the south on this date and the temperature rose into the 50s. On the 19th, when the high temperature reached 62°, a strong cold front set off a series of drenching thunderstorms that prevailed over the entire watershed. The major flooding that resulted caused the highest crest on the Potomac River at Washington since Hurricane Agnes in 1972. The following is copied from local news reports:

The snowmelt floods were the worst since 1936 in most areas, and high winds in the thunderstorms downed many trees and power lines. As much as three inches of rain fell atop the two-foot layer of snow, sending all rivers and streams over their banks. Ice jams on the lower Susquehanna River broke, sending a surge of ice and water rushing to the Conowingo Dam. The operators were forced to open the flood gates to prevent a disastrous dam failure, and the waters surged all the way to the Chesapeake Bay, causing a rapid and significant flood to hit the town of Port Deposit. Early warnings enabled people to flee without loss of life, but dozens of families lost their belongings. Upstream from the Nation's Capital, river towns such as Harpers Ferry and Point of Rocks lay beneath thirty feet of muddy water. Damage to the C & O Canal towpath was extensive; it is estimated that a year of repair work would be necessary before the recreational areas could be restored.

The flood crest at Wisconsin Avenue was 13.9 feet and the crest at Chain Bridge measured 19.3 feet, both somewhat lower than the crest of June 1972. Upstream from Washington, the flood crest was 36.5 feet and at Harpers Ferry it was 29.4 feet. The latter mark was 1.4 feet higher than that of June 1972; crests at Williamsport and Hancock, farther upstream, were significantly higher than those of June 1972.

On September 3-4, 1996, heavy thunderstorms deluged the Washington region. National Airport received exactly 2.00 inches of rain from these storms, but many areas of the Potomac Basin were drenched with 3 inches or more. On September 6, Tropical Storm Fran came ashore near Wilmington, North Carolina and moved northward directly over Washington, D.C. The storm was not a full hurricane, but it was accompanied by drenching rains and gales. The following is copied from local news reports:

Although Fran had weakened considerably by the time it reached this section, it was still at tropical storm force. Wind gusts of 50 mph downed many trees and power lines, leaving thousands without electricity. Fran's rainfall amounted to 1.55 inches at National Airport, but the Potomac Basin was overwhelmed by heavier downpours which fell on saturated ground. This resulted in the second twenty-year flood of the year on the Potomac River, something that had never occurred before in Washington weather annals. The C&O Canal was again destroyed in several places, and riverfront towns such as Point of Rocks again found themselves inundated. Damage was severe from Harpers Ferry eastward, and hundreds of people were forced to evacuate homes and businesses. The waterfront area of Alexandria was flooded for the second time in nine months. September rainfall in Washington totaled 7.79 inches, the most since 1975.

The crest at Wisconsin Avenue was 13.8 feet on September 8, only slightly below the crest of January 21, 1996. The double flood crests of 1996 are shown in the following table:

Station	Flood Stage	Jan 21, 1996	Sep 8, 1996
Cumberland, MD	17.0	25.6	23.0
Paw Paw, MD	25.0	40.9	37.0
Hancock, MD	30.0	36.4	36.0
Harpers Ferry, WV	18.0	29.4	29.1
Point of Rocks, MD	16.0	36.5	36.0
Chain Bridge	10.0	19.3	17.8
Wisconsin Ave	7.0	13.9	13.8

ICE GORGES

Potomac River ice gorges are rare at Washington. Two instances of them are discussed below:

The ice gorge of February 1881. The following note is taken from the *Monthly Weather Review*: "Washington, D.C., February 12, ice broke up, carrying away about 600 feet of the Long Bridge, lower portion of city flooded, causing great damage to property. The Potomac River overflowed, completely inundating the lower portion of the city. The water was the highest ever known, people passed about in boats in front of the Metropolitan Hotel and about the Baltimore and Potomac Depot, houses and stores flooded above the first floors."

February 1881

<i>Day</i>	<i>Max temp</i>	<i>Min temp</i>	<i>Mean</i>	<i>Precip</i>
1	30	12	21	0
2	14	2	8	0.16
3	19	4	12	0
4	26	6	16	0.64
5	25	8	16	0.66
6	34	14	24	0.34
7	35	7	21	0
8	40	26	33	0
9	51	36	44	1.17
10	64	39	52	0.34
11	56	33	44	0.13
12	63	36	50	trace

The ice gorge of February 1918. The following table gives the daily weather for the first half of February:

February 1918

<i>Day</i>	<i>Max temp</i>	<i>Min temp</i>	<i>Precip</i>	<i>Snow on ground</i>
1	26	20	0	11.0
2	28	17	trace	10.5
3	41	26	0.01	8.0
4	40	4	0	7.8
5	14	-2	0	7.5
6	45	11	trace	6.5
7	59	38	0	4.7
8	42	29	0.01	4.0
9	43	30	0.14	3.0
10	53	31	0	2.2
11	52	31	0	1.5
12	62	40	0	0.5
13	57	35	0	trace
14	53	29	0	trace
15	62	34	0.01	trace

The minimum temperature on the night of February 12-13 was 47° and this was the night the ice broke. The following is from the *Monthly Weather Review*:

February 13, 1918. Ice broke up at 2 AM and a gorge formed from Chain Bridge nearly to the Aqueduct Bridge (note: today site of the Key Bridge), gorged from Rock Creek to Highway Bridge (14th St. Bridge), water 6 feet above bank at Chain Bridge and ice left 6 feet deep from river to canal bank. Gorges broke in places during the day and reformed at night. A firm gorge formed against Aqueduct Bridge during the night of February 13-14 and extended to Highway Bridge on the District side. The old channel on the Virginia side of the Analostan Island (Roosevelt Island) cleared about 5 AM and allowed the flow of the river to go by that channel. Before the old channel on the Virginia side cleared, the ice was piled up 3 to 4 feet above the river wall at the gage, 27th and G streets, and would probably have gone 5 feet higher if the Virginia channel had not cleared. The water was 3.5 feet deep on K Street and 31st Streets, but stores were not flooded below 8th and Pennsylvania Avenue.

February 16, 1918. Small gorges still held between Chain Bridge and Aqueduct Bridge.
February 18, 1918. Channel on District side cleared from Aqueduct Bridge to Highway Bridge. All houseboats on the river were crushed by the ice and all boathouses, except three, were practically destroyed. Many dredges were carried down the river, but most of these were recovered later. Total losses estimated at \$45,000.

The ice gorge of February 16, 1948. On January 24, 1948 a blizzard struck Washington, D.C. and ushered in the coldest weather since January 1940. This prolonged cold period caused the Potomac River to freeze solidly from Chain Bridge to the upper Chesapeake Bay. Warmer weather did not prevail until February 14, when a sudden thaw followed a severe ice storm. The following is copied from news reports:

January 26: High temperature 30°, low temperature today 5°, the coldest since 1942. Ice on the Potomac River reported to be 6 inches thick; channel is blocked to river commerce.

January 28: A trace of snow fell, borne on winds of 39 mph. High 26°, low 12°. This is the 5th consecutive day that the temperature has not risen above 32°. The thickness of the ice on the Potomac River and Chesapeake Bay has halted the delivery of fuel barges to the city, resulting in severe shortages. The Bay is reported to be frozen over and all lighthouses have been abandoned for the first time since 1936. Many water mains are also reported to be broken in the city.

February 14: A sudden thaw occurred after the ice storm of the 11th. High 54°, low 37°, rainfall amounted to 0.20 inches. Ice jam flooding is reported from upper stretches of the Potomac River and parts of West Virginia and Pennsylvania. The ice is breaking up on the Anacostia River, resulting in some moderate flooding.

February 16: A severe ice gorge formed on the Potomac River following the warm weather and rain of the past two days. The height of the pent-up waters above Chain Bridge measured 31 feet and the structure itself is threatened by huge cakes of ice. The river is completely blocked by ice from the Three Sisters to Chain Bridge, and many riverside residents have been forced to flee. At high tide (1 AM) the situation was deemed very dangerous and an icebreaker was summoned to attempt to smash the ice floes. Many large trees along the shoreline have been snapped like toothpicks; docks and boathouses have been wrecked; and the fender of the Memorial Bridge was crushed by the ice.

February 17: High temperature 65°, low 36°. The warming temperatures have melted the ice jam and eased the dangerous situation. Large masses of ice have passed down the Potomac into the Chesapeake Bay; fuel barges may begin to deliver supplies tomorrow.

HIGH TIDES

Records of tide heights have not been maintained continuously at Washington. However, from the available broken records it is evident that floods caused by tidal waves are rare.

The high tide of August 23, 1933. The highest recorded tide (as distinguished from a flood or freshet) was at 9:40 PM on August 23, 1933, when the tide reached a height of 11.0 feet above mean low water. This high tide was caused by a tropical hurricane. The following is copied from the Daily Local Record for August 23, 1933:

Northeast gales and torrential rain throughout the day. Extreme gust velocity of wind, 51 mph northeast, at 10 AM and of rain about 10:50 AM. The greatest amount for 24

hours, 6.40 inches, has been exceeded but once since the beginning of the record. On August 11-12, 1928, 7.31 inches fell during 24 hours.

From the Maryland and Delaware section:

The storm of August 23, while not the most severe in the history of Maryland and Delaware, certainly caused the greatest and most widespread damage. Originating near the Cape Verde Islands on August 14, it moved westward across the ocean to longitude 55° W, and thence northwestward, arriving at the Virginia capes on August 22. From thence it sped northward, its center passing over Maryland. The first hurricane advisory messages were distributed in this section on the morning of the 17th and storm warnings were hoisted in Maryland, Delaware, and the District of Columbia on the morning of the 21st, 2 days before the passage of the storm. All interests were then on the alert and loss of life was negligible, about 13 persons dying by accidents in Maryland. The following extract from the Baltimore instrumental record illustrates the conditions that prevailed on August 23:

<i>Hours ending at</i>	<i>Total rainfall</i>	<i>Max wind</i>	<i>Direction</i>
8 AM	0.36	36	NE
9 AM	0.35	40	N
10 AM	0.39	46	NE
11 AM	0.58	40	NE
Noon	0.55	41	NE
1 PM	0.72	41	NE
2 PM	0.65	49	NE
3 PM	0.61	44	NE
4 PM	1.02	50	NE
5 PM	0.53	43	NE
6 PM	0.34	40	NE
7 PM	0.40	37	NE
8 PM	0.19	38	E
9 PM	0.41	46	SE
10 PM	0.16	46	SE
11 PM	0.03	40	SE
Midnight	0.01	35	S

The 24-hour rainfall at Baltimore (7.62 inches) exceeded the record for over 116 years and made the month of August 1933 the wettest month of any name in that period. The steady northeast gale, shifting to southeast in the evening, caused very high tides, and the excessive rain and the high tides made extensive river and lowland floods. The prevailing dampness favored the development of molds and fungi in stored crops, animal feeds, and merchandise. The damage to property, exclusive of crops, is estimated to be in excess of \$10 million, and to crops about \$7.5 million. The fisheries industry was injured severely, the amount being difficult to estimate but probably around \$3 million. Many boats were destroyed and a larger number sunk and damaged; buildings and wharves were wrecked, etc. At Crisfield, Maryland alone the damage to the industry was \$100,000. Miscellaneous damage to dwellings, pleasure resorts, coast towns, etc. was \$2 million; shore land lost in Maryland by wave action about 2 square miles, in Delaware about 1 square mile.

The following is from the Virginia section:

The principal storm damage of the month occurred on the 23rd, when an unusually severe low pressure crossed the eastern part of the state from Norfolk to Washington, D.C., and beyond, taking a toll of 15 lives and leaving in its wake a loss of approximately \$5 million to crops, and another \$5 million to other property. Most of the property loss occurred in Norfolk and vicinity, where gusts of wind, measured at 88 mph, unroofed houses, shattered windows, uprooted trees, and drove unprecedented tides into business districts. Water covered many blocks of streets to a depth of 4 to 6 feet, and flooded the first floors of many offices and stores. On Willoughby Street water reached to ceiling of many houses, and 141 cottages were wrecked. Similar but less extensive damage occurred at Ocean View and Virginia Beach. At Buckroe Beach and Old Point 60 dwellings and stores were demolished, in addition to the destruction of many concession stands, fish camps, and seine houses. At Fortress Monroe water flooded the parade grounds to a depth of 3.5 feet. At Langley Field similar conditions existed. Light, power, and phone lines were out of condition over much of this southeastern area for many hours. As the storm moved northward from this densely populated section, the principal damage occurred to crops and truck, through sand deposited in flooded fields, and wind-stripped vegetation.

The high tide of September 18, 2003 which resulted from the storm surge of Tropical Storm Isabel broke the record set in 1933 and is discussed below.

DROUGHTS

Washington is located too close to the Atlantic Ocean and Gulf of Mexico with reference to the general circulation of the atmosphere for long spells of dry weather to be common. Droughts are likely to be most injurious to vegetation in summer. This is the season of most frequent thunderstorms; and it may happen, even in a generally dry season, that a particular rain gage might catch a greater-than-average rainfall. The following tables are based on the average rainfall over central Maryland and northern Virginia. The first table shows the 10 driest years since 1891 when the 2 months of April and May are considered:

Year	Percentage
1963	30.6
1986	40.8
1969	43.5
1991	44.2
1926	45.0
1915	46.0
1994	46.9
1896	49.8
1965	50.4
1999	50.4

The next table shows the same information when the two months of June and July are considered:

<i>Year</i>	<i>Percentage</i>
1954	37.6
1966	37.8
1993	39.6
1964	40.6
1893	41.6
1999	41.9
1894	43.3
2007	47.7
1957	52.1
1962	52.1
1997	52.2

This third table likewise is for the 2 months of August and September:

<i>Year</i>	<i>Percentage</i>
1930	18.4
1917	28.1
1895	31.6
1998	32.3
1943	32.7
1970	35.5
1980	40.1
1962	42.5
1941	43.1
1910	45.5

The dry weather of 1930. The following excerpts are from the Maryland and Delaware sections of Climatological Data:

This July was warm, sunshiny, and exceptionally dry. It was not the warmest July of record, however, when the monthly mean temperature is considered, though such an impression was created by the heat wave of unprecedented intensity and duration, which began on the 18th and continued at the close of the month. The maximum temperature of 110° at Millsboro on the 21st was the highest summer temperature ever recorded in the section. Highest temperatures of the month equaled or exceeded previous highest temperature recorded in July, except between the Allegheny and Blue Ridge Mountains. The month was 2° warmer than normal; 3° warmer than July 1929; and the warmest July since 1921; but it was nearly 2° cooler than July 1901, the second warmest July. July 1872 was the warmest July of record.

This was the driest July of record in western and north-central Maryland. Southern Maryland and the Eastern Shore were better favored. For the section as a whole, the average monthly rainfall was the least of record for July. Monthly sunshine was 10% above normal. Relative humidity was unusually low, being between 10 and 15% below normal. The heat wave caused many prostrations and deaths in Baltimore. The drought was the cause of many forest and grass fires in the section.

