# REGIONAL PRECIPITATION-FREQUENCY ANALYSIS AND SPATIAL MAPPING OF 24-HOUR PRECIPITATION FOR OREGON
## Final Report

**SPR 656**

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16. Abstract

For this study regional frequency analyses were conducted for precipitation annual maxima in the state of Oregon for the 24-hour duration. A total of 693 precipitation gages in Oregon, southern Washington, western Idaho, northern California and northern Nevada were included in the study, representing 34,062 station-years of record. A regional analysis methodology was utilized that pooled data from climatologically similar areas to increase the dataset and improve the reliability of precipitation-frequency estimates. The regional analysis methodology included L-moment statistics, and an index-flood type approach for scaling the annual maxima data. L-moment statistics were used to: characterize the variability, skewness and kurtosis of the data; measure heterogeneity in proposed homogeneous sub-regions; and assist in identification of an appropriate regional probability distribution.

Spatial mapping techniques were employed for mapping of the precipitation-frequency information. This included spatial mapping of at-site means, L-moment ratio values of L-Cv and L-Skewness, and mapping of precipitation for selected recurrence intervals. Procedures were employed to minimize differences between mapped values and observed station values in a manner that was consistent with the regional behavior of the data and also recognized uncertainties due to natural sampling variability.

Color-shaded isopluvial maps were developed for the 6-month, 2-year, 10-year, 25-year, 50-year, 100-year, 500-year, and 1000-year precipitation recurrence intervals. Electronic gridded datasets are available for use in creation of GIS applications that utilize precipitation-frequency information.

A catalog of extreme storms was assembled that lists precipitation events that exceeded a 20-year return period for the various climatic regions. The information from the storm catalog was also used to conduct seasonality analyses that identified the occurrence frequency of extreme storms by month. In particular, the seasonality analyses identified those months that were the most likely and least likely for an extreme event to occur. This information is useful in rainfall-runoff modeling and can be used in conducting hydrologic analyses throughout the Oregon study area.

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# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| **LENGTH** | | | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| mi | miles | 1.61 | kilometers | km |
| **AREA** | | | | |
| $in^2$ | square inches | 645.2 | millimeters squared | $mm^2$ |
| $ft^2$ | square feet | 0.093 | meters squared | $m^2$ |
| $yd^2$ | square yards | 0.836 | meters squared | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | kilometers squared | $km^2$ |
| **VOLUME** | | | | |
| fl oz | fluid ounces | 29.57 | milliliters | ml |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.028 | meters cubed | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | meters cubed | $m^3$ |
| NOTE: Volumes greater than 1000 L shall be shown in $m^3$. | | | | |
| **MASS** | | | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |
| **TEMPERATURE (exact)** | | | | |
| °F | Fahrenheit | (F-32)/1.8 | Celsius | °C |

## APPROXIMATE CONVERSIONS FROM SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| **LENGTH** | | | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| **AREA** | | | | |
| $mm^2$ | millimeters squared | 0.0016 | square inches | $in^2$ |
| $m^2$ | meters squared | 10.764 | square feet | $ft^2$ |
| $m^2$ | meters squared | 1.196 | square yards | $yd^2$ |
| ha | hectares | 2.47 | acres | ac |
| $km^2$ | kilometers squared | 0.386 | square miles | $mi^2$ |
| **VOLUME** | | | | |
| ml | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| $m^3$ | meters cubed | 35.315 | cubic feet | $ft^3$ |
| $m^3$ | meters cubed | 1.308 | cubic yards | $yd^3$ |
| **MASS** | | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.205 | pounds | lb |
| Mg | megagrams | 1.102 | short tons (2000 lb) | T |
| **TEMPERATURE (exact)** | | | | |
| °C | Celsius | 1.8C+32 | Fahrenheit | °F |

*SI is the symbol for the International System of Measurement

# ACKNOWLEDGEMENTS

The authors would like to acknowledge Chris Daly of the PRISM Group at OSU who provided the precipitation data layers which formed the basis for the spatial mapping. Cadee Hale of OCS and Joseph Smith of the PRISM Group were involved in collecting daily and hourly precipitation data.

# DISCLAIMER

# REGIONAL PRECIPITATION-FREQUENCY ANALYSIS AND SPATIAL MAPPING OF 24-HOUR PRECIPITATION FOR OREGON
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# EXECUTIVE SUMMARY

Regional frequency analyses were conducted for precipitation annual maxima in Oregon State for the 24-hour duration. A total of 693 precipitation gages in Oregon, southern Washington, western Idaho, northern California and northern Nevada were included in the study, representing 34,062 station-years of record. A regional analysis methodology was utilized that pooled data from climatologically similar areas to increase the dataset and improve the reliability of precipitation-frequency estimates. The regional analysis methodology included L-moment statistics, and an index-flood type approach for scaling the annual maxima data. L-moment statistics were used to: characterize the variability, skewness and kurtosis of the data; measure heterogeneity in proposed homogeneous sub-regions; and assist in identification of an appropriate regional probability distribution.

It was found that the study area could be described by 17 climatic regions and two transition zones. The 17 climatic regions were geographic areas that had similar topographic and climatological characteristics and were subjected to similar meteorological conditions during storm events. Eight of the regions were in western Oregon, including windward and leeward mountain areas and interior lowlands. The other nine climatic regions were in eastern Oregon, comprising arid and semi-arid plains and mountain and inter-mountain areas. One transition zone was used near the crests of the Cascade and Klamath Mountains for spatial mapping of precipitation where precipitation characteristics changed rapidly over short distances. A second transition zone was used for spatial mapping of precipitation at the eastern foothills of the Cascade Mountains. Steep gradients in storm statistical measures were found along with a sharp change in the seasonality of storms in this eastern Cascade foothills area.

Separate regional analyses were conducted for each of the climatic regions. Within each climatic region, precipitation gages were assigned to groups where the gage sites had similar magnitudes of mean annual precipitation and latitude. A total of 68 sub-regions were formed by this process and were found to be acceptably homogeneous. Predictor equations were then developed to describe the variability of the L-moment ratios, L-Cv and L-Skewness, between the sub-regions and within and/or across climatic region boundaries. The sub-region L-moment ratio plots for L-Skewness and L-Kurtosis revealed the data to be near or slightly more kurtotic than the Generalized Extreme Value distribution. The four-parameter Kappa distribution was chosen to describe the regional magnitude-frequency relationship for the 24-hour precipitation annual maxima data.

Spatial mapping techniques were employed for mapping of the precipitation-frequency information. This included spatial mapping of at-site means, L-moment ratio values of L-Cv and L-Skewness, and mapping of precipitation for selected recurrence intervals. Procedures were employed to minimize differences between mapped values and observed station values in a manner that was consistent with the regional behavior of the data and also recognized uncertainties due to natural sampling variability.

Color-shaded isopluvial maps were developed for the 6-month, 2-year, 10-year, 25-year, 50-year, 100-year, 500-year, and 1000-year precipitation recurrence intervals. Electronic gridded datasets are available on a CD for use in creation of GIS applications that utilize precipitation-frequency information.

A catalog of extreme storms was assembled that lists precipitation events that exceeded a 20-year return period for the various climatic regions. The information from the storm catalog was also used to conduct seasonality analyses that identified the occurrence frequency of extreme storms by month. In particular, the seasonality analyses identified those months that were the most likely and least likely for an extreme event to occur. This information is useful in rainfall-runoff modeling and can be used in conducting hydrologic analyses throughout the Oregon study area.

# 1.0 OVERVIEW

This report documents the findings of regional precipitation-frequency analyses of 24-hour precipitation annual maxima for the State of Oregon. It also describes the procedures used for spatial mapping of precipitation-frequency estimates for selected recurrence intervals. This study is an update of the information contained in the precipitation-frequency atlas published by the National Weather Service (NWS) in 1973 (*Miller et al.*). Data collection for the NWS study ended in 1966, and this study includes the 40-years of precipitation records collected since. Additional data from sources not available in 1966 is also utilized. These additional data provide a precipitation database with more than double the record than was available in the original NWS study.

Since the original 1966 study, major advances have been made in methods for statistical analysis of precipitation annual maxima, and for spatial mapping of precipitation in complex terrain. Specifically, L-Moment statistical analysis techniques, conducted within a regional framework, have greatly improved the reliability of precipitation magnitude-frequency estimates, particularly for rare storm events (*Hosking 1990; Hosking and Wallis 1997)*. Development of the PRISM model incorporating digital terrain data has also improved the spatial mapping of precipitation and increased the reliability of estimating precipitation in the broad areas between precipitation measurement stations (*Daly 1994*) These methodologies are particularly effective in areas with high topographic and climatic variability that exist in Oregon. Both of these methodologies have been utilized in this study in conducting the precipitation-frequency analyses and in developing the isopluvial maps for selected recurrence intervals.

# 2.0 STUDY AREA

While the state of Oregon was the area of interest, the study area was expanded to provide additional data in border geographic areas. The Oregon study area included portions of southern Washington, western Idaho, northern California and northern Nevada (Figure 1). Specifically, the Oregon study area was bounded on the North by latitude 47°00′ N, to the south by latitude 41°00′ N, and to the east by latitude 116°00′ W. Addition of precipitation stations in the boundary areas also provided data from areas climatologically similar to data-sparse areas in Oregon such as locations in the Coastal Mountains, Cascade Mountains, Blue Mountains, Cabinet Mountains, and Klamath Mountains.

## 2.1 CLIMATIC AND METEOROLOGIC CHARACTERISTICS OF STUDY AREA

### 2.1.1 Annual Precipitation

Mean annual precipitation within the Oregon study area varies dramatically from the windward faces of the Coast Range and Cascade Mountains to the desert areas in central Oregon. Mean Annual Precipitation (MAP) ranges from a high of over 200-inches in the Coast Range, to a low near 6-inches in the inter-Mountain desert area in southeast Oregon (Figure 2.1) (*Oregon Climate Service 2000, 2005*).

### 2.1.2 Weather Systems and Sources of Atmospheric Moisture

In general, two ingredients are needed for precipitation to occur; a source of atmospheric moisture and a meteorological mechanism to release that moisture. There is also a greater potential for extreme precipitation events when the source of moisture originates in areas with warmer temperatures and higher dewpoints. There are four generalized geographic areas that are sources of atmospheric moisture to the study area. These four areas have differing characteristic temperatures and dew points (*Miller et al. 1973; National Weather Service 1966, 1994*). These source areas include: the Gulf of Alaska; the Pacific Ocean north of the Canadian border; and the Pacific Ocean from as far south as latitude 20°N, near the Hawaiian Islands. The Gulf of Mexico is the fourth source of moisture that occasionally penetrates sufficiently north to be a source of precipitation in warm months.

Storm systems moving in a southeasterly direction out of the Gulf of Alaska, primarily affect northern portions of the study area and generally contain cooler temperatures and dewpoints (*Miller et al. 1973; National Weather Service 1966, 1994*). Storm systems originating over the Pacific Ocean are the most common, while those that originate from southerly latitudes, near the Hawaiian Islands, have been responsible for many of the largest long-duration precipitation

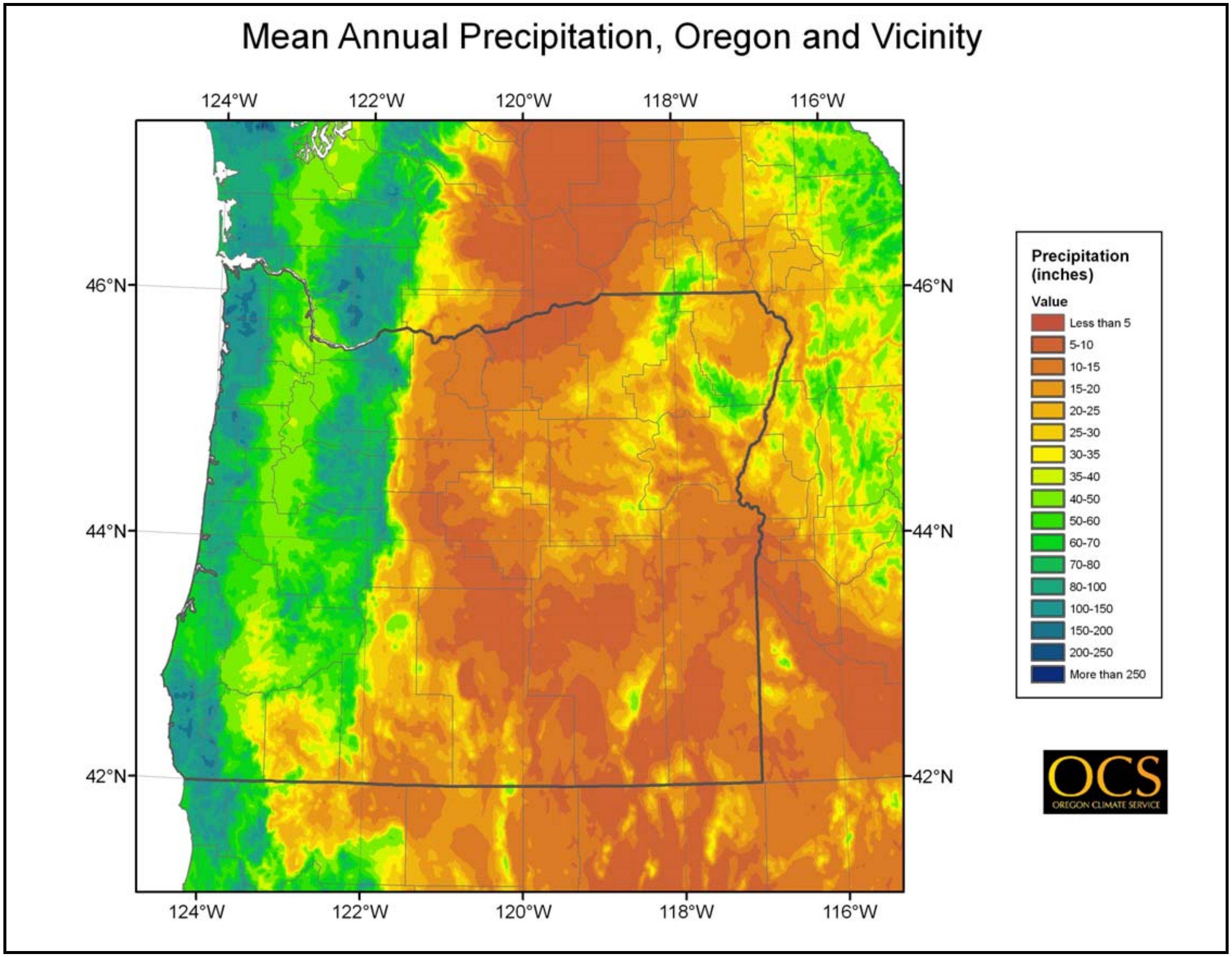


Figure 2.1: Mean Annual Precipitation for Oregon study area (*Oregon Climate Service 2000, 2005*).

totals experienced in the winter months. Synoptic-scale cyclonic weather systems, and associated fronts, generally provide the mechanism for producing precipitation annual maxima (the greatest precipitation amount in a 12-month period for a specified duration at a given measurement site) at 24-hour and longer durations. Precipitation is enhanced in mountain areas as atmospheric moisture is lifted over the Coastal, Cascade, Klamath and Blue Mountains. This orographic component of precipitation has the greatest effect at 24-hour and longer time scales, and can significantly enhance the total accumulation of precipitation over several days. Precipitation annual maxima at 24-hour duration occur predominately in the fall and winter seasons in western Oregon and on east slopes of the Cascade and Klamath Mountains. Areas of eastern Oregon experience precipitation annual maxima at the 24-hour duration in both the fall and winter months as well as the spring and summer months. Additional information on the seasonality of precipitation annual maxima is presented in the discussion of climatic regions.

# 3.0 DATA SOURCES

A precipitation annual maximum is the greatest precipitation amount in a 12-month period for a specified duration at a given measurement site. For the purpose of this study, the calendar year, January 1$^{st}$ through December 31$^{st}$ was used for determining 24-hour precipitation annual maxima.

Precipitation annual maxima and associated storm dates were obtained from precipitation records from a variety of sources. The majority of data were obtained from electronic files of the National Climatic Data Center (NCDC). Data from SNOTEL gages (see description in Section 3.1) located in mountain areas were obtained from electronic files of the Natural Resources Conservation Service (NRCS). Data were also obtained for precipitation gages operated by the State of California, whose electronic files were available through the California Data Exchange Center (CDEC).

## 3.1 PRECIPITATION GAGE TYPES, METHODS OF MEASUREMENT AND REPORTING

Precipitation is measured by a variety of devices and reported by a number of different agencies in the United States. Descriptions of the gage types and reporting methods are summarized below.

*Daily Gages*

Daily gages in US are standardized devices comprised of simple vertical cylinders that are open to the atmosphere. A variety of shields for protection from the wind are used, with shields being more common now than in the past. Precipitation is measured once each day at a specified time and represents the precipitation for the previous 24-hours.

*Automated Gages*

Automated gages, such as weighing buckets, Fisher-Porter tipping buckets, and other types of tipping buckets can provide information about precipitation depth and intensity on various time scales. The standards in the US are for reporting on either hourly or 15-minute intervals. Weighing bucket gages with paper strip charts came into use in the early 1940's. Tipping bucket gages and automated reporting systems were installed at many sites beginning in the 1970's. These gages are often given the generic term, "hourly gages" to distinguish them from daily gages.

*SNOTEL Gages*

Snotel gages are a type of automated gage commonly used in mountain areas. They have external heating systems and are designed for cold weather operation. Precipitation falling as snow is converted to liquid water for measurement. SNOTEL gages were first installed in the late 1970s and reported precipitation on a daily basis on a midnight-to-midnight reporting schedule. In the late 1990s, SNOTEL gages began reporting on an hourly schedule. The short record of hourly data currently available is insufficient for regional-frequency analysis and the SNOTEL data used in this study is equivalent to a daily gage with midnight to midnight reporting.

## 3.2 NUMBER OF GAGES AND GAGE TYPES

The number of gages and gage types used in the regional analyses are summarized in Table 3.1. Both daily and hourly precipitation gages were co-located at some precipitation measurement sites. In addition, sometimes there are clusters of gages located within short distances of each other. To avoid duplication of records when this occurred, only the gage with the longest record was utilized in analyses. When both daily and hourly records, with similar record lengths, were available at a given site, the record from the hourly gage was selected. This situation resulted in 156 gages/records in the study area being marked as duplicates. After these gages/records were removed, a total of 693 gages remained to be used in the study. The resultant precipitation station network is shown in Figure 3.1. The figure shows good spatial distribution that is representative of the diverse topographic and climatic characteristics in Oregon. Figure 3.2 depicts the range of record lengths for the 693 gages of various gage types.

**Table 3.1: Number and Type of Gages Utilized for Analyses of 24-Hour Annual Maxima.**

| State | Precipitation Gage Type | | | Station-Years |
|---|---|---|---|---|
| | Daily | Hourly | Snotel | |
| Northern California | 38 | 20 | 3 | 3,136 |
| Western Idaho | 34 | 9 | 9 | 2,903 |
| Northern Nevada | 12 | 6 | 10 | 1,124 |
| Oregon | 273 | 80 | 66 | 20,096 |
| Southern Washington | 99 | 19 | 15 | 6,803 |
| **Totals** | **456** | **134** | **103** | **34,062** |

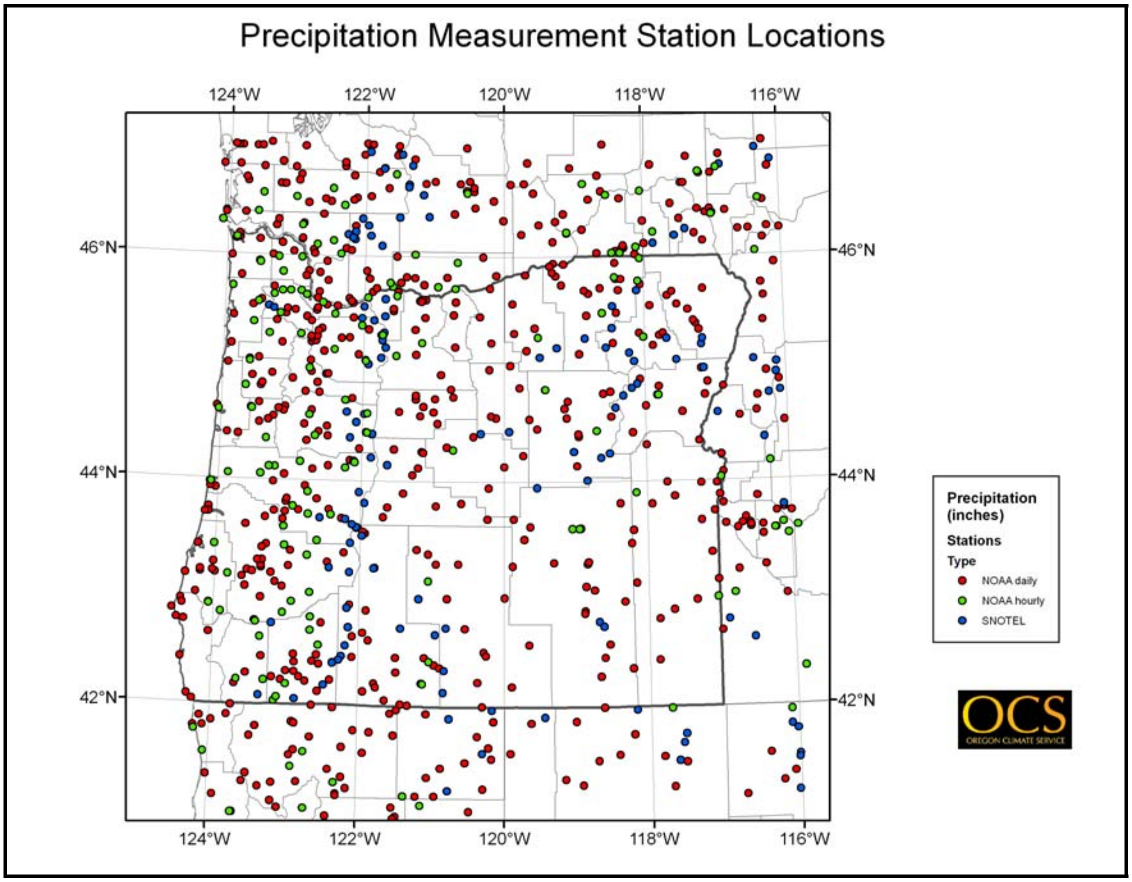


Figure 3.1: Precipitation Gaging Network for Oregon Study Area.

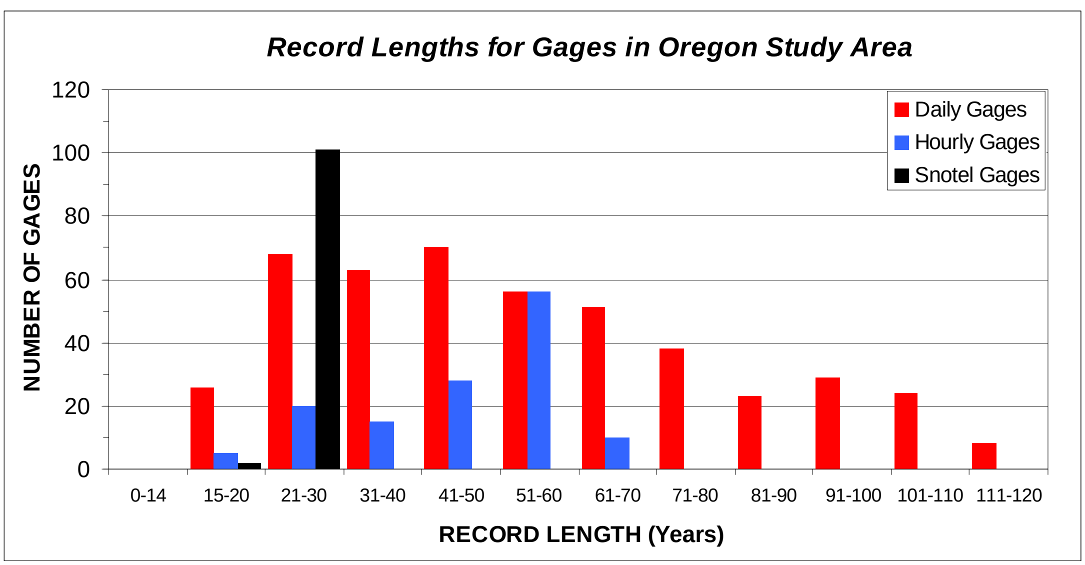


Figure 3.2: Record Lengths for Gages in Oregon Study Area.

# 4.0 DATA SCREENING AND QUALITY CHECKING

Extensive efforts were made in screening and quality checking the annual maxima data. Quality checking was needed to eliminate false annual maxima associated with a variety of data measurement, reporting, transcription errors, and incomplete reporting during some years. The record for all sites and calendar-years was checked for completeness. In addition, all records were scanned for anomalously small or large precipitation amounts and the Hosking and Wallis measure of discordancy was used to identify gages whose sample statistics were markedly different from the majority of gages in a given climatic region (*Hosking and Wallis 1993, 1997*). Suspicious gages and data were checked to verify the validity of records. Nearby sites were also examined to corroborate the magnitude and date of occurrence of any anomalously small or large precipitation annual maxima. Data that were clearly erroneous were removed from the datasets.

## 4.1 STATIONARITY AND SERIAL INDEPENDENCE

Two underlying assumptions inherent in frequency analyses were the data were stationary over the period of observation and use, and the data at a given site (gage) were serially independent. As part of the data screening process, standard statistical tests for stationarity and serial independence were conducted.

To meet the stationarity criterion, the data had to be free from trends during the period of observation. This was confirmed by standard linear regression techniques where the station data were first rescaled by division of the at-site mean and then regressed against the year of occurrence, minus 1900. This approach allowed comparisons to be made among all gages and to interpret the relative magnitude of any trend over the past century. The average value of the slope parameter was -0.008 percent. The regression results for the collective group of gages were tested against a null hypothesis of zero slope (stationarity). The null hypothesis could not be rejected at the 5% level and the data were accepted as stationary.

To confirm independence of the annual maxima data, a serial correlation coefficient was computed for the data at each gage. The regression results for the collective group of gages were tested against a null hypothesis of zero serial correlation (independence). The null hypothesis could not be rejected at the 5 percent level. The annual maxima data were found to be serially independent, consistent with the findings in Washington and California (*Schaefer and Barker 2000; Schaefer et al. 2002, 2006*).

# 5.0 REGIONAL FREQUENCY ANALYSIS METHODOLOGY

The cornerstone of a regional frequency analysis is that data from sites within a homogeneous region can be pooled to improve the reliability of the magnitude-frequency estimates for all sites. A homogeneous region may be a geographic area delineated on a map or it may be a collection of sites having similar characteristics pertinent to the phenomenon being investigated.

Early in the study it was recognized that the climatic and topographic diversity in the study area would likely preclude the use of large geographic areas that would meet statistical criteria for homogeneity. It was decided to employ climatic/geographic regions that had basic similarities in the climatic and topographic setting. It was anticipated that these regions might require further sub-division to meet homogeneity criteria for use in regional frequency analysis.

## 5.1 DESCRIPTION OF CLIMATIC/GEOGRAPHIC REGIONS

Identification of climatologically similar regions meant delineating geographic areas that had similar climatological and topographical characteristics. To assist in this effort, a literature review was conducted to examine region designations utilized in prior studies. This included a review of NOAA Atlas 2 (*Miller et al. 1973*), studies of extreme precipitation in the Pacific Northwest (*NWS 1966, 1994*), and prior regional frequency analyses conducted in mountain areas (*Schaefer 1989, 1990, 1997; Schaefer and Barker 1997, 2000; Schaefer et al. 2002, 2006*). Each of the region designations utilized in these prior studies were based, to some extent, on the spatial distribution of mean annual precipitation and topographic characteristics, particularly the orientation of mountain ranges relative to common storm tracks.

This information was augmented by seasonality analyses of 24-hour precipitation annual maxima. Those analyses revealed winter storms to be the dominate events in western Oregon and in the Cascade and Klamath Mountains (Figure 5.1). Areas east of the eastern Cascade Foothills exhibited seasonality characteristics with a mixture of winter (Nov-Apr), spring-summer (May-Aug) and fall (Sep-Oct) annual maxima (Figures 5.1, 5.2, and 5.3).

Seventeen climatic regions and two transition zones (Figure 5.4) were identified based on information contained in the previously discussed precipitation studies; the spatial distribution of mean annual precipitation; and the seasonality characteristics of precipitation annual maxima. The magnitude and gradient of mean annual precipitation were the primary measures used to define the boundaries between the regions. The following sections contain descriptions of the climatic regions and progress from climatic regions nearest the Pacific coast eastward across the study area.

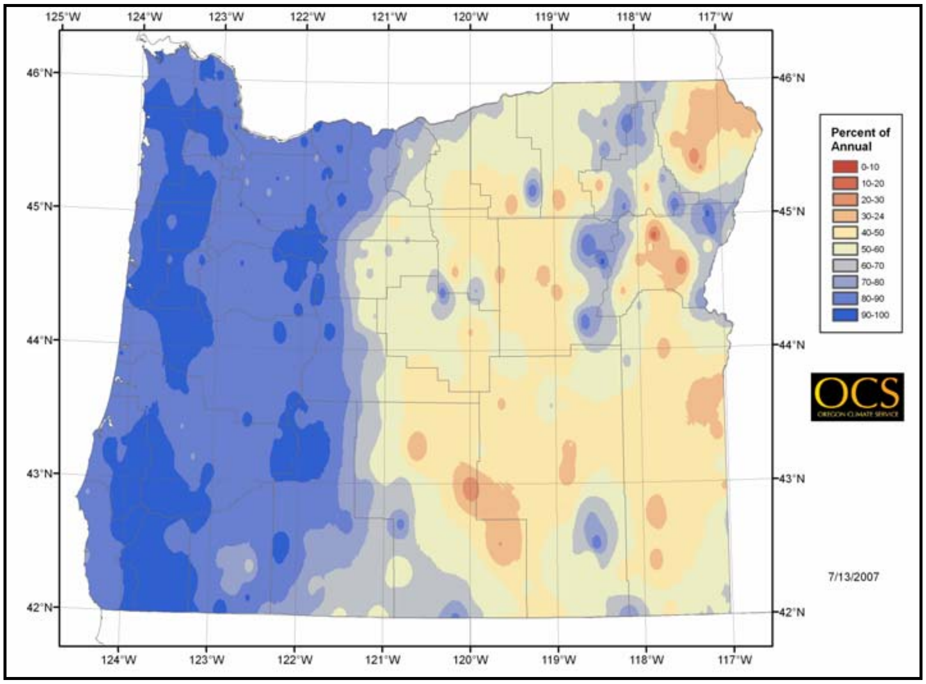


Figure 5.1: Frequency of Winter (November – April) 24-Hour Annual Maxima for Oregon Study Area.

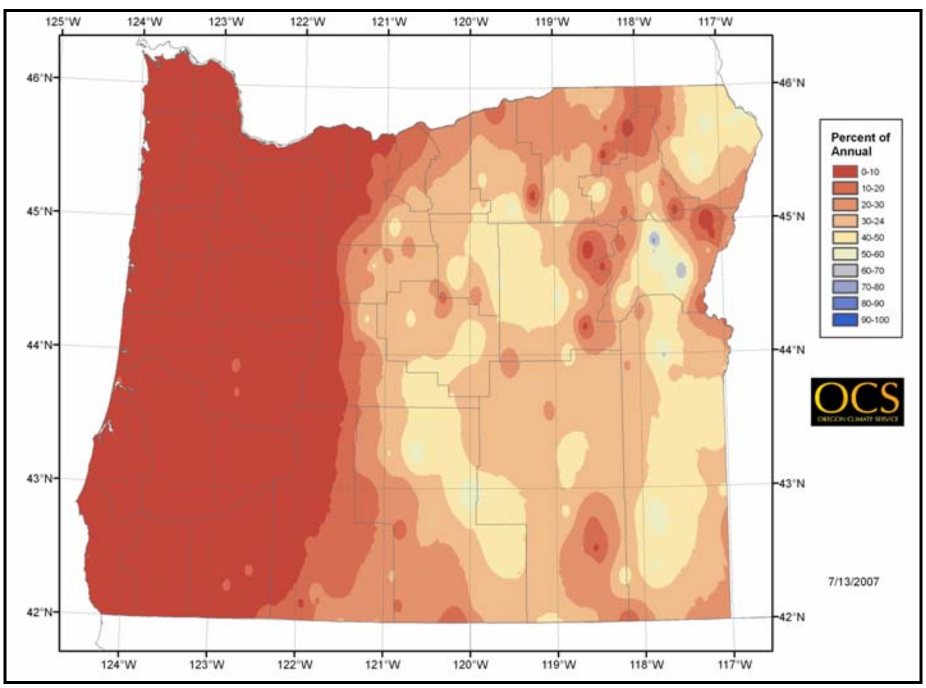


Figure 5.2: Frequency of Spring-Summer (May – August) 24-Hour Annual Maxima for Oregon Study Area.

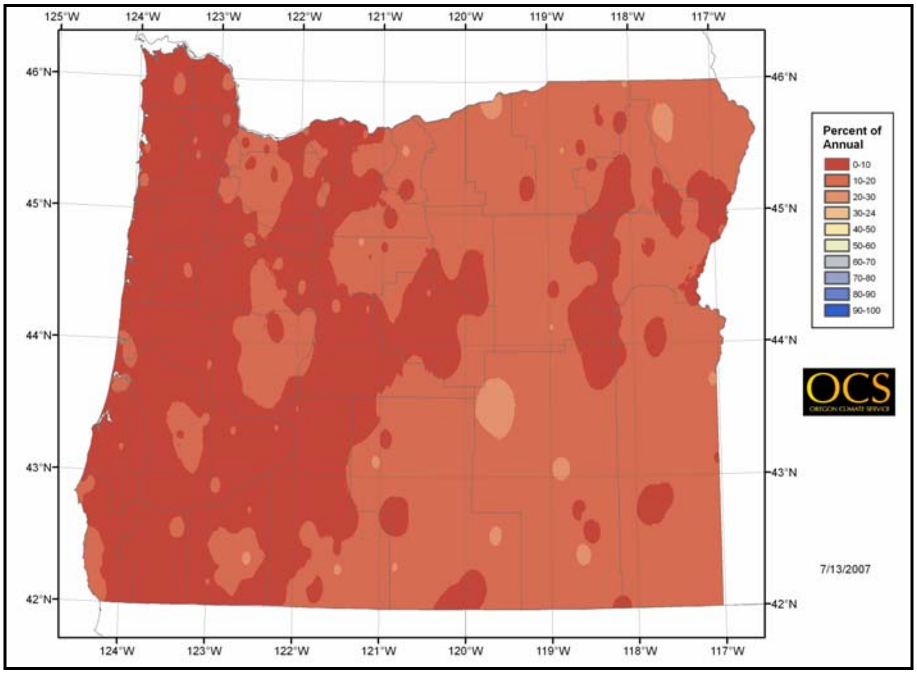


Figure 5.3: Frequency of Fall (September – October) 24-Hour Annual Maxima for Oregon Study Area.

