HISTORY OF WEATHER OBSERVATIONS
HELENA, MONTANA
1866 – 1948

August 2006

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ACKNOWLEDGEMENTS

Numerous people were involved in the preparation of the records of the climate of Helena beginning one hundred forty years ago. Scores of people later cleaned out their files but chose not to throw away those data, notes, photographs, and other materials we now find so valuable. Now scores of people seek to preserve those documents and to identify Helena's climate station histories. All of these people made this study possible and, to them, thank you.

Special assistance was received from the Montana Historical Society's Research Center in Helena. Several people were especially helpful among them were Brian Shovers, Becca Kohl, and Katie Curey.

Thanks to Mr. and Mrs. Peter O. Lenmark for their hospitality and access to the Brown Block.

Thanks to Janet Conner for her assistance in the research and for the use of her photographs of some of the buildings that were used as weather observation sites.

Perhaps someone will read this study when it is a hundred years old. If so, to you, thanks for continuing the thread of interest in climate history.

CONTENTS

Acknowledgements	ii
List of Illustrations	iv
Introduction	1
The Location	1
The Record	2
Goal of the Study	4
Location of Observations	5
Environment	5
Latitude, Longitude, and Elevation	6
Street Addresses	6
Smithsonian Years	6
Gap in the Record 1868-1880	9
Signal Service Years	9
Weather Bureau Years	15
Airport Location	19
Instrumentation	
Thermometer	21
Psychrometer	24
Rain Gauge	27
Barometer	29
Barograph	31
Shelters	32
Wind Instruments	35
Triple Register	38
The Observers	
The Smithsonian Years	42
Gap in the Record 1868-1880	43
The Signal Service Years	43
The Weather Bureau Years	46
The Observations	
Smithsonian Observations	53
Signal Service Observations	53
Weather Bureau	54
The Digital Record	54
Climatology	55

Appendices
Appendix 1, Methodology 56
Appendix 2, Wheaton's Helena Plat Map 57

Bibliography 58

ILLUSTRATIONS

Figures

1.	Helena, Montana 1870	1
2.	First Observations from Helena, January 1866	2
3.	First Signal Service Observations from Helena, April 1880	3
4.	Topographic Map of Helena	5
5.	Smithsonian Record of Helena Observations	7
6.	Locale of First Observations	8
7.	Wheaton's Comments March 1868	9
8.	Locations of Observation Sites in Helena	10
9.	Brown Block Location	11
10.	Brown Block	12
11.	Murphy Building	13
12.	Montana State Bank Building	14
13.	Power Block	15
14.	Dwelling, 200 Seventh Street	16
15.	Map Location of 200 7th Street	17
16.	Power Block 2006	18
17.	Federal Office Building	19
18.	Helena Airport	20
19.	Green Maximum and Minimum Thermometers	22
20.	Sling Psychrometer	25
21.	Whirling Psychrometer	26
22.	Standard Eight Inch Rain Gauge	27
23.	Airport Rain Gauges	28
24.	Aneroid Barometer	29
25.	Mercury Barometer	30
26.	Barograph	31
27.	Shelter	32
28.	Shelter on Montana State Bank Building	33
29.	Fire Report July 1928	34
30.	Shelter at the Helena Airport	35
31.	Instruments of the Power Block Roof	37
32.	Wind Instruments Tower	38
33.	Triple Register	39
34.	Miles Run Dial	40
35.	Tipping Bucket Rain Gauge	41
36.	Sunshine Recorder	42

Tables

1. Latitude and Longitude of Station Locations 6
2. Street Addresses of Observation Sites 6
3. Exposed Thermometers at Helena 22
4. Maximum Thermometers at Helena 23
5. Minimum Thermometers at Helena 24
6. Dry Bulb Thermometers at Helena 25
7. Wet Bulb Thermometers at Helena 26
8 Aneroid Barometers Used at Helena 29
9. Mercury Barometers Used at Helena 30
10. Anemometers Used at Helena 36

HISTORY OF WEATHER OBSERVATIONS
Helena, Montana
1866 —1948

Glen Conner
Kentucky State Climatologist Emeritus

INTRODUCTION

Making and recording weather observations were new to the Helena area in 1866 but almost everything else in the area was new too. President Abraham Lincoln signed the act that established the Montana Territory on 26 May 1864. Gold was discovered on 14 July 1864 and, soon afterward, Helena was first established as a settlement[1] in the gulch where the discovery was made. Only one and a half years later, the first weather observations were submitted from the Helena area. The city grew rapidly and by 1870 (Figure 1) was well on its way to becoming a major city in the Territory. Statehood was still years away, Montana did not become a state until 8 November 1889.

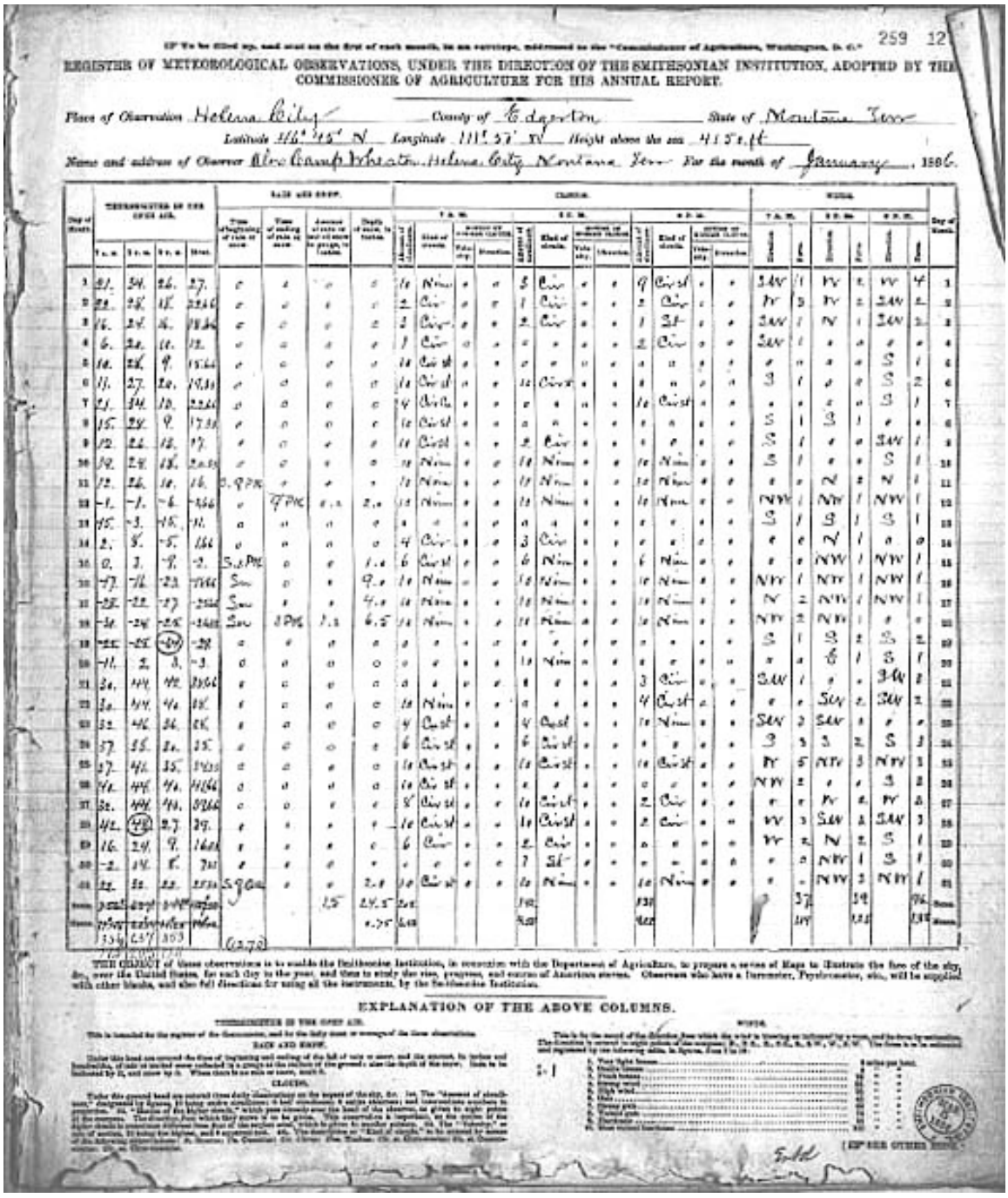
Location

Figure 1. Helena, Montana 1870
Source: William H. Jackson Photograph, National Archives, Wikipedia

[1] According to Baucus, the city was mostly tents and log cabins

Record

The first observations in Helena (Figure 2) were submitted as part of the Smithsonian Institution's climate network.



REGISTER OF METEOROLOGICAL OBSERVATIONS, UNDER THE DIRECTION OF THE SMITHSONIAN INSTITUTION, ADOPTED BY THE COMMISSIONER OF AGRICULTURE FOR HIS ANNUAL REPORT.

Place of Observation Helena City County of Edgerton State of Montana Terr

Latitude 46° 45' N Longitude 111° 57' W Height above the sea 4152 ft

Name and address of Observer Alex Camp Wheaton Helena City Montana Terr For the month of January, 1866.

EXPLANATION OF THE ABOVE COLUMNS.

Figure 2. First Observations from Helena, Montana, January 1866
Source: National Climatic Data Center

Congress created the Smithsonian Institution in 1846 to increase and diffuse knowledge. The Smithsonian network wasn't the first such effort. The U.S. Army's Office of the Surgeon General established the first climate network at its Army Posts beginning in 1818 but there was no post in Helena from which to take observations. The Smithsonian Network under the leadership of Joseph Henry grew rapidly. In two years, it had over 150 observers providing monthly reports containing daily data. It would eventually supplant the U.S. Army as the primary collector of climate data. By 1860, there were over 500 stations reporting monthly to the Smithsonian. As an observer of weather, it seems likely that Alex Camp Wheaton would have known about those stations before he arrived in Montana. In any case, he was the first to submit reports (Figure 2) to the Smithsonian from the Helena area. He only did so for about two and one half years.

The observations resumed when the first Signal Service observations from Helena began in April 1880. Pvt. Napoleon C. Smith made observations of temperature at 7:35 a.m., 4:35 p.m., and 11:35 p.m. and recorded daily rainfall totals. At the end of that first month (November), he forwarded the completed form (Figure 3) to the Signal Service Headquarters in Washington.

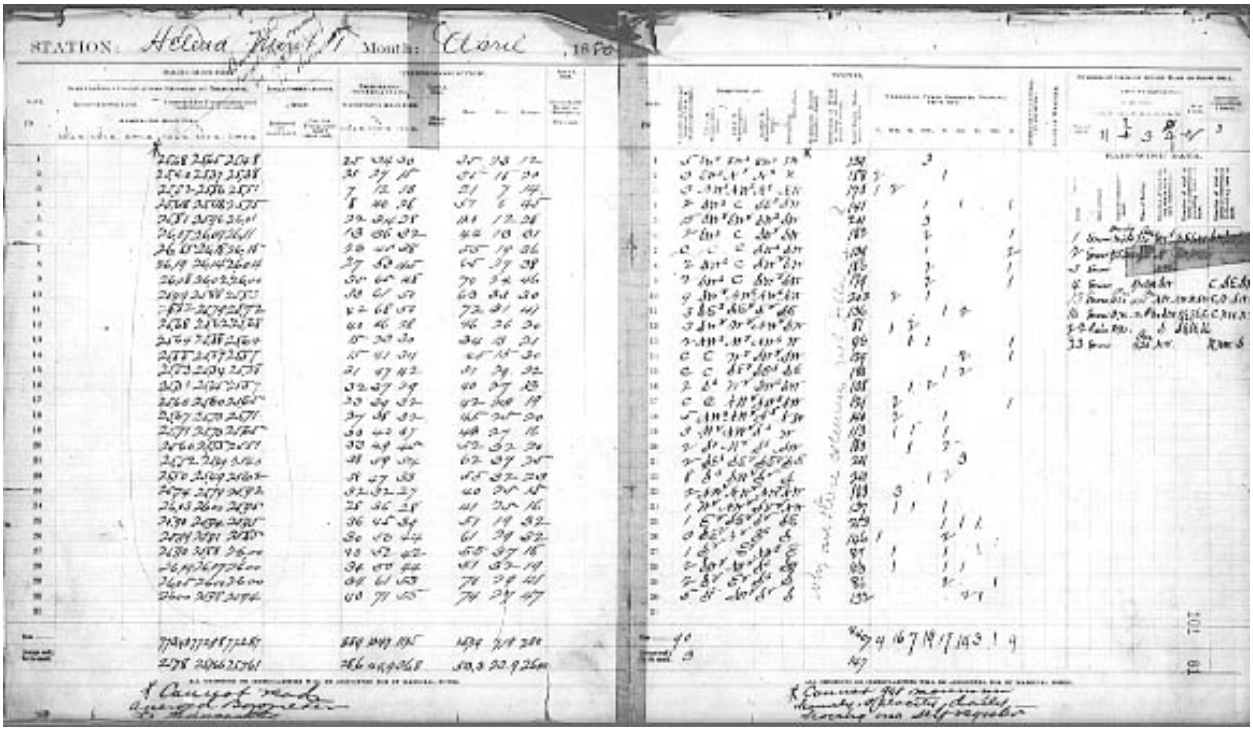


Figure 3. First Signal Service Observations from Helena, April 1880
Source: National Climatic Data Center

In 1870, President U. S. Grant signed a law that directed led to the new Signal Service's weather network that would displace the Smithsonian's. The responsibility for the new network was given to the Army because "military discipline would probably secure the greatest promptness, regularity, and accuracy in the required observations." The Signal Service was

created within the Army's Signal Corps and began telegraphing weather reports to Washington on 1 November 1871. Those observations were used to formulate forecasts[2] that were distributed using the telegraph. By 1878, reports were being received from 284 locations around the country. But it was another two years before the Helena would be included in that list.

The Signal Service's network, including the Helena station, was transferred to the Department of Agriculture's Weather Bureau in 1892. It in turn was renamed the National Weather Service in 1947 and placed under the Department of Commerce with its new interest focused on aviation.

The observations continue in Helena with the continuous record now extending to 126 years.

Goal of the Study

The goal of this study was to document the weather observational history of Helena, Montana. The climatic data, and information from the observations made there, are readily available and may be accessed through the National Climatic Data Center, the Western Regional Climate Center, and the State Climatologist of Montana. The challenge of this study was to identify the role that Helena played in the development of a federal weather observational program and where it fit in the route that followed from the Smithsonian Institution's observer, through the U. S. Army's Signal Service Observers, and the Weather Bureau meteorologists, to the current National Weather Service Forecasters and their extensive observational and forecast network of today.

[2] Called "probabilities" in those days

LOCATION OF OBSERVATIONS

Environment

The downtown of Helena was established in the Last Chance Gulch where gold was discovered. Main Street was built in the gulch. The city occupied that valley and the surrounding interfluves (Figure 1). The city's expansion was constrained by Mount Helena to the west and other high hills to the south. The expansion toward the north and east has been extensive.

The relief in the city is significant. Mount Helena to the west is 5,462 feet above mean sea level (MSL) and Mount Ascension to south is 5,465 feet MSL. About 1.5 miles away from them in downtown in the Last Chance Gulch where the elevation is about 1,400 feet lower (Figure 4). From downtown, the terrain generally slopes downward toward the northeast.

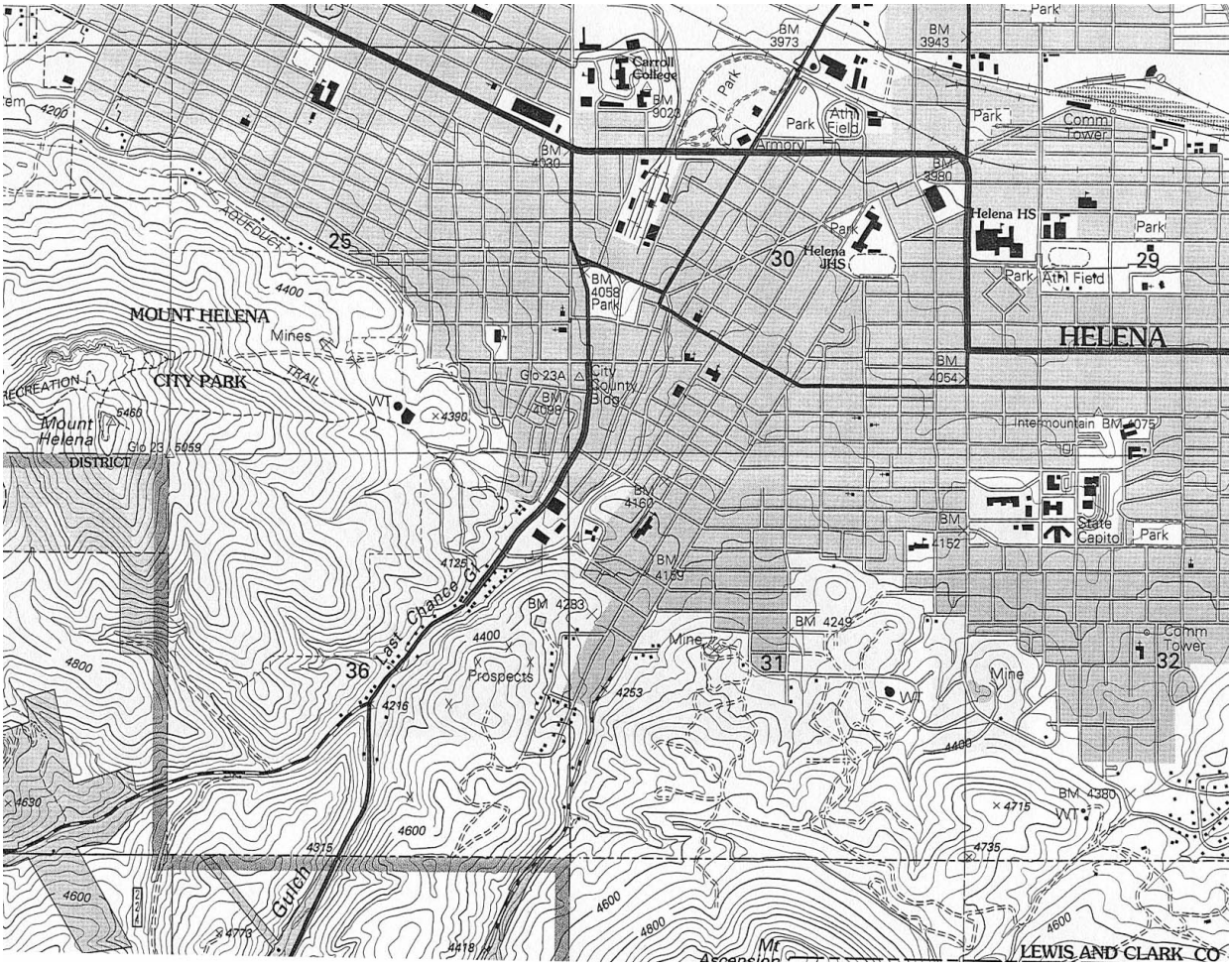


Figure 4. Topographic Map of Downtown Helena
Source: U. S. Geologic Survey

Latitude and Longitude

The observation sites moved several times over the years. Table 1 is a summary of those moves. Only the first and last moves were significant in their difference in distance.

