USGS
science for a changing world

Prepared in cooperation with the USDA Forest Service, Bureau of Land Management, and the Oregon Water Resources Department

Floods of November 1996 through January 1997 in the Umpqua River Basin, Oregon

Background

During November 1996 through January 1997, a series of storms caused flooding throughout southeastern Oregon, northern California, and parts of Nevada. In Oregon's Umpqua River Basin (fig. 1) the most significant flooding occurred on November 18–19, December 4–9, and January 1–2. The combination of heavy rains, snowmelt, saturated soils, and flooding also resulted in debris flows and landslides. Four people were killed by a debris flow on November 18, 1996, near Rock Creek, a tributary to Hubbard Creek near Millwood. Over the 3-month period, flooding and land disturbances caused over $11 million in damage to public and private property within the Umpqua River drainage basin (Mikeal Jones, USDA Forest Service, Umpqua National Forest, Roseburg, Oregon, written commun., 2004; Lowell Duell, Bureau of Land Management (BLM), Roseburg District, Roseburg, Oregon, written commun., 2004; Wayne Stinson, Douglas County, Sheriff's Office, Roseburg, Oregon, written commun., 2004). The Umpqua National Forest and Oregon State highways within Douglas County incurred over $4 million and $3 million in damage, respectively. Damage to BLM lands, local municipal infrastructure, and private property were each over $1 million.

