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AGENDA
JUNE 22ND HOUSING COMMITTEE MEETING WORK SESSION
128 S. MAIN STREET, CONDON, OR 97823
MONDAY, JUNE 22, 2026, 4:00 PM

Zoom Information

<https://us02web.zoom.us/j/84016161365?pwd=CtNm4nM7rYtczzaDIYHtjByhaphms.1>

Meeting ID: 840 1616 1365

Passcode: 407624

- 1. CALL THE MEETING TO ORDER**
- 2. DISCUSS**
 - 2.1. Fairway Housing**
 - 2.2. MIRL Program**
 - 2.3. Housing Study**
 - 2.4. Update Title XV: Land Usage in the City Ordinances**
- 3. OTHER**
- 4. ADJOURN**

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Work Session agenda distributed 06/18/2026

STORMWATER MANAGEMENT REPORT

**Cottonwood Subdivision
Condon, Oregon**

DRAFT

Prepared for: City of Condon

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Date: May 09, 2026

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1. Introduction

The City of Condon is developing the Cottonwood Subdivision near Old Cottonwood Road in Condon, Gilliam County, Oregon. This report presents a stormwater management concept and sizing analysis for roadside planter strip infiltration/storage basins located behind the sidewalk, consistent with the construction drawing concept provided for in the construction drawings. The system is intended to collect runoff from subdivision streets and sidewalks and a limited portion of adjacent residential lot area, provide water quality benefit through filtration and sedimentation, store the design storm within open-graded drain rock voids, and infiltrate stormwater into native soils.

This report references the Central Oregon Stormwater Manual because it provides regional design guidance for drainage submittals, infiltration facilities, flow control, overflow routing, and maintenance procedures. Although Condon is outside the Central Oregon jurisdictions listed in the manual, the manual is a practical design reference for arid and semi-arid Oregon communities.

2. Project Description and Existing Conditions

The subdivision area reviewed in the NRCS soil report is located along Old Cottonwood Road and Lincoln Street in Condon, Oregon. The NRCS report maps the entire 44.8-acre area of interest as Map Unit 5B, Condon and Valby silt loams, 1 to 7 percent slopes. The soil report cover image shows the project area extending generally east-west along Old Cottonwood Road with the golf course and open drainage area to the south.

The proposed drainage approach is to create linear or modular drainage areas behind the sidewalk within the planter strip. Runoff from the street and sidewalk will be collected through curb cuts/inlets into the planter strip drainage basins. For design purposes, 20 percent of the adjacent lot area is also assumed to drain to these basins. Overflow from storms larger than the design event, or from localized inlet plugging, will be directed to the drainage easement and then toward the golf course to the south.

3. Design Criteria and References

Criterion	Value / Requirement Used
Design storm	100-year, 24-hour storm event
Rainfall depth used for preliminary sizing	2.5 inches for the 100-year, 24-hour event;
Runoff assumption	All sidewalks and streets drain to planter strip drainage basins; 20% of lot area drains to basins
Infiltration rate	0.75 in/hr design infiltration rate
Soil support for infiltration	NRCS soil Ksat: 0.57 to 1.98 in/hr; well drained Condon and Valley silt loams
Basin module	One basin per 100 ft of street unless plan-based drainage map requires adjustment
Basin geometry	6 ft wide x 25 ft long x 4 ft deep
Backfill	2-3 inch clean drain rock wrapped in nonwoven drainage geotextile
Assumed drain rock void ratio	40%
Drain-down objective	Drain within 72 hours after design storm, consistent with Central Oregon Stormwater Manual infiltration guidance
Overflow routing	Safe overflow route to drainage easement and toward golf course to the south

The Central Oregon Stormwater Manual lists eight basic requirements for stormwater management, including drainage submittal, geotechnical site characterization, water quality treatment, flow control, conveyance, erosion and sediment control, source control, and operation and maintenance. For projects adding 5,000 square feet or more of impervious surface or disturbing one acre or more, the manual applies drainage, flow control,

conveyance, erosion control, source control, and operation and maintenance requirements, with geotechnical and water quality applicability determined by the project characteristics.

The manual states that infiltration facilities shall be capable of providing service for the 25-year, 24-hour design storm, shall drain within 72 hours, and shall provide a safe overflow path capable of conveying the 100-year storm event. The Cottonwood concept exceeds the storage target by sizing the planter strip drainage basins for the 100-year, 24-hour storm, subject to final confirmation of contributing drainage areas and rainfall depth.

4. Soils and Infiltration

The NRCS Custom Soil Resource Report for Gilliam County identifies one soil map unit within the area of interest: Map Unit 5B, Condon and Valby silt loams, 1 to 7 percent slopes, comprising 44.8 acres or 100 percent of the mapped AOI. The map unit setting is Columbia River basalt plateaus, with mean annual precipitation of 10 to 15 inches and elevation ranging from 1,100 to 4,000 feet.

The Condon component is described as H1 silt loam over H2 silt loam over H3 unweathered bedrock, with a restrictive lithic bedrock feature at 20 to 40 inches, well-drained drainage class, depth to water table greater than 80 inches, no flooding, no ponding, and moderately high to high saturated hydraulic conductivity of 0.57 to 1.98 in/hr. The Valby component is similarly described as silt loam over silt loam over unweathered bedrock, with the same restrictive depth range, well-drained drainage class, water table greater than 80 inches, no flooding, no ponding, and Ksat of 0.57 to 1.98 in/hr. Both components are Hydrologic Soil Group C.

A conservative design infiltration rate of 0.75 in/hr is used for sizing. This rate is within the NRCS reported Ksat range and remains below the upper reported Ksat value. Because the soil profile includes shallow lithic bedrock at approximately 20 to 40 inches, final design should confirm basin depth, bedrock exposure, and effective infiltration surface during excavation. If bedrock is encountered above design depth, the basin bottom should be over-excavated/adjusted only as recommended by the engineer and approved by the City.

5. Stormwater Collection and Management Concept

The proposed stormwater system uses distributed planter strip drainage basins behind the sidewalk. The drainage basins are located at approximately one module per 100 linear feet of street, unless final grading or inlet layout requires closer spacing. Each basin will be excavated 6 feet wide, 25 feet long, and 4 feet deep. The excavation will be lined with nonwoven drainage geotextile fabric, filled with clean 2-3 inch drain rock, and wrapped with the fabric to reduce migration of fines into the drain rock voids.

Street and sidewalk runoff will be directed to the basins through sidewalk chase drains as shown in the construction drawings. Finished grades should direct runoff away from building pads and toward the street/planter strip drainage system. Basin inlets should include sediment forebays, rock aprons, or removable inlet protection where practicable to reduce plugging and simplify maintenance.

The design is based on distributed retention/infiltration rather than concentrating runoff at a single downstream facility. This approach reduces peak flow, reduces erosive discharge at the easement, and provides multiple redundant storage locations along the street corridor.

6. Hydrologic Analysis

The runoff volume method is used for preliminary sizing. For a drainage area A and storm depth P, the volume is calculated as: $V = A \times P / 12$, where V is cubic feet, A is square feet, and P is inches. For impervious street and sidewalk surfaces, runoff coefficient is assumed as 0.85 for conservative volumetric sizing. For the lot contribution, the user-provided assumption is used directly: 15 percent of lot area drains to the basins. No

additional abstraction is taken for that contributing lot area in the preliminary capacity check; this is conservative for pervious yards.

The 100-year, 24-hour rainfall depth used in this draft is 2.5 inches. This value is conservative based on a review of Oregon 24-hour precipitation-frequency mapping. Storm intensities of 5 minutes, 10 minutes, 20 minutes, 30 minutes, 40 minutes, 50 minutes, 60 minutes, 100 minutes, 200 minutes, 300 minutes and 400 minutes were used based upon information provided in the Central Oregon Stormwater Manual. For instance, a 5 minute storm assumes a 100 year design rate of 3.7 inches of precipitation per hour. This would be indicative of a very heavy thunderstorm event.

7. Planter Strip Drainage Basin Sizing

Each per-100-foot basin module provides the following preliminary storage and infiltration capacity:

Parameter	Calculation	Result
Basin footprint	6 ft x 25 ft	150 sf
Gross excavation volume	6 ft x 25 ft x 4 ft	600 cf
Drain rock void storage	600 cf x 40%	240 cf
Wetted infiltration area	Bottom + sidewalls = 150 sf + 248 sf	398 sf
24-hour infiltration credit	398 sf x 0.75 in/hr x 24 hr / 12	597 cf
Total 24-hour capacity	Void storage + 24-hour infiltration	837 cf
Equivalent tributary impervious area at 2.5 in	837 cf x 12 / 2.5 in	4,018 sf

Based on these assumptions, one 6 ft x 25 ft x 4 ft rock-filled basin can manage approximately 4,018 sf of tributary impervious-equivalent area during the 100-year, 24-hour storm. The calculation uses the trench bottom and sidewalls as infiltration surfaces, which is appropriate for a rock-filled subsurface trench wrapped in drainage geotextile; the design should be adjusted if exposed bedrock or construction conditions reduce sidewall infiltration.

The table below provides a sensitivity check for common street widths and lot depths. Values shown are per 100 linear feet of street, assuming a basin on each side of the street receives half of the street section, one sidewalk, and 15 percent of the lot frontage on that side. A negative margin indicates that the assumed drainage area exceeds one basin module and that either tributary area should be reduced, basin spacing should be shortened, basin dimensions should be increased, or additional basins should be added.

Scenario per 100 ft street	Tributary Area (sf)	100-year Volume (cf)	Basin Capacity (cf)	Margin (cf)
One side: 36/2 ft street + 5 ft sidewalk + 15% of one lot 100 ft deep	3,800	792	837	45

8. Overflow, Emergency Routing, and Downstream Considerations

The system will be designed to infiltrate and store the 100-year, 24-hour storm event under the assumptions described above. Larger events, snowmelt-on-rain events, inlet plugging, sediment accumulation, or partial basin failure may cause localized overflow. The overflow path will be established along the drainage easement and directed toward the golf course to the south. Overflows should be conveyed through a shallow swale, stabilized curb opening, riprap apron, to prevent scour at concentrated discharge locations.

The overflow route will not direct runoff toward building foundations, crawl spaces, private yards without drainage easements, or public sidewalks in a manner that creates nuisance flooding or icing hazards. The drainage easement will be graded and maintained as a positive, unobstructed emergency flow path. Where the overflow enters the golf course and existing drainageway, the outlet should be armored or spread to reduce erosive velocities.

9. Construction Notes

- Excavate each basin to the dimensions and elevations shown on the approved construction drawings. Notify the engineer if basalt, cemented soil, groundwater, undocumented fill, utility conflicts, or other unsuitable conditions are encountered.
- Use clean, durable 2-3 inch drain rock with minimal fines. Do not use recycled material, soil-contaminated rock, or material with sufficient fines to clog void space.
- Wrap the drain rock in nonwoven drainage geotextile fabric. Provide fabric overlap consistent with manufacturer recommendations, typically at least 12 inches.
- Protect basins from construction sediment. Do not allow disturbed soil, concrete washout, sawcut slurry, or stockpile runoff to enter completed basins.
- Install inlet protection during construction and remove temporary controls only after contributing surfaces are stabilized and the basin is cleaned.
- Finished grades should provide positive drainage toward inlets and should preserve the emergency overflow route to the drainage easement.

10. Operation and Maintenance

The City or designated maintenance entity should inspect the planter strip drainage basins at least annually and after major storm events. Inlets, curb cuts, and rock surfaces should be kept clear of sediment, leaves, trash, weeds, and debris. Sediment should be removed before it blocks inlet openings or forms a low-permeability layer over the drain rock surface. Damaged geotextile, exposed fabric, displaced drain rock, or eroded overflow locations should be repaired promptly.

The drainage easement and overflow swales should be maintained free of obstructions. No fences, landscaping berms, sheds, fill, or other improvements should be allowed to block the emergency overflow route. Maintenance access should be preserved along the street and within any dedicated drainage tracts or easements.

11. Conclusions

The proposed distributed planter strip drainage basins are suitable for the Cottonwood Subdivision concept based on the provided assumptions and the available soil information. The NRCS soil report indicates well-drained Condon and Valby silt loams with moderately high to high Ksat values of 0.57 to 1.98 in/hr, and the design uses a conservative infiltration rate of 0.75 in/hr. Each 6 ft x 25 ft x 4 ft rock-filled basin provides approximately 240 cf of void storage and approximately 597 cf of 24-hour infiltration capacity, for a total preliminary 24-hour capacity of approximately 837 cf. At a 2.5-inch 100-year, 24-hour rainfall depth, this corresponds to approximately 4,018 sf of impervious-equivalent tributary area per basin.

Final design is based on a plan-derived drainage area exhibit and the jurisdiction-approved rainfall depth. Where the tributary area to any basin exceeds the allowable capacity, the design provides additional basin modules, increased basin dimensions, or both to maintain compliance. The system incorporates a defined and protected overflow route to the drainage easement and ultimately to the golf course to the south, with appropriate erosion control measures at all overflow and discharge locations to ensure long-term stability and performance.

Appendix A - Calculation Summary

Primary formula: $V = A \times P / 12$

P100 = 2.5 inches (draft conservative placeholder; confirm with final approved rainfall source).

Basin storage = 6 ft x 25 ft x 4 ft x 40% = 240 cf.

Basin infiltration in 24 hours = 398 sf x 0.75 in/hr x 24 hr / 12 = 597 cf.

Total 24-hour basin capacity = 837 cf.

Maximum equivalent tributary area = 837 cf x 12 / 2.5 in = 4,018 sf.

Drain-down check: void storage / infiltration rate = 240 cf / (398 sf x 0.75 in/hr / 12) = 9.6 hours, less than 72 hours.

Note: The drain-down calculation assumes the basin bottom remains available for infiltration and is not blocked by sediment or exposed bedrock. Maintenance and field verification are required.

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Appendix B - References Reviewed

- NRCS Custom Soil Resource Report for Gilliam County, Oregon, Cottonwood project AOI, dated May 4, 2026.
- ODOT Research Unit, SPR 656, Regional Precipitation-Frequency Analysis and Spatial Mapping of 24-Hour Precipitation for Oregon, Final Report, January 2008.
- Central Oregon Intergovernmental Council, Central Oregon Stormwater Manual, August 2010 update, Chapters 2, 3, 5, 6, 7, 8, 9, 11, and 12 as applicable.
- Oregon Department of Transportation Hydraulics Manual precipitation maps and current public web page listing 2-year through 1,000-year 24-hour precipitation maps.
- NOAA precipitation-frequency information was reviewed for context

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Stormwater Calculations - Modified Rational Method

Condon Oregon

Site Area	3800 sqft
Infiltration Rate	1 In/Hr
Drainage Facility Area	150 SF
Drainage Facility Infiltration Area	398 SF

Each planter strip basin is designed to receive runoff from a defined segment of the subdivision frontage. For sizing purposes, a single basin is assumed to serve:

- 100 linear feet of street length,
- One-half of the street width (drainage from the near side only),
- The adjacent sidewalk, and
- Approximately 15% of the contributing residential lot area, based on a typical 100-foot lot depth.

2 Year Water Quality Design Storm

2 Yr./24 Hr. Storm	Site Runoff	Effective	Detention
1.2	3800	3230	323

This tributary area represents a combination of fully impervious surfaces (street and sidewalk) and a limited portion of pervious lot area that is assumed to drain toward the street. The basin captures this runoff via curb cuts or inlets and provides storage and infiltration within the rock-filled trench system.

50 Year Storm Worksheet

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Storm Duration (min.)	Storm	50 year	Site Runoff	Assumed	Effective	Inflow (cts)	Runoff	Infiltration	Facility Area	Infiltration	Infiltration	Detention Volume	Depth (Ft)
5	300	3.22	3800	0.85	0.07	0.2388	95.98	1	398	0.552777778	2.76	93.22	0.62
10	600	2.45	3800	0.85	0.07	0.1817	146.06	1	398	0.552777778	5.53	140.53	0.94
20	1200	1.87	3800	0.85	0.07	0.1387	222.97	1	398	0.552777778	11.06	211.91	1.41
30	1800	1.48	3800	0.85	0.07	0.1097	264.70	1	398	0.552777778	16.58	248.12	1.65
40	2400	1.22	3800	0.85	0.07	0.0905	290.93	1	398	0.552777778	22.11	268.82	1.79
50	3000	1.05	3800	0.85	0.07	0.0779	312.99	1	398	0.552777778	27.64	285.35	1.90
60	3600	0.92	3800	0.85	0.07	0.0682	329.09	1	398	0.552777778	33.17	295.92	1.97
100	6000	0.61	3800	0.85	0.07	0.0452	363.66	1	398	0.552777778	55.28	308.39	2.06
200	12000	0.38	3800	0.85	0.07	0.0282	453.09	1	398	0.552777778	110.56	342.53	2.28
300	18000	0.28	3800	0.85	0.07	0.0208	500.78	1	398	0.552777778	165.83	334.95	2.23
400	24000	0.25	3800	0.85	0.07	0.0185	596.17	1	398	0.552777778	221.11	375.06	2.50

100 Year Storm Worksheet

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Storm Duration (min.)	Storm	100 year	Site Runoff	Assumed	Effective	Inflow (cts)	Runoff	Infiltration	Facility Area	Infiltration	Infiltration	Detention Volume	Depth (Ft)
5	300	3.70	3800	0.85	0.07	0.2744	110.29	1	398	0.552777778	2.76	107.53	0.72
10	600	2.89	3800	0.85	0.07	0.2143	172.29	1	398	0.552777778	5.53	166.77	1.11
20	1200	2.15	3800	0.85	0.07	0.1594	256.35	1	398	0.552777778	11.06	245.30	1.64
30	1800	1.68	3800	0.85	0.07	0.1246	300.47	1	398	0.552777778	16.58	283.89	1.89
40	2400	1.41	3800	0.85	0.07	0.1046	336.24	1	398	0.552777778	22.11	314.13	2.09
50	3000	1.21	3800	0.85	0.07	0.0897	360.68	1	398	0.552777778	27.64	333.04	2.22
60	3600	1.08	3800	0.85	0.07	0.0801	386.32	1	398	0.552777778	33.17	353.15	2.35
100	6000	0.70	3800	0.85	0.07	0.0519	417.32	1	398	0.552777778	55.28	362.04	2.41
200	12000	0.42	3800	0.85	0.07	0.0311	500.78	1	398	0.552777778	110.56	390.23	2.60
300	18000	0.32	3800	0.85	0.07	0.0237	572.32	1	398	0.552777778	165.83	406.49	2.71
400	24000	0.27	3800	0.85	0.07	0.0200	643.86	1	398	0.552777778	221.11	422.75	2.82

Custom Soil Resource Report for **Gilliam County, Oregon**



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

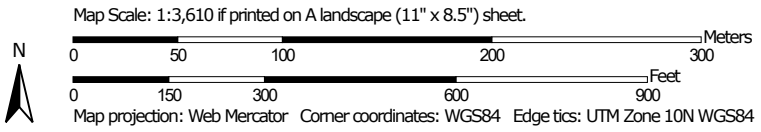
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report Soil Map




Soil Map may not be valid at this scale.



