SURFACE-WATER RESOURCES OF THE COLUMBIA PLATEAU, WASHINGTON, OREGON, AND IDAHO

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ABSTRACT

This report describes and documents surface-water resources for the Columbia Plateau, defined by the boundaries of the regional aquifer system. Annual precipitation ranges from less than 7 inches in the arid parts of the plateau to more than 100 inches in the bordering mountains. The mean annual precipitation distribution was redefined for this study area. Relations were established between mean annual precipitation and runoff, and were used in conjunction with the lines of equal precipitation to map the mean annual runoff distribution. The spatial distributions of precipitation and surface-water runoff on the plateau are presented on maps.

About 5 million acre-feet of surface water is used to irrigate about 1 million acres in Washington and 230,000 acres in Oregon. Because much of the annual surface-water runoff occurs from December through June, surface water is stored for use during the summer irrigation season. Streamflow can be estimated by using precipitation and is affected by storage in reservoirs and by diversions. In most streams, streamflow is insufficient to meet the demands of irrigation and established minimum flows.

PURPOSE OF REPORT

A study of the Columbia Plateau regional aquifer system began in October 1982 as one of a series of Regional Aquifer-System Analysis (RASA) studies by the U.S. Geological Survey. The Columbia Plateau aquifer system includes central and eastern Washington, north-central and eastern Oregon, and small parts of northwestern Idaho. The purpose of the RASA program is to define and establish the geologic, hydrologic, and geochemical framework of regional ground-water systems. The objective of this report is to describe and document the availability of surface-water data and to describe the resources on the Columbia Plateau for use in an analysis of the water budget of the aquifer system.

The four sheets in this report describe and document the quantity and distribution of precipitation and runoff in the study area, and present descriptions of surface-water facts, statistics, and water use. The four maps are:

Sheet 1. Distribution of precipitation on the Columbia Plateau.

Sheet 2. Distribution of runoff on the Columbia Plateau.

Sheet 3. Streamflow on the Columbia Plateau.

Sheet 4. Low flow and water use on the Columbia Plateau.

DESCRIPTION OF STUDY AREA

The Columbia Plateau aquifer system underlies about 51,000 square miles in Washington, Oregon, and Idaho. The area is within the drainage of the Columbia River and its major tributaries, the Snake, Grande Ronde, Yakima, Walla Walla, Umatilla, John Day, Deschutes, and Klickitat Rivers. The study area is bounded on the west by the Cascade Range, on the south and southeast by the Blue Mountains, on the east by the Rocky Mountains, and on the north by the Okanogan Highlands.

In the bordering mountains, the predominant land cover is forest, and the annual precipitation ranges from 20 to more than 45 inches. Parts of some drainage basins for streams that originate in the Cascade Range receive more than 100 inches of precipitation a year. The central plateau is arid to semiarid and receives less than 15 inches of precipitation annually. Except for storm runoff, most of the rainfall in the arid and semiarid regions is absorbed by the soil; most of the absorbed rainfall is subsequently lost through transpiration by the plants or through evaporation. As described in "Comprehensive Framework Study of Water and Related Lands" (Pacific Northwest River Basins Commission, 1970), ranges, in inches, of various measures of evaporation and evapotranspiration in the study area are:

1. Annual class A pan evaporation; 30 to 40 in the mountains, 50 to 60 in the warmest parts.
2. Annual lake evaporation; 25 in the mountains, 40 in the central plateau.
3. Monthly pan evaporation in agricultural areas; 2 to 5 in the spring and fall, 7 to 12 in the summer.
4. Annual potential evapotranspiration; 25 to 30 in the mountains, 35 to 40 in the warmest parts.
5. Actual evapotranspiration; 7 to 10 in the central plateau, 12 to 16 in the mountains (assuming that soils have a water-storage capacity of 6 inches).

Generally, the potential evapotranspiration exceeds the actual by 15 to 20 inches.

In the study area, more than 5 million acre-feet of surface water is used annually, about 98 percent for irrigation and the remainder largely for municipal and industrial uses. Recreation, a nonconsumptive use, is the major use of surface water in the mountains. Because much of the annual surface-water runoff occurs from December through June, water is stored for use during the summer irrigation season. Most of the irrigation using diverted streamflow is in valleys along the lower reaches of the Yakima, Walla Walla, and Umatilla Rivers. In the central part of the plateau, there is no major tributary stream to supply water for irrigation. Here, much of the water used for irrigation is pumped from the Columbia and Snake Rivers. The Columbia River provides more than 2.2 million acre-feet to irrigate more than 500,000 acres in the Federal Columbia Basin Irrigation Project area.