The period from the 1st to 17th averaged one to two degrees daily below normal; moderately warm weather prevailed during the 1st-2nd and 6th-13th, while the 3rd-5th and 14th-17th were cool. The heat wave of the 18th-31st gave an average daily

temperature of 8-10° above normal. The 15th was the coolest day, while the 19th-22nd was the hottest period. Highest temperatures were between 100° and 110° in the divisions between the Allegheny Mountains and the Chesapeake Bay on the 19th, 25th, 26th, 27th, and 29th, and over the entire section, except the Allegheny Mountain region, on the 20th, 21st, and 22nd. They were also 100° or slightly above in Washington and southern Frederick Counties and at Newburg on the 28th. In the Allegheny Mountain region the highest temperatures occurred on the 28th and were 95° or slightly above.

Monthly rainfall averaged about two-fifths of normal. Rainfall was mostly in the form of thundershowers. Monthly amounts were 0.20 to 1 inch generally in western and west-central Maryland; 1 to 3 inches in southern Maryland; and 2 to 4 inches on the Eastern Shore, except 4 to 6 inches in the Milford district. They averaged 19% of normal in western Maryland; 14% in north-central Maryland; 33% in southern Maryland; and 53% on the Eastern Shore.

Despite the drought that prevailed, beginning June 27, crops were in fair to good condition and pastures were poor to fair during the first and second decades. The heat wave of the 18th-31st, and the absence of rain, was severe on all crops and grasses. Most of the crops wilted or dried up, except in the Allegheny Mountain region and in those districts on the Eastern Shore favored by generous thundershowers. At the close of the month the crop situation was serious.

The following is copied from the Virginia section:

It was the driest July of record, with the smallest number of rainy days, and also one of two Julys since statewide records began with a mean temperature above 78° (78.3° this year and 78.6° in 1901). The extremes this year, however, 109° and 40°, exceed those of 1901 (106° and 47°); in fact, 109° is the highest for all months, the next highest being 108° in July 1902 and in August 1918.

Two periods with a high percentage of sunshine and subsequent high day temperatures, 5th to 12th and 18th to 30th, furnished a large temperature excess for the month, the warmest days being, as a rule, the 20th to 22nd. There were only a few stations in the interior that did not record maximum temperatures of 100° or higher; while in July 1901, with a higher monthly mean, less than one-third of the total number of stations recorded maxima as high as 100°. The higher daytime temperatures of the past month were offset in the daily means to some extent by comparatively low night temperatures, due mainly to the absence of cloudiness.

The month was unusually dry, the average rainfall for the state, 1.77 inches, being the least on record for July. Showers were fairly well distributed as to time, but monthly totals of one inch or more were confined to the eastern third of the state, southern border counties, and the extreme southwest. The remainder of the state, including much of middle Virginia, Piedmont, and the Great Valley section, received less than one inch, while the totals in western border counties from Craig to Rockingham were less than 0.50 inch. In tidewater and middle Virginia the heavier rains came on the 1st, but on the 14th in the Great Valley.

The large deficiency in rainfall and high percentage of sunshine served to accentuate the droughty conditions prevailing in many parts of the state at the first of the month, so that farm crops have deteriorated and dried up in some localities; all streams are low and small streams in mountain areas have ceased to flow, causing scarcity of water for stock. It is believed the drought-stricken area is the most extensive and the situation the most serious of record in Virginia.

The following is copied from the August issue of the Maryland and Delaware section:

For the sections, as a whole, this was the driest August of record, and it marked the second month of a summer drought unprecedented for intensity and duration. The heat wave that began on July 18 was ended on August 10 by fresh to strong northwest winds,

ushering in much cooler weather. This has been the longest and most intense summer heat wave of record, with an average daily temperature of 8-10° above normal. Monthly rainfall averaged one-fourth of normal. Rain was mostly in the form of light showers. Monthly amounts were less than one inch generally, and the least of record in August, in southern and north-central Maryland, in eastern Washington County, and in the southern and central sections of the Eastern Shore; were between 1 and 2 inches in western Washington County, eastern and central Allegheny County, and over the northern Eastern Shore, except between 2 and 4 inches in the Dover and Millington districts; and were between 2 and 3 inches in the Allegheny Mountain region. The area of least rainfall, 0.20 inches, embraced Anne Arundel and Calvert Counties. Crops wilted or dried up during the hot spell. Pastures and grasses were dry or burned up. Water was hauled in some localities for stock and home.

The year 1930 was the driest of record in Washington, D.C. The annual total was 21.66 inches, or 53% of the normal, 1871-present. The following table shows each month's rainfall and its percentage of normal:

Month	<i>January</i>	<i>February</i>	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>
Rainfall	2.85	1.64	2.26	3.12	1.81	3.19
Percent	90%	58%	63%	101%	49%	87%

Month	<i>July</i>	<i>August</i>	<i>September</i>	<i>October</i>	<i>November</i>	<i>December</i>
Rainfall	2.30	0.62	0.76	0.28	0.79	2.04
Percent	55%	15%	21%	10%	29%	67%

The Great Northeast Drought of the 1960s. The greatest long-term drought to affect Washington and the surrounding region commenced in 1962, though it did not become severe and enduring until early 1963. By September 1964 the drought reached the extreme stage and remained at that critical level until the fall of 1966. This very long period of dry weather was caused by the absence of the usual coastal storms that bring moisture to the Northeastern region of the United States. The years 1964 and 1965 were the two driest years, back-to-back, in Washington's weather history; total rainfall for 1964 was 29.48 inches and for 1965, 26.94 inches. October 1963 was the driest single month ever recorded: only a trace of rain fell during that calendar month, and the rainless period of 31 consecutive days was the longest ever measured. This five-year drought was not characterized by long heat waves, except during the summer of 1966. That summer was marked by extremely hot, dry weather, and the rainfall total of 4.62 inches tied the 1962 record as the driest ever known. The heat wave began in June, which saw 15 days over 90°. July was the fourth hottest, and the second driest, ever experienced in Washington. The mercury rose to 101° on July 3, the same day that New York City tied its all-time record of 106°. August continued the hot and dry conditions, and on August 11 the Potomac River reached a new record for the lowest measured flow in its history with 265 million gallons per day. This broke the previous mark of 474 million gallons per day set in 1930. From August 12 to September 13, only 0.29 inches of rain fell on the parched city and within days, the District government declared the first water restrictions since 1859.

The drought of 2001-2002. This two-year drought deserves mention because it broke certain records that were set during the year 1930. This also marked the end of the third driest meteorological autumn ever known. The city's total rainfall of 2.66 inches over a three-month period was the least since 1941. From October 17 to November 19, only .01 inches of rain fell at DCA, and most stations in the Metro area recorded none at all. Had

this small amount of rain not fallen on November 3, Washington would have set a new record of 34 consecutive days without precipitation. When September ended with only 2.10 inches of rain, the Nation's Capital set a new record for the driest October-September period in its history. Twelve-month totals amounted to a mere 23.31 inches, breaking the 1929-30 record of 27.26 inches. (56% of normal).

Month	<i>April</i>	<i>May</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>
Rainfall	3.47	2.17	3.81	2.20	1.63	2.10
Percent	112%	59%	104%	53%	39%	53%

Month	<i>October</i>	<i>November</i>	<i>December</i>	<i>January</i>	<i>February</i>	<i>March</i>
Rainfall	0.69	0.55	1.53	1.32	0.47	3.37
Percent	24%	20%	50%	42%	17%	94%

Longest rainless period. The longest stretch of days without measurable rainfall (defined as more than a trace) was 34 days, from September 15-October 18, 2007. During this time a trace of rain was recorded on seven days. This broke the earlier record of 33 days set from August 7-September 8, 1995; a trace of rain fell on five days during this period. The driest calendar month was October 1963, when only a trace of rain fell on seven different days.

HIGH WINDS

High winds are infrequent at Washington. Those few which occur from time to time are usually caused by tornadoes, thunderstorms, or tropical hurricanes although there are rarely high winds not associated with these three phenomena.

TORNADOES

Only eight tornadoes have been observed within the District of Columbia since 1800. The first to be recorded occurred on August 25, 1814, during the British invasion of the War of 1812. A tornado struck Washington during the burning of the Capitol and White House by British troops. Great damage was done to the residential part of the city, blowing the roofs from houses, downing chimneys, and leveling fences. In some areas every home was damaged, and many large trees fell all over the city. The tornado-producing thunderstorm lasted for two hours and was accompanied by vivid lightning, hail, and intense darkness. One source stated that thirty soldiers were killed, buried in the debris. The description of the damage would indicate an F2 tornado. Thirty miles to the northwest, another tornado struck Leesburg, Virginia, injuring two people and destroying large areas of forest. Other noteworthy tornadoes are discussed below.

The tornado of September 16, 1888. At 3:15 PM, an F2 tornado touched down in the 900 block of the District of Columbia between 9th and 10th streets. It moved along the south edge of the downtown area and then passed up Maryland Avenue. Two homes were unroofed, the roof of the National Museum was damaged, and extensive damage occurred at the Botanical Gardens. The funnel lifted at the foot of Capitol Hill. The damage path was 2 miles long and 70 yards wide. No injuries or fatalities were reported.

The tornado of April 5, 1923. The following note appears in the Monthly Weather Review for April 1923:

A true tornado apparently originating between 2:30 and 3 PM, April 5, 1923, in the northern portion of Rock Creek Park, Washington, D.C., about 5 miles from the U.S. Capitol, moved thence northeastward, crossing the B & O Railroad tracks about a quarter-mile north of the Silver Spring Station, MD, and continued thence north-northeast for about 11 miles. Its path was from 100 to 250 yards in width; a funnel-shaped cloud was seen by some observers. Four persons were seriously injured, seven houses were demolished, and about a dozen more suffered some damage. The property loss is estimated at \$100,000. At the time this storm occurred a vigorous cyclone was moving northeastward, with its center probably between 200 and 300 miles distant in a northwesterly direction. The morning map showed the center in southern Ohio; the sea level pressure near the center being about 29.58 inches; the evening chart of the day located the center in the north central part of New York, with pressure about 29.46 inches. The trace of the barograph at the Washington office shows a rapid fall in pressure and an even more rapid rise about the time the storm occurred, the marked dip and rise covering about 45 minutes. The trace indicates 29.55 at 2 PM, lowest 29.46 about 2:35 PM, and return to 29.54 by 2:45 and to 29.57 by 2:55. The thermograph trace shows a sharp fall of about 9° (72° to 63°) about the time the tornado formed. The wind, from south-southeast, 12 to 16 mph, during the period 2 to 2:40, shifted to west-northwest by 2:45, and at about 2:50 reached the highest velocity for the day, 30 mph. Light rain began at the Washington office 2:27 PM, but became heavy only at 3:22, many minutes after the sharp pressure changes. The drop in temperature and the shift of wind had occurred in 12 minutes, ending at 3:34; 0.13 inch fell, then the rain returned to light, and continued so until it ceased at 8:10 PM.

The maximum wind movement during any 5-minute interval at 24th and M Streets was a speed of 27 mph at 2:46 PM; the extreme was a speed of 30 mph. This tornado was preceded by a very strong and slow moving high pressure area. On April 1, 1923, the temperature was 15°, the lowest of record for April, and the pressure was 30.74 inches, the highest of record for April. The pressure fell steadily but slowly until the 5th. The following is copied from the Maryland and Delaware section:

On the afternoon of the 5th, about 2:30 to 3 PM, a tornado traversed the northern part of the District of Columbia, the southeastern part of Montgomery County, MD, and the northwestern part of Prince Georges County. The first damage occurred in Rock Creek Park, west of the creek, where many fine trees were destroyed. The creek was crossed not quite a mile directly south of the north corner of the District, and the storm continued northeastward, crossing the state line in a region of fields and pastures. The railroad tracks and the important Brookeville Road were crossed a quarter-mile north of Silver Spring Station, at a point where, fortunately, there were but few houses in the way. The path continued to northeastward across fields and woods. There was injury to buildings near the Montgomery-Prince Georges County line, in the vicinity of Avenel, about 3 miles from Silver Spring; also about 1 mile northwest of the railroad station at Beltsville; and again near Muirkirk. In all, the storm traveled about 11 miles, in direction between northeast and east-northeast. The path was from 110 to 250 yards wide. Some eyewitnesses saw the dark, funnel-shaped, whirling clouds; and the wreckage, especially of trees, clearly indicates rotary winds of great violence. Four persons were seriously hurt, seven houses were demolished, and about a dozen more suffered some damage. The property loss was about \$100,000. Hundreds of trees, some very large, were uprooted, broken, or twisted and torn, but their marketable value was very little; however, considerable expense and many years will be needed to replace the shade trees that were ruined.

The tornado and waterspout of November 17, 1927. This tornado was especially noteworthy because of the automatic records of the weather elements obtained during its passage by the naval air station. The following is copied from the *Monthly Weather Review*:

During November 17, 1927, a low from the south, centered over southwestern Virginia by the morning weather observations of that date, moved north-northeastward, the center passing some 50 miles west of the District of Columbia near midday. About 2:15 PM, a tornado formed in rough country in Fairfax County, VA, reaching the ground about 3 miles southwest of Alexandria. It traversed the western part of that city and the extreme southeast corner of Arlington County, then crossed the Potomac River at an acute angle. In the District of Columbia the naval air station and the navy yard were visited, and from the latter (at 8th and M Streets, SE) for about 2 miles to Benning Road and 19th Street NE, the tornado swept a strip in a thickly built area. Beyond there was practically undeveloped land. The tornado went on into Prince Georges County, MD, to near East Riverdale. The length of path was 17 miles. The width was found to vary from 20 yards or less to not quite 300 yards. The best established times were 2:34 PM at the naval air station and 2:38 at Benning Road, the latter noted by a trolley car conductor. These are in good accord, but separated by too short a distance to fix the speed of advance satisfactorily. The tornado was probably most intense in Alexandria and in Arlington County, and seemed to be rather intense again just before and just after crossing the District-Maryland line. There were no fatalities due to the tornado, but those injured enough to require more than first aid treatment numbered 31—10 in Alexandria, 2 in Arlington County, and 19 in Washington. The total damage to property, according to conservative estimates, amounted to \$690,000, including \$200,000 in Alexandria. The advance of the tornado, when the path is plotted on a large-scale map, is found to have been in direction north 33° east. The primary low during this 12 hour period between observations advanced north 38° east, according to the Washington weather map. This is the third tornado noted in the District of Columbia within a 5-year period and very much the most serious. It is also noteworthy that the Virginia portion of the track shows far greater damage than any one tornado ever before caused in that state.