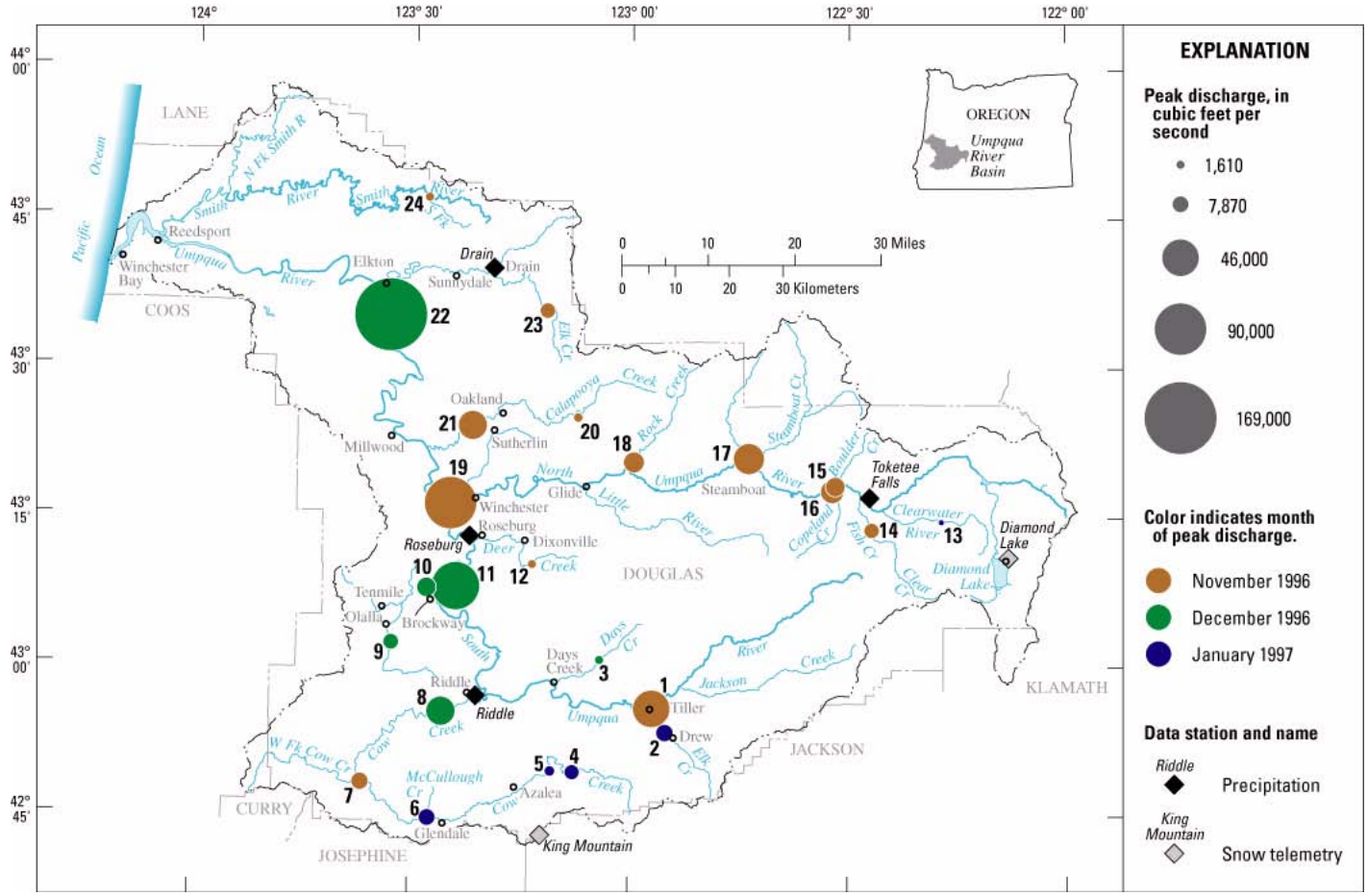

Figure 1. Locations of selected stream-gaging and meteorological stations in the Umpqua River Basin, Oregon. (Stream-gaging-station site numbers refer to table 2.)

November Floods

Flooding on November 18-19 was caused by heavy rains that fell on many locations throughout the Umpqua River Basin (table 1). The rains resulted from the convergence of a broad upper-air weather system of moist subtropical air, which originated over the tropical Pacific, and a cold-air mass over Washington (fig. 2). Roseburg received a record 4.35 inches of rainfall in a single day, which surpassed the previous record of 3.28 inches set in 1965. Prior to the storm, soil moisture and precipitation levels throughout the basin were already above average. October 1996 precipitation amounts at Drain, Roseburg, Riddle, and Toketee Falls were 178–215 percent of average.

Most of the precipitation during the period of November 17–19 was rainfall. Air temperature and snowpack data collected at the King Mountain and Diamond Lake snow telemetry (SNOTEL) stations indicated that there was no significant snow accumulation. These stations, operated by the U.S. Department of Agriculture Natural Resources Conservation Service, are located at 4,000 and 5,200 feet elevation, respectively. Because the storm event occurred prior to the winter season and there was no preexisting snowpack at either of these two stations, snowmelt did not provide a significant contribution to the flooding.

Although precipitation from the November 17–19 storm was broadly distributed over the entire Umpqua River Basin, flooding in the North Umpqua River Basin was more severe than flooding in the South Umpqua River Basin (table 2), possibly due to differing antecedent conditions. The recurrence interval for the November peak discharges within the entire basin ranged from less than 2 years to more than 50 years. A 50-year flood has a magnitude that would be expected to occur every 50 years, on average. Such a flood has a 2 percent chance of being equalled or exceeded in any given year. The November flood for Boulder Creek near Toketee Falls (14316495) had an unusually high magnitude in comparison to the other basins. The event had a greater than 50-year recurrence and a unit discharge of 372 cubic feet per second per square mile.

Table 1: Daily precipitation, in inches, for principal storms from November 1996 through January 1997 at selected locations, Umpqua River Basin, Oregon.

Date	Drain[1]	Roseburg[1]	Riddle[1]	Toketee Falls[1]	King Mountain[2]	Diamond Lake[2]
			ELEVATION (FEET)			
....	290	420	680	2,060	4,000	5,200
			LATITUDE			
....	43 40 00	43 13 00	42 57 00	43 17 00	42 43 00	43 11 00
			LONGITUDE			
....	123 19 00	123 22 00	123 21 00	122 27 00	123 12 00	122 08 00
			NOVEMBER 1996 FLOODS			
11/16/1996	0.21	0.06	0.09	0.2	0	0.2
11/17/1996	0.33	0.13	0.02	0.04	0.5	0.4
11/18/1996	1.59	1.8	0.87	5.11	5.8	7.5
11/19/1996	5.92	4.35	2.3	2.01	2.4	2
			DECEMBER 1996 FLOODS			
12/3/1996	0.49	0.53	0.31	0.17	0.3	0.5
12/4/1996	0.06	0.03	0.02	1.8	2.2	2.5
12/5/1996	2.22	1.97	1.39	0.89	0.3	0.9
12/6/1996	0.64	0.82	0.88	0.65	0.5	0.9
12/7/1996	0.61	0.23	0.17	1.03	3.3	1.6
12/8/1996	2.3	3.53	2.75	2.19	4.2	1.6
12/9/1996	0.97	1.57	2.02	0.87	1.2	1.2
			JANUARY 1997 FLOODS			
12/28/1996	0.18	0.03	0.14	0.65	1.3	1
12/29/1996	0.92	0.62	0.81	1.37	2.2	1.2
12/30/1996	1.09	0.18	0.94	1.18	2.8	2
12/31/1996	1.22	0.85	1.34	0.81	3	1.6
1/1/1997	1.14	1.01	1.51	2.4	3.4	2.6
1/2/1997	0.66	0.4	0.73	0.97	1.2	1.3
1/29/1997	0.01	0.02	0	0	0.3	0.2
1/30/1997	0	0	0.02	0.73	0	1.1
1/31/1997	1.63	0.05	0.3	1.33	0.9	1.3

