WILLAMETTE BASIN

STATE OF OREGON

WATER RESOURCES DEPARTMENT

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INTRODUCTION

PURPOSE OF REPORT

The purpose of the Willamette Basin Report (report) is to present the information and data that the Water Resources Commission (Commission) relied upon to revise the Willamette Basin program. The Commission is responsible for managing the state's water resources. The Commission sets water policy statewide through a series of coordinated, interagency water resources programs pursuant to Oregon Revised Statutes 536.300 and 536.310. Basin programs are administrative rules that govern the use of water in an administratively defined basin, such as the Willamette Basin.

The Willamette Basin program contains a set of policies, objectives and provisions that govern the future use and control of unappropriated surface water and groundwater in the Willamette Basin (Figure 1). The program prescribes the uses that may be made of both surface water and groundwater, and directs the Water Resources Department's (Department) water use permitting activities. The administrative rules which comprise the Willamette Basin program are the primary product of a planning process undertaken to update a series of programs originally adopted for the basin in the 1960s. These rules also implement those management strategies identified in a companion document, the Willamette Basin plan (plan), that are within the regulatory authority of the Commission.

In addition to basin programs, the Commission often approves plans for each individual basin. The basin plans contain recommendations to address the water resource issues that are evaluated during the planning process leading up to Commission adoption of a basin program. The Willamette Basin plan contains policies and strategies addressing each issue discussed in this report. The plan identifies policies and actions to be implemented by the Department and also recommends actions for implementation by other agencies.

This report provides supporting data on the six water resource issues that were the focus of the Willamette Basin planning effort. These issues are: 1) surface water allocation, 2) groundwater management and protection, 3) municipal and domestic water systems, 4) state coordination in US Army Corps of Engineers (Corps) regulation of the Willamette reservoir system, 5) water conservation and drought planning, and 6) land use coordination. It describes the management strategies and alternatives available to the Commission in addressing each of the issues. The Department identified these issues during the basin planning process through input from the general public and federal, state and local government resource management agencies.

Section 2

SURFACE WATER ALLOCATION

PROBLEM STATEMENT

The Willamette Basin is the largest river basin in Oregon. It supports most of the state's population, larger cities and many major industries. The basin also contains some of Oregon's most productive agricultural lands and supports important fishery resources. Water-dependent and water-related recreational opportunities abound on the basin's lakes and streams.

These and other uses place a growing demand on the surface water and groundwater resources of the basin. Seasonal water demands are exceeding water supplies with growing frequency. Competition between instream and out-of-stream uses is intensifying. Recent water legislation reflects a growing public interest in conservation, instream values and water for future economic development. In addition, the public is increasingly concerned about the need for, and obstacles to, reservoir storage for out-of-stream uses and stream flow improvement.

Existing water allocation rules and management strategies must be updated to reflect changing conditions. These changing conditions include population growth and development trends, increased water demands, changing social values, and the public interest obligations of the Water Resources Commission.

Although the Commission has primary administrative authority, other agencies also have a role in managing water in Oregon. For example, in some locations the Legislature has withdrawn streams from further water use, granted cities exclusive rights to certain waters, and established scenic waterways. The Northwest Power Planning Council (NWPPC) influences the use of water for hydroelectric development through the designation of protected areas, and the Department of Environmental Quality (DEQ) controls effluent discharges through a permitting process (National Pollutant Discharge Elimination System). Counties and cities govern land uses which demand water, and special districts serve as major water providers throughout the basin.

Current water availability and use, as well as future needs, must be evaluated to determine appropriate allocation policies and to identify strategies for implementing those policies. This section of the report provides a brief overview of

The permit has a priority date which establishes its standing relative to all past and future rights. Older or "senior" water uses have a higher priority and can preempt younger or "junior" uses during times of shortage. The Department enforces water rights and permits according to priority date.

The Department places conditions on water use permits for various reasons, including limited water availability. Conditions may prevent the use of water after a certain time each year when availability estimates show that a stream is fully appropriated.

In the Willamette Basin, the Department limits irrigation use to one cfs per 80 acres. The maximum quantity of water applied to a crop may not exceed 2.5 af of water per acre during the irrigation season. Nursery use is allowed at a rate of 0.15 cfs per acre, with the maximum quantity applied to nursery crops not to exceed 5.0 af per acre per year. A compilation of the water rights issued in the basin is provided in Appendix B.

Instream Water Rights

The Legislature created instream water rights in 1987. Instream water rights are water rights held in trust by the Water Resources Department to support public uses in streams and lakes. Only ODFW, DEQ, and PRD may apply for instream water rights. Approximately 110 instream water rights have been established in the Willamette Basin through conversion of minimum streamflows or approval of applications. Most of the converted instream water rights have a priority date of June 22, 1964.

Instream water rights can also be established by transferring a valid out-of-stream water right to instream use through purchase, lease or gift. Instream water rights created in this manner retain the original water right priority date. A water right leased for instream purposes may be used again for its original purpose at the end of the lease without loss of priority.

Citizens who implement water conservation measures and return a portion of the conserved water to the stream may request establishment of instream water rights on that conserved water.

ODFW, DEQ, and PRD have named 240 streams in the Willamette Basin that warrant the establishment of instream water rights. Instream water rights cannot be set on these streams as part of the Willamette Basin planning process, but must be established through the application procedure. However, the streams may be classified to protect public instream values. The streams are listed in Appendix C.

WITHDRAWAL FROM FURTHER APPROPRIATION

Waters of the state may be withdrawn from further appropriation pursuant to ORS 536.410. Withdrawals are most commonly used when streams or aquifers are fully appropriated and unable to support further development. The Commission must hold a public hearing prior to issuing a withdrawal order. Like classifications, withdrawals can specify the time of use, amount of water, and beneficial uses allowed.

The Commission may withdraw streams as part of the basin planning process but to date has used this tool sparingly. In the Willamette Basin, the Commission's only withdrawal is a groundwater withdrawal in a three- square-mile area of the Parrett Mountain Groundwater Limited Area located in Clackamas and Washington Counties.

The Legislature may also withdraw waters from further appropriation. Legislative withdrawals have been made almost exclusively for the protection of municipal or public instream values. The State Engineer, the Commission's predecessor, withdrew a number of streams in the basin and many of these withdrawals remain in force today. Statutory and State Engineer withdrawals are listed in the proposed classifications and in Appendix E.

LIMITED LICENSES

The Department can issue limited licenses to use surface water and goundwater for purposes such as fire fighting, small storage ponds, trucked water for livestock, forest and rangeland management, fish passage, road construction and maintenance, construction, and the initial filling and testing of waste water lagoons. The use of water under a limited license is limited to a 180 day period within a calendar year and subordinate to all other permitted or certificated uses. Limited licenses can be revoked if such uses harm other water users, minimum streamflows, or instream water rights.

RESERVATIONS OF WATER FOR FUTURE ECONOMIC DEVELOPMENT

The 1987 Legislature created a process by which any state agency may request that the Commission reserve unappropriated water for future economic development. The Department's Division 79 administrative rules describe the process by which an agency may request a reservation. Reservations are established solely through a contested case proceeding and an order of the Commission. A reservation bears the priority date of the request or agency application.

Reservations function as a type of "water banking." The reserved water may not actually be withheld from appropriation, but the right to future use is senior to those uses approved after the reservation is established.

The Oregon Department of Agriculture (ODA) has identified significant amounts of surface water needed for future irrigation in the Willamette Basin. The details of ODA's proposal to reserve water are provided in the Discussion portion of this section.

CRITICAL GROUNDWATER AREAS

Critical groundwater areas are established by order of the Commission as authorized in ORS 537.735. The Department may initiate critical groundwater area proceedings if certain conditions exist. These conditions include excessive groundwater level declines, interference between wells, well interference with geothermal production, interference between pumping wells and surface water, groundwater overdraft, and groundwater quality which threatens public welfare, health and safety.

Critical groundwater area orders contain provisions for restricting groundwater use. Commonly, the order will halt further groundwater development within area or sub-area boundaries. Existing groundwater uses may also be reduced. The Commission may establish the total permissible pumpage, allow certain uses, regulate individual users or wells, establish a rotation system for groundwater use, or use other alternatives to correct the problems.

In the Willamette Basin, only one critical groundwater area is currently in force. This is the Cooper Mountain-Bull Mountain Critical Groundwater Area in Washington County. The State Engineer established this critical area by order on May 17, 1974. The Commission reaffirmed the critical area designation on January 5, 1990. Figure 33 shows the critical area boundary.

SERIOUS WATER MANAGEMENT PROBLEM AREAS

Serious water management problems may include groundwater declines, user disputes, and frequent water shortages. Oregon law requires water use reporting by certain public entities as classified in ORS 540.435. The law allows the Commission to require water use reporting in areas with serious water management problems. The Commission is not given the additional authority to control water use in these areas but conservation measures and other tools available to the Commission can be used to bring the problems under control.

ADJUDICATIONS

Many of the oldest water rights in the Willamette Basin are not officially recognized yet. Water rights have been established through a permit process since February 24, 1909. However, certain water uses in the Willamette Basin began prior to 1909 and are valid until determined otherwise. These rights are known as "undetermined vested rights," "undetermined claims," or "unadjudicated rights." Undetermined claims can be verified, and if found valid, assigned priority dates in a judicial (court) process known as adjudication. In an adjudication, the rights become "decreed rights," "adjudicated rights," "vested rights," or "perfected rights."

An adjudication relies on physical evidence and testimony from witnesses with first-hand knowledge about the history of the claim. As time passes, more and more of the pre-1909 water claim records are lost as people from that time die. This makes adjudication increasingly difficult. As a result, the 1987 Legislature passed legislation to preserve the record of claims by requiring that all claims be registered with the Department by December 31, 1992.

About 38 percent of the Willamette Basin has been adjudicated. Unadjudicated areas include the drainages of the Middle and Coast Fork Willamette, McKenzie, Long Tom, Molalla and Clackamas Rivers. The Coast Range drainages, Tualatin, and the Santiam-Calapooia subbasins have been adjudicated. Some of the water rights to Willamette main stem tributaries have also been adjudicated. Figure 2 is a map of the Willamette Basin showing adjudicated and unadjudicated drainages.

Until the entire basin has been adjudicated, the total legal claims to water cannot be accurately assessed. Unadjudicated claims cast some uncertainty over the value of permitted rights. For example, the claim for use of water at Portland General Electric's Willamette Falls hydroelectric plant in Oregon City is still unadjudicated. The claim has the potential to call on a significant share of the flow of the Willamette River for power generation. Until decided by the courts, this claim is an unknown quantity that could affect the value of all junior upstream rights.

SCENIC WATERWAYS

The Oregon Scenic Waterway System created in 1970 by voter initiative included six streams. Over the last 20 years, the system has grown to include eighteen scenic waterways, including one lake. In the Willamette Basin, Waldo Lake and portions of the North Fork of the Middle Fork Willamette, McKenzie, Little

Figure 2
ADJUDICATED AREAS IN THE WILLAMETTE BASIN*

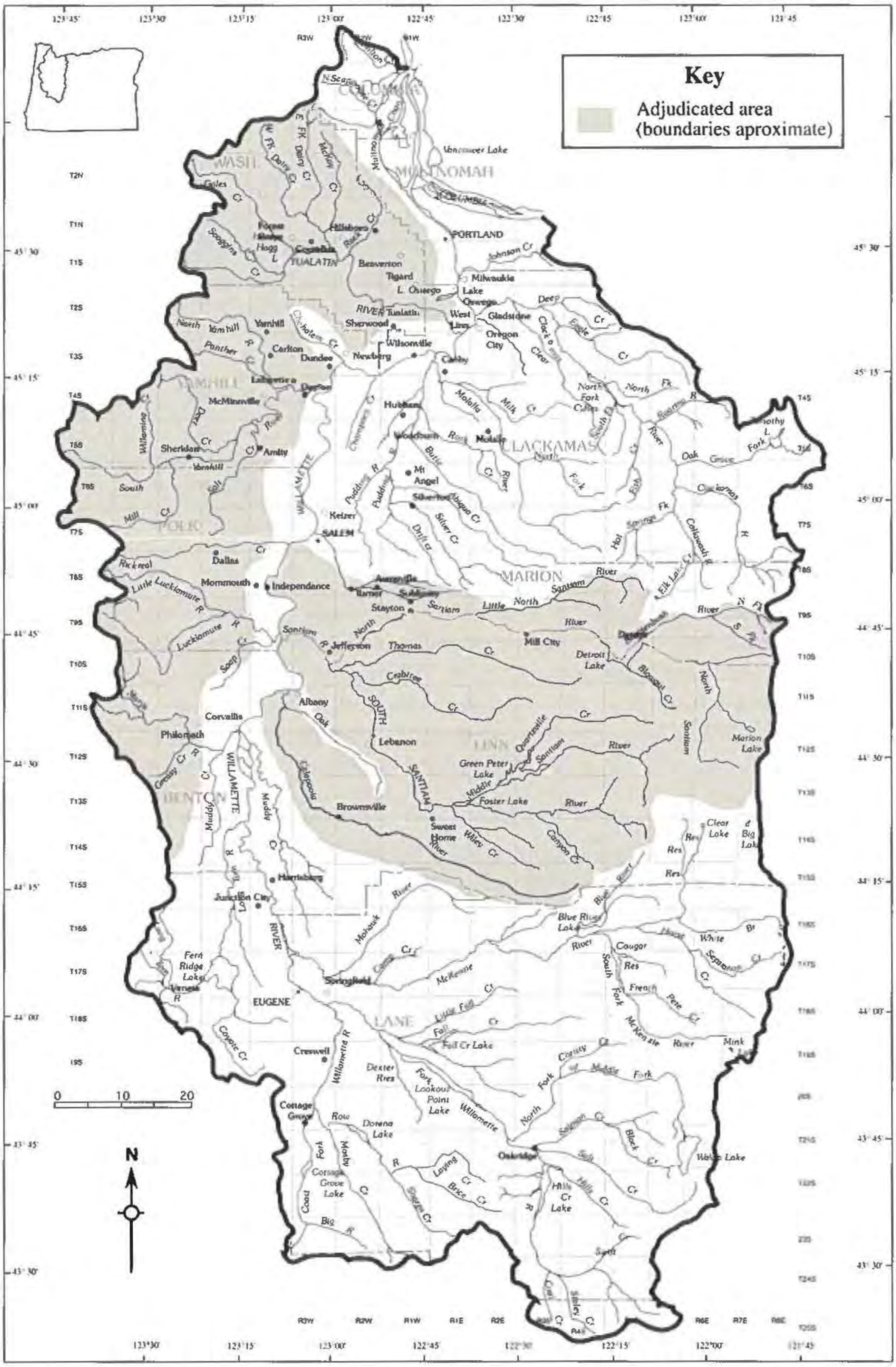


Table 1

WILLAMETTE BASIN SCENIC WATERWAYS

Water Body	Reach	Miles	Year	Process
Clackamas River	River Mill Dam to Carver Bridge	15	1975	Legislative
North Fork of Middle Fork Willamette River	Waldo Lake to one mile above Westfir railroad bridge	43	1983	Legislative
Waldo Lake	N/A	N/A	1983	Legislative
Little North Santiam River	Confluence of Battle Ax & Opal Creeks to USFS boundary	7	1983	Legislative
Clackamas River	River Mill Dam to Carver	12	1975	Legislative
	Olallie Lake Scenic Area boundary to North Fork Res.	54	1988	Initiative Petition
South Fork Clackamas River	River mile 4 to mouth	4	1988	Initiative Petition
North Fork Clackamas River	Source to North Fork Reservoir	12	1988	Initiative Petition
McKenzie River	Clear Lake to Carmen Reservoir	2	1988	Initiative Petition
	Tamolitch Falls to Trail Bridge Reservoir	2	1988	Initiative Petition
	Trail Bridge Dam to Paradise Campground	10	1988	Initiative Petition
South Fork McKenzie River	Three Sisters Wilderness Boundary to Cougar Reservoir	16	1988	Initiative Petition
	Cougar Dam to mouth	4	1988	Initiative Petition

North Santiam, and Clackamas Rivers are designated state scenic waterways. Table 1 lists each waterway, the date it was added to the system, and how it was established.

Oregon law (ORS 390.835) declares that recreation, fish, and wildlife are the highest and best uses of the waters in a state scenic waterway. Dams, placer mining, impoundments, new diversions and fill or removal of material in the bed or banks of the waterway are prohibited.

In 1988, the Oregon Supreme Court, in resolving *Diack vs. City of Portland* (306 Or 287), interpreted the statutory protections afforded scenic waterways. The court declared that the law protects scenic waterway flows from diversions upstream of a scenic waterway reach. The Commission may only permit new diversions after making findings that the flows needed to maintain scenic waterway values will not be diminished to the point of impairing or conflicting with the uses of the scenic waterway.

The Department has determined the flow levels needed for recreation and fish and wildlife uses in the state scenic waterways. Flow levels for the scenic waterway reaches in the Willamette Basin were approved by the Commission in 1991 and 1992 and are shown in Appendix D. Figure 3 shows the scenic waterway reaches in the Willamette Basin and the drainage areas affected.

There are also a number of streams in the basin that are federally designated wild and scenic rivers (Figure 3). These include Quartzville Creek, tributary to the Middle Santiam River, portions of the Clackamas River and Roaring River (tributary to the Clackamas), the North Fork of the Middle Fork of the Willamette River, and parts of the McKenzie River. These wild and scenic rivers are managed by either the Bureau of Land Management or the U.S. Forest Service. Several other reaches in the basin are being studied for potential wild and scenic designation.

Federal law mandates the protection of the values identified in the designation of, or the management plan for, wild and scenic rivers. After determining the flow levels necessary to protect those values, the management agencies are coordinating with the Parks and Recreation Department to file for instream water rights. In addition, the federal may seek to assert rights to the use of water that it claims for itself to fulfill the purposes of the Wild and Scenic Rivers Act.

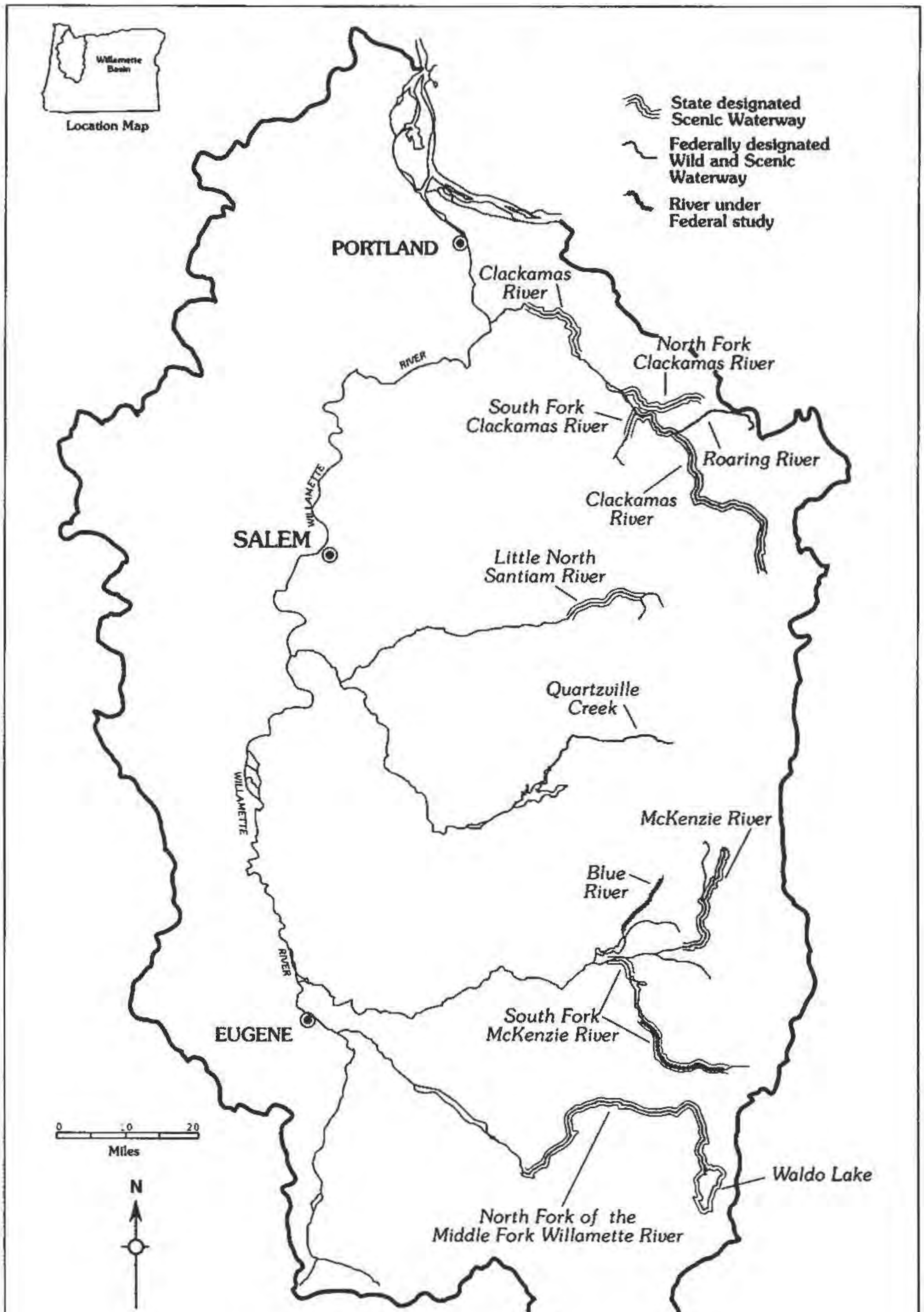
MANAGEMENT OF STORED WATER

About 1.6 million af of water is stored annually in Corps of Engineers reservoirs in the Willamette Basin. Congress has authorized use of this stored water for specific purposes, namely flood control, navigation, power, and irrigation.

Large amounts of water are stored in existing reservoirs in the Coast Fork, Middle Fork, Long Tom, McKenzie, and Santiam subbasins. The Bureau of Reclamation currently holds permits to use 1.64 million af of stored water for irrigation. However, as of 1987, irrigators had contracted for only about 36,000 af, or about two percent of the water from the entire storage system. Future irrigators could purchase existing stored water or work to develop additional storage in subbasins which do not currently have large storage reservoirs.

The Corps manages the uncontracted water in various ways. In some cases, reservoirs are kept full as long as possible through the summer to maximize

Figure 3
STATE AND FEDERAL WILD AND SCENIC WATERWAYS IN THE WILLAMETTE BASIN



summer lake recreation and power generation in the fall. This strategy requires large, rapid releases of water in the fall to meet flood control needs during high-runoff months. The Corps also releases water during low-flow months to meet instream needs. A certain amount is released to meet minimum requirements established in the Corps' own authorization (6,500 cfs in the main stem Willamette at Salem and 5,000 cfs at Albany for water quality). Often, however, the releases are made in response to requests from state agencies to meet fish, wildlife, water quality, and recreation needs.

Each year, the Corps develops an annual operating plan for Willamette Basin reservoirs. State agencies, local governments and various interest groups provide input to the Corps' plan. The Department is responsible for coordinating requests from state agencies to the Corps during preparation of the annual operations plan and release schedule. The Corps attempts to meet the demands so long as they do not interfere with other authorized purposes. This process is further detailed in Section 5, State Coordination in Corps of Engineers Regulation of Willamette System Reservoirs.

Under current administrative rules, the Department is obliged to protect releases from storage that are destined to meet an existing water use permit or water right. Storage releases that are not earmarked for downstream users with permits or rights are treated as natural flow available for appropriation.

The Department has proposed policies and implementing actions to improve management of storage releases in the Willamette Basin. These are included in the basin rules and plan.

DISCUSSION

This subsection contains a subbasin by subbasin analysis of water resources issues. Starting at the confluence of the Willamette and Columbia Rivers and working up to the headwaters, these include the Columbia, Willamette main stem, Tualatin, Clackamas, Molalla-Pudding, Santiam-Calapooia, Coast Range, Long Tom, McKenzie, Coast Fork Willamette, and Middle Fork Willamette subbasins.

Water conditions and uses vary significantly among Willamette River subbasins. Thus, each subbasin is discussed separately. However, the Lower, Middle, and Upper Willamette Basin units are used in this discussion to facilitate reference and comparison between earlier documents and the updated Willamette Basin program. Each subbasin section contains subsections entitled General Orientation, Water Availability and Needs, and Summary.

General Orientation provides information on the physical characteristics of the subbasin including topography, discharge, and land use.

Water Availability and Needs covers the types and amounts of water uses in the subbasin. Both instream and out-of-stream uses are discussed. Reference is made to actual water use where such information is available, as well as to the maximum use allowed by existing water rights. The discussion also includes information on projected water use, with particular emphasis on instream needs, irrigation and municipal uses. The extent to which water uses and needs are met, today and in the future, is also addressed in this subsection.

The discussion of non-consumptive uses is presented in terms of whether current out-of-stream demands and established instream water rights or minimum streamflows are being met. The analysis is primarily based on water availability but integrates several other criteria as well. The Department's methodology and assumptions are explained below:

1. Water availability was determined for more than 300 streams (the Department's database and methodology for determining streamflows are described in Robison, 1991). The analysis includes a number of stream reaches or points where gages and/or instream water rights exist. The analysis also includes streams identified by ODFW, DEQ, or PRD as "candidates" for instream water rights. These are streams where significant in-stream values are not yet protected by instream water rights.

2. The Department determined the 80 percent exceedence flows for the streams analyzed. The 80 percent exceedence flow at a given point on a stream for a particular month is the flow which is less than or equal to the average monthly flow every four out of five years. Using 80 percent exceedence flows was consistent with the Department's definition of "over-appropriated" (Oregon Administrative Rules (OAR) 690-400-010(6)).

3. The Department's water availability analysis reflects *actual use* of water from the stream (rather than the total amount of water use allowed by existing water rights). This means that the 80 percent exceedence flows are those expected after the usual diversions and return flows have taken place. For river reaches where flows are modified by reservoir operations, post-dam or regulated flows were used for the availability analysis.

4. To determine the surplus waters available for further appropriation, the Department subtracted instream water rights or minimum streamflows (including the storage component where one existed) from the 80 percent exceedence flows.

5. ODFW submitted instream water rights applications or identified instream flow needs for about 50 streams which do not yet have instream water rights or minimum streamflows. These instream flow needs were also subtracted from the 80 percent flows as part of the water availability analysis.

6. Water is assumed to be available for additional appropriations if flows are expected to exceed out-of-stream and instream needs.

7. Water availability and conditions were not determined for each individual stream in the basin. The Department applied general availability patterns found across a group of sample streams to neighboring streams within the subbasin based on location, topography, land use and other factors.

8. In addition to the water availability analysis, information on the Department's current water distribution activities and local conditions as recorded in the 1990 Surface Water Regulation Summary by Region (WRD, 1991) was used to assess water availability and needs.

9. The Department considered the mandate of laws establishing state scenic waterways to protect fish, wildlife, and recreation uses on these stream reaches.

10. The Department consulted other sources such as the 1990 Water Quality Status Assessment Report (DEQ, 1990) for information on water quality problems in the basin. This report lists various water quality problems associated with numerous streams in the Willamette Basin.

The discussion also focuses on consumptive uses in the subbasins. For example, ODA predicts that more than 195,000 additional acres will be irrigated in the Willamette Basin by the year 2010 than were irrigated in 1988 (Andrews, 1990). According to ODA, about 51 percent will rely on surface water supplies. ODA projects that acreage irrigated with surface water in the basin will increase from 171,426 to 338,375 acres, or about 98 percent by the year 2010. This is nearly double the estimates for surface water irrigated acreage in 1988. ODA contends reservations of water for future irrigation are essential to the stability of agriculture in the Willamette Valley. ODA is requesting that the Department reserve 654,700 af of water per year to meet future demand for irrigation.

Municipal water uses and needs are also evaluated. The discussion provides information on current municipal water use for peak use months. The Department used water reporting information from municipal providers where such reports had been submitted. Where no water use reports were available, the Department estimated water use based on population information and standard water use assumptions. Reported or estimated water use information was converted to average monthly rates of use, which were then compared with the allowable rate of use under existing municipal water rights. This allowed for a rough determination of how much municipal providers could expand their water service without needing expanded water rights. This potential growth factor was then evaluated in light of growth projections for the subbasin.

This approach is not intended to represent a complete analysis of municipal water needs. It has several limitations, including: 1) Water may not be available at the permitted rate if senior water rights are not satisfied. 2) Permitted rates in some cases include both natural flow and storage. Rights for water from storage may also be limited by the total volume of water which may be used over the year. 3) The water-use information shows average monthly use for the peak month, not peak daily use. 4) Other factors, such as system capacity, water quality, and treatment costs constrain expansion of water service even when water rights might allow such expansion. However, the approach does illustrate the extent to which municipalities are, in essence, reserving water for future use. This information is important when estimating how much water *could* be used under existing rights and the corresponding impacts on rivers and streams in the basin. A more thorough assessment of municipal needs is being undertaken in coordination with municipal purveyors.

Summary provides an overview of the information presented in the previous subsections.

LOWER WILLAMETTE BASIN

Columbia Subbasin

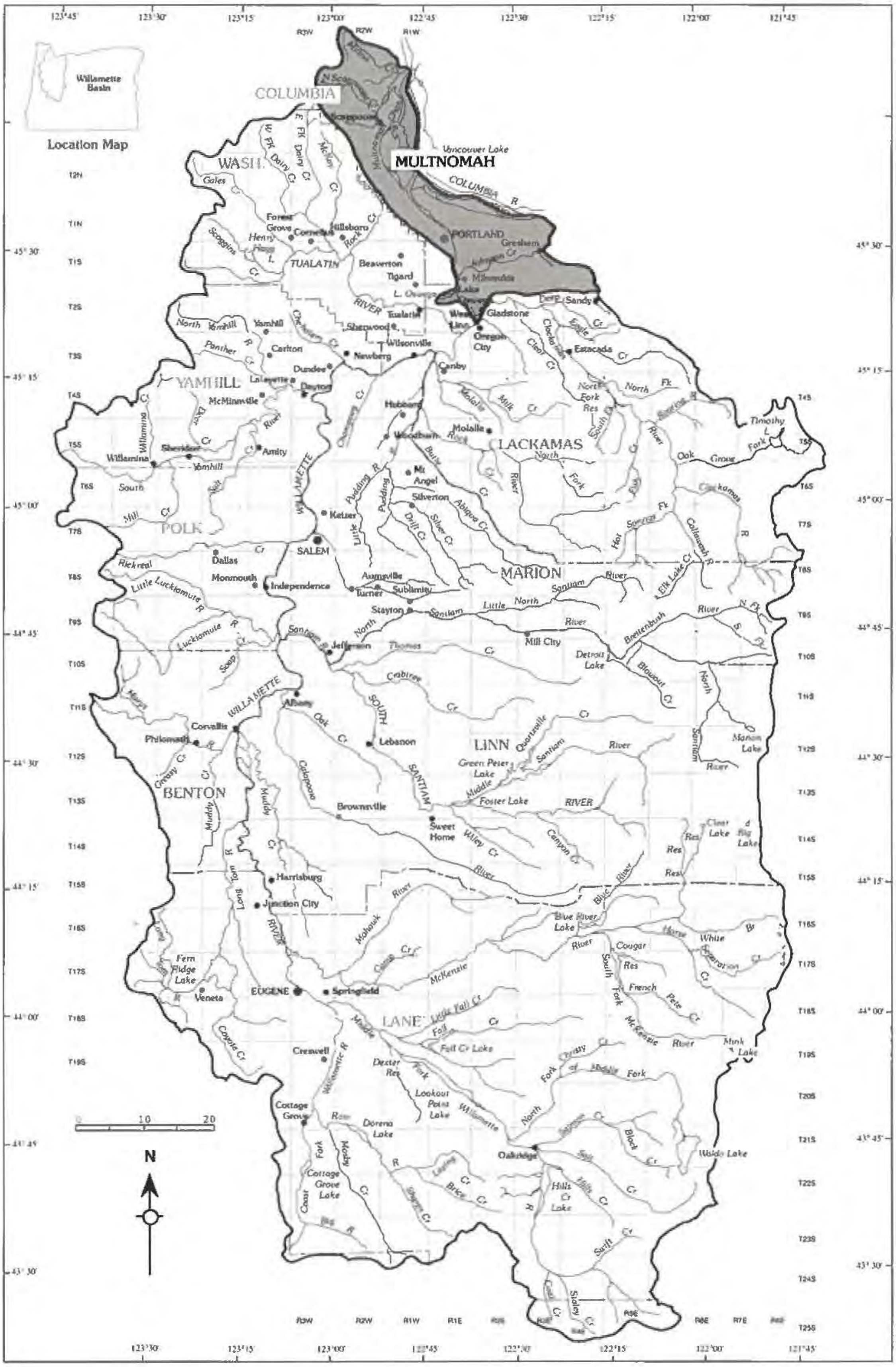
General Orientation

The Columbia subbasin, shown in Figure 4, occupies the downstream portion of the Willamette Basin. It includes the lower 27 miles of the Willamette River main stem, from Willamette Falls to the mouth, its tributaries along this reach, and stream systems draining into the Columbia River. Major tributaries to the Willamette River include Johnson, Kellogg and Tryon Creeks. In the northwestern portion, Scappoose and Milton Creeks are the largest tributaries to Scappoose Bay on the Columbia River.

The southeastern portion of the subbasin is largely urbanized, comprising Portland and a number of adjacent cities. The northwestern part is made up of low-lying flood plains along the Multnomah Channel and Sauvie Island, and the steep uplands of the Tualatin Mountains and Coast Range.

Runoff in the low-elevation watersheds in the subbasin reflects rainfall patterns rather than snow melt. Streams typically respond quickly to precipitation. Run-

Figure 4
COLUMBIA SUBBASIN



off from impervious surfaces in urban areas contributes to the flashy nature of flows in these streams. As an example, about 85 percent of the annual discharge in Johnson Creek occurs from November through March when rainfall is high (Appendix A). Only four percent is produced during the five months from June through October.

The main stem Willamette River flows for 27 miles through the Portland metropolitan area providing a waterway for commerce, recreation, and wildlife. The river is a natural focal point for the city. Along with providing recreational and aesthetic features, the Willamette is the migration corridor for all anadromous fish leaving and returning to the basin's rivers and streams.

Smaller streams in the subbasin have been affected by the rapid urbanization of adjacent lands. The streams have been rerouted, channeled, bridged and confined in concrete culverts. They have also become dumping grounds, their channels choked with debris and their waters polluted. In winter, streams are prone to flooding, which can cause significant property damage in adjacent lowlands.

Water Availability and Needs

Overview

The Columbia subbasin is unusual in that the major streams, other than the main stem Willamette, are statutorily withdrawn from further appropriation. Johnson and Scappoose Creeks and their tributaries have been withdrawn from further appropriation except for protection of fish life (ORS 538.170 and ORS 538.251). Milton Creek and its tributaries are withdrawn from appropriation except for domestic purposes and seasonal storage (538.300).

Water rights would allow about 25 cfs to be diverted from Kellogg Creek. Most of this use would be for irrigation of agricultural lands with some water allocated for miscellaneous uses (Appendix B). About 24 cfs can also be diverted from Johnson Creek, including 16 cfs for agricultural purposes and four cfs for industrial purposes. Water rights allow the diversion of about 26 cfs from Scappoose Creek. Of this, 14 cfs can be diverted for municipal use. The remainder of the water may be used for agricultural and industrial purposes. Water rights on Milton Creek allow diversions of nearly 72 cfs. More than 70 cfs are designated for municipal uses.

Water rights regulation in the Columbia subbasin is rarely needed. Development is modest and the uses are compatible with the seasonal flow regime. The Department has not found it necessary to condition new permits in this area based on limited water availability.

Nonconsumptive Uses

Minimum Streamflows

A minimum perennial streamflow is set for the Willamette River above Willamette Falls (just upstream from the subbasin boundary) to the mouth. This minimum streamflow involves a natural flow component of 1,500 cfs with a storage component of up to 4,700 cfs. The flow is needed through the Portland harbor reach to the mouth for water quality purposes. Sufficient flows are available to meet the combined minimum of 6,200 cfs year-round (Table 2).

Instream Water Rights

Instream water rights have also been established for 13 streams in the Milton and Scappoose creek drainages. The primary purpose of these instream water rights is to support aquatic life. The Department estimates that flows can satisfy existing out-of-stream uses and has established instream water rights on Milton Creek and its tributaries. However, streamflows drop to relatively low levels from July through October (Table 3).

The Legislature has withdrawn Milton Creek and its tributaries from appropriation for all but domestic use and seasonal storage. Flows in Scappoose Creek cannot meet the existing out-of-stream demands and instream water needs during any months of the year.

Consumptive Uses

Agricultural Use

ODA has estimated that about 8,175 acres were irrigated in the Columbia subbasin in 1988. ODA also projects that irrigated agriculture will decline by 1,175 acres over the next 20 years due to urban expansion in the subbasin.

This decline would reduce total irrigation demand by 2,702 af. The acreage irrigated with surface water is expected to decrease from 6,376 (1988) to 6,240 acres by 2010 (Weber, 1991). The corresponding decrease in surface water demand is predicted to be about 313 af per season. No reservations for future irrigation use are requested in the subbasin.

Table 2

MINIMUM FLOW ANALYSIS

1. Willamette River near Willamette Falls

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	31,235	34,930	29,868	28,995	21,693	11,389	5,580.5	3,293.4	3,738.9	6,413.8	16,568	28,449
80% Ex. Regulated Flow	33,530	28,465	22,197	17,561	14,395	9,324	6,617.6	6,854.1	9,666	13,220	20,838	36,908
Min. Flow (Natural)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Addl. Releases from Storage	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700
W. A. Unregulated	29,735	33,430	28,368	2,7495	20,193	9,889	4,081	1,793	2,239	4,914	15,068	26,949
W.A. Regulated	27,330	22,265	15,997	1,1361	8,195	3,124	418	654	3,466	7,020	14,638	30,708

Table 3

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

COLUMBIA SUBBASIN STREAMS

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Milton Cr. > Scappoose Bay	0	18.75	50%	105.3	104.9	74.2	57.4	28.5	14.4	9.3	5.2	5.8	10.6	37.6	103.4
			80%	49.7	60.3	47.4	39.3	19.3	10.0	4.7	3.6	3.7	6.4	19.7	45.9
			IWR CERT	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0
			AVAILABLE	24.7	35.3	22.4	14.3	19.3	10.0	4.7	3.6	3.7	6.4	-5.3	20.9
Cox Cr > Milton Cr	0	3.07	50%	18.8	18.4	12.9	9.2	6.2	3.3	2.2	1.3	1.3	1.5	6.1	19.0
			80%	8.3	10.3	7.9	6.1	3.9	2.0	1.0	0.9	0.9	0.9	3.0	7.9
			IWR CERT	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0
			AVAILABLE	2.3	4.3	1.9	0.1	3.9	2.0	1.0	0.9	0.9	0.9	-3.0	1.9
Salmon Cr > Milton Cr	0	3.94	50%	25.1	24.7	17.4	12.6	8.6	4.5	2.9	1.6	1.7	2.2	8.7	25.5
			80%	11.3	13.9	10.7	8.4	5.4	2.8	1.3	1.2	1.1	1.2	4.3	10.9
			IWR CERT	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0
			AVAILABLE	6.3	8.9	5.7	3.4	5.4	2.8	1.3	1.2	1.1	1.2	-0.7	5.9
N Scappoose Cr > Scappoose Cr	0	4.58	50%	27.4	27.0	18.9	14.1	4.7	2.2	1.5	0.8	0.9	2.5	9.0	27.5
			80%	12.3	15.2	11.7	9.4	3.2	1.6	0.7	0.5	0.5	1.4	4.7	11.6
			IWR CERT	40.0	40.0	40.0	40.0	40.0	20.0	20.0/5.0	5.0	5.0	5.0	40.0	40.0
			AVAILABLE	-27.7	-24.8	-28.3	-30.6	-36.8	-18.4	-19.3/-4.3	-4.5	-4.5	-3.6	-35.3	-28.4
Alder Cr > N Scappoose Cr	0	3.28	50%	23.2	22.8	16.1	11.9	4.7	2.2	1.3	0.7	0.8	2.1	8.6	24.1
			80%	10.5	12.8	10.0	7.9	3.2	1.5	0.7	0.4	0.5	1.1	4.3	10.5
			IWR CERT	8.0	8.0	8.0	8.0	8.0	3.0	1.0	1.0	1.0	1.0	8.0	8.0
			AVAILABLE	2.5	4.8	2.0	-0.1	-4.8	-1.5	-0.3	-0.6	-0.5	0.1	-3.7	2.5
Cedar Cr > N Scappoose Cr	0	32.32	50%	190.8	190.8	136.1	110.6	85.1	47.2	28.7	17.2	18.1	22.1	75.4	188.6
			80%	92.9	111.3	88.8	77.1	56.3	30.4	15.3	12.9	12.6	13.4	40.2	87.5
			IWR CERT	6.0	6.0	6.0	6.0	6.0	3.0	1.0	1.0	1.0	1.0	6.0	6.0
			AVAILABLE	86.9	105.3	82.8	71.1	50.3	27.4	14.3	11.9	11.6	12.4	34.2	81.5
Chapman Cr > N Scappoose Cr (Lizzie Cr)	0	1.88	50%	13.8	13.5	9.5	6.9	2.8	1.3	0.8	0.4	0.4	1.2	5.0	14.5
			80%	6.1	7.5	5.9	4.5	1.8	0.9	0.4	0.3	0.3	0.6	2.5	6.2
			IWR CERT	6.0	6.0	6.0	6.0	6.0	3.0	1.0	1.0	1.0	1.0	6.0	6.0
			AVAILABLE	0.1	1.5	-0.1	-1.5	-4.2	-2.1	-0.6	-0.7	-0.7	-0.4	-3.5	0.2

Table 3 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
N Fk N Scappoose Cr >	0	1.18	50%	8.9	8.7	6.1	4.3	2.5	1.2	0.7	0.4	0.4	0.7	3.2	9.4
N Scappose Cr			80%	3.9	4.8	3.7	2.8	1.6	0.8	0.4	0.3	0.3	0.4	1.5	4.0
			IWR CERT	7.0	7.0	7.0	7.0	7.0	3.0	3.0/1.0	1.0	1.0	1.0	7.0	7.0
			AVAILABLE	-3.1	-2.2	-3.3	-4.2	-5.4	-2.2	-2.6/0.6	-0.7	-0.7	-0.6	-5.5	-3.0
Sierkes Cr >	0	3.95	50%	27.8	27.3	19.3	14.5	9.9	5.1	3.1	1.7	1.8	2.6	10.5	28.8
N Scappoose Cr			80%	12.6	15.5	12.1	9.7	6.3	3.2	1.5	1.3	1.2	1.4	5.3	12.6
(Deep Cr)			IWR CERT	7.0	7.0	7.0	7.0	7.0	7.0/0.5	0.5	0.5	0.5	0.5	7.0	7.0
			AVAILABLE	5.6	8.5	5.1	2.7	-0.7	-3.8/2.7	1.0	0.8	0.7	0.9	-1.7	5.6
S Fk N Scappoose Cr >	0	2.37	50%	14.8	14.5	10.1	7.0	4.5	2.3	1.5	0.8	0.9	1.1	4.8	15.1
N Scappoose Cr			80%	6.5	8.1	6.2	4.5	2.8	1.4	0.7	0.6	0.6	0.6	2.3	6.2
			IWR CERT	8.0	8.0	8.0	8.0	8.0	4.0	1.0	1.0	1.0	1.0	8.0	8.0
			AVAILABLE	-1.5	0.1	-1.8	-3.5	-5.2	-2.6	-0.3	-0.4	-0.4	-0.4	-5.7	-1.8
S Scappoose Cr >	0	18.86	50%	115.8	115.2	82.0	66.0	29.4	14.5	8.9	5.0	5.5	13.1	45.0	115.7
Scappoose Cr			80%	55.3	66.7	52.9	45.7	20.4	10.3	4.8	3.4	3.5	7.8	23.9	52.8
above Raymond Cr			IWR CERT	25.0	25.0	25.0	25.0	25.0	12.0	5.0	5.0	5.0	5.0	25.0	25.0
			AVAILABLE	30.3	41.7	27.9	20.7	-4.6	-1.7	-0.2	-1.6	-1.5	2.8	-1.1	27.8
Gourlay Cr >	0	3.45	50%	23.6	23.1	16.3	11.9	8.0	4.1	2.5	1.4	1.5	2.1	8.5	24.3
S Scappoose Cr			80%	10.6	13.0	10.1	7.9	5.0	2.6	1.2	1.0	1.0	1.1	4.2	10.5
			IWR CERT	10.0	10.0	10.0	10.0	10.0	2.0	2.0/0.5	0.5	0.5	0.5	10.0	10.0
			AVAILABLE	0.6	3.0	0.1	-2.1	-5.0	0.6	-0.8/0.7	0.5	0.5	0.6	-5.8	0.5
Raymond Cr >	0	4.22	50%	26.1	25.6	18.0	13.3	5.7	2.8	1.8	1.0	1.1	2.3	8.8	26.3
S Scappoose Cr			80%	11.7	14.4	11.1	8.8	3.8	1.9	0.9	0.7	0.7	1.3	4.5	11.1
			IWR CERT	8.0	8.0	8.0	8.0	8.0	1.0	1.0/0.5	0.5	0.5	0.5	8.0	8.0
			AVAILABLE	3.7	6.4	3.1	0.8	-4.2	0.9	-0.1/0.4	0.2	0.2	0.8	-3.5	3.1

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Municipal Use

Incorporated cities in the Columbia subbasin include Fairview, Gladstone, Gresham, Happy Valley, Johnson City, Lake Oswego, Maywood Park, Milwaukie, Portland, Scappoose, St. Helens, West Linn and Wood Village. Lake Oswego, West Linn, and parts of Gladstone are also located in the subbasin but obtain their water primarily from the Clackamas subbasin and are discussed in the Clackamas River subbasin section.

Municipal water service in the Columbia subbasin is supplied through a network of interconnected city systems and water districts (Table 4). Portland is the major water purveyor, serving more than 700,000 people in the greater metropolitan area. The city obtains its water from the Bull Run watershed in the neighboring Sandy Basin. Many of the smaller water districts in and around Portland rely on groundwater to supplement service from Portland.

Portland currently uses only about 26 percent of the average annual runoff of the Bull Run watershed. This suggests the Bull Run supply can support substantial population growth. On peak use days though, Portland Water Bureau conduits from the Bull Run are at or near capacity.

Those water providers not served by the city of Portland are diverting an average of seven percent of the water they are allowed under existing permits or rights. This would imply that the providers could accommodate substantial growth without new water rights. However, other constraints exist. For example, the recent discovery of contamination in the city of Milwaukie wells could preclude further use of groundwater. The city has relied on the Portland Water Bureau while cleanup options are studied.

Summary

The major streams in the subbasin have been withdrawn by the Legislature primarily for protection of fish life. Minimum streamflows and instream water rights are met year-round on the Willamette main stem and in the Milton Creek drainage. Flows are insufficient in the Scappoose drainage to satisfy out-of-stream and instream uses during all months of the year.

Parts of the subbasin are highly urbanized and will become even more so over time. Significant amounts of water are imported to the subbasin for municipal use or for maintaining flows in the Willamette main stem through Portland. The overall amount of irrigation is expected to decline in the future due to urbanization. However, the intensity of existing agricultural uses, particularly in the northwest part of the subbasin, may increase with changes in agricultural pricing and technologies. New or expanded municipal, industrial, and agricultural uses

Table 4

MUNICIPAL WATER RIGHTS AND USAGE FOR THE PORTLAND WATER BUREAU

					Month of Maximum Rate of Use			
Municipal water supplier [1]	**Population** [2]	**Surface rights (cfs)** [3]	**GW rights (cfs)** [4]	**Total rights (cfs)** [5]	**Average rate (cfs)** [6]	**Average rate (gpd)** [7]	**Average per capita rate (gpd)** [8]	**Comments**
Portland	429,410	Legis- lative	554.34	--	230.83	149,180,000	--	The Portland Water Bureau serves several cities and districts in the metro area.
Other cities and districts served	248,496	--	--	--	--	--	--	Estimate of population served in other districts and cities based on 82,832 active services at 3 persons each for year previous to year of water-use data. There may be double-counting, and some districts may receive a portion of their supply from other sources.
Total	677,906	Legis- lative	554.34	--	230.83	149,180,000	220	ORS 538.420 grants to the City of Portland the right to use the waters of the Bull Run and the Little Sandy Rivers. All usage in water year 1989 was from Bull Run.

[1] Includes Portland and other cities and districts served by Portland Water Bureau.

[2] Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.

[3] Total municipal surface water rights of record in cubic feet per second.

[4] Total municipal groundwater rights of record in cubic feet per second.

[5] Total municipal water rights (total of columns 2 and 3).

[6] Maximum average monthly rate of use in cubic feet per second, based on total

[7] Maximum average monthly rate in gallons per day.

[8] Maximum average monthly rate in gallons per day per capita (column 6 divided by column 1).

Table 4 (Continued)

MUNICIPAL WATER RIGHTS AND USAGE FOR THE COLUMBIA SUBBASIN

					Month of Maximum Rate of Use				
Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Fairview	1,940	--	19.66	19.66	0.60	387,098	200	19.06	
Gilbert Water District	1,708	--	2.67	2.67	1.26	812,032	475	1.41	Also supplied by Portland Water Bureau.
Milwaukie	19,045	--	11.36	11.36	(6.10)	(3,942,315)	(207)	(5.26)	Because of well contamination, water supplied by Portland Water Bureau in 1989. Max. mo. rate and unused rights derived from per capita gpd reported in 1986 WRD survey.
Scappoose Water Dist.	3,505	14.00	1.00	15.00	0.60	388,413	111	14.40	
St. Helens	7,525	130.50	7.99	138.49	3.89	2,498,903	332	134.60	
Wood Village	2,580	--	2.98	2.98	0.63	403,968	157	2.35	
TOTAL	36,303	144.50	45.66	190.16	13.08	8,432,729	232	177.08	

1 Includes incorporated cities with water rights and larger water districts which may serve unincorporated areas.Smaller water districts,water associations, etc. are not included. Gresham, Hazelwood Water District, Maywood Park, and Rockwood Water District are served by the Portland Water Bureau, Happy Valley by Tigard Water District, and Johnson City by a private company.

2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989.

3 Total municipal surface water rights of record in cubic feet per second.

4 Total municipal groundwater rights of record in cubic feet per second.

5 Total municipal water rights (total of columns 3 and 4).

6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989. The month of maximum rate of use is not the same for every city.

7 Maximum average monthly rate in gallons per day.

8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).

9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus averagemonthly rate of use (column 6).

will likely turn to the Willamette or Columbia river main stems or the Bull Run watershed for larger water needs.

Willamette River Main Stem Subbasin

General Orientation

For the purposes of this planning process, the Willamette River main stem subbasin includes the main stem above Willamette Falls, to the confluence of the Coast Fork and Middle Fork Willamette Rivers, as shown in Figure 5. The subbasin also includes a number of tributaries which drain directly into the main stem and are not part of the major subbasins covered in this report. The discharge, or flow in the main stem includes flows from these smaller tributaries as well as major tributaries such as the Santiam, McKenzie, Coast Range, and Coast and Middle Fork Willamette Rivers. The subbasin area is about 994 square miles.

Water Availability and Needs

Overview

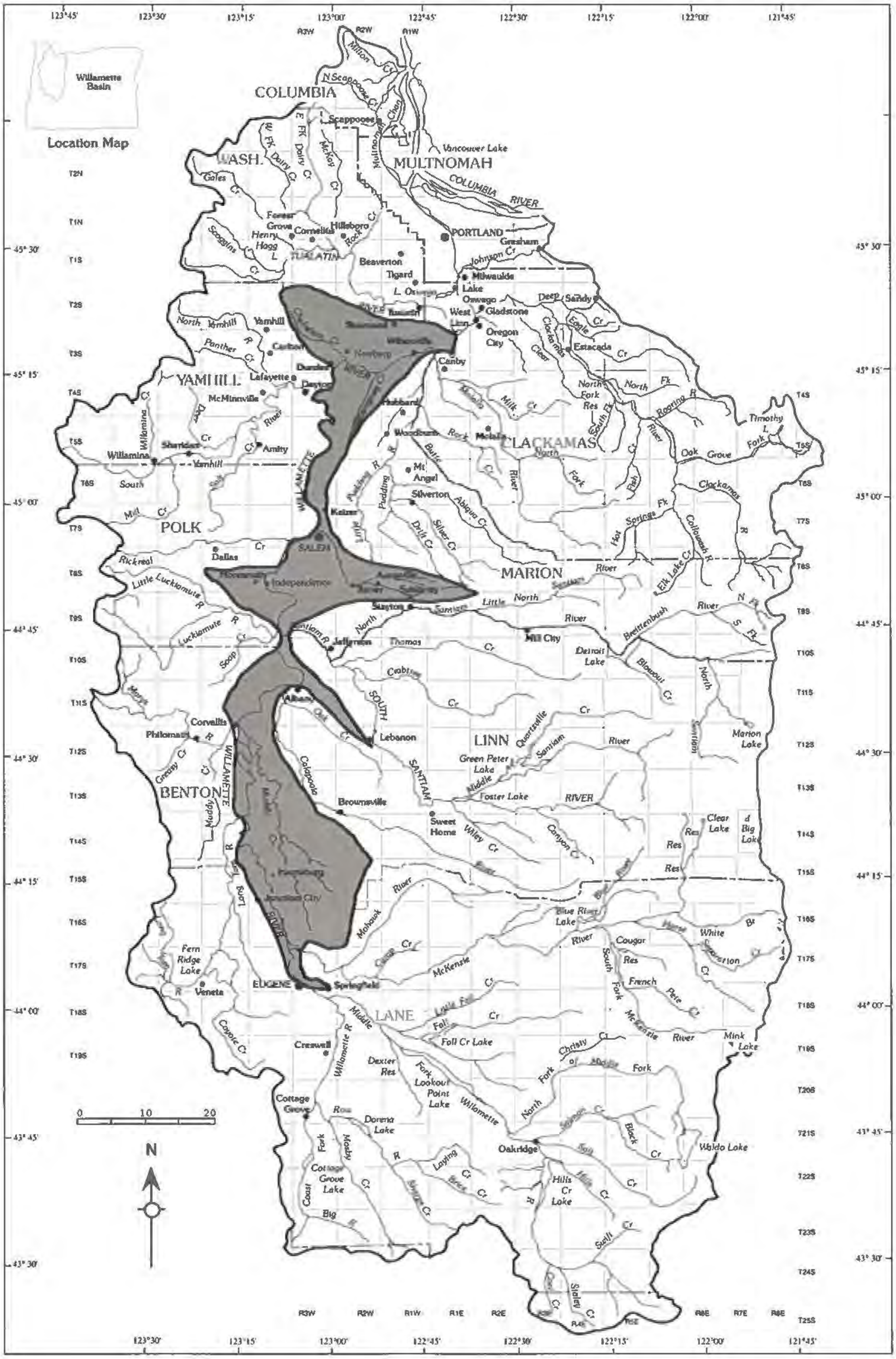
The Water Resources Department has issued water rights to divert up to 2,755 cfs from the waters of the subbasin (Appendix B). Based on water rights information, the largest water use category is industrial use with a total permitted diversion rate of about 1,325 cfs, or 957,400 af, per year. Water rights allow the diversion of up to 834 cfs, or 166,800 af, per irrigation season for irrigation use, according to the Department's rate and duty limitations. Other agricultural uses are minimal, using about six cfs, or 4,380 af, annually. Municipal uses are about 425 cfs, or approximately 308,000 af. Meeting the combined instream water right of 6,200 cfs at Wilsonville requires about 4.5 million af annually.

Nonconsumptive Uses

Minimum Streamflows

Minimum streamflows were established in 1964 for reaches of the Willamette main stem to be measured at Wilsonville, Salem, and Albany. These minimum streamflows involve both natural flow and storage release com-ponents, and have not yet been converted to instream water rights. The Corps and DEQ are also striving to maintain certain flow levels established at Salem and Albany for the purposes of meeting water quality standards.

Figure 5
WILLAMETTE RIVER MAIN STEM SUBBASIN



The minimum streamflow as measured at Wilsonville (USGS gage 14198000) is for 1,500 cfs from natural flow and up to 4,700 cfs from upstream storage. The Department's analysis indicates that the combined minimum is met year-round (Table 5).

The minimum streamflow above Salem is for 1,300 cfs from natural flow and up to an additional 4,700 cfs from storage releases. Natural and regulated flows as measured at USGS gage 14191000 are sufficient to meet the natural flow component, and the 6,000 cfs combined minimum streamflow year-round. However, flows are usually expected to fall short of the 6,500 cfs water quality flow target by about 300 cfs during July.

The minimum streamflow above Albany is for 1,750 cfs from natural flow and up to an additional 3,140 cfs from storage releases. Flow estimates show that the natural flow minimum is met year-round. Flows fall short of the 4,890 cfs combined minimum streamflow by 29 cfs in July and do not meet the 5,000 cfs water quality target during July and August.

A minimum streamflow established from the confluence with the McKenzie, to confluences with the Coast and Middle Forks of the Willamette, involves natural flow only and has been converted to an instream water right. Department flow estimates as measured at USGS gage 14158000 at Springfield show that natural flows do not meet the minimum streamflow of 2,000 cfs in July, August, and September and 2,500 cfs during the remaining months. Flow deficits reach a maximum of 1,109 cfs in September.

Consumptive Uses

Industrial Use

Some of the larger industrial users include pulp and paper manufacturers, canning operations, mining operations (sand/gravel/concrete, salt), and chemical plants.

Agricultural Use

Using the Department's current water rights records and rate and duty limitations, the maximum amount of land which could be irrigated in a season from March through October would be about 66,700 acres. The irrigation seasons of Ash and Mill Creeks were set by court adjudication to be from April 1 through September 30, and May 1 through September 30, respectively.

Table 5

MINIMUM FLOW ANALYSIS

2. Willamette River at Wilsonville and at gage 14198000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	26,743	29,536	25,908	26,152	20,049	10,646	5,310	3,155	3,546	6,031	14,901	24,452
80% Ex. Regulated Flow	29,701	23,960	18,412	14,953	12,807	8,613	6,314	6,641	9,376	12,763	19,196	33,484
Min. Flow (Natural)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Addl. Releases from Storage	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700
W. A. Unregulated	25,243	28,036	24,408	24,652	18,549	9,146	3,810	1,655	2,046	4,531	13,401	22,952
W.A. Regulated	23,501	17,760	12,212	8,753	6,607	2,413	114	441	3,176	6,563	12,996	27,284

3. Willamette River at Salem and at gage 14191000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	24,112	29,444	23,794	21,617	16,272	7,622	4,370	3,256	3,320	4,291	12,845	22,322
80% Ex. Regulated Flow	27,879	22,608	17,520	14,307	12,303	8,350	6,203	6,546	9,136	12,342	18,242	31,342
Min. Flow (Natural)	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Addl. Releases from Storage	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700
W. A. Unregulated	22,812	28,144	22,494	20,317	14,972	6,322	3,070	1,956	2,020	2,991	11,545	21,022
W.A. Regulated	21,879	16,608	11,520	8,307	6,303	2,350	203	546	3,136	6,342	12,242	25,342

4. Willamette River at Albany and at gage 14174000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	14,813	18,312	14,850	14,427	9,879	5,198	3,298	2,503	2,528	2,918	7,864	12,809
80% Ex. Regulated Flow	16,486	13,591	10,172	8,298	7,277	5,316	4,431	4,919	6,075	8,355	10,471	17,814
Min. Flow (Natural)	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750
Addl. Releases from Storage	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140
W. A. Unregulated	13,063	16,562	13,100	12,677	8,129	3,448	1,548	753	778	1,168	6,114	11,059
W.A. Regulated	11,596	8,701	5,282	3,408	2,387	426	-459	29	1,185	3,465	5,581	12,924

ODA has projected future irrigation needs in the main stem subbasin, but these are included in projections calculated for adjacent subbasins . ODA requested reservations of water for future irrigation throughout the Willamette Basin. These reservation requests are presented throughout the remainder of this discussion.

Municipal Use

A number of cities are located in the subbasin. Several have rights to use water from the Willamette main stem for municipal purposes. These include Adair Village, Corvallis, Dundee, Monmouth, Newberg, and Wilsonville. The cities of Aumsville, Independence, Junction City, St. Paul and Sublimity are located in the subbasin but rely on groundwater to serve their residents. Salem, Albany, and Harrisburg obtain water primarily from other subbasins and are covered in later subsections.

As illustrated in Table 6, about 36 of the 278 cfs, or 13 percent of that flow allowed by rights, are used at present. It would seem that most of the municipalities could accommodate significant population growth without needing new water rights. Indeed these areas are expected to grow. For example, the population of Benton County is projected to increase by about 14 percent over the next ten years. Yamhill County is projected to grow by more than 18 percent by the year 2000 (PSU, 1984). The county grew about 10 percent from 1980 to 1989 (PSU, 1990). Based on recent trends, most of the increase can be expected to occur in urban areas like Dundee and Newberg.

Although these unused water rights are valuable, there are other constraints to developing these sources. For example, Wilsonville holds groundwater and surface water rights that appear well in excess of the city's needs. In actuality, the city relies entirely on groundwater. Surface water rights to 30 cfs from the main stem Willamette are not currently used. The city would have to fund and construct a treatment plant in order to use the river water. This may be needed as groundwater levels have been declining rapidly in the Wilsonville area making groundwater an unreliable long-term source (see Section 3, Groundwater Management and Protection). The Department has advised Wilsonville to prepare a water management plan describing how the city plans to supply future municipal water needs.

The city of Sublimity is also having problems meeting its water needs. It is located in a proposed groundwater management area where water levels in the Columbia River Basalt Group aquifers are declining substantially. New uses are likely to be restricted in these areas. The Department has met with representatives from Sublimity and the city of Stayton to identify reliable, long-term water source options.

Table 6

MUNICIPAL WATER RIGHTS AND USAGE FOR THE WILLAMETTE MAIN STEM SUBBASIN

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use				Comments
					Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	
Adair Villlage	530	82.00	--	82.00	0.41	263,774	498	81.59	
Aumsville	1,500	--	2.74	2.74	0.42	271,010	181	2.32	
Corvallis	42,520	102.13	1.00	103.13	18.15	9,257,742	218	84.98	More than half of usage from Willamette R. The rest from Mary's River drainage
Dundee	1,445	5.75	1.75	7.50	0.59	382,668	265	6.91	
Harrisburg	1,860	--	1.48	1.48	0.61	394,984	212	0.87	
Independence	4,180	--	2.23	2.23	(1.97)	(1,270,720)	(304)	(0.26)	No data reported. Max. mo. rate and unused rights derived from per capita gpd reported in 1986 WRD survey.
Junction City	3,160	--	5.10	5.10	1.97	1,273,155	403	3.13	
Monmouth	5,825	3.74	7.15	10.89	1.87	1,211,277	208	9.02	Surface rights are for the Luckiamute sub-basin. All usage from wells near Willamette River.
Newberg	11,630	8.00	15.16	23.16	6.14	3,967,726	341	17.02	In addition, Newberg has right to waters of Oliver spring, but right does not verify rate.

Table 6 (Continued)

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Month of Maximum Rate of Use: Average rate (gpd) [7]	Month of Maximum Rate of Use: Average per capita rate (gpd) [8]	Month of Maximum Rate of Use: Unused rights (cfs) [9]	Comments
St. Paul	355	--	0.24	0.24	(0.15)	(95,850)	(270)	(0.09)	No data reported. Max. mo. rate and unused rights derived from assumed per capita gpd of 270, based on basin average.
Sublimity	1,640	--	0.38	0.38	0.39	253,058	154	-0.01	
Wilsonville	5,025	30.00	9.02	39.02	2.82	1,825,100	363	36.20	
TOTAL	79,670	231.62	46.25	277.87	35.49	20,467,064	257	242.38	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.

2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989.

3 Total municipal surface water rights of record in cubic feet per second.

4 Total municipal groundwater rights of record in cubic feet per second.

5 Total municipal water rights (total of columns 3 and 4).

6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.

7 Maximum average monthly rate in gallons per day.

8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).

9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

Summary

Water demands for industrial, irrigation, and municipal purposes are expected to grow. However, minimum streamflows and water quality targets on the main stem are not always being met. Specifically, the water quality flow target is not met in Salem during the month of July. The target is not met at Albany during both July and August. The Department's minimum streamflows are not met at Albany during July, and above the McKenzie from July through October.

Future water uses may be limited by water availability and quality constraints upstream from Salem during July and August. Future irrigation needs can be satisfied through the purchase of stored water from Corps reservoirs located in upstream subbasins. Municipal water rights appear adequate to accommodate projected growth in the basin. However, cities which currently rely on groundwater may be turning to surface water to meet their current as well as future needs. Expansion of undeveloped municipal uses may deplete streamflows, increasing the challenge to meet water quality targets and causing junior water right holders to be regulated. Increasing problems in supplying rural domestic populations may result in higher demand for surface water from the main stem subbasin. Municipal and industrial users should explore opportunities to purchase stored water from upstream Corps projects.

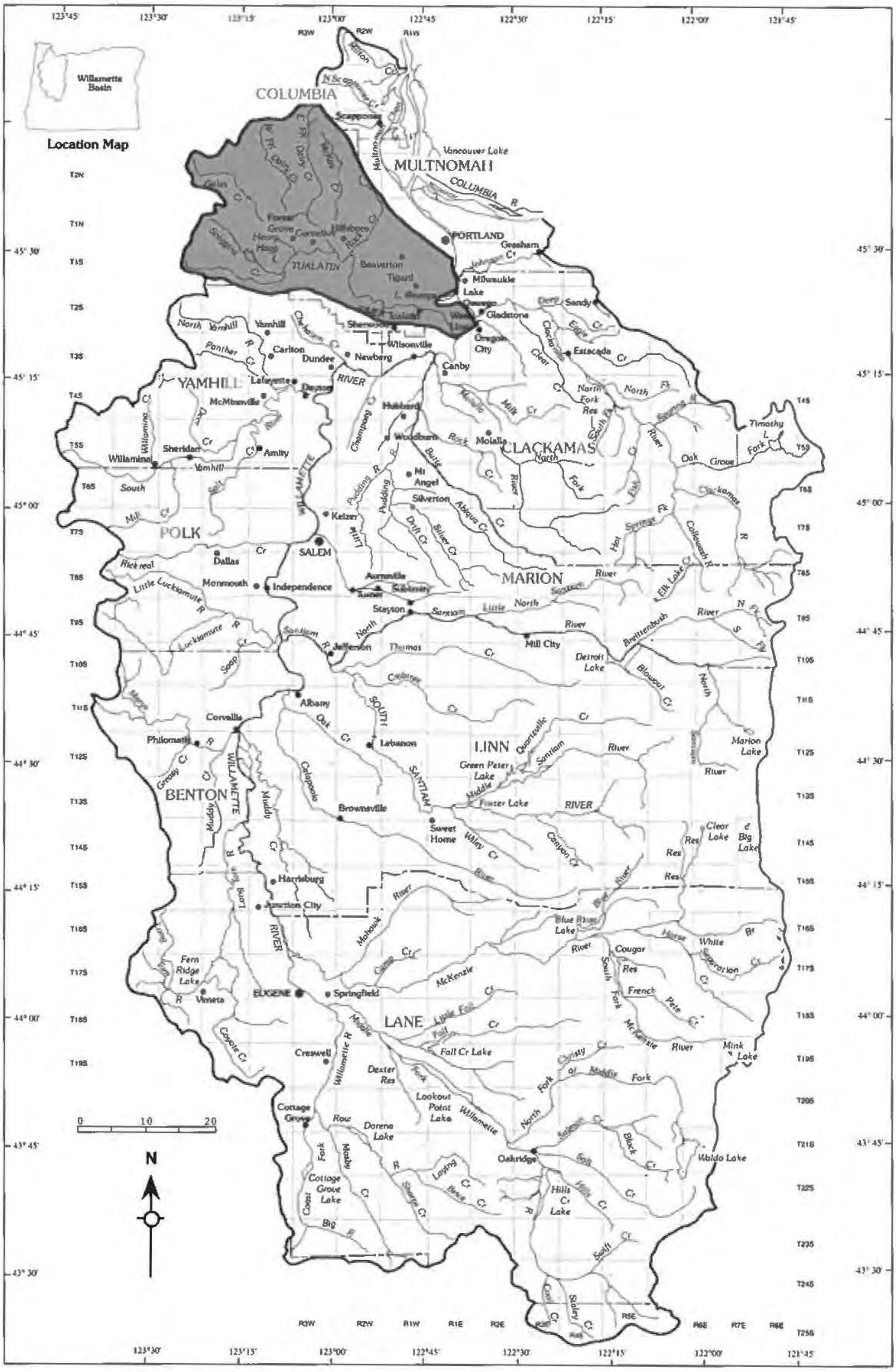
Tualatin River Subbasin

General Orientation

The Tualatin River subbasin is a low elevation, low gradient drainage covering 708 square miles almost entirely within the boundaries of Washington County (Figure 6). Low hills surround the subbasin. The Tualatin River headwaters originate in the Coast Range to the west. The Tualatin subbasin is about 38 miles long measured in a straight line from the headwaters to mouth. The river itself meanders over 83 miles in this distance. Tributaries to the north and east flow from the Tualatin Mountains and the west hills of Portland. The Chehalem Mountains form the subbasin's southern boundary.

On an annual basis, the subbasin yields slightly more than 1.1 million af of water or 1,554 af per square mile (USGS, 1990). Nearly 85 percent of the total annual discharge occurs in the five months from November through March. More than 2.9 percent of the total discharge occurs from June through October (Appendix A). A small amount of this water is imported from the Trask River system in the North Coast Basin and from the Bull Run River in the Sandy Basin. These interbasin transfers supply municipal uses in the Tualatin Basin. Treated waste water is then discharged to the Tualatin, thereby supplementing its flows.

Figure 6
TUALATIN RIVER SUBBASIN



About 93 percent of the land in the subbasin is privately owned. The State of Oregon and the Bureau of Land Management (BLM) manage about five percent and two percent of the subbasin, respectively. Forest lands occupy the higher elevations in the Coast Range and Tualatin Mountains. Agricultural lands predominate in the lower elevations and Tualatin Valley. Substantial portions of the subbasin are becoming urbanized, especially along the middle and lower reaches of the Tualatin River.

Henry Hagg Lake on Scoggins Creek has an active storage capacity of about 56,000 af. The project, owned by the Bureau of Reclamation, is operated by the Tualatin Valley Irrigation District and provides flood control, irrigation, municipal water supply, and water quality benefits. The reservoir is located in the foothills of the Coast Range near the town of Gaston and releases into Scoggins Creek enter the Tualatin River at about river mile 63.

Summer low flows have been a problem in the Tualatin River system for many years. In 1976, the river was classified to allow only human and livestock consumption for the period from July 31 to September 15 each year. During this time, less than 0.4 percent of the total subbasin discharge occurs. Conditions included in recent permits prohibit the use of water earlier in the summer.

Water Availability and Needs

Overview

The Department has issued rights to divert about 1,194 cfs from the Tualatin subbasin (Appendix B). Agricultural users hold rights to use about 722 cfs of the total amount. About 678 cfs are specifically for irrigation. Using the Department's rate and duty limitations, irrigators could potentially be diverting up to 135,700 af per season. According to ODA's estimates, less than half of this amount, or about 56,882 af, was used for irrigation in 1988. Nurseries, which are becoming more prominent in the subbasin, use more water than traditional food crops.

Rights have also been issued to use substantial amounts of water for municipal, industrial and miscellaneous purposes (330 cfs, 37 cfs, and 104 cfs, respectively). Full use of non-irrigation rights could reach 372,600 af per year. The combined total demand for out-of-stream uses could reach 508,300 af, or 46 percent of the subbasin's average annual discharge.

Meeting the combined minimum streamflow at West Linn (including only the storage component for releases from Scoggins reservoir) requires 138,500 af per year. Added to the out-of-stream demand, the total becomes 646,800 af annually or about 58 percent of the average annual discharge. Nearly half this potential demand (about 287,400 af) occurs during the period June through September when the Tualatin subbasin yields only 1.9 percent, or about 21,000 af, of its average annual discharge.

Nonconsumptive Uses

Water Quality

Natural conditions such as low gradient, low summer flows, high ambient levels of phosphorus, and high summer temperatures make the river prone to poor water quality conditions, especially in the lower main stem. Recent land development, farming practices, increased water demand and waste-loads have overwhelmed the Tualatin's ability to function as a healthy natural river system.

The more populous areas of Washington County receive sewer service from the Unified Sewerage Agency (USA). USA discharges treated waste to the Tualatin River in accordance with a National Pollutant Discharge Elimination System (NPDES) permit issued by DEQ. In September 1988, the National Environmental Defense Center (NEDC) filed suit alleging that USA had committed 13,000 violations of its NPDES permits. DEQ subsequently declared the Tualatin River a water quality limited stream. In response to the NEDC suit, DEQ established Total Maximum Daily Loads (TMDLs) for the Tualatin in efforts to meet water quality standards. TMDLs establish a measure of the upper levels of specific contaminants allowable at certain flow levels. DEQ has also established waste load allocations for the Tualatin system. Waste load allocations assign shares of the TMDLs to specific sources of pollution such as USA and the agriculture and forestry sectors.

Low summer flows are a critical factor in the Tualatin River water quality condition. Higher flows are needed to assimilate wasteloads and reduce the need for costly waste management and/or treatment. Streamflow needs for water quality are an important element in a current study of additional storage potential in the Tualatin subbasin.

Instream Water Rights and Minimum Perennial Streamflows

From 1966 to 1983, seventeen minimum perennial streamflows were set on various streams in the Tualatin subbasin. All but one have been converted to instream water rights. The remaining minimum streamflow is on the Tualatin River at West Linn.

This minimum streamflow (measured at USGS gage 142075000 at West Linn) was set in 1975. It ranges from 25 cfs to 250 cfs from natural flows, and up to an additional 75 cfs of stored water from Haag Lake and up to 250 cfs from a storage project that has not been built. The Department estimates that the natural flow component is met during all months except August. The combined minimum streamflow is not met from June through October (Table 7).

Flows on larger tributaries to the Tualatin (i.e., Dairy Creek, McKay Creek, and Scoggins Creek) are barely meeting existing out-of-stream demands plus established instream water rights. Total demands are not being met on smaller tributaries (i.e., McFee Creek, Plentywater Creek, Denny Creek, and Gales Creek). Deficit months range from May to September on Gales Creek and year-round on smaller tributaries to Scoggins Creek.

ODFW, DEQ and PRD have identified ten candidate streams for additional instream water rights in the Tualatin subbasin (Appendix C). Flows for these ungaged streams are nearing full appropriation during low flow months (Table 8). Several already have some flow protection, but more is needed. ODFW, DEQ and PRD have not provided recommended flow levels for these streams.

Consumptive Uses

Agricultural Use

ODA has estimated that 26,310 acres in the subbasin were irrigated in 1988 (Andrews, 1990). About 94 percent, or 24,731 acres, was irrigated using surface water. ODA expects irrigated acreage to reach 30,000 acres by the year 2010. This expansion would be served entirely by surface water. In fact, the agency predicts that reliance on groundwater for irrigation uses will decline in the future. ODA requested that the Department reserve 8,670 af of surface water to irrigate an additional 3,769 acres (79 acres converted from groundwater). The water would come from existing and future storage in the subbasin. Irrigators are expected to divert water mainly from the Willamette and Tualatin River main stems. Water providers in Washington County have asked the Bureau of Reclamation to include 15,000 af of storage for irrigation in the feasibility study for a new reservoir in the Tualatin subbasin.

Municipal Use

A complex network of municipal water supply systems operates in the Tualatin subbasin. A number of water districts serve both incorporated and unincorporated areas in response to urbanization adjacent to but outside city limits. Some districts hold water rights but choose to obtain water from another purveyor, while others purchase water from purveyors in the vicinity. For example, several districts purchase water from the cities of Portland or Lake Oswego which import water primarily from the Sandy and Clackamas subbasins.