PREVIOUS STUDIES

A number of previous studies by the U.S. Geological Survey have tabulated the surface-water resources for small areas of the plateau. These include studies by Kinnison and Sceva (1963), Nassar and Walters (1975), Mundorff, MacNish, and Cline (1972), U.S. Geological Survey (1975), Gregg and Laird (1975), Cline (1976), Molenaar (1977, 1982), and Brown (1979). Anderson and Bodhaine (1956) reported on the 1956 flood on Esquatzel Coulee area, and Waananen and others (1971a,b) reported on the 1964-65 floods in the far western states. Laird and Walters (1967), Parker (1971), and Dion and Lum (1977) presented the water-use information for Washington. Lines of mean annual runoff were presented for part of the study area by Bodhaine and Thomas (1964) and Hulsing and Kallio (1964).

Other reports have contained statistical values for streamflow, including those by Cummans, Collings, and Nassar (1975), Haushild (1979), Moss and Haushild (1978), Friday and Miller (1984), and Williams and Pearson (1985). Reports for Oregon (Friday and Miller, 1984) and Washington (Williams and Pearson, 1985) present summaries of streamflow statistical values that include monthly and annual mean discharges, magnitude and probability of annual low flow, magnitude and probability of instantaneous peak flow, magnitude and probability of annual high flow, and duration tables of daily mean flows.

DISTRIBUTION OF PRECIPITATION

Mean annual distribution of precipitation was redefined for the study area because previously published maps for Oregon and Washington (U.S. Weather Bureau, 1964, 1965) did not adequately define the distribution in parts of the study area for the time period of interest. This map was reviewed by the National Weather Service.

Daily precipitation data for 103 stations covering 22 years of record (1956-1977) were obtained from the National Climatic Data Center (written commun., 1982). Missing data for a station were estimated by interpolating between the available data and the data at nearby stations. The mean annual precipitation values presented in table 1 include estimated values. The annual precipitation at four stations for the 22-year period (shown in figure 1) indicates large year-to-year variation and no apparent trend.

Lines of equal mean annual precipitation at each of 103 weather stations were plotted on a map on the basis of precipitation values for the 22-year period at the 103 stations, land-surface elevation, and the rate of changes in elevation or slope of the land surface. Smooth lines were drawn in areas of large changes in precipitation between stations and where data were lacking. In the high-precipitation areas, few data are available to define the position of the lines.

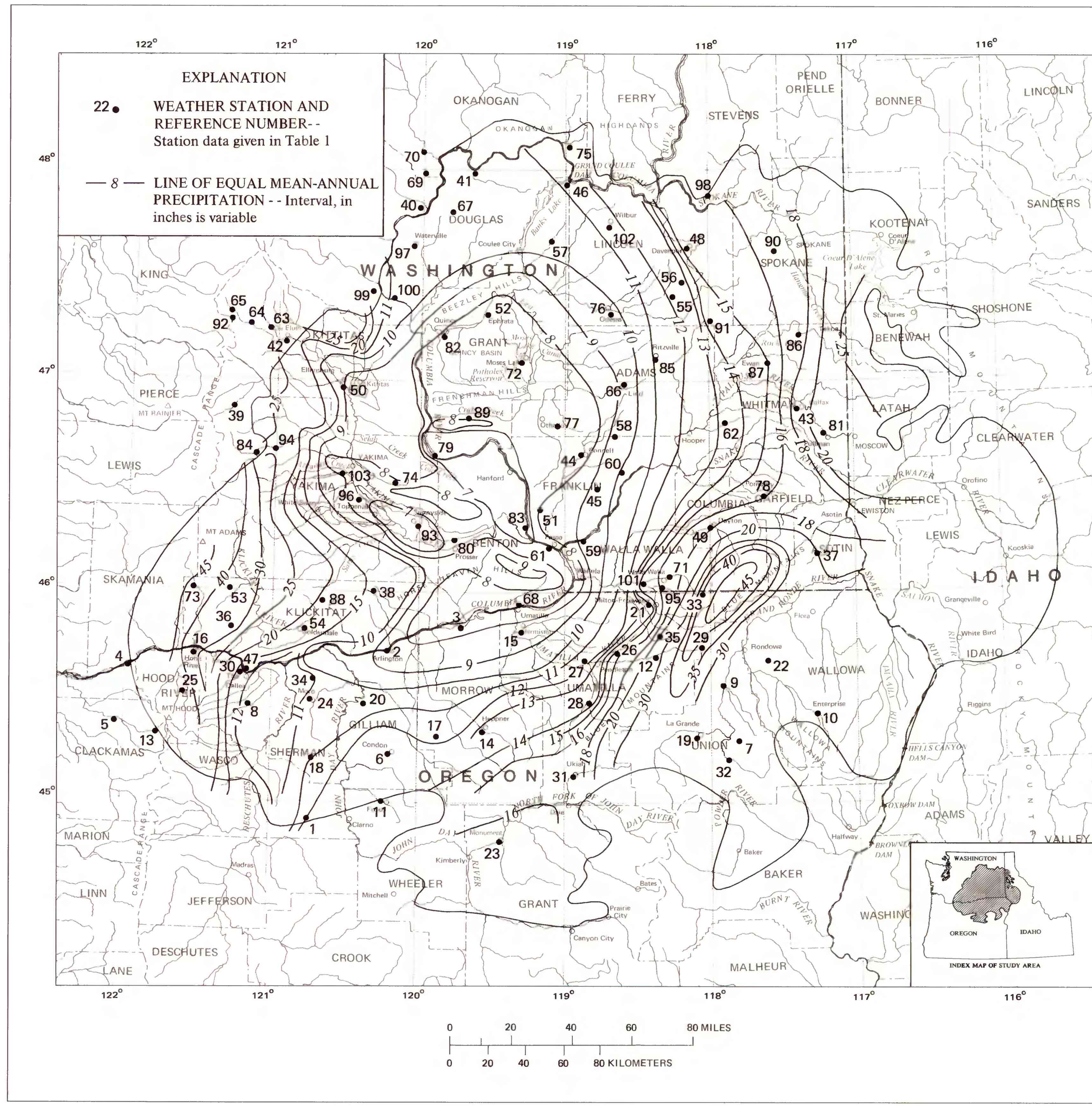
The distribution of precipitation within the year is similar throughout the study area. The mean monthly precipitation for the 103 weather stations (fig. 2) is highest in December or January and lowest in July. The percentage of annual precipitation falling monthly at each of the 103 weather stations is included in table 1, and shows the similarity in this distribution throughout the study area.

