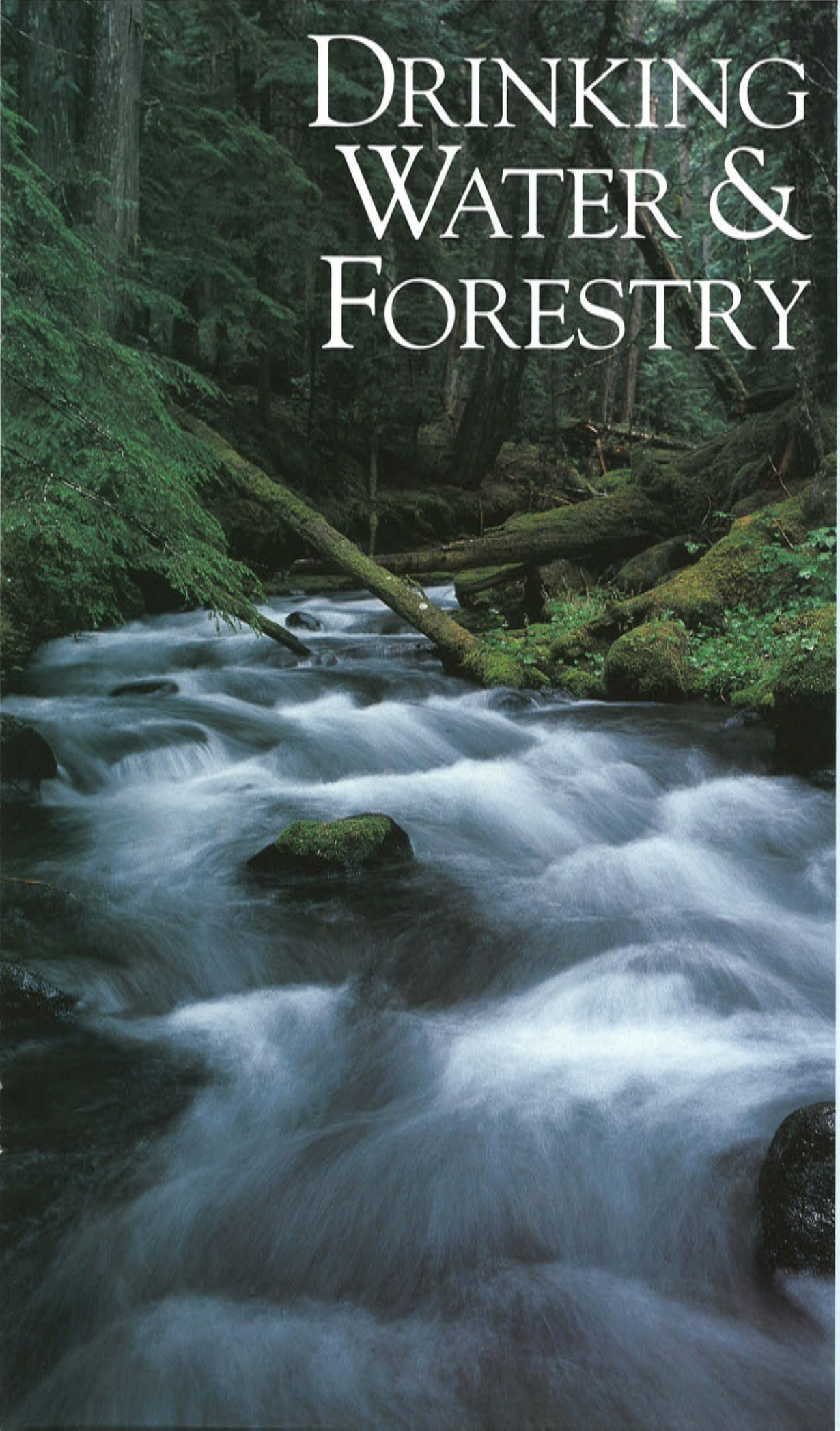
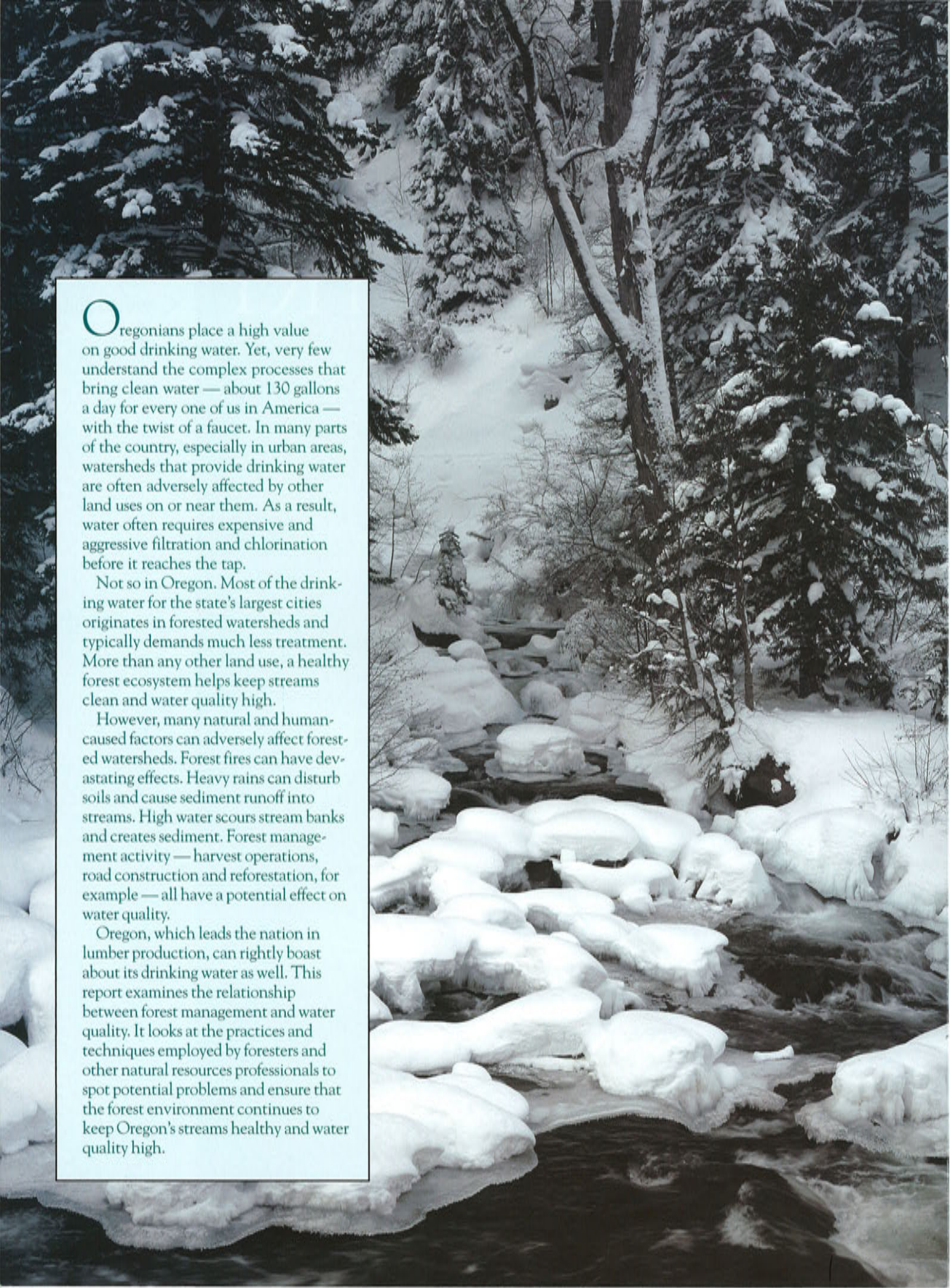


