

# History of Weather Observing in Portland, Oregon 1858 - 1950

Current as of February 2005

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## **Executive Summary**

The goal of this study is to document the primary weather observational path at Portland OR leading to the Weather Bureau observing program in the first half of the 20<sup>th</sup> Century. These years were selected since descriptions of Portland weather observations after 1950 are available through easily obtainable climatic records. Extrinsic observations are considered in relation to the beginning of the central observational stream eventually established by the Signal Service in 1871.

The primary weather observation stream at Portland, OR is comprised of the Smithsonian Institution (1858-1859 and 1870-1873), the U.S. Army Signal Service (1871-1891) and the Weather Bureau (1891 through 1950). Weather observing in Portland OR began with a Smithsonian observer on Dec 9, 1858, but stopped on Aug 31, 1859. No weather records exist from 1859 until Jan 1870 when another Smithsonian observer began taking observations. The Signal Service began its formal observing program in Portland on Nov 1, 1871 with the Weather Bureau assuming responsibility on Jul 1, 1891.

Weather observing in Portland Oregon can be divided into two periods, 1) Weather observations prior to the aviation years, i.e., before Jul 14, 1928, and 2) Weather observations during the aviation years, i.e., from Jul 14, 1928 through 1950. Prior to the aviation years, weather observations were taken near downtown Portland; whereas, aviation observations were taken at Swan Island Airport (Jul 14, 1928 to Oct 13, 1940) and at Portland-Columbia Airport (name later changed to Portland International Airport) subsequent to Oct 13, 1940. During the 1940s, a transition began of transferring significant weather observing from the Weather Bureau City Office to the Weather Bureau Airport Office.

Exact location of the Smithsonian observations could not be found. During the Signal Service and Weather Bureau years of this study, i.e., from 1871 through 1950, weather observations were taken at six locations within downtown, as well as at Swan Island and Portland-Columbia Airport. Four of the downtown offices were during the Signal Service years and three were during the Weather Bureau years (the station in the Kamm Building initially was under the Signal Service before being transferred to the Weather Bureau on Jul 1, 1891).

The transition of weather observations from downtown to the airport began when the Weather Bureau airport station opened on Jul 14, 1928 at Swan Island, with the primary emphasis occurring during the 1940s at the Portland-Columbia Airport. Airport weather observations through 1950 continued to be taken by the Weather Bureau at both locations, with the City Office maintaining an active observing program through the 1950s.

## **Goal of the Study**

The goal of this study is to document the primary weather observational path at Portland OR leading to the Weather Bureau observing program in the first half of the 20<sup>th</sup> Century. Descriptions of Portland weather observations since around 1950 are available through easily obtainable climatic records, with the challenge being to identify and define the roots of the path that began in the 1800s and continued through times of significant transition in the early 1900s. Extrinsic observations, i.e., those by Smithsonian and Voluntary (or Cooperative) observers, are considered in relation to the beginning of the central observational stream eventually established by the Army surgeons, Signal Service, or Weather Bureau. This does not minimize the importance of these collateral observations, but rather to focus on the original events that led to the routine, formal weather observing program of modern times.

## **Portland Historical Overview**

The City of Portland is located in Multnomah County in northwest Oregon. Lewis and Clark made note of the Indian village of Multnomah on Sauvie Island (located on the Columbia River approximately 15 miles northwest of the current downtown of Portland) in 1805. The name “Multnomah” is probably derived from an Indian term meaning “downriver.” Multnomah County was created from parts of the Oregon counties of Washington and Clackamas by the Territorial Legislature on December 22, 1854.

Portland was founded in 1843 when two men from Tennessee, William Overton and Massachusetts lawyer Asa Lovejoy, beached their canoe on the banks of the Willamette River. Overton and Lovejoy filed the land claim for the 640-acre site known as "The Clearing," and Overton subsequently sold his half of the claim to Francis W. Pettygrove. Lovejoy and Pettygrove eventually decided to name their growing township, and Lovejoy wanted to name the new township after his hometown of Boston. Pettygrove was equally adamant about his native, Portland, Maine. A coin flip resulted in the name Portland.

By 1850, approximately 800 people lived in Portland. At that time, the city had a log-cabin hotel and a newspaper, the Weekly Oregonian. The city was becoming a major transportation center for the area due to the proximity of navigable rivers. By the end of the 19<sup>th</sup> Century, Portland was a major port and its population had grown to approximately 90,000 people.

Two major airports have served Portland. In September 1927, the Swan Island Airport (located on the Willamette River approximately three miles northwest of downtown Portland), was dedicated for service as the region’s first commercial airport, replacing the municipal field at Westmoreland Park (located approximately seven miles southeast of the Swan Island Airport, or three miles southeast of downtown). However, when the U.S. Bureau of Air Commerce denied authorization to operate DC-3 commercial aircraft (the most modern aircraft of the time) out of Swan Island in the mid 1930s, plans were made for a new airport. Using funds from the New Deal’s Works Progress Administration (WPA), the City of Portland purchased 700 acres of land along the

Columbia River to build the Portland-Columbia Airport. The Portland-Columbia Airport was opened for service in 1940, changing its name to Portland International Airport in 1951.

## **Location Descriptions**

Weather observing in Portland Oregon can be divided into two periods, 1) Weather observations prior to the aviation years, i.e., before Jul 14, 1928; and 2) Weather observations during the aviation years, i.e., from Jul 14, 1928 through 1950. Prior to the aviation years, weather observations were taken near downtown Portland, whereas aviation observations were taken at Swan Island Airport (Jul 14, 1928 to Oct 13, 1940) and at Portland Columbia Airport (Portland International Airport) subsequent to May 1, 1936 (a supplementary aviation observing station was established at the site prior to the completion of the Portland-Columbia Airport). During the 1940s, a transition began of transferring significant weather observing from the Weather Bureau City Office to the Weather Bureau Airport Office.

### Weather Observation Locations Before July 14, 1928 (Weather Observations Prior to the Aviation Years)

#### Smithsonian Institution Observations

The first documented weather observations for Portland, OR in the National Climate Data Center (NCDC), and supported by records from the Smithsonian Institution, were taken on Dec 9, 1858 by Mr. George H. Stebbins. No address was indicated on any of Mr. Stebbins forms, nor in any Smithsonian or Portland directories for the time, but Latitude/Longitude coordinates were given as 45°24'N 121°30'W (NOTE – These coordinates placed this station over 40 miles east of downtown Portland, likely reflecting the error and difficulty of surveys and calculating Latitude/Longitude at that time) . Elevation was listed as “about 150 feet,” with the Smithsonian Institution Annual Report listing the elevation as 170 feet. This set of observations stop on Aug 31, 1859. Mr. Stebbins initially measured temperature (indicated on the form as “Temperature in the Open Air”), began listing total monthly rainfall in Jan 18, 1859, and started recording daily rainfall in Apr 1859 which continued until the observations stopped on Aug 31, 1859. He also began estimating “Amount of Cloudiness” on Jul 7, 1859 which continued until the end of observations.

Both the NCDC database and Smithsonian Institution archives indicate no weather observations exist for Portland from Aug 31, 1859 until Jan 1870 when Mr. J.W. Gilliland began taking weather observations for the Smithsonian Institution at a location in Portland with coordinates 45°31'13" N, 122°26'6". These coordinates placed the station approximately 10 miles east of downtown near the current intersection of NE Glisan Street and NE 223 Avenue. Mr. Gilliland measured temperature, wet bulb, precipitation, winds, and pressure, as well as estimating amount, type, and movement of clouds.

In Jun 1870, Mr. James S. Reed assumed Smithsonian weather observations with the same parameters and location (as defined by observation forms Latitude/Longitude). Mr. Reed took the observations until Mar 1871 when the responsibility was assumed by Mr. Henry A. Ozer who continued until the program was transferred from the Smithsonian Institution to the Signal Service in 1873.

No information could be found regarding Mr. Stebbins nor Mr Gilliland. The 1873 Portland Directory listed James S. Reed as the City Agent for the Imperial Fire Insurance Company with his office located at 23 First Street (NOTE – Historical experts at the Oregon Historical Society stated the street numbering system changed after 1873 and the address of 23 First Street in 1873 would correspond to an address of 60 First Street today), and his residence on the northwest corner of Eighth and Stark.

The 1873 Portland Directory listed Mr. Henry A. Ozer as a Librarian for the Portland Library, located at the time on Stark between First and Second. The residence for Mr. Ozer in 1873 was listed as the southeast corner of Fifth and Washington. No information could be found to indicate where Mr. Reed or Mr. Ozer took their weather observations for the Smithsonian. Considering the various combinations of locations of residences and places of business for the two individuals, i.e., one-third to one-half mile separations, any change in location observation location would have been reflected in change in Latitude/Longitude. It is possible that all the Smithsonian weather observations at Portland during the early 1870s were taken at one location. The former Meteorologist in Charge of the National Weather Service Weather Forecast Office at Portland stated a perception existed that the Smithsonian observations in the 1870s were taken at the Public Library, primarily because Mr. Ozer was a Librarian at that location.