It is of interest that the observatory of the naval air station obtained an actual meteorological record of the tornado at close quarters, since it was struck by the right-hand edge of the funnel just prior to the destruction done to hangers, planes, and buildings. In advance of the tornado the reading of the barometer was 29.57 inches, which is only a hundredth of an inch lower than the simultaneous reading at the central office of the Weather Bureau, almost 4 miles to the northwestward. The first violent blast at 2:34 PM gave a velocity of 93 mph from the south and south-southeast on the observatory register, with pressure suddenly dropping to 29.11 inches. The wind then shifted rapidly to southeast and east, by which time the wind speed had dropped to 33 mph, with recovering pressure. At the Weather Bureau (about 3 miles distant) the wind and pressure being unaffected as far as the records indicate. Nearly an hour and a half after the tornado, a waterspout struck the eastern shore of the Potomac or, precisely, at 3:54 PM, at which time the worst rain and wind squall of the general cyclone occurred at 24th and M Streets. The waterspout formed in the river west of Anacostia; although the spout was considerably veiled by the gloom and heavy rain then prevailing, it was seen from the naval air station to move directly toward the southeast and dash itself to pieces on the shore 2 minutes later. It is said to have been some 300 feet in height, reaching to the squall cloud, with river water seen to course up about one-third of its length. At this time the extreme wind speed of 48 mph for a 2- minute period from the southwest was registered at 24th and M Streets. The wind direction for the hour preceding 3:45 PM had been from the south. This is probably the first waterspout known to have occurred along this portion of the Potomac.

The time of the waterspout is marked by abrupt changes on the automatic records at the naval air station, though less marked than the changes caused by the tornado. The highest pressure for the month was 30.74 inches at 9 AM on November 13; the pressure fell steadily until 3 PM on the 17th when it was 29.56 inches. The November 5, 10, and 15 minute maximum precipitation records at 24th and M Streets were established at this time.

The tornado and waterspout of May 21, 1943. This tornado passed closer to the 24th and M Street location than any other tornado in the District of Columbia. The following notes are copied from the Daily Record:

May 21, 1943: Thunderstorm; first thunder heard at 1:58 PM, last heard at 3:05 PM; storm came from west. During this storm a Negro boy was killed by a falling tree limb in the 300 block of Eye Street SW. Extreme wind velocity, 38 mph, north at 2:20 PM. During the afternoon of May 21, 1943, an energetic thundersquall moved into Washington from the northwest. An extremely turbulent area was just ahead of the rain sheet. It was characterized by violent updrafts as indicated by the high vertical velocity of the low-hanging clouds. Condensation in this particular portion of the cloud was occurring at a much lower altitude than in other visible portions of the cloud. When first noted, its location was approximately 30th and Pennsylvania Avenue NW. When it reached the approximate vicinity of the Naval Hospital at 24th Street, a definite funnel cloud formed and its revolving motion could be seen. This funnel appeared the reach to the ground, although this could not be verified because of buildings in line of vision. The funnel cloud existed for an estimated duration of 5 to 10 seconds and then disintegrated. After disintegration, a few objects could be seen in the air although they could not be identified. They might have been newspapers. After an elapsed time, estimated at 3 to 5 minutes, a second pendant formed. This second formation was slim and cylindrical, having much more the usual appearance of a waterspout than a tornado. Its locations at that time could have been over either the Potomac or the Tidal Basin. This second formation also lasted for only a few seconds. It disappeared at 3:22 PM.

The tornado of May 18, 1995. At 1:22 PM, a small F1 tornado struck the National Arboretum in the Northeast section of the District of Columbia. Its path was only a half-mile long and 50 yards wide. The tornado uprooted dozens of trees at the Arboretum, crossed the Anacostia River, and then snapped many more trees in half on the opposite shore at Langston Golf Course. Damages were estimated at \$50,000. A second F1 tornado struck the Cheverly, MD area shortly thereafter on a very short path. It damaged buildings in an industrial park and two nearby residences. A truck was crushed by debris, and two people were injured. Damages were estimated at \$2,000,000.

The tornado of September 24, 2001. Although this tornado did not touch down in the District of Columbia, proper, it did pass over the National Mall in the form of a funnel cloud. The following is copied from National Weather Service reports:

The rotating thunderstorm that spawned the tornado had previously produced a smaller tornado that struck the Shirlington area of Arlington County. The tornado lifted and passed over the Pentagon and the 14th Street Bridge without causing any damage. Many people then witnessed the funnel cloud as it passed directly over the Mall and over the McMillan Reservoir and Children's Hospital in Northeast D.C. A few trees were downed along the river and the Tidal Basin, the only damage suffered in the District. The weather observer at DCA watched the tornado weakening as it crossed the 14th Street Bridge and noted another funnel cloud descending. This second tornado touched down in College Park, MD, causing grave damage and killing two people. Dozens of autos were swept into the air and a large group of trailers was demolished; debris from the trailers was

found up to sixty miles away in Harford County. Four of the six people inside the trailers were injured, one seriously. The other four occupants, including one child, took shelter under desks and survived. Two sisters, students at the University, were killed when their car was thrown into the side of a dormitory, and many other students were injured by flying debris. Hundreds of windows were smashed, and the brand-new University Arts Center was damaged. Hundreds of automobiles were damaged or destroyed, and the woods behind the parking lot were flattened. The bubble roof of the football practice facility was removed. At least 3,000 students were left without shelter due to damage to dormitories and apartment houses. The tornado then moved across the National Agricultural Research Center, causing over \$40 million in damage. The next concentrated area of damage was found at Laurel High School, where the roof was torn off the building and three people suffered injuries. On Montrose Avenue, a woman and her dog were briefly picked up by the tornado. The woman sustained injuries to her hip and leg after being tossed 3 feet in the air and the dog landed uninjured. Across Prince George's County, the tornado was responsible for \$100 million in damage. A total of 861 homes, 561 vehicles, and 23 businesses were damaged countywide. This event was termed the deadliest in Maryland in 75 years.

HIGH WINDS WITH THUNDERSTORMS

Most thunderstorms recorded at Washington are not accompanied by very high winds. Of the thunderstorms with high winds, several have been selected for discussion.

The thunderstorm and high wind of July 7, 1911. A gust recorder was installed at 24th and M Streets in 1907. The highest gust of record at this location, 77 mph, was recorded on July 7, 1911. The following is copied from the Daily Local record:

First thunder heard at 1:13 PM; last heard at 6:20 PM. A very severe and destructive storm passed over the city from the northwest, unroofing houses and blowing down trees. Nearly every street in the western part of the city was for a time blockaded with fallen trees and limbs. Wind attaining a maximum velocity of 32 mph and an extreme velocity of 42 mph was accompanied by excessive precipitation and some hail.

The thunderstorm of July 30, 1913. The most violent thunderstorm ever recorded at 24th and M Streets occurred on July 30, 1913. The Daily Local Record states:

A most terrific thunder and lightning storm broke over the city at 3 PM. Clouds began to gather early in the forenoon, in the north, after a most sultry and humid day. Thunder was first heard at 2:30 PM, increasing in intensity at the hour of 3 PM. The storm was most intense between 3:10 and 3:17 PM, a terrific thunder and lightning accompanied with excessive rain and for a period of 11 minutes great quantities of hail from size of a pea to a chestnut fell. During the storm the wind attained a maximum speed of 53 mph, the total rainfall being 2.02 inches. Streetcar traffic interrupted considerably, some lines being tied up for hours. Much damage done to trees and buildings, especially roofs, throughout the city. Two people killed and several injured in the collapse of a building at 7th and L Street NW.

The following is copied from the *Monthly Weather Review*:

On the afternoon of July 30, 1913, between 3 and 4 o'clock, there occurred one of the most severe thunderstorms that ever visited the city of Washington. While the extent of territory affected by the storm was comparatively small, it presented some unusual phenomena in the matter of high winds, heavy rains, and destruction to property. Up to the time of the occurrence of the storm the atmospheric pressure presented no marked

variation from the usual conditions. The barometer was steadily falling as the result of the diurnal change and stood at about 29.90 inches when the storm broke. The day had opened clear with temperature around 76°, from which point it rapidly climbed to 94° by noon and to 97° at 2 PM, with prospects of going even higher had not the gathering clouds interfered with its further upward march. Light variable winds, mostly from the north or west, had prevailed up to about 3 PM, when the direction changed to north and then to northeast, the velocity increasing rapidly from 4 or 5 mph to a gale of unusual force. Clouds began to gather early in the afternoon and by 2:30 they had obscured the sun, at which time the first thunder was heard. The storm rapidly gathered force, and angry, dust-colored lower clouds formed in the north and northeast, moving rapidly southward, while the ragged edges of the more elevated clouds indicated the probability of still higher winds to follow. Light rain began at 3 PM, becoming torrential about 3:10 PM, at which time the wind shifted from north to northeast and increased greatly in velocity. At the same time heavy hail began, the rattling of which, with the brilliant flashes of lightning, the terrific thunder, the violence of the wind, the flying debris from houses and trees, and the near approach to total darkness, probably produced a more terrifying condition than was ever before experienced in the District. At the Weather Bureau office the wind attained a velocity of 68 mph from the north and northeast from about 3:10 to 3:20 PM, with occasional gusts that probably exceeded 70 mph, the highest velocity ever recorded at that point. With the beginning of the rain and the increased velocity of the wind the usual rise in pressure that accompanies the thunderstorms occurred, the barograph responding promptly to the increased pressure, and showing a sudden rise of nearly two-tenths of an inch. At the same time there was a rapid fall in the temperature, the change from 3 to 3:15 PM, 15 minutes, amounting to slightly more than 30°. The severest portion of the storm lasted about 15 minutes, during which time the fall of rain amounted to more than an inch and a half, and damage from wind and hail in the District alone probably amounted to several hundred thousand dollars. The most significant feature of the storm was the apparent shortness of its path considering the length of the period which it raged with such severity. From reports from postmasters and others in the immediate vicinity of Washington it seems that the storm suddenly developed its severe character near the northeastern boundary of the District, only light winds and but little rain as a rule occurring in the adjoining portions of Maryland.

The severest portion of the storm appears to have traveled in a course slightly west of south across the central part of the city, and was dissipated rapidly on reaching the hills on the Virginia side of the Potomac. In its course through the city severe damage was wrought to many different interests. Houses were unroofed and flooded, windows on the north sides of buildings were shattered by the hail, many shade trees were broken sharply off or uprooted, while thousands of others had many of their branches torn off or badly broken. Several buildings collapsed from the force of the storm, the falling of one at 7th and L Streets NW causing the death of two persons and the severe injury of several others. Numerous narrow escapes from death were reported, and many persons were injured in the streets or at their homes by flying debris of various kinds. On the river the wind was even more severe than in the city, but sufficient warning of the approach of the storm had enabled those interested to prepare for it. Some damage was done, however, to the smaller craft, and to property along the riverfront, the flooring of the Aqueduct Bridge being partly torn up and several persons narrowly escaping death from the flying boards. Hundreds of telephones were damaged, poles and wires were broken down, and streetcar traffic was delayed. Much damage occurred in the parks and to the shade trees throughout the city, many magnificent and noted trees being uprooted or broken off, or so badly injured as to require their removal. Outside the limits of the District the rainfall, wind, and other evidences of the storm were light, no rain falling at nearby points to the northwest and southwest, and but little beyond the first few miles on the Virginia side of the Potomac, while the severe wind was likewise confined largely within the limits of the District. From reports received it appears that the storm began near Laurel, MD, at about

2:30 PM, with moderate winds from the northwest, and accompanied by heavy thunder; it increased in intensity as it approached the District line and at Takoma Park rain began at 3 PM, and continued until 4:15 PM, accompanied by hail heavy enough to crack windows and shred leaves of vegetables and plants. At College Park, MD, rain began at 3 PM and ended at 5 PM; total fall, 0.66 inch. At Rockville, MD, it began at 2:30 PM and ended at 5 PM, with 0.90 inch rain, light hail being reported east of the town. The wind was heavy from the north, but did very little damage. A trace of rain fell at Poolesville, MD, at 3 PM, with wind from the east, but without damage. The wind was brisk southeast at Germantown, MD, but there was no evidence of the storm to the westward in Virginia. The southeastward of the District line there was little evidence of the storm, and it appears to have soon spent its force after crossing the Potomac, as only 0.05 inch of rain, and light wind were reported from Fairfax, and there was no rain or wind at Manassas and other nearby points in Virginia.

The 10 and 15 minute maximum precipitation of record for 24th and M Streets were established during this thunderstorm.

The thunderstorm and high wind of June 9, 1928. There was nothing particularly unusual in the course of the weather as recorded at 24th and M Streets on June 9, 1928. There was a thunderstorm with the first thunder heard at 4:10 PM and last heard at 9:30 PM and 0.21 inch of rain fell during its progress. The temperature fell from 90° at 4 PM to 67° at 10 PM and the wind shifted from south during the afternoon to northwest at night. The maximum wind movement during any 5-minute interval was at a speed of 18 mph beginning at 6:23 PM. The lowest pressure on this day was 29.60 inches at 5 PM.

However, it was on this day that the highest recorded wind speed within the District of Columbia occurred. The Daily Local Record contains the following note:

Thunderstorm, northwest, first thunder, 4:10 PM, last heard, 9:30 PM This storm was violent, over a restricted area in southeast Washington, in the vicinity of Hains Point, Bolling Field, and the Naval Air Station. The chief damage was reported from Bolling Field, where 12 airplanes were destroyed. The Naval Air Station reported a maximum wind velocity of 89 mph, south-southwest, registered by a cup anemometer, and an extreme velocity of 100 mph, on the pressure tube anemometer. One fatality occurred at Hains Point, where a woman was struck by the branch of a tree.

The Monthly Weather Review for June 1928 lists the width of path as 100 yards and the length 1 mile, describing it as a severe thunder squall, and states that 115 trees were uprooted and 6 persons injured. The total value of property destroyed was \$100,000.

The thunderstorm and high wind of June 14, 1989. Although the brunt of this thunderstorm did not pass over the observing site at National Airport, it caused extensive damage across a wide swath of Northwest Washington and is therefore included for discussion. June 14 was warm and sultry, but not excessively so. The temperature at 3 PM was 87° when a cold front approached the city from the northwest, triggering a line of severe thunderstorms. The worst storm struck Dulles Airport at 4 PM, where a wind gust of 74 mph was measured. This storm then traveled due east across Bethesda, Chevy Chase, Northwest Washington, and Takoma Park. The following is copied from news reports:

The thunderstorm brought blinding sheets of rain and hurricane-force winds that completely immobilized traffic across the affected area. Residential areas were especially hard hit, with thousands of trees damaged or uprooted. In one block in Bethesda, 200 trees fell. Connecticut Avenue and River Road were both blockaded by downed trees and power lines, bringing traffic to a halt. Pepco reported that power was

out to 150,000 customers, making this the worst thunderstorm in the utility's history. The tree damage totally changed the appearance of many neighborhoods and it will be many years before these areas will resemble their former aspect. No wind measurements were available in the corridor of greatest damage, but the Weather Service estimated that wind gusts reached 86 mph in some spots. It took two weeks to fully clear some of the damaged areas.