Drinking Water & Forestry

How a Healthy Forest Ecosystem Helps Keep Streams Clean and Water Quality High

A Special Report From The Oregon Forest Resources Institute



Oregonians place a high value on good drinking water. Yet, very few understand the complex processes that bring clean water — about 130 gallons a day for every one of us in America — with the twist of a faucet. In many parts of the country, especially in urban areas, watersheds that provide drinking water are often adversely affected by other land uses on or near them. As a result, water often requires expensive and aggressive filtration and chlorination before it reaches the tap.

Not so in Oregon. Most of the drinking water for the state's largest cities originates in forested watersheds and typically demands much less treatment. More than any other land use, a healthy forest ecosystem helps keep streams clean and water quality high.

However, many natural and human-caused factors can adversely affect forested watersheds. Forest fires can have devastating effects. Heavy rains can disturb soils and cause sediment runoff into streams. High water scours stream banks and creates sediment. Forest management activity — harvest operations, road construction and reforestation, for example — all have a potential effect on water quality.

Oregon, which leads the nation in lumber production, can rightly boast about its drinking water as well. This report examines the relationship between forest management and water quality. It looks at the practices and techniques employed by foresters and other natural resources professionals to spot potential problems and ensure that the forest environment continues to keep Oregon's streams healthy and water quality high.

Drinking Water And Forestry

In a small, wooden structure set in a clearing at the end of a forest road about 11 miles west of Bend, Roger Prowell of the city's public works department crosses a small, steel walkway and swings a window open. Outside, large, wet snowflakes are falling quietly into a pristine pool of water about 40 feet across. The pool bottom is clearly visible, even through 15 feet of water. "There," says Prowell with a gesture and dramatic pause, "is some of the best water in America."

Prowell's pride is well founded. The pool is the intake point for Bend's water supply and is situated in the Deschutes National Forest on Bridge Creek, which flows from its headwaters a few miles up the Cascade slope through prime, predominantly hemlock forestland.

Geography, topography and climate differ, but Bend's story plays itself out over and over again in municipal water systems across the state. For example, a couple hundred miles northwest and two mountain ranges away, the Bear Creek watershed drains north and west toward the Columbia and the Pacific. Similar in size to Bend's watershed, the Bear Creek system is the source of Astoria's drinking water. Crossing east and south into the Willamette Valley, the city of Dallas gets its drinking water from the Rickreall Creek watershed, which begins in the upland forest of the Coast Range and stretches all the way to the Willamette River.

These three municipalities are typical of water systems in Oregon, but their watersheds differ dramatically in one particular way — the degree of forest management that takes place in each. Bend's water supply is totally within the boundaries of the Deschutes National Forest and, as such, is under the control of the USDA Forest Service. There is no commercial timber harvest at all in the watershed. Astoria owns its watershed and does conduct periodic timber operations, primarily thinning, for the general health of the forest. On the other hand, nearly all of Dallas's watershed is owned by two forest products companies — Boise Cascade and Willamette Industries — both of whom actively manage it as commercial timberland.

Oregon citizens have indicated in surveys that water resources are among the highest values associated with forestlands and, not surprisingly, that forest management activities are a prime cause of concern because of their potential impact on water quality. Many are confused about whether logging increases streamflow and contributes to flooding or actually helps dry up streams. In fact, given the myriad and complex factors at work, either scenario could be true, especially in the short term.