Table 1. Latitude and Longitude of Station Locations

Location	Period	Latitude	Longitude
Wheaton's Site	1 Jan 1866- Mar 1868	46˚ 45' N	111˚ 50' W
Parchen Building	1 April 1880-30 Apr 1881	46˚ 35' N	112˚ 02' W
Brown Block	1 May 1881-31 Dec 1883	46˚ 35' N	112˚ 02' W
Murphy Building	1 Jan 1884-30 Apr 1891	46˚ 35' N	112˚ 02' W
Montana State Bank Building	1 May1891-31 Mar 1994	46˚ 35' N	112˚ 02' W
Power Block	1 Apr 1894-27 Sep 1904	46˚ 35' N	112˚ 02' W
200 7th Avenue	28 Sep 1904-25 Feb 1912	46˚ 35' N	112˚ 02' W
Power Block	26 Feb 1912-20 Jun 1933	46˚ 35' N	112˚ 02' W
Federal Building	21 Jun 1933-29 April 1940	46˚ 35' N	112˚ 02' W
Helena Municipal Airport	30 Apr 1940-	46˚ 35' N	112˚ 00' W

Street Addresses

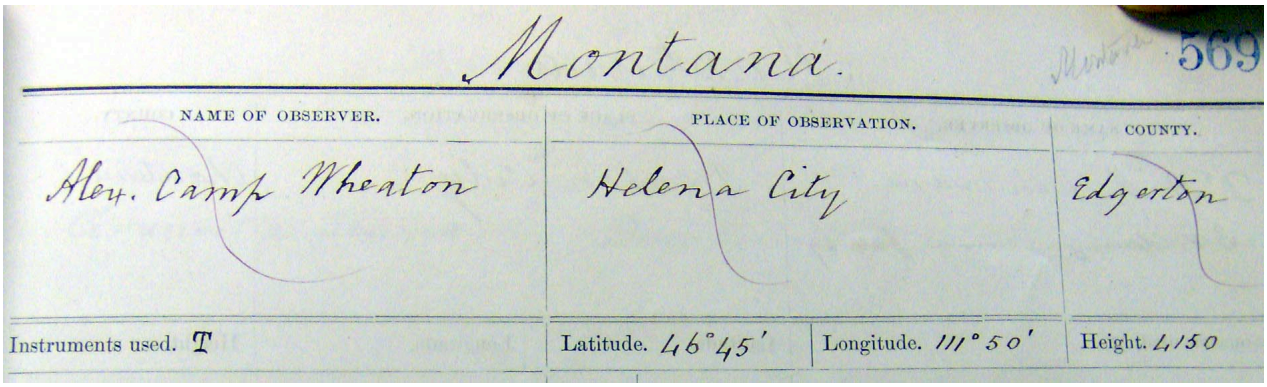
Most of the observation sites had street addresses. Table 2 is a summary of those addresses.

Table 2. Street Addresses of Observation Sites

Location	Period	Street Address
Wheaton's Site	1 Jan 1866- Mar 1868	None
Parchen Building	1 April 1880-30 Apr 1881	106 Broadway
Brown Block	1 May 1881-31 Dec 1883	Breckenridge and Warren
Murphy Building	1 Jan 1884-30 Apr 1891	104 Main and Price
Montana State Bank Building	1 May1891-31 Mar 1994	Main and Edwards
Power Block	1 Apr 1894-27 Sep 1904	Main and 6th
200 7th Avenue	28 Sep 1904-25 Feb 1912	7th and Warren
Power Block	26 Feb 1912-20 Jun 1933	Main and 6th
Federal Building	21 Jun 1933-29 April 1940	Park and 6th
Helena Municipal Airport	Apr 1940-	

Smithsonian Years

The first observations submitted to the Smithsonian Institution on January 1866 were from "Helena City" in what was then Edgerton County. The specific location was listed as 46˚ 45' N and 111˚ 50' W at an elevation of 4050 feet above mean sea level (MSL). The Smithsonian Records of receipt of his submissions recorded the elevation at 4150 feet MSL (Figure 5).



Montana. 569

NAME OF OBSERVER.	PLACE OF OBSERVATION.	COUNTY.
Alex. Camp Wheaton	Helena City	Edgerton

Instruments used. T	Latitude. 46°45′	Longitude. 111°50′	Height. 4150

Figure 5. Location Record of the First Observations in Helena
Source: Smithsonian Institution Receipt Journal

The location of the first site raised at least three questions. First, the location was several miles northeast of the city. However, the rules of the Smithsonian Institution required that the station adopt the name of its nearest post office. It would not have been unusual to find that the Smithsonian observer was not in the Helena city proper.

Second, the accuracy of the latitude and longitude of a rural location as determined in 1866 could be questioned. There was no indication as to how the location was determined.

Third, the elevation was lower than would be expected for a downtown Helena location where one would have expected the observation site to be.

The seriousness of all three questions faded when research revealed that the observer was a civil engineer who surveyed and prepared a plat map of Helena (see Appendix 2). He certainly was qualified to determine the location of his observation site. Therefore, his location as written on the observation form can be accepted.

Smithsonian Observation Site

The location of 46˚ 45' N and 111˚ 50' W placed the observation site on the east side of the Missouri River. The author used GPS to go near that location. A private road and a no trespassing sign precluded travel to the exact site. Figure 6 shows the view northward from a GPS position on Huotari Lane at 46˚ 44.115' N and 111˚ 51.000' W at an elevation of 3837 MSL, ± 23 feet, very near to the first observation site.

Figure 6. Locale of First Observations
Source: Author

The actual observation site would have been north of the confluence of the Missouri River with Favorite Gulch, on the north side of what is now Huotari Lane. The floodplain might have been seen as suitable for farming. However, gold and sapphire mine tailings from the worked gravel deposits were south of the road. The presumed observation site was just a few hundred yards north of the road. The date of the opening of that mine was not recorded but perhaps gold was the reason for the observer being there. The Missouri River has since been dammed just downstream. The Lake now obscures the riverbed and history does not record if a ford or a ferry was located there.

The reason for the observer being at this location remains a mystery. But the acceptance of the site's location seems to the author to be easy when one considers that the observations ended at this location at the end of May 1868, a date consistent with the date when the observer began the survey for the plat map of Helena.

Other evidence comes from his comments contained on the observation forms. There was a reference to a storm that occurred "in the town" as if he was not a resident. There are his references to farming and to the river itself. In his last report in March 1848, he writes about the river (Figure 7).

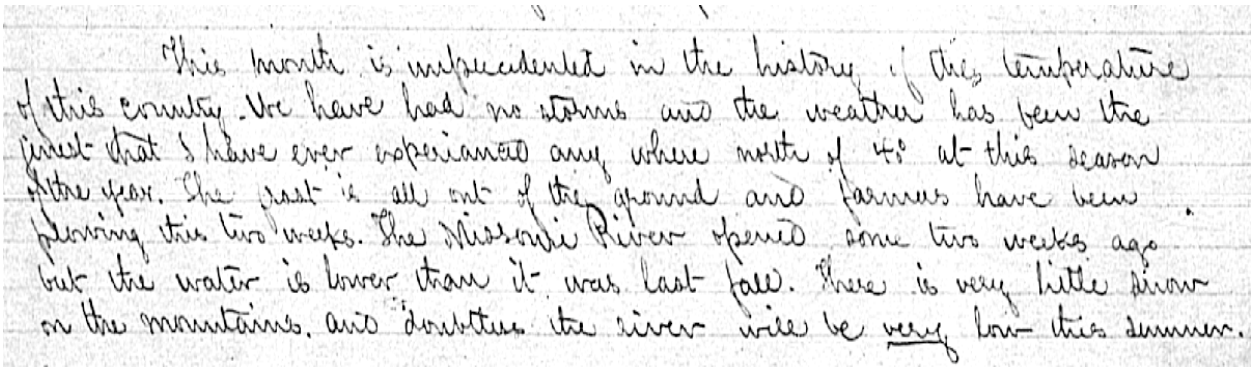

This month is unprecedented in the history of this temperature of this country. We have had no storms and the weather has been the finest that I have ever experienced any where north of 45° at this season of the year. The grass is all out of the ground and farmers have been plowing this two weeks. The Missouri River opened some two weeks ago but the water is lower than it was last fall. There is very little snow on the mountains, and doubtless the river will be very low this summer.

Figure 7. Wheaton's March 1868 Comments about the Missouri River
Source: National Climatic Data Center

The Gap in the Record 1868-1880

There was a gap in the record from April 1868 to 1 April 1880. There were no indications that observations were taken during that period.

Signal Service Years

Signal Service Observation Sites

1 April 1880

The Signal Service opened an office in Helena and began making weather observations on 1 April 1880. They continued observations until the climate network was transferred to the Department of Agriculture in 1892. The first location for the Signal Service was in the Parchen Building that stood at Broadway and Main Streets (Figure 8). It was at 46˚ 35' N and 112˚ 02' W at an elevation estimated by the Weather Bureau as being about 4,089 feet MSL. The building was located at 106 Broadway and was a newspaper office at first. That building was torn down some time later.

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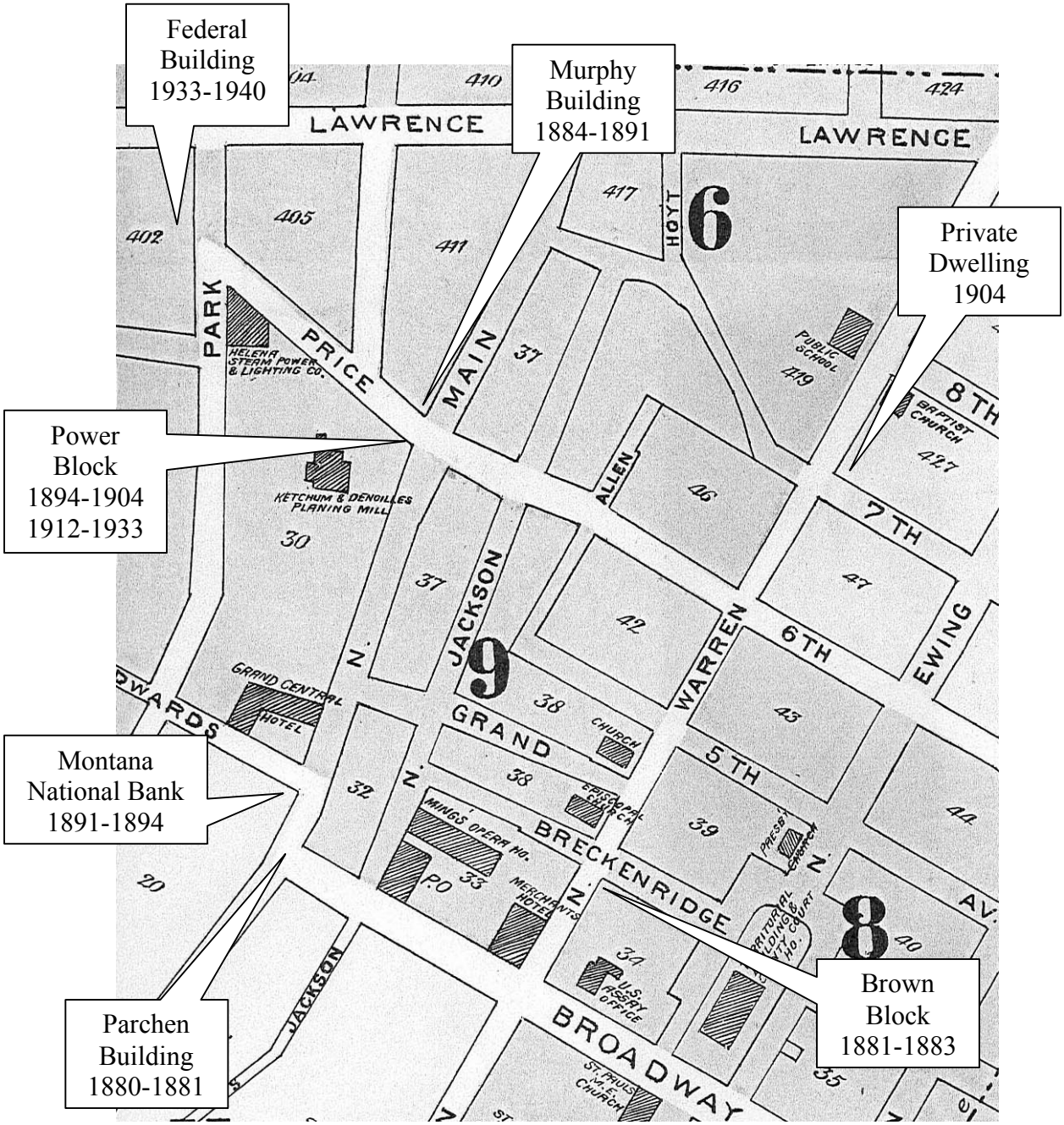


Figure 8. Location of Observation Sites in Helena
Source: Adapted from Sanborn Map, 1888

1 May 1881

The Signal Service moved their station to the Brown Block (Figures 9 and 10) located at the southeast corner of Breckenridge and Warren on 1 May 1881. Its location was estimated by the Weather Bureau as 46˚ 35' N and 112˚ 02' W. The author located it using GPS as 46˚35.201' N 112˚ 02.233' W at an estimated elevation of 4,130 feet MSL.

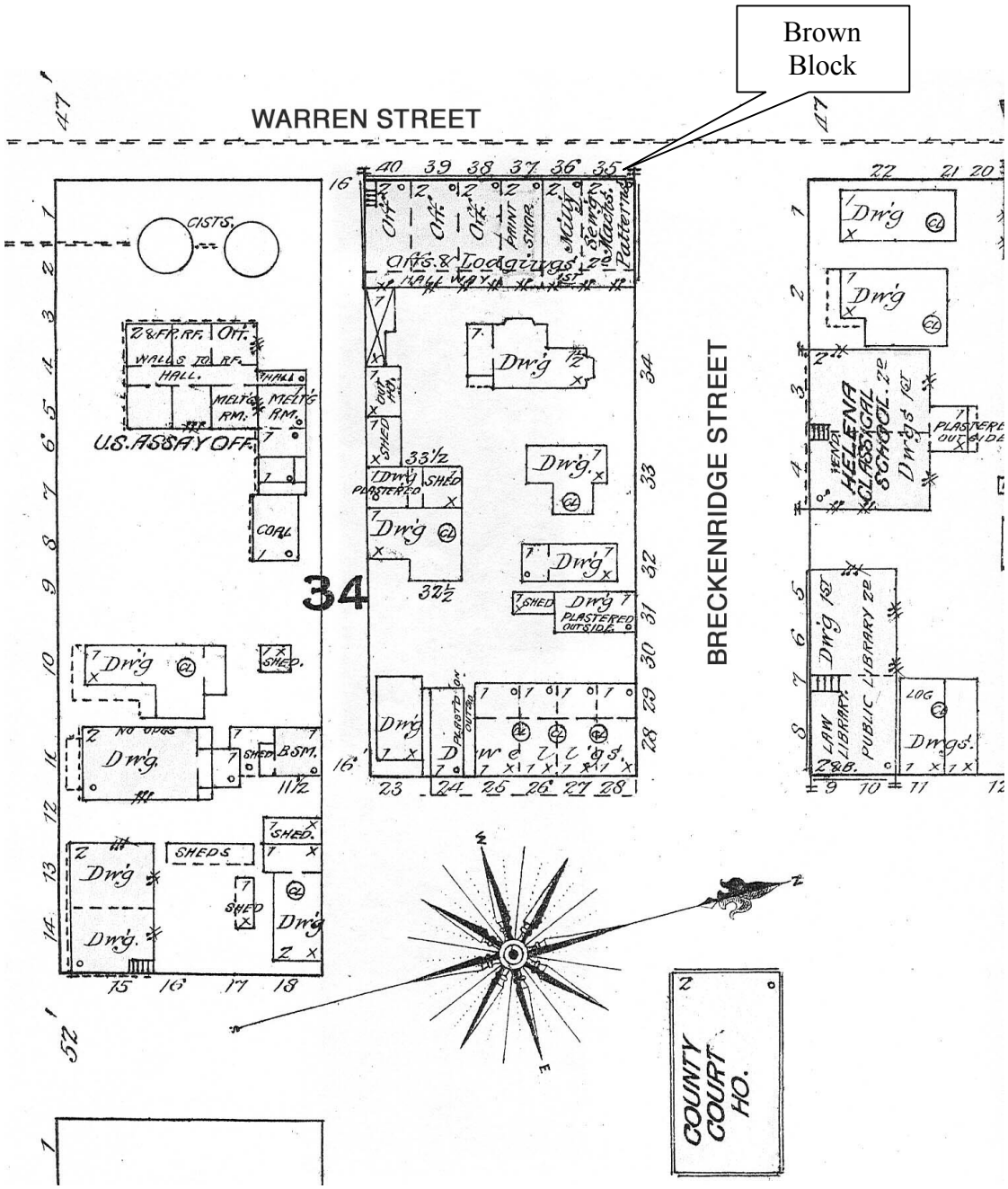


Figure 9. Brown Block Location
Source: Adapted from Sanborn Map, 1884

In an 11 December 1881 letter in the Frank Burke Papers, there is a statement that the same building also housed the Quartermaster, Paymaster, Attorney General, and Commissary Offices. It seems certain that the federal government offices occupied all the rooms in the Brown Block. The building had six spaces that were occupied by shops 1884 as shown in Figure 8. Burke wrote that the observers were quartered in one of the hotels.