MAP LEGEND


Area of Interest (AOI)

 Area of Interest (AOI)




















Soils







 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

Special Point Features






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features


Water Features

 Streams and Canals

Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Gilliam County, Oregon
 Survey Area Data: Version 25, Sep 10, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 1, 2020—Jun 2, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
5B	Condon and Valby silt loams, 1 to 7 percent slopes	44.8	100.0%
Totals for Area of Interest		44.8	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Gilliam County, Oregon

5B—Condon and Valby silt loams, 1 to 7 percent slopes

Map Unit Setting

National map unit symbol: 21lq
Landscape: Columbia river basalt plateaus
Elevation: 1,100 to 4,000 feet
Mean annual precipitation: 10 to 15 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Condon and similar soils: 45 percent
Valby and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Condon

Setting

Landscape: Columbia river basalt plateaus
Landform: Plateaus
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over basalt

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 31 inches: silt loam
H3 - 31 to 41 inches: unweathered bedrock

Properties and qualities

Slope: 1 to 7 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R008XY120OR - Loamy 12-14 PZ
Hydric soil rating: No

Description of Valby

Setting

Landscape: Columbia river basalt plateaus
Landform: Plateaus
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess and a small amount of volcanic ash over basalt

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 36 inches: silt loam
H3 - 36 to 40 inches: unweathered bedrock

Properties and qualities

Slope: 1 to 7 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R008XY120OR - Loamy 12-14 PZ
Hydric soil rating: No

Minor Components

Rhea

Percent of map unit: 10 percent
Ecological site: R008XY120OR - Loamy 12-14 PZ
Hydric soil rating: No

Bakeoven

Percent of map unit: 5 percent
Ecological site: R008XY150OR - Very Shallow Loam 10-14 PZ
Hydric soil rating: No

Lickskillet

Percent of map unit: 5 percent
Ecological site: R008XY210OR - Shallow South 10-14 PZ
Hydric soil rating: No

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

SPR 656

**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
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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 m³.

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
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APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
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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
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*SI is the symbol for the International System of Measurement

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DISCLAIMER

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This report does not constitute a standard, specification, or regulation.

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

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COMPACT DISC (CD)

Includes: catalog of stations, precipitation annual maxima for all gages, gridded dataset for 24-hour mean annual maxima (at-site means), gridded datasets of L-moment ratios L-Cv and L-Skewness for 24-hour duration, gridded datasets of precipitation estimates for selected recurrence intervals, precipitation magnitude-frequency estimates for selected recurrence intervals for each station, catalog of extreme storms for 24-hour duration, final report and supporting graphics.

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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

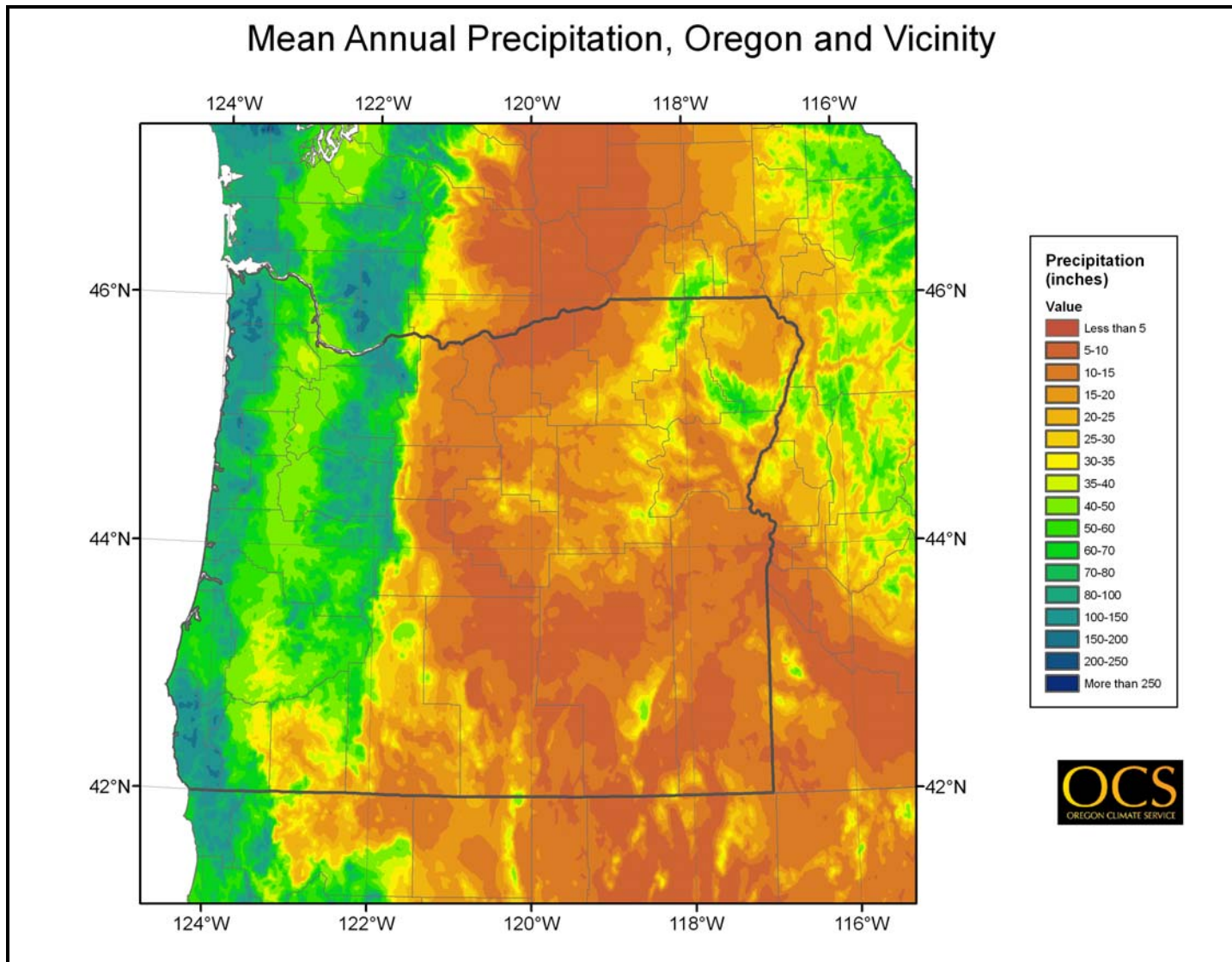


Figure 2.1: Mean Annual Precipitation for Oregon study area (*Oregon Climate Service 2000, 2005*).

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 1st through December 31st 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

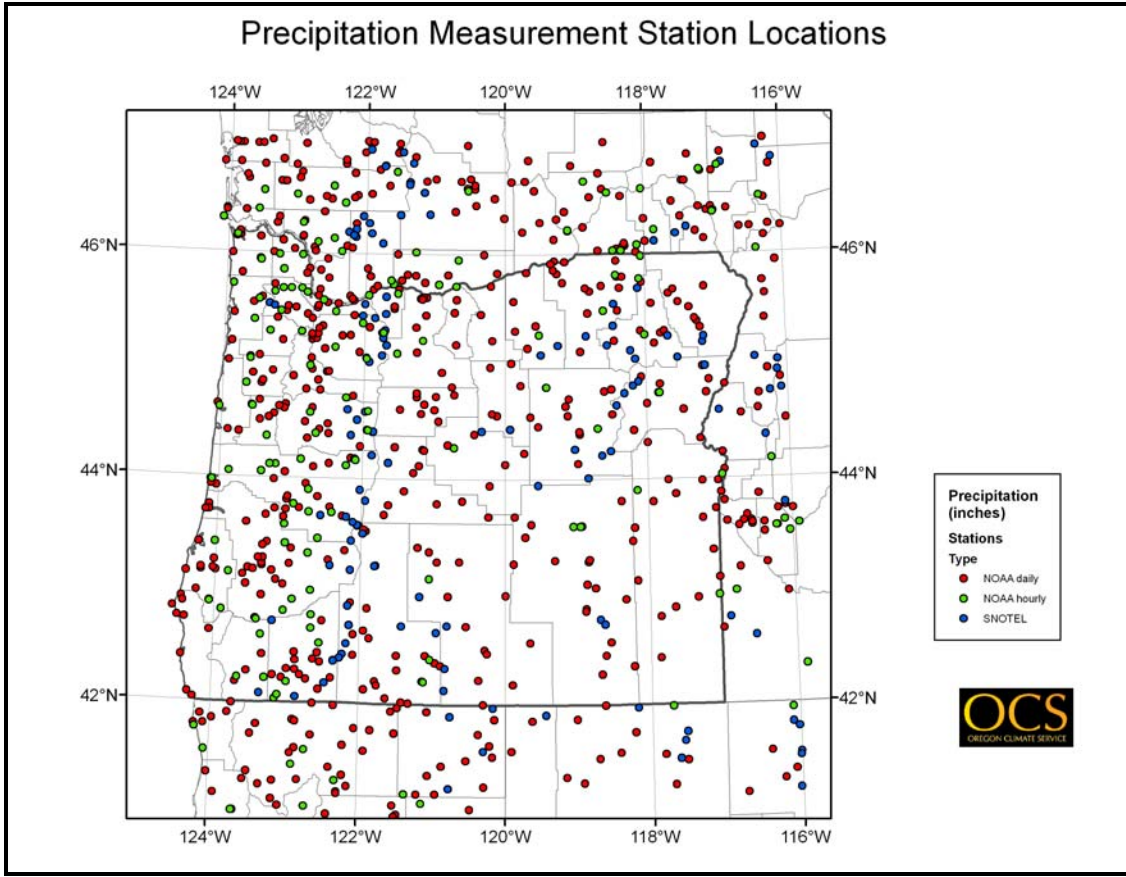


Figure 3.1: Precipitation Gaging Network for Oregon Study Area.

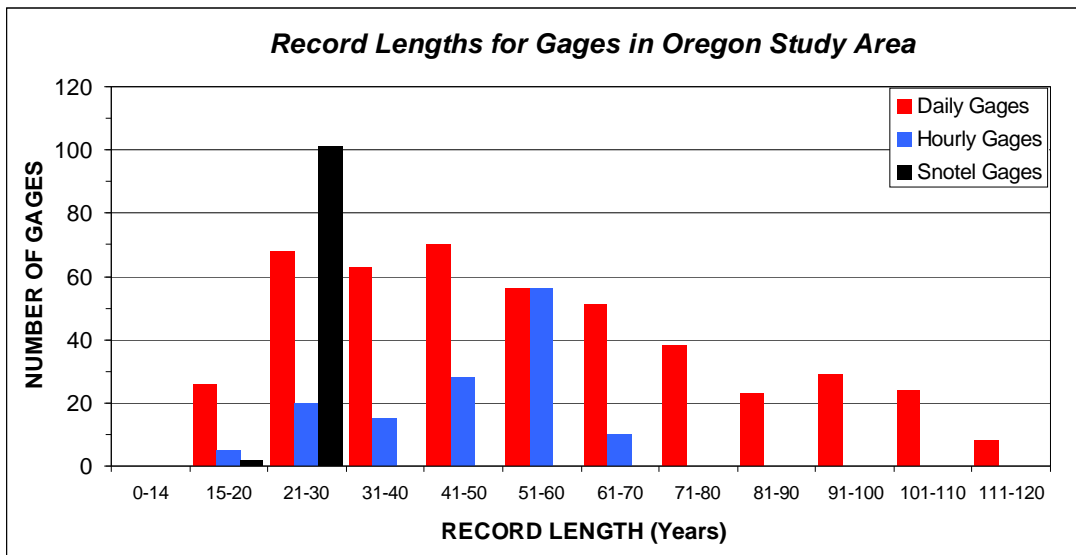


Figure 3.2: Record Lengths for Gages in Oregon Study Area.

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.

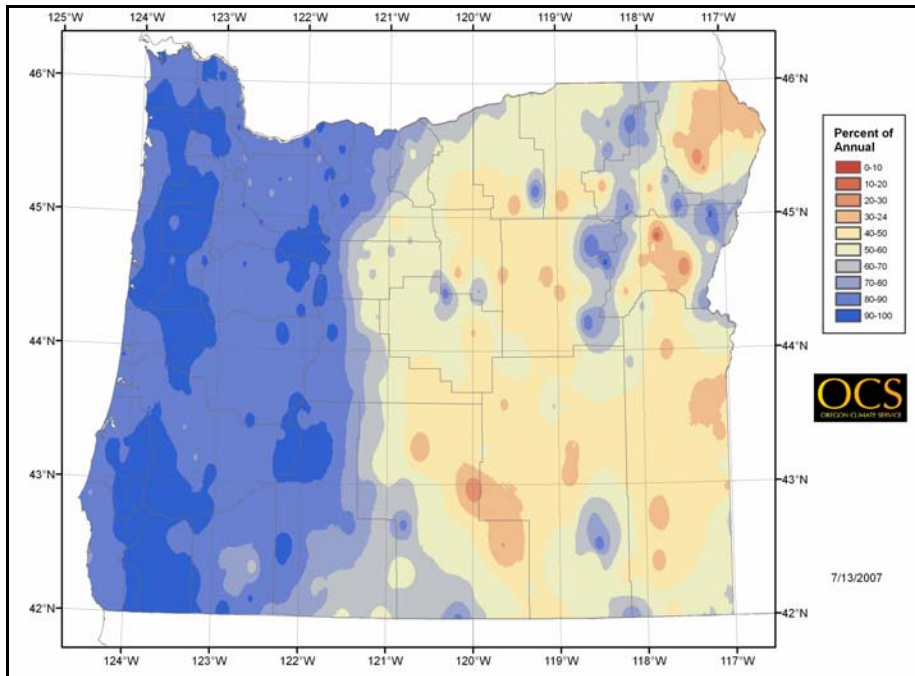


Figure 5.1: Frequency of Winter (November – April) 24-Hour Annual Maxima for Oregon Study Area.

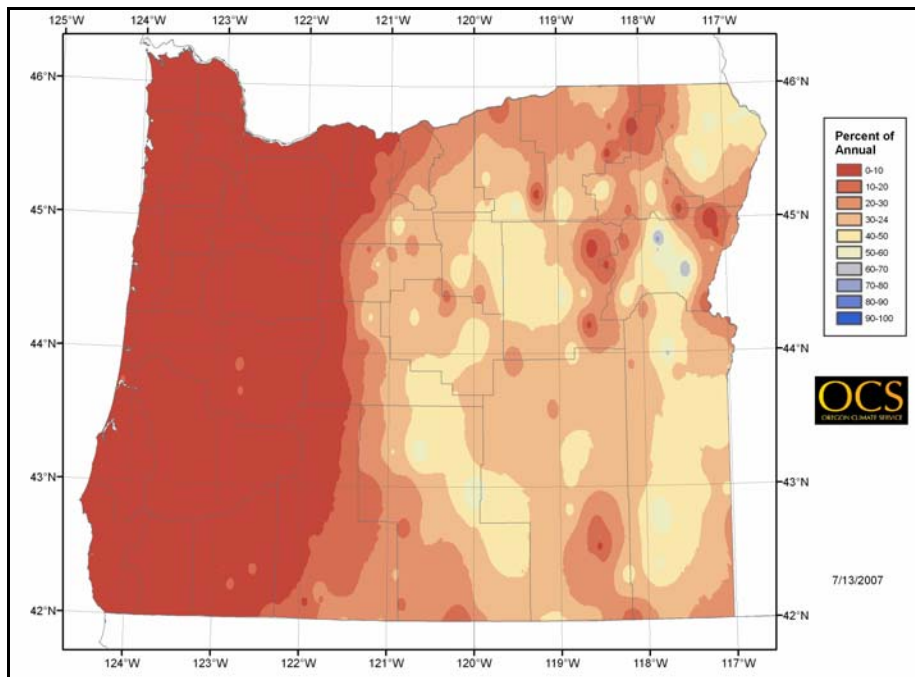


Figure 5.2: Frequency of Spring-Summer (May – August) 24-Hour Annual Maxima for Oregon Study Area.

