

ESTIMATES OF GROUND-WATER RECHARGE TO THE COLUMBIA PLATEAU
REGIONAL AQUIFER SYSTEM, WASHINGTON, OREGON, AND IDAHO,
FOR PREDEVELOPMENT AND CURRENT LAND-USE CONDITIONS

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Table 5.--Summary of estimated recharge and data used for predevelopment and current land-use conditions

Zone refer- ence number	Average precipi- tation	Average current irriga- tion	Average potential evapotrans- piration	Average actual		Average stream discharge		Average recharge	
				evapotranspiration					
				Predevel- opment	Current	Surface runoff	Base flow	Predevel- opment	Current
1	7.29	23.74	43.06	6.74	18.56	*0.06	0	0.43	12.27
2	8.91	.32	35.93	7.62	7.83	.10	0	1.25	1.35
3	9.34	.29	39.92	7.75	7.97	*.13	0	1.37	1.45
4	6.61	0	42.45	6.09	6.09	*.07	0	.38	.38
5	8.77	0	36.14	7.54	7.54	*0	0	1.18	1.18
6	8.64	.67	37.32	7.66	8.07	.12	0	.66	.93
7	8.26	0	39.43	6.62	6.66	.19	0	1.31	1.29
8	6.95	.23	41.89	6.61	6.73	*0	0	.30	.29
9	7.64	6.50	38.92	7.24	12.47	.10	0	.43	1.56
10	7.93	0	40.25	7.39	7.47	*0	0	.45	.41
11	7.76	0	41.49	7.24	7.28	*0	0	.44	.43
12	7.41	22.02	41.72	7.28	22.11	.07	0	.15	7.26
13	8.19	9.86	42.15	7.66	15.13	*0	0	.47	2.83
14	7.95	7.20	42.82	7.36	11.56	.14	0	.23	2.83
15	6.98	2.73	40.56	6.52	9.23	.16	.04	.13	.66
16	8.31	4.30	40.56	7.71	10.68	*.16	0	.39	1.78
17	8.09	5.31	41.19	7.39	11.54	*.40	0	.26	1.50
18	12.05	.13	40.47	8.64	8.75	2.44	1.29	1.30	1.33
19	10.09	0	40.71	8.57	8.54	1.26	1.20	.83	.87
20	9.19	1.48	41.04	7.49	8.77	.76	.06	.87	1.16
21	17.27	.08	36.16	9.92	10.00	3.61	3.15	5.39	5.39
22	22.75	1.83	28.69	10.58	11.65	3.56	5.08	10.52	11.11
23	22.32	0	36.13	14.05	14.05	2.82	3.55	6.01	6.00
24	9.64	2.51	44.24	9.19	11.64	.13	0	.57	.51
25	10.33	1.54	43.43	8.92	10.68	*0	0	1.36	1.20
26	12.61	.77	41.32	10.24	11.13	.29	.32	2.30	2.11
27	12.54	.27	41.32	10.24	10.90	.65	.25	1.68	1.35
28	10.05	.11	39.09	8.75	9.10	.07	0	1.16	1.01
29	21.80	0	37.45	14.37	14.94	4.30	1.70	3.51	2.97
30	10.09	1.62	41.64	8.41	9.71	*.22	0	1.42	1.81
31	8.69	3.92	42.49	7.91	10.81	*0	0	.73	1.79
32	7.78	30.15	41.41	7.11	19.08	*.05	0	.58	18.71
33	11.12	17.43	34.73	8.33	18.71	*0	0	2.74	9.72
34	10.24	3.59	43.09	8.89	12.01	*.25	0	1.04	1.58
35	8.94	3.96	44.78	8.23	10.68	.28	0	.24	1.86
36	10.26	0	40.00	8.93	9.32	*.11	0	1.17	.85
37	24.30	0	27.92	11.71	11.71	3.32	9.24	10.65	10.65
38	8.24	6.82	44.9	8.06	13.89	.10	0	.13	1.21
39	22.42	0	34.5	16.03	16.54	2.39	2.28	4.13	2.79
40	8.15	18.64	40.41	7.32	16.30	*.21	0	.57	10.07

Table 5.--Summary of estimated recharge and data used for predevelopment and current land-use conditions--Con.