The office, according to the Inspection Report of September 1881, was in good condition. It was supplied with a "full set of meteorological instruments and a complete set of telegraph instruments." During the year, the telegraph office had sent 6,538 messages and had received 8,207 messages. In addition, the men in the office maintained 70 miles of telegraph wire.

The original building at 11-21 North Warren, said by Juisto to have been built in 1879, has survived and is shown in Figure 10.

Figure 10. Brown Block, 2006, viewed from the north
Source: Janet Conner

The current owner of the building, Peter O. Lenmark, understands that only the part of the building in the foreground was built at that time. The longer section (behind the vehicle in the photograph) extending toward the background was added some time later. Note that in the map shown in Figure 9, only the front portion of the building was present. An alley and, beyond that, two cisterns occupied the space in 1884, the year after the Signal Service moved away and before the longer addition was built.

The building was built on a northwest-facing slope overlooking the previous location from a point about eighty feet higher than the Main Street below. It must have had an impressive view across the cityscape from the Signal Service offices.

1 January 1884

The next location was on the second floor of the John J. Murphy Building at the northwest corner of Price[3] and Main[4] Streets. The street address was 104 Main Street. They occupied rooms 14 and 15. The Weather Bureau estimated the site as being at 46˚ 35' N and 112˚ 02' W at an estimated elevation of 4,069 feet MSL. The Murphy Building (Figure 11) was a prominent building in the downtown area with space on the roof for the instruments.

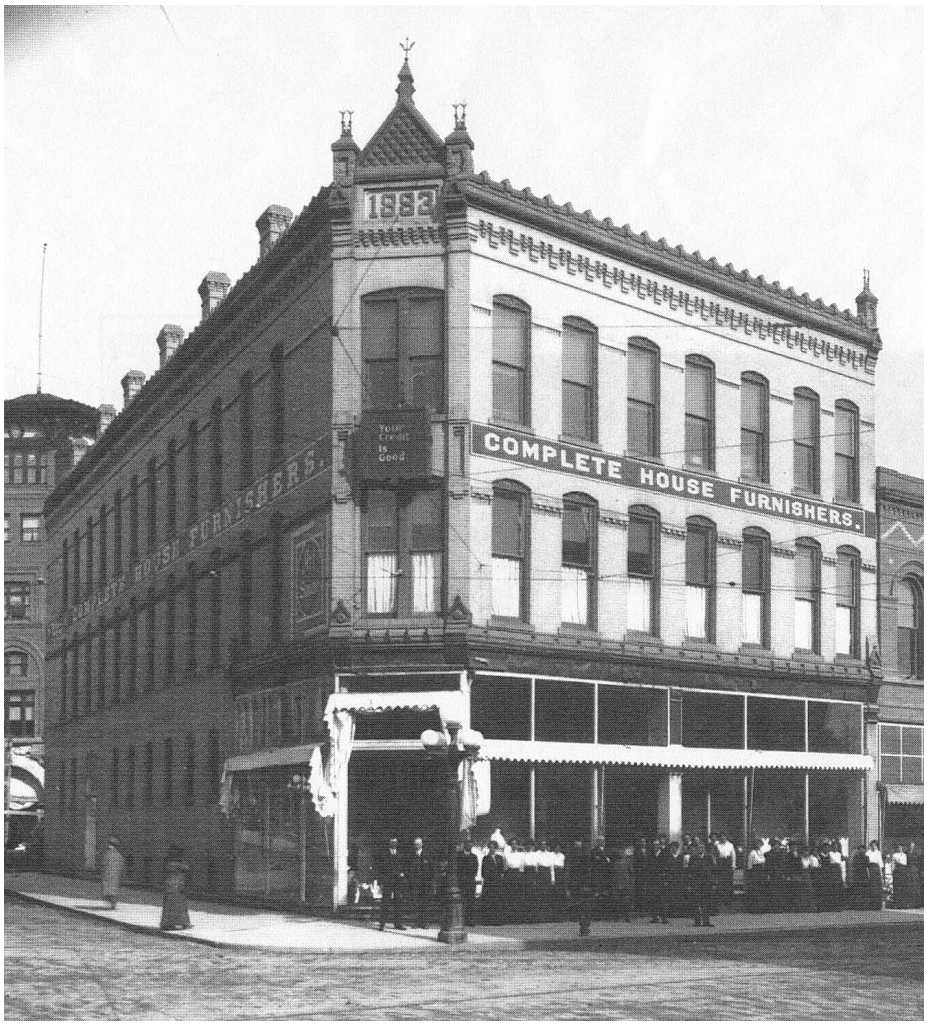


Figure 11. John J. Murphy Building
Source: Montana Historical Society

[3] Price Street was later renamed 6th Street.
[4] Portions of Main Street were later renamed Last Chance Gulch

1 May 1891

The office was moved to the Montana National Bank Building on 1 May 1891. The building had been remodeled in 1890. The bank (Figure 12) was located on the southwest corner of Main and Edwards. The Signal Service occupied rooms 47 and 48 of bank building.
The site was at 46˚ 35' N and 112˚ 02' W at an estimated elevation of 4,080 feet MSL. The office was transferred from the Signal Service to the new Weather Bureau in 1892.

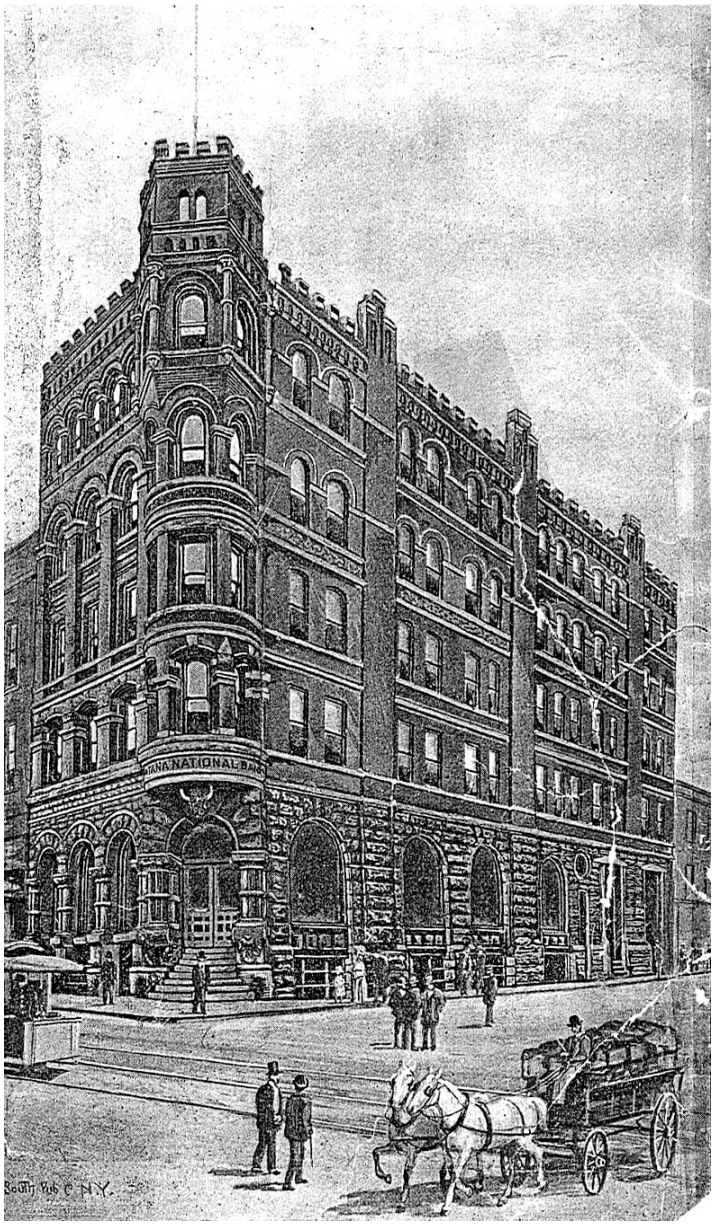


Figure 12. Montana State Bank Building, 1891
Source: Lyman, A. W.

Weather Bureau Years
1 Apr 1894

On 1 April 1894, the Weather Bureau Station moved from the Montana State Bank building to the Power Block (Figure 13) that was located on the southwest corner of Main and Sixth Avenue. Their offices occupied rooms 501, 502, 503, and 520 on the fifth floor. The building was at 46˚ 35' N and 112˚ 02' W at an estimated elevation of 4,069 feet MSL. The Power Block was built in 1889. The Montana Senate used it in 1893.

Like at other locations downtown, the instruments were located on the roof.

Figure 13. Power Block, 1891
Source: Lyman, A. W.

28 Sep 1904

On 28 September 1904, the Weather Bureau's offices were moved to a private dwelling located at 200 Seventh Avenue on the northeast corner of Seventh and Warren (Figure 14). The

offices occupied three rooms on the first floor of the dwelling. The site was at a GPS location of 46˚ 35.315' N 112˚ 02.134'W at an estimated elevation of 4,112 feet MSL.

Figure 14. Dwelling, 200 Seventh Avenue, 2006
Source: Janet Conner

The house was and is located only two blocks away from the Brown Block on Warren Street. Like the Brown Block, it overlooked the panorama of the city in the Last Chance Gulch below. The Sanborn map from 1888 depicts the location (Figure 15).

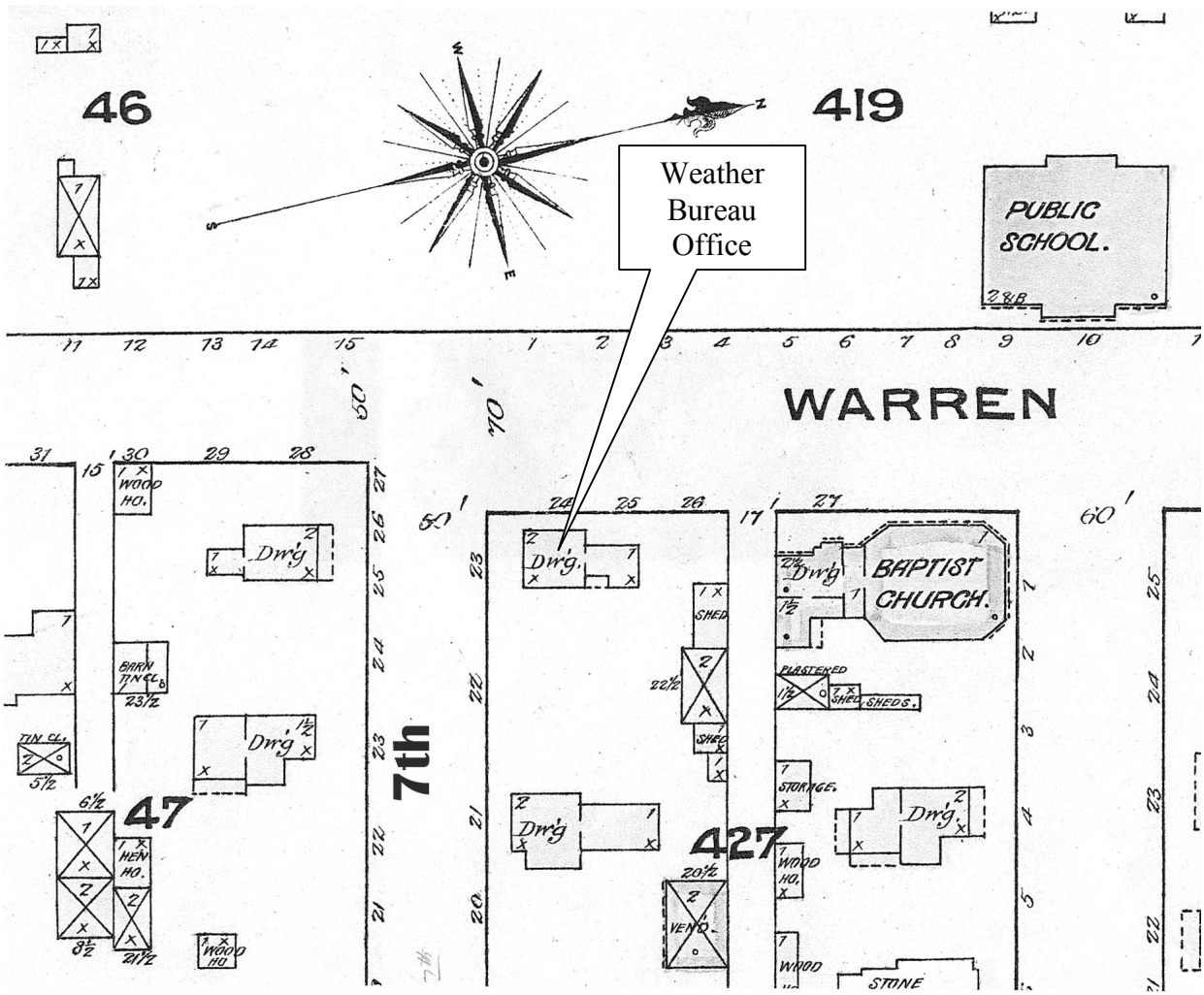


Figure 15. Map Location of 200 7th Avenue
Source: Adapted from Sanborn Map, 1888

26 Feb 1912

The Weather Bureau offices moved back to the Power Block (Figure 16) on 26 February 1912. The reasons for leaving the Power Block and for returning there were not recorded. They occupied rooms that had been renumbered to 601, 602, 604, 605 and 606 on the sixth floor. Instrument elevations suggest that an additional floor may have been added before they moved back. The GPS location of the building was at 46˚35.346' N and 112˚02.330' W. The elevation was estimated at 4,069 feet MSL. The offices were renovated after a fire on 16 July 1928.

Figure 16. Power Block, 2006
Source: Janet Conner

21 Jun 1933

On 21 June 1933, the Weather Bureau offices were moved to the new wing of the Federal Office Building (Figure 17). That building was located at 6th and Park. They occupied rooms 407, 408, 425, 426, and 427 on the fourth floor.

The GPS location was 46˚ 35.390' N 112˚ 02.418' W at an estimated elevation of 4,090 feet MSL

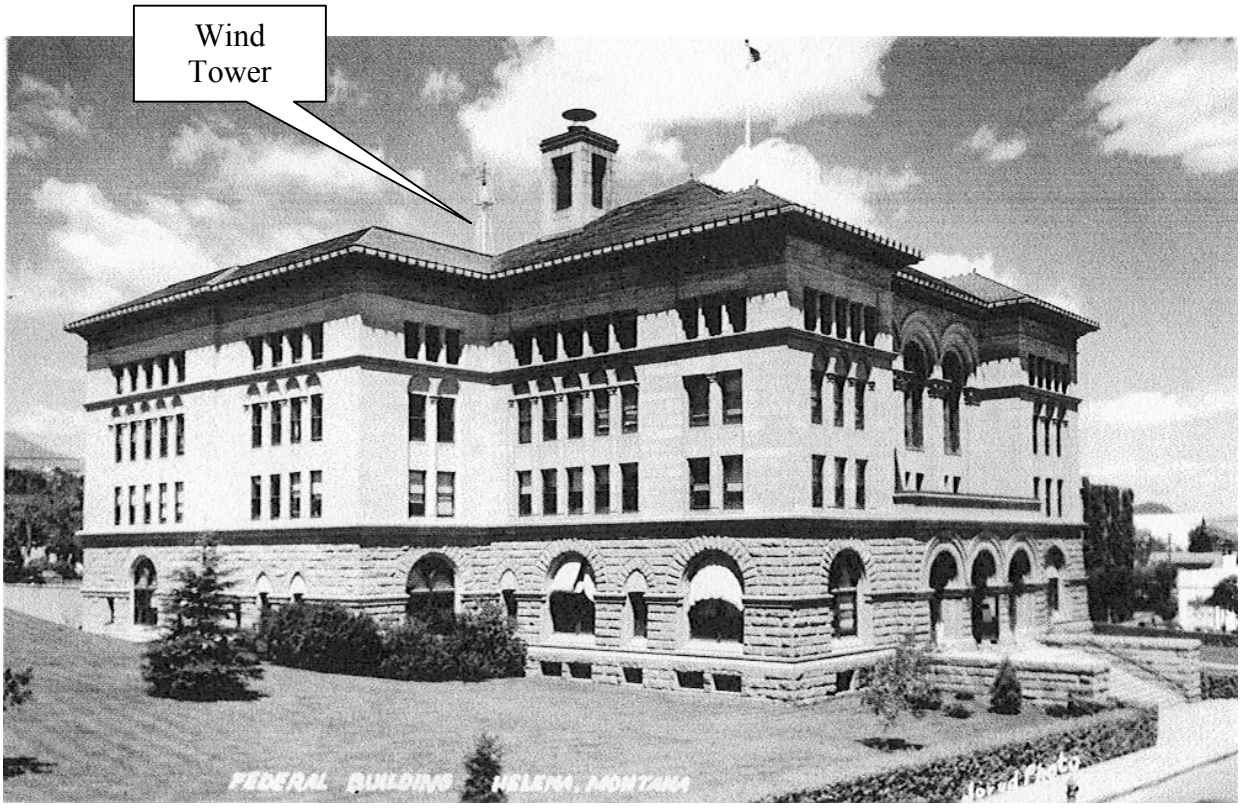


Figure 17. Federal Office Building
Source: Montana Historical Society

The instruments were located on the roof and the tower for the anemometer is visible in the photograph. The date of the photograph is unknown.

Airport Location

30 Apr 1940

On 30 April 1940, a second Weather Bureau office was opened at the Helena Municipal Airport in rooms A, B, C, & D of the Administration Building. The collocation of the weather office with the airport also happened across the country as the importance of aviation grew. The new location at the airport was given as 46˚ 35' N and 112˚ 00' W at an elevation of 3,893 feet MSL.

