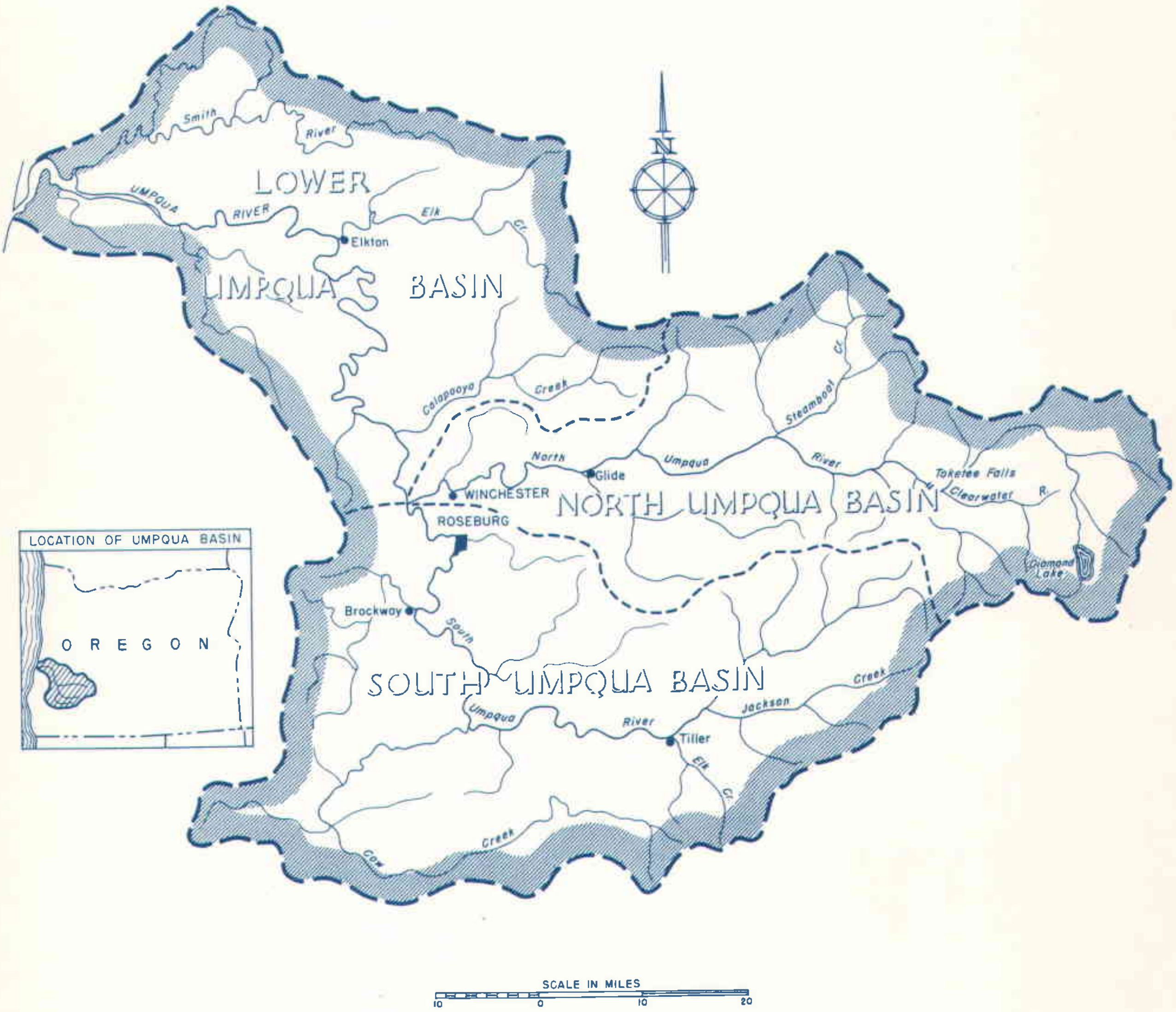
198

Some Water Problems and Hydrologic Characteristics of the UMPQUA BASIN

by G. L. HAYES and H. G. HERRING

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
U. S. DEPT. OF AGRICULTURE · FOREST SERVICE
JULY 1960

MAIN DRAINAGES *in the* UMPQUA BASIN



------ Major Drainage Divide

SOME WATER PROBLEMS AND
HYDROLOGIC CHARACTERISTICS
OF THE UMPQUA BASIN

by

G. L. Hayes and H. G. Herring

July 1960

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
R. W. Cowlin, Director Portland, Oregon

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

CONTENTS

INTRODUCTION

The Umpqua River, in southwestern Oregon, drains an area comprising an entire county in which water resources are inseparably related to economic and social development. The basic industries--timber, agriculture, recreation, mining, and commercial fishing--need adequate supplies of high-quality water for further development. Unfortunately, mankind and nature have joined in creating a number of watershed problems. If progress in utilization of the Basin's resources is to continue, a better understanding of these problems, their causes and the extent to which we can remedy them, is needed.

The timber industry in the Umpqua Basin has reached a peak in development and contribution to the local economy that cannot be exceeded without closer utilization of the wood resource. This will involve more secondary manufacture, including chemical utilization, and will require abundant water of good quality.

Irrigation agriculture is increasing rapidly (8). The area under irrigation increased from 2,947 acres in 1939 to 3,798 acres in 1949 and 13,070 acres by 1955. If additional water becomes available the potential is 119,800 acres.

The Umpqua River is a nationally famous sports fishery for salmon, steelhead, and cutthroat and rainbow trout, and its value is increasing. More than $300,000 of county and private capital has been invested to facilitate sports fishing for salmon at Winchester Bay alone. The Oregon State Game Commission has a special project for rebuilding the Umpqua River salmon and steelhead runs. These fish not only have high recreational value, but they are also taken by offshore commercial fishermen as far north as Alaska.