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
	2.54	centimeter
foot (ft)	0.3048	meter
acre	4,047	square meter
	0.4047	hectare
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	28.32	liter per second
	0.02832	cubic meter per second

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

DISTRIBUTION OF PRECIPITATION



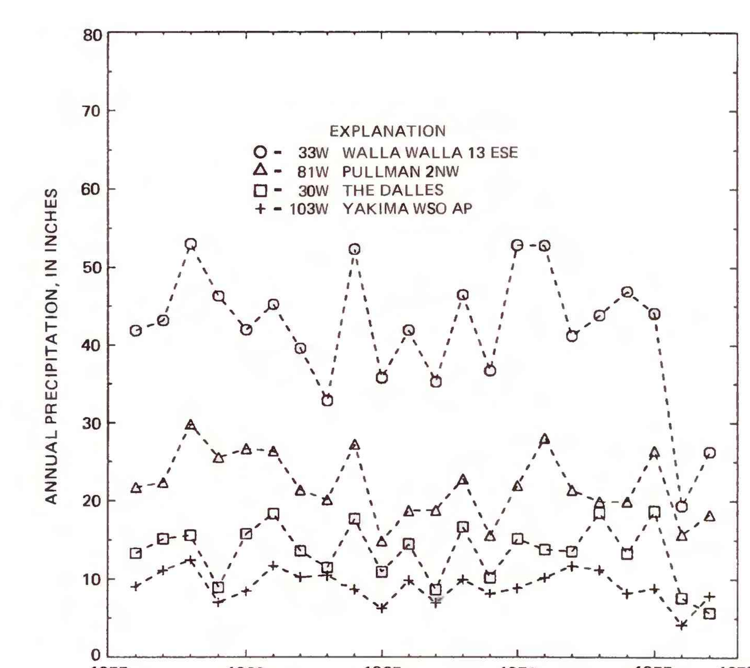


FIGURE 1.--Annual precipitation at four weather stations during a 22-year period (1956-77) showing a large year to year varibility of precipitation.