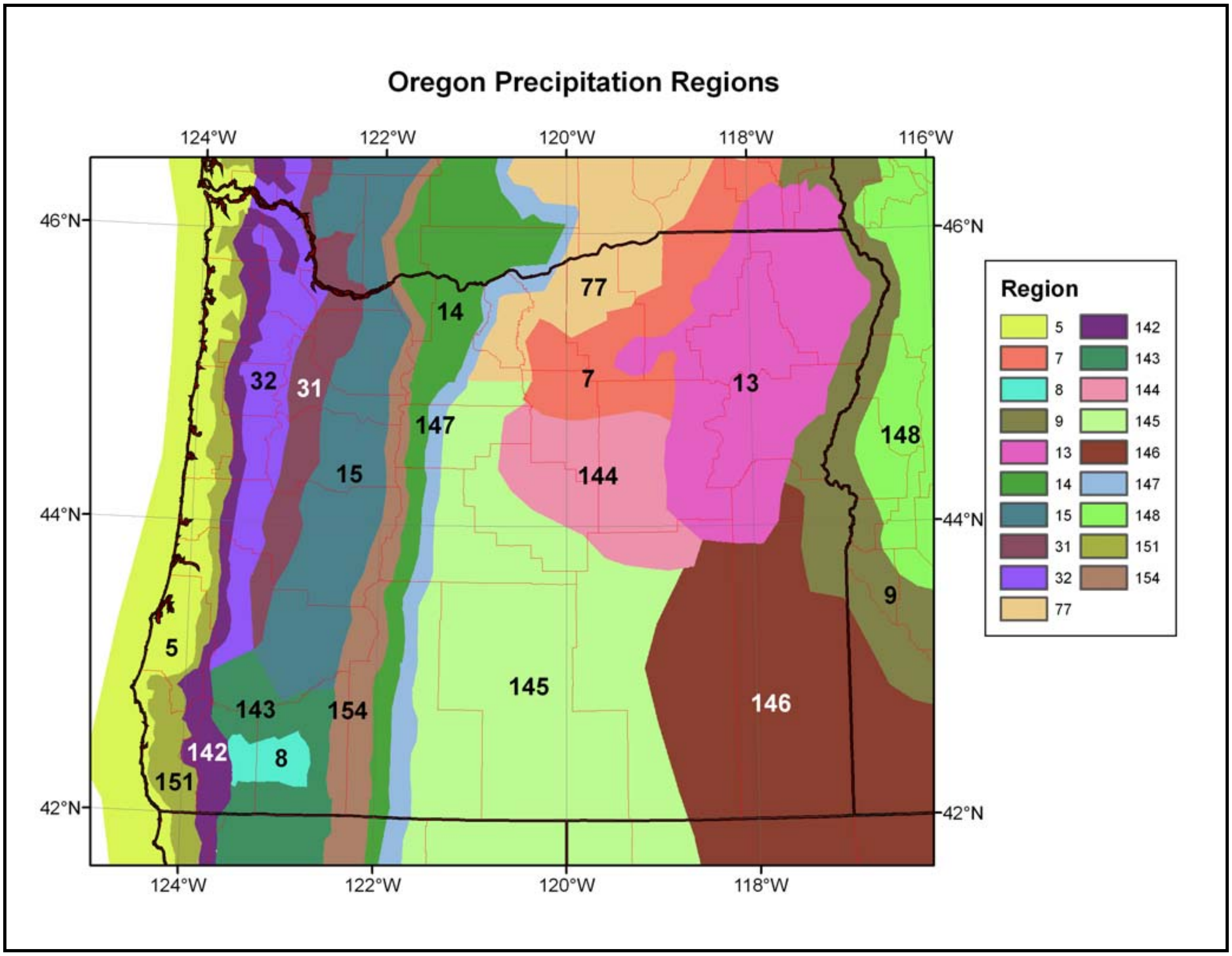


Figure 5.4: Delineation of Climatic Regions and Transition Zones for Oregon State and Surrounding Areas

## 5.2 CLIMATIC REGIONS FOR WESTERN OREGON STUDY AREA

### Region 5 - Coastal Lowlands

This region includes the lowlands along the west coast of southern Washington, Oregon and northern California that are open to the Pacific Ocean. The eastern boundary is a generalized contour line of 1,000 feet elevation in the foothills of the coastal mountains.

### Region 151 - Coastal Mountains West

This region includes the windward faces of the Coastal Mountains in southern Washington, Oregon and northern California above a generalized contour line of 1,000 feet elevation. These areas are bounded to the west by the 1,000 feet contour line, and bounded to the east by the ridgeline of mean annual precipitation near the crest line of the Coastal Mountains.

### Region 142 - Coastal Mountains East

This region includes the leeward faces of the Coastal Mountains in southern Washington, Oregon, and northern California above a generalized contour line of 1,000 feet elevation. These areas are bounded to the west by the ridgeline of mean annual precipitation near the crest line of the mountain barrier, and bounded to the east by the 1,000 feet contour line.

### Region 32 - Interior Lowlands West

The interior lowlands, primarily in the Willamette Valley, are below a generalized contour line of 1,000 feet elevation and are bounded to the east by the trough-line of mean annual precipitation through the Willamette Valley. This is a zone of low orography where mean annual precipitation generally decreases from west to east.

### Region 31 - Interior Lowlands East

The interior lowlands, primarily in the Willamette Valley, are below a generalized contour line of 1,000 feet elevation and are bounded to the west by the trough-line of mean annual precipitation through the Willamette Valley. This is a zone of low orography where mean annual precipitation generally increases from west to east.

### Region 15 - West Slopes of Cascade Mountains

This region is comprised of the windward faces of the Cascade Mountains in southern Washington, Oregon, and northern California, above a generalized contour line of 1,000 feet elevation. This region is bounded to the east by the ridgeline of mean annual precipitation near the Cascade crest that forms the boundary with Region 14.

### Region 8 – Rogue Valley

This region is comprised of low elevation areas in southwestern Oregon between Medford and Grants Pass that reside in a rain-shadow created by the Coastal Mountains to the southwest.

### Region 143 – Klamath Mountains and West Slope of Cascade Mountains

This region is comprised of the windward faces of the Klamath and Cascade Mountains in southern Oregon and northern California. This region is bounded to the west by the leeward faces of the Coastal Range (Region 142) and to the east by the ridgeline of mean annual precipitation near the Cascade crest.

## 5.3 CLIMATIC REGIONS FOR EASTERN OREGON STUDY AREA

### Transition Zone 154 - Cascade Crest Transition Zone

This is a transition zone used for spatial smoothing of precipitation and is located near the crest of the Cascade Mountains between the west slopes of the Cascade Mountains (Regions 15 and 143) and the east slopes of the Cascade Mountains (Region 14). The transition zone has an average width of about six miles and the width varies with the steepness of the gradient of mean annual precipitation. This zone is wider where mean annual precipitation changes more slowly eastward of the Crest of the Cascade and Klamath Mountains. The transition narrows where there is a rapid drop-off of mean annual precipitation on the steeper leeward slopes of the Mountains.

## Region 14 - East Slopes of Cascade and Klamath Mountains

This region is comprised of mountain areas on the east slopes of the Cascade and Klamath Mountains where precipitation annual maxima are produced predominately by winter storm events. This region is bounded to the west by the ridgeline of mean annual precipitation that generally parallels the crest line of the Cascade and Klamath Mountains. Region 14 is bounded to the east by the generalized contour line of 12-inches mean annual precipitation.

## Transition Zone 147 - Cascade Foothills Transition Zone

This is a transition zone used for spatial smoothing of L-moment ratio statistics and precipitation in the eastern foothills of the Cascade Mountains. The transition zone is located between the east slopes of the Cascade Mountains (Region 14) and arid and semi-arid areas to the east. It also extends southward into the eastern Klamath Mountains. The transition zone has an average width of about 6 mile. The width varies with the steepness of the gradient of mean annual precipitation. The transition zone is narrower where there is a rapid drop-off of mean annual precipitation in the foothills of the Cascade Mountains.

## Region 77 - Central Basin

The Central Basin region is comprised of the Columbia Basin and adjacent low elevation (non-orographic) areas in eastern Washington that extend into northern Oregon. It is bounded to the west by Region 14. The region is bounded to the northeast and southeast by the generalized (smoothed) contour line of 12-inches mean annual precipitation.

## Region 7 – Pendleton-Palouse

This region is comprised of a mixture of lowland areas of low to moderate relief and extensive valley areas between mountain barriers. This includes areas near the Palouse, in southern Washington, and Pendleton, in northern Oregon. The region is bounded to the northwest by Region 77, which generally conforms to the contour line of 12-inches mean annual precipitation at the eastern edge of the Central Basin. It is bounded to the southeast by the Blue Mountains at the contour line of 22-inches mean annual precipitation.

## Region 13 – Wallowa and Blue Mountains

This region is comprised of mountain areas in the northeastern part of Oregon where there is a significant orographic component to precipitation magnitudes. Mean annual precipitation ranges from a minimum of 22-inches to over 70-inches in the mountain areas. The western boundary of this region generally conforms to the contour line of 22-inches mean annual precipitation.

## Region 9 – Snake River Canyon

This region is comprised of areas within and adjacent to the Snake River Canyon along the eastern border of Oregon.

### Region 148 – Western Idaho Mountains

This region is comprised of mountain areas in western Idaho including the Selkirk, Clearwater and Salmon Mountains, where there is a significant orographic component to precipitation magnitudes. Mean annual precipitation ranges from a minimum of 22-inches to over 70-inches in these mountain areas. Region 9 forms the western boundary for this region.

### Region 144 – Ochoco and Malheur

This region is comprised of mountain areas within the Ochoco and Malheur National Forests in central Oregon.

### Region 145 – Fremont and Warner

This region is comprised of leeward slope mountain areas residing to the east of the Cascade Mountains in the Freemont National Forest and Warner Mountains. This region is bounded to the west by the crest line of mean annual precipitation in the Cascade Mountains (Regions 15 and 143) and bounded to the east by Climatic Region 146.

### Region 146 –Pueblo and Crooked Creek Mountains

This region is a high desert intermountain area located in southeastern Oregon and northern Nevada. It is bounded to the west by the Fremont and Warner Region (Region 145).

## 5.4 REGIONAL GROWTH CURVE

Implicit in the definition of a homogeneous region, is the condition that all sites can be described by one probability distribution having common distribution parameters after the site data are rescaled by their at-site mean. Thus, all sites within a homogeneous region have a common regional magnitude-frequency curve (regional growth curve, Figure 5.5) that becomes site-specific after scaling by the at-site mean of the data from the specific site of interest. Thus, the at-site inverse Cumulative Distribution Function (CDF) is calculated as follows:

$$Q_i(F) = \hat{\mu}_i \; q(F) \qquad \textbf{(5-1)}$$

In this equation; $Q_i(F)$ is the at-site inverse Cumulative Distribution Function (CDF), $\hat{\mu}_i$ is the estimate of the population at-site mean, and $q(F)$ is the regional growth curve, regional inverse CDF. This is often called an index-flood approach to regional frequency analyses and was first proposed by Dalrymple (*1960*) and expanded by Wallis (*1980 and 1982*).

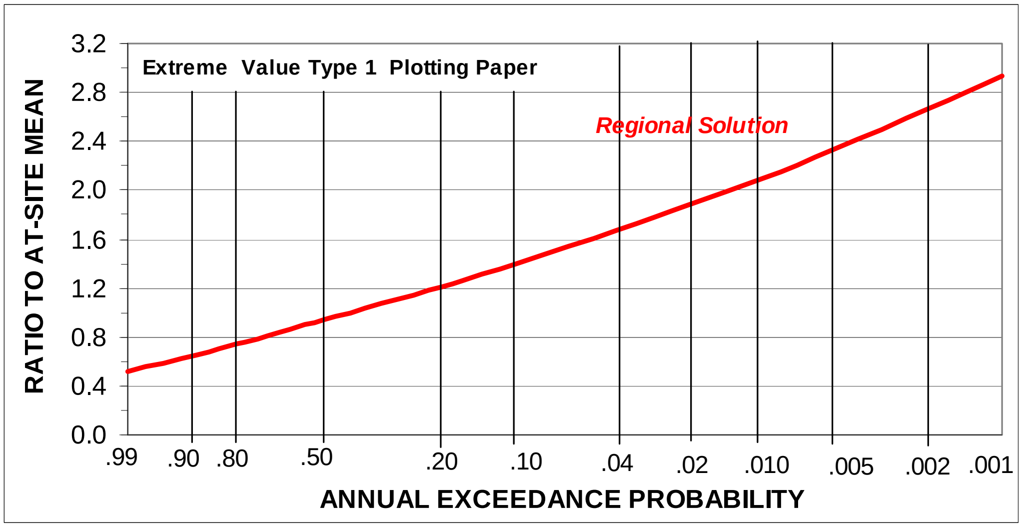


Figure 5.5: Example of Regional Growth Curve.

# 6.0 FORMING HOMOGENEOUS SUB-REGIONS

Identification and formation of homogeneous regions is an iterative process. It was anticipated that the climatic regions defined here would require further subdivision to meet homogeneity criteria. The methodology used herein for forming and testing proposed homogeneous sub-regions follows the procedures recommended by Hosking and Wallis (*1993, 1997*).

The basic approach was to propose homogeneous sub-regions (grouping of sites/gages) based on the similarity of the physical/meteorological characteristics of the sites. L-moment statistics were then used to estimate the variability and skewness of the pooled regional data and to test for heterogeneity as a basis for accepting or rejecting the proposed sub-region formulation (Appendix C) (*Hosking and Wallis 1993, 1997*).

In general, proposed homogeneous sub-regions can be formed by utilizing some measure(s) of physical and/or climatological characteristics for assigning sites/gages to sub-regions. Candidates for physical features included such measures as: site elevation; elevation averaged over some grid size; localized topographic slope; macro topographic slope averaged over some grid size; distance from the coast or source of moisture; distance to sheltering mountains or ridgelines; and latitude or longitude (*Miller et al. 1973; NWS 1966, 1994*). Candidate climatological characteristics included such measures as: mean annual precipitation; precipitation during a given season; seasonality of extreme storms; and seasonal temperature/dewpoint indices.

A review of the topographic and climatological characteristics in the Oregon study area showed that the 17 climatic regions already had similarities regarding several of the physical and climatological measures listed above. As such, only two measures, mean annual precipitation (MAP) and latitude were needed for grouping of sites/gages into homogeneous sub-regions within a given climatic region. Homogeneous sub-regions were therefore formed with gages/sites within small ranges of MAP and latitude.

## 6.1 HETEROGENEITY MEASURES OF PROPOSED HOMOGENEOUS SUB-REGIONS

Heterogeneity measures were developed by Hosking and Wallis as indicators of the amount of heterogeneity in the L-moment ratios for a collection of sites/gages (*1993, 1997*). The statistics H1 and H2 measure the relative variability of observed L-Cv and L-Skewness sample statistics, respectively, for gages/sites in a sub-region. Specifically, these measures compared the observed variability to that expected from a large sample drawn from a homogeneous region of the Kappa distribution having weighted average L-moment ratios that were observed in the sub-region (*Hosking and Wallis 1997; Hosking 1988*). Initial recommendations from Hosking and Wallis were that: regions with H1 and H2 values less than 1.00 were acceptably homogeneous; values between 1.00 and 2.00 were possibly heterogeneous; and values greater than 2.00 indicated definite heterogeneity. When H1 and H2 values exceeded 2.00, Hosking and Wallis recommended that redefinition of the region and/or reassignment of sites/gages should be considered (*1993, 1997*)

These heterogeneity criteria measure statistical heterogeneity from known distributions and do not account for variability that arises from other sources. Most cooperative precipitation measurement networks include gages operated by various organizations and individuals that provide a varied level of quality control. Therefore, precipitation measurements often contain additional variability due to: gages being moved during the many years of operation; frequent change of operators and level of diligence in timely measurement; missing data arising from inconsistent reporting; lack of attention to measurement precision; and localized site and wind condition changes over time due to the construction of building or the growth of trees in the vicinity of the gage. Recognizing this additional variability, Wallis suggested that for precipitation annual maxima, H1 values less than 2.00 may be considered acceptably homogeneous and H1 values greater than 3.00 would be indicative of heterogeneity (*1997*). Both the H1 and H2 measures will be used later to assess the relative heterogeneity in proposed sub-regions.

## 6.2 ACCEPTANCE OF PROPOSED HOMOGENEOUS SUB-REGIONS

When a proposed sub-region is found to satisfy homogeneity criteria, the regional L-moment ratios are then used to conduct goodness-of-fit tests to assist in selecting a suitable probability distribution, and to estimate the parameters of the regional distribution (*Hosking and Wallis 1993, 1997*). Examples of this type of approach are described for Washington State (*Schaefer 1990; Schaefer et al. 2002, 2006*), southern British Columbia (*Schaefer 1997*), and the Sierra Mountains in California (*Schaefer and Barker* 2000). The basic approach adapted to this study is summarized in adopted methodology below.

### Adopted Methodology

1. Form proposed homogeneous sub-regions by assigning gages within a climatic region to groups within a small range of mean annual precipitation and a small range of latitude.
2. Compute L-moment sample statistics for gages within the proposed homogeneous sub-regions.
3. Use L-moment heterogeneity criteria to test proposed homogeneous sub-regions.
4. Develop a mathematical predictor for describing the behavior of regional L-Cv and L-Skewness values with mean annual precipitation and latitude across the climatic region.
5. Conduct goodness-of-fit tests to identify a suitable probability distribution for regional growth curve.
6. Solve for the distribution parameters of the selected probability distribution for each sub-region using the regional values of L-Cv and L-Skewness (from Step 4).

## 6.3 SYSTEMATIC VARIATION OF L-CV AND L-SKEWNESS WITH MEAN ANNUAL PRECIPITATION AND LATITUDE

As described previously, climatic regions were comprised of numerous homogeneous sub-regions. A mathematical relationship was therefore needed to link the sub-regions and provide an estimate of L-moment ratios, L-Cv and L-Skewness across climatic regions, and for the full study area. The predictor relationships were formulated to provide continuity with adjacent climatic regions. This approach had the benefit of eliminating or minimizing discontinuities at the boundaries between the climatic regions. Recognizing that the sub-regions were formed as groupings of gages within a small range of mean annual precipitation (MAP) and latitude, it was found that MAP and latitude were suitable explanatory variables. Predictor equations for L-Cv and L-Skewness were obtained through regression analyses and took a variety of forms that included various combinations of $2^{nd}$ order polynomials; linear and exponential formulations. Details about the predictor equations will be discussed in the sections that follow.

# 7.0 ANALYSES OF 24-HOUR PRECIPITATION ANNUAL MAXIMA

As described previously, homogeneous sub-regions were formed as collections of gages within small ranges of mean annual precipitation (MAP) and latitude within each of the climatic regions. The ranges of MAP and latitude were chosen so that about 7 to 15 gages, 350 to 750 station-years of record, were included in each sub-region. A minimum record length of 15-years was required to be included in the analysis. Record lengths at precipitation measurement stations varied from a minimum of 15-years to near 120-years; with nearly 50 percent of the stations having record lengths in excess of 50-years. Figure 3.2 depicts the number of stations within various ranges of record length.

As the analysis progressed, it was found that gages in adjoining climatic regions could often be grouped together with gages from the climatic region being analyzed. It was also found that resampling of gages in a region, or grouping of regions, was often required to separately evaluate the variation of L-Cv and L-Skewness with MAP and latitude. This approach resulted in the grouping of climatic regions as shown in Table 7.1 with a total of 68 sub-regions for the 24-hour duration.

**Table 7.1: Number of Sub-Regions, Gages and Station-Years of Record for 24-Hour Duration Annual Maxima.**

| Study Area | Climatic Regions | Number Of Sub-Regions | Number Of Gages | Station-Years Of Record |
|---|---|---|---|---|
| Western Oregon | 5, 151 | 7 | 60 | 3,227 |
| | 142, 32, 31, 15 (North of 43°N) | 19 | 143 | 6,692 |
| | 142, 8, 143 (South of 43°N) | 10 | 88 | 4,061 |
| Eastern Oregon | 154, 14, 147 | 11 | 102 | 4,632 |
| | 77, 7, 13, 144, 9, 148, 145, 146 | 21 | 327 | 16,427 |

## 7.1 REGIONAL SOLUTIONS FOR L-MOMENT RATIOS, L-CV AND L-SKEWNESS

Regional predictor equations for L-moment ratios were developed for groupings of climatic sub-regions using regression methods for various mathematical formulations with MAP and latitude as explanatory variables. Care was taken to select mathematical formulations that had the capability of minimizing discontinuities with adjoining climatic regions.

### 7.1.1 Spatial Variability of L-Cv

In western Oregon, latitude was found to explain the greatest proportion of variability in L-Cv, with MAP being of secondary importance. In examining the spatial variation of L-Cv over large areas of the west coast of North America, MAP was found to be an excellent explanatory variable for southern British Columbia and Washington State (*Schaefer 1997; Schaefer et al. 2002, 2006*). At the latitude of about 45°N, a combination of latitude and MAP provided the best predictors of L-Cv. Further south, on the west face of the Sierras, latitude was found to be the best predictor of L-Cv (*Schaefer and Barker 2000*). The change in correlation characteristics with MAP and latitude appeared to be associated with the frequency of storm tracks originating over the Pacific Ocean that affected different areas along the west coast. Areas in southern British Columbia and Washington were more centrally located relative to average storm tracks. Areas in southern Oregon and California were on the southerly end of the storm track, where there was greater variability in the number of large storms in any given year. The following relationships (Equations 7-1, 7-2, 7-3) provided the best predictors of spatial variation in L-Cv in the western portions of the Oregon study area. Figures 7.1 and 7.2 depict examples of the level-of-success of the predictor equations and a typical relationship of L-Cv with latitude (degrees Lat).

***Regions 5, 151***

$$L\text{-}C_v = 2.5883 - 0.1010 * Lat + 0.001039 * Lat * Lat + 0.08 * EXP(-0.060 * MAP) \qquad \textbf{(7-1)}$$

***Regions 142, 32, 31, 15; North of 43°N***

$$L\text{-}C_v = 9.2169 - 0.3948 * Lat + 0.004297 * Lat * Lat + 0.08 * EXP(-0.060 * MAP) \qquad \textbf{(7-2)}$$

***Regions 142, 8, 143; South of 43°N***

$$L\text{-}C_v = 0.08 * EXP(-0.040 * MAP) + 0.172 \qquad \textbf{(7-3)}$$

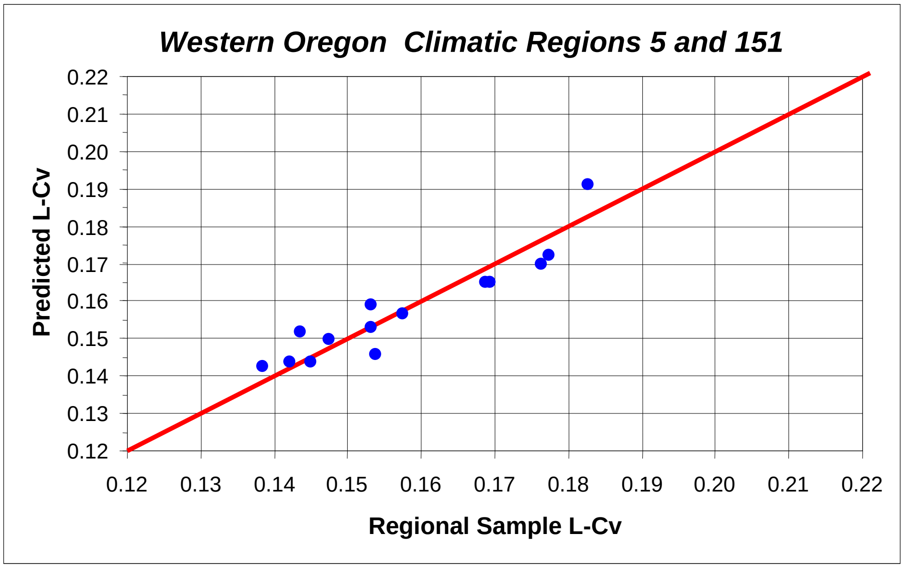


Figure 7.1: Comparison of Observed Regional Sample Values of L-Cv and Predicted L-Cv (Equation 7-1) for Climatic Regions 5 and 151.

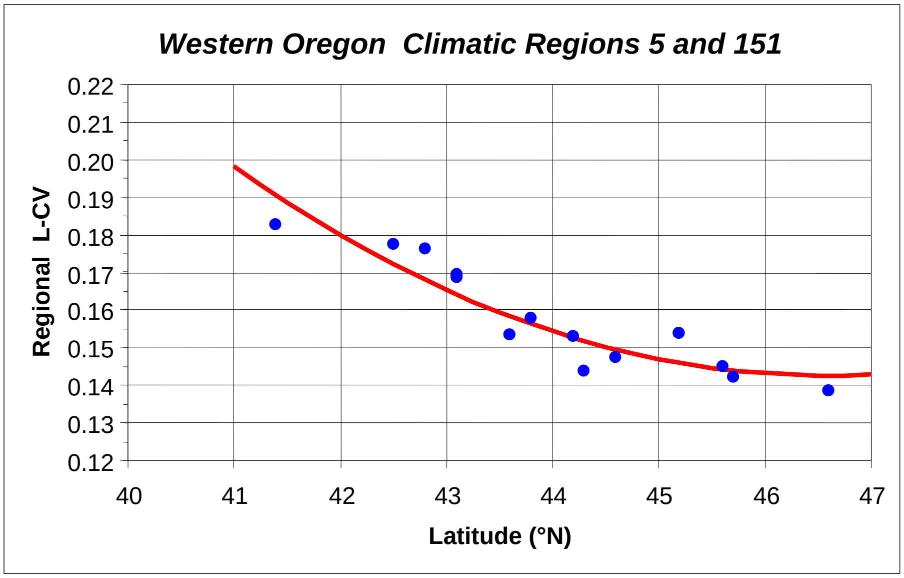


Figure 7.2: Relationship of Regional L-Cv with Latitude for Climatic Regions 5 and 151.

In eastern Oregon, MAP was found to be the primary factor in explaining spatial variation of L-Cv (Equations 7-4, 7-5). There was limited influence of latitude in the predictor equations for eastern Oregon. As indicated previously, the stronger correlation of latitude with L-Cv, in the western portion of the study area, appeared to be associated with the winter storm season that is dominant in that area. Conversely, precipitation annual maxima in eastern Oregon occurred across a wide range of seasons and the winter storm season is only a partial contributor. Figures 7.3 and 7.4 depict examples of the level-of-success of the predictor equations and a typical relationship of L-Cv with mean annual precipitation.

***Regions 154, 14, 147***

$L\text{-}C_v = 0.2195 - 0.00103*MAP + 0.00000036*MAP*MAP$; MAP < 92-inch **(7-4)**

$L\text{-}C_v = 0.155$; MAP $\geq$ 92-inch

***Regions 77, 7, 13, 144, 9, 148, 145, 146***

**(7-5)**

$L\text{-}C_v = 0.4071 - 0.0029*MAP + 0.0000268*MAP*MAP - 0.0041*Lat$; MAP < 55-inch

$L\text{-}C_v = 0.3288 - 0.0041*Lat$ MAP $\geq$ 55-inch

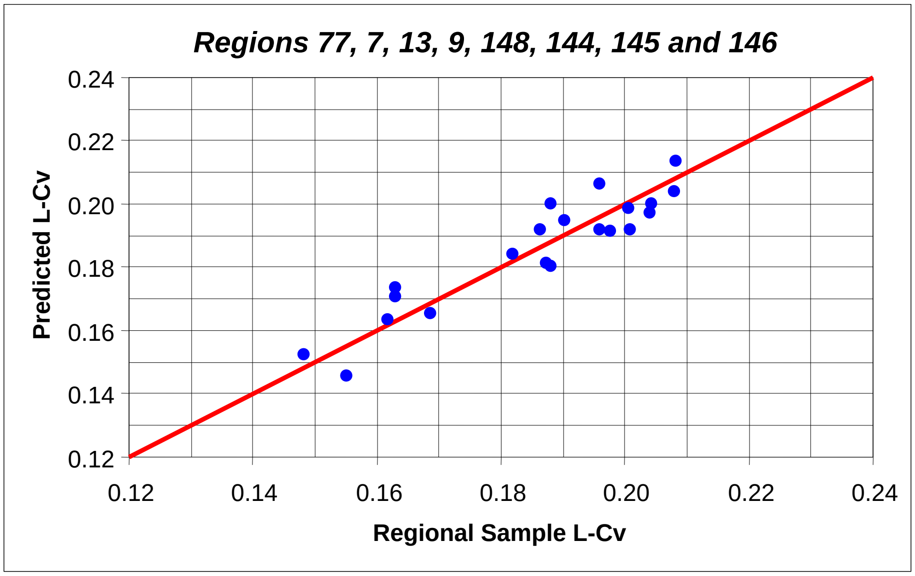


Figure 7.3: Comparison of Observed Regional Sample Values of L-Cv and Predicted L-Cv (Equation 7-1) for Climatic Regions 77, 7, 13, 9, 148, 144, 145, and 146.

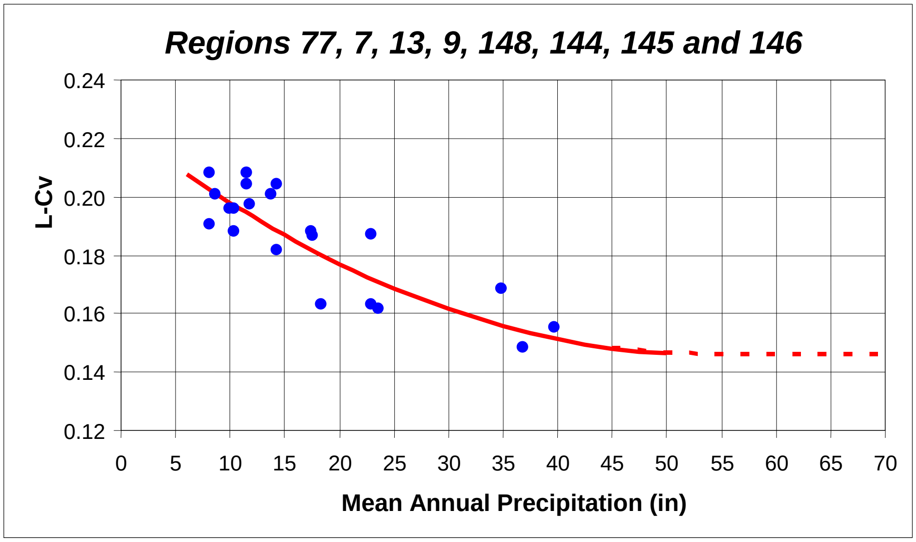


Figure 7.4: Relationship of Regional L-Cv with Mean Annual Precipitation for Climatic Regions 77, 7, 13, 9, 148, 144, 145, and 146.

### *Transition Zones*

Transition zones were needed for mapping of L-Cv in several localized geographic areas. This was due to relatively steep gradients for L-Cv and/or moderate discontinuities in the predicted values of L-Cv at boundaries of adjacent climatic regions. Specifically, transition zones were used in the crest of the Cascade and Klamath Mountains (Transition Zone 154), and at the Foothills of the Cascade Mountains and eastern Klamath Mountains (Transition Zone 147). Transition Zone 147 delineated the break in the magnitudes of the variability measure L-Cv for the East Slopes of the Cascade Mountains relative to that in the arid and semi-arid regions further east (Figure 7.5). Review of Figures 5.1-5.3 also showed that a sharp change in storm seasonality accompanies this distinctive change in the magnitude of L-Cv at the Cascade foothills. Specifically, 24-hour precipitation annual maxima was predominately produced by winter storms on the east slopes of the Cascade Mountains. In areas further east, the 24-hour annual maxima were produced by a mixture of winter, spring and summer storms (Figures 5.1-5.3).

Figure 7.5 depicts the behavior of L-Cv across the eastern portion of the study area. This behavior of L-Cv, where there is an abrupt change at the foothills of the Cascade Mountains (Transition Zone 147), matched that observed in a prior study for eastern Washington (*Schaefer et al. 2006*). The figure depicts the relationship at latitude 44°N. There were very minor changes in L-Cv values to the north (smaller L-Cv) and to the south (larger L-Cv).

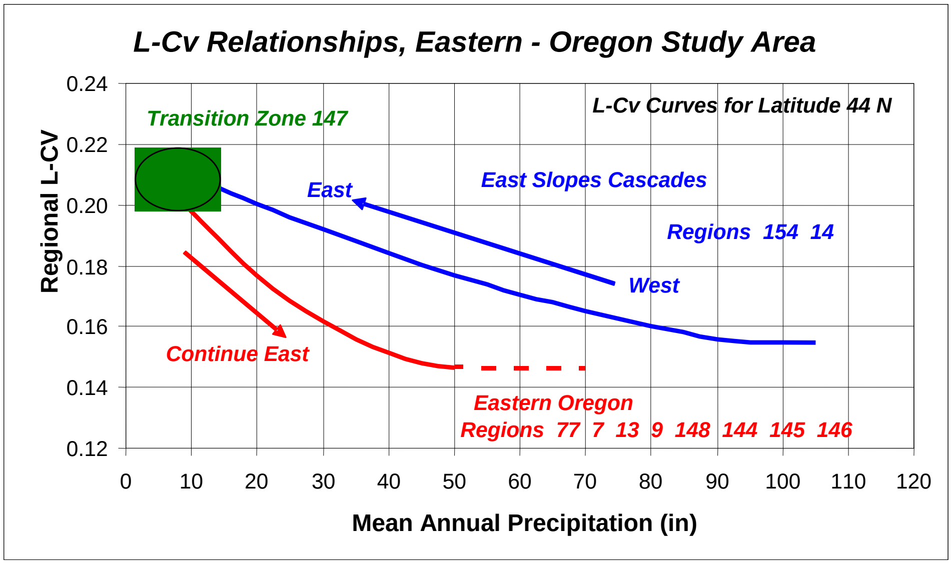


Figure 7.5: Behavior of L-Cv progressing eastward from the Crest of the Cascade Mountains, through the Eastern Foothills, and Across Eastern Oregon at Latitude 44°N.

### 7.1.2 Spatial Variability of L-Skewness

Skewness measures are highly variable for the record lengths commonly available for precipitation-frequency analysis. This greater sampling variability is exhibited in larger Root Mean Square Error (RMSE) values of the predictor equations for L-Skewness (Equations 7-6 and 7-7) (Table 7.2). Regional predictor equations for L-Skewness were developed in the same manner as that described above for L-Cv. Two predictor equations for L-Skewness were developed, one each, for the western and eastern portions of the study area. Homogeneous sub-regions, representing broad areas, were grouped for analysis to help reduce the effects of sampling variability and allow for a determination of the underlying behavior of L-Skewness. Figures 7.6 and 7.7 depict the predictor equations for L-Skewness for the western and eastern portions of the study area, respectively.

***Regions 5, 151, 142, 3, 31, 15, 8 and 143***

$$\text{L-Skewness} = 0.10*\text{EXP}(-0.024*\text{MAP}) + 0.3810 \; -0\ .0050*\text{Lat} \qquad \textbf{(7-6)}$$

***Regions 154, 14, 147, 77, 7, 13, 144, 9, 148, 145 and 1467***

$$\text{L-Skewness} = 0.08*\text{EXP}(-0.018*\text{MAP}) + 0.2680 \; -0\ .0025*\text{Lat} \qquad \textbf{(7-7)}$$

**Table 7.2: Root Mean Square Error (RMSE) of Predictor Equations for L-Cv and L-Skewness for Oregon Study Area.**

| Study Area | Climatic Regions | Standardized RMSE Of L-Cv Predictor Equation (Percent) | Standardized Rmse Of L-Skewness Predictor Equation (Percent) |
|---|---|---|---|
| Western Oregon | 5, 151 | 3.2 | 15 |
| | 142, 32, 31, 15 (North of 43°N) | 5.9 | |
| | 142, 8, 143 (South of 43°N) | 4.1 | |
| Eastern Oregon | 154, 14, 147 | 3.3 | 8.5 |
| | 77, 7, 13, 144, 9, 148, 145, 146 | 3.8 | |

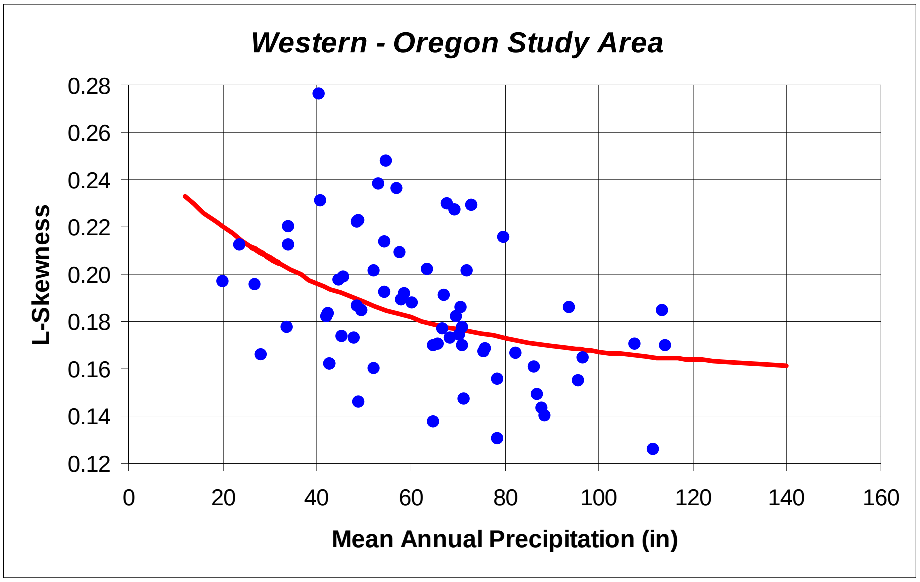


Figure 7.6: Relationship of Regional L-Skewness with Mean Annual Precipitation for Climatic Regions 5, 151, 142, 32, 31, 15, 8, and 143 in the Western Portion of Oregon Study Area.