Table 7

MINIMUM FLOW ANALYSIS

1. Tualatin River at West Linn and at gage 14207500 for 1970 minimum flows.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	2,013	2,675	1,842	1,014	461	221	74	28	55	111	483	1,730
80% Ex. Regulated Flow	1,351	1,786	1,668	779	405	188	107	103	152	185	456	1,157
Min. Flow (Natural)	30	30	30	30	85	130	40/30	30	25	90	110	30
Addl. Releases from Storage						250	250	250	250	250		
W. A. Unregulated	1,983	2,645	1,812	984	376	91	34/44	-2	30	21	373	1,700
W.A. Regulated	1,321	1,756	1,638	749	320	-192	-183/-173	-177	-123	-155	346	1,127

2. Tualatin River at West Linn and at gage 14207500 for 1975 minimum flows.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	2,013	2,675	1,842	1,014	461	221	74	28	55	111	483	1,730
80% Ex. Regulated Flow	1,351	1,786	1,668	779	405	188	107	103	152	185	456	1,157
Min. Flow (Natural)	250	250	250	250	250	130	40/30	30	25	90	250	250
Addl. Releases from Storage						250	250	250	250	250		
W. A. Unregulated	1,763	2,425	1,592	764	211	91	34/44	-2	30	21	233	1,480
W.A. Regulated	1,101	1,536	1,418	529	155	-192	-183/-173	-177	-123	-155	206	907

Table 8

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

TUALATIN RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tualatin R > Willamette R	70.0		50%	435	450	321	197	93	40	19	12	14	39	205	410
Gage 14202500			80%	211	279	216	138	64	30	14	7.9	8.1	18	82	204
			IWR CERT	65	65	65	65	65	20	20/10	10	10	10	10/65	65
			AVAILABLE	146	214	151	73	-1	10	-6.0/4.0	-2.1	-1.9	8	72/17	139
McFee Cr > Tualatin R	0	6.65	50%	51	50	36	23	15	7.0	2.9	1.5	1.7	3.2	22	53
			80%	24	29	23	15	9.5	4.2	1.7	1.0	1.1	1.4	8.6	24
			IWR CERT	12	12	12	12	12	0.0	0.0	2.0	2.0	0.0	0.0/12	12
			AVAILABLE	12	17	11	2.6	-2.5	4.2	1.7	-1.0	-0.9	1.4/-10.6	8.6/-3.4	12
Rock Cr > Tualatin R	0	72.87	50%	483	485	352	253	120	53	22	11	14	41	230	486
			80%	247	290	238	172	82	37	14	7	9	21	100	244
			AVAILABLE	247	290	238	172	82	37	14	7	9	21	100	244
Beaverton Cr > Rock Cr	0	40.5	50%	277	278	201	140	62	27	11	6	7	22	129	282
			80%	139	164	134	94	42	18	7	4	4	11	55	139
			AVAILABLE	139	164	134	94	42	18	7	4	4	11	55	139
Dairy Cr > Tualatin R	0	229.9	50%	1424	1445	1055	803	358	159	64	34	41	142	716	1406
			80%	761	879	734	560	254	114	46	22	27	78	324	733
			AVAILABLE	761	879	734	560	254	114	46	22	27	78	324	733
McKay Cr > Dairy Cr	0	71	50%	471	473	343	246	96	40	16	8.2	10	40	224	474
			80%	241	282	232	167	67	29	11	5.2	6.3	21	97	238
			AVAILABLE	241	282	232	167	67	29	11	5.2	6.3	21	97	238
	15.5	23.86	50%	169	168	121	82	64	31	13	6.8	7.9	12	76	173
			80%	83	99	80	54	40	19	7.7	4.8	5.2	6.1	32	83
			IWR CERT	36	36	36	36	36	0	0	4	4	0	0/36	36
			AVAILABLE	47	63	44	18	4.3	19	7.7	0.8	1.2	6.1	32/-4.0	47
E Fk McKay Cr >	0	8.03	50%	60	60	43	28	19	8.7	3.6	1.9	2.2	3.9	26	63
McKay Cr			80%	29	34	28	18	12	5.2	2.1	1.3	1.4	1.8	10	29
			IWR CERT	0	0	0	0	0	0	0	2	2	0	0	0
			AVAILABLE	29	34	28	18	12	5.2	2.1	-0.7	-0.6	1.8	10	29

Table 8 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
E Fk Dairy Cr > Dairy Cr	13.0	32.03	50%	223	222	160	111	89	43	18	10	11	17	102	227
			80%	111	131	107	74	56	26	11	6.9	7.5	8.5	43	111
			IWR CERT	50	50	50	50	50	25	25/12	12	12	12	12/50	50
			AVAILABLE	61	81	57	24	6.3	1.2	14/-1.0	-5.1	-4.5	-3.5	31/-7.0	61
Plentywater Cr > E Fk Dairy Cr	0	2.17	50%	18	17	12	7.4	4.4	1.9	0.8	0.4	0.5	1.0	7.1	19
			80%	8.0	9.7	7.6	4.6	2.7	1.1	0.4	0.3	0.3	0.4	2.7	8.4
			IWR CERT	5	5	5	5	5	2	2	1	1	1	1/5	5
			AVAILABLE	3.0	4.7	2.6	-0.4	-2.3	-0.9	-1.6	-0.7	-0.7	-0.6	1.7/-2.3	3.4
Denny Cr > E Fk Dairy Cr	0	4.17	50%	33	32	23	14	9.1	4.0	1.7	0.9	1.0	1.9	14	34
			80%	15	18	14	9.1	5.6	2.4	0.9	0.6	0.6	0.9	5.4	16
			IWR CERT	15	15	15	15	15	3	3	2	2	2	2/15	15
			AVAILABLE	0.1	3.3	-0.5	-5.9	-9.4	-0.6	-2.1	-1.4	-1.4	-1.1	3.0/-1.0	0.6
W Fk Dairy Cr > Dairy Cr	0.0-2.0	76	50%	502	505	366	264	110	47	19	9.7	12	43	240	505
			80%	258	302	248	179	76	33	13	6.2	7.5	22	104	254
			IWR CERT	30	30	30	30	30	10/6	3/2	2	2	4/10	30	30
			AVAILABLE	228	272	218	149	46	23/27	10/11	4.2	5.5	18/12	74	224
Gales Cr > Tualatin R	0	75.77	50%	501	503	365	263	102	43	17	8.8	11	43	239	504
			80%	257	301	248	179	71	31	12	5.6	6.8	22	104	253
			IWR CERT	100	100	100	100	100	35	35/12	12	12	12	100	100
			AVAILABLE	157	201	148	79	-29	-4.1	-23/0	-6.4	-5.2	10	4.0	153
Gage 14204500	12.0		50%	541	540	396	195	93	42	19	13	13	37	222	530
			80%	256	327	268	135	69	34	14	8.8	9.8	20	100	269
			IWR CERT	70	70	70	70	70	0	0	0	8	8/0	0/70	70
			AVAILABLE	471	470	326	125	23	42	19	13	5	12/20	100/30	460
L Beaver Cr > Gales Cr	0	6.61	50%	50	50	35	23	7.7	3.0	1.2	0.6	0.7	3.2	21	53
			80%	24	28	23	15	5.1	2.1	0.7	0.3	0.4	1.4	8.6	24
			IWR CERT	0	0	0	0	0	0	0	1	1	0	0	0
			AVAILABLE	24	28	23	15	5.1	2.1	0.7	-0.7	-0.6	1.4	8.6	24
Beaver Cr > Gales Cr	0	9.83	50%	80	79	57	43	32	16	7.2	4.1	4.5	8.1	37	84
			80%	38	46	37	29	20	10	4.5	3.0	3.0	4.1	18	40
			IWR CERT	17	17	17	17	17	3	3/1	1	1	1	1/17	17
			AVAILABLE	21	29	20	12	3.3	6.8	1.5/3.5	2.0	2.0	3.1	17/1	23

Table 8 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
N Fk Gales Cr > Gales Cr	0	2.63	50%	23.0	22.4	16.1	11.5	7.2	3.4	1.6	0.9	0.9	2.0	10.2	24.9
			80%	10.6	12.8	10.2	7.6	4.6	2.1	0.9	0.6	0.6	0.9	4.6	11.4
			IWR CERT	25	25	25	25	25	3	3/1.5	1.5	1.5	1.5	1.5/25	25
			AVAILABLE	-14.4	-12.2	-14.8	-17.4	-20.4	-0.9	-2.1/-0.6	-0.9	-0.9	-0.6	3.1/-20.4	-13.6
S Fk Gales Cr > Gales Cr	0	3.96	50%	34	33	24	17	11	5.4	2.5	1.4	1.5	3.1	15.2	36
			80%	16	19	15	12	7.2	3.4	1.5	1.0	1.0	1.5	7.0	17
			IWR CERT	20	20	20	20	20	2	2/1	1	1	1	1/20	20
			AVAILABLE	-4.2	-1.0	-4.8	-8.5	-13	1.4	-0.5/0.5	0.0	0.0	0.5	6.0/-13	-3
Scoggins Cr > Tualatin R Gage 14203000	0	43.3	50%	343	334	249	136	63	27	11	5.7	6.2	19	125	340
			80%	174	210	174	94	46	21	8.2	3.5	4.2	10	56	177
			AVAILABLE	174	210	174	94	46	21	8.2	3.5	4.2	10	56	177
Seine Cr > Scoggins Cr	0	5.13	50%	40	39	28	18	11	5.2	2.1	1.1	1.3	2.4	17	42
			80%	18	22	18	11	7.0	3.1	1.2	0.7	0.8	1.1	6.6	19
			IWR CERT	25	25	25	25	25	8	2	2	2	2	2/25	25
			AVAILABLE	-6.6	-2.7	-7.2	-14	-18	-4.9	-0.8	-1.3	-1.2	-0.9	4.6/-18.4	-5.9
Tanner Cr > Scoggins Cr	0	3.96	50%	31	30	22	14	8.6	3.8	1.6	0.8	0.9	1.8	13	33
			80%	14	17	14	8.6	5.3	2.3	0.9	0.5	0.6	0.8	5.1	15
			IWR CERT	9.0	9.0	9.0	9.0	9.0	0.0	0.0	1.0	1.0	0.0	0/9	9.0
			AVAILABLE	5.3	8.4	4.8	-0.4	-3.7	2.3	0.9	-0.5	-0.4	0.8	5.1/-3.9	5.9

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time)
IWR APP: Instream water application has been filed.
IWR CERT: Insream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Table 9 provides information on the water rights and water uses of the major cities and water districts obtaining water from the Tualatin system. Water providers hold rights to use about 216 cfs from surface water and 16 cfs from groundwater sources. They are using approximately 40 cfs or 17 percent of the total amount allowable. Although on paper, water providers could legally supply substantial population growth, water availability and water quality pose real constraints to expanded service.

The Tualatin subbasin is located almost entirely within Washington County boundaries. The county has a population of about 295,000 residents. It is projected to be among the fastest growing counties in the state over the next ten years. The county experienced about a 20 percent growth rate from 1980 to 1989 (PSU, 1990) and is projected to grow an additional 24 percent by the year 2000 (PSU, 1984). At this rate, Washington County's population would double in about 30 years.

Population growth involves an increase in demand for municipal water supplies. At the request of local agencies and organizations, the Bureau of Reclamation has developed preliminary cost information for a new storage facility to meet municipal, domestic, and industrial needs, and water quality objectives in the subbasin. Since detailed information on needs was not available, the cost estimate is arbitrarily based on 40,000 af of water for municipal and industrial uses. This estimate will be used in considering alternatives for meeting the needs. The water districts would bear 100 percent of the costs assigned to the municipal portion of the storage.

As part of this effort, the Hillsboro-Beaverton-Forest Grove Joint Water Commission requested that the Department reserve 40,000 af for municipal use in the basin rules. The Department is working with the Joint Water Commission and other interested parties to evaluate the need for a reservation for municipal purposes.

Summary

The Tualatin River has been designated as "water quality limited." Control of wasteload, particularly nonpoint source pollution, as well as flow enhancement would improve water quality in the system. The Bureau of Reclamation is currently reviewing the feasibility of new storage to meet water quality flows and municipal needs in the subbasin.

The minimum streamflow measured at West Linn is not met from June through October. Flows on larger tributaries to the Tualatin just barely meet existing out-of-stream demands plus established instream water rights. Total demands are not being met on smaller tributaries with deficit periods ranging from May to

Table 9

MUNICIPAL WATER RIGHTS AND USAGE FOR THE TUALATIN RIVER SUBBASIN

					Month of Maximum Rate of Use				
Municipal water supplier [1]	**Population** [2]	**Surface rights (cfs)** [3]	**GW rights (cfs)** [4]	**Total rights (cfs)** [5]	**Average rate (cfs)** [6]	**Average rate (gpd)** [7]	**Average per capita rate (gpd)** [8]	**Unused rights (cfs)** [9]	**Comments**
Banks	495	0.51	0.67	1.18	0.34	218,421	441	0.84	Water year 1990 data.
Hillsboro- Forest Grove-Beaverton Joint Water Commission		203.70	--	203.70	35.06	22,663,000	--	--	Joint Water Comm. serves Beaverton, Hillsboro, Forest Grove. Hillsboro serves Cornelius,
Beaverton	40,515	--	3.01	3.01	--	--	--	--	Gaston and Laurelwood. Wolf Cr. Hwy Water Dist.
Forest Grove	12,120	8.80	--	8.80	1.60	1,033,613	--	--	supplies 15 -25% of Beaverton's
Hillsboro	32,320	--	--	--	--	--	--	--	and 5% of Hillsboro's
Cornelius	5,090	1.00	--	1.00	--	--	--	--	water; population figures
Gaston	570	--	--	--	--	--	--	--	are not adjusted.
Laurelwood	200	0.10	--	0.10	--	--	--	--	Laurelwood population
Total	90,815	213.60	3.01	216.61	36.66	23,696,613	261	179.95	estimated by Health Div.
North Plains	1,055	1.63	--	1.63	0.23	149,872	142	1.40	
Rivergrove District	3,200	--	5.00	5.00	1.18	764,499	239	3.82	
Sherwood	2,990	--	7.33	7.33	1.22	754,400	252	6.11	
TOTAL	98,555	215.74	16.01	231.75	39.63	25,583,805	260	192.12	

1 Includes incorporated cities with water rights and larger water districts which may serve unincorporated areas. Smaller water districts, water associations, etc. are not included. For King City, Durham, and Tigard Water District, see the Clackamas River subbasin. Tualatin and the Wolf Creek Highway Water District are served by the Portland Water Bureau.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5)minus average monthly rate of use (column 6).

September, to year-round. ODFW, DEQ and PRD have identified ten candidate streams for additional instream water rights in the Tualatin subbasin. Flows on these streams are nearing full appropriation during low-flow months.

Irrigation is the largest water use in the subbasin. ODA has requested that the Department reserve 8,668 af of surface water annually to irrigate an additional 3,770 acres in the future. It is expected that additional irrigation water supplies would come from existing and/or new storage facilities.

Rapid population growth in the subbasin means an increased demand for municipal water. Numerous providers, consisting of both cities and special districts, sell water outside incorporated areas and/or their primary service area. Water providers hold substantial water rights which have not been developed. However, water quality and availability constraints warrant a vigilant effort to explore various options for long-term supplies.

Clackamas River Subbasin

General Orientation

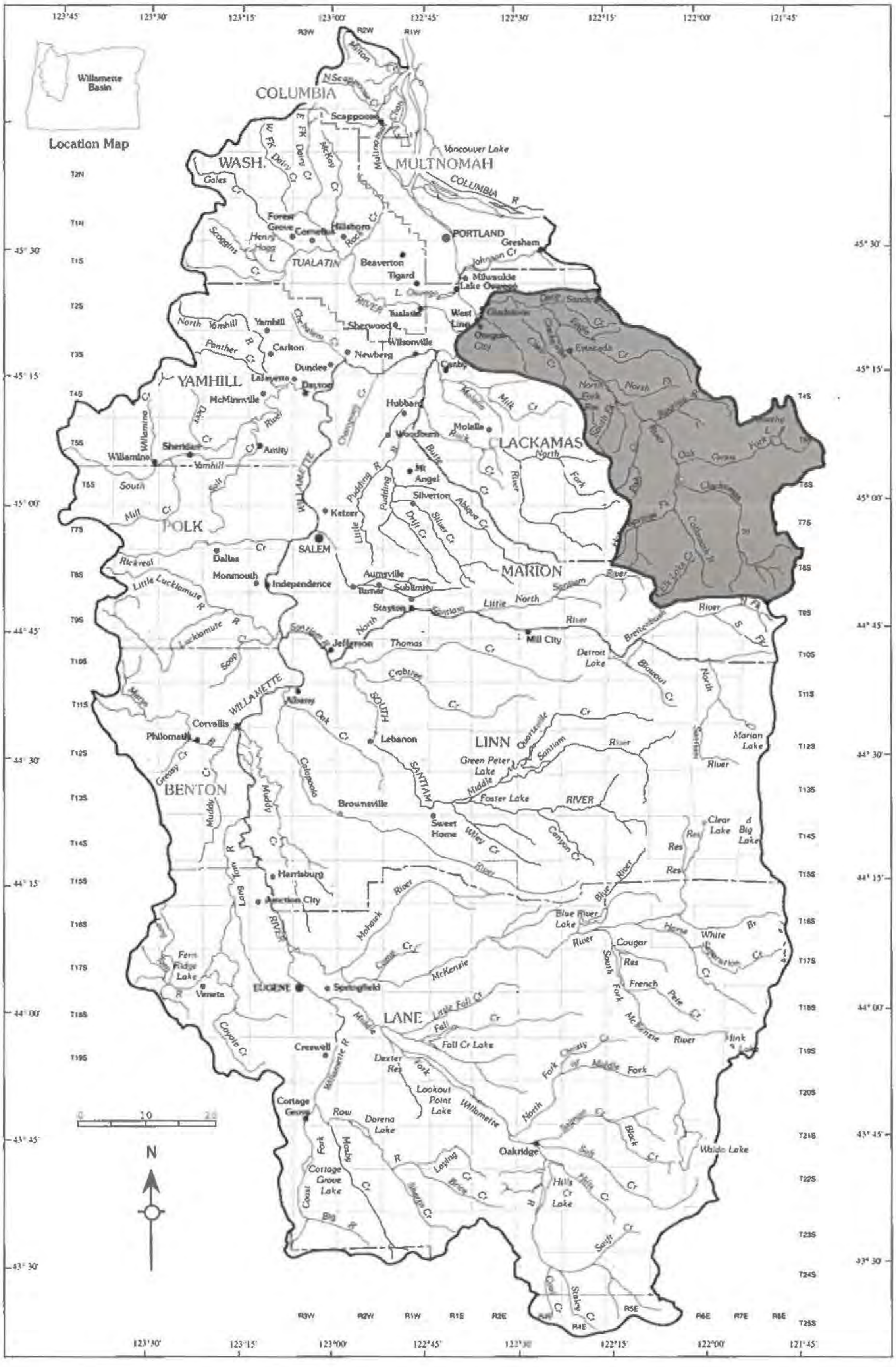
The headwaters of the Clackamas River are found in the Cascades between Mt. Hood to the north, and Mt. Jefferson to the south. The source originates at about 6,000 feet near Olallie Butte in the Mt. Hood National Forest. The subbasin drains 934 square miles from headwaters to mouth where the Clackamas is tributary to the Willamette at river mile 25.

The Clackamas River subbasin is contained almost entirely within Clackamas County (see Figure 7). The uppermost headwaters are in Marion County. About 72 percent of the land is owned and managed by the federal government. Twenty-five percent is privately owned. Three percent along the eastern boundary of the subbasin is part of the Warm Springs Indian Reservation.

Forest lands comprise about 85 percent of the subbasin. Most of the federal forest land is within the Mt. Hood National Forest under the management of the U.S. Forest Service (USFS). A small portion is within the Willamette National Forest. BLM manages small tracts of forest land along the boundary between the Molalla-Pudding and Clackamas subbasins. The lower-elevation, northwestern portion consists of privately owned woodlands, interspersed with farmlands.

The Clackamas subbasin yields an average of about 2.66 million af per year (USGS, 1990). This translates to about 2,847 af of annual runoff per square mile of drainage area. About 63 percent of the average annual runoff occurs from November through March. From June through October, the subbasin yields about 17.5 percent of the average annual runoff (Appendix A).

Figure 7
CLACKAMAS RIVER SUBBASIN



The waters of the Clackamas subbasin provide valuable recreational opportunities, extensive hydroelectric power generation, and municipal water supplies for major population centers in Clackamas County. More information on these uses is provided in the following discussion.

Despite the existence of hydroelectric reservoirs and major municipal water rights, flows in the Clackamas largely reflect natural conditions. Flows show a daily fluctuation but seasonal flow distribution is not regulated to the extent of other Willamette Basin rivers with major storage dams.

Water Availability and Needs

Overview

The Department has issued water rights to divert flows totaling about 716 cfs from the Clackamas system (Appendix B). Municipal water uses constitute the largest use with rights to divert about 300 cfs. Allocations for fish and industrial uses equal about 180 cfs and 156 cfs, respectively. About 58 cfs are allocated for irrigation. At a maximum allowable duty of 2.5 af per acre, irrigators could use up to 11,600 af per season for up to 4,640 acres. If used continually at full capacity, the remaining 658 cfs allowed by rights could equal up to 475,500 af per year. The instream water right as measured at the Clackamas mouth requires a volume of 426,000 af per year. Total annual demand under existing rights could reach about 913,000 af, or about 34 percent of annual discharge in the subbasin. About 288,500 af of demand could occur from June through September when about 372,000 af, or about 14 percent of total annual discharge, is produced.

Nonconsumptive Uses

Scenic Waterway Issues

The Clackamas River subbasin hosts four state scenic waterway reaches (see Table 1). A popular boating river, the Clackamas also sustains an extremely valuable recreational fishery. Other important recreational resources in the area include the Bull of the Woods and Mt. Jefferson Wilderness Areas, and the Olallie Lake Scenic Area, which lie along the southern edge of the subbasin.

The Department's assessment of the flow levels needed to support scenic waterway values is complete for the Clackamas subbasin. The Commission has approved flow levels for the Clackamas River and South Fork Scenic Waterways. The scenic waterway flow levels on the upper Clackamas are not met in most months. The flow levels on the lower Clackamas are not being met during the low-flow summer months. Sufficient information is not available to determine flow levels for the North Fork Clackamas River. (WRD, May 1991)

Fisheries

The Clackamas subbasin is important for its populations and diversity of anadromous fish. Anadromous species using the subbasin include winter and summer steelhead, fall and spring chinook and coho salmon. The subbasin supports multiple stocks of some of these species. Both wild and hatchery fish spawn and rear here. The U.S. Fish and Wildlife Service operates Eagle Creek National Fish Hatchery on Eagle Creek. ODFW runs Clackamas Fish Hatchery at McIver State Park (ODFW, 1990).

Streamflows in the Clackamas subbasin generally satisfy fish needs. However, diversions for municipal, industrial and hydropower use affect fish passage and production by depleting flows and changing flow patterns. Perhaps more important, hydroelectric dams and private diversion structures are obstacles to fish migration. Land management practices, especially on the subbasin's extensive forest lands, also affect aquatic habitat in subbasin streams.

Instream Water Rights

A number of instream water rights have been established on the Clackamas main stem and tributaries. Most of these instream water rights have a priority date of 1966. The instream water right on the Clackamas main stem from Three Lynx to the mouth has a 1968 priority.

Estimated flows for the main stem are sufficient to satisfy out-of-stream uses and instream rights above the mouth of the main stem (measured at USGS gage 14211000 near Clackamas), to and above Three Lynx (measured at USGS gage 14209599 at Three Lynx) (Table 10). Flows (measured at USGS gage 14208000 at Big Bottom) above Big Bottom are expected to meet all demands except, possibly, during the month of September.

Flows on tributaries to the Clackamas vary in ability to support all out-of-stream and instream uses. For example, flows on Clear Creek fall short of meeting all uses plus the established instream water right (above the mouth to river mile 12) by about 24 cfs in June, 36 cfs in July, 18 cfs in August, and 18 cfs in September. Uses and instream needs are not met on Deep Creek from May through November. Flows fall short of the demand from 4 cfs in November to 18 cfs in July. On the Roaring River, flows do not meet total demand from June through October.

ODFW is interested in establishing new instream water rights on eighteen streams in the subbasin (Appendix C). Most of these streams flow through national forest lands, upstream from major water development. Few rights have been issued to use the waters of these streams. ODFW has not yet proposed specific flow levels for these streams.

PRD has identified a need for instream water rights for recreational purposes at ten locations in the Clackamas subbasin. Two would apply to the main stem at the mouth and River Mill Dam. The others would apply to major tributaries. Instream water rights have already been established on all but the North Fork Clackamas. PRD has not yet provided enhanced instream flow targets for these streams.

The Department's water availability estimates indicate that instream flows on these ungaged streams exceed current out-of-stream uses but are very low from July through October.

Hydroelectric Power Needs

Portland General Electric (PGE) Company owns and operates five hydroelectric facilities in the Clackamas subbasin. There are three facilities on the main stem. These are the River Mill at river mile 23, the Casaderio diversion and Faraday powerhouse at river mile 26, and the North Fork at river mile 30. Two other dams are located on the Oak Grove Fork forming Harriet and Timothy Lakes. The Oak Grove power plant is located near Three Lynx.

The Timothy Lake facility is the only large storage facility in the subbasin with a usable storage capacity of about 64,500 af. PGE uses this storage for power generation at the Oak Grove power plant. Several smaller reservoirs regulate flows for power projects on the main stem Clackamas. These run-of-river operations provide minimal storage capacity.

Consumptive Uses

Agricultural Use

ODA estimates that 8,000 acres were irrigated in the Clackamas subbasin in 1988. Approximately 5,360 acres were irrigated with surface water (Weber, 1991). By 2010, irrigated acreage is expected to increase to 9,000, with 6,300 acres irrigated with surface water. ODA has requested a reservation of 2,162 af of surface water to irrigate the additional 940 acres. This water would come from existing storage outside the subbasin and, potentially, some new storage within the subbasin. New irrigation is expected to occur on lands within economical pumping distance of the main stems Willamette and Clackamas Rivers. Winter flows in the subbasin are adequate to provide this additional storage for future irrigation needs.

Table 10

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

CLACKAMAS RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Clackamas R >	0.0	930	50%	8139	5993	4499	4872	4667	2880	1,583	1,276	1,307	1,879	4,212	5,883
Willamette R			80%	3,547	4,000	3,507	3,868	3,429	2,046	1,252	1,106	1,114	1,454	2,761	3,791
Gage 14211000			IWR CERT	640	640	640	640	640	640	400	400	400/640	640	640	640
			AVAILABLE	2,907	3,360	2,867	3,228	2,789	1,406	852	706	714/474	814	2,121	3,151
Gage 14210000	23.0	671	50%	4,237	4,324	3,246	3,515	3,367	2,078	1,142	921	943	1,356	3,039	4,245
			80%	2,559	2,886	2,530	2,791	2,474	1,476	903	798	804	1,049	1,992	2,735
			AVAILABLE	2,559	2,886	2,530	2,791	2,474	1,476	503	398	804	1,049	1,992	2,735
Gage 14209500	47.8	479	50%	2,953	2,981	2,329	2,674	2,740	1,710	943	781	791	1,026	2,129	2,951
			80%	1,830	2,005	1,851	2,109	2,021	1,229	779	693	708	821	1,452	1,931
			IWR CERT	640	640	640	640	640	640	400	400	400/640	640	640	640
			AVAILABLE	1,190	1,365	1,211	1,469	1,381	589	379	293	308/68	181	812	1,291
Gage 14208000	65.1	136	50%	632	647	510	620	687	472	293	264	261	292	473	625
			80%	416	453	415	499	515	349	251	234	236	252	355	426
			IWR CERT	240	240	240	240	240	240	150	150	150/240	240	240	240
			AVAILABLE	176	213	175	259	275	109	101	84	86/-4	12	115	186
Rock Cr >	0.0	19.2	50%	105.1	104.7	73.9	33.3	13.1	4.7	1.5	0.6	0.9	2.5	36.7	102.7
Clackamas R			80%	49.5	60.2	47.1	19.5	8.0	2.9	0.8	0.3	0.5	1.0	10.5	45.3
			AVAILABLE	49.5	60.2	47.1	19.5	8.0	2.9	0.8	0.3	0.5	1.0	10.5	45.3
Clear Cr >	0.0	73.31	50%	466.8	469.4	339.4	169.7	70.7	25.2	6.6	2.8	4.1	15.3	214.8	466.3
Clackamas R			80%	237.9	279.7	229.0	103.7	44.7	15.9	4.4	1.6	2.3	6.0	62.5	231.1
			IWR CERT	0.0	0.0	0.0	0.0	0.0	40.0	40.0	20.0	20.0	0.0	0.0	0.0
			AVAILABLE	237.9	279.7	229.0	103.7	44.7	-24.1	-35.6	-18.4	-17.7	6.0	62.5	231.1
	12.0	42.97	50%	282	283	204	99	74	30	7.8	3.5	4.9	8.6	127	285
			80%	141	167	136	60	44	17	4.9	2.2	3.0	3.3	36	138
			IWR CERT	0	0	0	0	0	25	25/15	15	15	0	0	0
			AVAILABLE	141	167	136	60	44	-8	-20.1/10.1	-12.8	-12	3.3	36	138
Richardson Cr >	0.0	4.56	50%	27.1	26.7	18.7	7.8	2.5	0.8	0.3	0.1	0.2	0.5	8.9	27.2
Clackamas R			80%	12.1	15.0	11.5	4.4	1.5	0.5	0.1	0.1	0.1	0.2	2.4	11.4
			AVAILABLE	12.1	15.0	11.5	4.4	2.6	1.0	0.3	0.1	0.2	0.2	2.4	11.4

Table 10 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Foster Cr > Clackamas R	0.0	3.8	50%	22.8	22.5	15.7	6.5	3.8	1.4	0.5	0.2	0.3	0.4	7.4	22.9
			80%	10.1	12.6	9.6	3.7	2.1	0.8	0.2	0.1	0.2	0.2	2.0	9.6
			AVAILABLE	10.1	12.6	9.6	3.7	2.1	0.8	0.2	0.1	0.2	0.2	2.0	9.6
Deep Cr > Clackamas R	0.0	55.34	50%	284.8	286.4	203.3	96.4	37.3	13.7	4.4	1.8	2.7	7.9	104.6	273.2
			80%	139.3	167.3	132.7	57.9	23.4	8.7	2.4	1.0	1.5	3.3	30.9	125.1
			IWR CERT	35	35	35	35	35	20	20/10	10	10	10	35	35
			AVAILABLE	104.3	132.3	97.7	22.9	-11.6	-11.3	-17.6/-7.6	-9.0	-8.5	-6.7	-4.1	90.1
N Fk Deep Cr > Deep Cr	0.0	13.73	50%	76.6	76.2	53.6	23.8	16.0	6.4	2.1	0.9	1.3	1.8	26.4	75.3
			80%	35.6	43.5	33.9	13.8	9.1	3.5	1.0	0.5	0.7	0.7	7.4	32.8
			IWR CERT	20	20	20	20	20	3	3	3	1	1	20	20
			AVAILABLE	15.6	23.5	13.9	-6.2	-10.9	0.5	-2.0	-0.5	-0.3	-0.3	-12.6	12.8
Tickle Cr > Deep Cr	0.0	16.15	50%	89.3	88.9	62.6	28.0	19.2	7.8	2.5	1.1	1.5	2.1	31.0	87.5
			80%	41.8	50.9	39.8	16.3	11.0	4.3	1.3	0.7	0.9	0.8	8.8	38.4
			IWR CERT	30	30	30	30	30	6	4	4	4	4	30	30
			AVAILABLE	11.8	20.9	9.8	-13.7	-19.0	-1.7	-2.7	-3.3	-3.1	-3.2	-21.2	8.4
Eagle Cr > Clackamas R	0.0	156.9	50%	955.8	967.4	702.4	364.6	316.9	134.4	35.0	16.5	22.5	34.5	455.6	942.5
			80%	500.8	583.3	482.3	226.9	189.5	74.4	23.3	10.7	14.6	14.2	136.2	479.6
			IWR CERT	125	125	125	125	125	100	100/40	40	40	40	125	125
			AVAILABLE	375.8	458.3	357.3	101.9	64.5	-25.6	-76.7/-16.7	-29.3	-25.4	-25.8	11.2	354.6
N Fk Eagle Cr > Eagle Cr	0.0	51.14	50%	365	357	318	320	250	148	67	41	42	112	264	357
			80%	0.24	0.24	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.24	0.24
			IWR CERT	45	45	45	45	45	30	20	10	10	10	45	45
			AVAILABLE	319.76	311.76	272.12	274.12	204.12	117.12	46.12	30.12	31.12	101.12	218.76	311.76
S Fk Eagle Cr > Eagle Cr	0.0	7.5	50%	54.5	53.8	38.4	17.2	10.5	3.9	1.0	0.4	0.6	1.3	22.6	56.6
			80%	25.6	30.9	24.6	9.9	6.0	2.2	0.6	0.3	0.4	0.5	6.1	25.9
			AVAILABLE	25.6	30.9	24.6	9.9	6.0	2.2	0.6	0.3	0.4	0.5	6.1	25.9
N Fk Clackamas >Clackamas R	0.0	34.22	50%	227.7	227.6	163.8	78.9	57.6	22.9	6.0	2.7	3.7	6.7	101.2	230.5
			80%	112.9	134.0	108.6	47.4	33.7	12.6	3.7	1.6	2.3	2.6	28.7	111.2
			AVAILABLE	112.9	134.0	108.6	47.4	33.7	12.6	3.7	1.6	2.3	2.6	28.7	111.2

Table 10 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Fish Cr >	0.0	46.02	50%	374.8	374.6	274.5	258.8	230.3	128.1	63.2	40.6	40.3	67.1	206.9	394.1
Clackamas R			80%	193.5	224.7	188.1	189.2	156.4	83.2	44.4	32.4	29.7	38.9	116.7	205.3
			IWR CERT	60	60	60	60	60	60	15	15	15	15	60	60
			AVAILABLE	133.5	164.7	128.1	129.2	96.4	23.2	29.4	17.4	14.7	23.9	56.7	145.3
Wash Cr >	0.0	14.09	50%	122.9	121.7	88.5	78.8	61.2	32.3	16.0	9.9	10.0	18.8	64.3	131.9
Fish Cr			80%	60.8	71.6	59.0	56.0	40.8	21.0	10.7	7.6	7.0	10.3	34.8	65.9
			IWR CERT	25	25	25	25	25	25/10	10/3	3	3	3	25	25
			AVAILABLE	35.8	46.6	34.0	31.0	15.8	-4.0/11.0	0.7/7.7	4.6	4.0	7.3	9.8	40.9
Fish Cr abv	6.8	13.62	50%	119.0	117.8	85.7	76.1	58.9	31.1	15.4	9.5	9.6	18.2	62.1	127.8
Wash Cr			80%	58.8	69.3	57.1	54.1	39.3	20.2	10.3	7.3	6.7	9.9	33.6	63.8
			IWR CERT	0	0	0	0	0	0	0	3	3	0	0	0
			AVAILABLE	58.8	69.3	57.1	54.1	39.3	20.2	10.3	4.3	3.7	9.9	33.6	63.8
Roaring R >	0.0	42.8	50%	350.0	349.7	256.1	240.6	212.3	117.8	58.1	37.3	37.0	62.1	192.6	368.5
Clackamas R			80%	180.3	209.5	175.2	175.6	144.0	76.5	40.7	29.7	27.2	35.8	108.4	191.5
			IWR CERT	100	100	100	100	100	100	40	40	40	40/100	100	100
			AVAILABLE	80.3	109.5	75.2	75.6	44.0	-23.5	0.7	-10.3	-12.8	-4.2 /64.2	8.4	91.5
Sandstone Cr >	0.0	4.05	50%	38.0	37.2	26.9	22.5	15.2	7.6	3.8	2.2	2.3	4.9	18.8	41.6
Clackamas R			80%	18.0	21.5	17.4	15.5	9.9	4.9	2.4	1.6	1.5	2.5	9.7	19.9
			AVAILABLE	18.0	21.5	17.4	15.5	9.9	4.9	2.4	1.6	1.5	2.5	9.7	19.9
Oak Grove Fk >	0.0	126	50%	585	590	527	650	733	526	374	349	342	344	447	577
Clackamas R			80%	418	449	443	544	571	419	330	310	308	308	366	418
Gage 14209000			IWR CERT	0	0	0	0	0	0	0	10	10	0	0	0
			AVAILABLE	418	449	443	544	571	419	330	300	298	308	366	418
Memaloose Cr >	0.0	12.67	50%	111.2	110.0	80.0	70.8	54.4	28.6	14.2	8.7	8.8	16.8	57.9	119.6
S FK Clackamas			80%	54.8	64.6	53.2	50.2	36.2	18.5	9.4	6.7	6.1	9.1	31.2	59.5
R			AVAILABLE	54.8	64.6	53.2	50.2	36.2	18.5	9.4	6.7	6.1	9.1	31.2	59.5
Shellrock Cr >	0.0	18.1	50%	155.6	154.3	112.5	101.3	81.0	43.3	21.4	13.3	13.4	24.7	82.3	166.3
Oak Grove Fk			80%	77.7	91.2	75.4	72.5	54.3	28.1	14.5	10.3	9.5	13.6	45.0	83.8
			AVAILABLE	77.7	91.2	75.4	72.5	54.3	28.1	14.5	10.3	9.5	13.6	45.0	83.8
Stone Cr >	0.0	15.84	50%	137.2	136.0	99.0	88.6	69.8	37.1	18.4	11.4	11.5	21.4	72.1	147.0
Oak Grove Fk			80%	68.2	80.2	66.2	63.2	46.6	24.0	12.3	8.8	8.0	11.7	39.2	73.8
			AVAILABLE	68.2	80.2	66.2	63.2	46.6	24.0	12.3	8.8	8.0	11.7	39.2	73.8

Table 10 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Cooper Cr > Oak Grove Fk	0.0	5.06	50%	46.8	46.0	33.3	28.1	19.5	9.8	4.9	2.9	3.0	6.3	23.4	51.2
			80%	22.3	26.6	21.7	19.5	12.8	6.4	3.1	2.2	2.0	3.2	12.2	24.7
			AVAILABLE	22.3	26.6	21.7	19.5	12.8	6.4	3.1	2.2	2.0	3.2	12.2	24.7
Crater Cr > Oak Grove Fk	0.0	4.2	50%	39.3	38.5	27.8	23.3	15.8	7.9	3.9	2.3	2.4	5.1	19.4	43.1
			80%	18.6	22.2	18.1	16.1	10.3	5.1	2.5	1.7	1.6	2.6	10.1	20.6
			AVAILABLE	18.6	22.2	18.1	16.1	10.3	5.1	2.5	1.7	1.6	2.6	10.1	20.6
Collowash R > Clackamas R	0.0	152.38	50%	1,2958	1,3068	971.8	1,0101	1,0244	591.6	269.3	182.4	176.4	304.4	839.5	1,3650
			80%	709.5	805.0	693.4	768.2	715.7	388.4	217.9	152.8	137.9	183.3	498.1	766.9
			IWR CERT	250	250	250	250	250	200	200/75	75	75/250	250	250	250
			AVAILABLE	459.5	555.0	443.4	518.2	465.7	188.4	17.9/142.9	77.8	62.9/-112.1	-66.7	248.1	516.9
Hot Sprs Fk Collowash > Collowash R	0.0	60.72	50%	544.6	545.0	403.2	400.5	365.7	202.9	92.7	60.9	59.6	113.4	338.2	582.8
			80%	288.5	330.9	281.7	298.1	252.0	133.0	72.2	49.4	44.7	65.0	194.4	317.1
			IWR CERT	75	75	75	75	75	75	75/15	15	15/75	75	75	75
			AVAILABLE	213.5	255.9	206.7	223.1	177.0	58.0	-2.8/57.2	34.4	29.7/-30.3	-10.0	119.4	242.1
Nohorn Cr > Hot Sprs Fk Collowash	0.0	17.5	50%	168.7	167.1	122.8	114.7	90.9	47.7	21.9	13.8	13.7	29.8	98.9	184.5
			80%	85.4	99.5	83.4	82.9	61.4	31.2	16.2	10.7	9.7	16.0	54.5	96.1
			AVAILABLE	85.4	99.5	83.4	82.9	61.4	31.2	16.2	10.7	9.7	16.0	54.5	96.1
Hugh Cr > Nohorn Cr	0.0	5.06	50%	52.4	51.4	37.5	33.0	22.7	11.3	5.2	3.1	3.2	7.9	29.0	58.6
			80%	25.4	30.0	24.8	23.1	15.0	7.4	3.6	2.3	2.1	4.0	15.3	29.2
			AVAILABLE	25.4	30.0	24.8	23.1	15.0	7.4	3.6	2.3	2.1	4.0	15.3	29.2
Elk L Cr > Collowash R	0.0	20.48	50%	195.6	194.0	142.7	134.3	108.4	57.3	26.3	16.6	16.5	35.3	115.6	213.3
			80%	99.6	115.8	97.3	97.5	73.4	37.5	19.6	13.0	11.8	19.1	64.0	111.8
			IWR CERT	0	0	0	0	0	0	0	15	15	0	0	0
			AVAILABLE	99.6	115.8	97.3	97.5	73.4	37.5	19.6	-2.0	-3.2	19.1	64.0	111.8
E Fk Collowash > Collowash R	0.0	16.37	50%	158.4	156.8	115.2	107.3	84.3	44.2	20.3	12.7	12.7	27.8	92.6	173.4
			80%	80.0	93.2	78.1	77.4	57.0	28.9	14.9	9.9	9.0	14.9	50.9	90.2
			IWR CERT	0	0	0	0	0	0	0	10	10	0	0	0
			AVAILABLE	80.0	93.2	78.1	77.4	57.0	28.9	14.9	-0.1	-1.0	14.9	50.9	90.2

Table 10 (Continued)

Stream Name	Riv. Mile	Area SqMi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Pinhead Cr > Clackamas R	0.0	24.7	50%	233.4	231.9	170.7	162.2	133.7	71.3	32.7	20.8	20.6	43.2	139.1	253.7
			80%	119.7	138.7	116.8	118.2	90.8	46.7	24.5	16.4	14.9	23.6	77.5	133.8
			IWR CERT	75	75	75	75	75	50	50	50	50	50	75	75
			AVAILABLE	44.7	63.7	41.8	43.2	15.8	-3.3	-25.5	-33.6	-35.1	-26.4	2.5	58.8
Camp Cr > Last Cr	0.0	1.27	50%	14.3	13.8	10.0	8.2	4.8	2.3	1.1	0.6	0.6	1.8	7.4	16.3
			80%	6.6	7.9	6.4	5.6	3.1	1.5	0.7	0.4	0.4	0.8	3.7	7.8
			AVAILABLE	6.6	7.9	6.4	5.6	3.1	1.5	0.7	0.4	0.4	0.8	3.7	7.8
Lowe Cr > Clackamas R	0.0	5.95	50%	61.1	59.9	43.8	38.8	27.2	13.6	6.3	3.8	3.8	9.4	34.1	68.0
			80%	29.7	35.1	29.0	27.3	18.1	8.9	4.4	2.9	2.6	4.8	18.1	34.1
			IWR CERT	8	8	8		8	8	2	2	2	2	8	8
			AVAILABLE	21.7	27.1	21.0	19.3	10.1	0.9	2.4	0.9	0.6	2.8	10.1	26.1
Rhododendron Cr > Clackamas R	0.0	7.35	50%	74.5	73.3	53.6	48.0	34.4	17.4	8.0	4.9	4.9	11.8	42.0	82.7
			80%	36.6	43.0	35.7	34.0	23.0	11.4	5.7	3.7	3.4	6.0	22.4	41.8
			AVAILABLE	36.6	43.0	35.7	34.0	23.0	11.4	5.7	3.7	3.4	6.0	22.4	41.8
Tumble Cr > Rhododendron Cr	0.0	3.04	50%	32.4	31.7	23.0	19.7	12.8	6.2	2.9	1.7	1.7	4.6	17.6	36.6
			80%	15.4	18.3	15.0	13.7	8.4	4.1	2.0	1.3	1.1	2.2	9.1	17.9
			AVAILABLE	15.4	18.3	15.0	13.7	8.4	4.1	2.0	1.3	1.1	2.2	9.1	17.9
Fawn Cr > Clackamas R	0.0	4.31	50%	45.1	44.1	32.2	28.0	18.9	9.4	4.3	2.6	2.6	6.6	24.8	50.5
			80%	21.7	25.7	21.2	19.6	12.5	6.1	3.0	1.9	1.8	3.3	13.0	25.1
			AVAILABLE	21.7	25.7	21.2	19.6	12.5	6.1	3.0	1.9	1.8	3.3	13.0	25.1

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights).

Municipal Use

There are numerous water providers in the Clackamas subbasin. Most of the water is provided by districts serving both incorporated and unincorporated areas (Table 11). An exception, the city of Estacada has its own municipal water system. In addition, Lake Oswego (located in the Tualatin subbasin) holds substantial water rights on the Clackamas River and is therefore included in this portion of the discussion.

The Clackamas Water District and South Fork Water Board represent the major providers in the area. The two districts supply water to other districts and three cities. Some of the other districts hold water rights but are not using them now. Some districts have no water rights and rely entirely on other suppliers for water.

Combined, these various districts hold rights to use approximately 301 cfs from the Clackamas River system. (This total does not include the six cfs listed in Table 11 from the Willamette River for Lake Oswego.) The districts hold rights to an additional 22 cfs from local groundwater sources. Only an average of about 40 cfs, or about 13 percent of the allowable amount, is currently being used (during the maximum use month) to provide municipal service. If the rights were to be fully developed, streamflows could be reduced. However, most of the municipal diversion points are located on the main steam, downstream from the scenic waterway reach which ends at Carver at river mile nine. The South Fork Water Board does have rights on the South Fork Clackamas scenic waterway. The South Fork Water Board has transferred one point of diversion downstream to be close to its customers, but still holds rights to divert from the South Fork Clackamas.

The potential impact that full use of municipal rights could have on the Clackamas River would depend on the respective priority dates of the municipal water rights, instream water rights, and the establishment of the state scenic waterways. Instream water rights on the main stem from Three Lynx to the mouth have a priority date of August 26, 1968. Main stem scenic waterway reaches were established on July 1, 1975.

As shown in Table 12, the bulk of municipal rights predates both the instream water rights and the scenic waterway designation. This means that significant flows could be diverted senior to instream water rights and scenic waterway flows. About 70 cfs of additional use would be senior to the scenic waterway flows but not the instream water rights. The remaining municipal rights are junior to both instream water rights and scenic waterway flows.

Table 11

MUNICIPAL WATER RIGHTS AND USAGE FOR THE CLACKAMAS RIVER SUBBASIN

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Month of Maximum Rate of Use: Average rate (gpd) [7]	Month of Maximum Rate of Use: Average per capita rate (gpd) [8]	Month of Maximum Rate of Use: Unused rights (cfs) [9]	Comments
Clackamas W.Dist.	20,000	46.50	--	46.50	21.72	14,039,000	--	--	Clackamas WD serves cities and districts listed
Barwell Park WD	2,060	--	--	--	--	--	--	--	in this block.
Gladstone	9,780	13.73	--	13.73	--	--	--	--	
Mt. Scott W.Dist. Happy Valley	8,000	--	--	--	--	--	--	--	Population estimates for water districts supplied by districts.
Oak Lodge WD	25,000	62.00	--	62.00	--	--	--	--	
Total	64,840	122.23	--	122.23	21.72	14,039,000	217	100.51	
Lake Oswego Water Dist.	28,360	65.00	2.54	67.54	19.83	12,818,000	--	--	Lake Oswego serves Tigard WD. LO's rights include 6 cfs from Willamette R., but no use from Willamette was reported. Wells are near Willamette R., not in Clackamas subbasin.
Tigard Water Dist.	36,155	--	3.64	3.64	1.15	740,665	--	--	Tigard WD serves King City and Durham. Dist. estimated total popula-tion served, based on
King City		--	--	--	--	--	--	--	10,333 meters at 3.5 per-sons each. Wells are in the Tualatin subbasin.

Table 11 (Continued)

					Month of Maximum Rate of Use				
Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Durham		--	--	--	--	--	--	--	Dist. also receives some water from Portland Water Bureau in summer
Total	64,515	65.00	6.18	71.18	20.98	13,558,665	210	50.20	
South Fork Water Board	--	116.00	--	116.00	15.60	10,079,000	--	--	S. Fk. Water Board serves Clackamas WD, which serves Oregon City and West Linn. Populations served estimated by S. Fk. Water Board
Clairmont WD	15,000	--	8.90	8.90	--	--	--	--	
Oregon City	16,500	--	--	--	--	--	--	--	
West Linn	14,500	--	0.41	0.41	--	--	--	--	
Total	46,000	116.00	9.31	125.31	15.60	10,079,000	219	109.71	
Damascus Water Dist.	7,600	--	5.98	5.98	2.12	1,372,514	181	3.86	Population served estimated by district.
Estacada	1,950	4.00	--	4.00	1.30	830,710	426	2.70	Annual, not monthly, water use was reported. Max. month data were estimated at 16% of annual total, about average for other cities in the basin.
TOTAL	184,905	307.23	21.47	328.70	61.72	39,879,194	216	266.98	

1 Includes incorporated cities with water rights and larger water districts which may serve unincorporated areas. Smaller water districts, water associations, etc. are not included.

2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.

3 Total municipal surface water rights of record in cubic feet per second.

4 Total municipal groundwater rights of record in cubic feet per second.

5 Total municipal water rights (total of columns 3 and 4).

6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.

7 Maximum average monthly rate in gallons per day.

8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).

9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

In 1988, Clackamas County had a total population of 262,200. About 58 percent of the residents lived in unincorporated areas, down from 61 percent in 1978. The county as a whole grew 12.5 percent during this period. The population of Clackamas County is projected to increase almost 22 percent by the year 2000 (PSU, 1984). Recent trends suggest that the majority of the increase will occur in incorporated areas. If the county sustains this growth rate, the population would double in 33 years.

Although existing municipal rights could accommodate the projected population beyond the year 2020, other instream and out-of-stream uses could be harmed by development of unused municipal rights.

Summary

The Clackamas River system is important as the water supply for both a major population center and a host of valuable natural fish and wildlife resources. It serves as a major source of municipal water supplies. The system also yields water for extensive hydroelectric power production. Despite extensive water use in the subbasin, regulation and permit conditioning have not generally been necessary in the Clackamas subbasin.

The river, its tributaries, and surrounding areas are highly valued and heavily used for recreation. Parts of the Clackamas River main stem and its tributaries are designated state scenic waterways. The flow levels required to support scenic waterway values on the Clackamas are not met during low-flow months. Flows on the main stem are sufficient to satisfy out-of-stream uses and instream rights above the mouth of the main stem, to and above Three Lynx. Flows above Big Bottom should be high enough to satisfy total demand except possibly during the month of September. The extent to which out-of-stream and instream uses are satisfied on tributaries varies.

ODFW and PRD intend to apply for new instream water rights on a number of streams in the subbasin. Many of these streams flow through national forest lands, upstream from major water development. Two would apply to the main stem at the mouth and River Mill Dam. Estimates for ungaged streams show low flows from late July through October.

Irrigated agriculture and storage in the Clackamas subbasin are minimal compared to some other subbasins in the Willamette system. ODA has requested that the Department reserve 2,162 af of surface water for future irrigation. Irrigators would obtain this water from new storage in the subbasin and/or existing storage outside the subbasin.

Table 12

WATER DISTRICT RIGHTS AND PRIORITIES CLACKAMAS MAIN STEM

District	Pre 8/26/68	Between 8/26/68 & 7/1/75	After 7/1/75	Total Rights
Clackamas Water District	40.00	6.50		46.50
Estacada	2.00	2.00		4.00
Gladstone	4.00		9.73	13.73
Lake Oswego	50.00		9.00	59.00
Oak Lodge		62.00		62.00
South Fork Water Board	116.00			116.00
Subtotal	212.00	70.50	18.73	301.23

Municipalities in the subbasin appear to have adequate water rights to serve projected needs well into the future. The majority of municipal rights are senior to existing instream water rights and the scenic waterway designation. These rights are not yet fully used. As they are developed, flow levels in the river may be depleted which could impair instream values.

Molalla-Pudding Subbasin

General Orientation

The Molalla and Pudding Rivers drain 870 square miles of the north-central Willamette Valley (Figure 8). The Pudding River is tributary to the Molalla at river mile 1.5 but has the greater drainage area as measured from the confluence of the two rivers. Upstream from their confluence, the Pudding River also discharges more water on an annual basis, about 882,300 af to the Molalla's 842,600 af. The estimated total annual yield of the subbasin is about 1.725 million af (USGS, 1990). Streamflows reflect natural conditions as there are no significant water storage projects in the subbasin.

Runoff from November through March makes up about 70 percent and 77 percent of the average annual discharge from the Molalla and Pudding Rivers, respectively. The June through October period yields 11 percent and seven percent of the annual discharge from the Molalla and Pudding drainages (Appendix A).

Table 13 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Butte Cr >	0.0-	72.80	50%	542	544	398	292	121	51	18	9.4	12	50	288	559
Pudding R	15.0		80%	282	328	274	199	84	36	14	6.0	7.3	25	124	290
			IWR APP	75	75	75	75	75	75/50	25	12	20	75	75	75
			AVAILABLE	207	253	199	124	9	-39/-14	-11	-6.0	-13	-50	49	215
Abiqua Cr >	0.0	78.49	50%	582	585	428	315	132	55	20	10	13	54	311	599
Pudding R			80%	304	352	294	215	92	39	15	6.6	8.0	27	133	312
			IWR CERT	75	75	75	75	75	60/40	25/20	15	15	40/60	75	75
			AVAILABLE	229	277	219	140	17	-21/-1	-10/-5	-8.4	-7.0	-13/-33	58	237
Silver Cr >	0.0-	47.90	50%	428	376	303	239	132	61	23	10	17	49	256	446
Pudding R	3.2		80%	227	248	210	173	90	39	15	6.9	9.9	23	118	250
Gage 14200300			IWR CERT	60	60	60	60	60	50/35	23	23	23	23/60	60	60
			AVAILABLE	167	188	150	113	30	-11/4	-8.0	-16	-13	0/-37	58	190
Drift Cr >	0.0	24.40	50%	155	154	110	62	24	9.3	3.3	1.5	2.0	6.7	63	155
Pudding R			80%	75	90	72	39	16	6.1	2.0	0.9	1.2	3.0	22	72
			IWR APP	40	40	40	40	40	20/5	3.0	2.0	2.0	3/10	20/ 40	40
			AVAILABLE	35	50	32	-1	-24	-14/-1.1	-1.0	-1.1	-0.8	0/-7	2/ -18	32
Gribble Cr >	0.0	14.20	50%	116	115	83	56	20	7.9	2.9	1.4	1.8	8.6	57	123
Molalla R			80%	57	68	55	37	14	5.5	2.0	0.9	1.0	3.9	23	60
			AVAILABLE	57	68	55	37	14	5.5	2.0	0.9	1.0	3.9	23	60
Milk Cr >	0.0	98.70	50%	543	548	393	187	154	65	18	8.1	11	15	225	526
Molalla R			80%	275	325	263	113	90	35	11	5.1	7.2	6.2	64	253
			IWR CERT	85	85	85	85	85	60/45	40/30	20	20	20/40	85	85
			AVAILABLE	190	240	178	28	5.3	-25/-10	-29/-19	-15	-13	-14/-34	-21	168

Table 13 (Continued)

Stream Name	Riv. Mile	Area Sq. Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Woodcock Cr >	1.0	13.60	50%	84	83	59	26	9.3	3.2	0.9	0.3	0.5	1.8	32	84
Milk Cr			80%	40	48	38	15	5.6	1.9	0.5	0.2	0.3	0.7	8.4	38
			AVAILABLE	40	48	38	15	5.6	1.9	0.5	0.2	0.3	0.7	8.4	38
Nate Cr >	0.0	10.08	50%	63	63	44	19	6.1	2.0	0.6	0.2	0.3	1.3	24	64
Milk Cr			80%	30	36	28	11	3.7	1.3	0.3	0.1	0.2	0.5	6.2	28
			AVAILABLE	30	36	28	11	3.7	1.3	0.3	0.1	0.2	0.5	6.2	28
Randall Cr >	0.0	2.72	50%	18	18	13	5.1	1.3	0.4	0.1	0.0	0.1	0.3	6.5	19
Nate Cr			80%	8.2	10	7.8	2.8	0.8	0.2	0.1	0.0	0.0	0.1	1.6	8.1
			AVAILABLE	8.2	10	7.8	2.8	0.8	0.2	0.1	0.0	0.0	0.1	1.6	8.1
Canyon Cr >	0.0	15.20	50%	93	93	66	29	10	3.2	0.9	0.3	0.5	2.1	35	93
Milk Cr			80%	44	53	42	17	5.9	2.0	0.5	0.2	0.3	0.8	9.4	42
			AVAILABLE	44	53	42	17	5.9	2.0	0.5	0.2	0.3	0.8	9.4	42
Bee Cr >	0.0	3.52	50%	23	23	16	6.6	1.9	0.6	0.2	0.1	0.1	0.4	8.3	24
Canyon Cr			80%	11	13	10	3.7	1.1	0.4	0.1	0.0	0.0	0.1	2.1	10
			AVAILABLE	11	13	10	3.7	1.1	0.4	0.1	0.0	0.0	0.1	2.1	10
Jackson Cr >	0.0	4.48	50%	29	29	20	8.4	2.5	0.8	0.2	0.1	0.1	0.6	11	30
Milk Cr			80%	13	16	13	4.7	1.5	0.5	0.1	0.0	0.1	0.2	2.7	13
			AVAILABLE	13	16	13	4.7	1.5	0.5	0.1	0.0	0.1	0.2	2.7	13
Mill Cr >	0.0	2.24	50%	15	15	11	4.2	2.2	0.8	0.2	0.1	0.1	0.3	5.3	16
Milk Cr			80%	6.8	8.4	6.5	2.3	1.2	0.4	0.1	0.0	0.1	0.1	1.3	6.7
			AVAILABLE	6.8	8.4	6.5	2.3	1.2	0.4	0.1	0.0	0.1	0.1	1.3	6.7
Dickey Cr >	0.0	4.96	50%	41	40	29	18	6.7	2.6	1.0	0.5	0.6	2.4	18	44
Molalla R			80%	19	23	18	11	4.3	1.7	0.6	0.3	0.3	1.0	6.9	20
			AVAILABLE	19	23	18	11	4.3	1.7	0.6	0.3	0.3	1.0	6.9	20
Cedar Cr >	0.0	2.40	50%	21	20	14	8.6	3.2	1.2	0.5	0.2	0.3	1.1	8.9	22
Molalla R			80%	9.4	11	9.1	5.3	2.0	0.8	0.3	0.1	0.1	0.4	3.3	10
			AVAILABLE	9.4	11	9.1	5.3	2.0	0.8	0.3	0.1	0.1	0.4	3.3	10

Table 13 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
N Fk Molalla	0.0	56.00	50%	400	401	292	203	171	83	31	17	20	32	200	410
R > Molalla R			80%	205	240	198	136	109	50	20	12	13	15	83	207
			AVAILABLE	205	240	198	136	109	50	20	12	13	15	83	207
Trout Cr >	0.0 -	14.40	50%	111	110	80	52	38	17	6.4	3.3	3.9	7.4	52	117
Molalla R	4.3		80%	54	64	52	34	23	10	4.0	2.3	2.5	3.3	21	56
			IWR APP	35	35	35	35	35	8/6	4	4	4	10/15	25/ 35	35
			AVAILABLE	19	29	17	-1.3	-12	2.3/4.3	0.0	-1.7	-1.5	-6.7/ -11	-4.4 /14	21
Pine Cr >	0.0	10.08	50%	100	99	72	58	41	19	7.5	4.3	4.6	12	57	111
Molalla R			80%	50	58	49	39	27	12	5.5	3.1	3.1	5.4	27	57
			AVAILABLE	50	58	49	39	27	12	5.5	3.1	3.1	5.4	27	57
Gawley Cr >	0.0	7.68	50%	78	76	56	44	30	14	5.4	3.1	3.3	8.6	44	86
Molalla R			80%	38	45	37	30	20	8.9	3.9	2.2	2.2	4.0	20	44
			AVAILABLE	38	45	37	30	20	8.9	3.9	2.2	2.2	4.0	20	44
Table Rock Fk >	0.0	34.40	50%	319	318	234	198	162	81	31	18	20	43	193	345
Molalla R			80%	165	191	162	140	108	51	24	14	14	22	93	184
			AVAILABLE	165	191	162	140	108	51	24	14	14	22	93	184
Ogle Cr >	0.0	1.92	50%	21	20	15	11	6.4	2.8	1.1	0.6	0.7	1.9	11	24
Molalla R			80%	9.8	12	9.6	7.2	4.1	1.8	0.7	0.4	0.4	0.8	4.9	12
			AVAILABLE	9.8	12	9.6	7.2	4.1	1.8	0.7	0.4	0.4	0.8	4.9	12

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Water Quality

The Pudding River has been designated as water quality limited by the U.S. Environmental Protection Agency. Runoff from agricultural lands in Marion County drains into the Pudding River. The Pudding drainage houses numerous confined animal feeding operations including more than 30 dairies, 20 hog operations, 12 mink farms, 70 horse stables, and a number of beef, turkey, and chicken farms. Animal wastes are frequently pumped onto fields for disposal. Seepage and runoff carry some of this waste into rivers and streams. In addition, erosion from tilled fields and other farm practices contribute to pollutant loads in the waters.

Excessive fecal coliform bacteria and low levels of dissolved oxygen have been measured in the lower 30 miles of the Pudding River (DEQ, 1990). These violations of water quality standards are attributed to agricultural practices, municipal waste discharges, septic effluent and natural causes.

Low flows aggravate these water quality problems. Better waste treatment and disposal and/or enhanced streamflows are needed to solve them. DEQ is interested in instream water rights on the Pudding main stem and Bear Creek to assist in maintaining flows for water quality.

Consumptive Uses

Agricultural Use

The surface waters of the Molalla-Pudding subbasin support more irrigated acreage than those of any other subbasin in the Willamette Basin (Weber, 1991). ODA estimates that surface water irrigated about 44,730 acres in 1988. Total irrigated lands are projected to expand by 47,165 acres over the next 20 years. About 33,270 acres would be irrigated with surface water. ODA requested the Department to reserve 76,520 af to meet these future irrigation needs in the subbasin. Given low summer flows, it is expected that the water would come from existing storage located outside the subbasin (i.e., from reservoirs in the Santiam system) and/or new storage constructed in the subbasin.

ODA predicts that irrigators will consider diverting stored water releases from the North Santiam, Molalla, Pudding and Willamette Rivers. It is likely that future irrigated lands will be located adjacent to or within economical pumping distance from these sources. Irrigation development beyond an economical pumping distance may have to rely on groundwater.

Municipal Use

There are eleven incorporated cities in the Molalla-Pudding subbasin. Table 14 provides information on population and water usage for each of the cities. The cities hold rights to use about 43 cfs from surface water and 28 cfs from groundwater sources. It is important to note that most of the cities hold only rights to use groundwater. Only about 19 percent of the total, or 14 cfs are being used at present. This would imply that the cities could expand their service areas without obtaining new water rights.

The Molalla-Pudding subbasin is split almost evenly between two rapidly growing counties. From 1978 to 1988, the population of Marion County increased by 14 percent. The proportion of residents in incorporated areas increased from 55 to 65 percent of the total population. The population of Clackamas County grew about 12 percent with a three percent increase (from 39 to 42 percent) in urban residents.

Populations in Marion and Clackamas counties are projected to grow by 17.3 and 21.8 percent, respectively, by the year 2000 (PSU, 1984). These figures may overstate the growth that is apt to occur in the subbasin because the major population centers in the counties are situated outside the Molalla- Pudding subbasin.

Summary

The surface waters of the Molalla-Pudding subbasin support more irrigated acreage than any other subbasin in the Willamette Basin. They also sustain, along with groundwater, a number of municipalities and industrial uses in an area of rapid population growth. A high demand for water combined with distinctly low summer flows are currently resulting in shortages and regulation of water rights on the main stems and several tributaries to the Pudding. There is no significant storage in the subbasin.

Flows at the mouth of the Molalla are sufficient to satisfy existing out-of-stream uses and a proposed instream water right except in October. Upstream, flows are too low from July through October to meet both out-of-stream uses and established and pending instream water rights. The flows in Milk Creek fall short of existing demand from June through November. Flows in Trout Creek cannot meet total demand from April through November. In many cases, flows in ungaged tributaries are close to fully appropriated to out-of-stream uses from May through November.

Flows in the Pudding main stem appear sufficient to fulfill instream and out-of-stream demands year-round. Tributary flows cannot meet the total existing demand from June through October on Drift Creek, Butte Creek, and Abiqua

Table 14

MUNICIPAL WATER RIGHTS AND USAGE FOR THE MOLALLA-PUDDING SUBBASIN

					Month of Maximum Rate of Use				
Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Aurora	535	--	1.73	1.73	0.19	120,637	225	1.54	
Barlow	110	--	0.33	0.33	(0.05)	(29,700)	(270)	(0.28)	No data reported. Max.mo. rate and unused rights derived from assumed per capita gpd of 270, based on basin average.
Canby	8,295	20.45	4.84	25.29	3.80	2,458,710	296	21.49	
Donald	300	--	0.78	0.78	0.09	58,510	195	0.69	
Gervais	845	--	1.96	1.96	0.47	301,740	357	1.49	
Hubbard	1,850	--	1.56	1.56	0.44	286,645	155	1.12	
Molalla	3,230	7.00	--	7.00	1.29	834,516	258	5.71	
Mt. Angel	2,970	--	4.29	4.29	1.09	702,397	236	3.20	
Scotts Mills	280	0.27	0.73	1.00	0.007	4,622	17	0.993	City may have other sources.
Silverton	5,455	15.00	1.12	16.12	2.20	1,421,300	261	13.92	
Woodburn	12,080	--	11.36	11.36	4.00	2,586,4671	214	7.36	Includes usage from wells not covered by indicated water rights
TOTAL	35,950	42.72	28.70	71.42	13.63	8,800,616	247	57.79	Scotts Mills data not included in totals for columns 7 and 8.

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.

2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.

3 Total municipal surface water rights of record in cubic feet per second.

4 Total municipal groundwater rights of record in cubic feet per second.

5 Total municipal water rights (total of columns 3 and 4).

6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.

7 Maximum average monthly rate in gallons per day.

8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).

9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5)minus average monthly rate of use (column 6).

Creek and Silver Creek. ODFW and PRD have applied for instream water rights on the main stem, Butte Creek, and Drift Creek.

Water quality problems exist in the subbasin, particularly in the Pudding River system. Violations of water quality standards are attributed to agricultural practices, municipal waste discharges, septic effluent and natural causes. Low flows also aggravate water quality problems from point and nonpoint sources. Meeting water quality standards will require better waste treatment and disposal and enhanced streamflows. DEQ would like instream water rights to be established on the Pudding main stem and Bear Creek, a tributary. PRD is also interested in instream water rights on the main stem Molalla and Pudding Rivers and some of the larger tributaries.

Irrigation is projected to increase significantly over the next 20 years. ODA has requested that the Department reserve 76,520 af per year for this pur-pose. Water to meet the irrigation demand must come from as yet un-constructed storage within, or existing storage outside the subbasin. The subbasin yields sufficient water in the winter to meet the projected need.

Municipal water rights appear adequate to meet projected growth rates for the next several decades. Some cities relying on groundwater may be seeking surface water to replace and/or supplement declining groundwater supplies. Full use under existing water rights could deplete streamflows.

MIDDLE WILLAMETTE BASIN

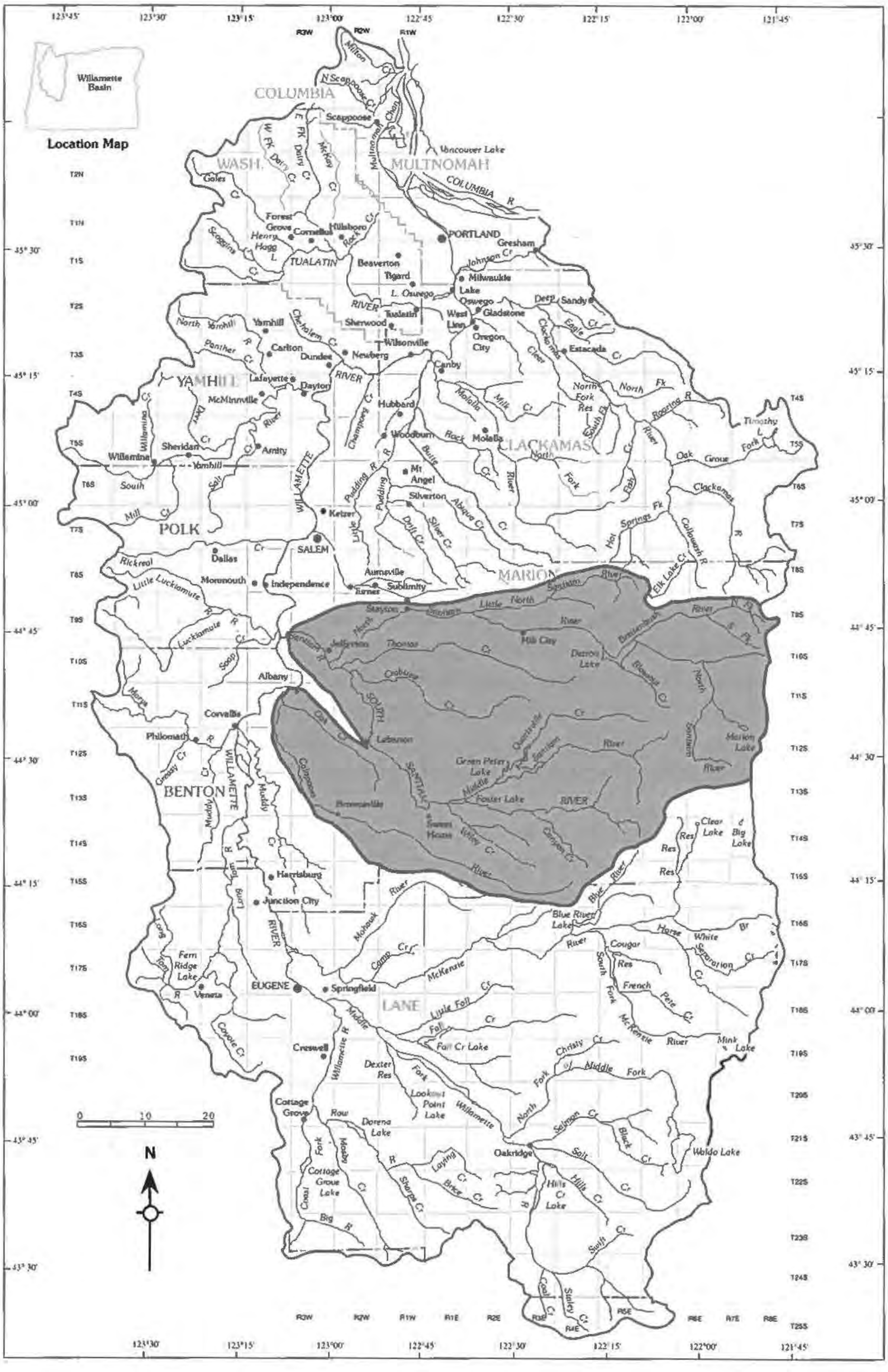
Santiam-Calapooia Subbasin

General Orientation

The Santiam-Calapooia subbasin is located near the center of the Willamette Basin. It is bordered by the Cascade Range to the east, the McKenzie subbasin to the south, and the Willamette River to the west (Figure 9). The Molalla-Pudding and Clackamas subbasins form its northern boundary.

The Calapooia River discharges directly to the Willamette River at Albany. Its drainage occupies the southwestern corner of the subbasin but it is not otherwise a physical part of the Santiam system. The Calapooia drainage area of 374 square miles has an average annual discharge of 648,400 af as measured at USGS gage 14173500 (Calapooia River at Albany) at river mile three. This translates to about 1,734 af of runoff per square mile. Eighty-one percent of the annual discharge occurs from November through March, while only 5.7 percent of the runoff occurs from June through October (USGS, 1990). Streamflows in the Calapooia drainage are unregulated. A Corps storage project on the Calapooia River near Holley was authorized by Congress but never built.

Figure 9
SANTIAM-CALAPOOIA SUBBASIN



The Santiam subbasin has a drainage area of 1,827 square miles—the largest in the Willamette system. The drainage also yields the greatest amount of discharge, about 5.65 million af per year at USGS gage 1418900 (Santiam River at Jefferson) at river mile 9.6, or 3,156 af per square mile (Appendix A).

The Santiam River main stem is only about 12 miles long. Two forks, the North Santiam and South Santiam Rivers comprise the major portion of the system. Flows in both forks are regulated by the operation of large Corps storage reservoirs. Combined, the three reservoirs have seasonal storage capacity of 556,400 af or about ten percent of the average annual runoff in the subbasin.

Detroit Reservoir on the North Santiam River provides 281,630 af of seasonal storage. Big Cliff Dam located a short distance downstream is a reregulating dam and does not store significant quantities of water. Green Peter Dam is located on the Middle Santiam River, a tributary to the South Santiam River. Green Peter Reservoir provides seasonal storage of 249,970 af. Foster Dam is located on the main stem South Santiam River, about 7.5 miles downstream from Green Peter. Seasonal storage at Foster is about 24,800 af.

Measurements at USGS gage 14189000 (Santiam River at Jefferson), indicate that 67.9 percent of average annual discharge occurs from November through March. Prior to construction of the reservoirs, 67.5 percent of the discharge occurred during this period. Since the projects were built, 18 percent of annual discharge occurs from June through October. Prior to construction, 13.2 percent of the annual discharge was generated during this period.

At USGS gage 14183000 (North Santiam River at Mehama), 59.1 percent of the average annual discharge occurs November through March. This is relatively similar to the 59.6 percent yielded during this period before Detroit and Big Cliff dams were built (USGS, 1990). During the June through October period at the same gage, only 24.8 percent of average annual discharge runs off. This compares with 18.9 percent for the same period before the dams were built.

Measurements at USGS gage 14187500 (South Santiam River at Waterloo), show that 67.7 percent of the average annual discharge occurs from Novem-ber through March. About 68.6 percent occurred from November through March before Green Peter and Foster Reservoirs were built. Discharge from June through October at the same gage is 18.9 percent today, as compared to 11.5 percent of the total before completion of the projects.

About 53 percent of the land in the subbasin is privately owned. Almost 47 percent is owned and managed by the federal government, while state lands comprise only a fraction of a percent. About 85 percent of the federally own-ed lands are within the Willamette National Forest and are managed by the USFS. BLM and the Corps manage the remaining lands in federal ownership.

Water Availability and Needs

Overview

The Department has issued water rights to use about 338 cfs from surface flows in the Calapooia drainage (Appendix B). The majority of this water would be put to use generating hydroelectric power at the historic Thompson Mill at about river mile 23. The other major water rights category in the Calapooia drainage is for agricultural uses. Annual allowable use of surface flows in the Calapooia drainage could reach about 165,700 af, or about 25 percent of annual discharge. Meeting the 30 cfs natural flow component of the minimum streamflow (at Holley) would require an additional 21,700 cfs, bringing total demand to 187,400 af, or about 29 percent of total annual dis-charge. However, a demand of about 82,700 af could occur from June through September when only about 3.8 percent or 24,100 af of discharge is generated.

Total water rights on the Santiam system equal about 3,316 cfs. Most of these rights (2,018 cfs) are for industrial uses, with nearly 1,200 cfs of these for nonconsumptive hydroelectric power generation at Stayton on the North Santiam River. Agricultural, municipal, and miscellaneous water users also hold rights to use substantial amounts of water from the system. Water rights for miscellaneous uses on the South Santiam River include fisheries, aquatic life and aesthetics.

Total diversion (under current water rights) of surface flows from the Santiam drainage could reach about 2.08 million af per year. Adding the 1.37 million af per year needed to meet the minimum streamflow at Jefferson brings the total annual demand to about 3.44 million af, or about 61 percent of total annual discharge. About 1.23 million af could be demanded from June through September when only 12.3 percent or about 700,000 af of discharge is generated.

Water rights regulation is common on Thomas Creek and new permits issued on Thomas Creek are being conditioned to prohibit use when streamflows are inadequate to meet both instream and out-of-stream uses.

Nonconsumptive Uses

Minimum Streamflows - Calapooia River Drainage

Minimum streamflows were established at two locations in 1964. Both minimum streamflows had a natural flow and storage component. The project which was to provide the stored water was never built. Thus, only the natural flow component of the minimum streamflow was considered for conversion to an instream water right.

The assessment of water availability for the minimum streamflow at Albany, as shown in Table 15, shows that the natural flow component of 20 cfs is met during all months. However, unregulated streamflows barely meet the 20 cfs minimum flow during August and September.

Streamflow records at USGS gage 14172000 show that the natural flow component of 30 cfs for the minimum streamflow at Holley is met except in September. The minimum streamflow is barely met in August (Table 15).

Both of the natural flow components of these minimum streamflows were converted to instream water rights with a 1964 priority date. The stored water components were rescinded and not adopted as instream water rights since there were no storage projects to provide the water.

State agencies have identified Oak Creek as a priority stream for flow protection. Streamflows are relatively low July through September (Table 16).

Water Quality - Calapooia River Drainage

The lower 35 miles of the Calapooia River are designated as water quality limited for bacteria. DEQ has stated that TMDLs need to be developed.

Hydroelectric Power Needs - Calapooia River Drainage

Water is diverted from the Calapooia River for the purposes of generating power at Boston Mill at about river mile 22. The diversion significantly depletes flow in the river, which historically has resulted in regulation of upstream uses.

Minimum Streamflows - Santiam River Mainstem

There is a minimum streamflow at the mouth of the main stem Santiam River consisting of 320 cfs in natural flow, plus up to 1,570 cfs from storage releases. There is no gage at this point. There is also a minimum stream-flow measured at USGS gage 14189000, Santiam River at Jefferson. The natural flow component is 330 cfs and the storage component is 1,570 cfs for a total of 1,900 cfs. Diversions below the gage at Jefferson are not precisely known but are not major. Therefore, flows at the Jefferson gage closely represent flows at the mouth.

According to Department estimates, the natural flow component of both minimum streamflows on the main stem are met year-round. Regulated flows should be sufficient to meet the combined minimum streamflows except during the months of July and August (Table 17).

Table 15

MINIMUM FLOW ANALYSIS

1. Calapooia River at Albany and at gage 14173500

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	1,025	1,090	883	582	311	131	53	25	27	52	341	980
Min. Flow (Natural)	20	20	20	20	20	20	20	20	20	20	20	20
Addl. Releases from Storage	340	340	340	340	340	340	340	340	340	340	340	340
W. A. Unregulated	1,005	1,070	863	562	291	111	33	5	7	32	321	960

No dam was built on the Calapooia system so there are no calculations for regulated flow.

2. Calapooia River at Holley and at gage 14172000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	454	533	464	399	236	107	50.8	30.7	29.4	52	246	494
Min. Flow (Natural)	30	30	30	30	30	30	30	30	30	30	30	30
Addl. Releases from Storage	340	340	340	340	340	340	340	340	340	340	340	340
W. A. Unregulated	424	503	434	369	206	77	21	1	-1	22	216	464

No dam was built on the Calapooia system so there are no calculations for regulated flow.

Table 16

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

CALAPOOIA RIVER DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Calapooia R >	0	569	50%	4403	4491	3360	3388	2161	1105	448	278	297	954	2982	4519
Willamette R			80%	2522	2821	2465	2585	1603	803	398	212	220	576	1671	2644
			AVAILABLE	2522	2821	2465	2585	1603	803	398	212	220	576	1671	2644
Gage 14173500	3	372	50%	2950.7	2998.5	2238.0	2209.8	1343.1	673.8	273.6	167.7	180.1	604.5	1959.2	3050.2
			80%	1664.4	1871.2	1626.4	1669.5	990.0	489.3	239.2	126.0	130.9	357.0	1082.1	1758.5
			IWR APP	20	20	20	20	20	20	20	20	20	20	20	20
			AVAILABLE	1644	1851	1606	1650	970	469	219	106	111	337	1062	1739
Gage 14172000	45.4	105	50%	896.3	901.3	667.9	619.6	326.0	154.7	63.2	37.1	40.5	155.6	561.5	946.9
			80%	483.0	551.2	471.6	454.5	235.8	112.2	52.3	26.7	27.8	86.0	296.8	522.4
			IWR APP	30	30	30	30	30	30	30	30	30	30	30	30
			AVAILABLE	453	521	442	425	206	82	22	-3	-2	56	267	492
Oak Cr >	0	44.48	50%	399	398	294	261	125	57	23	13	15	62	240	428
Calapooia R			80%	209	240	204	188	89	41	19	9.3	9.7	33	123	229
			AVAILABLE	209	240	204	188	89	41	19	9.3	9.7	33	123	229

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Table 17

MINIMUM FLOW ANALYSIS

1. Santiam River near mouth based on Jefferson gage values.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	7,626	8,604	7,272	7,541	5,839	2,546	991	520	569	1,093	5,106	8,562
80% Ex. Regulated Flow	8,876	6,387	5,286	4,803	4,088	2,389	1,438	1,423	2,649	3,843	7,241	10,492
Min. Flow (Natural)	320	320	320	320	320	320	320	320	320	320	320	320
Addl. Releases from Storage	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570
W. A. Unregulated	7,306	8,284	6,952	7,221	5,519	2,226	671	200	249	773	4,786	8,242
W.A. Regulated	6,986	4,497	3,396	2,913	2,198	499	-452	-467	759	1,953	5,351	8,602

2. Santiam River at Jefferson and at gage 14189000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	7,626	8,604	7,272	7,541	5,839	2,546	991	520	569	1,093	5,106	8,562
80% Ex. Regulated Flow	8,876	6,387	5,286	4,803	4,088	2,389	1,438	1,423	2,649	3,843	7,241	10,492
Min. Flow (Natural)	330	330	330	330	330	330	330	330	330	330	330	330
Addl. Releases from Storage	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570
W. A. Unregulated	7,296	8,274	6,942	7,211	5,509	2,216	661	190	239	763	4,776	8,232
W.A. Regulated	6,976	4,487	3,386	2,903	2,188	489	-462	-477	749	1,943	5,341	8,592

Table 17 (Continued)

3. North Santiam River above gage 14184100

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Regulated Flow	2,877	2,134	2,181	2,071	2,378	1,435	825	825	1,480	2,155	2,763	3,390
Min. Flow (Natural)	430	430	430	430	430	430	430	430	430	430	430	430
Addl. Releases from Storage	640	640	640	640	640	640	640	640	640	640	640	640
W.A. Regulated	1,807	1,064	1,111	1,001	1,308	365	-245	-245	410	1,085	1,693	2,320

This gage only has 1-4 years of record. The 80% exceedence streamflow was estimated by ratio of streamflows with gage 14183000.
No unregulated flows were estimated.

4. North Santiam River at Mehama and at gage 14183000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	2,972	3,178	2,899	3,617	3,186	1,758	885	646	665	844	2,636	3,147
80% Ex. Regulated Flow	3,213	2,383	2,096	2,229	2,426	1,590	1,140	1,101	1,727	2,321	3,722	3,752
Min. Flow (Natural)	580	580	580	580	580	580	580	580	580	580	580	580
Addl. Releases from Storage	640	640	640	640	640	640	640	640	640	640	640	640
W. A. Unregulated	2,392	2,598	2,319	3,037	2,606	1,178	305	66	85	264	2,056	2,567
W.A. Regulated	1,993	1,163	876	1,009	1,206	370	-80	-119	507	1,101	2,502	2,532

5. North Santiam River above gage 14181500 at Niagara

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	1,706	2,166	1,978	2,378	2,280	1,410	813	630	546	743	1,337	2,004
80% Ex. Regulated Flow	2,070	1,202	982	1,104	1,519	1,233	1,015	994	1,582	2,124	2,818	2,483
Min. Flow (Natural)	500	500	500	500	500	500	500	500	500	500	500	500
Addl. Releases from Storage	640	640	640	640	640	640	640	640	640	640	640	640
W. A. Unregulated	1,206	1,666	1,478	1,878	1,780	910	313	130	46	243	837	1,504
W.A. Regulated	930	62	-158	-36	379	93	-125	-146	442	984	1,678	1,343

Table 17 (Continued)

6. South Santiam River at Waterloo

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	3,039	3,427	2,909	2,982	2,105	898	385	208	204	440	1,998	3,397
80% Ex. Regulated Flow	3,504	2,104	1,745	1,673	1,335	809	575	590	862	1,436	3,081	4,272
Min. Flow (Natural)	170	170	170	170	170	170	170	170	170	170	170	170
Addl. Releases from Storage	930	930	930	930	930	930	930	930	930	930	930	930
W. A. Unregulated	2,869	3,257	2,739	2,812	1,935	728	215	38	34	270	1,828	3,227
W.A. Regulated	2,404	1,004	645	573	235	-291	-525	-510	-238	336	1,981	3,172

7. Middle Fork Santiam River near Foster

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	1,570	1,738	1,537	1,722	1,175	470	210	121	117	265	1135	1,889
Min. Flow (Natural)	110	110	110	110	110	110	110	110	110	110	110	110
Addl. Releases from Storage	260	260	260	260	260	260	260	260	260	260	260	260
W. A. Unregulated	1,460	1,628	1,427	1,612	1,065	360	100	11	7	155	1,025	1,779

Scenic Waterway - North Santiam River

The upper Little North Santiam River, from the confluence of Battle Ax and Opal Creeks to the USFS boundary, is a state scenic waterway. Classifications and appropriations must be consistent with statutory priorities for

fish, wildlife, and recreation within scenic waterways. The Department's assessment of the flow levels needed to support the scenic waterway values for the Little North Santiam River is complete. The flows approved by the Commission are the same as those requested for fish needs in an instream water right application. These flows are not currently being met August through October (WRD, November 1991). Quartzville Creek, tributary to the Middle Santiam River, is a federal wild and scenic river. A manage-ment plan for the river is not yet complete. Federal law mandates the protection of the values identified in the designation of, or management plan for, wild and scenic rivers. PRD has identified Quartzville Creek as a priority for an instream water right. In addition, federal reserved rights dating back to the designation may exist to fulfill the purposes of the Wild and Scenic Rivers Act.