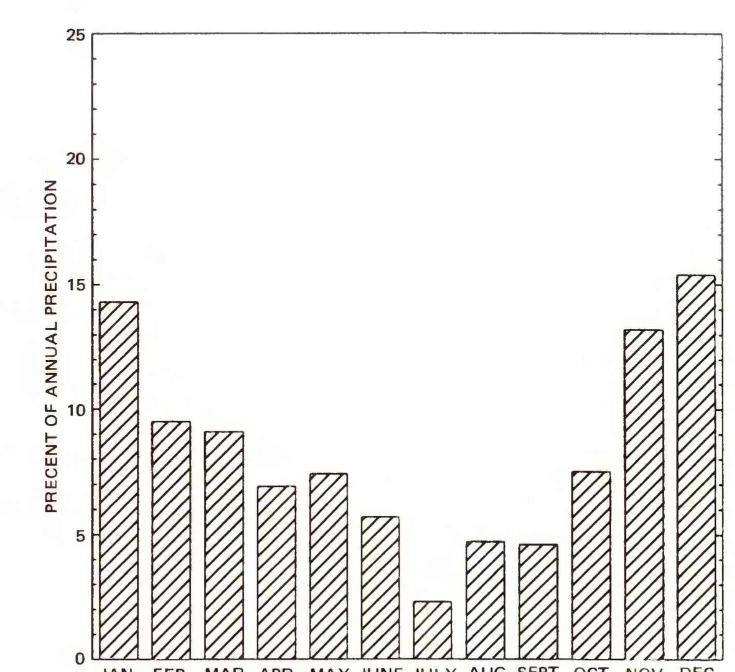


FIGURE 2.--Mean monthly distribution of precipitation for 103 weather stations during a 22-year period (1956-77).

Table 1. -- Weather station on the Columbia Plateau.