The senior author, G. L. Hayes, was formerly in charge of the Experiment Station's research center at Roseburg, Oreg. At present he is chief of forest management research at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

H. G. Herring is watershed management research specialist at the Roseburg Center.

The recreational value of the water resource is not limited to fishing. Boating has grown phenomenally in the last 10 years and swimming has lost none of its popularity. Campers and tourists much prefer to camp or drive beside a stream or lake, chiefly for its scenic value.

All recreational uses are nonconsumptive but they do require adequate quantities of clear water in the streams and lakes.

An expanding population, coupled with an increasing per capita consumption of water, is creating a ballooning demand for domestic water. Douglas County, which is almost exactly coincident with the Umpqua Basin, had a population of 19,674 in 1910. The population grew slowly but steadily to 25,728 in 1940. With the timber boom, the population took a sudden spurt and rose to 54,549 in 1950--an increase of 112 percent. The estimate for 1955 was 71,830 and 152,911 is predicted for 1975 (1). Furthermore, the rising standard of living, with its multiplicity of home conveniences, has quadrupled the per capita domestic water consumption in the United States since 1900.

The land-use pattern stresses the important role forest-land managers will play in determining future adequacy of the basin's water resources. Eighty-nine percent of Douglas County is forest land and 83 percent is considered commercial forest (table 1). Activities in these forested source areas will determine to a large extent quality and to a lesser degree the quantity of water available to downstream users.

Table 1.--Land use in Douglas County, 1950

Class of land	Area	Proportion of total area
	Acres	Percent
Commercial forest	2,684,000	82.8
Noncommercial forest	94,000	2.9
Reserved lands	98,000	3.0
Cropland	124,197	3.8
Pasture, not woodland	138,820	4.3
Farm houses, farm roads, wasteland	18,100	.6
Urban and other private use	82,563	2.6
Total	3,239,680	100.0

Source: Douglas County Planning Commission (1).

LOCATION AND EXTENT OF THE BASIN

The Umpqua Basin comprises an area of about 4,710 square miles in southwestern Oregon. The Umpqua River is 111 miles long, with tidewater extending as far as Scottsburg at river mile 28. Major tributaries are Cow Creek and the North Umpqua, South Umpqua, and Smith Rivers. All but the Smith River drain the east slopes of the Coast Range, the west slopes of the Cascade Range, and intervening valleys. The Smith River and a part of the Umpqua River drain the west slopes of the Coast Range. The Umpqua Basin is separated from the Willamette Basin on the north by the Calapooya Mountains and from the Rogue River system to the south by the Rogue River Range.

WATERSHED CHARACTERISTICS

The water yield and uniformity of flow from any watershed depend principally upon three key factors:

1. Precipitation--kind, amount, intensity, and seasonal distribution

2. Vegetative cover

3. Soil--kind and depth

Precipitation

Most precipitation occurs in the winter months, with little in summer. Furthermore, most occurs as rain. Only at higher elevations in the Cascades does any significant amount of snow remain on the ground into the summer months to feed streams during the dry season; and in the Umpqua Basin, only the North Umpqua watershed includes any extensive area of such elevations. Twenty percent of the North Umpqua watershed lies above 5,000 feet, whereas only 3 percent of the South Umpqua lies as high.

The varied topography of high relief has a strong effect on the precipitation pattern, causing very large differences within a relatively small area. Average annual precipitation at Riddle is 27.82 inches,[1/]

1/ Precipitation data comes from published daily and annual records of the U.S. Weather Bureau, except as noted.

whereas 100 inches or more fall in the vicinity of Scottsburg and along the lower reaches of Smith River. In general, annual precipitation averages 60 to 70 inches along the coast, increases to maximums of 80 to 100 inches near the Coast Range crest, and then drops to about 30 inches in the interior valley. It then increases again in the Cascades, reaching a maximum of 70 to 80 inches.

Precipitation intensity is as variable as normal annual precipitation. Generally speaking, however, storms of extreme intensity are rare. High-intensity thunderstorms, typical of some regions, are not common in the Umpqua Basin. Virtually all precipitation comes from general storms associated with extratropical cyclones originating over the Pacific. The Corps of Engineers has prepared a map, showing maximum 3-day precipitation that may be expected to occur only once in 10 years (4). At Roseburg, this 3-day storm total is 4.6 inches, whereas on parts of the Smith River watershed it is slightly over 12 inches. The storm precipitation pattern is essentially the same as was described for the annual pattern. Maximum 24-hour precipitation recorded at Roseburg was 4.15 inches on February 28, 1899.

Vegetative Cover

An ideal watershed cover under prevailing climatic and topographic conditions would be a forest sufficiently dense to exclude ground vegetation and to keep the soil covered with a blanket of litter. Such a condition would provide maximum soil protection and regulation of streams. The present cover is something less than the best. How nearly it approaches optimum is not known. Certain soils, such as those developed from serpentine or those that are extremely shallow or rocky, will not support such a vegetation. Agricultural lands, of course, are not ideal watersheds and special precautions are required with them. Approximately 220,000 acres of commercial forest land are nonstocked and a much larger acreage is poorly stocked (2). These areas are the result of fire and logging with inadequate provision for regeneration. Measures taken to bring such lands back into full productivity may well improve water yield and stream regulation as well as yield valuable returns on the timber.