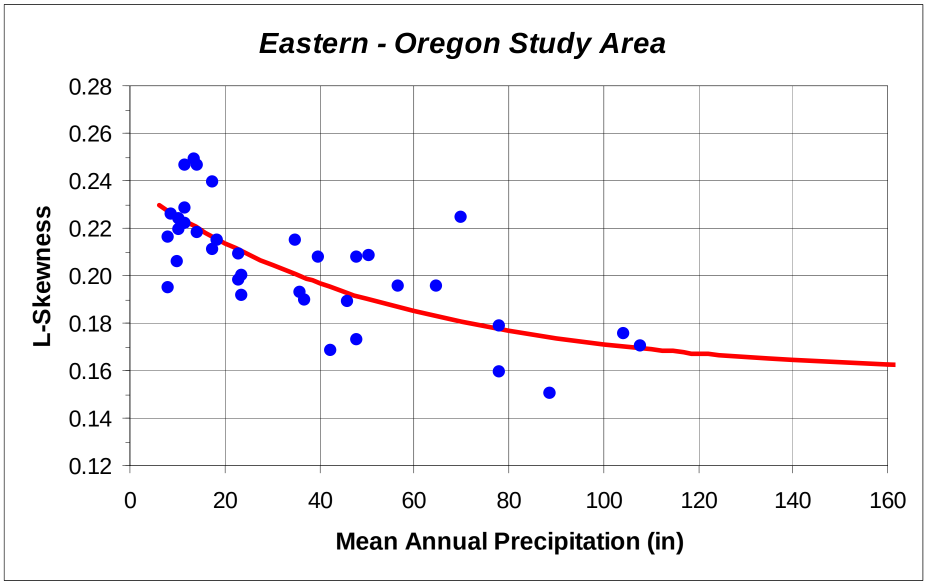


Figure 7.7: Relationship of Regional L-Skewness with Mean Annual Precipitation for Climatic Regions 154, 14, 77, 7, 13, 9, 148, 144, 145 and 146, in the Eastern Portion of Oregon Study Area.

## 7.2 HETEROGENEITY MEASURES, 24-HOUR DURATION

Heterogeneity measures H1 and H2 were used to judge the relative heterogeneity in the proposed sub-regions for L-Cv and L-Skewness, respectively (*Hosking and Wallis 1993, 1997*). Computation of H1 and H2 values for the various sub-regions indicated that nearly all sub-regions were acceptably homogeneous (Table 7.3). In those cases where computed heterogeneity measures exceeded acceptance criteria, the excursions were generally of a minor amount. In summary, small ranges of mean annual precipitation and latitude were excellent explanatory variables for grouping of stations/sites within climatic regions.

**Table 7.3: Results of Heterogeneity and Goodness-of-Fit Tests for 24-Hour Duration.**

| Study Area | Climatic Regions | Number Of Sub-Regions | Homogeneous Sub-Regions H1 ≤ 2.00 | Homogeneous Sub-Regions H2 ≤ 1.00 | Sub-Regions Accepting GEV Distribution |
|---|---|---|---|---|---|
| Western Oregon | 5, 151 | 7 | 6 | 7 | 5 |
| | 142, 32, 31, 15 (North of 43°N) | 19 | 16 | 15 | 15 |
| | 142, 8, 143 (South of 43°N) | 10 | 10 | 7 | 8 |
| Eastern Oregon | 154, 14, 147 | 11 | 10 | 7 | 6 |
| | 77, 7, 13, 144, 9, 148, 145, 146 | 21 | 18 | 17 | 18 |
| **Total** | | **68** | **60** | **53** | **52** |

## 7.3 IDENTIFICATION OF REGIONAL PROBABILITY DISTRIBUTION, 24-HOUR DURATION

One of the primary tasks in the regional analyses was to identify the best probability distribution for describing the behavior of the annual maxima data. Accordingly, a goodness-of-fit test statistic was computed for each sub-region for use in identifying the best three-parameter distribution (*Hosking and Wallis 1993, 1997*). Using the L-moment based test statistic, the Generalized Extreme Value (GEV) distribution was identified most frequently as the best three-parameter probability model (Table 7.3) (*Hosking and Wallis 1997; Schaefer et al. 2002, 2006*).

Plots of regional L-Skewness and L-Kurtosis values for 68 sub-regions in the western and eastern portions of the study area are shown in Figures 7.8 and 7.9. Nearness to the GEV distribution was clearly evident and consistent with the goodness-of-fit test results listed in Table 7.3.

The GEV was a suitable distribution for estimating precipitation quantiles out to the 500-year recurrence interval. If quantile estimates are desired for events more extreme than the 500-year recurrence interval, it would be worthwhile to refine the selection of the regional probability distribution. Given this consideration, it was decided to utilize the four-parameter Kappa distribution, which can mimic the GEV and produce a variety of regional growth curves immediately around the GEV (*Hosking 1988; Hosking and Wallis 1997*). The inverse form of the Kappa distribution is shown in the following equation (7-8):

$$q(F) = \xi + \frac{\alpha}{\kappa}\left\{1 - \left(\frac{1 - F^h}{h}\right)^{\kappa}\right\} \qquad \textbf{(7-8)}$$

In this equation: ξ, α, κ, and h are location, scale, and shape parameters, respectively.

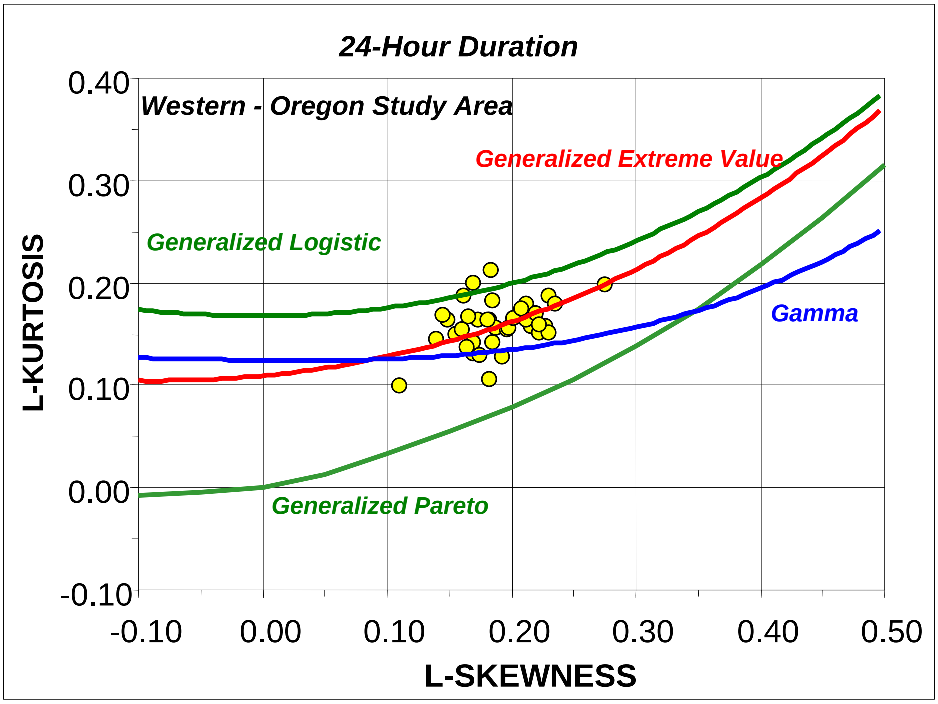


Figure 7.8: L-Moment Ratio Plot, for 24-Hour Duration, for Sub-Regions in Climatic Regions 5, 151, 142, 32, 31, 15, 8, and 143, in the Western Oregon Study Area.

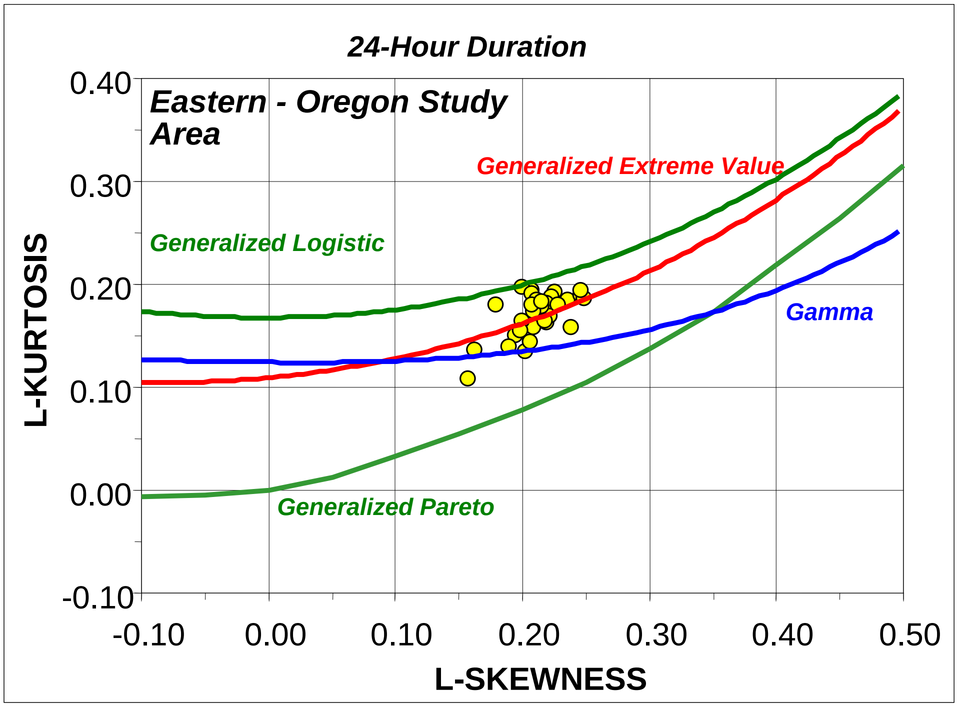


Figure 7.9: L-Moment Ratio Plot, for 24-Hour Duration, for Sub-Regions in Climatic Regions 154,14,147,77,7,13,9,148,144,145, and 146, in the Eastern Oregon Study Area.

Different distributions were produced with unique *h* values. The distributions were as follows: an *h* value of zero, led to the GEV distribution; an *h* value of one, produced the Generalized Pareto (GP) distribution; and an *h* value of -1, produced the Generalized Logistic (GL) distribution. Thus, positive values of *h* produced regional growth curves that were flatter than the GEV, and negative values of *h* produced steeper regional growth curves. Minor adjustments of *h*, near a zero value (GEV), allow fine-tuning of the regional growth curves. This minor adjustment of the *h* value only becomes important for the estimation of very rare quantiles.

To solve for an appropriate *h* value, a hierarchical approach was taken wherein the shape parameter *h* was computed as the average value from the group of sub-region solutions (*Fiorentino et al. 1979*). An average *h* value of -0.038 was computed with a standard error of estimation of approximately ± 0.058 for the western portion of the study area. For the eastern portion of the study area, an average *h* value of -0.060 was computed with a standard error of estimation of approximately ± 0.042. These values compared with an *h* value of -0.05 that was found in the prior studies in Washington (*Schaefer et al. 2002, 2006*) and eastern British Columbia (*Schaefer 1997*). A nominal *h* value of -0.05 was adopted for the Oregon study area, which was consistent with the findings of prior studies and was well within one standard deviation of the sample average. Thus a regional growth curve was produced that was slightly steeper than the GEV, for very rare events, and essentially matched the GEV out through approximately the 500-year recurrence interval.

# 8.0 PRECIPITATION MAGNITUDE-FREQUENCY ESTIMATES FOR GAGED SITES

The first step in developing a site-specific precipitation magnitude-frequency curve is to compute the regional growth curve. The findings described in the previous sections provided the information necessary to develop the regional growth curve. Specifically, the first three parameters of the Kappa distribution ($\xi$, $\alpha$, and $\kappa$) (*Hosking and Wallis 1997; Hosking 1988*) were solved using a mean of unity and the applicable regional values of L-Cv and L-Skewness, as indicated in Equations 7-1 through 7-7. The fourth parameter ($h$) of the Kappa distribution was set to the regional average value of -0.050, as discussed in the prior section. Equation 7-8 was then used to describe the regional growth curve. The site-specific precipitation-frequency curve was obtained by scaling the regional growth curve by the at-site mean.

$$\hat{\mu} = C_{nop}\,(\bar{x}) \qquad \textbf{(8-1)}$$

For gaged sites, the at-site mean ($\hat{\mu}$) could be computed from the gage mean ($\bar{x}$) using a correction factor. The correction factor accounted for the difference in sample statistics for precipitation measurement and reporting on a fixed time interval rather than on the desired 24-hour continuous basis. The correction factor ($C_{nop}$) varied with the length of the observational period (24-hours for daily gage). A correction factor of 1.13 was estimated from theoretical considerations of Weiss (*1964*) and has also been found in numerous studies (*Miller et al. 1973*). The value of 1.13 is commonly taken as a standard in humid environments subjected to numerous yearly storms and the typical duration of those storms approaches or exceeds the observational period.

In arid and semi-arid areas, there may be few noteworthy storms each year. The duration of these storms is also somewhat less than the length of the daily observational period. In these cases, it is possible that the correction factor for converting from maximum daily statistics, to maximum 24-hour precipitation statistics, is a value less than the conventional 1.13. Studies were previously conducted in Washington State to examine the magnitude of the correction factors (*Schaefer et al. 2006*). That study included precipitation stations sites in Oregon. The results of those analyses have been applied to the Oregon study area, and are listed in Table 8.1.

**Table 8.1: Correction Factors ($C_{nop}$) Used to Adjust Gage Sample Statistics**.

| Climatic Regions | Gage Type | Correction Factors 24-Hour Duration |
|---|---|---|
| *Western Oregon Study Area*<br>5, 151, 32, 31, 15, 8, 143, 154 | Daily and SNOTEL | 1.13 |
| *East Slopes Cascade and Klamath Mountains*<br>14, 147 | Daily and SNOTEL | 1.11 |
| *Eastern Oregon Study Area*<br>77, 7, 13, 9, 148, 144, 145, 146 | Daily and SNOTEL | 1.08 |
| All Regions | Automated/<br>Hourly Reporting | 1.00 |
| All Regions | Automated/<br>15-Minute Reporting | 1.00 |

## 8.1 EXAMPLES OF PRECIPITATION-FREQUENCY RELATIONSHIPS

The procedures for developing site-specific precipitation-frequency curves can be explained by using examples from existing gaged sites. The examples include a daily gauge from McMinnville, Oregon and an hourly gauge at the airport in Pendleton, Oregon.

### 8.1.1 24-hour Precipitation-Frequency Relationship: McMinnville, Oregon

The city of McMinnville, Oregon is located in Climatic Region 32 and has a daily gage. The mean annual precipitation for the site is 42.8-inches. The site is located at a latitude of 45.22º North. For the 24-hour duration, the regional value of L-Cv was 0.157, which was obtained from Equation 7-2. The regional value of L-Skewness was 0.191, which was obtained from Equation 7-6. The regional value of the h parameter was -0.05. Using a mean value of unity, the solution for the four distribution parameters of the Kappa distribution (*Hosking and Wallis 1997; Hosking 1988*), yields:

$\xi$= 0.8723, $\alpha$= 0.2132, $\kappa$= -0.0450, and h= -0.05.

Application of Equation 7-8 yielded the regional growth curve depicted in Figure 8.1. McMinnville has a daily gage with a gage mean of 2.15-inches for 104-years of record. The precipitation-frequency curve for the daily gage was obtained by scaling (multiplying) the regional growth curve with the gage mean (Figure 8.2). The observed daily annual maxima for the McMinnville site, from 1894-2006, are also depicted in Figure 8.2 for a comparison with the regional solution. There is agreement between the historical data and that predicted by the regional solution.

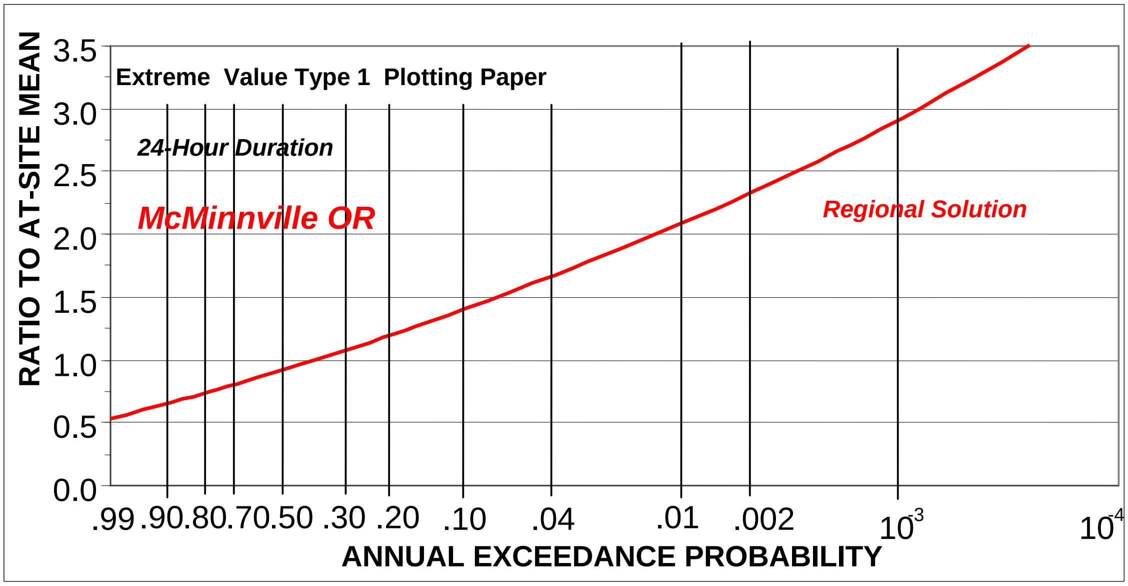


Figure 8.1: Regional Growth Curve for McMinnville, Oregon for 24-Hour Duration.

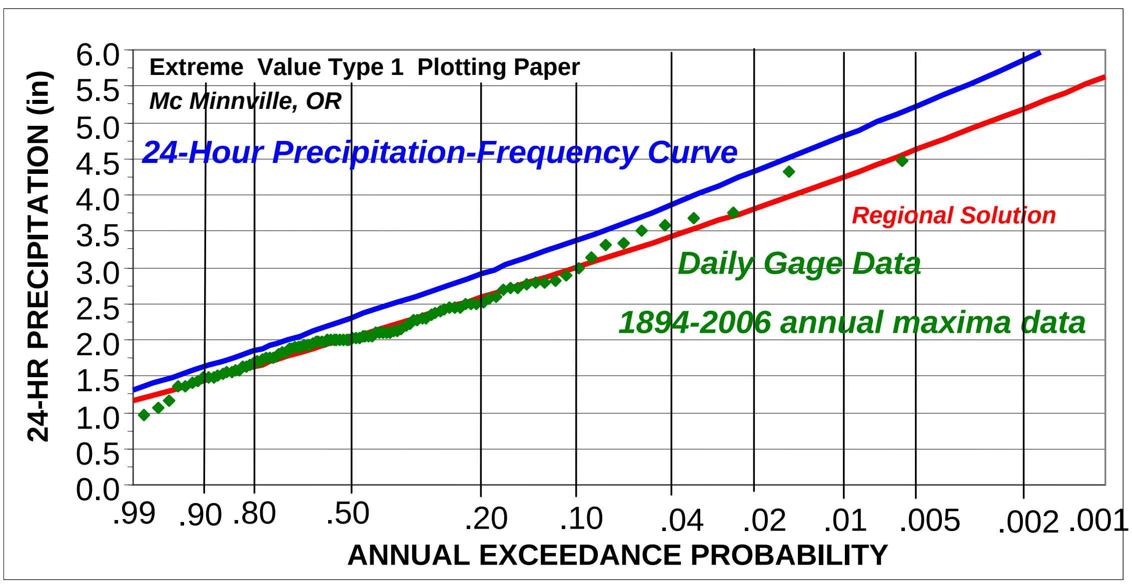


Figure 8.2: Precipitation Magnitude-Frequency Curve for McMinnville, Oregon for 24-Hour Duration.

Computation of the at-site precipitation-frequency curve (Figure 8.2) for the 24-hour duration required use of the correction factors listed in Table 8.1. Numerically, this is accomplished by multiplication of the distribution parameters for location ($\xi$) and scale ($\alpha$) by the correction factor of 1.13 and reapplying Equation 7-8. The at-site precipitation-frequency curve for the 24-hour duration at McMinnville is shown as the blue curve in Figure 8.2. These types of computations for daily and SNOTEL gages (adjusting from a fixed daily observational period to a continuous 24-hour time-interval) are incorporated in the precipitation spatial mapping products that are described in later sections.

### 8.1.2 24-hour Precipitation-Frequency Relationship: Pendleton, Oregon

Another example of a 24-hour precipitation-frequency relationship is shown for the hourly gage at the Pendleton Airport in Oregon. The Pendleton Airport is located in eastern Oregon, in Climatic Region 7, at latitude 45.68°N. The mean annual precipitation is 13.0-inches. For the 24-hour duration, the station gage mean is 0.93-inches. The regional value of L-Cv was 0.187, which was obtained from Equation 7-5. The regional value of L-Skewness was 0.217, which was obtained from Equation 7-7. The regional value of the *h* parameter was -0.05. Using a mean value of unity, the solution for the four distribution parameters of the Kappa distribution (*Hosking and Wallis 1997; Hosking 1988*), yields:

$\xi = 0.8433$, $\alpha = 0.2437$, $\kappa = -0.0839$, and $h = -0.05$.

No corrections were required for hourly gages, and the at-site mean equaled the gage mean of 0.93-inches. Application of Equation 7-8, with the distribution parameters listed above, yielded the precipitation-frequency curve shown in Figure 8.3. The 24-hour annual maxima data for 1941-2006 have been plotted for comparison. There is good agreement between the regional solution for the precipitation-frequency relationship and the historical data.

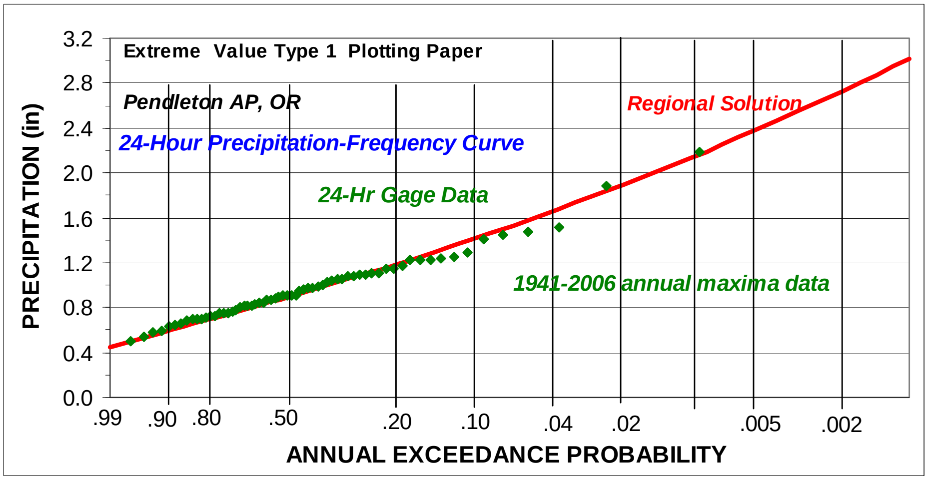


Figure 8.3: Precipitation Magnitude-Frequency Curve for 24-Hour Duration, for the Pendleton Airport in Oregon.

# 9.0 SPATIAL MAPPING OF PRECIPITATION-FREQUENCY INFORMATION

Products from the PRISM model (*Daly 1994*), operated by Oregon Climate Service, were used in conducting spatial mapping of precipitation for selected recurrence intervals. Gridded datasets and isopluvial maps were prepared for the 6-month, 2-year, 10-year, 25-year, 50-year, 100-year, 500-year and 1000-year recurrence intervals for the 24-hour duration. Precipitation estimates for the 6-month and 2-year recurrence intervals were converted from annual maxima to partial duration series equivalents (*Stedinger et al. 1992*) using the conversion developed by Langbein (*1949*). This was done to improve the frequency estimates for common events and to be consistent with past mapping products produced by the National Weather Service (*Miller et al. 1973*).

The spatial mapping of precipitation for selected recurrence intervals is dependent upon the production of two key components. The first component required is the spatial mapping of at-site means (station mean values, also called mean annual maxima). Grid-cell values of at-site means are used to scale dimensionless magnitude-frequency relationships to obtain precipitation estimates for the recurrence interval of interest. The second component required is the spatial mapping of regional statistical parameters. This provides L-moment ratio statistics L-Cv and L-Skewness applicable to each grid-cell in the study area domain, which are used to determine the probability distribution parameters for describing the magnitude-frequency relationship applicable to each grid-cell. Thus, the spatial mapping of at-site means and the spatial mapping of regional statistical parameters are the primary work products needed for isopluvial mapping.

## 9.1 MEAN ANNUAL PRECIPITATION

The gridded dataset of mean annual precipitation provided a basis for spatial mapping of both at-site means and L-moment statistics, and, is therefore, an important element of this project. An analysis of mean annual precipitation for the period from 1971 to 2000 has been completed for the study area by Oregon Climate Service using the PRISM model. The resultant map has been utilized in this study and has provided digital values of mean annual precipitation on a gridded latitude-longitude system with a nominal resolution of 0.50 minutes per grid-cell for the study area (about 0.23 $mi^2$). This resolution yields a study area domain that is a matrix of 840 rows by 1080 columns (907,200 grid-cells).

# 10.0 SPATIAL MAPPING OF AT-SITE MEANS

Spatial mapping of at-site means encompasses a number of separate tasks that address spatial behavior and seeks to minimize differences between mapped values and sample values computed at precipitation measurement stations. The first task involved developing relationships between at-site means, computed at precipitation measurement stations, and climatic/physiographic factors. An example of this type of relationship is depicted in Figure 10.1, where mean annual precipitation and latitude were used as explanatory variables. These relationships were then used to populate the grid-cells in the study area domain with the values predicted from the applicable regression equation based on the climatic and physiographic factors representative of each grid-cell. At-site mean values for grid-cells within transition zones 154 and 147 were computed as a weighted average of the at-site mean values in adjacent climatic regions in the same manner had the grid-cell been located in the adjoining regions. This provided continuity with at-site mean values at region boundaries and provided a smooth transition between adjoining regions. It should be noted that discontinuities in the transition zones prior to smoothing were relatively minor, typically less than 5 percent of the mapped value.

Residuals were then computed for each of the station at-site means that quantified the magnitude of difference between mapped values and station values. This allowed analyses to be conducted of the residuals to identify if there was a coherent spatial pattern to the magnitude and sign of the residuals. When coherent residual patterns were encountered, they were used to adjust the original estimates. Lastly, standard bias and root mean square error measures were computed to quantify the overall goodness-of-fit of the mapped values, relative to the observations at the gages. The map of the at-site means for the 24-hour duration is shown in Figure 10.2.

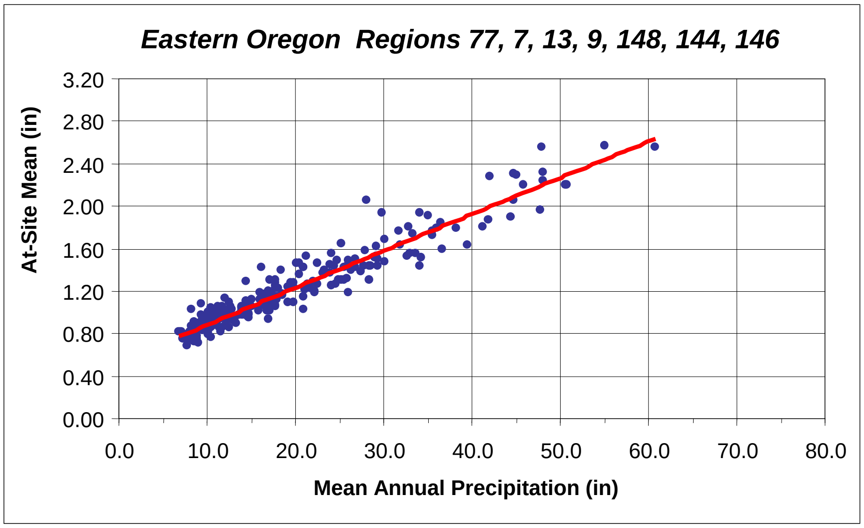


Figure 10.1: Example Relationship of Observed 24-Hour At-Site Mean with Mean Annual Precipitation for Eastern Oregon Study Area (Regions 77, 7, 13, 9, 148, 144, and 146).

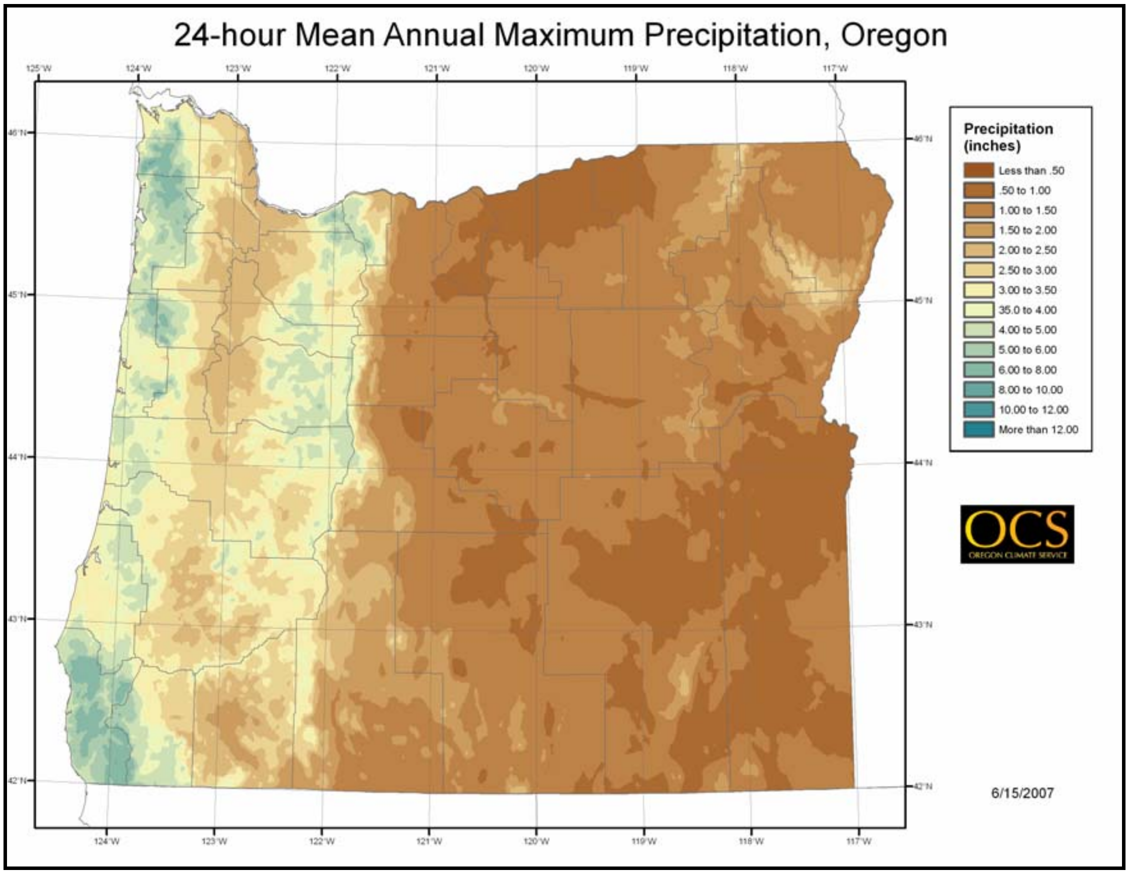


Figure 10.2: Map of At-Site Means for 24-Hour Duration for Oregon Study Area.

## 10.1 QUANTITATIVE ASSESSMENT OF SUCCESS ACHIEVED IN SPATIAL MAPPING OF AT-SITE MEANS

A quantitative measure was needed to assess the relative success of the spatial mapping procedures in capturing the spatial behavior of the at-site means. This is a difficult task in all studies of this type, because the true values of the at-site means are unknown. The logical standard for comparison is the station sample value of the at-site mean. However, station sample values of the at-site mean will differ from the true population values due to sampling variability, and other natural and man-related variability associated with precipitation measurement and recording.

This problem was approached by framing the question as: *how do the observed station values compare with the final mapped values*? Given this question, the bias and root mean square error (RMSE) computations (*Helsel and Hirsch 1992*) were expressed in standardized units using the mapped values as the predicted value.  This equates to computing bias and RMSE for the standardized residuals ($SR_2$) as:

$$SR_2 = (S - P_2) / P_2 \qquad \textbf{(10-1)}$$

In this equation: $S$ is the observed station value of the at-site mean (in); and $P_2$ is the mapped value of the station at-site-mean (in).

The computed standardized residuals are listed in Table 10.1 and a graphical example, comparing observed and mapped values, is shown in Figure 10.3.  A review of Table 10.1 shows that the final mapped values of the at-site means are nearly unbiased.  If the RMSE values for the stations are representative of the at-site mean maps taken as a whole, then the final maps of at-site means have a standard error of estimate that is near 5 percent.  The RMSE of the final mapped values are generally similar in magnitude to that expected from natural sampling variability and, thus, are as low as can reasonably be expected.