[1] Source: Oregon Climate Service, Corvallis, Oregon.
[2] Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Portland, Oregon.

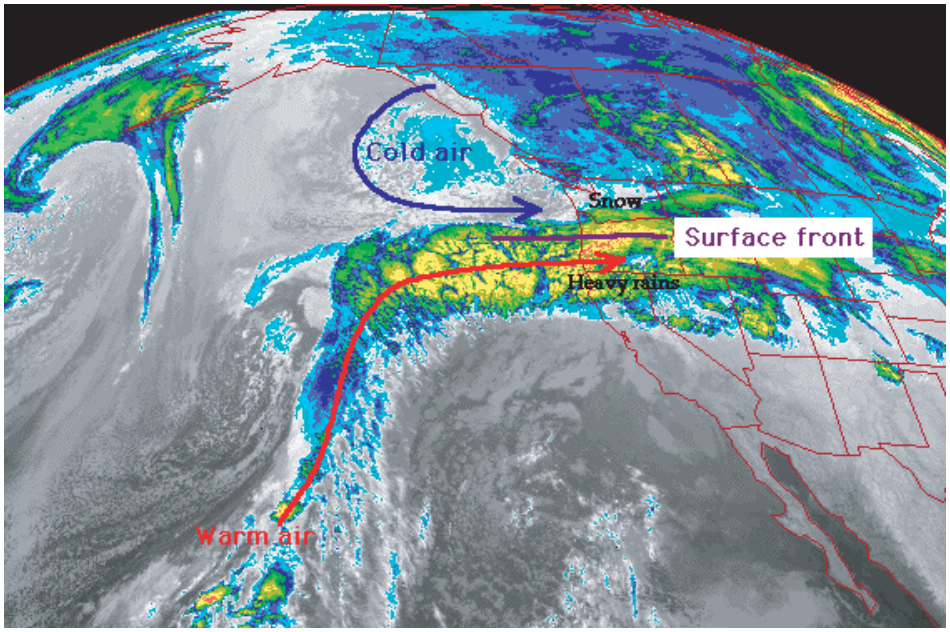

Figure 2. Infrared satellite photograph for November 18, 1996, showing subtropical jet stream bringing moisture from the southwest, and a cold air mass over Washington. (Photograph courtesy of the Oregon Climate Service, Corvallis, Oregon).

Table 2: Peak discharge, peak stage, and recurrence intervals for November 1996–January 1997 floods at selected sites, Umpqua River Basin, Oregon.

[no.number; fig., figure; USGS, U.S. Geological Survey; mi^2, square miles; ft^3/s, cubic feet per second; flood events in red print are the annual peaks for water year 1997]