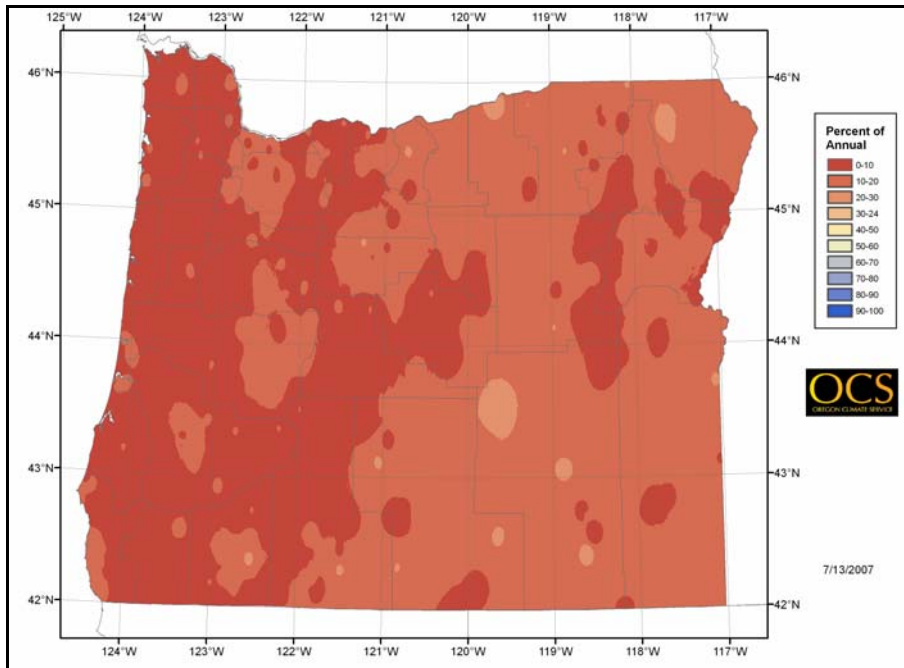


Figure 5.3: Frequency of Fall (September – October) 24-Hour Annual Maxima for Oregon Study Area.

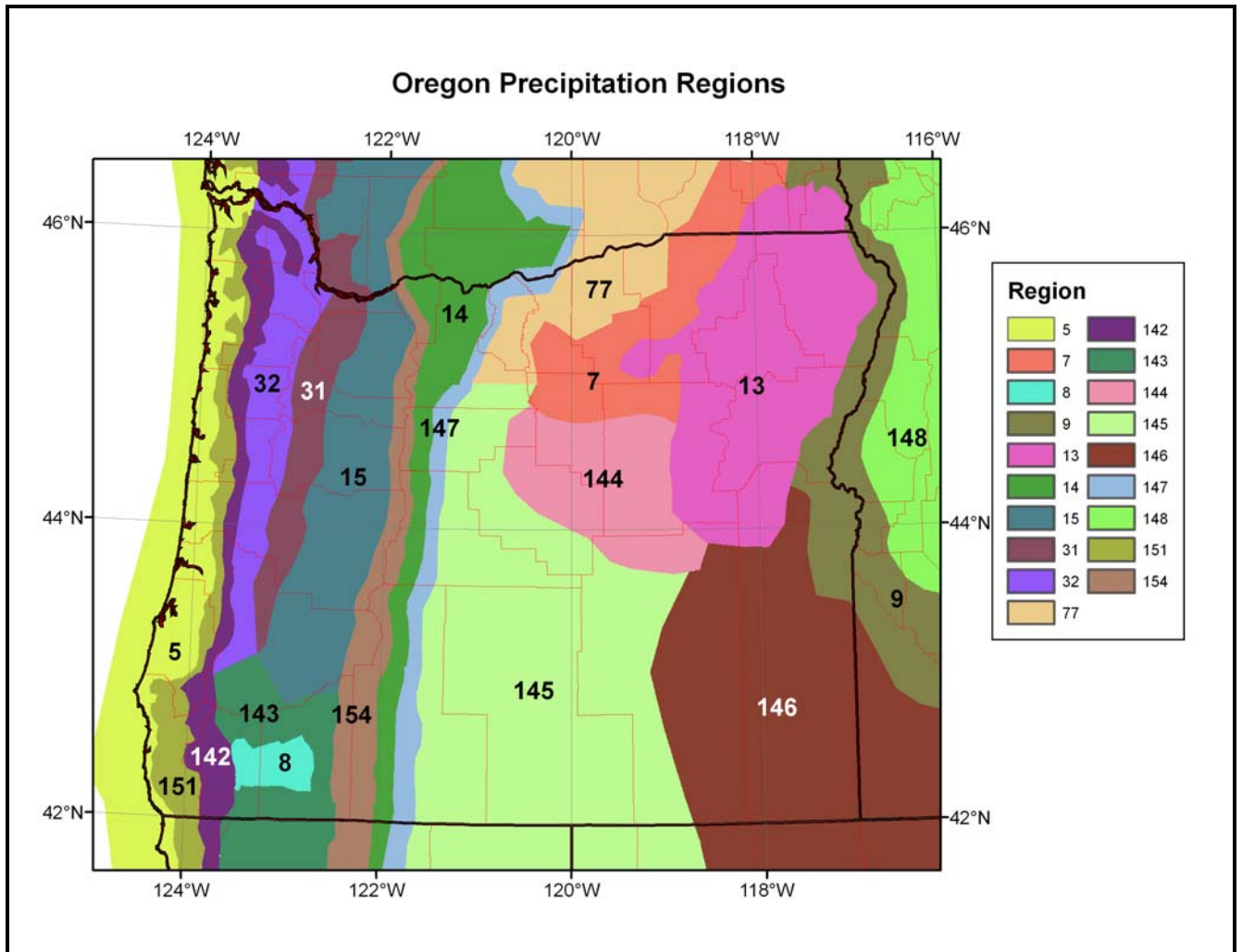


Figure 5.4: Delineation of Climatic Regions and Transition Zones for Oregon State and Surrounding Areas

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 Fremont 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:

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

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).

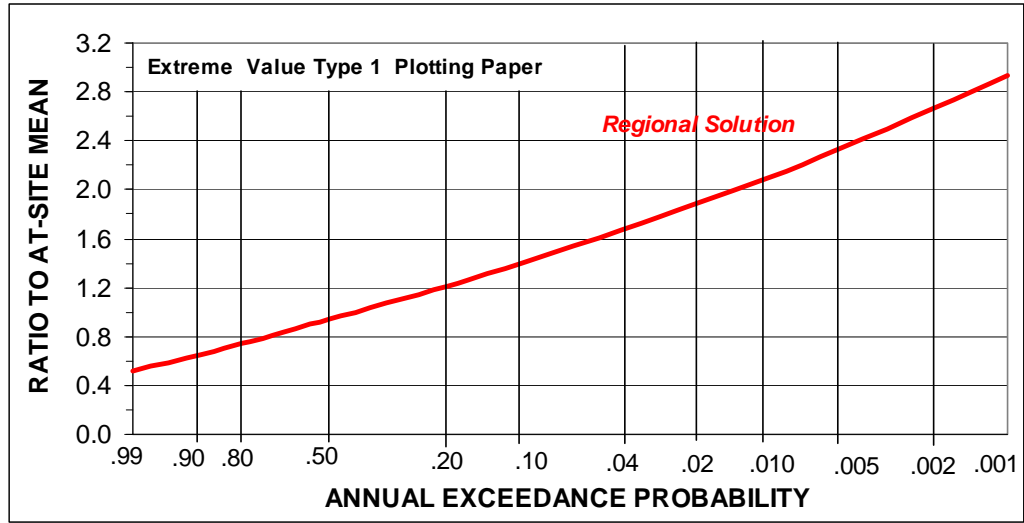


Figure 5.5: Example of Regional Growth Curve.

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 2nd 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

$$L-C_v = 2.5883 - 0.1010*Lat + 0.001039*Lat*Lat + 0.08*EXP(-0.060*MAP) \quad (7-1)$$

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

$$L-C_v = 9.2169 - 0.3948*Lat + 0.004297*Lat*Lat + 0.08*EXP(-0.060*MAP) \quad (7-2)$$

Regions 142, 8, 143; South of 43°N

$$L-C_v = 0.08*EXP(-0.040*MAP) + 0.172 \quad (7-3)$$

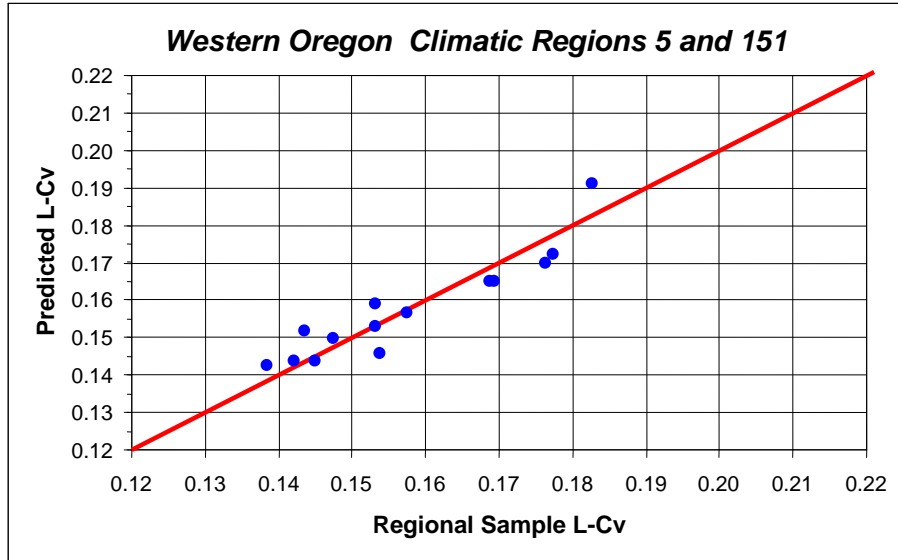


Figure 7.1: Comparison of Observed Regional Sample Values of L-Cv and Predicted L-Cv (Equation 7-1) for Climatic Regions 5 and 151.

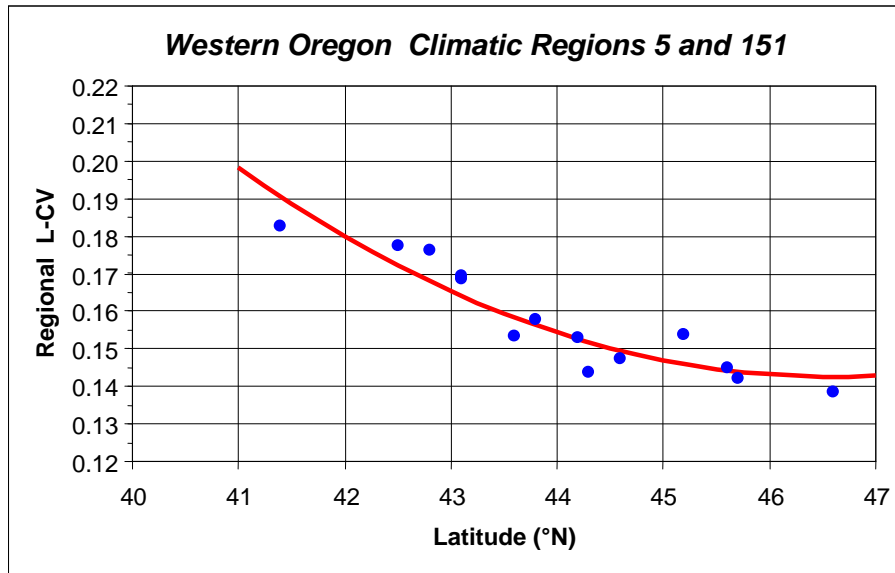


Figure 7.2: Relationship of Regional L-Cv with Latitude for Climatic Regions 5 and 151.

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

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

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

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

$$L-C_v = 0.4071 - 0.0029 * MAP + 0.0000268 * MAP * MAP - 0.0041 * Lat; \quad MAP < 55\text{-inch} \quad (7-5)$$

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

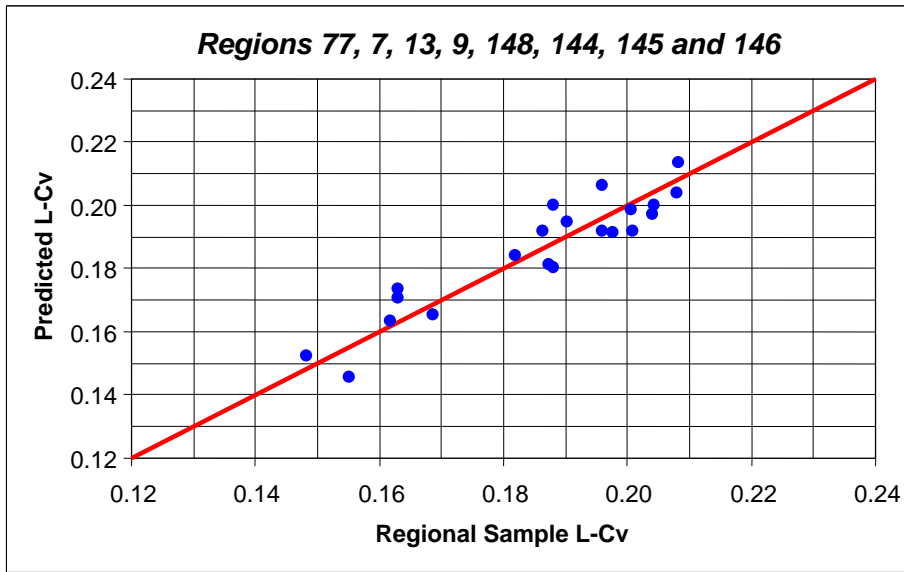


Figure 7.3: Comparison of Observed Regional Sample Values of L-Cv and Predicted L-Cv (Equation 7-1) for Climatic Regions 77, 7, 13, 9, 148, 144, 145, and 146.

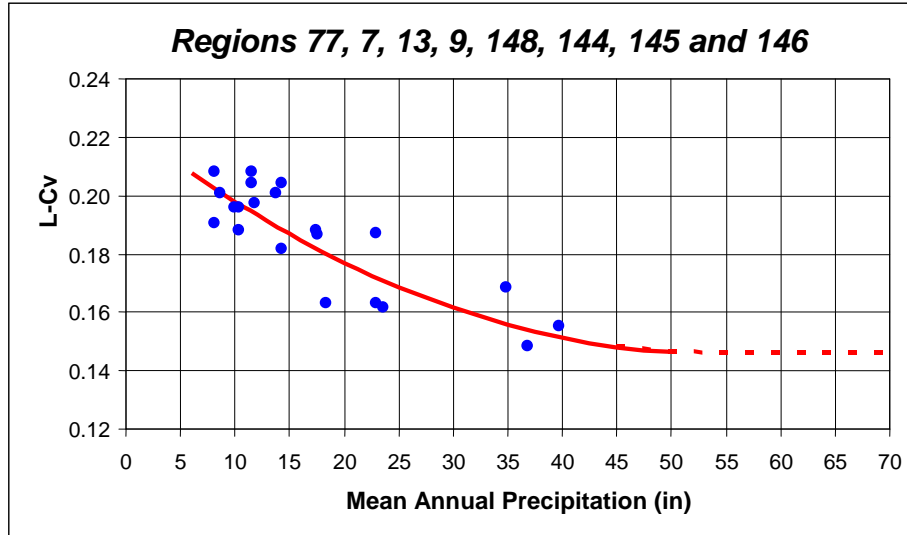


Figure 7.4: Relationship of Regional L-Cv with Mean Annual Precipitation for Climatic Regions 77, 7, 13, 9, 148, 144, 145, and 146.

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).

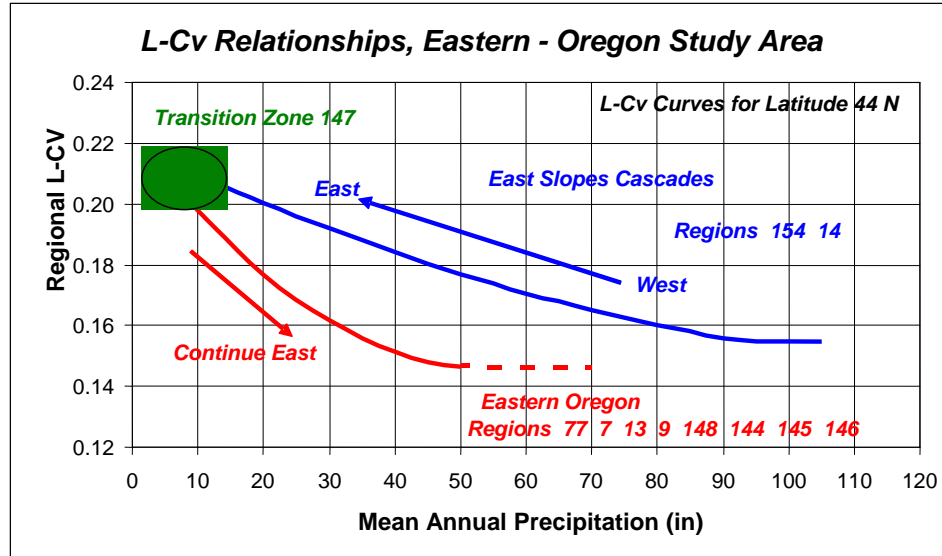


Figure 7.5: Behavior of L-Cv progressing eastward from the Crest of the Cascade Mountains, through the Eastern Foothills, and Across Eastern Oregon at Latitude 44°N.