#### Signal Service Observations – City Offices

NOTE – All station elevations in this report are for the office barometer unless otherwise indicated. All elevations related to barometers in this report are above sea level unless otherwise indicated.

Below is the timeline for Signal Service weather observing stations in Portland. Specific office locations for Signal Service and Weather Bureau offices are shown in Figure 1.

Nov 1, 1871 – Dec 21, 1872 – Elevation 72 feet

- Gilman Building, southeast corner of 1<sup>st</sup> & Alder Streets, 3<sup>rd</sup> floor, Room No. 2.

Dec 21, 1872 - Jan 1, 1878 – Elevation 62 feet

- Parrish Building , southwest corner of Front and Washington Streets, 3<sup>rd</sup> floor, (located 600 feet northeast of Gilman Building)

Jan 1, 1878 - Aug 1, 1885 – Elevation 67 feet

- Oregon-Washington Trust Building, 48 1<sup>st</sup> Street (building numbering system used in the 1870s and 1880s and later changed to current system; Signal Service office was located between Ash and Pine Streets), 3<sup>rd</sup> floor, (located 1,200 feet north of Parrish Building)

Weather Bureau Observations – City Offices

Aug 1, 1885 - Oct 5, 1892 – Elevation 80 feet – Weather Bureau began taking weather observations Jul 1, 1891

- Kamm Building, northeast corner 1<sup>st</sup> and Pine Streets, 4<sup>th</sup> floor, Rooms 10 & 11, (located approximately 200 feet south of the Oregon-Washington Trust Building)

Oct 5, 1892 - Jun 8, 1902 – Elevation 157 feet (the following minor elevation changes were reported at this location, primarily as a result of new surveys: elevation changed to 154 feet on Sep 18, 1896; changed to 153 feet in Oct 1896; and changed to 154 feet Jan 1, 1900) – The move to this location the result of office in Kamm Building destroyed by fire Oct 3, 1892

- Oregonian Building, northwest corner of 6<sup>th</sup> and Alder Streets, 9<sup>th</sup> floor, Rooms 906 -909, (located 2,000 feet southwest of Kamm Building)

Jun 8, 1902 past 1950 – Elevation 60 feet then changed to 57 feet Jan 1905; changed to 58 feet Jan 1936; and changed to 74 feet Jun 6, 1938 when the office moved one floor higher in the same building

- U.S. Custom House Building, Davis-Everett on Park (another address for same location given as 7<sup>th</sup> and 8<sup>th</sup>, Davis and Everett Streets; the name of 7<sup>th</sup> street later was changed to Broadway) , Rooms 219 – 225 on the 2<sup>nd</sup> floor. The office moved to the 3<sup>rd</sup> floor to rooms 319 – 325 on Jun 8, 1938 where it remained past 1950. (located 2,000 feet north of Oregonian Building)

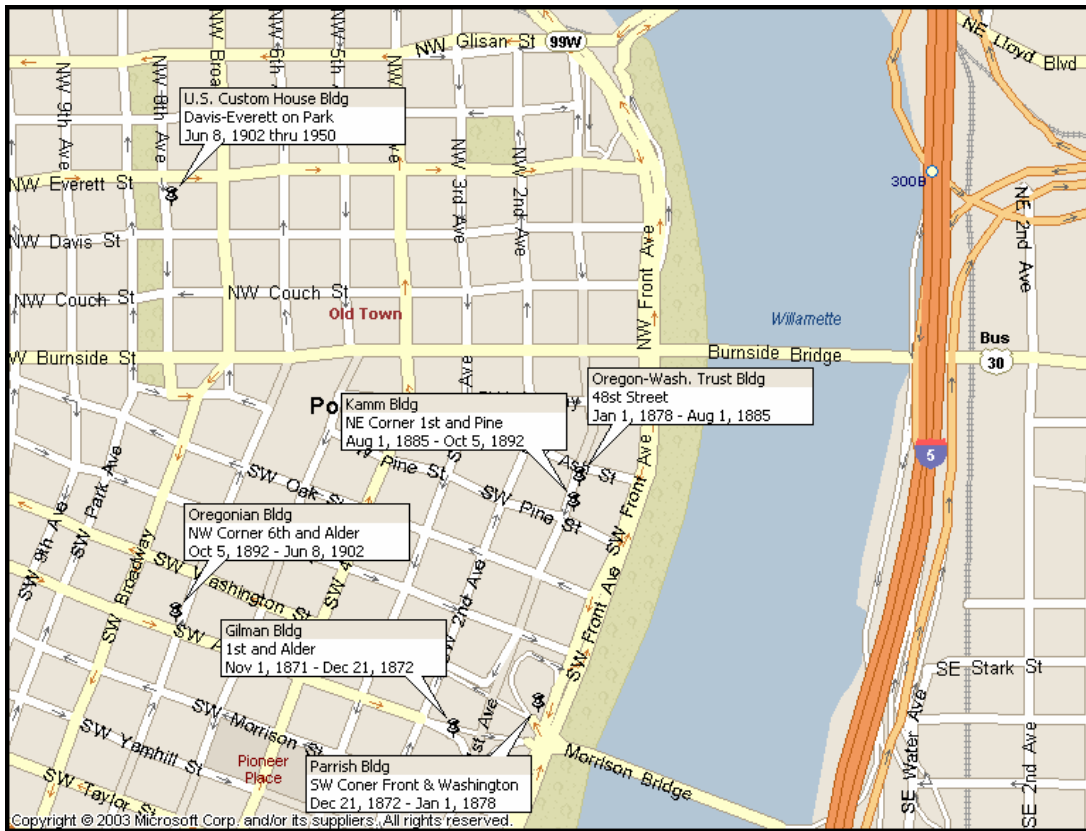


Figure 1. Signal Service and Weather Bureau stations for the Portland City Office from Nov 1, 1871 through 1950. Office locations are plotted on current Portland map.

### Weather Observations During the Aviation Years, i.e., from Jul 14, 1928 through 1950

#### Weather Bureau Observations – Airport Stations

During the period Jul 14, 1928 to Oct 13, 1940, the path of weather observations underwent a transition prior to the station at Portland International Airport (originally named Portland-Columbia Airport) becoming the primary weather observing location. The first step was on May 7, 1930 when the Weather Bureau began taking observations at the Swan Island Airport (see Figure 2) – a path that eventually would lead to weather observations at the Portland International Airport (see Figure 2). The Portland City Office (at the U.S. Custom House) remained as a primary observing site through the 1940s, until weather observing responsibility was transferred fully to the Weather Bureau station at Portland International Airport during the 1950s.

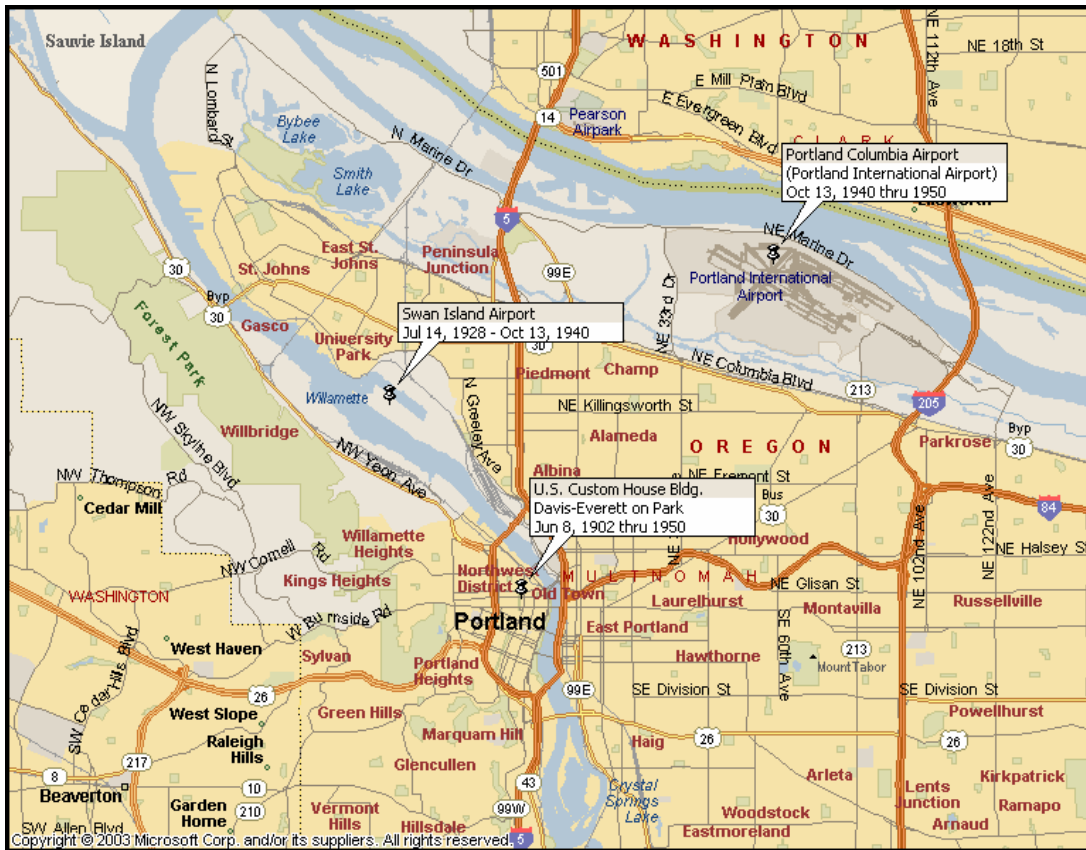


Figure 2. Locations of Weather Bureau observations during the 1930s and 1940s at the City Office, Swan Island Airport, and Portland International Airport. Office locations are plotted on current Portland map.