Some Watershed Facts

The following are from a new study, "Municipal Water Supplies from Forest Watersheds in Oregon: Fact Book and Catalog," by Dr. Paul Adams and Mark Taratoot.

- Forest cover — trees, vegetation and the litter layer of leaves and dead branches that cover the ground — typically results in significant losses of water back to the atmosphere through canopy interception, transpiration, soil uptake and evaporation. (See illustration on pages 6 and 7.)
- Because forest cover results in significant losses of water, timber harvest, afforestation or land use changes that markedly alter this cover can increase or decrease local streamflows.
- Soils, not trees, act like sponges by slowly releasing water to streams. Management practices that maintain favorable soil infiltration and water storage are most vital in watershed conservation for desirable streamflow patterns.
- Rapid revegetation and favorable soil properties and climate patterns in western Oregon appear to greatly limit nutrient losses to streams following timber harvest.
- Logging and road construction between 1980 and 1991 on 13 municipal watersheds in western Oregon did not result in sustained increases in turbidity at the water treatment facilities.

The complexity of the forest ecosystem contributes to this confusion. Since the majority of Oregon's drinking water comes from streams that originate on forestland, one can better understand the potential effects of forest management activity with a basic knowledge of the forest environment and the fascinating role that water plays in sustaining it.

The Water Cycle In A Forest Environment

All the water we drink begins as precipitation, which works its way into the soil and ultimately to the streams and underground aquifers that supply municipal water systems. Dr. George Brown, former dean of the College of Forestry at Oregon State University and a specialist in forest hydrology, calls water movement the key component of the forest environment. "Water flow links together the atmosphere, soil, plant community and stream compartments of the system," he says. Forest streams are not separate from the forest ecosystem, but rather an integral part of it. The hydrologic cycle pictured on pages 6 and 7 illustrates the process described in the following section.

Paul Adams
Professor and Forest Watershed Extension Specialist
Oregon State University
Corvallis, Oregon

"Clean water clearly is among the basic necessities of life. Oregonians are especially fortunate in that most of the municipal water used in our largest cities originates on forest lands, which helps ensure a reliable and high-quality supply that requires little treatment. In contrast, most Americans get their water from municipal supplies originating in watersheds having more developed areas and diverse land uses. This often adversely affects water quality."

Between Rain and Reservoir

The forest environment differs from others in that a large percentage of the rainfall does not strike the bare soil directly. Instead it is dissipated by the tree canopy, low-lying vegetation and the forest floor and is less likely to cause erosion. But forest canopy and ground cover have another, perhaps less-anticipated, effect. The common assumption that gravity carries the moisture from rain down to the soil is generally true, but a good deal of water moves the other direction as well, particularly in a forest environment where there are so many surfaces to intercept it. Through natural processes of interception, evaporation and transpiration, a tremendous amount of the water — as much as 15-20 inches annually in some forests — vaporizes and moves back into the atmosphere. Collectively this process is known as evapotranspiration.

Precipitation works its way through the forest canopy and low-lying vegetation to the forest floor. There, it filters through plant debris to the mineral soil layer. Oregon forest soil, known for its porosity, acts like a sponge and slowly releases water through subsurface channels to the streams that feed municipal water systems.

The water that does reach the soil moves to streams and

ultimately becomes, among other things, our drinking water. This movement happens in several ways. Water flows with gravity through the soil to streams; it seeps downward into groundwater storage, some of which later joins streams; and, less often, it moves across the soil surface to a stream. In hydrology, these processes are known as subsurface flow, groundwater flow and overland flow.

There actually are two sources of drinking water — surface water and groundwater. Oregon's drinking water comes from both. Groundwater supplies wells, which are often sources for individual homes and small groups. Most water for municipal systems, however, comes from surface water — water from streams and rivers. Surface water has a direct relationship to forests and is the focus of this report.

Influences On Water Quality: Natural & Human

The term "water quality" embraces many physical, chemical and biological characteristics. They include clarity, sediment concentrations, temperature, dissolved oxygen content and the presence of bacteria, algae, insects, manufactured chemicals and various nutrients. Dr. Paul Adams, a professor and forest watershed extension specialist at Oregon State University, says that the quality of raw water from Oregon forestland is generally very high.

Human activity is not necessarily a degrading factor. "Excellent water can come from managed forests," Adams says, "and conversely, even old growth watersheds with no human disturbance sometimes produce low-quality water." (Adams and Mark Taratoot, now a water research specialist for the city of Corvallis, have authored a new report, *Municipal Water Supplies from Forest Watersheds in Oregon: Fact Book and Catalog*, for the Oregon Forest Resources Institute. The report is available free from OFRI.)

There are many natural processes in the forest environment that affect water quality. Erosion, for example, is a natural process that is constantly shaping the Oregon landscape, and the resulting sediment movement to streams is an inevitable and ecologically necessary byproduct. Other natural phenomena affecting water quality include natural chemicals found in soil and rock, coliform organisms and soil microorganisms. Wildfire, another natural process, can have a devastating effect on water quality by destroying trees and ground vegetation that protect soil and minimize erosion. Fire also can change the nature of the soil and affect its ability to absorb water, thus changing water flow patterns and ultimately resulting in sediment movement to streams.

Human activities, forest management among them, do have the potential to affect water quality. Forest management includes activities like thinning, road maintenance and construction, fire suppression, timber harvest and reforestation.

Rain and Erosion

The illustrations below show the effect of watershed condition on rainstorm runoff and erosion when 2.44 inches of rain fall in one hour.

