

HISTORY OF WEATHER OBSERVATIONS
Fort Snelling, Minnesota
1819 - 1892

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INTRODUCTION

Historical Overview

Following the conclusion of the War of 1812 with the British, the struggling U.S. Government took control of large tracts of land of the “Northwest Frontier,” including the future state of Minnesota. This vast territory, inhabited by fur traders and Indians still loyal to the British, was well beyond the original colonies, and outside the influence of the new nation. In response, the U.S. established Indian agencies and supporting forts from Lake Michigan west to the Missouri River. Fort Snelling was built at the confluence of the Minnesota and Mississippi Rivers (Figures 1 and 2).

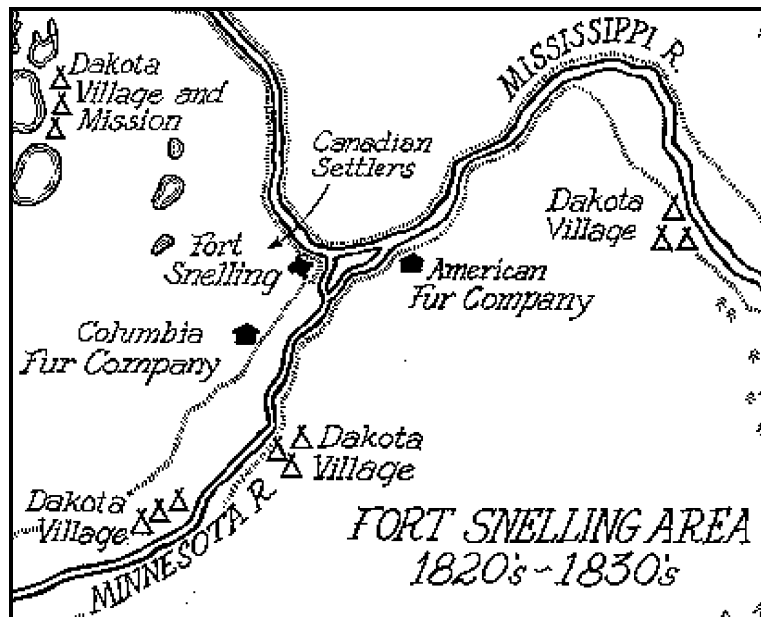


Figure 1. Fort Snelling and surrounding area during the 1820s and 1830s. North is at the top of the figure. East-west distance across the map is approximately 25 miles. From the Minnesota Historical Society.

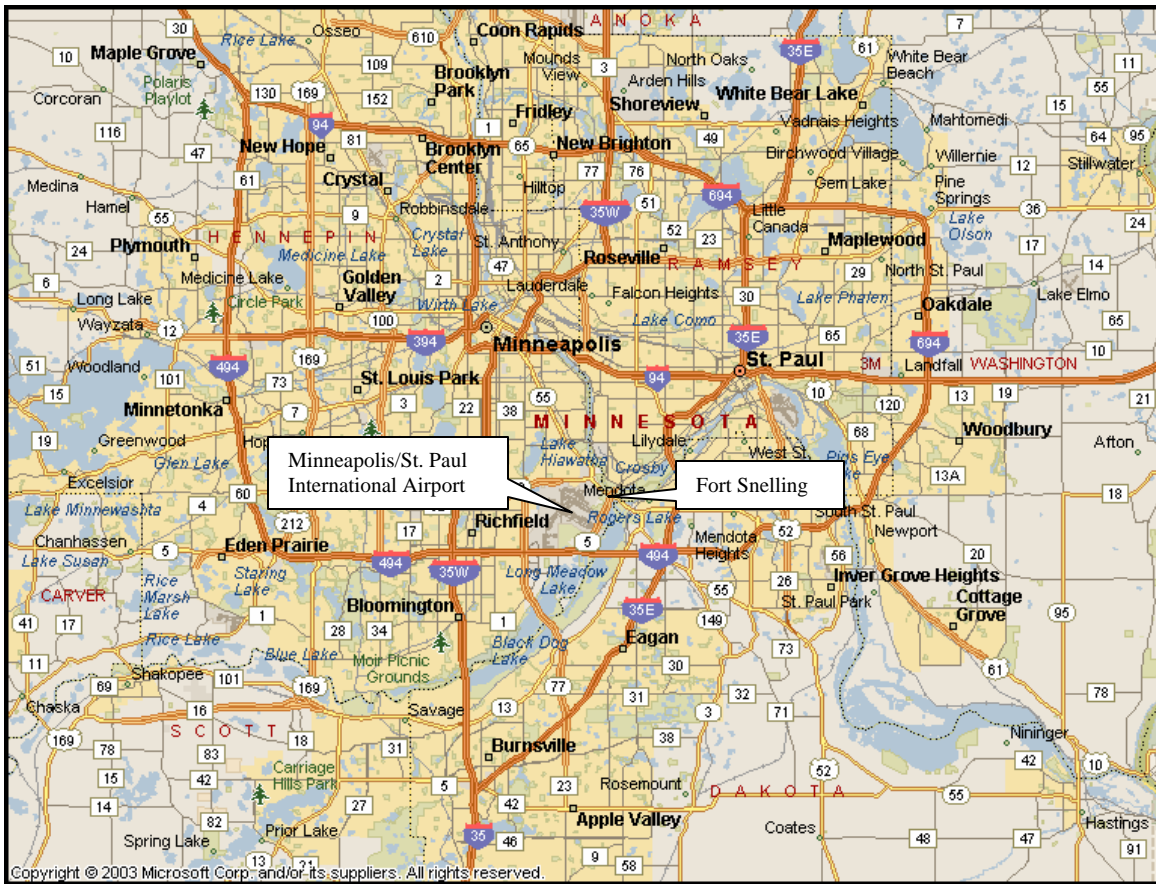


Figure 2. Location of Fort Snelling plotted on a current map of Minneapolis/St. Paul. North is at the top of the page. East-west distance across the map is approximately 39 miles.

The permanent fort was built on a bluff and construction began in 1820 by the U.S. Army 5th Infantry. Originally named Fort Anthony, the post was renamed Fort Snelling upon completion in 1824, after Colonel Josiah Snelling, commanding officer of the 5th Infantry.

When the 5th Infantry arrived in the area in August 1819, a temporary campsite was constructed on the St. Peter (Minnesota) River (see Figure 3). Named Cantonment New Hope, or St. Peter River, this post was staffed until moving to another location (called Camp Coldwater) approximately one-half mile northwest of the permanent fort on the bluff in May 1820. The permanent fort was started in 1820 and completed in 1824.

For approximately 30 years, Fort Snelling was the center of activity along the Mississippi and Minnesota Rivers. The fort was the focus for the Army in the Northwest Territory and the springboard for lodging and supplies for pioneers and settlers that were headed west into the frontier. The post also was a center for traders hawking their wares. In 1839 a small settlement was formed just downriver on the Mississippi, later to be named St. Paul.