For the most part, however, the Umpqua Basin is covered with a dense timber stand (fig. 1). As is to be expected, the higher, less accessible parts of the watershed are more completely vegetated than the lower parts. Several forest types are represented, with Douglas-fir being most important. A mixed-conifer type occupies extensive

Figure 1.--Typical forest conditions in the older Cascades of the Umpqua Basin.

areas and includes Douglas-fir, ponderosa pine, sugar pine, grand fir, and incense-cedar. In the high Cascades, the true fir–mountain hemlock and lodgepole pine types are also present. The oak–madrone type, which includes Pacific madrone, Oregon white oak, and California black oak, prevails on lower foothills in the interior valley. Numerous cutover and burned areas are covered with a brush type that is quite varied and made up of a number of species.

Soils and Geology

Soils have not been classified and mapped for the mountain areas, but some differences between those on major geological formations have been observed. There are four such formations or groups of formations in the basin:

Pumice of the high Cascades.--From the viewpoint of flow regulation and water storage, pumice comprises an excellent formation for watersheds. It has a very high infiltration rate and overland flow is rare. Streams draining deep pumice areas almost never flood and they maintain a good summer flow. Highest flows from such streams are typically only 5 to 50 times greater than the least flows. If an unusual combination of circumstances results in surface runoff, however, pumice will erode rapidly, creating deep, vertical-sided gullies (fig. 2).

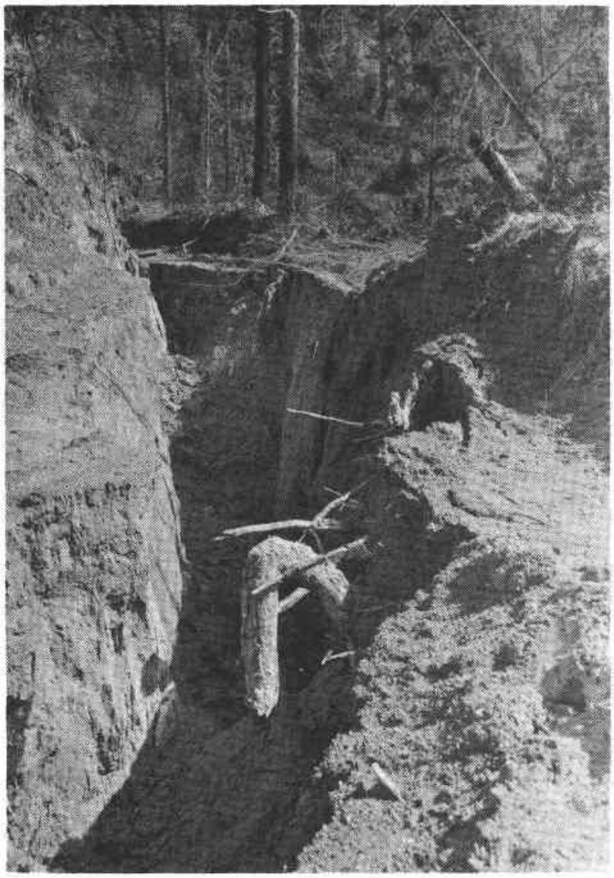


Figure 2.--Erosion caused by concentrated runoff on an abandoned road in pumice soil.

Lavas of the lower, or old, Cascades.--Typical soil cover includes a porous clay-loam, 8 to 12 inches deep, underlain by a dense clay subsoil of variable depth. The clay subsoil is capable of storing large quantities of water, but water moves through it very slowly. Runoff during heavy storms is great and summer water yield is low. Ratios of maximum-to-minimum observed flows are typically about 1,500 to 1.

Complex rocks of the Klamath Plateau.--These are highly variable. Some form soils that are hydrologically better and others form soils that are poorer than those in the lower Cascades, but they will average about the same. The two extremes found in this group are granitoid and ultrabasic intrusions, both of which present serious watershed management problems. The granitoid rock, mostly quartz diorite, weathers to a loamy sand, with high infiltration rates. When subjected to overland flow, however, soils derived from quartz diorite erode rapidly; gullies 3 feet deep are not uncommon (fig. 3).

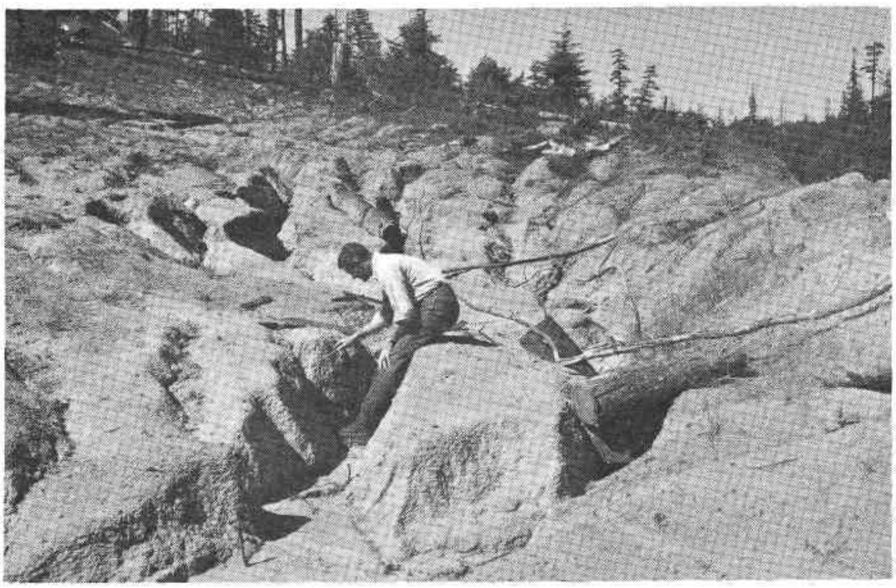


Figure 3.--Quartz diorite soils require special care to avoid overland flow when plant cover is removed.