The data above came from a study done on the Subalpine Range Ephriam Watershed, Utah. Edward L. Noble, U.S. Dept. Agr., Misc. Pub. No. 970.

Forest Practices And Water Quality

The extent of timber harvesting and the number of forest roads in the Pacific Northwest have made the region a natural setting for studying the effects of forest management on watershed resources. Adams says that some of the first comprehensive studies of entire watersheds were done in this region. He co-authored a 1994 summary and annotated bibliography of this research, *The Effects of Timber Harvesting & Forest Roads on Water Quantity and Quality in the Pacific Northwest*, which was prepared for OFRI and is available free upon request. Many of these studies date back to the '60s and measure the effect of logging practices that are no longer used. Such studies became the basis for strengthening forest protection rules through the Oregon Forest Practices Act (OFPA) and have been of great value to professional foresters in improving management techniques.

In addition, forest practices are carefully monitored by the Oregon Department of Forestry, which administers the comprehensive act. The OFPA devotes a large portion of its rules to protecting water quality, strictly regulating forestry-related activity in the vicinity of streams and lakes. Riparian zones (areas immediately adjacent to bodies of water) are protected by OFPA regulations designed to minimize disturbance of stream edges and provide buffer zones that help maintain shade and prevent soil disturbance, erosion and sediment deposits. The OFPA also mandates high standards in road construction and maintenance to minimize or eliminate sediment runoff.

The following is a listing of typical forest management activities, the ways they can affect water quality and the methods foresters employ to mitigate or minimize their effect. In many cases, these preventive measures are required by the OFPA.

Sediment – The Major Problem

As with numerous natural phenomena, most of the potential problems stemming from forest management activities have to do with sediment in streams. In fact, according to the Environmental Protection Agency, sediment, not toxic chemicals or municipal wastes, is the nation's number one pollutant.

Water is the primary carrier of sediment to streams. Erosion occurs naturally when heavy rainfall overloads the capacity of the soil to absorb it. If left unchecked, the resulting surface runoff can carry sediment to streams. Increased sediment can also result from forest management activity. Runoff from forest roads, for example, can discharge onto less-stable soil and cause erosion. Harvest operations such as moving logs or operating mechanical equipment can disturb the soil, making it susceptible to erosion.

Timber Harvest

The Challenge. Logging creates varying degrees of soil disturbance. In simplistic terms, timber harvest disturbs a certain amount of vegetation cover that previously was inter-

Oregon Forest Practice Laws Protecting Streams & Lakes

The following are some of the regulations that govern forest practices around water resources.

Timber Harvest Near Streams

Riparian management areas of 20 to 70 feet wide (depending on stream size) are required on each side of streams used for domestic water supply. Where fish also are present, RMA widths are 50 to 100 feet. Harvest and operating restrictions within the RMA include 1) retention of all vegetation within 10 feet and all trees within 20 feet of streams, 2) retention of a specific number, size and type of trees between 20 feet and the outer RMA boundary (depending on stream size and geographic region), 3) no skid trails within 35 feet of stream except for crossings, 4) prior approval required for any yarding across streams, 5) full log suspension required for any cable yarding across streams, and 6) written plans required for slash or other burning within 100 feet of streams and large lakes.

Notification and Written Plans

The Oregon Department of Forestry must be notified at least 15 days prior to operations such as timber harvesting, road construction, site preparation, chemical applications, slash treatment

(Continued on next page)

cepting raindrops. If logging also disturbs surface duff (organic matter on the forest floor), rain can hit the soil directly and possibly cause erosion. Soil on forest land is rarely bare, as duff provides significant protection even if trees are removed. But logging equipment can churn and scour the duff, exposing the mineral soil and making it more susceptible to erosion. In addition, logging vehicles can compact soil, making it less porous. This in turn can prevent the absorption of rain, creating the potential for erosion by forcing water to travel on the surface.

In the forest environment, trees and vegetation intercept precipitation and moisture spreads across their many surfaces. Water not only works its way down to the soil, but also back into the atmosphere through evaporation. The illustration on the next page explains the forest's complex hydrologic cycle.

Preventive Measures. Modern forestry better utilizes specific logging methods to suit conditions. For example, logging methods can be matched to soil type. Cable yarding — the aerial removal of logs by elevated cable — can be effective in reducing soil disturbance on steep terrain. Tree limbs and organic debris left after harvest help protect the soil from direct rain splash. There have also been dramatic improvements in harvesting equipment; for example, sophisticated, tracked vehicles can cut and process trees at the harvest site, leaving behind tops and limbs that protect the soil.

Forest Roads

The Challenge. Forest roads have the potential to be a major source of sediment, particularly where they cross streams. Any road construction involves soil movement. The challenge is to minimize such disturbance. In addition, ditches and other drainage systems, if poorly designed, can deliver sediment directly to streams.

Preventive Measures. Forest engineers have learned a great deal about road construction and maintenance over the last 40 years. They use this knowledge not only in the construction of new roads, but also in upgrading and improving existing roads. For example, they now strategically create water bars to divert runoff into stable roadside areas before it reaches streams. Cross drains under roads serve the same purpose. Culvert installation techniques are much improved, and some even have open bottoms that maintain a natural stream bed. Furthermore, new harvest methods like long-reach skylines have eliminated the need for many roads.

Oregon Forest Practice Laws Protecting Streams & Lakes

(Continued)

and land clearing. A detailed written plan and prior approval are needed prior to any such operation within 100 feet of streams and lakes used for domestic water supply.