**Table 10.1: Bias and Root Mean Square Error of Standardized Residuals for Final Mapped Values of Station At-Site Means for 24-Hour Duration.**

| Study Area | Climatic Regions | Final Mapped Values | |
|---|---|---|---|
| | | Bias (%) | RMSE (%) |
| Western Oregon | Region 5 – Coastal Lowlands | 0.0 | 3.7 |
| | Region 151 – Windward Faces Coastal Mountains | -0.3 | 3.9 |
| | Region 142 – Leeward Areas Coastal Mountains | 1.6 | 5.0 |
| | Region 32 – Interior Lowlands - West | -0.6 | 4.2 |
| | Region 31 – Interior Lowlands - East | -0.3 | 4.6 |
| | Region 15 – West Slopes of Cascade Mountains | -1.1 | 4.2 |
| | Region 8 – Rogue Valley | -1.5 | 3.1 |
| | Region 143 – Klamath Mountains and West Slopes Cascade Mountains | 0.8 | 4.9 |
| Eastern Oregon | Zone 154 – Transition Zone Crest Cascades and Klamath Mountains | -0.5 | 4.3 |
| | Region 14 – East Slopes of Cascade Mountains | 0.2 | 4.4 |
| | Zone 147 – Transition Zone Cascade Foothills | 0.1 | 4.3 |
| | Region 77 – Central Basin | -0.9 | 2.8 |
| | Region 7 – Pendleton-Palouse | 0.2 | 2.6 |
| | Region 13 – Wallowa and Blue Mountains | -0.6 | 4.0 |
| | Region 9 – Snake River Canyon | -0.5 | 3.7 |
| | Region 148 – Western Idaho Mountains | -1.3 | 3.1 |
| | Region 144 – Ochoco and Malheur | -1.2 | 4.7 |
| | Region 145 – Fremont and Warner | -1.0 | 4.9 |
| | Region 146 – Pueblo and Crooked Creek Mountains | 0.0 | 4.2 |
| **Weighted Averages for All Regions** | | **-0.4** | **4.1** |

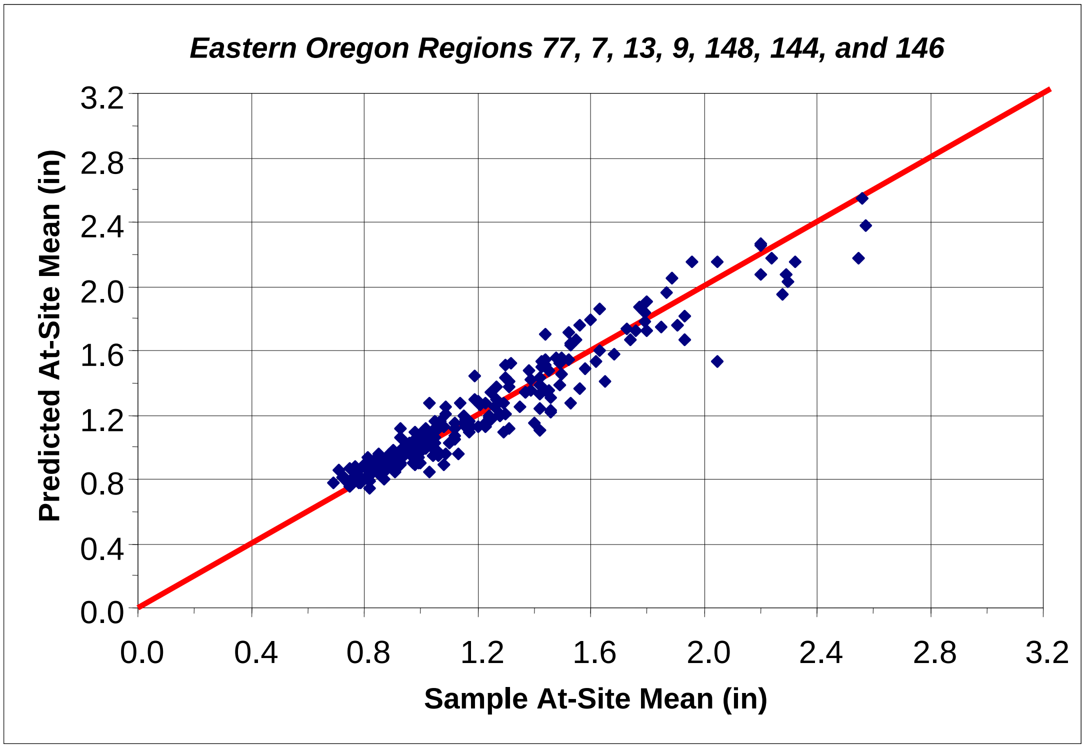


Figure 10.3: Comparison of Observed and Predicted Values of At-Site Means where Mean Annual Precipitation and Latitude were Used as Explanatory Variables for Climatic Regions 77, 7, 13, 9, 148, 144, 146 in Oregon Study Area).

# 11.0 SPATIAL MAPPING OF REGIONAL L-MOMENT STATISTICAL PARAMETERS

In order to compute precipitation estimates for the selected recurrence intervals, the appropriate value of L-Cv and L-Skewness had to be obtained for each grid-cell. This was accomplished by populating the grid-cells in the study area domain with the functional relationships for L-Cv and L-Skewness (Equations 7-1 through 7-7) that were developed in the regional precipitation-frequency analysis. Population of the grid-cells within transition zones 154 and 147 was accomplished as a weighted average of the L-moment ratio values. The weight factors were based on the nearness of a given grid-cell to the boundaries of the transition zone. This approach provided continuity at the region boundaries and a smooth transition between region boundaries within the transition zones. Discontinuities of L-Cv at L-Skewness in transition zones, prior to smoothing, were relatively minor; typically less than 5% of the mapped value.

Color-shaded maps of L-Cv and L-Skewness values are depicted in Figures 11.1 and 11.2. Separate gridded data files are included as electronic files with this report (Appendix A).

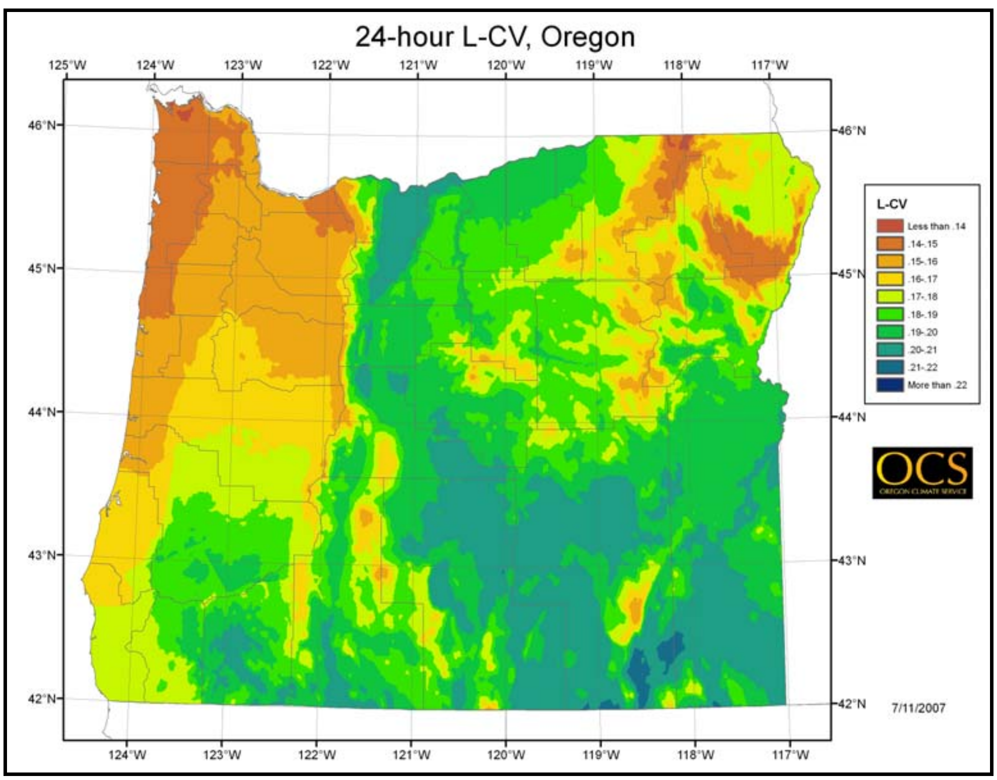


Figure 11.1: Oregon Variation of L-Cv for 24-Hour Precipitation Annual Maxima.

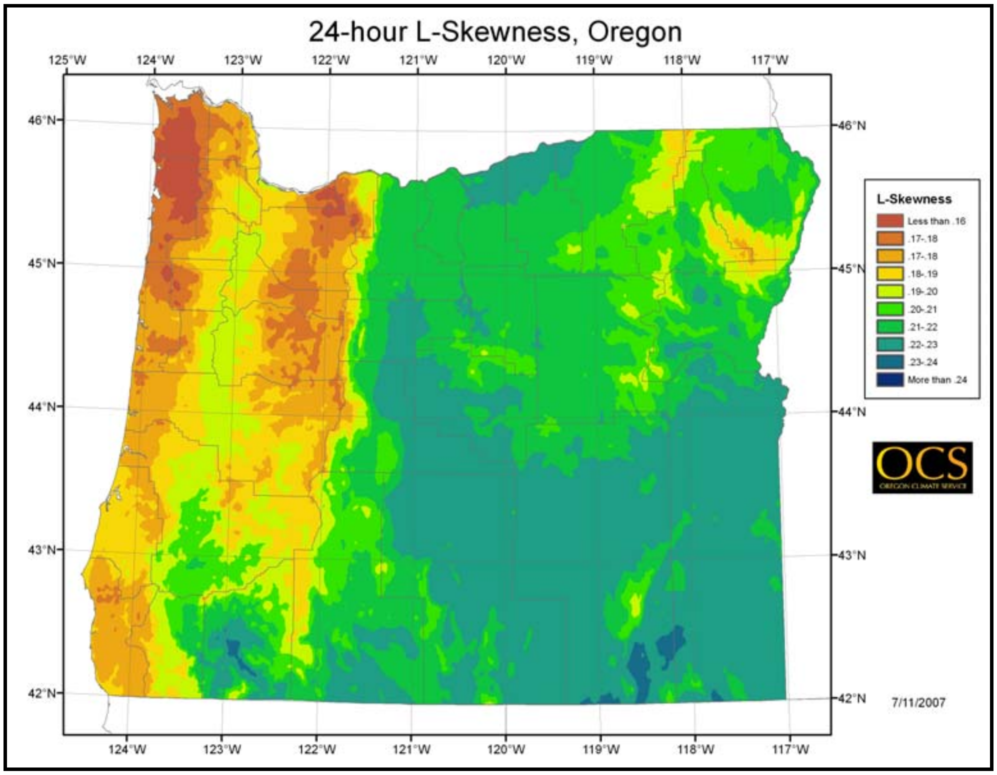


Figure 11.2: Oregon Variation of L-Skewness for 24-Hour Precipitation Annual Maxima.

# 12.0 PRODUCTION OF ISOPLUVIAL MAPS

The isopluvial maps were produced by incorporating the information described in prior sections. For each grid-cell, the applicable value of the at-site mean and L-moment ratios; L-Cv, and L-Skewness, were used to solve the distribution parameters for the four-parameter Kappa distribution (*Hosking 1988; Hosking and Wallis 1997*). The distribution parameters were then used in Equation 7-8 to compute the expected value of precipitation for the desired recurrence interval. This procedure was repeated for each grid-cell until the domain for the study area was populated. The resultant precipitation field was then contoured to yield isopluvials for selected values of precipitation.

## 12.1 PRECIPITATION MAGNITUDE-FREQUENCY ESTIMATES FOR MODERATE TO LARGE SIZE WATERSHEDS

The precipitation magnitude-frequency information contained in the gridded datasets, and depicted on the isopluvial maps, corresponded to 10-$mi^2$ precipitation for the 24-hour duration. Estimation of precipitation volumes of larger watersheds for a selected recurrence interval require analysis of historical storms or application of areal reduction factors. Areal reduction factors would be obtained from analyses of historical storms from climatologically similar areas. The topics of areal reduction factors, depth-area-duration analyses, and estimation of precipitation for moderate to large size watersheds, is beyond the scope of this report. It is mentioned here to alert the reader that precipitation values from the gridded datasets and isopluvial maps need to be adjusted in order to obtain estimates of precipitation volumes for moderate to large watersheds. Additional information on areal reduction factors can be found in articles by Bell (*1976*), Meyers and Zehr (*1980*), and Siriwardena and Weinmann (*1996*).

## 12.2 UNCERTAINTY BOUNDS FOR 100-YEAR VALUES

The accuracy of estimation of 100-year precipitation annual maxima, at a given location, is dependent upon the success attained in estimating the at-site mean, and L-moment ratios; L-Cv and L-Skewness, as well as the similarity between the chosen probability model (Kappa distribution), and what actually is occurring in nature.

In general, uncertainties associated with estimating L-moment ratios; L-Cv and L-Skewness, resulted in standard errors of estimation of about 5 percent at the 100-year recurrence interval. These relatively low levels of uncertainty were attributable to very large datasets that were used to estimate the L-moment ratios and identify a suitable probability model. The interaction of these standard errors of estimation with errors due to estimation of the at-site mean (Table 10.1), yielded the standard errors of estimation that is shown in Table 12.1. The range in standard errors of estimation for a given duration was primarily due to the region-to-region variation of standard errors for the at-site mean estimates for recurrence intervals cited in Table 12.1.

Table 12.1 shows the range of standard errors of estimation for selected recurrence intervals. The values shown in Table 12.1 are approximate. Detailed studies that compute uncertainty bounds have not been conducted at this time. The values shown in the table represent regional averages. Values applicable to a given location may be somewhat smaller or larger than those indicated in Table 12.1.

**Table 12.1: Range of Standard Errors of Estimation for Selected Recurrence Intervals.**

| Duration | 10-Year | 100-Year |
|---|---|---|
| 24-Hour | 4% to 7% | 7% to 10% |

## 12.3 ISOPLUVIAL MAPS

An example of an isopluvial map, which was produced by processes described in this chapter, is depicted in Figure 12.1. The figure shows a color-shaded map of 24-hour, 100-year precipitation. Isopluvial maps for the other selected recurrence intervals are contained as electronic files as part of Appendix B.

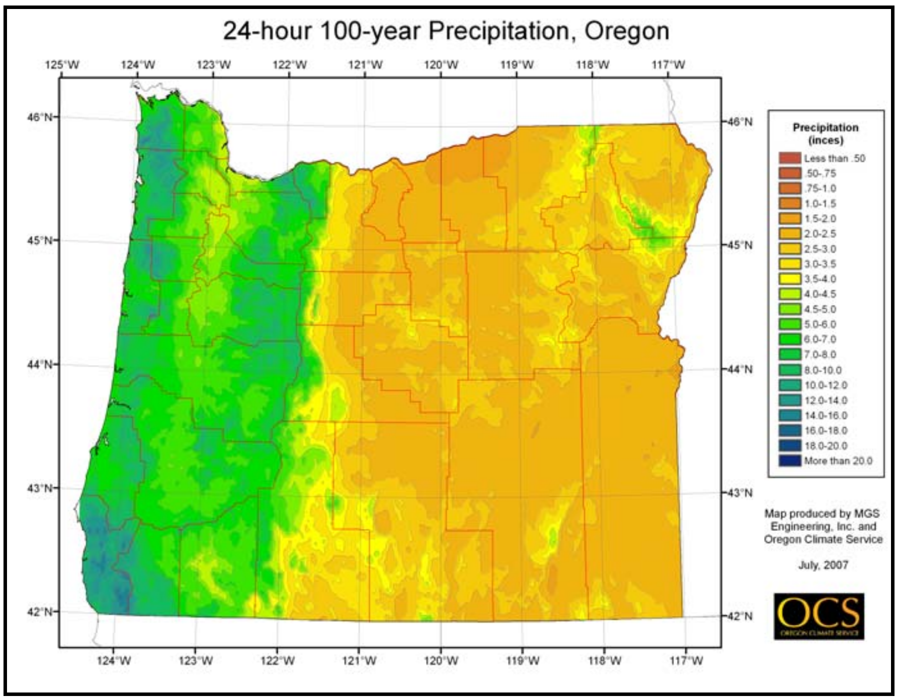


Figure 12.1: Isopluvial Map of 24-Hour Precipitation for 100-Year Recurrence Interval for the State of Oregon.

# 13.0 SEASONALITY OF EXTREME STORMS

The seasonality of extreme storms can be a valuable tool for application of precipitation-frequency information to rainfall-runoff modeling. Specifically, information on the seasonality of storms is helpful when setting watershed conditions antecedent to the storm.

The seasonality of extreme storms was investigated by constructing frequency histograms of the storm dates for rare 24-hour precipitation amounts for groupings of climatic regions. Storms characterized as extreme, were those where the precipitation amounts had annual exceedance probabilities of less than 0.05 (rarer than a 20-year event). Precipitation amounts/gages with duplicate storm dates (generally dates within about 3 calendar days) were removed before the frequency histograms were constructed for each climatic region. The results of the seasonality analyses are discussed below.

## 13.1 SEASONALITY OF 24-HOUR EXTREME EVENTS

Well-defined seasonal patterns were apparent for storms which were rare at the 24-hour duration in western Oregon and on the eastern slopes of the Cascade and Klamath Mountains (Figures 13.1-13.5). These storms were the result of synoptic scale cyclonic weather systems and associated fronts. These storms remain organized and would penetrate a considerable distance inland from the coast. There was a rapid transition in the seasonality of storms at the foothills of the Cascade and Klamath Mountains into eastern Oregon where arid, semi-arid, and humid climatic regions showed extreme storms occurring throughout the year (Figures 13.6-13.8).

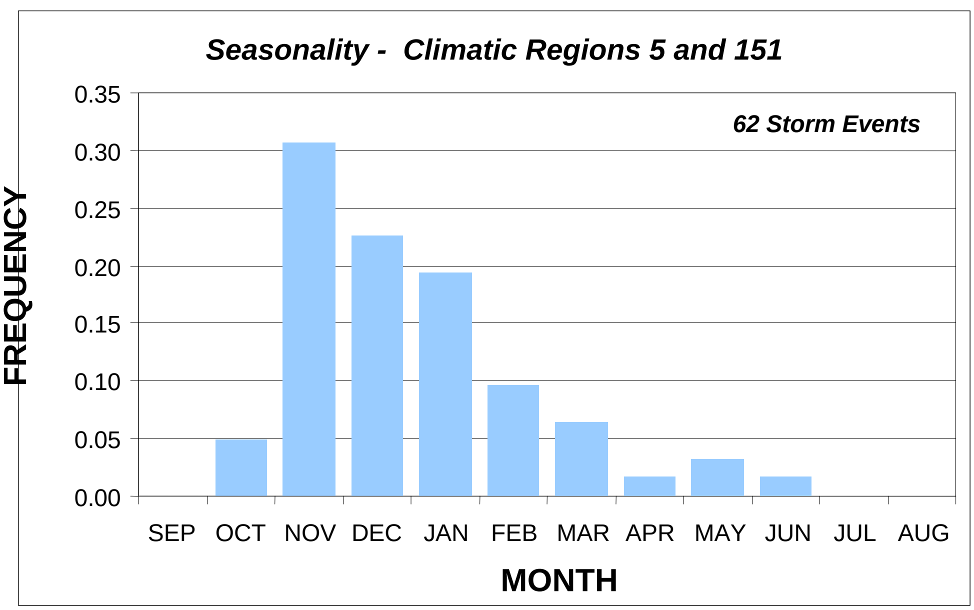


Figure 13.1: Seasonality of Extreme Storms in Climatic Regions 5 and 151 (Western Oregon – Coastal Lowlands and Windward Faces of the Coastal Mountains).

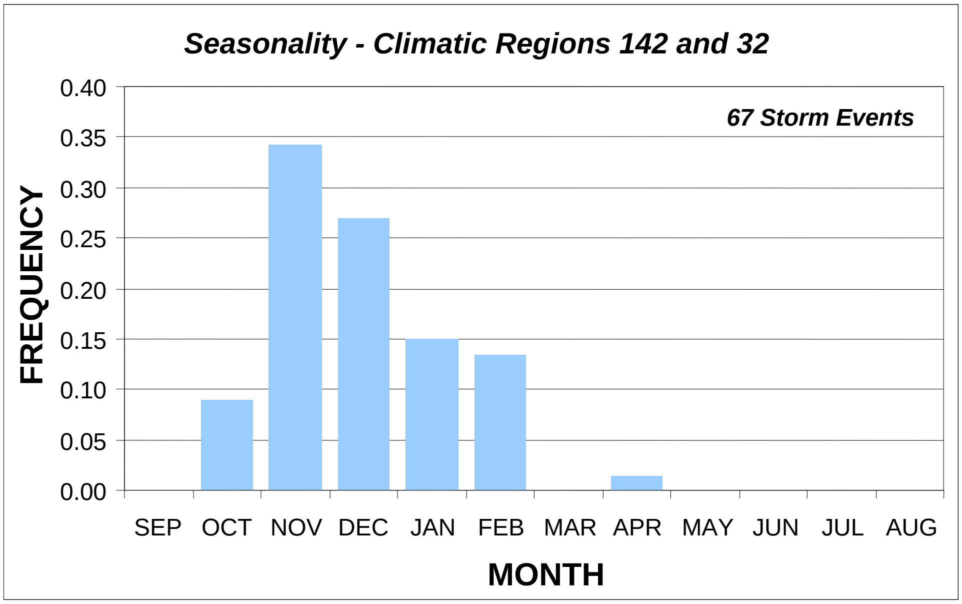


Figure 13.2: Seasonality of Extreme Storms in Climatic Regions 142 and 32 (Western Oregon – Leeward Faces of the Coastal Mountains and the Interior Lowlands to the West).

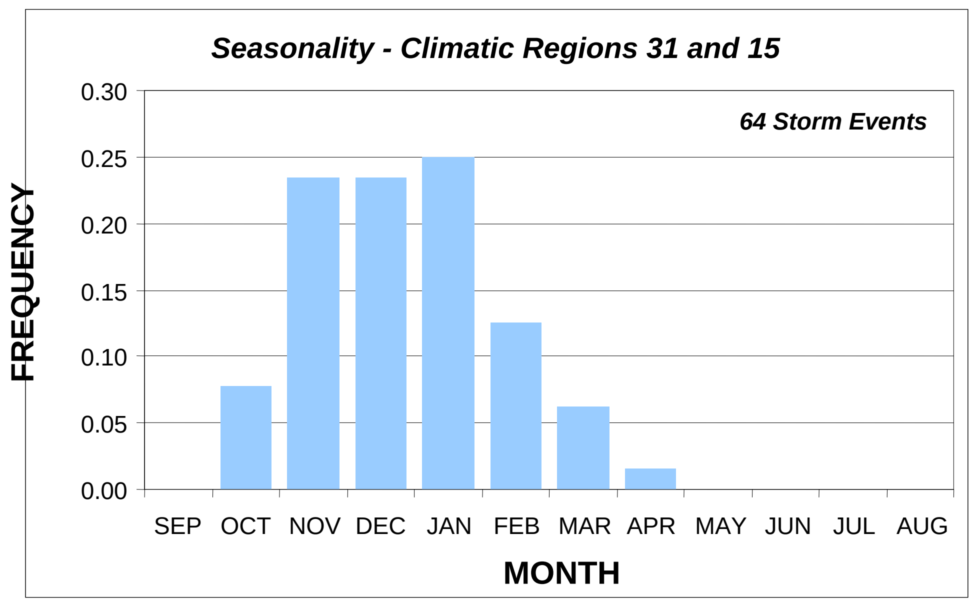


Figure 13.3: Seasonality of Extreme Storms in Climatic Regions 31 and 15 (Western Oregon -Interior Lowlands to the East and the Windward Faces of the Cascade Mountains).

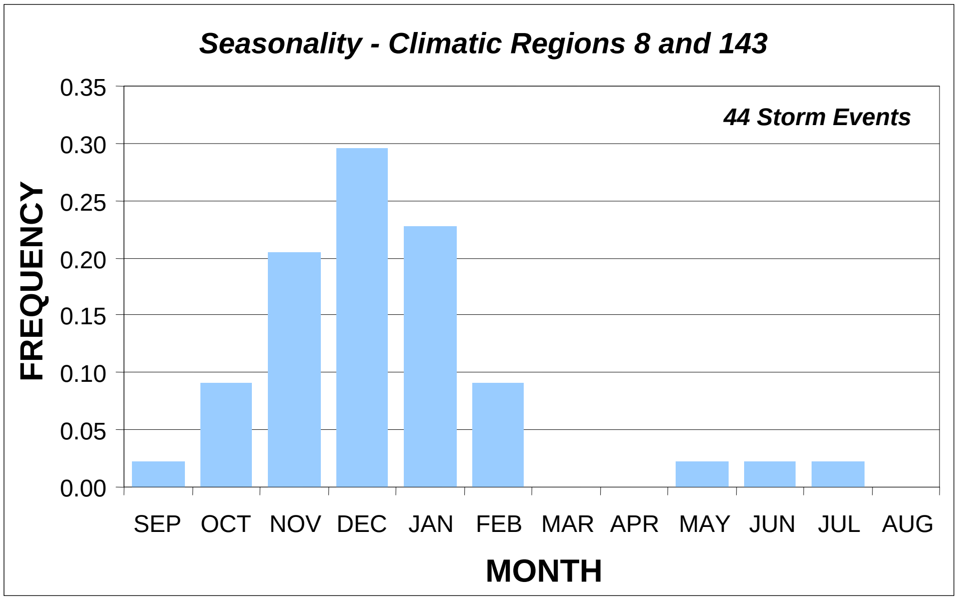


Figure 13.4: Seasonality of Extreme Storms in Climatic Regions 8 and 143 (Southwest Oregon – Rogue Valley and the Windward Faces of the Klamath Mountains).

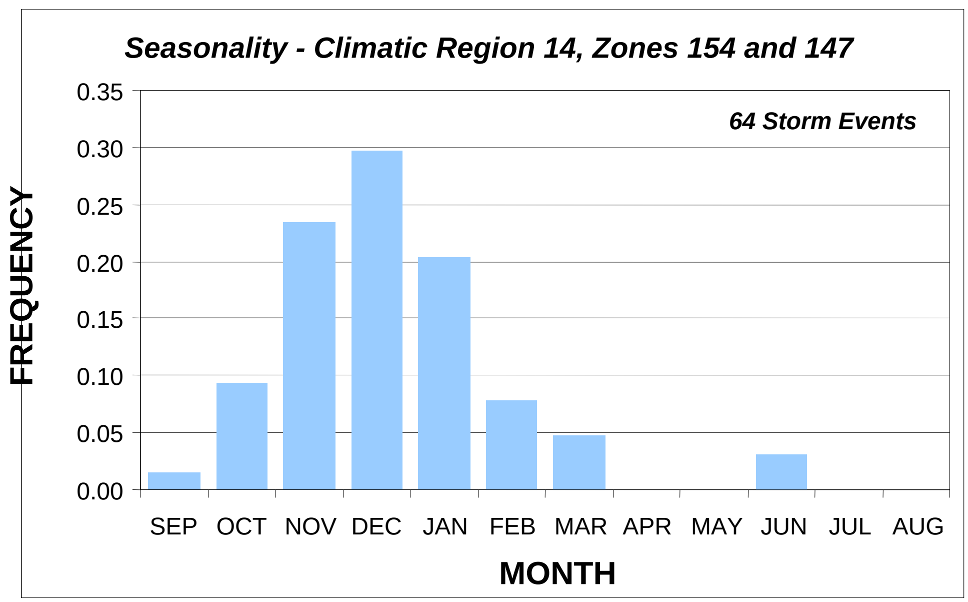


Figure 13.5: Seasonality of Extreme Storms in Climatic Region 14 and Transition Zones 154, and 147 (Eastern Oregon – Leeward Faces of the Cascade and Klamath Mountains).

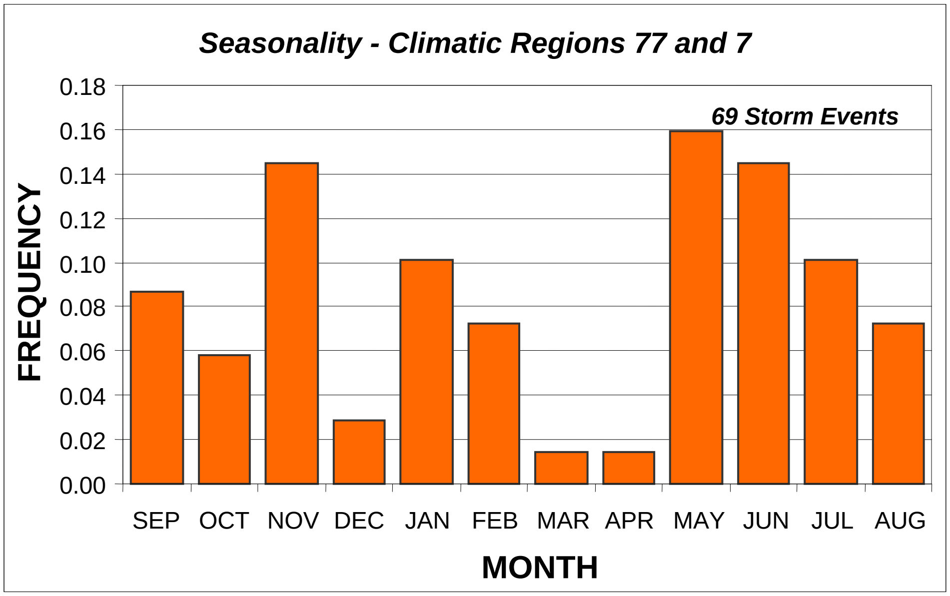


Figure 13.6: Seasonality of Extreme Storms in Climatic Regions 77 and 7
(Northeastern Oregon – Low Orographic Areas).

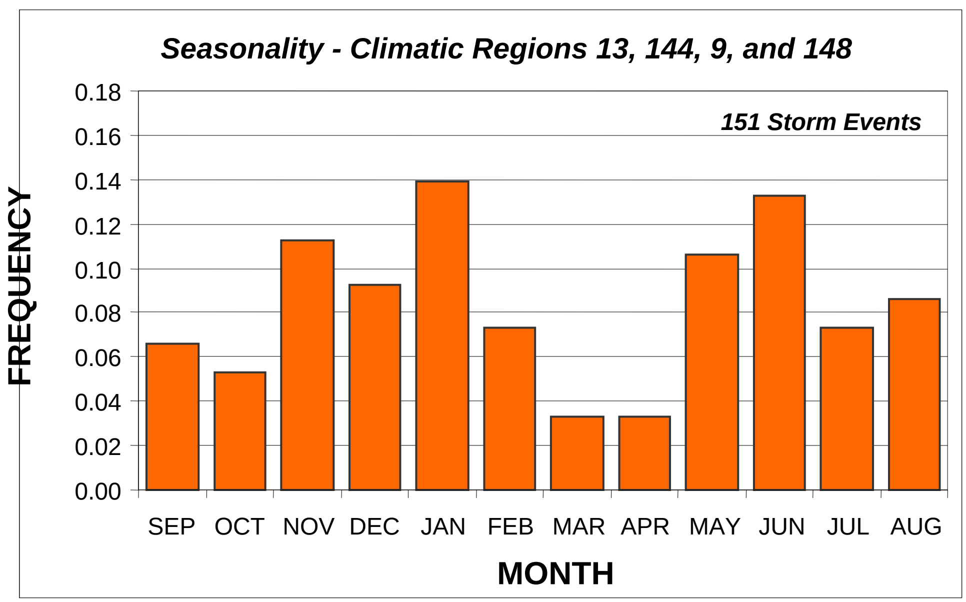


Figure 13.7: Seasonality of Extreme Storms in Climatic Regions 13, 144, 9, and 148
(Northeastern and Central Oregon – Mountainous Areas).

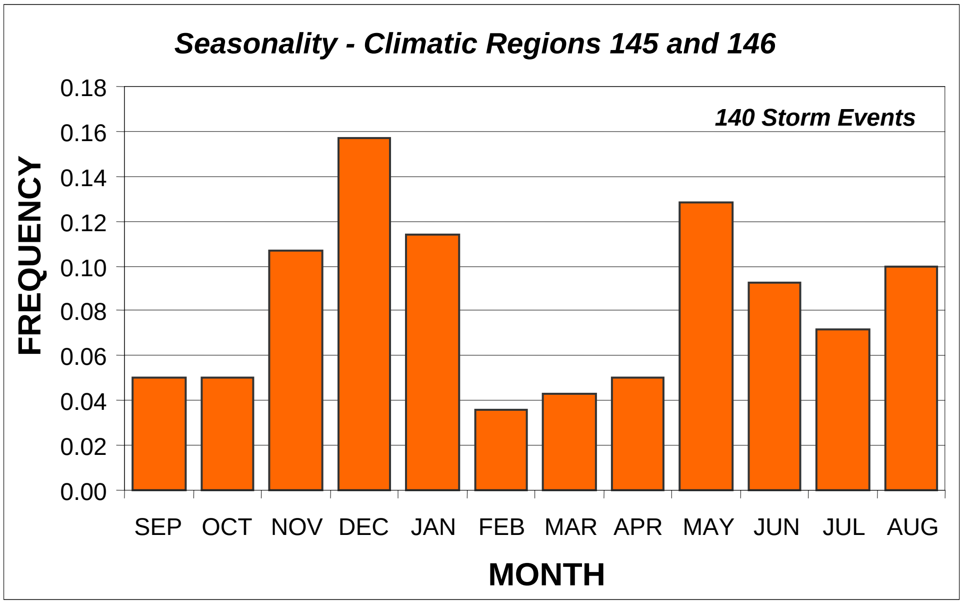


Figure 13.8: Seasonality of Extreme Storms in Climatic Regions 145 and 146 (Southeastern Oregon – Desert Mountain Areas).

# 14.0 SEASONALITY OF PRECIPITATION ANNUAL MAXIMA

Information on the seasonality of 24-hour annual maxima can be helpful early in the regional analysis for delineating climatic regions. Differences in the seasonality of annual maxima across a broad geographic area often indicate that there may also be systematic changes in L-Cv and L-Skewness across the area. Seasonality of annual maxima may be analyzed graphically, as depicted in the prior section. However, circular statistics are often more useful because they provide a quantitative measure of the differences in seasonality.

## 14.1 USE OF CIRCULAR STATISTICS FOR ASSESSING SEASONALITY OF 24-HOUR ANNUAL MAXIMA

Circular statistics are appropriate for seasonality analysis because of the continuous (circular) nature of the counting system for dates and months (*Fisher 1993*). For example, January (month 1) follows December (month 12). Arithmetic averaging of a group of numerical months or dates is not appropriate with conventional sample statistics because the counting system is circular not linear. Using circular statistics, the *average day of occurrence* is analogous to the arithmetic mean, and the *seasonality index* (*Dingman 2001*) is analogous to a standardized measure of variation. Specifically, values of the seasonality index range from zero to unity. Values near zero indicate a wide variation in the dates of occurrence. A seasonality index near unity indicates low variation in the dates of occurrence and strong clustering of dates.

Table 14.1 lists summary circular statistics for the various climatic regions. Review of values from the seasonality index, indicates that there are similar values for humid areas in western Oregon as there are on the eastern slopes of the Cascade Mountains. These relatively high values indicated strong clustering of 24-hour precipitation annual maxima in the fall and winter seasons. Graphics for seasonality of annual maxima for these climatic regions would be similar to that seen in Figures 13.1 through 13.5. By comparison, arid and semi-arid areas in the eastern portion of the study area had low seasonality index values, which indicated that the annual maxima occurred across a wide range of dates. These values were indicative of the wide variation in dates of annual maxima and would have a graphic depiction similar to that seen in Figures 13.6 through 13.8.

Review of Table 14.1 and Figures 2.1, 3.1, 3.2, 5.1-5.3 and 5.4 reveal that the seasonality index generally varies with mean annual precipitation (MAP). Climatic regions with larger MAP values tended to receive greater proportions of storms and annual maxima in the fall and winter seasons and had higher values of the seasonality index. This was true for regions in both the western and eastern portions of the study area, as mountain regions tended to have higher MAP and larger values of the seasonality index. Conversely, the driest climatic regions in the eastern portions of the study area had the lowest values of the seasonality index, with storms occurring throughout the year. The eastern Foothills of the Cascade Mountains (Zone 147) were a transition area where the annual maxima in the western areas were predominately fall-winter, and the frequency in eastern areas varied widely throughout the year. The value of the seasonality index in Transition Zone 147 was seen to be intermediate in magnitude between the wetter areas to the west and the drier areas to the east. The Rogue Valley (Region 8) was an interesting anomaly. The Rogue Valley exists in a rain-shadow that is down-slope from the Coastal Mountains and has generally low values of MAP. Yet the region has a high seasonality index because the annual maxima are caused by fall and winter storms. These findings are presented here as background information and as a supplement to the delineation of climatic regions presented earlier in this report. Equations for computation of circular statistics are presented in Appendix C.

**Table 14.1: Summary of Circular Statistics for Seasonality of 24-Hour Annual Maxima for the Various Climatic Regions and Transition Zones.**

| Study Area | Region/Zone | Average Julian Day of Occurrence | Seasonality Index |
|---|---|---|---|
| Western Areas and East Slopes of the Cascade Mountains | Region 5 – Coastal Lowlands | 362 (Dec) | 0.697 |
| | Region 151 – Windward Faces Coastal Mountains | 360 (Dec) | 0.764 |
| | Region 142 – Leeward Areas Coastal Mountains | 362 (Dec) | 0.744 |
| | Region 32 – Interior Lowlands - West | 359 (Dec) | 0.740 |
| | Region 31 – Interior Lowlands - East | 355 (Dec) | 0.688 |
| | Region 15 – West Slopes of Cascade Mountains | 357 (Dec) | 0.710 |
| | Region 8 – Rogue Valley | 353 (Dec) | 0.695 |
| | Region 143 – Klamath Mountains and West Slopes Cascade Mountains | 358 (Dec) | 0.730 |
| | Zone 154 – Transition Zone Crest Cascades and Klamath Mountains | 357 (Dec) | 0.724 |
| | Region 14 – East Slopes of Cascade Mountains | 357 (Dec) | 0.673 |
| Eastern Areas | Zone 147 – Transition Zone Eastern Cascade Foothills | 349 (Dec) | 0.419 |
| | Region 77 – Central Basin | 338 (Dec) | 0.178 |
| | Region 7 – Pendleton-Palouse | 043 (Feb) | 0.159 |
| | Region 13 – Wallowa and Blue Mountains | 358 (Dec) | 0.363 |
| | Region 9 – Snake River Canyon | 080 (Mar) | 0.231 |
| | Region 148 – Western Idaho Mountains | 027 (Jan) | 0.361 |
| | Region 144 – Ochoco and Malheur | 221 (Aug) | 0.235 |
| | Region 145 – Fremont and Warner | 352 (Dec) | 0.297 |
| | Region 146 – Pueblo and Crooked Creek Mountains | 107 (Apr) | 0.289 |

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# APPENDIX A

# STATION CATALOG

## OVERVIEW

This appendix includes a station catalog for the stations/gages used in the study for analysis of precipitation annual maxima at the 24-hour duration. This listing includes the station identification number, station name, type of gage, climatic region number, latitude, longitude, elevation, and mean annual precipitation. This appendix is also included as an electronic file on a compact disc (CD).