By the 1850s, the Territory of Minnesota was being settled extensively and the frontier was pushed farther west. In response, newer forts were being built along the frontier and becoming centers for the Army, traders, and settlers. Fort Snelling was degraded to a supply depot, and in 1858, the old fort was closed and sold to a land developer.

With the onset of the Civil War, Fort Snelling was used by the state of Minnesota as a training center for volunteers to the Union cause. Following the Civil War (1867), the U.S. Army returned and Fort Snelling became headquarters and a supply base for the military Department of Dakota which extended from the Mississippi River to the Rocky Mountains. Between the early 1880s and the beginning of the 20th Century, new buildings were built in Fort Snelling, replacing the deteriorating structures from the old stone fort. Fort Snelling was active through the first half of the 20th Century including World War II. Following the war, the fort was closed and turned over to the Veterans Administration.

Weather observations around Fort Snelling were taken at three separate locations. In 1819, the precursor fort was located almost one mile southeast and approximately 100 feet lower than the more permanent fort on the bluff (to be constructed later). In 1820 the observing site moved to a location approximately one-half mile northwest of the permanent fort (approximately the same elevation), and in 1825, possibly a year or so sooner (exact date unknown), weather observations were transferred to near the hospital in the permanent post.

Weather observations were almost continuous from the mid 1820s until April 1858 when the fort closed. Observations resumed in April 1867 and continued until February 1892.

Goal of the Study

The goal of this study was to document the location and exposure of weather instruments at Fort Snelling, MN. The scope of this study primarily covered the 19th Century. Extrinsic observations related to the Army surgeons' weather observing program also were considered.

LOCATION OF OBSERVATIONS

Fort Snelling was located on a bluff overlooking the confluence of the Mississippi and Minnesota Rivers (previously called St. Peter River until the early 1820s). The post was over 100 feet above the rivers (Figures 3 and 4).

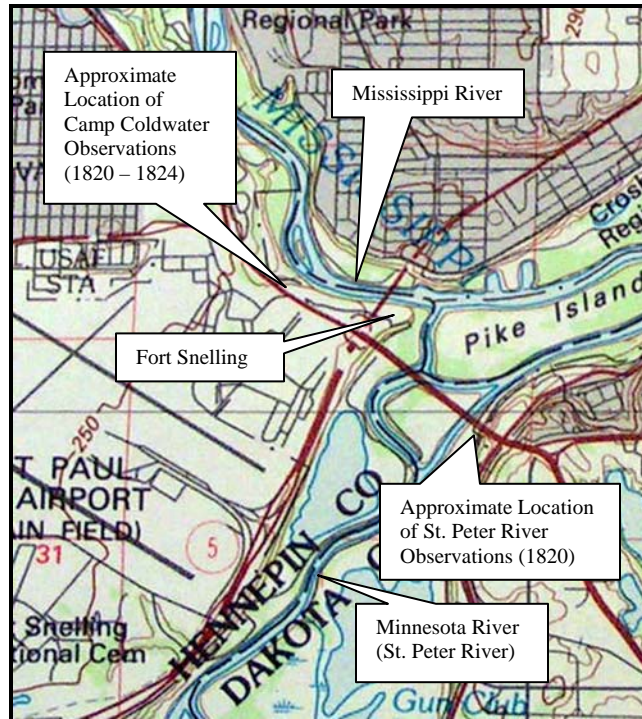


Figure 3. Topographical map showing the location of Fort Snelling with respect to the Mississippi and Minnesota Rivers. Also shown are approximate locations of the St. Peter River and Camp Coldwater observing sites. North is at the top of the page. East-west distance across the map is approximately three miles.

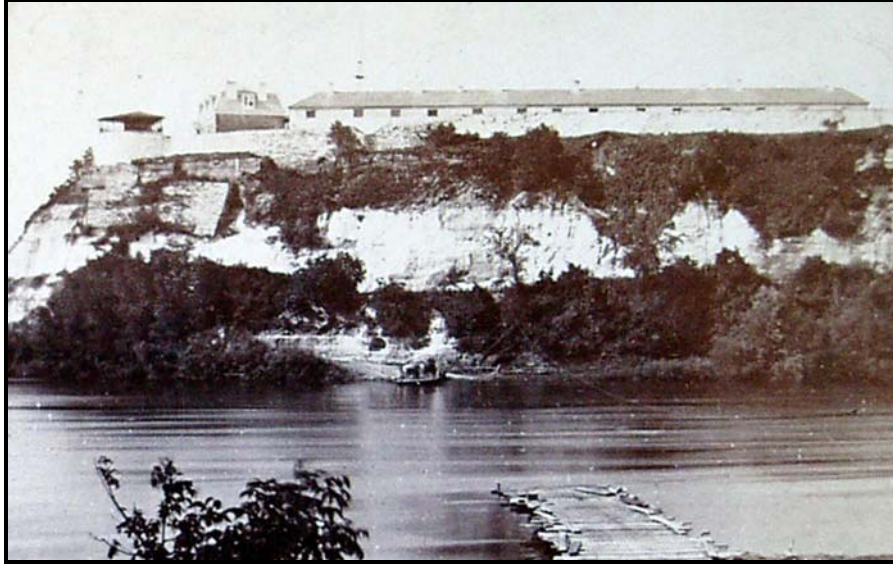


Figure 4. Fort Snelling looking southwest (1860s). Location of St. Peter River observations would have been to the left of the bluff and location of the Camp Coldwater observations would have been to the right of the fort. From the Minnesota Historical Society.

Initial weather observations in the Fort Snelling vicinity were taken in 1820 (based on the National Climatic Data Center, i.e., NCDC, database) in the bottomlands on the south bank of the Minnesota (or St. Peter) River, exact location unknown. The approximate location was near the southeast end of the present day Mendota bridge (Figure 3). Although the camp was initially established at this site in August 1819, first weather observation in the NCDC database was on 1 January 1820. According to Charles Fisk (who extensively researched weather observing at Fort Snelling), temperature observations began at this site in October 1819, with only recorded monthly means surviving. Location of the site on the forms was listed as "...at the mouth of the River St. Peter, Missouri Territory."

On 21 – 23 May 1820, a note was included on the observation form that stated, "Moving from St. Peters to Cold Water Camp." However, location of the observations continued to be listed as "the mouth of the River St. Peter." Reliable references indicated the camp and weather observations were moved to Camp Coldwater which was located approximately one-half mile northwest (exact location unknown) of the later permanent Fort Snelling on the bluff.

The National Climatic Data Center (NCDC) database contains continuous weather observations for the "St. Peter" site (including Cold Water Camp) from 1 January 1820 until 4 October 1820. A gap existed from 4 October 1820 until 2 November 1820, with essentially continuous weather observations recorded until 31 December 1821. Following the 31 December 1821 observations, no weather observations were indicated in the NCDC database until resuming 1 April 1825.