REFERENCE NUMBER	INDEX NUMBER	STATION	STATION ELEVATION (FEET)	LONGITUDE (DEGREES)	LATITUDE (DEGREES)	MEAN ANNUAL PRECIPITATION (INCHES)	MEAN MONTHLY PRECICITATION, IN PERCENTAGE OF MEAN ANNUAL: JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1W	35-197	ANTELOPE	2680	120.7167	44.9167	12.23	12.5	8.0	8.5	5.6	11.0	7.4	2.8	5.8	5.7	7.4	13.2	12.2
2W	35-265	ARLINGTON	285	120.2000	45.7167	8.56	17.1	10.5	9.1	6.0	6.1	3.7	2.6	2.8	4.1	6.8	13.9	17.4
3W	35-858	BOARDMAN	300	119.7000	45.8333	7.87	14.9	9.8	8.4	6.5	8.1	5.7	2.2	3.8	4.4	7.8	13.7	14.7
4W	35-897	BONNEVILLE DAM	60	121.9500	45.6333	75.64	16.5	11.1	11.5	6.9	4.9	3.1	0.8	2.3	4.0	8.3	14.0	16.4
5W	35-1028	BRIGHTWOOD	1065	122.0167	45.3667	87.89	15.3	10.0	11.4	8.0	6.3	4.4	1.2	2.7	4.8	8.2	12.7	14.9
6W	35-1765	CONDON	2830	120.1833	45.2333	13.40	12.0	8.4	9.8	7.2	10.3	7.0	3.4	4.6	5.1	6.8	13.1	12.2
7W	35-1924	COVE	2920	117.8000	45.3000	16.32	9.9	6.9	8.2	8.8	11.3	9.4	3.2	5.8	6.9	8.4	10.1	11.1
8W	35-2440	DUFUR	1330	121.1333	45.4500	11.57	17.3	10.7	11.1	5.3	6.6	4.2	1.7	3.4	3.6	6.7	13.5	16.0
9W	35-2597	ELGIN	2655	117.9167	45.5667	24.25	14.0	9.9	9.4	6.8	7.5	5.7	2.4	3.2	4.9	8.2	12.4	15.5
10W	35-2672	ENTERPRISE	3790	117.2667	45.4333	12.82	7.8	4.5	6.9	7.1	13.5	15.1	5.5	7.7	8.0	8.2	7.4	8.1
11W	35-3038	FOSSIL	2650	120.2167	45.0000	13.80	12.9	7.7	9.8	6.7	11.4	7.5	2.8	4.5	5.4	8.0	12.0	11.6
12W	35-3250	GIBBON	1740	118.3667	45.7000	23.93	13.9	8.7	9.3	8.5	8.5	6.4	1.9	4.2	5.5	8.2	11.5	13.3
13W	35-3402	GOVERMENT CAMP	3980	121.7500	45.3000	88.26	16.5	11.1	11.1	8.1	5.6	3.9	0.8	2.4	4.5	7.8	12.5	15.8
14W	35-3827	HEPPNER	1950	119.5500	45.3500	13.29	11.8	7.8	10.3	8.1	10.7	6.1	2.6	4.6	5.6	8.2	11.2	13.1
15W	35-3847	HERMISTON 2 S	624	119.2833	45.8167	8.57	14.9	9.3	8.5	7.1	7.9	4.8	2.1	4.1	4.3	8.3	13.3	15.3
16W	35-4003	HOOD RIVER EXP STA	500	121.5167	45.6833	30.59	19.0	11.6	11.5	5.3	3.4	2.0	0.5	2.0	3.2	7.8	15.7	18.0
17W	35-4161	IONE 18 S	2130	119.8500	45.3167	11.60	13.2	8.0	10.1	7.5	10.4	6.6	2.9	6.6	5.0	6.7	11.3	11.6
18W	35-4411	KENT	2720	120.7000	45.2000	11.12	13.3	8.9	9.5	7.1	8.8	5.9	2.8	4.8	4.9	6.5	13.6	13.8
19W	35-4622	LA GRANDE	2755	118.0833	45.3167	17.26	12.1	8.3	8.6	7.9	10.0	8.1	3.3	5.2	5.9	8.3	10.5	11.9
20W	35-5545	MIKKALO 6 W	1550	120.3500	45.4667	10.19	14.3	9.7	9.4	7.1	8.6	5.9	2.4	4.1	4.4	6.6	13.9	13.5
21W	35-5593	MILTON FREEWATER	970	118.4167	45.9500	13.20	13.4	8.1	9.4	7.5	9.8	7.0	3.0	5.2	5.3	8.1	11.1	12.2
22W	35-5610	MINAM 7 NE	3615	117.6000	45.6833	26.82	14.0	9.2	9.1	6.8	8.2	6.4	2.5	4.0	5.7	8.2	12.2	13.8
23W	35-5711	MONUMENT 2	1995	119.4167	44.8167	13.12	12.3	7.5	9.1	8.1	11.1	7.5	3.2	4.7	5.6	8.0	11.1	11.6
24W	35-5734	MORO	1870	120.7167	45.4833	10.58	14.7	8.8	10.0	6.4	7.8	5.8	2.2	3.9	4.5	6.6	14.3	14.9
25W	35-6468	PARKDALE 2 SSE	1890	121.5833	45.5000	44.97	18.5	11.4	11.3	6.1	4.3	2.8	0.6	2.2	3.6	8.1	13.9	17.1