**Table A-1.1: Station Catalog of Gages Used in Analyses of Precipitation Annual Maxima at 24-Hour Duration.**

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 450008 | ABERDEEN | WA | 46.966 | -123.829 | 10 | 1891 | 2006 | 116 | 5 | DY | 83.2 |
| 350036 | ADEL | OR | 42.176 | -119.896 | 4583 | 1956 | 2006 | 51 | 145 | DY | 10.8 |
| 20H13S | ADIN MTN | CA | 41.250 | -120.767 | 6200 | 1984 | 2006 | 23 | 145 | Snotel | 29.6 |
| 040029 | ADIN RS | CA | 41.200 | -120.950 | 4193 | 1943 | 2006 | 64 | 145 | DY | 16.1 |
| 350041 | ADRIAN | OR | 43.733 | -117.067 | 2231 | 1909 | 1972 | 64 | 9 | DY | 9.6 |
| 350078 | ALBANY 1 N | OR | 44.650 | -123.100 | 210 | 1893 | 1963 | 71 | 32 | DY | 43.0 |
| 450094 | ALDER DAM CAMP | WA | 46.800 | -122.317 | 1302 | 1917 | 1954 | 38 | 15 | DY | 47.8 |
| 350118 | ALKALI LAKE | OR | 42.969 | -119.993 | 4332 | 1961 | 2006 | 46 | 145 | DY | 8.7 |
| 350126 | ALLEGANY | OR | 43.417 | -124.017 | 50 | 1948 | 2006 | 59 | 5 | HR | 71.1 |
| 350145 | ALSEA F H FALL CREEK | OR | 44.404 | -123.753 | 230 | 1954 | 2006 | 53 | 151 | DY | 87.5 |
| 040161 | ALTURAS | CA | 41.500 | -120.533 | 4462 | 1905 | 2006 | 102 | 145 | DY | 12.2 |
| 450184 | ANATONE | WA | 46.133 | -117.133 | 3573 | 1912 | 1981 | 70 | 13 | DY | 20.1 |
| 350188 | ANDREWS 2 S | OR | 42.433 | -118.617 | 4104 | 1915 | 1942 | 28 | 146 | DY | 8.9 |
| 350189 | ANDREWS WESTON MINE | OR | 42.550 | -118.550 | 4779 | 1969 | 1993 | 25 | 146 | DY | 17.8 |
| 17D02S | ANEROID LAKE #2 | OR | 45.214 | -117.193 | 7300 | 1980 | 2006 | 27 | 13 | Snotel | 47.7 |
| 350197 | ANTELOPE 6 SSW | OR | 44.820 | -120.753 | 3030 | 1924 | 2006 | 83 | 145 | DY | 13.8 |
| 350217 | APPLEGATE | OR | 42.245 | -123.175 | 1282 | 1979 | 2006 | 28 | 8 | DY | 26.2 |
| 450217 | APPLETON | WA | 45.810 | -121.282 | 2336 | 1959 | 2006 | 48 | 14 | DY | 33.7 |
| 19D02S | ARBUCKLE MTN | OR | 45.191 | -119.254 | 5400 | 1978 | 2006 | 29 | 13 | Snotel | 34.2 |
| 450242 | ARIEL DAM | WA | 45.950 | -122.550 | 224 | 1930 | 1971 | 42 | 31 | DY | 73.6 |
| 350265 | ARLINGTON | OR | 45.721 | -120.205 | 277 | 1893 | 2006 | 114 | 147 | DY | 9.1 |
| 350304 | ASHLAND | OR | 42.213 | -122.714 | 1746 | 1892 | 2006 | 115 | 8 | DY | 20.2 |
| 350312 | ASHWOOD 2 NE | OR | 44.750 | -120.717 | 2820 | 1945 | 2006 | 62 | 145 | DY | 13.7 |
| 450294 | ASOTIN 14 SW | WA | 46.201 | -117.252 | 3500 | 1976 | 2006 | 31 | 13 | DY | 16.6 |
| 350318 | ASTOR EXPERIMENT STN | OR | 46.150 | -123.817 | 49 | 1937 | 1973 | 37 | 5 | DY | 79.6 |
| 350324 | ASTORIA | OR | 46.183 | -123.833 | 200 | 1892 | 1960 | 69 | 5 | DY | 77.8 |
| 350328 | ASTORIA AP PORT OF | OR | 46.150 | -123.867 | 9 | 1953 | 2006 | 54 | 5 | HR | 71.7 |
| 350343 | AURORA | OR | 45.233 | -122.749 | 98 | 1950 | 1969 | 20 | 31 | DY | 42.4 |
| 350356 | AUSTIN 3 S | OR | 44.575 | -118.491 | 4213 | 1929 | 2006 | 78 | 13 | DY | 21.0 |
| 350409 | BAKER #2 | OR | 44.767 | -117.817 | 3467 | 1956 | 2006 | 51 | 13 | HR | 12.4 |
| 350412 | BAKER CITY AIRPORT | OR | 44.843 | -117.809 | 3361 | 1943 | 2006 | 64 | 13 | DY | 10.7 |
| 350417 | BAKER KBKR | OR | 44.767 | -117.833 | 3445 | 1928 | 1981 | 54 | 13 | DY | 12.2 |
| 350471 | BANDON 2 NNE | OR | 43.150 | -124.402 | 20 | 1897 | 2006 | 110 | 5 | DY | 61.2 |
| 350501 | BARNES STATION | OR | 43.946 | -120.217 | 3970 | 1961 | 2006 | 46 | 145 | DY | 13.6 |
| 450482 | BATTLE GROUND | WA | 45.779 | -122.529 | 284 | 1928 | 2006 | 79 | 31 | DY | 52.5 |
| 260691 | BATTLE MOUNTAIN 4 SE | NV | 40.600 | -116.883 | 4540 | 1948 | 2006 | 59 | 146 | HR | 9.1 |
| 16E11S | BEAR BASIN | ID | 44.952 | -116.143 | 5350 | 1981 | 2006 | 26 | 148 | Snotel | 36.7 |
| 16E10S | BEAR SADDLE | ID | 44.604 | -116.983 | 6180 | 1981 | 2006 | 26 | 9 | Snotel | 36.0 |
| 350571 | BEAR SPRINGS RS | OR | 45.117 | -121.533 | 3360 | 1961 | 2006 | 46 | 14 | HR | 31.5 |
| 18D09S | BEAVER RESERVOIR | OR | 45.145 | -118.220 | 5150 | 1980 | 2006 | 27 | 13 | Snotel | 29.3 |
| 350595 | BEAVERTON 2 SSW | OR | 45.455 | -122.820 | 270 | 1972 | 2006 | 35 | 32 | DY | 40.7 |
| 350631 | BEECH CREEK | OR | 44.567 | -119.117 | 4715 | 1909 | 1949 | 41 | 144 | DY | 19.2 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 350652 | BELKNAP SPRINGS 8 N | OR | 44.287 | -122.039 | 2152 | 1960 | 2006 | 47 | 15 | DY | 77.1 |
| 350673 | BELLFOUNTAIN | OR | 44.367 | -123.350 | 322 | 1949 | 1977 | 29 | 32 | HR | 47.5 |
| 350694 | BEND | OR | 44.057 | -121.285 | 3660 | 1901 | 2006 | 106 | 145 | DY | 11.7 |
| 350699 | BEND 7 NE | OR | 44.118 | -121.211 | 3358 | 1991 | 2006 | 16 | 145 | DY | 10.3 |
| 450628 | BENTON CITY 2 NW | WA | 46.283 | -119.500 | 679 | 1905 | 1964 | 60 | 77 | DY | 8.5 |
| 350723 | BEULAH | OR | 43.900 | -118.150 | 3270 | 1948 | 2006 | 59 | 13 | HR | 11.9 |
| 450668 | BICKLETON | WA | 45.998 | -120.301 | 3015 | 1927 | 2006 | 80 | 14 | DY | 13.9 |
| 040731 | BIEBER | CA | 41.117 | -121.133 | 4125 | 1948 | 2006 | 59 | 145 | HR | 17.8 |
| 350753 | BIG EDDY | OR | 45.617 | -121.117 | 131 | 1916 | 1957 | 42 | 14 | DY | 14.9 |
| 22G21S | BIG RED MOUNTAIN | OR | 42.053 | -122.855 | 6250 | 1980 | 2006 | 27 | 143 | Snotel | 54.5 |
| 23G15S | BIGELOW CAMP | OR | 42.079 | -123.344 | 5120 | 1980 | 2006 | 27 | 142 | Snotel | 65.0 |
| 22G13S | BILLIE CREEK DIVIDE | OR | 42.407 | -122.266 | 5300 | 1978 | 2006 | 29 | 154 | Snotel | 53.2 |
| 350773 | BIRKENFELD 1 N | OR | 46.000 | -123.333 | 531 | 1939 | 1953 | 15 | 32 | DY | 73.5 |
| 350781 | BLACKBUTTE 1 N | OR | 43.583 | -123.067 | 970 | 1948 | 2006 | 59 | 15 | HR | 58.9 |
| 21D33S | BLAZED ALDER | OR | 45.428 | -121.856 | 3650 | 1980 | 2006 | 27 | 15 | Snotel | 118.2 |
| 18E16S | BLUE MOUNTAIN SPRING | OR | 44.248 | -118.518 | 5900 | 1978 | 2006 | 29 | 13 | Snotel | 35.0 |
| 350853 | BLY RANGER STN | OR | 42.400 | -121.033 | 4390 | 1949 | 2006 | 58 | 145 | HR | 14.5 |
| 350858 | BOARDMAN | OR | 45.840 | -119.701 | 300 | 1971 | 2006 | 36 | 77 | DY | 8.5 |
| 101016 | BOISE 3 E | ID | 43.617 | -116.117 | 3377 | 1972 | 2006 | 35 | 148 | HR | 19.9 |
| 101017 | BOISE 7 N | ID | 43.717 | -116.200 | 3891 | 1973 | 2006 | 34 | 148 | DY | 17.8 |
| 101022 | BOISE AIR TERMINAL | ID | 43.567 | -116.233 | 2814 | 1948 | 2006 | 59 | 148 | HR | 12.2 |
| 101018 | BOISE LUCKY PEAK DAM | ID | 43.517 | -116.050 | 2840 | 1951 | 2006 | 56 | 148 | HR | 15.8 |
| 101022 | BOISE WSFO AIRPORT | ID | 43.567 | -116.217 | 2858 | 1940 | 2006 | 67 | 148 | DY | 12.3 |
| 350897 | BONNEVILLE DAM | OR | 45.633 | -121.950 | 62 | 1940 | 2006 | 67 | 154 | HR | 79.1 |
| 18E05S | BOURNE | OR | 44.831 | -118.188 | 5800 | 1978 | 2006 | 29 | 13 | Snotel | 34.3 |
| 18D20S | BOWMAN SPRINGS | OR | 45.364 | -118.467 | 4580 | 1978 | 2006 | 29 | 13 | Snotel | 28.4 |
| 351033 | BRIGHTWOOD 1 WNW | OR | 45.383 | -122.033 | 978 | 1971 | 2000 | 30 | 15 | HR | 86.4 |
| 351055 | BROOKINGS 2 SE | OR | 42.030 | -124.245 | 50 | 1912 | 2003 | 92 | 5 | DY | 71.9 |
| 450917 | BROOKLYN | WA | 46.783 | -123.500 | 190 | 1927 | 1974 | 48 | 32 | DY | 82.2 |
| 351067 | BROTHERS | OR | 43.809 | -120.600 | 4640 | 1959 | 2006 | 48 | 145 | DY | 9.2 |
| 101180 | BROWNLEE DAM | ID | 44.837 | -116.898 | 1844 | 1966 | 2006 | 41 | 9 | DY | 17.1 |
| 16D09S | BRUNDAGE RESERVOIR | ID | 45.043 | -116.132 | 6300 | 1986 | 2006 | 21 | 148 | Snotel | 50.8 |
| 17H02S | BUCKSKIN LOWER | NV | 41.751 | -117.532 | 6700 | 1980 | 2006 | 27 | 146 | Snotel | 25.9 |
| 351124 | BUENA VISTA STATION | OR | 43.066 | -118.868 | 4135 | 1957 | 2001 | 45 | 146 | DY | 9.8 |
| 450969 | BUMPING LAKE | WA | 46.867 | -121.300 | 3442 | 1910 | 1967 | 58 | 14 | DY | 49.4 |
| 21C38S | BUMPING RIDGE | WA | 46.810 | -121.332 | 4600 | 1978 | 2006 | 29 | 154 | Snotel | 63.9 |
| 351149 | BUNCOM 1 NNE | OR | 42.183 | -122.983 | 1949 | 1948 | 2006 | 59 | 143 | HR | 23.8 |
| 351174 | BURNS JUNCTION | OR | 42.777 | -117.853 | 3930 | 1972 | 1999 | 28 | 146 | DY | 8.6 |
| 351175 | BURNS MUNICIPAL AP | OR | 43.583 | -118.950 | 4140 | 1981 | 2006 | 26 | 145 | HR | 10.5 |
| 351176 | BURNS WSO CITY | OR | 43.583 | -119.050 | 4141 | 1948 | 1981 | 34 | 145 | HR | 10.6 |
| 351207 | BUTTE FALLS 1 SE | OR | 42.533 | -122.550 | 2500 | 1948 | 2006 | 59 | 143 | HR | 36.2 |
| 351222 | BUXTON | OR | 45.683 | -123.183 | 355 | 1948 | 2006 | 59 | 32 | HR | 49.6 |
| 351227 | BUXTON MOUNTAINDALE | OR | 45.683 | -123.067 | 360 | 1948 | 1975 | 28 | 32 | HR | 53.3 |
| 101380 | CALDWELL 3 E | ID | 43.667 | -116.633 | 2421 | 1904 | 2006 | 103 | 9 | DY | 11.1 |
| 041316 | CALLAHAN | CA | 41.317 | -122.800 | 3192 | 1943 | 2006 | 64 | 143 | DY | 22.2 |
| 101408 | CAMBRIDGE | ID | 44.573 | -116.675 | 2650 | 1894 | 2006 | 113 | 148 | DY | 20.5 |
| 351324 | CANARY | OR | 43.917 | -124.033 | 79 | 1932 | 1970 | 39 | 5 | DY | 84.5 |
| 351332 | CANBY | OR | 45.244 | -122.686 | 94 | 1943 | 1966 | 24 | 31 | DY | 43.0 |
| 351329 | CANBY 2 NE | OR | 45.283 | -122.667 | 89 | 1948 | 1979 | 32 | 31 | DY | 44.2 |
| 041476 | CANBY RANGER STN | CA | 41.450 | -120.867 | 4310 | 1943 | 2006 | 64 | 145 | DY | 16.6 |
| 351352 | CANYON CITY | OR | 44.400 | -118.950 | 3192 | 1938 | 1953 | 16 | 144 | DY | 15.4 |
| 351360 | CAPE BLANCO | OR | 42.833 | -124.567 | 217 | 1952 | 1979 | 28 | 5 | DY | 76.4 |
| 451160 | CARSON FISH HATCHERY | WA | 45.868 | -121.973 | 1134 | 1977 | 2006 | 30 | 154 | DY | 89.6 |
| 101514 | CASCADE 1 NW | ID | 44.523 | -116.048 | 4896 | 1942 | 2006 | 65 | 148 | DY | 23.2 |
| 351407 | CASCADE LOCKS | OR | 45.683 | -121.883 | 102 | 1894 | 1954 | 61 | 154 | DY | 78.7 |
| 351415 | CASCADE SUMMIT | OR | 43.583 | -122.033 | 4843 | 1927 | 1947 | 21 | 154 | DY | 54.9 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 22F03S | CASCADE SUMMIT | OR | 43.590 | -122.060 | 4880 | 1980 | 2006 | 27 | 154 | Snotel | 60.3 |
| 351433 | CASCADIA | OR | 44.398 | -122.486 | 860 | 1908 | 2006 | 99 | 15 | DY | 65.0 |
| 451189 | CASTLE ROCK | WA | 46.283 | -122.900 | 112 | 1917 | 1941 | 25 | 31 | DY | 47.5 |
| 451191 | CASTLE ROCK 2 NW | WA | 46.267 | -122.917 | 39 | 1954 | 1978 | 25 | 31 | HR | 47.7 |
| 451205 | CATHLAMET 6 NE | WA | 46.260 | -123.299 | 180 | 1959 | 2006 | 48 | 32 | DY | 80.7 |
| 451207 | CATHLAMET 9 NE | WA | 46.317 | -123.267 | 479 | 1937 | 1959 | 23 | 142 | DY | 87.2 |
| 351448 | CAVE JUNCTION 1 WNW | OR | 42.177 | -123.675 | 1280 | 1962 | 2006 | 45 | 142 | DY | 61.8 |
| 041606 | CECILVILLE | CA | 41.142 | -123.139 | 2310 | 1954 | 2003 | 50 | 143 | DY | 35.9 |
| 20H06S | CEDAR PASS | CA | 41.583 | -120.300 | 7100 | 1978 | 2006 | 29 | 145 | Snotel | 34.9 |
| 041614 | CEDARVILLE | CA | 41.534 | -120.174 | 4670 | 1894 | 2006 | 113 | 145 | DY | 13.5 |
| 451257 | CENTERVILLE 2 SW | WA | 45.733 | -120.950 | 1650 | 1941 | 1956 | 16 | 14 | HR | 16.1 |
| 451276 | CENTRALIA | WA | 46.720 | -122.953 | 185 | 1902 | 2006 | 105 | 31 | DY | 46.5 |
| 351546 | CHEMULT | OR | 43.229 | -121.789 | 4760 | 1937 | 2006 | 70 | 14 | DY | 27.1 |
| 21F22S | CHEMULT ALTERNATE | OR | 43.226 | -121.807 | 4760 | 1980 | 2006 | 27 | 14 | Snotel | 28.7 |
| 351552 | CHERRY GROVE 2 S | OR | 45.417 | -123.250 | 781 | 1936 | 1983 | 48 | 32 | DY | 56.0 |
| 351571 | CHILOQUIN 1 E | OR | 42.583 | -121.867 | 4193 | 1913 | 1979 | 67 | 14 | DY | 18.2 |
| 351574 | CHILOQUIN 7 NW | OR | 42.651 | -121.948 | 4155 | 1980 | 2006 | 27 | 14 | DY | 20.6 |
| 451457 | CINEBAR 2 E | WA | 46.600 | -122.483 | 1040 | 1941 | 2000 | 60 | 15 | HR | 65.9 |
| 21D13S | CLACKAMAS LAKE | OR | 45.096 | -121.753 | 3400 | 1980 | 2006 | 27 | 154 | Snotel | 55.3 |
| 451474 | CLARKSTON HEIGHTS | WA | 46.383 | -117.083 | 1191 | 1937 | 1959 | 23 | 9 | DY | 14.6 |
| 351643 | CLATSKANIE | OR | 46.108 | -123.206 | 22 | 1935 | 2006 | 72 | 32 | DY | 55.4 |
| 041799 | CLEAR CREEK | CA | 41.717 | -123.450 | 981 | 1960 | 1977 | 18 | 143 | DY | 59.4 |
| 21D12S | CLEAR LAKE | OR | 45.188 | -121.691 | 3500 | 1980 | 2006 | 27 | 154 | Snotel | 50.8 |
| 041805 | CLEAR LAKE DAM | CA | 41.933 | -121.067 | 4573 | 1907 | 1954 | 48 | 145 | DY | 15.0 |
| 351682 | CLOVERDALE | OR | 45.205 | -123.893 | 187 | 1940 | 2006 | 67 | 5 | DY | 84.3 |
| 041886 | COFFEE CREEK R S | CA | 41.083 | -122.700 | 2500 | 1961 | 2006 | 46 | 143 | HR | 53.7 |
| 22G24S | COLD SPRINGS CAMP | OR | 42.533 | -122.177 | 5880 | 1981 | 2006 | 26 | 154 | Snotel | 56.5 |
| 451586 | COLFAX | WA | 46.883 | -117.350 | 1980 | 1892 | 1994 | 103 | 7 | DY | 19.8 |
| 351735 | COLTON | OR | 45.167 | -122.417 | 680 | 1948 | 2006 | 59 | 31 | HR | 59.6 |
| 351765 | CONDON | OR | 45.233 | -120.181 | 2840 | 1910 | 2006 | 97 | 7 | DY | 14.2 |
| 451690 | CONNELL 1 W | WA | 46.650 | -118.867 | 1020 | 1960 | 2003 | 44 | 77 | HR | 8.8 |
| 451691 | CONNELL 12 SE | WA | 46.509 | -118.788 | 1078 | 1951 | 2006 | 56 | 77 | DY | 10.2 |
| 041990 | COPCO NO 1 DAM | CA | 41.983 | -122.333 | 2703 | 1959 | 2006 | 48 | 154 | DY | 20.7 |
| 351826 | COPPER | OR | 42.033 | -123.133 | 1903 | 1948 | 1976 | 29 | 143 | HR | 28.6 |
| 351828 | COPPER 4 NE | OR | 42.067 | -123.100 | 1820 | 1976 | 2006 | 31 | 143 | HR | 26.0 |
| 351836 | COQUILLE CITY | OR | 43.187 | -124.203 | 23 | 1971 | 2006 | 36 | 5 | DY | 57.7 |
| 351852 | CORNUCOPIA | OR | 45.000 | -117.200 | 4705 | 1909 | 1972 | 64 | 13 | DY | 48.1 |
| 351857 | CORVALLIS | OR | 44.566 | -123.257 | 192 | 1936 | 1972 | 37 | 32 | DY | 43.5 |
| 351862 | CORVALLIS STATE UNIV | OR | 44.633 | -123.189 | 225 | 1893 | 2006 | 114 | 32 | DY | 44.0 |
| 351877 | CORVALLIS WATER BURE | OR | 44.509 | -123.458 | 592 | 1936 | 2006 | 71 | 32 | DY | 66.2 |
| 351897 | COTTAGE GROVE 1 NNE | OR | 43.808 | -123.049 | 595 | 1916 | 2006 | 91 | 31 | DY | 45.4 |
| 351902 | COTTAGE GROVE DAM | OR | 43.718 | -123.058 | 831 | 1943 | 2006 | 64 | 31 | DY | 49.6 |
| 102159 | COTTONWOOD 2 WSW | ID | 46.033 | -116.383 | 3945 | 1948 | 2006 | 59 | 148 | HR | 22.5 |
| 451759 | COUGAR 4 SW | WA | 46.017 | -122.350 | 520 | 1941 | 2006 | 66 | 15 | HR | 101.0 |
| 451760 | COUGAR 6 E | WA | 46.050 | -122.200 | 659 | 1930 | 2006 | 77 | 15 | DY | 122.4 |
| 351914 | COUGAR DAM | OR | 44.117 | -122.233 | 1260 | 1961 | 2006 | 46 | 15 | HR | 75.6 |
| 102187 | COUNCIL | ID | 44.750 | -116.417 | 3153 | 1911 | 2006 | 96 | 148 | DY | 25.2 |
| 18D08S | COUNTY LINE | OR | 45.191 | -118.550 | 4800 | 1980 | 2006 | 27 | 13 | Snotel | 24.6 |
| 351926 | COVE 1 E | OR | 45.296 | -117.790 | 3130 | 1917 | 2006 | 90 | 13 | DY | 22.6 |
| 102246 | CRAIGMONT | ID | 46.233 | -116.467 | 3798 | 1980 | 1996 | 17 | 148 | DY | 22.3 |
| 351946 | CRATER LAKE NPS HQ | OR | 42.897 | -122.133 | 6475 | 1919 | 2006 | 88 | 154 | DY | 66.6 |
| 042147 | CRESCENT CITY 3 NNW | CA | 41.796 | -124.215 | 40 | 1893 | 2006 | 114 | 5 | DY | 64.9 |
| 042148 | CRESCENT CITY 7 ENE | CA | 41.800 | -124.083 | 120 | 1953 | 2001 | 49 | 5 | DY | 82.9 |
| 042150 | CRESCENT CITY MNTC S | CA | 41.767 | -124.200 | 49 | 1948 | 1984 | 37 | 5 | HR | 64.5 |
| 351978 | CRESCENT LAKE JUNCTI | OR | 43.533 | -121.933 | 4764 | 1938 | 1973 | 36 | 14 | DY | 36.4 |
| 351998 | CROW 6 ESE | OR | 43.983 | -123.233 | 502 | 1947 | 1968 | 22 | 31 | DY | 47.3 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 352010 | CURTIN NEAR | OR | 43.723 | -123.209 | 400 | 1978 | 2006 | 29 | 31 | DY | 50.4 |
| 352112 | DALLAS 2 NE | OR | 44.946 | -123.292 | 290 | 1935 | 2006 | 72 | 32 | DY | 49.4 |
| 451972 | DALLESPORT 9 N | WA | 45.750 | -121.150 | 1923 | 1948 | 1980 | 33 | 14 | DY | 23.7 |
| 451968 | DALLESPORT AP | WA | 45.619 | -121.167 | 235 | 1948 | 2006 | 59 | 14 | DY | 14.2 |
| 22E08S | DALY LAKE | OR | 44.522 | -122.087 | 3600 | 1980 | 2006 | 27 | 15 | Snotel | 88.3 |
| 042269 | DANA 2 SE | CA | 41.100 | -121.517 | 3323 | 1959 | 1976 | 18 | 145 | DY | 29.4 |
| 352135 | DANNER | OR | 42.945 | -117.339 | 4225 | 1929 | 2006 | 78 | 146 | DY | 12.3 |
| 042306 | DAY | CA | 41.200 | -121.367 | 3650 | 1948 | 2006 | 59 | 145 | HR | 21.5 |
| 452030 | DAYTON 1 WSW | WA | 46.316 | -118.001 | 1557 | 1893 | 2006 | 114 | 7 | DY | 19.8 |
| 452037 | DAYTON 9 SE | WA | 46.217 | -117.850 | 2343 | 1940 | 1977 | 38 | 13 | HR | 32.7 |
| 352168 | DAYVILLE | OR | 44.467 | -119.533 | 2362 | 1895 | 1978 | 84 | 144 | DY | 12.8 |
| 352173 | DAYVILLE 8 NW | OR | 44.556 | -119.645 | 2260 | 1978 | 2006 | 29 | 144 | DY | 11.6 |
| 102444 | DEER FLAT DAM | ID | 43.576 | -116.747 | 2510 | 1948 | 2006 | 59 | 9 | DY | 10.3 |
| 102451 | DEER POINT | ID | 43.750 | -116.100 | 7156 | 1954 | 1970 | 17 | 148 | DY | 32.1 |
| 262229 | DENIO | NV | 41.990 | -118.634 | 4190 | 1951 | 2006 | 56 | 146 | DY | 9.5 |
| 19E03S | DERR. | OR | 44.446 | -119.930 | 5670 | 1980 | 2006 | 27 | 144 | Snotel | 29.4 |
| 352277 | DETROIT | OR | 44.733 | -122.150 | 1591 | 1909 | 1972 | 64 | 15 | DY | 81.2 |
| 352292 | DETROIT DAM | OR | 44.717 | -122.250 | 1220 | 1955 | 2006 | 52 | 15 | HR | 89.3 |
| 352295 | DEVILS FLAT | OR | 42.817 | -123.050 | 2030 | 1977 | 2006 | 30 | 143 | HR | 41.4 |
| 352305 | DIAMOND 4 WNW | OR | 43.033 | -118.750 | 4163 | 1942 | 1957 | 16 | 146 | DY | 11.5 |
| 22F18S | DIAMOND LAKE | OR | 43.188 | -122.140 | 5315 | 1980 | 2006 | 27 | 154 | Snotel | 49.7 |
| 352325 | DILLEY 1 S | OR | 45.483 | -123.124 | 165 | 1943 | 2006 | 64 | 32 | DY | 44.3 |
| 18H01S | DISASTER PEAK | NV | 41.967 | -118.189 | 6500 | 1980 | 2006 | 27 | 146 | Snotel | 21.0 |
| 20H12S | DISMAL SWAMP | CA | 41.967 | -120.167 | 7000 | 1980 | 2006 | 27 | 145 | Snotel | 49.1 |
| 352345 | DISSTON 1 NE LAYING | OR | 43.700 | -122.733 | 1218 | 1948 | 2006 | 59 | 15 | HR | 56.6 |
| 452197 | DIXIE 4 SE | WA | 46.083 | -118.100 | 2250 | 1940 | 2006 | 67 | 13 | HR | 39.6 |
| 352348 | DIXIE MOUNTAIN | OR | 45.683 | -122.917 | 1430 | 1976 | 2006 | 31 | 32 | HR | 63.6 |
| 352370 | DORA 2 W | OR | 43.164 | -123.996 | 95 | 1969 | 1999 | 31 | 5 | DY | 62.1 |
| 352371 | DORAVILLE | OR | 46.033 | -123.033 | 751 | 1902 | 1936 | 35 | 32 | DY | 66.6 |
| 352374 | DORENA DAM | OR | 43.767 | -122.950 | 820 | 1950 | 2006 | 57 | 31 | HR | 48.5 |
| 452220 | DOTY 3 E | WA | 46.633 | -123.200 | 260 | 1958 | 2006 | 49 | 32 | DY | 55.5 |
| 352406 | DRAIN | OR | 43.666 | -123.328 | 292 | 1902 | 2006 | 105 | 32 | DY | 48.1 |
| 352415 | DREWSEY | OR | 43.807 | -118.376 | 3515 | 1970 | 2006 | 37 | 146 | DY | 10.7 |
| 452253 | DRYAD | WA | 46.633 | -123.250 | 310 | 1937 | 1978 | 42 | 32 | DY | 55.8 |
| 352440 | DUFUR | OR | 45.455 | -121.128 | 1330 | 1909 | 2006 | 98 | 14 | DY | 13.5 |
| 262394 | DUFURRENA | NV | 41.867 | -119.017 | 4803 | 1959 | 2006 | 48 | 145 | DY | 7.3 |
| 042572 | DUNSMUIR | CA | 41.217 | -122.267 | 2421 | 1906 | 1978 | 73 | 154 | DY | 59.5 |
| 042574 | DUNSMUIR TREATMENT P | CA | 41.200 | -122.267 | 2170 | 1978 | 2006 | 29 | 154 | DY | 61.4 |
| 352482 | DURKEE 3 NNW | OR | 44.617 | -117.483 | 2782 | 1948 | 1976 | 29 | 13 | DY | 11.6 |
| 102845 | DWORSHAK FISH HATCHE | ID | 46.500 | -116.317 | 995 | 1967 | 2006 | 40 | 13 | HR | 25.5 |
| 352493 | EAGLE CREEK 9 SE | OR | 45.274 | -122.202 | 926 | 1972 | 2006 | 35 | 15 | DY | 63.3 |
| 352564 | ECHO | OR | 45.750 | -119.183 | 659 | 1903 | 1971 | 69 | 77 | DY | 10.6 |
| 18E03S | EILERTSON MEADOWS | OR | 44.869 | -118.114 | 5400 | 1980 | 2006 | 27 | 13 | Snotel | 30.2 |
| 452493 | ELECTRON HEADWORKS | WA | 46.900 | -122.033 | 1732 | 1943 | 1980 | 38 | 15 | DY | 68.2 |
| 352597 | ELGIN | OR | 45.562 | -117.920 | 2655 | 1937 | 2006 | 70 | 13 | DY | 24.0 |
| 16C20S | ELK BUTTE | ID | 46.840 | -116.123 | 5690 | 1982 | 2006 | 25 | 148 | Snotel | 60.8 |
| 102892 | ELK RIVER 1 S | ID | 46.783 | -116.167 | 2913 | 1952 | 2006 | 55 | 148 | DY | 36.5 |
| 042749 | ELK VALLEY | CA | 41.987 | -123.718 | 1705 | 1938 | 1976 | 39 | 142 | DY | 79.2 |
| 352633 | ELKTON 3 SW | OR | 43.595 | -123.599 | 120 | 1936 | 2006 | 71 | 142 | DY | 52.5 |
| 452505 | ELLENSBURG | WA | 46.969 | -120.540 | 1480 | 1893 | 2006 | 114 | 14 | DY | 9.2 |
| 452531 | ELMA | WA | 47.000 | -123.400 | 70 | 1940 | 2006 | 67 | 32 | DY | 67.6 |
| 452542 | ELTOPIA 8 WSW | WA | 46.383 | -119.150 | 700 | 1954 | 2006 | 53 | 77 | DY | 8.9 |
| 18D04S | EMIGRANT SPRINGS | OR | 45.558 | -118.454 | 3925 | 1980 | 2006 | 27 | 13 | Snotel | 35.5 |
| 102942 | EMMETT 2 E | ID | 43.854 | -116.466 | 2390 | 1906 | 2006 | 101 | 148 | DY | 14.0 |
| 352678 | ENTERPRISE 20 NNE | OR | 45.708 | -117.153 | 3280 | 1969 | 2006 | 38 | 13 | DY | 19.2 |
| 352672 | ENTERPRISE R S | OR | 45.426 | -117.297 | 3815 | 1931 | 1981 | 51 | 13 | DY | 14.4 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 352693 | ESTACADA 2 SE | OR | 45.269 | -122.319 | 450 | 1909 | 2006 | 98 | 31 | DY | 60.2 |
| 352697 | ESTACADA 24 SE | OR | 45.077 | -121.971 | 2200 | 1920 | 1951 | 32 | 15 | DY | 57.9 |
| 352697 | ESTACADA 24 SE | OR | 45.067 | -121.967 | 2200 | 1948 | 2006 | 59 | 15 | HR | 57.9 |
| 042899 | ETNA | CA | 41.450 | -122.883 | 2950 | 1948 | 2006 | 59 | 143 | HR | 27.1 |
| 352706 | EUGENE | OR | 44.050 | -123.083 | 390 | 1892 | 1945 | 54 | 31 | DY | 44.4 |
| 352709 | EUGENE MAHLON SWEET | OR | 44.117 | -123.217 | 353 | 1948 | 2006 | 59 | 32 | HR | 44.5 |
| 352728 | EULA | OR | 43.833 | -122.617 | 879 | 1923 | 1950 | 28 | 15 | DY | 55.4 |
| 042910 | EUREKA WFO WOODLEY I | CA | 40.800 | -124.150 | 20 | 1948 | 2006 | 59 | 5 | HR | 40.6 |
| 352775 | FAIRVIEW 4 NE | OR | 43.259 | -124.023 | 195 | 1974 | 2006 | 33 | 5 | DY | 69.7 |
| 352793 | FALL RIVER HATCHERY | OR | 43.767 | -121.633 | 4304 | 1928 | 1942 | 15 | 14 | DY | 22.2 |
| 042964 | FALL RIVER MILLS INT | CA | 41.017 | -121.467 | 3343 | 1923 | 2006 | 84 | 145 | DY | 21.0 |
| 352800 | FALLS CITY 2 SSW | OR | 44.836 | -123.453 | 690 | 1896 | 1961 | 66 | 32 | DY | 73.5 |
| 352805 | FALLS CITY NO 2 | OR | 44.858 | -123.431 | 420 | 1961 | 2001 | 41 | 32 | DY | 66.2 |
| 16H08S | FAWN CREEK | NV | 41.821 | -116.101 | 7000 | 1980 | 2006 | 27 | 146 | Snotel | 31.7 |
| 352867 | FERN RIDGE DAM | OR | 44.117 | -123.300 | 485 | 1948 | 2006 | 59 | 32 | HR | 44.5 |
| 18G02S | FISH CREEK | OR | 42.711 | -118.626 | 7900 | 1978 | 2006 | 29 | 146 | Snotel | 44.8 |
| 352928 | FISH LAKE | OR | 42.383 | -122.350 | 4642 | 1918 | 1956 | 39 | 154 | DY | 45.0 |
| 22G14S | FISH LK. | OR | 42.380 | -122.349 | 4665 | 1980 | 2006 | 27 | 154 | Snotel | 45.3 |
| 352972 | FLORENCE | OR | 43.967 | -124.100 | 12 | 1948 | 2006 | 59 | 5 | HR | 68.6 |
| 352974 | FLOURNOY VALLEY | OR | 43.191 | -123.554 | 700 | 1978 | 1998 | 21 | 32 | DY | 45.0 |
| 355424 | FORD EXPERIMENT S | OR | 42.296 | -122.870 | 1457 | 1937 | 2003 | 67 | 8 | DY | 20.9 |
| 352997 | FOREST GROVE | OR | 45.524 | -123.103 | 197 | 1893 | 2006 | 114 | 32 | DY | 42.9 |
| 043157 | FORT BIDWELL | CA | 41.867 | -120.150 | 4505 | 1911 | 2006 | 96 | 145 | DY | 18.2 |
| 043173 | FORT DICK | CA | 41.883 | -124.133 | 59 | 1951 | 1988 | 38 | 5 | DY | 73.9 |
| 043176 | FORT JONES 6 ESE | CA | 41.583 | -122.717 | 3323 | 1948 | 1977 | 30 | 143 | HR | 24.7 |
| 043182 | FORT JONES RANGER ST | CA | 41.600 | -122.850 | 2723 | 1936 | 2006 | 71 | 143 | DY | 21.3 |
| 353038 | FOSSIL | OR | 44.999 | -120.211 | 2650 | 1923 | 2006 | 84 | 7 | DY | 15.0 |
| 353047 | FOSTER DAM | OR | 44.400 | -122.667 | 550 | 1970 | 2006 | 37 | 15 | HR | 54.1 |
| 22G12S | FOURMILE LAKE | OR | 42.439 | -122.229 | 6000 | 1978 | 2006 | 29 | 154 | Snotel | 52.0 |
| 452984 | FRANCES | WA | 46.550 | -123.500 | 231 | 1941 | 2006 | 66 | 142 | HR | 96.8 |
| 353095 | FREMONT 5 NW | OR | 43.394 | -121.212 | 4609 | 1909 | 1996 | 88 | 145 | DY | 12.5 |
| 353121 | FRIEND | OR | 45.350 | -121.267 | 2441 | 1923 | 1976 | 54 | 14 | DY | 16.6 |
| 353193 | GARDINER 1 N | OR | 43.746 | -124.122 | 30 | 1983 | 2006 | 24 | 5 | DY | 70.1 |
| 043357 | GASQUET RANGER STN | CA | 41.850 | -123.967 | 384 | 1948 | 2006 | 59 | 151 | DY | 90.4 |
| 353232 | GERBER DAM | OR | 42.205 | -121.131 | 4850 | 1925 | 1956 | 32 | 145 | DY | 18.6 |
| 353232 | GERBER DAM | OR | 42.200 | -121.117 | 4850 | 1958 | 2006 | 49 | 145 | HR | 18.5 |
| 353250 | GIBBON | OR | 45.700 | -118.367 | 1739 | 1972 | 1995 | 24 | 13 | DY | 28.0 |
| 353305 | GLENDALE | OR | 42.733 | -123.417 | 1385 | 1950 | 2006 | 57 | 143 | HR | 40.3 |
| 453177 | GLENOMA | WA | 46.517 | -122.133 | 840 | 1906 | 2004 | 99 | 15 | DY | 68.7 |
| 453183 | GLENWOOD | WA | 46.017 | -121.283 | 1896 | 1941 | 2006 | 66 | 14 | HR | 32.3 |
| 353318 | GLENWOOD 2 WNW | OR | 45.650 | -123.300 | 644 | 1948 | 2006 | 59 | 142 | HR | 61.7 |
| 353340 | GOBLE 3 SW | OR | 45.983 | -122.917 | 530 | 1948 | 2006 | 59 | 32 | HR | 54.9 |
| 353356 | GOLD BEACH RANGER ST | OR | 42.404 | -124.424 | 50 | 1948 | 2006 | 59 | 5 | DY | 77.9 |
| 18E08S | GOLD CENTER | OR | 44.764 | -118.312 | 5340 | 1980 | 2006 | 27 | 13 | Snotel | 26.1 |
| 453222 | GOLDENDALE | WA | 45.817 | -120.817 | 1657 | 1906 | 2006 | 101 | 14 | DY | 16.6 |
| 353402 | GOVERNMENT CAMP | OR | 45.300 | -121.733 | 3980 | 1955 | 2006 | 52 | 15 | HR | 88.9 |
| 353421 | GRAND RONDE TREE FAR | OR | 45.050 | -123.617 | 395 | 1948 | 2006 | 59 | 5 | HR | 62.6 |
| 103760 | GRAND VIEW | ID | 42.983 | -116.100 | 2362 | 1909 | 2006 | 98 | 9 | DY | 7.1 |
| 103771 | GRANGEVILLE | ID | 45.930 | -116.115 | 3360 | 1922 | 2006 | 85 | 148 | DY | 23.9 |
| 353430 | GRANITE 4 WSW | OR | 44.800 | -118.500 | 4944 | 1947 | 1967 | 21 | 13 | DY | 27.8 |
| 17H08S | GRANITE PEAK | NV | 41.671 | -117.566 | 7800 | 1980 | 2006 | 27 | 146 | Snotel | 34.1 |
| 353445 | GRANTS PASS | OR | 42.424 | -123.324 | 930 | 1893 | 2006 | 114 | 8 | DY | 31.2 |
| 103811 | GRASMERE 3 S | ID | 42.333 | -115.883 | 5140 | 1963 | 2006 | 44 | 146 | HR | 9.4 |
| 453320 | GRAYLAND | WA | 46.801 | -124.086 | 10 | 1953 | 2006 | 54 | 5 | DY | 74.4 |
| 453333 | GRAYS RIVER HATCHERY | WA | 46.383 | -123.567 | 100 | 1954 | 2006 | 53 | 5 | HR | 112.9 |
| 21C10S | GREEN LAKE | WA | 46.548 | -121.171 | 6000 | 1982 | 2006 | 25 | 14 | Snotel | 38.1 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 353509 | GREEN SPRINGS POWER | OR | 42.126 | -122.545 | 2435 | 1960 | 2006 | 47 | 143 | DY | 23.3 |
| 21D01S | GREENPOINT | OR | 45.622 | -121.704 | 3200 | 1979 | 2006 | 28 | 14 | Snotel | 74.1 |
| 043614 | GREENVIEW | CA | 41.552 | -122.907 | 2820 | 1943 | 2006 | 64 | 143 | DY | 23.2 |
| 353521 | GRESHAM | OR | 45.483 | -122.417 | 310 | 1948 | 2006 | 59 | 31 | HR | 56.9 |
| 353542 | GRIZZLY | OR | 44.518 | -120.939 | 3635 | 1934 | 2006 | 73 | 145 | DY | 13.3 |
| 353604 | HALFWAY | OR | 44.878 | -117.113 | 2665 | 1936 | 2006 | 71 | 9 | DY | 21.3 |
| 453444 | HANFORD A E C | WA | 46.567 | -119.583 | 722 | 1912 | 1944 | 33 | 77 | DY | 8.0 |
| 043761 | HAPPY CAMP RANGER ST | CA | 41.804 | -123.376 | 1120 | 1914 | 2006 | 93 | 143 | DY | 50.8 |
| 353659 | HARNEY BRANCH EXPERI | OR | 43.583 | -118.933 | 4144 | 1922 | 1954 | 33 | 145 | DY | 10.5 |
| 353666 | HARPER | OR | 43.867 | -117.617 | 2513 | 1919 | 1975 | 57 | 146 | DY | 10.2 |
| 043791 | HARRISON GULCH R S | CA | 40.350 | -122.950 | 2750 | 1949 | 2006 | 58 | 154 | HR | 37.1 |
| 353692 | HART MOUNTAIN REFUGE | OR | 42.548 | -119.656 | 5616 | 1939 | 2006 | 68 | 145 | DY | 11.8 |
| 353705 | HASKINS DAM | OR | 45.300 | -123.350 | 756 | 1948 | 2006 | 59 | 142 | HR | 75.1 |
| 043821 | HAT CREEK RANGER STN | CA | 40.800 | -121.500 | 3353 | 1948 | 1975 | 28 | 145 | HR | 25.3 |
| 453546 | HATTON 9 SE | WA | 46.722 | -118.651 | 1510 | 1905 | 2006 | 102 | 77 | DY | 10.2 |
| 353737 | HAY CREEK | OR | 44.950 | -120.900 | 2943 | 1919 | 1944 | 26 | 145 | DY | 13.6 |
| 353770 | HEADWORKS PTLD WTR B | OR | 45.450 | -122.154 | 748 | 1899 | 2006 | 108 | 15 | DY | 79.8 |
| 353827 | HEPPNER | OR | 45.365 | -119.564 | 1885 | 1893 | 2006 | 114 | 7 | DY | 14.3 |
| 353830 | HEPPNER 5 SSE | OR | 45.283 | -119.517 | 3240 | 1975 | 2006 | 32 | 7 | HR | 15.9 |
| 353847 | HERMISTON 1 SE | OR | 45.829 | -119.264 | 640 | 1906 | 2006 | 101 | 77 | DY | 9.6 |
| 18D19S | HIGH RIDGE | OR | 45.697 | -118.105 | 4980 | 1978 | 2006 | 29 | 13 | Snotel | 48.1 |
| 353915 | HILLS CREEK DAM | OR | 43.700 | -122.417 | 1247 | 1961 | 2006 | 46 | 15 | HR | 49.7 |
| 353908 | HILLSBORO | OR | 45.514 | -122.990 | 160 | 1929 | 2003 | 75 | 32 | DY | 40.0 |
| 043987 | HILTS SLASH DISPOSAL | CA | 42.000 | -122.617 | 2923 | 1939 | 1984 | 46 | 143 | DY | 24.1 |
| 21E06S | HOGG PASS | OR | 44.421 | -121.857 | 4760 | 1979 | 2006 | 28 | 154 | Snotel | 88.1 |
| 22F42S | HOLLAND MEADOWS | OR | 43.669 | -122.569 | 4900 | 1980 | 2006 | 27 | 15 | Snotel | 77.2 |
| 353971 | HOLLEY | OR | 44.353 | -122.784 | 610 | 1940 | 2006 | 67 | 31 | DY | 50.7 |
| 104318 | HOMEDALE 1 SE | ID | 43.617 | -116.917 | 2230 | 1990 | 2006 | 17 | 9 | DY | 9.1 |
| 353995 | HONEYMAN STATE PARK | OR | 43.929 | -124.106 | 115 | 1971 | 2006 | 36 | 5 | DY | 71.1 |
| 354008 | HOOD RIVER TUCKER BR | OR | 45.650 | -121.533 | 383 | 1941 | 2006 | 66 | 14 | HR | 32.0 |
| 044089 | HOOPA | CA | 41.033 | -123.667 | 333 | 1948 | 2006 | 59 | 143 | HR | 55.3 |
| 453807 | HOQUIAM BOWERMAN AP | WA | 46.973 | -123.930 | 12 | 1953 | 2006 | 54 | 5 | DY | 72.5 |
| 354060 | HOWARD PRAIRIE DAM | OR | 42.229 | -122.381 | 4567 | 1960 | 2006 | 47 | 154 | DY | 32.6 |
| 354098 | HUNTINGTON | OR | 44.356 | -117.255 | 2110 | 1901 | 2006 | 106 | 9 | DY | 14.0 |
| 044191 | HYAMPOM | CA | 40.600 | -123.450 | 1275 | 1948 | 2006 | 59 | 143 | HR | 45.1 |
| 453883 | ICE HARBOR DAM | WA | 46.245 | -118.879 | 368 | 1957 | 2006 | 50 | 77 | DY | 10.2 |
| 104450 | IDAHO CITY 11 SW | ID | 43.717 | -116.000 | 5003 | 1948 | 1963 | 16 | 148 | DY | 28.1 |
| 044202 | IDLEWILD HWY MNTNC S | CA | 41.900 | -123.767 | 1250 | 1959 | 1977 | 19 | 142 | DY | 78.7 |
| 354126 | IDLEYLD PARK 4 NE | OR | 43.371 | -122.965 | 1080 | 1958 | 2006 | 49 | 15 | DY | 63.3 |
| 354133 | ILLAHE | OR | 42.629 | -124.058 | 348 | 1938 | 2006 | 69 | 151 | DY | 82.7 |
| 354161 | IONE 18 S | OR | 45.318 | -119.857 | 2130 | 1935 | 2006 | 72 | 77 | DY | 12.6 |
| 21F21S | IRISH TAYLOR | OR | 43.804 | -121.949 | 5500 | 1978 | 2006 | 29 | 154 | Snotel | 70.4 |
| 354175 | IRONSIDE 2 W | OR | 44.325 | -117.996 | 3915 | 1955 | 2004 | 50 | 13 | DY | 12.4 |
| 16H02S | JACK CREEK UPPER | NV | 41.547 | -116.009 | 7250 | 1978 | 2006 | 29 | 146 | Snotel | 29.2 |
| 16H04S | JACKS PEAK | NV | 41.517 | -116.018 | 8420 | 1981 | 2006 | 26 | 146 | Snotel | 35.5 |
| 354216 | JACKSONVILLE | OR | 42.300 | -122.983 | 1640 | 1893 | 1948 | 56 | 8 | DY | 24.0 |
| 044374 | JESS VALLEY | CA | 41.268 | -120.295 | 5400 | 1948 | 2006 | 59 | 145 | DY | 18.0 |
| 354276 | JEWELL WILDLIFE MEAD | OR | 45.941 | -123.528 | 570 | 1919 | 1943 | 25 | 142 | DY | 108.0 |
| 354276 | JEWELL WILDLIFE MEAD | OR | 45.933 | -123.517 | 570 | 1954 | 2006 | 53 | 142 | HR | 102.6 |
| 354291 | JOHN DAY | OR | 44.423 | -118.959 | 3063 | 1953 | 2006 | 54 | 144 | DY | 13.9 |
| 354321 | JORDAN VALLEY | OR | 42.967 | -117.050 | 4390 | 1949 | 2006 | 58 | 146 | HR | 14.0 |
| 354329 | JOSEPH | OR | 45.346 | -117.225 | 4260 | 1893 | 1954 | 62 | 13 | DY | 18.6 |
| 22E07S | JUMP OFF JOE | OR | 44.386 | -122.167 | 3500 | 1978 | 2006 | 29 | 15 | Snotel | 88.7 |
| 22C09S | JUNE LAKE | WA | 46.148 | -122.155 | 3340 | 1982 | 2006 | 25 | 15 | Snotel | 166.6 |
| 354357 | JUNTURA 9 ENE | OR | 43.800 | -117.933 | 2830 | 1963 | 1996 | 34 | 146 | DY | 10.7 |
| 454077 | KAHLOTUS 5 SSW | WA | 46.583 | -118.600 | 1552 | 1914 | 1996 | 83 | 77 | DY | 10.7 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 454085 | KALAMA 5 ENE | WA | 46.050 | -122.750 | 902 | 1917 | 1967 | 51 | 15 | DY | 63.5 |
| 454084 | KALAMA FALLS HATCHER | WA | 46.016 | -122.733 | 310 | 1967 | 2006 | 40 | 15 | DY | 69.1 |
| 104793 | KAMIAH | ID | 46.233 | -116.017 | 1191 | 1913 | 2006 | 94 | 148 | DY | 24.1 |
| 454131 | KELSO | WA | 46.143 | -122.916 | 20 | 1923 | 1953 | 31 | 31 | DY | 45.0 |
| 454154 | KENNEWICK | WA | 46.211 | -119.101 | 390 | 1894 | 2006 | 113 | 77 | DY | 7.8 |
| 454159 | KENNEWICK 10 SW | WA | 46.133 | -119.300 | 1503 | 1949 | 1974 | 26 | 77 | DY | 9.9 |
| 354403 | KENO | OR | 42.130 | -121.930 | 4116 | 1927 | 2006 | 80 | 14 | DY | 20.0 |
| 354411 | KENT | OR | 45.197 | -120.699 | 2598 | 1922 | 2004 | 83 | 77 | DY | 12.4 |
| 354420 | KERBY | OR | 42.217 | -123.650 | 1270 | 1949 | 1967 | 19 | 142 | HR | 63.1 |
| 354426 | KERBY 3 NNW | OR | 42.217 | -123.650 | 1210 | 1967 | 2006 | 40 | 142 | HR | 63.1 |
| 454201 | KID VALLEY | WA | 46.367 | -122.617 | 689 | 1938 | 1980 | 43 | 15 | DY | 61.4 |
| 23G09S | KING MOUNTAIN | OR | 42.724 | -123.200 | 4000 | 1980 | 2006 | 27 | 142 | Snotel | 62.9 |
| 264236 | KINGS RIVER VALLEY | NV | 41.750 | -118.233 | 423 | 1956 | 2006 | 51 | 146 | DY | 8.9 |
| 044577 | KLAMATH | CA | 41.567 | -124.067 | 28 | 1948 | 2006 | 59 | 5 | HR | 73.5 |
| 354506 | KLAMATH FALLS 2 SSW | OR | 42.201 | -121.781 | 4098 | 1898 | 2001 | 104 | 147 | DY | 13.9 |
| 354511 | KLAMATH FALLS AG STA | OR | 42.164 | -121.755 | 4092 | 1948 | 2006 | 59 | 147 | DY | 12.5 |
| 044587 | KNEELAND 10 SSE | CA | 40.633 | -123.900 | 2450 | 1954 | 2006 | 53 | 151 | HR | 62.8 |
| 454286 | KOSMOS | WA | 46.500 | -122.183 | 781 | 1905 | 1965 | 61 | 15 | DY | 64.6 |
| 105038 | KUNA 2 NNE | ID | 43.517 | -116.400 | 2690 | 1926 | 1996 | 71 | 9 | DY | 10.8 |
| 454328 | LA CENTER | WA | 45.850 | -122.650 | 200 | 1896 | 1940 | 45 | 31 | DY | 48.3 |
| 354622 | LA GRANDE | OR | 45.317 | -118.075 | 2755 | 1948 | 2006 | 59 | 13 | DY | 17.1 |
| 454360 | LA GRANDE | WA | 46.833 | -122.317 | 961 | 1954 | 1983 | 30 | 15 | DY | 39.3 |
| 354620 | LA GRANDE CAA AIRPOR | OR | 45.283 | -118.017 | 2707 | 1948 | 1966 | 19 | 13 | HR | 14.0 |
| 354603 | LACOMB 1 WNW | OR | 44.583 | -122.750 | 650 | 1948 | 1987 | 40 | 31 | HR | 48.4 |
| 354606 | LACOMB 3 NNE | OR | 44.625 | -122.719 | 520 | 1973 | 2006 | 34 | 31 | DY | 57.5 |
| 454338 | LACROSSE | WA | 46.816 | -117.881 | 1450 | 1908 | 2006 | 99 | 7 | DY | 14.8 |
| 354632 | LAKE 2 N | OR | 43.267 | -120.633 | 4366 | 1909 | 1978 | 70 | 145 | DY | 9.5 |
| 044675 | LAKE CITY | CA | 41.633 | -120.217 | 4613 | 1929 | 1960 | 32 | 145 | DY | 21.4 |
| 354634 | LAKE CREEK 2 S | OR | 42.390 | -122.626 | 1865 | 1955 | 1972 | 18 | 143 | DY | 26.0 |
| 354633 | LAKE CREEK 3 NE | OR | 42.450 | -122.567 | 2400 | 1978 | 1995 | 18 | 143 | DY | 30.1 |
| 354635 | LAKE CREEK 6 SE | OR | 42.367 | -122.533 | 1752 | 1917 | 1953 | 37 | 143 | DY | 30.2 |
| 18E18S | LAKE CREEK R.S. | OR | 44.210 | -118.638 | 5200 | 1981 | 2006 | 26 | 13 | Snotel | 25.5 |
| 354670 | LAKEVIEW 2 NNW | OR | 42.214 | -120.364 | 4778 | 1893 | 2006 | 114 | 145 | DY | 15.8 |
| 17H07S | LAMANCE CREEK | NV | 41.515 | -117.631 | 6000 | 1980 | 2006 | 27 | 146 | Snotel | 29.8 |
| 354721 | LANGLOIS #2 | OR | 42.924 | -124.453 | 90 | 1956 | 2006 | 51 | 5 | DY | 74.8 |