Site no. (fig. 1)	USGS station number	Station name	Drainage area (mi^2)	Flood frequency period of record	November 1996 Flood				Site no. (fig. 1)	December 1996 Floods								100-year peak discharge (ft^3/s)		
					Date	Peak discharge (ft^3/s)	Peak stage (feet)	Recurrence interval (years)		Date	Peak discharge (ft^3/s)	Peak stage (feet)	Recurrence interval (years)	Date	Peak discharge (ft^3/s)	Peak stage (feet)	Recurrence interval (years)	Date	Magnitude (ft^3/s)	
1	14308000	South Umpqua River at Tiller	449	1911, 1940–2002	[1]11/18/1996	[1]46,000	[1]22.17	[1]>25	1	12/4/1996	27,500	17.2	<5	1/1/1997	31,700	18.45	<10	58,890	12/22/1964	60,200
2	14308500	Elk Creek near Drew	54.4	1955–1982; 1987–2002	11/18/1996	4,810	8.8	<5	2	12/8/1996	5,000	9.02	>5	[1]1/1/1997	[1]8,550	[1]10.87	[1]<25	13,310	1/9/1995	9,120
3	14308685	Days Creek above May Creek near Days Creek	13	1985–2002	11/18/1996	1,610	3.79	<25	3	[1]12/8/1996	[1]1,730	[1]3.88	[1]<25	1/1/1997	691	2.84	<5	3,118	12/8/1996	1,730
4	14308990	Cow Creek above Galesville Reservoir near Azalea	64.7	1986–2002	11/18/1996	3,010	7.81	<5	4	12/8/1996	4,900	10.01	<10	[1]1/1/1997	[1]6,130	[1]11.25	[1]<25	10,070	1/9/1995	6,980
5	14309000	Cow Creek near Azalea[2]	78	1928–1931; 1933–1985	(3)	(3)	(3)	(3)	5	(3)	(3)	(3)	(3)	[1]1/2/1997	[1]2,490	[1]9.69	[1]<2	10,920	1/15/1974	10,600
6	14309220	Cow Creek below McCollough Creek near Glendale[4]	195.1	1986–2002	11/18/1996	2,160	7.68	<2	6	12/8/1996	7,560	14.56	>10	[1]1/1/1997	[1]7,870	[1]14.87	[1]>10	15,060	1/9/1995	7,970
7	14309500	West Fork Cow Creek near Glendale	86.9	1956–2002	[1]11/18/1996	[1]8,560	[1]13.2	[1]<5	7	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	15,540	12/22/1964	15,700
8	14310000	Cow Creek near Riddle	456	1955–2002	(3)	(3)	(3)	(3)	8	[1]12/8/1996	[1]27,400	[1]22.52	[1]>5	(3)	(3)	(3)	(3)	52,150	1/15/1974	38,400
9	14311200	Olalla Creek near Tenmile[5]	61.3	1980–2002	11/18/1996	1,810	5.45	<2	9	[1]12/8/1996	[1]6,780	[1]9.24	[1]<25	1/1/1997	2,350	6.45	>2	11,630	2/18/1983	6,970
10	14311500	Lookingglass Creek at Brockway	158	1956–2002	(3)	(3)	(3)	(3)	10	[1]12/8/1996	[1]11,300	[1]15.72	[1]<5	(3)	(3)	(3)	(3)	35,370	12/26/1955	35,000
11	14312000	South Umpqua River near Brockway	1,670	1906–1912; 1924–1927; 1942–2002	11/19/1996	60,500	24.63	<5	11	[1]12/8/1996	[1]76,300	[1]28.46	[1]>5	1/1/1997	64,500	25.48	<5	127,200	12/23/1964	125,000
12	14312170	South Fork Deer Creek near Dixonville	15.2	1990–2000	[1]11/18/1996	[1]1,720	[1]6.84	[1]<10	12	12/8/1996	1,460	6.33	>5	(3)	(3)	(3)	(3)	5,008	1/20/1996	1,910
13	14314500	Clearwater River above Trap Creek near Toketee Falls[6]	41.6	1928–2002	(3)	(3)	(3)	(3)	13	(3)	(3)	(3)	(3)	[1]1/1/1997	[1]968	[1]6.92	[1]>100	824	12/23/1964	1,020
14	14316000	Fish Creek at Big Fish Ranger Station near Toketee Falls[7]	68.8	1948–1955; 1957–2002	[1]11/18/1996	[1]6,390	[1]10.66	[1]<25	14	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	10,350	12/22/1964	12,100
15	14316495	Boulder Creek near Toketee Falls	30.4	1987–1993; 1995–2002	[1]11/18/1996	[1]11,300	[1]9.78	[1]>50	15	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	13,010	11/18/1996	11,300
16	14316500	North Umpqua above Copeland Creek near Toketee Falls[8]	475	1950–2002	[1]11/18/1996	[1]17,200	[1]14.56	[1]>10	16	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	34,380	12/22/1964	40,700
17	14316700	Steamboat Creek near Glide	227	1956–2002	[1]11/18/1996	[1]31,400	[1]19.54	[1]<25	17	12/8/1996	14,700	11.78	>2	1/1/1997	13,100	10.98	<2	40,910	12/22/1964	51,000
18	14317600	Rock Creek near Glide	97.4	1957–1973; 1981–2002	[1]11/18/1996	[1]13,200	[1]12.79	[1]>10	18	12/4/1996	7,130	9.74	>2	1/31/1997	3,860	7.47	<2	18,630	12/22/1964	22,800
19	14319500	North Umpqua River at Winchester[8]	1,344	1909–1913; 1924–1929; 1954–2002	[1]11/19/1996	[1]90,000	[1]27.6	[1]>10	19	12/8/1996	60,200	20.61	<5	1/1/1997	50,500	18.1	>2	129,400	12/22/1964	150,000
20	14319850	Gassy Creek near Nonpareil	9.19	1989–2000	[1]11/18/1996	[1]1,940	[1]6.59	[1]<25	20	12/8/1996	656	4.4	>2	(3)	(3)	(3)	(3)	3,032	11/18/1996	1,940
21	14320700	Calapooya Creek near Oakland	210	1956–1980; 1987–2001	[1]11/18/1996	[1]27,100	[1]21.62	[1]>25	21	12/8/1996	12,400	18.42	>2	1/1/1997	6,390	13.13	<2	34,980	11/18/1996	27,100
22	14321000	Umpqua River near Elkton	3,683	1906; 1908–2002	11/19/1996	162,000	38.41	<10	22	[1]12/9/1996	[1]169,000	[1]39.42	[1]>10	1/1/1997	127,000	33.14	<5	254,300	12/23/1964	265,000
23	14321400	Elk Creek near Elkhead	28.7	1987–1999	[1]11/18/1996	[1]6,670	[1]10.82	[1]<50	23	12/8/1996	2,420	7.79	<5	1/1/1997	945	5.86	<2	8,409	11/18/1996	6,670
24	14323085	Smith River near Drain	22.74	1981–1984; 1986–1989; 1992–2002	[1]11/19/1996	[1]1,750	[1]10.67	[1]>5	24	12/4/1996	1,110	7.47	>2	1/31/1997	995	6.89	<2	2,987	12/6/1981	2,040