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

$$\text{L-Skewness} = 0.10 \cdot \text{EXP}(-0.024 \cdot \text{MAP}) + 0.3810 - 0.0050 \cdot \text{Lat} \quad (7-6)$$

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

$$\text{L-Skewness} = 0.08 \cdot \text{EXP}(-0.018 \cdot \text{MAP}) + 0.2680 - 0.0025 \cdot \text{Lat} \quad (7-7)$$

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	

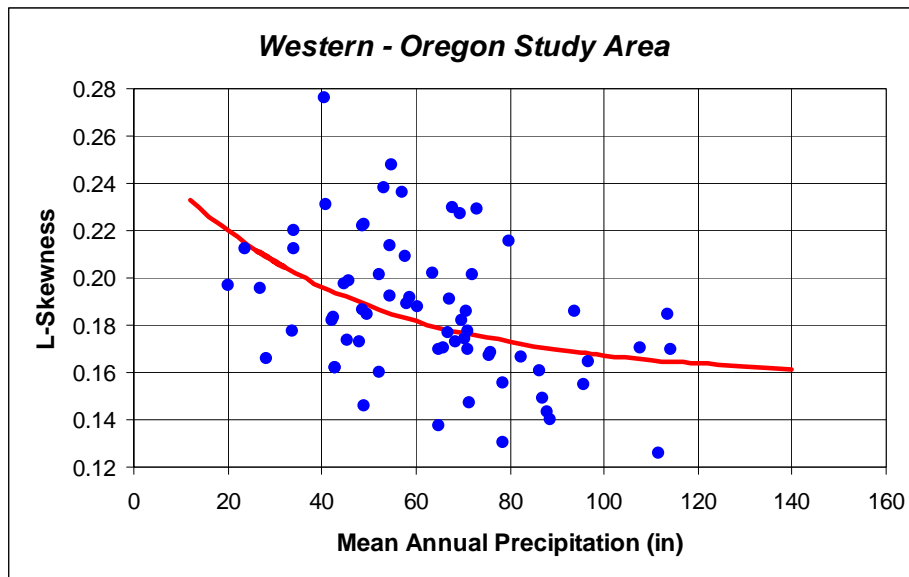


Figure 7.6: Relationship of Regional L-Skewness with Mean Annual Precipitation for Climatic Regions 5, 151, 142, 32, 31, 15, 8, and 143 in the Western Portion of Oregon Study Area.

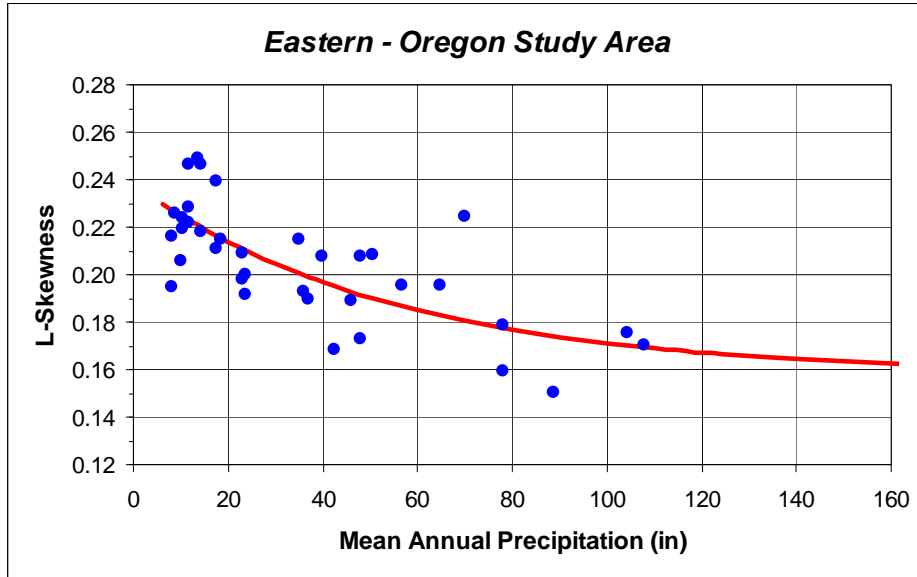


Figure 7.7: Relationship of Regional L-Skewness with Mean Annual Precipitation for Climatic Regions 154, 14, 77, 7, 13, 9, 148, 144, 145 and 146, in the Eastern Portion of Oregon Study Area.

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 $H1 \leq 2.00$	Homogeneous Sub-Regions $H2 \leq 1.00$	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):

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

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

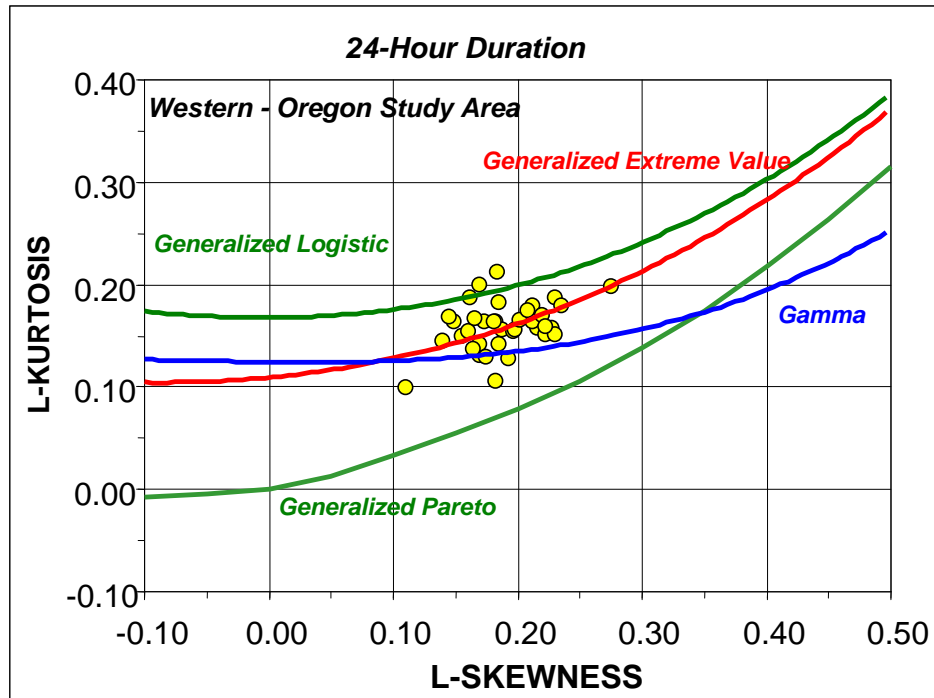


Figure 7.8: L-Moment Ratio Plot, for 24-Hour Duration, for Sub-Regions in Climatic Regions 5, 151, 142, 32, 31, 15, 8, and 143, in the Western Oregon Study Area.

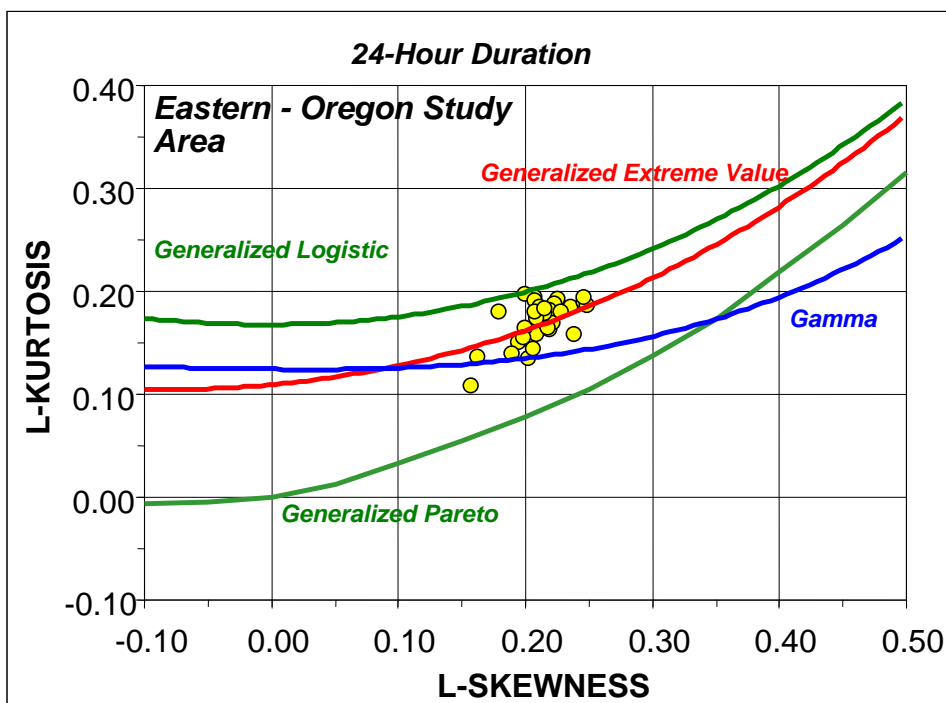


Figure 7.9: L-Moment Ratio Plot, for 24-Hour Duration, for Sub-Regions in Climatic Regions 154,14,147,77,7,13,9,148,144,145, and 146, in the Eastern Oregon Study Area.

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 (ξ , α , and κ) (*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.

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

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
<i>Western Oregon Study Area</i> 5, 151, 32, 31, 15, 8, 143, 154	Daily and SNOTEL	1.13
<i>East Slopes Cascade and Klamath Mountains</i> 14, 147	Daily and SNOTEL	1.11
<i>Eastern Oregon Study Area</i> 77, 7, 13, 9, 148, 144, 145, 146	Daily and SNOTEL	1.08
All Regions	Automated/ Hourly Reporting	1.00
All Regions	Automated/ 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 gauge. The mean annual precipitation for the site is 42.8-inches. The site is located at a latitude of 45.22° 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:

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

Application of Equation 7-8 yielded the regional growth curve depicted in Figure 8.1. McMinnville has a daily gauge with a gage mean of 2.15-inches for 104-years of record. The precipitation-frequency curve for the daily gauge 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.

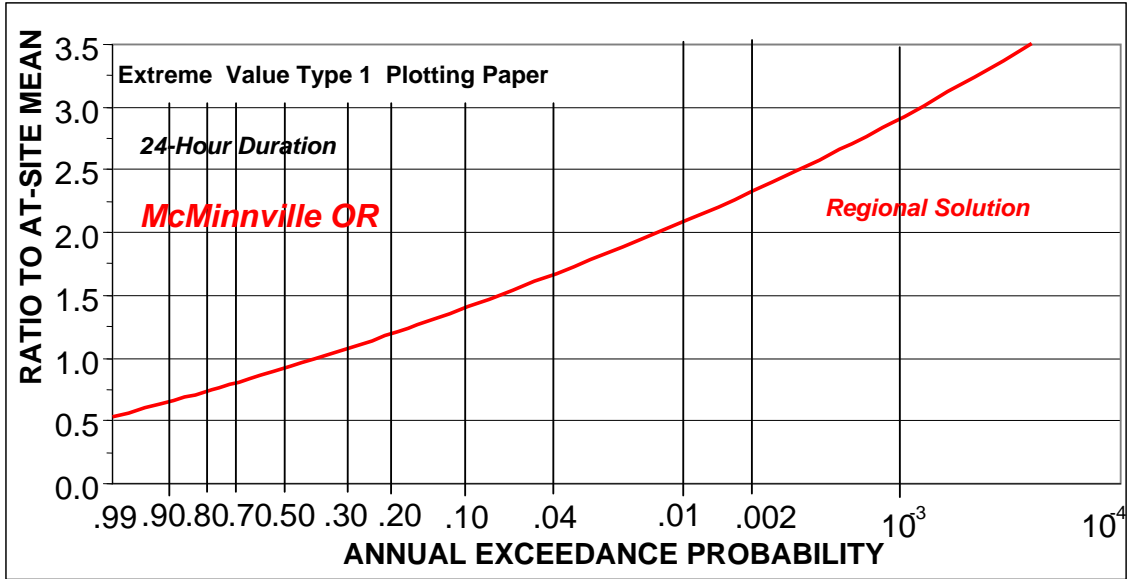


Figure 8.1: Regional Growth Curve for McMinnville, Oregon for 24-Hour Duration.

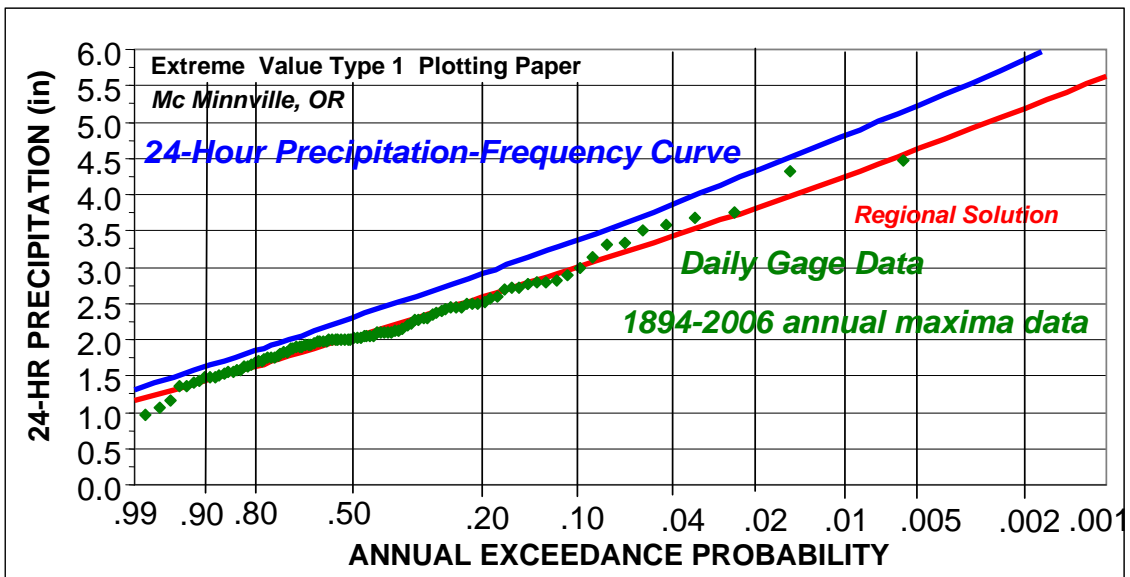


Figure 8.2: Precipitation Magnitude-Frequency Curve for McMinnville, Oregon for 24-Hour Duration.

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 (ξ) and scale (α) 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:

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

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.

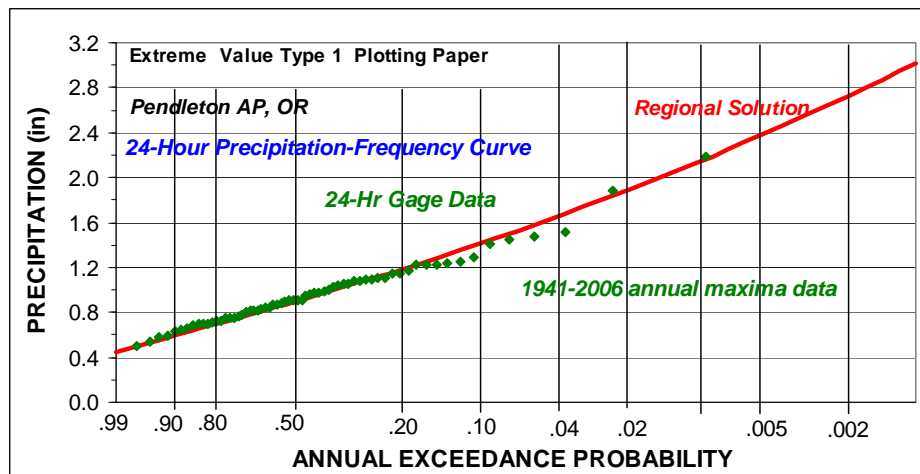


Figure 8.3: Precipitation Magnitude-Frequency Curve for 24-Hour Duration, for the Pendleton Airport in Oregon.

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 mi²). 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.

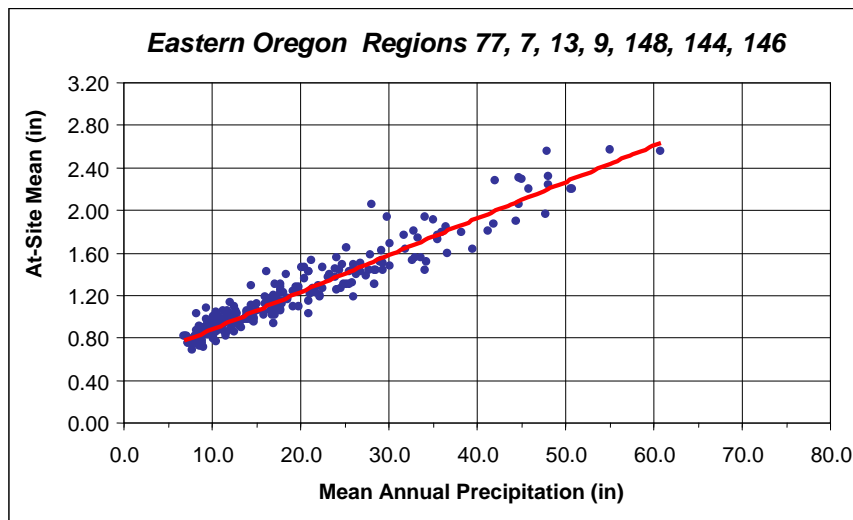


Figure 10.1: Example Relationship of Observed 24-Hour At-Site Mean with Mean Annual Precipitation for Eastern Oregon Study Area (Regions 77, 7, 13, 9, 148, 144, and 146).