Although the permanent Fort Snelling was completed in 1824, it is not known when the weather instruments were transferred. The first weather observation for “Fort Snelling” in the NCDC database was 1 April 1825. Observing records continued from April 1825 until May 1858. A gap in observations existed from May 1858 through March 1867. The gap from 1858 into 1867 is likely the result of the fort being deactivated during the period. Although Fort Snelling was reactivated during the Civil War as a training facility, the regular U.S. Army did not return to the fort until after the Civil War. Consistent weather observations existed in the NCDC database from March 1867 until 29 February 1892 (the last observation).

Latitude and longitude were first logged on Fort Snelling observation forms on January 1836. At that time, the location of the fort was listed as 44°53'49"N, 93°8'7"W. On the October 1839 form, the coordinates for the fort changed to 44°52'45"N, 93°1'9"W. In June 1875, latitude/longitude was listed as 44°52'46"N, 16°1'54"W (west of Washington DC). On the November 1885 form, and afterwards, the longitude was changed to 10°1'54"W (west of Washington DC). Actual coordinates for the fort were 44°53'28"N, 93°10'54"W.

First mention of elevation at Fort Snelling was in January 1843 when the elevation was listed as 94 feet above the Mississippi, later changed to 96 feet. In April 1867, the elevation was listed as 820 feet above sea level, and in June 1875 the elevation was listed as 840 feet. Actual elevation of the fort was 804 feet above sea level.

Weather observations at Fort Snelling most likely were taken at or very near the hospital. Figure 5 shows the locations of the post hospital before and after 1839 and Figure 6 is a drawing of the two buildings. According to the Minnesota Historical Society, the original hospital was utilized until 1839 when the Shops building, located immediately southwest of the original hospital, was expanded into the new post hospital. Any changes in weather instrument locations likely were not far.

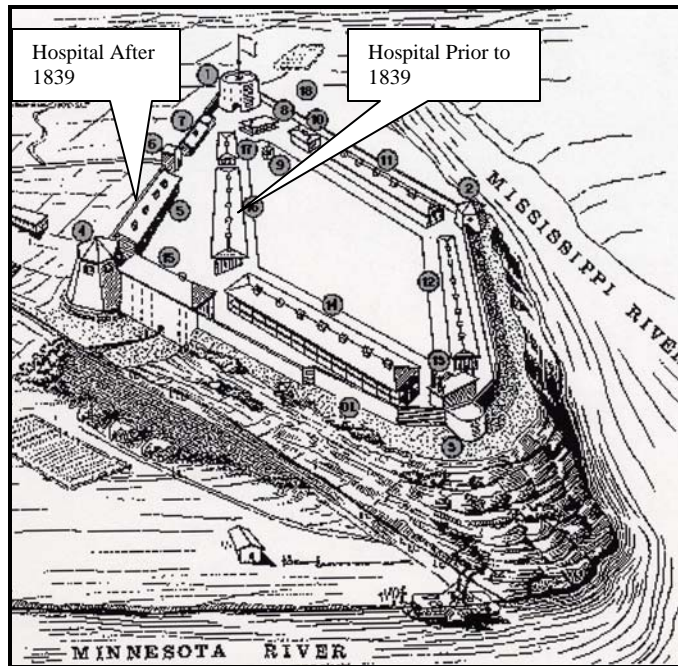


Figure 5. Schematic of reconstructed Fort Snelling as it appeared in 1827. View is west northwest. From the Minnesota Historical Society.

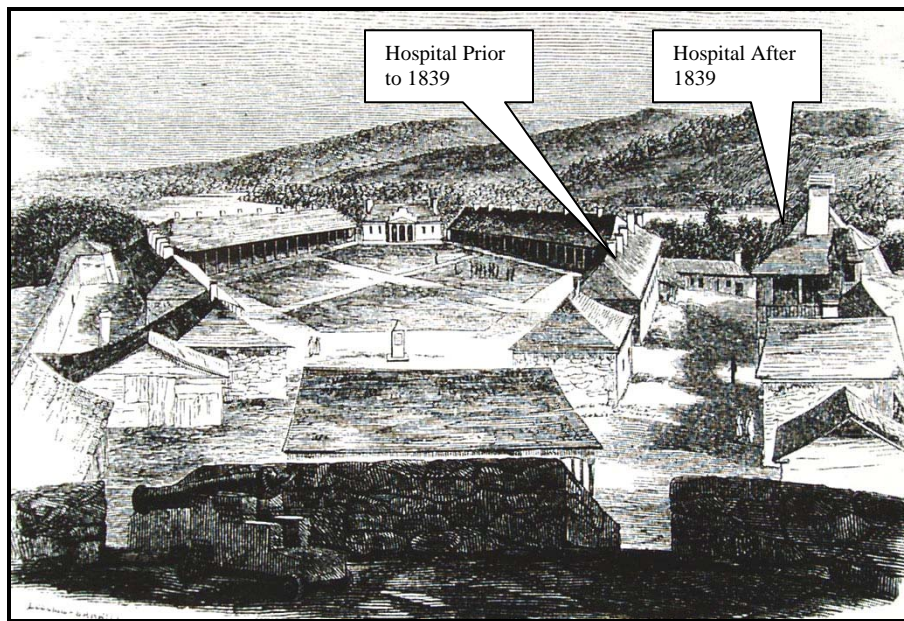


Figure 6. Interior of Fort Snelling showing the two hospitals. View is east. Drawing was made in 1853. From the Minnesota Historical Society.

INSTRUMENTATION

Parameters Measured/Observed

NOTE – In 1984, Charles John Fisk concluded a detailed research project on weather observations at Fort Snelling for the period 1820 – 1872 as part of his Master’s Thesis for the University of Wisconsin-Madison (see Bibliography). Results from his research were helpful in identifying the location and exposure of weather instruments at Fort Snelling. Also, an informal document authored by Tom St. Martin was an important source of information.

The first observation available in the NCDC database for the Fort Snelling area was 1 January 1820 for St. Peter (Figure 7), although temperature observations at this site likely began as early as October 1819.

Meteorological Diary, for February 1820, at the Mouth of the St. Peter River, Wisconsin						
Date	Thermometer			Wind	Weather	Remarks
	7	2	9			
February 1	14	10	04	N. W.	Cloudy	Light Snow in Morning
2	14	7	112	W.	Clear	Scurbutic diseases, Pneumonia
3	17	9	5	W.	Cloudy	Inflammatory diseases increasing
4	02	17	14	E.	Clear	
5	24	39	16	W. - N. W.		Clear in forenoon Cloudy & rainy in afternoon
6	0	14	8	N. - W.	Clear	
7	02	37	19	S. W.	Clear	
8	18	38	21	S. W.	Clear	
9	17	33	30	S. W.	Clear	Ice begins to break up
10	25	33	26	S. W.	Clear	Clear in afternoon & Cloudy in forenoon
11	20	39	21		Clear	

Figure 7. Observation form for St. Peter for February 1820. The month of February was used due to clarity of the image. Only the top part of the observation form is shown to improve readability. From the official station history files at the National Climatic Data Center.