Road Construction Near Streams
The number of stream crossings must be minimized and designed to pass a 50-year peak flow effectively. Road location, design, construction and maintenance must minimize erosion and promote filtering of sediments from runoff. Use of large road fills (more than 15 feet deep) requires a written plan and prior approval. Any machine activity in streams requires prior approval.

Chemical Application Near Streams
Community water system managers must be notified of any chemical application within 50 (ground) or 100 (aerial) feet of a stream used for domestic water supply. Mixing and staging areas for aerial spraying are not allowed within 100 feet of such streams. Aerial application is not allowed within 60 to 300 feet of such streams, depending on the type of chemical; ground application is generally allowed beyond 10 feet, but wider buffers are required for some chemicals.

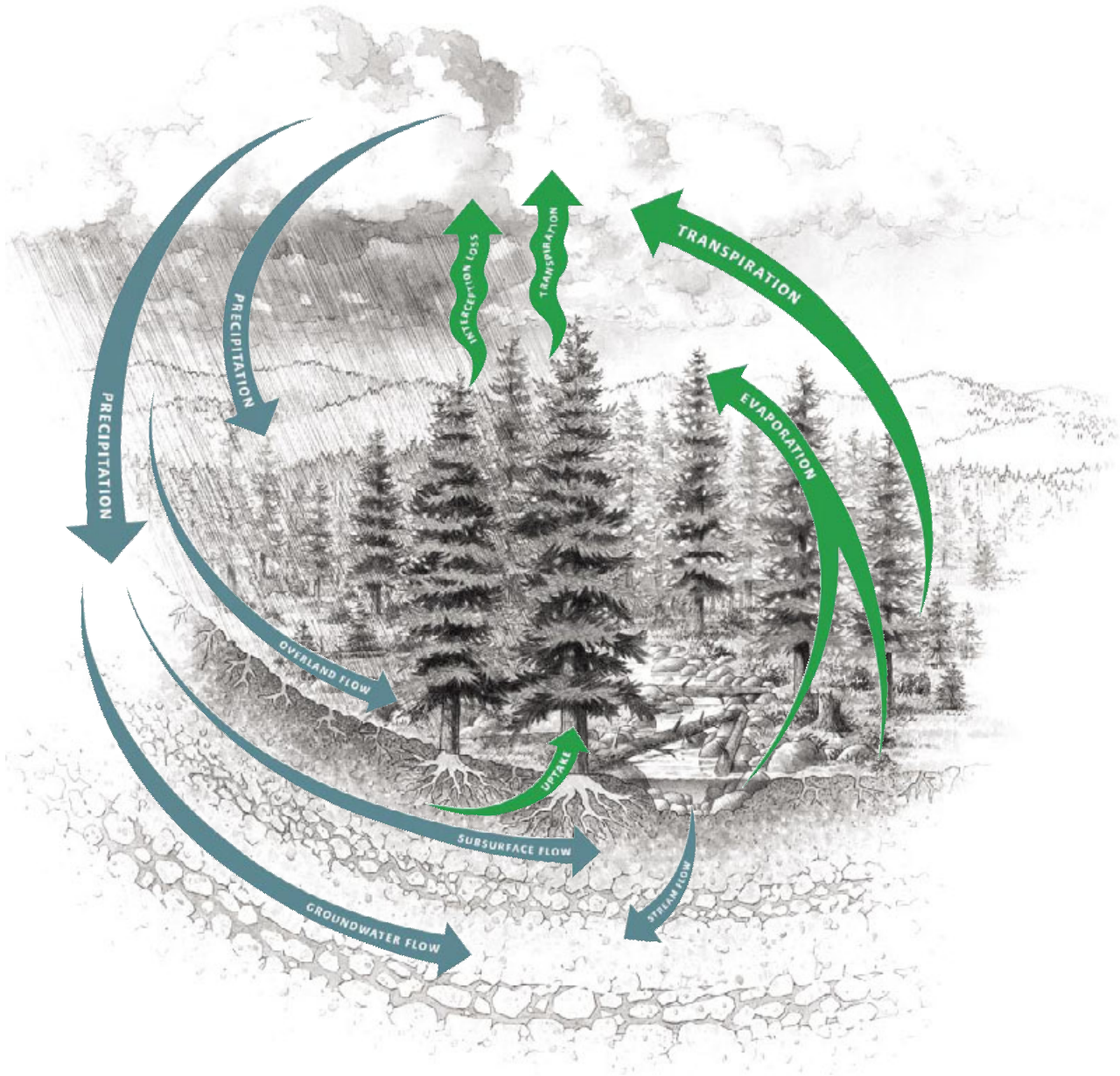
The Water Cycle In Oregon's Forests

Most of the rivers in the West are fed by precipitation, which falls on forests either as rain or snow. In a typical forest environment, most water does not strike bare soil, but is caught by trees, other vegetation, or the litter layer of dead leaves and branches that cover the ground. This process is known as **interception**. Interception minimizes erosion by preventing rain from striking the soil directly. Most of this intercepted precipitation eventually works its way to the soil, streams and underground aquifers, but in a forest environment intercepted moisture on trees and other vegetative surfaces—and even moisture on the soil surface—returns to the atmosphere by direct **evaporation**. Once water reaches the forest soil, trees and other vegetation use it for growth and other life processes. From the soil, roots take water (**soil uptake**), which moves upward through the plants into leaves and back into the atmosphere in a process called **transpiration**. These processes of interception, evaporation, soil uptake and transpiration are known collectively as **evapotranspiration**, which can return a significant portion of the precipitation to the atmosphere. The amount varies with the type and density of the vegetation as well as the climate.