Minimum Streamflows - North Santiam River

There is a minimum streamflow on the North Santiam River (near Jefferson) of 430 cfs in natural flow, plus up to 640 cfs from storage releases. The measurement point is the former USGS gage 14184100 site on the North Santiam River near Jefferson. The gage operated intermittently from October 1964 to September 1968, but did not produce records usable for this analysis. The upstream gage at Mehama has been substituted to determine whether the minimum streamflow is met.

Flows at Mehama should meet the combined minimum streamflow except during the month of August. However, large amounts of water are diverted below the gage. About 1,057 cfs of these diversions are for hydro-electric uses and are returned to the river above the Jefferson gage site. Flows at Jefferson can be used as a check to see if the minimum streamflow is met. Combined flows for the North Santiam River at Mehama and the South Santiam River at Waterloo run 295 cfs and 354 cfs higher than flows at Jefferson during July and August, respectively. If these flows are diverted from the North Santiam River, the minimum streamflow near Jefferson (gage 14189000) is not met.

The minimum streamflow at Mehama consists of 580 cfs from natural flows, plus up to 640 cfs from storage releases as measured at USGS gage 1418300. The Department estimates that natural flows exceed the natural minimum streamflow year-round. However, estimated flows fall short of the combined minimum streamflow (1220 cfs) by 80 cfs and 119 cfs during the months of July and August, respectively.

The minimum streamflow on the Little North Santiam River is for 40 cfs from natural flow as measured at USGS gage 14182500. The Department estimates that the minimum is met during all months except August. ODFW has applied for an instream water right which would greatly increase minimum flows during all months except July and August. Department estimates indicate that water is available to meet requested instream flows for all months except August and the first half of September.

The minimum streamflow on the North Santiam River below Big Cliff Dam is for 500 cfs in natural flow plus up to 640 cfs from storage releases as measured at USGS gage 14181500 at Niagara. Here, the river flows through a combination of state and private lands. Department estimates show that the natural flow component of the minimum streamflow is met year-round. However, the combined minimum streamflow of 1,140 cfs would not be met by 158 cfs in March, 36 cfs in April, 125 cfs in July, and 146 cfs in August.

The minimum streamflow above Detroit is for 345 cfs from natural flow as measured at USGS gage 14178000 (North Santiam River below Boulder Creek, near Detroit). Except for small tracts, the North Santiam River flows through national forest land in this reach. There is no regulation or diversion above the gage. Records from this gage show that the minimum streamflow are being met year-round.

Large amounts of water are diverted from the North Santiam River at Stayton for irrigation, municipal, power development, and for aesthetic uses in the city of Salem. These water rights are some of the oldest in the system. The south channel of the river is nearly dewatered for a reach of three or four miles during the summer months. Since the power diversions are nonconsumptive, water is returned again to the river downstream of the diversion point. The diversions may prevent fish passage and cause problems for boaters because the flows during the summer are often inadequate for negotiation of the affected reach.

Minimum Streamflows - South Santiam River

Two minimum streamflows with storage components are in the South Santiam system. The lower minimum streamflow point on the South Santiam River is measured at USGS gage 14187500 at Waterloo. The natural flow component is 170 cfs and the storage component is 930 cfs for a com-bined total of 1100 cfs. The Department estimates that natural flows at Waterloo meet the natural flow component year-round. Flows fall short of the combined flows by 291 cfs in June, 525 cfs in July, 510 cfs in August, and 238 cfs in September.

The upper point is on the Middle Santiam River near Foster. Foster Reservoir began operating in 1967 and inundated the minimum streamflow point. The upper end of slack water is nearly three miles upstream from the minimum streamflow point. Foster Dam is nearly three miles downstream from the measuring point. From the head of Foster Reservoir, it is only about two miles to the toe of Green Peter Dam. The Department is explor-ing alternatives to ensure that instream values are protected as needed along this reach.

Recreation - South Santiam River

Additional releases from Foster and Green Peter reservoirs would be needed to meet several of the minimum streamflows discussed above. However, Linn County relies on these recreation facilities to draw tourism to help bolster the largely timber-based local economy. The county opposes changes in reservoir operations that would detract from recreational use of Green Peter and Foster reservoirs. Drafting water to meet minimum streamflows could be such an operational change.

Other Streams

ODFW, DEQ, and PRD have identified 16 streams in the Santiam subbasin as high priorities for instream water rights (Appendix C). ODFW has submitted applications for instream water rights for seven of them. The streams include: Wiley Creek, Neal Creek, Little Wiley Creek, Stout Creek, Rock Creek, Mad Creek, and as mentioned above, the Little North Santiam River. Department streamflow estimates show that flows are insufficient to support additional appropriation on a number of these streams (Table 18). Issuance of additional consumptive permits on these and other streams like them will increase the need for permit conditions and summer water rights regulation. Preventing further appropriation on these streams should have little affect on development as they flow through headwaters and/or forested areas, largely managed by the federal government.

Consumptive Uses

Agricultural Use

ODA has estimated that about 60,000 acres were irrigated in the Santiam-Calapooia subbasin in 1988 (Andrews, 1990). About 51 percent, or 30,600 acres, are irrigated with surface water. Irrigated acreage is projected to increase by 40,000 acres over the next 20 years. ODA predicts that the increase would require an additional 92,000 af of water, 90,620 af of which would be from surface water sources (Weber, 1991). ODA has requested that the Department reserve this amount of water to supply future irrigation needs in the subbasin. It is projected

Table 18

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

SANTIAM RIVER DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Stout Cr > N	0	10.88	50%	91	90	65	43	16	6.5	2.4	1.2	1.5	6.5	44.2	96
Santiam R			80%	44	52	43	28	11	4.5	1.6	0.7	0.9	2.9	17.7	47
			IWR APP	20	20	20	20	20	10/6	4/3	3.0	3.0	6/10	20.0	20
			AVAILABLE	24	32	23	8.3	-9.0	-5.5	-2.4	-2.3	-2.1	-3.1	-2.3	27
L N Santiam R >	0	112	50%	1290	1216	950	957	816	395	112	53	85	325	1183	1421
N Santiam R			80%	714	768	661	743	583	241	73	37	46	127	598	846
Gage 14182500			IWR APP	180	180	180	180	180	180/60	40	40	100/180	180	180	180
			AVAILABLE	534	588	481	563	403	61/181	33	-3.0	-54/-134	-53	418	666
Rock Cr >	0	23.2	50%	185	184	133	93	71	33	12	7	8	15	93	194
N Santiam R			80%	92	109	89	62	45	20	8.1	5	5	6.8	38	97
			IWR APP	50	50	50	50	50	30/12	8/6	4	3	15/30	50	50
			AVAILABLE	42	59	39	12	-5.2	-10/8.0	0.0/2.0	1	2	-8.2/-27.2	-12	47
Mad Cr >	0	7.1	50%	61	60	43	28	11	4.5	1.7	0.8	1.0	4.1	29	65
N Santiam R			80%	29	35	28	18	7.5	3.0	1.1	0.5	0.6	1.8	11	31
			IWR APP	25	25	25	25	25	10/5.0	3.0/2.0	3.0	3.0	5.0/10	25	25
			AVAILABLE	4.0	9.6	3.0	-6.8	-17.5	-7.0/-2.0	-1.9/-0.9	-2.5	-2.4	-3.2/-8.2	-14	6.1
S Santiam R >	48.5	174	50%	1471	1499	1076	1119	956	447	154	78	87	250	1094	1660
Santiam R			80%	743	873	772	858	650	271	108	60	60	117	520	855
Gage 14185000			IWR CERT	50	50	50	50	50	50	50	50	50	50	50	50
			AVAILABLE	693	823	722	808	600	221	58	10	10	67	470	805

Table 18 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Thomas Cr >	0	146.82	50%	1028	1038	761	718	354	176	88	52	57	183	553	1042
S Santiam R			80%	547	631	530	531	260	131	64	38	39	112	313	551
			IWR CERT	100	100	100	100	100	50/40	35/30	25/20	20/100	100	100	100
			AVAILABLE	447	531	430	431	160	81/91	29/34	13/18	19/-61	12	213	451
Neal Cr >	0	25.99	50%	201	200	145	126	53	24	12	6.9	7.6	28	100	210
Thomas Cr			80%	101	118	97	89	38	18	8.3	4.7	4.9	16	53	104
			IWR APP	60	60	60	60	60	20/12	10/7.0	6.0/5.0	5	20/14	60	60
			AVAILABLE	41	58	37	29	-22	-2.0/6.0	-2.0/1.0	-1.0/0.0	-0.1	-4.0/2.0	-7	44
Crabtree Cr >	0	147.2	50%	1028	1038	761	718	347	172	86	51	55	183	553	1042
S Santiam R			80%	547	631	530	531	256	129	63	37	38	112	313	551
			IWR CERT	100	100	100	100	100	50/40	35/30	25/20	20/100	100	100	100
			AVAILABLE	447	531	430	431	156	79/89	28/33	12/17	18/-62	12	213	451
Hamilton Cr >	0	40.93	50%	308	308	224	198	92	44	22	13	14	46	156	319
S Santiam R			80%	157	183	152	142	66	32	15	8.9	9.2	27	85	161
			IWR CERT	40	40	40	40	40	15/10	8.0/5.0	3	3	10/20	40	40
			AVAILABLE	117	143	112	102	26	17/22	7.0/10	5.9	6.2	17/7.0	45	121
McDowell Cr >	0	23.67	50%	184	183	133	115	52	25	12	7.0	7.7	26	91	193
S Santiam R			80%	92	108	89	81	37	18	8.3	4.9	5.0	14	48	96
			IWR CERT	45	45	45	45	45	15	5	3	3	10	45	45
			AVAILABLE	47	63	44	36	-8.3	2.8	3.3	1.9	2.0	4.4	3.4	51
Ames Cr >	0	12.6	50%	102	101	73	61	26	12	6.1	3.4	3.7	13	49	107
S Santiam R			80%	50	59	48	42	18	8.7	4.0	2.3	2.4	7.1	25	52
			AVAILABLE	50	59	48	42	18	8.7	4.0	2.3	2.4	7.1	25	52
Wiley Cr >	0	51.8	50%	385	385	281	252	151	77	39	23	25	60	197	397
S Santiam R			80%	197	230	191	181	106	54	26	17	17	35	108	202
Gage 14187000			IWR APP	100	100	100	100	100	40/25	18/15	15	15/110	110	100	100
			AVAILABLE	97	130	91	81	6	14/29	8.0/11	2.0	2.0/-93	-75	8	102

Table 18 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
L Wiley Cr >	0	16	50%	127.2	126.2	91.3	77.3	60.7	32.1	16.2	9.8	10.1	16.9	61.8	134.0
Wiley Cr			80%	62.5	74.0	60.5	54.2	40.0	20.5	10.2	7.4	7.0	9.2	32.4	65.6
			IWR APP	30.0	30.0	30.0	30.0	30.0	15/10	8/6	4.0	4.0	4/15	30.0	30.0
			AVAILABLE	32.5	44.0	30.5	24.2	10.0	6.0/11	2.2/4.2	3.4	3.0	5.2/-5.8	2.4	35.6
Quartzville Cr >	0	99.2	50%	1225	1258	877	881	680	292	94	52	67	245	1025	1421
M Santiam R			80%	660	764	625	639	448	176	65	37	40	97	519	760
Gage 14185900			AVAILABLE	660	764	625	639	448	176	65	37	40	97	519	760

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

that the water would come from existing storage projects in the subbasin with diversions occurring along the main stems of the Willamette, Santiam, and South and North Santiam Rivers.

Municipal Use

Sixteen incorporated cities are located within the Santiam subbasin. Salem, the third largest city in the Willamette Basin, is located in the Mill Creek drainage but obtains its water from the North Santiam River. Table 19 provides information on population and municipal water use in the subbasin. Cities and major providers hold rights to use about 435 cfs from surface water and 71 cfs from groundwater. Of this total amount, cities and the Lyons Mehama Water District are using only about 103 cfs, or about 20 percent, of the total allowable diversion.

These cities are located in Linn and Marion Counties. Linn County had a 1988 population of 88,800. Forty percent of the Linn County residents were reported to live in unincorporated areas. The county's total population grew 0.6 percent from 1980 to 1989 (PSU, 1990). However, population in unincorporated areas declined by 6.9 percent, reflecting out-migration from rural areas and movement to urban areas during that period. Linn County's population is projected to grow thirteen percent over the next 10 years (PSU, 1984). At a growth rate of thirteen percent every ten years for the next several decades, Linn County's population would double in about 55 years.

Marion County population grew 14.2 percent from 1978 to 1988. Population in unincorporated areas decreased by 10.4 percent in the same time frame. The county is expected to grow 17.3 percent between now and the year 2000 (PSU, 1984). If this rate were sustained, population would double in about 42 years. If the water is available and affordable, then most of the cities could expand public water service without obtaining additional water rights. Of the entities listed in Table 19, it appears that the city of Stayton and the Lyons Mehama Water District are actually using a large percentage of the amount allowed. The Department has met with representatives of Stayton to discuss options for enhancing the city's long-term water supply.

Summary

In most months, streamflows are sufficient to meet the natural flow components of minimum streamflows along the Calapooia River. The natural flow components of the minimum streamflows were converted to instream water rights. The stored water components were rescinded. Diversions at Boston Mill have resulted in regulation of uses upstream from about river mile 22. Based on the Department's water availability estimates and regulatory activities in the

Table 19

MUNICIPAL WATER RIGHTS AND USAGE FOR THE SANTIAM-CALAPOOIA SUBBASIN

					Month of Maximum Rate of Use				
Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Albany	--	29.00	--	29.00	(20.12)	--	--	--	No data reported. Max. mo. rate and unused rights derived from per capita gpd reported in 1986 WRD survey. Population served is 1986 estimate by Albany
Millersburg and N. Albany Co. Service District	--	--	--	--	--	--	--	--	
Total	33,580	29.00	--	29.00	(20.12)	(12,995,460)	(387)	(8.88)	
Brownsville	1,280	1.25	--	1.25	0.34	222,214	174	0.91	
Detroit	410	1.25	--	1.25	0.33	216,000	527	0.92	Water year 1990 data.
Gates	535	1.70	--	1.70	0.36	235,281	440	1.34	
Halsey	680	--	--	--	--	--	--	--	No data reported. No water rights of record, but city may have taken over service of private company.
Idanha	345	0.93	--	0.93	0.26	166,645	483	0.67	Data available for Aug/ Sep 1990 only.
Jefferson	1,800	3.09	2.10	5.19	0.70	449,333	250	4.49	
Lebanon	10,475	27.00	--	27.00	4.39	2,834,452	271	22.61	Rights include municipal right for 9 cfs originally filed by Pacific Power & Light.
Lyons-Mehama Water District	1,920	5.00	--	5.00	0.97	624,750	325	4.03	Population served based on 640 connections at 3 persons each. Includes the City of Lyons and surrounding unincorporated area.
Mill City	1,545	1.78	--	1.78	0.30	191,898	124	1.48	

Table 19 (Continued)

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use				Comments
					Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	
Salem	96,830	344.40	58.67	403.07	60.72	--	--	--	City of Salem supplies
Turner	1,175	--	--	--	--	--	--	--	the City of Turner.
Total	98,005	344.40	58.67	403.07	60.72	39,245,000	400	342.35	
Scio	600	--	3.97	3.97	0.18	116,458	194	3.79	
Sodaville	190	--	0.17	0.17	0.03	21,322	112	0.14	
Stayton	4,945	10.99	5.68	16.67	11.42	7,381,900	1493	5.25	Usage reflects amount diverted from N. Santiam R., not amout metered in town.
Sweet Home	6,990	13.10	--	13.10	2.49	1,608,387	230	10.61	
Waterloo	205	--	--	--	--	--	--	--	No water rights of record.
TOTAL	162,620	435.50	70.59	506.09	102.61	66,309,100	408	403.48	Population total excludes Halsey and Waterloo

1 Includes incorporated cities and larger water districts which may serve unincorporated areas. Smaller water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

subbasin, streamflow is barely adequate to satisfy out-of-stream uses and the instream water rights.

While the natural flow components of minimum streamflows in the Santiam subbasin are generally met, combined minimum streamflows are not being met during certain months of the year on the main stem, North and South Santiam Rivers. Classifications and permitting activities must be consistent with fish, wildlife, and recreation priorities established for the state scenic waterway reach of the Little North Santiam River.

The minimum streamflow at Foster Reservoir is inundated and is being evaluated by the Department outside of the basin planning process.

ODFW, PRD and DEQ are interested in establishing instream water rights on a number of additional streams in the Santiam subbasin. ODFW has submitted applications on several streams. These applications are currently pending before the Commission. The Department's estimates for these ungaged streams show that flows on smaller streams drop to very low levels from July/August through September/October.

Based on water rights, the largest water use categories in the Santiam subbasin are irrigation, industrial and miscellaneous uses (fisheries, aesthetics). About half the amount of water appropriated for industrial uses is for hydroelectric power generation at Stayton on the North Santiam River.

Miscellaneous and municipal use are the other large use categories in the subbasin. In the Calapooia, industrial and irrigation uses are also relatively high. Municipal use is low.

ODA expects irrigation to increase by about 30,600 acres in the Santiam-Calapooia subbasin by 2010. ODA has requested a reservation for 90,620 af of water from existing storage. There is sufficient uncontracted water in Foster and Green Peter Reservoirs to meet the proposed reservation. The Bureau of Reclamation holds a permit for 300,000 af of water in Detroit Reservoir. In 1987, only 4,682 af of this water had been contracted. Plenty of water is available for existing and new consumptive needs without users having to divert storage releases needed and intended to protect public instream values.

Except for Stayton and the Lyons-Mehama District, municipalities hold water rights which appear sufficient to serve projected growth for the next 50 to 100 years. Stayton is exploring options for meeting long term water needs. Existing storage is available to meet unexpected demands.

Coast Range Subbasin

The Coast Range subbasin is comprised of four individual river drainages which are tributary to the Willamette River main stem. The Yamhill River, Rickreall Creek, Luckiamute River, and Marys River drainages are discussed separately below.

YAMHILL RIVER DRAINAGE

General Orientation

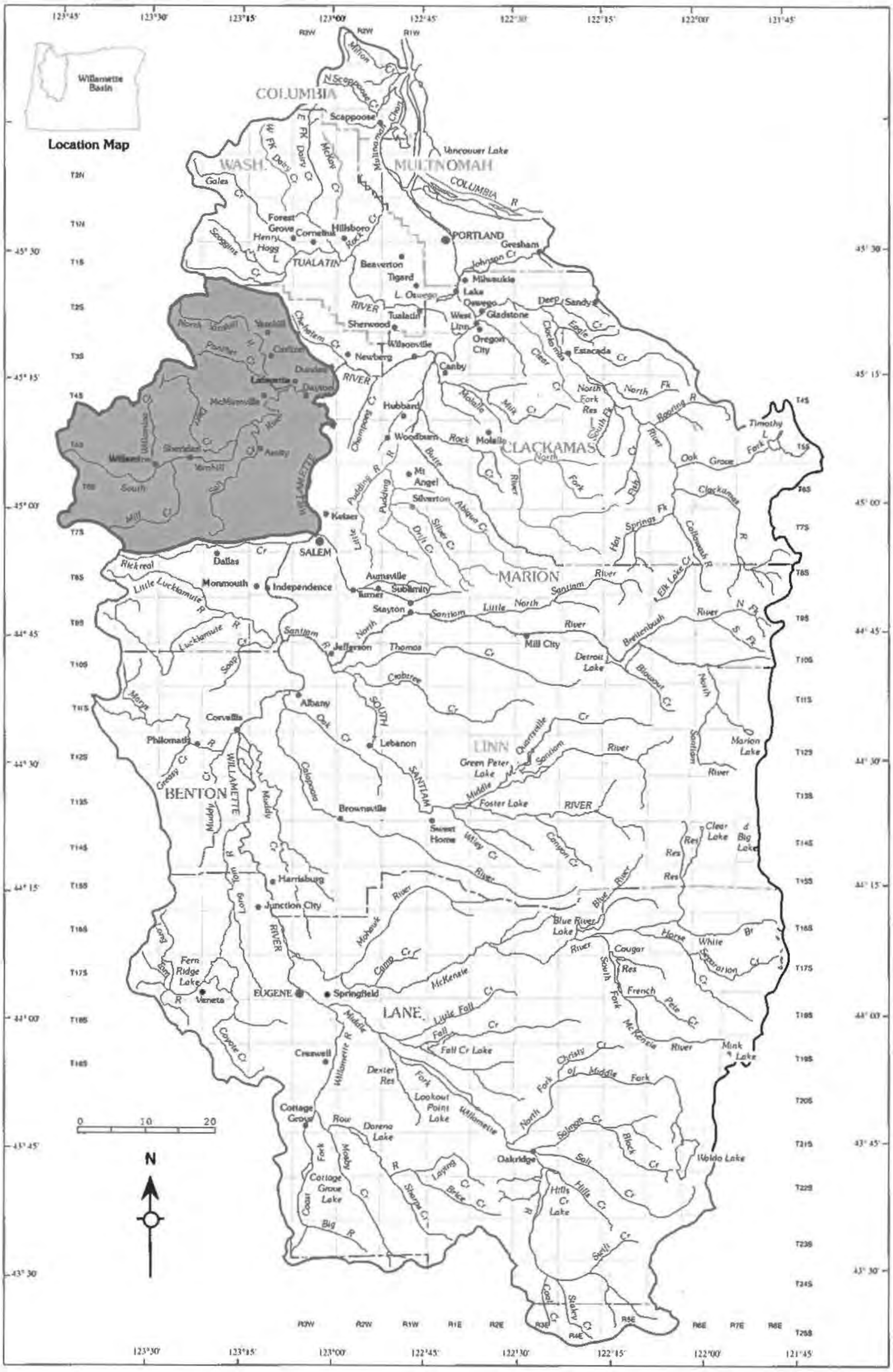
The Yamhill River drains an area of 772 square miles in Polk and Yamhill Counties. It is the largest and northernmost of the Coast Range subbasin drainages (Figure 10). The Yamhill River main stem is about eleven miles long. The North and South Forks are the major tributaries at 33 and 62 miles long, respectively.

No gages exist on the Yamhill main stem. The downstream-most gage on the South Fork (USGS gage 14194000, South Yamhill River near Whiteson) is located at river mile 16.7 and measures runoff from a 502 square mile drainage area. Gage records show an average annual discharge of about 1.271 million af, or about 2,532 af per square mile (USGS 1990). A former gage on the North Fork Yamhill River at river mile 20.5 (USGS gage 1419700 near Pike) measured runoff from 66.8 square miles. Twenty-five years of record showed an average annual discharge of 175,300 af, or 2,624 af of runoff per square mile (Appendix A). These gages recorded runoff from 569 square miles or about 74 percent of the drainage. By extrapolating, total drainage discharge can be estimated at 1.96 million af per year.

The distribution of discharge is similar for the North and South Yamhill Rivers. About 85 percent of the runoff occurs from November through March. About 4.3 percent of the average annual yield occurs from June through October. Flow in the Yamhill system relies mostly on natural flows as no major storage facilities have been constructed in the subbasin. However, a number of small reservoirs in the drainage are used for irrigation or municipal supply.

Approximately 96.4 percent of the land in the drainage is privately owned, while 3.1 percent and 0.5 percent are owned by the federal and state governments, respectively.

Figure 10
YAMHILL RIVER DRAINAGE-COAST RANGE SUBBASIN



Water Availability and Needs

Overview

Low summer flows combined with high demand result in significant water supply problems in the Yamhill drainage. Seasonal shortages have prompted the Department to condition new water use permits based on water availability.

Total rights allow the diversion of about 560 cfs from the Yamhill system (Appendix B). About 467 cfs can be used for agricultural purposes, with 436 cfs designated specifically for irrigation. Irrigation is specified by court decree from April 1 through September 30. In general, the courts decreed the same rate and duty used by the Department. Water rights would also allow the diversion of approximately 42 cfs from the Yamhill system for municipal use. Water rights for other water use categories are relatively minimal.

Applying the Department's rate and duty limits, up to 87,200 af per year could be diverted to irrigate 34,880 acres. The use of surface flows allowed by the remaining rights could reach 89,800 af per year for an annual total diversion of 177,000 af. Meeting the instream water right at the mouths of the South and North Forks requires about 111,900 and 33,900 af per year, respectively. Thus, total demand allowed by water rights could equal approximately, 322,700 af per year. This represents only about 16 percent of the total discharge in the subbasin. However, the out-of-stream demand alone could reach 117,160 af from June through September. Only 2.5 percent, or about 49,000 af, of discharge generally occurs during this period.

Nonconsumptive Uses

Instream Water Rights and Minimum Streamflows

Instream water rights have been established at ten locations in the Yamhill drainage. Half of these instream water rights have a priority of 1964 and half have a 1983 priority. In addition, two minimum streamflows were established on Willamina Creek and the South Yamhill River in 1983. These are described in further detail below.

Yamhill Main Stem

The instream water right of 15 cfs as measured at USGS gage 14197500 is met year-round (Table 20).

Table 20

WILLAMETTE BASIN STREAMFLOW AVAILABILITY
YAMHILL RIVER DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Yamhill R >	0	747	50%	5227	5347	3982	3069	1628	708	216	114	143	552	3312	5250
Willamette R			80%	2989	3355	2911	2172	1157	494	189	77	97	282	1397	3023
			AVAILABLE	2989	3355	2911	2172	1157	494	189	77	97	282	1397	3023
Gage 14197500	8.0	735	50%	5148	5266	3921	3019	1598	694	212	112	140	542	3259	5172
			80%	2942	3303	2865	2136	1135	485	185	75	95	277	1374	2976
			IWR CERT	15	15	15	15	15	15	15	15	15	15	15	15
			AVAILABLE	2927	3288	2850	2121	1120	470	170	60	80	262	1359	2961
N Yamhill R >	0	172.8	50%	1316	1330	983	705	322	132	40	20	26	115	780	1356
Yamhill R			80%	714	816	695	482	223	92	33	13	17	54	313	742
			IWR APP	70	70	70	70	70	40/25	15/10	10	10	10	70	70
			AVAILABLE	644	746	625	412	153	52/67	18/23	3.1	6.5	44	243	672
Gage 14197000	20.5	66.8	50%	538	539	396	271	111	44	13	6.6	8.5	41	305	563
			80%	282	326	274	181	76	30	11	4.1	5.2	19	118	298
			IWR CERT	10	10	10	10	10	10	10	10	10	10	10	10
			AVAILABLE	272	316	264	171	66	20	0.6	-5.9	-4.8	8.6	108	288
Panther Cr >	0	14.2	50%	125	124	90	57	17	6.2	1.9	0.9	1.2	7.8	66	134
N Yamhill R			80%	62	73	60	37	12	4.4	1.4	0.5	0.7	3.3	24	67
			IWR APP	25	25	25	25	25	6/4	4/3	3	3	3/5	25	25
			AVAILABLE	37	48	35	12	-13	-2.0/0.0	-3.0/-2.0	-2.5	-2.3	0.0/-2.0	-0.7	42
Baker Cr >	3.0	22.3	50%	191	190	139	90	31	12	3.6	1.7	2.2	13	103	204
Panther Cr			80%	96	113	94	59	21	8.2	2.7	1.0	1.3	5.4	39	104
			AVAILABLE	96	113	94	59	21	8.2	2.7	1.0	1.3	5.4	39	104

Table 20 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Turner Cr >	0	13.9	50%	123	121	88	56	21	7.9	2.5	1.2	1.5	7.7	65	132
N Yamhill R			80%	61	71	59	36	14	5.4	1.8	0.7	0.9	3.2	24	66
			IWR APP	25	25	25	25	25	8/6	5/3	2	2	2/3	25	25
			AVAILABLE	36	46	34	11	-11	-3.0/-1.0	-3.0/-1.0	-1.3	-1.1	1.0/0.0	-1.2	41
Cedar Cr >	0	4	50%	38	37	27	16	10	3.9	1.2	0.6	0.7	2.0	19	42
N Yamhill R			80%	18	21	17	10	6	2.3	0.8	0.4	0.4	0.8	6.6	20
			AVAILABLE	18	21	17	10	6	2.3	0.8	0.4	0.4	0.8	6.6	20
Haskins Cr >	0	14.8	50%	130	129	94	60	23	8.8	2.7	1.3	1.7	8.2	69	140
N Yamhill R			80%	65	76	63	38	15	5.9	2.0	0.8	1.0	3.4	25	70
			IWR APP	25	25	25	25	25	5/3	3/2	2	2	2/3	25	25
			AVAILABLE	40	51	38	13	-10	1.0/3.0	-1.0/0.0	-1.2	-1.0	1.0/0.0	0.3	45
Fairchild Cr >	0	8	50%	73	72	52	32	21	8.8	2.8	1.4	1.7	4.2	37	79
N Yamhill R			80%	35	42	34	20	13	5.3	1.9	0.9	1.0	1.7	14	39
			AVAILABLE	35	42	34	20	13	5.3	1.9	0.9	1.0	1.7	14	39
S Yamhill R >	0.0-	507.2	50%	4592	4249	2903	1484	650	251	93	45	60	258	1779	4636
Yamhill R	16.7		80%	2254	2518	1964	984	448	175	64	27	35	105	775	2442
Gage 14194000			IWR CERT	200	200	200	200	200	150/100	62	62	62	150	200	200
			AVAILABLE	2054	2318	1764	784	248	50/75	2.0	-35	-27	-45	575	2242
Gage 14192500	45.6	133	50%	1493	1332	1010	531	256	104	43	23	30	142	870	1636
			80%	784	856	690	374	177	73	31	15	18	59	406	939
			IWR CERT	20	20	20	20	20	20	20	20	20	20	20	20
			AVAILABLE	764	836	670	354	157	53	11	-5.0	-2.0	39	386	919

Table 20 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Deer Cr >	0	58.32	50%	464	465	341	235	98	39	13	6.2	7.9	36	256	485
S Yamhill R			80%	241	280	234	157	67	27	10	3.9	4.8	17	101	254
			IWR CERT	80	80	80	80	80	25/20	15/10	8/6	6	20/40	80	80
			AVAILABLE	161	200	154	77	-13	2.0/7.0	-5.0/0.0	-4.0/-2.0	-1.2	-3.0/23	21	174
Mill Cr >	0	52.8	50%	575	574	430	438	199	91	35	21	22	131	422	640
S Yamhill R			80%	311	352	306	328	148	69	33	15	15	70	237	367
			IWR CERT	80	80	80	80	80	15/10	7/5	5	5	20/40	80	80
			AVAILABLE	231	272	226	248	68	44/59	26/28	10	10	50/30	157	287
Gooseneck Cr >	0	9.6	50%	115	114	84	79	29	12	4.8	2.7	2.9	21	78	132
Mill Cr			80%	59	68	58	57	21	9.4	4.2	1.8	1.8	10	41	71
			AVAILABLE	59	68	58	57	21	9.4	4.2	1.8	1.8	10	41	71
Willamina Cr >	0.0-	84	50%	891	892	670	698	332	154	59	36	38	215	668	984
S Yamhill R	6.2		80%	490	551	482	529	249	117	57	26	26	118	380	573
Gage 14193000			IWR CERT	70	70	70	70	70	50/30	20	20	20	20/40	70	70
			AVAILABLE	420	481	412	459	179	67/87	37	6.3	6.2	98/78	310	503
Coast Cr >	0	22.08	50%	204	203	149	120	58	26	10	5.3	6.0	24	118	221
Willamina Cr			80%	104	121	101	83	40	18	7.5	3.6	3.9	12	55	115
			AVAILABLE	104	121	101	83	40	18	7.5	3.6	3.9	12	55	115
Canada Cr >	0	7.52	50%	74	73	53	41	28	13	5.0	2.8	3.1	7.7	41	82
Coast Cr			80%	36	43	35	28	18	8.2	3.5	2.0	2.0	3.5	18	41
			AVAILABLE	36	43	35	. 8	18	8.2	3.5	2.0	2.0	3.5	18	41
Burton Cr >	0	3.52	50%	36	35	26	19	12	5.4	2.1	1.1	1.2	3.4	19	41
Coast Cr			80%	17	21	17	13	7.6	3.4	1.4	0.8	0.8	1.5	8.5	20
			AVAILABLE	17	21	17	13	7.6	3.4	1.4	0.8	0.8	1.5	8.5	20
E Fk Willamina	0	14.7	50%	139	138	101	80	59	28	11	6.2	6.7	16	79	152
Cr >			80%	70	82	68	55	39	18	7.9	4.5	4.5	7.5	36	78
Willamina Cr			AVAILABLE	70	82	68	55	39	18	7.9	4.5	4.5	7.5	36	78

Table 20 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gold Cr >	0	8.64	50%	94	93	68	51	35	16	5.1	2.8	3.1	9.5	58	106
S Yamhill R			80%	47	55	46	35	23	10	4.0	2.0	2.0	4.1	25	55
			AVAILABLE	47	55	46	35	23	10	4.0	2.0	2.0	4.1	25	55
Salt Cr >	0	53.2	50%	425	426	312	214	78	30	10	4.7	6.0	33	234	445
S Yamhill R			80%	220	256	214	143	54	21	7.5	2.9	3.6	15	92	232
			AVAILABLE	220	256	214	143	54	21	7.5	2.9	3.6	15	92	232
Cosper Cr >	0	10.4	50%	112	111	82	62	43	19	6.4	3.5	3.9	12	69	126
S Yamhill R			80%	56	66	55	42	28	12	5.0	2.5	2.6	5.0	30	66
			AVAILABLE	56	66	55	42	28	12	5.0	2.5	2.6	5.0	30	66
Rowell Cr >	0	12	50%	128	127	93	71	51	23	7.5	4.2	4.6	14	80	144
S Yamhill R			80%	65	75	64	49	33	14	6.0	3.0	3.1	5.9	35	76
			AVAILABLE	65	75	64	49	33	14	6.0	3.0	3.1	5.9	35	76
Rock Cr >	0	23.7	50%	244	242	179	142	66	27	9.0	4.8	5.6	28	157	270
S Yamhill R			80%	126	146	124	98	45	19	7.6	3.2	3.5	13	69	146
			AVAILABLE	126	146	124	98	45	19	7.6	3.2	3.5	13	69	146
Cow Cr >	0	2	50%	24	23	17	12	6.8	2.8	0.9	0.5	0.6	2.0	14	27
Rock Cr			80%	11	13	11	7.7	4.3	1.8	0.7	0.3	0.3	0.8	5.5	14
			AVAILABLE	11	13	11	7.7	4.3	1.8	0.7	0.3	0.3	0.8	5.5	14
Joe Day Cr >	0	2.88	50%	33	33	24	17	10	4.3	1.4	0.8	0.9	2.9	20	38
Rock Cr			80%	16	19	16	11	6.5	2.7	1.1	0.5	0.5	1.2	8.0	19
			AVAILABLE	16	19	16	11	6.5	2.7	1.1	0.5	0.5	1.2	8.0	19
Rogue R >	0	10.88	50%	117	115	85	65	26	10	3.3	1.7	2.0	12.2	73	131
S Yamhill R			80%	59	69	58	44	18	7.1	2.7	1.1	1.2	5.3	31	69
			AVAILABLE	59	69	58	44	18	7.1	2.7	1.1	1.2	5.3	31	69

Table 20 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Agency Cr >	0	25.6	50%	262	260	193	153	119	55	18	10	11	31	169	290
S Yamhill R			80%	136	157	133	106	78	34	15	7.5	7.7	14	75	157
			IWR CERT	80	80	80	80	80	25/20	15/10	8/6	6	20/40	80	80
			AVAILABLE	56	77	53	26	-2.4	9.0/14	0.0/2.0	0.0/2.0	1.7	-6.0/-36	-5.1	77
Ead Cr >	0	5.6	50%	63	61	45	33	22	9.4	3.1	1.7	1.9	6.0	38	71
S Yamhill R			80%	31	36	30	22	14	5.9	2.4	1.2	1.2	2.5	16	36
			AVAILABLE	31	36	30	22	14	5.9	2.4	1.2	1.2	2.5	16	36
Pierce Cr >	0	2.4	50%	28	27	20	14	8.4	3.5	1.2	0.6	0.7	2.4	16	32
S Yamhill R			80%	13	16	13	9.3	5.3	2.2	0.9	0.4	0.4	1.0	6.7	16
			AVAILABLE	13	16	13	9.3	5.3	2.2	0.9	0.4	0.4	1.0	6.7	16
Hanchet Cr >	0	1.12	50%	14	13	10	6.6	3.6	1.4	0.5	0.2	0.3	1.1	7.7	16
S Yamhill R			80%	6.4	7.6	6.2	4.2	2.2	0.9	0.3	0.2	0.2	0.4	3.1	7.8
			AVAILABLE	6.4	7.6	6.2	4.2	2.2	0.9	0.3	0.2	0.2	0.4	3.1	7.8
Kitten Cr >	0	1.92	50%	23	22	16	11	6.5	2.7	0.9	0.5	0.5	1.9	13	26
S Yamhill R			80%	11	13	11	7.4	4.1	1.7	0.7	0.3	0.3	0.8	5.3	13
			AVAILABLE	11	13	11	7.4	4.1	1.7	0.7	0.3	0.3	0.8	5.3	13

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

North Fork Yamhill River

The instream water right established at the mouth of the North Yamhill River is met year-round. However, flows further upstream, as measured at USGS gage 14197000 at Lafayette, are insufficient to satisfy out-of-stream uses and meet the 10 cfs instream water right. Flows fall short by about 6 cfs in August and 5 cfs in September.

Flows in Panther Creek are insufficient to satisfy out-of-stream uses and meet the instream water right from May through November. Estimated shortfalls range from 0.7 cfs in November to 13 cfs in May. Flows in Turner and Haskins Creeks are too low to meet combined out-of-stream demands and instream water rights from May through November and May through September, respectively.

The Department has also estimated monthly flows for a number of ungaged streams which have been identified as high priority for future instream water rights by ODFW, DEQ, and/or PRD. Virtually all the streamflow is appropriated from these streams for out-of-stream uses from July through October.

South Fork Yamhill River

Flows in the South Yamhill River are too low during summer months to meet both out-of-stream demand and the instream water right established from the mouth to USGS gage 14194000 near Whiteson at river mile 16.7. Department flow estimates show a deficit of 35 cfs in August, 27 cfs in September, and 45 cfs in October as measured at the gage. It is unlikely that these deficits are made up between the gage and the mouth as there are no significant tributaries along that reach.

There are two additional instream water rights on the South Yamhill River. One is for 15 cfs year-round above USGS gage 14194000 near Whiteson. Flows at this gage should be high enough to meet out-of-stream and instream demand year-round. However, flows measured at USGS gage 141925000 near Willamina fall short of meeting total demand by five cfs in August and two cfs in September.

Flows on tributaries to the South Yamhill River vary in ability to meet total water demand. On Deer Creek, flows fall short by 13 cfs in May, five cfs in July, 4 cfs in August, 1.2 cfs in September and 3 cfs in October. However, flows on Mill Creek and Willamina Creek appear sufficient to meet the demand year-round.
For ungaged tributaries, flows appear to drop significantly from June through October. On many of the smaller streams without water rights, flows are nearing full appropriation to out-of-stream uses.

ODFW, DEQ and PRD have shown substantial interest in protecting streamflows in the Yamhill drainage for public benefit. ODFW has submitted the names of 23 streams needing flow protection for fish (Appendix C). PRD is interested in preserving and enhancing recreation values on the main stems of the Yamhill River and its forks, but has yet to determine the necessary flows. Recreation is directly linked to water quality and fishery values. Flow protection for these other purposes will benefit recreation as well.

Water Quality

Since monitoring began in 1976, data have indicated that high pH levels and algal concentrations exist in the lower Yamhill River during summer low flow conditions. High bacterial concentrations have been measured at all sites, especially during the winter months (DEQ, 1990). A more intensive study began in 1987 and provided the basis for the establishment of the TMDL on the lower South Fork Yamhill River and main stem Yamhill River. DEQ asserts that TMDLs are needed on seven other reaches in the Yamhill system.

Water diversions in low-flow months reduce the capacity of streams to assimilate waste load. DEQ is working to curb point and nonpoint pollution in the Yamhill drainage but has yet to determine appropriate water quality flow needs for these streams. Preserving existing flows instream for pollution abatement may reduce or delay the need for more costly or difficult waste disposal.

Consumptive Uses

Agricultural Use

In addition to conventional crops, the Yamhill drainage supports a growing nursery stock industry. Nursery stock and growing practices (i.e., temperature control) require more water than conventional open-field crops. Vineyards are also increasing in portions of the Yamhill basin.

ODA estimates that 38,760 acres were irrigated in the entire Coast Range subbasin in 1988. ODA expects that irrigated lands in the Yamhill drainage will increase by 15,647 acres by 2010. This is 20 percent of the total expansion projected for the Coast Range subbasin. ODA has requested that the Department reserve 35,989 af of surface water for this purpose. Lacking sufficient natural summer flows, irrigators in the Yamhill drainage will need to develop storage in the drainage, or purchase stored water from projects located outside the subbasin.

Municipal Use

Eight incorporated cities are located in the Yamhill drainage. Information on municipal populations and water use is presented in Table 21. These municipalities can divert up to about 50 cfs from surface water and 17 cfs from groundwater sources. However, only about 13 cfs, or 19 percent, are being used during the maximum use month. This leaves a surplus of almost 54 cfs which could be developed in the future. Each of the cities is using a low proportion the total amount they could develop.

In 1988, the population of Yamhill County was estimated to be 59,800. About 20,645 people (35 percent) lived in unincorporated areas. The total population in the county grew by nearly sixteen percent from 1978 to 1988, while the number of people residing in unincorporated areas grew by only one percent. It is estimated that the population grew almost 10 percent from 1980 to 1989 (PSU, 1990).

The Center for Population Research and Census at Portland State University projects that the population of Yamhill County will increase by 18.8 percent by the year 2000 (PSU, 1984). If recent distribution trends continue, urban areas will probably absorb most of the projected increase. At 18.8 percent increase every ten years, the county's population would double in about 40 years.

Water rights seem adequate to accommodate projected population growth for several decades. However, water supplies are limited in the drainage. Communities which rely largely on groundwater are finding this source to be unreliable. The full development of water rights could deplete streamflows during low-flow periods and further intensify water quality problems. Yamhill County has joined with Polk County to explore opportunities to meet long-term water needs using a regional approach. The two counties are currently working with the Bureau of Reclamation to determine the feasibility of purchasing stored water, constructing a new storage facility, and other options.

Summary

The Yamhill River system reflects the high winter runoff and low summer flows which are characteristic of Coast Range drainages. Streamflows are often insufficient to meet existing out-of-stream and instream demands during low-flow summer months. There are also significant water quality problems in the Yamhill drainage, particularly during low flow months.

Significant problems on the Yamhill main stem and South Yamhill River have resulted in the establishment of TMDLs for pollutants along certain reaches.

Table 21

MUNICIPAL WATER RIGHTS AND USAGE FOR THE YAMHILL RIVER DRAINAGE

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use				Comments
					Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	
Amity	1050	1.63	0.84	2.47	0.48	310,080	295	1.99	
Carlton	1,305	5.57	--	5.57	0.69	445,710	342	4.88	
Dayton	1,520	0.31	1.56	1.87	0.48	307,426	202	1.39	
Lafayette	1,335	1.57	1.79	3.36	0.22	139,727	105	3.14	Water year 1990 data. Includes usage from an unpermitted well.
McMinnville	16,400	36.10	--	36.10	9.30	6,010,330	366	26.8	Water diverted from Nestucca R. into Haskins Cr. Totals here reflect total diversion from Haskins, assumed to include Nestucca water.
Sheridan	2,500	0.50	12.87	13.37	0.90	578,017	231	12.47	
Willamina	1,860	3.35	--	3.35	0.70	451,143	243	2.65	
Yamhill	710	0.67	--	0.67	0.41	265,690	374	0.26	
TOTAL	26,680	49.70	17.06	66.76	13.18	8,508,123	319	53.58	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5)minus average monthly rate of use (column 6).

Flows on the Yamhill main stem, and downstream reaches of the North Fork Yamhill River can satisfy out-of-stream uses and instream water rights year-round. The remainder of the North Yamhill, and many of its tributaries, appear unable to satisfy total demand, or are nearing full appropriation from May through September or October. Flows on the South Yamhill River appear unable to meet instream and out-of-stream needs from August through October. Flows in the smaller tributaries vary in their ability to meet water demands. The Department estimates that flows in many ungaged tributaries throughout the basin are nearing full appropriation to out-of-stream uses. Many are streams which have been identified by ODFW, DEQ and PRD as high priority for protection of flows.

Irrigated acreage in the drainage is expected to increase by 15,647 acres by the year 2010. ODA has requested that the Department reserve 35,989 af of surface water for this purpose. The Yamhill drainage supports a growing nursery stock industry. Storage will have to be constructed in the drainage and/or water imported from outside the drainage to meet future irrigation demand.

Municipal water rights appear adequate to meet substantial growth in population and water demand. However, development of unused water rights could have impacts on both surface and groundwater sources. Communities on wells in unincorporated areas may not have adequate supplies. There may be requests for municipalities to extend service to these areas.

RICKREALL CREEK DRAINAGE

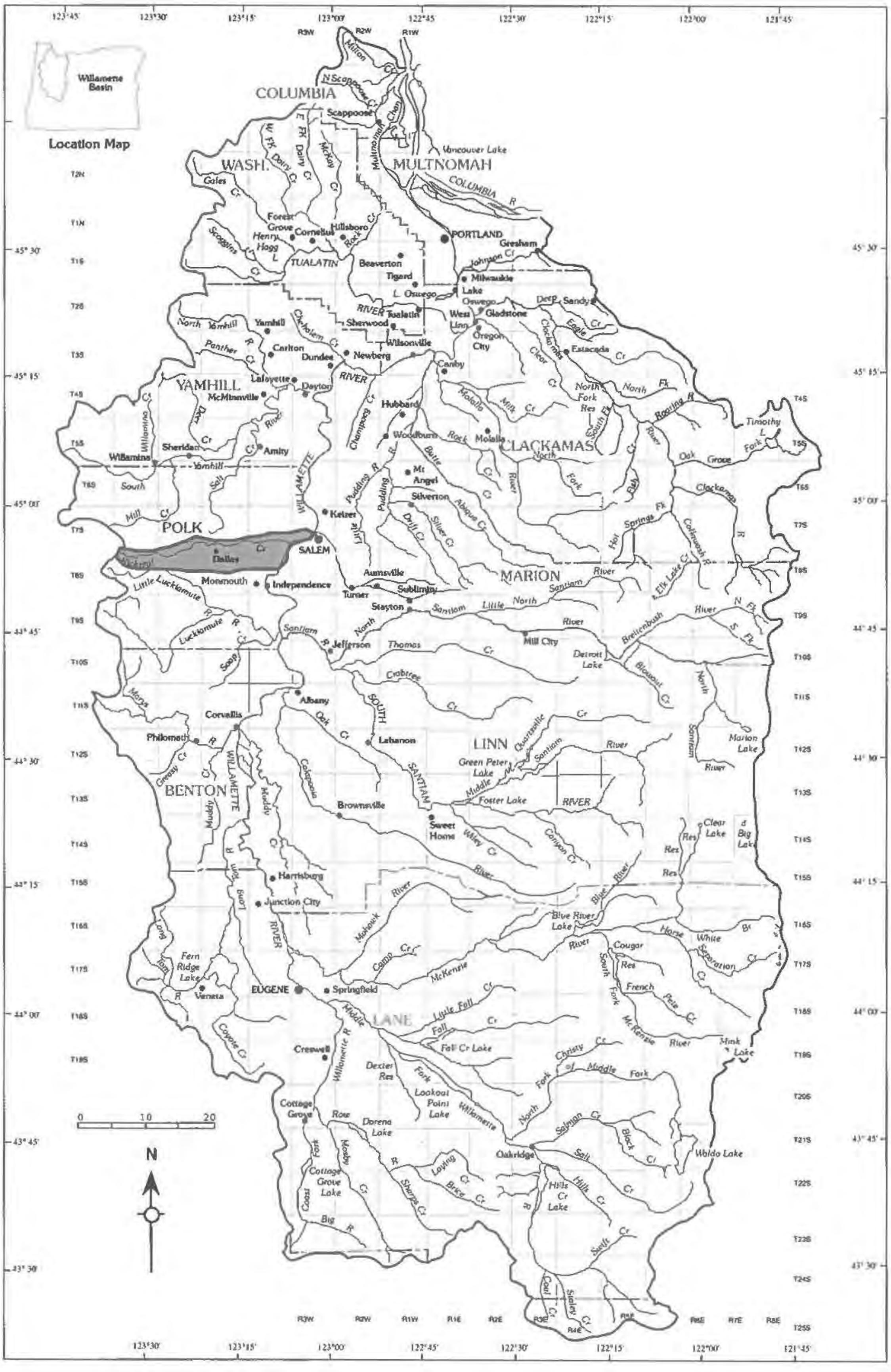
General Orientation

At 94 square miles, Rickreall Creek is the smallest of the four drainages in the Coast Range subbasin (Figure 11). Privately owned lands, including farm, forest, urban, and rural residential lands, make up 89 percent of the drainage. Federal forest lands managed by the BLM and USFS account for seven percent of the area. The Basket Slough National Wildlife Refuge managed by the U.S. Fish and Wildlife Service comprises the remaining four percent of the drainage. Agriculture is the major economic activity in the area.

Rickreall Creek is currently ungaged. Twenty-one years of flow record do exist from a former gage at river mile 18 upstream from Dallas. The records show Rickreall Creek yields an average of 105,800 af annually at the gage (Appendix A). This translates to about 3,861 af annual runoff per square mile.

The heavy winter runoff pattern common for Coast Range subbasin streams is even more pronounced in the Rickreall Creek drainage. Nearly 86 percent of the annual discharge occurs from November through March, while only 3.9 percent of the runoff occurs during the months of June through October (USGS, 1990).

Figure 11
RICKREAL CREEK DRAINAGE-COAST RANGE SUBBASIN



Water Availability and Needs

Overview

Total water rights to surface flows in the Rickreall drainage amount to about 61 cfs (Appendix B). Agricultural use accounts for about 43 cfs. Virtually all of this amount is allocated for irrigation. The court has decreed an irrigation season in the Rickreall drainage from April 1 to September 30. Irrigation rate and duty limits are identical to those applied by the Department. About 15 cfs can be diverted for municipal uses. Other types of water uses appear to be negligible.

If water users fully developed their rights, up to about 21,700 af of surface water flows could be diverted annually. Meeting the instream water right at the former gaging sites requires an additional 3,620 af per year. The total demand, therefore, could reach about 24 percent of total annual discharge from the drainage. However, about 12,900 af could be diverted from June through September when only about 2.3 percent of total discharge, or about 2,400 af, are discharged.

The Department is responding to the summer shortages on Rickreall Creek by conditioning new water use permits.

Nonconsumptive Uses

Instream Water Rights

A year-round, five cfs, instream water right on Rickreall Creek dates back to 1964. This flow was set to protect fish life at and above a point about four miles upstream from Dallas at river mile 19.1. The Department estimates that flows in Rickreall Creek cannot satisfy both out-of-stream uses and the established instream water right from July through October (Table 22). Natural flows alone cannot provide for additional consumptive or instream needs during these months.

Water Quality

There are serious water quality problems in the Rickreall Creek system. DEQ studies show that dissolved oxygen and fecal coliform are problematic, particularly during low flow months. Both DEQ and PRD are interested in establishing instream water rights in Rickreall Creek at the mouth. Neither agency has indicated the quantity of flow needed for instream purposes.

Table 22

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

RICKREALL CREEK DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rickreall Cr >	0	94	50%	990.4	993.0	746.4	782.0	350.0	160.9	62.0	37.4	39.6	242.8	746.2	1091.5
Willamette R			80%	546.6	614.4	538.5	593.8	264.8	124.3	60.4	27.1	27.2	133.4	426.6	638.0
			AVAILABLE	546.6	614.4	538.5	593.8	264.8	124.3	60.4	27.1	27.2	133.4	426.6	638.0
	19.1	27.4	50%	401.6	366.7	232.6	112.6	47.1	16.7	5.9	3.0	3.6	12.0	121.1	395.2
			80%	162.9	178.6	127.4	63.3	28.0	10.6	3.5	1.6	2.0	4.9	42.6	167.2
			IWR CERT	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
			AVAILABLE	157.9	173.6	122.4	58.3	23.0	5.6	-1.5	-3.4	-3.0	-0.1	37.6	162.2

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Consumptive Uses

Agricultural Use

ODA predicts that the land irrigated with surface water in the Rickreall drainage will expand by 3,922 acres, or about five percent of the total expansion expected to occur in the Coast Range subbasin by 2010. This would increase irrigated acreage by over 200 percent in the drainage however (Andrews, 1990). Using a duty factor of 2.3 af per acre, ODA has requested that the Department reserve 8,998 af of surface water per season for this purpose. Since streamflows are insufficient to support expanded year-round diversions, it is expected that the additional water would come from stored water either inside or outside the drainage. Winter runoff is available for storage in the drainage. Stored water releases from existing Corps reservoirs on the Willamette main stem could also be diverted to areas that are adjacent or close to the river.

Municipal Uses

Dallas, the only incorporated city in the drainage, relies on surface water from local streams and stored water (Table 23). Aaron Mercer Reservoir, a 1,550 af storage facility on Rickreall Creek, is an important source of supply during summer months when streamflows drop below community needs (Shea, 1991). The reservoir was constructed on private timber land several miles upstream from the city. In 1987, the watershed around the reservoir burned, threatening the city's water supply. Conditions caused by the burn have not prevented Dallas from continuing to use this water source. However, the effect of deposition in the reservoir on storage capacity (5 to 12 af per year) is of concern to the city.

The city of Dallas has conducted a water supply study which addresses current supplies, water use efficiencies, and future water needs. Future water needs are projected to the year 2010 in accordance with the City of Dallas Comprehensive Plan (12/16/87). Projections indicate that the annual water demand will reach about 1,100 million gallons, or three million gallons per day (mgd). Peak-day demand is estimated to reach seven mgd (CH2M Hill, 1989).

Present supplies appear sufficient to meet the city's needs through 2020. Improving capture efficiency of reservoir releases, improving watershed management, and removing sediments from the reservoir have been identified as strategies for delaying the need for new water storage. However, it is anticipated that new storage will ultimately be needed to satisfy long-term demand. The city is considering applying for new water rights to Rickreall Creek flows. The Department is working with representatives from Dallas to evaluate reserving water for this purpose.

Table 23

MUNICIPAL WATER RIGHTS AND USAGE FOR THE RICKREALL CREEK DRAINAGE

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Month of Maximum Rate of Use: Average rate (gpd) [7]	Month of Maximum Rate of Use: Average per capita rate (gpd) [8]	Month of Maximum Rate of Use: Unused rights (cfs) [9]	Comments
Dallas	9,100	15.27	--	15.27	5.13	3,312,700	364	10.14	

[1] Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
[2] Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
[3] Total municipal surface water rights of record in cubic feet per second.
[4] Total municipal groundwater rights of record in cubic feet per second.
[5] Total municipal water rights (total of columns 3 and 4).
[6] Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989),except as noted. The month of maximum rate of use is not the same for every city.
[7] Maximum average monthly rate in gallons per day.
[8] Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
[9] Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

Severe domestic water supply problems are occurring in unincorporated parts of the drainage. Individual households and local water associations are having difficulty developing groundwater supplies adequate to serve even minor uses. The city of Dallas has been serving small rural communities in the Rickreall area on a temporary basis for some time. However, proposals to interconnect water systems and/or expand Dallas' service area have not succeeded for various reasons. Currently, Polk andYamhill counties are working with the Bureau of Reclamation to study the potential for water storage to solve these and other problems.

Summary

The Rickreall Creek drainage is over-appropriated during summer months. Flows are insufficient to meet total out-of-stream and instream demands from July through October. Low flows during the summer months increase water quality problems.

Total out-of-stream use allowed by existing water rights equals about 20 percent of total annual discharge. However, the total demand for out-of-stream and instream uses from July through September could legally exceed discharge during that period by more than two-fold.

Despite these constraints irrigated agricultural acreage is projected to increase significantly over the next 20 years. ODA has requested that the Department reserve 8,998 af to irrigate an increase of 3,992 acres by the year 2010.

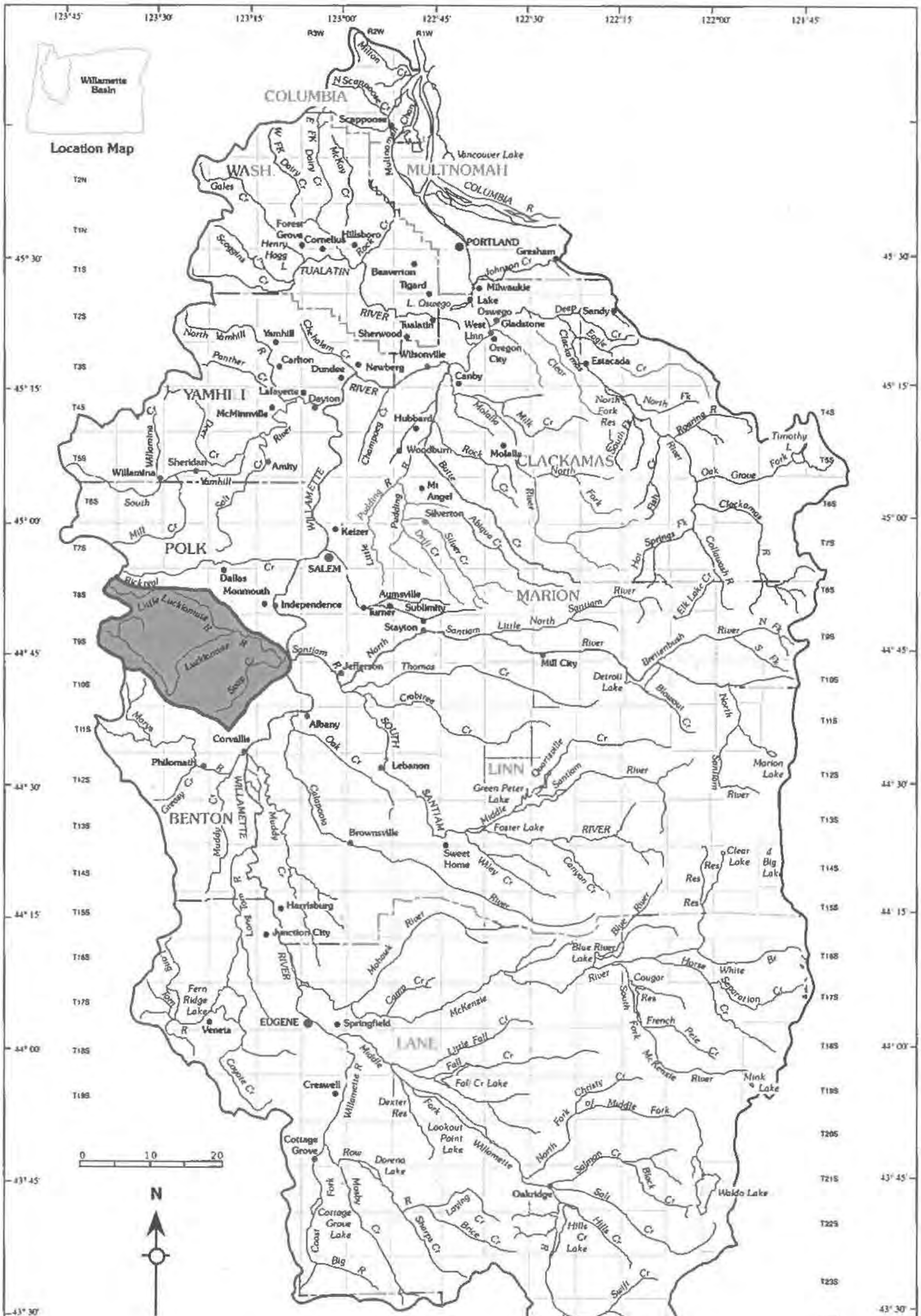
The city of Dallas is the major municipal user in the drainage. The city anticipates needing more water within 20 to 30 years and has requested the Department to consider reserving water for municipal uses in the drainage. Severe water supply problems plague rural domestic users in the drainage. A coordinated effort is underway to identify long-term water supply options for Polkand Yamhill counties.

LUCKIAMUTE RIVER DRAINAGE

General Orientation

The Luckiamute River drains 311 square miles and is bordered by the Rickreall Creek drainage to the north, the Willamette River to the east, the Coast Range to the west, and the Marys River drainage to the south (Figure 12). Nearly 89 percent of the drainage is privately owned. About four percent is administered by BLM while about seven percent is managed by the Oregon Department of Forestry. Streamflows are comprised of only natural runoff as there are no large storage facilities in the drainage.

Figure 12
LUCKIAMUTE RIVER DRAINAGE-COAST RANGE SUBBASIN



The gage nearest the mouth of the Luckiamute River is located at river mile 13.5. USGS gage 14190500 (Luckiamute River near Suver) measures runoff from about 77 percent of the drainage. The Luckiamute River has an average annual yield of 665,700 af at this point (USGS, 1990). Using extrapolation, the total drainage yield could reach about 862,600 af per year or about 2,774 af per square mile. About 82 percent of the annual discharge occurs from November through March. Just six percent of the annual yield occurs in the period June through October (Appendix A).

Water Availability and Needs

Water rights for surface water in the Luckiamute drainage total about 182 cfs (Appendix B). Almost 157 cfs have been allocated for agricultural uses, specifically irrigation. The court decreed an irrigation season in the Luckiamute drainage from April 1 through September 30. A total of about 22 cfs can be diverted for municipal, domestic, and industrial uses combined. Water use for recreational and other miscellaneous uses are negligible.

Full use of out-of stream water rights could result in the diversion of up to about 49,000 af per year. Meeting the 20 cfs instream water right from the mouth of the main stem up to Suver and the 25 cfs instream right above Suver at river mile 13.5 requires approximately 18,000 af per year. Thus, the total annual demand on the system could reach about 67,900 af, or about eight percent of total yearly discharge. It should be noted, however, that demand could reach about 43,500 af from June through September when about 3.4 percent, or about 29,300 af of the annual discharge is expected to occur.

Given low summer flows and relatively high demand, it is surprising that water in this area is not commonly regulated. Users may be accustomed to the regular shortages and essentially regulate themselves.

Nonconsumptive Uses

Instream Water Rights

Instream water rights have been established at six points in the Luckiamute drainage. These instream water rights are on Pedee Creek, the Little Luckiamute and main stem Luckiamute Rivers. Most of these instream water rights have 1964 priority dates. Those on Pedee Creek and the Little Luckiamute River at Falls City have 1983 priority dates.

The Department estimates that streamflows in the Luckiamute main stem are sufficient year-round to satisfy existing out-of-stream uses and instream water rights from the mouth, up to and above Suver (Table 24). However, flows in the main stem would be too low during August and September to satisfy out-of-stream uses and instream water rights above gages at Pedee (USGS 1419000) and near Hoskins (USGS 14189500). Flows in the Little Luckiamute River and Pedee Creek are insufficient to satisfy out-of-stream uses and instream water rights from June through September, and May through October, respectively.

The Department has estimated flows on several other streams in the drainage, namely those identified by ODFW, PRD, and DEQ as high priority for public instream values (Appendix C). Summer flows on these streams are nearing, or have reached total appropriation. New instream rights in the Luckiamute system could, in many cases, only be met during summer months if flows are enhanced. Conservation, riparian enhancement, and storage could provide flow enhancement opportunities.

Water Quality

Like the Yamhill and Rickreall drainages, water quality problems exist in the Luckiamute system. Specific problems relate primarily to bacteria in the waters. This problem exists year-round but may be worse during low-flow summer months (DEQ, 1990).

Consumptive Uses

Agricultural Use

ODA has estimated that an additional 15,648 acres in the Luckiamute drain-age will need surface water for irrigation by 2010. ODA has requested that the Department reserve 35,990 af for this purpose. Lacking sufficient natural flows during the summer, water for future irrigation is expected to come from storage reservoirs. Either construction of new impoundments in the drainage or releases of stored water would be needed to meet the new agricultural demands imported from an upstream subbasin. The imported water could be diverted from the Willamette River main stem to nearby farmlands.

Municipal Use

Falls City is the only incorporated city in the Luckiamute drainage and holds rights to use six different surface sources for municipal purposes. The near-by city of Monmouth is located on Ash Creek which drains directly to the Willamette River. Monmouth uses primarily groundwater but holds rights to use springs in this subbasin. Monmouth is covered here as well as in the discussion of the main stem subbasin (Table 25). The city reported that several municipal wells are no longer in use and are considered abandoned.

Table 24

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

LUCKIAMUTE RIVER DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Luckiamute R > Willamette R	0.0-1.0	311	50%	2105	2140	1576	1167	569	245	83	43	54	198	1185	2112
			80%	1153	1317	1118	810	398	171	650	28	35	101	499	1150
			IWR CERT	20	20	20	20	20	20	20	20	20	20	20	20.0
			AVAILABLE	1133	1297	1098	790	378	151	45	8	15	81	479	1130
	13.5	240	50%	2244	2071	1432	784	380	161	66	37	44	119	827	2202
			80%	1129	1241	957	533	270	119	47	25	30	60	364	1152
			IWR CERT	25	25	25	25	25	25	25	25	25	25	25	25
			AVAILABLE	1104	1216	932	508	245	94	22	0	5	35	339	1127
	30.3	115	50%	1106	1022	736	391	200	90	41	24	25	68	450	1110
			80%	568	622	493	267	141	68	31	17	17	34	200	594
			IWR CERT	20	20	20	20	20	2	20	20	20	20	20	20
			AVAILABLE	548	602	473	247	121	48	11	-3	-3	14	180	574
	43.2	34.3	50%	463	456	350	191	87	43	22	14	14	45	256	509
			80%	255	291	241	129	61	32	17	11	9.7	22	122	297
			IWR CERT	10	10	10	10	10	10	10	10	10	10	10	10
			AVAILABLE	245	281	231	119	51	22	7	1	-0.3	12	112	287
L Luckiamute R > Luckiamute R	0	82	50%	599.8	602.9	440.7	305.5	126.6	51.4	17	8.6	11	47.3	317.5	615.4
			80%	313.1	363.3	303.3	205.4	87.0	35.9	13.0	5.4	6.8	22.5	127.7	319.9
			IWR CERT	80.0	80.0	80.0	80.0	80.0	50/35	25/20	15.0	15.0	15/20	40/80	80.0
			AVAILABLE	233.1	283.3	223.3	125.4	7.0	-14.1/0.9	-12.0/-7.0	-9.6	-8.2	7.5/2.5	87.7/47.7	239.9
Pedee Cr > Luckiamute R	0	15	50%	145.9	144.3	105.9	81.6	30.7	12.4	4.4	2.3	2.7	15.5	85.0	159.9
			80%	73.5	85.7	71.7	55.8	21.4	8.9	3.5	1.5	1.6	7.2	37.7	82.9
			IWR CERT	25.0	25.0	25.0	25.0	25.0	12/8	6/5	5.0	5.0	5/10	15/25	25.0
			AVAILABLE	48.5	60.7	46.7	30.8	-3.6	-3.1/0.9	-2.5/-1.5	-3.5	-3.4	2.2/-2.8	22.7/12.7	57.9

Table 24 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
S Fk Pedee Cr >	0	3	50%	32.0	31.3	22.7	16.2	9.9	4.3	1.6	0.8	0.9	2.8	17.3	36.1
Pedee Cr			80%	15.2	18.1	14.8	10.7	6.3	2.7	1.1	0.6	0.6	1.2	7.3	17.7
			AVAILABLE	15.2	18.1	14.8	10.7	6.3	2.7	1.1	0.6	0.6	1.2	7.3	17.7
N Fk Pedee Cr >	0	8.4	50%	84.5	83.2	60.9	45.6	31.4	14.3	5.1	2.8	3.2	8.3	47.9	93.6
Pedee Cr			80%	41.7	48.9	40.7	30.7	20.2	8.9	3.8	2.0	2.1	3.7	20.9	47.5
			AVAILABLE	41.7	48.9	40.7	30.7	20.2	8.9	3.8	2.0	2.1	3.7	20.9	47.5
Ritner Cr >	0	13.9	50%	135.8	134.3	98.5	75.6	28.8	11.6	4.2	2.1	2.5	14.3	78.8	149.1
Luckiamute R			80%	68.2	79.6	66.6	51.6	20.0	8.3	3.3	1.4	1.5	6.6	34.9	77.1
			AVAILABLE	68.2	79.6	66.6	51.6	20.0	8.3	3.3	1.4	1.5	6.6	34.9	77.1
Clayton Cr >	0	3.2	50%	34.0	33.2	24.2	17.3	10.7	4.6	1.7	0.9	1.0	3.0	18.5	38.3
Rittner Cr			80%	16.2	19.3	15.8	11.4	6.8	2.9	1.2	0.6	0.6	1.3	7.8	18.8
			AVAILABLE	16.2	19.3	15.8	11.4	6.8	2.9	1.2	0.6	0.6	1.3	7.8	18.8
Sheythe Cr >	0	2.4	50%	26.0	25.3	18.4	12.9	7.7	3.3	1.2	0.6	0.7	2.2	13.9	29.4
Rittner Cr			80%	12.2	14.6	11.9	8.5	4.9	2.1	0.8	0.4	0.4	0.9	5.8	14.3
			AVAILABLE	12.2	14.6	11.9	8.5	4.9	2.1	0.8	0.4	0.4	0.9	5.8	14.3
Maxfield Cr >	0	9.5	50%	80.5	79.4	57.5	34.1	11.9	4.3	1.4	0.6	0.8	4.2	39.4	86.1
Luckiamute R			80%	39.0	46.3	37.8	21.5	7.7	2.9	0.9	0.4	0.5	1.7	13.8	41.8
			AVAILABLE	39.0	46.3	37.8	21.5	7.7	2.9	0.9	0.4	0.5	1.7	13.8	41.8
Price Cr >	0	9.3	50%	70.9	69.9	50.5	29.7	9.4	3.3	1.0	0.5	0.6	3.6	34.5	76.0
Luckiamute R			80%	34.2	40.7	33.1	18.7	6.2	2.3	0.7	0.3	0.3	1.5	12.0	36.7
			AVAILABLE	34.2	40.7	33.1	18.7	6.2	2.3	0.7	0.3	0.3	1.5	12.0	36.7

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Both Falls City and Monmouth have grown in population by about six percent between 1980 and 1989. Polk County as a whole grew an estimated six percent during this period (PSU, 1990). In general, water rights should be sufficient to allow Falls City and Monmouth to supply a significantly expanded service area. The population of Polk County is expected to grow by about 15 percent over the next 10 years (PSU, 1984). However, water availability and quality as well as system capacity may limit this expansion potential.

Summary

Streamflows in the Luckiamute main stem are sufficient year-round to satisfy existing out-of-stream uses and instream water rights from the mouth, up to and above Suver. However, upstream flows in the main stem are too low during August and September to satisfy out-of-stream uses and instream water rights. Late spring through early fall flows in the Little Luckiamute and Pedee Creek are insufficient to satisfy out-of-stream uses and instream water rights. Summer flows on numerous small tributaries have been, or are nearing full appropriation. Water quality problems exist year-round but may be worse during low-flow summer months. ODA has requested that the Department reserve 35,990 af of surface water to irrigate an additional 15,648 acres in the drainage by 2010. Municipal water rights appear large enough to serve growing urban populations in the drainage well into the next century. However, rural residents are having problems obtaining adequate groundwater in some areas. It may be necessary to develop community/regional water supply systems to serve these areas in the future. Surface water may be sought to replace groundwater as a source of supply for these people. New storage projects or the transfer of stored water from one of the large Corps projects would be needed to supply these future needs.

Table 25

MUNICIPAL WATER RIGHTS AND USAGE FOR THE LUCKIAMUTE RIVER DRAINAGE

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Falls City	880	5.56	--	5.56	1.23	793,840	902	4.33	
Monmouth	5,825	3.74	7.15	10.89	1.87	1,211,277	208	9.02	Surface rights are for the Luckiamute sub-basin, but all usage was from wells near the Willamette River.
TOTAL	6,705	9.30	7.15	16.45	3.10	2,005,117	299	13.35	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

MARYS RIVER DRAINAGE

General Orientation

The Marys River joins the Willamette main stem at Corvallis. The river is about 46 miles long and drains about 329 square miles along the east slope of the Coast Range (Figure 13). It is bounded by the Luckiamute River drainage to the north, the Willamette River to the east, the Long Tom subbasin to the south, and the Coast Range to the west. About 85 percent of lands in the drainage are privately owned. Federally-owned lands make up about ten percent, while state lands comprise about five percent of the total drainage area. Agriculture and forestry are the main economic activities.
Average annual yield at USGS gage 14171000 near Philomath is about 334,700 af (Appendix A). This is equal to 1,017 af per square mile. Gage records show that about 83 percent of the annual runoff occurs from November through March. Only about four percent of average annual runoff occurs from June through October (USGS, 1990). Average annual discharge reflects natural rainfall-runoff patterns as there is no significant storage in the drainage.

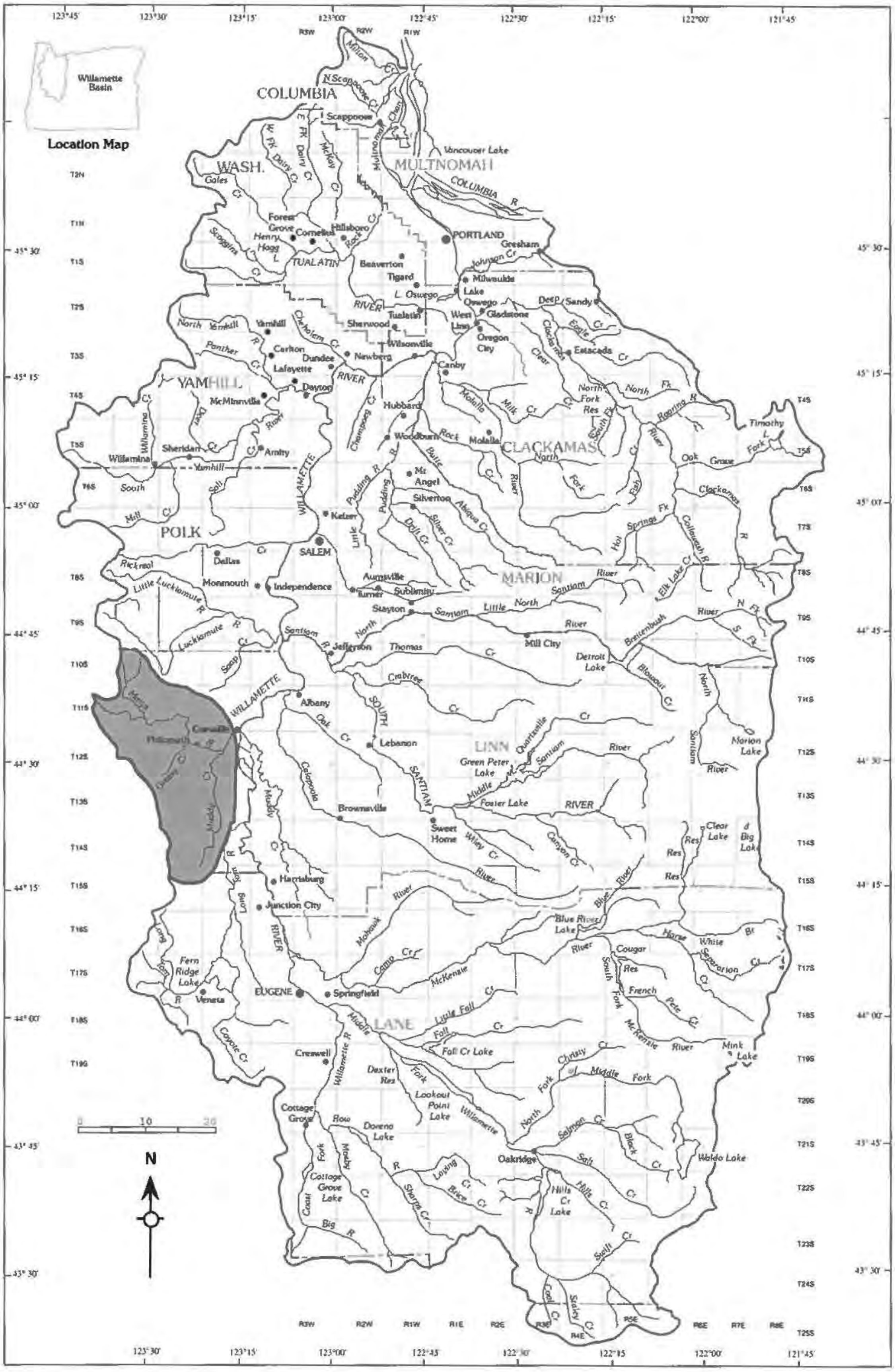
Water Availability and Needs

Overview

Water rights have been issued for use of about 135 cfs of surface water flows in the Marys River system (Appendix B). Almost 91 cfs can be diverted for agricultural purposes, specifically irrigation. Municipal, miscellaneous, and industrial uses could make up an additional 16, 12, and 11 cfs, respectively. Other water uses in the drainage are relatively minor according to Department water rights information.

If water users fully develop these rights, up to about 50,500 af could be diverted for out-of-stream purposes. Meeting the flows specified in the pending instream water right application at the mouth of the Marys River will require an additional 62,700 af per year. Total annual demand, as allowed by water rights, could reach about 113,200 af, or about 34 percent of the total annual discharge in the basin. Up to 28,900 af could be diverted for out-of-stream uses from June through September. An additional 6,100 af are needed instream during this period. However, only about three percent, or 10,400 af, would be the expected discharge from the drainage during this time.

Figure 13
MARYS RIVER DRAINAGE-COAST RANGE SUBBASIN



Nonconsumptive Uses

Instream Water Rights

Minimum streamflows at two locations on the Marys River main stem and on Greasy Creek have been converted to instream water rights. Instream water rights on the main stem have a 1964 priority. The Department's flow estimates indicate that the instream water right for 5 cfs at the mouth is met year-round. ODFW has applied for an additional instream water right from river mile 0 to river mile 20. The Department's flow estimates indicate that water is available to meet this request year-round (Table 26).

There is also a water right of 10 cfs as measured at USGS gage 14171000 near Philomath. Flows appear sufficient to meet this instream water right year-round, although just barely in August.

ODFW has also applied for an instream water right for the Marys River to extend from the East Fork of the Marys River downstream to river mile 20. Flows are insufficient to meet the requested flows most months of the year. Flows on Greasy Creek are insufficient to meet both out-of-stream uses and the 1983 instream water right during August through October. Streamflows are also very low in July given the size of Greasy Creek during maximum flow months (Table 26).

ODFW has identified nine streams in the drainage as candidates for flow protection and provided data on minimum flow levels necessary to protect aquatic life (Appendix C). These flows are the result of work the Oregon State Game Commission did in the 1970s. In general, these streams are located in headwater areas where current and future water uses are expected to be minimal.

DEQ is interested in flow protection for Oak Creek and the Marys River main stem. PRD is also interested in flow protection for the main stem. However, the agencies have not yet requested specific flow levels for these streams. Summer flows are already close to being fully appropriated on these streams, and probably throughout the drainage. Water rights of record for the drainage exceed estimated flows at the mouth by wide margins in July, August, and September. New instream water rights in the Marys River might not be met during low flow months, but would provide management goals that could be met through future flow enhancement. Without flow enhancement, additional water rights permitted in these months would have little value.