[1] Flood events are the annual peaks for water year 1997.
[2] Water years 1986–2002 not used in frequency analysis due to Galesville Reservoir regulation.
[3] Months with no data did not have flood events.
[4] Site is partially affected by Galesville Reservoir regulation.
[5] Site is partially affected by Ben Irving Reservoir regulation.
[6] 200 ft^3/s diversion flow added to peak discharge values from 1984 to 2002. Prior to 1984 measured diversions were included in the annual peak flows.
[7] 150 ft^3/s diversion flow added to peak discharge values from 1984 to 2002. Prior to 1984 measured diversions were included in the annual peak flows.
[8] Site is partially affected by upstream lake and reservoir regulation.

Flooding on November 19, 1996 on the Calapooya River at the Rochester Bridge located on County Road 10-A near Sutherlin. (Photograph courtesy of Douglas County Department of Public Works, Roseburg, Oregon.)

December Floods

Most of the December flooding occurred early in the month in response to a series of storms. Precipitation for December 8 at Roseburg, Riddle, and King Mountain was 3.53, 2.75, and 4.2 inches, respectively (table 1). Unlike the November 16–19 storm, the December storms resulted in some snow accumulation at higher elevations. Precipitation for the period of December 3–9 contributed to both snowpack and runoff. The December flooding was more severe in the South Umpqua River Basin than the November flooding, which was more severe in the North Umpqua River Basin. The recurrence interval for the December peak discharges within the entire basin ranged from more than 2 to less than 25 years (table 2). Most of the peak discharges occurred on December 8.

Aerial view of flooding on the lower Umpqua River in December 1996. (Photograph by Jerry Redfern, Roseburg, Oregon, News Review; used by permission.)

January Floods

Another moist subtropical weather system brought steady rain starting around December 28 and continuing until January 2. Snowpack and air temperature data collected during this period at the King Mountain and Diamond Lake SNOTEL stations showed a net depletion of the preexisting snowpack.

Most of the January peak discharges occurred on January 1 within the Umpqua River Basin. However, a separate storm later in the month caused January peak discharges to occur on January 31 in some tributary creeks in the lower section of the Umpqua River. The recurrence interval for the January peak discharges ranged from less than 2 to more than 100 years (table 2).