Most water works its way to the soil, where gravity ultimately carries it to streams or underground aquifers. This flow or movement of water to streams happens in several ways. Most commonly water seeps into the soil, moving toward streams through myriad small channels in the upper soil levels. This movement is known as **subsurface flow**. Some water seeps deeper into the soil through **groundwater flow**, eventually reaching underground aquifers. Water that sheets across the soil surface is known as surface or **overland flow**. This movement is very uncommon in Oregon forests because of the litter layer that protects the soil and the high porosity of forest soil. It generally occurs only in high intensity rainfall events such as thunderstorms, or when the soil is saturated.

It is very difficult to make generalizations about water movement in the forest because, as the illustration shows, it is a complicated process that varies with forest type, soil type, geology, topography and climate. Soils, not trees as sometimes assumed, act like sponges by slowly releasing water to streams. Timber harvest generally increases streamflow by reducing transpirational losses, but not measurably unless a large portion of the watershed—more than 25 percent— is clearcut over a very short period of time.

THE FOREST WATER CYCLE



Forest soils act as a natural filtration system resulting in high-quality source water that requires minimal treatment.

George Brown
Dean Emeritus,
College of Forestry,
Oregon State
University
Corvallis, Oregon

George Brown, whose specialty is forest hydrology, has watched forestry respond to the need for clean water in Oregon over the past four decades. "I've talked with foresters who conduct operations in municipal watersheds," he says. "They have a strong sense of purpose and are constantly mindful that they are working near their neighbors'—and often their own—water source. We've learned a tremendous amount about how to minimize the impact of forest management on our streams. We know, for example, how to reduce the amount of sediment entering streams, but it's important to remember also that sedimentation is a process that goes on all the time. Erosion shapes our landscape whether people are there or not."

Reforestation

The Challenge. Every year in Oregon more than 45 million new trees are planted, generally after clearcut harvests. Tree planting itself has a minor positive effect on water quality through increased soil stability and in the long run helps maintain forest cover and health. However, to ensure that new seedlings are protected from competing vegetation until they are well established, foresters may apply herbicides or fertilizers, which then have the potential to enter streams. Such applications are sporadic and occur briefly and usually only in the early stages of a rotation cycle—perhaps once or twice every 40 to 50 years. This is a small amount when compared with the quantity of chemicals used in agriculture or in residential areas.

Preventive Measures. Much study has been done on the effects of chemical use on water quality in Oregon and the Pacific Northwest. Oregon forest protection laws require that chemicals not be applied directly to waterways or riparian zones. For example, operators cannot spray on windy days when airborne chemicals could travel to open water. Control methods include careful selection of chemicals low in toxicity, careful timing of applications and alteration of application methods. All have been highly effective, according to Paul Adams, in reducing or eliminating stream contamination.

Fire Prevention

The Challenge. Wildfires in forest environments can have catastrophic effects on water quality. Besides the presence of ash in the water, the potential for erosion occurs from the elimination of protective duff and vegetation. Rain splash is greatly increased, and the resultant disturbance of the soil loosens sediment and increases chances of its movement toward streams. In addition, a fire affects the character of the soil, altering its ability to absorb water. This can cause erosion (by increasing surface runoff) or mass movement (landslides).

Preventive Measures. Over the last century, as the public increasingly has turned to the forest for recreation and development, foresters have developed numerous fire reduction and containment techniques. The practice of thinning trees is a major fire reduction method. Providing more space between trees lowers the risk of fire spreading from tree to tree. Thinning has the added virtue of enhancing forest health, positively changing forest structure to allow remaining trees to thrive. Access to a fire site, primarily through forest roads, is critically important to fire containment. A good road system can provide timely, cost-effective access for fire-fighting vehicles and personnel to reach remote forest areas.

Fuel reduction — removing flammable organic material from areas of the forest—greatly reduces the risk of fire spreading. Depending on the terrain and forest type,

mowing certain brush species is an effective technique. The resulting slash is then burned in periods of low fire risk, usually in the spring or fall. Prescribed burning is another way of using fire to fight fire. Another is to crush organic waste on site to speed up its breakdown and return to the soil. Finally, early detection is a highly effective fire reduction technique, and vigilant monitoring in periods of high risk prevents many small fires from spreading.

Fire is one of the most complex issues facing society, often bringing out conflicting human values and objectives. Before there was any human presence or intervention, fire was a natural part of the forest ecosystem. In the historic westside forest cycle, old growth forests ultimately burned, periodically clearing large portions of the landscape and preparing the forest for new growth. Fire suppression first began about a century ago to protect timber resources, but as population increased and forestland was converted to urban use and farmland, protection from fire became more urgent. It is even more so today, as more people are building homes in remote areas of forestland.

Forested watersheds — the primary source of Oregon's municipal drinking water supplies — are under constant threat of fire, yet there is often reluctance to employ forest management techniques that can help prevent fires because they are in conflict with the philosophy of minimizing human disturbance.

Forestry Activity In Municipal Watersheds

According to the recently completed fact book and catalog of Oregon's municipal watersheds by Adams and Taratoot (see page 3), most of the 30 largest water systems have

Astoria owns its 3,700-acre watershed, and does conduct some forest management activity — mostly thinning — for general forest health. The four pools adjacent to the reservoir shown here comprise the city's slow sand filtration system, which provides 6.2 million gallons of water per day.