Table 26

WILLAMETTE BASIN STREAMFLOW AVAILABILITY
MARYS RIVER DRAINAGE

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Marys R >	0-20	299	50%	2162.3	2195.7	1624.4	1171.3	590.7	248.2	75.7	38.7	49.1	190.8	1289.2	2197.6
WIllamette R			80%	1193.0	1356.1	1160.1	806.5	409.4	170.3	62.5	25.3	32.1	92.4	517.5	1218.1
			IWR APP	135.0	135.0	135.0	135.0	135.0	70/40	20/15	15.0	15.0	20/40	70/135	135.0
			AVAILABLE	1058.0	1221.1	1025.1	671.5	274.4	100.3/130.3	42.5/47.5	10.3	17.1	72.4/52.4	447.5/382.5	1083.1
	20-	16.5	50%	155.0	152.0	109.0	63.0	37.0	15.0	4.6	2.1	2.6	7.7	75.0	171.0
	40		80%	73.0	87.0	71.0	39.0	23.0	8.8	3.1	1.5	1.5	3.1	26.0	81.0
			IWR APP	75.0	75.0	75.0	75.0	75.0	40/15	10/6	6.0	6.0	8/20	40/75	75.0
			AVAILABLE	-2.0	12.0	-4.0	-36.0	-52.0	-31.2/6.2	-6.9/-2.9	-4.5	-4.5	-4.9/-16.9	-14/-49	6.0
Greasy Cr >	0	33.6	50%	275.9	275.1	201.0	130.1	54.3	21.0	6.5	3.1	4.0	18.3	148.7	291.1
Marys R			80%	140.7	164.1	136.6	85.1	36.2	14.2	4.8	1.9	2.4	7.9	55.4	149.5
			IWR CERT	30.0	30.0	30.0	30.0	30.0	20/15	33518	5.0	5.0	33368	20/30	30.0
			AVAILABLE	110.7	134.1	106.6	55.1	6.2	7.3	2.4	-3.1	-2.6	2.9/-2.1	35.4/25.4	119.5
Rock Cr >	0	14.08	50%	121.6	120.4	87.5	54.3	22.1	8.4	2.6	1.2	1.6	7.2	63.0	130.2
Greasy Cr			80%	60.1	70.8	58.3	34.8	14.4	5.5	1.9	0.7	0.9	3.0	22.7	64.9
			AVAILABLE	60.1	70.8	58.3	34.8	14.4	5.5	1.9	0.7	0.9	3.0	22.7	64.9
Oak Cr >	0	15.04	50%	129.4	128.1	93.2	58.0	22.4	8.4	2.6	1.2	1.6	7.7	67.2	138.4
Marys R			80%	64.1	75.5	62.2	37.2	14.7	5.7	1.9	0.7	0.9	3.2	24.3	69.1
			AVAILABLE	64.1	75.5	62.2	37.2	14.7	5.7	1.9	0.7	0.9	3.2	24.3	69.1
Woods Cr >	0	9.53	50%	84.2	83.1	60.3	36.7	24.5	10.3	3.2	1.6	1.9	4.7	42.8	90.8
Marys R			80%	41.0	48.6	39.8	23.3	15.0	6.1	2.2	1.0	1.2	1.9	15.3	44.6
			AVAILABLE	41.0	48.6	39.8	23.3	15.0	6.1	2.2	1.0	1.2	1.9	15.3	44.6

Table 26 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Blakesly Cr >	0	4.96	50%	45.5	44.7	32.3	19.0	11.8	4.8	1.5	0.7	0.9	2.3	22.5	49.6
Marys R			80%	21.7	25.8	21.0	11.9	7.2	2.8	1.0	0.5	0.5	0.9	7.8	23.8
			AVAILABLE	21.7	25.8	21.0	11.9	7.2	2.8	1.0	0.5	0.5	0.9	7.8	23.8
TumTum R >	0	35.52	50%	290.7	290.0	212.0	137.6	59.2	23.1	7.1	3.4	4.4	19.4	157.1	306.4
Marys R			80%	148.5	173.1	144.2	90.1	39.4	15.5	5.3	2.1	2.7	8.4	58.6	157.7
			AVAILABLE	148.5	173.1	144.2	90.1	39.4	15.5	5.3	2.1	2.7	8.4	58.6	157.7
Mulkey Cr >	0	4.56	50%	42.0	41.2	29.8	17.5	10.7	4.4	1.4	0.7	0.8	2.1	20.7	45.9
TumTum R			80%	19.9	23.8	19.3	10.9	6.5	2.6	0.9	0.4	0.5	0.8	7.2	22.0
			AVAILABLE	19.9	23.8	19.3	10.9	6.5	2.6	0.9	0.4	0.5	0.8	7.2	22.0
Shotpouch Cr >	0	7.2	50%	64.6	63.6	46.1	27.7	17.9	7.4	2.3	1.1	1.4	3.5	32.5	70.0
TumTum R			80%	31.2	37.0	30.2	17.5	10.9	4.4	1.5	0.7	0.9	1.4	11.5	34.1
			AVAILABLE	31.2	37.0	30.2	17.5	10.9	4.4	1.5	0.7	0.9	1.4	11.5	34.1
W Fk Marys R >	3	3	50%	28.3	27.7	20.0	11.5	6.7	2.7	0.8	0.4	0.5	1.4	13.7	31.2
Marys R			80%	13.2	15.9	12.8	7.1	4.1	1.6	0.5	0.3	0.3	0.5	4.7	14.7
			AVAILABLE	13.2	15.9	12.8	7.1	4.1	1.6	0.5	0.3	0.3	0.5	4.7	14.7
Oleman Cr >	0	3.2	50%	30.1	29.4	21.2	12.2	7.2	2.9	0.9	0.4	0.5	1.5	14.6	33.1
W Fk Marys R			80%	14.1	16.9	13.7	7.6	4.4	1.7	0.6	0.3	0.3	0.6	5.0	15.7
			AVAILABLE	14.1	16.9	13.7	7.6	4.4	1.7	0.6	0.3	0.3	0.6	5.0	15.7

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Consumptive Uses

Agricultural Use

ODA predicts that the acreage irrigated with surface water in the Marys drainage will increase by 3,912 acres over the next 20 years. This represents five percent of the total anticipated increase for the Coast Range subbasin. ODA has requested that the Department reserve 8,997 af of surface water for future irrigation in the drainage. Because summer flows are largely appropriated, this water would have to come from storage either within or outside the drainage. New storage facilities could potentially be built to store this water.

Municipal Water Use

Corvallis and Philomath are the two incorporated cities located in the Marys River drainage. Corvallis holds rights to divert 90 cfs from the Willamette River main stem. The city also has rights to use 8.14 cfs from the Marys drainage. The analysis of Corvallis' water use and growth potential is covered here and in the Willamette main stem discussion earlier in this report.

According to the information provided in Table 27, Corvallis and Philomath hold water rights to divert a total of 106 cfs from surface water and about three cfs from groundwater sources. The cities are currently using only about 19 cfs, or 17 percent of the amount which could be diverted under current water rights.

Corvallis and Philomath are located in Benton County. Benton County population grew by 4.8 percent from 1978 to 1988. Most of this growth occurred in urbanized areas, primarily Corvallis. Population in unincorporated areas grew only 1.4 percent, falling from 35 percent to 34 percent of the total county population during this same period. Benton County popula-tion maintained an estimated four percent growth rate from 1980 to 1989 (PSU, 1990).

The county population is projected to grow 14.1 percent during the upcoming decade (PSU, 1984). If Corvallis and Philomath grow at the projected rate for the next several decades, it would take slightly over 50 years for their populations to double. Given their existing water rights, the cities should be able to meet future municipal needs if the water and system capacity are available.

Summary

Flows on the lower Marys River can satisfy out-of-stream and instream rights year-round. ODFW has filed for two new instream water rights on the main stem. Streamflow should be sufficient to meet the proposed instream flow levels on the lower river, but it appears insufficient during many months on the upper

Table 27

MUNICIPAL WATER RIGHTS AND USAGE FOR THE MARYS RIVER DRAINAGE

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Philomath	2,675	3.50	2.45	5.95	0.75	487,181	182	5.20	
Corvallis	42,520	102.13	1.00	103.13	18.15	9,257,742	218	84.98	Willamette R. is source for more than half of usage.
TOTAL	45,195	105.63	3.45	109.08	18.90	9,744,923	216	90.18	

[1] Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
[2] Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
[3] Total municipal surface water rights of record in cubic feet per second.
[4] Total municipal groundwater rights of record in cubic feet per second.
[5] Total municipal water rights (total of columns 3 and 4).
[6] Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
[7] Maximum average monthly rate in gallons per day.
[8] Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
[9] Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

reach. Tributary flows are nearing full appropriation and are in some cases insufficient to meet total demand during the summer months.

ODA predicts that acreage irrigated with surface water in the Marys drainage will increase by 3,912 acres over the next 20 years. The agency has requested a reservation of 8,997 af of surface water for this purpose. Because summer flows are largely appropriated, this water would have to come from storage either within or outside the drainage. New storage facilities could potentially be built to store winter flows.

UPPER WILLAMETTE BASIN

Long Tom River Subbasin

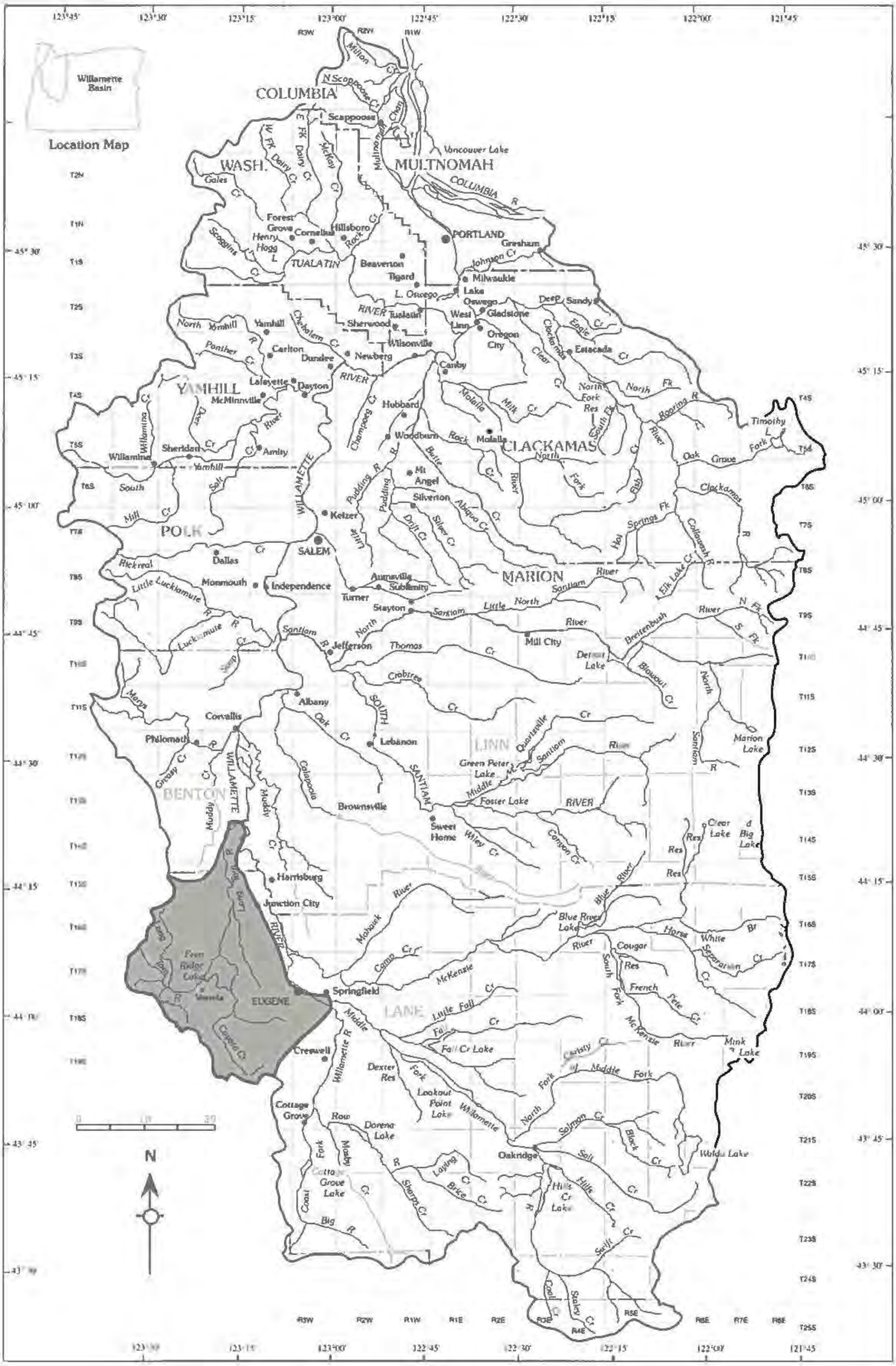
General Orientation

The Long Tom is the smallest of the four subbasins comprising the Upper Willamette Basin (Figure 14). Subbasin characteristics include low elevation, low gradient, and low runoff. The Long Tom drains about 406 square miles on the east side of the Coast Range and yields about 581,000 af annually. This is equal to about 1,431 af per square mile (USGS, 1990).

Lower elevations and lack of snowpack in this subbasin are reflected in the lower yield per square mile and the seasonal distribution of runoff. Before storage was developed in the basin, over 84 percent of the annual discharge at the mouth occurred in the period November through March. Discharge during June through October yielded only 3 percent of the annual total. Storage at Fern Ridge Reservoir has modified this distribution somewhat. Today, discharge for the November through March period is about 80 percent of the total and about 12.7 percent for the June through October period. However, of these flows, about 8 percent is recorded during October when the Corps is drafting for flood control purposes (Appendix A).

Fern Ridge Reservoir stores about 94,000 af during the season, or about 16 percent of the annual runoff. Its authorized purposes are flood control, irrigation and navigation. Because of its extensive surface area, proximity to Eugene-Springfield, easy access and favorable weather conditions, Fern Ridge has become a major water recreation center and a mecca for sailing enthusiasts. Conflicts relating to uses and operation of the reservoir provided the major impetus for Congress to fund the study of the Willamette Basin reservoir system undertaken by the Corps of Engineers.

Figure 14
LONG TOM RIVER SUBBASIN



Water Availability and Needs

Overview

The Department has issued water rights to divert about 236 cfs from the Long Tom system (Appendix B). Nearly 196 cfs are for irrigation purposes. Industrial users have rights for about 32 cfs. Municipal, domestic and recreation uses are minimal. Full use of these water rights could result in the diversion of about 68,000 af per year, or about 12 percent of average annual discharge. Meeting the 370 cfs minimum streamflow at Monroe would require about 267,400 af per year, bringing the total demand to about 335,400 af, or 58 percent, of average annual discharge. The total demand from June through September could reach approximately 138,200 af when only about 4.6 percent, or 26,700 af, are produced. Storage at Fern Ridge Reservoir has helped offset seasonal shortages somewhat, but reservoir storage has generated spin-off problems related to water quality.

Nonconsumptive Uses

Minimum Streamflow

The only minimum streamflow in the Long Tom subbasin is for the Long Tom River main stem at Monroe (measured at USGS gage 14170000). The 1964 minimum streamflow is for up to 370 cfs from Fern Ridge Reservoir storage releases. According to Department estimates, the minimum streamflow is met only from October through February (Table 28).

ODFW, PRD and DEQ have expressed interest in establishing instream water rights in the Long Tom subbasin (Appendix C). The agencies have not yet filed applications identifying specific flow needs for these streams. Department estimates show that flows on these streams are generally sufficient to meet current out-of-stream uses, but that significant decreases in flows occur from July through October (Table 29).

Recreation

Drafting Fern Ridge Reservoir to meet the minimum streamflow at Monroe would impair the valuable recreational use of the reservoir. It would also preclude expanded use of Fern Ridge Reservoir water for the autho-rized purpose of irrigation. Without additional storage in the subbasin, interbasin water transfers, or sacrifice of recreation and irrigation benefits, this flow cannot be met. Maintaining recreational uses at Fern Ridge Reservoir is a primary impetus for the Corps' current review of the Willamette reservoir system (Section 4 of this report).

Table 28

MINIMUM FLOW ANALYSIS

1. Long Tom River at gage 14170000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	822	1,122	857	372	169	79	26	9	12	18	136	554
80% Ex. Regulated Flow	862	789	352	150	87	49	31	29	40	459	434	733
Min. Flow (Natural)	0	0	0	0	0	0	0	0	0	0	0	0
Addl. Releases from Storage	370	370	370	370	370	370	370	370	370	370	370	370
W. A. Unregulated	822	1122	857	372	169	79	26	9	12	18	136	554
W.A. Regulated	492	419	-18	-220	-283	-321	-339	-341	-330	89	64	363

Table 29

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

LONG TOM RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Long Tom R >	37.4	89.3	50%	576	569	401	230	118	61.5	28.9	15.7	16.9	29.9	154	445
Willamette R			80%	260	339	274	152	86.1	45.9	19.6	10.1	12.4	19	72.5	209
Gage 14166500			AVAILABLE	260	339	274	152	86.1	45.9	19.6	10.1	12.4	19	72.5	209
Ferguson Cr >	0.0	21.2	50%	111.3	111.0	78.2	43.9	33.3	15.8	7.1	3.5	4.4	4.8	37.8	107.7
Long Tom R			80%	52.3	63.7	49.7	27.4	20.0	9.1	3.4	2.3	2.8	2.3	14.0	47.2
			AVAILABLE	52.3	63.7	49.7	27.4	20.0	9.1	3.4	2.3	2.8	2.3	14.0	47.2
Bear Cr >	0	30.8	50%	158.2	158.4	111.7	63.9	50.7	24.4	10.9	5.5	6.8	7.1	54.7	152.2
Long Tom R			80%	75.4	91.4	71.7	40.3	30.6	14.1	5.3	3.7	4.4	3.5	20.5	67.5
			AVAILABLE	75.4	91.4	71.7	40.3	30.6	14.1	5.3	3.7	4.4	3.5	20.5	67.5
Amazon Cr >	0	55	50%	273.1	274.7	194.5	114.5	96.9	47.9	21.4	11.1	13.6	13.3	96.9	260.2
Long Tom R			80%	132.9	160.1	126.4	73.1	59.1	27.7	10.7	7.5	9.0	6.8	37.0	117.8
			AVAILABLE	132.9	160.1	126.4	73.1	59.1	27.7	10.7	7.5	9.0	6.8	37.0	117.8
Noti Cr >	0	43.5	50%	219.0	219.8	155.4	90.4	74.6	36.5	16.3	8.4	10.3	10.3	76.9	209.4
Long Tom River			80%	105.7	127.6	100.5	57.4	45.3	21.0	8.1	5.7	6.7	5.2	29.1	94.1
			AVAILABLE	105.7	127.6	100.5	57.4	45.3	21.0	8.1	5.7	6.7	5.2	29.1	94.1
Poodle Cr >	0	26	50%	134.8	134.8	95.0	53.9	41.9	20.0	9.0	4.5	5.6	6.0	46.2	130.1
Elk Cr			80%	63.9	77.6	60.7	33.8	25.2	11.6	4.3	3.0	3.6	2.9	17.2	57.4
			AVAILABLE	63.9	77.6	60.7	33.8	25.2	11.6	4.3	3.0	3.6	2.9	17.2	57.4

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Consumptive Uses

Agricultural Use

Of the upper Willamette subbasins, the Long Tom is the most extensively developed for agriculture. ODA estimates that 26,000 acres were irrigated in the subbasin in 1988 (Andrews, 1990; Weber, 1991). The majority of irrigation water is pumped from groundwater (66 percent). Thirty four percent is supplied by surface sources. Thousands of additional acres are farmed without benefit of irrigation.

A projected 14,000 additional acres will be irrigated by 2020, an increase of 54 percent. ODA has requested that the Department reserve 25,668 af of surface water to irrigate 11,160 acres of this increase. Given low summer flows in the subbasin, this water will only be available from existing storage in or outside the subbasin.

The Bureau of Reclamation holds a permit to use 95,000 af, or the entire seasonal storage at Fern Ridge Reservoir, for irrigation purposes. In 1987, the Bureau held irrigation contracts for only about 23,550 af from the reservoir. This leaves about 71,450 af available for irrigation. The projected future need for irrigation represents only about a third of the remaining seasonal storage in Fern Ridge Reservoir. Nevertheless, releasing this water for irrigation would impair the recreation (boating/sailing) opportunities on the reservoir. Recreation is not an authorized purpose of Fern Ridge but is currently the major use of the reservoir.

As mentioned above, the Corps is studying its reservoir operations in the Willamette Basin. The study will explore the relative costs and benefits of various uses of the stored waters. Water uses and reservoir operations at Fern Ridge Reservoir are a central component of the study. If the Corps pursues reallocation of waters stored at Fern Ridge Reservoir, water for irrigation in the Long Tom would have to come largely from some other source.

Another factor complicates irrigation forecasting in the Long Tom subbasin. Currently, irrigators rely extensively on groundwater. ODA attributes 66 percent of the current irrigation, and half the irrigation in 2010, to groundwater sources (Andrews, 1990). However, much of the subbasin west of the Long Tom River is underlain by marine sediments. Water storage in these rocks is large but movement is slow. Water wells in this area typically have low yields. Groundwater yields may not be great enough to supply large irrigated tracts.

Additional water could be stored, or transferred into the subbasin. For example, the Middle Fork and Coast Fork Willamette subbasins could potentially supply stored water for irrigation in the Long Tom subbasin.

Municipal Water Uses

Monroe and Veneta use water from the Long Tom system. (The city of Eugene is located in this subbasin but is discussed in the following section on the McKenzie River subbasin.) Only Monroe holds rights to use surface waters (Table 30). Veneta is located at the south (upper) end of Fern Ridge Reservoir near the upper Long Tom River. Groundwater supply problems are common in areas further west and south of Fern Ridge Reservoir.

The two cities are located in Benton and Lane counties. From 1978 to 1988, Monroe grew about fourteen percent while Veneta's population declined by three percent. The counties are projected to grow between 13 and 14 percent over the next 10 years (PSU, 1984). If all of these cities grow at the projected county rates, it will take over fifty years for their populations to double. Their water rights could accommodate more than double the current populations at current use rates. Groundwater availability and system capacity may provide additional constraints on expansion of service.

Rural dwellers in the Coyote and Spencer Creeks area southwest of Eugene can no longer get adequate water from their wells. This problem may require development of community or regional water service systems that rely on surface sources to supply water short areas.

Summary

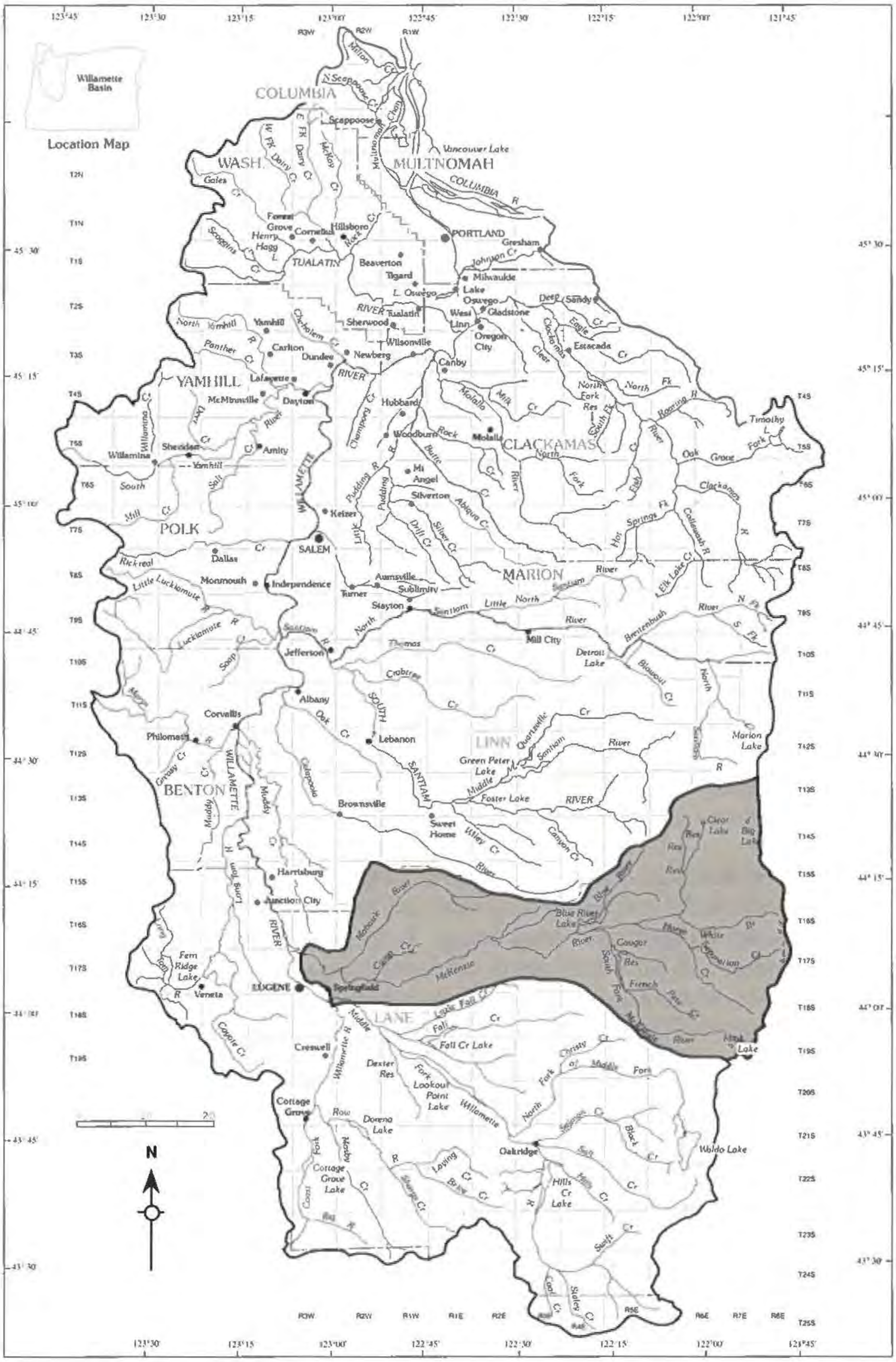
Regulated flows on the Long Tom River fail by a wide margin to meet the minimum streamflow during virtually the entire irrigation season. Supplemental releases from Fern Ridge Reservoir are minimal and only occur between July and October.

ODFW, PRD and DEQ are interested in establishing instream water rights on several streams in the subbasin. These small streams tend to run low in the summer. Groundwater is also difficult to obtain throughout much of the subbasin compounding water availability problems.

Flat water recreation at Fern Ridge Reservoir is an important and controversial issue in the subbasin. The Corps is studying potential options for reservoir operations in the Willamette Basin that will provide for recreation at Fern Ridge Reservoir. However, meeting the growing demand for irrigation water and instream flows may prevent optimum recreation use at the reservoir.

ODA has requested that the Department reserve 25,668 af of surface water to irrigate an additional 11,160 acres. ODA anticipates this water would come from existing storage in or outside the subbasin.

Figure 15
MCKENZIE RIVER SUBBASIN



The McKenzie River also provides municipal water supplies for Eugene, the second largest city in the state. EWEB owns and operates the municipal water system for the city.

Water Availability and Needs

Overview

The Department has issued water rights to divert about 10,890 cfs from the McKenzie River system. The vast majority (10,075 cfs) of water rights have been granted for industrial purposes. Most of these rights are held by EWEB and are used to divert water for hydroelectric uses. About 304 cfs and 235 cfs can be diverted for municipal and irrigation uses, respectively.

To date, water supply conflicts are rare on most reaches of the main stem McKenzie River, and on tributary streams. The Department seldom regulates water rights due to shortages and none of the streams are reported to have chronic supply problems (McGinnis, 1989).

Nonconsumptive Uses

Scenic Waterway Issues

Several reaches of the upper main stem and virtually all of the South Fork McKenzie River are designated state scenic waterways (see Table 1). Authorizing statutes have established that the highest and best uses of scenic waterways are for recreation, fish, and wildlife.

The Department's assessment of the flow levels needed to support scenic waterway values for the McKenzie River and its South Fork is complete. Sufficient information was not available to determine scenic waterway flows on the uppermost McKenzie River from Clear Lake to Carmen Reservoir and from Tamolitch Falls to Trail Bridge Reservoir. Below Trail Bridge dam, however, streamflows on the McKenzie River are more than adequate to satisfy the scenic waterway flows adopted by the Commission in November 1991. On the South Fork of the McKenzie River above Cougar dam, streamflow appears to be just adequate to support scenic waterway values during the low-flow months and may not be sufficient for some recreational uses during the high-flow months. Summer shortfalls are also evident below Cougar dam (WRD, November 1991). These scenic waterways are in headwater areas on public lands.

Much of the upper McKenzie River is also a designated federal wild and scenic river. Federal law mandates the protection of the values identified in the designation of, or management plan for, wild and scenic rivers. In addition, federal reserved rights dating back to the designation may exist to fulfill the purposes of the Wild and Scenic Rivers Act.

Minimum Streamflows and Instream Water Rights

Minimum streamflows have been established at six points in the McKenzie subbasin. Minimum streamflows on Gate Creek and the Mohawk River have been converted to instream water rights. The remaining four, on the South Fork McKenzie River, Blue River, and McKenzie main stem consist of both natural flow and storage components and have not yet been converted. The storage release components were adopted in anticipation of releases from Cougar Reservoir on the South Fork McKenzie River and Blue River Reservoir on Blue River.

The minimum streamflow on the McKenzie main stem at the Interstate Highway 5 bridge is for 1,025 cfs from natural flow and up to 700 cfs additional flow from storage. Department estimates for flows at USGS gage 14165500 (located about a quarter mile downstream) indicate that the combined minimum streamflow is met in all months (Table 31).

The minimum streamflow on the main stem McKenzie near Vida (USGS gage 14162500) is 1,400 cfs from natural flow with up to an additional 580 cfs from storage (which equals the sum of the storage components of minimum streamflows on Blue River and the South Fork McKenzie). Flow records show the minimum streamflow is met year-round with a margin of more than 300 cfs in the lowest flow month of September.

The minimum streamflow on the South Fork McKenzie is 200 cfs from natural flow and up to 230 cfs additional flows from storage releases. The natural minimum flow is met year-round, while the combined minimum streamflow is met only from August through January. The maximum additional flows needed to meet the 430 cfs in all months would be 191 cfs or 11,724 af during the month of March. This would equal about eight percent of Cougar Reservoir's annual storage. Meeting minimum streamflows for all months would require about 42,469 af in additional flows, or about 30 percent of the annual storage at Cougar Reservoir.

The combined minimum streamflow on Blue River is 380 cfs with 30 cfs from natural flow and up to 350 cfs from storage releases. The natural flow component is met year-round, though just barely in August and September. However, the Department estimates that regulated flows do not meet the combined minimum streamflow during any months except January and August. Additional flows needed to meet the 380 cfs minimum by month range from 28 cfs in November to 306 cfs in March. Meeting the combined minimum streamflow in

Table 31

MINIMUM FLOW ANALYSIS

1. McKenzie River at river mile 7.1, at gage 14165500 and at Interstate 5 Bridge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	5,925	6,652	6,070	5,883	5,075	3,325	2,315	1,879	1,831	1,986	3,613	5,524
80% Ex. Regulated Flow	5,061	3,677	3,243	3,502	3,608	2,807	2,538	2,602	2,393	2,589	3,761	5,236
Min. Flow (Natural)	1,025	1,025	1,025	1,025	1,025	1,025	1,025	1,025	1,025	1,025	1,025	1,025
Addl. Releases from Storage	700	700	700	700	700	700	700	700	700	700	700	700
W. A. Unregulated	4,900	5,627	5,045	4,858	4,050	2,300	1,290	854	806	961	2,588	4,499
W.A. Regulated	3,336	1,952	1,518	1,777	1,883	1,082	813	877	668	864	2,036	3,511

2. McKenzie River at river mile 47.7, at gage 14162500 and near Vida

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	3,983	3,736	3,633	4,300	4,048	2,776	2,086	1,765	1,639	1,740	2,783	3,933
80% Ex. Regulated Flow	4,185	3,249	2,948	3,157	3,216	2,635	2,492	2,527	2,367	2,521	3,322	4,302
Min. Flow (Natural)	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Addl. Releases from Storage	580	580	580	580	580	580	580	580	580	580	580	580
W. A. Unregulated	2,583	2,336	2,233	2,900	2,648	1,376	686	365	239	340	1,383	2,533
W.A. Regulated	2,205	1,269	968	1,177	1,236	655	512	547	387	541	1,342	2,322

Table 31 (Continued)

3. Blue River at mouth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	418	518	435	479	315	136	57	33	31	59	216	468
80% Ex. Regulated Flow	459	132	74	78	134	132	204	387	144	169	352	538
Min. Flow (Natural)	30	30	30	30	30	30	30	30	30	30	30	30
Addl. Releases from Storage	350	350	350	350	350	350	350	350	350	350	350	350
W. A. Unregulated	388	488	405	449	285	106	27	3	1	29	186	438
W.A. Regulated	79	-248	-306	-302	-246	-248	-176	7	-236	-211	-28	158

The 80% exceedence unregulated flow values were determined by extending the streamflow record of gage 14162000 to a 1947-1986 time period and doing a basin ratio.

4. South Fork McKenzie River below Cougar Dam

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	705	843	738	926	956	497	291	249	238	268	524	761
80% Ex. Regulated Flow	762	300	239	252	340	375	362	491	728	803	859	769
Min. Flow (Natural)	200	200	200	200	200	200	200	200	200	200	200	200
Addl. Releases from Storage	230	230	230	230	230	230	230	230	230	230	230	230
W. A. Unregulated	505	643	538	726	756	297	91	49	38	68	324	561
W.A. Regulated	332	-130	-191	-178	-90	-55	-68	61	298	373	429	339

March would require about 18,782 af or about 23 percent of annual storage at Blue River Reservoir. Meeting minimum streamflows year-round would exceed annual storage at Blue River.

ODFW, PRD and DEQ have identified 43 streams in the McKenzie subbasin with high public instream values (Appendix C). ODFW places a high priority on fish resources in all of these streams. PRD places high priority on protecting recreation values on the main stem McKenzie and major tributaries including the South Fork McKenzie River, Blue River and Mohawk River. DEQ is concerned about water quality in the lower seventeen miles of the McKenzie main stem.

Department estimates show that flows on these streams generally exceed current out-of-stream uses although flows in many of the smaller streams (i.e., Gate, Indian, Camp, Cash, and Cartwright Creeks) are very low from July through October (Table 32). About half of the streams listed as priorities by state agencies flow through federal forest lands in the headwaters of the subbasin. Few water rights have been issued for use on these streams. Based on location and land use, the Department does not expect demand for water on these streams to increase. Protecting flows in these streams would preserve high fish life values and provide water for additional uses downstream.

Hydroelectric Use

In the lower main stem (river mile 20 to 40), EWEB diverts significant amounts of water (up to 2,500 cfs) for its Leaburg and Walterville power projects. The Leaburg diversion affects about six miles of river and the Walterville diversion about seven miles. Until recently, EWEB was re-quired by the Federal Energy Regulatory Commission (FERC) to maintain a minimum 500 cfs below its projects from July 15 through August, 450 cfs in September, and 350 cfs from October through December. During the sum-mer, EWEB diversions combined with operations at the Corps' Cougar andBlue River dams, have had a pronounced effect on flow levels in the McKenzie River. Recreationists and fishermen have commonly complained of inadequate flows for boating and fishing.

EWEB recently requested and obtained approval from FERC to increase the minimum requirement below the Leaburg project to 700 cfs from August 15 through April 14. Below the Walterville project, EWEB is now required to release 1,300 cfs from April 15 through May 31, 900 cfs from June 1 through August 14, 700 cfs from August 15 through October 14, and 1,300 from October 15 through November 30. These new requirements were approved for one year. The approval expired April 14, 1992 and EWEB expects that the new requirements will be extended until the FERC relicensing process is complete (FERC, 1991).

Table 32

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

McKENZIE RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
McKenzie R >	69.9	348.0	50%	2169.0	1912.0	1674.0	2008.0	2136.0	1747.0	1433.0	1242.0	1123.0	1155.0	1587.0	2158.0
Willamette R			80%	1598.0	1428.0	1400.0	1688.0	1720.0	1384.0	1229.0	1103.0	1011.0	1010.0	1258.0	1558.0
Gage 14159000			AVAILABLE	571.0	484.0	274.0	320.0	416.0	363.0	204.0	139.0	112.0	145.0	329.0	600.0
Mohawk R >	0.0-	177.0	50%	1229.0	1198.0	893.0	563.0	325.0	176.0	74.4	36.9	39.4	77.9	450.0	1088.0
Mckenzie R	1.0		80%	602.0	719.0	611.0	388.0	222.0	110.0	48.5	23.9	26.5	46.0	203.0	527.0
Gage 14165000			IWR CERT	20	20	20	20	20	20	20	20	20	20	20	20
			AVAILABLE	582.0	699.0	591.0	368.0	202.0	90.0	28.5	3.9	6.5	26.0	183.0	507.0
	21.0	31.3	50%	236.7	236.1	171.4	124.8	57.9	25.1	10.0	5.2	6.2	21.2	117.4	245.9
			80%	119.0	139.9	115.1	84.4	39.3	17.2	6.8	3.4	3.9	10.4	51.3	122.7
			AVAILABLE	119.0	139.9	115.1	84.4	39.3	17.2	6.8	3.4	3.9	10.4	51.3	122.7
McGowan Cr >	0	12.7	50%	101.2	100.2	72.4	50.4	20.6	8.5	3.4	1.7	2.1	8.0	48.2	106.8
Mohawk R			80%	49.3	58.5	47.6	33.4	13.8	5.9	2.2	1.1	1.2	3.8	20.4	51.7
			AVAILABLE	49.3	58.5	47.6	33.4	13.8	5.9	2.2	1.1	1.2	3.8	20.4	51.7
Parsons Cr >		16.2	50%	127.3	126.3	91.3	64.4	26.2	10.9	4.4	2.2	2.7	10.4	61.3	133.7
Mohawk R			80%	62.5	74.0	60.4	42.9	17.7	7.6	2.9	1.4	1.6	5.0	26.2	65.2
	0		AVAILABLE	62.5	74.0	60.4	42.9	17.7	7.6	2.9	1.4	1.6	5.0	26.2	65.2
Cartwright Cr >		10.4	50%	83.9	82.9	59.8	41.2	16.8	6.9	2.8	1.4	1.7	6.5	39.5	88.8
Mohawk R			80%	40.5	48.2	39.2	27.2	11.2	4.7	1.8	0.9	1.0	3.0	16.6	42.6
	0		AVAILABLE	40.5	48.2	39.2	27.2	11.2	4.7	1.8	0.9	1.0	3.0	16.6	42.6
Mill Cr >		33.3	50%	251.0	250.4	181.8	132.8	67.7	30.0	12.0	6.3	7.5	22.6	124.8	260.4
Mohawk R			80%	126.4	148.5	122.3	89.9	45.5	20.2	8.1	4.2	4.7	11.2	54.7	130.3
	0		AVAILABLE	126.4	148.5	122.3	89.9	45.5	20.2	8.1	4.2	4.7	11.2	54.7	130.3
Cash Cr >		8.7	50%	70.9	69.9	50.4	34.5	11.8	4.7	1.9	0.9	1.1	5.4	33.1	75.2
Mohawk R			80%	34.0	40.6	32.9	22.6	8.0	3.3	1.2	0.6	0.7	2.5	13.9	35.9
	0		AVAILABLE	34.0	40.6	32.9	22.6	8.0	3.3	1.2	0.6	0.7	2.5	13.9	35.9

Table 32 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Shotgun Cr >	0.0	15.7	50%	123.6	122.6	88.6	62.4	46.4	22.0	8.8	4.8	5.5	10.1	59.4	129.9
Mohawk R			80%	60.6	71.8	58.6	41.5	29.4	13.4	5.6	3.4	3.6	4.8	25.3	63.3
			AVAILABLE	60.6	71.8	58.6	41.5	29.4	13.4	5.6	3.4	3.6	4.8	25.3	63.3
Drury Cr >	0.0	3.8	50%	32.5	31.8	22.8	15.0	9.5	4.2	1.7	0.9	1.0	2.2	14.6	35.0
Mohawk R			80%	15.1	18.2	14.6	9.6	5.9	2.6	1.0	0.6	0.6	1.0	5.9	16.2
			AVAILABLE	15.1	18.2	14.6	9.6	5.9	2.6	1.0	0.6	0.6	1.0	5.9	16.2
Camp Cr >	0	25.7	50%	196.6	195.8	142.0	102.4	42.3	17.8	7.1	3.6	4.4	17.1	96.6	204.9
Mckenzie R			80%	98.1	115.6	94.9	68.9	28.9	12.5	4.9	2.3	2.7	8.4	41.9	101.6
			AVAILABLE	98.1	115.6	94.9	68.9	28.9	12.5	4.9	2.3	2.7	8.4	41.9	101.6
Holden Cr >	0.0	4.2	50%	35.7	35.0	25.1	16.6	10.6	4.7	1.9	1.0	1.2	2.5	16.1	38.4
Mckenzie R			80%	16.7	20.1	16.1	10.7	6.6	2.9	1.2	0.7	0.7	1.1	6.6	17.9
			AVAILABLE	16.7	20.1	16.1	10.7	6.6	2.9	1.2	0.7	0.7	1.1	6.6	17.9
Finn Cr >	0.0	3.6	50%	30.9	30.2	21.7	14.2	8.9	4.0	1.6	0.8	1.0	2.1	13.9	33.3
Mckenzie R			80%	14.4	17.3	13.9	9.1	5.5	2.4	1.0	0.6	0.6	0.9	5.6	15.4
			AVAILABLE	14.4	17.3	13.9	9.1	5.5	2.4	1.0	0.6	0.6	0.9	5.6	15.4
Indian Cr >	0	6.3	50%	52.3	51.5	37.0	24.9	16.7	7.6	3.1	1.6	1.9	3.8	24.1	55.8
Mckenzie R			80%	24.8	29.7	24.0	16.2	10.4	4.6	1.9	1.1	1.2	1.7	10.0	26.4
			AVAILABLE	24.8	29.7	24.0	16.2	10.4	4.6	1.9	1.1	1.2	1.7	10.0	26.4
Gate Cr >	0.0-	45.7	50%	380.0	422.0	307.0	275.0	153.0	86.5	42.3	27.0	25.4	51.9	216.0	403.0
Mckenzie R	1.0		80%	209.0	263.0	219.0	204.0	104.0	58.5	32.3	21.3	19.4	30.3	105.0	216.0
			IWR APP	80.0	80.0	80.0	80.0	80.0	50/35	25/20	20.0	20.0	20.0	50/80	80.0
			AVAILABLE	129.0	183.0	139.0	124.0	24.0	8.5/23.5	7.3/12.3	1.3	-0.6	10.3	55/35	136.0
N Fk Gate Cr >	0	26.2	50%	200.2	199.4	144.6	104.4	82.3	39.9	16.0	8.9	10.0	17.5	98.5	208.6
Gate Cr			80%	100.0	117.8	96.7	70.3	52.5	24.4	10.4	6.3	6.7	8.5	42.8	103.5
			AVAILABLE	100.0	117.8	96.7	70.3	52.5	24.4	10.4	6.3	6.7	8.5	42.8	103.5

Table 32 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
S Fk Gate Cr >	0	17.3	50%	135.4	134.4	97.2	68.8	51.7	24.6	9.9	5.4	6.1	11.2	65.4	142.1
Gate Cr			80%	66.6	78.9	64.4	45.8	32.8	15.0	6.3	3.8	4.0	5.4	28.0	69.5
			AVAILABLE	66.6	78.9	64.4	45.8	32.8	15.0	6.3	3.8	4.0	5.4	28.0	69.5
Marten Cr >	0	15.7	50%	112.2	111.4	80.0	61.0	47.2	24.3	12.1	7.0	7.5	11.2	49.3	115.7
McKenzie R			80%	54.3	64.9	52.3	41.5	30.4	15.1	7.0	5.1	5.1	6.0	23.7	54.8
			AVAILABLE	54.3	64.9	52.3	41.5	30.4	15.1	7.0	5.1	5.1	6.0	23.7	54.8
Deer Cr >	0	12.5	50%	90.5	89.7	64.3	48.5	36.6	18.6	9.3	5.3	5.7	8.8	39.3	93.7
McKenzie R			80%	43.4	52.0	41.8	32.9	23.5	11.6	5.4	3.9	3.8	4.6	18.8	44.0
			AVAILABLE	43.4	52.0	41.8	32.9	23.5	11.6	5.4	3.9	3.8	4.6	18.8	44.0
Ennis Cr >	0	7.9	50%	58.8	58.0	41.5	30.6	21.9	10.9	5.5	3.1	3.3	5.4	25.0	61.3
Mckenzie R			80%	27.7	33.4	26.7	20.5	13.9	6.8	3.1	2.2	2.2	2.8	11.8	28.3
			AVAILABLE	27.7	33.4	26.7	20.5	13.9	6.8	3.1	2.2	2.2	2.8	11.8	28.3
Quartz Cr >	0	41.8	50%	426.1	424.7	315.9	313.7	271.6	144.5	60.2	39.0	38.4	89.8	287.1	468.7
Mckenzie R			80%	225.9	258.1	221.7	232.8	187.1	95.1	50.2	31.2	28.3	48.6	161.0	260.0
			IWR APP	60	60	60	60	60	25/18	12/10	8	8	8	40/60	60
			AVAILABLE	165.9	198.1	161.7	172.8	127.1	70/77	38/40	23.2	20.3	40.6	121/101	200.0
Elk Cr >	0	5.4	50%	62.0	60.7	44.7	40.1	18.1	8.1	3.4	1.9	2.0	10.0	38.0	70.6
Mckenzie R			80%	30.5	35.7	29.9	28.4	12.6	5.8	2.7	1.3	1.3	4.9	19.9	36.5
			AVAILABLE	30.5	35.7	29.9	28.4	12.6	5.8	2.7	1.3	1.3	4.9	19.9	36.5
Blue R >	8.0	45.8	50%	404.0	489.0	327.0	367.0	285.0	117.0	38.9	20.9	21.5	58.0	289.0	460.0
Mckenzie R			80%	206.0	285.0	232.0	263.0	178.0	69.2	28.3	15.8	14.3	29.0	143.0	218.0
Gage 14161100			AVAILABLE	206.0	285.0	232.0	263.0	178.0	69.2	28.3	15.8	14.3	29.0	143.0	218.0
Simmonds Cr >	0	3.9	50%	45.6	44.6	32.7	28.9	19.1	9.2	3.9	2.3	2.3	7.0	27.6	52.3
Blue R			80%	22.2	26.1	21.8	20.3	12.7	6.0	2.9	1.7	1.5	3.4	14.2	26.7
			AVAILABLE	22.2	26.1	21.8	20.3	12.7	6.0	2.9	1.7	1.5	3.4	14.2	26.7
Quartz Cr >	0	2.9	50%	34.5	33.6	24.7	21.5	13.7	6.5	2.7	1.6	1.6	5.1	20.6	39.7
Blue R			80%	16.6	19.6	16.3	15.0	9.1	4.3	2.0	1.2	1.1	2.4	10.5	20.1
			AVAILABLE	16.6	19.6	16.3	15.0	9.1	4.3	2.0	1.2	1.1	2.4	10.5	20.1

Table 32 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Lookout Cr >	0	24.1	50%	208.0	231.0	151.0	173.0	145.0	66.7	25.2	14.7	14.0	28.1	131.0	226.0
Blue R			80%	110.0	137.0	107.0	124.0	93.5	41.5	18.9	12.0	10.8	16.1	63.7	119.0
Gage 1416500			AVAILABLE	110.0	137.0	107.0	124.0	93.5	41.5	18.9	12.0	10.8	16.1	63.7	119.0
McRae Cr>	0	7.1	50%	80.2	78.8	58.0	52.8	37.4	18.4	7.7	4.7	4.7	13.4	49.8	91.0
Lookout Cr			80%	39.9	46.5	39.1	37.6	25.0	12.1	6.0	3.5	3.2	6.6	26.3	47.4
			AVAILABLE	39.9	46.5	39.1	37.6	25.0	12.1	6.0	3.5	3.2	6.6	26.3	47.4
Tidbits Cr >	0	9.8	50%	108.7	107.0	79.0	73.0	53.6	26.7	11.2	6.9	6.9	18.9	68.5	122.6
Blue R			80%	54.7	63.5	53.6	52.4	36.1	17.6	8.8	5.3	4.8	9.5	36.5	64.6
			AVAILABLE	54.7	63.5	53.6	52.4	36.1	17.6	8.8	5.3	4.8	9.5	36.5	64.6
Cook Cr >	0	8.7	50%	97.1	95.6	70.5	64.8	46.9	23.3	9.8	6.0	6.0	16.7	60.9	109.8
Blue R			80%	48.7	56.6	47.7	46.3	31.5	15.3	7.6	4.6	4.1	8.3	32.4	57.6
			AVAILABLE	48.7	56.6	47.7	46.3	31.5	15.3	7.6	4.6	4.1	8.3	32.4	57.6
Quentin Cr >	0	10.4	50%	114.9	113.2	83.6	77.5	57.3	28.7	12.0	7.4	7.4	20.2	72.6	129.5
Blue R			80%	58.0	67.3	56.8	55.7	38.6	18.8	9.5	5.7	5.1	10.2	38.8	68.4
			AVAILABLE	58.0	67.3	56.8	55.7	38.6	18.8	9.5	5.7	5.1	10.2	38.8	68.4
S Fk Mckenzie R	10.0		50%	882.0	982.0	737.0	883.0	965.0	614.0	309.0	245.0	232.0	282.0	589.0	931.0
> Mckenzie R			80%	556.0	656.0	568.0	693.0	712.0	416.0	257.0	221.0	214.0	230.0	372.0	558.0
Gage 14159200			AVAILABLE	556.0	656.0	568.0	693.0	712.0	416.0	257.0	221.0	214.0	230.0	372.0	558.0
East Fk >	0	18.2	50%	142.1	141.0	102.1	91.6	74.4	41.0	22.5	14.1	14.1	22.1	68.7	148.9
S Fk Mckenzie R			80%	70.0	82.8	67.7	65.5	49.7	26.5	14.0	11.0	10.0	12.7	38.5	73.0
			AVAILABLE	70.0	82.8	67.7	65.5	49.7	26.5	14.0	11.0	10.0	12.7	38.5	73.0
French Pete Cr>	0	31.7	50%	239.6	239.0	173.5	160.1	138.4	78.1	42.8	27.4	27.1	40.0	118.9	248.8
S Fk Mckenzie R			80%	120.5	141.6	116.5	115.9	93.2	50.7	27.3	21.7	19.7	23.8	67.9	124.3
			AVAILABLE	120.5	141.6	116.5	115.9	93.2	50.7	27.3	21.7	19.7	23.8	67.9	124.3
Rebel Cr >	0	6.7	50%	52.2	51.5	36.9	31.4	22.9	12.3	7.2	4.4	4.4	7.0	22.8	55.1
S Fk Mckenzie R			80%	24.6	29.6	23.7	21.9	15.1	8.0	4.1	3.3	3.0	3.9	12.5	25.6
			AVAILABLE	24.6	29.6	23.7	21.9	15.1	8.0	4.1	3.3	3.0	3.9	12.5	25.6

Consumptive Uses

Agricultural Use

ODA reports that about 7,000 acres were irrigated in the McKenzie subbasin in 1988 (Andrews, 1990; Weber, 1991). About 59 percent, or 4,130 acres, are irrigated with surface water. The amount of irrigated acreage in the McKenzie subbasin is not expected to change over the next 20 years according to ODA projections.

Municipal Use

Parts of three incorporated cities occupy the lower end of the McKenzie subbasin near its juncture with the Willamette River. Eugene is situated primarily on the west side of the Willamette River opposite the McKenzie sub-basin but has spread eastward into the McKenzie drainage. Springfield is located mostly within the subbasin, but uses water from the Middle Fork Willamette River and is covered later in the discussion. Coburg, a small town, is the only other incorporated city in the McKenzie subbasin.

Table 33 lists population, water rights, and water use information for Coburg and Eugene. Based on its water rights and reported water use in 1989, it appears that Coburg's appropriation is being fully used during some months. Coburg relies entirely on wells for municipal water.

EWEB holds rights to 300 cfs from the McKenzie River for municipal use. The intake is located just north of Springfield, near river mile 15. In 1989, EWEB's maximum use occurred in July. It reported municipal diversions of nearly 1.49 billion gallons of water during this month. This equals an average of 47.9 million gallons (147 af) of water per day, or a constant diversion of 74 cfs. With 228 cfs remaining, it would appear that Eugene could expand its service significantly without obtaining new water rights.

It is estimated that Eugene grew by almost four percent from 1980 to 1989 while the population of Lane County grew by almost two percent (PSU, 1990). Most population increases in the foreseeable future would most likely occur in the Eugene-Springfield area. At present use rates, EWEB's water rights should be adequate well into the 21st century.

Summary

Water is available for further appropriation on the McKenzie main stem during all months of the year. However, on certain reaches, diversions for hydroelectric power can impair instream values warranting caution in further permitting

Table 33

MUNICIPAL WATER RIGHTS AND USAGE FOR THE McKENZIE RIVER SUBBASIN

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Average rate (gpd) [7]	Average per capita rate (gpd) [8]	Unused rights (cfs) [9]	Comments
Coburg	665	--	0.71	0.71	0.53	340,097	511	0.18	
Eugene	109,000	300.08	1.94	302.02	74.14	47,913,000	440	227.88	
TOTAL	109,665	300.08	2.65	302.73	74.67	48,253,097	440	228.06	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

activities. Combined minimum streamflows on the South Fork McKenzie River and Blue River are not being met during a number of months. Combined minimum streamflows on the Blue River at the mouth are not met during any months of the year. Combined minimum streamflows on the South Fork McKenzie River below Cougar Dam are only being met during August through January. Flows in many streams which have been identified as having high value aquatic habitat can approach zero during summer months. Flows on these streams could be protected without constraining development downstream as most are in headwater areas managed by the USFS.

The McKenzie River subbasin provides a large variety of water-based recreational opportunities. Further appropriations on scenic waterway reaches of the main stem and the South Fork McKenzie can be allowed only if they do not conflict with statutory priorities established for these streams.

Irrigated acreage in the McKenzie subbasin is expected to remain static over the next twenty years leaving unused stored waters available for additional locations or types of uses. Extensive rights to water from the McKenzie have already been issued for municipal and industrial purposes. Eugene holds water rights which could accommodate growth well into the next century.

Coast Fork Willamette River Subbasin

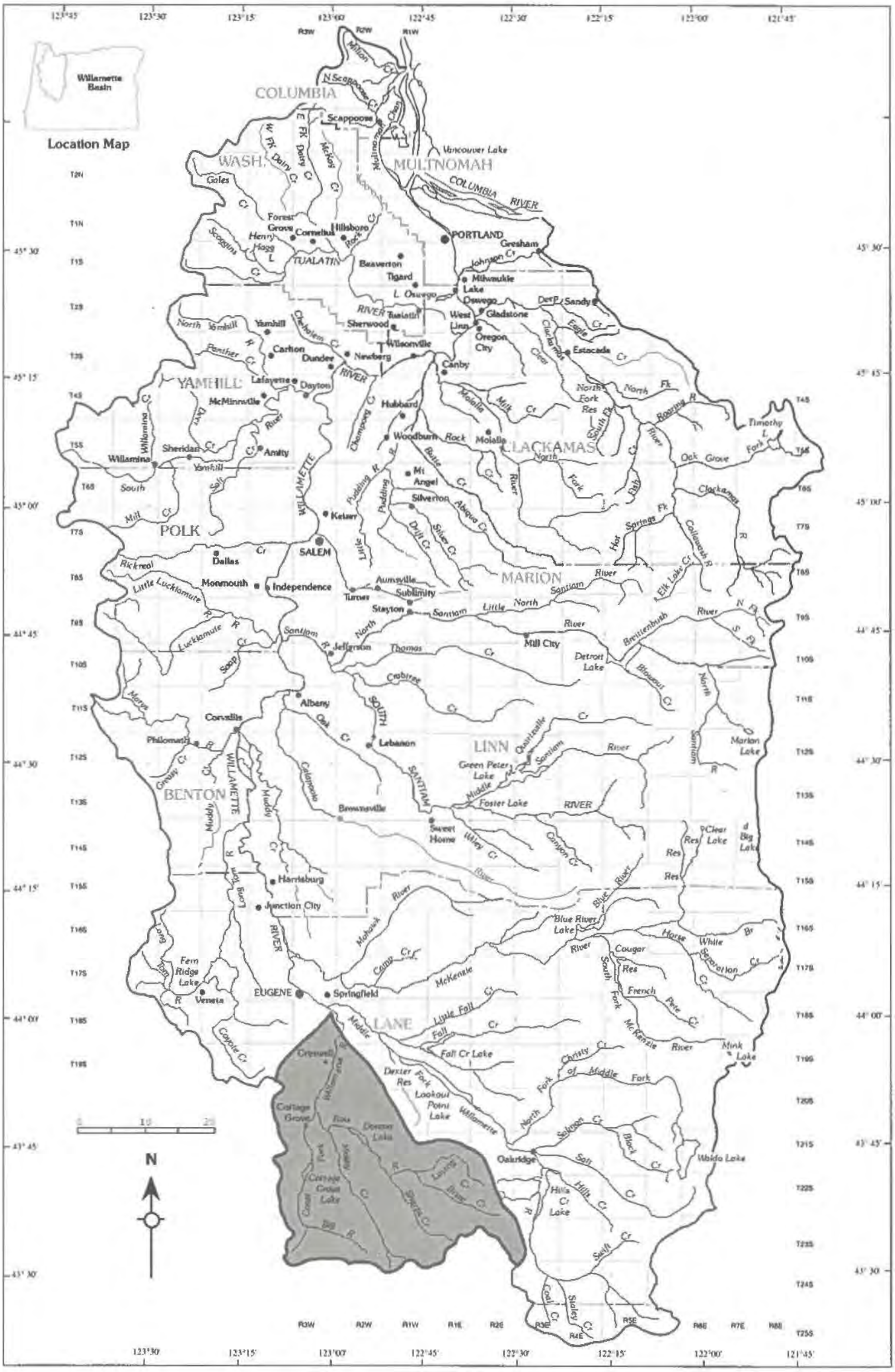
General Orientation

The Coast Fork Willamette River originates in the Calapooya Mountains at the south end of the Willamette Valley (Figure 16). The subbasin includes about 670 square miles and yields an average of 1.19 million af per year (USGS, 1990). This averages 1,784 af per square mile. Low summer flows in the Coast Fork Willamette system reflect the low elevation and a reliance on rainfall rather than snowmelt. About 73 percent of the runoff in the Coast Fork Willamette subbasin occurs during November through March. Only about 14 per-cent occurs from June through October (Appendix A).

The Coast Fork main stem is only about 40 miles long. It joins the Middle Fork Willamette River a mile south of Springfield to form the Willamette River main stem. The subbasin is about 90 percent forested, mountainous uplands. About 64 percent of the land in the subbasin is privately owned. About 36 percent is owned and managed by the federal government.

The Corps operates Cottage Grove and Dorena Reservoirs in this subbasin. Cottage Grove Reservoir, on the Coast Fork Willamette main stem, was constructed primarily for flood control purposes. Dorena Reservoir was constructed on the Row River main stem for the purposes of flood control, navigation and

Figure 16
COAST FORK WILLAMETTE RIVER SUBBASIN



irrigation. Together, the two reservoirs provide seasonal storage of 93,600 af, or about eight percent of the average annual discharge in the subbasin.

Water Availability and Needs

Overview

The Department has issued water rights to divert about 170 cfs from the Coast Fork Willamette River system (Appendix B). The agricultural sector uses over 90 cfs for irrigation purposes. About 44 cfs and 32 cfs have been appropriated for industrial and municipal purposes, respectively. Other water uses are negligible. Full development of these water rights could result in a diversion of up to 76,000 af per year. Meeting the 290 cfs minimum streamflow at the mouth requires an additional 209,600 af. The combined demand is about 285,600 af, or about 24 percent, of average annual discharge in the subbasin. Over 70,000 af of demand could occur, however, from June through September when only 9.6 percent, or about 114,100 af, of discharge are produced.

Nonconsumptive Uses

Minimum Streamflows

Minimum streamflows were adopted for three stream reaches in the Coast Fork Willamette subbasin. The primary purpose of these flows is to support aquatic life. Two of these flows are on the Coast Fork Willamette main stem and one is on Row River. The three minimum streamflows, which include both natural flow and storage components, have not yet been converted to instream water rights.

The minimum streamflow at the mouth of the Coast Fork Willamette River consists of 40 cfs year-round from natural flow and up to 250 cfs additional flow from storage releases upstream. Streamflow records from USGS gage 14157500 near Goshen indicate that the regulated flows at the mouth of the Coast Fork should meet the combined minimum streamflow of 290 cfs except during July and August (Table 34).

There is a minimum streamflow for the Coast Fork Willamette River upstream of its confluence with the Row River of 15 cfs from natural flow and up to 100 cfs additional flow from storage releases. Streamflow records from USGS gage 14153500 (below Cottage Grove Dam), upstream from the Row River, show that regulated flows meet the combined minimum streamflow of 115 cfs only during September and from November through March.

There is also a minimum streamflow for the Row River itself of 40 cfs year-round from natural flow and up to 150 cfs year-round additional flow from storage

Table 34

MINIMUM FLOW ANALYSIS

1. Coast Fork Willamette River near mouth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Regulated Flow	1549	1589	1173	834	479	298	196	218	365	409	689	1703
Min. Flow (Natural)	40	40	40	40	40	40	40	40	40	40	40	40
Addl. Releases from Storage	250	250	250	250	250	250	250	250	250	250	250	250
W.A. Regulated	1259	1299	883	544	189	8	-94	-72	75	119	399	1413

Evaluated at gage 14157500 upstream from mouth.

2. Row River near confluence with the Coast Fork Willamette R. at gage 141555500

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	681	872	761	689	394	147	59	33	32	78	335	708
80% Ex. Regulated Flow	661	599	401	369	242	171	119	141	193	226	336	758
Min. Flow (Natural)	40	40	40	40	40	40	40	40	40	40	40	40
Addl. Releases from Storage	150	150	150	150	150	150	150	150	150	150	150	150
W. A. Unregulated	641	832	721	649	354	107	19	-7	-8	38	295	668
W.A. Regulated	471	409	211	179	52	-19	-71	-49	3	36	146	568

3. Coast Fork Willamette River upstream from confluence of Row River

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Regulated Flow	244	216	135	90	68	61	45	45	120	110	131	267
Min. Flow (Natural)	15	15	15	15	15	15	15	15	15	15	15	15
Addl. Releases from Storage	100	100	100	100	100	100	100	100	100	100	100	100
W.A. Regulated	129	101	20	-25	-47	-54	-70	-70	5	-5	16	152

Evaluated at gage 14153500.

releases. Regulated flow estimates for the Row River at gage 141555500 near its confluence with the Coast Fork Willamette River indicate that flows should meet the combined minimum streamflow of 190 cfs except for the months June, July, and August. Estimated natural flow appears sufficient to meet the natural flow component of the minimum streamflow except during the months of August and September.

ODFW, DEQ, and PRD are interested in establishing instream water rights on 14 stream reaches in the Coast Fork Willamette River subbasin (Appendix C). Twelve of these reaches are on streams which are currently without minimum flow protection. Streams of interest to ODFW are upstream from the Corps' reservoirs. They flow through steeper, forested and publicly owned lands where private water development is not likely to occur. Protecting flows for aquatic life in these headwater streams would not be expected to hinder development or deplete flows for additional use downstream.

PRD and DEQ are interested in the Row River and Coast Fork main stems. DEQ has identified water quality problems, namely dissolved oxygen and pH, from the mouth to river mile 29. These lower reaches are bordered by private lands and are more likely to be developed. Instream uses here will compete more directly with existing and future out-of-stream needs. The agencies have not yet proposed specific minimum flow levels for these streams.

Department estimates indicate that streamflows in ungaged streams currently exceed existing out-of-stream rights throughout the year. In other words, they would not generally dry up at any point during the year. However, significantly lower flows would be expected to occur from August through October (Table 35). Flows on small streams, even those without water rights, can approach zero during the summer months. Of the 14 streams, Saroute, Wilson, and Tetter Creeks have no recorded water rights.

Consumptive Uses

Agricultural Use

ODA has projected that irrigated farmland in the Coast Fork Willamette subbasin will increase by 1,000 acres (from 4,650 acres in 1988 to 5,580 acres) over the next 20 years. This will create a demand for an additional 2,300 af of water. Ninety-three percent, or 2,140 af, is expected to come from surface water to irrigate 930 acres. The remaining 160 af would be from additional groundwater use. (Andrews, 1990; Weber, 1991) The agency has requested a reservation of surface water to supply future irrigation uses in the Willamette Basin.

Table 35

WILLAMETTE BASIN STREAMFLOW AVAILABILITY

COAST FORK WILLAMETTE RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
C Fk Willamette	33	72.1	50%	399	409	332	223	134	64	30	19	20	44	193	395
R >			80%	195	245	220	155	89	45	23	15	15	26	90	199
Willamette R			AVAILABLE	195	245	220	155	89	45	23	15	15	26	90	199
Row R > C Fk	12	211	50%	1146	1224	940	782	526	210	66	33	37	124	645	1183
Willamette R			80%	539	699	615	561	322	120	46	25	24	59	262	565
			AVAILABLE	539	699	615	561	322	120	46	25	24	59	262	565
Mosby Cr >	0	95.3	50%	495	505	388	253	149	61	21	11	13	49	262	506
Row R			80%	236	295	253	167	87	37	15	7.7	8.4	23	110	250
			AVAILABLE	236	295	253	167	87	37	15	7.7	8.4	23	110	250
Rat Cr > Row R	0	10.1	50%	72	71	51	36	26	13	6.2	3.4	3.8	5.9	30	75
			80%	34	41	33	24	17	8	4	2	3	3	14	35
			AVAILABLE	34	41	33	24	17	8	4	2	3	3	14	35
Smith Cr >	0	24.8	50%	168	168	120	89	72	37	17	9.9	11	15	74	171
Row R			80%	82	98	79	60	46	23	10	7.2	7.4	8.1	34	82
			AVAILABLE	82	98	79	60	46	23	10	7	7	8	34	82
Teeter Cr >	0	12.1	50%	86	85	61	43	32	16	7.6	4.2	4.7	7.1	36	88
Smith Cr			80%	41	49	39	29	20	9.8	4.3	3	3.1	3.6	16	41
			AVAILABLE	41	49	39	29	20	9.8	4.3	3	3.1	3.6	16	41
Sharps Cr >	0-	66.5	50%	426	428	309	240	216	116	55	32	35	44	195	426
Row R	11.0		80%	216	255	208	166	140	71	33	24	25	25	94	210
			AVAILABLE	216	255	208	166	140	71	33	24	25	25	94	210
	11	12.8	50%	90	89	64	46	34	17	8.1	4.5	5	7.6	38	93
			80%	43	52	42	31	22	10	4.6	3.2	3.3	3.9	17	43
			AVAILABLE	43	52	42	31	22	10	4.6	3.2	3.3	3.9	17	43

Table 35 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Martin Cr > Sharps Cr	0	18.8	50%	130	129	92	67	53	27	13	7.1	7.9	11	56	133
			80%	63	75	61	45	34	16	7.3	5.1	5.3	5.9	26	63
			AVAILABLE	63	75	61	45	34	16	7.3	5.1	5.3	5.9	26	63
Layng Cr > Row R	0	65.3	50%	419	421	304	235	211	113	54	32	34	44	192	419
			80%	213	250	205	163	137	70	33	24	24	24	92	207
			AVAILABLE	213	250	205	163	137	70	33	24	24	24	92	207
Brice Cr > Row R	0	57.4	50%	371	372	269	207	183	97	46	27	29	38	169	372
			80%	187	221	180	143	119	60	28	20	21	21	80	183
			AVAILABLE	187	221	180	143	119	60	28	20	21	21	80	183
Champion Cr > Brice Cr	0	10.4	50%	74	73	53	37	27	13	6.4	3.5	3.9	6.1	31	77
			80%	35	42	34	25	17	8.2	3.6	2.5	2.6	3.1	14	36
			AVAILABLE	35	42	34	25	17	8.2	3.6	2.5	2.6	3.1	14	36
Wilson Cr > C Fk Willamette R	0	8.3	50%	60	59	42	30	21	10	4.9	2.7	3	4.8	25	62
			80%	28	34	27	20	13	6.3	2.7	1.9	1.9	2.4	11	29
			AVAILABLE	28	34	27	20	13	6.3	2.7	1.9	1.9	2.4	11	29
Saroute Cr > C Fk Willamette R	0	17.4	50%	120	120	86	62	48	24	12	6.5	7.2	11	52	123
			80%	58	70	56	42	31	15	6.7	4.7	4.8	5.5	24	58
			AVAILABLE	58	70	56	42	31	15	6.7	4.7	4.8	5.5	24	58
Big R > C Fk Willamette R	0	41.7	50%	274	275	198	150	128	67	32	18	20	27	123	277
			80%	137	162	132	103	83	41	19	14	14	15	58	135
			AVAILABLE	137	162	132	103	83	41	19	14	14	15	58	135

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights).

ODA expects that the additional surface water needed will come from existing storage and would be diverted directly from the Coast Fork main stem. This implies that new irrigation development will probably occur in downstream portions of the subbasin, most likely between Cottage Grove and Eugene. Irrigation development in this area would have little impact on the streams, or flows for fish, of interest to ODFW. The projected irrigation demand represents only 2.5 percent of the total existing seasonal storage capacity in the subbasin. If additional irrigation demand is supplied by stored water, diversions from the Coast Fork main stem will not compete for flows necessary for recreation and water quality.

Municipal Uses

Cottage Grove and Creswell are the only two incorporated cities in the Coast Fork Willamette subbasin. The cities are in Lane County. From 1978 to 1988, Cottage Grove's population increased 8 percent while Creswell grew 22.7 percent. If Creswell were to maintain this growth rate, its population would double in about 32 years.

The county had a total population of 273,700 in 1988 (PSU, 1990). Thirty-six percent of the population resided in unincorporated areas. From 1978 to 1988, the population of Lane County grew by 11,000, or 4.2 percent. The overall population in the County's unincorporated areas declined by 2.5 percent from 1978 to 1988. Lane County population is projected to increase by 14.5 percent by the year 2000 (PSU, 1984). Most of this growth is expected in the Eugene - Springfield area.

Based on the information shown in Table 36, during their peak-use months, Cottage Grove and Creswell are using only about four of the 29 cfs they can divert for municipal purposes. Cottage Grove has rights to several surface water sources. Creswell has both surface and groundwater rights and maintains more than 20 municipal wells. Some of these wells are not in use. If water rights were the only constraint, both cities could expand their service substantially if needed to accommodate population growth. However, water quality and system capacity constraints can also affect such expansion.

Summary

The combined minimum streamflow as measured at the mouth of the Coast Fork Willamette River is generally met except during July and August. Upstream from the Row River, minimum streamflows are met only during September and from November through March. Regulated flows in the Row River itself meet the combined minimum streamflow except from June through August.

Table 36

MUNICIPAL WATER RIGHTS AND USAGE FOR THE COAST FORK WILLAMETTE RIVER SUBBASIN

Municipal water supplier [1]	Population [2]	Surface rights (cfs) [3]	GW rights (cfs) [4]	Total rights (cfs) [5]	Month of Maximum Rate of Use: Average rate (cfs) [6]	Month of Maximum Rate of Use: Average rate (gpd) [7]	Month of Maximum Rate of Use: Average per capita rate (gpd) [8]	Month of Maximum Rate of Use: Unused rights (cfs) [9]	Comments
Cottage Grove	6,915	22.20	3.10	25.30	3.23	2,091,161	302	22.07	
Creswell	1,975	3.00	1.08	4.08	1.20	773,154	391	2.88	
TOTAL	8,890	25.20	4.18	29.38	4.43	2,864,315	322	24.95	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

DEQ and PRD have identified the Coast Fork main stem as important for flow protection. DEQ has identified water quality problems, namely dissolved oxygen and pH, from the mouth to river mile 29. Low flows increase these problems. PRD and ODFW have also identified the Row River as important for fish and recreational uses.

Many of the streams which ODFW has identified as providing high priority aquatic habitat have very low flows during summer months. Most of these streams are in upland areas that offer little opportunity for water develop-ment. Protecting natural flows in these streams will contribute to making water available for development elsewhere in the subbasin.

ODA has projected that irrigated farm land in the Coast Fork Willamette subbasin will increase by 1,000 acres over the next 20 years, creating a demand for an additional 2,300 af of water. ODA has requested a reservation of 2,140 af of surface water to serve these future needs. Water to meet this demand is proposed to come from existing storage in the subbasin. Most of the stored water is already allocated to irrigation and is sufficient to meet ODA's requested reservation amounts.

Domestic and municipal water needs are expected to grow, but existing municipal water rights have the capacity to serve current rates of population growth well into the future. Water availability, quality and system capacity may constrain the expansion of service.

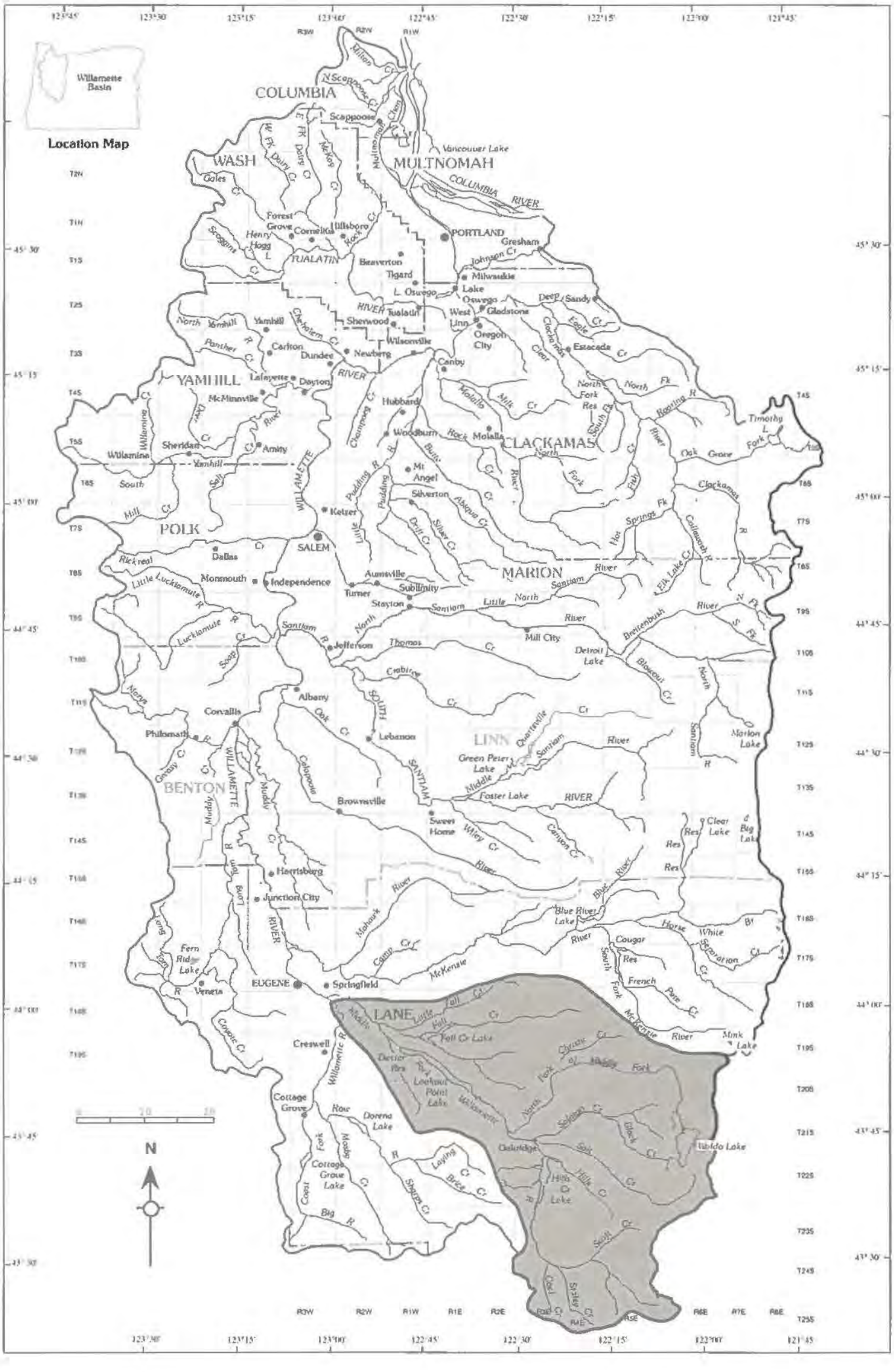
Middle Fork Willamette River Subbasin

General Orientation

The Middle Fork Willamette River subbasin constitutes the headwaters of the Willamette River. From its source in Timpanogas Lake, the Middle Fork main stem flows 84 miles to its confluence with the Willamette River at river mile 187. The subbasin is bounded by the McKenzie subbasin on the north, the Cascade Range on the east, the Calapooya Mountains on the south, and the Coast Fork Willamette subbasin on the west (Figure 17). The subbasin is mostly mountainous forest land under USFS (78 percent) and BLM (3 percent) administration. The remaining 19 percent is privately owned.

The Middle Fork Willamette River drains 1,360 square miles and yields an average of 3.02 million af annually (USGS, 1990). This translates to about 2,221 af per square mile. About 58 percent of the average annual yield runs off during November through March. From June through October, the subbasin yields about 30 percent of annual runoff (Appendix A).

Figure 17
MIDDLE FORK WILLAMETTE RIVER SUBBASIN



Minimum perennial streamflows to support aquatic life have been adopted for seven stream reaches in the Middle Willamette subbasin. The minimum flows on four of these streams have been converted to instream water rights as directed by ORS 537.346. The three remaining minimum streamflows contain both natural flow and storage components and have not been converted.

Streamflow on the main stem is regulated by four Corps reservoirs. In downstream order, the reservoirs are Hills Creek, Lookout Point, and Dexter on the main stem Middle Fork Willamette River and Fall Creek Reservoir on Fall Creek, which enters the Middle Fork Willamette River downstream from Dexter Reservoir. Combined, these four reservoirs store 630,000 af of water annually, or about 21 percent of the average annual discharge. From November through March, the upper Middle Fork Willamette River yields about 56 percent of its total discharge. This is three percent less than regulated flows below all the reservoirs. From June through October, unregulated yields are about 22 percent, or eight percent less than the regulated flows.

Water Availability and Needs

Overview

The Department has issued water rights to use about 186 cfs of surface water from the Middle Willamette system (Appendix B). More than 90 cfs have been allocated for fish, wildlife and minor miscellaneous uses. The other major water uses include irrigation (35 cfs), industrial (29 cfs), and muni-cipal (23 cfs). Full development of these water rights could result in a demand of up to 116,300 cfs, or about 3.8 percent of the average annual discharge in the subbasin.

Meeting the combined minimum streamflow at the mouth requires an additional 1,528,500 af, annually. The total potential demand of 1.64 million af represents about 54 percent of total annual discharge. 554,400 af of demand could occur from June through September when about 21 percent, or 646,500 af of discharge is generated.

Nonconsumptive Uses

Scenic Waterway

Forty-three miles of the North Fork of the Middle Fork Willamette River, as well as Waldo Lake, are designated state scenic waterways (See Table 1). Authorizing statutes have established that the highest and best uses of scenic waterways are for recreation, fish, and wildlife.

The Department has completed an assessment of the flow levels needed to support scenic waterway values for the North Fork of the Middle Fork Willamette River. Flows above the confluence of Plateau Creek at river mile 17 are sufficient to satisfy the scenic waterway flows in all months except June, September and October. Below Plateau Creek, however, the scenic waterway flows are not met in any month. Sufficient information was not available to establish scenic waterway lake levels for Waldo Lake.

The Middle Fork Willamette subbasin contains major natural recreation areas. Parts of the Diamond Peak, Waldo Lake and Three Sisters Wilderness Areas are located here. Given the level and types of uses in the subbasin, it would appear that recreation, fish life, wildlife, and aesthetic values are the highest and best uses for not only scenic waterways but also for ODFW's and PRD's priority streams. Restricting new uses of these streams now would preserve flows to meet instream needs and anticipated instream water right requests. As nonconsumptive uses, future instream water rights would not deplete flows available for additional development downstream.

Much of the upper North Fork of the Middle Fork Willamette River is also a designated federal wild and scenic river. Federal law mandates the protection of the values identified in the designation of, or management plan for, wild and scenic rivers. In addition, federal reserved rights dating back to the designation may exist to fulfill the purposes of the Wild and Scenic Rivers Act.