Jul 14, 1928 - Oct 13, 1940 – Elevation 39 feet (permanent quarters)

- Weather Bureau Airways Station at Swan Island Airport. Located in temporary quarters (exact location not available) at the airport Jul 14, 1928 to May 7, 1930, then moved to the Administration Building of the airport, 1<sup>st</sup> floor, (located 3.3 miles northwest of Weather Bureau office in the U.S. Custom Building)

May 1, 1936 – Oct 13, 1940 – Ground Elevation 20 feet (this station did not have a barometer)

- SAWRS (Supplementary Aeronautical Weather Reporting Station) observing station at Portland-Columbia Airport (precursor to Portland International Airport); located in temporary quarters (exact location not available) until Oct 28, 1938 before moving one mile northeast to the United Airlines building. The station was inoperative Jul 26, 1939 through Aug 25, 1939. (located 5 miles east northeast of the Weather Bureau Airways Station at Swan Island)



Oct 13, 1940 – May 31, 1948 – Elevation 37 feet then changed to 26 feet Sep 30, 1943

- Weather Bureau Airways Station at the Portland-Columbia Airport; located in the United Airlines Building, 2<sup>nd</sup> floor. On Sep 30, 1943, the office moved 75 feet east to the Port Building, 1<sup>st</sup> floor (located 5 miles east northeast of the previous location at Swan Island Airport).

Nov 23, 1940 – Mar 6, 1942 – Ground Elevation 33 feet (this station did not have a barometer)

- SAWRS at Swan Island Airport. The station opened at the S&M Flying Service (exact location not available but was located near the Swan Island Airport Administration Building) and moved to the Swan Island Administration Building on Dec 16, 1940 (located 5 miles west southwest of the Weather Bureau station at the Portland Airport).

May 31, 1948 – Aug 24, 1948 – Elevation 74 feet

- Weather Bureau Airways Station temporarily moved to the Weather Bureau City office at the U.S. Custom Building (3<sup>rd</sup> floor) due to flooding from the Columbia River (located 9 miles south southwest from the airport location)

Aug 24, 1948 – Feb 4, 1949 – Elevation 38 feet

- Weather Bureau Airways Station at Portland International Airport; temporarily located in the United Airlines Building (2<sup>nd</sup> floor), awaiting new Port Administration Building to be built (located 9 miles north northeast from the temporary downtown location)

Feb 4, 1949 past 1950 – Elevation 27 feet

- Weather Bureau Airways Station in the newly completed Port Administration Building (5420 Northeast Marine Drive) at the Portland International Airport, 1<sup>st</sup> floor, (located one-eighth mile west from previous location in the United Airlines Building). The station was located at the north side of Portland International Airport approximately 100 yards from the bank of the Columbia River.

### **Instrumentation Descriptions**

No significant information could be found regarding exposure and type of instruments used by the Smithsonian weather observers in Portland. Smithsonian Annual Reports indicate temperature and rainfall were measured during the 1858 and 1859 observations. Smithsonian observations in Portland in 1870 through 1873 measured pressure, temperature, atmospheric moisture and rainfall.

Weather Instruments at Locations Before July 14, 1928 (Weather Observations Prior to the Aviation Years)

Signal Service Observations – City Offices

NOTE – From 1872 through 1888, the U.S. Signal Service conducted seven inspections of its Portland, OR weather offices. The inspection reports, available at the National Archives and Records Administration (NARA), contained drawings and textual information regarding weather instrument placement and exposure. The quantity and quality of information varied, depending primarily on the inspector. However, these reports contained revealing information not available from other sources, especially with regard to instrument location and exposure.

**Nov 1, 1871 – Dec 21, 1872;** Signal Service office located in the Gilman Building, southeast corner of 1<sup>st</sup> and Alder Streets, 3<sup>rd</sup> floor, Room No. 2 (see Figure 3).

NOTE – The Signal Service conducted one station inspection (based on available records) at this location on Oct 15, 1872. This inspection report contained considerable information on weather instrument location and exposure in/on the Gilman Building.

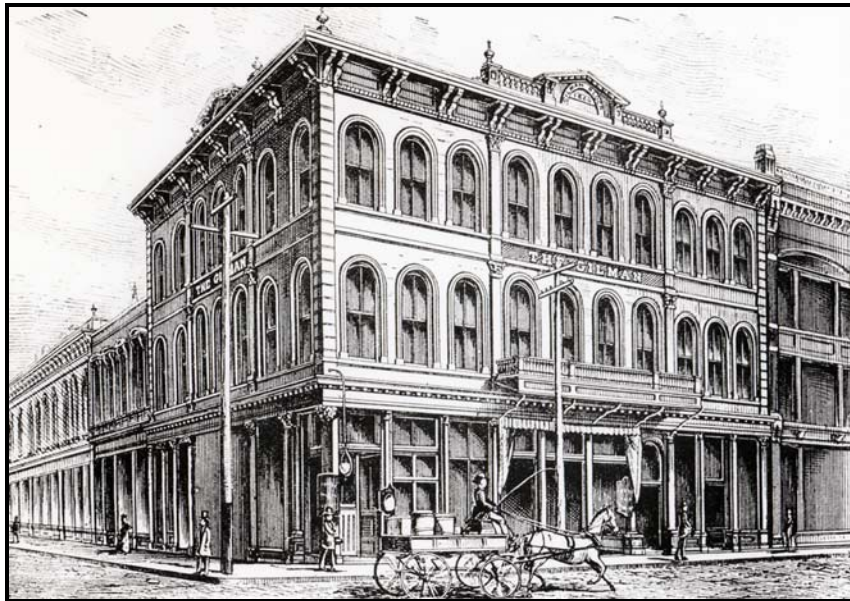


Figure 3. The Gilman Building (circa 1885) on the southeast corner of 1<sup>st</sup> and Adler that housed the Signal Service Office Nov 1, 1871 – Dec 21, 1872. View is looking southeast with Adler Street to the left of the building and 1<sup>st</sup> Avenue in front of the building. The Signal Service office was located on the 3<sup>rd</sup> floor of the Gilman Building on the left (i.e., north) side of the building. The “window” or “thermometer” shelter was attached to one of the windows, with the rain gage and wind instruments located on the roof. From the Oregon Historical Society.

Barometer – Elevation of the barometer was 72 feet above sea level. It was located on the northwest wall of the office approximately 5 feet away from the north wall. The stove was located approximately 15 feet from the barometer on the southeast wall directly across the room. (NOTE – The Signal Service Instructions to Observers published in 1871 states: “The barometer should be placed in a room of a temperature as uniform as possible, not heated nor too much exposed to the sun.” No instructions could be found that indicated the minimum distance allowable for placing the barometer from the stove that heated the room.) During an inspection in 1872, the condition of the barometer was listed as “fair”.

Instrument Shelter – Based on drawings from the 1872 inspection report, the instrument shelter was a thermometer (or window) type shelter used by the early Signal Service and modeled after a similar shelter used by Smithsonian observers. In this Signal Service office, the thermometer shelter was hung outside a north facing window (according to installation instructions) overlooking Alder Street. The window containing the instrument shelter was approximately 15 feet away from the stove that heated the room. The inspection report indicates one thermometer (42 feet above ground) and one hygrometer (42 feet above ground) were situated in the instrument shelter. The condition of the thermometer and hygrometer was rated as “good.”

Rain/Snow Gages – One rain gage was located on the roof of the Gilman Building, which according to the station’s climatological record (contained in the remarks on the exposure of the rain gage) was as high as other buildings in the vicinity. The rain gage was 59 feet above ground and was located on southeast one-third of the building. The 1872 inspection rated the condition of the rain gage as “good.”