This November 1996 debris flow along Hubbard Creek killed four people. Debris flows occur when soils saturated by extended heavy rainfall give way, carrying rocks and other debris, sometimes long distances. (Photograph by Amiran White, Roseburg, Oregon, News Review; used by permission.)

The most severe flooding occurred in the upland reaches of the South Umpqua River Basin. Although the magnitudes of the November floods at some sites were greater than those of the January floods, the January floods caused more damage. After 3 months of above average precipitation throughout the Umpqua River Basin, soils had become saturated by January, and conditions were more conducive to landslides and road failures than they were earlier in the season. Damage to roads and bridges within the Umpqua National Forest caused by the January floods were roughly equivalent to damage caused by the November and December floods combined (Mikeal Jones, USDA Forest Service, written commun., 2004).

Data Collection and Analyses

Streamflow data are crucial for real-time flood monitoring, emergency response, water-supply planning, dam and reservoir system operation, and engineering and maintenance of bridges, roads, and other structures. The U.S. Geological Survey (USGS) operates more than 20 stream-gaging and lake-level monitoring stations in the Umpqua River Basin. Douglas County, Oregon Water Resources Department, and the Bureau of Land Management also operate a total of about 15 stream-gaging stations. The stream-gaging stations selected for this analysis had minimal upstream regulation and an adequate stream stage-discharge relation. [1]

The technical method used to determine the recurrence interval of floods for almost all of the stream-gaging stations followed guidelines recommended by the U.S. Interagency Advisory Committee on Water Data (1982). Flood-frequency characteristics for stations with at least 10 years of record were calculated by fitting the logarithms of annual peaks to a Pearson Type III frequency distribution.

The period of record used in the flood frequency analysis, upstream drainage area, 100-year peak discharge, and date and magnitude of the largest historical peak discharge for each station are shown in table 2. The stations on Cow Creek below McCollough Creek near Glendale (14309220), Olalla Creek near Tenmile (14311200), Clearwater River above Trap Creek near Toketee Falls (14314500), Fish Creek at Big Creek Ranger Station near Toketee Falls (14316000), North Umpqua River above Copeland Creek near Toketee Falls (14316500) and at Winchester (14319500) had records that were partially affected by upstream reservoir regulation or diversions. More information on how the flood frequency analyses were made at these stations is described in table 2.

[1] **Stage-discharge relation** is the relation between the water-surface elevation, termed stage, and the volume of water flowing in a channel per unit time, termed discharge.

A mudslide on November 21, 1996, resulted in the collapse of a section of Interstate 5 along the South Umpqua River near Roseburg, Oregon. Damage to roads and bridges was widespread during the storms of November–January 1996–97. (Photograph by Christian Murdock, Roseburg, Oregon, News Review; used by permission.)

References Cited

U.S. Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency, Bulletin 17B of the Hydrology Subcommittee: Reston, Virginia, U.S. Geological Survey, Office of Water Data Coordination, 183 p.

Acknowledgements

This publication was produced in cooperation with the USDA Forest Service, Umpqua National Forest; Bureau of Land Management, Roseburg District; and the Oregon Water Resources Department Douglas County Watermaster. Special thanks for assistance from Mikeal Jones, Umpqua National Forest, and Elaine Youngquist, Public Works Department, Douglas County, Oregon.

By John C. Risley

Floodwater carried logs and other debris into backyards along the North Umpqua River near Winchester during the November 1996 floods. (Photograph by Jerry Redfern, Roseburg, Oregon, News Review; used by permission.)

For More Information

The U.S. Geological Survey has served the public and Federal, State, Tribal, and local governments since 1879 by collecting, analyzing, and publishing detailed information about the Nation's mineral, land, and water resources. For more information on water resources in Oregon:

Public Information Specialist
U.S. Geological Survey
10615 SE Cherry Blossom Drive
Portland, Oregon, 97216
tel: (503)251-3200
fax: (503) 251-3470
email: info-or@usgs.gov

Selected data and interpretive reports are available from the USGS Oregon District Web site: http://oregon.usgs.gov

The rising waters of South Myrtle Creek forced many residents to evacuate their homes. (Photograph by Christian Murdock, Roseburg, Oregon, News Review; used by permission.)