Minimum Streamflows

The minimum streamflow at the mouth of the Middle Fork Willamette River is comprised of 640 cfs from natural flow and up to 1,475 cfs from storage. The nearest gage is USGS 14152000 (Middle Fork Willamette River at Jasper) at river mile eight. Based on the gaging record, the estimated regulated streamflow at the mouth is sufficient to meet the combined minimum streamflow of 2,115 cfs from September through February but falls short from March through August (Table 37).

The minimum streamflow on the North Fork of the Middle Fork Willamette River, according to natural flow estimates at USGS gage 14147500, is being met through all months.

A minimum streamflow with both natural flow and storage release components is in place at the mouth of Fall Creek. The natural flow component is 40 cfs and the storage component is 470 cfs year-round for a total of 510 cfs. Fall Creek Reservoir is seven miles upstream. Streamflow estimates for Fall Creek from gage data at USGS gage 14151000 (below Winberry Creek near Fall Creek) show natural flows meeting the natural flow minimum during all months but August

Table 37

MINIMUM FLOW ANALYSIS

1. Middle Fork Willamette River at mouth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Regulated Flow	3,830	2,368	2,085	1,899	1,948	1,776	1,575	1,690	2,143	3,095	4,233	4,217
Min. Flow (Natural)	640	640	640	640	640	640	640	640	640	640	640	640
Addl. Releases from Storage	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475
W.A. Regulated	1,715	253	-30	-216	-167	-339	-540	-425	28	980	2,118	2,102

Evaluated at gage 14152000 at river mile 8.

2. Fall Creek near mouth (combined flow of gages 14151000 and 14151500)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	768	886	727	539	335	203	101	56	62	109	345	756
80% Ex. Regulated Flow	706	402	247	262	208	178	94	102	409	498	630	863
Min. Flow (Natural)	40	40	40	40	40	40	40	40	40	40	40	40
Addl. Releases from Storage	470	470	470	470	470	470	470	470	470	470	470	470
W. A. Unregulated	728	846	687	499	295	163	61	16	22	69	305	716
W.A. Regulated	196	-108	-263	-248	-302	-332	-416	-408	-101	-12	120	353

Note: Flow represents the combined flow from the lowest gages on Fall Creek and Little Fall Creek

3. Middle Fork Willamette River above the North Fork

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80% Ex. Unregulated Flow	1,700	1,893	1,662	1,980	2,110	1,280	718	558	358	395	756	1,513
80% Ex. Regulated Flow	1,607	991	910	1,154	1,406	1,074	758	773	1,234	1,337	1,706	1,814
Min. Flow (Natural)	285	285	285	285	285	285	285	285	285	285	285	285
Addl. Releases from Storage	690	690	690	690	690	690	690	690	690	690	690	690
W. A. Unregulated	1,415	1,608	1,377	1,695	1,825	995	433	273	73	110	471	1,228
W.A. Regulated	632	16	-65	179	431	99	-217	-202	259	362	731	839

Streamflows for the mouth were calculated by adding flows for gages 14145500 (Middle Fork below Hills Creek), 14146000 (Salt Creek) and 14146500 (Salmon Creek).

and September. However, estimates for regulated flows show that the combined minimum streamflow would only be met during November through January.

The minimum streamflow for the Middle Fork Willamette River above the North Fork is 285 cfs from natural flow and up to 690 cfs from storage. Streamflows and water availability were estimated at USGS gage 14145500 on the Middle Fork Willamette River, above Salt Creek, near Oakridge. This gage is about seven miles upstream from the minimum streamflow point. Salt Creek and Salmon Creek are major Middle Fork Willamette River tributaries in the intermediate stream reach. Natural flows would be expected to meet the natural minimum flow component in all months. Post-dam or regulated flows estimated for this point would meet the combined minimum of 975 cfs during all months of the year except March, July and August. (About 58,700 af, annually would be contributed by Salt and Salmon Creeks below this gage).

Meeting the two minimum streamflows on the Middle Fork Willamette main stem could be possible through additional storage releases. Releasing significant additional water from Hills Creek Reservoir during the summer would require operational changes at both Hills Creek and Lookout Point Reservoirs. Recreation values and power generation could be affected at Hills Creek. Increased discharge at Lookout Point would be necessary during all or part of the year to accommodate the additional releases from Hills Creek. Meeting the combined minimum streamflow at the mouth of Fall Creek would require nearly the complete drafting of Fall Creek Reservoir during the summer months.

Water stored in the reservoirs is currently allocated to irrigation. The Bureau of Reclamation holds the permit for this water and administers contracts for its use. Most of the water is presently uncontracted. The water could be allocated to other uses if agreements could be worked out with the Bureau, Corps and other parties.

ODFW and PRD are interested in setting additional instream water rights on 34 stream reaches in the Middle Fork subbasin (Appendix C). Thirty of these are on streams currently without minimum flow or instream water right protection. Four reaches are on streams already protected. The Department produced flow estimates for more than 30 of these ungaged streams and found that the smaller streams drop to very low levels from July through October (Table 38). All of these streams, except Lost Creek, are partially or entirely on federal forest land and are located upstream from one or more of the Corps' reservoirs. Private development on these streams and upstream from the Corps' reservoirs is minimal. Only eleven of the streams have a record of permitted water rights. Since this area is unadjudicated, water right claims predating 1909 may exist but have not been quantified. On those streams that have water rights, estimated natural flows exceed total water rights in all cases.

Table 38

WILLAMETTE BASIN STREAM AVAILABILITY

MIDDLE FORK WILLAMETTE RIVER SUBBASIN

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
M Fk Willamette	33	924.0	50%	4638	4104	3263	3983	3894	2564	1280	853	793	1030	2600	4374
R >Willamette R			80%	2681	2573	2368	3048	2919	1769	1015	745	700	772	1513	2360
Gage 14148000			AVAILABLE	2681	2573	2368	3048	2919	1769	1015	745	700	772	1513	2360
Gage 14144800	53	258.0	50%	1149	1288	954	1089	1175	805	422	303	277	335	742	1154
			80%	687	851	711	845	880	557	332	264	248	275	437	649
			AVAILABLE	687	851	711	845	880	557	332	264	248	275	437	649
Fall Cr >M Fk	14	118.0	50%	742	784	556	549	324	169	70	43	46	104	468	756
Willamette R			80%	379	473	381	391	212	102	52	32	32	56	228	379
Gage 14150300			AVAILABLE	379	473	381	391	212	102	52	32	32	56	228	379
Little Fall Cr >	0	59.0	50%	398	495	321	264	152	101	53	32	30	63	225	410
Fall Cr			80%	224	315	208	170	99	65	39	25	23	37	101	210
Gage 14151500			IWR CERT	80	80	80	80	80	60/40	25/15	10	10	10	60/80	80
			AVAILABLE	144	235	128	90	19	5.2/25.2	13.7/23.7	15	13	27	41/21	130
Winberry Cr >	0	56.5	50%	375	376	272	221	198	108	53	32	34	44	175	378
Fall Cr			80%	190	224	183	155	130	67	33	25	24	25	88	187
			AVAILABLE	190	224	183	155	130	67	33	25	24	25	88	187
N Fk Winberry Cr	0	11.5	50%	84	83	59	45	33	17	8	5	5	8	36	87
> Winberry Cr			80%	40	48	39	30	21	11	5	3	3	4	17	41
			AVAILABLE	40	48	39	30	21	11	5	3	3	4	17	41
S Fk Winberry Cr	0	21.0	50%	148	147	106	82	65	34	17	10	11	15	66	152
> Winberry Cr			80%	72	86	70	56	42	21	10	7	7	8	32	73
			AVAILABLE	72	86	70	56	42	21	10	7	7	8	32	73

Table 38 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
N Fk Fall Cr > Fall Cr	0	9.3	50%	69	68	48	36	26	13	7	4	4	6	29	71
			80%	33	39	31	24	17	8	4	3	3	3	14	33
			AVAILABLE	33	39	31	24	17	8	4	3	3	3	14	33
Portland Cr > Fall Cr	0	19.9	50%	140	140	100	77	62	32	16	9	10	14	62	144
			80%	68	82	66	53	40	20	9	7	7	8	30	69
			AVAILABLE	68	82	66	53	40	20	9	7	7	8	30	69
Alder Cr > Fall Cr	0	6.6	50%	50	49	35	26	18	9	4	2	3	4	21	52
			80%	23	28	22	17	11	6	2	2	2	2	10	24
			AVAILABLE	23	28	22	17	11	6	2	2	2	2	10	24
HeHe Cr > Fall Cr	0	14.6	50%	105	104	75	57	43	22	11	6	7	10	46	108
			80%	51	60	49	39	28	14	6	5	5	5	22	51
			AVAILABLE	51	60	49	39	28	14	6	5	5	5	22	51
Pernot Cr > HeHe Cr	0	3.1	50%	24	24	17	12	8	4	2	1	1	2	10	26
			80%	11	14	11	8	5	2	1	1	1	1	5	12
			AVAILABLE	11	14	11	8	5	2	1	1	1	1	5	12
Gold Cr > Fall Cr	0	5.0	50%	38	38	27	19	13	6	3	2	2	3	16	40
			80%	18	21	17	13	8	4	2	1	1	2	7	18
			AVAILABLE	18	21	17	13	8	4	2	1	1	2	7	18
Delp Cr > Fall Cr	0	10.1	50%	74	73	52	39	29	15	7	4	4	7	32	77
			80%	35	42	34	26	18	9	4	3	3	4	15	36
			AVAILABLE	35	42	34	26	18	9	4	3	3	4	15	36
Lost Cr > M Fk Willamette R	0	55.9	50%	362	363	262	201	99	46	22	12	14	37	164	363
			80%	183	215	176	139	68	32	14	8	9	20	78	178
			IWR CERT	50	50	50	50	50	25/15	8/6	3	3	3	30/50	50
			AVAILABLE	133	165	126	89	18	7.1/17.1	5.8/ 7.8	5	6	17	48.3/28.3	128

Table 38 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	7	13.9	50%	97	97	69	50	37	19	9	5	6	8	42	100
			80%	47	56	45	33	24	12	5	4	4	4	19	47
			AVAILABLE	47	56	45	33	24	12	5	4	4	4	19	47
Guiley Cr >	0	7.2	50%	52	52	37	26	18	9	4	2	3	4	22	55
Lost Cr			80%	25	30	24	17	11	5	2	2	2	2	10	25
			AVAILABLE	25	30	24	17	11	5	2	2	2	2	10	25
N Fk M Fk > M Fk	0	250.4	50%	1227	1374	1014	1174	1068	623	292	184	164	238	728	1273
Willamette R			80%	689	861	745	885	764	416	227	156	143	171	390	673
Gage 14147500			IWR CERT	115	115	115	115	115	115	115	115	115	115	115	115
			AVAILABLE	574	746	630	770	649	301	112	41	28	56	275	558
	17	141.9	50%	893	902	656	620	636	384	218	144	142	157	434	886
			80%	468	544	451	458	433	247	138	118	110	102	254	453
			AVAILABLE	468	544	451	458	433	247	138	118	110	102	254	453
Christy Cr >	0	44.7	50%	301	301	217	194	174	100	57	36	36	46	139	304
N Fk M Fk			80%	151	178	146	140	117	64	34	29	27	28	78	149
			AVAILABLE	151	178	146	140	117	64	34	29	27	28	78	149
Fisher Cr >	0	11.9	50%	86	86	61	51	40	22	12	7	8	11	37	90
N Fk M Fk			80%	41	50	40	36	26	14	7	6	5	6	20	42
			AVAILABLE	41	50	40	36	26	14	7	6	5	6	20	42
Salmon Cr > M Fk	0	129.4	50%	664	688	548	660	693	463	250	184	173	205	438	676
Willamette R			80%	415	459	415	505	520	322	199	158	152	166	272	396
Gage 14146500			AVAILABLE	415	459	415	505	520	322	199	158	152	166	272	396
Wall Cr >	0	8.9	50%	66	65	46	38	29	15	9	5	5	8	28	68
Salmon Cr			80%	31	37	30	26	19	10	5	4	4	4	15	32
			AVAILABLE	31	37	30	26	19	10	5	4	4	4	15	32
Black Cr >	0	32.4	50%	222	222	160	140	122	69	39	25	25	32	101	226
Salmon Cr			80%	110	131	106	100	81	44	23	19	18	19	56	110
			AVAILABLE	110	131	106	100	81	44	23	19	18	19	56	110

Table 38 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Salt Cr > M Fk	0	122.3	50%	776	783	569	534	538	323	184	121	120	134	375	772
Willamette R			80%	404	471	390	393	366	208	115	99	91	86	218	393
			AVAILABLE	404	471	390	393	366	208	115	99	91	86	218	393
Eagle Cr > Salt Cr	0	9.4	50%	69	68	49	40	30	16	9	6	6	9	30	72
			80%	33	39	32	28	20	10	5	4	4	5	16	33
			AVAILABLE	33	39	32	28	20	10	5	4	4	5	16	33
S Fk Salt Cr >	0	9.3	50%	68	67	48	40	30	16	9	6	6	8	29	71
Salt Cr			80%	32	39	31	28	20	10	5	4	4	5	16	33
			AVAILABLE	32	39	31	28	20	10	5	4	4	5	16	33
Hills Cr > M Fk	0	19.7	50%	139	138	99	77	40	19	9	5	6	14	62	143
Willamette R			80%	68	81	65	52	27	13	6	4	4	8	30	68
			IWR CERT	12	12	12	12	12	8/4	2	1	1	1	6/12	12
			AVAILABLE	56	69	53	40	15	5.0/9.0	4	3	3	7	24/18	56
Hills Cr > M Fk	14	22.2	50%	147	147	105	94	79	46	29	18	18	22	63	150
Willamette R			80%	72	86	69	67	53	29	16	14	13	14	36	71
Gage 14144900			AVAILABLE	72	86	69	67	53	29	16	14	13	14	36	71
Larison Cr > M Fk	0	12.0	50%	83	82	58	50	40	22	14	9	9	11	34	85
Willamette R			80%	39	47	38	35	26	14	8	7	6	7	19	39
			AVAILABLE	39	47	38	35	26	14	8	7	6	7	19	39
Packard Cr > M	0	14.0	50%	96	95	68	59	47	27	17	11	11	13	40	98
Fk Willamette R			80%	46	55	44	42	31	17	9	8	7	8	23	45
			AVAILABLE	46	55	44	42	31	17	9	8	7	8	23	45
Big Willow Cr >	0	4.9	50%	36	35	25	21	15	8	5	3	3	4	14	37
M Fk			80%	16	20	16	14	10	5	3	2	2	2	8	17
Willamette R			AVAILABLE	16	20	16	14	10	5	3	2	2	2	8	17
Coffeepot Cr > M	0	8.4	50%	59	58	41	35	26	15	9	6	6	8	24	61
Fk Willamette R			80%	28	33	26	24	17	9	5	4	4	5	13	28
			AVAILABLE	28	33	26	24	17	9	5	4	4	5	13	28

Table 38 (Continued)

Stream Name	Riv. Mile	Area Sq.Mi.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Windfall Cr > M Fk Willamette R	0	5.1	50%	37	36	26	21	15	8	5	3	3	5	15	38
			80%	17	21	16	15	10	5	3	2	2	3	8	17
			AVAILABLE	17	21	16	15	10	5	3	2	2	3	8	17
Buck Cr > M Fk Willamette R	0	11.9	50%	82	81	58	50	39	22	14	9	9	11	34	84
			80%	39	47	37	35	26	14	8	7	6	7	19	39
			AVAILABLE	39	47	37	35	26	14	8	7	6	7	19	39
Coal Cr > M Fk Willamette R	0	24.0	50%	163	162	116	103	87	50	30	19	19	24	71	166
			80%	80	95	77	74	58	32	17	15	14	15	40	79
			AVAILABLE	80	95	77	74	58	32	17	15	14	15	40	79
Simpson Cr > M Fk Willamette R	0	11.9	50%	84	83	60	51	40	22	13	8	8	11	36	87
			80%	40	48	39	36	26	14	7	6	6	7	20	40
			AVAILABLE	40	48	39	36	26	14	7	6	6	7	20	40
Staley Cr > M Fk Willamette R	0	38.1	50%	252	252	182	164	147	86	52	33	33	40	113	255
			80%	125	149	121	119	98	55	30	26	24	25	65	123
			AVAILABLE	125	149	121	119	98	55	30	26	24	25	65	123
Swift Cr > M Fk Willamette R	0	26.6	50%	180	179	129	115	98	56	34	22	22	27	79	183
			80%	88	105	85	82	65	36	20	17	16	16	45	87
			AVAILABLE	88	105	85	82	65	36	20	17	16	16	45	87

50% flow: Flow is exceeded one out of two years (50% of the time).
80% flow: Flow is exceeded four out of five years (80% of the time).
IWR APP: Instream water application has been filed.
IWR CERT: Instream water right certificate has been issued.
AVAILABLE: Water available for appropriation (80% flow minus instream water rights)

Consumptive Uses

Agricultural Use

ODA has estimated that lands irrigated with surface water will increase from 2,250 to 2,625 acres by 2010 and requested a reservation of 863 af per year to irrigate 375 additional acres. Groundwater is projected to supply an additional 125 acres. Existing storage is the proposed source of surface water for future irrigation needs. There is sufficient water stored in the subbasin, already allocated for irrigation, to satisfy the reservation. It is expected that irrigators would draw releases of stored water directly from the main stem Middle Fork Willamette River This would suggest that new irrigation development is likely to be within an economical pumping distance of the main stem. Further, this would mean that future irrigation would tend to not compete with demand for instream uses on tributaries to the Middle Fork Willamette River.

Municipal Uses

Oakridge and Lowell are the only two incorporated cities in the subbasin. Springfield, although located outside the subbasin, is included here because it holds water rights to use Middle Fork Willamette River water for municipal purposes. These cities hold water rights to both surface water and groundwater sources. Table 39 indicates that these cities have ample water rights to support significant population growth.

Oakridge, Lowell, and Springfield are located in Lane County. The county had a total population of 273,700 in 1988 (PSU, 1990). Thirty-six percent of the population resided in unincorporated areas. From 1978 to 1988, the population of Lane County grew by 11,000, or 4.2 percent. During this period, Lowell grew 10 percent while Oakridge lost 5.3 percent of its population. Springfield's population increased by 8 percent. The overall population in the County's unincorporated areas declined by 2.5 percent from 1978 to 1988.

Between now and the year 2000, Lane County population is projected to grow by 14.5 percent. Most of this growth is expected in the Eugene-Springfield area If Springfield's growth matches this pace, its population would double in about 50 years. Based only on water rights and current usage, it appears that the cities have adequate supplies for well into the next century.

Summary

In general, natural flows are sufficient to meet the natural flow components of minimum streamflows below Corps storage reservoirs. However storage releases, and in some cases total regulated flows, do not meet combined minimum

Table 39

MUNICIPAL WATER RIGHTS AND USAGE FOR THE MIDDLE FORK WILLAMETTE RIVER SUBBASIN

					Month of Maximum Rate of Use				
Municipal water supplier [1]	**Population** [2]	**Surface rights (cfs)** [3]	**GW rights (cfs)** [4]	**Total rights (cfs)** [5]	**Average rate (cfs)** [6]	**Average rate (gpd)** [7]	**Average per capita rate (gpd)** [8]	**Unused rights (cfs)** [9]	**Comments**
Lowell	705	1.00	0.44	1.44	0.20	126,707	180	1.24	
Oakridge	3,465	1.56	8.20	9.76	1.24	803,433	232	8.52	
Springfield	41,080	20.00	46.76	66.76	17.80	12,084,174	294	48.96	
TOTAL	45,250	22.56	55.40	77.96	19.24	13,014,314	288	58.72	

1 Incorporated cities only. Unincorporated cities, water districts, water associations, etc. are not included.
2 Certified estimate, July 1, 1988, Center for Population Research and Census, Portland State University, 1989, except as noted.
3 Total municipal surface water rights of record in cubic feet per second.
4 Total municipal groundwater rights of record in cubic feet per second.
5 Total municipal water rights (total of columns 3 and 4).
6 Maximum average monthly rate of use in cubic feet per second, based on total reported water use for 1989 water year (October 1, 1988 to September 30, 1989), except as noted. The month of maximum rate of use is not the same for every city.
7 Maximum average monthly rate in gallons per day.
8 Maximum average monthly rate in gallons per day per capita (column 7 divided by column 2).
9 Remaining water use capacity in cubic feet per second. Total municipal rights (column 5) minus average monthly rate of use (column 6).

streamflow requirements below the reservoirs. Specifically, the minimum streamflow at the mouth of the Middle Fork Willamette River is met from September through February but is not met from March through August. The minimum streamflow on the North Fork of the Middle Fork Willamette River is met through all months. However, new appropria-tions must not conflict with scenic waterway designations affecting most of the North Fork and Waldo Lake.

Natural flows on Fall Creek are expected to meet the natural flow minimum during all months except August and September. However, regulated flows would not meet the combined minimum streamflow downstream from Fall Creek Reservoir except from November through January.

The natural flow components of the minimum streamflow for the Middle Fork Willamette River above the North Fork are generally met during all months except October. Regulated flows, however, would not be expected to meet the combined minimum except during the month of November.

ODFW and PRD have expressed interest in establishing instream water rights on some streams which offer priority aquatic habitat and for recreational purposes. The Department produced flow estimates for more than 30 of these ungaged streams and found that flows on smaller streams are close to fully appropriated from July through October. However, most of these streams are located upstream of the reservoirs in headwaters areas and flow through federal forest land. Additional diversions for consumptive water uses are expected to be minimal. Protecting flows in these streams would not reduce the amount of water available for economic development elsewhere in the subbasin.

Only minimal increases in irrigation are expected in the future. These could be met by releases of water stored in existing reservoirs in the subbasin. Municipal and domestic water demand is growing. However, municipal water rights seem adequate to meet projected growth in the Middle Fork Willamette subbasin over the next several decades.

MANAGEMENT PROPOSALS

These management proposals takes into account the major issues that were raised throughout the previous discussion in this section. A brief synopsis is provided for each of the three major policy issues (Allocation of Unappropriated Surface Water, Management of Stored Waters, and Irrigation Season). Proposed policies and implementing actions designed to address the issues in a comprehensive manner follow the synopses.

ALLOCATION OF UNAPPROPRIATED SURFACE WATER

The Willamette Basin supports two thirds of the state's population. Many of Oregon's major industries are located here. The Willamette Valley contains some of Oregon's most productive agricultural lands and supports important fishery resources. Water-dependent and water-related recreational opportunities abound on the basin's lakes and streams.

These and other uses place a substantial and growing demand on the basin's surface and groundwater resources. Seasonal water demands are exceeding supplies with growing frequency. Competition between instream and out-of-stream uses is intensifying. New water legislation emphasizes the growing public interest in conservation, instream values and water for future economic development.

Existing water allocation rules and management strategies should be updated to reflect changing conditions. These conditions include decreasing supplies of unappropriated water, changing social values, projected development trends and the interest in instream values which the Water Resources Commission has an obligation to protect.

The Willamette Basin presents a number of water management challenges. Despite abundant annual rainfall and snowpack, natural flows in many streams are low during four or five months through the summer. A growing number of smaller streams, and even major tributaries to the Willamette River, are over-appropriated relative to instream needs. Demand for water on these streams exceeds the natural supply. The results are annual water rights regulation, diminished fish populations and water quality standards violations. The remaining unappropriated water must be managed better in the future to help restore and maintain fish runs, water quality, and other instream values while sustaining economic development in the basin.

A number of large storage projects have been built in the basin. These projects are managed by the U.S. Army Corps of Engineers and provide a variety of benefits including flood control, power generation, irrigation, recreation, and flow enhancement for fish and water quality. They also present their own set of management challenges. The reservoirs are operated under federal guidelines that do not always accommodate the state's interests. Revised operating guidelines, more intensive state management of released water and a more formal state-federal working relationship affecting the stored water could yield some benefits not being realized now.

In summary, water demand in the basin is growing. Consumptive uses associated with irrigation needs are expected to increase along with municipal and industrial uses. Care should be taken now to insure water supplies for future economic development and to avoid over-appropriating the basin's streams and rivers. By adopting administrative rules, the Commission directs the course of water development and use. The Commission's rules also direct the Department in managing water resources in cooperation with other resource agencies seeking to protect instream values like fish life, recreation and water quality.

The water use classifications in the basin rules were developed using a methodology based on water availability for each subbasin. The Department estimated the mean monthly flows expected to occur 80 percent of the time. These flow estimates reflect actual water use in the stream. The Department determined whether surplus flows were available for appropriation by subtracting established instream water rights, minimum streamflows (including storage components where they exist in the current basin rules) and proposed instream flow needs, from the 80 percent exceedence flow estimates. For months during which the remaining flow was found to be in-sufficient to support additional out-of-stream uses, the water use classifi-cations were set to allow only domestic, livestock, and instream uses. The rules also restrictively classify those streams which have important in-stream use values and are located in headwater areas, often on public lands.

The Commission's intentions in responding to these water allocation needs in the Willamette Basin are stated in the following policies. These policies were adopted in basin rules.

Policies

Protect undeveloped streams with instream values for public instream uses.

Seek a balance in the future appropriation of water for instream and out-of-stream uses on those streams already significantly developed for out-of-stream purposes.

Preserve opportunities for future economic development by reserving water for future use.

Minimize the likelihood of over-appropriation due to new uses.

Implementing Actions

1. Classify the surface waters of the Willamette Basin so that no significant new demands are placed on streamflow unless water is estimated to be available in excess of existing instream and out-of-stream needs at least 80% of the time.

2. Protect headwater streams with instream values from development for out-of-stream use by applying a restrictive classification.

3. Limit further appropriations during certain months on streams that have water quality problems during low flow periods.

4. Consider establishing reservations of water for future economic development that provide for an appropriate mix of future uses as established by local or regional plans such as comprehensive land use plans or water supply plans. Design, condition, or subordinate reservations so that future municipal and irrigation needs can be met without disadvantaging either use. Reserve water in a manner consistent with the public interest.

MANAGEMENT OF STORED WATER

About 1.6 million af of water is stored annually in Corps of Engineers reservoirs in the Willamette Basin. Nearly all of this water is under permit to the Bureau of Reclamation for irrigation. The Bureau only contracts with irrigators for about two percent, or about 30,000 af, of this water per year. The Corps of Engineers manages the unused portion in a discretionary manner but not necessarily in response to the range of existing needs or state priorities. In some cases, reservoirs are kept full as long as possible through the summer to maximize lake recreation and power generation in the fall. This requires hurried releases of large volumes of water in the fall to draft the pools to flood control levels. Instream needs and downstream needs could benefit from earlier release of more water during the summer. In other cases, reservoirs are drafted to augment streamflows throughout the summer months.

The Corps of Engineers releases water from storage reservoirs throughout the basin for instream uses. The Corps releases water both to meet required minimum outflows and on a discretionary basis. Minimum release requirements are established in the Congressional authorization for each project to benefit fish life and water quality. Discretionary releases are made up of water not otherwise used for a primary project purpose. The Corps makes these releases in response to special requests but is not required to release the requested flows. Some of the water released in the minimum and discretionary releases is stored water and some is natural flow being passed through the reservoir.

The Water Resources Department treats these minimum and discretionary releases as natural flow available for appropriation. Accordingly, the Department has issued permits to use these minimum and discretionary releases. Consumptive use of this water has a negative impact on the instream values the releases are intended to support. This approach also has allowed some people to use stored water without payment, while others must contract and pay for the use of stored water.

Policy

> Manage stored waters which have been released for instream purposes to meet flow needs reflected in established instream water rights.

Implementing Actions

1. Cooperate with the Corps of Engineers to obtain flow information needed to protect storage releases. Secure storage releases needed for state-identified public instream uses.

2. Discuss with the Bureau of Reclamation the discrepancy between estimates for current/future irrigation uses and water rights for the use of stored water. Identify and pursue options for resolving the discrepancy.

IRRIGATION SEASON

Approximately 38 percent of the Willamette Basin has been adjudicated. The courts assigned a shorter irrigation season to adjudicated rights than the period in which the Water Resources Department generally regulates irrigation uses (March 1-October 31).

The Department has applied the court decreed irrigation season to subsequently-issued permits and water rights granted to irrigators located in adjudicated areas. Numerous individuals and agricultural industry representatives have requested the Department to consider establishing a longer irrigation season for adjudicated areas. These parties have provided information which indicates that the longer season would provide significant benefit.

The Commission cannot change the irrigation season for previously adjudicated rights. Only the courts can do that. The Commission can, however, change the irrigation season for subsequent, state-issued permits and water rights.

Policy

Allow irrigation use for the longest period possible between March 1 and October 31 provided sufficient water is available.

Implementing Actions

1. Establish a basin-wide irrigation season of March 1 through October 31.

2. To prevent adverse impacts on existing users, require that irrigators in adjudicated areas apply for new permits to extend the period of irrigation use. These permits will be subject to adopted classifications and water availability analysis.

WIllamette Basin

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Section 3

GROUNDWATER MANAGEMENT AND PROTECTION

PROBLEM STATEMENT

Groundwater levels are declining in several areas in the Willamette Basin. In other areas, extremely slow movement of groundwater to wells gives the impression of dwindling water resources. Wells drilled into shallow aquifers near streams may draw water from the streams to the detriment of streamflow. Shallow aquifers are also prone to contamination. These and other problems related to supply and quality are becoming more widespread as the population of the basin increases.

This section addresses four major groundwater management questions:

1. How can long-term groundwater level declines be controlled?
2. How should slow water yield from certain aquifers be managed?
3. How can groundwater contamination be minimized?
4. How should groundwater/surface water hydraulic connection be managed?

BACKGROUND

Groundwater in the Willamette Basin occurs in several geologically distinct aquifers (groundwater reservoirs). Most of the available groundwater is in loose sediments—clay, silt, sand and gravel—laid down in flood plains and deltas. Lava flows, ancient marine sediments, and porous rocks such as sandstone and siltstone contain lesser amounts of available water. Water moves extremely slowly through some of these rocks. In some areas, weathered seams between lava flows contain water.

In alluvium near streams, groundwater can move freely between wells and the streams. Where groundwater levels are lower than stream water levels, water seeps from streams to adjacent wells. Also, when the water level in a well is higher than a stream surface, water seeps from the well to the stream. This interaction between streams and wells is referred to as hydraulic connection.

MAJOR AQUIFERS

For management planning purposes, this report divides the Willamette Basin into five major aquifer units (geologic formations grouped by hydraulic and geologic similarities). The aquifer unit map, Figure 18, shows the general locations of the units. This paper discusses only four of the aquifer units. The fifth aquifer unit, Tertiary-Quaternary Volcanic Rocks of the High Cascades, is in an area of rugged landscape and small population. Very little water is used from this aquifer.

The aquifer boundaries shown in Figure 18 are approximate. The map is based on water well records and surface exposures, and the accompanying table provides written descriptions of the units. The aquifers vary in size, both horizontally and vertically. Clay or rock layers separate some aquifers. Separation is not total. There is some groundwater movement between aquifers. Groundwater also moves down gradient toward the Willamette and Columbia Rivers.

Figure 19 is a generalized cross section of the valley from west to east just north of Salem. The cross section shows how the aquifers relate to one another. The following paragraphs describe aquifer units in order of age, from the youngest to the oldest. Sub-units are introduced to clarify the descriptions.

The map and cross section give an idea of different aquifer yields and rates of groundwater movement. For example, anywhere in the Tertiary Rocks of the Coast Range unit, one could expect low yields and possibly saline or brackish water. A general description of the aquifers is provided below.

Tertiary-Quaternary Sedimentary Deposits

These sediments form the main aquifer in most of the central Willamette Valley. The water surface in the aquifer changes in response to additions (recharge) and withdrawals (discharge) of water (Hampton, 1972). Recharge to the sediments is primarily from winter rainfall. Pumping from wells and seepage to streams are the main modes of discharge. This aquifer unit has three sub-units identified by age and composition. These are Younger Alluvium, Older Alluvium, and Troutdale Formation. Alluvium is defined as unconsolidated stream-deposited materials.

YOUNGER ALLUVIUM

Younger alluvium forms the flood plains of the major streams. Its main components are gravel, sand and silt. The alluvium is thickest near the streams and thins out with distance from the streams. Near its outer edges, it is almost identical to the older alluvium. Shallow wells (less than 100 feet deep) usually can

Figure 18
WILLAMETTE BASIN AQUIFER UNITS

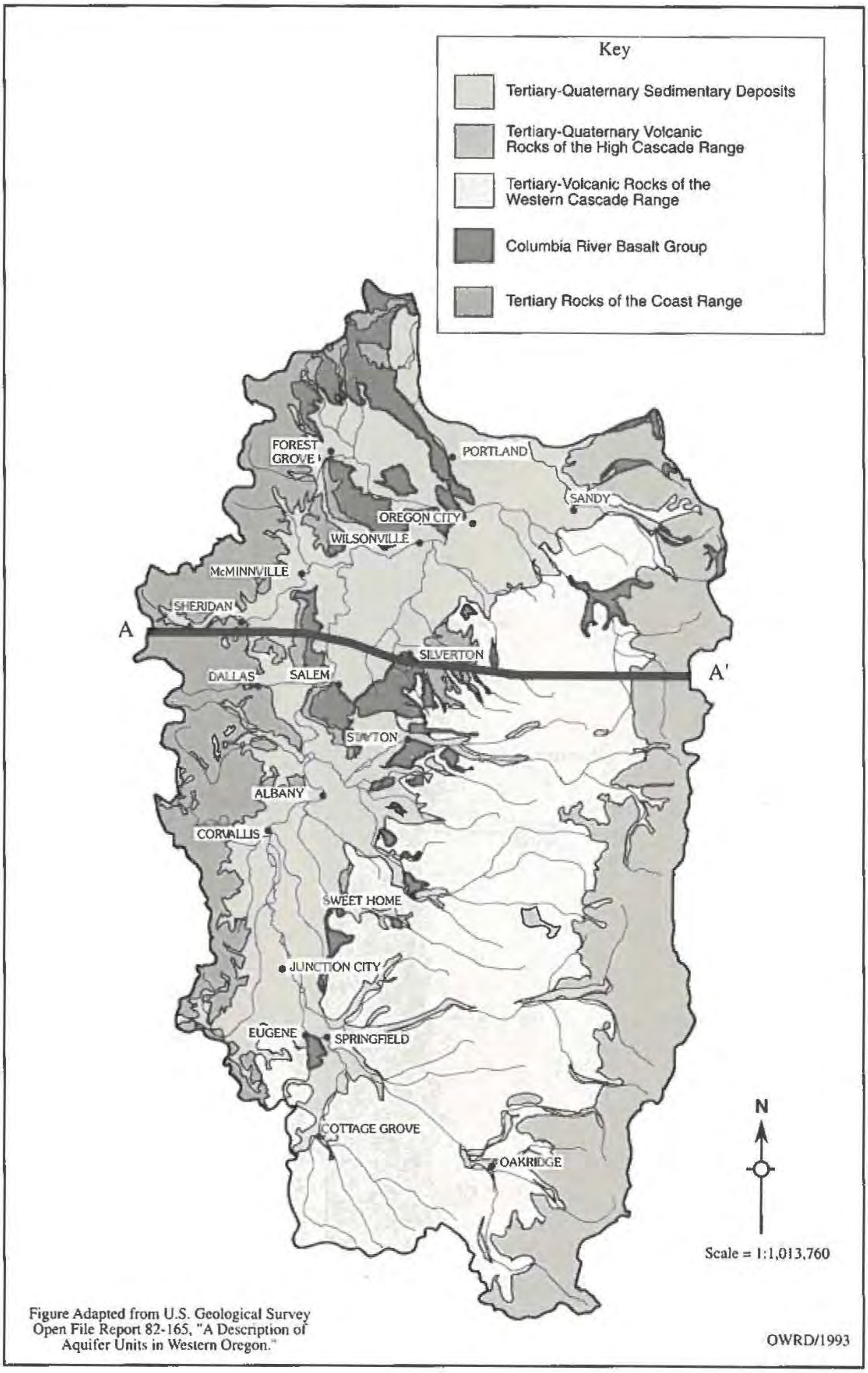
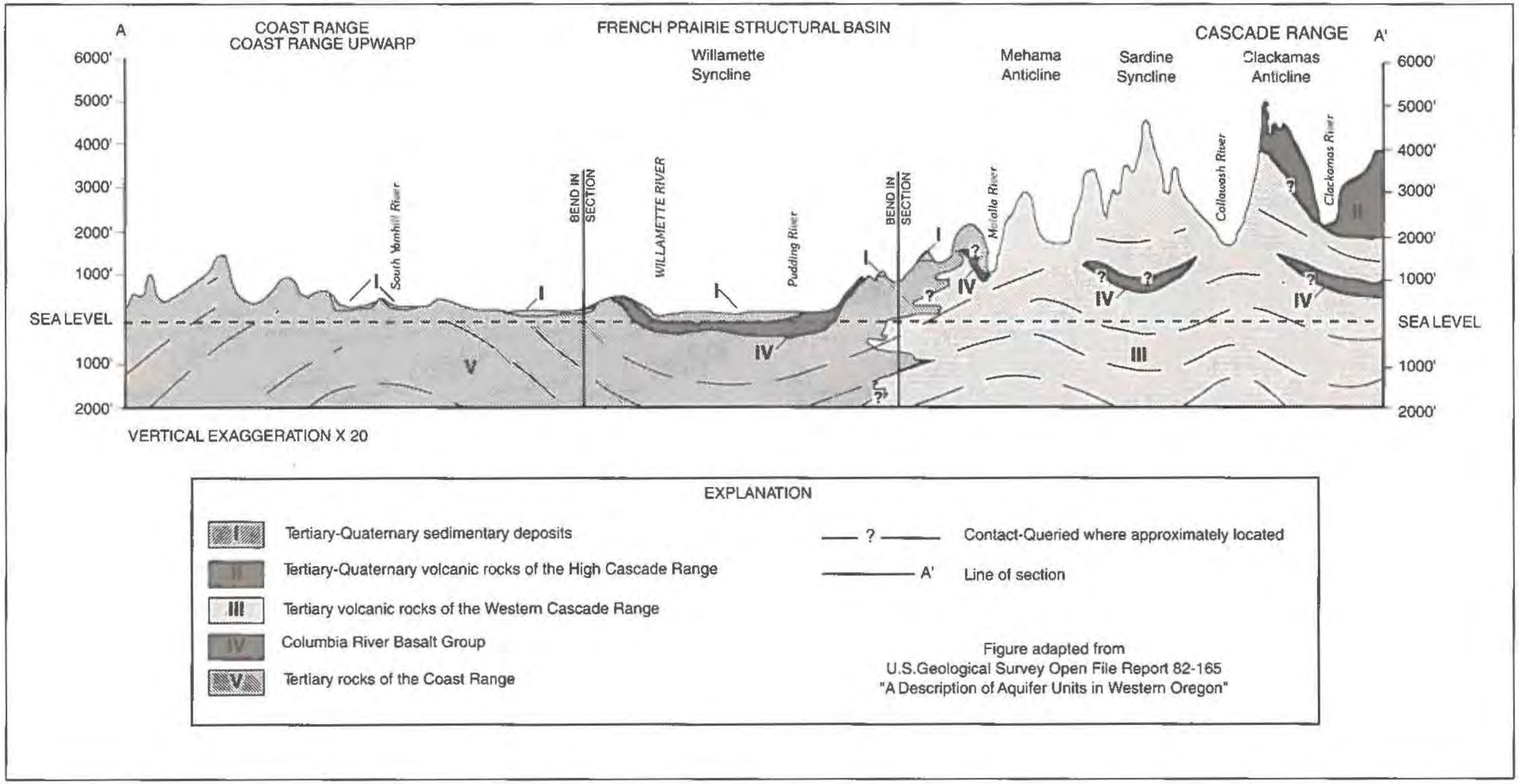


Figure 19
GENERALIZED CROSS SECTION OF THE WILLAMETTE BASIN



develop water from this aquifer. Efficiently designed and constructed wells in this aquifer unit can yield up to 1,000 gallons per minute (gpm).

Groundwater in the younger alluvium is hydraulically connected to most streams in the valley. Water levels in wells near streams will fluctuate with stream levels. The size of the fluctuations lessens as the distance from streams increases. Silt and clay lenses (layers) at some places in the younger alluvium impede seepage of water between streams and nearby wells (Frank, 1976).

Alluvial materials along the smaller streams in the Willamette Basin are thin and somewhat impermeable (Frank, 1973). Often only enough water is available for domestic use and irrigation of small parcels.

OLDER ALLUVIUM

The older alluvial sediments are usually finer grained and more tightly compacted than those of the younger alluvium. The unit varies in thickness due to the irregular underlying bedrock. It is thin near the foothills and increases to about 300 feet thick near the Willamette River. Yields to wells are typically less than 50 gpm.

TROUTDALE FORMATION

The Troutdale Formation is a nonmarine sand and gravel deposit under much of the valley north of Salem. It is one of the most productive aquifers in the northern part of the basin. Some wells yield more than 1,000 gpm (Price, 1967). Grain size of the sediments decreases from east to west, as does well production. Output is typically 50 to 100 gpm in the Tualatin Valley, and recharge is slower.

Columbia River Basalt Group

The Columbia River Basalt Group (also CRBG or basalt) is a series of volcanic flows dating back about 15 million years. The flows poured out onto an area of high relief in the northern half of the basin. Fingers of lava filled valleys and smoothed the terrain. Later folding and faulting rearrang-ed the landscape. Western Oregon then underwent a long period of erosion. Fragments of lava flows now cap scattered hills in the basin. Elsewhere, the downwarped lava underlies large areas of the valley floor. Figure 20 shows the areas in the valley where Columbia River Basalt Group lava has been identified by geologists. The lava flows are not continuous. Because of folding and faulting, the basalt is less a large single aquifer than it is several small, unconnected aquifers. Weathered, rubbly interflow zones, fractures in the denser flows, frothy lava at the tops of flows, or combinations of these features may contain water. Some wells yield large quantities of water (Frank & Collins, 1978). A few have exceeded 1,000

Table 41

ESTIMATED GROUNDWATER STORAGE AND RECHARGE

Drainage Subdivision	Area (Sq. Mi.)	Natural Recharge (Millions af/yr.)	Storage (Millions of af)
Clackamas	1,019	1.1	2.4
Coast Fk Willamette	665	0.4	1.2
Coast Range	1,795	0.3	0.7
Columbia	431	0.2	1.0
Long Tom	526	0.2	2.0
McKenzie	1,342	2.0	
Middle Fk Willamette	1,354	1.1	10.0
Pudding	1,186	0.5	6.3
Santiam	2,443	1.0	14.4
Tualatin	721	0.4	4.2
TOTALS	11,472	7.2	46.2

Source: United States Geological Survey, 1968.

The figures for total water stored in the basin seem to show that pumpage can increase without overdrawing the resource. Aquifers in the basin are not uniform, however, so the area of greatest need is not necessarily the area of greatest storage.

Except for a study in the 1960s to see if artificial recharge was practical in the Salem Heights basalt aquifer, artificial recharge has not been tried. The South Fork Water Board is currently studying the feasibility of recharge using surplus treated municipal water.

Under natural conditions, alluvial aquifers recharge annually from rainfall and snow melt. Heavy development of an aquifer upsets this balance. Two aquifers within the Troutdale Formation near Sandy do not recover completely during the rainy season. Pumping of large amounts of water in summer is causing long-term declines.

Columbia River Basalt Group aquifers usually recharge very slowly. They tend not to recover completely when large amounts of water are removed. This suggests limited storage and/or recharge to the groundwater reservoir.

Artificial recharge might alleviate some water shortages and ease the need to deepen wells. Obvious shortcomings with this approach are: 1) availability and timing of water to recharge; 2) water quality considerations; and 3) the cost of constructing recharge facilities. Table 41 suggests that ample water is available for recharge. Successful recharge would allow continued development based on the effectiveness of the project.

GROUNDWATER INVESTIGATIONS AND WATER LEVEL MONITORING

The Department completed a review of the Cooper Mountain-Bull Mountain Critical Groundwater Area in 1989. The investigation showed that water levels have recovered somewhat since the critical area desig-nation in 1974. However, resumption of pumping at previous levels would most likely cause further declines.

The USGS is conducting a groundwater study east of Portland. The study area is bounded by the Portland Hills-Willamette River, the Clackamas River, the Sandy River, and Salmon Creek in Clark County, Washington. The Portland Well Field is in the study area as are the Gresham, Boring and Troutdale areas. The City of Portland and the Department are supplying data and financial resources to the project. The goal of the study is to construct a predictive groundwater model for the region.

The USGS has also begun a separate groundwater study for the whole Willamette Basin. The projected completion date is 1993. This is part of a nationwide Regional Aquifer System Analysis (RASA) program. The USGS will also be looking at groundwater in the basin as part of the upcoming National Water Quality Assessment.

The DEQ is also conducting a Willamette Basin water quality study. The study concentrates on surface water, but groundwater quality issues may also be addressed during the investigation.

The Department manages a network of observation wells throughout the state. The largest concentration of wells is in the Willamette Basin. Figure 22 shows the location of observation wells in the basin. Department employees measure groundwater levels in these wells regularly. Table 42 shows water level changes in several state observation wells producing water from basalt aquifers in the basin. Network wells are located in actual or potential problem areas. Wells are added or dropped as areas of concern shift. The data from recent work will provide a growing technical basis for making sound management decisions regarding use of groundwater and prevention of problems. Figures 23 through 32 are representative hydrographs of the declines. A hydrograph is a graphic representation of changes in water level over time.

Figure 22
WILLAMETTE BASIN OBSERVATION WELLS*

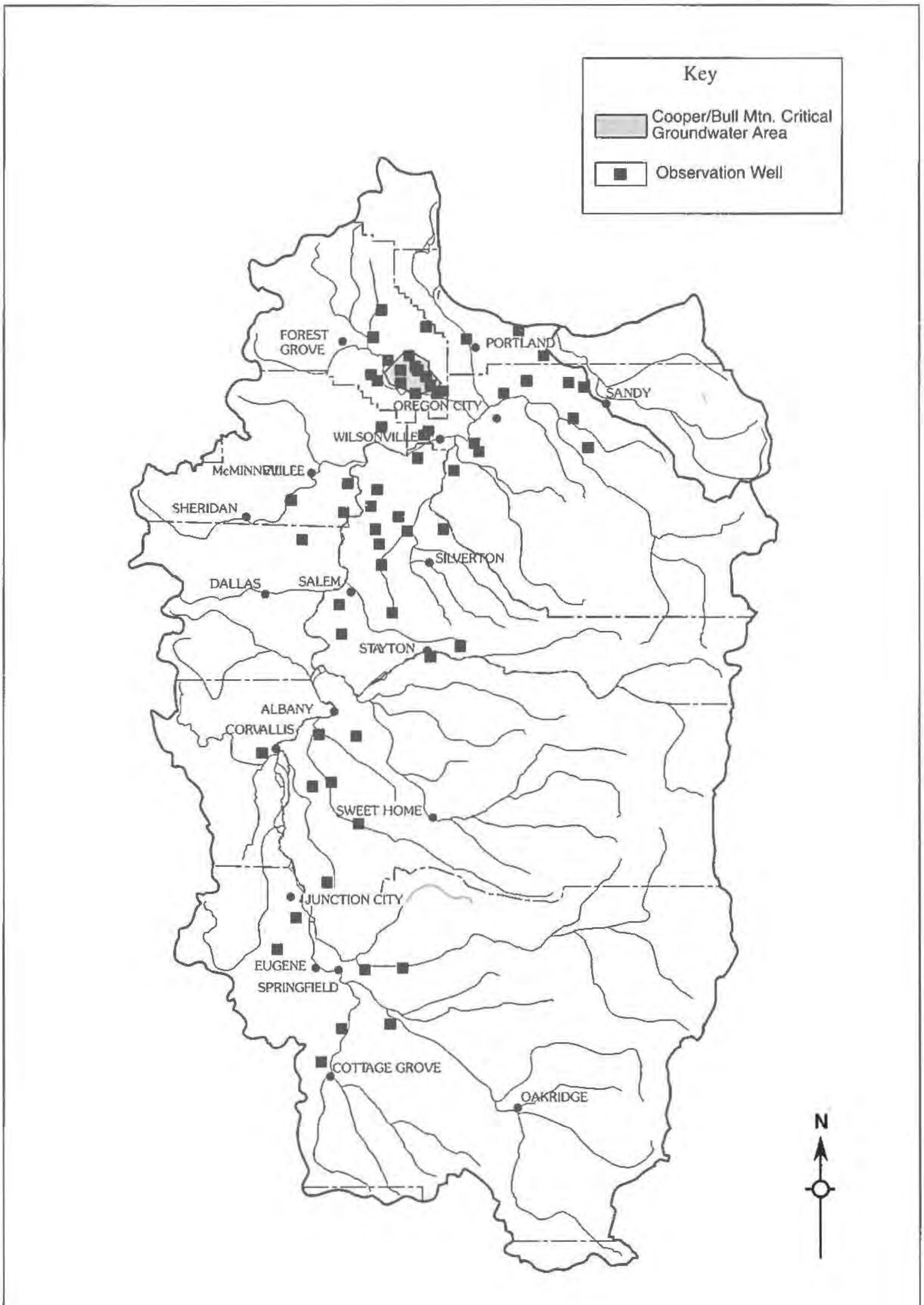


Table 42

STATE OBSERVATION WELLS
WATER LEVEL DECLINES IN BASALT AQUIFERS

WELL LOCATION					
Township	Range	Section	County	Years of Record	Change in Feet
1N	1W	21	WASH	22	-14.60
1N	3E	26	MULT	13	-80.25
1S	1W	17	WASH	20	-81.73
1S	1W	19	WASH	19	-11.52
1S	2W	13	WASH	16	-12.44
1S	2W	26	WASH	20	-8.98
1S	2W	26	WASH	23	-16.05
1S	2W	26	WASH	21	-8.93
2S	1W	4	WASH	17	-20.04
2S	1W	4	WASH	17	-19.81
2S	1W	10	WASH	18	-109.91
3S	1W	10	CLAC	34	-26.75
3S	1W	15	CLAC	22	-30.96
3S	1W	16	CLAC	24	-27.40
7N	3W	13	COLU	18	-34.82
8S	2W	11	MARI	25	-7.65
9S	1E	3	MARI	23	-49.57
9S	1W	2	MARI	18	-27.31
9S	1W	14	LINN	22	-110.36

Source: Water Resources Department, May 14, 1990

Figure 23

HYDROGRAPH FOR STATE OBSERVATION WELL 33

TOWNSHIP 2 SOUTH RANGE 3 EAST SECTION 6bdb

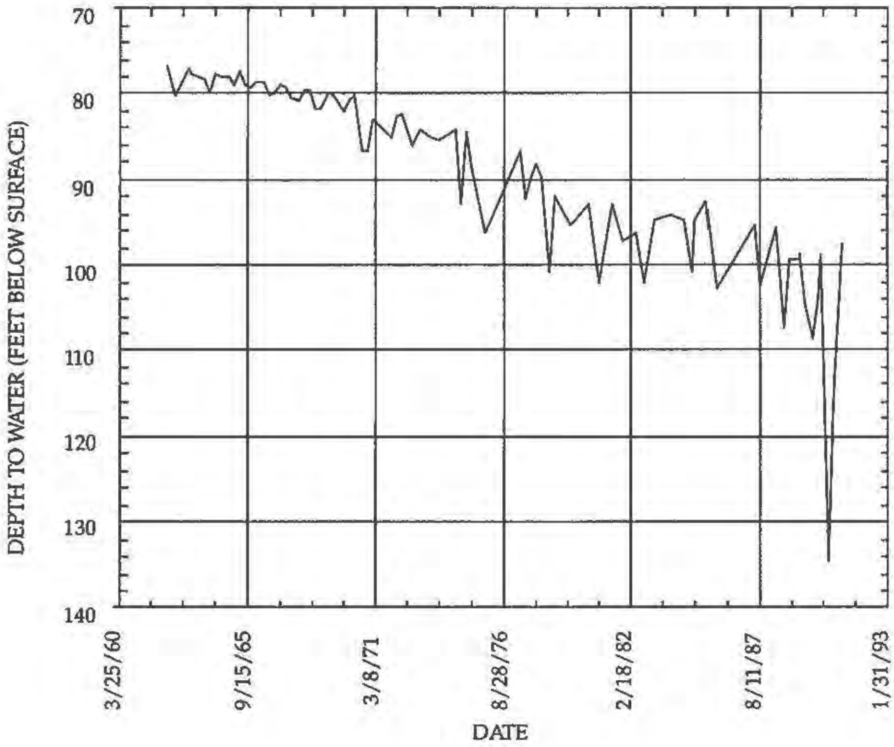


Figure 24

HYDROGRAPH FOR STATE OBSERVATION WELL 35

TOWNSHIP 2 SOUTH RANGE 4 EAST SECTION 5cbb

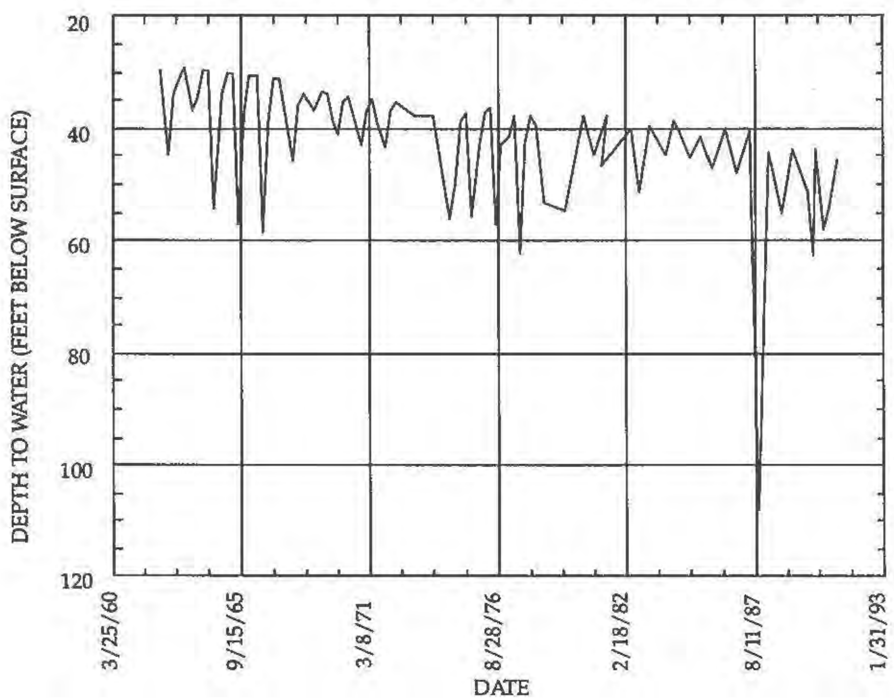


Figure 25

HYDROGRAPH FOR STATE OBSERVATION WELL 38

TOWNSHIP 3 SOUTH RANGE 1 WEST SECTION 10ccd

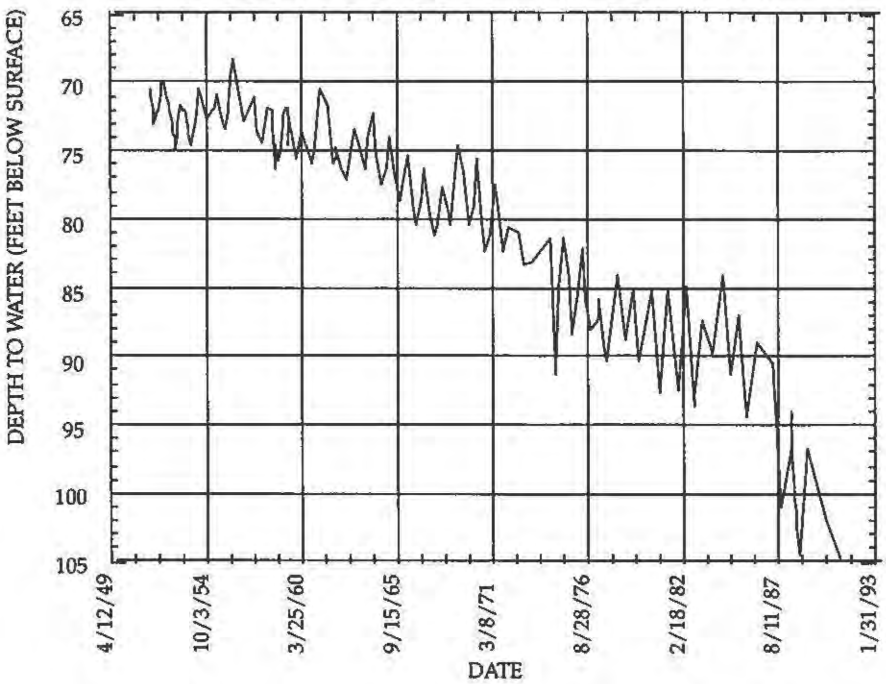


Figure 26

HYDROGRAPH FOR STATE OBSERVATION WELL 39

TOWNSHIP 3 SOUTH RANGE 1 WEST SECTION 15cac

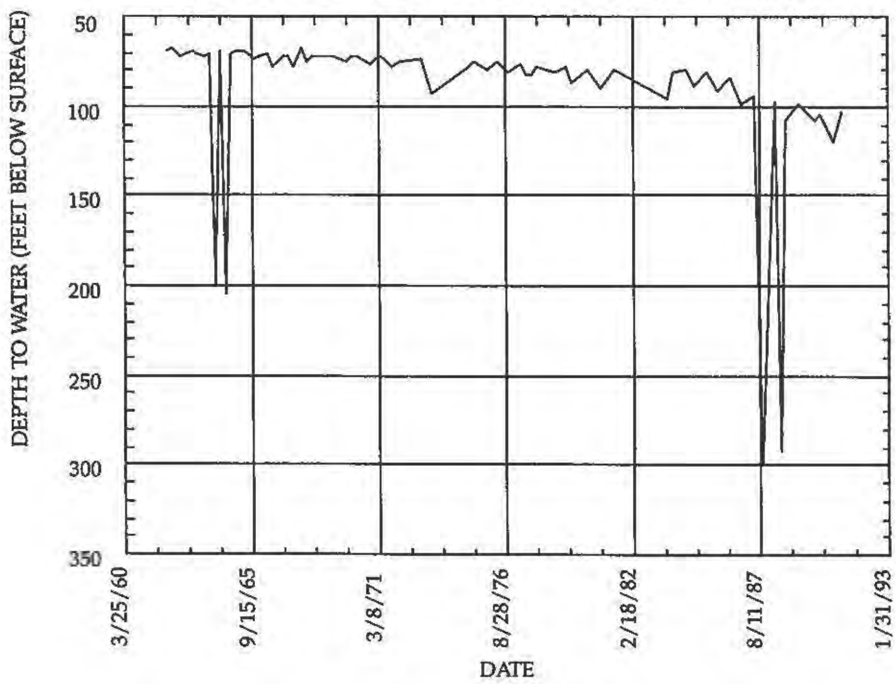


Figure 27

HYDROGRAPH FOR STATE OBSERVATION WELL 40

TOWNSHIP 3 SOUTH RANGE 1 WEST SECTION 16ddd

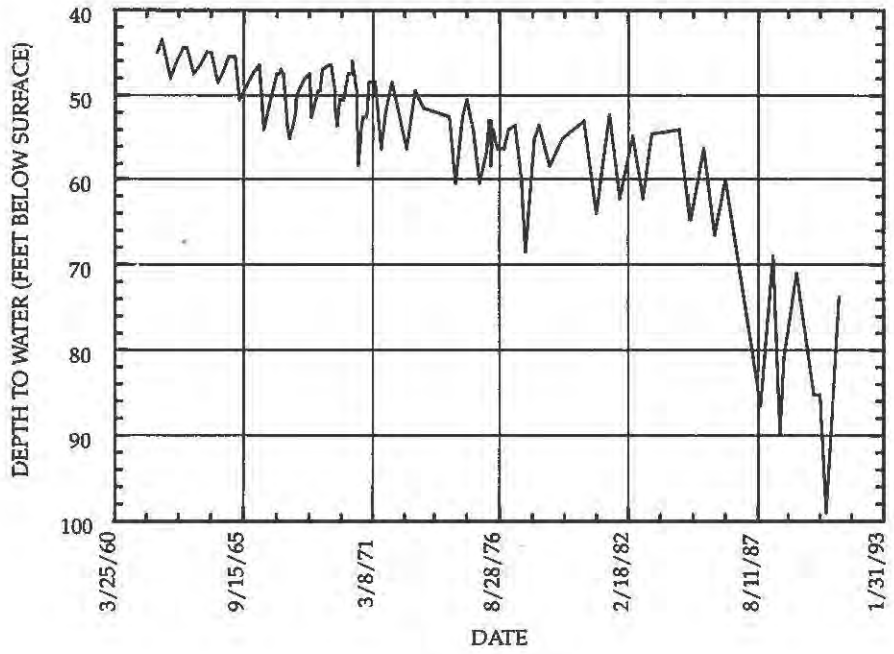


Figure 24

HYDROGRAPH FOR STATE OBSERVATION WELL 502

TOWNSHIP 9 SOUTH RANGE 1 WEST SECTION 14dca

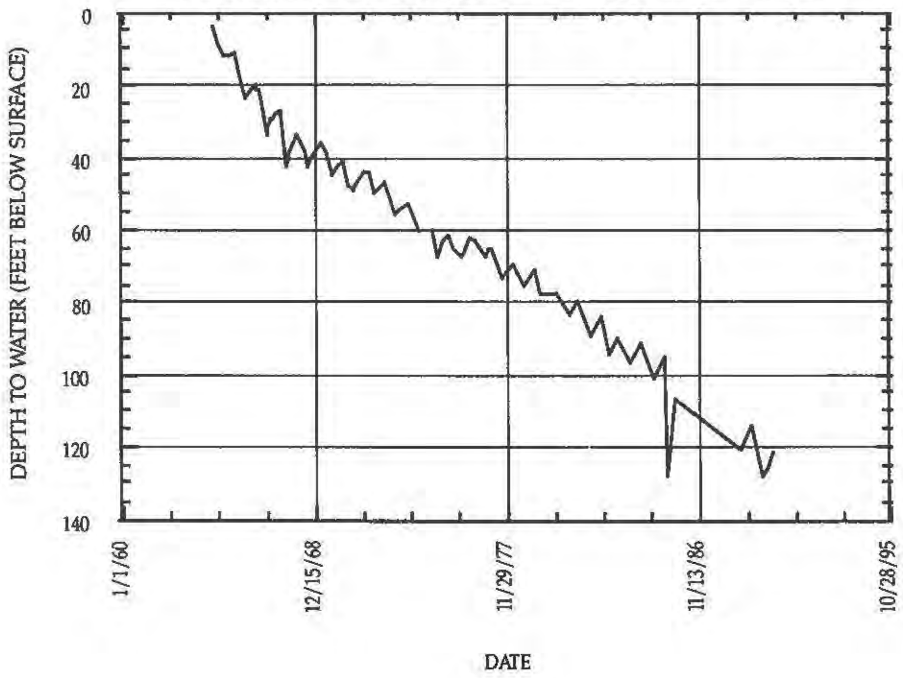


Figure 29

HYDROGRAPH FOR STATE OBSERVATION WELL 625

TOWNSHIP 9 SOUTH RANGE 1 EAST SECTION 3bcc

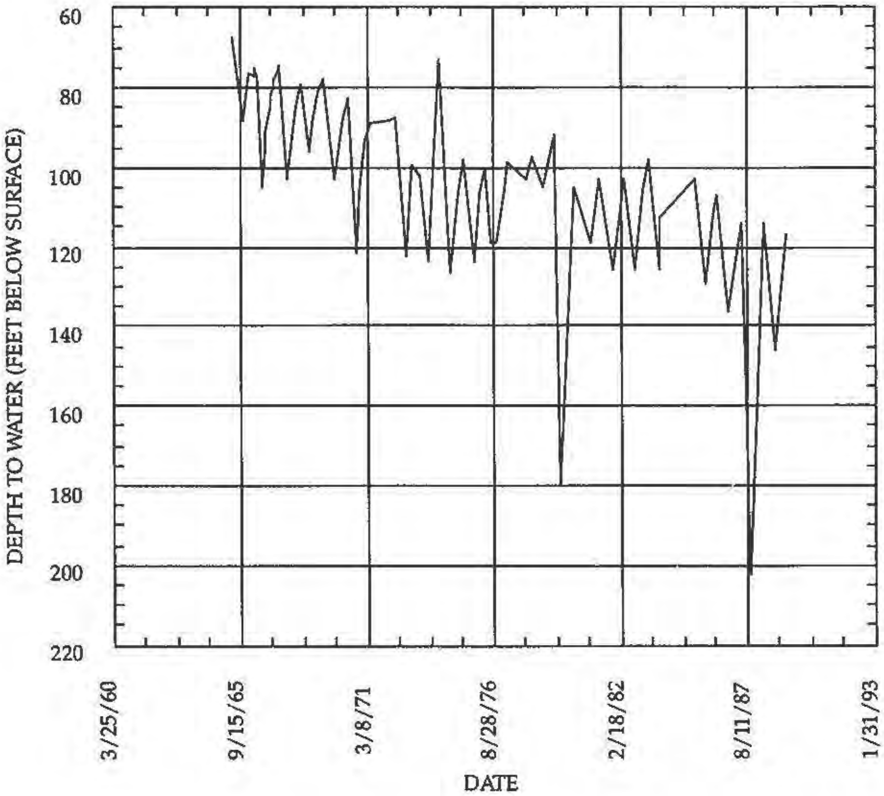


Figure 30

HYDROGRAPH FOR STATE OBSERVATION WELL 957

TOWNSHIP 2 SOUTH RANGE 1 WEST SECTION 32bd

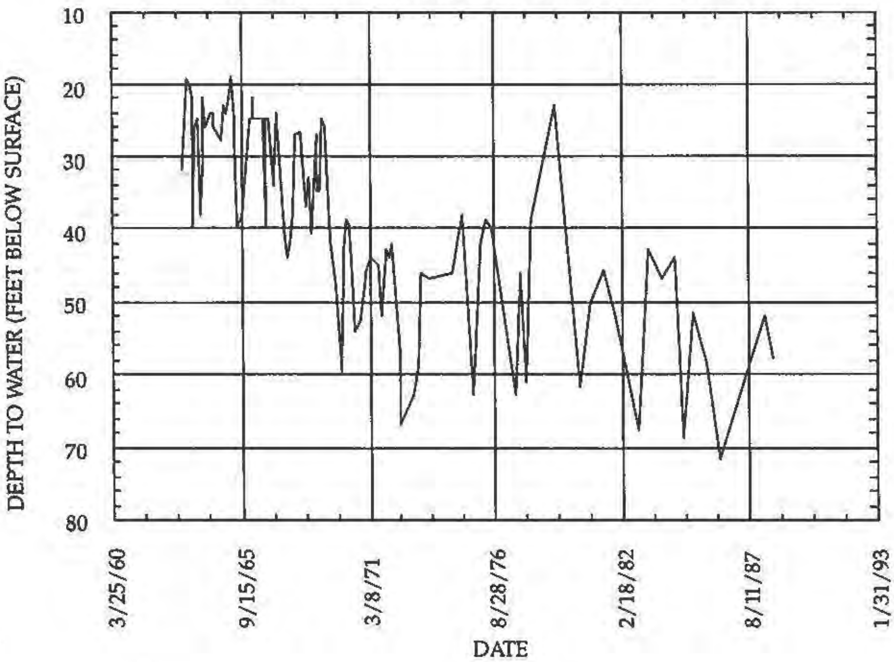


Figure 31

HYDROGRAPH FOR STATE OBSERVATION WELL 938

TOWNSHIP 1 SOUTH RANGE 2 WEST SECTION 26bdc

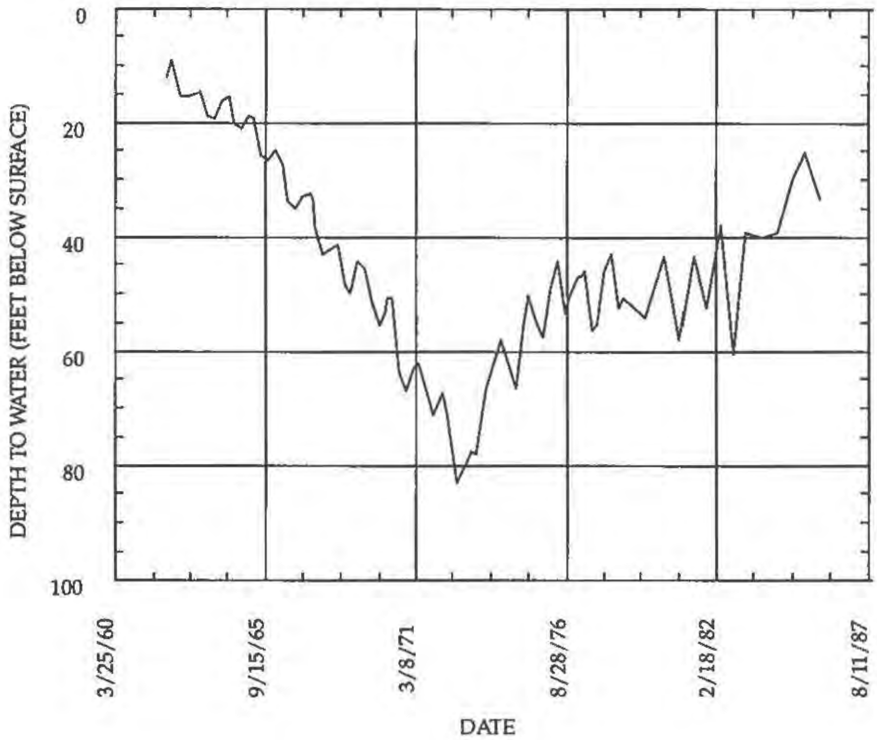
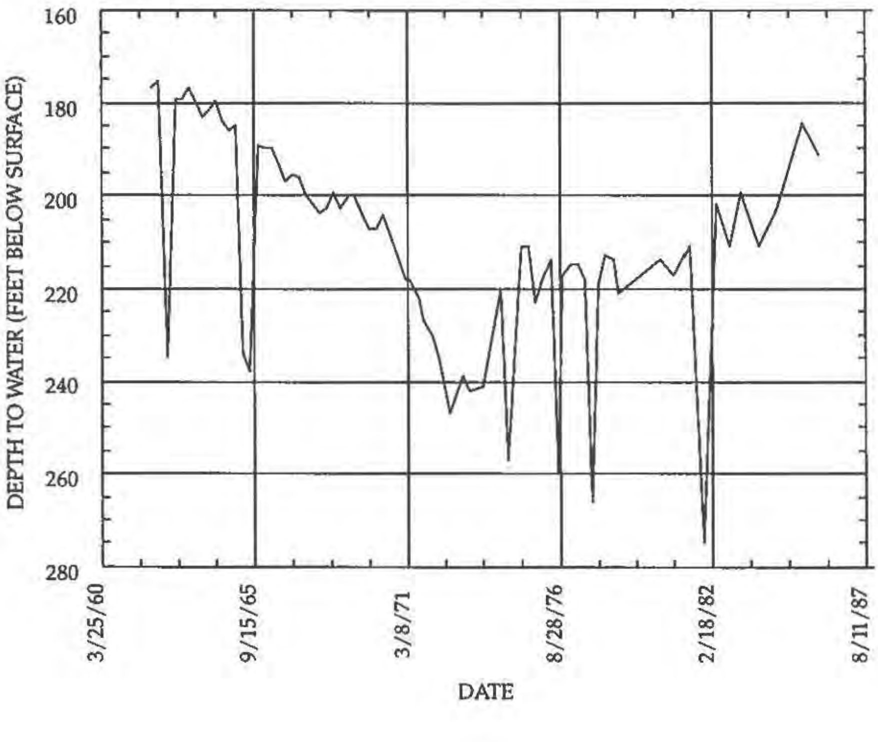


Figure 32

HYDROGRAPH FOR STATE OBSERVATION WELL 939

TOWNSHIP 1 SOUTH RANGE 2 WEST SECTION 26dcd



DISCUSSION

DECLINING GROUND WATER LEVELS

Heavy pumping of groundwater from Columbia River Basalt Group aquifers in the northern half of the basin is causing local water level declines. Other water-bearing basalt formations occur in the basin, but serious declines are evident only in the Columbia River Basalt Group aquifers. Therefore, the term "basalt" in this section refers to only the Columbia River Basalt Group.

The Department takes water level measurements at wells which are used for domestic, irrigation, municipal and industrial purposes. Both heavily used and unused wells are measured. Some wells are measured several times a year; others only once in spring when water levels are highest.

Water levels have declined in all basalt aquifers where demand is high. Associated problems include interference between wells, interference with surface water, aquifer overdrafting, commingling of water from different aquifers, and increased groundwater contamination.

The Department has measured water level changes in a large number of wells in the Cooper Mountain-Bull Mountain, Damascus, Gladtidings, Kingston, Mt. Angel, Sherwood-Dammasch-Wilsonville, Stayton-Sublimity and Sandy-Boring areas. Table 43 lists known problem areas and the stressed aquifers.

Table 43

EXISTING WATER LEVEL DECLINE PROBLEM AREAS

Area Name	Area Size (Sq. Mi.)	Aquifer
Cooper Mtn-Bull Mtn.	20	CRBG
Damascus	25	CRBG, Troutdale
Gladtidings	5	CRBG
Kingston	16	CRBG
Mt. Angel	23	CRBG
Sandy-Boring	23	Troutdale
Sherwood-Dammasch-Wilsonville	61	CRBG
Stayton-Sublimity	72	CRBG

Source: WRD, Observation Well Network

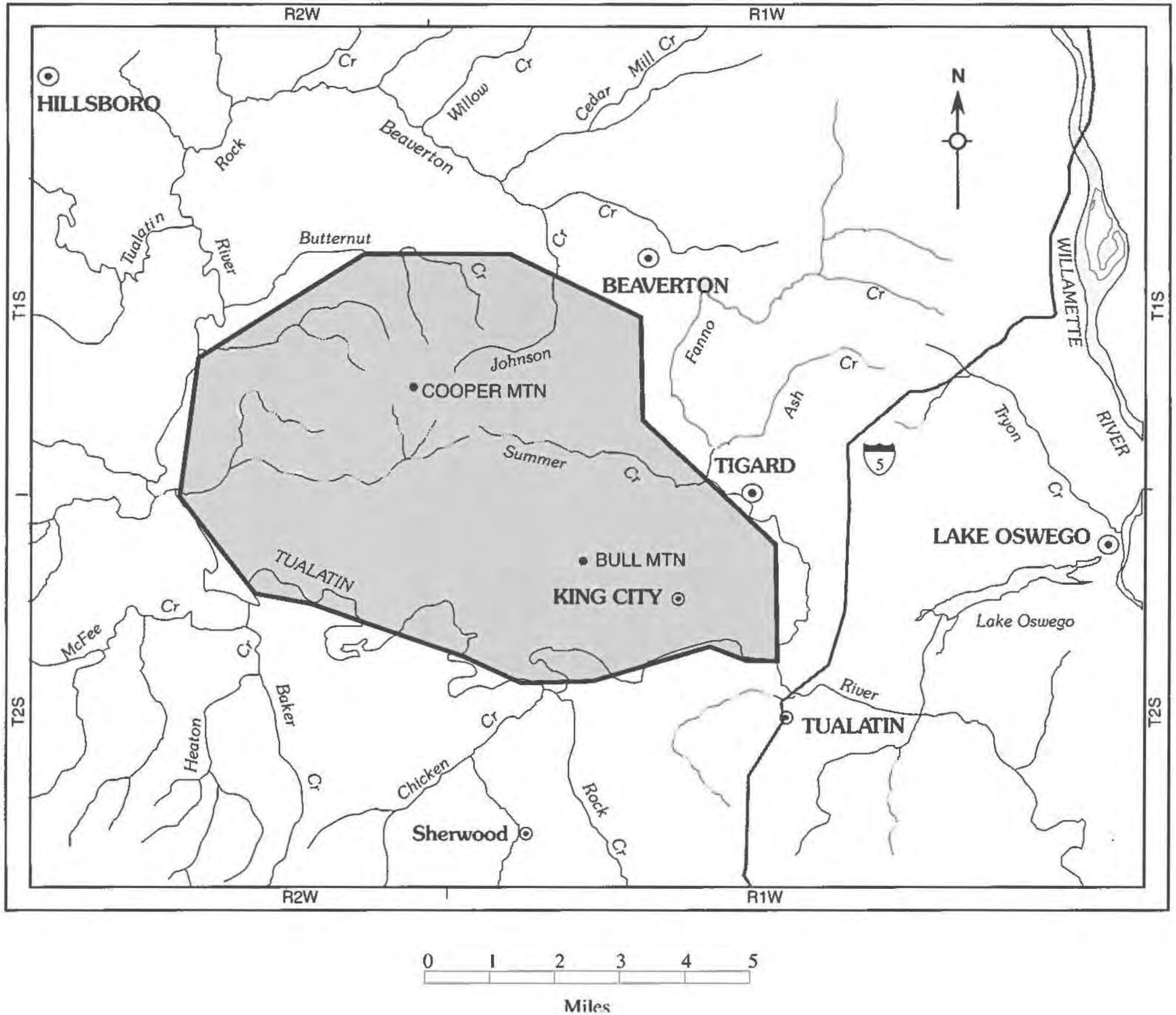
Basalt aquifers in the Cooper Mountain-Bull Mountain area in Washington County and at Salem Heights in the South Salem Hills had declined drastically by the 1960s. Water levels declined as withdrawals exceeded recharge. Instead of continuing to draw down the aquifer, the Salem Heights area connected to Salem's water distribution system. Since then, water levels in the Salem Heights basalt aquifer have recovered, and the aquifer is no longer stressed.

Cooper Mountain-Bull Mountain Area

In 1974, the Oregon State Engineer designated the area shown in Figure 33 as the Cooper Mountain-Bull Mountain Critical Groundwater Area. The State Engineer placed strict controls on development and use of water from basalt aquifers. Since then, cities, water districts and other water users have been changing to more reliable surface water sources. According to recent data, water levels have recovered to some extent. Hydrographs of state observation wells 938 and 939 (Figures 31 and 32) show decline and recovery of two wells in the critical area. In November 1989, the Water Resources Commission reaffirmed the Critical Area designation since levels had not fully recovered.

A review of the Cooper Mountain-Bull Mountain Critical Groundwater Area in the mid-1980s showed a renewal of local water level declines. At a rock quarry operating below the water table, water was being pumped out of a pit into a nearby creek. The pumpage maintained the water table below the pit floor. During the review, a second quarry began pumping groundwater for the same reason. Monitoring of the effects of pumpage on the groundwater reservoir at both sites took about one year. An analysis of the data showed that pumpage at the quarries was affecting the local water table. Representatives from the Department and the Department of Geology and Mineral Industries met with quarry operators to set dates for pumping to stop in accordance with circumstances at each quarry. The Department of Geology and Mineral Industries also changed the operating permits of two other nearby quarries to prevent operating below the water table.

Figure 33
COOPER MOUNTAIN-BULL MOUNTAIN CRITICAL GROUNDWATER AREA



Damascus Area

The Damascus area encompasses 20 square miles north of the Clackamas River in Clackamas County (Figure 34). Two aquifers are involved, one in the Columbia River Basalt Group and one in the Troutdale Formation. Inside this area, 11 wells are experiencing water level declines. Water level changes in the wells are shown in Table 44.