HIGH WINDS WITH TROPICAL HURRICANES

Washington is situated so far from the open sea that the winds of most tropical hurricanes have diminished when the storm affects this city. Several of the noteworthy storms are discussed below.

The tropical hurricane of October 13, 1893. The following is copied from the Daily Journal:

Cloudy. Barometer falling rapidly, wind increasing. Hurricane approaching from the south. Rain set in at 8:28 AM, heavy showers at intervals. Wind increased to 34 mph at 7 PM, 29.15" barometer. Barometer readings taken at 5 PM (29.34), 6 PM (29.24), 7 PM (29.15), 8 PM (29.05). The low point was reached between 8 PM and 9 PM. The northeast wind during the day had veered to southeast at 7 PM. At 4 PM the rain was being driven in blinding sheets along the streets. Great damage to telegraph and telephone wire communication nearly cut off. Church in course of erection at 8th and H Streets blown down. Considerable damage to shade trees in the parks. Rainfall, 1.82, rain ended 9:20 PM, began again at 11:45 PM.

The extreme wind speed recorded during this hurricane was 39 mph, and this was the third highest record at 24th and M Streets due to a tropical hurricane.

The high wind of September 29, 1896. This wind occurred during the passage of a tropical hurricane. The fastest wind movement during any 5-minute period was 51 mph, while the fastest moment during any mile recorded was a speed of 62 mph. September 29, 1896 was the highest "extreme wind speed" ever recorded at 24th and M Streets. This high wind took place before a gust recorder was installed, so that the highest gust during this tropical hurricane passage is not known. The anemometer cups at the Naval Observatory on Massachusetts Avenue were blown away at 11:05 PM. This is the only known instance of anemometer cups being blown away in the District of Columbia. The lowest pressure during this storm was 29.14 inches at 10:50 PM. This is the lowest pressure of record for September. The loss of property in the District was \$443,000 and one person was killed. The following is copied from the Daily Journal:

September 29: Cloudy; Rain 2:30 AM to 2:50 AM. Fresh to brisk east to southeast wind. Rain 8:15 AM. Special observation at 1:30 PM. Rain continuing during the day and evening. Wind increased in velocity during the evening reaching a hurricane at 11 PM. Maximum velocity 66 mph, extreme 80 mph. Barometer fell off rapidly reaching lowest point 29.30 at 11:20 PM. Roof of instrument shelter carried away 11:15 PM. No thermometers broken. The damage to property and shade trees exceeded that of any storm on record.

September 30: Telegraph and telephone wires all prostrated, no reports received except by mail until evening, and then only a few. Clear. Rain until 12:40 AM. Wind 34 mph continued from southwest until 8 AM, gradually decreasing to light. Clear in the morning and during the day. Cloudy at night.

The following is copied from the records at the Naval Observatory:

At 10 PM a violent gale of wind from southeast, increasing in force and lasting nearly until midnight. The anemometer cups were blown away at 11:05 PM when the wind was 60 mph. This storm left devastation in its track all around, unroofing houses, uprooting trees that had withstood every storm of this century. The copper roof on the southern exposure of main building of Observatory swept bare, some of it landed in northern lawn about 800 feet from building.

Hurricane Hazel, October 15, 1954. Hazel was a powerful tropical hurricane that came ashore near Myrtle Beach, NC on the morning of October 15, 1954. The storm followed a trough of low pressure that sped the hurricane directly northward to Washington at the remarkable rate of 60 mph. The central part of Hazel reached the immediate area at 5:45 PM and created widespread damage with its powerful winds. At National Airport, a sustained wind of 78 mph was measured and a wind gust of 98 mph occurred at 5:05 PM. Both these measurements were the highest of record for the District of Columbia. The lowest pressure was 28.80 inches and a brief period of calm was noted as the elongated eye passed over the region. The following is copied from news reports:

High winds forced personnel in the control tower at the airport to abandon the building when the windows blew in. The high winds toppled hundreds of trees, downed over 1,200 power lines, and tore the roofs off houses throughout the metropolitan area. A wind gust of 98 mph was recorded at 5:05 P.M., breaking the old record of 76 mph set in 1911. The storm's swift passage resulted in a moderate rainfall of 1.73 inches, but tremendous destruction resulted from the high winds. Downtown windows were smashed and the Arlington Recreation Center burned to the ground in minutes when the flames were fanned by furious winds. Government employees were let off early on this Friday, all high school football games were cancelled, and traffic was quickly snarled by downed trees and flooded streets. Nearly all streetcar lines in the city were blocked by wreckage. At least 20 trees were toppled on the grounds of the U.S. Capitol. Hurricane Hazel killed 12 people in Maryland, 10 in Virginia, and 3 in the District. A flood tide of 8.5 ft was measured at Hains Point, slightly lower than that of the famous hurricane of 1933, and downtown Alexandria was flooded for several blocks inland. Dozens of small craft in Potomac River marinas were swamped or sunk. Power was out to 400,000 in the area and Pepco described it as the greatest disaster in history. Several days later, power was still out to 50,000 residents. The track of Hazel's eye passed directly over Fairfax County, which saw heavy wind damage and many flooded roads. The Potomac rose to flood stage along its entire length, but the waters subsided fairly quickly. Hazel's path and destructive effects were remarkably similar to the hurricane of 1846.

HIGH WINDS FROM OTHER CAUSES

The frequency tables of high wind speeds all show that speeds of 50 mph at Washington are rare. Those that are not due to tornadoes, thunderstorms, and tropical hurricanes are very rare.

The high wind of March 1, 1914. From 7 PM, March 1, to 7 PM, March 2, 1914, the actual wind movement was 799 miles or an average of 33.3 mph. The following is copied from the Daily Local Record:

March 1: Heavy northwest gale set in about 2 PM, increasing in force during the night, and was accompanied by rapidly falling temperature.

March 2: The northwest gale continued throughout the day, the most violent of record, in point of duration. A maximum velocity of 47 mph was recorded about 3 AM, and an extreme velocity of 56 mph, for an interval of about one minute. Considerable damage

was done in sections of the city. The tin roofs of many houses were stripped off; fences, awnings, and chimneys were blown down; and many plate glass windows were broken. Telegraph and telephone service was seriously interrupted, all eastern communications being suspended. Portions of the city were in darkness in the evening owing to damages sustained by the power companies. No fatalities reported.

The high wind of January 23, 1936. The winter of 1935-36 was one of the most brutal in Washington's history, as many arctic outbreaks passed over the region following strong low pressure systems. A brief warming trend had occurred during the week of January 12-18, with the mercury actually rising to 58° on the 13th. The high temperature on January 22 was 48° as one of the most powerful arctic cold fronts in U.S. history hurtled toward Washington. The front arrived with wind gusts measuring 69 mph and plunged temperatures from 48° to 0° in only 12 hours. This is still the highest wind speed measured in the District of Columbia associated with a cold front; higher speeds have only been experienced in thunderstorms and tropical cyclones.

PRESSURE

Unbroken records of pressure reading on which synoptic weather maps are based are available from 1870. Many barograms are available and hourly pressure readings are also available prior to 1915 but these records are not unbroken. Since 1915 there are unbroken records of barograms available. In the following discussions of large pressure rises and falls and of highest and lowest pressures the limitations of the record should be kept in mind.

PRESSURE RISES AND FALLS

Washington is so situated that it has more and larger pressure changes than places to the south, as in Florida, but fewer and smaller pressure changes than to the north as in New England. Below is a table which shows the greatest, average, and least monthly range of station pressure for each month of the year.

Monthly range of pressure (inches)

	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
Greatest	1.87	1.65	2.10	1.39	1.45	0.92	0.76	1.39	0.96	1.43	1.42	1.76
Year	1922	1918	1993	1931	1929	1920	1926	1933	1997	1929	1930	1942
Average	1.28	1.18	1.21	1.06	0.83	0.68	0.59	0.63	0.76	0.95	1.10	1.24
Least	0.75	0.78	0.80	0.49	0.53	0.41	0.27	0.35	0.49	0.56	0.63	0.75
Year	1990	1931	2003	1998	1965	1993	1993	1995	1995	1990	1995	1995

The above table gives an idea of the limit of the pressure changes which take place over a whole month. The two tables below give a list of the pressure rises and falls equaling or exceeding one inch. These tables are compiled from observations from 1889-1945, with two later additions.

Pressure rises

<i>Year</i>	<i>Month</i>	<i>Day</i>	<i>Beginning Time</i>	<i>24-hour change</i>
1896	February	6	Noon	1.00
1912	February	21	10 PM	1.15
1914	January	24	9:15 AM	1.00
1918	March	10	5 AM	1.07
1932	December	31	10 AM	1.08
1939	February	15	10 AM	1.22
1943	January	19	10:30 AM	1.05
2003	February	23	7:00 AM	1.07

Pressure falls

<i>Year</i>	<i>Month</i>	<i>Day</i>	<i>Beginning Time</i>	<i>24-hour change</i>
1893	October	12	9 PM	1.10
1894	February	25	6 AM	1.25
1896	February	5	Noon	1.17
1899	December	23	8 AM	1.00
1900	February	28	8 AM	1.15
1901	April	2	8 AM	1.01
1907	December	22	2 PM	1.12
1908	January	6	5 PM	1.14
1908	January	11	2 PM	1.16
1908	January	31	10 AM	1.25
1909	March	24	8 AM	1.15
1912	February	20	10 PM	1.14
1913	January	2	10 AM	1.47
1914	February	13	5 AM	1.13
1915	November	18	10 AM	1.13
1929	January	5	6 AM	1.16
1933	August	22	8 PM	1.06
1942	March	2	5 AM	1.35
1944	December	10	11 PM	1.10
1993	March	13	8 PM	1.62

Two of the above pressure changes have already been mentioned, namely that of October 1893, in connection with the tropical hurricane under High Winds, and August 1933, under High Tides. Several of these changes have been selected for special mention.

The pressure rise of February 15-16, 1939. The lowest pressure for the month was 29.33" at 10 AM on the 15th when the temperature was 68° and the highest for the month was 30.68" at 1 AM of the 17th with a temperature of 26°. The greatest rise in 24 hours is given in the foregoing table. For the 24 hours preceding the lowest pressure the wind had been steady from the south and the temperature rather warm for that time of year. When the pressure began to rise at 10 AM, February 15, the wind shifted from the south

to the southwest and rain began. The wind remained southwest until 3 PM when the temperature had fallen to 55°; the wind then shifted to northwest. The temperature continued to fall until 9 AM of the 16th when it was 23°. The wind was not unusually strong; the highest gust being a speed of 42 mph.

The low barometer of February 6, 1896. This low pressure was accompanied by heavy rains for this time of the year. The following is copied from the Daily Journal:

Cloudy. Heavy rain continued throughout the night ended 8:20 AM. Barometer fell very rapidly through the night, continuing to fall until 1:30 PM when it reached 28.706, the lowest ever recorded at the station to the present date. Thunderstorm. First thunder 11:05 AM and loudest 11:05 AM, last 11:09 AM. Flash of lightning at 11:09 AM. Thunderstorm seemed to be in the west without a decided movement, temperature before, 56°, temperature after, 43°. Direction of wind before east and after, west. Rain 11:10 AM to 12:55 PM and 1:45 PM to 4:20 PM. Special observation at 1:30 PM. Wind changed to west at 12:15 PM. Rain ended at 4:20 PM followed by clearing and clear weather becoming cloudy again at 9 PM. Brisk to high west to southwest winds reaching 30 mph.

The pressure fall of January 2-3, 1913. As shown in the above table the 24-hour fall of pressure at this time was 1.47 inches and is the greatest of record at 24th and M Streets. The temperature rose from a minimum of 29° on the morning of the 3rd to a maximum of 60° on the following morning. Some rain fell but it was not heavy. The wind was very light throughout the 2nd, the average speed being only 4.7 mph and also for the first 8 hours of the 3rd with an average speed of 6.2 mph. After 8 AM the wind increased. The following note is from the Daily Local Record:

Very low barometer, and high winds, which blew off many roofs and injured trees, signs, and awnings, prevailed during most of the day.

The following is copied from the Monthly Weather Review:

At the beginning of the month a depression of fair proportions was central over Manitoba, with a high area of moderate strength over the Rocky Mountains. Temperatures were high and precipitation was unimportant except along the Atlantic Coast. By the evening of the 1st the northwestern depression had moved to Lake Superior and a secondary one had formed over northeastern Texas, so that a narrow trough extended from that locality to Lake Superior. There was no precipitation to the eastward, but westward to the mountains there were light local snows, accompanied by lower temperatures and rapidly rising pressure with a strong crest over southern Idaho. There had also been a rapid rise in pressure to the eastward of the narrow trough. On the evening of the 2nd the low pressure trough extended from Alabama to Georgian Bay and the barometer had fallen decidedly to the eastward, with rapidly rising temperature from the eastern Gulf of Mexico northward, and with rains south of the Ohio River and rains and snows to the northward. Pressure had also fallen considerably over the west and northwest with a decided rise in temperature over the latter district, but with a fall to nearly normal conditions over the upper lake region, central valleys, and the southwest. During the ensuing 12 hours there was a fall in pressure that was unprecedented in respect to rapidity and extent. The barometer read 28.90 inches in Virginia, a fall of nearly 1 inch in 12 hours and, except over the east Gulf States, there was also a fall westward to the Pacific Ocean, especially over the western slope of the northern Rocky Mountains. General rains were in progress east of the Mississippi River, with some snow north of the Ohio River, and temperature had fallen to somewhat below normal conditions from the Gulf States northward and had risen decidedly over the Plains, the

Rocky Mountain region, and the northwest. Winds had become high over the south and they were increasing to the northward, and storm warnings were soon extended to Eastport, Maine. The pressure continued to fall as the storm center moved northward, and by the evening of the 3rd the barometer at Montreal, Canada read 28.24 inches, a fall of 1.06 inches in 12 hours and of 1.52 inches in 24 hours. The barometer was below 29 inches as far west as the Pennsylvania-Ohio Line and the readings were the lowest of record over the eastern lower lake region, the Middle Atlantic States, and New England. Rains and snows, severe local storms, and dangerous gales had occurred over the east, and temperatures had fallen considerably although not to low readings, east of the Mississippi River, except for New England. The gales were especially severe, with wind velocities ranging from 50 to 88 mph from the south and southwest from North Carolina northward, and much damage was caused both on land and sea.

The storm of March 2-3, 1942. At 5:30 AM, March 3, 1942, the pressure was 28.74"; at this same time of day on March 2 it was 30.09"; the fall of pressure was thus 1.35 inches which was the next greatest drop in pressure over a 24-hour interval for 24th and M Streets.