Wind Instruments – One anemometer and two wind vanes were located on the roof of the Gilman Building. The anemometer was 64 feet above ground. A large wind vane was located 91 feet above ground and a small wind vane 69 feet above ground. The small wind vane was located near the northern edge of the building (along Alder Street), with the larger vane situated a few feet farther south toward the center of the building. The 1872 inspection report rated the condition of all wind equipment as “good.”

Additional Equipment/Information – During the 1872 inspection, the comment was made that instrument exposure at the station “...was as good that could be asked.” See Figure 4 for the drawing from the Signal Service inspection report showing the location of weather observing instruments on the roof of the Gilman Building.

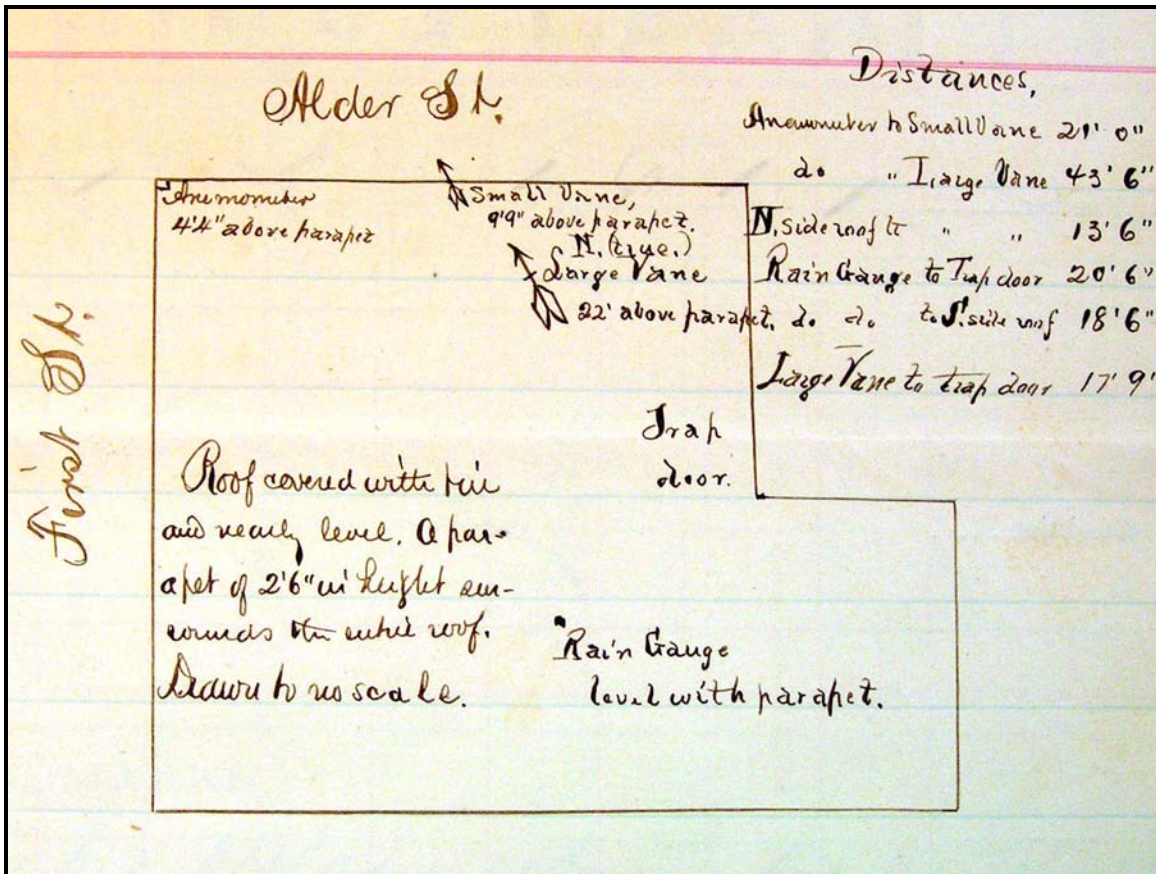


Figure 4. Drawing from the Oct 15, 1872 Signal Service inspection report showing the location of weather instruments on top of the Gilman Building. North is toward the top of the drawing. From the National Archives and Records Administration.

**Dec 21, 1872 - Jan 1, 1878;** Signal Service office located in the Parish Building on the southwest corner of Front and Washington Streets, 3<sup>rd</sup> floor. Figure 5 shows the Parrish Building and also indicates the location of the Signal Service office within the building.

NOTE – The Signal Service conducted one station inspection at this location on Aug 19, 1874. Information from this inspection was sketchy.



Figure 5. The Parrish Building (tallest building on right side of picture; circa 1899) at the southwest corner of Washington and Front Streets that housed the Signal Service office Dec 21, 1872 – Jan 1, 1878. View is southwest with Front Street located to the left of the building and Washington Street intersecting from the right. The Signal Service office was located on the top floor, in the northeast part of building (indicated by letter “A” in the photograph). The three windows were on the east wall of the Signal Service office with the two windows to the right of the building corner the northern wall of the office. The temperature shelter was mounted outside the second window to the right of the building corner (indicated by letter “B”). From the Oregon Historical Society.

Barometer – The inspection report shows the station had two mercurial barometers mounted on the south wall of the office on the southeast side of the room, located approximately four feet from the east wall bordering on Front Street. The barometers were located approximately 15 feet away from the stove that heated the room (i.e., the stove was located across the room). The elevations of the barometers were 62 feet above sea level.

Instrument Shelter – The “thermometer shelter” was located outside a window on the north wall bordering on Washington Street. The shelter was located on the northwest side of the room. The window containing the shelter was located about four feet from the stove that heated the room. The shelter contained at least one thermometer and one hygrometer (based on Signal Service general regulations and shelter contents at previous location), but no information was available to indicate if additional instruments were in the shelter. Instruments in the shelter were 34 feet above ground.

Rain/Snow Gages – The 8 inch rain gage was located on the roof of the Parish Building 47 feet above ground.



Wind Instruments – Located on top of the Parish Building. Height of the anemometer was 53 feet above ground and wind vane was 72 feet above ground. The anemometer was located toward the center of the building approximately half way between the center of the roof and Front Street. The wind vane was in a similar location on the other side of the roof. First automatic wind velocity records began Jul 17, 1873 when a single register was installed.

**Jan 1, 1878 - Aug 1, 1885;** Signal Service office located in the Oregon-Washington Trust Building, 48 1<sup>st</sup> Street (building numbering system used in the 1870s and 1880s and changed at a later date; Signal Service office was located between Ash and Pine Streets), 3<sup>rd</sup> floor.

NOTE – The Signal Service conducted three station inspections while the office was located in the Oregon-Washington Trust Building: Sep 10, 1879, Sep 15, 1880, and Aug 21, 1884. These inspection reports contained considerable information on weather instrument location and exposure.

Barometer – The office was located in the northwest part of the Oregon-Washington Trust Building with windows on the west and north sides. Office size was approximately 14 feet (east-west) by 23 feet (north-south) According to the inspection reports, the office had two mercurial barometers (i.e., one station barometer and an extra barometer) on Oct 15, 1872 with three barometers by the Aug 21, 1884 report. The barometers were located in the southwest part of the office approximately three feet from the west wall and attendant window. The stove was located in the northeast corner of the room approximately 20 feet from the barometers. The barometers were located 67 feet above sea level.

Instrument Shelter – The instrument shelter was mounted outside a window on the north side of the room (approximately in the middle part of the wall). The window containing the shelter was located approximately 10 feet from the room stove. The thermometer and two hygrometers in the shelter were 45 feet above the ground.

The shelter was described as a single lattice structure painted white. The shelter was listed as 7 feet 11 inches high, 3 feet 3 inches wide, and 2 feet 8 inches deep (NOTE – The large size of this instrument shelter is indicated in both the Sep 10, 1879 and Aug 21, 1884 inspection reports and likely was constructed to cover the entire window).

Rain/Snow Gages – The rain gage was located on the roof of the Trust Building 60 feet above ground.

Wind Instruments – Wind instruments were located on the roof of the Trust Building. The anemometer was 72 feet above ground and the wind vane 86 feet above ground. The wind vane rod extended through the ceiling of the office.

Additional Equipment/Information – On Sep 1, 1881, the Signal Service office began taking water temperature (river) and river observations (depth in feet and inches) of the Willamette River. A note on the Dec 1888 observation states: “Temperature of water is taken from SE corner of Boat House foot of Stark St.” and also “Bench Mark SW corner of Front and Washington Streets.” In later observations, i.e., around 1890, the Boat House was referred to as the “Ferry Landing.”