| 105132 | LAPWAI | ID | 46.400 | -116.800 | 889 | 1916 | 1938 | 23 | 9 | DY | 17.8 |
| 16H05S | LAUREL DRAW | NV | 41.777 | -116.028 | 6700 | 1979 | 2006 | 28 | 146 | Snotel | 26.0 |
| 354776 | LAUREL MOUNTAIN | OR | 44.923 | -123.575 | 3589 | 1978 | 2006 | 29 | 142 | DY | 124.7 |
| 044838 | LAVA BEDS NAT MONUME | CA | 41.740 | -121.507 | 4770 | 1959 | 2006 | 48 | 145 | DY | 14.6 |
| 354811 | LEABURG 1 SW | OR | 44.100 | -122.688 | 675 | 1933 | 2006 | 74 | 15 | DY | 65.3 |
| 354824 | LEES CAMP | OR | 45.583 | -123.517 | 655 | 1948 | 2006 | 59 | 151 | HR | 124.6 |
| 354835 | LEMOLO LAKE 3 NNW | OR | 43.360 | -122.221 | 4077 | 1978 | 2006 | 29 | 154 | DY | 65.1 |
| 264527 | LEONARD CREEK RANCH | NV | 41.517 | -118.719 | 4224 | 1954 | 2006 | 53 | 145 | DY | 9.6 |
| 105236 | LEWISTON | ID | 46.417 | -117.017 | 810 | 1895 | 1955 | 61 | 9 | DY | 13.6 |
| 105241 | LEWISTON AP | ID | 46.367 | -117.000 | 1436 | 1950 | 2006 | 57 | 9 | HR | 17.2 |
| 454679 | LIND 3 NE | WA | 46.998 | -118.571 | 1630 | 1931 | 2006 | 76 | 77 | DY | 10.1 |
| 454702 | LITTLE GOOSE DAM | WA | 46.583 | -118.033 | 702 | 1964 | 1979 | 16 | 77 | HR | 12.6 |
| 22E09S | LITTLE MEADOWS | OR | 44.613 | -122.226 | 4000 | 1980 | 2006 | 27 | 15 | Snotel | 111.8 |
| 354939 | LITTLE RIVER | OR | 43.233 | -122.987 | 1060 | 1955 | 2006 | 52 | 15 | DY | 52.4 |
| 355008 | LONDON | OR | 43.650 | -123.083 | 932 | 1947 | 1967 | 21 | 31 | DY | 52.4 |
| 21C26S | LONE PINE | WA | 46.272 | -121.964 | 3800 | 1981 | 2006 | 26 | 15 | Snotel | 100.8 |
| 454752 | LONG BEACH 3 NNE | WA | 46.383 | -124.033 | 30 | 1953 | 1967 | 15 | 5 | DY | 78.3 |
| 454748 | LONG BEACH EXP STN | WA | 46.367 | -124.033 | 30 | 1953 | 2006 | 54 | 5 | DY | 80.3 |
| 355020 | LONG CREEK | OR | 44.714 | -119.101 | 3740 | 1957 | 2006 | 50 | 144 | DY | 16.6 |
| 454764 | LONGMIRE RAINIER NPS | WA | 46.750 | -121.817 | 2762 | 1909 | 2006 | 98 | 15 | DY | 84.7 |
| 454769 | LONGVIEW | WA | 46.151 | -122.916 | 12 | 1925 | 2006 | 82 | 31 | DY | 46.1 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 355026 | LOOKINGGLASS | OR | 43.181 | -123.485 | 622 | 1978 | 2006 | 29 | 32 | DY | 39.4 |
| 045093 | LOOKOUT 3 WSW | CA | 41.200 | -121.200 | 4183 | 1963 | 1977 | 15 | 145 | DY | 21.9 |
| 355050 | LOOKOUT POINT DAM | OR | 43.900 | -122.750 | 712 | 1955 | 2006 | 52 | 15 | HR | 48.1 |
| 355055 | LOST CREEK DAM | OR | 42.667 | -122.667 | 1580 | 1970 | 2006 | 37 | 143 | HR | 34.2 |
| 21C39S | LOST HORSE | WA | 46.357 | -121.081 | 5000 | 1990 | 2006 | 17 | 14 | Snotel | 34.9 |
| 264698 | LOVELOCK | NV | 40.183 | -118.467 | 3975 | 1952 | 2006 | 55 | 145 | HR | 5.8 |
| 355080 | LOWER HAY CREEK | OR | 44.733 | -120.975 | 1887 | 1938 | 2006 | 69 | 145 | DY | 11.1 |
| 454841 | LOWER MONUMENTL DAM | WA | 46.550 | -118.533 | 460 | 1963 | 1979 | 17 | 77 | HR | 10.5 |
| 18D06S | LUCKY STRIKE | OR | 45.275 | -118.848 | 5050 | 1978 | 2006 | 29 | 13 | Snotel | 28.5 |
| 045231 | MADELINE | CA | 41.067 | -120.483 | 5262 | 1908 | 1975 | 68 | 145 | DY | 14.7 |
| 19D03S | MADISON BUTTE | OR | 45.105 | -119.496 | 5250 | 1980 | 2006 | 27 | 13 | Snotel | 22.2 |
| 355139 | MADRAS | OR | 44.617 | -121.001 | 3372 | 1920 | 2006 | 87 | 145 | DY | 10.7 |
| 355142 | MADRAS 2 N | OR | 44.666 | -121.144 | 2414 | 1974 | 2006 | 33 | 145 | DY | 11.6 |
| 355160 | MALHEUR BRANCH EXP S | OR | 43.979 | -117.025 | 2260 | 1942 | 2006 | 65 | 9 | DY | 10.2 |
| 355162 | MALHEUR REFUGE HDQ | OR | 43.266 | -118.843 | 4109 | 1959 | 2006 | 48 | 146 | DY | 10.2 |
| 355170 | MALIN | OR | 42.017 | -121.417 | 4052 | 1925 | 1946 | 22 | 145 | DY | 11.8 |
| 355174 | MALIN 5 E | OR | 42.008 | -121.319 | 4627 | 1968 | 2006 | 39 | 145 | DY | 13.9 |
| 355206 | MAPLETON 2 NNW | OR | 44.050 | -123.867 | 41 | 1975 | 2006 | 32 | 5 | HR | 83.6 |
| 355213 | MARCOLA | OR | 44.167 | -122.867 | 545 | 1948 | 2006 | 59 | 31 | HR | 51.7 |
| 355218 | MARIAL 7 N | OR | 42.817 | -123.900 | 2313 | 1956 | 1984 | 29 | 142 | HR | 90.8 |
| 21E04S | MARION FORKS | OR | 44.594 | -121.974 | 2600 | 1980 | 2006 | 27 | 15 | Snotel | 81.0 |
| 355221 | MARION FRKS FISH HAT | OR | 44.600 | -121.933 | 2475 | 1948 | 2006 | 59 | 154 | HR | 77.2 |
| 355258 | MASON DAM | OR | 44.672 | -117.994 | 3900 | 1969 | 2006 | 38 | 13 | DY | 17.0 |
| 455105 | MAYFIELD | WA | 46.483 | -122.517 | 600 | 1893 | 1937 | 45 | 31 | DY | 59.7 |
| 455110 | MAYFIELD POWER PLANT | WA | 46.504 | -122.594 | 280 | 1980 | 2006 | 27 | 31 | DY | 58.1 |
| 045449 | MC CLOUD | CA | 41.267 | -122.133 | 3304 | 1909 | 2006 | 98 | 14 | DY | 51.4 |
| 355335 | MC DERMITT 26 N | OR | 42.411 | -117.866 | 4464 | 1955 | 2006 | 52 | 146 | DY | 9.3 |
| 355357 | MC KENZIE BRIDGE | OR | 44.183 | -122.167 | 1371 | 1954 | 1970 | 17 | 15 | DY | 76.4 |
| 355362 | MC KENZIE BRIDGE R S | OR | 44.178 | -122.116 | 1478 | 1931 | 2006 | 76 | 15 | DY | 66.7 |
| 355384 | MC MINNVILLE | OR | 45.221 | -123.162 | 98 | 1894 | 2006 | 113 | 32 | DY | 42.8 |
| 105708 | MCCALL | ID | 44.887 | -116.105 | 5025 | 1905 | 2006 | 102 | 148 | DY | 27.4 |
| 264935 | MCDERMITT | NV | 41.983 | -117.717 | 4527 | 1950 | 2006 | 57 | 146 | HR | 9.1 |
| 21E07S | MCKENZIE | OR | 44.210 | -121.873 | 4800 | 1981 | 2006 | 26 | 154 | Snotel | 95.7 |
| 355362 | MCKENZIE BRIDGE RS | OR | 44.167 | -122.100 | 1478 | 1948 | 1975 | 28 | 15 | HR | 68.8 |
| 355375 | MCKINLEY | OR | 43.183 | -124.033 | 141 | 1897 | 1944 | 48 | 5 | DY | 62.8 |
| 455231 | MCNARY DAM | WA | 45.941 | -119.298 | 361 | 1954 | 2006 | 53 | 77 | DY | 8.5 |
| 355396 | MEACHAM WSO AIRPORT | OR | 45.500 | -118.400 | 4050 | 1948 | 2006 | 59 | 13 | DY | 33.4 |
| 355429 | MEDFORD INTL AP | OR | 42.381 | -122.872 | 1297 | 1928 | 2006 | 79 | 8 | DY | 18.4 |
| 355447 | MEHAMA | OR | 44.783 | -122.617 | 620 | 1923 | 1966 | 44 | 15 | DY | 68.4 |
| 105841 | MERIDIAN 1 SSW | ID | 43.600 | -116.400 | 2612 | 1911 | 1960 | 50 | 9 | DY | 11.4 |
| 355505 | MERRILL 2 NW | OR | 42.050 | -121.633 | 4198 | 1949 | 1968 | 20 | 147 | DY | 12.0 |
| 455305 | MERWIN DAM | WA | 45.950 | -122.550 | 224 | 1934 | 2006 | 73 | 31 | DY | 70.2 |
| 355515 | METOLIUS 1 W | OR | 44.583 | -121.183 | 2503 | 1945 | 1993 | 49 | 145 | DY | 10.4 |
| 265105 | MIDAS 4 SE | NV | 41.200 | -116.733 | 5203 | 1952 | 1969 | 18 | 146 | DY | 11.4 |
| 355545 | MIKKALO 6 W | OR | 45.467 | -120.350 | 1550 | 1948 | 1994 | 47 | 77 | DY | 10.9 |
| 455377 | MILL CREEK | WA | 46.017 | -118.117 | 2001 | 1915 | 1973 | 59 | 13 | DY | 45.8 |
| 455387 | MILL CREEK DAM | WA | 46.076 | -118.274 | 1175 | 1948 | 2006 | 59 | 7 | DY | 19.6 |
| 355593 | MILTON FREEWATER | OR | 45.943 | -118.409 | 970 | 1928 | 2006 | 79 | 7 | DY | 16.0 |
| 355610 | MINAM 7 NE | OR | 45.683 | -117.600 | 3616 | 1955 | 1985 | 31 | 13 | DY | 26.9 |
| 455425 | MINERAL 1 SW | WA | 46.717 | -122.183 | 1470 | 1935 | 1980 | 46 | 15 | DY | 82.5 |
| 355621 | MIRA MONTE FARM | OR | 45.267 | -122.750 | 161 | 1893 | 1924 | 32 | 31 | DY | 42.4 |
| 355641 | MITCHELL 2 NW | OR | 44.583 | -120.183 | 2645 | 1931 | 1994 | 64 | 144 | DY | 12.1 |
| 355656 | MODOC ORCHARD | OR | 42.450 | -122.883 | 1220 | 1915 | 1966 | 52 | 8 | DY | 21.7 |
| 355677 | MOLALLA | OR | 45.150 | -122.567 | 400 | 1935 | 1976 | 42 | 31 | DY | 45.0 |
| 355707 | MONTGOMERY RANCH | OR | 44.617 | -121.483 | 1903 | 1930 | 1949 | 20 | 147 | DY | 16.1 |
| 355711 | MONUMENT 2 | OR | 44.818 | -119.419 | 1995 | 1961 | 2006 | 46 | 7 | DY | 14.8 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 355715 | MONUMENT RANGER STN | OR | 44.817 | -119.417 | 1981 | 1948 | 2006 | 59 | 7 | HR | 14.8 |
| 355726 | MORGAN 3 NE | OR | 45.583 | -119.883 | 951 | 1923 | 1979 | 57 | 77 | DY | 9.5 |
| 355734 | MORO | OR | 45.482 | -120.724 | 1870 | 1917 | 2006 | 90 | 147 | DY | 11.6 |
| 21C17S | MORSE LAKE | WA | 46.906 | -121.483 | 5400 | 1978 | 2006 | 29 | 15 | Snotel | 83.9 |
| 106148 | MOSCOW 5 NE | ID | 46.783 | -116.917 | 3000 | 1972 | 2006 | 35 | 148 | HR | 31.9 |
| 106152 | MOSCOW U OF I | ID | 46.733 | -117.000 | 2631 | 1893 | 2006 | 114 | 148 | DY | 26.4 |
| 17D06S | MOSS SPRINGS | OR | 45.272 | -117.688 | 5850 | 1980 | 2006 | 27 | 13 | Snotel | 50.6 |
| 455656 | MOTTINGER | WA | 45.933 | -119.150 | 312 | 1899 | 1946 | 48 | 77 | DY | 8.9 |
| 455659 | MOUNT ADAMS RANGER S | WA | 46.000 | -121.540 | 1950 | 1924 | 2006 | 83 | 14 | DY | 42.6 |
| 355770 | MOUNT ANGEL | OR | 45.067 | -122.750 | 489 | 1893 | 1926 | 34 | 31 | DY | 45.5 |
| 045941 | MOUNT HEBRON RNG STN | CA | 41.784 | -122.045 | 4250 | 1942 | 2006 | 65 | 14 | DY | 12.6 |
| 045983 | MOUNT SHASTA | CA | 41.317 | -122.300 | 3590 | 1948 | 2006 | 59 | 154 | HR | 41.7 |
| 455686 | MOXEE | WA | 46.583 | -120.433 | 1001 | 1892 | 1945 | 54 | 77 | DY | 8.8 |
| 455688 | MOXEE CITY 10 E | WA | 46.500 | -120.150 | 1550 | 1901 | 2006 | 106 | 77 | DY | 8.3 |
| 21D08S | MT HOOD TEST SITE | OR | 45.321 | -121.716 | 5400 | 1980 | 2006 | 27 | 154 | Snotel | 110.7 |
| 17D18S | MT. HOWARD | OR | 45.265 | -117.173 | 7910 | 1980 | 2006 | 27 | 13 | Snotel | 44.5 |
| 16G07S | MUD FLAT | ID | 42.600 | -116.559 | 5730 | 1980 | 2006 | 27 | 146 | Snotel | 17.8 |
| 21D35S | MUD RIDGE | OR | 45.254 | -121.737 | 3800 | 1978 | 2006 | 29 | 154 | Snotel | 71.5 |
| 355892 | MYRTLE CREEK 12 ENE | OR | 43.050 | -123.067 | 1191 | 1955 | 1980 | 26 | 15 | DY | 41.2 |
| 355891 | MYRTLE CREEK 8 NE | OR | 43.091 | -123.167 | 825 | 1980 | 2006 | 27 | 15 | DY | 39.9 |
| 356151 | N WILLAMETTE EXP STN | OR | 45.282 | -122.752 | 98 | 1963 | 2006 | 44 | 31 | DY | 42.5 |
| 455736 | NACHES HEIGHTS | WA | 46.650 | -120.633 | 1870 | 1910 | 1948 | 39 | 147 | DY | 11.1 |
| 106300 | NAMPA 2 NW | ID | 43.617 | -116.583 | 2470 | 1946 | 1960 | 15 | 9 | DY | 10.6 |
| 106305 | NAMPA SUGAR FACTORY | ID | 43.600 | -116.567 | 2470 | 1976 | 2006 | 31 | 9 | DY | 10.5 |
| 455774 | NASELLE 2 ENE | WA | 46.373 | -123.753 | 50 | 1929 | 2006 | 78 | 5 | DY | 112.0 |
| 355969 | NEHALEM | OR | 45.717 | -123.900 | 75 | 1948 | 2006 | 59 | 5 | HR | 99.4 |
| 355971 | NEHALEM 9 NE | OR | 45.814 | -123.775 | 140 | 1969 | 2006 | 38 | 5 | DY | 119.8 |
| 21F10S | NEW CRESCENT LAKE | OR | 43.512 | -121.980 | 4800 | 1980 | 2006 | 27 | 154 | Snotel | 41.8 |
| 106388 | NEW MEADOWS RANG S | ID | 44.967 | -116.283 | 3862 | 1905 | 2006 | 102 | 148 | DY | 24.7 |
| 356032 | NEWPORT | OR | 44.643 | -124.056 | 122 | 1893 | 2006 | 114 | 5 | DY | 69.1 |
| 106424 | NEZPERCE | ID | 46.250 | -116.200 | 3251 | 1948 | 2006 | 59 | 148 | DY | 21.8 |
| 356073 | NORTH BEND FCWOS | OR | 43.413 | -124.244 | 6 | 1902 | 2006 | 105 | 5 | DY | 64.8 |
| 22D02S | NORTH FORK | OR | 45.550 | -122.003 | 3170 | 1979 | 2006 | 28 | 15 | Snotel | 143.2 |
| 356171 | NOTI 2 ESE | OR | 44.050 | -123.417 | 449 | 1948 | 1984 | 37 | 32 | HR | 57.8 |
| 356179 | NYSSA | OR | 43.876 | -116.990 | 2175 | 1937 | 2006 | 70 | 9 | DY | 10.5 |
| 356302 | O O RANCH | OR | 43.278 | -119.311 | 4136 | 1950 | 2006 | 57 | 145 | DY | 10.2 |
| 046329 | OAK KNOLL RANGER STN | CA | 41.850 | -122.883 | 1700 | 1972 | 2006 | 35 | 143 | DY | 24.7 |
| 046328 | OAK KNOLL W C | CA | 41.839 | -122.850 | 1980 | 1943 | 2006 | 64 | 143 | DY | 25.3 |
| 356200 | OAKLAND | OR | 43.423 | -123.300 | 430 | 1978 | 2006 | 29 | 31 | DY | 40.6 |
| 356213 | OAKRIDGE FISH HATCHE | OR | 43.743 | -122.443 | 1275 | 1914 | 2006 | 93 | 15 | DY | 46.1 |
| 456011 | OAKVILLE | WA | 46.833 | -123.233 | 80 | 1916 | 1997 | 82 | 32 | DY | 57.7 |
| 356238 | OCHOCO DAM | OR | 44.283 | -120.717 | 3057 | 1949 | 2006 | 58 | 145 | HR | 11.8 |
| 20E02S | OCHOCO MEADOWS | OR | 44.429 | -120.331 | 5200 | 1980 | 2006 | 27 | 144 | Snotel | 29.0 |
| 356243 | OCHOCO RANGER STATIO | OR | 44.400 | -120.433 | 3975 | 1909 | 2004 | 96 | 144 | DY | 16.2 |
| 356251 | ODELL LAKE | OR | 43.583 | -122.050 | 4793 | 1948 | 1973 | 26 | 154 | DY | 58.9 |
| 356252 | ODELL LAKE EAST | OR | 43.549 | -121.964 | 4800 | 1974 | 2006 | 33 | 154 | DY | 35.5 |
| 356254 | ODELL LAKE WATER PAN | OR | 43.583 | -122.050 | 4793 | 1945 | 1959 | 15 | 154 | DY | 58.9 |
| 106586 | OLA | ID | 44.167 | -116.267 | 3075 | 1948 | 2006 | 59 | 148 | HR | 23.3 |
| 356269 | OLIVE LAKE | OR | 44.783 | -118.600 | 5945 | 1920 | 1947 | 28 | 13 | DY | 33.0 |
| 456114 | OLYMPIA AIRPORT | WA | 46.973 | -122.903 | 188 | 1948 | 2006 | 59 | 32 | DY | 50.3 |
| 356294 | ONTARIO KSRV | OR | 44.033 | -116.967 | 2145 | 1949 | 2006 | 58 | 9 | HR | 9.6 |
| 356334 | OREGON CITY | OR | 45.355 | -122.605 | 167 | 1911 | 2006 | 96 | 31 | DY | 45.5 |
| 046498 | ORICK PRAIRIE CREEK | CA | 41.367 | -124.017 | 160 | 1937 | 2006 | 70 | 151 | DY | 67.6 |
| 046508 | ORLEANS | CA | 41.309 | -123.532 | 400 | 1903 | 2006 | 104 | 143 | DY | 52.9 |
| 106681 | OROFINO | ID | 46.483 | -116.250 | 1030 | 1903 | 1981 | 79 | 148 | DY | 24.5 |
| 265818 | OROVADA 4 WSW | NV | 41.550 | -117.833 | 429 | 1911 | 2006 | 96 | 146 | DY | 10.4 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 456215 | OTHELLO 6 ESE | WA | 46.789 | -119.046 | 1190 | 1941 | 2002 | 62 | 77 | DY | 8.5 |
| 356366 | OTIS 2 NE | OR | 45.033 | -123.924 | 150 | 1948 | 2006 | 59 | 5 | DY | 97.9 |
| 265869 | OWYHEE | NV | 41.950 | -116.100 | 5397 | 1948 | 1975 | 28 | 146 | HR | 14.5 |
| 356405 | OWYHEE DAM | OR | 43.650 | -117.247 | 2400 | 1935 | 2006 | 72 | 9 | DY | 9.9 |
| 356853 | P RANCH REFUGE | OR | 42.827 | -118.888 | 4195 | 1942 | 2006 | 65 | 146 | DY | 12.8 |
| 456262 | PACKWOOD | WA | 46.609 | -121.674 | 1060 | 1924 | 2006 | 83 | 15 | DY | 57.5 |
| 356426 | PAISLEY | OR | 42.692 | -120.540 | 4360 | 1905 | 2006 | 102 | 145 | DY | 10.8 |
| 21C35S | PARADISE | WA | 46.781 | -121.747 | 5120 | 1980 | 2006 | 27 | 15 | Snotel | 115.9 |
| 266005 | PARADISE VALLEY RANC | NV | 41.500 | -117.533 | 468 | 1894 | 2006 | 113 | 146 | DY | 11.2 |
| 356464 | PARKDALE | OR | 45.517 | -121.583 | 1713 | 1912 | 1969 | 58 | 14 | DY | 41.6 |
| 356466 | PARKDALE 1 NNE | OR | 45.533 | -121.583 | 1520 | 1928 | 2006 | 79 | 14 | DY | 37.7 |
| 456385 | PARKWAY 6 S | WA | 46.917 | -121.533 | 3553 | 1943 | 1966 | 24 | 15 | DY | 56.3 |
| 106844 | PARMA EXPERIMENT STN | ID | 43.802 | -116.944 | 2290 | 1922 | 2006 | 85 | 9 | DY | 10.0 |
| 456400 | PASCO | WA | 46.217 | -119.100 | 350 | 1942 | 2003 | 62 | 77 | HR | 7.8 |
| 356500 | PAULINA | OR | 44.133 | -119.997 | 3684 | 1961 | 2005 | 45 | 144 | DY | 11.7 |
| 106891 | PAYETTE | ID | 44.077 | -116.929 | 2150 | 1892 | 2006 | 115 | 9 | DY | 10.8 |
| 21D14S | PEAVINE RIDGE | OR | 45.041 | -121.933 | 3500 | 1981 | 2006 | 26 | 15 | Snotel | 68.1 |
| 356532 | PELTON DAM | OR | 44.728 | -121.251 | 1410 | 1958 | 2006 | 49 | 145 | DY | 10.9 |
| 356540 | PENDLETON BR EXP STN | OR | 45.721 | -118.626 | 1487 | 1956 | 2006 | 51 | 7 | DY | 17.3 |
| 356541 | PENDLETON DOWNTOWN | OR | 45.670 | -118.796 | 1040 | 1892 | 1936 | 45 | 7 | DY | 14.0 |
| 356541 | PENDLETON DOWNTOWN | OR | 45.670 | -118.796 | 1040 | 1987 | 2006 | 20 | 7 | DY | 14.0 |
| 356546 | PENDLETON E OR RGNL | OR | 45.698 | -118.855 | 1486 | 1928 | 2006 | 79 | 7 | DY | 13.0 |
| 456456 | PEOLA | WA | 46.333 | -117.467 | 4003 | 1909 | 1936 | 28 | 9 | DY | 20.5 |
| 456477 | PETERSONS RANCH | WA | 46.050 | -122.200 | 600 | 1927 | 1953 | 27 | 15 | DY | 122.4 |
| 356614 | PHILOMATH 2 SE | OR | 44.533 | -123.333 | 220 | 1940 | 1972 | 33 | 32 | DY | 44.3 |
| 21C33S | PIGTAIL PEAK | WA | 46.621 | -121.386 | 5900 | 1981 | 2006 | 26 | 154 | Snotel | 72.7 |
| 356634 | PILOT ROCK 1 SE | OR | 45.476 | -118.825 | 1720 | 1908 | 2006 | 99 | 7 | DY | 14.4 |
| 356636 | PILOT ROCK 11 E | OR | 45.500 | -118.600 | 1920 | 1978 | 2006 | 29 | 13 | HR | 24.2 |
| 356655 | PINE GROVE 5 ENE | OR | 45.129 | -121.256 | 2059 | 1969 | 1998 | 30 | 14 | DY | 17.7 |
| 046944 | PIT RIVER P H 1 | CA | 41.000 | -121.500 | 2880 | 1972 | 1996 | 25 | 145 | DY | 19.1 |
| 456553 | PLEASANT VIEW | WA | 46.517 | -118.333 | 1670 | 1936 | 1979 | 44 | 77 | DY | 13.4 |
| 456610 | POMEROY | WA | 46.469 | -117.589 | 1900 | 1929 | 2006 | 78 | 9 | DY | 17.6 |
| 356784 | PORT ORFORD 2 | OR | 42.752 | -124.501 | 42 | 1905 | 2006 | 102 | 5 | DY | 73.3 |
| 356795 | PORT ORFORD 5 E | OR | 42.739 | -124.403 | 150 | 1971 | 2006 | 36 | 5 | DY | 122.7 |
| 356751 | PORTLAND INTL AIRPOR | OR | 45.583 | -122.600 | 19 | 1941 | 2006 | 66 | 32 | HR | 38.4 |
| 356749 | PORTLAND KGW-TV | OR | 45.517 | -122.683 | 160 | 1928 | 2006 | 79 | 32 | DY | 43.8 |
| 356761 | PORTLAND WB CITY | OR | 45.533 | -122.667 | 200 | 1928 | 1973 | 46 | 32 | DY | 43.5 |
| 21C14S | POTATO HILL | WA | 46.349 | -121.514 | 4500 | 1981 | 2006 | 26 | 14 | Snotel | 66.3 |
| 107301 | POTLATCH 1 SE | ID | 46.900 | -116.867 | 2592 | 1915 | 2006 | 92 | 148 | DY | 26.8 |
| 356820 | POWERS | OR | 42.889 | -124.069 | 230 | 1932 | 2006 | 75 | 151 | DY | 59.8 |
| 356822 | POWERS TELEMETERING | OR | 42.883 | -124.067 | 220 | 1971 | 2006 | 36 | 142 | HR | 58.1 |
| 356845 | PRAIRIE CITY RS | OR | 44.450 | -118.700 | 3540 | 1949 | 2006 | 58 | 13 | HR | 17.7 |
| 456747 | PRIEST RAPIDS DAM | WA | 46.643 | -119.910 | 460 | 1956 | 2006 | 51 | 77 | DY | 7.0 |
| 456753 | PRINDLE 2 NW | WA | 45.583 | -122.167 | 249 | 1933 | 1949 | 17 | 31 | DY | 71.5 |
| 356883 | PRINEVILLE | OR | 44.307 | -120.807 | 2915 | 1897 | 2006 | 110 | 145 | DY | 10.7 |
| 356907 | PROSPECT 2 SW | OR | 42.734 | -122.516 | 2482 | 1905 | 2006 | 102 | 143 | DY | 41.7 |
| 456768 | PROSSER | WA | 46.200 | -119.750 | 830 | 1913 | 2006 | 94 | 77 | DY | 8.6 |
| 456789 | PULLMAN 2 NW | WA | 46.750 | -117.183 | 2545 | 1940 | 2006 | 67 | 13 | HR | 22.0 |
| 456784 | PULLMAN EXP STN | WA | 46.733 | -117.167 | 2582 | 1893 | 1954 | 62 | 7 | DY | 21.4 |
| 20G06S | QUARTZ MOUNTAIN | OR | 42.319 | -120.825 | 5700 | 1980 | 2006 | 27 | 145 | Snotel | 21.8 |
| 356955 | QUARTZVILLE 13 SW | OR | 44.483 | -122.500 | 820 | 1939 | 1962 | 24 | 15 | DY | 82.6 |
| 266504 | QUINN RIVER CROSSING | NV | 41.567 | -118.433 | 409 | 1901 | 1951 | 51 | 146 | DY | 6.9 |
| 22F05S | RAILROAD OVERPASS | OR | 43.659 | -122.213 | 2750 | 1981 | 2006 | 26 | 15 | Snotel | 57.1 |
| 456887 | RAINBOW FALLS PARK 2 | WA | 46.633 | -123.183 | 279 | 1928 | 1963 | 36 | 32 | DY | 54.6 |
| 456892 | RAINIER CARBON R ENT | WA | 46.994 | -121.911 | 1735 | 1926 | 1974 | 49 | 15 | DY | 71.9 |
| 456896 | RAINIER OHANAPECOSH | WA | 46.733 | -121.567 | 1950 | 1941 | 2006 | 66 | 15 | HR | 76.9 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 456898 | RAINIER PARADISE RNG | WA | 46.786 | -121.743 | 5427 | 1917 | 2006 | 90 | 15 | DY | 128.2 |
| 456909 | RANDLE 1 E | WA | 46.533 | -121.933 | 900 | 1930 | 2006 | 77 | 15 | DY | 62.4 |
| 456914 | RAYMOND 2 S | WA | 46.653 | -123.730 | 30 | 1980 | 2006 | 27 | 5 | DY | 85.0 |
| 21D04S | RED HILL | OR | 45.465 | -121.704 | 4400 | 1978 | 2006 | 29 | 154 | Snotel | 108.9 |
| 357056 | REDMOND 1 SSE | OR | 44.263 | -121.158 | 3042 | 1930 | 1989 | 60 | 145 | DY | 9.3 |
| 357062 | REDMOND AIRPORT | OR | 44.256 | -121.139 | 3043 | 1948 | 2006 | 59 | 145 | DY | 8.9 |
| 047342 | REDWOOD CREEK O'KANE | CA | 40.900 | -123.800 | 880 | 1975 | 2006 | 32 | 142 | HR | 60.9 |
| 357082 | REEDSPORT | OR | 43.700 | -124.117 | 200 | 1937 | 1983 | 47 | 5 | DY | 73.1 |
| 357112 | RESTON | OR | 43.131 | -123.620 | 890 | 1955 | 2004 | 50 | 32 | DY | 49.9 |
| 357127 | REX 1 S | OR | 45.300 | -122.900 | 515 | 1948 | 2006 | 59 | 32 | HR | 45.0 |
| 107648 | REYNOLDS | ID | 43.206 | -116.749 | 3930 | 1961 | 2006 | 46 | 9 | DY | 10.9 |
| 357160 | RICHLAND | OR | 44.766 | -117.160 | 2215 | 1893 | 2006 | 114 | 9 | DY | 12.7 |
| 457015 | RICHLAND | WA | 46.312 | -119.263 | 373 | 1944 | 2006 | 63 | 77 | DY | 7.8 |
| 357169 | RIDDLE | OR | 42.951 | -123.357 | 680 | 1899 | 2006 | 108 | 143 | DY | 32.3 |
| 107706 | RIGGINS RANGER STN | ID | 45.417 | -116.300 | 1801 | 1896 | 2006 | 111 | 148 | DY | 17.9 |
| 457038 | RIMROCK TIETON DAM | WA | 46.650 | -121.133 | 2733 | 1917 | 1977 | 61 | 14 | DY | 25.6 |
| 354003 | RIVER EXP STN | OR | 45.685 | -121.518 | 500 | 1893 | 2006 | 114 | 14 | DY | 30.7 |
| 357208 | RIVERSIDE 7 SSW | OR | 43.451 | -118.224 | 3380 | 1897 | 2006 | 110 | 146 | DY | 10.1 |
| 22F43S | ROARING RIVER | OR | 43.901 | -122.031 | 4900 | 1980 | 2006 | 27 | 154 | Snotel | 70.9 |
| 357250 | ROCK CREEK | OR | 44.910 | -118.073 | 4095 | 1920 | 2006 | 87 | 13 | DY | 21.1 |
| 18F01S | ROCK SPRINGS | OR | 44.009 | -118.838 | 5100 | 1980 | 2006 | 27 | 144 | Snotel | 17.7 |
| 357277 | ROCKVILLE 5 N | OR | 43.364 | -117.114 | 3670 | 1963 | 2006 | 44 | 146 | DY | 12.5 |
| 357310 | ROME 2 NW | OR | 42.859 | -117.657 | 3405 | 1950 | 2006 | 57 | 146 | DY | 8.5 |
| 357331 | ROSEBURG KQEN | OR | 43.213 | -123.366 | 425 | 1965 | 2006 | 42 | 32 | DY | 33.7 |
| 357326 | ROSEBURG WB AIRPORT | OR | 43.233 | -123.367 | 505 | 1931 | 1965 | 35 | 32 | DY | 34.1 |
| 357354 | ROUND GROVE | OR | 42.341 | -120.889 | 4888 | 1920 | 1987 | 68 | 145 | DY | 18.7 |
| 047581 | ROUND MOUNTAIN | CA | 40.783 | -121.933 | 2100 | 1970 | 2001 | 32 | 145 | HR | 65.0 |
| 357391 | RUCH | OR | 42.223 | -123.047 | 1550 | 1963 | 2006 | 44 | 143 | DY | 25.0 |
| 267192 | RYE PATCH DAM | NV | 40.450 | -118.300 | 4135 | 1948 | 2006 | 59 | 145 | HR | 8.6 |
| 23D01S | SADDLE MOUNTAIN | OR | 45.545 | -123.373 | 3250 | 1979 | 2006 | 28 | 142 | Snotel | 103.9 |
| 357444 | SAGINAW | OR | 43.833 | -123.033 | 620 | 1941 | 1971 | 31 | 31 | DY | 48.1 |
| 357500 | SALEM AP MCNARY FIEL | OR | 44.905 | -123.001 | 205 | 1892 | 2006 | 115 | 31 | DY | 41.1 |
| 22F04S | SALT CREEK FALLS | OR | 43.612 | -122.118 | 4000 | 1980 | 2006 | 27 | 154 | Snotel | 74.4 |
| 357533 | SAND CREEK | OR | 42.850 | -121.900 | 4682 | 1929 | 1948 | 20 | 14 | DY | 32.6 |
| 21E05S | SANTIAM JCT. | OR | 44.435 | -121.945 | 3750 | 1978 | 2006 | 29 | 154 | Snotel | 77.3 |
| 357554 | SANTIAM JUNCTION | OR | 44.433 | -121.933 | 3750 | 1948 | 2006 | 59 | 154 | HR | 76.5 |
| 357559 | SANTIAM PASS | OR | 44.417 | -121.867 | 4754 | 1963 | 1985 | 23 | 154 | DY | 87.0 |
| 457327 | SATSOP | WA | 46.967 | -123.533 | 39 | 1928 | 1947 | 20 | 32 | DY | 82.2 |
| 457342 | SATUS PASS 2 SSW | WA | 45.950 | -120.667 | 2610 | 1956 | 2006 | 51 | 14 | HR | 21.2 |
| 357572 | SAUVIES ISLAND | OR | 45.650 | -122.833 | 40 | 1948 | 2006 | 59 | 32 | HR | 41.5 |
| 048025 | SAWYERS BAR RS | CA | 41.302 | -123.133 | 2169 | 1931 | 1988 | 58 | 143 | DY | 40.1 |
| 17D08S | SCHNEIDER MEADOWS | OR | 45.001 | -117.165 | 5400 | 1980 | 2006 | 27 | 13 | Snotel | 48.0 |
| 357631 | SCOTTS MILLS 9 SE | OR | 44.947 | -122.525 | 2315 | 1956 | 2001 | 46 | 15 | DY | 82.9 |
| 357641 | SEASIDE | OR | 45.987 | -123.924 | 10 | 1930 | 2006 | 77 | 5 | DY | 75.0 |
| 23D02S | SEINE CREEK | OR | 45.526 | -123.297 | 2000 | 1980 | 2006 | 27 | 142 | Snotel | 77.5 |
| 357675 | SENECA | OR | 44.138 | -118.975 | 4660 | 1931 | 2006 | 76 | 144 | DY | 13.7 |
| 22G33S | SEVENMILE MARSH | OR | 42.698 | -122.142 | 6200 | 1980 | 2006 | 27 | 154 | Snotel | 63.8 |
| 357698 | SEXTON SUMMIT | OR | 42.600 | -123.350 | 3832 | 1948 | 2006 | 59 | 143 | HR | 33.4 |
| 048135 | SHASTA DAM | CA | 40.700 | -122.400 | 1075 | 1948 | 2006 | 59 | 154 | HR | 62.3 |
| 357736 | SHEAVILLE 1 SE | OR | 43.121 | -117.039 | 4620 | 1931 | 2004 | 74 | 146 | DY | 16.1 |
| 22C10S | SHEEP CANYON | WA | 46.193 | -122.254 | 4030 | 1980 | 2006 | 27 | 15 | Snotel | 135.9 |
| 267443 | SHELDON | NV | 41.850 | -119.633 | 6506 | 1933 | 1972 | 40 | 145 | DY | 12.7 |
| 19H05S | SHELDON | NV | 41.904 | -119.445 | 5860 | 1989 | 2006 | 18 | 145 | Snotel | 10.8 |
| 16C01S | SHERWIN | ID | 46.950 | -116.340 | 3200 | 1982 | 2006 | 25 | 148 | Snotel | 41.2 |
| 108412 | SILVER CITY 5 W | ID | 43.000 | -116.817 | 6160 | 1983 | 2006 | 24 | 146 | HR | 26.0 |
| 21F12S | SILVER CREEK | OR | 42.956 | -121.181 | 5720 | 1980 | 2006 | 27 | 145 | Snotel | 26.1 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 357809 | SILVER CREEK FALLS | OR | 44.873 | -122.648 | 1350 | 1938 | 2006 | 69 | 31 | DY | 78.3 |
| 357817 | SILVER LAKE RANGER S | OR | 43.117 | -121.050 | 4382 | 1968 | 2006 | 39 | 145 | HR | 10.3 |
| 357823 | SILVERTON | OR | 45.000 | -122.767 | 408 | 1962 | 2006 | 45 | 31 | HR | 47.6 |
| 18G01S | SILVIES | OR | 42.753 | -118.688 | 6900 | 1979 | 2006 | 28 | 146 | Snotel | 33.6 |
| 357857 | SISTERS | OR | 44.284 | -121.549 | 3180 | 1958 | 2006 | 49 | 14 | DY | 14.2 |
| 357866 | SITKUM 1 E | OR | 43.150 | -123.817 | 610 | 1976 | 2006 | 31 | 151 | HR | 80.1 |
| 457680 | SIXPRONG | WA | 45.833 | -120.117 | 1102 | 1906 | 1943 | 38 | 147 | DY | 10.6 |
| 457696 | SKAMANIA FISH HATCHE | WA | 45.623 | -122.218 | 440 | 1965 | 2006 | 42 | 31 | DY | 87.5 |
| 457727 | SMYRNA | WA | 46.837 | -119.663 | 560 | 1951 | 2006 | 56 | 77 | DY | 7.9 |
| 19F01S | SNOW MOUNTAIN | OR | 43.949 | -119.540 | 6220 | 1979 | 2006 | 28 | 144 | Snotel | 28.4 |
| 357940 | SOUTH DEER CREEK | OR | 43.171 | -123.225 | 690 | 1978 | 2006 | 29 | 15 | DY | 36.5 |
| 16G01S | SOUTH MTN. | ID | 42.765 | -116.901 | 6500 | 1980 | 2006 | 27 | 146 | Snotel | 32.8 |
| 21C20S | SPENCER MEADOW | WA | 46.180 | -121.926 | 3400 | 1981 | 2006 | 26 | 15 | Snotel | 104.2 |
| 22C12S | SPIRIT LAKE | WA | 46.095 | -121.763 | 3120 | 1985 | 2006 | 22 | 154 | Snotel | 98.6 |
| 457919 | SPIRIT LAKE RANGER S | WA | 46.267 | -122.150 | 3241 | 1932 | 1956 | 25 | 15 | DY | 99.6 |
| 358007 | SPRAGUE RIVER 2 SE | OR | 42.431 | -121.489 | 4483 | 1953 | 2001 | 49 | 145 | DY | 16.0 |
| 358009 | SPRAY | OR | 44.833 | -119.783 | 1742 | 1958 | 1978 | 21 | 7 | DY | 15.0 |
| 358029 | SQUAW BUTTE EXP STAT | OR | 43.487 | -119.721 | 4660 | 1937 | 2006 | 70 | 145 | DY | 11.8 |
| 16E05S | SQUAW FLAT | ID | 44.771 | -116.249 | 6240 | 1981 | 2006 | 26 | 148 | Snotel | 45.0 |
| 357466 | ST HELENS RFD | OR | 45.861 | -122.810 | 100 | 1976 | 2006 | 31 | 31 | DY | 45.0 |
| 358034 | STAFFORD | OR | 45.417 | -122.750 | 410 | 1896 | 1919 | 24 | 32 | DY | 42.4 |
| 358079 | STARKEY | OR | 45.233 | -118.450 | 3402 | 1909 | 1948 | 40 | 13 | DY | 18.0 |
| 19E07S | STARR RIDGE | OR | 44.265 | -119.021 | 5300 | 1980 | 2006 | 27 | 144 | Snotel | 20.9 |
| 358095 | STAYTON | OR | 44.789 | -122.815 | 425 | 1951 | 2006 | 56 | 31 | DY | 53.5 |
| 358102 | STEAMBOAT RANGER STN | OR | 43.333 | -122.733 | 1200 | 1955 | 2006 | 52 | 15 | HR | 50.1 |
| 20G09S | STRAWBERRY | OR | 42.126 | -120.836 | 5760 | 1980 | 2006 | 27 | 145 | Snotel | 23.0 |
| 358173 | SUMMER LAKE 1 S | OR | 42.959 | -120.790 | 4192 | 1957 | 2006 | 50 | 145 | DY | 12.8 |
| 20G02S | SUMMER RIM | OR | 42.696 | -120.802 | 7100 | 1978 | 2006 | 29 | 145 | Snotel | 28.3 |
| 358182 | SUMMIT | OR | 44.637 | -123.579 | 746 | 1909 | 1995 | 87 | 142 | DY | 65.6 |
| 358182 | SUMMIT | OR | 44.633 | -123.567 | 746 | 1971 | 2006 | 36 | 142 | HR | 66.7 |
| 358190 | SUMMIT GUARD STN | OR | 45.300 | -121.750 | 3904 | 1895 | 1951 | 57 | 15 | DY | 86.0 |
| 22F14S | SUMMIT LAKE | OR | 43.449 | -122.138 | 5600 | 1978 | 2006 | 29 | 154 | Snotel | 73.4 |
| 358221 | SUNDOWN RANCH | OR | 44.950 | -122.500 | 2402 | 1931 | 1955 | 25 | 15 | DY | 79.1 |
| 458207 | SUNNYSIDE | WA | 46.324 | -120.010 | 747 | 1894 | 2006 | 113 | 77 | DY | 7.3 |
| 358245 | SUNRISE VALLEY | OR | 43.100 | -118.167 | 3714 | 1913 | 1936 | 24 | 146 | DY | 14.1 |
| 358250 | SUNTEX | OR | 43.600 | -119.633 | 4311 | 1961 | 1990 | 30 | 145 | DY | 9.4 |
| 21C13S | SURPRISE LAKES | WA | 46.095 | -121.763 | 4250 | 1980 | 2006 | 27 | 154 | Snotel | 98.6 |
| 048703 | SUSANVILLE 1 WNW | CA | 40.417 | -120.667 | 4555 | 1952 | 2006 | 55 | 145 | HR | 15.6 |
| 358263 | SUTHERLIN 12 ENE | OR | 43.417 | -123.050 | 960 | 1955 | 2006 | 52 | 15 | HR | 63.7 |
| 358260 | SUTHERLIN 2 W | OR | 43.396 | -123.359 | 500 | 1978 | 2006 | 29 | 32 | DY | 40.9 |
| 108928 | SWAN FALLS P H | ID | 43.244 | -116.378 | 2325 | 1935 | 2006 | 72 | 9 | DY | 8.5 |
| 358338 | TALENT | OR | 42.250 | -122.800 | 1552 | 1913 | 1960 | 48 | 8 | DY | 19.2 |
| 21G03S | TAYLOR BUTTE | OR | 42.691 | -121.426 | 5100 | 1978 | 2006 | 29 | 145 | Snotel | 22.6 |
| 15H09S | TAYLOR CANYON | NV | 41.229 | -116.030 | 6200 | 1980 | 2006 | 27 | 146 | Snotel | 13.2 |
| 17D07S | TAYLOR GREEN | OR | 45.077 | -117.551 | 5740 | 1979 | 2006 | 28 | 13 | Snotel | 38.2 |
| 048873 | TERMO 1 E | CA | 40.867 | -120.433 | 5300 | 1948 | 2000 | 53 | 145 | HR | 10.7 |
| 358407 | THE DALLES | OR | 45.607 | -121.205 | 150 | 1893 | 2006 | 114 | 14 | DY | 14.5 |
| 358420 | THE POPLARS | OR | 43.264 | -120.945 | 4310 | 1941 | 2006 | 66 | 145 | DY | 11.7 |
| 21E13S | THREE CREEKS MEADOW | OR | 44.144 | -121.641 | 5650 | 1980 | 2006 | 27 | 14 | Snotel | 43.1 |
| 358466 | THREE LYNX | OR | 45.125 | -122.072 | 1120 | 1923 | 2006 | 84 | 15 | DY | 72.2 |
| 358481 | TIDEWATER | OR | 44.412 | -123.902 | 50 | 1940 | 2002 | 63 | 5 | DY | 91.2 |
| 458442 | TIETON INTAKE | WA | 46.667 | -121.000 | 2280 | 1920 | 1972 | 53 | 14 | DY | 21.0 |
| 358494 | TILLAMOOK 1 W | OR | 45.457 | -123.873 | 10 | 1948 | 2006 | 59 | 5 | DY | 90.1 |
| 358504 | TILLAMOOK 12 ESE | OR | 45.400 | -123.583 | 420 | 1949 | 2006 | 58 | 151 | HR | 121.4 |
| 358514 | TILLER | OR | 42.917 | -122.933 | 1040 | 1971 | 2006 | 36 | 15 | HR | 41.5 |
| 358512 | TILLER 15 ENE | OR | 43.000 | -122.683 | 2500 | 1956 | 2006 | 51 | 15 | HR | 42.1 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 358522 | TIMBER | OR | 45.717 | -123.300 | 942 | 1924 | 1976 | 53 | 142 | DY | 66.5 |
| 18E09S | TIPTON | OR | 44.656 | -118.426 | 5150 | 1980 | 2006 | 27 | 13 | Snotel | 25.2 |
| 358536 | TOKETEE FALLS | OR | 43.275 | -122.450 | 2060 | 1953 | 2006 | 54 | 15 | DY | 48.6 |
| 458500 | TOLEDO | WA | 46.469 | -122.841 | 325 | 1948 | 2006 | 59 | 31 | DY | 44.7 |
| 358549 | TOLLGATE | OR | 45.783 | -118.083 | 4892 | 1948 | 1963 | 16 | 13 | HR | 55.4 |
| 458540 | TOUCHET | WA | 46.033 | -118.667 | 440 | 1905 | 1940 | 36 | 7 | DY | 11.7 |
| 17C05S | TOUCHET | WA | 46.119 | -117.851 | 5530 | 1980 | 2006 | 27 | 13 | Snotel | 55.0 |
| 458543 | TOUCHET RIDGE | WA | 46.117 | -117.983 | 3602 | 1909 | 1943 | 35 | 13 | DY | 44.7 |
| 358588 | TRAIL 12 NE | OR | 42.783 | -122.667 | 1850 | 1951 | 1970 | 20 | 143 | HR | 43.4 |
| 358634 | TROUTDALE | OR | 45.553 | -122.389 | 33 | 1948 | 2006 | 59 | 31 | DY | 44.7 |
| 049053 | TULELAKE | CA | 41.967 | -121.467 | 4042 | 1932 | 2006 | 75 | 145 | DY | 11.5 |
| 049056 | TULELAKE 5 WSW | CA | 41.933 | -121.550 | 4042 | 1932 | 1957 | 26 | 145 | DY | 11.2 |
| 268346 | TUSCARORA | NV | 41.317 | -116.233 | 6184 | 1957 | 2006 | 50 | 146 | DY | 14.2 |
| 268349 | TUSCARORA ANDRAE RAN | NV | 41.400 | -116.083 | 5863 | 1888 | 1956 | 69 | 146 | DY | 16.7 |
| 358717 | TYGH VALLEY | OR | 45.233 | -121.167 | 1115 | 1972 | 2006 | 35 | 14 | HR | 15.4 |
| 358726 | UKIAH | OR | 45.136 | -118.934 | 3400 | 1922 | 2006 | 85 | 7 | DY | 17.0 |
| 358734 | UMATILLA | OR | 45.917 | -119.350 | 269 | 1892 | 1965 | 74 | 77 | DY | 8.7 |
| 358740 | UMPQUA | OR | 43.700 | -124.167 | 112 | 1915 | 1937 | 23 | 5 | DY | 71.5 |
| 458688 | UNDERWOOD 4 W | WA | 45.733 | -121.600 | 1260 | 1941 | 1962 | 22 | 14 | HR | 37.5 |
| 358746 | UNION EXPERIMENT STN | OR | 45.208 | -117.876 | 2765 | 1911 | 2006 | 96 | 13 | DY | 14.8 |
| 358780 | UNITY | OR | 44.436 | -118.188 | 4031 | 1936 | 2006 | 71 | 13 | DY | 11.0 |
| 358788 | UPPER OLALLA | OR | 43.047 | -123.581 | 860 | 1978 | 2006 | 29 | 32 | DY | 42.2 |
| 358790 | UPPER STEAMBOAT CREE | OR | 43.467 | -122.600 | 1855 | 1957 | 2006 | 50 | 15 | HR | 45.5 |
| 358797 | VALE | OR | 43.981 | -117.244 | 2240 | 1893 | 2006 | 114 | 9 | DY | 10.3 |
| 358812 | VALLEY FALLS | OR | 42.484 | -120.282 | 4325 | 1910 | 1964 | 55 | 145 | DY | 13.2 |
| 358818 | VALLEY FALLS 3 SSE | OR | 42.450 | -120.250 | 4583 | 1965 | 1983 | 19 | 145 | DY | 17.3 |
| 358833 | VALSETZ | OR | 44.833 | -123.667 | 1155 | 1948 | 1987 | 40 | 142 | HR | 122.8 |
| 458773 | VANCOUVER 4 NNE | WA | 45.678 | -122.652 | 210 | 1898 | 2006 | 109 | 31 | DY | 42.5 |
| 458778 | VANCOUVER INTERSTATE | WA | 45.621 | -122.674 | 2 | 1902 | 1959 | 58 | 31 | DY | 40.0 |
| 358884 | VERNONIA 2 | OR | 45.850 | -123.183 | 625 | 1954 | 2006 | 53 | 32 | HR | 50.5 |
| 049390 | VOLTA POWER HOUSE | CA | 40.450 | -121.850 | 2220 | 1948 | 2006 | 59 | 145 | HR | 35.4 |
| 358924 | VOLTAGE 2 NW SOD HOU | OR | 43.283 | -118.833 | 4114 | 1937 | 1959 | 23 | 146 | DY | 10.2 |
| 268810 | VYA | NV | 41.583 | -119.917 | 5663 | 1959 | 1980 | 22 | 145 | DY | 14.2 |
| 358948 | WAGONTIRE | OR | 43.250 | -119.883 | 4727 | 1960 | 1986 | 27 | 145 | DY | 9.9 |
| 458903 | WAHLUKE | WA | 46.650 | -119.717 | 420 | 1904 | 1944 | 41 | 77 | DY | 7.3 |
| 358985 | WALLA WALLA 13 ESE | OR | 45.983 | -118.050 | 2400 | 1940 | 2006 | 67 | 13 | HR | 42.1 |
| 458926 | WALLA WALLA 3 W | WA | 46.050 | -118.400 | 801 | 1931 | 1962 | 32 | 7 | DY | 16.9 |
| 458928 | WALLA WALLA FAA AIRP | WA | 46.100 | -118.283 | 1166 | 1949 | 2006 | 58 | 7 | DY | 19.9 |
| 458931 | WALLA WALLA WSO CITY | WA | 46.033 | -118.333 | 949 | 1940 | 1988 | 49 | 7 | HR | 18.1 |
| 358997 | WALLOWA | OR | 45.572 | -117.531 | 2923 | 1903 | 2006 | 104 | 13 | DY | 17.5 |
| 458959 | WAPATO | WA | 46.435 | -120.420 | 841 | 1915 | 2006 | 92 | 77 | DY | 8.1 |
| 359038 | WARM SPRINGS AGENCY | OR | 44.767 | -121.250 | 1503 | 1902 | 1928 | 27 | 145 | DY | 10.1 |
| 359046 | WARM SPRINGS RESERVO | OR | 43.567 | -118.200 | 3343 | 1927 | 1967 | 41 | 146 | DY | 9.3 |
| 359051 | WARREN | OR | 45.817 | -122.850 | 79 | 1950 | 1976 | 27 | 32 | DY | 45.0 |
| 359068 | WASCO | OR | 45.597 | -120.696 | 1264 | 1907 | 2006 | 100 | 147 | DY | 11.9 |
| 458999 | WASHOUGAL 8 ENE | WA | 45.600 | -122.183 | 761 | 1950 | 1964 | 15 | 31 | DY | 82.9 |
| 359083 | WATERLOO | OR | 44.500 | -122.819 | 437 | 1923 | 2006 | 84 | 31 | DY | 45.9 |
| 459024 | WAWAWAI 2 NW | WA | 46.650 | -117.400 | 702 | 1928 | 1965 | 38 | 7 | DY | 18.4 |
| 049490 | WEAVERVILLE | CA | 40.733 | -122.933 | 2040 | 1948 | 2006 | 59 | 143 | HR | 37.0 |
| 049498 | WEED | CA | 41.433 | -122.383 | 3514 | 1943 | 1957 | 15 | 154 | DY | 29.1 |
| 049499 | WEED FIRE DEPT | CA | 41.433 | -122.383 | 3590 | 1957 | 1989 | 33 | 154 | DY | 29.1 |
| 109638 | WEISER 1 S | ID | 44.233 | -116.950 | 2123 | 1911 | 2006 | 96 | 9 | DY | 12.4 |
| 16D08S | WEST BRANCH | ID | 45.072 | -116.455 | 5560 | 1980 | 2006 | 27 | 148 | Snotel | 41.9 |
| 359208 | WEST LINN | OR | 45.333 | -122.650 | 69 | 1938 | 1968 | 31 | 31 | DY | 47.5 |
| 359176 | WESTFALL | OR | 43.990 | -117.719 | 3040 | 1962 | 2006 | 45 | 146 | DY | 10.8 |
| 359213 | WESTON | OR | 45.817 | -118.417 | 1922 | 1953 | 2006 | 54 | 7 | HR | 18.6 |