The airport station was described as being located at the northeastern edge of Helena and on the southeastern side of a broad mountain valley trending mostly northwest to southeast. The ground around the station was mostly level but sloping gradually upward toward Helena. Mountains or low foothills surrounded the station at distances of three to six miles to the south and east and of 12 to 20 miles in the other directions.

The change in location at Helena involved a significant move in distance, elevation, and environment. Compare the airport location (Figure 18) to the downtown terrain (Figure 1) to see the difference.

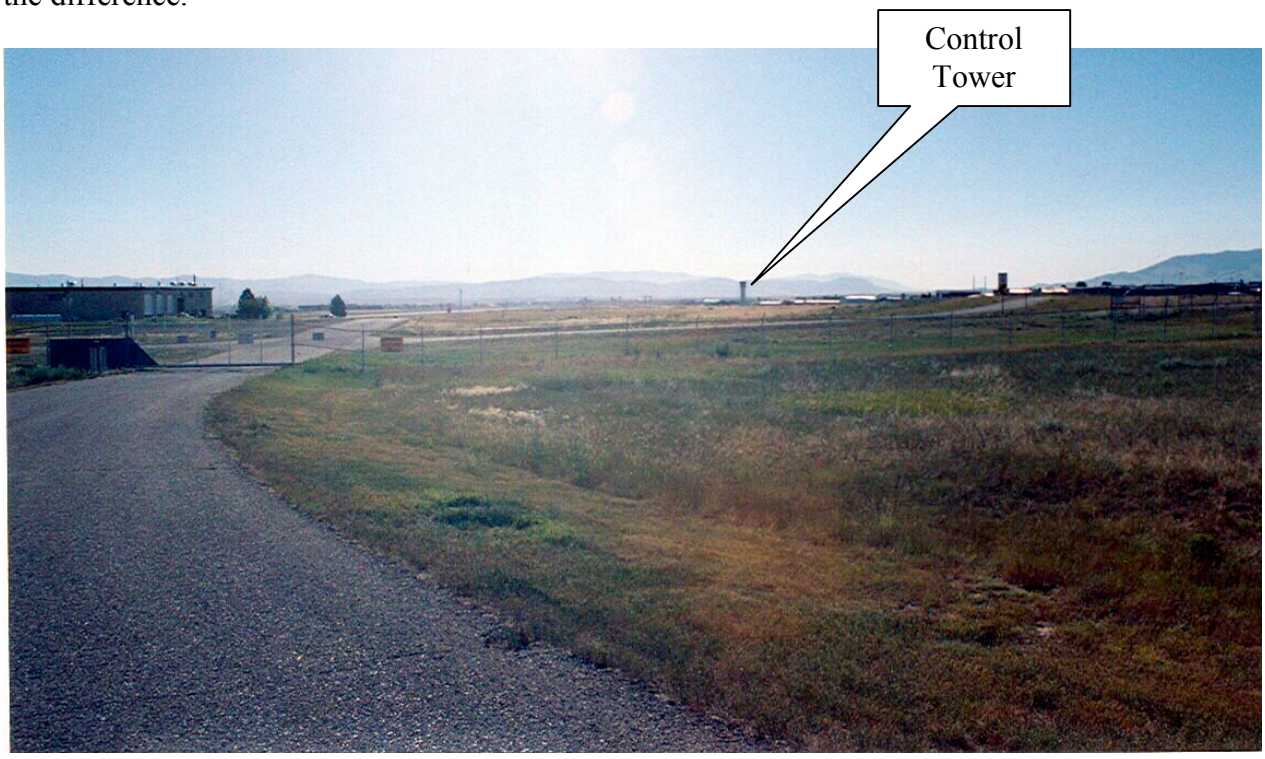


Figure 18. Helena Airport Looking East
Source: Author

26 Oct 1946

The move to the airport changed too much in both distance and elevation to consider it to be a continuation of the downtown data set. The old station at the Federal Building was used as their climate office by the Weather Bureau for a short period until all activities were moved to the airport site.

INSTRUMENTATION

Documentation of the instruments used in Helena was not complete. Nevertheless, all available data were included in this section of the study.

Thermometer

The first observer at Helena had only one meteorological instrument, the thermometer. That is all that is known but one could surmise that he must have brought the instrument with him because it likely would not have been available locally. He used a Smithsonian form to make his report. He must have brought that with him also.

The second location was the Signal Service's site in the Parchen Building in 1880. The exposures were said to be very good. The thermometers were six feet above ground level (AGL). They were the only instruments available at that site.

The Chief Signal Officer's Annual Report for 1879 gave instructions for calibrating the thermometers using ice. That indicated the concern with maintaining instrument accuracy.

> Place the thermometer to be tested in the vessel provided for this purpose, keep them in a vertical position, pack finely pounded ice around them to a height a little above the freezing point, and let them remain for one hour, at the expiration of which time read off the height of the mercury, without removing them from the ice, note the result of the test of each thermometer in the daily journal, and report it to this Office in the journal abstract.

The thermometers used at the Brown Block from 1881-1883 were mounted at a height of 5.6 feet AGL. Their exposure was said to be very good.

The thermometers at the Murphy Building beginning in 1884 were on the roof of that three-story building. Their exposure was said to be good. They were moved from one location to another on the roof. They were at 21 feet AGL from 1844-1886, at 66 feet AGL in 1886-1887, and 64 feet AGL in 1887-1891.

The instruments were on the roof of the Montana National Bank from 1 May 1891 to 1 April 1894. The exposure was reported to be very good. The thermometers were at 85 feet AGL.

The Power Block rooftop was the location of the thermometers from 1 April 1894 to 28 September 1904. They were at 88 feet AGL.

The thermometers at the private dwelling at 200 Seventh Street were at 8 feet AGL with reportedly very good exposure. They were at that location from 20 September 1904 to 26 February 1912.

The observation site returned to the roof of the Power Block on 26 February 1912. The thermometers were at 87 feet AGL and 11 feet above the roof. On 13 May 1929, the height changed to 89 feet AGL with the height above the roof remaining the same.

The final downtown location was on the roof of the new wing of the Federal Office Building. On 21 June 1933, the thermometers were at 85 feet AGL and 10 feet above the roof.

The exposed thermometer (Table 3) was named to distinguish it from the thermometer that was attached to the barometer. Use of the exposed thermometer was eventually replaced with the dry thermometer used with the psychrometer.

Table 3. Exposed Thermometers Used at Helena

	In Use	
Number	**From**	**To**
576	1 Jan 1885	31 Jan 1886
4069	1 Feb 1886	31 May 1887
1810	1 Jun 1887	31 Dec 1888

Thermometers made by H. H. Green (Figure 19) were in common use to measure the highest and lowest temperatures of the day.

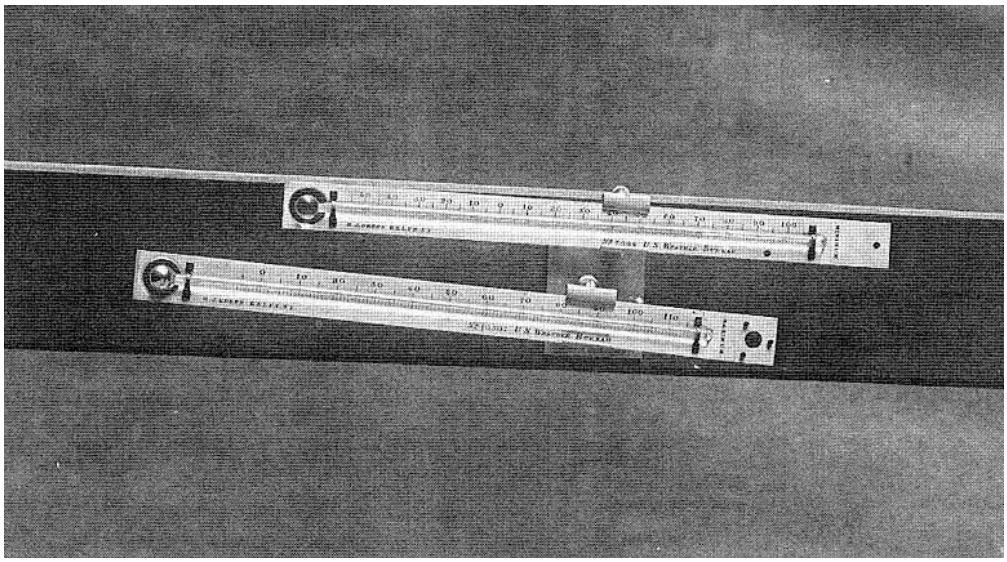


Figure 19. Green Maximum and Minimum Thermometers
Source: National Archives and Records Administration

The Green Maximum Thermometer had a small constriction just above the bulb that broke the column of mercury as it contracted from cooling. The column remained at its highest point

until it was forced through the constriction by spinning the thermometer. In February 1888, the Signal Office in Washington wrote to the observer expressing concern that "when the maximum thermometer does not register low enough to meet the usual fall in temperature during the winter, you substitute the extra at once" and that "if the extra thermometer is not graduated sufficiently low, requisition should be made in ample time for one that will answer the purpose."

Table 4. Maximum Thermometers Used at Helena

	In Use	
Number	**From**	**To**
464	1 Apr 1880	Feb 1881
78	Feb 1881	3 Jan 1885
*663	3 Jan 1885	25 Apr 1885
791	25 Apr 1885	20 Apr 1887
1746	20 Apr 1887	7 Jan 1885
844	7 Jan 1885	28 Feb 1888
1746	28Feb 1888	
2114	1895	1896
4007	1896	1897
4507	1897	1903
1109	1903	1904
2026	1904	1906
*9425	1906	25 Apr 1911
*2026	25 Apr 1911	15 May 1911
*8298	15 May1911	20 Jun 1918
*20933	20 Jun 1918	27 Aug 1918
**20216	27 Aug 1918	21 Aug 1919
*22131	21 Aug 1919	13 Oct 1922
24839	13 Oct 1922	5 Dec 1922
*24753	5 Dec 1922	13 Oct 1922
*24842	13 Oct 1922	1923
***24839	1923	12 May 1923
***25309	12 May 1923	18 Jun 1925
**22525	18 Jun 1925	24 Feb 1925
*27764	24 Feb 1925	16 Jul 1927
*29395	16 Jul 1927	23 Jul 1928
30975	23 Jul 1928	1928
31041	1928	23 Jul 1928
*31091	23 Jul 1928	3 Dec 1931
*31077	3 Dec 1931	13 mar 1935
*36767	13 mar 1935	10 Jan 1938
**38629	10 Jan 1938	28 Nov 1940
*42275	28 Nov 1940	2 Apr 1944
****46207	2 Apr 1944	8 May 1945
46211	8 May 1945	6 Jul 1946
64803	6 Jul 1946	

* Broken
** Retreater
*** Recording unsatisfactorily
**** Hard Setter

The Green Minimum Thermometer had alcohol instead of mercury. Within the column of alcohol was a glass index. As the column shrank with cooling, it dragged the index downward with it. When the temperature rose, the alcohol flowed around the index leaving it at its lowest point. It was reset each day by tilting the thermometer downward toward its top, until the index slid to the top of the column.

Table 5. Minimum Thermometers Used at Helena

	In Use	
Number	**From**	**To**
*373	1 Apr 1880	
160	31 Jan 1885	20 Dec 1885
1590	20 Dec 1887	
2059	1895	1903
6369	1903	1907
6075	1907	
4924	1907	
10410	12 Aug 1912	
6075	1 Dec 1913	11 Aug 1916
13391	18 Aug 1916	28 May 1923
16838	28 May 1923	15 Dec 1926
16826	15 Dec 1926	16 Jul 1928
*16864	16 Jul 1928	3 Oct 1932
**19782	3 Oct 1932	24 Feb 1940
*18177	24 Feb 1940	10 May 1940
19782	10 May 1940	16 Apr 1942
***400218	16 Apr 1942	2 Jul 1942
***400217	2 Jul 1942	3 Jul 1942
*25264	3 Jul 1942	17 Apr 1943
400200	17 Apr 1943	21 Apr 1945
400189	21 Apr 1945	

* Broken
** Separation
*** Faulty Index

Psychrometer

Relative humidity was one of the determinations made at the Helena weather stations. That required two instruments: the dry bulb thermometer and the wet bulb thermometer. The two were identical except that the wet bulb thermometer had a piece of cloth covering its bulb. The dry bulb thermometer measured the current temperature of the air. The cloth covering the wet bulb was saturated with water by dipping it in water or by wicking the water to the cloth from a reservoir. In the sling psychrometer, those two thermometers were mounted side by side on mount attached to a swiveled handle. The psychrometer was twirled to ventilate them and to expedite the evaporation of water from the cloth. The evaporation caused cooling. The difference in the temperatures of the two thermometers would be used to calculate the dew point and the relative humidity. One type of psychrometer is shown in Figure 20.

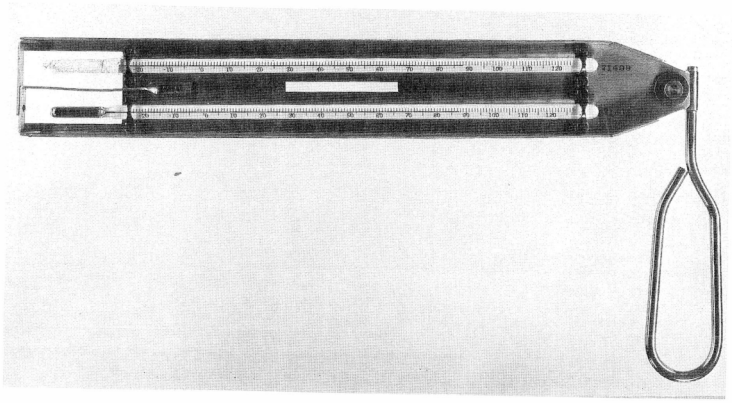


Figure 20. Sling Psychrometer, Wet Bulb above, Dry Bulb Below
Source: National Archives and Records Administration

The dry bulb thermometers used in Helena are listed in Table 6.

Table 6. Dry Bulb Thermometers Used at Helena

	In Use	
Number	**From**	**To**
*85	1 Apr 1880	31 Dec 1883
567	18 Jan 1889	
1810	18 Mar 1889	
*5067	23 Jun 1908	1 May 1912
*2015	1 May 1912	26 Apr 1913
*6827	26 Apr 1913	17 Aug 1915
5382	17 Aug 1915	
*6964		10 Aug 1919
*3563	10 Aug 1919	3 Oct 1919
*4050	3 Oct 1919	23 Mar 1922
*7955	23 Mar 1922	8 Mar 1924
**7954	8 Mar 1924	10 Jan 1927
7931	10 Jan 1927	16 Jul 1928
*8835	16 Jul 1928	2 Aug 1939
8594	2 Aug 1939	18 Mar 1937
*15417	18 Mar 1937	3 Aug 1940
*15370	3 Aug 1940	24 May 1941
*21161	24 May 1941	3 Seep 1941
*21162	3 Seep 1941	18 Apr 1942
*100301	18 Apr 1942	5 May 1942
***100300	5 May 1942	23 Nov 1942
100360	23 Nov 1942	4 Mar 1945
100373	4 Mar 1945	

* Broken
** Destroyed by Fire
*** Range extended only to -20˚

Table 7. Wet Bulb Thermometers Used at Helena

	In Use	
Number	**From**	**To**
995	1 Apr 1880	31 Jan 1885
*1410	31 Jan 1885	13 Mar 1887
1437	14 Mar 1887	30 Jun 1887
1790	1 Jul 1887	20 Dec 1887
*2333	20 Dec 1887	22 Dec 1887
1858	22 Dec 1887	1 Mar 1888
2456	1 Mar 1888	23 Nov 1889
2975	23 Nov 1889	
*4608	1906	26 Mar 1913
3564	26 Mar 1913	14 Aug 1914
6932	14 Aug 1914	21 Feb 1920
*5295	21 Feb 1920	14 Jan 1921
*5906	14 Jan 1921	16 Jul 1928
*8737	16 Jul 1928	3 Aug 1929
*7936	3 Aug 1929	3 May 1940
*15388	3 May 1940	23 Dec 1940
*15439	23 Dec 1940	5 Jun 1943
100348	5 Jun 1943	

* Broken

A whirling psychrometer was placed into use at Helena in September 1887. The dry and wet bulb thermometers were mounted on a device that used gears to whirl them. One type from this period is shown in Figure 21.

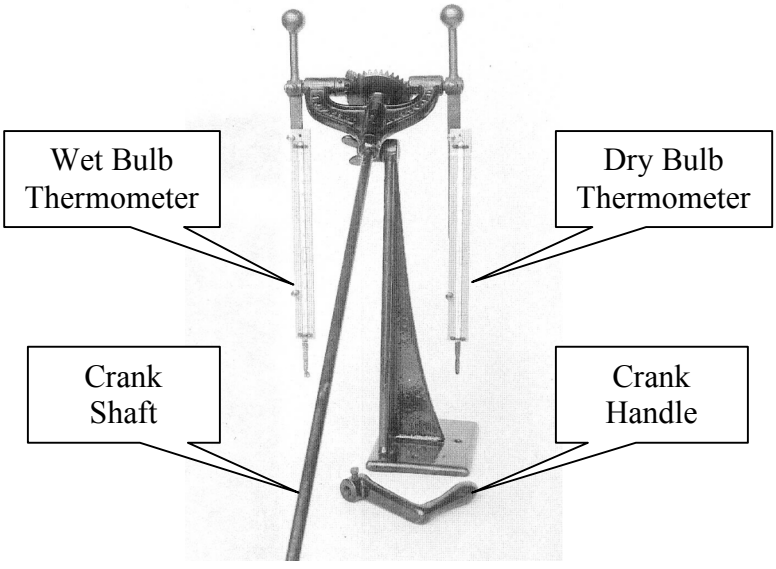


Figure 21. Whirling Psychrometer
Source: National Archives and Records Administration

Rain Gauge

The first precipitation measurements in Helena were made from the Brown Block location in 1881. At first, the top of the rain gauge was at a height of one foot AGL. In 1882, its height was at 29 feet AGL indicating that it was on the rooftop. In 1883, its height was 36 feet AGL indicating a move to another location on the roof, perhaps to the ridge of the roof.