26W	35-6540	PENDLETON BRCH EXP S	1487	118.6333	45.7167	15.68	13.6	8.5	9.9	8.7	8.8	6.0	2.2	4.1	4.8	7.7	12.0	13.7
27W	35-6546	PENDLETON WSO AP	1492	118.8500	45.6833	11.73	14.7	9.3	9.0	7.8	9.4	5.2	2.4	4.2	4.7	7.5	11.8	14.2
28W	35-6634	PILOT ROCK 1 SE	1720	118.8167	45.4833	13.63	12.3	7.9	9.8	9.4	9.5	7.6	2.1	5.2	5.9	8.0	10.6	11.7
29W	35-8000	SPOUT SPGS SKI LODGE	5035	118.0500	45.7500	35.38	15.5	10.3	10.5	8.5	6.5	4.7	1.4	3.3	5.0	7.1	11.8	15.2
30W	35-8407	THE DALLES	102	121.2000	45.6000	13.51	20.3	11.3	10.7	4.4	3.4	2.1	0.9	2.4	3.1	7.1	14.7	19.6
31W	35-8726	UKIAK	3355	118.9333	45.1333	16.77	13.0	7.5	8.2	7.3	10.0	7.0	4.0	4.7	5.8	8.3	11.8	12.3
32W	35-8746	UNION EXP STA	2765	117.8833	45.2167	13.74	9.3	5.8	8.0	8.2	13.2	11.1	3.9	6.5	7.7	8.2	8.9	9.2
33W	35-8985	WALLA WALLA 13 ESE	2400	118.0500	46.0000	41.77	14.8	10.1	10.9	8.9	6.6	4.9	1.3	3.1	5.2	7.9	13.1	13.2
34W	35-9068	WASCO	1264	120.7000	45.5833	11.01	15.8	9.4	10.0	6.3	5.8	4.9	2.1	3.6	4.2	7.4	15.2	15.4
35W	35-9219	WESTON 5 ESE	3200	118.3333	45.8000	26.09	13.3	8.3	9.2	8.4	8.5	6.5	2.0	4.3	5.7	8.6	11.8	13.4
36W	45-217	APPLETON	2336	121.2667	45.8167	31.50	20.2	11.2	11.2	4.4	3.4	1.8	0.7	1.9	3.3	7.7	14.9	19.2
37W	45-294	ASOTIN 14 SW	3500	117.2500	46.2000	19.20	13.7	9.3	9.7	7.2	8.0	7.0	2.6	4.1	5.1	7.7	11.9	13.8
38W	45-668	BICKLETON	3000	120.3000	46.0000	13.93	18.2	11.5	9.5	5.3	5.7	4.2	1.7	2.6	3.4	6.0	14.9	17.0
39W	45-969	BUMPING LAKE	3440	121.3000	46.8667	36.90	17.6	10.7	9.7	5.8	4.1	3.4	1.5	2.5	3.6	8.0	15.4	17.8
40W	45-1350	CHELAN	1120	120.0333	47.8333	10.31	13.2	9.6	8.2	8.3	5.3	5.3	2.4	5.7	4.3	7.4	13.8	16.4
41W	45-1400	CHIEF JOSEPH DAM	820	119.6500	48.0000	9.45	11.7	11.3	8.6	7.0	6.6	7.0	1.7	5.6	3.7	6.6	12.7	17.6
42W	45-1504	CLE ELUM	1930	120.9500	47.1833	24.65	18.3	10.8	9.1	5.7	3.2	2.8	1.2	2.6	4.3	7.3	15.4	19.3
43W	45-1586	COLFAX 1 NW	1955	117.3833	46.8833	19.29	13.3	9.6	9.6	7.8	7.4	6.8	2.6	4.1	4.9	7.3	11.7	15.0
44W	45-1690	CONNEL 1 W	1020	118.8833	46.6667	7.58	11.5	9.6	8.2	6.9	8.8	6.2	2.8	4.6	3.7	7.9	14.0	15.8
45W	45-1691	CONNEL 12 SE	1078	118.7667	46.5000	9.45	12.3	9.3	9.0	5.9	8.4	7.2	2.3	5.2	4.2	7.6	13.3	15.2
46W	45-1767	COULEE DAM 1 SW	1700	119.0000	47.9500	10.08	11.1	8.3	7.3	7.0	10.7	6.8	3.5	5.2	4.5	6.3	13.1	16.1
47W	45-1968	DALLESPORT FAA AP	240	121.1500	45.6167	12.75	20.7	10.9	9.5	3.7	3.2	1.8	0.7	2.3	2.9	6.9	16.0	21.4
48W	45-2007	DAVENPORT	2460	118.1500	47.6500	15.10	12.8	9.2	9.2	6.4	8.7	6.2	3.2	4.6	5.0	6.6	13.6	14.4
49W	45-2030	DAYTON 1 WSW	1557	118.0000	46.3167	18.16	13.5	8.7	10.6	7.7	7.3	5.9	2.1	4.0	5.1	7.6	12.4	15.1
50W	45-2505	ELLENSBURG	1480	120.5500	46.9667	9.47	15.2	9.0	8.8	6.8	6.3	6.4	1.8	4.1	4.1	6.7	13.6	17.2
51W	45-2542	ELTOPIA 8 WSW	700	119.1667	46.4000	8.09	13.1	10.0	7.8	6.2	8.4	7.0	1.7	5.4	3.8	7.4	12.7	16.3