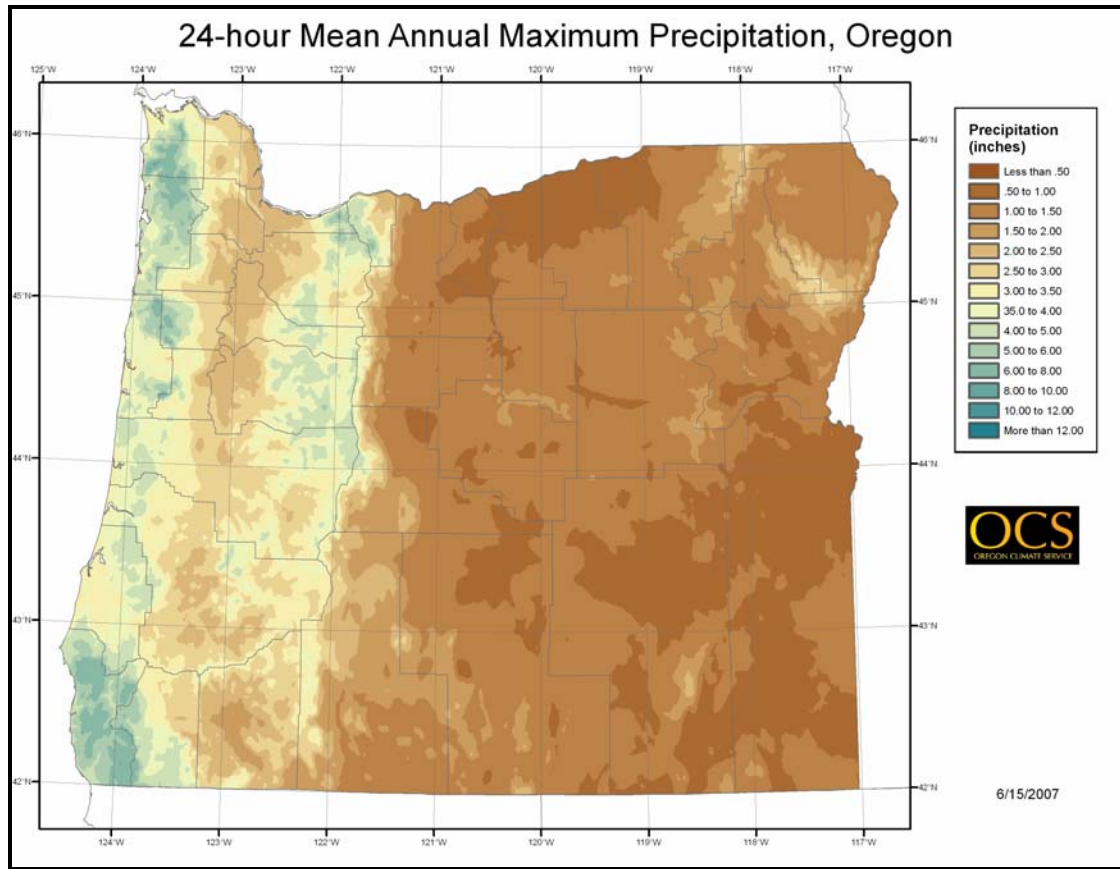


Figure 10.2: Map of At-Site Means for 24-Hour Duration for Oregon Study Area.

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:

$$SR_2 = (S - P_2) / P_2 \quad (10-1)$$

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

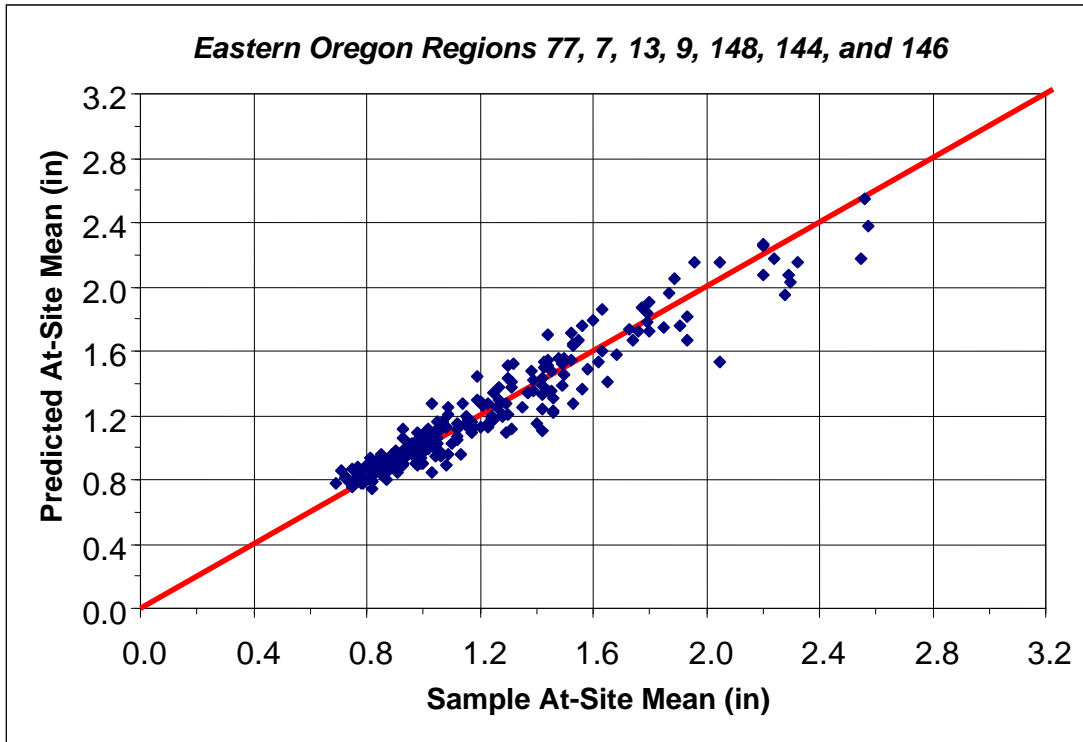


Figure 10.3: Comparison of Observed and Predicted Values of At-Site Means where Mean Annual Precipitation and Latitude were Used as Explanatory Variables for Climatic Regions 77, 7, 13, 9, 148, 144, 146 in Oregon Study Area).

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).

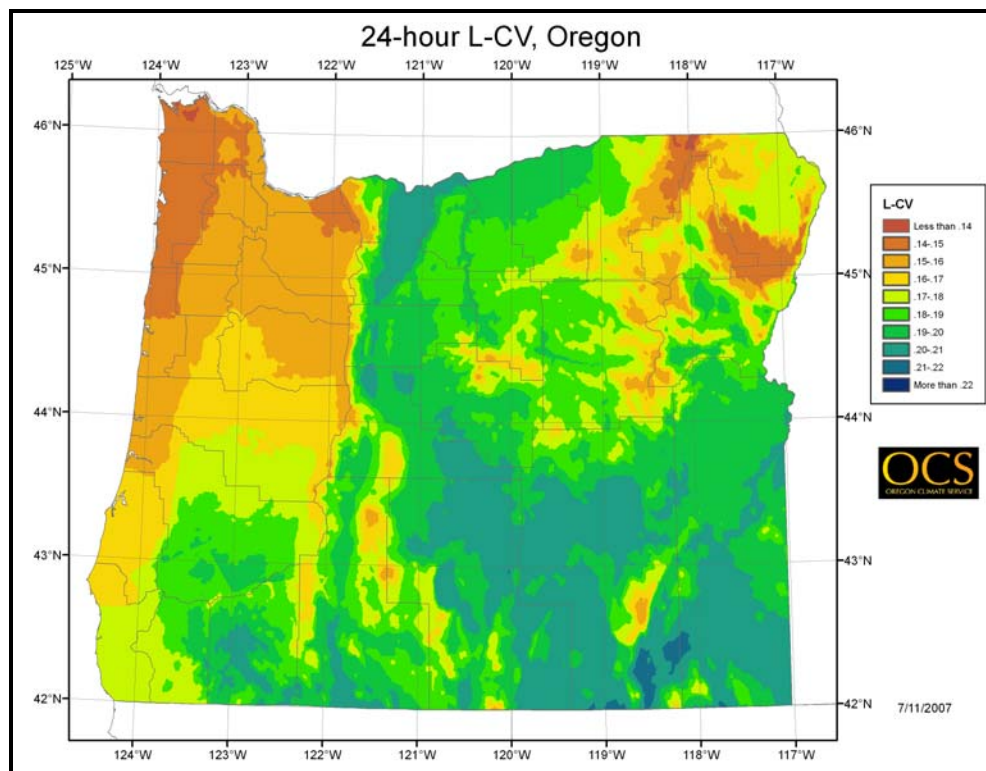


Figure 11.1: Oregon Variation of L-Cv for 24-Hour Precipitation Annual Maxima.

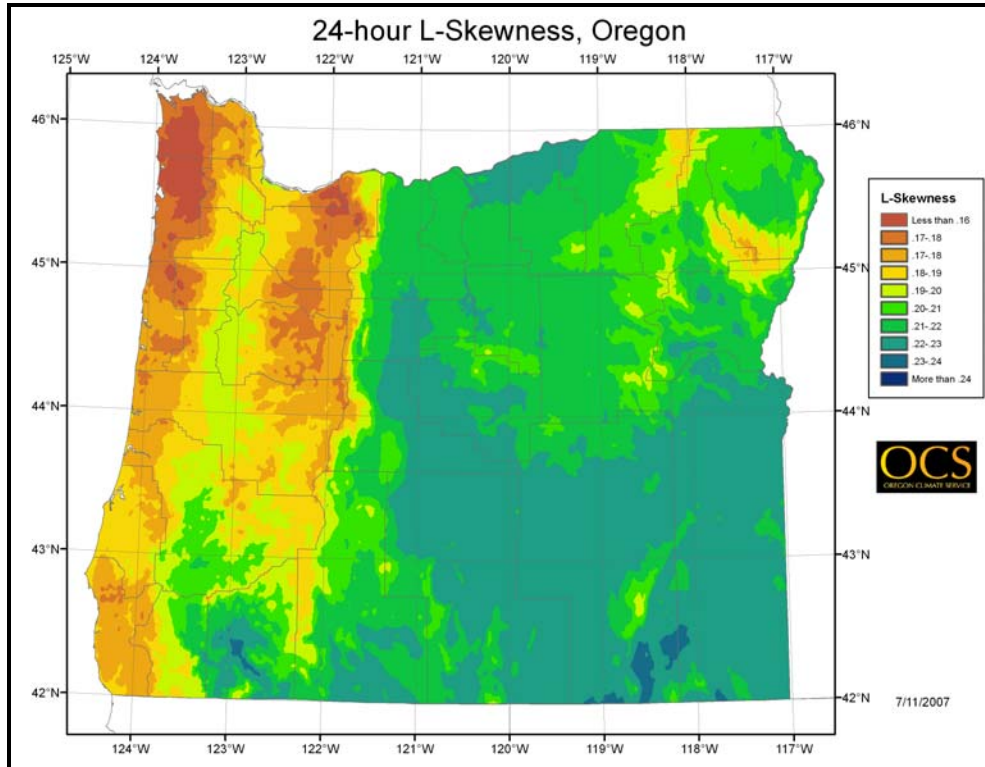


Figure 11.2: Oregon Variation of L-Skewness for 24-Hour Precipitation Annual Maxima.

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-mi² 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.

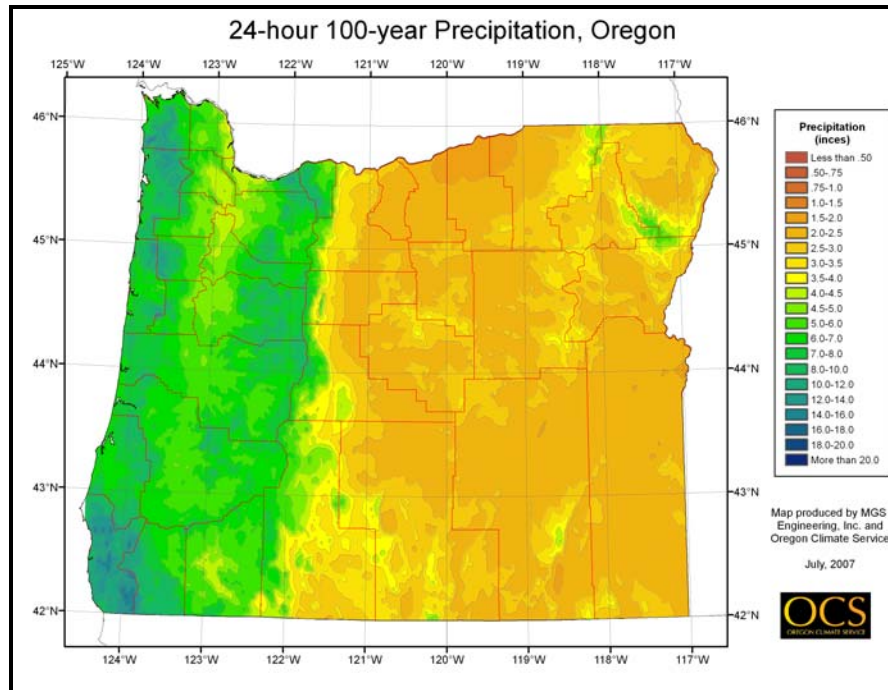


Figure 12.1: Isopluvial Map of 24-Hour Precipitation for 100-Year Recurrence Interval for the State of Oregon.

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).

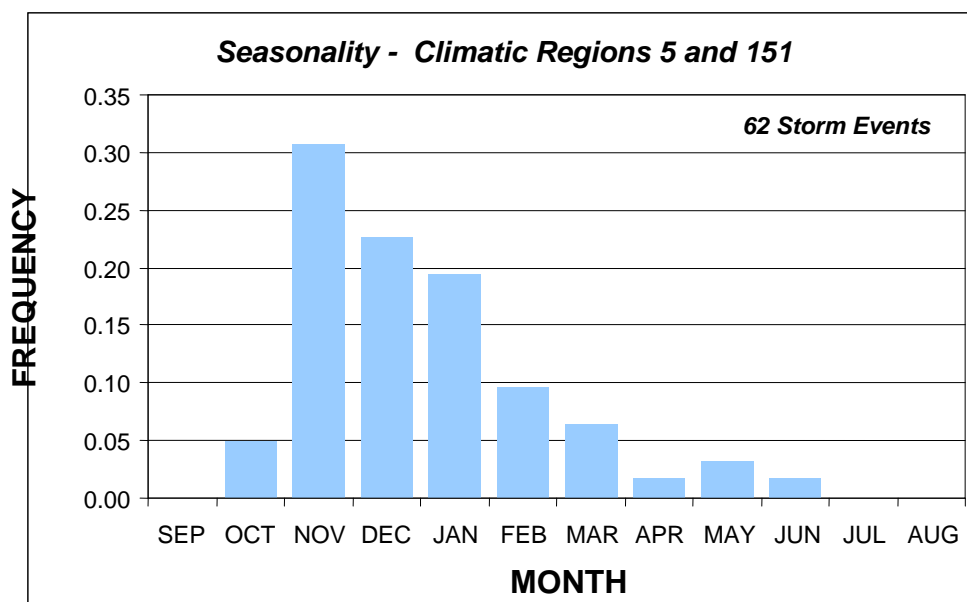


Figure 13.1: Seasonality of Extreme Storms in Climatic Regions 5 and 151 (Western Oregon – Coastal Lowlands and Windward Faces of the Coastal Mountains).

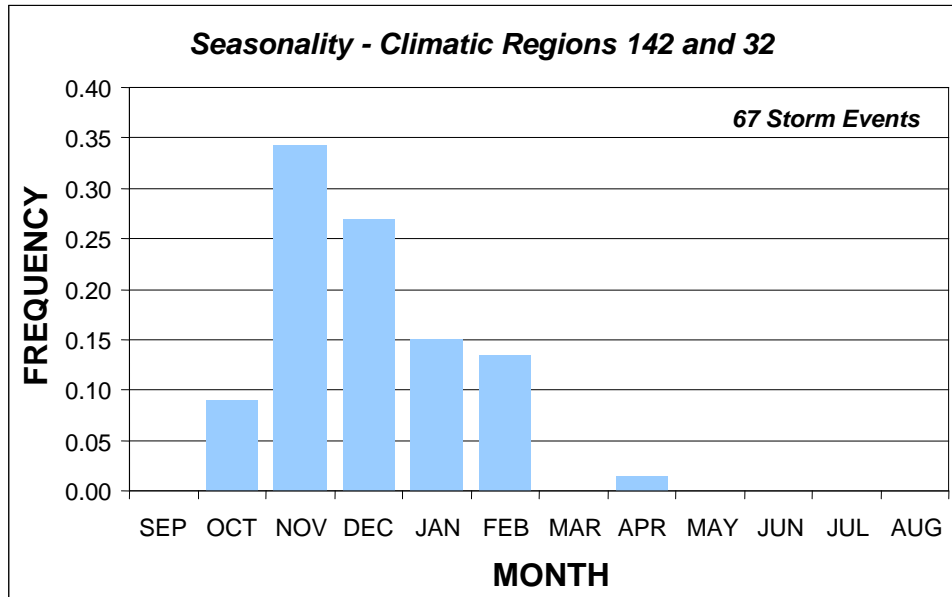


Figure 13.2: Seasonality of Extreme Storms in Climatic Regions 142 and 32 (Western Oregon – Leeward Faces of the Coastal Mountains and the Interior Lowlands to the West).