Hourly wind, temperature, and precipitation values are given here in the table:

Hourly data for Mar 2-3, 1942												
	Mar 2											
Hour	1	2	3	4	5	6	7	8	9	10	11	Noon
Temperature	37	35	34	33	32	30	32	34	37	38	40	43
Rainfall	---	---	---	---	---	---	---	---	---	---	---	---
Wind	SE	SW	S	S	SW	SW	NW	E	E	E	E	E
Pressure	---	30.15	---	---	---	---	30.09	---	---	---	---	---
Mar 2 PM												
Hour	1	2	3	4	5	6	7	8	9	10	11	Mid
Temperature	43	42	43	38	36	34	35	36	37	40	41	44
Rainfall	---	---	T	0.01	0.04	0.04	0.06	0.11	0.12	0.14	0.20	0.34
Wind	SE	E	E	E	NE	NE	NE	NE	NE	NE	NE	NE
Pressure	---	29.93	---	---	---	---	29.51	---	---	---	---	---
Mar 3 AM												
Hour	1	2	3	4	5	6	7	8	9	10	11	Noon
Temperature	44	46	44	44	45	41	37	37	37	39	39	38
Rainfall	0.21	0.01	0.02	0.04	0.04	T	0.01	0.02	T	T	T	T
Wind	NE	NE	NE	NE	NE	NE	NW	NW	NW	NW	NW	NW
Pressure	---	28.86	---	---	---	---	28.78	---	---	---	---	---
Mar 3 PM												
Hour	1	2	3	4	5	6	7	8	9	10	11	Mid
Temperature	38	38	40	41	41	40	40	39	39	38	38	38
Rainfall	0.04	0.03	0.02	0.01	--	--	--	--	--	--	--	--
Wind	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
Pressure	---	28.93	---	---	---	---	29.19	---	---	---	---	---

The following is copied from the Pennsylvania, Maryland and Delaware sections:

Heavy rain fell over the Eastern Shore and southern Maryland, heavy rain and light snow over north-central Maryland and in eastern and central Washington County, and heavy snow (7 to 18 inches) in western Washington, Allegany, and Garrett Counties during the 2nd-3rd. In the general storm of the 2nd-3rd, snow depths ranged from 2 inches in south-central Pennsylvania to 19 inches in the western counties. Four people

died at Pittsburgh in accidents caused by the storm. Roads were blocked, schools closed, and industries retarded as the heavy snow, blown by high winds, caused short circuits and broke down lines, poles, and trees.

The storm of March 13, 1993. This storm merits inclusion due to its extremely low pressure readings and its wide pattern of destruction across the eastern third of the U.S. At 8 PM on March 12 the pressure was 30.16"; at the same time on March 13 it was 28.54", the lowest ever recorded in Washington. This pressure fall of 1.62 inches was the greatest ever measured in 24 hours. The storm began on the evening of March 12, 1993 when an area of low pressure formed in the Gulf of Mexico and moved northeastward. The storm generated blizzard conditions, heavy snowfalls, and high winds from Alabama northward into the Middle Atlantic States. Snow began falling in Washington at 11 PM and continued throughout the 13th. The temperature at that time was 37° with northeast winds of 10 mph. The following is copied from *Local Climatological Data* and news reports:

March 13: Heavy snow during the night, amounting to 4 inches at 7 AM. Thunder heard at intervals from 7:30 AM until 8:30 AM, temperature 31°, wind NE at 15 mph. Sleet began mixing with snow at 11 AM, continued until 4 PM, when snow pellets began to mix in. Some locations report an inch of sleet. Light snow continued until 2 AM on the 14th. Pressure fell from 29.92" at 4 AM to 29.83" at 10 AM; rapid fall of pressure continued until approximately 6 PM when the barometer reached 28.54" (966.5 mb). This is the lowest pressure ever measured in the city's weather history. From 10 AM to 1 PM the barometer fell 19.3 mb (0.57 inches) in three hours, the greatest ever recorded. Temperature range for the 13th, high 35°, low 25°. Winds increased during the afternoon, averaging 21 mph NE with a peak gust of 47 mph from the NE in the late afternoon. Total snowfall at National Airport 6.6 inches, but much drifted by the strong winds. The two-day precipitation total was 2.31 inches. Nearby suburbs report snowfalls ranging from 8 to 12 inches. Most of the District received 10 inches of snow; Anne Arundel County between 12 and 14 inches; Northern Virginia between 12 and 14 inches, with heavier amounts to the west and north. Dulles Airport recorded 14.1 inches and Andrews Air Force Base 13.1 inches. Grantsville, MD set a new state single-storm snowfall record with 47 inches, breaking the mark set in December 1992.

March 14: Most roads are still blockaded by snow and schools have cancelled classes tomorrow. Strong northwest winds continued to blow throughout the day, averaging 18 mph with a gust of 44 mph. High temperature 28°, low 20°. Power is reported out to 20,000 customers in the immediate area and the airports remain closed. All rail service to the south has ceased and every major airport from Georgia to New England is reported to have been shut down at some point yesterday.

The storm set record snowfalls from Alabama to New England, as well as spawning dozens of tornadoes in Florida. Besides Washington, new record low barometric pressure readings were set in Augusta, GA (28.73"), Norfolk, VA (28.54"), Philadelphia, PA (28.43"), JFK Airport (28.43"), and even Boston, MA (28.51"), as well as in a dozen other cities in the storm's path. The storm was followed by record cold temperatures including 15° in Washington on March 15. The death toll was estimated at 273 persons and total damages amounted to over \$1 billion.

HIGH AND LOW PRESSURES

The following tables give the highest and lowest pressures of record prior to 1915 and since to 1915.

Prior to January 1, 1915

<i>Highest</i>					<i>Lowest</i>			
Month	Inches	Year	Day	Time	Inches	Year	Day	Time
January	31.04	1899	2	10 AM	28.72	1913	3	11 AM
February	30.97	1876	5	Noon	28.71	1896	5	2 PM
March	30.82	1913	18	9 AM	28.92	1909	25	8 AM
April	30.70	1909	11	9 AM	29.10	1901	3	8 AM
May	30.56	1914	19	9 AM	29.35	1883	21	3 PM
June	30.50	1884	15	11 AM	29.37	1902	26	2 AM
July	30.53	1892	7	10 AM	29.59	1900	8	7 PM
August	30.42	1880	17	7 AM	29.46	1888	21	8 PM
September	30.64	1904	22	9 AM	29.14	1896	29	11 AM
October	30.83	1879	26	8 AM	28.79	1878	23	7 AM
November	30.85	1891	19	10 AM	28.99	1878	22	2 PM
December	30.97	1896	28	10 AM	28.72	1872	10	5 PM

From January 1, 1915 to present

<i>Highest</i>					<i>Lowest</i>			
Month	Inches	Year	Day	Time	Inches	Year	Day	Time
January	31.01	1927	27	10 AM	28.85	1922	11	11 AM
February	31.05	1981	13	9 AM	29.04	1965	8	Noon
March	30.95	1996	10	10 AM	28.54	1993	13	6 PM
April	30.74	1923	1	8 AM	29.10	1929	16	4 PM
May	30.62	1936	22	11 AM	29.09	1929	3	1 AM
June	30.46	1919	13	8 AM	29.37	1918	12	4 PM
July	30.38	1943	2	8 AM	29.40	1932	1	6 PM
August	30.47	1925	24	Noon	28.94	1933	23	8 PM
September	30.57	1942	29	10 AM	29.38	1999	16	2 PM
October	30.72	1929	10	10 AM	28.80	1954	15	6 PM
November	30.84	1930	29	10 AM	29.26	1920	17	3 AM
December	30.94	1933	29	10 AM	29.08	1944	12	6 AM

It will be noted that the extreme range of pressure is from 31.05" on February 13, 1981 to 28.54" on March 13, 1993. There have been only three occasions when the pressure rose above 31.00" as follows:

The high barometer of January 2, 1899. The pressure reading of 31.04" was the second highest of record and occurred on one of the few days when a temperature below zero has

been recorded at 24th and M Streets. The observer did not enter any note of special interest this day.

The high barometer of January 27, 1927. The third highest pressure reading of record was on January 27, 1927, when the weather was otherwise not very unusual. The barometer read 30.44" at 8 AM on January 26 and rose to 30.99" at 8 AM, January 27, and to 31.01" at 10:30 AM. The weather was not unusually cold, the minimum temperature being 8° on this day and the dry bulb temperature was 16° when this high pressure was reached. The sky was cloudless and the wind light. This minimum temperature was the coldest temperature of the winter of 1926-27.

The high barometer of February 13, 1981. The reading of 31.05" was the highest pressure of record at National Airport and for the city of Washington. As with the other high pressure records, the weather this day was not especially cold. The high was 38° and the low was 20°; the skies were cloudless with a wind of 12 mph from the north-northeast at the time of the reading. The low temperature of 16° on February 12 was the lowest of the month.

The following table is a list of occurrences of pressures below 29.00 inches:

<i>Year</i>	<i>Month</i>	<i>Day</i>	<i>Pressure</i>
1878	October	23	28.79
1878	November	22	28.99
1878	December	10	28.72
1886	January	9	28.96
1888	December	17	28.97
1896	February	6	28.71
1908	January	7	28.93
1909	March	25	28.92
1912	February	21	28.99
1913	January	3	28.72
1918	January	12	28.89
1922	January	11	28.85
1924	March	11	28.98
1932	March	6	28.67
1933	August	23	28.94
1942	March	3	28.74
1954	October	15	28.80
1960	February	19	28.96
1961	February	26	28.98
1970	April	2	28.96
1978	January	25	28.88
1984	March	28	28.69
1993	March	13	28.54

MISCELLANEOUS

Under this heading will be discussed Thunderstorms, Hail, Lightning, Fog; Humid Weather, Dust, Tropical Hurricanes and Ice on the Potomac River.

THUNDERSTORMS

Thunderstorms are likely to be especially noticed on account of four different meteorological phenomena commonly associated with them. The heavy rain that sometimes falls during a thunderstorm may cause floods; the high wind may do damage; the lightning may start fire; and the hail may cause damage. The heavy rains and high winds with thunderstorms have already been discussed above; lightning and hail will be treated separately below; here will be mentioned unseasonable thunderstorms and long periods of consecutive days with thunderstorms. Thunderstorms are least common in December and January; the following table is a list of days with thunderstorms during these months since 1889:

<u>December thunderstorms</u>	<u>January thunderstorms</u>
December 22, 1898	January 24, 1896
December 30, 1907	January 25, 1898
December 22, 1916	January 24, 1899
December 14, 1918	January 12, 1908
December 5, 1920	January 27, 1908
December 6, 1923	January 23, 1913
December 23, 1923	January 21, 1916
December 19, 1929	January 12, 1918
December 1, 1934	January 24, 1928
December 24, 1941	January 19, 1937
December 1, 1942	January 26, 1947
December 15, 1954	January 22, 1959
December 25, 1965	January 15, 1962
December 1, 1974	January 12, 1963
December 17, 2000	January 27, 1967
December 7, 2004	January 26, 1971
December 23, 2004	January 23, 1972
	January 24, 1972
	January 4, 1982
	January 16, 1991
	January 20, 1995
	January 19, 1996
	January 18, 1999

The thunderstorm of January 12, 1918. January 1918 was the coldest month of record. Nevertheless a thunderstorm took place on the 12th. The lowest pressure was 28.89 at 2:30 AM on January 12. The highest temperature for the month was 50° at this same time. The total precipitation between 8 PM, January 11, and 2:30 AM January 12, when the rain ended, was 1.48 inches.

The following note appears in the Daily Local Record for this day:

The heavy rainstorm during last night and early this morning culminated in a thunderstorm at 2 AM. First thunder heard at 2 AM, last at 2:10 AM. Storm appeared to

be southeast of station. Some damage was done to business houses in lower Pennsylvania Avenue due to show windows collapsing. No wind velocity of consequence was recorded at station.

Periods of five or more consecutive days with thunderstorms have been recorded as follows since 1905:

<u>Year</u>	<u>Dates</u>	<u>Duration (days)</u>
1905	June 19-23	5
1908	July 21-26	6
1912	July 14-18	5
1913	July 28-August 1	5
1914	June 22-28	7
1918	August 10-14	5
1921	June 26-30	5
1925	July 4-8	5
1931	July 14-18	5
1933	June 3-8	6
1945	July 26-August 1	7
1958	July 6-10	5
1974	August 2-6	5
1984	June 28-July 2	5
1988	July 17-21	5
2000	July 30-August 4	6
2003	August 26-30	5
2005	July 12-16	5
2006	June 22-27	6

The thunderstorms of July 21-26, 1908. The following table shows the maximum and minimum temperature, average daily sky cover, and total precipitation for the six-day period:

<i>Day</i>	<i>Max temp</i>	<i>Min temp</i>	<i>Avg sky cover</i>	<i>Precip</i>
July 21	88	69	8	0.20
July 22	87	70	8	0.13
July 23	89	71	8	0.77
July 24	88	69	8	0.17
July 25	88	70	9	0.05
July 26	81	71	9	0.88

The following notes are taken from the Daily Local Record:

July 21, 1908: Thunderstorm passed over station; storm came from the northwest and moved southeast. Thunder first heard at 8:45 PM and continued at frequent intervals until midnight.

July 22, 1908: Thunderstorm that prevailed at midnight ended at 2:45 AM.

Thunderstorm: Thunder first heard at 4 PM in the southeast; last heard at 5 PM in the south.

July 23, 1908: Thunderstorm: Thunder first heard at 3:40 PM and continued at intervals to some time during the night.

July 24, 1908: Thunderstorm: Thunder first heard at 5:55 PM. Last heard at 9:50 PM.

July 25, 1908: Thunderstorm: Thunder first heard at 4:45 PM. Last heard at 6 PM.

July 26, 1908: Thunderstorm: Thunder first heard at 6:50 PM and continued until 10 PM.

At this time there were thunderstorms each day from the 21st to 27th at Taneytown in Carroll County, MD; from the 21st to 27th at Baltimore; from the 22nd to 26th at Frederick, MD; from the 21st to 27th at Rockville in Montgomery County, MD; and from the 22nd to 27th at Laurel, Prince Georges County, MD.

The thunderstorms of July 26-August 1, 1945. The month of July 1945 was the wettest July in history with a total rainfall of 11.06 inches. There were 14 thunderstorm days, the most of any July. A severe thunderstorm occurred on July 22 and 1.31 inches of rain fell at 24th and M Streets in one hour. Heavier rainfalls occurred in the Northeast section of the District, flooding homes and disrupting streetcar traffic. Two churches were struck by lightning and set afire during this storm. The following table shows the maximum and minimum temperature and total precipitation for the seven-day period from July 26 to August 1, 1945:

Day	Max temp	Min temp	Precip
July 26	90	73	trace
July 27	86	71	trace
July 28	85	71	1.35
July 29	79	70	0.37
July 30	88	70	trace
July 31	87	74	0.50
August 1	85	69	0.03

The thunderstorm of July 27 was excessive in Montgomery County, where two inches of rain fell and local roads were flooded. The storm of July 31 was so filled with vivid lightning that it was described as a "freak thunderstorm." Two people were struck by lightning and a young boy was washed into a culvert by floodwaters and drowned. Although the official site at 24th and M Streets recorded 11.06 inches of rain during July 1945, the Soldiers Home in Northeast Washington recorded a phenomenal 13.54 inches for the month. The greatest period of heavy rain during July 1945 occurred from the 14th through the 19th when a total of 5.66 inches fell in six days. Only two thunderstorms were noted during this period, however. Damage to roads, bridges, and railways was extensive in Maryland and along the Anacostia River. Great crop damage also occurred in the Eastern Shore during this six-day period.