The standard rain gauge has not changed much since it became the standard. An example is shown in Figure 22. The funnel of standard rain gage was placed over the inner cylinder and directed the water into it. The area of the top of the funnel was ten times the area of the top of the inner cylinder. Therefore, an inch of rainfall would stand ten inches deep in the inner cylinder. The measuring stick was magnified (in effect) ten times, to an actual length of twenty inches, and was marked in rainfall inches and hundredths of an inch. The inner cylinder and funnel were placed into the outer cylinder. The outer cylinder caught the overflow when the amount was greater than two inches and could be used to catch snowfall in the winter.

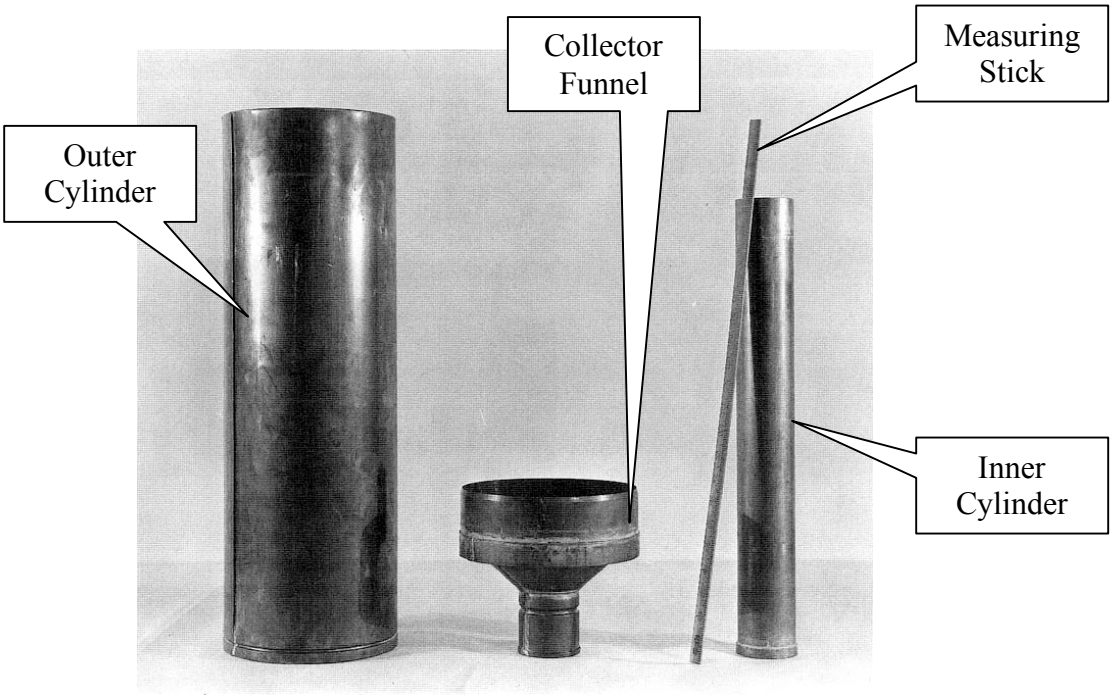


Figure 22. Standard Eight Inch Rain Gauge
Source: National Archives and Records Administration

The rain gauge at the Murphy Building was on the roof at 57 feet AGL in 1884-1886, 53 feet AGL in 1887, and was 51 feet AGL in 1888-1891. In November 1888, the Signal Office in Washington wrote to the observer in Helena with a recommendation that he move the rain and snow gauges from the edge of the roof to the center of the roof.

The rain gauge was mounted on the roof of the Montana National Bank from 1 May 1891 to 1 April 1894 at a height of 75 feet AGL.

On the rooftop of the Power Building, the rain gauge was at 80 feet AGL from 1 April 1894 to 28 September 1904. There was a tipping bucket rain gauge beginning on 18 February 1903.

The rain gauge at the dwelling at 200 Seventh Street was a three feet AGL. It was in the back yard midway between the house and the north fence, about 30 feet north of the house. The top of the gauge was 3 feet AGL. The surrounding trees and buildings were said to have reduced "the sweep of the wind" and the exposure was fairly good.

The return to the Power Block on 26 February 1912 placed the rain gauge at 80 feet AGL and 3 feet above the roof. There was a parapet four feet high about fifteen feet to the east and north. On 17 October 1928, the rain gauge was moved about 32 feet south and west and raised by one foot. On 13 May 1929, the height was changed to 88 feet AGL with the height above the roof unchanged.

On 21 June 1933, the site was moved to the roof of the new wing of the Federal Office Building. The rain and snow gauges were exposed on the southwest corner of a wooden platform on the west side of the new wing of the building according to Maugham. They were about fifteen feet from the nearest obstacle that was a small penthouse about 8 feet high. The rain gauge was at 79 feet AGL and three feet above the roof.

After 30 April 1940, the rain gauges at the airport location included the 8" standard rain gauge and a shielded 8" rain and snow gauge about 74 feet west of the Airport Administration building. All gauges were well exposed except from the east where the building was located. Figure 23 shows observer McKinney using the measuring stick.

Figure 23. Rain Gauges at the Helena Airport Observation Site
Source: Montana Historical Society

Barometer

An aneroid barometer was placed into use in April 1880. It may have been like the Signal Service one shown in Figure 24.

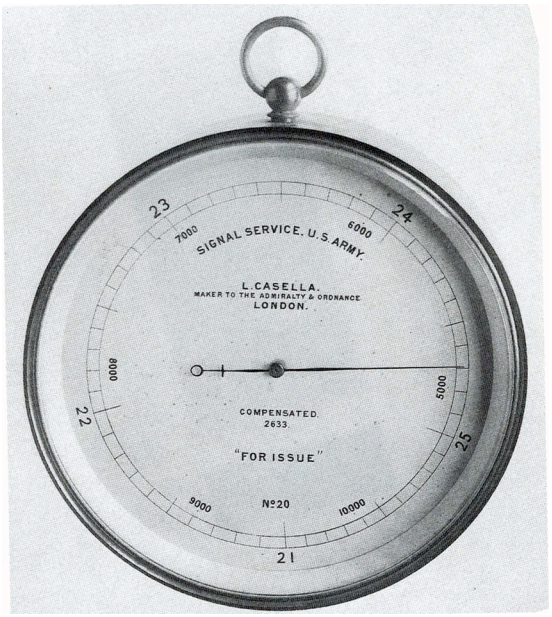


Figure 24. Aneroid Barometer used by the Signal Service
Source: National Archives and Records Administration

Table 8. Aneroid Barometers Used in Helena

	In Use	
Number	**From**	**To**
182	Apr 1880	16 Sep 1883
187	16 Sep 1883	3 Nov 1884
446	3 Nov 1884	5 Jul 1887
365	5 Jul 1887	1 Jan 1889
554	1 Jan 1889	12 Dec 1889
202	12 Dec 1889	1 Oct 1890
518	1 Oct 1890	1 Jan 1894
*452	1 Jan 1894	7 Feb 1894
518	7 Feb 1894	1 Apr 1894
338	1 Apr 1894	1 Dec 1899
518	1 Dec 1899	1 Sep 1900
338	1 Sep 1900	11 Jun1903
396	11 Jun 1903	5 Dec 1911
863	5 Dec 1911	13 Oct 1915
721	13 Oct 1915	1 Jan 1928
1421	1 Jan 1928	

* Rendered Unserviceable

A mercury barometer was also used in Helena. The date of its first use is not known. Neither is its type known but it may have been one like that in Figure 25.

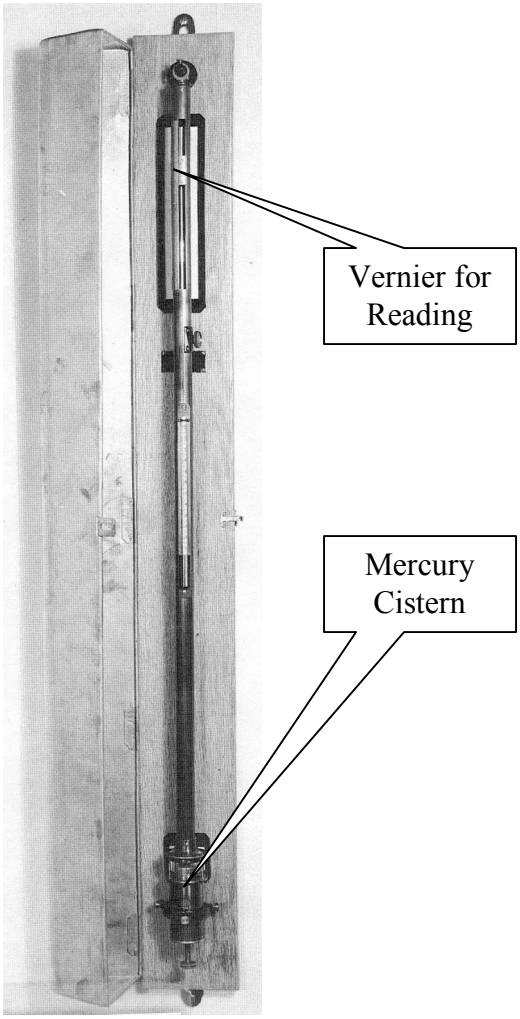


Figure 25. Mercury Barometer
Source: National Archives and Records Administration

Table 9. Mercury Barometers Used at Helena

	In Use	
Number	**From**	**To**
338		27 Nov 1916
567	16 Mar 1935	6 Dec 1925
643	6 Dec 1925	25 Apr 1938
567	25 Apr 1938	

The barometer readings from Jan 1895 to Nov 1899 were 0.048 inch too high. The barometer readings from Jan 1890 to Feb 1894 were 0.026 inch too high. The barometer readings for Mar 1894 were 0.022 inch too high.

Barograph

A barograph # 8820 was replaced by # 437 on 6 March 1931. Date of first use of # 8820 is not known. Number 437 was replaced by number 855 on 1 January 1939.

A barograph was an aneroid barometer that traced the pressure on a graph that was wrapped around a clock-driven cylinder. It may have resembled the one in Figure 26.

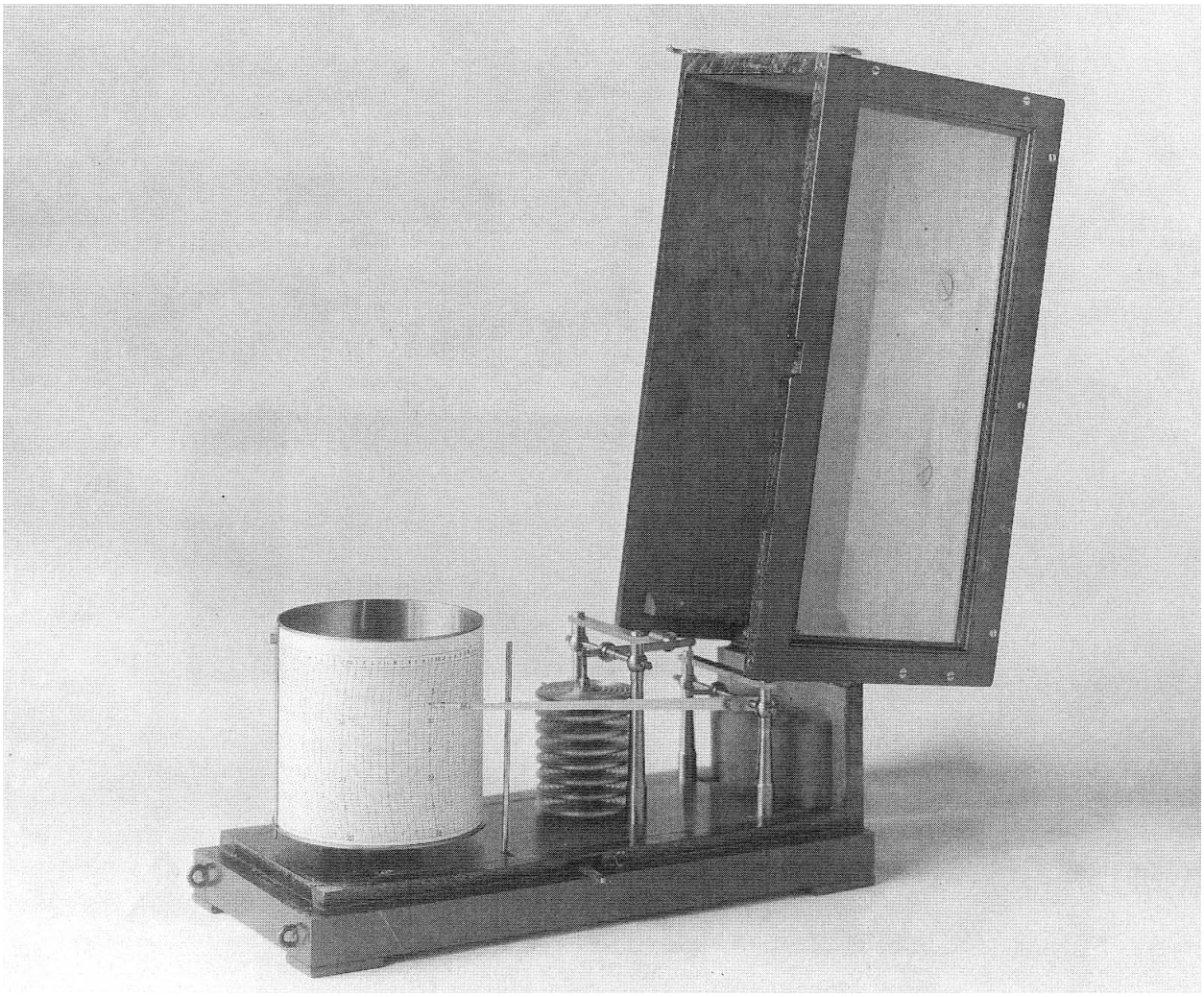


Figure 26. Barograph
Source: National Archives and Records Administration

Shelter

Instruments were housed in a back yard shelter 1 January 1911 to 26 February 1912. The shelter was located over sod and not affected by ventilators. There was a concern recorded in the Climate Record Book that "surrounding buildings probably affect day temperatures to some extent." An example of the shelter that may have been used is shown in Figure 27.

Figure 27. Cotton Region Instrument Shelter of a Type Used in Helena
Source: National Archives and Records Administration

Unfortunately, no photographs of the shelters in the early years were taken. At least, no one focused on the shelter as the object being photographed. Fortunately, they are visible in two photographs taken for other reasons.

The Murphy Building (Figure 11) was an attractive building to the photographer but our attention was drawn to what appears to be an instrument shelter (Figure 28) that can be seen partially hidden from view on the roof.

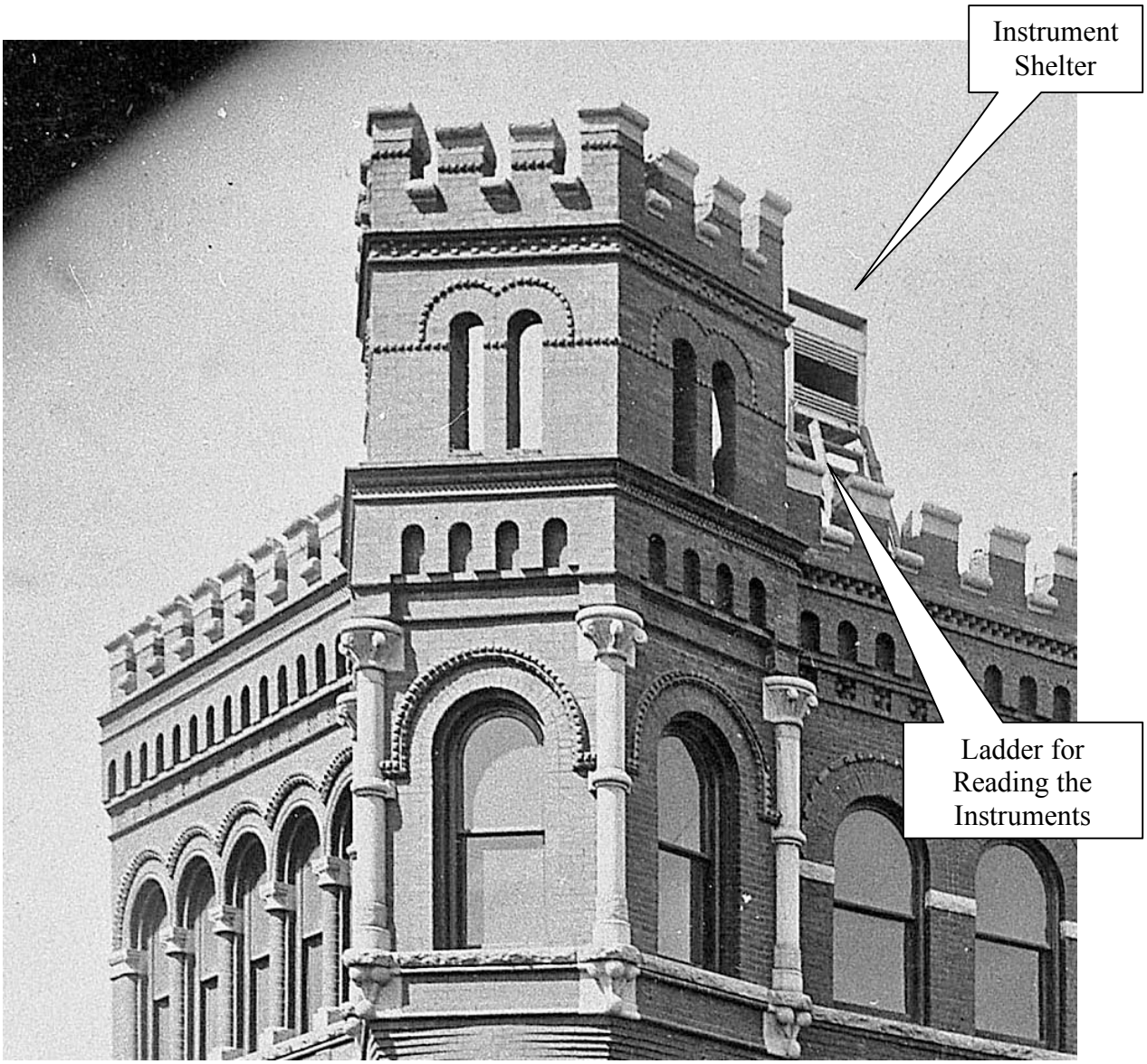
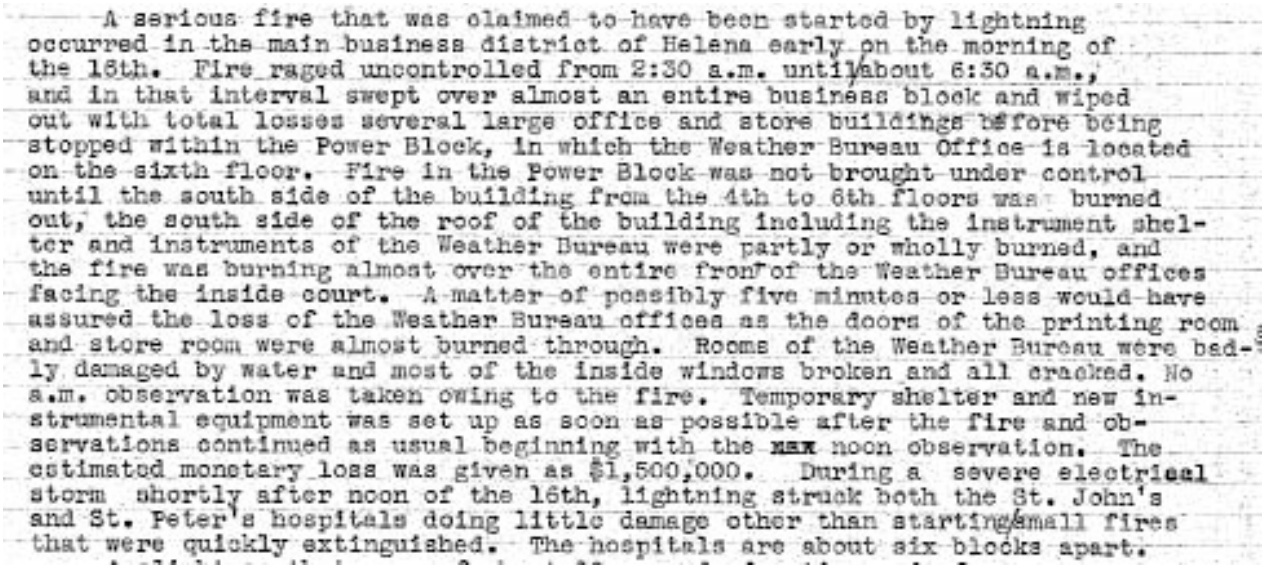