The ultrabasic rock, serpentine, contains internal shear planes that are quite slick, frequently causing the rock to be unstable.[2] Furthermore, serpentine weathers to a soil that is very infertile. As a result, little or no vegetation grows on such soils to hold them in place and the normal geologic erosion rate is quite high. Where deep soils do accumulate on ultrabasic rocks, it is often very fine textured, containing considerable talc. When wet, these soils become very unstable. Land slips become quite common, especially where roads have been cut through.

2/ Peridotite, the other locally occurring ultrabasic rock, changes to serpentine upon hydration, and both are present in varying proportions in any given formation.

Sedimentary formations of the Coast Range.--The sandy clay loams typical of these formations should be better hydrologically than lower Cascade soils, but no measurements are available for streams draining from these formations in the Umpqua Basin. Interbedded shale layers frequently produce clay soils that have hydrologic characteristics quite similar to those of the lower Cascades.

STREAM CHARACTERISTICS

Stream Development

The Umpqua system is in an early-mature stage of its development. Most of the tributaries flow in steep-sided, narrow valleys and are still down-cutting, but the Umpqua River and its larger tributaries have started to develop a flood plain in the interior valley. The South Umpqua River has the most extensive flood plain, which provides the principal agricultural soils of the basin. Several other tributaries have developed narrow flood plains in the region between the Coast Range and the Cascade Range, but very little deposition has occurred elsewhere.

The stream pattern is dendritic; that is, treelike. Although no figures are available for length of channel per square mile, it is quite high and surface runoff is quickly concentrated. The general pattern of development and principal streams are shown on the map on the inside front cover, but numerous small streams are not included.

Water Yield

Water is abundant in the Umpqua Basin. In the average year, 2,071,000 acre-feet empty from the South Umpqua River and 2,571,000 acre-feet from the North Umpqua River (table 2).[3] A total of 5,378,000 acre-feet pass the town of Elkton on the Umpqua River, but usable water is rapidly becoming inadequate in both quantity and quality.

Consumptive use of water can not exceed the flow during periods of low water, and should be further limited so as not to

---

3/ Statistics relative to the water resource have been derived from published records of the U.S. Geological Survey, Water Resources Division.

Table 2.--Flow of the Umpqua River and its main tributaries[1]

Stream and gaging station location	Drainage area	Discharge[2]			Mean annual runoff
		Mean	Minimum	Maximum	
	Sq.mi.	C.f.s.	C.f.s.	C.f.s.	Acre-ft.
Umpqua River:					
Elkton	3,683	7,428	640	218,000	5,378,000
North Umpqua River:					
Winchester	1,344	3,551	566	100,000	2,571,000
Toketee Falls	339	875	475	5,080	632,000
South Umpqua River:					
Brockway	1,670	2,860	36	102,000	2,071,000
Tiller	449	1,061	20	46,400	768,100

1/ Data is from U.S. Geological Survey Water Supply Paper 1518 (7) except for the North Umpqua River at Toketee Falls, which is from Water Supply Paper 1124 (6). Historical evidence indicates that most, if not all, maximum discharge figures quoted were exceeded in 1861, but actual measurements are not available.

2/ C.f.s. = cubic feet per second.

lower the water level below the minimum required to sustain low forms of aquatic life, dilute sewage effluent, and maintain water temperatures suitable for fish. Water for irrigation is needed only in the dry season, when flow is low, and use of water for irrigation should be restricted to that part of the flow that exceeds the requirements of the essential nonconsumptive uses mentioned above.

The Umpqua River, with average minimum flow in the summer months of 977 to 1,270 second-feet, has enough water for all uses thus far. The quality of the water is very good in the dry season, but the water is often muddy in the wet season.

Most of the abundant water found in the Umpqua River in summer comes from the North Umpqua River (table 2). The mean minimum flows of that stream for the summer months--820 to 1,083 second-feet--is sufficient for all foreseeable domestic and irrigation use. It is a cold, typically clear stream, ideally suited for recreation use and, at the same time, a source of water for potential industrial development. Water quality has been excellent in the past, but in recent years road building, hydro-power developments, and logging have been increasing the sediment load. During the high water of December 1955, filtering facilities of the Oregon Water Corporation were inadequate to remove all sediment from the Roseburg municipal water supply.

The flow of the North Umpqua is well regulated naturally, as is evidenced by maximum-to-minimum flow ratios. For the North Umpqua above the Clearwater River, this ratio is only 9:1 and it is only 7:1 for the Clearwater. Even as far downstream as Winchester, near the mouth of the North Umpqua, the maximum-to-minimum flow ratio is only 176:1. The water which maintains the summer flow of the North Umpqua comes primarily from high-elevation pumice soils on the upper river. Although less than 10 percent of the watershed which drains past Elkton lies above Toketee Falls, the least flow ever measured at Toketee was 74 percent of the least flow at Elkton.

All other streams in the Umpqua Basin fluctuate widely in flow, and produce relatively little water of good quality when most needed. The largest of these, the South Umpqua River, is typical. From an annual flow that approaches that of the North Umpqua, it rises to higher flood crests and drops to a much lower flow in summer (fig. 4). Mean minimum flows for the summer months at Brockway range from 161 second-feet in July to 101 second-feet in September, and have gone as low as 36 second-feet. The maximum-to-minimum flow ratio is about 2,833:1. Its waters in winter are normally very muddy, clearing up only in summer when it becomes too low to dilute its load of sewage effluent to a level that is safe for swimming.