George Ice
Principal Scientist
National Council for Air and Stream Improvement
West Coast Regional Office
Corvallis, Oregon

"If we look at data from the U.S. Geological Survey National Water Quality Assessment (NAWQA) program, it becomes clear that water quality from Oregon's forested watersheds is among the best in the nation. One of the fascinating things about forestry is the way long forest growing cycles have necessitated an adaptive management approach — instituting practices based on current science and altering them as new research is done. This is particularly true with water quality in forest streams, where foresters for some decades now have critically studied research and observed the impact of forest practices like road construction, riparian management and harvest methods on stream health. By recognizing problems and potential problems, they are better able to come up with good management solutions, and in the case of water, the NAWQA studies are a testament to their success."

had significant timber harvests and other types of forest management activities in the recent past.

Some municipalities conduct commercial logging in their watersheds to help offset costs and keep water bills down. Some do noncommercial clearing and thinning to lessen the threat of fire. Others thin trees of commercial value for the health of their forests. And there are those who do nothing. For the most part, the array of forest management activities is a result of differing perceptions and objectives as well as the varying needs of particular watershed landscapes. The three water systems mentioned earlier — Bend, Astoria and Dallas — represent the spectrum of forest management.

Roger Prowell
Water Division
City of Bend Public Works

Roger Prowell, who manages Bend's municipal water supply, says the Bridge Creek watershed provides some of the best drinking water in the country. Although the water is chlorinated, Bend's is one of the few systems in the state with an exemption from filtering. "Bridge Creek is in pristine, old-growth hemlock," he says. "Our chief issue is the threat of fire, which is the final fate of all old-growth forests. When that happens, and it will, we're either going to have to begin filtration or use ground water for some years until the land recovers."

Bend and the Bridge Creek Watershed

For Roger Prowell of the City of Bend's Water Division, maintaining the quality of the city's drinking water has been part of his life for the past 15 years. He has hiked Bend's pristine Bridge Creek watershed many times and has supervised major well and treatment facility installations. Bend's is one of the few systems in the state (Portland and Baker City are the others) with a federal exemption from filtering water.

Bridge Creek lies totally within the boundaries of the Deschutes National Forest, whose management is under the Forest Service. "There is no timber harvest in our watershed," Prowell says. "Basically we don't need it." Bill Peterson, a district ranger with the Bend-Ft. Rock Ranger District of the USDA Forest Service, agrees: "This unusual watershed is primarily older hemlock forest. It's long-lived, relatively stable and self-thinning. Stand tending and fuel reduction are emphasized in the mixed conifer stands that surround the watershed—stands that have a much higher potential for wildfire that could compromise watershed integrity."

The city and the Forest Service have an excellent relationship. Through a Memorandum of Understanding signed in 1991, each party communicates with the other about any anticipated changes or activities related to the watershed. "They're my favorite agency to work with," says Prowell.

But all is not totally rosy in Bend. A recent story in the local paper says the city is preparing for a devastating forest wildfire this summer that could eliminate Bridge Creek as a source of city water. "We're nervous," Prowell says in the article. "It's ripe to burn. It's not a matter of if but when." Here the practice of minimal management comes into conflict with the real danger of catastrophic fire.

The watershed almost burned in a 1979 fire and would have if the wind direction had been west rather than east. Even so, the '79 fire burned for four days and covered 4,500 acres. Prowell says the fire was so hot that the creek, whose water temperature is usually in the lower 40s, at one point heated up seven degrees in nine minutes. Peterson notes

that the fire actually started on drier forestland just within the watershed and then spread out of it. New trees planted in the burned areas are now two decades old, and Peterson said the Forest Service and the city will soon have to discuss thinning.

Bend and the Forest Service are aggressive about watching for fires and catching them early, particularly in high-risk periods. New and sophisticated equipment that measures temperature, humidity and wind has helped, but lack of fuel-reduction practices has resulted in a buildup of flammable organic matter. For the immediate future, concern and vigilance remain the best alternatives. Bend has also invested heavily in wells so that groundwater can replace surface water in the event of catastrophic fire.

Astoria's Bear Creek Watershed

At 3,700 acres, Astoria's watershed is about the same size as Bend's. Unlike Bend, however, it lies in a prime western hemlock and Sitka spruce forest influenced by the region's dramatically higher rainfall and more temperate coastal climate. Also, Astoria owns its entire watershed and does conduct some harvest and forest management activities based on guidelines developed by the city and Oregon State University's College of Forestry.

"We don't harvest for the money," says City Engineer Mike Caccavano, who is involved in managing the watershed and its reservoirs. "The quality and quantity of our water supply is our highest priority, but we want the forest in our watershed to be healthy."

Having been logged in the '30s, '40s and '50s when it was in private ownership, the forest is not old growth. Astoria started thinning operations in the '80s to control alders that can negatively affect water quality, and in other areas thinned conifers as well. Some of the tree removal was by cable yarding—an aerial system requiring less vehicle activity—thus minimizing soil disturbance. The city focuses on low-impact logging, Caccavano says.

"Our thinning is restricted," he says, "and we only conduct operations in the summer and fall to minimize wear on our roads. We're careful to stay away from our creeks, and we seed and water bar our trails to minimize erosion. We do what we have to so that our forests remain healthy."

Dallas and the Rickreall Watershed

The situation in Dallas is dramatically different from Astoria's or Bend's because Rickreall Creek, the source of the city's water, flows through prime commercial timberland that is actively managed by its primary corporate owners, Boise Cascade and Willamette Industries. Since the forest in the watershed is Douglas fir and other conifers typical of the east slope of the Coast Range, clearcutting and some thinning are the harvest methods of choice.