Initial weather measurements/observations at Fort Snelling/St. Peter were typical for Army forts during the mid 1820s, consisting of the following parameters:

1. Temperature (Fahrenheit) – Measured three times daily (7 a.m., 2 p.m., and 9 p.m.).
2. Wind direction (eight points on the compass) – One value recorded daily.
3. Weather condition (initially recorded as “rain,” “snow,” “cloudy,” or “clear”) – One value recorded daily.
4. Significant weather recorded in the “Remarks” section.

NOTE - It was not apparent from the data as to the meaning of the one wind direction and sky condition listed in the Army surgeon observations, i.e., if the values represented one observation at a particular time (and which time) or reflected the general weather over the day. This format (Figure 7) continued until 1 January 1836.

As pointed out by Charles Fisk, the daily observing schedule initially selected by the U.S. Army Medical Department around 1818 was likely influenced by a study made by Professor Chester Dewey of the New York Academy System a few years earlier. In his study, based on analysis of hourly New York temperature data for 1814 – 1816, Professor Dewey determined that the best hourly grouping for determining daily means was for the hours 7 a.m., 2 p.m., and 9 p.m. Subsequently, most American observers, including the Army Medical Department, began taking temperature observations at the times specified by Professor Dewey.

NOTE – Army surgeons took weather observations based on local times, as compared to the U.S. Signal Service which took observations based on Washington DC times. The U.S. Signal Service took weather observations at St. Paul beginning 1 November 1870 which overlapped by approximately 22 years with Fort Snelling observations by the Army Medical Department. Based on Meridian Time used by the Signal Service Office at St. Paul, observations were taken 64 minutes earlier than listed on the forms, e.g., the 7:00 a.m. observation actually was taken at 5:56 a.m. Recorded observations at 7:00 a.m. by Army surgeons were taken at 7:00 a.m.

The first observation in the NCDC database listed as Fort Snelling was on 1 April 1825 for the same parameters as observed at St. Peter. However, Charles Fisk indicated that weather observations may have been taken at the permanent fort as early as 1821, the year in which the post surgeon's staff began to use the still uncompleted post hospital. No information could be found regarding the exact date weather observations were transferred to the permanent fort.

The initial format of weather observing at Fort Snelling (started around 1820) continued through 1835. On 1 January 1836, new instructions were implemented by the Army Surgeon General regarding the time of the observations (Figure 8). Temperature readings changed from 7 a.m., 2 p.m., and 9 p.m. to morning (a.m.), afternoon (p.m.) and evening. In addition, wind and weather were recorded as “a.m.” and “p.m.” No information could be found with regard to specific times for the observations.

The new part of the observation was the recording of daily rainfall. Although Army Medical Department instructions added the requirement for daily rainfall on 1 January 1836 (i.e., added to the observation form), Fort Snelling did not begin recording rainfall until July 1836. Most likely the rain gage was late in arriving.

DIARY OF THE WEATHER at *Fort Snelling, Wp. Miss.*
 for the Quarter ending the *thirty first* day of *March* 1836.
North Latitude *44° 53' 49"* Longitude *93° 8' 7" West.*

MONTH.	THERMOMETER.				WINDS.	WEATHER.	RAIN.	BARROMETR.	REMARKS.
	A. M.	P. M.	EVENING.	MEAN.					
1st	23	36	28	28%	N. N. W.	Cloudy			
2d	19	32	20	23	N. N. W.	Fair			
3d	15	32	25	25%	N. W.	"			
4th	22	32	29	28%	N. W.	Light rain			
5th	29	40	36	35%	E. S. E.	"			Light fall of snow. A. M. Singling
6th	33	36	35	35%	E. S. E.	"			Rain in the afternoon
7th	36	38	34	34%	S. W.	"			Rain during day & night.
8th	29	30	36	25%	W. W.	"			Hazy & foggy weather in the morning
9th	13	22	18	17%	N. W.	Fair			Occasional snow squalls in afternoon
10th	12	29	28	21%	S. W.	"			Snow during night, depth 3 inches
11th	22	32	30	25%	N. W.	"			Snow during the night
12th	-3	7	1	2%	N. W.	"			Snow during the night
13th	-2	2	-6	-1%	W.	"			

Figure 8. Observations for Fort Snelling for January 1836. Only the top part of the observation form is shown to improve readability. From the official station history files at the National Climatic Data Center.

On 1 January 1841, observation forms from the Army Medical Department were changed to include temperature measurements for sunrise, 9 a.m., sunset, and 9 p.m. Also included was a requirement for atmospheric pressure measurements (Figure 9). However, Fort Snelling surgeons recorded no measurements until 5 July 1842, likely because a barometer had not arrived. Pressure readings from the barometer after 5 July 1842 were recorded as centimeters of mercury until changed to inches of mercury on 1 April 1844.

DIARY OF THE WEATHER at *Fort Snelling* *New Territory*
 for the quarter ending the *Twenty first* day of *March*. 1841
 Latitude *44° 52' 15" N* Longitude *93° 1' 9" West*

MONTH	THERMOMETER.					BAROMETER.	WINDS.		WEATHER.		RAIN, INCHES.	REMARKS.
	SUN RISE.	2 P. M.	SUN SET.	9 P. M.	MEAN.		NOON.	A. M.	P. M.	A. M.		
<i>January</i>												22 17
1st	22		11	-3	6.7		N	W	Cl	Cl	0.25	Snow
2d	-19		0	1	4		NW	W	Fair	Fair		
3d	-12		-6	-19	-12		NW	NW	Fair	Fair		
4th	-20		6	-2	-14		NW	SE	Fair	Cl		
5th	2		14	10	8.4		E	E	Cl	Cl		
6th	3		19	2	6.4		N	N	Cl	Cl		
7th	6		19	9	12		NW	NW	Cl	Cl		
8th	10		27	16	19		NW	NW	Cl	Cl		
9th	18		25	26	24.7		NW	SE	Cl	Cl		
10th	25		32	28	28.7		S	S	Cl	Cl		
11th	26		20	12	15		E	S	Cl	Cl	0.10	Snow

Figure 9. Observation form for Fort Snelling for January 1841. Only the top part of the observation form is shown to improve readability. From the official station history files at the National Climatic Data Center.

On 1 January 1843, changes occurred in the Army weather observation program that became fundamental to weather observing into modern times. However, the foundation for the changes occurred in the mid to late 1830s.

In 1836, Dr. Thomas Lawson was appointed Army Surgeon General. Dr. Lawson actively supported the weather observing program of the department and emphasized quality science in meteorology, as well as in medicine. Dr. Lawson approved the purchase of new and quality weather observing instruments to be used in the field observing program. Dr. Lawson ultimately envisioned the composition of weather maps to study the impact of weather and climate on disease.

In 1840, Professor James Espy was appointed Meteorologist to the War Department. Professor Espy was a highly respected meteorologist, and through his reputation and scientific expertise, was able to coordinate meteorological work between the Army (Medical Department), Navy (Naval Observatory), and later with the Smithsonian Institution.