| STATION ID | STATION NAME | STATE | LAT | LONG | ELEV (ft) | YEAR START | YEAR END | YEARS OPEN | RGN | GAGE TYPE | PRISM MAP[4,20] (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 359216 | WESTON 2 SE | OR | 45.800 | -118.400 | 2103 | 1893 | 1954 | 62 | 7 | DY | 20.9 |
| 359219 | WESTON 5 ESE | OR | 45.800 | -118.333 | 3202 | 1955 | 1982 | 28 | 13 | DY | 30.2 |
| 21C28S | WHITE PASS E.S. | WA | 46.642 | -121.381 | 4500 | 1980 | 2006 | 27 | 154 | Snotel | 52.5 |
| 459183 | WHITE SALMON 4 NNE | WA | 45.767 | -121.483 | 2011 | 1911 | 1952 | 42 | 14 | DY | 32.8 |
| 459191 | WHITE SWAN RANGER ST | WA | 46.383 | -120.717 | 971 | 1927 | 1981 | 55 | 147 | DY | 9.1 |
| 359290 | WHITEHORSE RANCH | OR | 42.337 | -118.235 | 4380 | 1965 | 2006 | 42 | 146 | DY | 8.3 |
| 459200 | WHITMAN MISSION | WA | 46.033 | -118.450 | 632 | 1963 | 2006 | 44 | 7 | HR | 14.5 |
| 359316 | WICKIUP DAM | OR | 43.682 | -121.687 | 4358 | 1941 | 2006 | 66 | 14 | DY | 21.9 |
| 359324 | WICOPEE | OR | 43.667 | -122.267 | 2881 | 1927 | 1954 | 28 | 15 | DY | 58.2 |
| 359372 | WILLAMINA | OR | 45.083 | -123.489 | 385 | 1935 | 2006 | 72 | 32 | DY | 52.0 |
| 459291 | WILLAPA HARBOR | WA | 46.683 | -123.750 | 10 | 1895 | 1979 | 85 | 5 | DY | 83.2 |
| 459295 | WILLARD FISH LAB | WA | 45.767 | -121.633 | 770 | 1962 | 1976 | 15 | 14 | HR | 42.4 |
| 359390 | WILLIAMS 1 NW | OR | 42.217 | -123.283 | 1450 | 1949 | 2006 | 58 | 143 | HR | 31.3 |
| 359398 | WILLOW CREEK | OR | 42.883 | -124.433 | 249 | 1922 | 1951 | 30 | 5 | DY | 89.9 |
| 109846 | WINCHESTER | ID | 46.233 | -116.617 | 3950 | 1939 | 2006 | 68 | 148 | DY | 24.9 |
| 359461 | WINCHESTER | OR | 43.283 | -123.354 | 460 | 1950 | 2006 | 57 | 32 | DY | 35.8 |
| 459342 | WIND RIVER | WA | 45.800 | -121.933 | 1150 | 1911 | 1977 | 67 | 15 | DY | 99.6 |
| 269171 | WINNEMUCCA AIRPORT | NV | 40.900 | -117.800 | 4296 | 1948 | 2006 | 59 | 146 | HR | 8.5 |
| 18D21S | WOLF CREEK | OR | 45.067 | -118.152 | 5700 | 1978 | 2006 | 29 | 13 | Snotel | 29.2 |
| 459465 | YAKIMA AIRPORT | WA | 46.567 | -120.533 | 1064 | 1940 | 2006 | 67 | 147 | HR | 8.4 |
| 359581 | YAQUINA BAY | OR | 44.617 | -124.033 | 15 | 1966 | 2006 | 41 | 5 | HR | 68.5 |
| 359604 | YONNA | OR | 42.300 | -121.483 | 4183 | 1907 | 1949 | 43 | 145 | DY | 15.6 |
| 049866 | YREKA | CA | 41.717 | -122.633 | 2631 | 1893 | 2006 | 114 | 143 | DY | 19.2 |
| 359616 | ZIGZAG RANGER STN | OR | 45.350 | -121.933 | 1385 | 1908 | 1953 | 46 | 15 | DY | 82.8 |