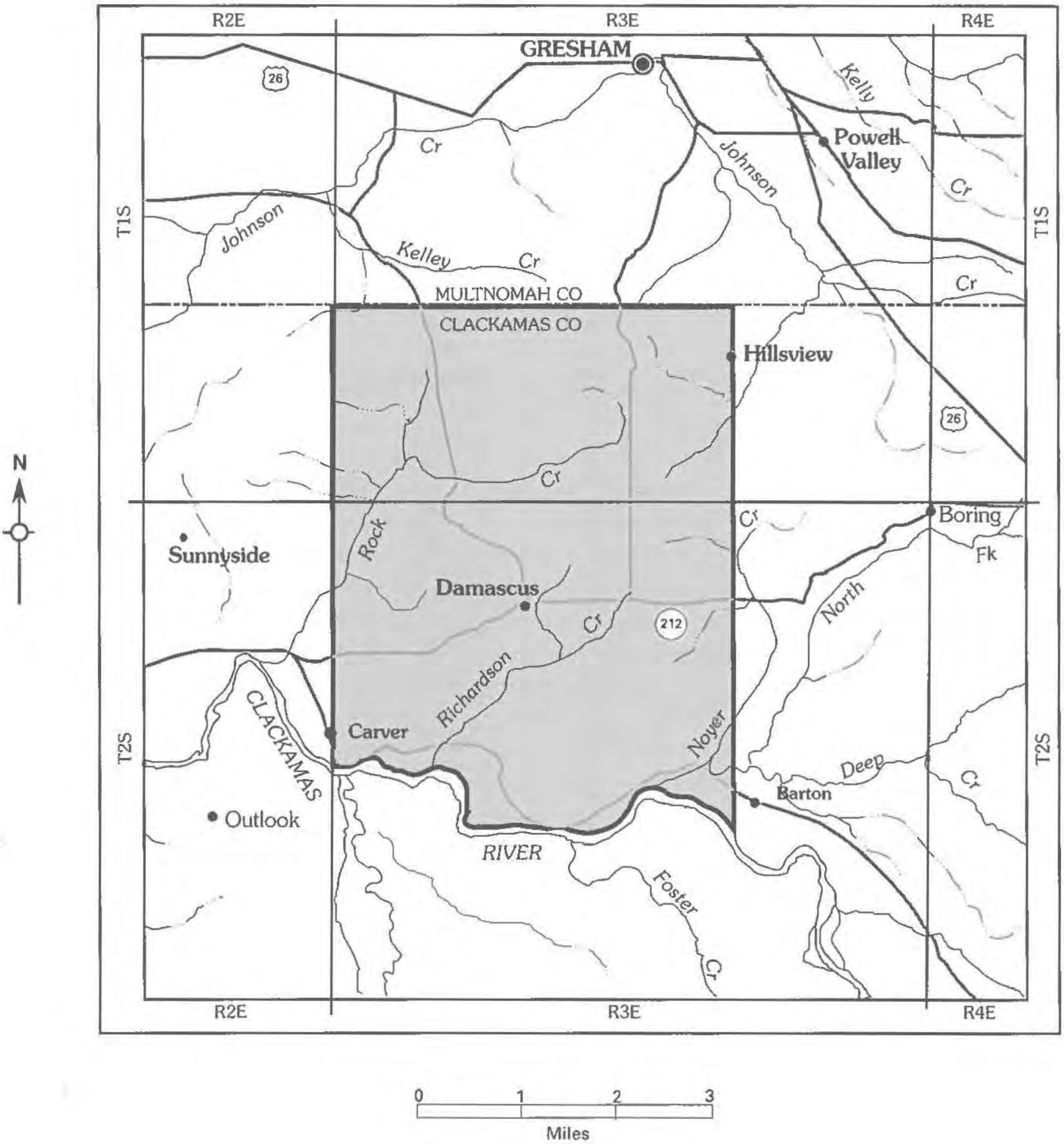
Table 44

DAMASCUS AREA GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
T2S/R3E-5ddb	7/30/63	190	1/19/88	301	-111
T1S/R3E-33dac	5/1/53	150	1/19/88	172	-22
T1S/R3E-33dda	4/19/55	205	1/19/88	216	-11
T1S/R3E-32daa	4/5/73	70	1/19/88	111	-41
T2S/R3E-6bdd	5/30/73	100	1/19/88	112	-12
T2S/R3E-9aca	4/7/76	380	1/19/88	399	-19
T2S/R3E-9aca	4/3/79	66	1/19/88	86	-20
T2S/R3E-9bdd	3/3/83	441	1/19/88	469	-28
T2S/R3E-10bac	2/28/68	165	1/19/88	160	5
T2S/R3E-6bdb	4/1/52	75	1/19/88	97	-22
T2S/R3E-6ac	1/1/57	150	1/19/88	170	-20

Source: WRD, Observation Well Network

Figure 34
DAMASCUS GROUNDWATER LIMITED AREA



Gladtidings Area

Figure 35 shows the Gladtidings area in western Clackamas County. Table 45 lists the groundwater level changes in wells. Sixteen wells are showing declines. In addition, 25 wells have been deepened, most probably because of loss of pumping capacity due to water level decline.

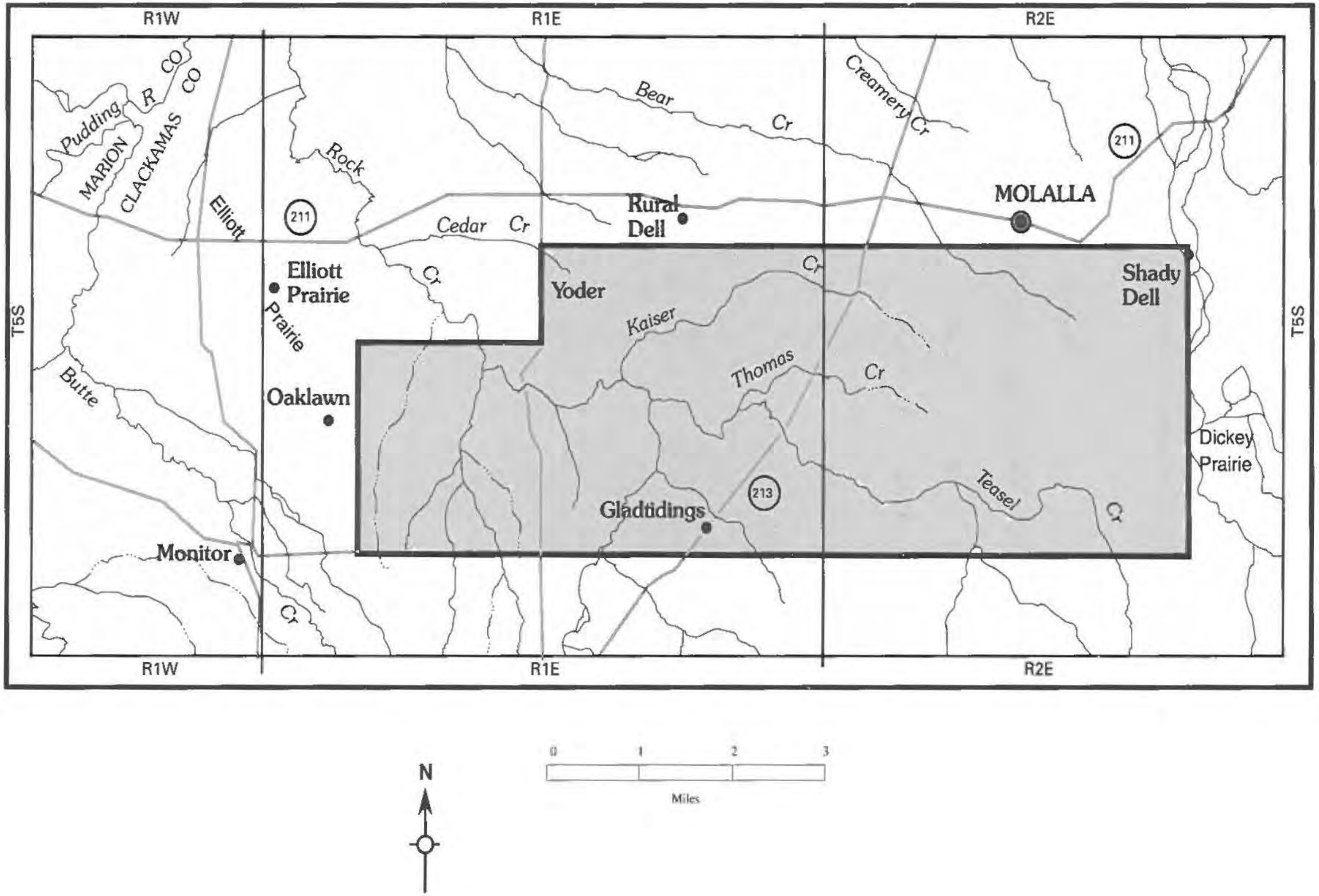
Table 45

GLADTIDINGS AREA GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth To Water	Last Date Measured	Depth to Water	Water Level Change
T5S/R1E-15cad	5/23/79	100	11/2/89	140	-40
T5S/R1E-22dc	5/11/89	70	11/19/89	79	-9
T5S/R1E-23aca	4/2/74	95	11/3/89	136	-41
T5S/R1E-23abb	5/7/05	80	11/3/89	143	-63
T5S/R1E-23cad	12/27/80	39	11/3/89	216	-177
T5S/R1E-23dcb	8/10/57	18	6/24/87	71	-53
T5S/R1E-25acb	5/6/05	145	11/3/89	196	-51
T5S/R1E-25acc	4/30/62	156	11/3/89	214	-58
T5S/R1E-25bca	8/10/86	135	2/18/88	149	-14
T5S/R1E-25bca	3/18/87	69	10/30/87	70	-1
T5S/R1E-25bca	8/3/74	102	10/30/87	132	-30
T5S/R1E-26daa	7/7/82	56	5/4/88	100	-44
T5S/R1E-26dbd	3/5/87	37	11/3/89	45	-7
T5S/R1E-32dcd	8/18/70	70	11/3/89	100	-30
T6S/R1E-5aab	2/5/86	87	7/28/87	115	-28
T6S/R1E-5abb	8/30/78	44	11/3/89	100	-56

Source: Water Resources Department, 1991.

Figure 35
GLADTIDINGS GROUNDWATER LIMITED AREA



Kingston Area

The Kingston area (Figure 36 and Table 46) covers five square miles in northern Linn County, across the North Santiam River from Stayton. Of 20 wells measured, 18 are experiencing declines in this area. Water levels are rising in two wells. Fifty-two wells have been deepened.

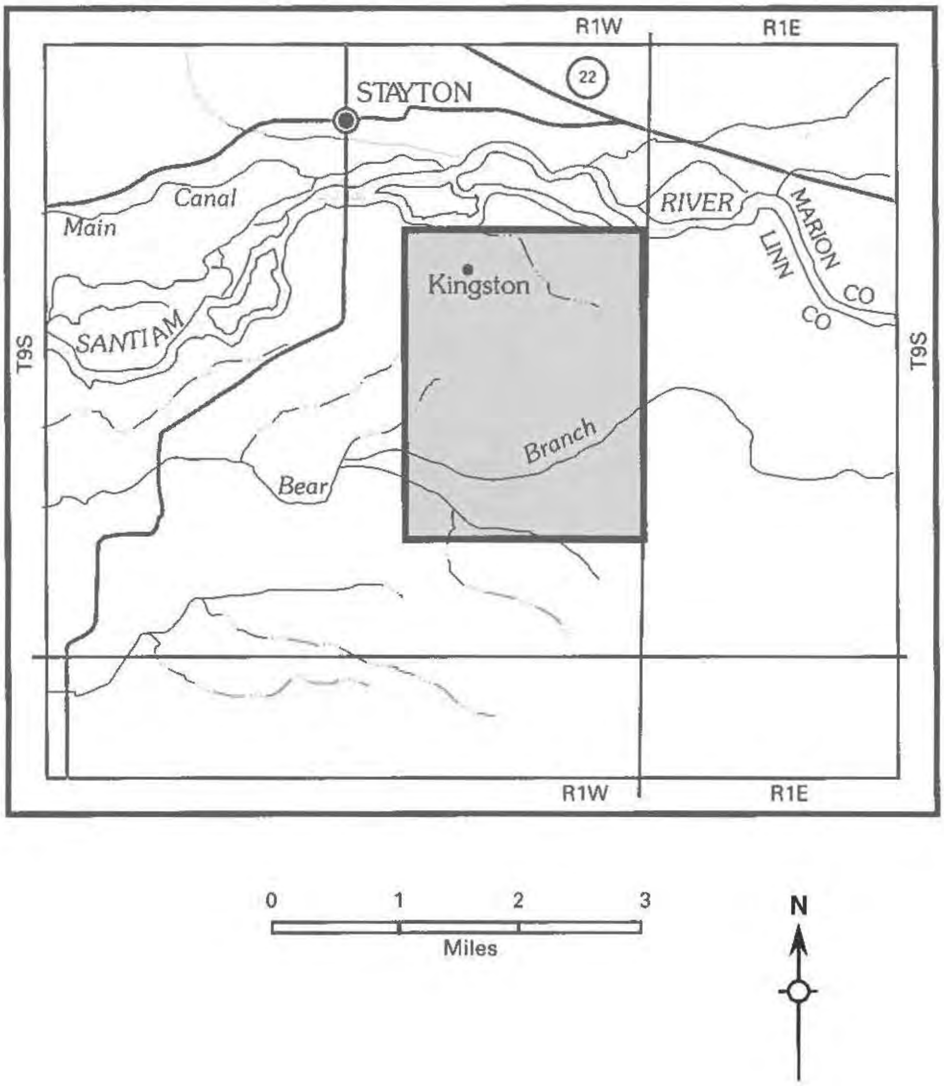
Table 46

KINGSTON AREA GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
T9S/R1W-13ccc	5/23/74	120	4/20/90	178	-58
T9S/R1W-13dcd	8/30/85	215	4/21/84	210	5
T9S/R1W-14dad	4/30/74	69	4/11/90	131	-62
T9S/R1W-14dbd	1/1/68	0	4/11/90	104	-104
T9S/R1W-14dca	3/19/64	3	4/11/90	121	-118
T9S/R1W-23aad	1/20/76	120	8/23/89	188	-68
T9S/R1W-23cda	2/25/86	72	8/24/89	75	-3
T9S/R1W-24aba	3/20/71	94	4/11/90	146	-52
T9S/R1W-24aba	5/9/66	86	4/21/89	121	-35
T9S/R1W-24aba	9/8/86	180	4/11/90	177	3
T9S/R1W-24bad	8/20/73	175	4/21/89	226	-51
T9S/R1W-24bba	8/26/86	190	10/19/88	213	-23
T9S/R1W-24bba	8/24/77	155	4/20/90	199	-44
T9S/R1W-24bbc	9/6/84	190	4/20/90	210	-20
T9S/R1W-24bbc	7/19/74	156	4/20/89	191	-35
T9S/R1W-24bcc	9/1/87	204	4/11/90	212	-8
T9S/R1W-24bcd	4/4/80	174	4/20/90	218	-44
T9S/R1W-25bcb	1/1/83	170	6/27/89	180	-10
T9S/R1W-25ccb	11/26/68	26	10/20/88	29	-3
T9S/R1E-18cdb	10/19/88	266	8/24/89	274	-8

Source: Water Resources Department, 1991.

Figure 36
KINGSTON GROUNDWATER LIMITED AREA



Mt. Angel Area

Nineteen wells in an area around Mt. Angel show groundwater level declines. Two wells show water level rises. Fifty six wells have been deepened. Figure 37 is a map of the area. Table 47 shows water level changes in the 19 wells.

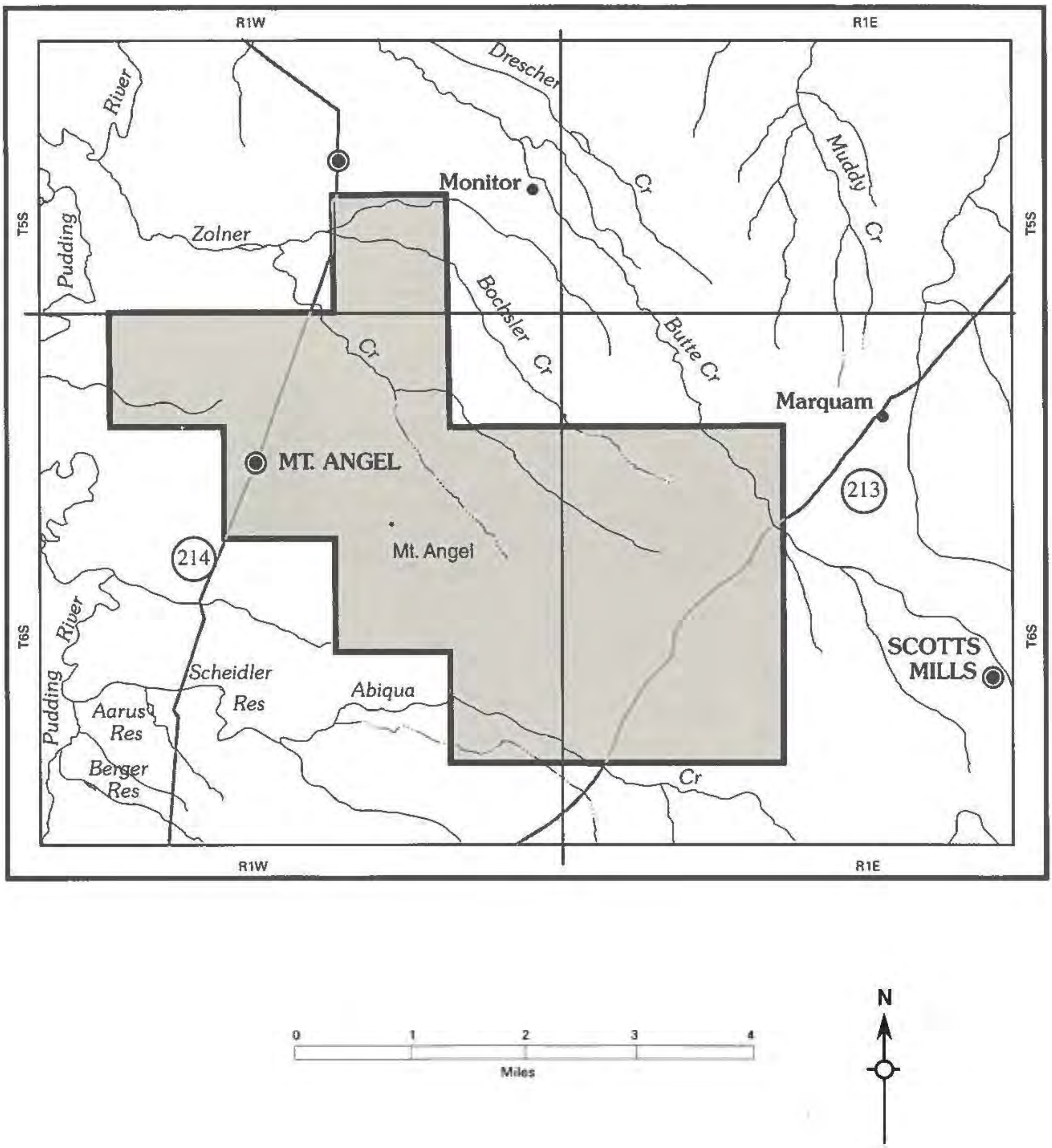
Table 47

MT. ANGEL AREA GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
T6S/R1E-3	3/12/70	0	10/26/90	18	-18
T6S/R1E-3	11/18/82	88	10/26/90	104	-16
T6S/R1E-7	1948	6	5/3/90	81	-75
T6S/R1E-17	3/4/80	34	10/24/90	108	-74
T6S/R1E-17	3/3/77	30	10/26/90	93	-63
T6S/R1E-18	8/1/85	89	10/26/90	86	3
T6S/R1E-18	5/1/74	111	5/3/90	161	-50
T6S/R1E-18	10/17/74	36	5/3/90	72	-36
T6S/R1E-18	3/23/84	46	5/4/90	70	-24
T6S/R1E-19	3/6/76	59	10/26/90	105	-46
T6S/R1W-2	8/5/80	100	10/24/90	118	-18
T6S/R1W-2	1/30/76	30	6/1/90	65	-35
T6S/R1W-3	6/4/71	30	10/24/90	106	-76
T6S/R1W-3	11/4/77	22	10/24/90	25	-3
T6S/R1W-4	5/1/75	57	10/24/90	125	-68
T6S/R1W-4	12/10/81	65	10/24/90	130	-65
T6S/R1W-12	9/27/69	92	7/30/85	149	-57
T6S/R1W-12	1949	60	6/13/64	77	-17
T6S/R1W-13	4/6/90	141	10/26/90	85	56

Source: Water Resources Department, 1991.

Figure 37
MT. ANGEL GROUNDWATER LIMITED AREA



Sherwood-Dmasch-Wilsonville Area

Reaching west from the mouth of the Tualatin River to a point west of Sherwood is the Sherwood-Dammasch-Wilsonville area (Figure 38). Groundwater level declines have been measured in 36 wells inside this 61-square-mile area. Conversely, six wells show rises in water level. The water level changes are listed in Table 48. Department records list 189 wells that have been deepened.

Table 48

SHERWOOD-DAMMASCH-WILSONVILLE AREA
GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
WASHINGTON COUNTY					
T2S/R1W-31dbb	9/25/52	30	5/23/90	48.82	-18.82
T2S/R1W-34dd	9/30/87	135	10/27/88	120.73	13.78
T2S/R1W-35ddb	7/5/72	43	6/13/88	33.98	9.02
T3S/R1E-5dbb	10/24/73	167	5/26/89	191.10	-24.10
T3S/R1E-6bdc	10/24/79	194	5/22/90	203.75	-9.75
T3S/R1E-6bdc	7/10/68	140	5/26/89	194.86	-54.86
T3S/R1E-7add	1/1/48	65	5/22/90	90.03	-25.03
T3S/R1E-8caa	1/1/11	120	8/17/87	172.00	-52.00
T3S/R1E-16cad	5/18/70	62	5/30/90	84.82	-22.82
T3S/R1W-1adb	4/22/69	230	5/30/89	281.80	-52.30
T3S/R1W-1cac	1/1/58	100	4/19/88	156.19	-56.19
T3S/R1W-1cda	7/25/70	112	6/1/90	174.40	-62.40
T3S/R1W-1dc	5/11/82	149	5/7/84	147.96	0.64
T3S/R1W-2cdc	10/17/41	20	4/1/80	33.00	-13.50
T3S/R1W-11bac	5/21/68	48	5/22/90	90.52	-42.52
T3S/R1W-5caa	3/16/67	105	6/13/88	111.37	-6.37
T3S/R1W-8bbaa	7/31/71	146	5/30/90	205.68	-59.68
T3S/R1W-8bbd	7/30/71	93	9/22/83	244.50	-151.50
T3S/R1W-8	3/17/78	110	8/7/90	378.00	-268.00
T3S/R1W-9adc	6/4/86	222	5/30/90	228.14	-6.59
T3S/R1W-10ccd	10/13/82	94	5/17/84	84.51	9.09
T3S/R1W-11adac	10/20/80	56	5/29/90	81.66	-25.66
T3S/R1W-12dbc	6/12/68	68	5/30/90	87.73	-19.73
T3S/R1W-13ac	2/21/84	58	6/8/90	80.16	-22.16
T3S/R1W-15cac	7/2/58	70	4/20/89	98.85	-28.85
T3S/R1W-19aad	6/3/72	143	6/17/77	144.34	-1.34
T3S/R1W-23aaa	1/1/40	26	5/22/90	66.82	-40.82
T3S/R1W-30dbc	6/16/72	328	5/23/90	362.82	-34.82

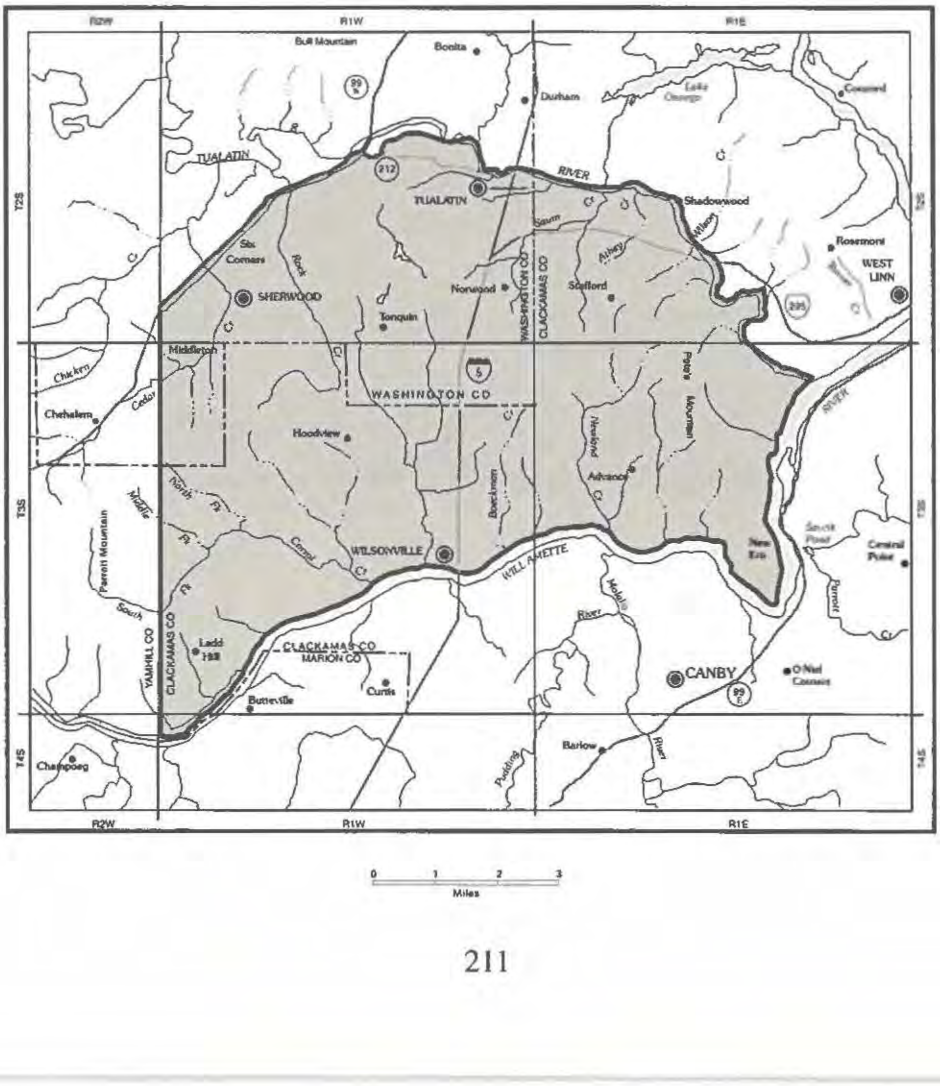
Source: Water Resources Department, 1991.

Table 48 (Continued)

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
CLACKAMAS COUNTY					
T2S/R1E-30bcd	11/29/76	124	5/29/90	182.68	-58.68
T2S/R1E-30cda	10/12/62	175	5/26/89	180.65	-5.65
T2S/R1E-31acc	3/9/62	184	5/8/84	195.64	-11.64
T2S/R1E-31adb	8/4/67	143	5/30/89	169.53	-26.53
T2S/R1E-31bbd	1/1/49	40	5/29/90	36.32	3.68
T2S/R1E-31bbd(2)	4/17/68	60	5/29/90	97.12	-37.12
T2S/R1E-31cbd	8/25/78	240	5/26/89	250.07	-10.07
T2S/R1E-31cba	10/29/79	245	5/26/89	253.12	-8.12
T2S/R1E-31dad	3/29/77	190	5/22/90	208.66	-18.66
T2S/R1E-32dbd	12/12/66	350	6/17/87	344.81	5.19
T2S/R1W-25ccb	4/2/74	42	6/13/88	49.97	-7.97
T2S/R1W-32dda	10/12/59	66	5/23/90	81.75	-15.75

Source: Water Resources Department, 1991.

Figure 38
SHERWOOD-DAMMASH-WILSONVILLE GROUNDWATER LITED AREA



Stayton - Sublimity Area

The last area where groundwater level declines in basalt aquifers have been measured is in the vicinity of Stayton and Sublimity, in southern Marion County. The area includes 72 square miles (Figure 39). Groundwater level declines have been measured in 33 wells. The water level has risen in four wells, the level in one well seems to be unchanged (Table 49). Fifty-three wells have been deepened in the area.

Figure 39
STAYTON-SUBLIMITY GROUNDWATER LIMITED AREA

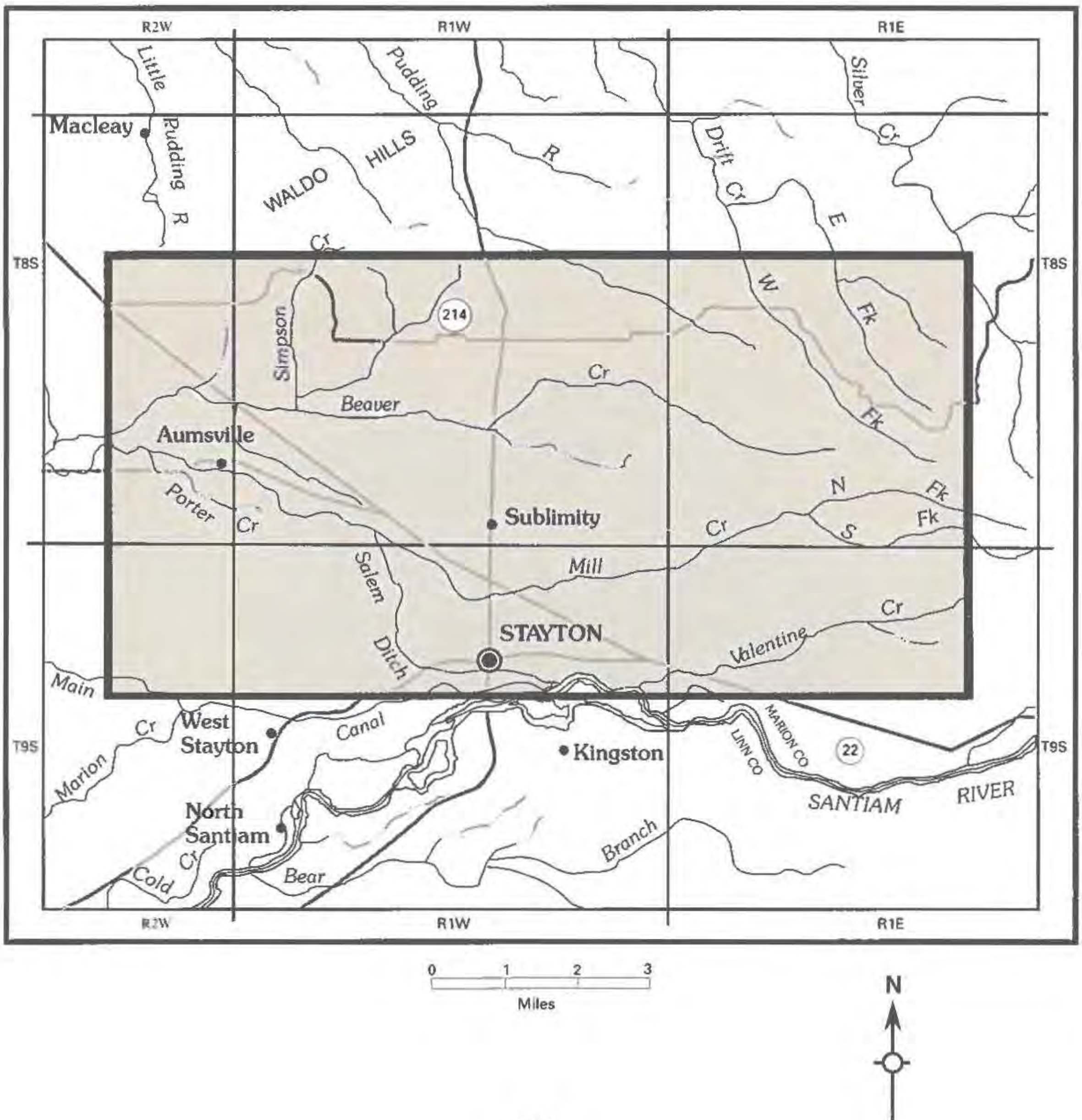


Table 49

STAYTON-SUBLIMITY AREA GROUNDWATER LEVEL CHANGES

Well Location	First Date Measured	Depth to Water	Last Date Measured	Depth to Water	Water Level Change
T8S/R2W-25cdb	1/25/83	11	7/22/86	51	-40
T8S/R1W-36cc	1/31/50	35	6/3/86	38	-3
T8S/R1W-32dac	2/26/81	40	2/11/86	42	-2
T8S/R1W-27cdb	6/24/76	60	2/20/86	80	-20
T8S/R1E-17dbc	1/9/85	291	3/6/86	293	-2
T8S/R2W-24dad	8/16/79	60	8/12/86	61	-1
T8S/R1W-36cca	12/2/67	94	2/21/86	119	-25
T8S/R2W-15dad	7/8/84	69	7/22/86	42	27
T8S/R2W-17da	7/26/85	103	1/23/86	134	-31
T9S/R1W-2ddb	4/4/62	77	6/3/86	106	-29
T9S/R1E-3bcc	4/24/61	61	3/7/86	110	-49
T8S/R1W-28acd	4/7/60	112	6/2/86	124	-12
T8S/R1W-7adb	5/1/79	93	6/2/86	89	3
T8S/R1E-27aca	2/2/78	169	6/2/86	250	-81
T9S/R1W-2adc	12/13/56	flowing	2/11/86	44	-44
T8S/R1W-33dbb	5/12/75	39	2/20/86	46	-7
T8S/R1W-33dac	4/17/65	flowing	2/20/86	34	-34
T8S/R1W-25add	3/1/83	70	6/2/86	119	-49
T8S/R1W-14dcc	3/6/73	40	7/22/86	63	-23
T8S/R1W-26acc	7/25/65	80	2/21/86	111	-31
T8S/R1W-20daa	5/9/79	36	6/2/86	34	2
T8S/R1W-33ab	9/26/78	76	6/2/86	76	0
T8S/R1W-35bcc	1/15/44	65	2/12/86	131	-66
T8S/R1W-33bca	8/10/74	71	6/3/86	76	-5
T9S/R1W-4ba	9/17/64	-28	6/3/86	-9	-19
T8S/R1E-31bcc	4/28/82	205	6/3/86	209	-4
T9S/R1W-10b	7/28/64	9	7/24/86	7	2
T9S/R1W-12abb	8/1/63	226	3/7/86	251	-25
T8S/R1W-35acb	6/28/76	35	2/21/86	171	-136
T8S/R1W-35bbc	9/1/67	93	7/24/86	116	-23
T8S/R1W-35baa	5/19/59	85	2/7/78	114	-29
T8S/R2W-16dbd	6/22/77	38	6/2/86	44	-6
T8S/R1W-34bad	10/24/58	52	2/20/86	90	-38
T8S/R1W-34d	3/31/48	68	7/28/61	83	-15
T8S/R1W-34caa	10/21/60	68	6/2/86	104	-36
T8S/R1W-34ddb	8/3/64	80	2/25/86	105	-25
T8S/R1W-33abc	12/3/65	50	2/21/86	139	-89
T8S/R1W-33bad	7/1/82	97	2/12/86	157	-60

Source: Water Resources Department, 1991.

Many wells encounter several water-bearing interflow zones. Water levels may change as a well penetrates the different zones. If the water levels do not change, chances are the zones are hydraulically connected. Large water level changes mean different aquifers are probably involved. Oregon law does not allow commingling of water from different aquifers.

Sandy-Boring Area

The Troutdale Formation is the major source of water in northern Clackamas County. In the Sandy-Boring area, Figure 40, two aquifers within the Troutdale Formation are being significantly affected by pumping. These aquifers are easily identified because they are generally separated by a semi-permeable layer. Further, the groundwater surface in the deep aquifer is usually more than 100 feet below that in the shallow aquifer. Large (30-70 feet) seasonal changes occur in the water level of the shallow aquifer. Late summer water levels approach the bottom of this aquifer in some locations. A pocket within the deep aquifer is reacting to heavy summer pumping. The aquifer is not recharging as fast as water is being used. On the average, water levels are dropping more than two feet per year.

Potential Water level decline Problem Areas

There are several areas in which the geologic and aquifer conditions are similar to those in areas where declines have been recorded (Table 50). Although significant declines have not been recorded for these four areas, the Department has received reports of interference between wells and of wells going dry. Many wells have been deepened. Well deepening reports do not show why the wells were deepened. It is probable, in most cases, that aquifer depletion (water level decline) was involved. Some wells may have been deepened to gain access to larger quantities of water. Figures 41, 42, 43 and 44 are maps of the areas.

Table 50

POTENTIAL WATER LEVEL DECLINE PROBLEM AREAS

Area Name	Area Size (Sq. Mi.)	Aquifer
Chehalem Mountain	100	CRBG
Eola Hills	70	CRBG
Parrett Mountain	10	CRBG
South Salem Hills	70	CRBG

Figure 40
SANDY-BORING GROUNDWATER LIMITED AREA

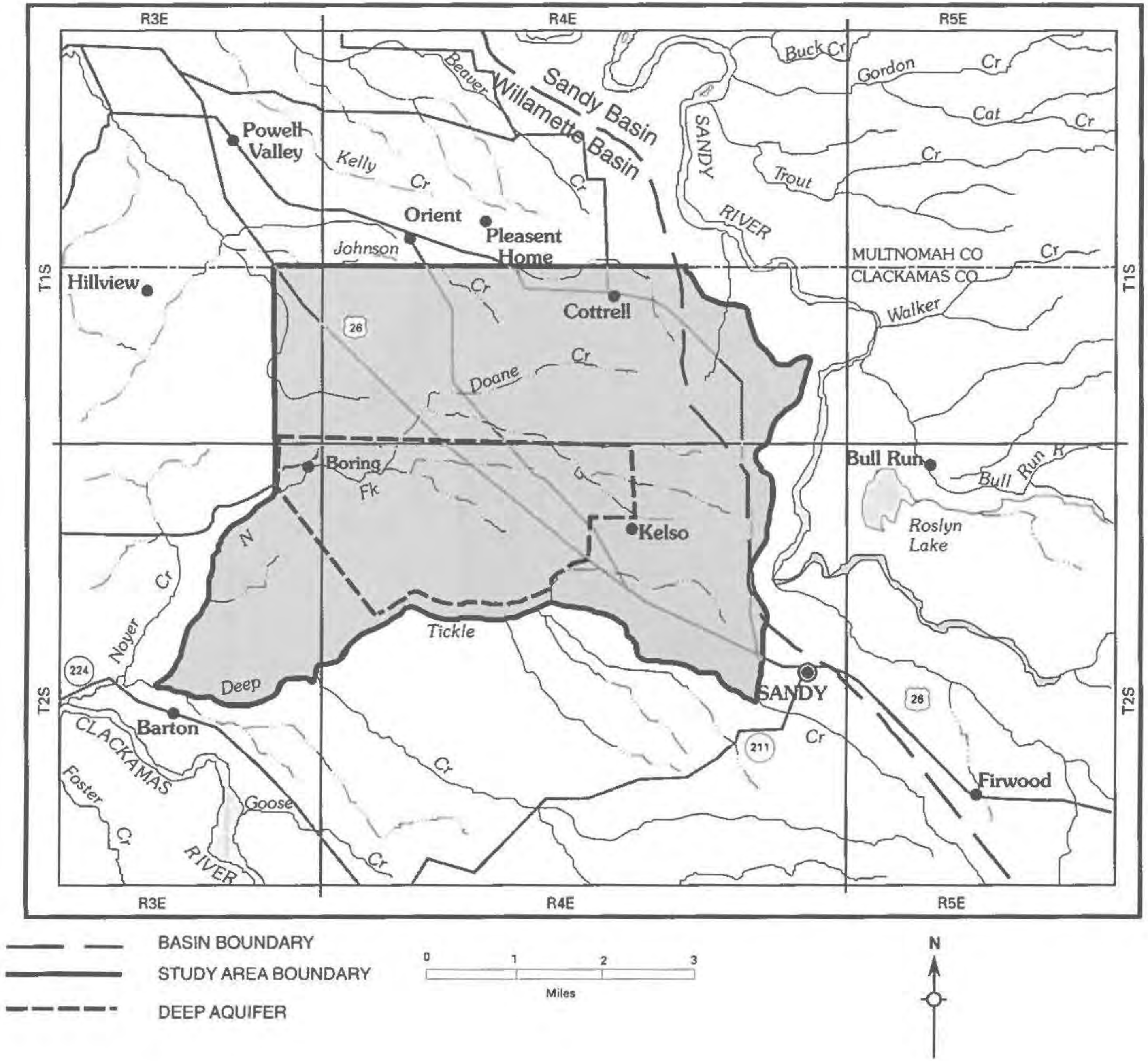


Figure 41
CHEHALEM GROUNDWATER LIMITED AREA

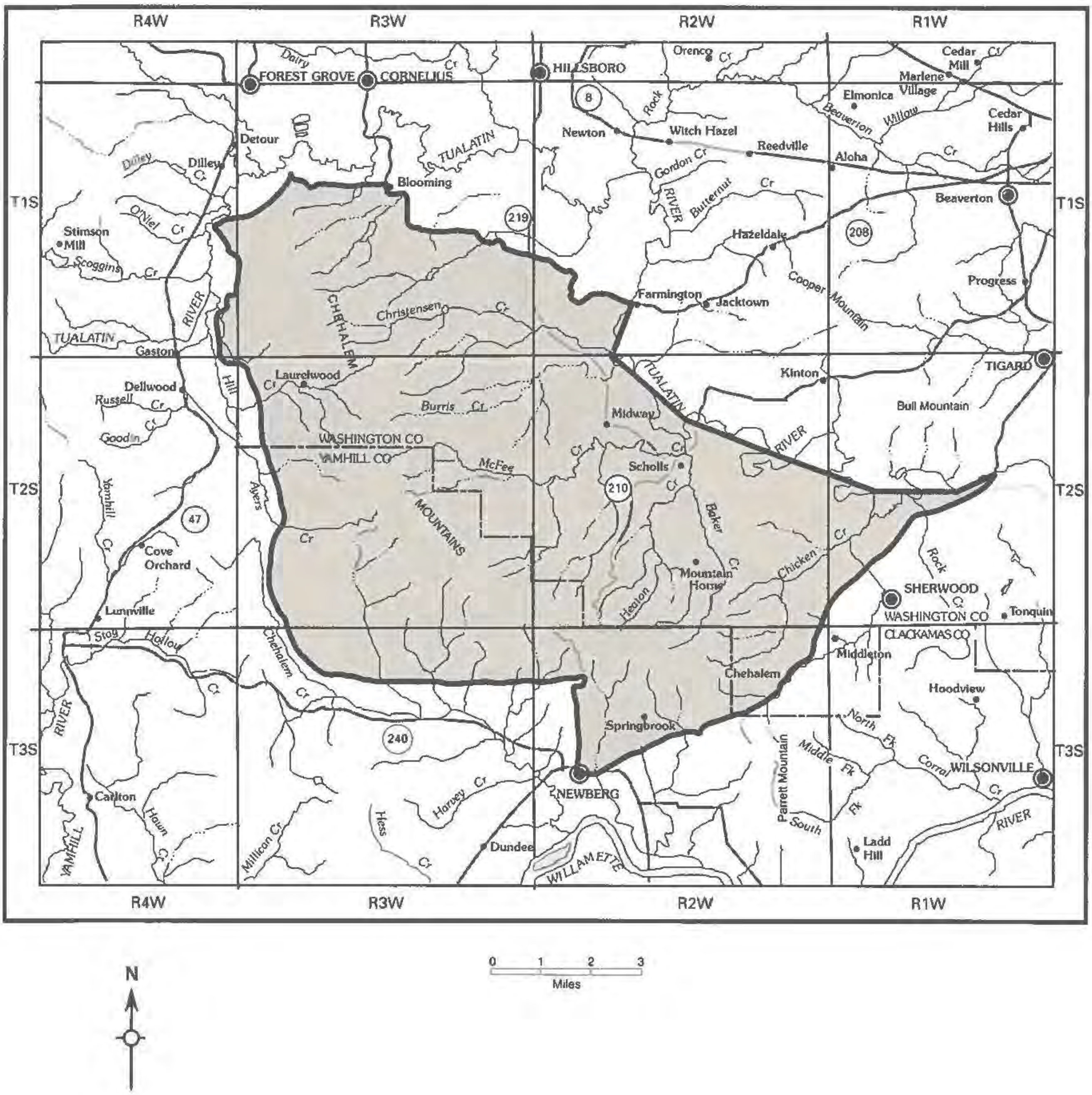


Figure 42
EOLA HILLS GROUNDWATER LIMITED AREA

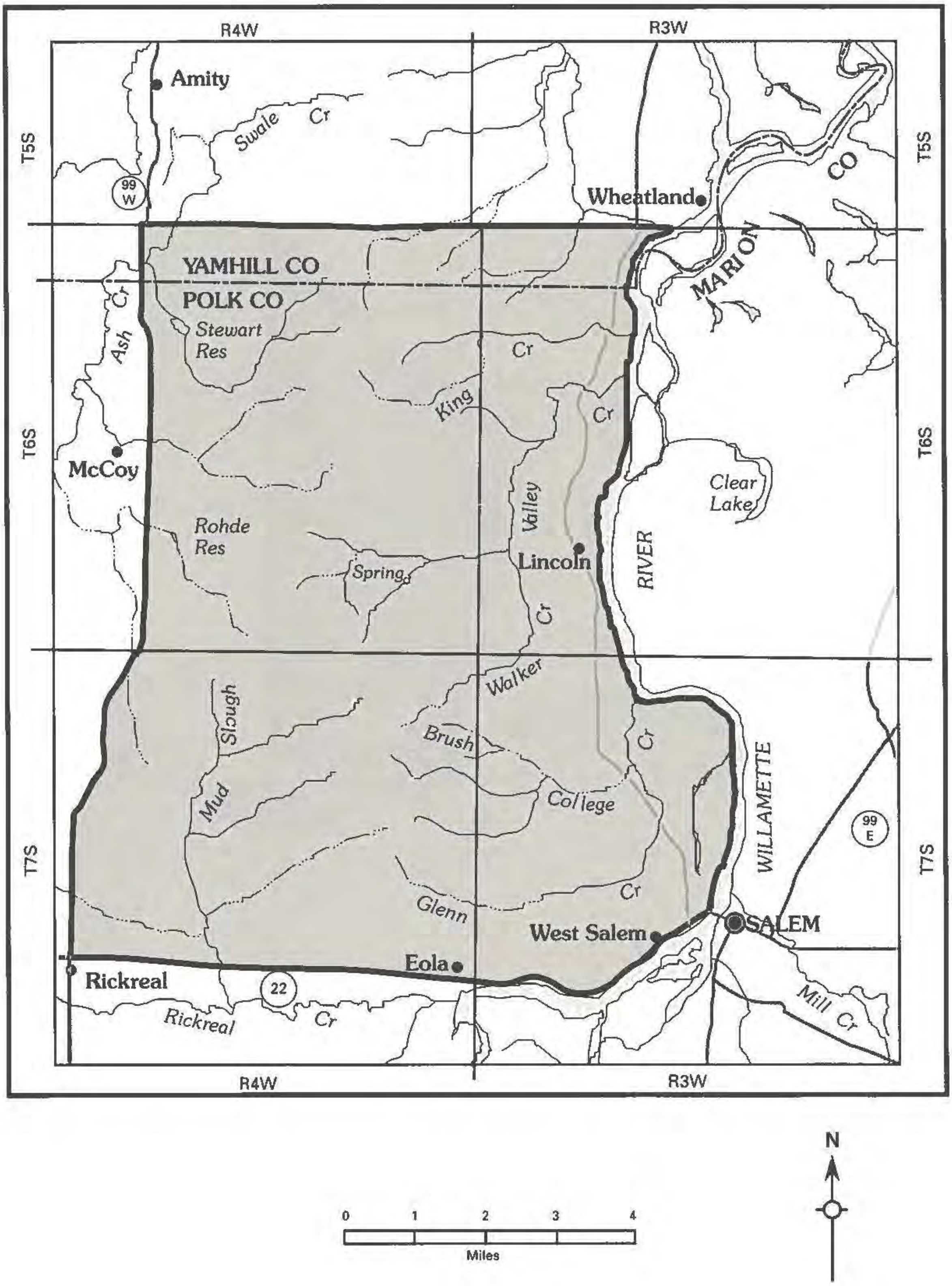


Figure 43
PARRETT MOUNTAIN GROUNDWATER LIMITED AREA

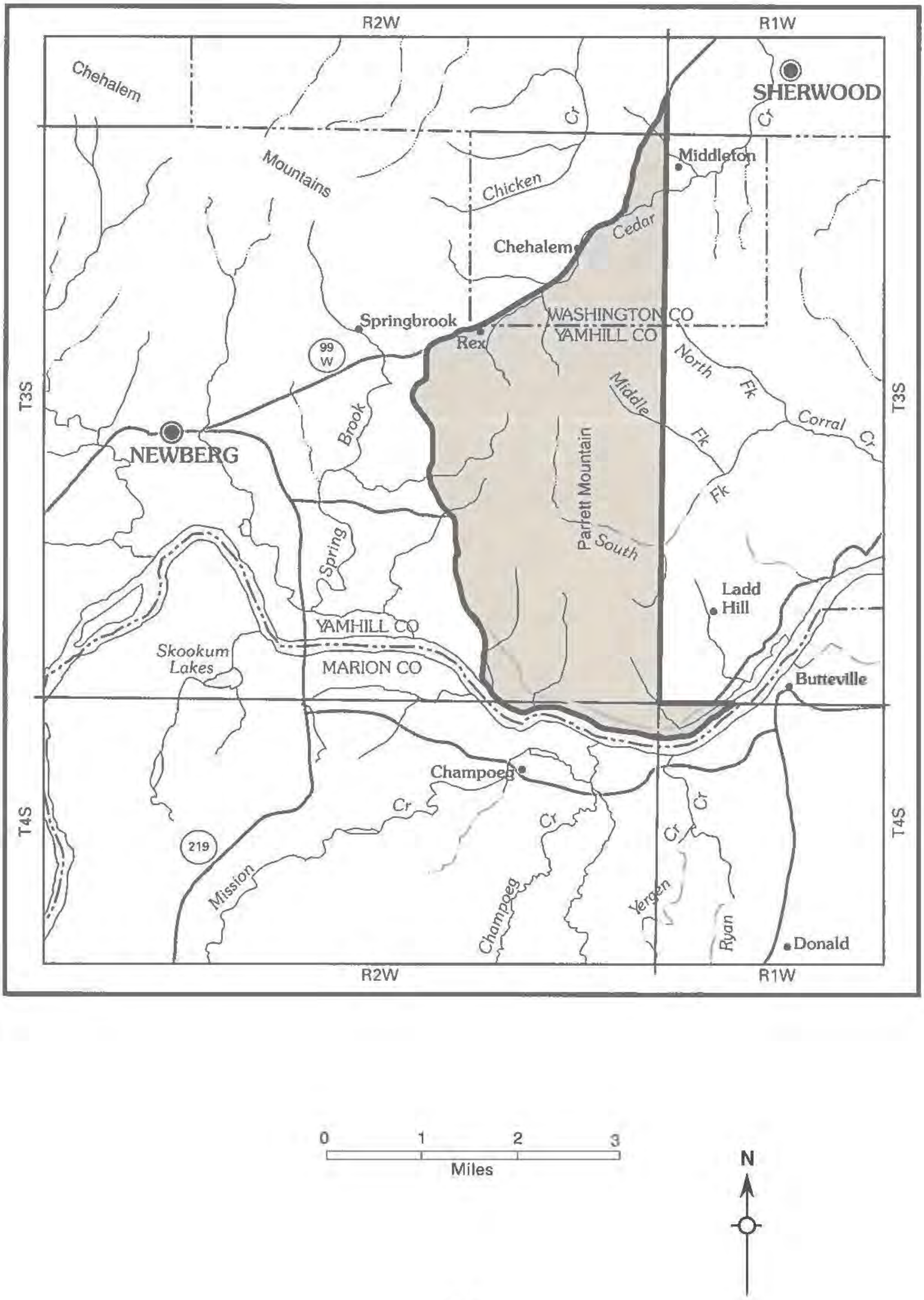
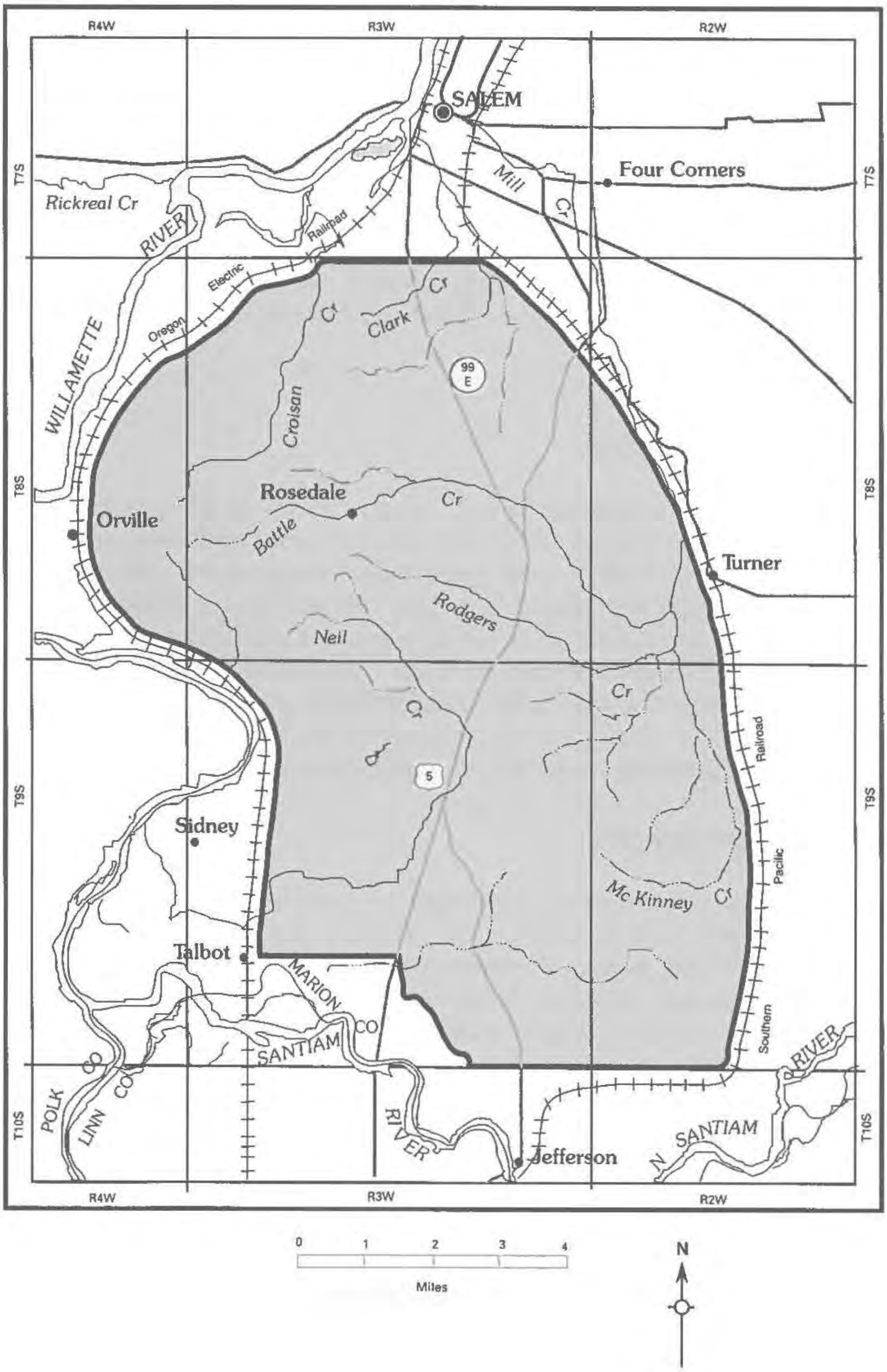


Figure 44
SOUTH SALEM HILLS GROUNDWATER LIMITED AREA



Unless protective measures are adopted, the future of these aquifers is in jeopardy. If large capacity wells continue to be drilled into the basalt aquifers, and if the wells are allowed to pump at or near capacity, groundwater overdraft will undoubtedly occur. Conversely, conservative use of water from small wells, such as domestic wells, should have a minimal effect on the resource. Also, short-term irrigation projects may be possible. Limited term (temporary) irrigation permits could be issued for specific purposes. As an example, drip irrigation might be used for a maximum of five years to establish an orchard or vineyard. After root systems are established, the crop should be able to sustain itself without further irrigation. The permit could then expire. The water would again be available for use if the aquifer has not been adversely affected. Alternatively, if declines occur, the Department could choose not to reallocate the water so that the aquifer could stabilize.

LOW-YIELDING AQUIFERS

Fine-grained marine rocks underlie large areas of the basin. These rocks store a large amount of water, but the small grain size prevents rapid movement of water. Wells drilled into these rocks usually yield small amounts of water. A well rarely can irrigate more than a few acres. Water moves so slowly through the ground that a well cannot fill as fast as water is pumped out. Sometimes a well must be drilled more than 200 feet deep to yield even enough water for domestic use. Compounding the low-yield problem are cases of inefficient well design, slow recovery after pumping, well maintenance deficiencies, and interference between neighboring wells. Occasionally, water is salty or brackish.

GROUNDWATER QUALITY

The DEQ has identified more than 100 areas of groundwater contamination in the basin. Both point source and nonpoint source areas have been identified. Point source pollution, such as the improper disposal of wastes by cities or industries, causes severe problems. Nonpoint source contamination can result from agricultural practices, storm water runoff, and on-site sewage disposal. Nitrate contamination from human and animal wastes and overuse of fertilizers is a common groundwater problem (DEQ, 1986). A map of the contaminated zones is not yet available.

Most people in the Willamette Basin live in cities and towns near the major streams. Municipal systems provide most homes with water and sewerage services. Rural homeowners use individual wells, septic tanks and leach fields. Fecal coliform, nitrates and other contaminants from septic systems sometimes seep into domestic water supplies.

There were about 56,000 cesspools in central Multnomah County, between Portland and Gresham, in 1986 (DEQ, 1986). Effluent from cesspools had contaminated many domestic wells. State and local agencies are now regulating septic system construction and extending sewer lines into the area.

Aquifers in most suburban areas around Eugene are at least partially degraded (DEQ, 1986, LCOG, 1974). Individual septic systems had contaminated the shallow aquifer in the Santa Clara/River Road area by 1974. Municipal sewage treatment facilities now serve much of the area. Additional homes are being connected as rapidly as possible. The system, when completed, should lessen the leaching of domestic wastes into the aquifer.

Many old solid waste disposal sites are leaking hazardous wastes into aquifers. The locations of many sites are unknown, and may not be discovered until uncovered by new construction. Agricultural chemical residues have been found in samples taken from domestic and municipal wells in the Salem, Hillsboro and Milwaukie areas. The actual extent of aquifer contamination is not known.

GROUNDWATER-SURFACE WATER HYDRAULIC CONNECTION

The Water Resources Commission has adopted rules for the treatment of groundwater-surface water hydraulic connection (OAR Chapter 690, Division 09). Many aquifers in the basin are hydraulically connected to streams. Wells which are drilled close to a stream are usually hydraulically connected to the stream. However, a well can be some distance away and still adversely impact a stream. The impact depends on geology and the distance from a well to a stream. Other factors which influence hydraulic connection are groundwater and surface water levels, number and size of adjacent wells and pumping rates.

Nearby wells may affect streams that are naturally low during late summer. A few of the streams which appear to be affected are Rickreall Creek, Thomas Creek, Butte Creek, Davis Creek and the South Yamhill River. The watermaster usually controls diversions of water from these streams for at least one month in late summer.

GROUNDWATER INFORMATION NEEDS

The Department has access to a large amount of groundwater supply information. Water rights information, water level measurements from the state observation well network, reports filed by well drillers, resource assessment reports and other types of information are in departmental files. Information from the observation well network, well reports, and resource assessment compiled by the Department can be used to better understand subsurface geology, water availability, well depths and aquifer character-istics. However, this information is not yet in a form readily usable by the public. Further, the Department does not have enough information to predict aquifer response to current and future pumping levels.

MANAGEMENT PROPOSALS

DECLINING GROUNDWATER LEVELS

Policy

Prevent excessive water level declines and restore aquifer stability while preserving limited storage aquifers for priority uses in the vicinity.

Implementing Actions

1) Classify the basalt aquifers in the Damascus, Gladtidings, Kingston, Mt. Angel, Parrett Mountain, Sherwood-Dammasch-Wilsonville and Stayton-Sublimity areas, and the Troutdale aquifer in the Damascus area for exempt uses only.

2) Classify the basalt aquifers in the Chehalem Mountain, Eola Hills and South Salem Hills areas for irrigation, residential fire protection systems and exempt uses only. Permits for fire protection or very efficient irrigation will be issued for a maximum of five years. If water use has not detrimentally affected the groundwater resource, and the Director finds the groundwater resource can support extended use, the water use permit may be extended for an additional five-year period.

3) Classify the shallow Troutdale aquifer , and the specially designated portion of the deep Troutdale aquifer in the Sandy-Boring area for exempt uses only. The balance of the deep Troutdale aquifer was classified for all beneficial uses, so part of the deep aquifer would still be open for appropriation.

4) Classify groundwater in the balance of the basin for all beneficial uses except groundwater hydraulically connected to surface water within one-quarter mile of a stream.

5) Declare the areas noted in actions 1, 2 and 3 (above) as Serious Water Management Problem Areas. This designation will allow the Department to obtain information on water use and groundwater levels from existing and new wells drilled in these areas.

6) To prevent over-appropriation of groundwater, attach special resource protection conditions to all new permits for use of groundwater from Columbia River Basalt Group aquifers. The conditions will require that pumping be regulated if the water level declines more than a specified amount.

7) Schedule a more detailed groundwater study of the Parrett Mountain area.

8) Encourage cities and other water purveyors dependent on groundwater from the basalt aquifers to seek alternate water supplies.

9) Urge users of groundwater from basalt aquifers to seek low-cost municipal-quality water from surface sources to recharge the aquifers during the off season.

10) Require conservation and efficient water use measures when permitting the use of groundwater from the Columbia River Basalt Group.

LOW-YIELDING AQUIFERS

Policy

Identify low yield aquifers and inform local agencies of probable insufficient groundwater flow for some uses.

Implementing Actions

1) Make low yield aquifer information more readily available to the public and local agencies. The data should be in the form of generalized maps and probable well yield.

2) Encourage water users to adopt the most efficient means to convey and use water, and actively promote water conservation in low yield aquifer areas. The Department will provide technical assistance to users seeking to increase water use efficiency.

3) Require conservation and efficient water use measures when permitting the use of groundwater from low-yield aquifers.

4) Coordinate with counties and other interested parties to identify workable strategies for better integrating water resources capabilities and classifications with local water planning and land use designations. Meet with local planners to discuss water quantity or quality limited areas such as those identified by Lane County, alternatives for expanding irrigated agriculture in areas such as Clackamas and Marion Counties, and other land and water issues.

GROUNDWATER CONTAMINATION

Policy

Ensure safe municipal and domestic groundwater supplies by participating with DEQ and the State Health Division in a formal monitoring program to document changes in quality and provide data for aquifer management.

Implementing Actions

1) When requested by DEQ, and as resources allow, collect and forward water quality samples from the observation well network. Cooperate with DEQ to secure funding for water quality sampling activities as needed.

2) Facilitate an investigation into the causes of salt water intrusion in the basalt aquifer near Mt. Angel.

HYDRAULIC CONNECTION BETWEEN GROUNDWATER AND SURFACE WATER

Policy

Minimize impairment of surface water uses resulting from hydraulic connection between groundwater and surface water.

Implementing Actions

1) Classify hydraulically connected groundwater within one-quarter mile of a stream for the same uses as the corresponding surface water, except for groundwater uses declared exempt by ORS 537.545. Allow the use of water from upstream storage, designating the well as the point of appropriation, for wells that are hydraulically connected to surface water.

2) Advise applicants of the restrictions associated with groundwater that is hydraulically connected to surface water.

GROUNDWATER INFORMATION NEEDS

Policy

Encourage the development of programs for making water resource information available to the public and local agencies.

Implementing Actions

1) Establish and promote a public information program.

2) Expand the observation well network in the Spencer Creek area, along the west side of the valley from Fern Ridge Reservoir to Yamhill, western Tualatin Valley, in the Salem-Molalla area, and in the Sandy-Boring area.

3) Through periodic review and technical assistance, encourage local governments to:

    a) Evaluate water supplies before approving development projects or zoning amendments.

    b) Adopt ordinances that require a showing of adequate water supply and legal abandonment of existing unused wells before issuing building permits.

    c) Consider available information to determine appropriate well-spacing and adopt well spacing ordinances as appropriate in low-yield areas.

4) Use groundwater information to assist local agencies in determining appropriate well-spacing requirements which should be applied through the local land use planning process.

5) Undertake a phased plan to program the database so the data can be recalled by aquifer unit and connect well reports for all non-exempt wells to water right permits.

6) Continue comparing original water levels with current water levels for basalt wells in the basin. Using these data, the Department can delineate areas of possible aquifer stress. If water levels are stable or rising, the Department may consider allowing more use from the aquifer.

7) Use information from required pump tests to build the database for aquifers in the basin.

8) Coordinate with pump installers and request them to measure water levels in wells when installing or reconditioning pumps in wells.

9) Coordinate with local governments on groundwater information as described in the implementing actions for Land Use Coordination.

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Section 4

MUNICIPAL AND DOMESTIC WATER SYSTEMS

PROBLEM STATEMENT

This section focuses on drinking water supply policy and strategies for managing municipal water supply. Water users in portions of the Willamette Basin experience chronic or periodic water supply shortages. Some areas of the basin have reached water resource carrying capacity. An increase in population and an expanding economy often create a demand for more water. In several instances, the availability of water and an array of regulations limit options for developing additional municipal and domestic water supplies.

In 1986, Congress amended the federal Safe Drinking Water Act. The amended Act sets new, stricter quality standards to safeguard both surface and groundwater drinking water supplies. Many small, public water systems will have a difficult time financing the water system improvements needed to meet federal standards.

Until recently, water purveyors in the Portland metropolitan area perceived the water right regulatory structure as impeding efficient municipal and domestic water service. In 1989, the Oregon Legislature passed legislation that streamlined the regulatory structure by allowing water authorities more flexibility in providing water throughout a regional service area. However, the legislation failed to resolve increasing public concerns about drinking water supplies and compliance with drinking water standards.

Increasing demand for, and limits to, water supplies in the basin will require that water users manage supplies as efficiently as possible. Greater economic and resource efficiencies can be achieved through cooperative planning and management of water supply services. Interconnection and consolidation of water service systems may help small water systems meet drinking water standards. Regionalizing water supply and treatment system operation may also be a cost-effective approach to meeting federal drinking water standards.

Regional in this section means dealing with water-related issues area-wide. An area or region can be defined by physical or natural hydrologic parameters such as river basins, subbasins, or drainage areas. Regions can also be based on administrative boundaries such as those of a county, a group of counties, a group of cities, and/or special districts.

BACKGROUND

The terms *"consolidation"* and *"regionalization"* are used throughout this section. Consolidation means the merger of two or more water purveyors or suppliers to form a single water development and/or distribution organization. Regionalization commonly refers to the formation of one, large water supply or water distribution organization to serve a large geographical area. There are, however, several variations to this approach. For example, one water supplier may be selling and delivering water to small, independent distributors. The independent distributors then serve their customers through water systems they construct and maintain. Another often-used approach is a cooperative arrangement or contract among suppliers and distributors to develop joint water supplies or share distribution facilities.

NEED FOR COORDINATION AND CONSOLIDATION OF REGIONAL WATER SYSTEMS

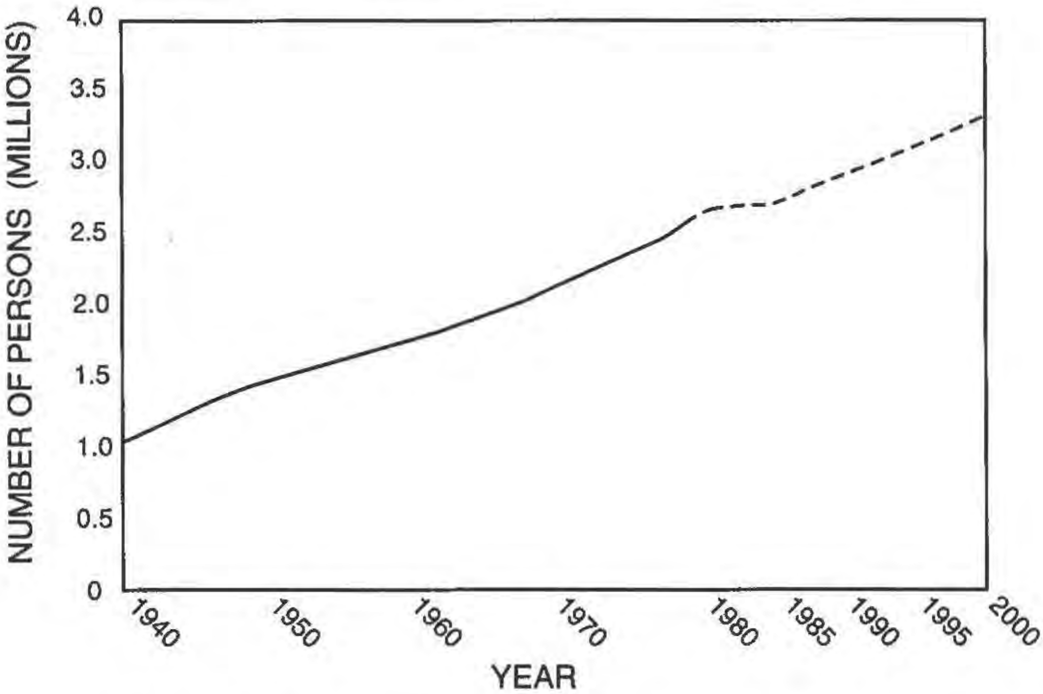
Increased Population

Nearly 70 percent of the state's population resides in the Willamette and Sandy River Basins. The 1990 census figures for the counties located in the two basins placed the population at 2,002,700. In 1984, the Center for Population Research and Census at Portland State University projected that Oregon's population would grow by one-quarter (25.5 percent) between 1980 and the year 2000. This trend in population growth is depicted by Figure 45. The projections show that the population in the two basins will increase proportionally, or by about 500,000 residents.

County growth projections vary from a low of nearly four percent in Multnomah County to a high of almost 52 percent in Washington County. Population in counties nearest the Portland metropolitan area, except Multnomah County, are expected to have the highest growth rates over the projected period. The population in Clackamas County is expected to increase by 38.5 percent and in Yamhill County by 36.1 percent during the projection period. Population in basin counties outside the Portland metropolitan area are projected to increase by at least 20 percent (Table 51).

Figure 45

Oregon Population Growth, 1940-1980
Pregon Projected Population Growth, 1985-2000



Source Population Projections, Oregon and Its Counties: 1980 to 2000. Center for Population Research and Census, Portland State University.

Table 51

POPULATION PROJECTIONS, 1980-2000

County	1980 Census	1985	1990	1995	2000	% Change 1980-1990	% Change 1990-2000	% Change 1980-2000
Benton	68,211	69,300	73,900	79,000	84,300	8.3	14.1	23.6
Clackamas	241,919	247,900	275,100	305,000	335,100	13.7	21.8	38.5
Columbia	35,646	36,700	39,600	42,600	45,700	11.1	15.4	28.2
Lane	275,226	271,000	292,000	312,900	334,200	6.1	14.5	21.4
Linn	89,495	90,400	96,900	103,300	109,500	8.3	13.0	22.4
Marion	204,692	208,800	228,300	247,900	267,700	11.5	17.3	30.8
Multnomah	562,640	562,200	572,400	579,300	584,400	1.7	2.1	3.9
Polk	45,203	44,600	48,300	52,000	55,700	6.9	15.3	23.2
Washington	245,808	266,500	301,900	337,400	373,400	22.8	23.7	51.9
Yamhill	55,332	57,300	63,400	69,300	75,300	14.6	18.8	36.1

Source: Population Projections, Oregon and Its Counties: 1980 to 2000. Center for Population Research and Census, Portland State University.

An analysis of preliminary 1990 Census data by the Center for Population Research and Census shows that the overall population increased between 1980 and 1990 as predicted (Table 52). However, a comparison of the population increases projected in 1984 (Table 51) with the 1990 data of Table 52 shows some counties did not experience as much population increase as expected. Other counties experienced greater population increases than expected. Much of the increase occurred during the latter half of the decade.

Table 52

PRELIMINARY 1990 CENSUS INFORMATION

County	1980 Census	1990 Census Estimates	% Change
Benton	68,211	71,200	+4.4
Clackamas	241,919	279,500	+15.5
Columbia	35,646	37,700	+5.8
Lane	275,226	283,500	+3.0
Linn	89,495	91,000	+1.7
Marion	204,692	228,000	+11.4
Multnomah	562,640	583,500	+3.7
Polk	45,203	49,700	+9.9
Washington	245,808	313,000	+27.3
Yamhill	55,332	65,600	+18.6

Source: Center for Population Research and Census, Portland State University.

Water Availability

Several areas in the basin either have limited water supply now, or are projecting potential future supply shortfalls. This is occurring today in several counties experiencing moderate to substantial population increases. Water shortages will be a function of several factors, including location and land characteristics, population and demand, economics, water availability, water system capability, water quality, and state and federal regulations.

The lack of reliable water supplies is of increasing concern in the counties located west of the Willamette River. The headwaters of surface sources originate in the Coast Range, where runoff from rainfall rather than snowpack is the main source of streamflow. The amount of water flowing in streams parallels precipitation patterns. The rainfall cycle of the Coast Range peaks between December and February. After February, the precipitation steadily decreases until it reaches a low during the summer. Following the summer dry period, the precipitation cycle again builds toward the winter peak. As emphasized earlier in the Surface

Water Allocation section of this report, peak water demand occurs during the summer dry period when streamflows reach their lowest levels.

Municipal users, and many domestic users west of the Willamette River, cannot rely on groundwater as a dependable supply source. Outside of alluvial deposits, the geology is not conducive to yielding large, consistent quantities of groundwater. Groundwater supplies typically are more abundant east of the Willamette River. In most years, a large snowpack collects in the Cascade Mountains. The melting snowpack feeds stream-flows and contributes to groundwater recharge. In certain places, the geo-logic formations of the Cascades and foothills are favorable to groundwater recharge as noted in the Groundwater Protection and Management section of this report. However, groundwater use from the Columbia River basalt group has caused declines and the opportunities for new uses are limited.

Streamflows draining the Coast Range often are not enough during the summer and fall months to satisfy all potential water users. Many streams are fully or close to fully appropriated during the period of peak demand in the summer. Without the benefit of storage, there are few new sources of water available for municipal supply.

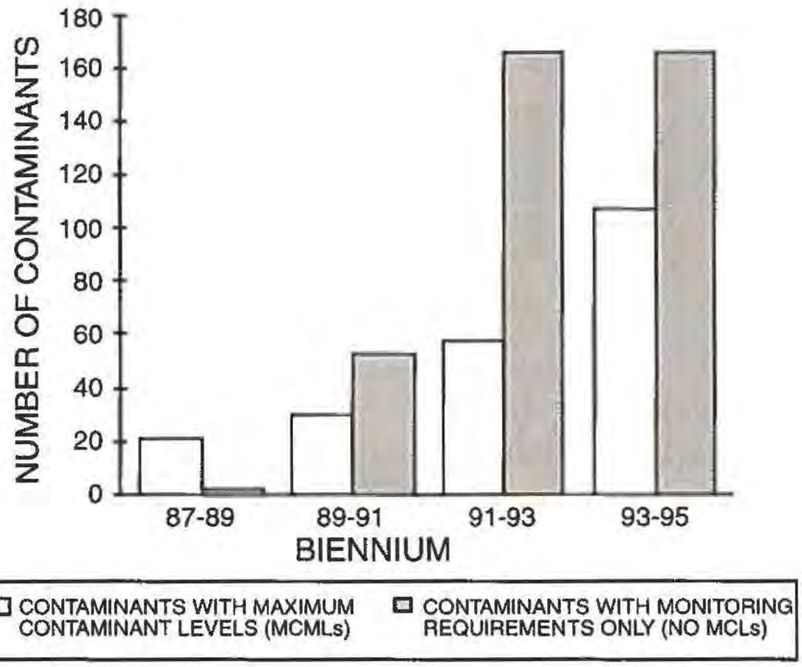
The U.S. Army Corps of Engineers (Corps) operates 13 dams in the Willam-ette Basin. The reservoirs are multiple-purpose facilities, but their primary purpose is to control floods as discussed in the next section of this report (State Coordination in Corps of Engineers Regulation of Willamette System Reservoirs). There are opportunities to obtain water stored at existing Corps reservoirs for municipal water supplies. Communities could purchase un-contracted stored water. However, few municipalities have taken advan-tage of this opportunity because the price of municipal water is relatively high. Unlike irrigation, municipal water use was not one of the original authorized purposes for constructing the reservoirs. Thus, the purchase price the Corps charges municipalities reflects, in part, current reservoir construction costs for that increment of water adjusted for inflation. To date, most municipalities have found that purchasing water from the Corps costs about as much as developing their own source. Consequently, most municipalities have chosen to develop and control their own supplies.

Drinking Water Standards

In 1974, the U.S. Congress passed the Safe Drinking Water Act. The Act sets water quality standards for public water systems. The U.S. Environmental Protection Agency (EPA) is responsible for enforcing the Act nationwide. The states are responsible for implementing the standard locally. In Oregon, the Health Division of the Department of Human Resources monitors water quality for public water supplies.

Congress amended the Safe Drinking Water Act in 1986 and set new, more stringent standards for monitoring and treatment. The amended Act requires that public suppliers of drinking water test for and monitor substantially more contaminants than before (see Figure 46).

Figure 46
TOTAL NUMBER OF CONTAMINANTS REGULATED BY BIENNIUM



Source: Oregon Task Force on Drinking Water Construction Funding and Regionalization, Strategic Water Management Group

The additional regulations of the 1986 Act require testing for organic contaminants such as pesticides and industrial solvents. Testing for these contaminants is more complex and costly than for biological contaminants such as bacteria.

The new testing requirements apply to both surface and groundwater sources. Surface land conditions often influence the water quality of springs, shallow wells and infiltration galleries. When surface conditions influence the quality of subsurface water supply sources, groundwater will be subject to the same treatment standards as surface water. Increased monitoring requirements will go into effect in areas that receive heavy pesticide and fertilizer use. In areas where a groundwater source is not vulnerable to certain contaminants, corresponding testing requirements may be waived. The responsible health agencies decide whether to grant a monitoring waiver.

Public water systems that rely on surface water will be subject to increased filtration and disinfection standards. Applying chlorine to a water supply is currently the typical method of disinfection. However, chlorination is often ineffective because of inadequate contact time between chlorine and water. To increase the contact time, water purveyors may need to construct larger reservoirs. An ozone treatment process offers an alternative to chlorination. Ozonation is a recently-developed technology that meets disinfection standards. Its use in Europe is common. However, ozonation has received limited use in the United States because it is more costly than traditional disinfection methods. The City of Portland is examining ozonation as an alternative treatment process to chlorine and ammonia disinfection.

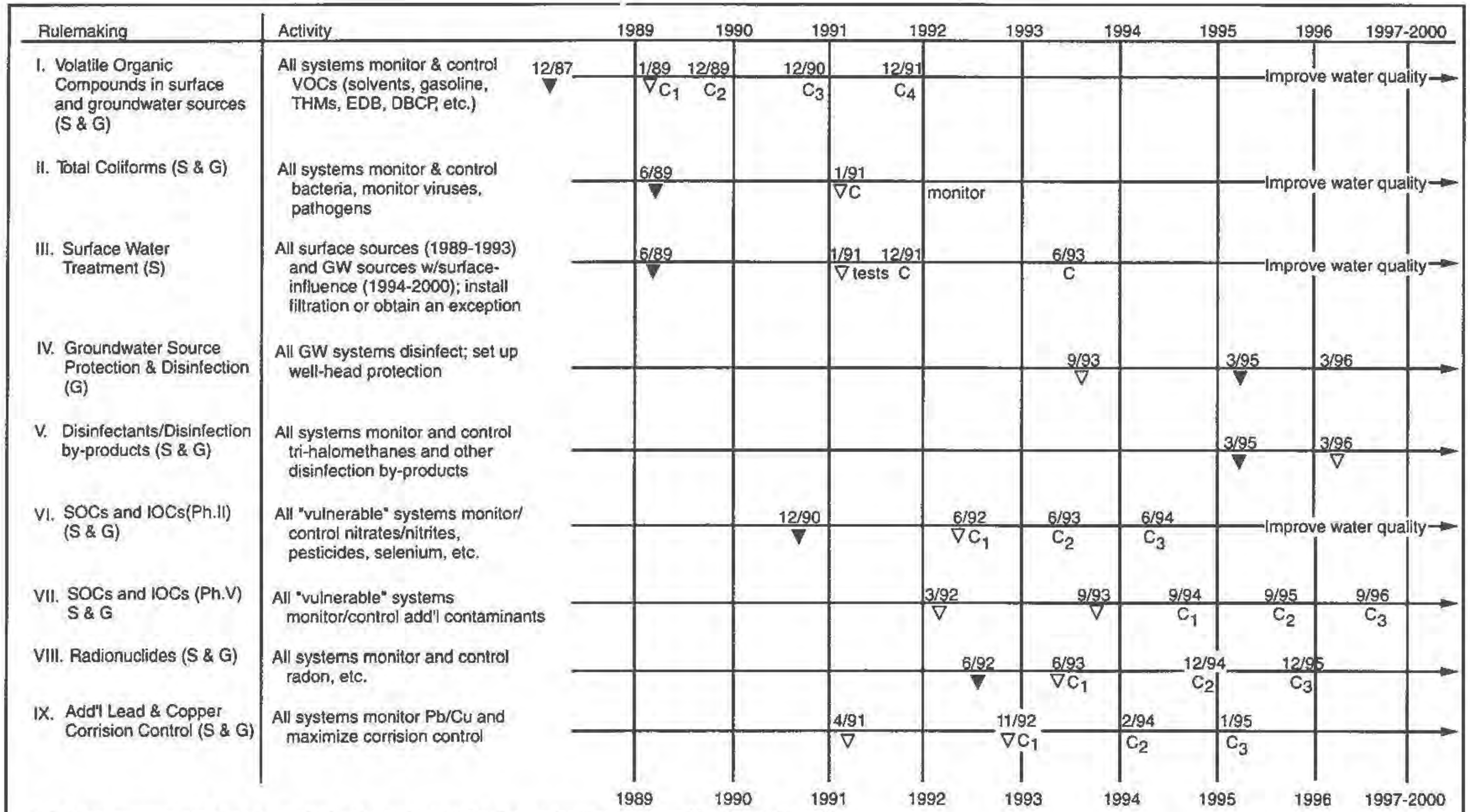
The EPA has considered, but does not yet require, disinfection of groundwater. Enactment of a groundwater disinfection rule could impact communities economically. Many communities use widely spaced wells and service customers directly from the wells. A disinfection requirement for groundwater sources could require treatment of water at each well head. Alternatively, communities could move water to a central treatment facility for disinfection and distribution. Figure 47 shows the anticipated schedule for adopting water quality improvements required by the Act. According to the schedule, the Oregon Health Division intends to adopt rules on groundwater disinfection by 1995.