52W	45-2614	EPHRATA FAA AP	1259	119.5167	47.3167	7.11	13.2	9.6	9.3	6.5	6.5	6.8	3.0	3.4	4.2	7.5	13.1	17.2
53W	45-3183	GLENWOOD 2	1850	121.2833	46.0000	35.06	20.0	11.2	11.5	4.6	3.2	1.9	0.6	1.9	3.1	7.8	15.6	18.5
54W	45-3226	GOLDENDALE 2 E	1800	120.7667	45.8167	16.39	18.4	11.2	9.5	5.4	4.5	3.5	1.7	2.1	3.5	6.4	15.6	18.2
55W	45-3502	HARRINGTON 5 S	2170	118.2500	47.4167	12.18	12.5	9.5	8.5	7.1	9.0	5.9	2.8	4.3	4.6	7.7	14.2	13.8
56W	45-3512	HARRINGTON 4 ENE	2266	118.1833	47.4833	12.82	12.5	9.4	8.6	6.9	8.8	5.9	2.9	4.3	4.6	7.1	14.6	14.4
57W	45-3529	HARTLINE	1910	119.1000	47.6833	10.38	11.9	8.1	8.1	6.8	8.5	6.9	3.9	4.1	4.5	6.7	14.5	15.9
58W	45-3546	HATTON 9 ESE	1430	118.6500	46.7500	9.79	12.5	9.5	8.9	6.8	8.5	5.8	2.3	5.0	4.0	8.0	13.6	15.1
59W	45-3883	ICE HARBOR DAM	368	118.8667	46.2500	9.07	12.6	8.7	8.4	6.1	8.7	7.7	1.9	4.6	4.5	7.5	13.3	16.0
60W	45-4077	KAHLOTUS 5 SSW	1550	118.6000	46.5833	10.43	12.4	9.2	8.9	6.9	8.3	7.4	2.6	4.1	4.2	7.5	13.3	15.1
61W	45-4154	KENNEWICK	390	119.1000	46.2167	7.35	15.1	9.1	7.9	6.1	8.3	5.3	1.6	5.2	4.6	7.5	13.2	16.1
62W	45-4338	LA CROSSE	1480	117.8833	46.8167	13.33	13.8	9.8	8.9	6.7	7.0	6.1	3.1	4.7	4.5	7.1	12.8	15.6
63W	45-4394	LAKE CLE ELUM	2250	121.0667	47.2444	37.27	20.4	11.1	8.0	4.9	2.7	2.2	0.9	2.0	3.8	8.8	15.5	19.6
64W	45-4406	KACHESS	2270	121.2000	47.2667	52.84	18.7	11.4	9.0	5.6	3.2	2.7	1.2	2.2	4.1	8.5	14.7	18.8
65W	45-4414	KEECHLEUS	2475	121.3389	47.3222	69.03	17.7	10.8	9.3	5.9	3.4	2.7	1.1	2.1	4.6	8.8	14.9	18.6
66W	45-4679	LIND 3 NE	1630	118.5833	47.0000	9.18	11.9	9.5	8.2	6.9	8.3	7.1	2.9	4.7	4.8	7.7	13.8	14.3
67W	45-4971	MANSFIELD 7 W	2500	119.8000	47.8167	10.54	12.5	8.8	8.2	7.0	7.3	6.6	2.5	5.5	3.8	6.9	13.4	17.5
68W	45-5231	MC NARY DAM	361	119.3000	45.9500	7.33	14.5	9.4	8.0	6.5	7.6	4.8	1.9	4.4	4.2	8.2	13.9	16.5
69W	45-5325	METHOW 2	1160	120.0000	48.0000	10.59	13.0	10.1	8.0	7.6	6.3	5.6	2.1	5.7	4.1	6.9	13.5	17.1
70W	45-5326	METHOW 2 S	1170	120.0167	48.1000	10.93	13.2	10.4	7.9	7.6	6.4	5.3	1.9	5.7	4.1	6.8	13.5	17.2
71W	45-5387	MILL CREEK DAM	1175	118.2667	46.0833	17.82	12.2	8.1	9.7	8.8	9.0	5.5	2.7	4.4	5.7	7.8	12.7	13.4
72W	45-5613	MOSES LAKE	1070	119.3000	47.1000	7.46	11.9	8.7	8.2	6.4	8.7	7.2	2.8	4.3	4.8	7.2	13.3	16.4
73W	45-5659	MT.ADAMS RANGER STA	1960	121.5333	46.0000	43.64	19.9	11.2	11.8	4.8	3.0	2.0	0.5	1.8	3.1	8.0	16.0	18.0
74W	45-5688	MOXEE CITY 10 E	1550	120.1667	46.5167	7.79	11.7	8.6	8.9	8.0	8.1	7.4	3.0	6.7	5.3	7.8	11.8	12.8
75W	45-5832	NESPELEM 2 S	1090	118.9833	48.1333	12.68	11.4	8.0	7.2	7.0	9.9	6.9	3.5	4.5	5.0	7.2	13.2	16.3
76W	45-6039	ODESSA	1540	118.6833	47.3333	9.72	12.9	9.1	9.2	6.4	9.4	5.8	2.6	3.8	4.6	6.7	14.4	15.3
77W	45-6215	OTHELLO 6 ESE	1190	119.0500	46.8000	7.82	13.6	10.9	8.2	6.3	7.8	7.4	2.6	3.8	4.0	6.9	13.6	15.1