Michael Caccavano
City Engineer
Astoria Public Works
Astoria, Oregon

Michael Caccavano is an engineer who has done graduate work in forestry. The latter experience has served him well in managing Astoria's 3,700-acre watershed. He has supervised logging in the watershed, principally thinning operations to promote forest health. During and after such work, he has carefully observed the water supply for signs of disturbance. "I plotted turbidity in the creek," he says, "and could not find a correlation between high sediment content and forest operations we conducted. In fact, one of our worst periods of turbidity occurred when we hadn't done any logging for a while. My experience has been that rainfall is more of a factor."

Roger Jordan
City Manager
Dallas, Oregon

"Dallas's drinking water comes from a watershed that is in active commercial timberland, yet our water quality is very high. There are several reasons that we've been able to minimize any logging impact. First, we have maintained excellent lines of communication with the landowners. They tell us where and when they are planning harvests or any other activities that might affect the watershed. Second, the city had the foresight to invest in a sophisticated filtration system. It's true that we are aggressive about treatment, but our water still comes from a clean, forested watershed. It's a lot easier to deal with than farther down on the valley floor where there's farmland, herbicides, pesticides, chemicals and industrial waste to cope with."

The City of Dallas watershed lies almost totally in actively managed commercial timberland. "We get excellent water out of the Rickreall River," says assistant public works director Kenn Carter (above). City Manager Roger Jordan credits the city's good water to its foresight in investing in an excellent water filtration system and close communication with the watershed's forest landowners.

City Manager Roger Jordan ascribes Dallas's water quality to good communication with the forest landowners and a sophisticated filtration system. The Rickreall Watershed Council was formed in 1997 to address management issues and promote a healthy watershed. Its 17 members represent all the constituencies: the city and county; environmentalists; farmers; private landowners Boise Cascade, Willamette Industries and Tyco Industries; and the U.S. Bureau of Land Management. In typical Oregon fashion, the council operates by consensus.

Mike Hicks, a forester with Boise Cascade, says the company does have an agreement with the city not to open the land for public use, but other than that conducts operations to the same standards in the watershed as on all its other land. "We have employees who live in Dallas," he says, "and they tell us the water is great."

Kenn Carter, the city's assistant public works director, corroborates that report. "We get excellent water out of the Rickreall," he says. "We do regular monitoring and we've never exceeded any of the safety limits."

Dallas also has dealt with the fire issue. A 1987 fire burned 40 percent of the land in the upper Rickreall watershed. There is no way to correlate resultant sediment runoff with the fire, but officials speculate that it may have contributed to sediment buildup in the city's reservoir following the major Pacific storms of 1996.

Forests And Streams

The interaction between Oregon's forest streams and forest management goes back more than a century. As communities grew and the need for water became a municipal issue,

cities and towns turned to forest watersheds as a source of clean drinking water. The growth in water demand coincided with the growth in the country's demand for high-quality lumber. As forestry increased, so did the potential for disturbance of the hydrologic cycle.

There is a complex and symbiotic relationship between forests and the streams that run through them. Of all land uses, forests are among the best sources of clean water because of their porous soils, canopy covers and limited human access. As understanding of the forest ecosystem has grown, the Oregon Forest Practices Act institutionalized responsible stewardship and has developed extensive regulations governing forest management near streams. Its riparian protection measures and road construction standards are designed to keep stream temperatures healthy, provide a buffer between the stream banks and forestry activity, and prevent erosion and the entry of sediment into stream channels.

Quoting the Oregon State of the Environment Report 2000, "Using 1997 as an example, instances of good or excellent water quality occur most often in the forested uplands of Oregon. Both forest practice rules on public and private forests and lack of development help explain this result. On the other hand, instances of poor or very poor water quality occur most often in the nonforested lowlands where intensive land uses and land conversion have occurred." The report continues, "Streams within urban, range and agricultural areas are the most likely to have water classified in the poor and very poor categories."

Looking to the future, water quality and the state of Oregon's drinking water will continue to be a bellweather issue, often bringing attention to diverse perceptions and competing management objectives when the public wants recreation, housing, timber, wildlife habitat and clean water, all from the same piece of land.

The Safe Drinking Water Act amendments of 1996 require that each state conduct source area assessments of all public drinking water sources on both public and private lands and report to the public about the condition of those water supplies by 2003. A recently published USDA Forest Service report, *Drinking Water from Forests and Grasslands: A Synthesis of Scientific Literature*, examines water quality in forests and grasslands as influenced by both natural processes and land use practices. The report reaffirms that these watersheds produce cleaner water than those affected by other land use practices.

Forestry has addressed erosion, fire protection and other management issues as they have occurred, and has responded with solutions that mitigate or minimize problems. Maintaining water quality has become one of the measures by which professional foresters are judged. Clearly forestry activity and high-quality water can coexist, but future population growth will present major policy choices and challenges as citizens work to maintain the excellence of the drinking water supplies that Oregonians have come to expect and continue to enjoy today.

Hugh Buchanan
Chairman
Rickreall Watershed Council
Dallas, Oregon

Hugh Buchanan is a regional environmental coordinator for Willamette Industries. He also chairs the Rickreall Watershed Council, a stewardship group that promotes environmental and economic sustainability in the watershed that supplies water for the city of Dallas. "The forests that Rickreall Creek flows through are active commercial timberland owned by Boise Cascade and Willamette Industries," he says, "and Dallas's water quality remains excellent. I'm proud of the progress made by the watershed council. All the stakeholders from the environmental community to the landowners and the city participate, and we have operated by consensus since we began."

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