Because of his research associated with writing the book *Philosophy of Storms*, Professor Espy recognized the value of measuring/observing all weather parameters at the same time (as opposed to previous Army Medical Department procedures of measuring/observing various weather parameters at different times). In 1842, Dr. Lawson and Professor Espy appointed an Army Medical Board to formulate standard

rules and times for taking field weather observations. The board consulted with recognized scientists of the day, along with prominent scientific organizations such as the Franklin Institute and the Royal Society of London. The Medical Board met in Philadelphia in May 1842 and formulated observing instructions for the field surgeons. Those instructions were implemented at Army Forts on 1 January 1843. The 1843 instructions and those for subsequent years are included in the section of this report entitled Instrument Type and Exposure.

The changes in weather observing implemented by the Army Medical Department in January 1843 were reflected at Fort Snelling (Figures 10A and 10B). Most measurements were made four times daily at “Sunrise,” “9 AM,” “3 PM,” and “9 PM.” According to the Annual Report of the Surgeon General, these times were selected to correspond with the observational times adopted by the Royal Society of London, with the exception that Army surgeons took the observations a “little before sunrise” versus the 3 a.m. observation recommended by the society.

The following weather parameters were measured/observed at Fort Snelling beginning 1 January 1843:

1. Temperature – Four times daily (degrees Fahrenheit) from the detached (or exposed) thermometer and the thermometer attached to the barometer
2. Pressure – Four times daily in centimeters of mercury
3. Clearness of the sky – Four times daily (the amount of clear sky at the hour of observation expressed from “0” to “10,” with “0” indicating no clear sky and “10” indicating no clouds)
4. Wind direction and force – Four times daily (direction expressed on an eight-point compass and wind force expressed on a scale from “0” for calm conditions, to “10” for a “violent hurricane”; e.g., SW4)
5. Clouds – Four times daily (direction from which the clouds were moving (eight-point compass) and cloud movement expressed on the same scale used for the force of the surface wind, i.e., “0” for no movement to “10” for movement corresponding to a “violent hurricane,” e.g., NE2 or SE1)
6. Daily rainfall – Beginning, ending, and amount
7. Significant weather in Remarks section

Wet bulb temperatures were first measured 3 April 1843 (at sunrise and 3:00 p.m. in degrees Fahrenheit). Wet bulb temperatures ceased being recorded on 1 February 1850 and no readings were indicated through 31 January 1852 when the parameter ceased being on the forms. New Army medical forms in July 1855 reinstated atmospheric moisture measurements under the term “hygrometer,” but measurements were not recorded at Fort Snelling until 6 October 1855.

First observations after the break in data, 1 April 1867, contained the following notes: “No barometer or barometer with thermometer attached,” “No hygrometer,” and “No vane” (referring to the absence of a wind vane). Only temperature, weather, and rainfall were recorded on the April 1867 form. Although wind direction and force commenced 1 May 1867, and hygrometer readings started 1 June 1867, barometric readings (and associated attached temperature readings) were not taken again at the fort until October 1871 (as indicated by records in the NCDC database). Notes continued to be placed in the column of the forms for barometer measurements that stated, “No Barometer.” When barometer measurements resumed in October 1871, an aneroid type was used based on comments on the observation forms. A note was included with the March 1872 observations that said, “The barometer is an aneroid. Correction for temperature is not stated.” The surgeons continued to label all barometric measurements through December 1886 with the word “aneroid.” Beginning with the January 1887 observations, this label was dropped.

New forms and requirements from the Army Surgeon General’s Office were implemented at Fort Snelling in December 1869, containing space for readings from “Self Registering Thermometer,” i.e., maximum and minimum thermometers. Army surgeons at Fort Snelling placed the word “None” in this column through the month, but began recording maximum/minimum temperatures (i.e., received the maximum/minimum thermometers) beginning 1 January 1870.

In January 1876, the surgeons at Fort Snelling ceased recording maximum/minimum temperatures, i.e., taking readings from the maximum/minimum thermometers. These recordings were not resumed until April 1881.

Hygrometric readings ceased to be recorded in November 1869 and resumed on an occasional basis in June 1881.

On 1 September 1888, the Army Medical Department went to a new form in which Army surgeons measured only temperature (maximum/minimum), precipitation, and general direction of the wind (Figure 11). This format was continued through February 1892, the last observation form for Fort Snelling in the NCDC database.

METEOROLOGICAL REGISTER.

Station: *Fort Snelling Minn.* Month: *September*, 18*88*
 Lat.: *44° 52' 46"* Long.: *10° 1' 54"* Alt. above sea: *840* ft.

DAY OF MONTH.	TEMPERATURE.			PRECIPITATION.				GENERAL DIRECTION OF THE WIND.
	Maximum.	Minimum.	Range.	Time of Beginning.	Time of Ending.	Total Precipitation.	Depth of Snow-fall.	
1	77	45	32					West
2	85	50	35					S. & S. W.
3	80	47	33					S.
4	70	45	25					W.
5	74	48	26					S. & S. E.
6	77	53	24	Night				S.
7	74	56	18		4:15 P.M.	.20		S.
8	75	49	26					W. & W.
9	79	46	33	Night	Night	.05		W.
	72	52	21					S. E.

Figure 11. Observation form for Fort Snelling for September 1888. Only the top part of the observation form is shown to improve readability. From the official station history files at the National Climatic Data Center.

Instrument Type and Exposure

Specific information regarding number, type, location, and exposure of weather instruments at Fort Snelling was sparse. However, general inferences can be made from the monthly weather summaries, as well as from documented instructions from headquarters of the Army Surgeon General’s Office. Instructions from the Army Surgeon General’s office were available for this report for the years 1844, 1850, 1856, and 1868.

Although two hospitals were used at Fort Snelling (before and after 1839), weather observations may have been taken at the same location within the post proper. The second hospital was located immediately southwest of the first hospital. The front of the first hospital bordered on the post’s courtyard and the rear of the second hospital was blocked by a nine foot high stone wall that surrounded the fort. Weather observations at the first hospital likely were taken at the rear of the building and observations taken in front of the second hospital.

Based on instructions from the Army Surgeon General’s Office and the post’s observations, by the mid 1840s, Army surgeons at Fort Snelling had the following instruments

1. Exposed thermometer – Available from initial observations, i.e., 1819
2. Wind Instruments – Although no specific information could be found regarding the presence of a wind vane at Fort Snelling, documents produced by the Army Surgeon General’s office indicated most, if not all, field

surgeons were provided wind vanes during the 1820s. No clear evidence exists that an anemometer was provided this fort. Available Surgeon General instructions as late as 1868 directed field surgeons without anemometers to estimate wind force by observation of leaves, flags, etc.

3. Rain gage – Obtained around July 1836
4. Barometer – Obtained around July 1842
5. Psychrometer – Obtained around April 1843
6. Maximum/minimum thermometers – Obtained around December 1869

Thermometer

Records from the Army Surgeon General's office indicate field Army surgeons in the 1820s were provided only one instrument for taking weather observations – a thermometer – and this appeared to be true for Fort Snelling. Information recorded on the early observations for the fort only required a thermometer with the other parameters estimated or observed.