#### Weather Bureau Observations – City Offices

**Aug 1, 1885 - Oct 5, 1892;** Signal Service office located in the Kamm Building, northeast corner 1<sup>st</sup> and Pine Streets, 4<sup>th</sup> floor, Rooms 10 and 11 which were located in the southwest part of the building, (Weather Bureau assumed weather observing responsibilities Jul 1, 1891). Figure 6 shows the Kamm Building.



Figure 6. The Kamm Building (exact date of photograph unknown but likely around 1900) at the northeast corner of Pine Street and 1<sup>st</sup> Avenue (building located on Pine Street between First and Front Avenues) that housed the Signal Service office Aug 1, 1885 to Nov 1, 1891 and the Weather Bureau office Nov 1, 1891 through Oct 5, 1892. Picture is taken from Front Avenue looking northwest with Pine Street to the left of the building and Front to the right. The Signal Service/Weather Bureau office was located on the 4<sup>th</sup> floor (top floor) at the far corner of the building (i.e., extreme left of the picture). Weather instruments were on the part of the building’s roof at the extreme left of the picture From the Oregon Historical Society.

NOTE - The Signal Service conducted two station inspections while the office was located in the Kamm Building and before the Weather Bureau assumed observing responsibility. Inspection dates were Jul 21, 1887 and Sep 5, 1888. These inspection reports contained considerable information on weather instrument location. Available information suggests no significant changes were made in location/exposure of the weather instruments from the Signal Service to Weather Bureau office in the Kamm Building.

Barometer – The office size was approximately 18 feet north-south (along 1<sup>st</sup> Avenue) and 22 feet east-west (along Pine Street). The station had two mercurial barometers (one station barometer and one extra barometer) located on the west wall (overlooking 1<sup>st</sup> Avenue). The station barometer was situated between two windows and was approximately seven feet south of the north wall of the office. The extra barometer was on the west wall approximately two feet south of the north wall. Both barometers were located 80 feet above sea level.

Instrument Shelter – When the Signal Service office moved to the Kamm Building on Aug 1, 1885, the window (or thermometer) shelter was changed to a “standard” roof shelter and mounted on the roof of the new residence. The shelter faced to the north. The Sep 5, 1888 inspection report indicated, “Shelter is of standard size and pattern erected on the western part of roof.” Signal Service documents indicate the “Standard Roof Shelter” for this period was approximately 10 feet high. The shelter was located 32 feet east of the western wall of the building (bordering on 1<sup>st</sup> Avenue) and approximately 25 feet north of the south wall of the building (bordering on Pine Street). The Kamm Building was the first location in Portland where the Signal Service instrument shelter was located on the roof and not attached to the north side of a window adjacent to the office. Maximum/minimum thermometers were added to the shelter, joining the dry bulb thermometer and hygrometer already present. Also, a thermograph was added. Instruments in the shelter were about 85 feet above ground. See Figure 7 for a drawing from the 1888 inspection showing the location of the roof instruments.

Rain/Snow Gages – The rain gage was a standard 8-inch brass gage located on the western roof of the Kamm Building 80 feet above ground. A weighing rain gage was installed Feb 11, 1890. The first mention of a snow gage is contained in the Sep 5, 1888 inspection report that states: “Snow gage is of ordinary pattern 8 inches in drain of galvanized iron.” The gages were located 32 feet east of the western wall and 39 feet north of the southern wall (Figure 7).

Wind Instruments – The wind instruments were located on the extreme western part of the roof of the Kamm Building. The anemometer was 16 feet east of the western building wall and approximately 35 feet north of the south wall (Figure 7). The wind vane was erected on the southwest corner of the building. The anemometer was about 19 feet above the roof and 92 feet above ground. The wind vane was 23 feet above the roof and 96 feet above ground. The wind vane in use was 12 feet long.



Additional Equipment/Information – Feb 1890 observation form had the following comment: “sunshine recorder and triple register received this month.” Little information was found regarding the existence or placement of sunshine recorders subsequent to Feb 1890. The Annual Reports of the Weather Bureau, beginning in 1891, indicated the Portland office had a sunshine recorder during the period of this study, i.e., from 1891 through 1950. Placement of the sunshine recorder most likely was on top of the instrument shelter.

River temperature readings stopped Nov 9, 1890 and remarks section stated: “Observations of water temperature discontinued Nov 9 1890 per letter dated Washington DC Nov 3 1890.” River height observations continued to be taken for the remainder of the Signal Service, through Oct 1891, and through the Weather Bureau years.

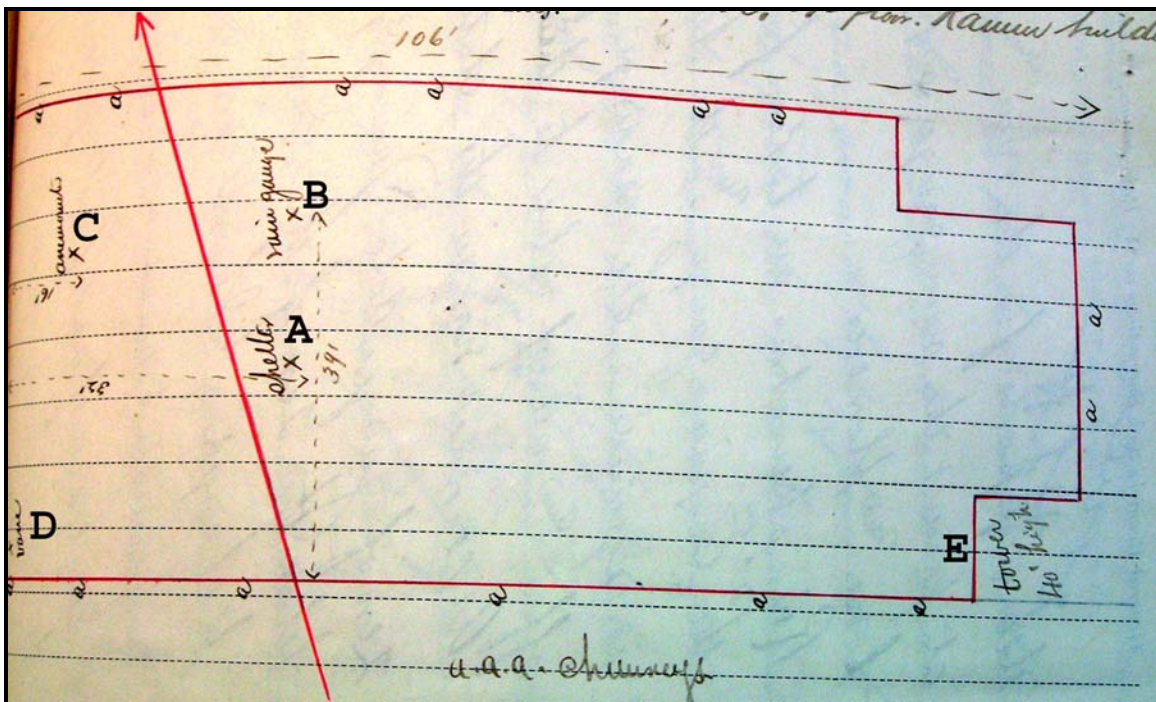


Figure 7. Drawing from the 1888 Signal Service inspection report showing the location of weather instruments on top of the Kamm Building. North is toward the top of the drawing. Instrument shelter is located at point “A,” rain/snow gages at “B,” anemometer at “C,” and wind vane at point “D.” Center tower of the Kamm Building is indicated at point “E.” From the National Archives and Records Administration.

**Oct 5, 1892 - Jun 8, 1902;** Weather Bureau office in the Oregonian Building, northwest corner of 6<sup>th</sup> and Alder Streets, 9<sup>th</sup> floor, Rooms 906 -909, (This move the result of office in Kamm Building destroyed by fire Oct 3, 1892). The Oregonian Building is shown in Figure 8.

NOTE - The observations form for Oct 1892 states: “Office in Kamm Building destroyed by fire Oct 3, 1892. New position of instrument shelter on top of tower of Oregonian Building. Bottom of shelter is 204 feet above ground. Some of the instruments were damaged by the fire, except the sunshine recorder which was totally destroyed. Elevation corrected for 157 feet. Located on NW corner of 6<sup>th</sup> and Alder Streets, rooms 909 – 912. Barometer is 76.76 feet higher than previous location in Kamm Building.”



Figure 8. The Oregonian Building (exact date of photograph unknown but likely in the 1890s) at the northwest corner of 6<sup>th</sup> Avenue and Alder Streets. Orientation of the photograph not clearly apparent, with best estimate the view is looking northwest with Alder Street in the foreground. From the Oregon Historical Society.

Barometer – Elevation of barometer 157 feet but changed to 154 feet on Sep 18, 1896; changed to 153 feet in Oct 1896; and changed to 154 feet Jan 1, 1900.