78W	45-6610	POMEROY	1810	117.6167	46.4667	15.44	13.3	9.0	10.0	7.1	7.8	7.5	2.7	5.1	4.7	7.5	11.3	14.1
79W	45-6747	PRIEST RAPIDS DAM	460	119.9000	46.6500	6.67	13.9	9.6	9.4	6.9	6.6	5.7	1.9	4.5	4.0	7.3	13.2	16.8
80W	45-6768	PROSSER 4 NE	903	119.7500	46.2500	7.68	12.6	8.7	7.2	7.8	9.0	7.4	2.9	4.2	4.3	8.3	12.9	14.7
81W	45-6789	PULLMAN 2 NW	2545	117.2000	46.7667	21.95	13.8	9.7	9.5	7.1	7.0	7.0	2.3	4.3	4.6	7.7	12.8	14.3
82W	45-6880	QUINCY 1 S	1274	119.8500	47.2167	7.95	11.2	9.7	9.6	7.7	6.7	5.8	2.8	4.2	5.0	7.5	13.7	16.2
83W	45-7015	RICHLAND	373	119.2667	46.3167	6.55	14.4	10.7	8.1	6.0	7.9	5.6	1.8	5.2	4.3	6.1	13.4	16.5
84W	45-7038	RIMROCK RESERVOIR	2730	121.1333	46.6500	24.72	19.5	10.7	8.7	5.4	3.2	2.7	1.7	2.9	3.0	7.7	15.2	19.3
85W	45-7059	RITZVILLE 1 SSE	1830	118.3667	47.1167	11.20	12.2	10.0	8.5	7.0	7.7	6.6	3.1	3.9	4.8	7.4	13.7	15.1
86W	45-7180	ROSALIA	2400	117.3667	47.2333	16.98	13.3	9.1	8.8	7.5	8.3	7.5	2.6	4.8	4.9	7.4	12.2	13.6
87W	45-7267	ST JOHN	1945	117.5833	47.1000	15.06	13.9	8.8	9.3	7.7	8.0	6.6	2.9	4.6	4.8	7.2	11.9	14.3
88W	45-7342	SATUS PASS 2 SSW	2610	120.6500	45.9500	19.28	19.4	11.7	9.3	4.9	4.1	3.3	1.5	1.9	3.3	6.4	15.6	18.6
89W	45-7727	SMYRNA	560	119.6667	46.8333	7.87	14.2	10.3	9.0	6.1	6.5	6.1	2.0	4.7	4.4	6.5	13.1	17.0
90W	45-7938	SPOKANE WSO AP	2356	117.5333	47.6333	16.61	14.3	9.8	8.7	6.4	8.3	7.7	2.6	4.3	4.0	6.4	12.8	14.6
91W	45-7956	SPRAGUE	1920	117.9833	47.3000	14.75	13.9	9.5	8.5	7.2	7.8	5.8	3.1	4.4	4.1	7.1	14.0	14.6
92W	45-8009	STAMPEDE PASS WSCMO	3958	121.3333	47.2833	94.53	16.3	10.7	9.3	6.7	4.1	3.9	1.6	3.1	5.1	8.8	13.6	16.8
93W	45-8207	SUNNYSIDE	747	120.0000	46.3167	6.44	14.6	8.9	7.3	7.9	8.1	5.3	2.3	4.5	5.4	7.5	12.4	15.8
94W	45-8442	TIETON HEADWORKS	2280	121.0000	46.6711	20.26	18.7	11.0	8.8	6.6	4.2	3.6	2.3	2.8	2.9	6.4	13.8	19.1
95W	45-8931	WALLA WALLA WSO CI	949	118.3333	46.0333	15.91	12.9	8.9	9.0	8.0	9.6	5.3	2.3	4.5	5.3	7.9	12.0	14.3
96W	45-8959	WAPATO	841	120.4167	46.4333	7.82	14.1	9.5	9.1	7.3	7.5	6.4	2.8	4.3	4.7	7.4	12.5	14.3
97W	45-9012	WATERVILLE	2620	120.0667	47.6500	10.38	13.1	9.8	8.0	7.2	6.3	6.0	2.2	6.4	4.0	7.1	13.3	16.6
98W	45-9058	WELLPINIT	2490	118.0000	47.9000	15.78	12.5	9.6	9.3	6.3	8.8	6.0	3.4	4.8	4.2	6.5	13.6	14.8
99W	45-9079	WENATCHEE EXP STA	800	120.3500	47.4333	11.69	14.7	9.9	8.8	6.8	5.4	4.9	1.8	4.7	4.4	7.3	14.4	16.9
100W	45-9082	WENATCHEE FAA AP	1229	120.2000	47.4000	10.75	14.3	9.8	8.8	7.2	5.8	5.3	2.0	4.9	4.4	7.3	13.7	16.6
101W	45-9200	WHITMAN MISSION	632	118.4500	46.0500	15.56	13.1	8.3	9.1	8.0	9.3	5.9	2.6	4.8	5.5	7.8	12.0	13.6
102W	45-9238	WILBUR	2160	118.7000	47.7500	11.14	12.1	8.6	8.4	6.4	9.7	6.2	3.6	4.7	4.6	6.7	13.9	15.1
103W	45-9465	YAKIMA WSO AP	1064	120.5333	46.5667	9.14	15.0	9.7	9.0	7.1	6.8	6.2	2.4	4.0	4.4	7.2	12.7	15.4

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By
L. M. Nelson

1991