Temperature observations were taken at three separate locations—near the Minnesota River (October 1819 to May 1820), approximately one mile northwest of the permanent fort (May 1820 to approximately 1824), and at the permanent fort (subsequent to 1824).

Exposure of the thermometers during the early observations was not consistent. For example, a note on the observation forms in the summer of 1820 states, “Note – The thermometer was placed in the shade facing the northwest,” and a note on the January 1821 form says, “The thermometer stayed in the shade and had a northeast aspect.” David Ludlum points out in his book (as indicated by Charles Fisk) that in 1823, the explorer William H. Keating observed the thermometer at Fort Snelling to be exposed to the southwest. As pointed out by Fisk, these exposure inconsistencies could have been due to the fact that the fort was under construction with no “permanent” spot in the stockade selected to house the thermometer. Tom St. Martin during his research discovered that during the late spring and summer months of the 1820s and early 1830s, the thermometer likely was exposed to direct sun rays in the morning hours, and goes into detail of how the exposure created significant spurious observations—a term he referred to as “sun pollution.” St. Martin also stated that most, if not all, of the temperature readings at Fort Snelling, or at the attendant locations from 1819 through 1858, were taken from unsheltered thermometers.

With regard to the type of thermometer used during the early 1820s at Fort Snelling, the explorer Keating, during his visit to the fort in 1823, indicated the instrument was a glass tube attached to a brass plate with marked graduations. This type of instrument was manufactured by Mr. Fisher of Philadelphia who was a respected manufacturer of thermometers. This thermometer likely was used until 1843 when the Army Medical Department issued new instruments to field surgeons. In 1843, Army field surgeons were provided thermometers manufactured by George Tagliabue, a New York City manufacturer of scientific instruments. As can best be determined, the

Tagliabue thermometers remained in use at Fort Snelling until the post was closed in 1858.

Based on available information (beginning in the early 1840s), Army field surgeons were given considerable flexibility in locating the station's detached (or exposed) thermometer. According to instructions from the Army Surgeon General in 1844:

“The Thermometer will be placed in a situation having a free circulation of air, not exposed to the direct or reflected rays of the sun, and sheltered from rain. Its situation should be remote from massy walls, which slowly imbibe or part with caloric. In making observations avoid breathing on the instrument, or touching it; and at night manage your lamp so as not to cause a rise of the mercury by its heat.”

NOTE – No changes occurred in the Army Surgeon General instructions with regard to the thermometer from 1844 through 1868. Similar instructions likely were in effect prior to 1844.

On 10 August 1868, the following instructions were issued to Army field surgeons by the Surgeon General's Office regarding thermometer placement:

“The thermometer should be placed in the open air, but under a roof of some kind, and should be well sheltered toward the South. It should be protected not only from the direct rays of the sun, but from the influences of all surfaces which strongly reflect the sun's heat, and of all bodies, such as thick walls, large rocks, etc., which become great reservoirs of heat during the day, and of cold during the night.’

‘...The height which it is deemed best to fix upon is that of four feet from the ground to the thermometer bulb, and the surface under the thermometer should be of short grass, sufficiently exposed to the sun and wind to keep it from habitual dampness.’

‘A thermometer box, in which most of the thermometers observed and recorded at the station are suspended, is generally used for the best conducted meteorological observations, and one should be made and set up at every post where there are means of constructing it. This box, which should be at least two feet square, is preferably made of louver-boards or overlapping slates, but ordinary boards pierced with numerous half inch holes may be used instead. It should be open at the bottom, and have a roof which will shed rain. One of the sides should be hinged for convenience of access to the interior, or the box may be left permanently open toward the North, a piece of board or of canvas being used to protect it against driving winds from that quarter. This box is to be well secured on posts, at the proper height from the ground. It should be sheltered from the sun between sunrise and 7 AM, and between 11 AM and 3 PM, special screens being

erected for the purpose if necessary. These screens, as well as the box itself, should be whitewashed or painted white.”

Maximum and minimum thermometers were provided to the Army surgeons at Fort Snelling by 1 January 1870 (date maximum/minimum temperature observations began). The Surgeon General’s instructions in 1868 were the first mention of maximum and minimum thermometers from the headquarters office:

“Maximum and minimum registering thermometers will be supplied to certain posts for the purpose of enabling the greatest cold of the night and the greatest heat of the day to be recorded. They are to be hung in a horizontal position, and observed once a day, preferably in the morning, when they will give the minimum of the preceding night and the maximum of the preceding day. After the readings have been taken the instruments are to be set and not disturbed until the same time the next day.’

‘The maximum thermometer is of the same plan as the maximum clinical thermometer furnished to Medical Officers, and special instructions will be sent with it when issued.’

‘The minimum is a spirit thermometer, in the bore of which a double-headed rod of black enamel floats. This rod or index is drawn back when the alcohol recedes, by reason of the resistance of the surface of the liquid to rupture or change of form, and thus reaches the lowest point to which the thermometer falls...’

Rain Gage

Fort Snelling Army surgeons began measuring and recording rainfall in July 1836. As best determined, precipitation observations at Fort Snelling during the late 1830s and 1840s (and possibly until the fort closed in 1858) were taken from a “DeWitt conical” rain gage. Based on information from the Army Surgeon General’s office, as well as from other sources, the gage was a hollow metal cone nine inches in height and five or six inches in diameter at the top. Exact location of the gage was unknown.

With the exception of a few entries in the remarks section on the observing forms, Fort Snelling surgeons did not record snowfall and snow cover during the period 1820-1858. However, beginning in 1836, the observations included snow “meltwater.” Tom St. Martin indicated that some observers likely did not melt the snow and measure the resulting water, but rather took the depth of the snow and divided by 10 to arrive at water equivalent. The result would have exaggerated precipitation amounts at Fort Snelling during the winter months. St. Martin also stated that Fort Snelling observers failed to record small amounts of precipitation, likely because of the difficulties in measuring small amounts of precipitation with the DeWitt gage.

The following are instructions and information regarding rain gages was taken from a book published in 1851 entitled, *Meteorological Register: Observations Made by*

the Officers of the Medical Department of the Army at the Military Posts of the United States:

“In 1836, rain gauges were furnished to many of the posts, by which the daily falls of rain and snow could be measured and entered upon the tables in inches and the fractions of an inch. The instrument employed is the conical rain gauge of De Witt; and observations are ordered to be made immediately after every shower or fall of rain or snow. The following are the instructions issued by the Department for its observers:’

‘The instrument used to measure the quantity of rain which falls, is the conical rain gauge. It will be kept remote from all elevated structures at a distance at least equal to their height, and still further off, where it can be conveniently done. It is to be suspended in a circular opening, made in a board, which is to be fixed to a post, eight feet from the ground; the opening to be five inches in diameter, and beveled, so as to fit the side of the gauge, into which the cap is to be fixed, base downwards, to prevent evaporation.’