NOTE – Based on a comparison of the elevations of the barometer (when converted from above sea level to above ground level), instrument shelter, rain gage, and wind instruments, it appears the weather instruments (with the exception of the barometer) were located on top of the tower of the Oregonian Building (see Figure 8). According to the 1896 Annual Report of the Weather Bureau, the elevation of the rain gage changed from 196 feet to 147 feet on Feb 1, 1896, with the only plausible reason for the elevation change to be the rain gage was moved from the top of the tower to the lower roof of the building.

Instrument Shelter – Published elevations for the instrument shelter vary a few feet at this location. Although the initial observation form indicated the shelter to

be 204 feet above ground, official height in the Annual Report of the Weather Bureau indicates 200 feet until Jul 3, 1894 when the elevation was changed to 203 feet.

Rain/Snow Gages – The 8 inch and weighting rain gages were mounted on the tower of the Oregonian Building 196 feet above ground. The elevations of the gages changed to 147 feet above ground on Feb 1, 1896 (likely moved from the top of the tower of the Oregonian Building to the lower roof), and changed from 147 feet to 145 feet on Dec 1, 1897.

Wind Instruments – The wind instruments were mounted on the Oregonian Building tower. The anemometer was 209 feet above ground and the wind vane 211 feet above ground. In 1894, both were moved upward four feet.

**Jun 8, 1902 past 1949;** Weather Bureau office in the U.S. Custom House Building, Davis and Everett Streets on Park, 2<sup>nd</sup> floor, Rooms 219 – 225. Moved to 3<sup>rd</sup> floor to rooms 319 – 325 on Jun 8, 1938. The Custom House is shown in Figure 9.



Figure 9. The U.S. Custom House Building (photo taken Sep 2004) at Davis-Everett on Park. View of the building looking southeast from the North Park. Instrument shelter and rain gages were located on flat part of roof near point “A.”

Barometer – Elevation 60 feet then changed to 57 feet Jan 1905; changed to 58 feet Jan 1936; and changed to 74 feet Jun 6, 1938 when the office moved one floor higher in the same building. A barograph was installed Jun 8, 1938.

Instrument Shelter – Thermometers (including maximum/minimum thermometers), hygrometer, and instrument shelter were 68 feet above ground. The shelter was approximately 9 feet above the roof of the building. No change in height was indicated past 1949. Only information available on instrument shelter type was listed on a Weather Bureau form (Description of Topography and

Exposure of Instruments) on Jun 1, 1951 that indicated the shelter to be a large type.

The Climate Record Book entry (no date indicated but language in the document suggests it likely was written in 1910) contains the following:

“The instrument shelter was placed on the northeast corner of the roof of the Custom House on Jun 7, 1902 and its position and surroundings were unchanged at the end of the year 1910.

The shelter is about 11 feet, at the nearest point, from a parapet wall about 2 feet 6 inches high. The roof is made of glazed tile. The shelter has a full exposure on the east, north, and south sides, but on the west, it is shielded to a small extent by the central portion of the building which rises 18 feet above the roof on which the shelter is located. This central portion of the building is 45 feet from the shelter and it is believed that it has no effect on the thermometer readings. The nearest ventilator is 36 feet southwest, and there is a smokestack about 55 feet west of the shelter. The stack extends about 37 feet above the shelter. No discrepancies in thermometer readings have been noted that can be ascribed to either of these objects.”

Records in Jan 1949 indicate no changes in instrument location occurred from the Climate Record Book entry. Maximum/minimum thermometers installed in the instrument shelter Apr 4, 1904 and located 68 feet above ground. Thermograph installed in the instrument shelter Apr 4, 1904.

Rain/Snow Gages – The height of the rain gage was 63 feet above ground. The tops of the gages were between 3 and 4 feet above the roof. The elevation of the gages did not change past 1949. A tipping bucket rain gage was installed Jun 8, 1902 and the weighing rain gage discontinued. The rain gages were located on the southeast corner of the roof and moved to a position on the roof over the northeast wing on Mar 31, 1904. No significant change in elevation occurred with the move.

The Climate Record Book entry (no date indicated but language in the document suggests it likely was written in 1910) contains the following:

“The rain gage is exposed on the flat, tile roof of the Custom House, 17 feet 6 inches southwest of the instrument shelter. A parapet wall about 2 feet 6 inches high surrounds the roof, and the gage at its nearest point is 12 feet 3 inches distant from this wall. The top of the gage is 3 feet 6 inches above the tile roof and 63 feet above the ground. A ventilator, 8 feet high, is located 20 feet southwest from the gage. The central portion of the building, which extends 18 feet above that portion of the roof on which the gage is located, is 33 feet west from the gage. This extension breaks the force of the westerly winds and probably has a slight tendency to produce eddies in the vicinity of the gage. The catch is probably

slightly greater than it would be if all parts of the building were the same height. A standard 8 inch snow gage is exposed 4 feet south of the rain gage.”

A 12 inch tipping bucket rain gage was installed on the northeast part of the roof on Mar 31, 1904.

On Jan 1, 1950, the tipping bucket rain gage was transferred to the Weather Bureau Airport Station and replaced at the City Office with a weighing rain gage. The standard 8 inch rain gage remained past Jan 1, 1950.

Wind Instruments – The wind instruments were located on the roof of the Custom House Building. Height of the anemometer was 96 feet above ground and the wind vane 97 feet above ground. On Oct 30, 1906, the instruments were elevated 10 feet to clear a time-ball apparatus that had been installed. The anemometer was subsequently 106 feet above ground and the wind vane 107 feet above ground. The anemometer was 30 feet above the roof of the building and the wind vane 31 feet above the roof.

The Climate Record Book entry (no date indicated but language in the document suggests it likely was written in 1910) contains the following:

“The wind vane and anemometer are located above all the buildings within a distance of three blocks. Two smoke stacks on the roof of the Custom House are located about 32 feet due north and south of the wind instruments’ support (NOTE – See Figure 10), and in Oct 1906, a time ball apparatus was erected 15 feet south of the support. On Oct 30, 1906, the support was elevated ten feet, which placed the vane and anemometer above all surrounding objects, except the flagstuffs. The exposure is considered good and the surrounding objects have little or no effect upon the recorded directions and velocities.”

No subsequent changes in wind instrument height were indicated through 1949. On Jan 1, 1950, the anemometer was transferred to the Weather Bureau station at Portland International Airport.





Figure 10. The U.S. Custom House Building (photo taken Sep 2004) at Davis-Everett on Park. View of the building looking southeast from the North Park. Wind instruments were located at point “A” in the photograph, midway between the two smoke stacks.

Additional Equipment/Information – Sunshine observations that were taken at the Portland City Offices since Feb 1890 were transferred to the Airport Station Jan 1, 1950, along with the sunshine recorder and triple register. The triple register had been installed on Jun 8, 1902. Psychometric observations were discontinued at the City Office on Jul 1, 1939.

#### Weather Instruments at Locations During the Aviation Years, i.e., from Jul 14, 1928 through 1950

##### Weather Bureau Observations – Airport Stations

**Jul 14, 1928 - Oct 13, 1940;** Weather Bureau Airways Station at Swan Island Airport. Located in temporary quarters at the airport (exact location not available) Jul 14, 1928 to May 7, 1930, then moved to the Administration Building of the airport.

NOTE – Available records indicate weather instruments were not located at the temporary quarters for this location, i.e., until after the office moved into permanent quarters at the Administration Building on May 7, 1930. NCDC records indicate no weather observations were taken at this location until Jan 1, 1930. When observations were started in Jan 1930, pressure, temperature, atmospheric moisture, and wind measurements were included. The only alternative was this office used these measurements from the City Office.

Barometer – Weather Bureau records indicate no barometer existed at this office while in temporary quarter, i.e., until after May 7, 1930. At that time, the

barometer was located on the first floor of the Administration Building at an elevation 39 feet above sea level.

Instrument Shelter – No instrument shelter or thermometers were located at the temporary station. After May 7, 1930, the instrument shelter was located on top of the Swan Island Airport Administration Building (see Figures 11 and 12) with the bottom of the shelter 4 feet 6 inches above the roof. Maximum/minimum thermometers, as well as a psychrometer, and dry bulb thermometer were located in the instrument shelter. The instruments were 5 feet above the roof and 29 feet above ground.



Figure 11. Administration Building for Swan Island Airport (circa 1930s) looking southeast. Weather Bureau instruments located on the southern roof of the building. From the Oregon Historical Society.



Figure 12. Enlargement of photograph in Figure 10 showing Weather Bureau instrument shelter, wind instruments, and rain gage (located in the lower left hand part of the photograph directly below point “A”). View is southeast. From the Oregon Historical Society.

Rain/Snow Gages – A standard 8-inch rain gage was installed May 7, 1930, with the top 3 feet 6 inches above the roof of the Administration Building and 25 feet above ground.