# APPENDIX B

# ISOPLUVIAL MAPS FOR SELECTED RECURRENCE INTERVALS

**OVERVIEW**

Isopluvial maps for 24-hour precipitation for recurrence intervals for the 6-month, 2-year, 10-year, 25-year, 50-year, 100-year, 500-year and 1,000-year are included as part of this appendix. Estimates of precipitation for 6-month and 2-year recurrence intervals were made using standard conversions developed by Langbein (*1949; Schaefer and Barker 2006*) for conversion from annual maxima to partial duration series equivalents. Gridded datasets used to create these maps are contained on the Compact Disc (CD) included with this report.

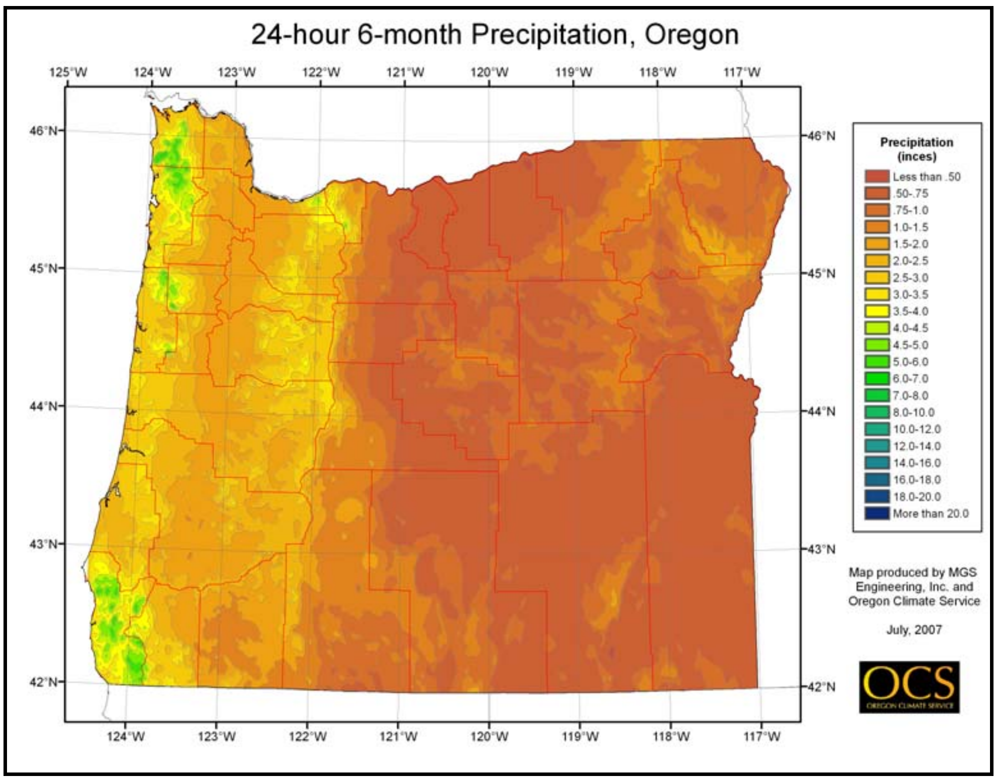


Figure B.1: Isopluvial Map of 24-Hour Precipitation for 6-Month Recurrence Interval for Oregon State.

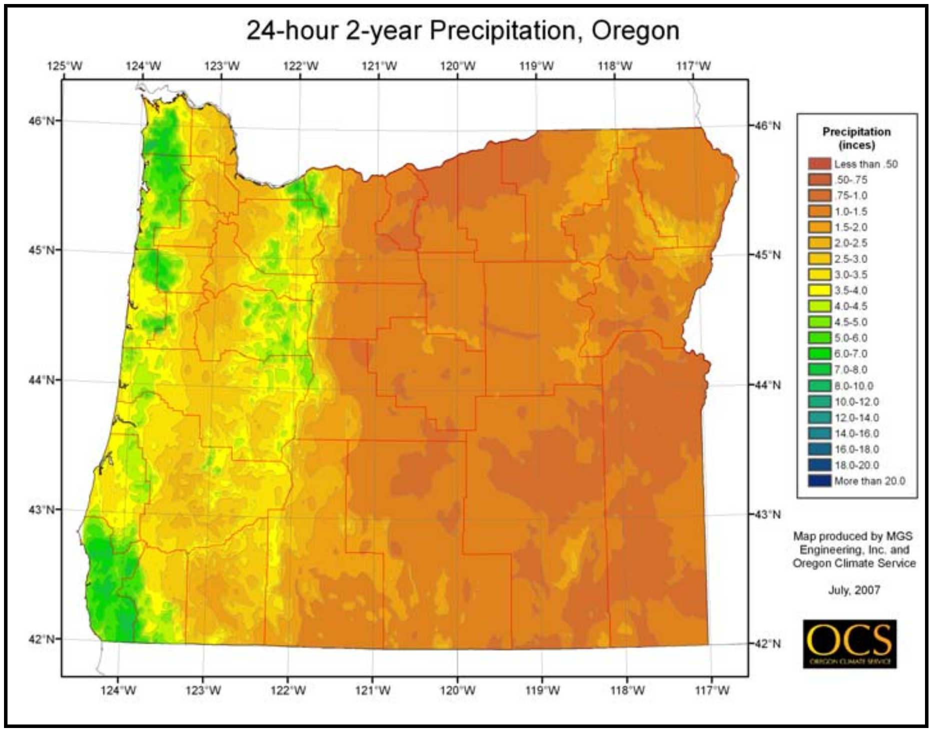


Figure B.2: Isopluvial Map of 24-Hour Precipitation for 2-Year Recurrence Interval for Oregon State.

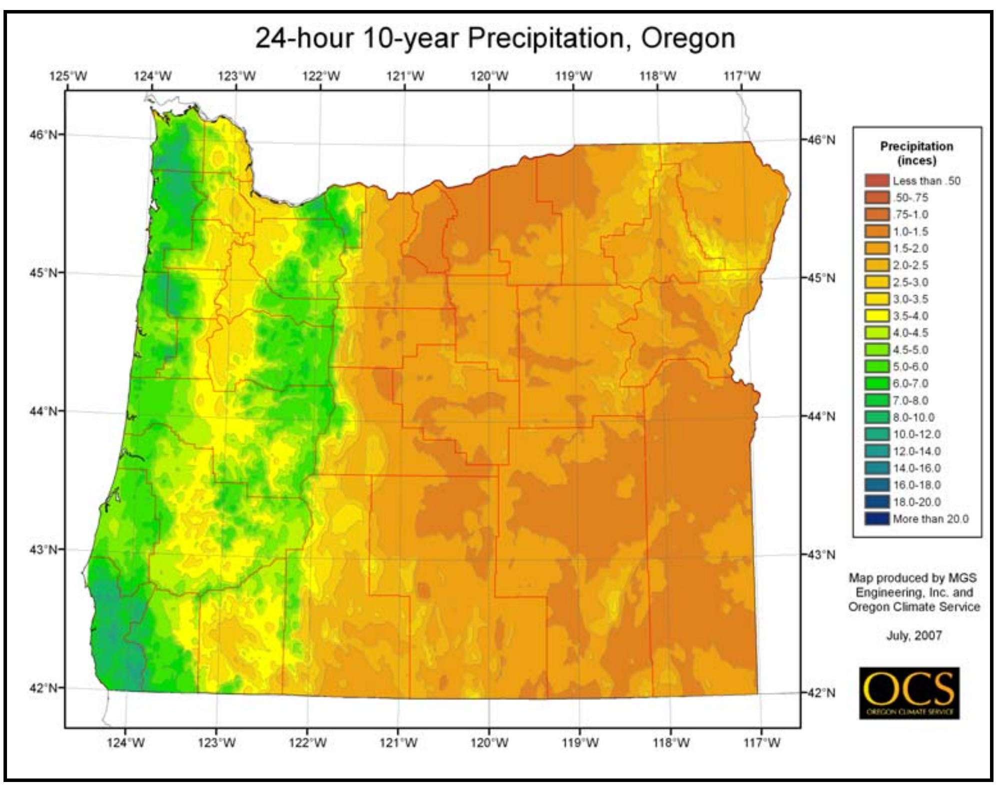


Figure B.3: Isopluvial Map of 24-Hour Precipitation for 10-Year Recurrence Interval for Oregon State.

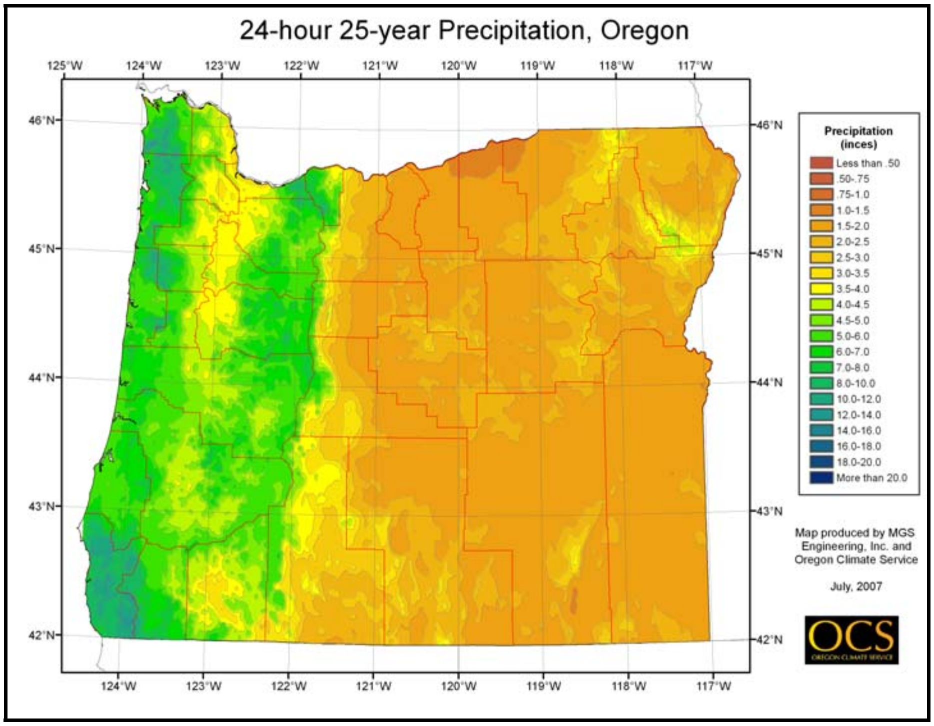


Figure B.4: Isopluvial Map of 24-Hour Precipitation for 25-Year Recurrence Interval for Oregon State.

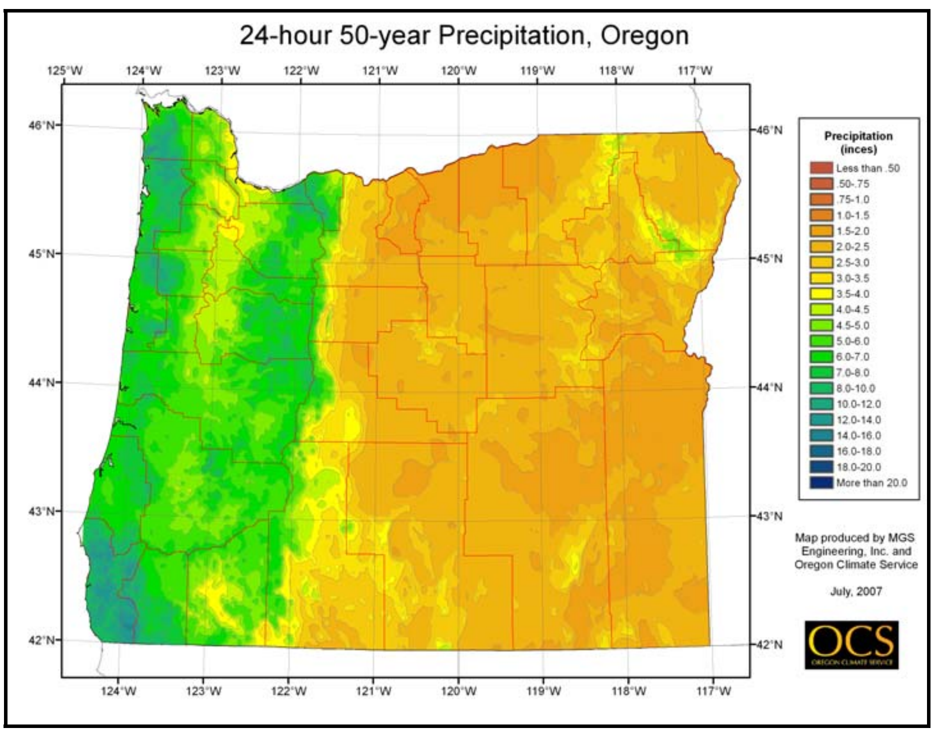


Figure B.5: Isopluvial Map of 24-Hour Precipitation for 50-Year Recurrence Interval for Oregon State.

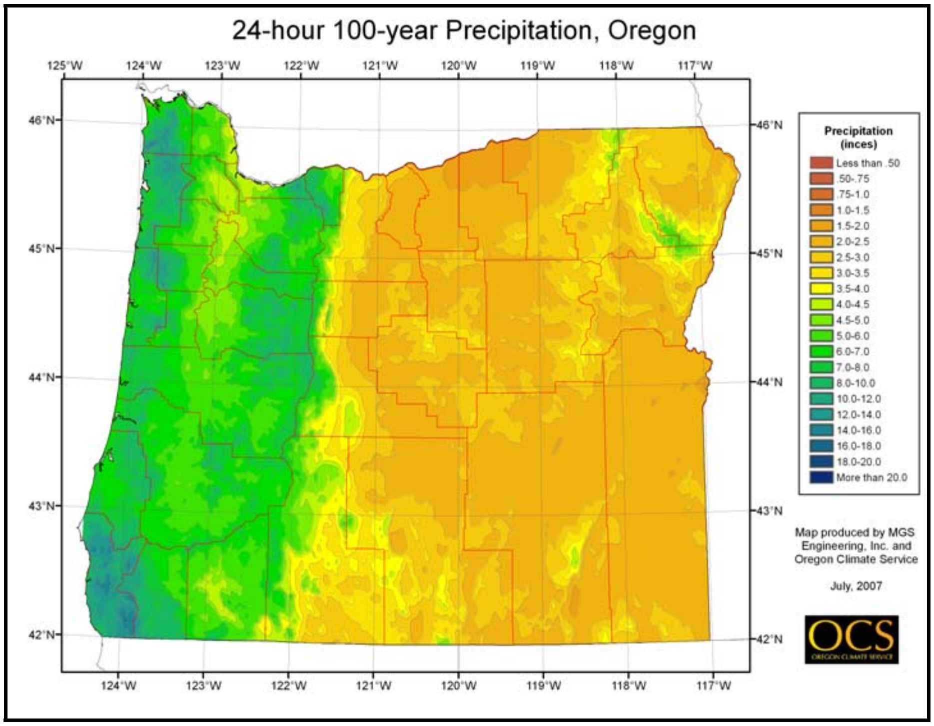


Figure B.6: Isopluvial Map of 24-Hour Precipitation for 100-Year Recurrence Interval for Oregon State.

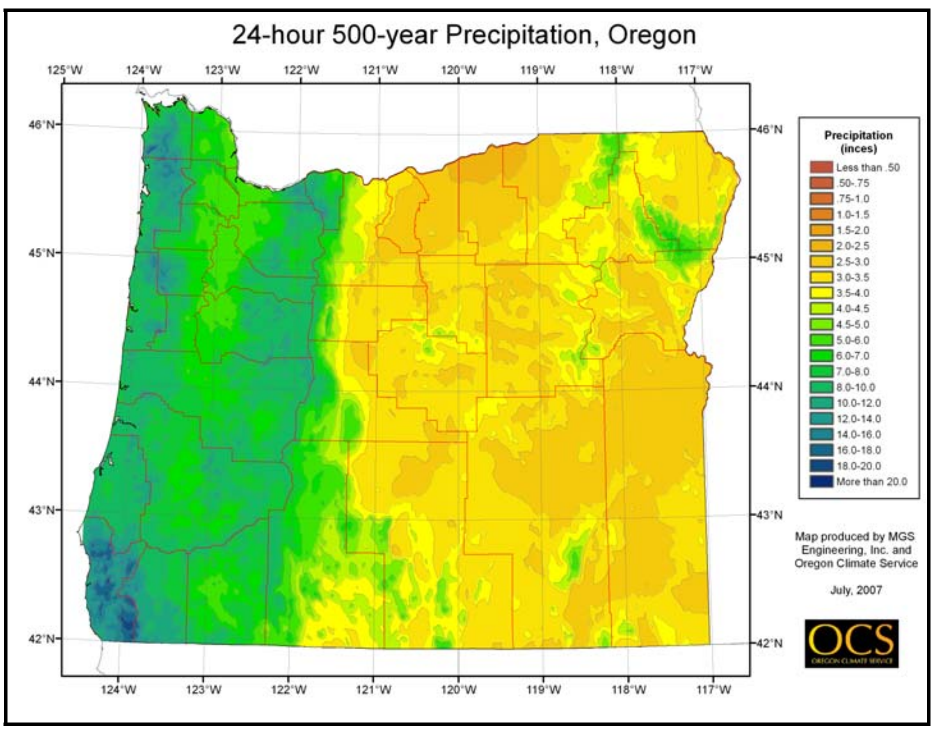


Figure B.7: Isopluvial Map of 24-Hour Precipitation for 500-Year Recurrence Interval for Oregon State.

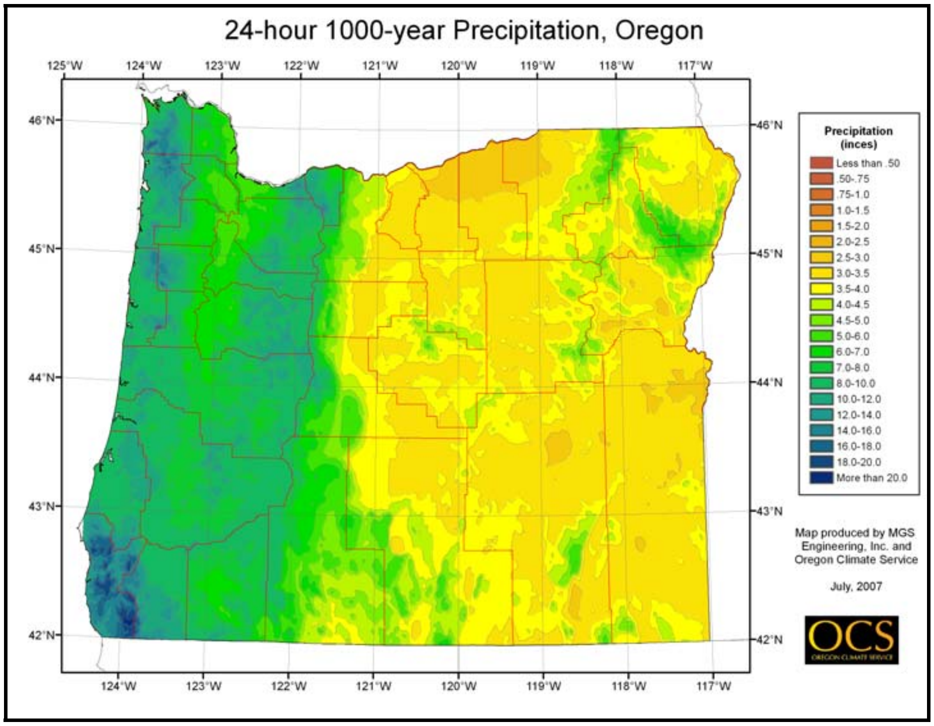


Figure B.7: Isopluvial Map of 24-Hour Precipitation for 1,000-Year Recurrence Interval for Oregon State.

# APPENDIX C

# L-MOMENT STATISTICS AND CIRCULAR STATISTICS

**L-MOMENT STATISTICS**

L-moments are a dramatic improvement over conventional statistics for characterizing the variance and skewness of data, for describing the shape of a probability distribution, and for estimating the distribution parameters (*Hosking 1986, 1990; Hosking and Wallis 1997*). They are particularly useful for describing environmental data that are often highly skewed. The at-site L-moment measure of location, and L-moment ratio measures of scale, skewness and kurtosis are:

Location, mean:

$$\text{Mean} = L_1 \qquad (C1)$$

Scale, L-Cv ($t_2$):

$$t_2 = L_2/L_1 \qquad (C2)$$

L-Skewness ($t_3$):

$$t_3 = L_3/L_2 \qquad (C3)$$

L-Kurtosis ($t_4$):

$$t_4 = L_4/L_2 \qquad (C4)$$

where:

$$L_1 = \beta_0 \qquad (C5)$$

$$L_2 = 2\beta_1 - \beta_0 \qquad (C6)$$

$$L_3 = 6\beta_2 - 6\beta_1 + \beta_0 \qquad (C7)$$

$$L_4 = 20\beta_3 - 30\beta_2 + 12\beta_1 - \beta_0 \qquad (C8)$$

and where the at-site data are first ranked in ascending order from 1 to n ($x_{1:n}$) and:

$$\beta_0 = n^{-1} \sum_{j=1}^{n} x_j \qquad (C9)$$

$$\beta_1 = n^{-1} \sum_{j=2}^{n} x_j\,[(j-1)/(n-1)] \qquad (C10)$$

$$\beta_2 = n^{-1} \sum_{j=3}^{n} x_j\,[(j-1)(j-2)]/[(n-1)(n-2)] \qquad (C11)$$

$$\beta_3 = n^{-1} \sum_{j=4}^{n} x_j\,[(j-1)(j-2)(j-3)]/[(n-1)(n-2)(n-3)] \qquad (C12)$$

Regional L-moments ratios are obtained as weighted averages of the at-site L-moments ratios where the at-site values are weighted by record length. Specifically: $n_i$ is the record length at site $i$ of $N$ sites: $n_R$ is the total record length for the $N$ sites in the region; $t_2^i$, $t_3^i$, $t_4^i$ are L-moment ratios at site $i$ ; and:

$$n_R = \sum_{i=1}^{N} n_i \tag{C13}$$

Regional Mean ( $L_1^R$ ) is unity using the index-flood procedure:

$$L_1^R = 1 \tag{C14}$$

Regional L-Cv ( $t_2^R$ ):

$$t_2^R = n_R^{-1} \sum_{i=1}^{N} n_i \, t_2^i \tag{C15}$$

Regional L-Skewness ( $t_3^R$ ):

$$t_3^R = n_R^{-1} \sum_{i=1}^{N} n_i \, t_3^i \tag{C16}$$

Regional L-Kurtosis ( $t_4^R$ ):

$$t_4^R = n_R^{-1} \sum_{i=1}^{N} n_i \, t_4^i \tag{C17}$$

The regional L-moment ratios for L-Skewness ( $t_3^R$ ) and L-Kurtosis ( $t_4^R$ ) were corrected for bias based on bias correction equations provided by Hosking and Wallis (*1995*, *1997*). These equations are valid for the range of regional L-moment ratios observed in the study area, where:

$$\text{bias } t_3^R = 4\text{N}(0.10 - t_4^R)/\, n_R \tag{C18}$$

$$\text{bias } t_4^R = 4\text{N}(0.15 - t_4^R)/\, n_R \tag{C19}$$

**CIRCULAR STATISTICS**

Circular statistics (*Fisher 1993*) are appropriate for analysis of data that are circular or directional in nature. Months of the year, days of the year (dates), and compass headings (wind direction) are all examples of circular data. For example, January (month 1) follows December (month 12). Arithmetic averaging of a group of numerical months or dates is not appropriate with conventional sample statistics because the counting system is circular not linear. In conducting the analysis of the seasonality of annual maxima or extreme storms, the Julian day of the year is used for describing the date of occurrence. The *average day of occurrence* is analogous to the arithmetic mean and the *seasonality index* (*Dingman 2001*) is analogous to a standardized measure of variation. Specifically, values of the seasonality index range from zero to unity, with values near zero indicating wide variation in the dates of occurrence. A seasonality index near unity indicates low variation in the dates of occurrence and strong clustering of dates. Circular statistics for dates of occurrence using Julian day-of-year are computed as follows:

Conversion of Julian day-of-year to compass direction ($\theta_i$):

$$\theta_i = 360\ [\ J_i / Days_{total}] \qquad \text{(C20)}$$

Compute vectors for compass direction:

$$S = \sum_{i=1}^{n} P_i\ [sin(\theta_i\ )] \qquad \text{(C21a)}$$

$$C = \sum_{i=1}^{n} P_i\ [cos(\theta_i\ )] \qquad \text{(C21b)}$$

Compute Average Day-of-Occurrence (Julian day-of-year $J_{mean}$):

$$\theta_2 = ArcTan(S/C) \qquad \text{(C22a)}$$

$$\theta_m = \theta_2 \qquad if\ S>0\ and\ C>0 \qquad \text{(C22b)}$$

$$\theta_m = \theta_2 + 180^{o} \qquad if\ C<0 \qquad \text{(C22c)}$$

$$\theta_m = \theta_2 + 360^{o} \qquad if\ S<0\ and\ C>0 \qquad \text{(C22d)}$$

$$J_{mean} = 365\ \theta_m \qquad \text{(C22e)}$$

Compute Seasonality Index (*SI*):

$$SI = SQRT(S^2 + C^2\ ) / P_{total} \qquad \text{(C23a)}$$

$$P_{total} = \sum_{i=1}^{n} P_i \qquad \text{(C23b)}$$

where:

$J_i$ = Julian day-of-year for given date of interest; $Days_{total}$ is the total number of days in the current year; $P_i$ is the precipitation value for a given date ($J_i$); $n$ is the total number of precipitation and date pairs; and $P_{total}$ is the sum of all precipitation values for the dataset.

# APPENDIX D

# SELECTED DEFINITIONS

SELECTED DEFINITIONS

*At-Site* - the term at-site is used in various ways. It may be used to distinguish analyses/data at a specific site from regional analyses/data. It may be used in reference to a given gage/station or a specific geographic location. Observed at-site precipitation is synonymous with observed point rainfall.

*At-Site Mean* - the mean value of precipitation for a specified duration at a specific location. For a gaged site, it is based on the gaged record for the specified duration. At an ungaged site, it is based on a statistical relationship. Also see mean annual maxima.

*Climatic Region* - a geographic area that has similar physical and climatological characteristics.

*Convective Precipitation* - precipitation that results from lifting of atmospheric moisture due to vertical instability in the air column. The thunderstorm is one type of convective precipitation producing mechanism.

*Convergence Precipitation* - convergence is intended to encompass all precipitation producing mechanisms associated with the circulation of a cyclonic weather system.

*Extreme Storm* - a precipitation amount for a specified duration that has an annual exceedance probability less than 0.05; rarer than a 20-year event.

*Gage Mean* - the mean value computed from the annual maxima data at a precipitation gage for some specified duration. At-site mean values are determined from gage mean values using minor correction factors to adjust from fixed measurement intervals to true intervals (*Weiss 1964*).

*Gaged Site* - a geographic location where a precipitation gage is used to measure and record precipitation data. See also ungaged site.

*Homogeneous sub-region* - a collection of sites/gages with similar physical and/or climatic characteristics that can be described by a common regional growth curve.

*Mean Annual Maxima (MAM)* - the mean value of precipitation annual maxima for a specified duration at a specific location. It is the terminology commonly used in Canada as an alternate to at-site-mean.

*Mean Annual Precipitation (MAP)* - the average precipitation for a calendar year (an example of an at-site-mean).

*Orographic Precipitation* - precipitation that occurs due to the lifting of atmospheric moisture over mountain barriers.

*Precipitation Annual Maxima* - the greatest precipitation amount in a 12-month period for a specified duration. The annual period may be a calendar year, or any other 12-month period such as the water-year, October 1st to September 30th. The calendar year was used as the annual period for this study of the State of Oregon.

*Regional* - the term regional is used in a generic manner to distinguish data/analyses for a group of sites/gages as opposed to individual at-site data/analyses. The term regional may be used in reference to homogeneous sub-regions or climatic regions.

*Regional Growth Curve* - a magnitude-frequency curve with a mean value of unity that is applicable to all sites within a homogeneous region.

*Seasonality* - frequency characteristics for the time of year (month) during which certain characteristics of precipitation have been observed to occur.

*Station* - refers to the weather station/collection site for precipitation. A particular station/location may contain any combination of daily, synoptic and automated gages. The term station and site are often used interchangeably.

*Ungaged Site* - a geographic location where no precipitation measurements are available.