Figure 28. Instrument Shelter atop the Montana State Bank Building
Source: Adapted from Edward Renig's Photograph from Montana State Historical Society

A second shelter was incidentally photographed on the roof of the Power Block. The photo was a wide panorama of Helena and the shelter was tiny in that context. But, it is very distinguishable (Figure 31). That shelter was on the southeast corner of the roof about 28 feet from the nearest ventilator and about 100 feet from the nearest chimney. Neither was considered to have any material affect.

A fire on the roof at 4 a.m. on 16 July 1928 was consuming the roof and instrument shelter at the time of observation. The office was filled with smoke and data for that day are sparse. The incident was reported in the July 1928 Form 1001. The applicable portion is shown in Figure 29. A temporary shelter was erected on the roof the same day. On 16 October 1928, a new shelter was installed about 15 feet from the original location.



A serious fire that was claimed to have been started by lightning occurred in the main business district of Helena early on the morning of the 16th. Fire raged uncontrolled from 2:30 a.m. until about 6:30 a.m., and in that interval swept over almost an entire business block and wiped out with total losses several large office and store buildings before being stopped within the Power Block, in which the Weather Bureau Office is located on the sixth floor. Fire in the Power Block was not brought under control until the south side of the building from the 4th to 6th floors was burned out, the south side of the roof of the building including the instrument shelter and instruments of the Weather Bureau were partly or wholly burned, and the fire was burning almost over the entire front of the Weather Bureau offices facing the inside court. A matter of possibly five minutes or less would have assured the loss of the Weather Bureau offices as the doors of the printing room and store room were almost burned through. Rooms of the Weather Bureau were badly damaged by water and most of the inside windows broken and all cracked. No a.m. observation was taken owing to the fire. Temporary shelter and new instrumental equipment was set up as soon as possible after the fire and observations continued as usual beginning with the max noon observation. The estimated monetary loss was given as $1,500,000. During a severe electrical storm shortly after noon of the 16th, lightning struck both the St. John's and St. Peter's hospitals doing little damage other than starting small fires that were quickly extinguished. The hospitals are about six blocks apart.

Figure 29. Fire Report, July 1928, Form 1001 METL
Source: National Climatic Data Center

A new shelter was on the northwest corner of the roof of the Federal Building mounted on a 29 by 56 foot wooden platform set six inches above the tar and graveled roof. It was about 32 feet north-northwest of the nearest ventilator and 80 feet northwest of the nearest live chimney. The exposure was said to be excellent because of the westerly winds. With a tar and gravel roof below the shelter, the note in he Climatological Record Book that "the temperature readings will not be effected (sic) by the heat of the building" may not have been true.

At the airport in 1940, there was an intentional photograph of the shelter (Figure 30). Rain gauges are also visible in the photograph. That instrument shelter was located about sixty feet due west of the Airport Administration Building. It was said to have no troublesome influence from the nearby building.

Figure 30. Instrument Shelter, Helena Airport, 1940
Source: National Climatic Data Center

Wind Instruments

There was an anemometer on the roof of the Murphy building beginning in 1887. It was 53 feet AGL in 1887, 51 feet AGL in 1888, and 91 feet AGL on 1 January 1891.

The anemometer was mounted on the roof of the Montana National Bank from 1 May 1891 to 1 April 1894 at a height of 91 feet AGL.

The height of the anemometer on the Power Block roof was 93 feet AGL from 1 April 1894 to 6 November 1901. From that date until 28 September 1904 it was at 94 feet AGL. After 6 November 1906, the height was 97 feet AGL.

The anemometer at the dwelling at 200 Seventh Street was at 56 feet AGL. The vane was reported to be on a 50 foot tower, 25 feet or more above the surrounding buildings.

The return to the Power building on 26 February 1912 placed the anemometer was on a tower at 114 feet AGL and 36 feet above the southwest corner of the roof. The height above ground level was changed to 112 feet on 1 November 1916 and to 113 feet on 13 May 1929. No change was made in the height above the roof. Surrounding buildings were thought to have little affect on the readings.

On 9 March 1916, a new ball-bearing wind vane was installed along with suitable electrical contact points. On 28 September 1916, there was a note that the report of installation incorrectly stated the mounting of the instrument when if fact it had been mounted correctly.

On 31 December 1927, a three-cup anemometer # 1421 replaced the four-cup anemometer # 721 that had been in use. There was no change in the exposure of the instruments.

On 1 January 1932, the four-cup anemometer # 437 was installed replacing the three-cup # 1421. The change appears to have been directed from the central office.

On 21 June 1933, the site was moved to the new wing of the Federal Office building. The anemometer was at 111 feet AGL and 38 feet above the roof. The exposure was said to be good except for exposure to easterly winds that were affected by the ridge of the gabled roof of the old wing of the building. The ridge extended 13 feet above the roof on which the instruments were located, 22 feet below the top of the wind instrument tower.

On 27-28 October 1943, the erection of the Air Traffic Control Tower required the anemometer to be moved ten feet from its original position to gain better exposure to winds from the north.

Table 10. Anemometers Used at Helena

	In Use	
Number	**From**	**To**
385	1 Apr 1880	8 Aug 1887
596	8 Aug 1887	22 Aug 1889
584	22 Aug 1889	
*648	1895	1896
*355	1896	1897
*648	1897	1899
*19	1899	1900
*648	1900	1903
*727	1903	1904
396	17 Jun 1903	5 Dec 1911
863	5 Dec 1911	13 Oct 1915
721	13 Oct 1915	3 Dec 1927
1421	1 Jan 1928	1 Jan 1932
**437	1 Jan 1932	18 Jan 1937
833	18 Jan 1937	27 Apr 1937
**759	27 Apr 1937	1 May 1940
***2192-S	1 May 1940	27 May 1940
***1805-S	27 May 1940	26 Dec 1940
***1962-S	17 Jan 1941	24 Nov 1941
***1547-S	9 Dec 1941	

* Uncertain how these anemometers were used or if they were extras
** A three cup anemometer
*** A four cup anemometer

The anemometer can be seen faintly on the roof of the Power Building in another panorama of the city. An enlargement (Figure 31) shows it and the instrument shelter on the roof.

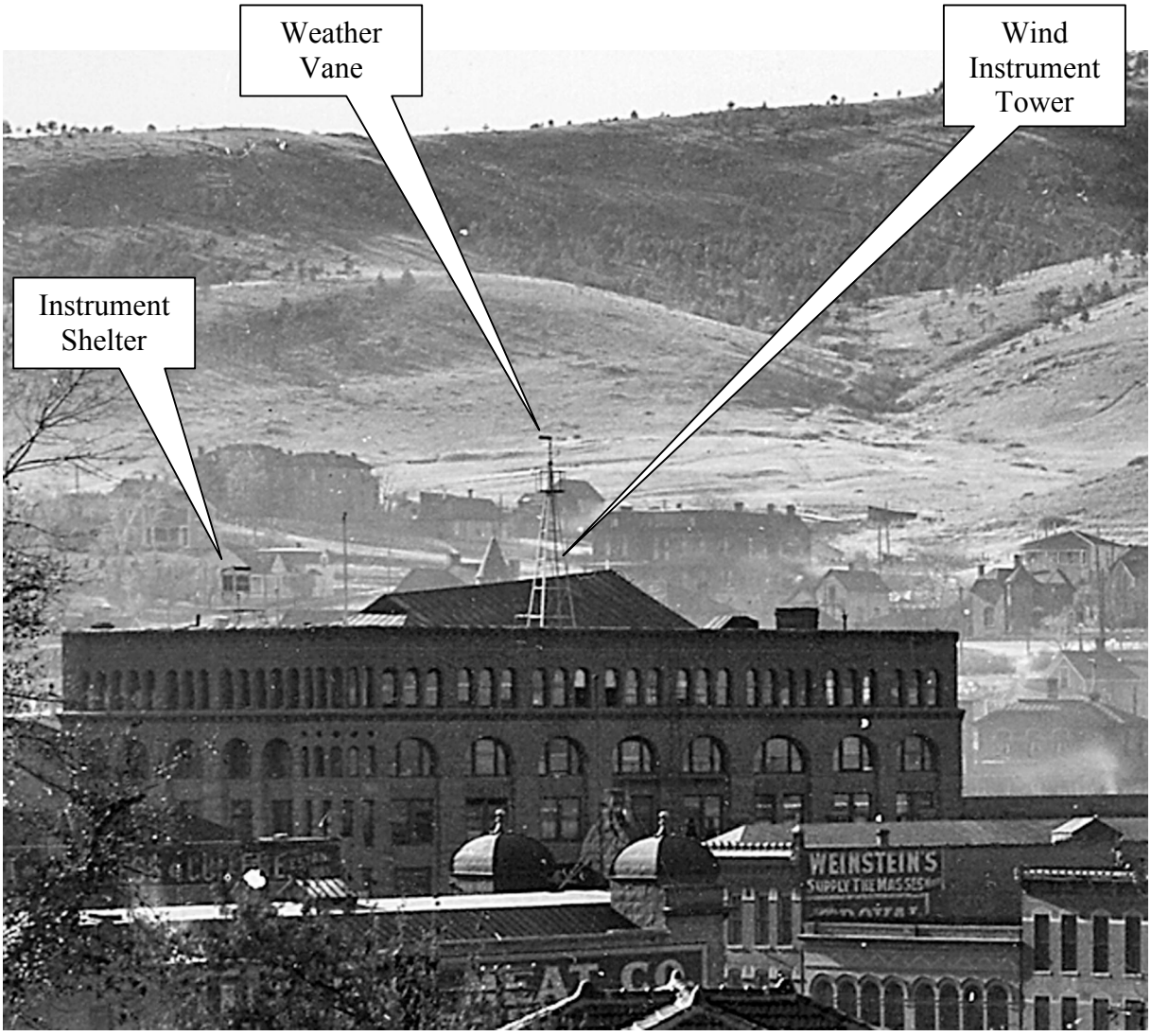


Figure 31. Anemometer and Instrument Shelter, Power Block, 1926
Source: Adapted from a Montana Historical Society Photograph

The towers on the Power Block (Figure 31) and the Federal Building (Figure 17) were similar to the one in Figure 32 from Salt Lake City.

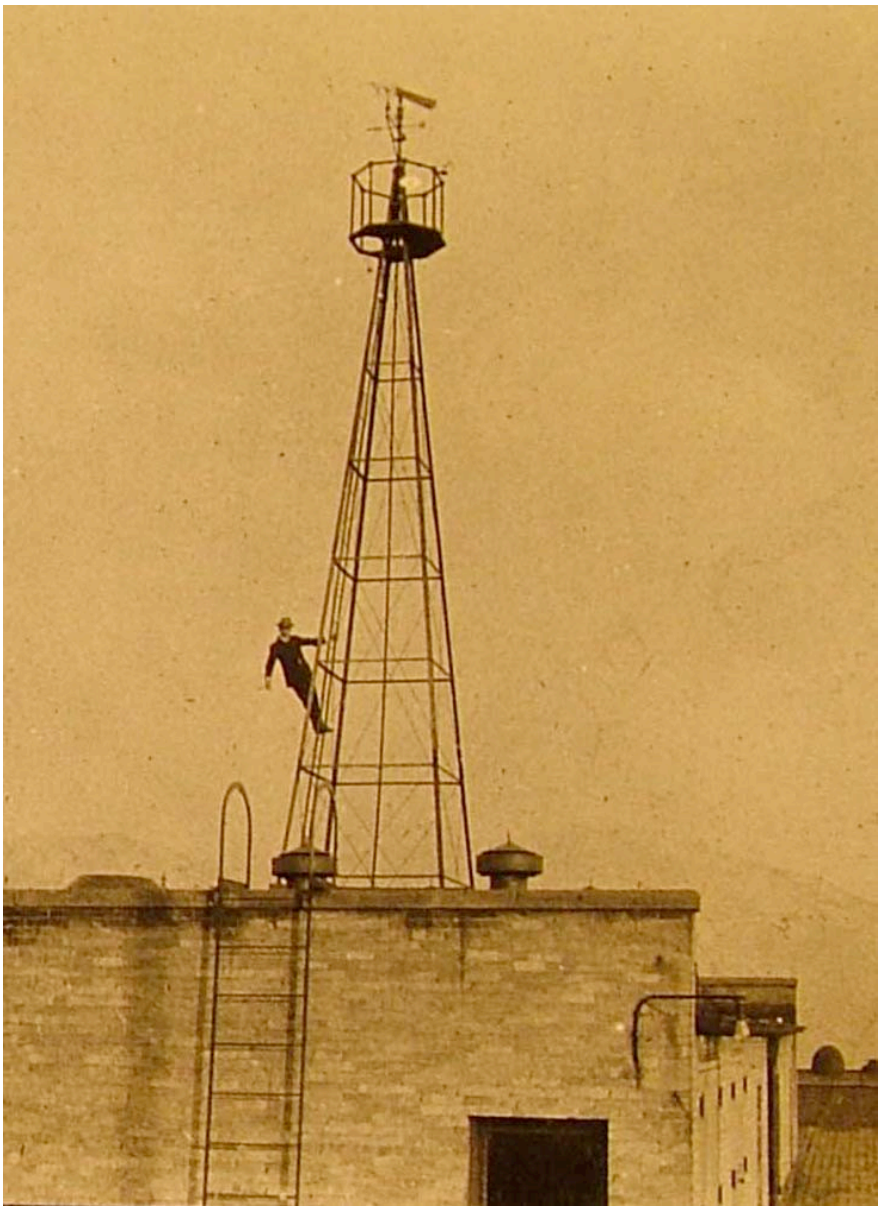


Figure 32. Wind Instrument Tower, Salt Lake City
Source: J. Cecil Alter Album, National Archives and Records Administration

Triple Register

Triple Register number 154 was shipped to the central office on May 25 1916 and was replaced by number 64 on the same day. Number 64 was replaced by number 297 on 20 September 1933.The triple register was one of the primary instruments of the Weather Bureau. It was featured in a display of weather instruments that were posed for a photograph. Observer

Wilbur F. McKinney was shown in Figure 33 with the triple register, anemometer cups, and a clinometer.[5]

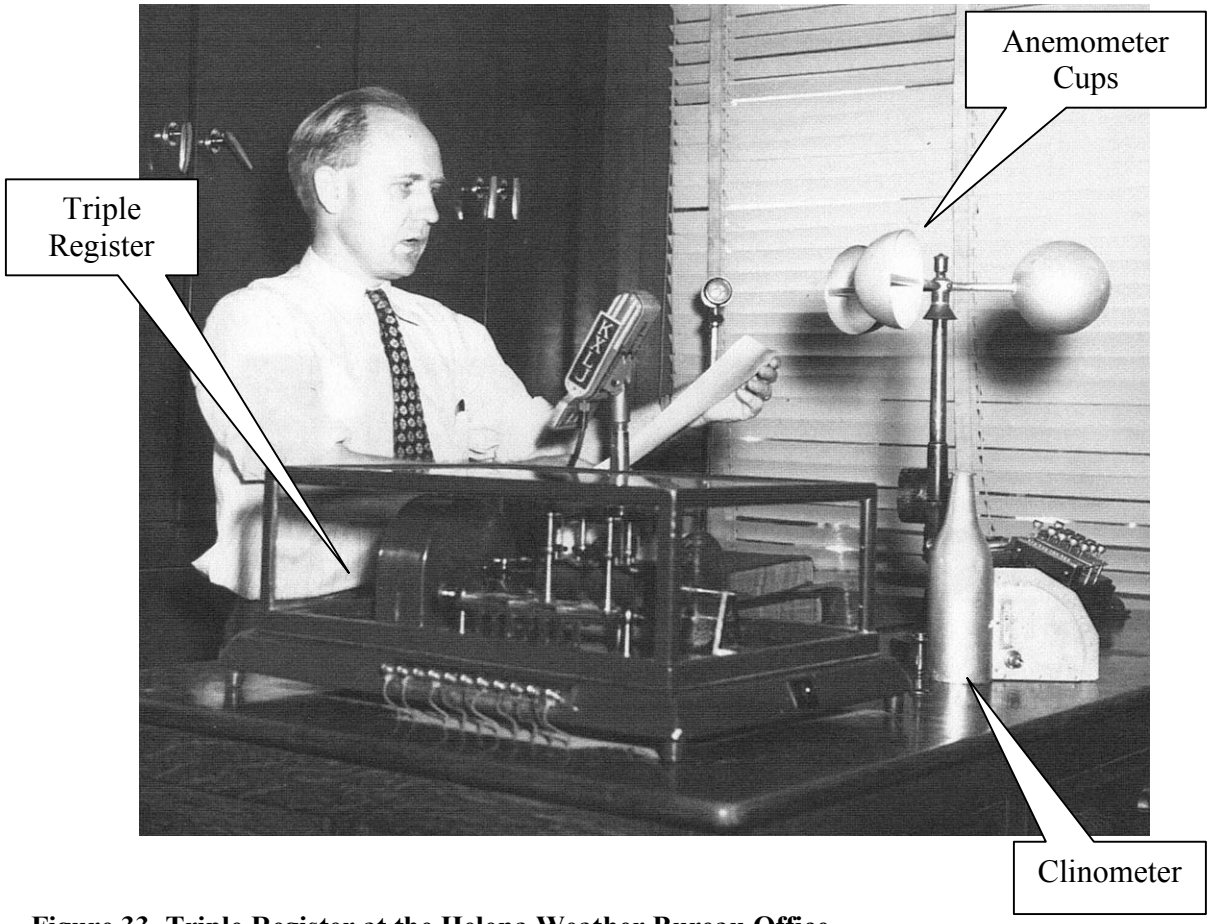


Figure 33. Triple Register at the Helena Weather Bureau Office
Source: Montana Historical Society

The Triple Register (Figure 33) was an electrical device that recorded the direction and velocity of the wind each minute, the amount of rainfall as it fell, and the accumulated hours and minutes of sunshine. The information was recorded by pens on graph paper wrapped around a drum that rotated once per week. The working parts of the Triple Register were made of brass and the unit was covered by a glass case to protect the device from dust. It was quite an impressive part of the meteorologist's equipment.