Several factors explain the difference between the flow regulation of the North Umpqua system and that of the other basin streams. It has been pointed out that only the North Umpqua drainage extends into the elevation required for an early summer snowpack (fig. 5). Diamond Lake also provides some slight flow regulation. The most important factor, however, is the soil. The deep extensive pumice acts as a reservoir, soaking up large quantities of moisture during the wet season and releasing it throughout the dry summer months. The clayey soils typical of most of the Umpqua Basin do not function in such a manner. Although clay soils are capable of holding more water than pumice of the same depth, water moves into, through, and

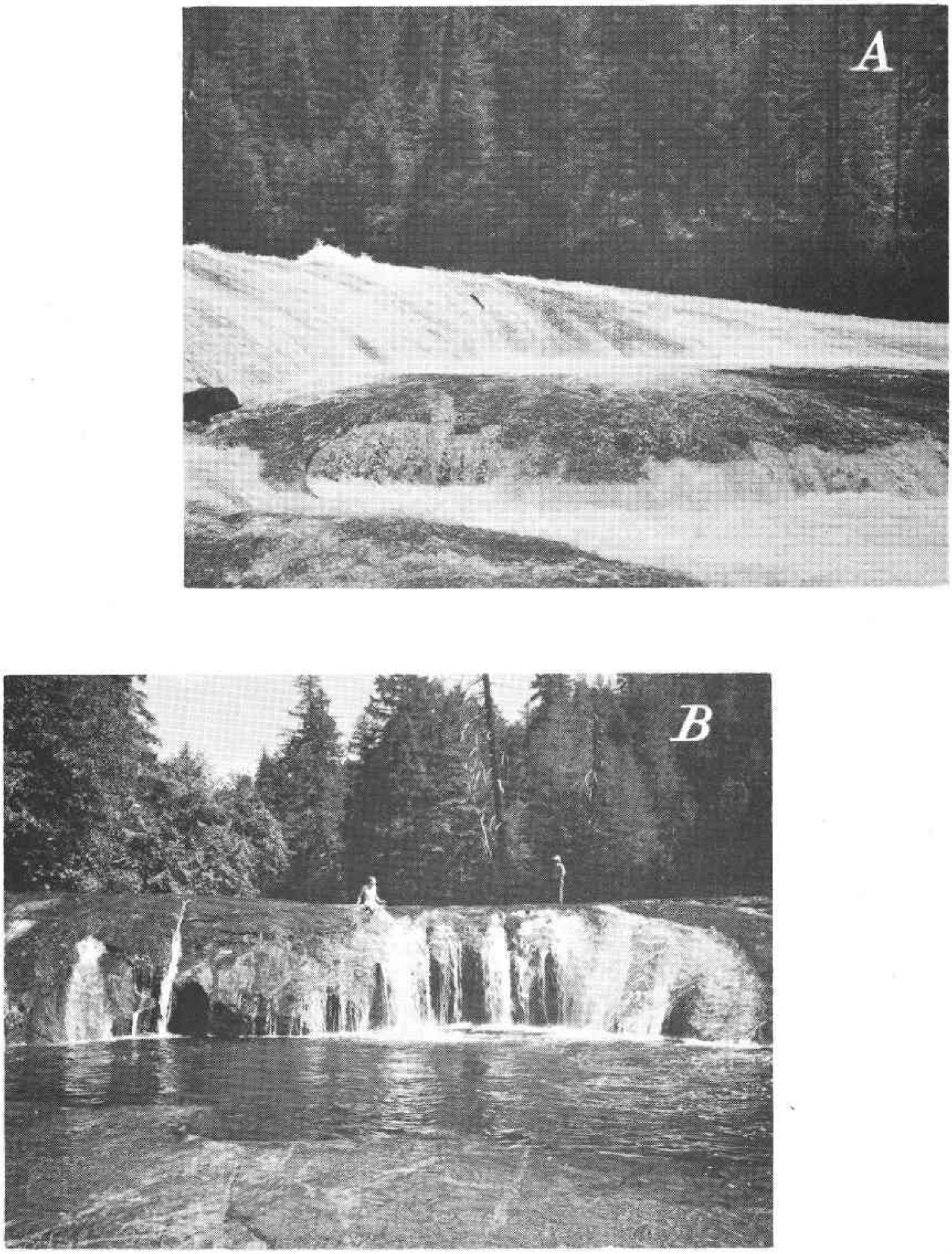


Figure 4.--Flow at the South Umpqua Falls in June (A) declines considerably by September (B). Drainage area above the falls is about 6 percent of the drainage area above Roseburg.

Figure 5.--A small snow-fed tributary of the North Umpqua River during the spring runoff.

out of clay very slowly. Most winter precipitation runs off as surface flow and relatively little water is released during summer.

The higher elevations of the South Umpqua watershed yield more water with less fluctuation than the lower areas. Above Tiller, the drainage comprises only 28 percent of the watershed area above Brockway but yields 38 percent of the average yearly runoff measured at Brockway. During summer months, the drainage above Tiller contributes proportionately greater amounts--42 to 66 percent of minimum flows--but during winter floods, the same area contributes only 31 percent of the maximum discharge. These figures demonstrate the regulatory value of forested watersheds. They also show that watershed management plans must include low-lying cutover, grazing, and agricultural lands, which contribute substantially to flood flows and sediment loads.

Watershed management cannot be the whole answer to flow regulation and flood control, however. The occasional high-intensity, prolonged storm that follows a wet period will make even the ideal watershed perform inadequately. The greatest flood known occurred in 1861, when the watersheds were still essentially untouched by man. Artificial storage is the only remedy for such floods. Proper watershed management can materially reduce the storage capacity which will be required, however, and can keep both flood peaks and frequencies from increasing before adequate storage is available. Of even more importance is the matter of protecting reservoirs, which are extremely expensive. Good flood control dam sites do not exist in the Umpqua Basin, and even fair ones are scarce. Once their storage capacity is lost it is gone forever. If reservoirs are built, it will be necessary to reduce sediments in the streams to the lowest practicable amount to protect the storage capacity of the reservoirs and the capital investment in them.