‘In freezing weather, when the rain gauge cannot be used out of doors, it will be taken into the room, and a tin vessel will be substituted for receiving the snow, rain, or sleet that may then fall. This vessel must have its opening exactly equal to that of the rain gauge, and widen downwards to a sufficient depth, with a considerable slope. It should be placed where nothing can obstruct the descending snow from entering, and where no drift snow can be blown into it. During a continued snow storm, the snow may be occasionally pressed down. The contents of the vessel must be melted by placing it near the fire, with a cover to prevent evaporation, and the water produced poured into the gauge to ascertain its quantity, which must then be entered into the Register.”

These instructions with respect to the rain gage remained in effect until the summer of 1868. On 10 August 1868, the Army Surgeon General’s Office issued the following with regard to the rain gage:

“The rain gauge now issued by the Department is a brass cylinder seven and a half inches high, and with a diameter at its mouth of one and ninety-seven hundredths (1.97) of an inch; this diameter being fixed upon for the reason that one inch of rain falling through such an aperture will measure exactly fifty cubic centimeters (50 cc), and centimeter graduates are furnished with each gauge for the purpose of making such measurement.’

‘The most desirable place for a rain gauge, other things being equal, is at the surface of the ground, but since it is not easy to protect an instrument in that situation, the gauge will be placed on the top of a post eight feet high,...

‘For measuring very heavy snow falls, a snow gauge must be used having a mouth of the same size with that of the rain-gauge, but wider at the bottom, so as

not to be easily overfilled. The snow which falls in it is to be melted and measured in the centimeter graduate.”

Hygrometer

The first measurement of atmospheric moisture at Fort Snelling was on 3 April 1843. Army Surgeon General instructions in 1844 stated the following with regard to hygrometric observations:

“The most easy method of finding this (wet bulb temperature) is to wet the bulb of a Thermometer covered round with fine gauze, and swing the instrument in the open air, in the shade, until the mercury sinks as low as it will.”

“The current of air upon the wet-bulb should be kept up (by swinging) as long as the mercury continues to descend in the tube of the instrument, and for a few minutes after it becomes stationary, in order to ensure the full effect of the evaporation and the lowest degree to which the mercury can be forced to descend by this process, will constitute the observation required...”

No mention is made of the hygrometer or wet-bulb thermometer in the 1850 instructions from the Surgeon General since the wet bulb temperature ceased to be measured in the Army Medical Department on 1 February 1850. Wet-bulb temperatures were again measured in the Army Medical Department beginning 3 January 1856. The Surgeon General instructions for 1856 contained the following:

“The hygrometer adopted by this Department consists essentially of a thermometer, the bulb of which is covered with floss silk enclosed in a piece of thin muslin, the ends of the silk sufficiently long to dip into water contained in a brass reservoir secured immediately below the bulb. In the top of this reservoir is a small opening to admit the silk, and to the front is attached a cylinder communicating with the interior by a small hole. The reservoir is to be kept always supplied with water poured into it through the cylinder, and the bulb will be constantly moistened by capillary absorption.”

The 1868 instructions elaborated on taking wet-bulb temperatures:

“An apparatus for swinging a pair of thermometers – a wet and dry bulb – has been constructed at this Office, and will be issued to a certain number of posts for making specially accurate observations. In using this apparatus the covering of the wet bulb is to be moistened with a soft brush before each observation, and the apparatus then whirled round for a few minutes...’

‘When a stationary wet bulb is used it is to be placed in the box with the other thermometers, but far enough from them not to communicate cold to their bulbs. All casings around the lower part of such a thermometer should be removed, and a piece of wick which dips by one end into a receptacle of rain water, should have

its other end coiled around the stem and resting on the top of the bulb, in such a way as to keep the muslin covering uniformly and sufficiently wet. If the wick is connected with the lower part of the bulb, the wetting is more apt to be unequal.”

Barometer

First barometric measurements were recorded at Fort Snelling on 5 July 1842. The barometer most likely was a mercurial barometer. The instructions in 1844 from the Army Surgeon General stated the following:

“The instrument adopted by the Department is the siphon Barometer of Bunten. ...The Barometer will be suspended perpendicularly in a good light, in an apartment having an equable temperature, and a dry atmosphere.”

“When once suitably placed, the position of the instrument should not be changed, unless from absolute necessity – in which case the circumstances will be carefully noted on the Register, under the head of ‘Remarks.’”

Instructions in 1856 stated, “The barometer now in use by the Department are the siphon, of Bunten, and the cistern, of Green.” No other changes are documented with respect to the barometer from instructions in 1844 through the instructions in 1856.

Based on recorded temperatures of the attached thermometer, as well as instructions from the Surgeon General’s Office, it appears the barometer at Fort Snelling may not have been located in a working or living space. A clerk at the Post Hospital at Carlisle Barracks, PA in 1867 indicated the barometer at that site was located in an outside kiosk along with the thermometers. It was not apparent where the barometer at Fort Snelling was located.

When the U.S. Army returned to Fort Snelling in 1867, weather observations resumed, but barometric pressure readings were not taken. Barometric readings resumed in October 1871 with a note included on the forms that an aneroid barometer was used. This note continued to be included on the forms until January 1887 when it was dropped. Subsequent to January 1887, a mercurial barometer likely was used.

Instructions issued by the Surgeon General’s Office on 1 July 1868 stated that two forms of barometers were in use at Army field stations—a cistern barometer for low altitudes (below 2,000 feet) that applied to Fort Snelling, and one for high altitudes (above 2,000 feet). The primary difference between the two barometers was that when taking an observation using the high-altitude barometer, the observer had to adjust the level of the mercury in the cistern (by means of an adjustment screw) until the mercury touched the ivory point. This was not required for the low altitude barometer.

Wind Instruments

Army instructions during the early and mid 1800s directed that field surgeons estimate wind direction subjectively, e.g., based on the direction leaves were blowing, direction of the camp flag, etc. However, it appears from publications by the Army Surgeon General's Office that wind vanes were distributed to many forts as early as the 1820s. However, no confirmation could be found when a wind vane was received at Fort Snelling.

Available documents suggest that no anemometers were available to Army field surgeons prior to the 1860s. Instructions from the Surgeon General's Office in 1844, 1850, and 1856 provided guidelines for subjective observations. Wind force was to be expressed by a subjective scale ranging from 0 to 10 (e.g., "A gentle breeze" for a scale value of "2," "A brisk breeze" for a scale value of "4," and a scale of "6" for "A very strong wind"). No definitions for these terms have been found. These guidelines appeared to have remained in effect until around the 1860s.

Instructions from the Surgeon General's Office issued on 10 August 1868, provided the following descriptions regarding wind instruments:

'The direction of the wind is to be determined in the usual way by a vane or weathercock placed as far above the ground as practicable and at a distance from all buildings, trees, etc., higher than itself. The staff of the wind vane should have attached to it bars indicating the direction of each of the four points of the compass.'

'Anemometers, or instruments for measuring the velocity of the wind, with instructions for their use, will be issued by the Department to those posts where observations on the winds are of the most importance.'