Wind Instruments – Wind instruments were installed May 7, 1930. The anemometer was 17 feet above the roof of the Administration Building and 48 feet above ground, and the wind vane 18 feet above the roof and 49 feet above ground.

Additional Equipment/Information – Weather Bureau records indicated a theodolite platform was located at this station with an elevation of 74 feet above sea level. No mention was made regarding the use of this platform.

**May 1, 1936 – Oct 13, 1940;** SAWRS (Supplementary Aeronautical Weather Reporting Station) at the Portland-Columbia Airport (precursor to Portland International Airport); located in temporary quarters (exact location not available) until Oct 28, 1938 before moving one mile northeast to the United Airlines building. The station was inoperative Jul 26, 1939 through Aug 25, 1939.

Barometer – This station did not have a barometer.



Instrument Shelter – Dry bulb thermometer and psychrometer located 5 feet above ground. No maximum/minimum thermometers at this site.

Rain/Snow Gages – A standard 8-inch rain gage was at this location with the top of the rain gage 4 feet above ground.

Wind Instruments – Wind instruments were located on a pole 51 feet above ground, then moved to the roof of the United Airlines building Apr 1, 1938 and located 28 feet above ground.

**Oct 13, 1940 – May 31, 1948;** Weather Bureau Airways Station at the Portland Columbia Airport; located in the United Airlines Building, 2<sup>nd</sup> floor. On Sep 30, 1943, the office moved 75 feet east to the Port Building at the airport. The location of the instruments remained unchanged with the move, with the exception of the barometer. Figure 13 shows the United Airlines Building at Portland Airport during the 1948 flood. Point “A” in Figure 13 is enlarged in Figure 14 and point “B” is enlarged in Figure 15, revealing the Weather Bureau instrument shelter and wind instruments respectively.



Figure 13. United Airlines Building during the 1948 flood at the Portland International Airport. The Weather Bureau office was housed on the second floor of the United Airlines Building Oct 13, 1940 – Sep 30, 1943 and Aug 24, 1948 – Feb 2, 1949. Point “A” in the photo is the Weather Bureau instrument shelter and is enlarged in Figure 14. Point “B” is the location of the wind instruments on the northwest corner of the building and is enlarged in Figure 15. Based on available information, the building located at point “C” most likely was the location for the Weather Bureau office Sep 30, 1943 – May 31, 1948. View is toward the northeast. From the Oregon Historical Society.

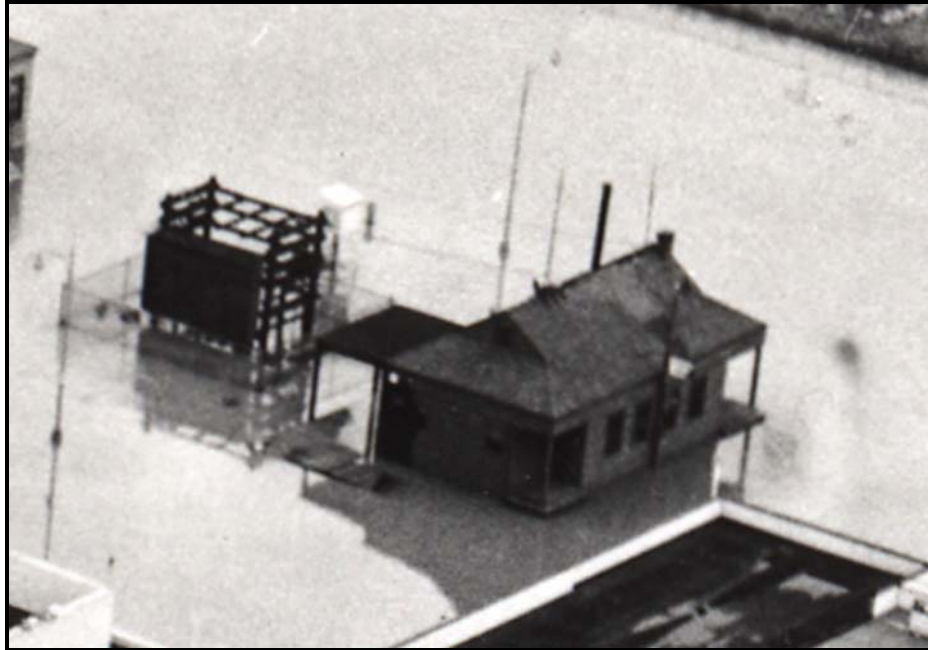


Figure 14. Enlargement of Weather Bureau instrument shelter (point “A” in Figure 13). Configuration of the shelter indicates the opening is to the left, i.e., facing north. View of photograph is towards the northeast. From the Oregon Historical Society.

Barometer – Elevation of barometer 37 feet and changed to 26 feet after the move on Sep 30, 1943.

Instrument Shelter – The instrument shelter was located 20 to 30 feet east of a transformer (see Figure 14). Dry-bulb thermometer, maximum/minimum thermometers, and psychrometer were 5 feet above ground.

Rain/Snow Gages – Top of rain gage (8 inch gage) 3 feet 6 inches above ground

Wind Instruments – Wind instruments were located on the northwest corner of the United Airlines Building (see Figure 15). Height of the anemometer was 17 feet above the roof and 62 feet above ground. The wind vane was 18 feet above the roof and 63 feet above ground.

Additional Equipment/Information – Weather Bureau records indicate a theodolite platform was located at this station with an elevation of 62 feet above sea level.



Figure 15. Enlargement of Weather Bureau wind instruments located on the northwest corner of the United Airlines Building (see Figure 13). View is generally north. From the Oregon Historical Society.

**Nov 23, 1940 – Mar 6, 1942** – SAWRS at Swan Island Airport. The station opened at the S&M Flying Service (exact location not available, but was located near the Swan Island Administration Building) and moved to the Swan Island Administration Building on Dec 16, 1940 (located 5 miles west southwest of the Weather Bureau station at the Portland Airport).

Barometer – This station did not have a barometer.

Instrument Shelter – Exact location of instrument shelter is unknown (most likely the instrument shelter was on top of the Administration Building used by the previous Weather Bureau station (see Figure 11). Weather Bureau records indicate the heights of the psychrometer (added Feb 21, 1942) and dry bulb thermometer were 30 feet above ground (almost identical to the heights of the thermometers at the Swan Island Weather Bureau station).

Rain/Snow Gages – This station did not have rain/snow gages.

Wind Instruments – Height of the wind instruments at the S&M Flying Service was 42 feet above ground (Nov 23, 1940 through Dec 16, 1940) and 47 feet above ground at the Swan Island Administration Building (almost identical to the height of the wind instruments of the Swan Island Weather Bureau station).

**May 31, 1948 – Aug 24, 1948;** Weather Bureau Airways Station temporarily moved to the Weather Bureau City Office at the U.S. Custom Building (3<sup>rd</sup> floor and roof) due to flooding from the Columbia River (Vanport Flood).

Barometer – Elevation of the barometer was 74 feet.

Instrument Shelter – Heights of the dry bulb, maximum/minimum thermometers, and psychrometer were 68 feet above ground.

Rain/Snow Gages – Records indicate only a tipping bucket rain gage was located at this site with an elevation of 63 feet above ground.

Wind Instruments – Wind instruments were located 106 feet above ground.

**Aug 24, 1948 – Feb 4, 1949;** Weather Bureau Airways Station at Portland International Airport; temporarily located in the United Airlines Building, 2<sup>nd</sup> floor, awaiting new Port Administration Building to be built.

Barometer – Elevation of barometer 38 feet.

Instrument Shelter – Dry bulb thermometer, maximum/minimum thermometers and psychrometer located 5 feet above ground. Exact location of instrument shelter not indicated, but likely in the same location as before the flood, i.e., before May 31, 1948.

Rain/Snow Gages – The standard 8 inch gage was removed Jun 2, 1948 due to the flooding at the Portland International Airport and reinstalled Sep 30, 1948, approximately 20 feet from previous location. A weighing rain gage also was installed. Top of both gages were 4 feet above ground.

Wind Instruments – Wind instruments located 62 feet above ground. Exact location not indicated, but likely on the northwest corner of the United Airlines Building.

**Feb 4, 1949 past 1950;** Weather Bureau Airways Station in the Port Administration Building at the Portland International Airport (5420 Northeast Marine Drive). Figure 16 shows the location of the Weather Bureau office in relation to the Portland International Airport.