Zone reference number	Average precipitation	Average current irrigation	Average potential evapotranspiration	Average actual evapotranspiration		Average stream discharge		Average recharge	
				Predevelopment	Current	Surface runoff	Base flow	Predevelopment	Current
41	8.04	21.02	41.71	7.13	17.10	*.04	0	.82	11.89
42	9.12	1.99	44.55	8.14	9.76	*.07	0	.84	1.30
43	9.04	1.97	42.47	9.04	11.02	*0	0	.01	.01
44	8.61	26.68	39.91	8.09	25.10	*0	0	.44	10.33
45	18.28	.37	38.75	12.33	13.18	3.16	1.54	3.30	2.93
46	21.06	0	38.51	12.64	12.98	2.11	4.06	6.79	6.50
47	16.49	.84	42.98	12.89	13.91	2.40	1.86	1.53	1.55
48	20.96	0	36.21	15.59	14.84	2.57	0	2.98	3.65
49	12.93	5.20	40.13	11.45	14.53	*.02	0	1.45	3.33
50	37.65	.28	35.72	15.08	15.53	10.05	24.47	15.06	15.19
51	11.35	.66	41.21	11.15	11.81	*0	0	.29	.29
52	11.34	.15	41.85	10.01	9.58	.46	0	.90	1.63
53	8.93	23.84	37.60	8.03	20.73	*0	0	.84	11.15

*Stream runoff assumed to be zero from all land surfaces within the zone; however, the presence of surface-water bodies results in surface-runoff output for those areas during model simulations.

Table 6.--Estimated recharge for predevelopment and current land-use conditions in the modeled zones

Land use	Area ¹ (square miles)	Predevelopment recharge		Area (square miles)	Current recharge	
		Cubic feet per second	Inches per year		Cubic feet per second	Inches per year
Forest	1,841	1,031	7.61	1,841	1,033	7.62
Grass	10,129	831	1.11	3,095	283	1.24
Sage	8,256	468	.77	5,490	409	1.01
Irrigated winter wheat			.00	820	1,192	19.72
Dryland winter wheat			.00	6,639	362	.74
Orchard (irrigated)			.00	210	183	11.88
Alfalfa (irrigated)			.00	1,202	1,179	13.32
Row crops (irrigated)			.00	425	710	22.66
Water	108		.00	230	0	.00
Corn (irrigated)			.00	152	129	11.54
Potato (irrigated)			.00	178	197	14.95
Sand/barren	102	13	1.77	91	12	1.74
Pea-lentil			.00	36	6	2.32
Dryland spring wheat			.00	26	2	1.27
Totals for modeled zones	20,436	2,343		20,436	5,697	
Area-weighted averages for modeled zones			1.56			3.79

¹Area based on the constant-model cell size as listed in Appendix A except for zones 43, 47, and 51; these zones had a slightly variable cell size, which was used in the calculations of area.