'Where special instruments are not furnished for the purpose, the velocity of the wind may be estimated by observing the horizontal motion of light bodies – as clouds of smoke, the pollen of plants, handkerchiefs thrown in the air, etc., when blown before the wind. A motion of one yard per second may be estimated as equal to two miles per hour.'

'If means can be found for estimating the pressure on a surface of known size, as on a piece of board held perpendicularly to the direction of the wind, or an open umbrella with its concave surface toward the wind, the velocity may be calculated from it. The square root of two hundred times the pressure expressed in pounds per square foot, will give the velocity expressed in miles per hour.'

The wind scale in the 1868 instructions changed to reflect quantitative values, e.g., a scale value of "2" represented a wind speed between 5 and 10 mile per hour, a

scale value of “4” represented a wind speed between 15 and 20 miles per hour, and a scale value of “8” represented winds between 50 and 60 miles per hour.

Figure 12 shows a lithograph of Fort Snelling from the March 1858 Harper’s New Monthly Magazine that shows the wind vane at Fort Snelling.

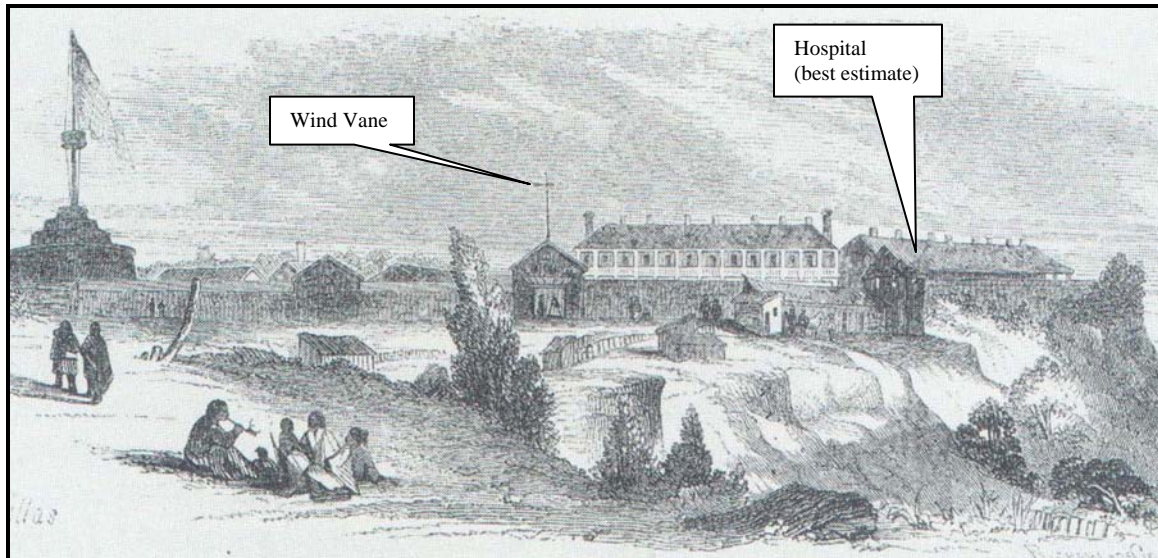


Figure 12. Lithograph of Fort Snelling (circa 1858) showing the wind vane. View is north northeast. Location of the hospital is a best estimate. From the March 1858 *Harper’s New Monthly Magazine* (page 444).

Special Observations

The following was listed in the Army Surgeon General instructions in 1844 with regard to taking special weather observations at Army forts:

“Hourly Observations of the Barometer will be taken for 24 hours, at the equinoxes and solstices, to correspond with those already instituted at numerous points of Europe and America, at the suggestion of Sir John Herschel. The days fixed upon for these observations are the 21st of March, June, September, and December. But should any one of these 21st days fall on Sunday, then the observations will be deferred till the next day, the 22nd.”

“The observations at each station will commence at 6 o’clock, A.M. of the appointed days, and be continued at the beginning of each hour till 6 A.M. of the following days, care being taken to obtain the correct time.”

“The exact maximum and minimum of temperature of the 24 hours should be recorded, under the head of ‘Remarks,’ at the precise hour and minute at which they occur.”

“The value of these hourly observations will be greatly enhanced, if they be extended to all the objects embraced in the daily Register. If there be a storm about those times, hourly observations of all the phenomena, from the beginning to the end of the storm, will also be valuable.”

“All special observations will be recorded separately.”

“Connected with meteorology are many interesting subjects of inquiry, which can only be elucidated by wide-spread, simultaneous observations. The Medical Officers of the Army are therefore confidently invited to co-operate in the collection of data tending to advance the interests of science. For the accuracy of our observations, (quoted as they will be both at home and abroad,) it is hardly necessary to say, the reputation of the Department is pledged.”

The instructions in 1850 contained the same information as depicted in 1844 regarding special observations. However, no mention is made of special observations in the 1856 instructions nor in the 1868 instructions, indicating this requirement probably was dropped.

OTHER OBSERVATIONS

Refer to the report on Minneapolis/St. Paul, MN under this same contract.

Information in the Minnesota State Climatology Office suggests that Dr. C.L. Anderson may have taken weather observations in Minneapolis from 1 January 1856 to 31 December 1859 (9 months of data were missing during 1858) under the direction of the Army Surgeon General. Location of these observations was listed as the corner of Helen Street (now 2nd Avenue) and 2nd Street, i.e., approximately eight miles northwest of Fort Snelling. However, the NCDC database for the same period for Fort Snelling listed only observations taken at the post by Army surgeons. Dr. Anderson was listed by the Smithsonian Institution (and the NCDC database) as an observer during 1854 (see the report on Minneapolis/St. Paul) with no mention of taking observations from 1856 through 1859. During 1854, Dr. Anderson recorded temperature, clouds, wind, and precipitation amounts.

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Appendix

Methodology

Specific information regarding weather instrument location and exposure at Fort Snelling during observations by Army surgeons was sparse. The NCDC database was the primary source of weather observations for this report. The Minnesota State Climatology Office also contained relevant weather observations for this study.

General information regarding weather instruments used by the Army surgeons, and procedures used to take the observations, came from publications by the Army Surgeon General's Office (1844, 1850, 1851, 1856, and 1868). This general information was included with the assumption that the military surgeons followed those instructions closely.

The research of Charles Fisk into weather observing at Fort Snelling for his Master's Thesis was very helpful in establishing a general timeline for the observations, as well as filling information gaps. The technical notes on Fort Snelling, prepared by Tom St. Martin, also were crucial to filling data gaps in the timeline.

Annual reports by the U.S. Army Surgeon General were reviewed for the years 1825 through 1875 with only bits and pieces of revealed information. The primary exception was the annual report for 1844, which contained a summary of instructions for taking weather observations; however, a more detailed document was obtained from the National Library of Medicine in Bethesda, MD. Several publications by the Army Surgeon General were obtained from the extensive government library microfiche collection at Oklahoma State University. Photographic documentation was obtained from the Minnesota Historical Society through the Minnesota State Climatology Office.