Wind was measured in two ways. A wind vane that was mounted on the roof determined the wind direction. It swiveled toward the direction from which the wind came. It can be seen in Figures 17. Also mounted on the roof were the anemometer cups (Figure 33). The wind rotated those cups that in turn rotated the shaft to which they were attached. Each time the shaft rotated 500 times, one mile was added to the "total miles run." That total was displayed as miles run on

[5] The clinometer was used in the determination of the height of the bases of clouds

a dial (Figure 34). That is to say, the dial displayed the total number of miles of air that had passed since the anemometer dial was reset. Both the wind direction and the wind speed were electrically connected to the triple register were they were registered on the Triple Register's graph. The difference between the miles run dial and its earlier reading could be divided by the elapsed hours to determine the average wind speed for the period.

Figure 34. Total Miles Run Dial, Western Kentucky University
Source: Author

A tipping bucket rain gage (Figure 35) was mounted on the roof. A funnel directed rainfall into a small "bucket" on one end of a seesaw like device. The seesaw tipped when the bucket filled with one hundredths of an inch of rain. The tipping emptied that bucket and placed the bucket at the other end of the seesaw under the funnel to be filled next. Each time the buckets tipped, an electrical signal marked another 0.01" of rain on the triple register.

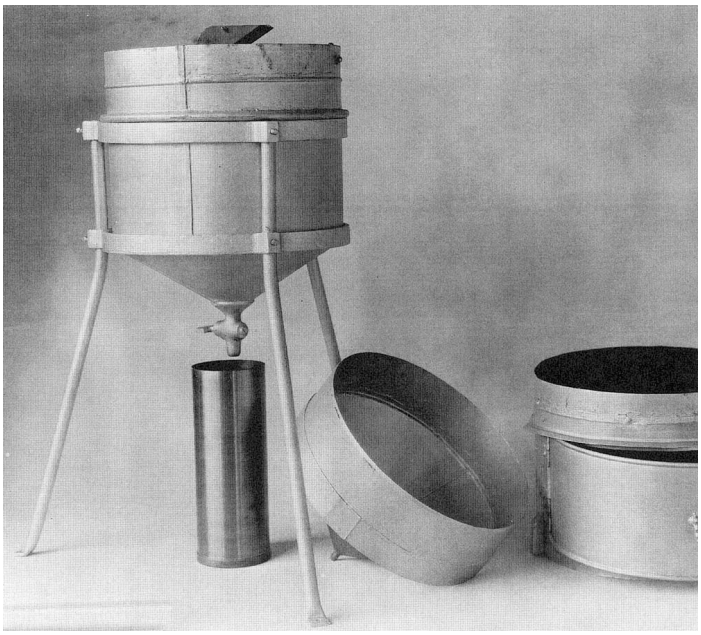


Figure 35. Tipping Bucket Rain Gauge
Source: National Archives and Records Administration

The triple register also recorded sunshine. At Helena, the electrical sunshine recorder was number 368. The sensor was a glass tube with a large bulb at either end (Figure 36). It was normally located on the roof. One end was clear, the other coated with lampblack. The tube was partially filled with mercury. In the middle of the tube were two wires. When exposed to sunshine, the lampblack would absorb solar radiation causing the mercury to expand and cover the ends of the two wires. The electrical circuit between the two wires would be completed. That connection would be recorded on the triple register until cooling (as the sunshine ended) caused the mercury to contract and uncover the two wire ends thus breaking the connection.

Figure 36. Sunshine Recorder, Western Kentucky University
Source: Author

OBSERVERS

The Smithsonian Years

Jan 1868-Apr 1868
Alex Camp Wheaton

The first observations from Helena were made by Alex Camp Wheaton in January 1866. Little information was discovered about him. The 1860 U.S. Census showed him as a 25 year old son living and working with his father on a from in Iowa. He was born in Rhode Island.

The next thread was his submission of his climate report to the Smithsonian. There are few clues about him in those reports.

His last climate observations were made in March 1868. That same year, he completed the plat map of the city of Helena. He showed terrain features on the map by the use of hachures. A note on the map stated that the survey was made in 1868 and provided some information about him.

> A. C. Wheaton being duly sworn says that he is a Civil Engineer by profession, that he surveyed the North West one fourth (1/4th) fractional, of Section 31 and the Southwest on (with ¼) of the South West one fourth (1/4) fractional of Section 30, Township Ten (10) North of Range Three (3) West and the East one half (1/2) of the North East one fourth (1/4) of section 36 and the South East one fourth (1/4) of the South East one fourth (1/40 of Section 25, Township Ten (10) North if Range Four (4) West at the request of M… F. Truett Probate[6] of Lewis and Clark Co. M. T. and the same applied for by said Truett as the town Site of Helena, that the Diagram attached is a true and correct plat of said town site with the blocks, lots, and streets and alley of the town as now located.

The carefully written entries on the Smithsonian forms and the labeling on the plat map appeared to be from the same hand. Although the meager information about him provides little insight to his life, he had been accepted as a Smithsonian observer. He had both the Smithsonian observation forms and a thermometer. Neither was common in the Montana Territory in 1866.

The Smithsonian Institution, headed by Joseph Henry, was created in 1846 and immediately began establishing a climate observation network. Professor Henry envisioned three types of observers; those without instruments who would observe the sky, extent of clouds, wind, and beginning and ending time precipitation. A second group would do that too but would also be equipped with thermometers. The third group would be equipped with a complete set of instruments to observe all of those and would also observe pressure, humidity, wind direction and wind speed — among others.

In 1847, the Smithsonian became the climate data collection agency for the U.S. Department of Agriculture. To create the Smithsonian network, Joseph Henry sent circulars to

[6] He was the Probate Judge of the County

individuals who were already making observations. James H. Coffin, a professor of mathematics and natural philosophy at Lafayette College in Easton, Pennsylvania provided such a list of observers. Professor Coffin had been collecting weather reports for several years from independent observers. By 1854, the Smithsonian had observers reporting from thirty-one states and was receiving real time observations by telegraph from some of them. In 1856, Professor Henry contracted with Professor Coffin to receive, analyze, and archive the information reported by the Smithsonian observers. Afterward, he received as many as half-a-million separate weather observations each year. He had up to fifteen people to make the necessary arithmetic calculations — human computers so to speak. In 1861, Professor Coffin published the first of a two-volume compilation of climatic data. The second was for storm observations for the years 1854 through 1859.

Gap in the Record
May 1868—Mar 1880

So far as is known, there were no observations made in Helena for the period between Wheaton's submissions to the Smithsonian and the arrival of the U. S. Signal Service in April 1880.

The Signal Service Years

Wisconsin Congressman Halbert E. Paine took action on an idea for a national service to collect and distribute weather information. He convinced Colonel Albert J. Myer, Chief of the Signal Corps that the Army was the proper place for that new service. Congressman Paine's resolution required the Secretary of War to "to provide for taking meteorological observations at the military stations in the interior of the continent and at other points in the States and Territories...and for giving notice on the northern (Great) lakes and on the seacoast by magnetic telegraph and marine signals, of the approach and force of storms." The resolution passed the Congress and President Ulysses S. Grant signed it into law on February 9, 1870.

The new function was given to the Signal Corps' because of its telegraph network. The newly promoted Brevet Brigadier General Albert J. Myer was placed in charge. On November 1, 1870, the initial weather network of twenty-four stations telegraphically transmitted their first reports at 7:35 a.m. to the central office in Washington. That Signal Service network would eventually evolve to become the Weather Bureau and later the National Weather Service.

The commissioned officers detailed to the Signal Service received instruction from leading meteorologists. A school of meteorology was created at Fort Myer (then Fort Whipple), in Virginia to train Observer Sergeants. That training included courses in military tactics, signaling, telegraphy, telegraphic line construction, and electricity. Most important were the courses in meteorology and the practical work in taking meteorological measurements. Training for commissioned officers was added to the school covering meteorology, mathematics, and electricity in 1882. The school continued until 1886.

Apr 1880- May 1882
Pvt. Napoleon C. Smith

Private Napoleon C. Smith opened the Signal Service Office on 15 October 1879 and began weather observations on 1 April 1880 in Helena. The U. S. Census of that year identified him as a 24 year old "telegraphist" who had been born in Pennsylvania. The inspection of the site in September 1880 reported that he was "highly spoken of."

He was not the only telegrapher in Helena. Stout records that telegraph lines had been extended to Helena on 14 October 1867. By the time Pvt. Smith arrived the Western Union had been there for at least twelve years. Their office in 1868 was located on Main Street.

In February 1881, he was promoted to Sergeant. Private Frank Burke arrived from Fort Missoula in October to become the second assistant, the first being Pvt. Sherwood Wheaton.[7] In December, Burke wrote to his mother about his new assignment.

> The government furnishes us quarters and we board at one of the hotels… Weather reporting is of but minor importance at this station. Telegraphing is the principal and most important work. I have now become quite an operator and will have a splendid chance for improvements at Helena…In the same building[8] as the Signal Office are the Quartermaster, Paymaster, Attorney General, and Commissary Offices…"

Burke's July 1882 letter to his mother told of another responsibility of the telegrapher.

> The troops are all out in the field and their movements and orders entail a great deal of the telegraphing. This in connection with our meteorological work keeps us rather busy… [The paymaster] always travels under a heavy escort of cavalry and it is necessary that an operator accompany it to report its arrival at the various points on the road. This is the occasion of most of the long rides I referred to.

Burke would later become head of the Kentucky Section of the Weather Bureau located in Louisville, Kentucky. A February 1898 newspaper clipping contained his obituary and described his reason for having been in Montana.

> … he secured an appointment as a cadet to the Fort Meyer academy[9] at Washington and entered the weather department of the United States signal service, then connected with the army. After two years of study and special training in that kind of work, he

[7] The relationship, in any, to Alex Camp Wheaton could not be determined
[8] That would have been the Brown Building
[9] That was the Signal Service's meteorology school at Fort Whipple in Virginia

> volunteered to accompany the "Greeley" expedition[10], and was sent to north Montana to become accustomed to the severe winter weather …

Jun 1882-Aug 1882
Pvt. Sherwood Wheaton

Pvt. Sherwood Wheaton made the observations from June 1882 through August 1882. Sep 1882. Perhaps he substituted from Sgt Smith during a leave of absence for these three months. Wheaton was an assistant observer with Sgt Smith.

According to the Great Falls News Association insert for 29 March 1937, Sherwood Smith was a telegraph operator with Western Union in 1883 and would later become an insurance man and a county commissioner of Lewis and Clark County. The City Directory for 1886-1887 listed him as a telegraph operator with Western Union.

Wheaton was identified by Raleigh as the third president of the Helena Business Men's Association.

Sep 1882
Sgt Napoleon C. Smith

Sgt Napoleon C. Smith resumed his duties as official in charge in September 1882 and continued until the end of 1883.

Jan 1884
Pvt. Samuel W. Morrison

Pvt. Samuel W. Morrison replaced Sgt Smith as the Signal Service observer in Helena. His first observation began on 1 January 1884.

Sep 1884
Sgt A. L. Mathews

Sgt A. L. Matthews began observations in Helena on 1 September 1884 and continued for about fifteen months.

Dec 1885
Sgt B. O. Lenoir

Sgt B. O. Lenoir became the official in charge in December 1885. His observations continued for about nineteen months.

[10] The ill-fated Greeley expedition was to the Arctic

Jul 1887
Pvt. Charles L. Trotter

Pvt. Charles L. Trotter observed the weather during the July though October 1887 period.

Nov 1887
Pvt. Everett C. Hobbs

Pvt. Everett C. Hobbs replaced Pvt. Trotter in November 1887. He was the official in charge for fourteen months until Sgt Butler arrived. In August 1891, the newspaper reported that he had been elected as a First Lieutenant in the Montana National Guard.

Jan 1889
Sgt C. E. Butler

Sgt C. E. Butler assumed the role of official in charge on 1 January 1889.

Sep-Oct 1889
Pvt. Everett C. Hobbs

Pvt. Hobbs apparently substituted for Sgt Butler during his two-month absence. That indicates that Pvt. Hobbs had been there throughout Sgt Butler's reign.

Nov 1889
Sgt C. E. Butler

Sgt. Butler returned to duty in November 1889.

Apr 1890
Pvt. Everett C. Hobbs

Pvt. Hobbs replaced Sgt Butler again, his third time as official in charge. This time he would be promoted. The 1891 City Directory listed him as "Sergt. Everett C. Hobbs, Observer U. S. Signal Service."

The Weather Bureau Years

The degree of autonomy the Signal Service developed was the cause of considerable discontent within the Army. One view was that it should be essentially autonomous, like the Corps of Engineers. Others saw that, should its military services ever be needed, its personnel could not be spared from their weather duties.

The discontent led in 1889 to President Benjamin Harrison's recommendation for the transfer of the weather service to the Department of Agriculture. Congress enacted the transfer on October 1, 1890 placing the weather service under the Department of Agriculture.

According to the new law:

> ...the enlisted force of the Signal Service, excepting those hereinafter provided for shall be honorably discharged from the Army on June 30, 1891, and such portion of this entire force, including civilian employees of the Weather Bureau shall, if they so elect be transferred to the Department of Agriculture...

After twenty years, the work of the Signal Corps' weather functions ended. On 1 July 1891, the weather stations, telegraph lines, apparatus, and personnel (who chose to do so) were transferred from its Signal Service to the Department of Agriculture and their newly formed Weather Bureau. One of those who made the choice to transfer was Pvt. Hobbs.

Aug 1891
Everett C. Hobbs

Everett C. Hobbs signed the August 1891 report and wrote “Weather Bureau” beneath his signature. He thus became the first Weather Bureau official in Helena. However, he was replaced after two months.

Oct 1891-Oct 1893
E. J. Glass

Elvin J. Glass arrived in Helena in October 1891 to take charge of that Weather Bureau Station. He organized the Montana Section of the Weather Bureau and was given the title of Section Director. He was born in Corvallis, Oregon and graduated from the Agricultural College there in 1878 with a B. S. Degree. He taught for three years before joining the Signal Service of the U.S. Army’s Signal Corps on 22 January 1882. He attended their meteorology school at Fort Meyer, Virginia. He served as an Observer Sergeant at several locations before the creation of the Weather Bureau. He moved to Helena from his previous assignment at Cairo, Illinois.

Like many of the Weather Bureau members, he published articles in professional journals. For example, his article on snowfall and flood crests in the Colorado appeared in a 1923 issue of the Monthly Weather Review. He retired in October 1927 and died February 28, 1935, at the age of 77.

Nov 1893-Sep 1994
J. M. Sherier

Julius M. Sherier was the Section Director at Helena from November 1893 through September 1994. He entered the Signal Service on November 2, 1886, at Fort Myer, Virginia and attended its meteorology school. After completion of that school, he worked in the Central Office and served in several stations across the country before coming to Helena. He retired after 51 years of service on 31 July 1937 and died in Denver, Colorado on 16 June 1946.

Oct 1894-Aug 1895
R. M. Crawford

Robert M. Crawford was the Section Director at Helena beginning in October 1894. He served in that capacity through August 1897 except for two brief periods when Elvin J. Glass substituted for him.

Sep 1895-Dec 1895
E. J. Glass

Elvin J. Glass substituted to Crawford for the four months September through December 1895.

Jan 1896-May 1897
R. M. Crawford

Robert M. Crawford resumed his duties for three months June through August 1897.

Jun-Aug 1897
E. J. Glass

Elvin J. Glass again served temporarily from September 1897 through June 1898.