HAIL

Hail has been observed at Washington on 129 days since observations began in 1889. The more notable (since 1905) of these falls of hail were those of June 10, 1916, June 14, 1917, April 21, 1929, May 13 and 18, 1936, April 29, 1938, June 28, 1940, June 2, 1945, May 11, 1951, April 26, 1953, and April 23, 1999. Two of these are discussed in detail here.

The hailstorm of April 29, 1938. The hail that fell on April 29, 1938 at 24th and M Streets was perhaps the most severe ever observed at that location. On that day at this location hail fell from 12:32 to 12:34 PM and again from 12:36 to 12:54 PM. The following note appears in the Daily Local Record:

Today's hailstorm was unusual for this vicinity. The stones were larger than usually fall here and they were of unusual form. The first ones that fell were spherical and about

the size of marbles; later ones were conical shaped, some of them appearing to have segments sliced from their sides. The largest stones that fell near 24th and M Streets were about 1 1/8 inches long and had a base diameter of about 3/4 inch. Spherical stones having a 3-inch diameter were reported from the Maryland suburbs. The principal damage was to greenhouses. This damage in Washington and vicinity was reported to be as much as \$100,000. Comparatively small damage was done to skylights, windows, and auto tops. Thunderstorm first heard at 12:23 PM, last at 12:58 PM, came from southwest.

Light to heavy hail fell over an area 20 to 25 miles wide and 110 to 115 miles long, from southern Montgomery County and the District of Columbia east-southeastward to the coast of Sussex County, in the afternoon of the 29th. Heavy hail of 29th, damage by: size of marbles to golf balls, hen eggs, and lemons. At Washington, greenhouse glass, \$100,000. At Shadyside, considerable to crops. At Wittman, Claiborne, and St. Michaels, many roofs and auto tops pierced, many windowpanes broken, some poultry killed. Between Easton and Cordova, many windowpanes broken, loss of crops \$10,000. Near Federalsburg, hail 2 inches deep over 5-mile area, loss of strawberries and plants was heavy.

The hailstorm of April 23, 1999. Although no hail was reported from this storm at National Airport, it deserves inclusion because it was probably the most damaging hailstorm ever to strike the Washington area. The following is copied from Weather Service reports:

On April 23, 1999 a horrific hailstorm moved southeast from Pennsylvania across Garrett County, Maryland into West Virginia. It had weakened somewhat as it crossed the mountains, but as it passed east of Keyser, West Virginia the hail began to increase in size once again. By the time the thunderstorm reached Capon Bridge in eastern Hampshire County, the size of the hail had grown from golf balls to baseballs. As it moved into Frederick County, Virginia, the hailstorm continued to grow, dropping golf ball hail in a ten-mile swath from Winchester to Stephen City. The intensity of the hail stripped and shredded the leaves and bark from trees. Hail stones grew to the size of grapefruit (4 inches in diameter) just east of Winchester. The storm continued east through Clarke, Loudoun and Fauquier Counties, doing considerable damage to Middleburg. The Fairfax County communities of Centreville, Chantilly, Fairfax, Burke, Springfield, and Lorton were pelted with huge stones. The storm crossed the Potomac River and weakened slightly as it moved into Maryland. Hail of 1 to 2 inches struck southern Prince Georges and Calvert Counties before moving over the Chesapeake Bay. The damage left behind by this storm was incredible. In Northern Virginia alone, damage was estimated at over \$50 million. In some communities, one-third of the homes suffered siding and roof damage. Windows were broken, cars dented, and windshields smashed. Piles of shredded plant debris were left on the ground all along the storm's path. In about 6 hours, this one thunderstorm did \$75 million in damage. Some drifts of hail were two feet deep after the storm and they took hours to melt. Dense fog occurred in the areas where heavy drifts of hail lay. There have been several severe hailstorms to hit this area before, but none ever caused this much damage to property.

LIGHTNING

From time to time the lightning which accompanies thunderstorms kills people or sets fire to property. About one such case is reported each year. Most thunderstorms pass without any damage to life or property due to lightning. Two occurrences of damage or death by lightning have been selected for special mention.

The lightning of August 10, 1943. In the worst lightning incident in regional history, six soldiers were killed on a Ft. Belvoir drill field. A large group of soldiers was playing baseball, and the game had just been called due to the approaching storm. As the troops began to disperse, a bolt of lightning struck in the middle of the group. Six soldiers were instantly killed and the sudden bolt of lightning injured nine other men. Army authorities called the men "heroes" who gave their lives for their country.

The lightning of July 22, 1945. There was a thunderstorm on this day between 12:35 PM and 1:50 PM. The following is copied from the Daily Local Record:

Three persons, including a fireman, were injured and two church steeples and six houses were struck by lightning and streetcar traffic was delayed in several sections by a raging thunderstorm which swept through the Washington area today. Homes throughout the city were flooded and electric power was cut off in a number of areas for a short time as a result of the downpour. The storm was heralded by vivid streaks of lightning which remained in the sky for more than a second in some instances following which a veritable torrent of rain poured over the city, amounting to almost cloudburst proportions in the northeast section of the city. The sewer system was unable to carry off the water immediately and water backed up in several places across streetcar tracks causing short interruptions to service. On the H Street car line water backed over the tracks so high that service was halted at Kenilworth Junction and passengers transported by bus to the District Line from that point.

FOG

While dense fog (visibility 1,000 feet or less) is common in Washington, the usual duration is considerably less than 12 hours. Two unusual cases of dense fog lasting 24 to 25 hours are discussed below.

The fogs of December 20-23, 1923. Weather data for each of these days is listed below:

Day	High	Low	Sky cover	Precip	Wind	Notes
20	59	41	9	Trace	3.3	Light fog from 8 AM to 2 PM; Dense fog from 11 PM to midnight
21	68	49	8	0.01	2.8	Dense fog from midnight ended 4:10 AM; Light fog from 4 AM to 5 PM; Light fog began 10 PM, continued after midnight
22	57	49	10	0.17	4.8	Light fog from midnight changed to dense fog 4 AM; continued throughout the day
23	57	49	10	0.37	5.6	Dense fog from midnight ended at 4 AM; light fog until 4:30 PM; Moderate thunderstorm from northwest; first thunder at 3:16 PM During the thick fog, which prevailed for 24 hours, the newspapers reported 4 fatalities and 9 persons injured due mostly to motor accidents caused by the fog and slippery streets

The dense fog of January 9-10, 1935. The longest duration of dense fog (visibility 1,000 feet or less) recorded at 24th and M Streets was from 11 AM, January 9 to 11:30 AM, January 10, 1935. From 1:30 AM January 7 to 8:30 PM January 10, a period of 91

hours, either light or dense fog prevailed. There was some blue sky visible and sunshine through light fog and broken clouds on the 7th but the sky was completely overcast on the 8th, 9th, and 10th. The wind was light in speed and variable in direction.

The following table shows the weather data for each of these days.

<i>Day</i>	<i>High</i>	<i>Low</i>	<i>Precip</i>	<i>Wind</i>	<i>Notes</i>
Jan 8	56	41	Trace	3.5	Dense fog continued from midnight until 12:30 PM; light fog to 5:30 PM; dense fog until midnight
Jan 9	52	44	0.35	3.2	Dense fog continued from midnight to 3:30 AM; light fog to 11 AM; dense fog until midnight
Jan 10	55	48	Trace	4.0	Dense fog continued from midnight until 11:30 AM; light fog ended about 8:30 PM
Jan 11	57	51	-----	3.7	

The lowest barometric pressure for the month was at 3:30 PM on the 10th when the sea level pressure was 29.56". During the night of the 10th-11th the wind shifted to the northwest and increased in speed; also the fog dissipated and the sky cleared. It is stated that the fog grounded air transportation, interrupted shipping activities, and delayed land traffic. It is also stated that it gave rise to spinach mold in the coastal truck region.

HUMID WEATHER

Long spells of humid weather are not common at Washington. The following list gives all periods of 14 days or longer when the dew point was 70° or higher each day since 1889.

<i>Year</i>	<i>Month</i>	<i>Day of beginning</i>	<i>Duration</i>
1901	July	10	16
1905	July	3	19
1920	August	6	14
1938	July	27	16
1945	July	19	16
1979	July-August	12	26
1994	July	13	15

The months shown below are the only ones in which the average monthly dew point equaled or exceeded 70°

<i>Year</i>	<i>Month</i>	<i>Average dew point</i>
1901	July	70.6
1906	August	70.3
1955	July	71.4
1979	August	70.0
1994	July	71.3

The humid weather of July 3-21, 1905. This was the longest period that the dew point remained above 70° each day at 24th and M Streets. The table below gives the weather

data for each day during this period. The highest observed dew point was 77° on July 3. The average dew point during this 19-day period was 71.4°. It is of interest that, while the observer gives special notes to thunderstorms, haloes, excessive precipitation, haze, and smoke from time to time during this period, he entered no note whatever about the high or prolonged humidity.

<i>Day</i>	<i>Max temp</i>	<i>Min temp</i>	<i>Mean</i>	<i>Precip</i>	<i>Dew point</i>
July 3	88	69	78		72
July 4	87	71	79	trace	70
July 5	87	70	78	3.68	70
July 6	78	70	74	0.55	73
July 7	87	74	80	0.06	74
July 8	88	72	80		72
July 9	89	71	80		72
July 10	89	73	81		70
July 11	88	73	80	0.09	70
July 12	87	71	79	0.84	71
July 13	79	72	76	0.56	71
July 14	85	67	76	1.14	71
July 15	88	67	78		72
July 16	84	67	76		70
July 17	93	72	82		73
July 18	95	74	84		74
July 19	93	68	80	0.94	70
July 20	88	70	79		72
July 21	84	70	77		70

The humid weather of July 12-August 6, 1979. This was the longest period that the dew point remained above 70° at National Airport and the longest in the city's history as well. It is interesting to note that the temperature did not reach 90° in 1979 until July 12, when 93° was recorded at the official site. This was the latest date of the first 90° day in the city's weather history. The table below shows the weather data for this period.

<i>Day</i>	<i>Max temp</i>	<i>Min temp</i>	<i>Mean</i>	<i>Precip</i>	<i>Dew point</i>
July 12	93	73	83		71
July 13	92	75	84	1.28	75
July 14	87	75	81	trace	75
July 15	90	75	83		74
July 16	92	77	85		74
July 17	90	76	83		73
July 18	89	77	83	0.01	72
July 19	86	75	81		72
July 20	86	76	81	trace	74
July 21	82	75	79	0.12	71
July 22	85	72	79		73
July 23	90	76	83	0.26	74
July 24	86	73	80	0.04	73
July 25	85	76	81	0.56	75
July 26	89	77	83	0.01	77
July 27	89	76	83		70
July 28	90	75	83	0.23	73
July 29	89	72	81	0.22	75
July 30	85	72	79	trace	74

July 31	91	77	84		77
August 1	93	78	85		78
August 2	92	77	85	0.57	77
August 3	88	76	82	0.04	76
August 4	91	75	83		71
August 5	93	76	85	trace	71
August 6	91	75	83		70

DUST

Regular observations of dust have not been made at Washington for any long period of time. Washington is so situated that dust storms are very infrequent. The single case of May 11, 1934 will be mentioned here.

The dust storm of May 11, 1934. On May 11, 1934, a dust cloud passed over Washington. Observations were made by an Owens dust counter and the highest dust count ever observed at Washington was on this day. The following note appears in the Daily Local Record:

An unusual condition of the sky prevailed throughout the day, due to dust particles in the air, presumably carried eastward from the dry areas farther west and northwest. Visibility was poor, although there was an absence of cloud, and the disc of the sun was visible throughout the day until 2:30 PM. Light conditions resembled, somewhat, the effect produced by a partial eclipse of the sun.

Another dust storm occurred in Washington on April 11, 1935, with similar conditions prevailing. A strong cold front brought the dust to the entire Eastern Seaboard. In New York, skyscrapers were hidden in a reddish mist, and brown snow fell in Vermont. Ships at sea reported dust-covered decks. An ochre-colored "mud rain" was observed in Virginia before the cold front arrived, plunging temperatures to 30°. Great crop damage occurred in the Midwest from the frost.

SMOKE

On rare occasions large forest fires will send plumes of smoke into the atmosphere and upper level winds will bring the smoke layer over Washington. Two cases will be mentioned here.

The smoke pall of September 24, 1950. An immense pall of smoke from a vast forest fire in Alberta, Canada drifted eastward across Washington, giving a yellowish cast to the sky during the day and turning the moon blue at night. The smoke layer drifted across the country at an altitude of about five thousand feet, creating the same eerie effect from Toronto to Virginia and westward to Iowa. Birds roosted, planes were forced down, and the populace grew fearful, thinking it was the result of atomic bomb testing.

The smoke pall of July 6-7, 2002. Huge plumes of smoke from Canadian forest fires swept over the Eastern United States, bathing the Washington region in an eerie dry haze, hampering pilots' visibility and filling the streets with the scent of burning trees. The wildfires in central Quebec were ignited by lightning strikes in extremely dry forests east of James Bay. Almost fifty separate wildfires consumed 150,000 acres, and smoke from the blazes rode northerly wind currents to New York and New England over the weekend. Visibility at airports in Philadelphia and Baltimore was cut to two or three miles by the smoke, which filtered the sunlight of a cloudless summer day into a milky

glow and delayed flights up to an hour in Philadelphia. In Baltimore and Washington, the acrid smoke degraded the air quality enough for weather forecasters to recommend that people with respiratory ailments remain indoors. The winds resulted from a strong low pressure system centered over the Maritime Provinces. Foliage took on an eerie yellow cast, and the sun appeared blood red throughout the afternoon.

TROPICAL HURRICANES

Tropical storms have already been given detailed treatment above in connection with floods (August 1938, September 1935, August 1944, August 1955, June 1972, and September 1996), high tides (August 1933), and high winds (October 1893, September 1896, and October 1954). Several more will be mentioned here because the tracks of their centers passed over, or very near to, Washington. The centers of the following tropical storms or hurricanes passed directly over, or within 30 miles, of Washington:

September 17, 1876
 October 23, 1878
 October 12, 1893
 September 29, 1896
 August 4, 1915
 September 19, 1928
 October 2, 1929
 August 23, 1933
 October 15, 1954
 August 12, 1955
 September 5, 1979
 September 16, 1999

The tropical hurricane of September 17, 1876. The following is copied from the *Monthly Weather Review*:

This hurricane struck the coast of North Carolina, near Wilmington, early on the morning of Sunday the 17th. As its center passed directly over Washington between 4 and 6 o'clock of the afternoon of the 17th, the accompanying copy of the records of self-registering instruments will be interesting.