Has streamflow changed? Are floods getting worse? Such questions are often asked. Flow records for the South Umpqua at Brockway since 1905 and at Tiller since 1940 have been analyzed in relation to rainfall in an attempt to answer such questions. As yet, no significant difference is apparent: winter, summer, and annual streamflow have remained the same for a given amount of rain. We have no evidence to show that changes in watershed conditions have changed flow characteristics.

It is reasonable to expect some change in the future, as a larger percentage of the watershed is modified. We know that improperly constructed roads and skidroads permit water to accumulate and drain from the land faster than it does from undisturbed ground, that water drains rapidly from our highways and city streets, that overland flow is accelerated following clearing and cultivation, and that grazing animals compact the soil and increase surface runoff drastically. All these factors concentrate runoff more rapidly, tending to cause increased flood peaks and decreased base flows.

An increase in flood peaks caused by changing land use, although theoretically probable, is not readily apparent on the basis of past records. It would first be necessary to correlate flood heights with amount and intensity of precipitation so as to permit separation of variation associated with precipitation from that attributable to a change in watershed conditions. It has not been possible to do this, however. Some of the largest storms were cold storms that piled snow deeply in the mountains and produced little immediate runoff.

Conversely, the greatest recorded flood on the South Umpqua River, in February 1890, was caused by a storm of only moderate intensity that probably melted large quantities of snow from the watershed.

It is true that the frequency of floods has increased in recent years (fig. 6), but this could be attributed to a corresponding increase in the frequency of rains of flood-producing intensity. Precipitation

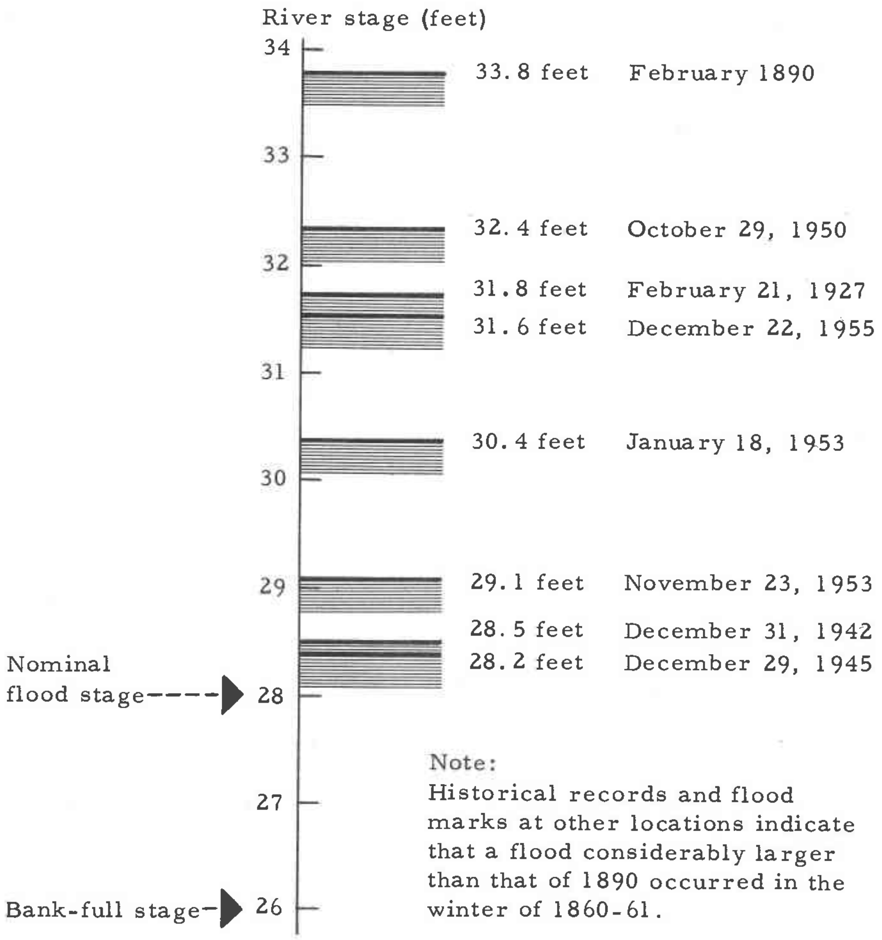


Figure 6.--Flood stages of the South Umpqua River at Brockway.

has been measured in Roseburg by the U. S. Weather Bureau since 1877. For this entire period, the second greatest amount of rainfall ever measured in 1 calendar day was recorded for November 22, 1953, and the fourth greatest on October 28, 1950. Of the 10 greatest 1-day storms, 4 have occurred since 1950 (table 3).

Table 3.--The 10 largest 1-, 2-, and 3-day storms recorded at Roseburg between 1877 and 1958

1-day storm		2-day storm		3-day storm	
Rainfall (inches)	Date	Rainfall (inches)	Date	Rainfall (inches)	Date
4.15	2/28/99	1/ 5.97	10/28-29/50	7.11	10/29-31/24
3.43	11/22/53	5.74	10/30-31/24	1/ 6.75	10/27-29/50
3.43	10/31/24	5.21	1/11-12/81	5.24	2/27-31/99
1/ 3.12	10/28/50	4.76	11/21-22/53	5.15	11/21-23/53
3.09	11/7/85	4.71	2/27-28/99	2/ 5.07	2/2-4/90
3.05	12/25/55	4.60	12/25-26/55	4.86	11/15-17/96
3/ 3.01	11/22/09	4.37	12/29-30/04	4.77	12/25-27/55
2.94	11/29/04	4.26	1/20-21/43	4.72	11/28-30/17
2.94	2/20/56	4.23	11/27-28/10	4.72	12/2-4/79
2.93	1/27/78	4.15	2/20-21/56	4.69	12/8-10/39

1/ Second greatest flood, South Umpqua, October 1950.