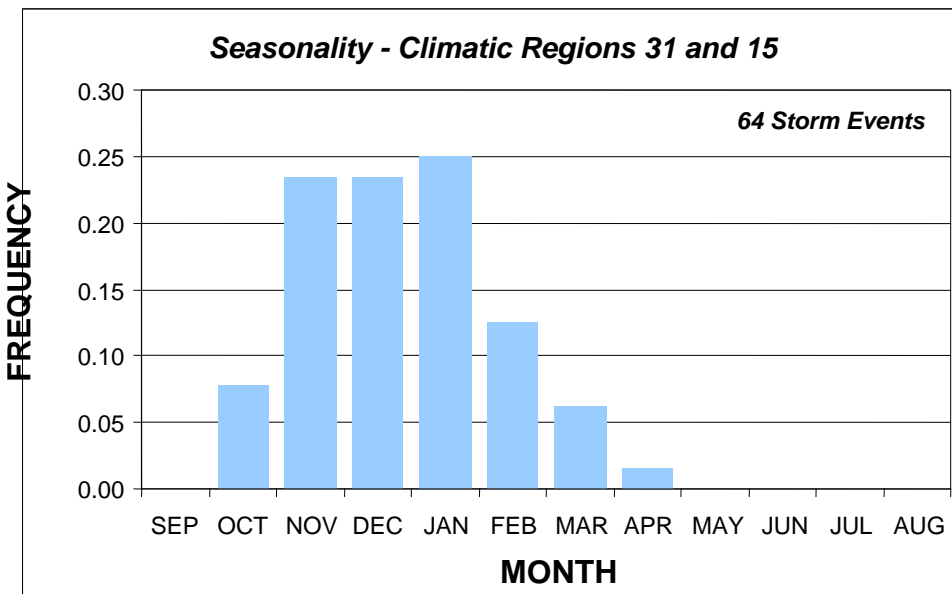


Figure 13.3: Seasonality of Extreme Storms in Climatic Regions 31 and 15 (Western Oregon -Interior Lowlands to the East and the Windward Faces of the Cascade Mountains).

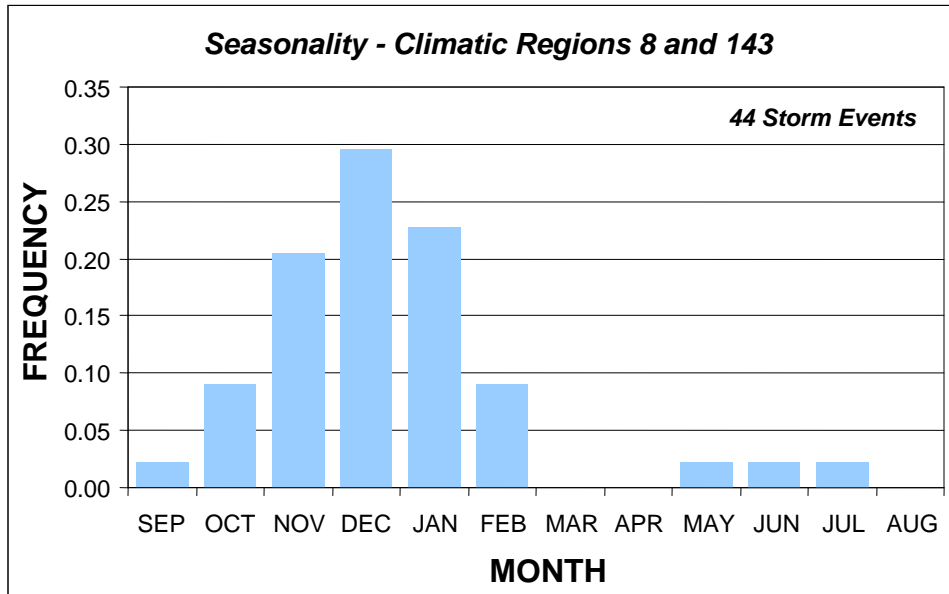


Figure 13.4: Seasonality of Extreme Storms in Climatic Regions 8 and 143 (Southwest Oregon – Rogue Valley and the Windward Faces of the Klamath Mountains).

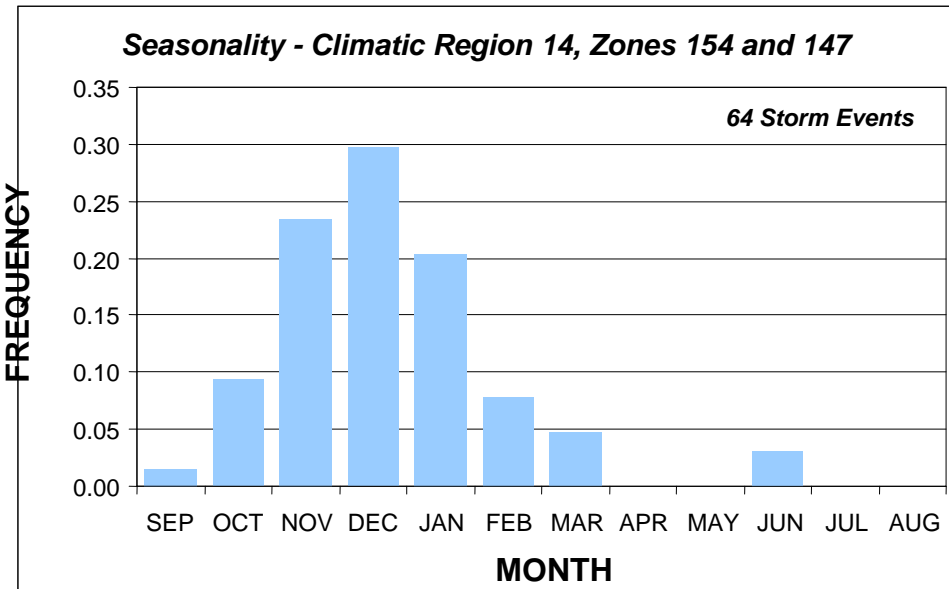


Figure 13.5: Seasonality of Extreme Storms in Climatic Region 14 and Transition Zones 154, and 147 (Eastern Oregon – Leeward Faces of the Cascade and Klamath Mountains).

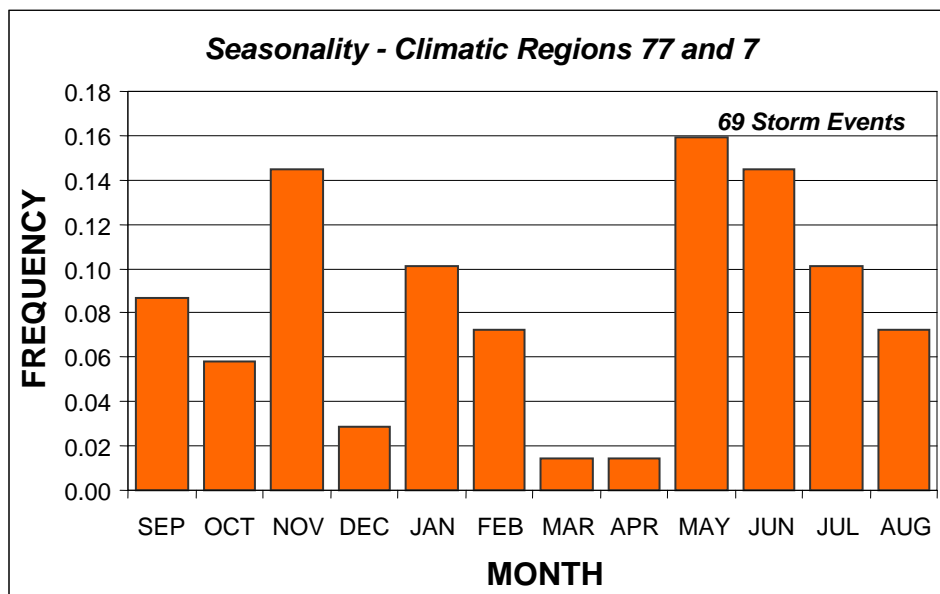


Figure 13.6: Seasonality of Extreme Storms in Climatic Regions 77 and 7 (Northeastern Oregon – Low Orographic Areas).

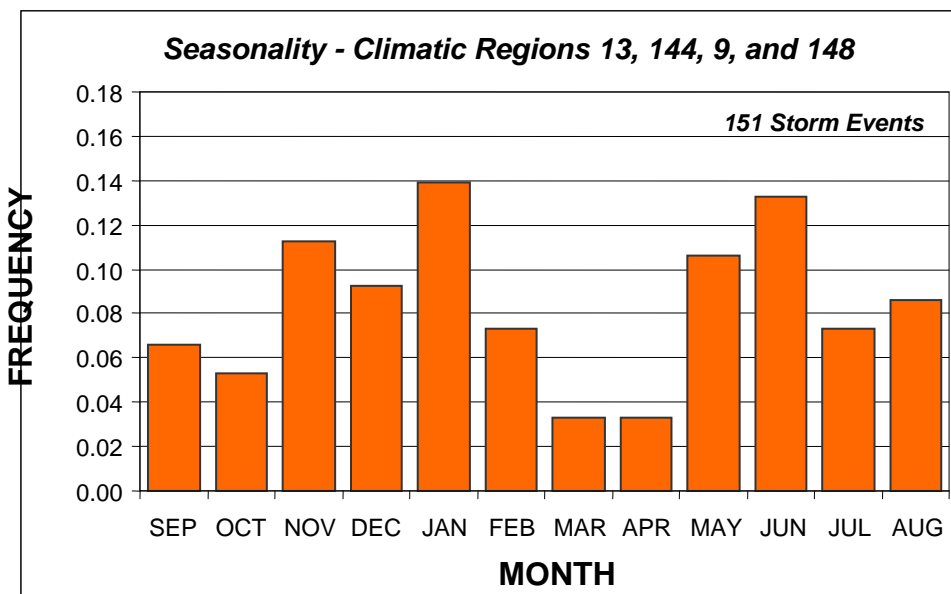


Figure 13.7: Seasonality of Extreme Storms in Climatic Regions 13, 144, 9, and 148 (Northeastern and Central Oregon – Mountainous Areas).

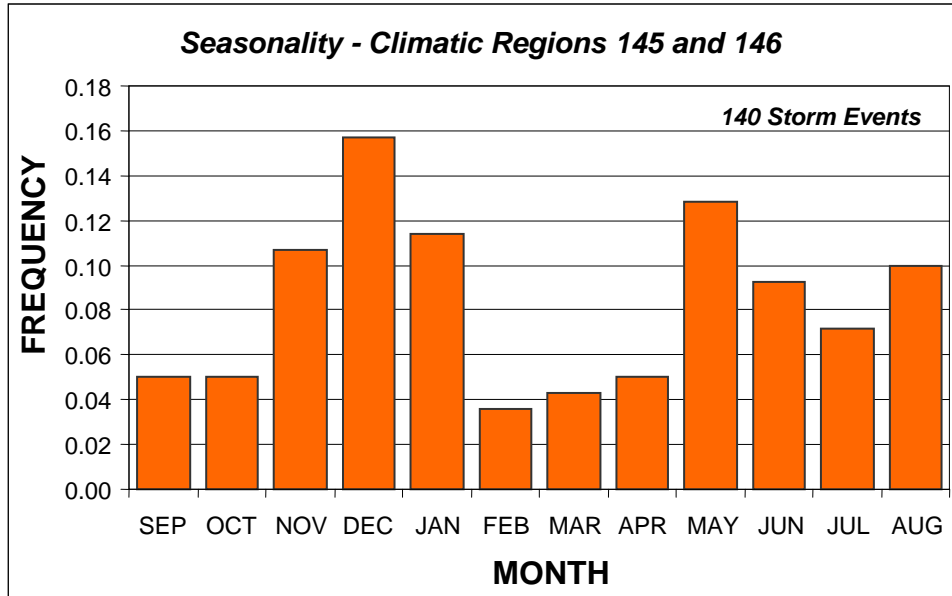


Figure 13.8: Seasonality of Extreme Storms in Climatic Regions 145 and 146 (Southeastern Oregon – Desert Mountain Areas).

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	APLEGATE	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	DALLESPOUR 9 N	WA	45.750	-121.150	1923	1948	1980	33	14	DY	23.7
451968	DALLESPOUR 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

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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

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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.

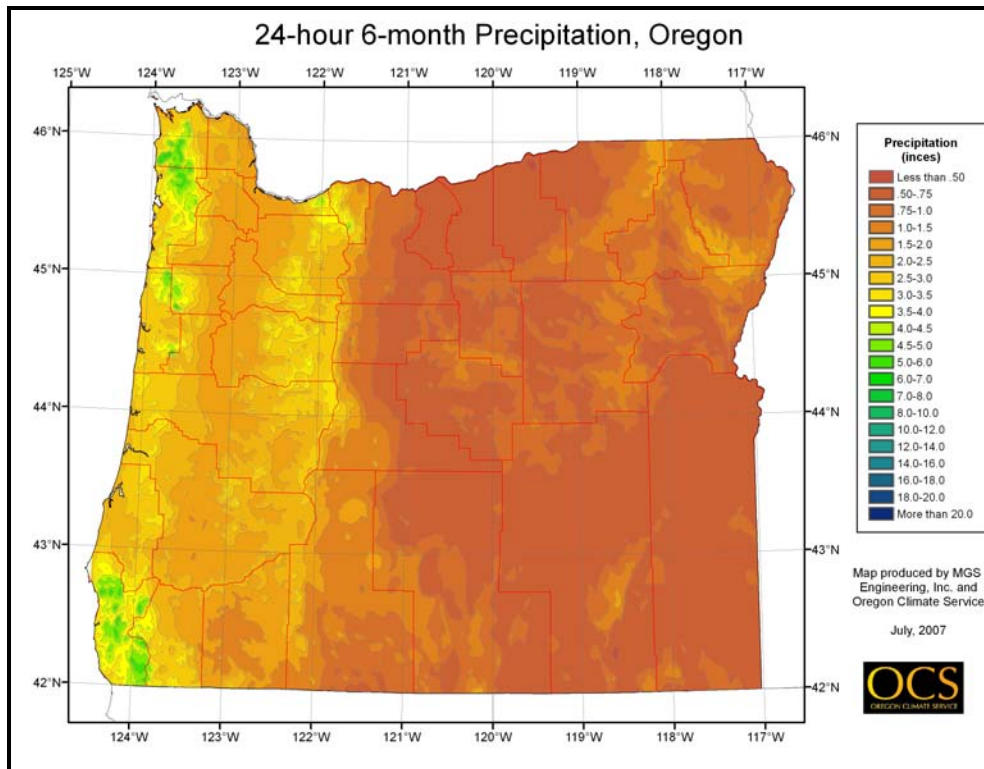


Figure B.1: Isopluvial Map of 24-Hour Precipitation for 6-Month Recurrence Interval for Oregon State.

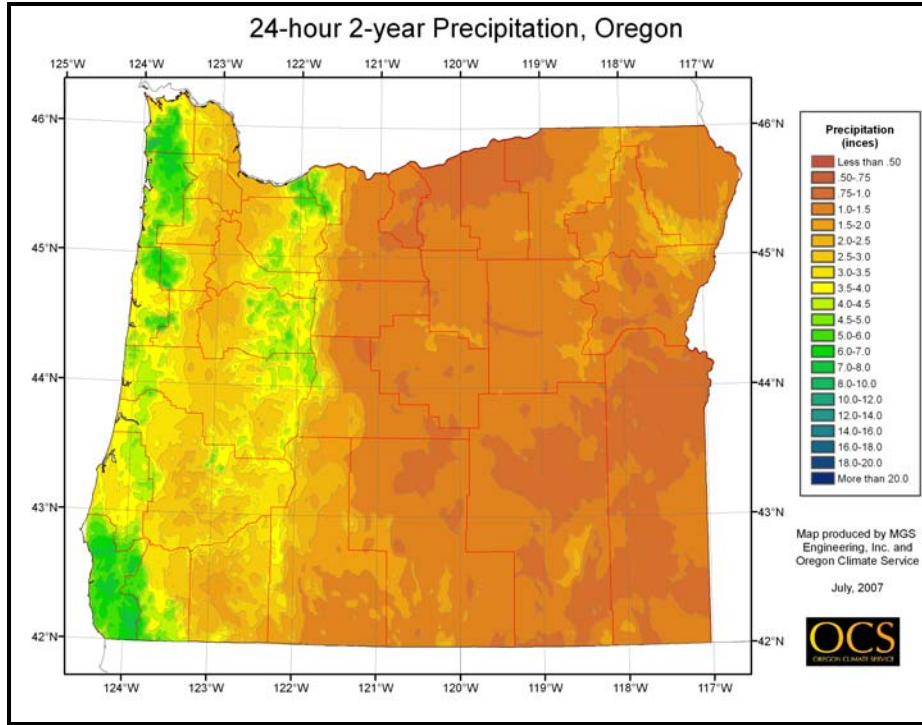


Figure B.2: Isopluvial Map of 24-Hour Precipitation for 2-Year Recurrence Interval for Oregon State.

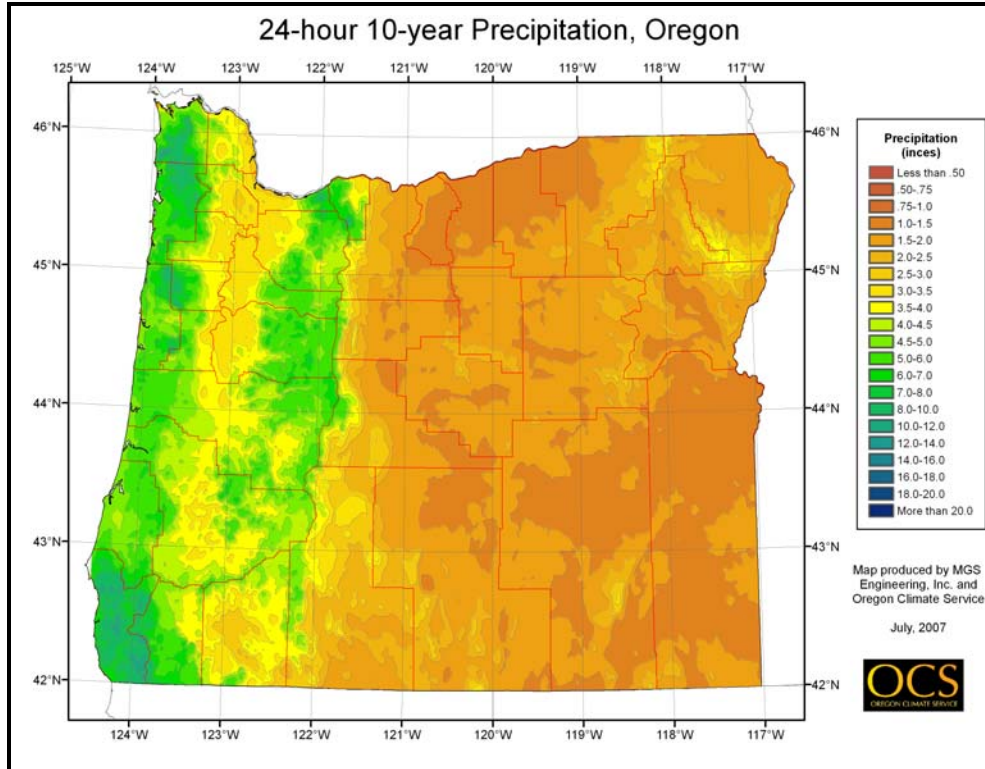


Figure B.3: Isopluvial Map of 24-Hour Precipitation for 10-Year Recurrence Interval for Oregon State.