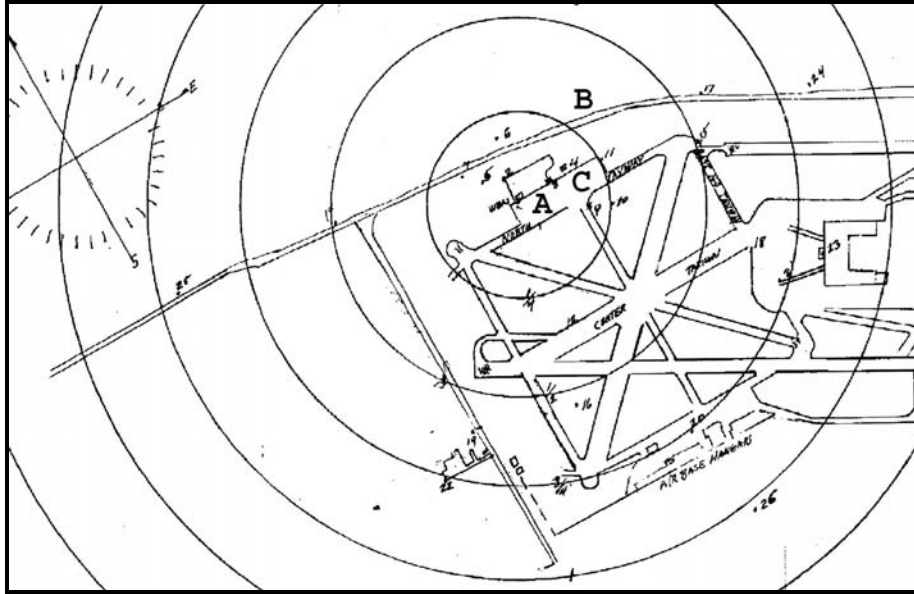


Figure 16. Schematic of visibility chart showing location of the Weather Bureau Airways Station (while housed in the Port Administration Building) in relation to the Portland International Airport (circa early 1950s). Point “A” is the location of the Weather Bureau station, point “B” is Northeast Marine Drive and point “C” represents the location of the United Airlines Building where the Weather Bureau station was located previously. North is toward the upper left corner of the schematic. First circle in one-quarter mile marker, second circle is one-half mile marker and third ring three-quarters mile marker. From the official station history files at the National Climatic Data Center.

Barometer – Elevation of the barometer was 27 feet above sea level. A barograph and altimeter setting indicator were installed Feb 1, 1949. The barograph was located 7 feet above ground and altimeter setting locator 8 feet above ground. The barometers were located on the ground floor of the building (one story building).

Instrument Shelter – The instrument shelter was located approximately 75 feet northwest of the Administration Building, which was a one story brick building approximately 25 feet in height. The shelter also was located approximately 50 feet north of the airport fire station, a brick building approximately 20 feet high. The instruments were over sod and broken ground. A concrete apron was located approximately 50 yards to the south of the shelter with runways and field area beyond. A north-south road was located approximately 30 feet east of the shelter. This road connected the Administration Building with Northeast Marine Drive. The Columbia River was located approximately 100 yards north of the shelter. Maximum/minimum thermometers and dry bulb thermometer were 6 feet above ground, the psychrometer (whirling device) 5 feet above ground, and a Telepsychrometer located 4 feet above ground.

Rain/Snow Gages – A standard 8 inch rain gage was located near the instrument shelter and 50 feet north of nearest obstruction (20 foot tall building). A weighing rain gage was located near the standard gage and tops of both gages 4 feet above ground. On Jan 1, 1950, the tipping bucket rain gage was transferred to this station from the City Office and the weighing gage removed.

Wind Instruments – Wind instruments were located on the roof of the Administration Building and were 33 feet above ground. Weather Bureau Surface Weather Observations forms indicate no nearby obstructions.

Additional Equipment/Information – The triple register and sunshine recorder were transferred from the Weather Bureau City Office to the Airport Office on Jan 1, 1950.

## **Acknowledgments**

Steve Todd, Meteorologist in Charge of the National Weather Service Forecast Office in Portland, provided considerable information on the history of the Weather Bureau offices. His support is greatly appreciated.

George Taylor, State Climatologist for Oregon, was instrumental in locating crucial pieces of information for the historical timeline in this study. He also provided considerable insight into the evolution of weather observing within the state of Oregon. George's generosity in giving his time and support are greatly appreciated.

George Miller, former Meteorologist in Charge of the Portland National Weather Service Forecast Office, provided a number of suggestions that were helpful in locating important data, in addition to researching the residences and work places of the very early Smithsonian observers. He also reviewed the report. His vast expertise of the area and in local climatology was very helpful and appreciated.

Steve Doty developed the procedures and methodologies used in developing this report. Without the extensive work of Steve in developing the appropriate process, this research would not have been possible.

## **References and Data Sources**

### References

*Reports of the Chief Signal Officer 1871 through 1891*; Government Printing Office, Washington D.C.; 1872.

*Reports of the Smithsonian Institution for the years 1850 through 1873*; A.O.P. Nicholson, Public Printer, Washington DC.

*Reports of the Chief of the Weather Bureau* for the years 1892 through 1934; Government Printing Office, Washington DC.

*Signal Service Station Inspection Reports* for the years 1872, 1874, 1879, 1880, 1884, 1887, 1888; National Archives and Records Administration.

*Substation History (Oregon)*; National Weather Service, Washington D.C; 1982.

United States Meteorological Yearbook for the years 1935 through 1942; Government Printing Office, Washington DC.

## Data Sources

Station history files at the National Climate Data Center provided descriptions of weather station locations beginning with the Signal Service years, i.e., Nov 1, 1871 with improving detail and resolution in the 1890s and 20<sup>th</sup> Century. Climatic/historical data from the Portland National Weather Service Forecast Office and the Oregon State Climatologist Office were helpful in filling information gaps for both station location and instrument exposure.

Specific building names and street addresses from different sources confirmed the locations of the weather stations from 1871 to 1902 (when the Weather Bureau office moved to the U.S. Custom House Building). During the latter time period of this study, Weather Bureau officials routinely documented station history and instrument status through forms entitled, Description of Topography and Exposure of Instruments, Report of Elevation and Position of Instruments, and Surface Weather Observations. Information on these forms provided significant detail regarding Portland Weather Bureau offices. In particular, Weather Bureau Station History forms from the early 1950s were instrumental in separating aviation weather observing responsibilities in the late 1920s, 1930s and 1940s among locations at Swan Island Airport, Portland Columbia Airport (i.e., Portland International Airport) and the Weather Bureau Office at the U.S. Custom House Building.

Tracking office location and instrument exposure on a yearly basis was important to ensure no information gaps existed. This yearly information was obtained from the Annual Reports of the Chief Signal Officer for the 1870s and 1880s, and from the Annual Reports of the Weather Bureau from 1892 through 1943. Information consistency for the mid to late 1940s was maintained from the wealth of historical records from the 1950s. Weather Bureau Annual Reports were more complete for this project than Signal Service versions.

Entries from Climate Record Books at the National Climate Data Center provided the backbone for locations and general exposures for instrument shelters (especially thermometers), rain gages, and anemometers/wind vanes for the Portland stations (city office locations) from Nov 1, 1871 through about 1910. Also helpful were Original Monthly Record of Observations which began listing elevations of the Portland station

thermometer, rain gage, and wind instruments around 1908 and continued through Jan 1938. These data were vital in confirming consistency of instrument location since other, more specific, information (such as that can be obtained from routine forms on the “Description of Installation and Exposure of Instrumental Equipment and Surroundings”) was lacking from about 1910 until the early 1930s. Numerous Station History reports prepared in the 1940s and early 1950s were instrumental in defining specific instrument elevation heights at both the Weather Bureau City Office and Airport Station.

Information regarding duration of observations by Smithsonian Institution weather observers at Portland was obtained from yearly Smithsonian Institution reports, as well as from the NCDC data base. Specific information about the individuals was obtained from the 1873 Portland, OR Directory.

Considerable information regarding the early Signal Service observing stations was available from station inspection reports located in the National Archives and Records Administration (NARA). These inspections provided drawings and detailed textual information on the placement and exposure of weather instruments at several of the Signal Service stations in Portland.

A number of relevant photographs used in this report were obtained from the Oregon Historical Society. Specific information regarding the Smithsonian observers also was available through the Historical Society. The Multnomah County Library also had information on the Smithsonian observers, primarily through newspaper archives. The newspaper archives also were beneficial in providing specific information regarding Weather Bureau offices, especially during the 1890s and early 20<sup>th</sup> Century. Sanborn maps for the various periods of interest from the Multnomah County Library were helpful with respect to station locations.

Other information and data sources checked (by person, telephone, or through the Internet) during this study were: Portland State University Library; Lewis and Clark College Library, Portland OR; Historic Preservation League of Oregon, Portland OR; Heritage Conservation, Salem OR; Oregon State University Library and Archives, Corvallis OR; Oregon State Archives, Salem OR; Oregon State Library, Salem OR; Multnomah County Records Inventory; Reed College Library, Portland OR; George Fox University Library, Newberg OR; University of Portland Library; National Transportation Library, Portland OR; and the Western Regional Climate Center.