2/ Greatest flood, South Umpqua, February 1890.

3/ Greatest flood, North Umpqua, November 1909.

As flood crests usually reach Roseburg the second day of intensive rain, and continuing rain contributes runoff from the lowlands to increase flood crests, the amounts falling in 2 days are especially significant. The greatest amount ever recorded in a 2-day period was measured October 28-29, 1950. And four of the ten greatest 2-day storms have occurred since 1950. Continuing further, three of the top ten 3-day storms have occurred since 1950.

Rains that accompanied the floods of January 1953 were not unusually great at Roseburg. Melting snow could have been an important factor, or possibly precipitation at Roseburg was not indicative of the intensity of that falling on the upper watersheds. Probably both factors were contributory.

Sediment Loads

Sediment loads in the streams during the wet season are inordinately large and indicate excessive erosional losses on the watersheds. Based on 15 samples taken at 2-week intervals in the wet season of 1951-52, the South Umpqua River at Brockway averaged 552 p. p.m., whereas at Tiller it averaged only 94 p. p.m. For the watershed above Brockway, this rate would result in an annual loss of 111 tons (117 cubic yards) of soil per square mile, assuming no soil loss during the dry season.

These figures are for the suspended sediment load only; data is not available for the bedload--the material that rolls or bounces along the stream bottom. Furthermore, such figures are not truly indicative of even the annual suspended load. The bulk of the annual sediment movement in streams occurs during storm flows. A relatively small number of periodic samples will not adequately reflect the sediment concentration of these high flows, especially the peaks, and annual sediment figures based on such samples are probably much too low.

During an October flood in 1950, the sediment content of the South Umpqua River at Brockway was 6,850 p. p.m., with a discharge of 37,400 second-feet. Converted to more familiar terms, this means that approximately 8.5 cubic yards of soil were passing Brockway every second.

Observations of the effect of watershed activities on sediment production have shown that as much as 90 percent of the sediment in the streams may come from only 10 to 20 percent of the watershed. These critical source areas should be located, studied, and subjected to corrective measures. Some of the more important areas are roadways, skidtrails, landings, and scarred stream banks.

WATER PROBLEMS RELATED TO WILD-LAND MANAGEMENT

The water problems of the Umpqua Basin, like those in all of western Oregon, are associated with excesses in winter, shortages in summer, impaired quality in some streams at all seasons, and debris in streams. Parts of these problems are inherent in the natural characteristics of the watersheds. Naturally unstable soil and rocks, steep topography, and copious but highly seasonal rainfall create many watershed problems. Man's activities on the watersheds have accentuated most of the natural problems and have created some additional ones. Before these man-made problems can be reduced or eliminated, we must first appraise the inherent characteristics of the watershed that determine the impact of man's use on the area.

Winter floods endanger life; disrupt utilities and services; endanger public health; and damage roads, homes, and bridges. Farms are inundated and valuable soil is lost through erosion or buried under debris and often infertile sediments. Livestock are lost and farm structures damaged. Recreational sites are impaired. Spawning grounds are disturbed, destroying fish eggs and insect larvae, and young fish are stranded when the waters recede.

In summer, on the other hand, water supplies are hardly adequate now for some communities, and the situation is worsening as populations increase. The South Umpqua River receives sewage effluent from seven communities, and although most of it is now treated, the summer flow is too low to adequately dilute the effluent. Withdrawals for irrigation aggravate the situation. Except for the Umpqua River and the North Umpqua River, irrigation farming has already been developed to the limit of available water supplies (8). The opportunities for economic expansion through chemical utilization of wood will grow less as other demands on the water supply increase.

The fishery values of the Umpqua River system are critically endangered by low water. The State Game Commission's program to restore runs of salmon and steelhead is showing encouraging results, but the rivers must serve as summer nurseries for the young fish. Already, waters in the lower reaches of the South Umpqua River get too low, too warm, and too polluted for the young fish to thrive.4/

Water quality suffers from sediments that come from roads and highways, logging areas, farm and grazing lands, and hydro-electric power developments. The silt and woody debris carried by

---

4/ Statement of the Oregon State Game Commission presented at a State Water Resources Board hearing in Roseburg, October 15-16, 1956.

streams in high water have scoured the stream banks and started them eroding, thus adding further to the sediment load. This material causes more erosion on flooded agricultural lands, reduces the carrying capacity of stream channels, and adds to natural sediment deposits on the land. It also makes the water more expensive to treat for domestic or industrial use, and it covers spawning beds and smothers fish eggs and insect larvae.

THE ROLE OF WATERSHED MANAGEMENT

Vegetation is a primary factor in regulating water flow and in erosion control. Consequently, the forests hold an important role in the future of the watershed. The forest cover is both the most effective watershed protector and the most important economic resource of the Umpqua Basin. Economic exploitation of the forest is damaging to its hydrologic functioning, but the amount of damage can be minimized if proper consideration is given to watershed management. Substantial watershed damage has already been done; much of it could have been prevented, in many cases at no additional cost.

Management of agricultural lands and downstream flood-control projects are important parts of the overall watershed problem and must be treated in any program for stream improvement. Storage facilities will be needed and soil conservation practices of the highest order will have to be practiced on agricultural land if we are to get maximum use of our water resource. The following discussion, however, is confined to suggestions for reducing watershed damage on wild lands without implying that this phase of water resource management is either more or less important than any other phase.