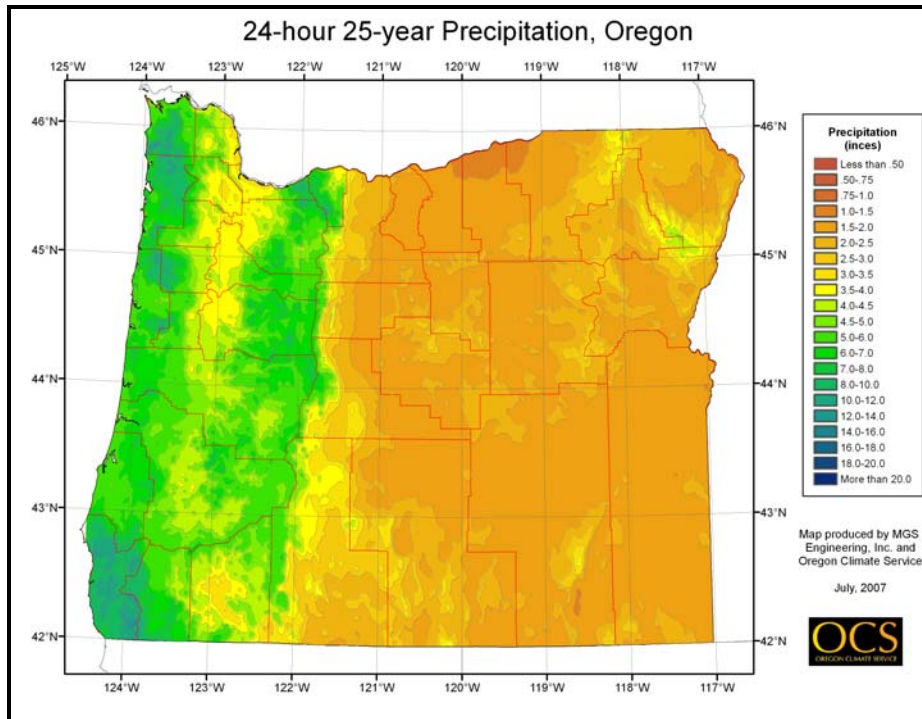


Figure B.4: Isopluvial Map of 24-Hour Precipitation for 25-Year Recurrence Interval for Oregon State.

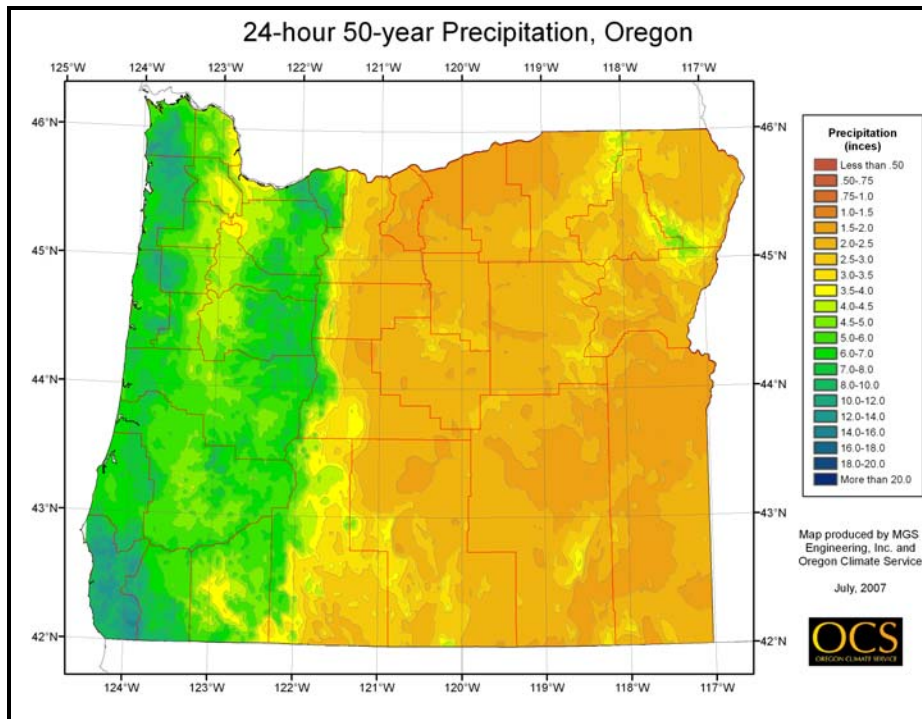


Figure B.5: Isopluvial Map of 24-Hour Precipitation for 50-Year Recurrence Interval for Oregon State.

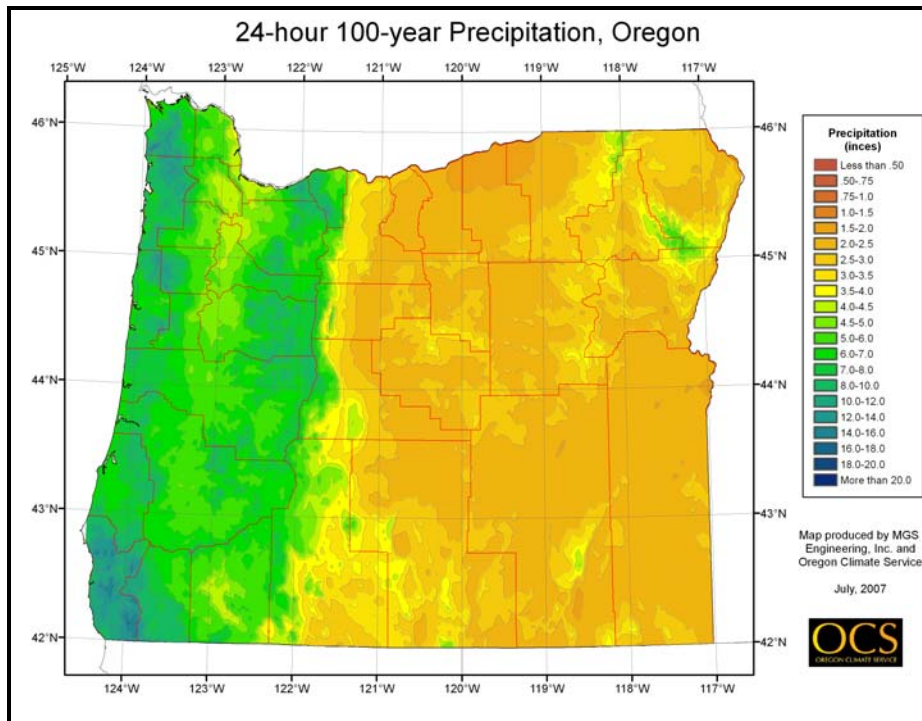


Figure B.6: Isopluvial Map of 24-Hour Precipitation for 100-Year Recurrence Interval for Oregon State.

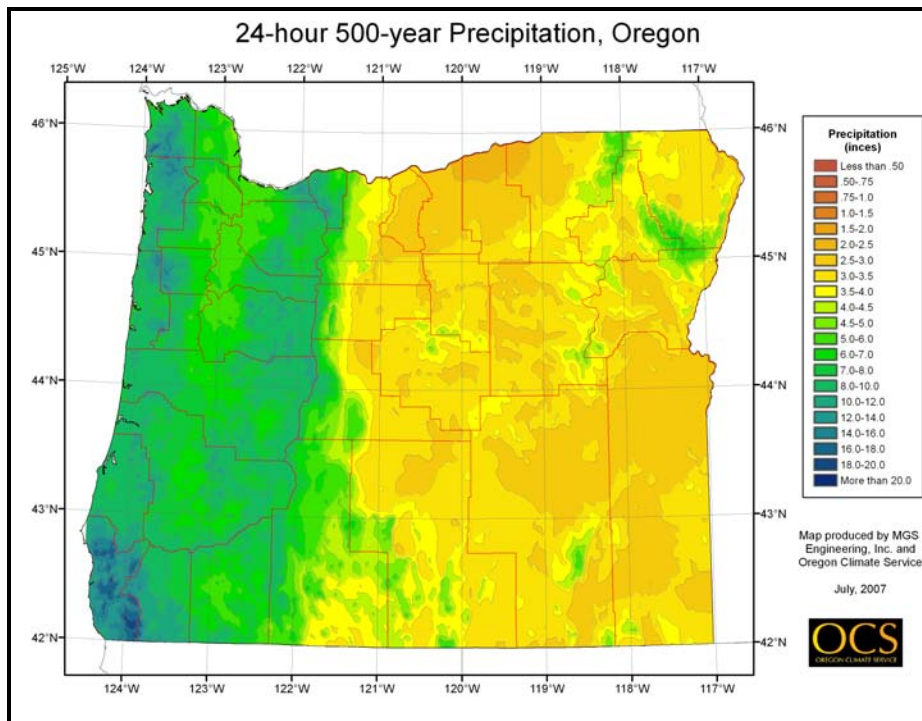


Figure B.7: Isopluvial Map of 24-Hour Precipitation for 500-Year Recurrence Interval for Oregon State.

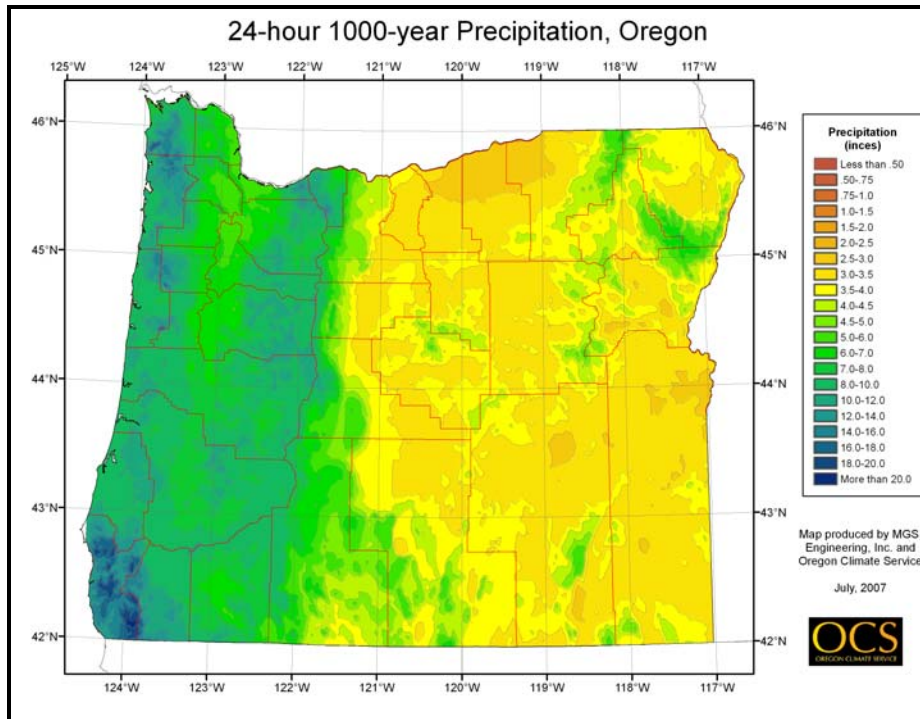


Figure B.7: Isopluvial Map of 24-Hour Precipitation for 1,000-Year Recurrence Interval for Oregon State.

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:

$$\begin{aligned} \text{Location, mean:} \\ \text{Mean} &= L_1 \end{aligned} \tag{C1}$$

$$\begin{aligned} \text{Scale, L-Cv (t}_2\text{):} \\ t_2 &= L_2/L_1 \end{aligned} \tag{C2}$$

$$\begin{aligned} \text{L-Skewness (t}_3\text{):} \\ t_3 &= L_3/L_2 \end{aligned} \tag{C3}$$

$$\begin{aligned} \text{L-Kurtosis (t}_4\text{):} \\ t_4 &= L_4/L_2 \end{aligned} \tag{C4}$$

where:

$$L_1 = \beta_0 \tag{C5}$$

$$L_2 = 2\beta_1 - \beta_0 \tag{C6}$$

$$L_3 = 6\beta_2 - 6\beta_1 + \beta_0 \tag{C7}$$

$$L_4 = 20\beta_3 - 30\beta_2 + 12\beta_1 - \beta_0 \tag{C8}$$

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

$$\beta_0 = n^{-1} \sum_{j=1}^n x_j \tag{C9}$$

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

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

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

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:

$$n_R = \sum_{i=1}^N n_i \quad (\text{C13})$$

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

$$L_1^R = 1 \quad (\text{C14})$$

Regional L-Cv (t_2^R):

$$t_2^R = n_R^{-1} \sum_{i=1}^N n_i t_2^i \quad (\text{C15})$$

Regional L-Skewness (t_3^R):

$$t_3^R = n_R^{-1} \sum_{i=1}^N n_i t_3^i \quad (\text{C16})$$

Regional L-Kurtosis (t_4^R):

$$t_4^R = n_R^{-1} \sum_{i=1}^N n_i t_4^i \quad (\text{C17})$$

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:

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

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

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 (θ_i):

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

Compute vectors for compass direction:

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

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

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

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

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

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

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

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

Compute Seasonality Index (SI):

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

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

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.

CITY/COUNTY OF [CITY/COUNTY NAME]
ORDINANCE NO. [#####]

AN ORDINANCE IMPLEMENTING THE MODERATE-INCOME REVOLVING LOAN (MIRL) PROGRAM, ENACTED THROUGH OREGON SENATE BILL 1537 (2024), AS AMENDED BY SB 48 (2025), AND AUTHORIZING THE [JURISDICTION] TO ENTER INTO AGREEMENTS WITH OREGON HOUSING AND COMMUNITY SERVICES (OHCS).

WHEREAS, the [JURISDICTION] desires to establish a Moderate-Income Housing Project Funding Program (the “Local MIRL Program”) to spur certain housing development activities within the [JURISDICTION] using tax increment financing-based resource structure or alternate funding source; and

WHEREAS, the [JURISDICTION] desires to establish a Local MIRL Program to provide financial assistance to developers for Eligible Housing Projects using funds obtained through the MIRL Program [FOR _% AMI]; and

WHEREAS, the [JURISDICTION] seeks to facilitate the development of [HOUSING TYPE] to increase affordability and housing availability within the [JURISDICTION];

WHEREAS, the [JURISDICTION] has consulted with the governing body of [ANY CITY OR COUNTY WITH TERRITORY INSIDE THE BOUNDARIES OF THE SPONSORING JURISDICTION] regarding [JURISDICTION]’s desire to establish a Local MIRL Program;

NOW, THEREFORE, [JURISDICTION] ORDAINS AS FOLLOWS:

SECTION 1: DEFINITIONS

For purposes of this Ordinance, the following definitions apply:

- **Affordability Requirements:** The income and affordability restrictions applicable to Eligible Housing Projects receiving funding under the Local MIRL Program.
 - If a project is rental housing, it must be rented to households with an annual income not greater than [120 OR LOWER] percent of the Area Median Income, and rented at a monthly rate (rent plus a utility allowance set by the [JURISDICTION]) that is affordable to households with an annual income not greater than [120 OR LOWER] percent of the Area Median Income, such affordability to be maintained for a period that is the longer of either ten years or the Agency Loan Term.
 - If a project is for-sale/homeownership housing, it must be affordable to, and sold or offered for sale to, households with an annual income not greater than [120 OR LOWER] percent of the Area Median Income, continuously from initial sale for a period that is the longer of either ten years or the Agency Loan Term.
- **Agency Loan:** The moneys received by [JURISDICTION] from Oregon Housing and Community Services pursuant to a MIRL loan agreement.

- **Agency Loan Term:** The presumptive number of years that the [JURISDICTION] has to repay an Agency Loan to OHCS. The Agency Loan Term is 10 years [unless otherwise allowed by this Ordinance, for up to 15 years].
- **Tax Increment Differential:** The amount that results when the County Tax Officer takes the amount in paragraph (A) of this definition and subtracts from it the amount in paragraph (B):
 - A. Using the last certified assessment roll for the property tax year in which an application for Project Funds is received, the County Tax Officer determines the amount of property taxes assessed against all tax accounts that include the Eligible Housing Project Property, and then subtracts the amount of operating taxes as defined in ORS 310.055 and local option taxes as defined in ORS 310.202 levied by fire districts.
 - B. For the first property tax year for which the completed Eligible Housing Project Property is estimated to be taken into account, the County Tax Officer determines the estimated amount of property taxes that will be assessed against all tax accounts that include the Eligible Housing Project Property and subtracts the estimated amount of operating taxes and local option taxes levied by fire districts.
- **Eligible Housing Project:** A project that constructs new housing or converts a non-residential building into housing and that meets MIRL Program requirements as set forth in applicable statutes (including but not limited to ORS 307.213-237) and administrative rules (Oregon Administrative Rules chapter 813, division 410), as the same may be amended from time to time.
- **Project Funding Agreement:** A legally binding agreement between the [JURISDICTION] and a developer outlining the disbursement, use, and, if applicable, repayment of Project Funds.
- **Project Funds:** The moneys that the [JURISDICTION] grants or loans to a developer via a Project Funding Agreement to develop an Eligible Housing Project.
- **Local Site Approval:** [Definition]
- **[Other]**

SECTION 2: ESTABLISHMENT OF LOCAL MIRL PROGRAM

The [JURISDICTION] hereby establishes a Local MIRL Program, which is intended to conform in all respects to the MIRL Program requirements, including ORS 307.213-237 and OAR chapter 813, division 410, as either may be amended from time to time. This Local MIRL Program shall award Project Funds to developers for Eligible Housing Projects using funds obtained through an Agency Loan from OHCS.