<i>Sept 16</i>	<i>6 PM</i>	<i>7 PM</i>	<i>8 PM</i>	<i>9 PM</i>	<i>10 PM</i>	<i>11 PM</i>	<i>Midnight</i>
Temperature	63	62	63	62	62	61	61
Pressure	30.14	30.13	30.10	30.10	30.07	30.05	30.00
Rainfall	0.02	0.02	0.02	0.01	0.01	0.02	0.02
Wind	NE	NE	NE	NE	NE	NE	NE
Speed	----	13	14	15	18	20	16

<i>Sept 17</i>	<i>1 AM</i>	<i>2 AM</i>	<i>3 AM</i>	<i>4 AM</i>	<i>5 AM</i>	<i>6 AM</i>	<i>7 AM</i>	<i>8 AM</i>
Temperature	60	60	60	60	60	61	61	60
Pressure	29.97	29.94	29.93	29.92	29.94	29.96	29.93	29.91
Rainfall	0.01	0.02	0.05	0.10	0.05	0.02	0.03	0.06
Wind	NE							
Speed	21	23	23	21	21	17	14	10

<i>Sept 17</i>	<i>9 AM</i>	<i>10 AM</i>	<i>11 AM</i>	<i>Noon</i>	<i>1 PM</i>	<i>2 PM</i>	<i>3 PM</i>	<i>4 PM</i>
Temperature	62	64	68	70	71	72	71	71
Pressure	29.87	29.83	29.73	29.70	29.59	29.50	29.39	29.25
Rainfall	0.02	0.04	0.49	0.66	0.19	0.13	0.18	0.49
Wind	NE	NE	NE	NE	NE	NE	NE	NE
Speed	11	13	15	8	22	22	24	26

<i>Sept 17</i>	<i>5 PM</i>	<i>6 PM</i>	<i>7 PM</i>	<i>8 PM</i>	<i>9 PM</i>	<i>10 PM</i>	<i>11 PM</i>	<i>Midnight</i>
Temperature	70	69	68	67	64	63	64	64
Pressure	29.30	29.43	29.60	29.71	29.74	29.80	29.81	29.82
Rainfall	0.04	0.04	Rain ends	----	----	----	----	----
Wind	NE	E	W	SW	SW	SW	SW	SW
Speed	13	15	28	26	23	18	18	15

A peculiar interest attaches to this hurricane, inasmuch as it is one of the few that, after approaching the Atlantic coast, has been deflected to the northwest instead of the northeast, and is apparently accounted for by the presence of the area of decidedly high pressure north of the Alleghenies on the 17th. At Washington, D.C., the records of the central office show that the lowest barometer was 29.15" about 4:35 PM during a period of calm that lasted from 4:50 to 5:50 PM, after which the wind, which had been steady from the east, shifted to the west; the maximum wind velocity was west, 36 mph.

The tropical hurricane of October 23, 1878. This hurricane caused great damage around Wilmington, NC, on the Chesapeake Bay, and around Philadelphia. The following is copied from the *Monthly Weather Review*:

The barometric vortex passed almost directly over Washington, probably a little to the east; at 4:40 AM the anemoscope was swung suddenly from east to south, and then back again, twice round the compass to the west, settling down to northeast, where it remained with little or no wind, until 7 AM, when it backed to northwest, with the abrupt beginning of the northwest wind; the lowest barometer, 28.80", occurred about 7:15 AM. This hurricane produced 3.48 inches of rain at Washington; the maximum wind speed recorded during this passage was 32 mph from the northwest.

The tropical hurricane of October 2, 1929. There is a long article about this hurricane in the *Monthly Weather Review* of October 1929, but there is no mention of its behavior at Washington. Rain fell continuously from 1:20 AM, October 1 until 9:40 AM, October 2. For two hours there was no rain and the sun shone intermittently for 18 minutes. The temperature was 58° when the rain stopped. The wind blew from northeast from 6 PM, September 30 until 9:40 AM, October 2. After the rain stopped the temperature rose to 76°. At 11:40 AM the rain resumed, the wind shifted to the south and the temperature fell to 68°. The lowest pressure was 29.29" at 11:30 AM.

Tropical Storm David, September 5, 1979. Hurricane David swept the area as a tropical storm after killing more than 2,000 people in the Caribbean. The storm's center did not pass directly over Washington, but it did move over nearby Fairfax County and is therefore included for discussion. The following is copied from news reports:

The center of the storm, moving at 30 mph, passed over Dulles Airport at midnight and drenched the entire region with heavy rains. A total of 3.68 inches fell at National Airport and wind gusts reached 60 mph across the entire metropolitan area. Some sections of nearby Maryland were drenched with over two inches of rain in one hour. To the west, as much as 7 inches of rain fell, causing severe flooding on the Monacacy River in Maryland. Tides on the Chesapeake rose two feet above normal. David spawned eight tornadoes in Virginia and seven in Maryland, killing one person and injuring 19 others; damage totaled nearly \$6 million. Two tornadoes were reported from the Hampton Roads area, where the tropical storm came ashore. A strong F3 tornado struck Fairfax County on an 18-mile path, killing one person and injuring six others. The fatality occurred when a giant tree fell onto a home, crushing the owner in his bedroom. The twister struck the same school hit by a tornado on April 1, 1973, this time causing \$150,000 in damage. Numerous cars were demolished, 90 homes were damaged, and local roads were blocked by downed trees and other debris. Damages in Fairfax County reached \$2.5 million. An F2 tornado struck Sterling, VA, injuring 2 people and damaging 80 homes. Four homes were unroofed or seriously damaged by the twister. Loudoun County, VA, was struck by another F2 twister that caused considerable damage but injured no one. An F1 tornado 50 yards wide struck Crofton, MD, blowing the roof off one house and destroying many trees. There were no fatalities, but one person was injured.

Tropical Storm Floyd, September 16, 1999. Although the center of this storm did not pass directly over the District, it did move over Annapolis, thirty miles to the east, and was one of the closest passes by a tropical system since Hurricane Connie in 1955. The following is copied from National Weather Service reports:

Hurricane Floyd loomed as an ominous threat for days off the Florida coast before weakening and moving northward. The storm was very close to being a Category 5 hurricane at one point, but upper level winds disrupted Floyd's eyewall, sparing coastal communities in the Southeast. Floyd's rainfall, however, caused the worst floods in North Carolina history. Twenty inches of rain fell in the eastern part of the state, inundating towns, washing out bridges and roads, and killing at least 60 people. This was the highest death toll from a single tropical system in the U.S. since Agnes in 1972. Floyd regained strength as it moved over Virginia Beach, and winds gusts of hurricane force severely damaged trees and buildings in the resort area. Although rainfall was somewhat diminished as the storm headed northward, drenching rains created havoc along the Chesapeake Bay and parts of Tidewater Virginia. Washington, D.C. received 3.67 inches on the 16th and a storm total of 4.57 inches. Annapolis, only thirty miles east of the Nation's Capital, measured a phenomenal 12 inches of rain during the hurricane's passage. Wind gusts of 60 mph damaged wharfs and pleasure craft, and many trees were downed throughout the metropolitan area. No fatalities were reported from this storm in the Washington region.

Tropical Storm Isabel, September 18-19, 2003. The most damaging tropical cyclone since Hurricane Hazel in 1954, Isabel struck a devastating blow to the entire Washington, D.C. area. The storm made landfall near Morehead City, NC at noon on the 18th as a Category 2 hurricane. At this time, the first rain bands were actually reaching the metropolitan Washington area, a fact that gives some idea of the breadth and power of this storm. The initial path of Isabel would have taken it on a trajectory similar to that of the August 1933 hurricane, but the system traveled some 65 miles farther to the west of the city than that storm. Wind gusts of 58 mph were measured at DCA, where a total of 2.31 inches of rain fell over an 18-hour period. A gust of 78 mph was recorded at Quantico, VA, the highest measured in the vicinity of Washington, D.C. The lowest

barometric pressure was 29.51 inches. The following is copied from National Weather Service reports:

The hurricane's storm surge and high winds extensively damaged vacation communities along the Outer Banks. Isabel cut a new inlet north of Buxton, North Carolina, severing Highway 12 and turning Hatteras into an island; it was not immediately apparent whether or not this inlet could be closed. Virginia Beach saw some major wind damage and beach erosion was severe. Tidal flooding resulting from the long duration of east and southeast winds raised the highest tide known on the Chesapeake Bay and the Potomac River. Old Town Alexandria was inundated at high tide by flood waters that rose to the second storey level, causing grave damage to stores and restaurants. The surge piled up even higher as it reached the D.C. waterfront, reaching an amazing 11.3 feet at Georgetown. This broke the record tide of 11.0 feet set during the August 1933 hurricane. The worst inundation occurred in the Belle View area south of Alexandria, where the water rose to 9.5 feet above sea level and completely flooded an entire subdivision. Although residents had been warned of flooding, the excessive surge caught many by surprise, and more than 80 people had to be rescued by boat in the middle of the night. Many victims were awakened in their beds by torrents of water pouring into their homes. Downtown Baltimore fared no better as a ten-foot storm surge "equal to a Category 3 hurricane" swept over the entire waterfront and flooded many streets; dozens of people had to be rescued and many automobiles were ruined. The next morning, kayaks and canoes cruised through streets that normally teemed with auto traffic. Annapolis was hit with record flooding as well when the Severn River overtopped sandbag barriers, swamping the waterfront and wrecking the marina. The previous record flood in Annapolis (6.35 feet during the 1933 hurricane) was eclipsed by the 7.58 feet of water that invaded the city. The Naval Academy was inundated, without electricity, and lacking drinking water after the passage of the storm. To the south, tremendous damage occurred along the western shore of the Chesapeake, where surges of five feet, topped by seven-foot waves, overran seawalls. The town of North Beach was especially hard hit and many homes were moved bodily inland, their porches and foundations destroyed.

The worst and most widespread impact of Isabel, however, was the extensive wind damage. Tropical storm winds of 60 mph were common from the Atlantic Shore to the Blue Ridge, resulting in the toppling of hundreds of thousands of trees. Fallen trees and branches cut off power to an estimated 6 million people who resided in the area from Hampton Roads to Western Maryland. In the Metro region, an incredible 1.3 million people were left without electrical power after Isabel's passage, by far the greatest power catastrophe in regional history. When power was cut off to water treatment plants in Fairfax County, over a million people were forced to boil water for safety. Cleanup after Isabel's passage was a massive undertaking, with nonfunctional traffic lights snarling traffic for days. Despite the influx of hundreds of linemen, the damage to the region's electrical grid was so extensive that a half-million people still remained without power five days later. The storm was a remarkable combination of the famous hurricanes of 1933 (tidal flooding) and 1954 (wind damage). Had this storm followed a path to the east, the destruction would have been even worse and Ocean City would have seen extensive damage. A total of 40 people were killed by Hurricane Isabel, many of them after the storm's passage. In the Washington area, four people died from carbon monoxide poisoning when they foolishly used generators inside their homes. Two power linesmen were electrocuted during post-storm repairs.

ICE ON THE POTOMAC RIVER

When the mean monthly temperature in Washington falls below 30°, ice usually forms on the Potomac River. One case has been selected for special mention.

Ice on the Potomac River in January 1940. The month of January 1940 was the third coldest January since 1870, the Januaries of 1893 and 1918 being colder. The daily mean temperatures for the course of January 1940 were as follows:

<i>Date</i>	<i>Mean.</i>	<i>Date</i>	<i>Mean</i>	<i>Date</i>	<i>Mean</i>
1	21	11	32	21	24
2	22	12	36	22	28
3	22	13	36	23	26
4	22	14	46	24	27
5	26	15	38	25	22
6	22	16	32	26	16
7	23	17	22	27	16
8	26	18	22	28	20
9	22	19	17	29	19
10	24	20	16	30	21
				31	25

It will be noted that the coldest weather was at the end of the month. The weather moderated on February 3. The following notes, all copied from the Daily Record, are of interest:

January 25: Thickness of ice on the Potomac River at Key Bridge: 9 to 12 inches; below Key Bridge, near shore in vicinity of Washington, about 9 inches; Washington and Georgetown channels, 4 to 6 inches; from Hains Point to Alexandria, mostly open water; pavements and sidewalks became quite rough and slippery due to packed frozen snow.

January 26: Ice along shore below Key Bridge near Georgetown reported to be about 8 inches thick. Pavements and sidewalks still quite rough and slippery in many places.

January 27: Ice in Potomac River above Key Bridge and along shores reported to be 10 to 12 inches thick; pavements quite rough and slippery in many places due to covering of frozen ice and snow.

January 29: Ice on Potomac River above Key Bridge and along shore south of Key Bridge reported to be 12-15 inches thick. Pavements and sidewalks rough and slippery in places.

February 2: Ice in Potomac River reported as being the same thickness as it was on January 29. Traffic was impeded this morning by slippery pavements and to the light fall of snow and a thin coating of glazed ice. Pavements became slippery in the afternoon in many places.

February 5: Thickness of ice in Potomac River below Key Bridge along shores, about 11 inches. Pavements and sidewalks rough and slippery in some places.

February 6: Light fog from 8:30 AM to 5 PM; moderate fog to past midnight. Thickness of ice in Potomac River above Key Bridge about 15 inches. Pavements and sidewalks rough and slippery in some places.

February 9: Thickness of ice in Potomac River along shore below Key Bridge 8 inches and showing signs of breaking up. Solar halo visible from 10:30 AM to 11:30 AM.

February 12: For more than 2 weeks the Norfolk and Washington steamers had been confined to port due to dangerous navigation on the Potomac. Never did ice block the channel, but it had beaten down familiar buoys and course markers and frozen ice over them. Only twice before since the steamship company was established in 1891 had ice

forced cancellation of schedules: once in 1918 for 4 weeks, and again in 1936, when the ships lay idle for about the same length. But both times the line had waited longer—until the channel ice was thinner and weaker—before a trial run. Thanks to the toughest job of ice breaking that boats using the route regularly have encountered in 49 years, the Potomac River today is navigable from Washington to the Chesapeake Bay. Ten miles below Washington, the tough going began. Winter had laid a thick, white blanket that extended in most places from bank to bank. The irregular course of the river played its part; the ice, with little chance to drift downstream, was compressed in almost a solid layer, varying from 6 to 20 inches in depth. Ice above Key Bridge was solid from shore to shore near Washington.