In the long term, these new federal drinking water requirements should protect the public health and prevent costly contamination problems. However, it is certain that the costs of supplying water will increase. Meeting the new standards may impose large operating and long-term capital investment costs on the water using public. Users of water supply systems that serve small populations will have a difficult time funding required system improvements. For example, Figure 48 shows EPA estimates of the annual cost to each household for installing filtration systems. The graph shows that the economic effect of installing filtration systems is greatest on water systems serving small populations.

Concern over the potential costs to meet the new drinking water standards prompted the Oregon Strategic Water Management Group (SWMG) to explore ways to fund needed water system improvements. SWMG consists of thirteen state agency directors and is chaired by the Governor's Natural Resources Senior Policy Advisor. It was created in 1983 to coordinate state agency water management activities. In 1990, the SWMG established a Task Force on Drinking Water Construction Funding and Regionalization to recommend legislative actions needed to assure a continued supply of high-quality, safe drinking water.

Figure 47

Schedule of Anticipated Drinling Water Quality Improvmenets (1989-2000)



N.B. Many systems are already monitoring for and controlling the contaminants covered by these rulemakings

C_1 = date when all regulated systems must monitor and start controlling problem contaminants

C_1 = date when all regulated systems serving >10,000 persons must monitor and start controlling problem contaminants

C_2 = date when all regulated systems serving 3,300-10,000 persons must monitor and start controlling problem contaminants

C_3 = date when all regulated systems serving 200-3,299 persons monitor and start controlling problem contaminants

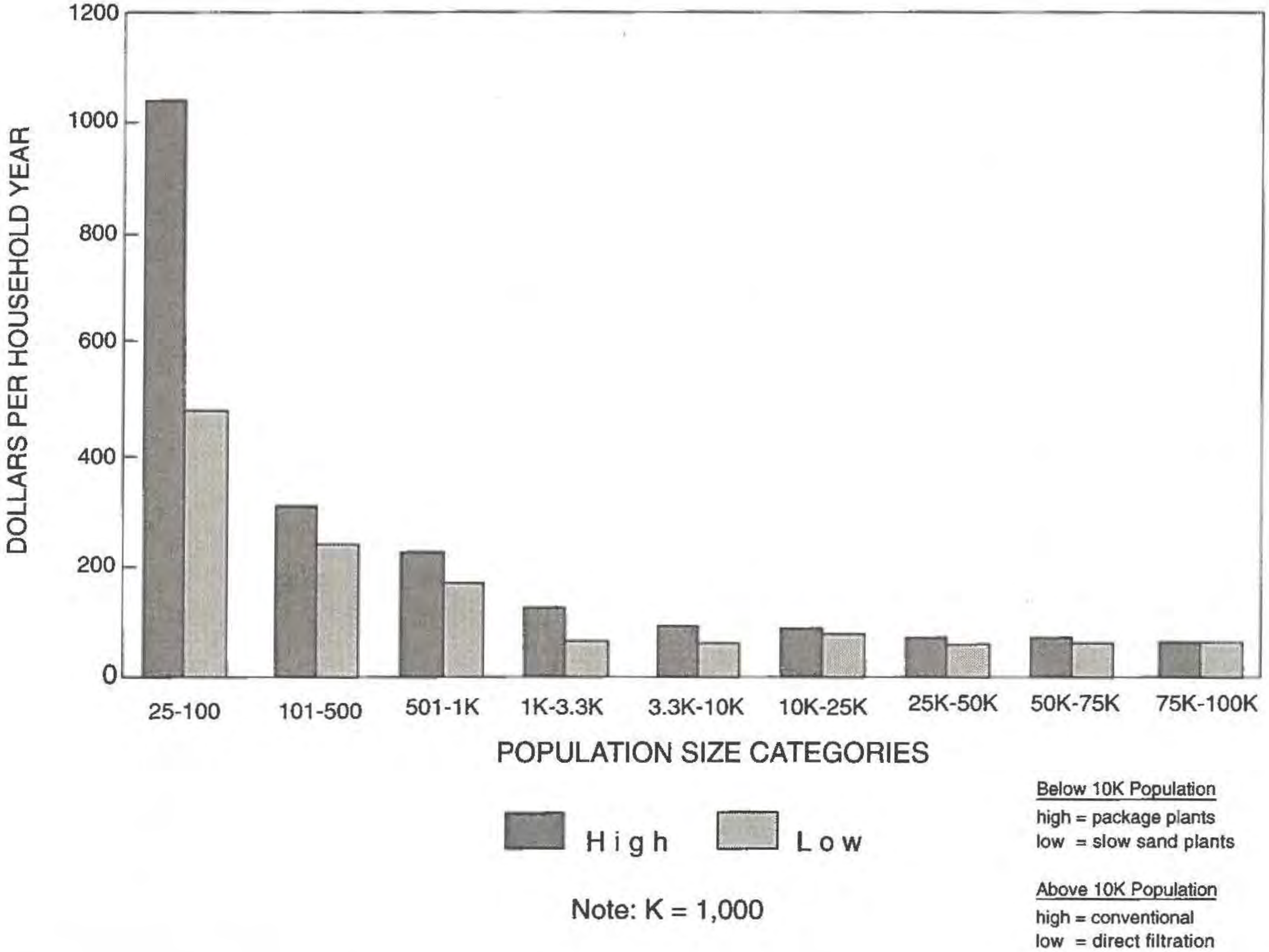
C_4 = date when all regulated systems serving 25-199 persons must monitor and start controlling problem contaminants

▼ = U.S. EPA finalizes rulemaking

▽ = Oregon State Health Division adopts final state rule

Figure 48

Cost of Instaling Filtration In Systems Serving Less Than 100,000 Population



The task force has recommended development of an integrated, state-sponsored grant and loan program (Safe Drinking Water Funding Program) to help water suppliers finance system improvements needed to meet the federal standards. Other key recommendations involve the provision of technical assistance and training to water system operators. Another recommendation involves "coordinated solutions" to drinking water supply and quality problems. Such solutions could mean cooperative agreements, service contracts, joint operating agencies, annexations, development of service districts and consolidations to foster more efficient and effective water supply delivery. Specifically, the recommendation calls for the state to fund development of coordination agreements by state agencies, local governments, special districts and water suppliers.

State Scenic Waterways

In 1988, Oregonians created nine state scenic waterways through the voter initiative process. There are now 18 state scenic waterways in the state. Eight of the waterways are in the Willamette and Sandy River Basins. There are also several streams in the basin that the federal government has designated as wild, scenic and recreation rivers. Additional streams are under study for suitability and inclusion in the federal designation of National Wild and Scenic Rivers. The effect of the federal system on the use of water is small. The major effect is the limitation on development of federal lands next to the streams.

The creation of state scenic waterways has already shown potential to affect public drinking water supplies. In 1988, the Oregon Supreme Court decided in *Diack v. City of Portland* that the Water Resources Commission must examine applications to use waters located both within and above scenic waterways. As noted in Section 1 of this report (Surface Water Allocation), the Water Resources Commission now examines applications to be sure a proposed water use will not have a detrimental effect on the uses of the scenic waterways. Before *Diack*, the Water Resources Commission examined applications only for the effect of appropriations within the scenic waterway.

When considering an application to use water, the *Diack* decision requires the Water Resources Commission to make findings about streamflow levels needed for the recreational, fish life and wildlife purposes of the scenic waterways. The Water Resources Commission must use this information to decide if there is more than enough water to meet the purposes of the scenic waterway. Staff have quantified streamflows necessary to satisfy the purposes of the scenic waterways. Those flow levels are arrayed in Appendix D. Water surpluses which exceed the amount necessary to satisfy the purposes of scenic waterways may be available for appropriation.

On the statewide level, satisfying scenic waterway flow needs may not significantly affect public water supplies since many scenic waterways are unlikely to serve as public water supply sources. In the Willamette Basin, however, several sections of the Clackamas River are designated scenic waterways. The Clackamas River presently supplies drinking water for thousands of Oregonians. Despite this designation, some water purveyors think the Clackamas River is a likely source of additional municipal water supply. However, it is possible that meeting the streamflow requirements intended under the Oregon Scenic Waterways Act may leave little or no additional water available for appropriation.

Future water supplies for McMinnville may have been affected by the designation of the Nestucca River and Walker Creek as scenic waterways. McMinnville is considering raising the height of McGuire Dam, its municipal supply reservoir on the upper Nestucca River. Raising the height of the dam would increase storage capacity. The Nestucca scenic waterway extends from McGuire Dam downstream 23 miles. The quantification of scenic waterway flows will help determine whether there will be water available for municipal use in the upper Nestucca River watershed. The streamflow needs for the Nestucca River and Walker Creek scenic waterways are displayed in Appendix D.

AREAS THAT COULD BENEFIT FROM REGIONALIZATION

Water Supply and Water Suppliers

The Portland metropolitan area is an obvious candidate for regional water systems because of population density, development patterns and water sources. The Portland Water Bureau is the major purveyor of water in the metropolitan area. Gresham, Clackamas Water District, South Fork Water Board, Hillsboro/ Forest Grove/Beaverton Joint Water Commission, Tigard Water District and Tualatin Valley Water District also provide water service to large areas in the region. Portland's primary water source is the Bull Run Watershed. This use of water involves an interbasin transfer of water from the Sandy River Basin to the Willamette Basin. Portland also has an extensive well field near Troutdale.

The Legislature withdrew the waters of the Bull Run and Little Sandy Rivers from further appropriation in 1909 (ORS 538.420). The Legislature granted Portland exclusive use of those waters. To date, Portland has not developed the Little Sandy River drainage as a source of public water supply.

Many water districts in the Portland metropolitan area contract for water from the Portland Water Bureau. These districts include Palatine Hill, Powell Valley, Richland, Rockwood and Tualatin Valley Water Districts. The Portland Water Bureau has been marketing water to these districts for several years. Gresham also purchases water from the Water Bureau. In total, a population of more than 700,000 people depends on Portland's Bull Run water source for supply.

The Clackamas River also is an important source of water for the Portland metropolitan area. It serves as the source of water for the Clackamas, Oak Lodge and Tigard Water Districts, the South Fork Water Board, Lake Oswego and other municipal corporations. Unlike the Bull Run watershed, the Clackamas River drainage is not specially managed, nor are the waters of the drainage reserved for the exclusive use of one water purveyor. Water from the Clackamas River system provides drinking water to more than 130,000 people.

The Bull Run and Clackamas Rivers originate in the Cascade Mountains. These two water sources have the potential to supply much of the Portland metropolitan area/tri-county region water needs into the future. The Portland Water Bureau estimates it uses 26 percent of the average annual flow of the Bull Run River. The undeveloped capacity of the watershed may be instrumental in meeting increased water demand fueled by projected population growth. As noted, however, the designation of portions of the Clackamas as a state scenic waterway may limit its potential as a source of additional water supply.

The Hillsboro/Forest Grove/Beaverton Joint Water Commission is a major water provider to the western portion of the Portland metropolitan area. It provides water service to a population proportional to that of the districts and cities using water from the Clackamas River. The Joint Water Commission's (JWC) primary water sources originate in the Coast Range. The JWC imports water into the basin from the Trask River. It also relies heavily on the Tualatin River and its tributaries as water sources. Water quality standards recently set for the Tualatin River may limit further use of the river's natural streamflow as a source of water supply.

The cities of Salem, Eugene, Springfield, Corvallis, Albany and McMinnville are the other major urban water purveyors in the middle and upper reaches of the basin. Each of these cities serves a population larger than 10,000 (see Table 53). The greatest concentrations of industrial and commercial development and population density outside the Portland metropolitan area are clustered around Salem and Keizer, Eugene and Springfield, and Corvallis and Albany. The McMinnville-Newberg-Portland transportation corridor likely will experience increased development and population overflow from Portland. These areas present opportunities for coordinating and consolidating water supply management and the provision of water services. They also pose political, social and financial challenges as how best to accomplish this. Figure 49 shows areas of the basin that could benefit from development of regional water systems.

Table 53

WILLAMETTE BASIN CITIES WITH POPULATIONS GREATER THAN 5,000
(1989 estimates)

County	City	Population
Benton	Corvallis	43,714
Clackamas	Canby	8,315
	Gladstone	9,685
	Lake Oswego	29,425
	Milwaukie	18,830
	Oregon City	14,975
	West Linn	14,270
	Wilsonville	5,800
Columbia	St. Helens	7,580
Lane	Cottage Grove	6,945
	Eugene	109,785
	Springfield	41,460
Linn	Albany	28,030
	Lebanon	10,485
	Sweet Home	7,005
Marion	Keizer	20,585
	Salem	99,860
	Silverton	5,480
	Woodburn	12,445
Multnomah	Gresham	65,470
	Portland	432,175
	Troutdale	7,375
Polk	Dallas	9,220
	Monmouth	5,950
Washington	Beaverton	44,265
	Cornelius	5,105
	Forest Grove	12,180
	Hillsboro	33,810
	Tigard	27,050
	Tualatin	13,340
Yamhill	McMinnville	16,310
	Newberg	11,890

Source: Population Estimates for Oregon, 1980-1989, Center for Population Research and Census, Portland State University.

The sources of water for most of these urban areas are surface streams draining the Cascade Mountains, or groundwater. However, Corvallis gets part of its water supply from the Rock Creek watershed and part from the Willamette River. The Rock Creek watershed lies to the west of the Willamette River with its headwaters in the Coast Range. McMinnville relies on surface water draining from the Coast Range. McMinnville's main source of water is from a reservoir located on the upper Nestucca River. The Nestucca River drains into the Pacific Ocean. McMinnville's use of water involves an interbasin transfer of water.

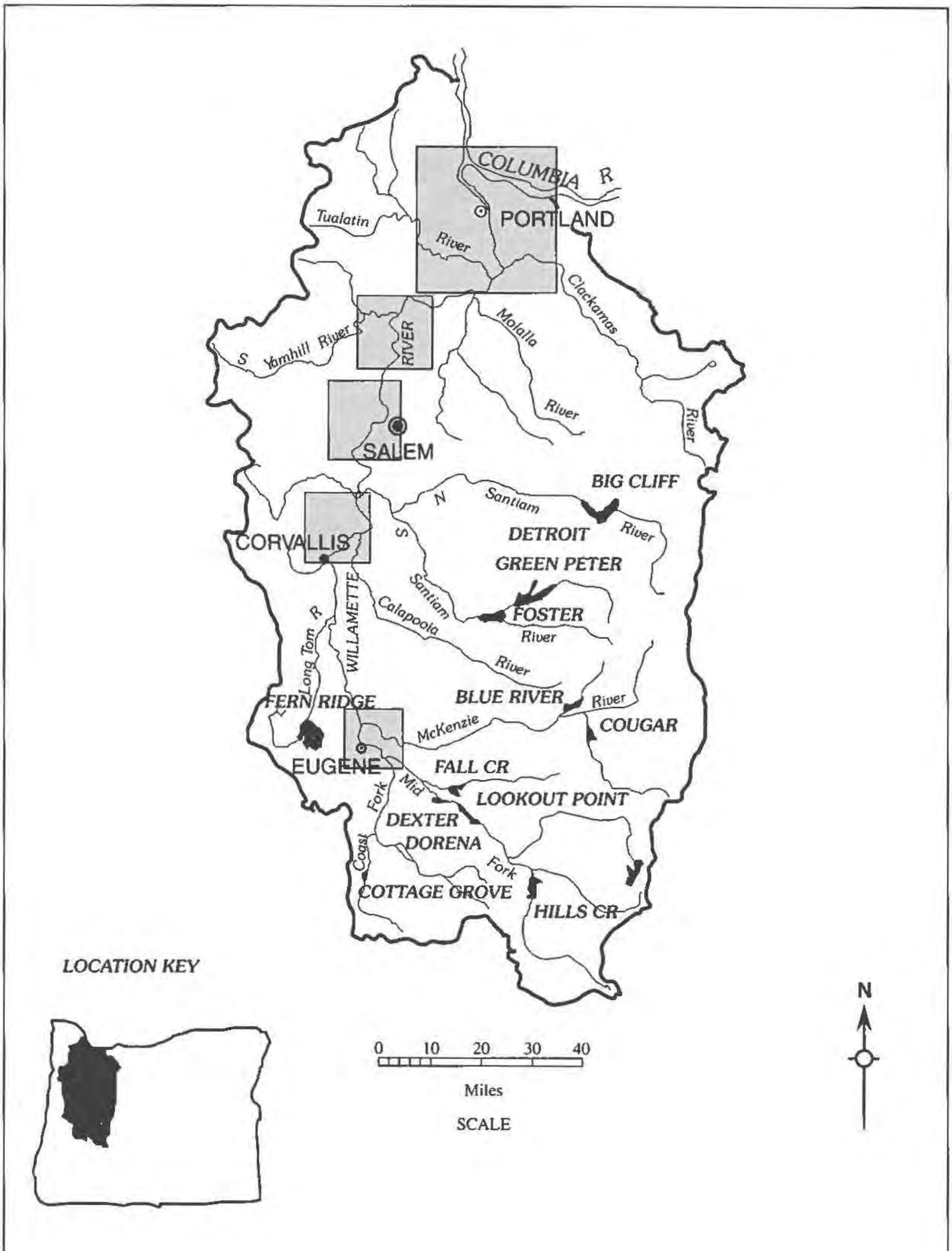
The municipal water rights held by cities and water districts are displayed in a series of tables in the Surface Water Allocation section of this report. The amount of water used by cities and districts in 1989 as reported to the Water Resources Department is also shown. An initial analysis suggests most municipalities have sufficient recorded water rights to meet future demand. This does not mean that water is available from all sources in quantities necessary to meet future demand. Rather, it means municipalities have a license to use water if it is present and not dedicated to other uses.

Regional Water Planning Effects—Two Case Studies

Population growth and expansion of agricultural, industrial and commercial sectors are occurring in many Willamette Basin counties despite limited surface water and groundwater supplies. Low streamflows during the summer months also add to water quality problems in streams draining the Coast Range and the foothills of the Cascades. DEQ has set water quality parameters for Total Maximum Daily Loads (TMDLs) for the Tualatin and Yamhill Rivers. TMDLs set the allowable concentrations for phosphate, nitrogen and ammonia in the rivers. TMDLs will be set in the near future for the Pudding and Coast Fork Willamette Rivers, and the Columbia Slough. TMDLs can be met by increasing streamflows to dilute concentrations of phosphate, nitrogen and ammonia. Reducing discharge of these elements to streams also will reduce concentrations. Waste water treatment plants may have to reduce discharge to streams to reduce the concentration of pollutants. A reduction in the discharge from waste treat-ment plants may further reduce streamflows.

These water quantity and quality problems have led communities and county governments to search for sources of future supply. Reservoir storage projects offer a viable supply option for the Coast Range stream systems where precipitation is abundant during the winter months. But storage projects are costly. Environmental considerations prevent development of many sites. Few small communities have the financial resources to de-velop storage for the single purpose of providing municipal water.

Figure 49
AREAS THAT COULD BENEFIT FROM THE DEVELOPMENT OF REGIONAL WATER SYSTEMS



The combined efforts of several communities and water districts have a better chance of financing reservoir storage than attempting to do so individually.

In 1989, water users from Polk, Yamhill and Lincoln Counties began to explore the options for developing reservoir storage. They formed the Tri-County Water Committee. The counties recognized the need to identify water needs and develop a long-term water supply plan. Investigating the feasibility of reservoir storage that would serve as a regional water supply is an integral part of the plan. The U.S. Bureau of Reclamation is assisting the counties in their investigation.

Washington County and the Tualatin River drainage experience seasonally limited surface water supplies. Washington County water suppliers import about 60 percent of the drinking water used in the county. Water comes into the county and the Tualatin River drainage from the Trask River that empties into the Pacific Ocean. Imported water also comes from the Bull Run drainage in the Sandy River Basin via the Portland Water Bureau. The Clackamas River is another source of imported water. Clackamas River water serves municipalities located in the lower reaches of the Tualatin River subbasin such as Lake Oswego and Tigard.

The Tualatin River drainage provides a good example of how water quality and quantity combine to affect municipal and domestic water supply. The imported water is used, treated, and then discharged into surface drainage or onto land as treated effluent. Stormwater runoff from urbanized areas and other nonpoint pollution sources also adds to the water quality problems. There is not enough natural summer streamflow to dilute both treated effluent and nonpoint pollution and still meet all surface water quality standards.

The Tualatin Valley Water District (TVWD), created by consolidation of the Wolf Creek Highway and Metzger Water Districts, provides water service to much of Washington County's population. The district primarily serves those areas located outside urban growth boundaries. The Hillsboro/ Beaverton/Forest Grove Joint Water Commission, Tigard Water District and other municipal suppliers serve areas within urban growth boundaries. As noted previously, TVWD obtains nearly all its water supply from the Portland Water Bureau. Without water provided by the Portland Water Bureau, the TVWD would have to develop other sources.

Wolf Creek Highway Water District and Metzger Water District merged and became Tualatin Valley Water District in order to simplify water supply and distribution to the non-urban service areas west of Portland. The TVWD has a permit to appropriate water from the Willamette River at a location near

Wilsonville. It is performing preliminary engineering and feasibility work on diversion, treatment and distribution facilities. The TVWD has initiated discussions with nearby districts and cities about participating in the development and use of these facilities.

Local governments, water purveyors, utilities and organizations in Washington County have formed a water management committee (WAMCO) to address water quality and quantity problems. County governments and organizations have funded development of a water resources management plan. While the focus of the plan is on water quality, water quantity concerns also are addressed. The plan points out that as early as 1995, peak water demand will exceed capacity of water supply systems. Average demand can be met in the short-term without additional source development if the present level of water imports continues. The water management plan calls for creating a single management entity to fund and manage all water resources and utility programs in the county. Recent statutory changes in the Unified Sewerage Agency charter gives the agency responsibility for managing surface water within its service boundaries.

Most of the county's water needs could be met if there were additional storage reservoirs in the drainage. These reservoirs could capture and store the abundant winter runoff that results from the large amount of winter rainfall. The U.S. Bureau of Reclamation recently completed a preliminary analysis of the cost to develop another storage reservoir in the Tualatin drainage. The analysis provides WAMCO and the public with the potential costs and repayment obligations to build a reservoir big enough to help meet water quality and water supply needs. A reservoir capable of storing 105,100 af of water would cost about $156,500,000 to build. Yearly operation and maintenance costs would run about $520,000. About 40,000 af would be used for municipal and industrial purposes. The cost for that portion of reservoir storage would be about $70,000,000. Both the Columbia and Willamette Rivers are potential alternative sources for meeting projected future water demand in the area.

Groundwater has limited potential as a source of additional municipal supply in these rapidly growing areas. The Cooper Mountain/Bull Mountain Critical Groundwater Area was established in 1974. It encompasses 41 square miles in the southeastern part of Washington county. Several cities and TVWD have wells in the critical area, but have not used them because of limitations on pumping. Well monitoring shows that groundwater levels in the critical area have risen in response to limitations on pumping. Yet, during the past 15 years, groundwater levels to the west and south of the critical area have declined. This has occurred in areas where there are no controls on pumping. Information and data about groundwater conditions are limited. Nonetheless, they suggest groundwater resources may not provide the level of long-term reliability which water suppliers seek when developing a source of supply.

DISCUSSION

Administrative actions that promote or affect coordinated water service planning and the consolidation or regionalization of water systems are discussed below.

WATER SYSTEM INTERCONNECTIONS

Municipal and regional water supply issues have received increasing attention from Willamette Basin residents. The Portland metropolitan area is experiencing rapid population and economic growth which is causing concern about the adequacy of water supplies and water quality. These issues are equally important to less populated areas and more isolated communities throughout the Willamette Valley.

Cities and water districts historically have developed individual water supply systems. A multitude of domestic and municipal water suppliers operate in the basin. In the Portland metropolitan area, the Portland Water Bureau, South Fork Water Board, Clackamas Water District and other water suppliers convey surplus water to other water districts and cities. Surplus water is water that a municipal entity has the right to divert but is not using. Surplus water is delivered through existing system interconnections.

The marketing of surplus water provides some users, such as Clairmont Water District, with its main source of water. Water providers often purchase surplus water to meet peak demand and supplement supply. Often the recipients of surplus water do not have the financial ability to develop diversion, distribution and treatment facilities. Groundwater and surface water quality and availability often makes developing water supplies difficult. Therefore, it is often less costly to purchase surplus water than to develop new sources.

Most water utilities recognize the need to have back-up water systems to augment supply. Many municipalities and districts have constructed links to other systems as a precautionary measure. If conveyance or treatment facilities fail, other sources of water can be tapped to maintain service. The recent discovery of contaminated municipal wells in Milwaukie illustrates the importance of having back-up water sources. The closeness and interconnection to the Portland water system allowed Milwaukie to purchase water and maintain service to its residents.

Municipal water suppliers who lack back-up water sources should consider linking their water system to an adjacent system. This would avoid total dependence upon one water source. A common method used to arrange system interconnections has been intergovernmental agreements between municipal water suppliers.

RECENT LEGISLATION

In 1987 and 1989, the Oregon Legislature amended statutes authorizing the formation of regional water supply authorities. These actions were taken in response to the need for greater flexibility and efficiency in the use of water resources. Yet the Legislature did not mandate or explicitly propose the formation of water supply authorities or the consolidation and regionalization of water supplies.

In 1987, the Legislature enacted legislation allowing the creation of water supply authorities by one or more cities or districts (ORS Chapter 450). The 1989 Legislature passed Senate Bill 1118 and companion House Bill 2936. Senate Bill 1118 allows partial, or incremental perfection of municipal water rights. It also encourages consolidation and regionalization of water service by allowing water to be severed from the land and marketed as long as:

1) The rate and use of water does not exceed that of the original water right certificate, and

2) The water is used on lands acquired by annexation or merger, or consolidation or formation of a water supply authority, or

3) The use continues to be for municipal purposes.

Specifically, the legislation provides for issuance of new water right certificates to municipal corporations that combine services or form water supply authorities. The new water right keeps the priority date of the original right. Water supply authorities may also acquire municipal water rights from cities and districts. Administrative rules that establish procedures to carry out the provisions of the bill were adopted by the Water Resources Commission in the fall of 1990.

Before enactment of Senate Bill 1118, a municipality had to prove that it was using the permitted quantity of water before it could receive a water right certificate. The municipality could obtain a water right certificate for a lesser quantity of water. However, the quantity of water not covered by the certificate would lose the priority tied to the permit. The recently adopted administrative rules allow municipalities to obtain a water right certificate for at least 25 percent of the water authorized by permit without losing the priority on the unused quantity.

Before passage of Senate Bill 1118, only water right certificates were transferable. The new transfer provisions allow a change in the point-of-diversion if water rights have been merged or consolidated during the formation of a water supply authority. Further, if water use remains for municipal purposes or within the boundaries of a water supply authority, the place-of-use can be severed from the land. Water then may be used anywhere within the boundary of the service area as long as the use is compatible with local comprehensive land use plans.

The 1989 Oregon Legislature also enacted Senate Bill 205 which sets new standards for interbasin transfers of water. It requires the approval of the Legislature for interbasin transfers of more than 50 cfs. The bill also requires the applicant to provide an analysis of how an out-of-basin or out-of-state transfer would affect the basin of origin. The analysis must include estimates of water available for future appropriation in the basin of origin. The analysis also must examine projected future needs in the basin and any loss of benefits derived from return flow. In addition, the applicant must assess alternatives to the proposed transfer.

Municipalities need not meet this requirement if they have historically transported water between basins and are proposing additional interbasin transfers to develop regional water service. Thus, the requirements imposed by the legislation will only affect potential new municipal water users who have not historically imported water from another basin. The Water Resources Commission adopted administrative rules in early 1991 that describe how the legislation will be carried out.

These two pieces of legislation include elements that promote consolidated or regional water systems. Both grant greater latitude in the use of water to water suppliers that consolidate or regionalize water service.

RESERVATION OF WATER FOR FUTURE ECONOMIC DEVELOPMENT

Senate Bill 140 authorized state agencies to request that the Water Resources Commission reserve unappropriated waters to aid future economic development (ORS 537.356). A reservation of water requires a public interest determination.

The Oregon Department of Agriculture has requested that water be reserved for future agricultural purposes. The ODA's concern centers on whether there will be enough irrigation water available in the Willamette Basin to support future production of high value crops.

The field burning controversy is one of the factors fueling ODA's request. Grass seed production yields good profits to producers and usually does not require irrigation. A ban on field burning may change agricultural cropping patterns. The ODA assumes that many growers would convert from growing grass seed to another crop of equal or higher value. Different crops may require irrigation.

The ODA estimates that by the year 2010, twice as much land in the basin will be irrigated than is irrigated presently. This increase in acreage would require the use of nearly twice as much water. The ODA further predicts that nearly 70 percent of the irrigation water used in the year 2010 will be surface water.

The opportunity to reserve water for future economic development could be useful to municipalities. However, ORS 537.356 and administrative rules (Chapter 690, Division 79) governing the review and approval of reservations only allow state agencies to reserve water. A state agency could apply for a reservation of water on behalf of a municipality.

The Water Resources Commission may also set aside quantities of water for specific purposes in its basin programs without receiving a request from a state agency. The Commission thus allocates water by classifying the types of uses for which unappropriated water can be used. This is a different process from that identified with ORS 537.356. Stream classifications may change with later basin updates.

The Commission could choose to reserve water for municipal supply and stipulate that the water be used in a regional supply framework.

AGENCY JURISDICTION AND AUTHORITY

The jurisdictional authority over municipal and domestic water service is not always clear. Municipalities (incorporated cities) typically act as the primary providers of urban services within urban growth boundaries. It is not clear which entities have the jurisdictional and regulatory powers to carry out the consolidation and regionalization of water services. The following discussion explores the various jurisdictional authorities that are available to foster consolidation of water services.

State Water Policy

One avenue for effecting consolidation or regionalization of services is through policy development and implementation. Oregon Revised Statutes (ORS) Chapter 536 identifies the basic policies that guide water resources administration in the state. These sections call for coordinated, integrated state water resources policy.

ORS 536.300 grants the Water Resources Commission the authority to formulate an integrated, coordinated program for the use and control of Oregon's water resources. ORS 536.300(3) specifically addresses procedures for adopting and amending basin programs. It makes the basin planning program an important part of the statewide water resources program.

The Water Resources Commission and Water Resources Department must consider a host of "purposes and policies" when formulating a state water resources program. The purposes and policies are found in ORS 536.310. They include existing rights, economic development, human consumption needs, local watershed development, storage, groundwater quality, wildlife, minimum perennial streamflows, watershed management, recreation, state sovereignty, and public beneficial uses.

ORS 536.360 requires that the activities of state agencies and public corporations conform to a statement of state water resources policy. Adopted river basin programs and plans create a statement of state water resources policy. The statute reads:

> In the exercise of any power, duty or privilege affecting the water resources of this state, every state agency or public corporation of this state shall give due regard to the statements of the commission and shall conform thereto. No exercise of any such power, duty or privilege by any such state agency or public corporation which would tend to derogate from or interfere with the state water resources policy shall be lawful.

A 1958 Oregon Attorney General's opinion interpreted ORS 536.360 to mean that agencies and public corporations must recognize the policies contained in a basin program. The Commission derives its ability to formulate policy from ORS 536.310 and administrative rules. The opinion says that the Commission can expect conformance to its policy if it is clear what the policies intend to accomplish.

Among the list of the policies and purposes the Commission shall consider when formulating a water resources program according to ORS 536.310 is the following:

> (3) That adequate and safe supplies be preserved and protected for human consumption, while conserving maximum supplies for other beneficial purposes.

Preserving and protecting water for human consumption is a high priority of the Commission. The conservation and efficient use of water is equally important to allow for other water uses. Commission actions to promote consolidated or regional water systems would meet both objectives of the policy.

The Water Resources Commission could seek expansion of its authority. It could use expanded authority to compel local, coordinated water service planning and consolidation of services. The Water Resources Commission can indirectly influence consolidation of services. Currently, it does not necessarily have broad authority to compel consolidation of services and the interconnection of water systems.

The Water Resources Commission has promoted consolidation of services through permit review by restricting or eliminating other options for obtaining water supplies. However, permit review occurs on a case-by-case basis. Permit review applies only to new applicants and to applicants that request additional time to apply water to beneficial use. Permit review has no affect on water purveyors who hold perfected water rights. This approach does not provide a systematic method for dealing with the issue of water supply management. However, legislative action should be considered only after the Commission has exhausted all options within its current authority.

The Water Resources Commission has regulatory authority over the use of water. The Water Resources Commission has not thoroughly tested all its regulatory powers. The Commission could direct the Department to review administrative rules and identify those that hasten consolidation of services. The Commission's administrative rules are wide ranging. The rules govern permits, waste of water, water conservation, serious water management problem areas, compliance with land use laws and other issues. Such an analysis would clarify whether the Commission has administrative tools to foster consolidation of water services. Such an analysis would clarify whether or not the Commission needs additional administrative tools.

The Water Resources Commission regularly amends administrative rules as the Legislature enacts new laws and as needs arise. The Department recently amended administrative rules governing water use applications, permits, certificates and transfers. As a part of this process, the Commission adopted rules implementing Senate Bill 1118. However, the rules only carry out the legislation. The rules do not speak directly to the issue of fostering regionalization or consolidation of water services.

State Land Use Planning Policy

Oregon's land use planning process provides another means of promoting coordinated water service planning and consolidated or regional water systems. The Land Conservation and Development Commission (LCDC) is the policy-making body that sets the standards for Oregon's statewide planning program. Oregon's standards for land use planning are set forth in 19 Statewide Planning Goals. The Goals are the framework for the planning program. They form the state policies for land use, resource management, economic development and citizen involvement.

ORS 197.005(3) requires local governments to "promote and manage the local aspects of land conservation and development for the best interests of the people within their jurisdictions." Statewide land use planning Goals 5 (Open Spaces, Scenic and Historic Areas, and Natural Resources) and 6 (Air, Water and Land Resources Quality) direct local governments to inventory and protect water resources. The goals also include reference to water resources for agricultural lands, forest lands, natural hazards, the Willam-ette River Greenway, and the coastal resource areas. Goal 11 (Public Facilities and Services) provides planning guidelines for developing an orderly and efficient arrangement of public facilities and services.

The goals are achieved through local comprehensive planning. Comprehensive plans provide overall guidance for land use, economic development, and resource management. Locally adopted plans must be consistent with the statewide planning goals. An adopted and acknowledged plan may be changed through amendment or periodic review.

Statewide land use planning Goals 5 (Open Spaces, Scenic and Historic Areas, and Natural Resources), 6 (Air, Water and Land Resources Quality) and 11 (Public Facilities and Services) and their corresponding administrative rules affect water development. However, the goals do not specifically identify guidelines and implementation strategies for regional water supply management. Goal 11 could be amended so comprehensive planning for public facilities and services addresses regional water supply management.

Amendments to Goal 11 could set up guidelines that prompt local governments and special districts to analyze water availability and the adequacy of present supply. This would help municipalities identify future needs within urban growth boundaries/service areas. In addition, it would focus planning on developing strategies to meet long-term needs. An obvious strategy centers on consolidating services or regionalizing water supply services. This concept embraces coordinated planning between adjacent water purveyors. Coordinated planning can lay the groundwork necessary for linking together water systems on a regional basis.

The Water Resources Commission would have to work closely with the Land Conservation and Development Commission and the public to amend statewide goals. The Water Resources Commission would have to show the need for amendment to the goal as required by ORS 197.230.

The Land Use Planning Act requires not only cities and counties, but also special districts and state agencies to follow statewide planning goals. Special districts and state agencies comply with the goals by carrying out their programs in harmony with acknowledged local plans. ORS 197.185 directs special districts to coordinate the development of district plans with plans of affected units of local government. It directs them to enter cooperative agreements with counties. It also directs them to identify strategies to bring district plans into compliance with acknowledged comprehensive plans.

The extent to which these directives have been implemented varies between counties. More often than not, special district involvement in land use planning has been limited to participating in the development of public facilities plans. Fully integrating water management with land use planning will require special districts to be more active in the local development of land use policy.

ORS 197.180 directs state agencies to "carry out their planning duties, powers and responsibilities in compliance with [the land use planning] goals in a manner compatible with comprehensive plans and land use regulations" of local governments. Accordingly, the Water Resources Commission must make sure that its management actions acknowledge the authority of local governments. Rules adopted by LCDC require agencies to develop and implement State Agency Coordination (SAC) programs. The SAC programs set up a framework that guide agency actions so they are compatible with local land use plans.

The Water Resources Commission adopted a SAC program (OAR Chapter 690, Division 5) in June 1990. The program provides a mechanism for balancing state and local roles in water resources management. The SAC program establishes procedures to resolve land use related disputes between WRD and local governments. The program also sets forth the Department's land use compatibility strategies.

It is both the intent of the Legislature and the goal of the Commission to achieve compatibility between state and local land use actions. If conflicts arise, the Department will negotiate with the local government in an effort to solve the problem. Failing that, the Department may consult with the Department of Land Conservation and Development about means to resolve the conflict. The Department may choose to deny, condition, or further restrict an action or program as allowed under OAR 660-30-070. Ultimately, the Water Resources Commission must fulfill its statutory water management mandate but must document the reason for any action which is incompatible with local plans.

ORS 197.640 sets up a process for periodic review of acknowledged comprehensive land use plans. During periodic review, local governments act to bring plans and regulations into compliance with the land use goals. They also act to make comprehensive plans and regulations consistent with new state programs developed after acknowledgment of the existing plan.

The Department's SAC program identifies the Department's procedures for participating in periodic review of comprehensive land use plans and providing technical assistance to local governments. The participation in periodic review of comprehensive plans gives the Water Resources Commission the opportunity to affect local water policy. Most of Oregon's local governments have not used their land use planning authority to promote the consolidation or regionalization of water services. The Commission can encourage counties and cities to consider important local water issues during periodic review. Local governments can address those issues by adopting appropriate policies and regulations in their land use plans and codes.

Local Government Boundary Commissions

The Oregon Legislature statutorily created two local government boundary commissions to secure the orderly development of public services in the state's urban areas. The Portland Metropolitan Area Local Government Boundary Commission has jurisdiction in Washington, Multnomah and Clackamas counties. The Lane County Local Government Boundary Commission has jurisdiction in Lane County (ORS 199.425). These boundary commissions control annexations and district service area expansions. This power allows the boundary commissions to control the quality and quantity of public services in urban areas. This power extends to the provision of water. The commissions also provide an impartial forum for the resolution of intergovernmental disputes. Boundary commission actions, like other state agency actions, must be compatible with local comprehensive plans.

The two boundary commissions play an important role in promoting or discouraging the consolidation of water services in the basin. As noted earlier, the Clackamas River drainage is an area of the basin that could benefit from a regional approach to water supply management. Several municipalities and water districts use the Clackamas River as a source of supply. Most municipal users divert and distribute water in relatively close proximity to each other. In 1989, the Clackamas Water District proposed forming a water supply authority. The proposed water supply authority would combine the assets of the Barwell Park and Clackamas Water Districts. The Portland Metropolitan Area Boundary Commission denied the proposed formation of a water supply authority.
The Boundary Commission cited several reasons for denying the proposal. First, part of the proposed water authority service area boundary included lands within the urban growth boundary of Milwaukie. Second, the Portland Metropolitan Boundary Commission determined that the proposed water supply authority would further fragment public services in the area. The Boundary Commission staff report said the water supply authority proposal did not in-

clude dissolution of the existing districts. It stated that formation of the water supply authority would unduly complicate the provision of water service to the proposed service area. The Boundary Commission staff report concluded that the proposed water supply authority would encompass only a small part of Clackamas County. It stated that the statutes authorizing water supply authorities envisioned regional and sub-regional solutions to water supply problems. The Boundary Commission staff felt this proposal did not provide the large-scale solution to water supply issues envisioned by statute.

As an alternative, the Boundary Commission staff proposed a merger between Barwell Park Water District and Clackamas Water District. However, the Boundary Commission decided this was not an acceptable alternative. The Boundary Commission stated, "Long term water supply for the north Clackamas area needs to be dealt with on an areawide basis with all those in the basin or utilizing water from the basin as participants in the process. Merging these two districts at this time would not in and of itself lead to an areawide approach."

The Boundary Commission decision did not define what constitutes an acceptable areawide approach to water service. Nor did it make an areawide approach to water service a requirement for consolidation of services. Rather, the decision appears to encourage some level of consolidation that effectively provides for long-term water supply service in the area.

Boundary commissions do not have the power to force regionalization of water services. However, they can foster regionalization as an arbiter in intergovernmental disputes over extension of water services. Additionally, boundary commissions can lead the way towards consolidation and regionalization of water services. They can do so by preventing piecemeal service area extensions that do not promote regional water supply management. At the same time, boundary commissions may take actions that impede efforts to consolidate services.

ANOTHER APPROACH TO WATER SYSTEM COORDINATION

The State of Washington provides an example of a legislated solution to public water service coordination. In 1977, the Washington State Legislature enacted the Public Water System Coordination Act to solve problems associated with the unplanned proliferation of public water supply systems. These problems included:

- Proliferation of small systems;
- Inconsistency of design;
- Overlapping of service areas;
- Conflicts between land use and water system plans; and
- Duplication of facilities.

The Act aims to:

1) Achieve organized development of water utilities within a given geographical area; and

2) Integrate water system development with land use planning in a given geographical area.

The Act created a process and provided funding for coordinated water service planning and water system construction. The first step in the coordinated planning process is a preliminary assessment of water systems and potential problems. Either city governments or the state may initiate a preliminary assessment of conditions. This assessment addresses the status of water service and land use planning, and describes the lack of coordinated planning between the two.

If the preliminary assessment reveals water quality or service related problems, an area may be designated a Critical Water Supply Service Area. The counties or Washington Department of Social and Health Services may request formation of a Critical Water Supply Service Area. Upon declaration of a Critical Water Supply Area, a committee is appointed to prepare a Coordinated Water System Plan. The entity requesting the critical area designation appoints the committee. The committee includes representatives from the county, county planning agency, county health agency, water purveyors with over 50 connections and Department of Social and Health Services. Other agencies, purveyors, or interested persons may be appointed to the committee.

The Coordinated Water System Plan is a water system plan for all water systems in the critical supply area. It sets up standards, service areas, and criteria for the construction of new systems. The plan is based on local land use plans and policies. It must address proposed projects and regional water supply concerns.

Washington's approach to solving its public water supply problems provides for a state/local partnership. The approach relies on the legal authority of local governments to manage the growth and development of water systems. Unlike Oregon, Washington does not have a statewide land use planning program. The Act serves as a local land use tool to manage growth and development of water services. In addition, coordinated planning is eligible for state-funded grants that pay 50 percent of planning costs. Construction projects identified by coordinated plans are eligible for a 40 percent cost-share grant.

Legislation similar to Washington State's Public Water System Coordination Act would set up a process for coordinated local planning of water services. A joint effort by the Commission and the Health Division conceivably could convince the Legislature of the need for water service planning legislation. The two agencies could propose an entirely new piece of legislation. Or, the water supply authority legislation could be amended to include features of Washington's law. However, state participation in funding such a program would likely raise concerns about its effect on the state budget.

Alternatively, Commission policy could be coupled more closely with existing land use planning guidelines to achieve results similar to Washington State's legislation. Existing programs do not provide direct funding mechanisms to aid local planning efforts. Washington State's program included funding mechanisms both as an incentive and a means to solve water supply problems.

Oregon's own comprehensive land use planning process contains most elements of the Washington approach. Land use planning in Oregon already emphasizes local management of resources. The Water Resources Commission's basin programs and statewide policies combine with local planning to create a state/local partnership for water management. Absent from Oregon's process is a grant program for coordinated planning. This may change if the Strategic Water Management Group recommendations lead to the state funding the development of coordination agreements.

MANAGEMENT PROPOSALS

Policy

> Support coordinated water service planning and consolidation by water purveyors to preserve and protect adequate safe drinking water supplies for human consumption in the Willamette Basin.

Implementing Actions

1) Assist the Department of Land Conservation and Development, counties and special districts to update or develop the mandatory planning agreements between counties and districts required by ORS 197.185 to consolidate or regionalize urban services.

2) Participate in the periodic review and amendment of comprehensive plans with the objective of enhancing water-supply management and protection consistent with Statewide Planning Goals and an adopted policy on municipal and domestic water supplies. Review comprehensive plans for compliance with basin policies and the Statewide Planning Goals using criteria, including but not limited to, the following:

a) Goal 5: *Open Spaces, Scenic and Historic Areas, and Natural Resources* - Local governments should inventory and establish management and protection strategies for existing and potential sources of water supply before developing new supply sources. The inventory should include the water supplies of adjacent water purveyors and opportunities for water conservation.

b) Goal 6: *Air, Water and Land Resources Quality* - Local governments should identify areas of water quality problems and analyze the effect of options for water supply service and development of regional water supplies on water quality.

c) Goal 11: *Public Facilities and Services* - Local governments should analyze water availability and the adequacy of supply and quality to meet future demands within the urban growth boundary and within any additional service areas, consistent with a standard water planning time horizon. The analysis should reflect:

   i) Projected populations and land uses within the affected urban growth boundary or service area;

   ii) Economic forecasts for industrial and commercial water needs;

   iii) Opportunities for water conservation;

   iv) The feasibility of meeting future needs by consolidating or regionalizing water supply services. A feasibility analysis should examine:

      - Economic, demographic, socio-political, environmental, regulatory and physiographic trends.

      - Opportunities to execute agreements between adjacent water providers for cooperative development and operation of water supply and distribution facilities.

   v) The viability of interconnecting systems and regional management of water supplies. Where water systems abut, or future extensions will abut other systems, local government or district plans should address:

      - The compatibility of system design, transmission sizing and pressure with adjacent systems;

- The compatibility of system operations, including but not limited to rate structures and use of meters;
- Land ownership patterns (public and private) and associated implications for the consolidation or regionalization of water services;
- The effect of water supply authority, county service district or regional water supply system service plans on undeveloped and land with potential for urbanization outside a current urban growth or water district boundary.

3) Through the State Agency Coordination Program and other activities, assist local governments and water providers in taking these actions to coordinate planning, consolidate services and develop regional water supplies.

4) Continue working with regional organizations like the Metropolitan Service District and the Tri-County (Polk, Yamhill, Lincoln) regional water planning committee to plan or coordinate development of long-term water supplies for the region.

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Section 5

STATE COORDINATION IN CORPS OF ENGINEERS REGULATION OF WILLAMETTE SYSTEM RESERVOIRS

PROBLEM STATEMENT

Operation of the Willamette Basin system of reservoirs by the U.S. Army Corps of Engineers (Corps) is vital to water management in the Willamette Basin. Water stored in the reservoirs helps reduce the frequency and intensity of floods. This stored water is a source of irrigation, municipal and industrial water supply. Stored water also provides flat-water recreation opportunities. Water released from storage produces power, contributes to maintenance of water quality and supports fish migration and habitat. Water released from storage also provides free-flowing river recreation opportunities.

Management of the reservoir system is becoming increasingly complex. Congress authorized the construction and management of the reservoir system for specific purposes. However, water stored in the reservoirs or released from storage also is used for purposes that were not explicitly authorized by Congress. Both the state and the public now recognize that unauthorized uses provide a wide array of benefits. Operation of the reservoir system should provide for these uses.

The Corps works with the state to develop an annual plan for reservoir operations. Through the plan, the Corps seeks to meet its operational obligations while also striving to accommodate state resource management objectives. Federally imposed obligations may conflict with state management objectives, and it is not always possible to satisfy both.

Congress has authorized a study to reexamine the operation of the Willamette Basin reservoir system. The Corps study will also examine the allocation of water stored in the reservoirs. The study was initiated because the nature of water use has changed substantially since the reservoirs were first authorized. The outcome of the study could lead to Congressional action that changes the way the Corps operates the reservoir system.

BACKGROUND

Twenty-five major dams operate in the Willamette Basin. Eleven dams are single-purpose hydroelectric projects operated by private and public utilities. The Corps operates 13 reservoirs, 11 as multiple-purpose storage reservoirs and two as reregulating dams for power projects (Table 54). The location of the 13 reservoirs are shown in Figure 50. One multipurpose project is managed by the Tualatin Valley Irrigation District for the U.S. Bureau of Reclamation (BOR).

Table 54

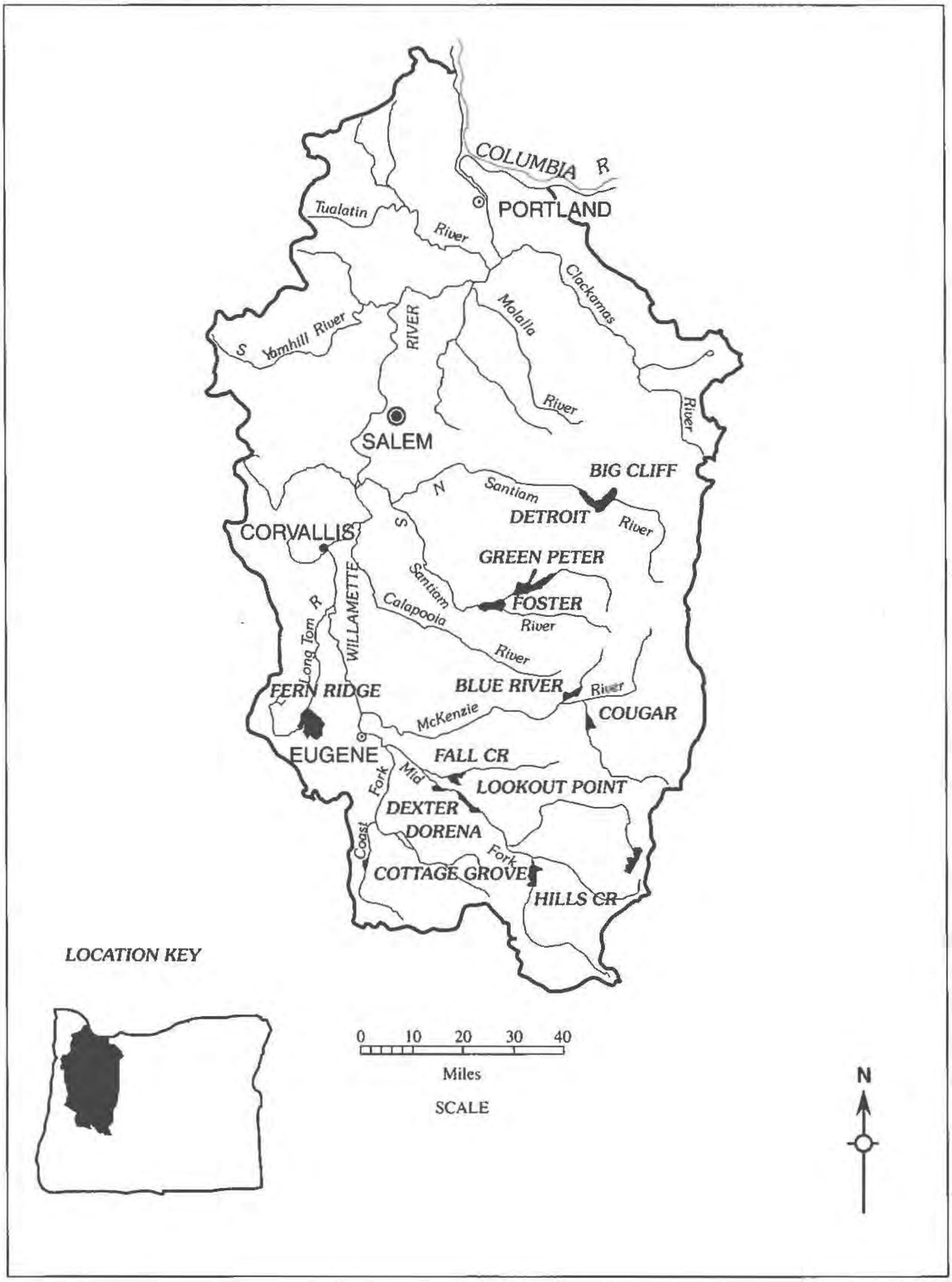
CORPS OF ENGINEERS WILLAMETTE BASIN SYSTEM OF RESERVOIRS

			STORAGE ACRE-FEET				
Project	Power Project	Drainage Area (sq. mi.)	Min. Flood Control Pool	Maximum Conserva-tion Pool	Full Pool	Usable Storage	BOR Permit Irrigation
Hills Creek	yes	389	155,370	350,010	355,570	194,640	194,600
Lookout Point	yes	991	118,760	442,990	455,840	324,230	340,000
Fall Creek	no	184	9,620	117,830	125,080	108,210	107,500
Cottage Grove	no	104	3,140	31,780	32,930	28,640	30,000
Dorena	no	265	7,090	72,050	77,600	64,960	70,000
Cougar	yes	208	63,900	207,760	219,080	143,860	144,000
Blue River	no	88	3,970	82,820	89,520	78,850	79,000
Fern Ridge	no	252	7,170	101,070	116,790	93,900	95,000
Green Peter	yes	277	159,860	409,830	428,110	249,970	250,000
Foster	yes	494	31,070	55,870	60,780	24,800	30,000
Detroit	yes	438	154,380	436,010	455,100	281,630	300,000
TOTALS			714,330	2,308,020	2,416,400	1,593,690	1,640,100

(1) Big Cliff and Dexter re-regulating dams have hydroelectric generating facilities and are not shown.

The Flood Control Act of June 28, 1938, included a comprehensive plan for the development of the water resources of the Willamette Basin. This comprehensive plan is referred to as the Willamette Basin Project. The Willamette Basin Project called for the construction of a system of 21 reservoirs for flood control, navigation, power development, irrigation and other purposes. Not all of the 21 authorized dams were constructed. This is significant since downstream flow augmentation objectives were based on a system of 21 dams. As a result, flow augmentation is met by releasing more water from fewer reservoirs.

Figure 50
U.S. ARMY CORPS OF ENGINEERS WILLAMETTE BASIN RESERVOIRS



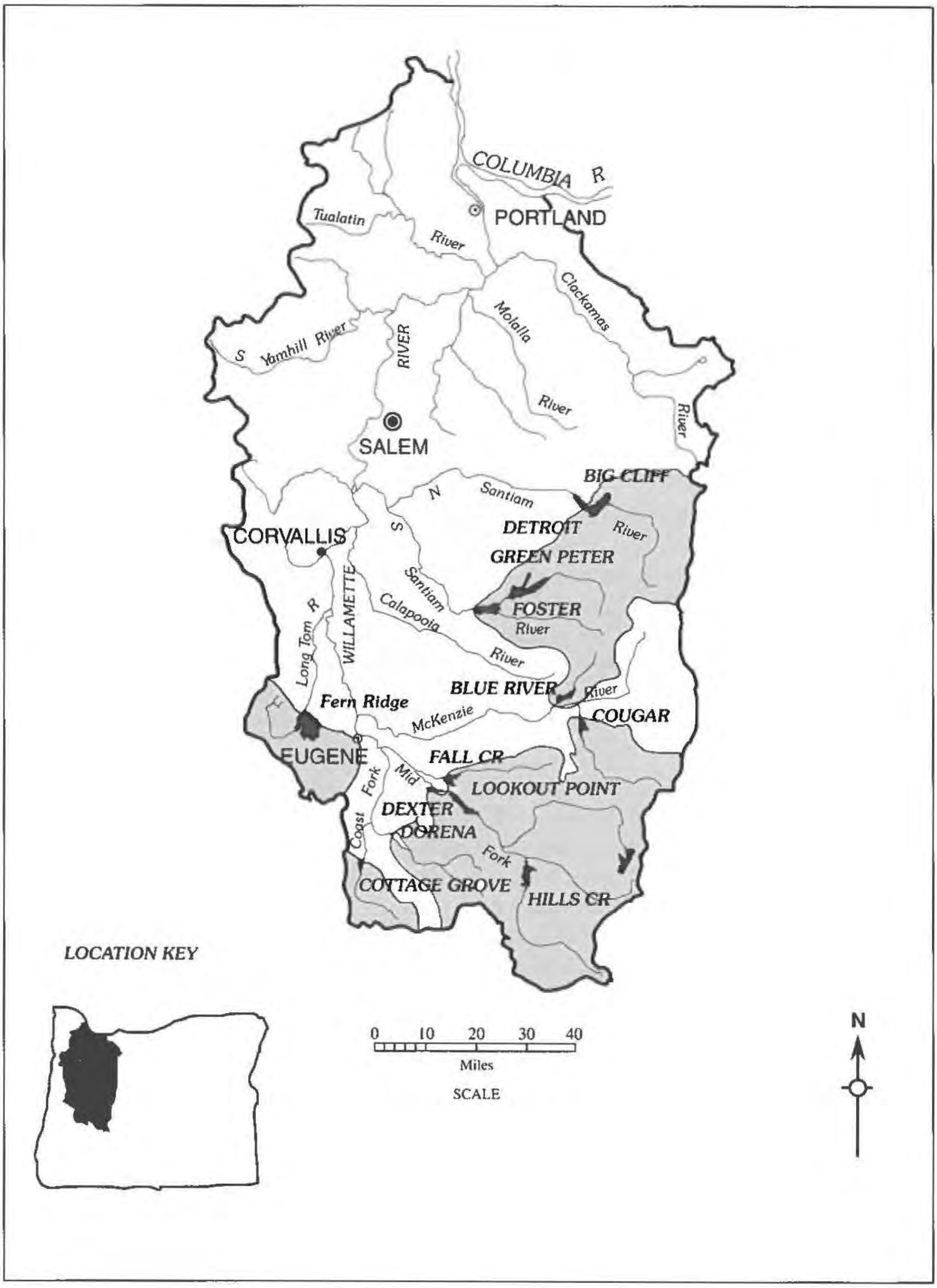
The Corps manages reservoirs for "authorized project purposes." Authorized project purposes for the reservoirs are flood control, irrigation, navigation, power production, and augmenting streamflows to maintain fish life and water quality.

Flood control receives the highest priority because the Flood Control Act of 1936 declares it the primary purpose for Corps involvement in water resource development projects. The Corps reservoirs in the Willamette Basin have a seasonal capacity to store approximately 1.6 million af of water. This seasonal storage capacity is roughly nine percent of the 17,110,000 af (23,610 cfs) average annual runoff of the Willamette River as measured at Salem. The reservoirs are operated to reduce the peak flows associated with large floods. Most reservoirs are designed to control, at the dam site, a flood with an expected frequency of about once in 100 years. These reservoirs control stream runoff from about one-third of the basin (see Figure 51). The Willamette River and its principal tributaries extend for over 1,100 miles. A large percentage of the drainage area is subject to flooding. Because the reservoirs only affect one-third of the basin, the reservoir system cannot totally prevent floods.

Public awareness of flooding impacts appears to have decreased with time since the last major flood event. The last major flood occurred in 1964 and was a 100-year flood. Less intense floods have occurred at varying intervals since 1964. The 1964 flood inundated over 320,000 acres of land in the Willamette Basin. Damage to agricultural and urban lands and improvements were severe. The 1964 flood was the second largest flood of record at Salem. The biggest flood occurred in 1861. Then, the Willamette River rose to a peak stage of 47.0 feet. Flood stage for the Willamette River is 28 feet at Salem. The 1861 flood had an estimated discharge of 500,000 cfs. In 1964, reservoir regulation held the peak flood stage to 37.8 feet, with a discharge of 309,000 cfs. Without the reservoirs, peak flood stage would have been 45.3 feet, with a discharge of 472,000 cfs. Just three years before the 1964 flood, the basin experienced a major flood. Reservoir regulation reduced flood stage by four feet and river discharge from 304,000 cfs to 240,000 cfs.

The flood plain of the basin is primarily agricultural land. Less intense floods that occur with a frequency of once in every 5 or 10 years affect these lands. The economic damages from such floods are less than from more intense floods such as a 100-year flood. At 100-year flood levels, economic damages to urban areas greatly exceed agricultural damages. Urban damages are more severe due to the concentration of high value properties and improvements. In 1979, the Corps estimated the value of land, improvements and personal property within the reservoir-regulated 100-year flood plain at more than one billion dollars. The Corps also estimated that through 1976, the reservoir system had prevented more than $900 million in damages. Urban areas have benefited the most from flood

Figure 51
DRAINAGE AREA REGULATED BY CORPS OF ENGINEERS DAMS



damage prevention. In the 15 years since those estimates were made, there has been increased development in the flood plain. It is likely that the value of both land and improvements and flood damage prevention has increased substantially since 1976.

RESERVOIR OPERATION

The Willamette Basin Project is operated as a system rather than as 13 separate reservoirs. The reservoirs are operated to meet downstream flood control and streamflow objectives.

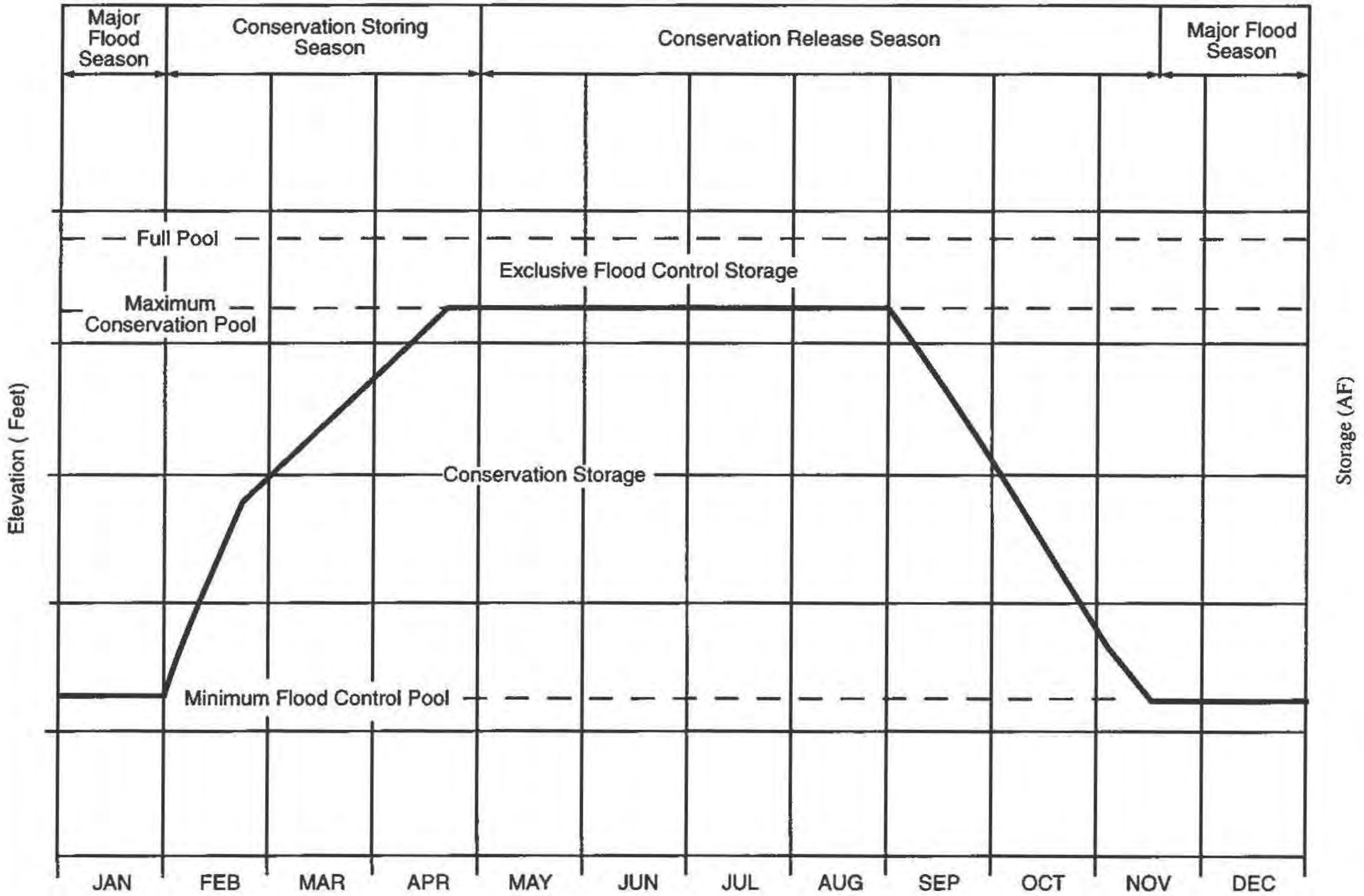
Weather and stream runoff forecasting are an integral part of reservoir operations. The Corps attempts to predict flood conditions and the amount of water available for storage. Long-range forecasting is difficult in the Willamette Basin because the basin does not follow either a strict snow or rainfall precipitation regime, but contains elements of both.

Floods generally occur in December and January. During February and March, most of the runoff is a direct result of rainfall. Storm volumes are not predictable beyond 24 to 48 hours. Snowmelt is the major source of runoff in the spring. In an average year, roughly 70 percent of the runoff to the reservoirs between April and June is produced by the water content of snow. Precipitation after the first of February is extremely important for filling the reservoirs. However, it also is difficult to predict how much precipitation will fall during the reservoir storage season.

Reservoir operations vary by season. The seasonal regulation of each reservoir is guided by a flood control rule curve. Three general seasons are associated with reservoir operations: major flood season, conservation storing season, and conservation release season. A generic flood control rule curve is displayed in Figure 52. The function of the rule curve is to show how much storage space a reservoir should maintain for flood control during any season of the year. The rule curve sets the operational limit for storing water by displaying the maximum allowable elevation (in feet) of stored water in the reservoir.

For safety reasons, the Corps generally will not store water that exceeds the pool levels specified by the rule curve. The Corps may, and often does, deviate below the rule curve. This means reservoir levels may be at less than full capacity allowed by the rule curve and actually provides more storage capacity to control floods. This occurs most often when the Corps draws down the reservoirs after September in preparation of reaching minimum flood control pool by November.

Figure 52
GENERIC FLOOD CONTROL RULE CURVE AND RESERVOIR REGULATION SSEASONS



Major Flood Season

The major flood season generally runs from the middle of November through the first few weeks of February. During this period, the reservoirs are kept at a minimum level to provide a maximum amount of space to capture and control flood waters. This level is the minimum flood control pool shown in Figure 52. Flood control is the operative purpose. During this time, power may be generated as water is evacuated from reservoirs to conform to the rule curve.

After a flood, water is released from the reservoirs at a rate designed to keep streamflow within downstream channel capacity. Flood control operations must balance downstream channel capacities and the amount of reservoir storage space available. The Corps will store water to prevent flows from exceeding downstream channel capacities. Release of flood waters from reservoirs generally does not begin until streams have receded and flow is contained within streambanks.

Conservation Storing Season

The chance of major floods decreases in late February as the frequency and intensity of storm activity lessens. At this time, the space reserved for flood control storage can gradually be filled. The goal is to fill reservoirs by May when the threat of floods has largely passed. Because of the seasonal distribution of flood events, full reservoirs after the first of May generally do not jeopardize flood control. Most reservoirs have a relatively small amount of storage space reserved for summer flood control. If reservoirs have not filled by then, the storage period can be extended as long as there is additional unappropriated inflow to the reservoirs.

During the storage period some of the natural inflow to the reservoir is passed through the dams. Inflow is passed through the dams to satisfy minimum releases required by the authorizing documents (see Table 55). At reservoirs with hydroelectric generating capability, releases may also be used for power production.

Runoff forecasts are essential to power production during the conservation storing season. Forecasts are used to optimize both reservoir filling and power production. When forecasts indicate that there will be more than enough runoff to fill reservoirs, releases can be increased in February and March to produce power. Power generated at the reservoirs produces substantial revenue at the beginning of the storing season when winter power demand is high. Power is in demand in part because the Columbia River

Table 55

FEDERALLY AUTHORIZED/ADOPTED MINIMUM RELEASE FLOWS U.S. ARMY CORPS OF ENGINEERS DAMS

Dams	Adopted Minimum Flow February-June Filling Season (cfs)	Adopted Minimum Flow July-November Low Water Season (cfs)
Hills Creek	100	100
Lookout Point	1,200	1,000
Fall Creek	30	30
Cottage Grove	75	50
Dorena	190	100
Cougar	300	200
Blue River	30	30
Fern Ridge	50	30
Green Peter (1)	500	300
Foster (2)	800	400
Detroit	1,000	750

(1) Minimum flow was waived because it had been established in conjunction with unbuilt Cascadia Dam. Present operation is to release Green Peter in conjunction with Foster inflows to maintain the Foster Reservoir minimum release. The minimum regulated Green Peter flow in May is 450 cfs and 300 cfs in June.
(2) Minimum regulated flow for May is 750 cfs and 600 cfs for June. Conservation purposes include consumptive water uses such as irrigation and nonconsumptive uses such as pollution abatement.

power system has yet to reach peak production. The demand for power decreases as the weather moderates.

Conservation Release Season

Stored water is retained for multiple (conservation) uses, including streamflow augmentation during the conservation release season. The conservation release season, May 1 through November 15, coincides with the seasonal pattern of low runoff. Conservation purposes include consumptive water uses such as irrigation and nonconsumptive uses such as pollution abatement.

The Willamette River met water quality standards for the first time in 1968. The release of water from the reservoirs plus secondary treatment of waste discharged to the river were critical to meeting the standards. Flow augmentation continues to play an important role in meeting future water quality standards by diluting pollutants. It may be necessary to increase future reservoir releases to augment streamflows in order to meet water quality standards. Tertiary (more advanced) treatment of wastes discharged to the river also may be required.

Tertiary treatment is expensive. Increasing the release of water from reservoirs may allow for a long-term, planned introduction of tertiary treatment.

Initially, the Corps planned to release water for streamflow augmentation only from nonpower projects. But the increasing emphasis on managing releases for fisheries and flat water recreation purposes has altered that approach. Now, both power and nonpower-generating projects are drafted to best meet management goals.

Toward the end of the conservation release season, water is evacuated from reservoirs at an accelerated rate to reach the minimum flood control pool by the start of the major flood season in November. At power-generating projects, water is evacuated at turbine capacity. Generally, the pattern of evacuation parallels the flood control rule curve, but at a level below the rule curve.

RESERVOIR COORDINATION

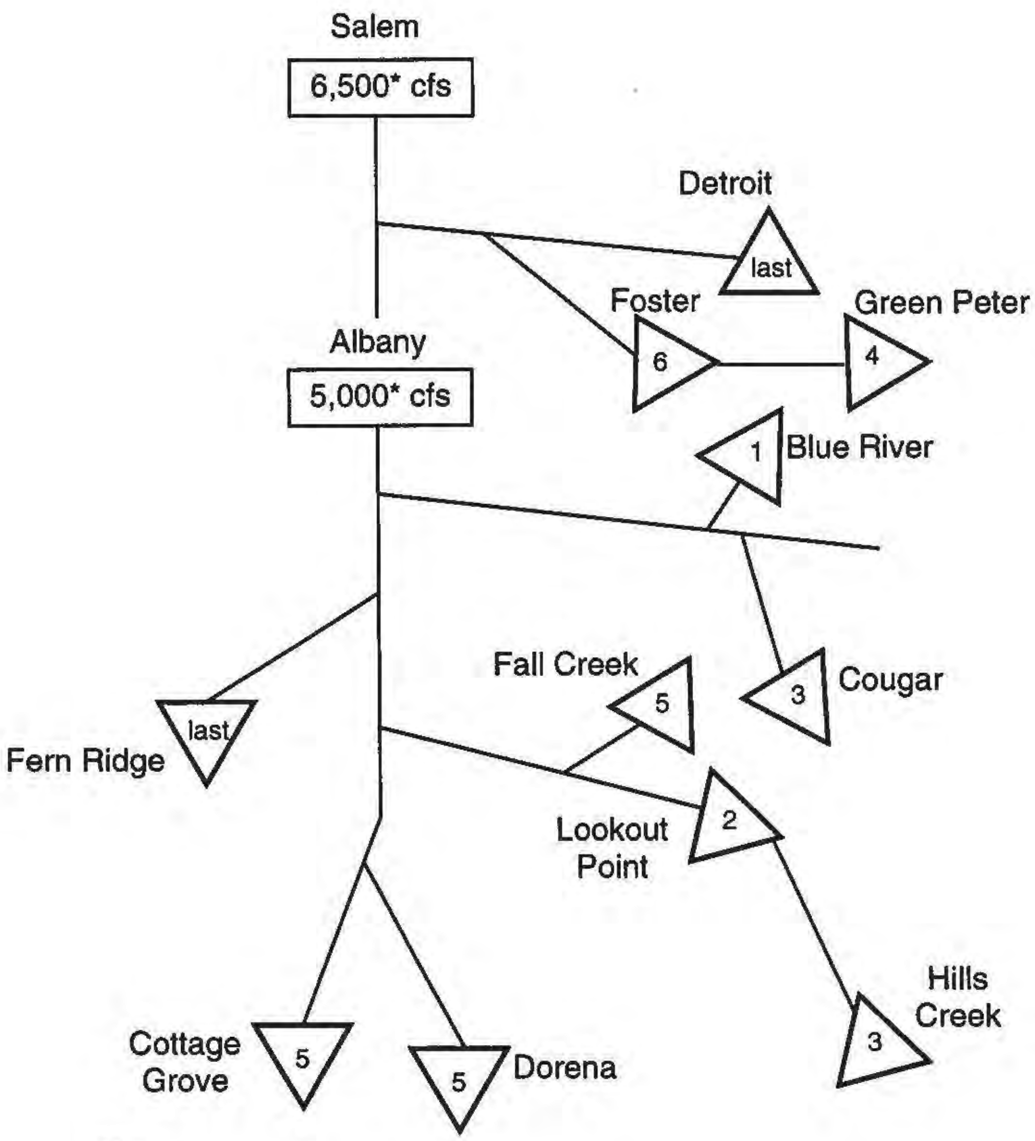
Since 1970, the Corps has held annual meetings at which it presents its draft plan for reservoir operations in the upcoming year. The Corps proposes a method of operation based on an analysis of precipitation and runoff patterns. The plan is oriented toward scheduling for the conservation release season. This release schedule takes into account any special operations linked to maintenance of facilities such as spill gates, turbines and generators as well as standing practices from past years.

The Department was assigned the responsibility for coordinating the state's position on reservoir operations by the Governor. State agencies review the Corps' proposed operations plan, and respond through the Department. Where conflicting requests arise, the Department acts as an arbiter and negotiates a common response to the Corps. The state's position is forwarded to the Corps as a written request.

Over the years, the Department has worked with various state agencies to develop a unified operations request which balances the various needs of the state agencies and the public. The state's request takes into account the expected inflow to each reservoir during the storage season.

In turn, the Corps has traditionally attempted to accommodate a broad range of public benefits through its operation of the reservoirs. The Corps' objective is to develop a collaborative plan with the state for the release of stored water. The plan objectives include keeping selected reservoirs as full as possible during the recreation season while maintaining regulated flows in the Willamette River of 5,000 cfs at Albany and 6,500 cfs at Salem. Figure 53 shows the order of reservoir drawdown.

Figure 53
TYPICAL ORDER OF RESERVOIR DRAWDOWN IN THE WILLAMETTE BASIN (after 1985)



Note:
*Have been subject to interagency management based on water year conditions.

Although these are the authorized flow levels, control of pollutants entering the Willamette River has allowed the Corps more flexibility in meeting these flows. Working in tandem with DEQ, the Corps releases less water than is authorized, but still a sufficient quantity to satisfy water quality needs in the Willamette River. This allows storage of more water in the reservoirs and use of the water for other purposes. Table 56 shows flow levels achieved at Albany and Salem for the years 1980 through 1988.

In 1989, the Corps initiated a series of public meetings in the basin to inform the public about how the Corps proposed to operate the reservoirs for the coming conservation season. The Corps plans to continue these meetings in order to inform and get direct feedback from the public. This process has been used by the Corps in the Rogue Basin for many years with good results.

Table 56

MINIMUM STREAMFLOW TARGETS FOR ALBANY AND SALEM, 1980-1988 (cfs)

Year	July	August	September	October
Albany				
1980	4,500	4,500	6,000	7,300
1981	5,000	5,300	7,000	7,500
1982-86	4,500	5,300	7,000	
1987	4,000/4,500	4,500	4,800	4,800
1988	4,500	4,500/5,000	5,000	6,000
Salem				
1980	6,000	6,000	9,000	10,500
1981	6,500	7,000	9,000	10,500
1982-85	6,000	6,300	8,000	
1986	6,000	6,300	8,800	
1987	5,000	5,500	7,000	8,000
1988	6,000	6,000/6,500	7,000	8,000
*	2,600	1,800	2,400	

* Annual average unregulated flow

WILLAMETTE BASIN REVIEW STUDY

Public concerns about recreation at Fern Ridge Reservoir prompted Congressional authorization of a study to reexamine storage allocations and operations of the Willamette system reservoirs. The House of Representatives Public Works Committee authorized the study in 1988. Funds were appropriated, and the Corps has completed the first phase of the Willamette Basin Review Study.

The first phase, the reconnaissance study, examined whether there is a federal interest in modifying reservoir operations. Generally, the study determined that modifying reservoir operations to increase minimum flows, fill reservoirs earlier, draw them down later, and change the order of drawdown resulted in overall economic gain.

Further work by the Corps on the Willamette System Temperature Control Study (WSTCS) was initially included as part of the reconnaissance study. Phase one of the WSTCS identified the physical outputs and effects of Blue River and Cougar Reservoirs on water temperature in the McKenzie River. It also described and analyzed the effects of Detroit, Foster and Green Peter Reservoirs on water temperature in the Santiam River drainage. The reconnaissance study would have taken this one step further and would have identified the benefits and costs associated with mitigation measures for temperature control at the reservoirs. However, Congress appropriated money for a separate feasibility analysis of temperature control. The Corps is now proceeding to conduct a feasibility analysis at federal expense and without non-federal cost-sharing.

The importance of the Willamette Basin reconnaissance study is twofold. Foremost, the study identifies benefits and costs of alternative management options. Second, it paves the way for sponsors to support the second phase. The second phase, or feasibility study, is a detailed analysis of the cost-effective management alternatives identified in phase one.

The feasibility study likely will take an additional 3-4 years to complete. Before a feasibility study can be initiated, nonfederal sponsors willing to share in the costs of further studies and potential projects must be identified. Sponsors then must enter into a feasibility cost-share agreement with the Corps.

DISCUSSION

This subsection explores the following questions:

1. How can the reservoir system best be operated within the framework of existing Congressional authorization?

2. Should the state change the way it coordinates its involvement in the development of the Corps' annual plan for operating the reservoirs?

3. How can stored water be used to maximum benefit if the authorization governing reservoir operations is modified as a result of the federal study?

OPERATION OF THE RESERVOIR SYSTEM WITHIN THE FRAMEWORK OF EXISTING CONGRESSIONAL AUTHORIZATION

Little of the 1.6 million af of water stored and allocated to irrigation has been contracted (purchased) for delivery. Release of this uncontracted water is largely at the discretion of the Corps. The reservoir coordination process is a cooperative effort by the Corps and the state to manage the release of uncontracted water. The annual plan of reservoir operation attempts to meet the management objectives of numerous federal and state agencies and local governments.