Sep 1897-Jun1898
J. Warren Smith

J. Warren Smith was the Montana Section Director for the Weather Bureau from September 1897 through June 1898. He was born at Grafton, New Hampshire on 21 September 1863. He enlisted in the Signal Corps' Signal Service on 6 October 1888. After his tour at Helena, he was assigned to other Signal Service stations before being placed in charge of the Division of Agricultural Meteorology in the Central Office in Washington. There he did research in agricultural meteorology and became recognized as one of the foremost authorities on the relation between weather and crops. He published dozens of articles in the Monthly Weather Review on agricultural meteorology during the period from 1914 through 1923. He also published a textbook on Agricultural Meteorology in 1920. He retired on 6 June 1923.

Jul 1898-Jul 1902
E. J. Glass

Elvin J. Glass again became the Section Director in July 1898 and continued in that capacity through July 1902.

Aug 1902-Feb 1904
Montrose W. Hayes

Montrose W. Hayes was the Montana Section Director from August 1902 through February 1904. He was born at Charlotte, North Carolina on 21 November 1874 and joined the Weather Bureau as an observer on 26 March 1892. He came to Helena when he returned from Havana, Cuba where he worked in the Havana weather office during the occupation after the Spanish-American War.

His tenure at Helena ended when he was selected to go to Argentina to assist their National Meteorological Service in organizing a weather forecasting service for that country. He worked there for the next two years.

After assignments at several stations, he was assigned as Chief of the River and Flood Division in Washington in 1929. After seven years in that position, he died on 16 November 1936.

Mar 1904-Jun 1905
R. F. Young

R. Frank Young replaced Montrose W. Hayes in March 1904 as the Section Director at Helena. He was listed as the Montana Section Director in the City Directory of 1904. With the exception of short absences, he would continue in that capacity through April 1915.

Jul 1905
E. S. Nichols

Esek S. Nichols was the Temporary Section Director in July 1905 during Young's absence. He was born in Caledonia, Wisconsin on 4 October 1874. He entered the Weather Bureau as an assistant at Seattle on 25 February 1899 and was serving as assistant at Helena in July 1905. Later in his career, he published an impressive number of articles in the Monthly Weather Review. Among them was his "Climate of San Jose" in 1923, He retired on 30 April 1939 and died at Brattleboro, Vermont on 26 July1941.

Aug 1905- Jul 1909
R. F. Young

R. Frank Young resumed his duties in August 1905. In the 1910 Census was a 22 year old born in Indiana and was listed as the Section Director, Weather Bureau in Helena.

Aug 1909
A. L. Bruckway

A. L. Bruckway was temporarily in charge during Young's absence during August 1909.

Sep 1909- Sep 1913
R. F. Young

R. Frank Young resumed his work in September 1909.

Oct 1913
G. K. Greening Jr

G. K. Greening was temporarily in charge during Young's absence in October 1913.

Nov 1913-Apr 1915
R. F. Young

R. Frank Young resumed his work in November 1913. He was reassigned to the Weather Bureau Office in Dayton Ohio. There he published an article on "Relation of Precipitation to Stream Flow in Montana" in 1916.

May 1915- Jun 1915
G. K. Greening Jr.

G. K. Greening Jr. was temporarily in charge during May and June 1915 after Young was transferred. He would subsequently present a paper "Climatic Conditions in the Louisiana Purchase as Found by Lewis and Clark in 1894 and 1895." He was with the Weather Bureau in Sioux City, Iowa at that time.

Jul 1915-Mar 1917
H. F. Alps

Henry F. Alps was the Section Director at Helena from June 1913 through March 1917 and was listed as such in the City Directory in 1917. He was in the Weather Bureau in Reno when he published "Foot-Layer Densities of Snow" in a 1922 issue of the Monthly Weather Review.

Apr 1917-Nov 1918
William A. Mitchell

William A. Mitchell became the Section Director in April 1917 and served through November 1918 after which he transferred to Lexington, Kentucky. He was born in Zebulon, Georgia on 28 January 1872. He entered the Weather Bureau on 13 July 1898 as assistant at Jacksonville, Florida. He was later in charge of the stations at Shreveport, Birmingham, Macon, Helena, Lexington, and Savannah. He retired on 31 January 1942.

Dec 1918-Apr 1928
W. T. Lathrop

William T. Lathrop became the Official In Charge at Helena in December 1918 having just finished a tour with the Signal Corps in the Army from June to November of that year. He was

born at Newport, Kentucky on 20 June 1878. He became an observer at the Weather Bureau in Galveston, Texas on 9 August 1899. Before arriving at Helena, he had been the official in charge at Port of Spain, Curacao, and Santiago de Cuba, West Indies; Williston; and Greenville, North Carolina. He retired on 31 March 1943.

May 1928-Mar 1932
Al Brand

Albert Brand was the Official in Charge at Helena from May 1928 until he retired on 31 March 1933. He was born at Fond du Lac, Wisconsin on 12 March 1863. He served in the Regular Army from 4 August 1884, to 3 August 1889; enlisted in the Signal Corps on 6 August 1889. He transferred from Evansville, Indiana on 3 April 1928 to Helena. He died 27 June 1934.

Apr 1933 -May1943
William E. Maughan

William E. Maughan assumed the role of Official in Charge at Helena in April 1933. He had a variety of interests. He published "Climatic Conditions of the State of Montana" in 1933.

Severe earthquakes in Helena on 12,October 1935 brought a new instrument to the Weather Bureau Office in the Federal Building. A strong motion seismograph was provided by the U.S. Coast and Geodetic Survey and placed in the basement and wired to the offices on the top floor of the building. According to the Helena Independent on 15 November 1935, Maughan received three days of training on the instrument. He discovered that the rumors would spread about his abilities in forecasting earthquakes.

> W. E. Maughan, meteorologist at the Helena weather bureau, branded as false a rumor that he had predicted shocks at 2, 4 and 7 o'clock. Although shocks were felt at approximately those hours, the official said he would not claim any credit, and explained that the weather bureau never makes such a forecast. He asserted no one could predict an earthquake. (Helena Independent, 13 October 1935)

There were additional earthquakes on 18, 19 and 31 October and on 28 November. He soon found that routine reports about earthquakes were required in addition to those he made about the weather.

> A file of all newspaper clippings concerning the "week of tremors" are being kept by W. E. Maughan, meteorologist at the Helena Weather bureau, for submission to weather officials at Washington D. C. The clippings were in good shape following the Friday night shaker, despite the fact that a bust of Julius Caesar had fallen from a cabinet and pinned them to a desk. (Helena Independent, 20 October 1935)

Jun 1943- Sep 1946
Andrew D. Robb

Andrew D. Robb became the Meteorologist in Charge at Helena in June 1943. He had published several articles in the Monthly Weather Review while in Kansas prior to his transfer to Montana. The subjects were varied but included precipitation studies, reports on a hailstorm, and the relation of rose culture to weather.

Oct 1946-Apr 1947
Wilbur F. McKinney, Temporarily in Charge

Wilbur F. McKinney (Figure 33) was temporarily placed in charge in October 1946. He served in that capacity through April 1947. He was born in Missouri in 1908 but grew up in Colorado. He first worked for the Weather Bureau in 1929 at Grand Junction, Colorado. He received his degree from the University of Colorado in 1936.

He transferred to the Weather Bureau office in Helena to pursue his interest in climatology. He became the State Climatologist for Montana and supervised the statewide network of observation stations and their measurement of rainfall. He retired in 1958. Afterward, he wrote a column for the Montana Citizen for seven years. He also worked as a volunteer with the photo archivist at the Montana Historical Society beginning in 1975.

May 1947- Dec 1948 (end of this study period)
R. A. Dightman

R. A. Dightman became the Meteorologist in Charge at Helena in May 1947. He was still in that capacity at the end of the period for this study in December 1948. He remained in charge for a number of years after that. He published several articles in Monthly Weather Review on Montana weather events as well as one on “Recent Montana Glacier and Climate Trends’ in 1952. He also published the “Historical and Climatological Study of Grinnell Glacier, Montana” in 1967. Another of his publications was an article in Weatherwise in 1963, “-70F in Montana,“ a record lowest temperature in Montana.

OBSERVATIONS

Smithsonian Observations

The first observation from Helena was entered on the Smithsonian Institution Form. The form was illustrative of their primary purpose of research by the number and variety of entries. The only instrumental data on the form were the temperature and the precipitation. One instrument was a thermometer that was read three times each day: at 7 a.m., 2 p.m. and 9 p.m. Precipitation (rain or snow) was measured in a rain gauge and entered with the beginning and ending times of the precipitation event that produced it. Other entries on the form were made by subjective observations. Cloud data were entered three times per day and included cloud type, amount of sky coverage, and direction of cloud movement in cardinal headings. The wind was entered three times per day as well. It too was subjective with the wind direction being that from which the wind blew and wind speeds estimated and recorded by a force number provided on the bottom of the form (Figure 2). Half of the back of the form was available for remarks about a wide variety of topics about which the Smithsonian desired comments. Those included such disparate topics as auroras, meteors, well water temperature, and so forth.

Signal Service Observations

After a gap in the record from 1868 through 1879, observations continued with the Signal Service managing the network.

The first Signal Service observations at Helena were recorded on the Signal Service's Form 22 in April 1880 (Figure 3). The form consisted of four pages. The first page had columns readings of the barometer and the thermometer. The catch was that there had to be barometer readings made at 7:35 a.m., 4:35 p.m., and 11:00 p.m. Washington Mean Time as well as 7:35 a.m., 4:35 p.m., and 11:00 p.m. Local Time. Washington Mean Time was sun time at the 75th meridian. Local Time was sun time[11] at Helena because standard time zones were not yet adopted. These two requirements were fulfilled by the Helena observer reading the aneroid barometer six times each day, at 5:07 a.m. 7:35 a.m., 2:07p.m., 4:35 p.m., 8:32 p.m., and 11:00 p.m. Quite a full day when only one person was available to make the observations.

Temperature and wind direction were recorded on the second page of the Form 22 only at the three Washington Mean times. The total miles run[12] of the wind was recorded once each day. Other rain-wind data were on this page. The third page had climatological data for the month and the fourth page served as the postal address when properly folded.

In March 1881, a new version of Form 22 was placed into use at Helena. The requirement for observations using Washington Mean Time was removed. The new observation times for temperature were A.M., P. M., and Midnight. There were also columns for the daily maximum and minimum temperature. The climatological data were entered in spaces provided at the bottom of the form. The entries for the barometer were made on the reverse side of the form.

[11] Time measured by a sun dial for example
[12] On 1 April 1880, 139 miles of air passed for an average of 5.59 mph

At many Signal Service stations, local publicity was sought and gained by press releases, feature stories, or tables of daily and weekly weather data. The Helena office seems to have been an exception. None of these items were found in the local newspaper of the period.

In September 1881 a new Form 113 was used. It was a six-page form and it resumed the information reported in 1880 but with new times at 7 a.m., 3 p.m., and 11 p.m. using both Washington Mean Time and Local Time. That meant observations had to be made six times each day at 4:32 a.m., 7 a.m., 12:32 p.m., 3 p.m., 8:32 p.m., and 11 p.m. local times. The new form added three times per day reports on clouds, both upper and lower, with their amount in tenths of coverage, their type, their direction, and their estimated velocity. The six pages consisted of four pages of data, one page of climatological summary and one page for the mailing address.

In August 1885, a new form was placed into use in Helena. It was Form 113a printed in 1884. It was a twelve-page form. It maintained the six times per day readings and expanded the information being reported.

Form 113a dated 1887 was used in September 1887. The form included a full page of instructions for making the observations, entering the data, and calculations of means. Columns were included for the whirling psychrometer data. Like its predecessor, it was a twelve-page form.

Forms 131 and 113 were combined in January1899.

Form 1001 Met'l was used in Jan 1891 and for many years afterward. It was an eight-page form that included one page of instructions.

Weather Bureau Observations

The Weather Bureau continued using the Signal Service form as Weather Bureau Form 1001 when they took over. By 1948 the form had grown to become a 20-page document for each month's data. It had evolved into an aviation-oriented document with data about ceilings, visibilities, and data from hourly observations.

The Digital Record

The observations from Helena have been converted to digital form. The identification number for Helena is 244055. Contact the State Climatologist for Montana, the Western Regional Climate Center, or the National Climate Center for those data.

CLIMATOLOGY

The weather data collected at Helena was summarized in publications about Montana's climate. As early as 1868, climate was included in a business directory of Helena that was published by the Herald. It recognized and rationalized the winters in Montana.

> True, she is not an Italy or California; but her climatic condition is no more objectionable than that of Illinois, Wisconsin, Michigan, Minnesota, or any other Northern State.

The concern about energy consumption was the motivation for a study by Brehrer in 1980. Its compilation of Montana Weather was included in her handbook intended for use in calculating energy usage for heating and cooling.

Joseph M. Caprio was the State Climatologist for Montana. His "Climate Atlas of Montana" was a true state atlas. Various climatic elements were presented using choropleth maps. It also contained tables for the normal climate that were calculated from the 1951-1980 period and for the extremes from the 1951-1990 period.

APPENDIX 1

Methodology

The primary sources of information for this study were the Helena's observers' daily weather records themselves. Copies of their monthly reports were available from the National Climatic Data Center in Asheville, North Carolina. The monthly reports can be considered original sources because they were written by the observers and not altered by subsequent readers. Data digitized from those reports were available from the Western Regional Climate Center in Reno, Nevada.

There were a variety of secondary sources that held information about Helena, its history, and its people. The author visited and collected information from the holdings of the National Climatic Data Center at Asheville, North Carolina; Lewis and Clark County Public Library, the Montana Historical Society Library and the Montana State Library in Helena, Montana; the National Archives and Records Administration in College Park, Maryland, the Smithsonian Institution Archives in Washington D.C., and the Western Kentucky University Library in Bowling Green, Kentucky.

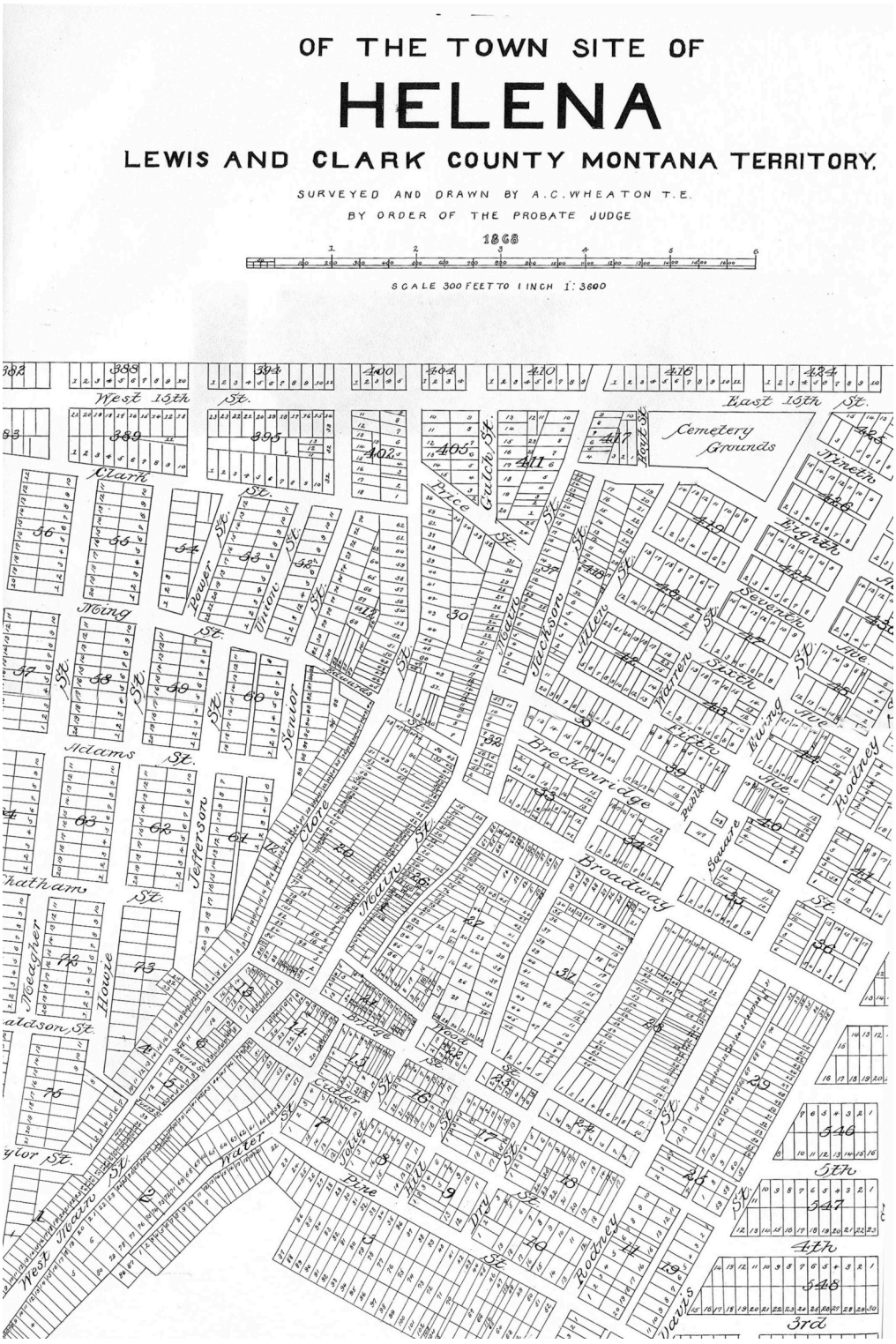
The tertiary sources were reference materials that are available on-line. Among those were the metadata that had been published by the National Weather Service Office in Helena, Montana; the Western Regional Climate Center in Reno, Nevada; and the National Climatic Data Center, in Asheville, North Carolina. In addition, substation histories previously prepared were consulted. The genealogical research source used was Ancestry.com to provide some of the personal information about the observers. For location analysis, the interactive maps available from TopoZone.com were used.

There was an attempt to glean information from all these sources that would allow a glimpse into the lives of the observers, the location of the observation site, the equipment used, and the historical environment that produced the climatic history of the Helena. Maps, drawings, and photographs were included when appropriate and available to illustrate the information.

Throughout the research for and preparation of this study, the objective was to produce a document that future studies can use to evaluate the validity of the data that were collected at Helena, judge the trustworthiness of the observers who collected them, and determine the climatological significance of the whatever variability may be discerned.

APPENDIX 2

Wheaton's Helena Plat Map



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