February 14: Channel in Potomac River below Key Bridge free of ice; above bridge river is completely covered with ice. Rivers and lakes, the tributaries of the Chesapeake Bay and the upper Bay were frozen over throughout the month. Ice was making during the first decade and making rapidly during the 16th-20th in the lower Chesapeake Bay, which was frozen over or was mostly filled with ice during the third decade, and prevented oystering. Ice disappeared by the 15th from the lower Chesapeake and by the 20th from the upper Chesapeake Bay. Oystering and navigation of small craft were resumed.

A very similar situation occurred during the very cold month of January 1977. The mean temperature that month was 25.4°, the lowest since January 1940, and every day recorded a low temperature below freezing; this was only the second time this had occurred in Washington. Ice had formed early in the season during the record cold of November and December, and it measured 11 inches thick by January 20. Islands in the Chesapeake Bay were isolated and supplies had to be airlifted to the residents. The ice thawed slowly as temperatures moderated in February and no ice jams occurred.

TABLES OF EXTREMES

TABLE 60. *Maximum precipitation for selected time intervals*

(Period of record: 1871-2007)

<i>Month</i>	<i>5 minutes</i>	<i>Date</i>	<i>10 minutes</i>	<i>Date</i>	<i>15 minutes</i>	<i>Date</i>
January	0.20	24, 1899	0.32	24, 1899	0.41	24, 1899
February	0.34	28, 1903	0.45	28, 1903	0.48	28, 1903
March	0.40	9, 1921	0.50	9, 1921	0.52	9, 1921
April	0.31	21, 1927	0.59	21, 1927	0.62	21, 1927
May	0.56	5, 1993	0.94	3, 1936	1.18	3, 1936
June	0.55	25, 1914	0.96	27, 1919	1.25	27, 1919
July	0.77	30, 1913	1.21	30, 1913	1.51	30, 1913
August	0.80	11, 1897	1.20	11, 1897	1.47	11, 1897
September	0.56	2, 1926	1.02	12, 1934	1.44	12, 1934
October	0.41	5, 1995	0.62	3, 1927	0.83	15, 1942
November	0.57	17, 1927	0.68	17, 1927	0.68	17, 1927
December	0.21	1, 1934	0.33	1, 1934	0.38	5, 1941
<i>Year</i>	0.80	August 11, 1897	1.21	July 30, 1913	1.51	July 30, 1913

<i>Month</i>	<i>1 hour</i>	<i>Date</i>	<i>2 hours</i>	<i>Date</i>	<i>6 hours</i>	<i>Date</i>
January	0.57	24, 1899	0.88	21, 1902	1.41	3, 1914
February	0.62	21, 1937	0.94	22, 2003	1.88	22, 2003
March	1.02	24, 1905	1.19	24, 1905	1.76	27-28, 1932
April	0.78	21, 1929	1.15	21, 1927	1.90	11, 1919
May	1.57	3, 1936	1.88	3, 1936	2.94	19, 1900
June	2.66	8, 1900	3.34	25, 2006	5.91	25-26, 2006
July	3.06	22, 1969	3.33	5, 1905	3.69	5, 1905
August	2.48	24, 1906	3.25	2, 1944	5.38	11-12, 1928
September	3.42	12, 1934	3.91	4, 1939	5.15	2, 1922
October	2.29	20, 1910	2.71	20, 1910	3.10	19-20, 1910
November	1.42	8, 1943	2.01	8, 1943	2.69	8, 1943
December	0.59	14, 1918	1.57	1, 1974	1.63	13, 1909
<i>Year</i>	3.42	Sept 12, 1934	3.91	Sept 4, 1939	5.91	June 25-26, 2006

TABLE 60. (*continued*)

<i>Month</i>	<i>12 hours</i>	<i>Date</i>	<i>24 hours</i>	<i>Date</i>	<i>48 hours</i>	<i>Date</i>
January	1.64	3, 1914	2.98	12-13, 1915	3.34	12-13, 1915
February	2.20	22, 2003	2.56	21-22, 2003	2.61	21-22, 2003
March	2.05	27-28, 1932	3.43	19-20, 1958	3.12	30-31, 1886
April	2.37	11-12, 1913	3.21	25-26, 1889	4.71	25-26, 1889
May	3.14	19, 1900	4.32	5-6, 1953	4.41	5-6, 1953
June	6.23	25-26, 2006	7.94	25-26, 2006	9.41	25-26, 2006
July	4.01	5, 1905	5.80	29-30, 1878	5.93	29-30, 1878
August	6.20	11-12, 1928	7.31	11-12, 1928	8.67	11-12, 1928
September	5.16	2, 1922	5.66	15-16, 1874	6.70	4-6, 1935
October	3.62	19-20, 1910	5.91	7-8, 2005	7.30	7-8, 2005
November	3.02	8-9, 1943	4.03	27-28, 1993	3.20	8-9, 1943
December	1.93	13, 1941	2.86	17-18, 1977	3.13	18-19, 1977
<i>Year</i>	6.23	June 25-26, 2006	7.94	Jun 25-26, 2006	9.41	June 25-26, 2006

<i>Month</i>	<i>72 hours</i>	<i>Date</i>
January	3.34	11-13, 1915
February	2.99	23-25, 1979
March	3.83	21-23, 1903
April	5.29	25-27, 1889
May	5.49	4-6, 1953
June	10.34	25-27, 2006
July	7.91	29-30, 1878
August	8.72	12-14, 1955
September	6.83	4-6, 1935
October	7.34	7-8, 2005
November	4.50	19-21, 1952
December	3.31	18-20, 1977
<i>Year</i>	10.34	June 25-27, 2006

TABLE 61. *Daily temperature extremes*
 (Period of record: 1871-2007)

Month	Maximum			
	Highest	Date	Lowest	Date
January	79	26, 1950	8	19, 1994*
February	84	25, 1930	4	10, 1899
March	93	23, 1907	20	4, 1883
April	95	17, 2002*	33	18, 1875
May	99	31, 1991	46	5, 1917
June	102	9, 1874	52	6, 1894
July	106	20, 1930	62	3, 1933
August	106	6, 1918	61	26, 1908
September	104	7, 1881	52	28, 1984
October	96	5, 1941	40	23, 1889
November	86	1, 1974	24	30, 1929
December	79	7, 1998	9	30, 1880
Year	106	July 20, 1930	4	February 10, 1899

Other dates: 95° high on April 27, 1915; April 23, 1960; and April 18, 1976.
 8° high on January 13, 1912.

Month	Minimum			
	Highest	Date	Lowest	Date
January	60	4, 1950	-14	1, 1881
February	59	17, 1976*	-15	11, 1899
March	66	22, 1948*	4	4, 1873
April	69	19, 1896	15	1, 1923
May	78	31, 1991	33	11, 1906
June	82	30, 1991	43	2, 1897
July	84	16, 1983	52	3, 1933*
August	81	3, 2006	49	29, 1986*
September	79	3, 1993	36	23, 1904
October	74	4, 1941*	26	31, 1917*
November	68	2, 1971	11	30, 1929
December	59	5, 1973	-13	31, 1880
Year	84	July 16, 1983	-15	February 10, 1899

Other dates: 59° low on February 20, 1939
 66° low on March 25, 1913
 80° low on August 9, 1980; August 5, 1989; and August 17, 1995
 52° low on July 31, 1895
 49° low on August 24, 1890 and August 31, 1934
 74° low on October 4, 1898
 26° low on October 30, 1873

TABLE 61. (*continued*)

Month	Daily mean			
	Highest	Date	Lowest	Date
January	68	26, 1950*	0	13, 1912
February	69	17, 1976	-2	10, 1899
March	75	29, 1989*	15	4, 1888*
April	81	20, 1941*	26	1, 1923
May	89	31, 1991	44	5, 1917
June	91	30, 1959*	50	2, 1907
July	93	6, 1999	58	8, 1891
August	92	6, 1918	59	29, 1986*
September	90	2, 1980	48	30, 1899
October	83	4, 1954*	35	31, 1917
November	77	2, 1971	18	30, 1929
December	69	7, 1998	1	30, 1880
Year	93	July 6, 1999	-2	February 10, 1899

Other dates: 68° on January 13, 1932

75° on March 22, 1948

81° on April 19, 1896

91° on June 29, 1959

83° on October 7, 1941

83° on October 4, 1954

83° on October 9, 2007

15° on March 4, 1873

59° on August 26, 1908

TABLE 62. *Average temperature (°F)*

<i>Month</i>	<i>Mean</i>			
	<i>Highest</i>	<i>Year</i>	<i>Lowest</i>	<i>Year</i>
January	48.0	1950	23.7	1918
February	46.9	1976	24.6	1934
March	55.5	1921*	34.5	1885
April	62.1	1981	47.1	1874
May	73.0	1991	59.2	1907*
June	79.4	1994	65.9	1907
July	83.1	1993	72.0	1891
August	82.8	1980	70.0	1927
September	77.1	1980	62.3	1871
October	67.0	2007	50.7	1876
November	54.8	2001	40.2	1880
December	45.6	1984*	26.5	1876
Annual	60.2	1991	52.2	1904, 1875

Other dates: 55.5° in March 1945
 45.6° in December 1889
 59.2° in May 1882

<i>Month</i>	<i>Mean maximum</i>			
	<i>Highest</i>	<i>Year</i>	<i>Lowest</i>	<i>Year</i>
January	57.0	1950	29.8	1918
February	58.0	1976	33.5	1934
March	69.1	1995	42.9	1960
April	72.8	1994*	55.9	1874
May	83.1	1991	68.3	2003
June	90.0	1994	75.1	1907
July	92.8	1999	80.6	1891
August	92.0	1980	78.7	1927
September	88.2	1881	72.1	1888
October	76.4	2007	59.3	1925
November	65.2	1975	47.7	1873
December	54.9	1889	34.4	1917
Annual	69.3	1991	60.9	1875

Other dates: 72.8° in 1960 and 1985

TABLE 62. (*continued*)

<i>Month</i>	<i>Mean minimum</i>			
	<i>Highest</i>	<i>Year</i>	<i>Lowest</i>	<i>Year</i>
January	39.4	1932	16.5	1893
February	36.6	1998*	15.6	1934
March	44.9	1945	26.6	1885
April	51.9	1981	38.3	1874
May	62.8	1991	48.7	1925
June	70.5	1943	56.7	1907
July	73.7	1993	63.3	1891
August	73.8	1978	61.2	1927
September	68.2	1881	53.7	1918
October	58.2	1984	40.8	1907*
November	47.5	1985	31.2	1903
December	38.0	1982	19.7	1876
Annual	51.5	1998	43.0	1904

Other dates: 36.6° in February 1997
 40.8° in October 1895

TABLE 63. *Consecutive days with snowfall*

(Period of record 1882-present)

<i>Month</i>	<i>Trace or more</i>	<i>Dates</i>	<i>0.1 or more</i>	<i>Dates</i>	<i>1.0 or more</i>	<i>Dates</i>
October	2	19-20, 1940	2	19-20, 1940	1	19-20, 1940
November	3	22-24, 1929	2	22-23, 1987	2	22-23, 1987
December	6	21-26, 1969	5	22-26, 1935	3	5-7, 1910
January	6	16-21, 1939	4	6-9, 1996	4	6-9, 1996
February	8	13-20, 1885	4	15-18, 2003	4	5-8, 1899
March	8	9-16, 1937	3	5-7, 1962	2	1-2, 1969
April	4	12-15, 1940	2	12-13, 1940	2	11-12, 1918
May	1	1, 1963	0		0	

TABLE 64. *Days with snow cover*

(Period of record 1893-present)

<i>Month</i>	<i>Trace or more</i>	<i>Dates</i>	<i>0.1 or more</i>	<i>Dates</i>	<i>1.0 or more</i>	<i>Dates</i>
October	2	30-31, 1925	1	19, 1940	1	30, 1925
November	7	24-30, 1938	7	24-30, 1938	4	11-14, 1987
December	21	9-29, 1989	21	9-29, 1989	21	9-29, 1989
January	28	4-31, 1893	23	4-26, 1893	21	2-25, 1893
February	28	1-28, 1936	26	1-26, 1905	25	1-25, 1905
March	12	1-12, 1907	11	3-13, 1960	11	3-13, 1960
April	3	1-3, 1924	2	1-2, 1924	1	1, 1924
May	0	-----	0	-----	0	-----

<i>Month</i>	<i>3.0 or more</i>	<i>Dates</i>	<i>6.0 or more</i>	<i>Dates</i>
October	0	-----	0	-----
November	3	25-27, 1938	2	13-14, 1987
December	10	5-14, 1910	4	17-20, 1932
January	19	13-31, 1982	11	7-17, 1996
February	17	8-24, 1979	14	6-19, 1899
March	6	3-8, 1960	4	3-6, 1960
April	1	1, 1924	0	-----
May	0	-----	0	-----

TABLE 65. *Frequency of days with thunderstorms*

<i>Month</i>	<i>Average</i>	<i>Greatest</i>	<i>Year</i>	<i>Least</i>	<i>Year</i>
January	0.2	4	2006	0	---
February	0.4	3	1943	0	---
March	1.3	5	1911	0	---
April	2.7	9	1992	0	---
May	5.4	15	1953	1	1969, 1992
June	7.0	14	1929	2	1988*
July	8.2	16	1931	2	2002*
August	5.9	12	1911, 2003	1	1995*
September	2.9	8	1921	0	---
October	0.9	4	1926	0	---
November	0.7	6	1988	0	---
December	0.1	2	2004*	0	---
Year	35.7	49	2003	18	1966, 1997

* Also in two other years: June 1950 & 1967; July 1963 & 1964; August 1949 & 1985; December 1923.

TABLE 66. *Snowfall, inches*

<i>Month</i>	<i>Greatest</i>	<i>Year</i>	<i>Least</i>	<i>Year</i>	<i>24 hours</i>	<i>Date</i>
October	2.2	1925	---	---	2.2	30, 1925
November	11.5	1987	---	---	11.5	11, 1987
December	16.2	1962	0.0	2001*	12.0	17, 1932
January	31.5	1922	trace	1998*	28.0	27-28, 1922
February	35.2	1899	0.0	1998*	18.7	18-19, 1979
March	19.3	1914	---	2002*	11.5	29-30, 1942
April	5.0	1924	---	2003*	5.0	1, 1924
May	trace	1963	---	2003*	trace	1, 1963
Annual	54.4	1899	0.1	1997-98	28.0	27-28, 1922

* Also in previous years.

TABLE 68. *High wind speeds*

<i>Month</i>	<i>Date</i>	<i>Velocity (mph)</i>
January	26, 1971	71 NW
February	25, 1956	69 W
March	1, 1954	73 SE
April	3, 1975	66 NW
May	17, 1948	65 SE
June	28, 1957	69 W
July	7, 1911	77 NW
August	18, 1965	67 NW
September	1, 1952	63 SW
October	15, 1954	98 SW
November	21, 1952	66 NE
December	20, 1957	67 NW
Annual	October 15, 1954	98 SW