SECTION 3: COMPLIANCE PLAN

The [JURISDICTION] shall enforce Affordability Requirements and compliance measures through a Compliance Plan [ATTACHED AS EXHIBIT OR OUTLINED BELOW], which includes:

- Procedures for monitoring compliance with Affordability Requirements;
- Reporting requirements for developers receiving Project Funds; and
- Remedies for noncompliance.

SECTION 4: PROJECT FUNDING ELIGIBILITY & LIMITATIONS

To qualify for Project Funding under the Local MIRL Program, a project must:

1. Be an Eligible Housing Project;
2. Be [DESCRIBE KINDS OF PROJECTS ALLOWED, AS REQUIRED BY ORS 307.214(2)(a): for-sale property (a single-family dwelling, middle housing as defined in ORS 197A.420, or a multifamily dwelling) or rental property (middle housing as defined in ORS 197A.420, a multifamily dwelling, an accessory dwelling unit as defined in ORS 215.501, or any other form of affordable housing or moderate income housing)];
3. Comply with all MIRL Program requirements, including the provisions of ORS 307.213-237 and OAR chapter 813, division 410;
4. Meet all applicable land use and permitting requirements; and
5. For projects located in Urban Renewal Areas, utilize the Alternative Funding Source repayment option and receive Project Funds via a loan to the developer.

SECTION 5: PROGRAM ADMINISTRATION

The [JURISDICTION ADMIN] or their designee shall be responsible for the administration of the Local MIRL Program, including:

- Developing a MIRL application process consistent with this Ordinance and all MIRL Program requirements;
- Reviewing and provisionally approving project applications;
- Project monitoring and compliance;
- Ensuring compliance with OHCS requirements; and
- Submitting required reports to OHCS.
- [OPTIONAL FOR JURISDICTION: Prioritize developments within specific zones, such as urban infill areas.];
- [OPTIONAL FOR JURISDICTION: Meet deeper affordability requirements beyond MIRL Program minimums.]; and
- [Other requirements as determined by the JURISDICTION].

SECTION 6: UTILITY ALLOWANCE CALCULATION FOR RENTAL HOUSING

The utility allowance for rental housing projects shall be calculated as follows:

- [Methodologies specified by the Jurisdiction]

SECTION 7: PROJECT FUNDING AND REPAYMENT

[JURISDICTION] will determine and define, in each Project Funding Agreement, the method of providing Project Funds to the developer, which shall depend on the Agency Loan repayment option selected by [JURISDICTION] for each Eligible Housing Project. The two options are as follows:

- A. Property Tax Exemption: [JURISDICTION] may repay the Agency Loan through Program Fees (fees in lieu of taxes) collected from developers or other fee payers with property tax exemptions on MIRL-funded improvements. [JURISDICTION] will work with the County Tax Officer to establish a

process for exempting the improvements of Eligible Housing Projects from property taxes. [JURISDICTION] shall provide Project Funds to the developer as a grant.

- B. Alternative Funding Source: [JURISDICTION] may repay the Agency Loan by pledging its full faith and credit and taxing authority and an alternative source of revenue that is acceptable to OHCS. [JURISDICTION] shall define the Alternative Funding Source in the Agency Loan Agreement. [JURISDICTION] shall provide Project Funds to the developer as a loan.

The Agency Loan repayment and exemption amounts will be determined using OHCS-provided proformas and amortization schedules in accordance with MIRL Program requirements.

SECTION 8: AGREEMENTS WITH OHCS

The [JURISDICTION] is authorized to enter into an Intergovernmental Master Agreement with OHCS to establish the terms under which the [JURISDICTION] will receive Agency Loans. The [JURISDICTION] shall also enter into an Agency Loan Agreement with OHCS for each approved project.

SECTION 9: SEVERABILITY

If any provision of this Ordinance is found to be invalid, the remaining provisions shall continue in full force and effect.

SECTION 10: EFFECTIVE DATE

This Ordinance shall take effect 30 days after adoption.

PASSED AND ADOPTED by the [JURISDICTION] this ___ day of ____, 20__.

[Mayor's Name], Mayor

ATTEST:

[City Recorder's Name], City Recorder

Resolution No 2026-05

City of Hood River

A Resolution Establishing Moderate Income Revolving Loan Program Rules

The City Council of the City of Hood River finds as follows:

Whereas, the City Council recognizes a compelling and critical public need for more affordable and moderate-income housing in Hood River; and

Whereas, the City Council enacted a local Moderate Income Revolving Loan (MIRL) Program via Ordinance 2095 on March 30, 2026, to provide financial assistance to developers with financing from the Oregon Housing & Community Services Department (OHCS) for housing serving households up to 120% of Area Median Income; and

Whereas, The following rules are intended to supplement the regulations enacted via Ordinance 2095 by the City Council to provide required guidance in support of the implementation of a MIRL;

Now, Therefore, based on the foregoing findings, the Hood River City Council ordains as follows:

Definitions

Capitalized terms are defined in the MIRL Enacting Ordinance 2095 (2026).

Compliance Plan

A. Recordkeeping: It is the responsibility of the Developer, initial property owner, or any successive owner, to maintain all compliance related records in a readily available format for inspection or audit at any time by City, County, or State officials for a minimum of six years after the Loan Term.

B. Reporting:

I. For-Sale Properties:

Throughout the Loan Term, prior to initial offer of sale of property or resale, MIRL recipients or subsequent property owners will deliver (electronically) the sales price, methodology, and assumptions used to calculate sales price to the City, or its agent. The City, or its agent, shall review and approve or revise the allowable sales price within 15 days of receipt.

II. Rental Properties:

i. Maximum Rents - Throughout the Loan Term, each year when available, the City, or its agent, will deliver (electronically) to MIRL recipients operating for-rent housing the current applicable

maximum rents as published by OHCS for Revolving Loan Program Projects minus the Utility Allowance as calculated in Section 6 of Ordinance 2095 (2026). MIRL grant recipients operating for-rent housing will deliver (electronically) to the City, or its agent, the current rents charged for all dwelling units and the relevant rent restriction level within 120 days of notice from the City of updated maximum rent levels.

- ii. **Income Verification** - Throughout the Loan Term, each year when available, the City, or its agent, will deliver (electronically) to MIRL recipients operating for-rent housing the current applicable maximum household incomes as published by OHCS for Revolving Loan Program Projects. MIRL grant recipients operating for-rent housing will verify that the income of rental applicants is less than the allowable maximum income. Income verification is only required at initial lease. MIRL grant recipients will retain documentation attesting that renter income was verified and met the applicable standard at lease inception.

- C. **Affordability Covenant:** The Developer shall record a covenant or deed restriction ensuring housing affordability for the Loan Term or ten (10) years, whichever is longer.
- D. **Monitoring:** The City Manager, or their designee, shall conduct periodic reviews of submitted documentation and inspect properties as necessary to ensure compliance.

Affordability Covenant/Remedies for noncompliance

MIRL Grant recipients are required to record an affordability housing covenant for all dwelling units utilizing MIRL Grants. This covenant shall run with the land and include, but is not limited, to:

- A. Reporting Requirements described in the Compliance Plan.
- B. Immediate payment of any outstanding annual program fee payments for the entire term of the program fee if:
 - I. The Developer has not completed the Eligible Housing Project within three (3) years following the date on which the Grant Funds were distributed to the Developer, unless the City, in its sole discretion, has provided an extension of the completion date
 - II. The Eligible Housing Project changes substantially from the Project for which the Developer's application was approved, such that the Project would not have been eligible for the Grant; or
 - III. The Developer has not complied with a requirement specified in the Grant Agreement.

- C. Penalty of 20% of the MIRL Grant plus the cost associated with collection if the City discovers that a developer, homeowner, or other project representative willfully made a false statement or misrepresentation or willfully failed to report a material fact to obtain a Grant with respect to an Eligible Housing Project or related to compliance requirements.

Utility Allowance Calculation

The Utility Allowance calculation methodology for the City of Hood River MIRL is derived from the Mid-Columbia Housing Authority’s PHA Utility Allowance schedule. It is applicable to for-rent properties only.

MIRL Grants Distribution Timing:

MIRL Grants will be distributed to awarded Eligible Housing Projects in tranches based on the following construction inspection milestones.

Inspection Milestones	
Foundation	15%
Framing w/ Rough In Electrical & Plumbing	40%
Insulation	30%
Final	15%
Total	100%

Completion of each milestone will be determined by the City of Hood River Building Official in their sole discretion. Building Official determinations will be made within 10 Business Days after receipt of completed inspection reports. Milestones will be deemed met for purposes of MIRL grant disbursements if no Building Official determinization is made within the 10 Business Day deadline.

City Credit Review Committee

All MIRL Applications will be reviewed by a credit review committee that includes, at minimum, the Finance Director and Urban Renewal Administrator.

Approved by the City of Hood River City Council on this 27th day of April, 2026, to take effect immediately.

Paul Blackburn, Mayor

ATTEST:

Jennifer Gray, City Recorder

ORDINANCE NO. 2095

City of Hood River

AN ORDINANCE IMPLEMENTING A MODERATE-INCOME REVOLVING LOAN (MIRL) PROGRAM AND AUTHORIZING THE CITY OF HOOD RIVER TO ENTER INTO AGREEMENTS WITH OREGON HOUSING AND COMMUNITY SERVICES (OHCS).

WHEREAS, the City of Hood River as a “Sponsoring Jurisdiction” under 2024 SB 1537, as amended under 2025 SB 48 (the “Legislative Bills”), desires to establish a Moderate-Income Housing Project Grant Program (the “MIRL Program”) to spur certain housing development activities within the City of Hood River using a tax increment financing-based resource structure capitalized by the State of Oregon; and

WHEREAS, the City of Hood River desires to establish a MIRL Program to provide financial assistance to developers for Eligible Housing Projects, as defined under the Legislative Bills, using funds obtained through the State MIRL Program for housing serving households up to 120% of Area Median Income; and

WHEREAS, the City of Hood River seeks to facilitate the development of all types of housing to increase affordability and housing availability within the City of Hood River; and

WHEREAS, the City of Hood River has consulted with the governing body of Hood River County regarding the City of Hood River’s desire to establish a MIRL Program;

NOW, THEREFORE, based on the foregoing findings, the Hood River City Council ordains as follows:

SECTION 1: DEFINITIONS

For purposes of this Ordinance, the following definitions apply:

A. Affordability Requirements: The income and affordability restrictions applicable to Eligible Housing Projects receiving funding under the MIRL Program.

1. If a project is rental housing, it must be rented to households with an annual income not greater than 120% percent of the Area Median Income, and rented at a monthly rate rent plus a utility allowance set by the City of Hood River that is affordable to households with an annual income not greater than 120% percent of the Area Median Income, such affordability to be maintained for a period that is the longer of either ten years or the Loan Term.
2. If a project is for-sale/homeownership housing, it must be affordable to, and sold or offered for sale to, households with an annual income not greater than 120% percent

of the Area Median Income, continuously from initial sale for a period that is the longer of either ten years or the Loan Term.

B. Annual Increment: The amount that results when the County Tax Officer takes the amount in paragraph (1) of this definition and subtracts from it the amount in paragraph (2):

1. Using the last certified assessment roll for the property tax year in which an application for MIRL Program Funds is received, the County Tax Officer determines the amount of property taxes assessed against all tax accounts that include the Eligible Housing Project Property, and then subtracts the amount of operating taxes as defined in ORS 310.055 and local option taxes as defined in ORS 310.202 levied by fire districts.
2. For the first property tax year for which the completed Eligible Housing Project Property is estimated to be taken into account, the County Tax Officer determines the estimated amount of property taxes that will be assessed against all tax accounts that include the Eligible Housing Project Property and subtracts the estimated amount of operating taxes and local option taxes levied by fire districts.

C. Developer: Any nonprofit corporation, government agency, or other legally formed ownership entity, with a controlling interest in a proposed or funded Eligible Housing Project and that is or will be compensated for that controlling interest.

D. Eligible Housing Project: A project that constructs new housing or converts a non-residential building into housing and that meets MIRL Program requirements as set forth in applicable statutes (including but not limited to SB 1537 (2024) and SB 48 (2025), as may be amended from time to time) and administrative rules (Oregon Administrative Rules chapter 813, division 410).

E. Grant Agreement: A legally binding agreement between the City of Hood River and a Developer outlining the use of MIRL Program Funds.

F. Grant Funds: The moneys that the City of Hood River awards to a Developer via a Grant Agreement to develop an Eligible Housing Project.

G. Loan Term: The presumptive number of years that the City of Hood River has to repay a Program Loan to OHCS. The Loan Term is multiplied by the Annual Increment to determine the maximum Project Grant Funds award. As a result of the way in which the annual program fee is calculated, in most instances, the City of Hood River will repay the Program Loan to OHCS before the end of the Loan Term. The Loan Term may not exceed the greater of:

1. Ten years following July 1 of the first property tax year for which the completed Eligible Housing Project Property is estimated to be taken into account; or

2. If agreed to by the City of Hood River and OHCS, and if authorized in this Ordinance, the period of time required for the Program Loan to be repaid in full.

H. Local Site Approval: A finding by the Sponsoring Jurisdiction that a proposed Eligible Housing Project has or is eligible to receive all necessary land use entitlements and approvals and meets other conditions of approval/requirements set forth under the City's Municipal and/or Development Code.

I. Program Loan: A loan provided by OHCS to the City of Hood River for Project Grant Funds.

J. Sponsoring Jurisdiction: The City of Hood River.

SECTION 2: ESTABLISHMENT OF GRANT PROGRAM

The City of Hood River hereby establishes an MIRL Program, which is intended to conform in all respects to the MIRL Program requirements, including SB 1537 and SB 48, as may be amended from time to time, and OAR chapter 813, division 410. This MIRL Program shall provide Grant Funds to Developers for Eligible Housing Projects using funds obtained through Program Loans from OHCS.

SECTION 3: COMPLIANCE PLAN

The City of Hood River shall enforce Affordability Requirements and compliance measures for the MIRL Program through a Compliance Plan outlined below, which will be set out in more detail in the Grant Agreement for the Project Funds:

- A. Procedures for monitoring compliance with Affordability Requirements;
 - 1. Annual certification of rental rolls for rental properties.
 - 2. Submission of sales price at initial sale of property resale.
- B. Reporting requirements for Developers receiving Grant Funds;
- C. The Developer shall record a covenant or deed restriction ensuring affordability as required under the MIRL Program; and
- D. Remedies for noncompliance.

SECTION 4: PROJECT GRANT ELIGIBILITY & LIMITATIONS

To qualify for a grant under the MIRL Program, a project must:

1. Be an Eligible Housing Project;
2. Be as required by SB 1537, SEC. 25(2)(a): for-sale property (a single-family dwelling, middle housing as defined in ORS 197A.420, or a multifamily dwelling) or rental property (middle housing as defined in ORS 197A.420, a multifamily dwelling, an accessory dwelling unit as defined in ORS 215.501, or any other form of affordable housing or moderate income housing);
3. Comply with all MIRL Program requirements, including the provisions of SB 1537, SB 48, and OAR chapter 813, division 410; and
4. Meet all applicable land use and permitting requirements.

SECTION 5: PROGRAM ADMINISTRATION

The City of Hood River or their designee shall be responsible for the administration of the MIRL Program, including:

- Developing a MIRL application process consistent with this Ordinance and all MIRL Program requirements;
- Developing program rules that can include additional program requirements
- Reviewing and provisionally approving project applications;
- Project monitoring and compliance;
- Ensuring compliance with OHCS requirements; and
- Submitting required reports to OHCS.

The City of Hood River may designate and contract with a third party, including but not limited to the Hood River Urban Renewal Agency, for services related to any aspect of MIRL program administration.

SECTION 6: UTILITY ALLOWANCE CALCULATION FOR RENTAL HOUSING

The City shall determine the applicable utility allowance for rental housing projects.

SECTION 7: TAX EXEMPTION

The City of Hood River will work with the County Tax Assessor to establish a process for exempting approved Eligible Housing Projects from property taxes. The City of Hood River will also coordinate with the County Tax Assessor to determine the program fee as set forth under state law for each project. Tax estimates and exemption amounts will be determined using

OHCS-provided proformas and amortization schedules in accordance with MIRL Program requirements.

SECTION 8: AGREEMENTS WITH OHCS

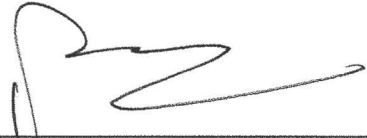
The City of Hood River is authorized to enter into a Master Agreement with OHCS to establish the terms under which the City of Hood River will receive Program Loans. The City of Hood River shall also enter into a Loan Agreement with OHCS for each approved project.

SECTION 9: SEVERABILITY

If any provision of this Ordinance is found to be invalid, the remaining provisions shall continue in full force and effect.

Read for the First Time on this 30 day of March 2026

Read for the Second Time and approved on this 30 day of March 2026. This Ordinance shall take effect on the 31st day following the second reading.



Paul Blackburn, Mayor

ATTEST:

Approved as to form:



Jennifer Gray, City Recorder

Daniel Kearns, City Attorney