Detailed recommendations for logging practices designed to reduce watershed damage are considered beyond the scope of this report. There are several good guides available, such as one published by the California Region of the U. S. Forest Service (5), but the applicability of any specific practice must be evaluated on the area under consideration. Basically, forest managers must take steps to (1) maintain adequate soil porosity and infiltration rates, (2) minimize surface runoff and channel it where it will do the least harm, and (3) avoid creating erosion hazards. The methods used to accomplish these aims will depend largely upon the local situation, but a few general suggestions can be given:

1. Roads are one of the most important contributors to rapid runoff and stream sedimentation;

detailed advance planning of the forest road system is therefore essential. Roads should be located and constructed with full consideration for existing and potential downstream values. Also, road mileage should be kept to a reasonable minimum. A well-designed system that considers future as well as present needs can materially reduce the required road mileage. In one study made north of the Umpqua Basin in the Blue River drainage, for example, a planned, systematic road network had 0.62 mile less road per square mile than did one which was built on a year-by-year basis--and 11-percent reduction (3).

An even more important objective of road planning is to fit the road system to the topography. Benches and ridgetops should be used as much as possible for road locations. Sidehill and streamside locations should be kept to a minimum. Long, sustained grades are undesirable; excessively steep grades should be limited to short stretches and used only to avoid an even more undesirable situation. More research is needed, however, before we can say what the maximum road grade should be on various soil types. Better means are needed for identifying unstable areas so they may be avoided--or special measures used to hold the soil in place. Road locators must consider watershed values as well as logging costs when laying out a forest road system.

2. More attention to drainage of all roads and skidtrails is needed. Temporary roads should be cross-ditched, and in some instances seeded with grass, when no longer required. Ditch water should be discharged onto the forest floor at frequent intervals in order to filter out much of the suspended material before it reaches a stream. Other road stabilization practices include provision for a good crown and proper bank slopes, disposal of excess cut material so as to keep it out of streams, and installation of aprons on culvert outlets where necessary.

3. Modification of current logging practices would also help minimize erosion and sedimentation. Some recommended practices include:

(1) Avoid logging with tractors on steep slopes that would require frequent skidroads side cut into the hillside.

(2) Curtail logging in excessively wet weather, when the soil structure is broken down by "puddling" and logging causes excessive erosion.

(3) Keep tractors out of streambeds.

(4) Fell trees away from waterways and live streams, and remove debris that accumulates in streams.

(5) Locate landings away from streams, and insure adequate drainage of all landings (fig. 7).

(6) Avoid yarding across streams. On high-lead settings, streams can be used as cutting boundaries and logs yarded away from them.

(7) Yard uphill, if possible, when cable logging.

Extreme care should be taken to maintain stability of streams. Damage to the channel in stream headwaters frequently results in a chain of events downstream that will increase the original damage many thousandfold. Sediment and debris carried from the headwaters and deposited in the lower reaches reduce the carrying capacity of the stream at the point of deposition. This in turn often results in bank cutting at that point. Actively eroding stretches of stream bank that are created contribute to sediment loads in the stream for years, destroying valuable agricultural land and amplifying the cycle of erosion, deposition, and bank cutting.

Figure 7.--When landings are located adjacent to streams, there is no opportunity for filtration of sediment-laden water before it reaches the stream.

4. In addition, more attention is needed toward assuring prompt reestablishment of the forest on cutover areas. "Sore spots" that continue to erode after revegetation should receive special treatment. Forest fires and other destructive agents should be curbed to the fullest extent possible.

Any list of recommended watershed practices is only a guide. Such practices are applicable in most instances, but exceptional cases arise. When dealing with the complex interrelationships present on most watersheds, there is no substitute for a well-trained, experienced land manager, who carefully considers--on the ground--all present or foreseeable conditions. Recommended practices are good working tools, and they provide a frame of reference from which the logging or road plan is evolved.

Much time-consuming research is needed to determine the best road-design criteria and watershed-management practices. However, we do not have to wait for research results before attacking the problem. Irreparable damage could be done to our watersheds before we have all the answers we want. Use of the knowledge we do have, coupled with common sense and a conscious consideration of watershed problems during all phases of planning and operation, will take us a long way toward the ultimate goal.

LITERATURE CITED

(1) Douglas County Planning Commission.
1955. The character of Douglas County. 66 pp., illus. Roseburg, Oreg. (Processed.)

(2) Moravets, F. L.
1951. Forest statistics for Southwest Oregon unit. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 104, 36 pp., illus. (Processed.)

(3) Silen, R. R.
1955. More efficient road patterns for a Douglas fir drainage. The Timberman 56(6): 82, 85-86, 88, illus.

(4) U.S. Engineers Corps.
1957. Ten year storm precipitation in California and Oregon coastal basins. Tech. Bul. 4 (Project CW-151), 7 pp., illus. (Processed.)

(5) U.S. Forest Service--California Region.
1954. A guide to erosion reduction on national forest timber sale areas. 78 pp., illus. (Processed.)

(6) U.S. Geological Survey.
1951. Surface water supply of the United States 1948. Part 14. Pacific slope basins in Oregon and lower Columbia River basin. Water-Supply Paper 1124, 273 pp., illus.

(7) ______________
1959. Surface water supply of the United States 1957. Part 14. Pacific slope basins in Oregon and lower Columbia River basin. Water-Supply Paper 1518, 361 pp., illus.

(8) U.S. Reclamation Bureau.
1956. Umpqua River basin, Oregon, special report. 55 pp., illus. (Processed.)

TREE SPECIES MENTIONED

Common Name	Scientific Name
California black oak	Quercus kelloggii
Douglas-fir	Pseudotsuga menziesii
Grand fir	Abies grandis
Incense-cedar	Libocedrus decurrens
Lodgepole pine	Pinus contorta
Mountain hemlock	Tsuga mertensiana
Oregon white oak	Quercus garryana
Pacific madrone	Arbutus menziesii
Ponderosa pine	Pinus ponderosa
Shasta red fir	Abies magnifica var. shastensis
Sugar pine	Pinus lambertiana