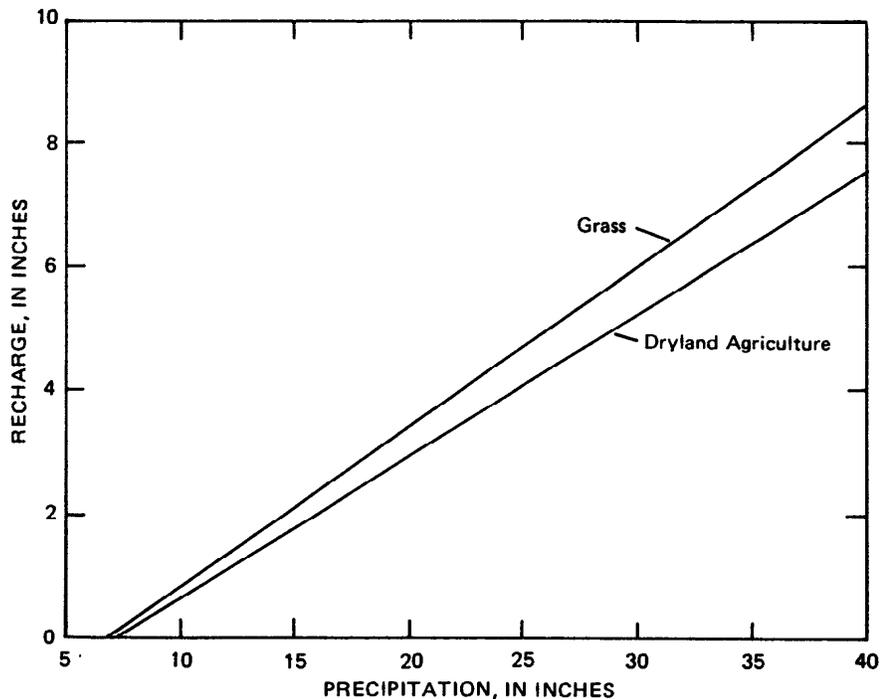


Figure 6.--Regression relations between estimated recharge and precipitation for two land uses.

Estimated recharge ranges widely over the project area, from 0.0 to about 30 in./yr for predevelopment conditions and from 0.0 to about 54 in./yr for current conditions. The highest predevelopment estimated recharge rates are in areas of high altitude (up to 6,000 feet), particularly along the west and southwest margins of the project area where precipitation is high (as much as 45 in./yr) and potential evapotranspiration is low (as low as 27 in./yr). Areas of little or no estimated recharge occur near the central part of the study area where land surface is only a few hundred feet above sea level, where precipitation is as low as 6.0 in./yr, and potential evapotranspiration is as high as 44 in./yr. Generally, estimated recharge rates parallel the precipitation amounts in areas of high precipitation (fig. E, plate 1). In areas of low precipitation, estimated recharge is generally small, but is less closely related to precipitation than in the areas of high precipitation. The cause of this effect will be discussed later.

Regression Estimates

Because streamflow and (or) soils data were not available for large parts of the study area, alternative methods for estimating recharge within the ground-water model boundaries were developed.

Linear regression of estimated predevelopment recharge versus the 1956-77 average annual precipitation for all cells of all the modeled zones produced a good correlation coefficient of 0.90. The plotted values of estimated predevelopment recharge versus average annual precipitation, however, showed a definite upward-curving trend.

A regression equation based on a second-order polynomial for all data was tested and had a slightly better correlation coefficient of 0.92. (The regression estimates and statistics on the cell data are given in table 7.)

Table 7.--Statistics and regressions for estimated predevelopment recharge and mean annual precipitation for all modeled zones

Statistics of recharge computed at cells			
		<u>Percentile</u>	<u>Cell recharge</u>
Number of cells	29,759	10	0.00
Number of cells with water	229	20	.09
Number of cell data points	29,530	30	.21
Maximum cell recharge	29.68	40	.36
Minimum cell recharge	.0	50	.56
Mean cell recharge	1.82	60	.84
Mean cell precipitation	11.43	70	1.34
Median cell precipitation	8.94	80	2.35
Maximum cell precipitation	45.43	90	4.63
Minimum cell precipitation	5.0		

Regression parameters for estimated recharge versus mean annual precipitation:		
	<u>Linear regression</u>	<u>Second-order polynomial regression</u>
Correlation coefficient	0.90	0.92
Recharge intercept at zero precipitation	-3.72 inches	-1.28 inches
Precipitation intercept ¹ at zero recharge	7.67 inches	6.49 inches
Slope	.48	Not applicable
<u>Slope parameters</u>	<u>Not applicable</u>	0.1416 0.00865 0.263 0.053

¹Recharge is zero for values of precipitation below this value.

The polynomial regression equation was chosen to estimate recharge for predevelopment and current land-use conditions for the nonmodeled area. The nonmodeled areas generally had average annual precipitation greater than 11 inches. The correlation is even better in this higher precipitation range. For example, the linear correlation coefficient between estimated recharge and average annual precipitation is only 0.35 for less than 11.0 inches of precipitation, but is 0.65 between 11.0 and 22.0 inches of precipitation.