The management objectives of different state agencies sometimes conflict with each other. This is partially a function of the mission of each agency. For example, the State Marine Board is responsible for regulating motorized boating. Several of the reservoirs receive heavy motorized boating use. The State Marine Board would prefer to see certain heavily used reservoirs remain full, or near full, throughout the recreation boating season. On the other hand, the Oregon Department of Fish and Wildlife and Department of Environmental Quality may want water released from storage. Storage releases augment streamflow for fishery purposes and help meet downstream water quality standards.

In additional, local governments and private concerns would like to see certain reservoirs remain full throughout the summer. Full reservoirs mean increased recreation use. Increased recreation use often translates into economic returns to the local economy. Drawdown of reservoirs may adversely affect recreation use linked to the reservoirs. Although stream-flow augmentation can improve river recreation, the economic return to the local economy is generally less than from intensive flat-water recreation.

Reservoir Operations and State Management Objectives

Completion of both phases of the Corps' Willamette Basin Review Study to examine reservoir operations will take roughly five years. It may take even longer to implement the management recommendations resulting from the study. This means coordination between the state and the Corps will remain the likely method for managing stored water for at least several more years.

The coordination process attempts to balance the state's management objectives with the Corps' authorizations. The flexibility to manage any one reservoir is limited by the project authorization. Additional limitations are imposed by the streamflow augmentation goals for the Willamette River at Albany and Salem. Contracts for use of stored water in any reservoir legally obligate specific reservoir releases. The flood control rule curve further limits management options and flexibility at both ends of the storage season.

Coordinating state input into reservoir operations has not been a high profile activity of the Department. However, it has been gaining in importance. The 1987 and 1988 water years reinforced the importance of the coordination function. These generally were below normal water years. The Department devoted more resources to its coordinating function and worked closely with the Corps and state agencies to develop operating plans that squeezed the most use out of limited resources. Agencies were forced to make hard decisions and rank water needs according to importance. In many cases, lower-ranked water needs were sacrificed to sustain high priority water needs.

One of the management options that emerged from this experience was the development of management objectives based on hydrologic parameters. Management objectives are decidedly different when hydrologic conditions are below normal.

Real-time adjustments to operating plans do not always fit neatly into the annual plan of operation but are sometimes necessary to match changing resource conditions. Adjustments to the operating plan often are made if the effect is minimal or does not jeopardize operations designed to satisfy authorized purposes.

The following discussion describes the site-specific conditions that drive the state's decision-making process within the existing federal-state coordination framework. It also lays out identified management objectives during average and better water conditions as well as below normal water conditions. At this time, given existing conditions and data, these management objectives describe the state's initial position on system operations. The annual review process is described in more detail in the next section.

Cottage Grove and Dorena Reservoirs

These reservoirs in the Coast Fork Subbasin have no power-generating facilities and the Corps uses them for downstream flow augmentation. The relatively small storage volumes (Table 54) preclude extensive downstream flow augmentation. Despite the absence of power facilities, local interests prefer that the Corps release water for flow augmentation from other reservoirs before releasing water from these two because of recreation use.

ODFW supports native and stocked trout fisheries in and downstream of each reservoir. Mercury that leaches from a mine site above Cottage Grove Reservoir creates concern about water quality in the reservoir as well as downstream of the reservoir.

Management Objectives

All Years

ODFW: Normal reservoir drawdown procedures are preferred under both good and bad water supply conditions. Maintenance of minimum streamflows is essential to support fish life during dry periods, and thus a high priority of the agency.

Deviation from normal scheduling generally has been within acceptable fish resource tolerance limits. ODFW requests that the Corps consult with it and other appropriate agencies and provide them with advanced notice of any proposed adjustments to reservoir operations.

WRD: Meeting the downstream objective of a minimum streamflow of 2,000 to 2,500 cfs in the Willamette River at Eugene is dependent upon reservoir releases. Satisfying this objective is a high priority of the Department.

Dexter and Lookout Point Reservoirs

Dexter is a run-of-river, hydroelectric, reregulating dam located downstream of Lookout Point Reservoir on the Middle Fork Willamette River. It catches water released from Lookout Point Reservoir and uniformly regulates the outflow. Lookout Point is a large reservoir equipped to produce power.

Lookout Point Reservoir has not been extensively developed for recreation. It does not receive much recreational use even though it is only about 20 miles from Eugene. Lake drawdown and limited boat access are the primary reason for low recreation use. Dexter Reservoir, although considerably smaller, has better recreation facilities and receives more use than Lookout Point Reservoir.

The Corps is contemplating development of a boat ramp on Lookout Point Reservoir (North Shore Boat Ramp.) The proposed boat ramp would allow access to the low point of the fluctuating reservoir pool. The idea is to develop year-round boater access to the reservoir. This also will accommodate development of a lake fishery. Lake fisheries generally adapt well to fluctuating reservoir levels.

Development of year-round boater access highlights a potential management concern. As recreation has become well developed on reservoirs, the public has lobbied the Corps to keep reservoirs full throughout the conservation release season. Releases are necessary to meet downstream water quality and fishery needs. Presently, the Corps drafts Lookout Point Reservoir for flow augmentation. Development of year-round recreation may produce public pressure to keep reservoir levels higher than at present. As long as the public is aware and accepts that Lookout Point Reservoir will experience fluctuating pool elevations, improved access poses no management conflicts.

In recent years, the Corps has moved Dexter and Lookout Point up in the order of reservoirs that are drafted for downstream flow augmentation. The Corps foregoes power generation in the fall to augment streamflow during the summer conservation season.

Releases from Dexter Reservoir can create problems during the spawning season of anadromous fish. The majority of spring chinook spawning occurs between September 15 and October 15. Fall reservoir releases must be adequate to reach minimum flood control pool by the start of the major flood season in November. If the reservoir is relatively full, a large volume of water must be released.

Anadromous fish may spawn in gravels that are covered by this release. If the following spring is relatively dry, reservoir outflow may be scaled back during the refill period because of less than normal inflow. The scaled back outflow may expose fish spawning redds that were used during the previous fall. De-watering spawning redds in this way can effectively destroy a significant percentage of the season's anadromous fish production.

Management Objectives

Average or Better Water Years

ODFW: Maintain a flow of 1,500 to 2,500 cfs below Dexter from May through August to best accommodate boat anglers. This is the peak use period for the popular spring chinook and summer steelhead fishery. Angling for these species is open all year and river conditions become difficult below 1,000 cfs and above 3,000 cfs.

To protect spawning spring chinook and their redds, flows should not vary greatly from mid-September through October. Flow levels should be maintained between 1,500 and 2,500 cfs through the egg incubation period to mid-March.

WRD: Meeting the downstream objective of a minimum streamflow of 2,000 to 2,500 cfs in the Willamette River at Eugene is dependent upon reservoir releases. Satisfying this objective is a high priority of the Department.

Low Water Years

ODFW: Maintain a flow of no less than 1,000 cfs below Dexter at any time. ODFW prefers a flow of no less than 1,500 cfs from September through mid-March to maintain salmon redds.

Of more importance are the wild winter steelhead which spawn from April through mid-May. Wild winter steelhead runs have been declining. Flows at this time of year must be maintained through the first of July to protect these incubating eggs.

WRD: Meeting downstream minimum streamflow objectives is a priority in low water years as well as normal or better years.

Hills Creek Reservoir

Hills Creek Reservoir is located upstream of Lookout Point. It does not receive heavy recreation use. Like Lookout Point, it is drafted early in the conservation release season for downstream flow augmentation. Some power generation capability is foregone in favor of flow augmentation. Despite limited recreation use, local residents have lobbied the Corps to maintain a full reservoir throughout the summer recreation season.

Management Objectives

Average or Better, and Low Water Years

ODFW: Maintain a reservoir release of at least 400 to 500 cfs to support the wild trout fishery below the dam. Keeping the lake full is not necessary to maintain the stocked trout fishery in the lake, although a relatively full level through Labor Day would enhance reservoir angling recreation.

WRD: Meeting the downstream objective of a minimum streamflow of 2,000 to 2,500 cfs in the Willamette River at Eugene is dependent upon reservoir releases. Satisfying this objective is a high priority of the Department.

Marine Board: A full reservoir would enhance motorized boating. However, maintaining a full reservoir at Hills Creek Reservoir is secondary to other management considerations. Boating opportunities at other reservoirs and downstream flow augmentation are higher priorities of the agency.

Local Interests: Local reservoir users place a high priority on keeping reservoir levels high during the summer recreation period of May through September.

Fall Creek Reservoir

Fall Creek Reservoir is a nonpower-generating project located relatively close to the Eugene/Springfield urban area in the Middle Fork Willamette Subbasin. It is a popular recreation site and receives heavy use. Recreation use is affected by drawdown. The Corps schedules Fall Creek Reservoir to be drafted later in the conservation release season for downstream flow augmentation.

ODFW uses Fall Creek reservoir as a rearing facility for spring chinook. The reservoir is used for rearing as mitigation for habitat lost as a result of reservoir construction. Each fall, the spring chinook fingerlings are flushed from the reservoir as water is evacuated to reach minimum flood control pool.

ODFW places a higher priority on maintaining a dwindling run of wild winter steelhead in the Fall Creek drainage. Reservoir releases of 150 cfs are needed between February 1 and June 30 for fish passage. Making such large releases while trying to fill the reservoir can be difficult, especially in less-than-normal runoff years. In addition, the minimum authorized release from Fall Creek is 30 cfs, not the 150 cfs needed for fish migration. The Corps is hesitant to release more than the authorized minimum if forecasts show that it will be difficult to fill the reservoir.

In past years of low runoff, the Corps has experimented with alternating periods of high and low releases during fish migration. This attempt to release sufficient flow for migration while also preserving the ability to store water proved unworkable.

Unlike the wild winter steelhead, spring chinook eggs could be gathered from other sources for hatching and rearing in Fall Creek if necessary. Since winter steelhead has priority, releases during low runoff years should be geared toward winter steelhead and not spring chinook rearing. Similarly, a choice may have to be made regarding the priority between recreation and fish resources.

Management Objectives

Average or Better Water Years

ODFW: Maintain a minimum of 150 cfs below the dam to attract returning adult spring chinook salmon and native winter steelhead from February 1 to June 30. This has become a very high priority since returning adult native winter steelhead numbers have been exceedingly low.

Spring chinook fingerlings are reared in the reservoir every spring and evacuated with the fall drawdown of the reservoir. ODFW requests the pool be drawndown in mid-November to a minimum elevation level of 692 feet. The evacuation process should extend over a period of at least 14 days. This process aids in reducing the number of predatory fish in the reservoir. It also maintains acceptable downstream water quality by limiting the release of sediments.

Low Water Years

ODFW: If 150 cfs is not available from February 1 to June 30, this level of flow should be provided for ten-day periods as frequently as possible. This has not been successfully implemented for an entire four-month period. However, similar scenarios have been employed in the past with good results.

Maintaining a full pool through the summer for rearing chinook fingerlings is not as high a priority as maintaining the return of adult anadromous fish. The recreational trout fishery in the reservoir also is secondary to the return of adult anadromous fish.

Blue River Reservoir

Blue River is a nonpower-generating project in the McKenzie Subbasin which receives little recreation use. The Corps generally drafts this project first for flow augmentation. The operation of Blue River and Cougar Reservoirs affect water temperature in the McKenzie River.

Management Objectives

Average or Better Water Years

ODFW: The Blue River reservoir trout fishery is not dependent on high reservoir levels. The evacuation of this reservoir early in the summer causes the outmigration of chinook salmon smolts and augments downstream flows. Later drawdown would improve growth and survival of these smolts.

Maintain at least the minimum below Blue River reservoir as it begins to empty in September. Flow fluctuations and release of sediments into the McKenzie River should be minimized.

Low Water Years

ODFW: Provide a minimum flow of 50 cfs to maintain fish life between the dam and McKenzie River. Gradually cutback on this level of release if inflow becomes less than 50 cfs.

Cougar Reservoir

Cougar Reservoir is a power-generating project on the South Fork McKenzie River. It does not receive heavy recreation use. Generally, operation of the reservoir system for downstream flow augmentation leaves sufficient water in the reservoir so that some power can be generated in the fall.

The McKenzie River is a prime trout stream and is heavily used for fishing and drift-boating. The major issues in the McKenzie River system center on water temperature and fluctuations in streamflow. Water released from the reservoirs is considered too cold for fish growth. Fluctuations in streamflow present boating safety concerns and affect the recreational use of the river.

The Corps has studied the effect of Blue River and Cougar Reservoirs on water temperature in the McKenzie River. The study indicates that the reservoirs have a measurable effect on water temperatures between June and November of each year. Reservoir releases generally reduce the daily mean water temperature between June and August and increase mean temperature from late September to mid-October. Reservoir releases can change the ambient water temperature by as much as 2 degrees Celsius. The study suggested the possibility of using multi-level water withdrawal towers to meet temperature requirements in the McKenzie River.

The Corps' intends to analyze the benefits that would be derived from constructing multi-level water withdrawal towers at the two reservoirs. The resulting benefit-cost ratio will help the Corps determine whether its cost effective to use withdrawal towers, or other means, to modify the reservoirs and their operation for water temperature control purposes.

Fluctuations in streamflow have resulted when maintenance work is performed on the dams. Often this has occurred in the fall during the fall spawning season. Reduced flows at this time can be damaging to fish populations. Better communication and coordination between the Corps and the state can prevent this from happening.

Management Objectives

Average or Better Water Years

ODFW: Maintain at least 400 cfs below Cougar Dam throughout the summer season with as little daily flow fluctuation as possible. Maintenance of the project facilities should be coordinated well in advance with other agencies. Avoid daily flow fluctuations during peak salmon spawning periods in September and October. Under normal flow conditions this maintenance work could be done between December 1 and April 15 without major impacts to fish resources.

The trout fishery in the reservoir is not dependent upon Cougar Lake staying full through the summer months. However, boat ramps should remain usable through Labor Day weekend.

Low Water Years

ODFW: Dropping flows to about 300 cfs could be tolerated after October as long as McKenzie River flows do not fluctuate greatly over short time periods.

Fern Ridge Reservoir

Fern Ridge Reservoir is a nonpower-generating project on the Long Tom River and was authorized for flood control, irrigation and navigation. The dam creates a large, shallow lake covering about 10,000 acres. The reservoir is dependent upon rainfall to fill. When below normal rainfall occurs, the chances that Fern Ridge will not fill increase.

Fern Ridge Reservoir is heavily used by recreationists. Recreation at Fern Ridge Reservoir receives management priority from many federal, state and local agencies. Access is difficult for large, fixed keel boats when lake levels decline. Recreationists have lobbied the Corps and Oregon's Congressional delegation to keep the lake full. Ideally, recreationists would prefer the Corps exceed the rule curve during the flood control season and store more water to insure refill of the lake. Recreationists would also like to see the lake filled to a higher elevation than is presently the practice. Presently, the Corps operates the project to maintain as high a pool as possible until October 1 for recreation.

The rule curve for Fern Ridge Reservoir was changed in 1963 so the project could fill earlier. The crest of the dam was raised 4.5 feet to compensate for flood control space lost from the change in the rule curve. The Congressional action necessary to amend the rule curve took 10 years. Flood control remains the chief purpose for the reservoir.

Fern Ridge Reservoir experiences a high rate of evaporation because of its size and depth. According to the Corps, surface evaporation can be as high as 200 af of water per day during the peak of the summer. Inflows during the summer are often in the range of 10 to 15 cfs, or about 20 to 30 af per day. Releases for conservation purposes generally are between 30 and 50 cfs. The Corps releases at least 30 cfs to maintain a minimum flow of 30 cfs at Monroe. Releases may vary with irrigation contract obligations. Using a release of 30 cfs as a conservative starting point, the reservoir may be depleted by about 230 af per day. Thus, a gross total of 260 af per day is lost from the reservoir through evaporation and release. However, the net loss is about 230 af per day because of the 30 af per day of inflow into the reservoir. Because of its shallow depth, a depletion of 10,000 af drops the lake level about one foot. In a period of two months the lake may drop more than one foot if rain fails to increase inflow. A decrease in lake depth of less than one foot significantly affects recreational boating.

The Bureau of Reclamation (BOR) holds the rights to irrigation water stored behind Corps dams. For 1987, the BOR issued 63 contracts to farmers for irrigation water from Fern Ridge Reservoir. These contracts totaled 23,546 af of water for irrigation of 10,128 acres. This does not mean 23,546 af of water are released from the reservoir for this purpose. Farmers purchase contracts but do not always use the water. Often, contracted water serves as insurance in case other primary sources of water are exhausted.

If farmers do call for contracted water, the Corps would be obligated to release it. This would have a significant affect on lake levels. Recently, the WRD received an inquiry from a group of people in the Long Tom drainage who are exploring the option of forming a water district. One source of water envisioned for the district is Fern Ridge Reservoir. If the district is formed and does contract with the BOR for delivery of water, releases from the reservoir might be increased. This would further reduce the lake level.

The wetlands associated with the reservoir provide good quality waterfowl habitat. The reservoir has the capacity to store water up to an elevation of 375 feet. However, ODFW prefers the lake elevation not exceed 373.5 feet in elevation when waterfowl are nesting or the nesting sites will be inundated. The Corps has cooperated with ODFW in improving and rehabilitating waterfowl habitat. The Corps has attempted to operate the reservoir to meet both conservation releases and recreation without filling the lake above 373.5 feet in elevation. The uppermost 1.5 feet of storage space is reserved for summer flood control.

Management Objectives

All Years

ODFW: Normal drawdown procedures are preferred. Maintenance of minimum streamflows is essential to support fish life during dry periods.
Deviation from normal operations generally has been within acceptable fish resource tolerance limits. The Corps should notify and consult with ODFW and other appropriate agencies in advance of deviation from normal operations.

Marine Board: Maintaining a full or near-full reservoir between May and September is a high priority of the Marine Board.

Local Interests: Maintaining a full reservoir for recreation purposes should be a primary management objective of the Corps and the state.

Foster and Green Peter Reservoirs

Reservoir operations in the South Santiam system highlight conflicts arising over management of stored water. Foster and Green Peter Reservoirs are in close proximity to each other with Green Peter Reservoir located upstream from Foster Reservoir. The operation of the two reservoirs is linked because Foster Reservoir re-regulates the flow released from Green Peter Reservoir. Both Foster and Green Peter Reservoirs are heavily used for recreation. They are readily accessible to recreationists from urban areas in the Willamette Valley. Both have well-developed recreation facilities including picnic areas, campgrounds and boat ramps.

The South Santiam River contains a wild run of winter steelhead. The ODFW places a high priority on restoring this run to pre-dam levels. Between mid-April and mid-May, Foster Reservoir is drawn down to an elevation of 614 feet above mean sea level. The drawdown is the only means for flushing wild winter steelhead smolts downstream. This operation is part of the Corps' mitigation responsibility for building the reservoir since there are no fish bypass facilities.

Elevation 614 is very near minimum flood pool. The Corps' goal is to refill Foster Reservoir by the end of May (Memorial Day). To accomplish this, stored water must be released from Green Peter Reservoir. In years of below normal runoff, this drawdown may result in Green Peter Reservoir not filling.

Throughout the conservation release season, water is released from both Foster Reservoir and Green Peter Reservoir. Releases are used to augment streamflow at Albany and Salem as well as to meet the authorized project minimums. Foster Reservoir stays full because it re-regulates release from Green Peter Reservoir. Because of drainage characteristics, inflow to Green Peter Reservoir during the conservation release season is minimal. Green Peter Reservoir experiences significant drawdown during this period

During 1987 and 1988, releases from Foster Reservoir were generally higher than the authorized minimum of 750 cfs in May, 600 cfs in June and 400 cfs thereafter. Higher releases were made to enhance angling in the South Santiam River. ODFW requested increased releases because surveys showed that three times as many fish were caught when streamflow exceeded 800 cfs than when streamflow was less than 700 cfs.

The Linn County Parks and Recreation Department has developed numerous recreation facilities in conjunction with the reservoirs. This constitutes a large capital investment for the county. The county expects user fees to generate revenue for maintaining and operating the facilities. During the low runoff years of 1987 and 1988, Green Peter Reservoir was drafted early and extensively. Linn County Parks and Recreation contends that boat ramps were unusable and that drawdown of the reservoir exposed steep, unsightly streambanks. The County has indicated that this management approach limits recreation opportunities, disrupts use patterns, and discourages out-of-state recreationists from returning to the area.

Linn County Parks and Recreation is also concerned about the operation of Foster Reservoir in April and May. Often, Foster Reservoir is not full until Memorial Day or shortly before. The County suggests that this negatively affects the early season use of recreation facilities. The County asserts that reservoir-related recreation use greatly exceeds downstream angling and boating use. It suggests that releases in excess of 600 to 650 cfs for downstream recreation negatively affects a far greater number of recreationists who use the reservoir facilities.

The County also operates and maintains several boat ramps and recreation sites along the South Santiam River. Nonetheless, there is concern that release priorities may be skewed towards a fewer number of river recreationists. Linn County Parks and Recreation, as well as the Linn County Commissioners, say that reservoir users spend more money in the local communities than do river users. This is important as recreation is second only to the timber industry in economic importance in East Linn County. Recreation and tourism are seen as the economic successors to forest products as the level of timber harvest declines.

Management Objectives

Average or Better Water Years

ODFW: Reduce Foster Reservoir pool to elevation 614 between April 10 and May 10 to facilitate the downstream passage of native winter steelhead smolts. Green Peter Lake should be at or above designated full pool to begin filling Foster Reservoir immediately after May 15 to meet Memorial Day weekend recreation demands.

Maintain 800 cfs below Foster Reservoir from June 1 through July 31 for recreational river angling of steelhead, trout and salmon and recreation at the reservoir. Peak use of the fishery is during the months of June and July.

Keep Foster Lake full, if possible, through the summer months for other recreational uses. However, the reservoir level has no major effect on the trout fishery.

Flow levels should remain constant or slightly increasing from late August through October to provide and maintain spawning habitat for both fall and spring chinook. These levels or higher must then be maintained through mid-March to protect incubating eggs.

Marine Board: Recreation at Green Peter Reservoir, although an important resource, is secondary in importance to other management considerations. However, the Corps and the state should jointly explore options for surcharging Green Peter Reservoir to maintain as full a reservoir as possible. To surcharge a reservoir means to store water in excess of the flood control rule curve. The re-regulating function of Foster Reservoir safeguards against downstream flooding. This management objective applies to low water years as well.

Local Interests: Maintain reservoir releases in the 600 to 650 cfs range from Foster Reservoir during the summer recreation season. This would lessen the drawdown at Green Peter Reservoir. Explore options to surcharge Green Peter and allow Foster Reservoir to refill faster after winter steelhead smolts are flushed downstream. Develop alternative fish bypass facilities at Foster Reservoir so the reservoir is not dramatically lowered to flush steelhead smolts downstream.

Low Water Years

ODFW: For smolt out-migration in the spring, keep Foster Reservoir at elevation 614 for fewer days (April 10 to May 10) and then gradually fill by Memorial Day weekend.

Maintain 800 cfs below Foster from June 1 to July 31. If a reduction in the release rule is needed, ODFW prefers to see fewer days at the 800 cfs level rather than an overall reduction in flows.

Maintain at least 600 cfs and preferably 800 cfs below Foster to maintain anadromous fish redds from late September through mid March. Flows should also remain constant from April 1 to July 1 to maintain winter steelhead redds.

Local Interests: Reduce outflow from Foster Reservoir proportional to decreased inflow. Proportionally reduce outflow to maintain reservoir levels suitable for recreation access and use during the recreation season.

Big Cliff and Detroit Reservoirs

Detroit and Big Cliff Reservoirs are power-generating projects on the North Santiam River. Big Cliff is a reregulating dam for Detroit. Detroit Reservoir receives heavy recreation use and probably ranks second in recreational use to Fern Ridge Reservoir. Local communities, the State Parks and Recreation Department, and the State Marine Board prefer that the lake remain full throughout the summer for recreation and boater safety. As the lake is drawn down, tree stumps present boating safety hazards. River recreationists, ODFW and the Santiam Water Control District prefer that releases be increased to benefit downstream uses while retaining most flat-water recreation opportunities.

The Corps typically releases 1,000 cfs during the conservation release season even though the authorized minimum release for the season is 750 cfs. This level of release assists in meeting flow augmentation goals for the Willamette River at Salem.

This level of release retains a large volume of water in the reservoir. The stored water can be used to produce power in the fall when power is more marketable. There would be even more power potential if the Corps released only 750 cfs. However, increased fall releases to achieve minimum flood control pool and produce power can adversely affect anadromous fish (see discussion of Dexter Reservoir). ODFW recommends releases of 1,000 to 2,500 cfs between September 10 and October 15.

Management Objectives

Average or Better Water Years

ODFW: Maintain flows below Big Cliff Dam between 1,000 and 1,200 cfs from June 1 to August 15. This is the peak period for anglers using an excellent steelhead fishery in addition to trout and salmon angling. ODFW suggests these flows maintain adequate river levels for boating as well as making fish more accessible to the angler.

Provide at least four to five hours of flows at 1,500 to 1,800 cfs below Big Cliff Dam for three boat planting releases of legal trout one day each in late May, mid-June and early July. Boats that plant fish displace more water and need more river flow for navigation purposes. Although reservoir level does not have a major effect on the trout fishery in Detroit Reservoir, ODFW supports keeping the lake as full as possible for other recreational activities.

During natural spawning of winter steelhead in April and May, and of salmon in September and October, release levels should remain constant or increase slightly. This protects egg deposits through their hatching cycle (2 to 3 months).

Marine Board: Maintaining a full reservoir for recreation use is a high priority. Releasing 1,000 cfs generally maintains the reservoir at a level that does not significantly affect recreation.

Local Interests: A reservoir release of 1,000 cfs generally supports recreation use through the peak use period. However, late in the recreation season tree stumps begin to emerge from the receding water and pose navigation hazards.

Low Water Years

ODFW: Maintain a streamflow of at least 900 cfs below Big Cliff Dam from June 1 through August 15 to maintain the above-mentioned boat fishery. Detroit Reservoir could be surcharged early to make this possible. The absolute minimum streamflow acceptable is 750 cfs. This level is not desirable for boat activity or fish movement but will support fish during drought conditions.

STATE INVOLVEMENT IN DEVELOPMENT OF THE CORPS' ANNUAL OPERATIONS PLAN

The Corps develops an annual plan for reservoir operations. The Corps operates the reservoir system according to procedures it has developed. These procedures were designed to meet the purposes for which the projects were authorized. But the Corps also can vary operations, at its discretion, as long as the authorized purposes are met. Much of the ongoing state-federal coordination centers on operating the reservoirs for unauthorized uses such as recreation and fish habitat and migration.

At the state level, the reservoir coordination process involves consensus-building between state agencies on the annual plan of operation. This approach involves a degree of give and take between state agencies when developing recommendations for input to the plan. Conditions driving state management objectives change as water conditions change. The existing process of seeking consensus works well because it is flexible and adaptable to changing conditions.

State-federal coordination on reservoir operation could be improved during below-normal water years. The state intends to work with the Corps on developing processes and procedures for dealing with below-normal water situations. Keeping reservoirs at minimum flood control pool in low-water years can make it difficult to fill the reservoirs. There is an opportunity to develop "rule curve bands" that take into account below normal precipitation. Based on a number of physical and hydrologic parameters and flood risk assessment, the rule bands would inject increased flexibility into low-water management of the reservoirs. These discussions could lead to a federal-state agreement that establishes operating guidelines. An agreement would clarify how the reservoirs are to be operated.

MAXIMIZING RESERVOIR BENEFITS THROUGH PROJECT RE-AUTHORIZATION

The present authorizations that govern reservoir operations do not give equal recognition of all purposes that provide public benefits. The need for flood control, the primary purpose for the reservoir system, remains. However, the public appears to take flood control for granted. A flood of intensity comparable to the 1964 flood would have disastrous consequences to development that has encroached into the 100-year flood plain. Despite this, the federal government needs to re-examine the flood control system, analyze current flood potential and conduct a flood risk assessment. The risk assessment would show the benefits and costs associated with building more flexibility into the flood control rule curve. Greater rule curve flexibility has potential to provide a substantial increase in public benefits. During low-water years, this could increase the opportunities to store water when it is available. Greater flexibility in application of the rule curve is a step towards managing water resources more efficiently.

Conditions in the basin have changed considerably since the projects were authorized. For example, irrigation use that was contemplated has not materialized. Twenty years ago, the Pacific Northwest River Basins Commission recommended redistributing the allocation of stored water assigned to irrigation. The River Basins Commission said that maximum irrigation development by the year 2020 would only use 75 to 80 percent of water allocated to irrigation. The Oregon Department of Agriculture has analyzed irrigation needs to the year 2010. Its findings suggest that an additional 507,200 af of water will be needed by then. This still leaves roughly 1,000,000 af of storage available for other uses. This supports the need to re-evaluate storage allocations as well as the operation of the reservoir system.

Further, society now places more value on recreation, fisheries and aesthetic values than when the projects were first analyzed. Reservoir releases are critical to maintaining water quality in the Willamette River. Without reservoir releases, water quality standards for the Willamette River probably could not be met without restricting the discharge of municipal and industrial effluent to the river. Table 56 illustrates the contribution of reservoir releases to meeting water quality targets at Salem and Albany in July, August, September and October. An analysis of pre-dam and post-dam flows suggests that about 305,000 af of storage release is necessary to meet the water quality targets. Allocating a sufficient quantity of stored water to pollution abatement would safeguard water quality in the Willamette River.

The basin population has more than doubled since the first project was completed. Water stored by the Corps reservoirs may provide relief to regions facing supply shortages. A significant proportion of the population increase has been in urban areas. Stored water could be purchased for municipal use. However, municipal use was not an original authorized purpose of the reservoirs and construction costs were not allocated to that purpose. The pricing structure for municipal supply purposes discourages municipalities from contracting for stored water.

The Water Supply Act of 1958 provides that reservoir storage can be used for present and future municipal water supply. The Act authorizes the Secretary of the Army to modify projects to provide for municipal water supply as long as authorized project purposes are not seriously affected, and would require no major structural or operational changes. The Act provides the authority to re-allocate stored water to municipal purposes. The Commander of the U.S. Army Corps of Engineers has the discretion to re-allocate a limited quantity of water from authorized purposes to municipal water supply purposes. Any re-allocation of water determined to have significant impacts on authorized purposes would require Congressional authorization.

The Water Resources Development Act of 1986 modified the Water Supply Act. Foremost among the provisions of the Act are the requirements that users assume the full cost for municipal and industrial water supply. This means the user assumes 100 percent of the storage costs, plus a portion of the annual facility operation and maintenance costs. Corps policy states that the cost to the municipal water user will normally be established as the highest of benefits foregone, revenues foregone, replacement cost or updated cost of storage. Often, the highest costs are associated with either the replacement cost or the updated cost of storage pricing method.

Updated costs are based in part on investment costs (a prorated share of original reservoir construction, and operation and maintenance costs for an increment of storage) and inflation. Thus, based on the updated cost of storage, the contract price the Corps charges for municipal and industrial water varies from reservoir to reservoir. Using a thirty-year repayment period, some suggest municipal and industrial water would cost $150 to $300 per af, or more, depending on which reservoir provides the storage. This is in marked contrast to irrigation water which is sold for as little as $1.75 per af plus contract administration costs.

Municipal and industrial water is more expensive because of the way the federal government schedules repayment for the benefits that result from the use of stored water. Agricultural irrigation is seen as yielding benefits to the nation and thus repayment is calculated differently than for municipal use. Municipal use is viewed as yielding only local benefits and users are charged 100 percent of storage costs. This determination of national versus local scope appears somewhat out-of-date in light of federal water quality requirements, drinking water standards and threatened and endangered fish concerns. These federal requirements are, in part, responsible for the growing interest among some local governments in using stored water for municipal purposes.

Federal contract procedures appear to allow some administrative flexibility in municipal water supply pricing. For example, in Idaho, the Bureau of Reclamation recently sold 1,000 af of water, on a five-year contract, for $17 per acre-foot. This water was allocated to another purpose but was not being used. The Corps interprets its pricing guidelines to be much less flexible than those of the Bureau of Reclamation. The Corps' pricing guidelines may embody some exceptions to the "highest cost" methodology described above. These guidelines should be explored for opportunities to contract for water at a price small communities can afford.

A re-evaluation of storage allocation for irrigation could pave the way for more contract storage. Of the 1.6 million af stored in Corps reservoirs and permitted for irrigation, only about two percent has been contracted for irrigation. However, the Oregon Department of Agriculture (ODA) suggests that by the year 2010, a total of 1,118,950 af of water will be needed for irrigation in the basin. This water would satisfy irrigation needs for 486,500 acres of land, or almost double the acreage presently irrigated. The projected water need is almost double the total quantity of water used now for irrigation purposes. The ODA expects that 507,200 af will come from reservoir storage presently allocated to the Bureau of Reclamation for irrigation purposes. One result of increased irrigation use of the water is that reservoirs that have been kept full for recreation could be further drawn down to meet new contract obligations.

Recreation at the reservoirs has increased in recent years. Table 57 illustrates recreation use trends at the reservoirs for 1985 through 1989. Many of the towns in the immediate vicinity of the reservoirs formerly were economically dependent upon forest products. Increasingly, these communities are attempting to diversify their economic base. Recreation and tourism are a component of this diversification. These communities view full reservoirs as essential to their diversification efforts. Not all reservoirs can remain full. Reservoirs must be drafted to meet contract demands and downstream water quality and fish life objectives.

There are insufficient data to quantify whether reservoir recreation can be sustained at all sites and also satisfy downstream flow needs. An initial analysis of existing boat ramp elevations and average end of month reservoir pool elevations indicate that not all boat ramps are usable throughout the recreation season. At Blue River, Lookout Point, Cottage Grove, Dorena and Green Peter Reservoirs, some boat ramps are unusable after the end of July. At Hills Creek, Fern Ridge, Green Peter and Detroit Reservoirs, ramps are unusable after the end of August. In below normal water years, ramps may be unusable earlier in the recreation season. More information is needed to determine how recreation needs can be balanced with other needs to get the most benefit from management of the reservoirs.

Reservoir operations have an impact upon fish life downstream and upstream of the dams. Federal and state fisheries agencies state that regulating the temperature of reservoir releases would benefit fish life. The Corps is currently undertaking a feasibility level study of temperature control at federal expense with no requirement for non-federal cost sharing. Modifying the temperature of water released from the reservoirs clearly fits within the federal responsibility to mitigate fish and wildlife impacts linked to construction and operation of the reservoirs. In addition, the inclusion of Willamette Basin fish species, such as the Oregon Chub, on the list of threatened and endangered species could profoundly affect reservoir operations. The potential effects are unknown at this time. However, operations likely would have to be changed to benefit the species. Changes to operations that benefit threatened and endangered species may reduce the opportunities to operate the reservoirs for multiple purpose benefits.

Table 57

VISITATION SUMMARY IN THOUSAND OF VISITOR DAYS, 1985-1989

Reservoir	1985	1986	1987	1988	1989	Average
Fern Ridge	704.8	757.2	661.5	745.0	686.7	710.9
Cottage Grove	291.9	359.7	312.6	396.0	379.8	388.0
Dorena	245.9	279.0	262.4	315.6	274.1	275.4
Lookout Point	88.0	72.3	83.1	106.8	124.5	94.9
Fall Creek	195.2	219.1	223.1	265.8	311.6	242.9
Hills Creek	99.2	98.5	99.2	135.2	111.8	108.8
Cougar	46.1	51.0	67.9	86.3	52.7	60.8
Blue River	61.5	78.9	81.3	63.3	47.4	66.5
Foster	356.7	388.9	550.5	544.8	403.4	448.9
Green Peter	102.2	127.5	141.4	140.4	135.8	129.5
Detroit	700.1	723.1	772.0	740.5	737.9	734.7
Totals	3,105.0	3,395.5	3,514.6	3,843.1	3,794.5	3,530.5

Source: U.S. Army Corps of Engineers, Comparison of Visitation Trends and Pool Elevations; 1985-1989, Willamette Basin Review Study Working Paper, 1990.

MANAGEMENT PROPOSALS

WILLAMETTE RIVER BASIN REVIEW STUDY

The reconnaissance phase of the Willamette Basin Review Study has been authorized and funded by Congress. This phase of the study concentrates on determining the benefits and costs of enhancing reservoir operations. Flood control is the primary purpose for reservoir operations. Thus, the federal government needs to re-examine the flood control system, analyze current flood potential and conduct a flood risk assessment. The risk assessment would show the benefits and costs associated with building more flexibility into the flood control rule curve.

The state's management objectives are linked to flexible operation of the reservoir system. This applies specifically to the application of the flood control rule curve to reservoir storage and release schedules. The feasibility study also requires sponsors willing to share costs. The state is a likely sponsor because of the importance of reservoir operations to the state meeting its water resource management objectives. Cost-share may be required if implementation requires construction of physical structures or modification to existing structures.

The state worked closely with the Corps as they conducted the reconnaissance phase of the review study. The state will have to decide whether to co-sponsor the feasibility phase of the study. The Water Resources Commission is responsible for coordinating the state's position on reservoir operations and will ultimately have to take the lead in deciding whether to co-sponsor the feasibility study.

Policy

> Promote funding to implement the Willamette Basin reconnaissance phase recommendations with significant potential to assist the state in meeting its resource management objectives.

Implementing Actions

1) Assist the Corps in re-evaluating storage allocations and reservoir operations with the goal of meeting state water management policies and objectives for the basin.

2) Promote revision of the reservoir system irrigation allocation to allow stored water to be allocated to other purposes, such as water quality, fish life and instream recreation. Recommend that any re-allocation of stored water accommodate at a minimum the Oregon Department of Agriculture's reservation request for the following stored water:

   Coast Fork Willamette Subbasin: 14,000 af from Cottage Grove and Dorena Reservoirs to serve irrigation needs in both the Coast Fork and downstream subbasins.

   Middle Fork Willamette Subbasin: 202,100 af from Lookout Point and Hills Creek Reservoirs to serve irrigation needs in both the Middle Fork and downstream subbasins.

   McKenzie River Subbasin: 85,000 af from Blue River and Cottage Grove Reservoirs to serve irrigation needs downstream subbasins.

   Santiam River Subbasin: 206,100 af from Green Peter and Detroit Reservoirs to serve irrigation needs in both the Santiam and downstream subbasins.

3) Promote the re-allocation of water stored in Corps reservoirs that is currently dedicated to irrigation to meet water quality flow objectives at Albany and Salem (estimated at 305,000 af per year).

4) Promote federal legislation to revise the reservoir system authorization to recognize additional important purposes such as water quality, recreation, fish life, wildlife, municipal and industrial.

5) Promote studies and funding for the Corps to make the structural modifications to the reservoirs necessary to mitigate project impacts on water temperature and fish passage.

6) Request that the Corps control the temperature of released water as part of its responsibility to mitigate the impacts of dam construction.

7) Evaluate the Willamette Basin Review Study reconnaissance phase recommendations and support state co-sponsorship of the feasibility study phase if to do so significantly assists the state in meeting its water resource management objectives.

RESERVOIR COORDINATION

If Congress does not act to change reservoir operations, the Corps will continue to operate the system according to existing authorizations. The federal-state coordination function takes on greater importance as a result. Management guidelines upon which the Corps and the state agree will simplify the task of managing water.

The state views flexibility in reservoir operations as critical to achieving many of its water management objectives in the basin. Unauthorized project purposes have increased in importance over time. The agreement of the Corps and state on operations is crucial to meeting water management objectives.

Operation of the reservoirs during the conservation storage release season raises several policy and management questions. For example, should some or all of the reservoirs be operated for flat-water recreation, downstream-flow augmentation and fisheries purposes or out-of-stream consumptive uses, or some combination of the three?

Answering these questions will be difficult and should be approached carefully. First, flow augmentation in the Willamette River at Albany and Salem is an authorized project purpose. Flow augmentation is necessary to meet water quality standards. Secondly, the reservoirs are operated as a system. In order to meet flow augmentation goals, reservoirs must be drafted to augment flow. Thirdly, meeting augmentation flows means sacrificing reservoir levels in a few or perhaps several reservoirs to achieve those augmentation goals. And finally, competing and incompatible resource demands are present at several of the reservoirs.

Policy

Formalize reservoir operation guidelines with the Corps of Engineers to meet state water management objectives. Enter into a memorandum-of-understanding or other agreement that defines the reservoir coordination process and water management objectives.

Implementing Actions

1) Coordinate with the Corps on providing state and local input on reservoir operation as described in the implementing actions for Land Use Coordination.

2) Initiate the development and implementation of a state-federal coordination agreement with the Corps of Engineers. The agreement should:

   a) Establish the respective water management roles and responsibilities of the Corps and the State of Oregon.

   b) Establish procedures and guidelines for developing the annual plan of operation to meet water management objectives.

   c) Identify and develop a process for cooperative water management decision-making and for state participation in the development of the annual reservoir operation plan.

   d) Establish guidelines and criteria for operating the reservoirs to meet authorized project purposes.

   e) Establish guidelines and criteria for operating the reservoirs to meet state water management objectives to include:

      - Aquatic habitat and fish life cycle needs
      - Pollution abatement
      - Reservoir and downstream recreation
      - Municipal and industrial water supply
      - Irrigation
      - Instream water rights
      - Other beneficial uses, and
      - Management flexibility for below normal water years.

f) Establish a process for resolving disputes and renegotiating the agreement.

g) Use the Oregon Department of Fish and Wildlife management objectives shown in Tables 58 and 59 to establish the starting point, or baseline, for state coordination efforts with the Corps in developing an annual plan for reservoir operation.

Table 58

BASIS FOR RELEASE OF UNCONTRACTED WATER
Average or Better Water Year

Reservoirs	Release Schedule	Basis for Release as Requested by ODFW
COAST FORK WILLAMETTE RIVER		
Cottage Grove	• Normal draw down	• Reservoir recreation
Dorena	• Normal draw down	• Flow augmentation
MIDDLE FORK WILLAMETTE RIVER		
Dexter/Lookout Point	• May - Aug; 1500 to 2500 cfs • Sept - mid-Mar; constant 1500 to 2500 cfs	• Boat angling • Maintain salmon redds • Flow augmentation
Hills Creek	• 400 to 500 cfs	• Support wild trout • Flow augmentation
Fall Creek	• Feb 1 - June 30; 150 cfs • Mid-Nov; draw down pool to 692′ over 14 day period	• Wild winter steelhead attraction and migration • Spring chinook fingerling passage
McKENZIE RIVER		
Blue River	• Sept; 50 cfs minimum release	• Maintain constant flow • Flow augmentation
Cougar	• Summer; constant flow of 400 cfs • Sept/Oct; avoid flow fluctuations	• Maintain constant flow for salmon spawning • Flow augmentation
LONG TOM RIVER		
Fern Ridge	• Maintain minimum project releases • Draw down last	• Reservoir recreation
SOUTH SANTIAM RIVER		
Foster	• Apr 10 - May 10; draw down pool to 614 ′ and quickly refill • June 1 - July 31; 800 to 1000 cfs • Sept - Mar; 800 cfs, constant flows Apr 1 - July 1	• Native winter steelhead out-migration • Angling flows • Maintain anadromous fish spawning redds • Reservoir recreation
Green Peter	• Surcharge • Normal draw down	• Augment Foster • Flow augmentation • Reservoir recreation
NORTH SANTIAM RIVER		
Detroit / Big Cliff	• June 1 - Aug 15; 1000 to 1200 cfs • Apr & May and Sept & Oct; 1000 to 2500 cfs, constant or slightly increasing flows • May, June & July; on selected days, 4 - 5 hours of 1500 to 1800 cfs for ODFW boat fish planting	• Angling flows • Anadromous fish spawning redds • Reservoir recreation

Table 59

BASIS FOR RELEASE OF UNCONTRACTED WATER
Below Normal Water Year

Reservoirs	Release Schedule	Basis for Release as Requested by ODFW
COAST FORK WILLAMETTE RIVER		
Cottage Grove	• Normal draw down	• Flow augmentation
Dorena	• Normal draw down	• Flow augmentation
MIDDLE FORK WILLAMETTE RIVER		
Dexter / Lookout Point	• Apr/May - July; at least 1000 cfs • Sept - mid-Mar; 1500 cfs	• Wild winter steelhead spawning • Maintain salmon redds
Hills Creek	• Normal draw down	• Flow augmentation
Fall Creek	• Feb 1-June 30; 150 cfs • If necessary, provide releases in 10 day periods	• Wild winter steelhead attraction and migration
McKENZIE RIVER		
Blue River	• Sept; 50 cfs minimum release	• Maintain fish life below reservoir
Cougar	• After Oct; constant flow of 300 cfs	• Maintain constant flow for salmon spawning
LONG TOM RIVER		
Fern Ridge	• Maintain minimum project releases • Draw down last	• Reservoir recreation
SOUTH SANTIAM RIVER		
Foster	• Apr 10-May 10; maintain pool at 614 ' for fewer days and then gradually refill • June 1-July 31; fewer days at 800 cfs • Sept-Mar; 600 cfs, constant flows Apr 1-July 1	• Native winter steelhead out-migration • Angling flows • Maintain anadromous fish spawning redds
Green Peter	• Surcharge • Normal draw down	• Recreation • Flow augmentation
NORTH SANTIAM RIVER		
Detroit / Big Cliff	• June 1 - Aug 15; 900 cfs • Absolute minimum release = 750 cfs	• Angling flows • Fish life

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Section 6

WATER CONSERVATION AND DROUGHT PLANNING: OPPORTUNITIES AND PRIORITIES

PROBLEM STATEMENT

Abundant water supplies are essential to the growth, development, prosperity and natural values of the Willamette Basin. However, continued growth is putting increasing pressure on available supplies. In some streams, there is not enough water during the summer months to meet all demands. Seasonal water shortages will occur more frequently and for longer periods as growth continues and various uses compete for available supplies.

Water conservation is one method of dealing with seasonal water shortages. The need for water conservation, water use efficiency and drought planning increases as growth continues and greater recognition is given to the needs for instream flows. Water users in the Willamette Basin need to modify water use practices to eliminate waste, secure sufficient supplies for future uses, and plan for potential drought conditions in the basin.

This section explores the needs and opportunities for conservation, as well as the priorities for drought planning in the Willamette Basin. It addresses the following questions:

1. Can water conservation be effective in alleviating water supply and quality problems?

2. What are the most appropriate conservation measures that can be applied in the Willamette Basin?

3. What should be done to increase basinwide water use efficiency?

The Water Resources Department formed a volunteer work group to assist staff in addressing these issues. Participants in the Water Conservation/ Drought Planning Work Group represented diverse backgrounds, expertise and occupations. Represented were the Portland Water Bureau, U.S. Geological Survey, U.S. Soil Conservation Service, Oregon State University, Oregon Trout, J and L Nursery, and interested citizens.

BACKGROUND

CONSERVATION, WATER USE EFFICIENCY AND DROUGHT PLANNING

Water conservation is defined in numerous ways. Oregon Revised Statutes (ORS) 537.455 states that conservation is a "reduction of the amount of water consumed in the process of satisfying an existing beneficial use, achieved either by improving the technology or method for diverting, transporting, applying or recovering the water or by implementing other approved conservation measures." Conservation is achieved through public education, incentives, standards and regulatory measures.

The purpose of efficient water use is to increase the benefits to the public and private users from a fixed supply of water and to minimize waste. More efficient use of water is achieved through better equipment, facility operation, and water management. The level of efficiency reached depends on personal preference, technology, time and cost. Increasing water use efficiency is usually viewed as reducing water use. This is achieved mainly through public education and information and incentives.

The terms *"conservation"* and *"water use efficiency"* are often used interchangeably. Both convey the concept of beneficial use without waste. The Water Resources Commission has defined "waste" as the continued use of more water than is needed to satisfy the specific beneficial uses for which a right was granted. The need for water shall be based on using the technology and management practices that provide for the efficient use of water considering:

(a) The economic feasibility of use of the technology and management practices by the water user;

(b) The environmental impacts of making modifications;

(c) The available proven technology;

(d) The time needed to make modifications;

(e) Local variations in soil type and weather; and

(f) Relevant water management plans and subbasin conservation plans.

Conservation involves short- and long-term measures to meet water demands with as little water as economically possible. Conservation and better water use efficiency help stretch existing water supplies and reduce the impact of drought and other water shortages.

Drought curtailment is the mandatory reduction of water use for a short time because of an interruption in supply. ORS 536.720 grants the Water Resources Commission the authority and responsibility to "curtail, adjust or allocate the supply of water resources for domestic, municipal and industrial uses; and to regulate the times and manner in which water resources are consumed during drought or likely drought conditions." The beneficiaries of these emergency actions, or the state, may have to assume financial liabilities if such actions are taken.

Reasons for Water Conservation and Drought Planning

Properly selected and carefully applied conservation measures can reduce, postpone and in some cases eliminate the need for costly new water projects. Conservation also reduces costs for water pumping, distribution, application and treatment, and sewage treatment and effluent disposal.

Water conservation helps maintain and enhance water quantity and quality for aesthetic and other environmental reasons. The public has a growing expectation that water should be used efficiently. This will provide more water instream to enhance environmental and aesthetic values. The availability of sufficient, high-quality water is crucial for fish, wildlife and pollution abatement.

Water conservation can also reduce point and nonpoint source pollution. Efficient irrigation diversion, conveyance and application can reduce contaminated return flows to surface and groundwater bodies. Municipal, domestic and industrial water conservation can reduce the amount of waste-water and effluent that are discharged into streams and other water bodies.

An easily recognized benefit of water conservation is the reduction of drought effects. In fall of 1987, the Portland Water Bureau asked its customers to reduce water use. This resulted in 19 percent reduction in demand. Significantly, this lower water use was achieved without any real hardship.

Conservation Opportunities, Technologies, Savings and Costs

Studies show that there are conservation opportunities in most water use categories. Water savings can result from simple modification of existing systems and public education. Significant quantities of water can be conserved through a mix of conservation measures including voluntary efforts, incentives, and regulations. Some measures are more effective than others, depending on locality and type of use. Costs of conservation measures can vary depending on the measures applied.

An estimated 15 to 20 percent of the water used in irrigated agriculture can be saved. The savings come mainly through better scheduling, efficient conveyance and application, and reducing runoff and percolation. Even higher irrigation efficiencies are possible through more costly conservation measures such as changing irrigation methods from those less efficient.

Irrigators benefit directly and indirectly from improving irrigation efficiency. Under Oregon law, they may receive a right to apply the conserved water to additional acreage or sell or lease it to someone else. Conservation can also reduce irrigation water and power costs, improve crop yield and reduce soil erosion.

The use of sprinkler systems such as hand-move, side-roll, big gun and center pivot is the common irrigation method in the Willamette Basin. Typical efficiencies of these systems vary from 55 to 85 percent. The goal should be to achieve efficiency and application uniformity at the higher end of the scale for each method. The cost of achieving higher irrigation efficiency has to be determined on an individual basis.

Conservation can also be achieved in the municipal water use sector. In the summer/fall of 1987, the Portland Water Bureau implemented a conservation plan which was based upon public education and requests for voluntary cutbacks in outdoor water use (Portland Water Bureau, 1988). As a result, water use was reduced by 19 percent. This amounted to a savings of more than 20 million gallons per day. In addition, the bureau detected and repaired a large number of leaks in its delivery and distribution systems. The leak detection and repair program saved the bureau significant amounts of water. The amount, however, was small compared to the overall amount used.

The Portland Water Bureau's success occurred over a short time span in a water-short year. Conservation projections, however, cannot be based on user response to a short-term water shortage. In normal water years, users may respond much differently to requests for conservation. For example, Seattle has achieved a reduction of eight percent through voluntary conservation measures.

Permanent water savings of up to 35 percent are achievable through changes in existing plumbing fixtures, installation of new fixtures and better water use practices (Portland Water Bureau, 1988). For example, up to 40 gallons a day per person can be saved by installing flow restrictors, aerators or low-flow faucets, shower heads, nozzles and toilet inserts in homes. The cost of purchasing and installing these fixtures is usually very low. Table 60 provides some examples (figures reflect savings and costs in 1986-1987).

Even larger water savings are possible by water-efficient appliances and plumbing fixtures, and lawn sprinkling systems. However, the benefits of these more costly measures should be determined before they are actively promoted.

Table 60

POTENTIAL WATER SAVINGS

Measure	Estimated Water Savings (gallons/person/day)	Cost (dollars per unit*)
Faucet Flow Restrictor	0.5-1.0	1.00
Faucet Aerator	6.5	3.00
Toilet Inserts	1.5-2.5	1.00
Shower Flow Restrictor	3.7-5.0	1.00
Low Flush Toilets	8.0-15.0	80.00
Low Flow Shower Head	7.5-11.3	4.00
Hose Nozzle	varies	5.00

* These costs do not include installation costs.
Sources: California Department of Water Resources, 1981, 1984; Portland Water Bureau, 1988

Industries can also improve efficiency and conserve water. Common industrial conservation measures include water use monitoring, water management programs, employee training and education, recycling, process modification, automatic shut-off valves, air cooling, low-flow plumbing fixtures, leak detection and eliminating nonessential water flow. Employing one or more of these measures can reduce use by an average of 30 percent. Costs of these measures vary, but are usually offset by the benefits. For example, in 1989, a California computer parts company reported saving $63,000 in water and sewer costs. The savings resulted from installing a recycling system that cost $5,000 (California Department of Water Resources, 1989). Industrial water conservation can be crucial to continued operation during drought conditions.

In the Willamette Basin, the greatest opportunity to save water appears to be through voluntary conservation and low-cost modifications to existing systems and fixtures. While conservation is more easily achieved in some sectors, the amount of water conserved in these sectors may not be substantial. Conservation programs should target all uses equally and include an evaluation of investment return and water saved.

STATEWIDE WATER CONSERVATION AND DROUGHT PLANNING

Conservation

Oregon is usually viewed as a state where water is plentiful. Recently, low-flow years, seasonal shortages in some basins, growing water demands and reduced availability have led to greater conservation awareness. Also, increased public interest in instream flows and values makes conservation an important societal goal.

Conservation and drought planning are two of the more promising methods of enhancing water supplies in many over-appropriated streams. For this reason, conservation and drought planning are becoming important components in water resource planning and management.

By law (ORS 536.300), the Commission is to "proceed as rapidly as possible to study: Existing water resources of this state, means and methods of conserving and augmenting such resources..."

ORS 536.710 (2) states, "The Legislative Assembly finds it necessary in the event of an emergency to promote water conservation and to provide an orderly procedure to assure equitable curtailment, adjustment, allocation or regulation in the domestic, municipal and industrial use of water resources where more than one user is dependent upon a single source of supply." Also, in case of drought or potential drought, the Commission can order state agencies and political subdivisions to develop water conservation and/or curtailment plans (ORS 536.720 (2)).

Increased water use efficiency is consistent with the principles of the doctrine of prior appropriation. This doctrine states, "a water right is limited to the quantity of water which is beneficially used without waste." Increased water use efficiency is also consistent with ORS 540.610 which states, "beneficial use shall be the basis, the measure and the limit of all rights to the use of water in this state." The use of the state's waters without waste is also echoed by ORS 536.310 (1). This statute says, "all of the waters within this state belong to the public for use by the people for beneficial purposes without waste." The doctrine of prior appropriation and state laws provide the guidance and flexibility for exploring and implementing measures to increase water use efficiency.

The Department's conservation efforts date back to the 1976-77 drought year. In 1985, the Commission directed Department staff to report on other states' conservation programs. Staff presented its report to the Commission in June 1986.

In March 1987, the Commission approved an interim report on water conservation and adopted an interim conservation policy. The Commission authorized formation of the Statewide Conservation Advisory Committee in 1988. The committee assisted staff in drafting a policy statement and recommending strategies to implement a statewide conservation program. The statewide conservation policy was adopted by the Commission in 1990.

The 1987 Legislature passed Senate Bill 24 (Conservation and Use of Conserved Water). This legislation (codified in ORS Chapter 537) aggressively promotes water conservation, increased beneficial use and enhanced streamflows throughout the state. It provides an incentive to conserve water by allowing water right holders to lease or reserve conserved water for instream use or future out-of-stream use. A percentage of the conserved water is allocated for public instream uses.

In the same session, the Legislature established the ten-member Governor's Watershed Enhancement Board (GWEB). GWEB is responsible for developing and implementing a program aimed at enhancing and rehabilitating Oregon's watersheds, riparian zones and streams. This program, coupled with other conservation measures, contributes to flow restoration and enhancement in Oregon's streams.

Several other laws enacted in 1987 and 1989 focus on increased water use efficiency. Senate Bill 156 (passed in 1989), for example, gives the Commission the power to impose civil penalties for violations of water law or terms of permits.

Drought Planning

Drought conditions in the late 1970s and 1980s prompted a number of actions in Oregon. These actions were designed to reduce the severity of drought impacts on water users in the state. In 1987, the Strategic Water Management Group (SWMG) formed a drought subcommittee to monitor conditions around the state. The subcommittee prepared the State Drought Response Plan. The plan outlines potential actions for water districts, cities, counties, state agencies and the federal government to take in event of a drought. The plan also sets up lines of authority and communications among the various agencies responsible for drought response and mitigation.

In early 1988, the SWMG replaced the Drought Subcommittee with the State Drought Council. Drought planning and preparation will be coordinated through the council. Other council tasks are to develop or review water and power conservation programs and develop public information programs to encourage voluntary conservation measures. Actions will be initiated to minimize conflicts through laws, policies, or other means.

Drought conditions in 1988 varied significantly from one location in the state to another. In the Willamette Basin, only mild drought conditions were reported. Drought conditions in other parts of the state varied from mild to extreme.

In 1987 and 1988, the Department published *Model Water Curtailment Measures for City Water Utilities*, and *Guidelines for Water Curtailment Planning and Program Development for Water Utilities*. These were designed to facilitate local response to drought conditions. About 300 of these publications were mailed to cities and water districts throughout the state. The Department advised the recipients of potential drought conditions and urged them to initiate planning. Some municipal water purveyors such as the Portland Water Bureau were already involved in drought planning.

The 1989 Legislature passed Senate Bill 152. This bill grants the Commission emergency powers to manage waters of the state during a drought. The Commission can require the development of local drought contingency plans in case of a potential or existing drought. Municipalities and other political subdivisions activate these plans as needed. The bill also allows local governments to purchase options to use reserved water during periods of drought.

FACTORS IN WATER CONSERVATION AND DROUGHT PLANNING

Stream Discharge Patterns

The Willamette River drains an area of 11,463 square miles. This is one-eighth of the state's total area, making the Willamette Basin the largest in the state. The estimated average annual discharge of the Willamette River is approximately 25 million af.

The basin contains four distinct physiographic units: the Coast Range, Willamette Valley, Western Cascades and High Cascades. Annual precipitation varies greatly from one unit to another. The Coast Range can receive 60 to 200 inches of precipitation. This amount decreases to 35 to 50 inches at the valley floor and increases with elevation to more than 130 inches at the crest of the Cascades.

As noted in the Surface Water Allocation Section of this report, the Coast Range, west Cascades and the valley floor receive most of the annual precipitation in the form of rain. The high Cascades, however, receive most precipitation in the form of snow. Rain and snow have different impacts on flow patterns in streams. Streams in the Coast Range (the Yamhill, Tualatin, Marys, Luckiamute, Long Tom and Coast Fork Willamette Rivers) respond very quickly to precipitation. The flows in these streams rise rapidly beginning in October, peak in January, then drop gradually until the lowest flows are reached in August. Approximately 93 percent of the annual discharge of these streams occurs during November through May. Only seven percent occurs during June through October when water demand in the Willamette Basin is highest.

Streams that originate in the Cascades (the Santiam, McKenzie, Clackamas, and Middle Fork Willamette Rivers) also show fluctuation in flow patterns from winter to summer. The flows in these streams increase gradually in the fall, peak in December, remain high through May, then decline gradually starting in June. Flows in these streams are influenced by snowmelt in the Cascades and releases from storage. Snowmelt and releases from reservoirs augment and prolong flows into late spring and early summer.

Other streams in the Willamette Basin, such as the Pudding and Molalla Rivers that originate in the foothills of the Cascades, resemble the discharge patterns of the Coast Range streams. These streams are not fed by snowmelt in the Cascades and are influenced by the rainfall pattern in the foothills. A very small percentage of the annual discharge of these streams occurs in the summer months. The users of nearly all Coast Range, lower Cascades and valley tributaries face water shortages in late summer.

Basin programs adopted in the 1960s for the Upper, Middle and Lower Willamette Basins indicate that seasonal water shortages were not uncommon even then. One finding in the Upper Willamette Basin program states, "total yields are adequate in average years but geographical and seasonal maldistribution will result in water shortages in some areas where reliance is placed on natural flows." The program makes it clear that in small streams, particularly those originating in the Coast Range and part of the lower Cascades, summer flows are not adequate to meet all existing rights simultaneously.

The same is true for the Middle and Lower Willamette Basins. The Middle Willamette Basin program states, "there is insufficient surface yield during low-flow periods to meet present demands in many areas, and to meet future demands in most areas." The Lower Willamette program points out that low precipitation during the June through October period, coupled with poor geographical distribution, results in seasonal water shortages in some areas.

The effects of shortages include degraded water quality, loss of suitable fish habitat, loss of recreational opportunities and curtailment of out-of-stream uses. The Department regulates users on a number of streams in the Willamette Basin to supply senior water rights and minimum streamflows. Most of the regulation in the past three years occurred in the Yamhill, Molalla, Tualatin, Long Tom, Marys, Calapooia, and Luckiamute subbasins. DEQ has declared some of these streams as water quality limited streams. These streams violate DEQ standards. They receive more pollutants than they can handle and need better treatment to protect water quality (DEQ, undated). These streams are the main candidates for conservation efforts.

Groundwater

Variations in groundwater storage and recharge, and local problems with quantity and quality occur in some parts of the basin. The Willamette Basin Groundwater Management and Protection section of this report evaluates the current conditions throughout the basin. It also lists areas of ground-water level decline and contamination in the basin. Conservation efforts in the Willamette Basin target both surface and groundwater.

Water Use

Agricultural, municipal and industrial are the three largest water uses in the basin. Demands for water in these categories usually peak during the summer months. Streamflows are lowest during this period of high use.

Agricultural Water Use

Agricultural water uses include irrigation, temperature control, dairy operations, nursery use, and greenhouse use. Irrigation accounts for more than 90 percent of the agricultural water use in the Willamette Basin.

Commercial irrigated agriculture did not start simultaneously with the settlement of the basin. Under dry land farming conditions, farmers raised crops that matured early or crops that were drought resistant. The expansion of irrigation was slow until the 1940s. There were about 1,000 irrigated acres in the Willamette Basin in 1911, 3,000 acres in 1920, 5,000 acres in 1930 and 27,000 acres in 1940. A dramatic increase in the number of irrigated acres occurred in the Willamette Basin during the postwar decades. In 1964, approximately 194,000 acres were irrigated in the basin (Oregon Water Resources Board, 1967). That number increased to 285,190 by 1987 (This includes about 3,000 acres in the Sandy Basin). A slowdown in irrigation expansion in the Willamette Basin occurred during the 1980s.

Irrigation methods in the basin have evolved significantly. Flood irrigation was the major method of irrigation until the 1930s. In 1939, sprinkler irrigation accounted for 50 percent of the total irrigation. This percentage increased to 75 percent in 1949 and 95 percent in 1964. In 1987, flood irrigation was used on less than 0.5 percent of the irrigated acres (Oregon State University Extension Service, 1987). Table 61 lists irrigated acreages and types of irrigation in the basin in 1987.

Table 61

TYPES OF IRRIGATION AND ACRES IRRIGATED

Types of Irrigation	Acres Irrigated
Center Pivot	5,140
Hand Move	151,170
Side Roll	73,330
Solid Set	17,900
Big Gun	34,460
Flood	1,070
Drip	2,030
TOTAL	285,190

Abundant water, improved and efficient irrigation methods, and low cost power are crucial factors in irrigation expansion in the basin. Since relatively efficient systems are in place, savings are most likely to come from low-cost system modification, efficient system operation and improved water management. These measures generally cost less than system conversion.

In 1987 and 1988, the Department watermasters regulated uses on a number of streams mainly to supply senior water rights. These included streams in the Tualatin, Yamhill, Molalla, Marys, Santiam, Luckiamute, Long Tom and Calapooia subbasins. Irrigation is the largest consumptive water use in these subbasins. These subbasins are priority locations to apply irrigation conservation measures.

Municipal Water Use

Municipal water use includes water use by incorporated cities, water districts, water supply companies, associations and cooperatives. Municipal water purveyors provide water for residential, industrial, commercial and public uses. Municipal water systems serve about 80 percent of the population and a large number of industries, commercial establishments and public facilities in the Willamette Basin.

The City of Portland has the largest municipal water system in the state. Portland gets its water almost entirely from the Bull Run Watershed in the Sandy Basin. About 26 percent of the average annual flow of the Bull Run River is used to serve a population of 700,000 in the Portland metropolitan area. This use ties management of the two basins together. Water use practices in one basin impact the water resources of both basins.

Most municipal water systems in the Willamette Basin enjoy ample and high quality water. However, some portions of the Willamette Basin experience chronic or periodic water supply shortages and some municipalities and water utilities experience supply problems during certain periods. In response to a 1987 Department survey, several cities in the Willamette Basin reported some kind of a supply or quality problem or both. There may have been a number of other systems facing supply problems that did not respond to the survey.

The survey also showed that a large number of municipal water systems in the Willamette Basin do not have any water conservation and/or drought plans. In addition, some of these systems reported un-accounted-for-water in excess of 15 percent and rate structures that may encourage wasteful use (decreasing-block rates or flat-rates).

Unaccounted-for-water includes water that is used for some unmetered beneficial uses such as fire fighting, street washing, water main flushing, etc. and water that is lost through system leakage. In some cases, water that is lost through leakage makes up a large portion of the unaccounted-for-water. This could be prevented by implementing aggressive leak detection programs. Systems reporting 15 percent or higher un-accounted-for-water included Lebanon, West Linn, Independence, Silverton, Springfield, Portland, Stayton and Salem. Systems serving populations of 10,000 or more that reported decreasing-block or flat-rate structures include Springfield, Lake Oswego, Salem, Eugene, Lebanon, West Linn, and Woodburn. Systems reporting supply or quality problems, high system losses and rate structures that may encourage wasteful uses are priority candidates for municipal water conservation.

Some municipal water purveyors are exploring alternatives to augment or extend current supplies. Some are developing or exploring alternative and back-up supplies. Others, such as small utilities in the Portland metropolitan area, are tying in to supplies of larger water purveyors. However, few have applied conservation measures to extend supplies.

Industrial Water Use

The Willamette Basin has a large industrial economic base that requires significant quantities of water. The wood products business, including pulp and paper, is the largest industry in the basin. This industry uses almost 80 percent of the water allocated for industrial uses in the basin. Paper processing uses 15,000 to 60,000 gallons of water per ton of pulp depending on the process and grade of paper produced (California Department of Water Resources, 1989).

Manufacturing, sand and gravel operations, food processing, mineral, chemical, primary metals, and other smaller industries account for the remaining 20 percent of the industrial water use. A number of industries in the basin are self-supplied. Others get water from local municipalities and water utilities. Many industries in the Willamette Basin use more than ten million gallons of water per day. Most of the water diverted for industrial uses is eventually discharged into streams or municipal treatment systems.

Among industrial users in the Willamette Basin, the wood products, food processing, and sand and gravel industries hold potential for conservation. Conservation by these industries could contribute significantly to improving water quality and quantity in the basin.

Other Uses

Although agricultural, industrial and municipal uses are the largest consumptive water uses in the Willamette Basin, they are not the only uses. Sufficient quantities of water are needed for a number of other instream and out-of-stream uses. Domestic, recreation, pollution abatement, hydroelectric power generation, fish and wildlife habitat, and aesthetics are some examples. Water uses in the Willamette Basin are covered in greater detail in the Willamette Basin Water Allocation section of this report. Instream needs and uses help determine priorities for conservation and drought planning. Conservation and drought planning efforts may be crucial in meeting instream needs.

DISCUSSION

CONSERVATION

By law, the Commission is directed to study the means and methods of conserving and augmenting the water resources of Oregon. The Commission also has the authority to promote water conservation and to provide an orderly procedure to assure equitable curtailment, adjustment, allocation, or regulation in the use of water resources of the state. During drought or likely drought conditions, the Commission can require individual state agencies and political subdivisions within any drainage basin or subbasin to develop a water conservation and curtailment plan and file it with the Department.

Generally, citizens participating in this planning effort put high priority on voluntary conservation through public education and information. Public education is usually an effective way to raise awareness about water conservation. Public awareness about the value of water and the benefits of water conservation would result in overall water use efficiency basinwide. It also prepares people to more effectively deal with water shortages when they occur.

Public education is a method of conveying the message that inefficient water use detracts from other beneficial uses. It also paves the way for more stringent conservation measures. Any general regulatory measures needed would be determined by the Statewide Conservation Advisory Committee and have a statewide application.

The Water Conservation/Drought Planning Work Group participants and staff recognized problems with targeting some water use categories for more conservation measures than others. Some water users may be able to apply conservation measures more easily than others. This is not to say that the potential for water conservation is greater in sectors where conservation measures can be easily implemented. For example, conservation measures can be more easily implemented in the municipal sector than in the agricultural sector. Municipal water purveyors are commonly perceived as having the money and resources to promote conservation. They can invest more in conservation-related activities. However, the amount of water conserved may not be significant when compared to the amount that could be conserved in irrigated agriculture. One percent savings in total water use in agriculture can be tens of times greater than one percent saved in the municipal sector. Conservation opportunities exist in all sectors. In order for efforts to be successful, conservation should be encouraged in all categories basinwide.

While encouraging basinwide conservation, initial efforts should focus on specific problem areas or subbasins. Local committees could be formed in the Coast Fork Willamette, Tualatin, Yamhill, Molalla, Marys, Calapooia, Long Tom, Pudding, Luckiamute, Rickreall Creek and Columbia Slough subbasins to explore local priorities and opportunities for conservation. The committees would represent a broad cross-section of the community and make specific recommendations on how to increase water use efficiency at the local level. Demonstration conservation projects could be implemented in these problem areas. Such projects, along with other seminars and workshops, would facilitate the flow of information among various water users. Successful conservation measures can be implemented elsewhere in the basin.

Providing incentives to encourage conservation is also a topic of debate. Some people believe that providing incentives to encourage conservation is important. Smaller water purveyors may not have the resources to make a strong commitment to conservation without assistance. Although incentives can be more effective than education and regulations in promoting conservation, they should be provided with a mix of other measures.

Conversely, some believe incentives reward wasteful practices and penalize efficient users. Financial incentives must apply to all to be equitable. Those who have already invested in efficient water systems should be rewarded.

The potential impact of conservation on water system revenues concerns some municipal purveyors. Water sales are the only source of revenue for most water purveyors. While conservation is a wise thing to do, it is not intended to give people the impression that there is a drought or to drive water purveyors out of business. The public should know how to use water wisely and to conserve or curtail when asked or needed. Water conservation should be a long-range educational goal. The user should not be confronted with sudden price increases or sudden reductions in water use. Sudden reductions in water use may be needed when a water purveyor is faced with short supply.

DROUGHT PLANNING

Views expressed during basin planning indicate that the best approach to reducing drought impacts in the Willamette Basin would be through education and information. To ensure that everyone is treated equally, the basin should be operated as a system during prolonged droughts. All users should be asked to make cuts in their water use. A collective reduction in water use may reduce the need for regulating junior users in favor of senior users.

Drought plans should be encouraged, especially in the municipal water use sector. Drought curtailment plans may assist purveyors in subbasins that already face seasonal water shortages. Municipalities should know what course of action to take in the event of drought. Curtailment plans would also aid municipal water purveyors in the event of other loss of supply. These plans should be updated periodically. Some small municipal water purveyors may not have the resources or expertise to draft conservation and drought plans. The Department can help any purveyor needing assistance in drafting such plans.

MANAGEMENT PROPOSALS

There is a potential to increase water use efficiency in the agricultural, municipal and industrial sectors in the Willamette Basin. Strategies for increasing water use efficiency are grouped into three categories: voluntary measures through public education and information; incentives; and regulatory measures.

An appropriate mix of these strategies would be most effective in the Willamette Basin. Measures that promote voluntary water conservation should be given first and highest priority in achieving basinwide efficiency. These measures are likely to be more readily accepted and implemented by water users in the Willamette Basin. These measures would also be beneficial during drought conditions.

Conservation efforts in the Willamette Basin must conform with the Commission's statewide conservation policy (OAR 690-410-060). The proposed conservation policies for the Willamette Basin reflects the major components of the statewide policy as follows:

Policies

- Implement programs to eliminate wasteful water use.
- Improve the efficiency of water use through implementation of voluntary conservation measures.
- Give priority to developing subbasin conservation plans and providing public assistance in areas of known over-appropriation of surface water and groundwater and of water quality problems.

Implementing Actions

Voluntary Measures

1) Encourage voluntary, cooperative water conservation practices by promoting increased public awareness of the value of water, methods and benefits of water conservation and water use efficiency. Increasing public awareness will require cooperation and coordination with other agencies, users and purveyors, professional organizations such as the Soil Conservation Service, Soil and Water Conservation Districts, American Water Works Association, Extension Service, city, county and regional planning departments and others.

2) Encourage and provide leadership in formation of conservation committees in subbasins facing seasonal shortages or quality problems. These subbasins include the Coast Fork Willamette, Tualatin, Yamhill, Molalla, Marys, Calapooia, Long Tom, Pudding, Luckiamute, Rickreall Creek and Columbia Slough. Assist these committees in selecting and applying effective conservation techniques to achieve a high degree of water use efficiency.

3) Encourage municipal water purveyors to develop public education and information programs on the value of water and increasing water use efficiency. Purveyors should provide information on water-saving plumbing fixtures and fixture altering devices, lawn watering, water efficient landscaping, and other conservation measures to their customers.

4) Encourage agricultural, municipal and industrial water purveyors in the Willamette Basin to develop water management plans that include conservation, drought planning, wastewater recycling and reuse and other water use efficiency measures. Provide assistance as resources allow.

Incentives

1) Assist water users and purveyors in identifying and securing grants, loans, tax credits and other financial assistance to implement conservation measures. Some of these incentives may already exist while others may have to be created. This effort should first focus on the areas or systems that experience seasonal water shortages or water quality problems.

2) Encourage water purveyors to consider and adopt rate structures that encourage water conservation.

3) Encourage water purveyors to work with local sewerage treatment agencies to develop reclaimed wastewater supplies and to distribute the water at a lower price than existing domestic or irrigation supplies.

Regulations

1) Place conditions on permits to appropriate water from sources including but not limited to the Columbia River basalts and low-yield aquifers to require implementation of conservation and water use efficiency measures.

2) Require that conservation and water use efficiency special conditions be employed when permitting the use of water from water quality limited streams and their tributaries including the Coast Fork Willamette, Tualatin, Yamhill, Pudding and Luckiamute Rivers, Rickreall Creek and the Columbia Slough.

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Section 7

STATE AND LOCAL COORDINATION OF WATER RESOURCE AND LAND USE PLANNING

PROBLEM STATEMENT

Water, and its availability and use, is becoming increasingly important in the land use equation. Water is critical for agricultural production, and necessary to support increased industrial capacity and population growth. Only in recent years has the capacity of the resource to sustain planned land uses become an issue to water managers and land planners alike. Greater coordination between water managers and land planners is necessary for sound land and water management.

BACKGROUND

Basin planning affects water—one of the most important resources addressed by the statewide land use planning goals. By establishing the types and limits of allowable future water uses, basin planning can influence the type and extent of land use. Conversely, by allocating land for a range of uses, land use planning establishes the potential for future water demand. Land use and water planning are integrally related. Therefore, the Water Resources Commission has designated basin planning as an agency "land use program," as defined by the Land Conservation and Development Commission. Under state law, agency land use programs are to comply with state-wide planning goals and be compatible with comprehensive plans. Accordingly, it is the Commission's goal to be compatible with local government land use plans to the maximum extent possible, consistent with the public interest as expressed through state water resources policy.

Today, there is increasing pressure on finite water resources for additional consumptive and instream uses as a result of rapid population growth, diminishing fish populations and continued agricultural needs. In many instances, we are approaching or exceeding the water resource carrying capacity. Coordination between land and water planning has never been more important.

For several reasons, coordination between local comprehensive plans and basin plans has been quite limited. First, when statewide land use planning was initiated and local plans were developed, there was a perception of abundant water supplies in the Willamette Basin and there were fewer demands for water use. Nothing compelled basin plans to reflect comprehensive plans or vice-versa.

Second, comprehensive plans are founded on the statewide planning goals but there is no water resources goal, per se. General references to water resources carrying capacity are spread throughout the goals. Although Goal 5 is frequently represented as a water resources goal, it actually deals in a very broad fashion with natural resources, open space, and scenic and historic areas. Thus, local plans have not addressed water resources issues in any specific or uniform way. Although the goals require coordination of state and local plans in a general fashion, coordination of local plans with Commission planning programs has not been achieved.

Third, the relationship between basin planning water classifications and land use is not straight-forward. For example, a basin classification may allow no additional irrigation use in an agricultural zone. Although it may appear so, this is not necessarily a conflict. There may be alternative water supply sources for new uses from storage, interbasin transfers or savings from water conservation. In addition, existing agricultural water uses could continue. Even if opportunities for additional irrigation were severely constrained, future agriculture activities which are not water-use intensive, such as grazing or dry land farming, would be possible.

DISCUSSION

Improving coordination is the goal of the Department's State Agency Coordination (SAC) Program. However, this program was established late in the Willamette Basin planning process. Despite efforts of both the Department and local governments during the process, more coordination is needed to explore land use related issues that have arisen during the planning process. These issues include the need to quantify present and future water needs based on planned land uses, identify additional water sources to serve those needs, improve the exchange of water resource information between the Department and local governments, further identify areas of groundwater concern, especially those referenced in local plans, and analyze effects of, or alternatives to, allowing exempt groundwater uses in areas of concern.

Many of the following actions are designed to address these issues in the Willamette Basin and are also contained in the SAC Program. The Willamette Basin Program offers one of the first opportunities to apply the SAC Program at a regional level through intensive coordination. Results from implementing the strategies will be basin-specific.

MANAGEMENT PROPOSALS

POLICY

Promote effective state and local water resource planning and protection and efficient water use through coordination with land use programs.

IMPLEMENTING ACTIONS

1) Work with municipal water suppliers and other local governments to assess future municipal and industrial needs and allocation options to meet those needs. Preserve opportunities for future economic development by reserving water for future use.

2) Encourage cities such as Sherwood and Wilsonville and other water purveyors dependent on groundwater from the basalt aquifers to seek alternate water supplies.

3) Urge users of groundwater from basalt aquifers to seek low-cost municipal-quality water from surface sources to recharge the aquifers during the off season.

4) Make low-yield aquifer information more readily available to the public and local agencies.

5) Coordinate with counties and other interested parties to identify workable strategies for better integrating water resource capabilities and classifications with local water planning and land use designations. Meet with local planners to discuss water quantity or quality limited areas such as those identified by Lane County, alternatives for expanding irrigated agriculture in areas such as Clackamas and Marion Counties, and other land and water issues.

6) Through periodic review and technical assistance, prepare and distribute information on surface and groundwater availability to county and city planning and building departments and coordinate land use/water use plans with the local agencies.

7) Through periodic review and technical assistance, encourage local governments to:

   a) Evaluate water supplies before approving development projects and plan and zone amendments.

b) Adopt ordinances that require a showing of adequate water supply and legal abandonment of existing unused wells before issuing building permits.

c) Consider available information on groundwater supply and vulnerability to determine appropriate land use designations and conditions of land use approval.

8) Use groundwater information to assist local agencies in determining appropriate well-spacing requirements which should be applied through the local land use planning process.

9) Assist the Department of Land Conservation and Development, counties and special districts to update or develop mandatory planning agreements between counties and districts, and METRO in the Portland area, as required by ORS 197.185.

10) Participate in the periodic review and amendment of comprehensive plans with the objective of enhancing water-supply management and protection consistent with statewide planning goals and state water policy. Review comprehensive plans for compliance with basin policies and the statewide planning goals using criteria including but not limited to the following:

a) Goal 5: *Open Spaces, Scenic and Historic Areas and Natural Resources* - Local governments should inventory and establish management and protection strategies for water resources using available information and develop strategies for on-going refinement of the information base.

b) Goal 6: *Air, Water and Land Resources Quality* - Local governments should evaluate the effects of existing and planned land and water uses on water quality.

c) Goal 11 *Public Facilities and Services* - Local governments should analyze water availability and the adequacy of supply and quality to meet future demands. The analysis should address:

i) Projected populations and land uses within affected urban growth boundaries and service areas;

ii) Future orderly expansion of urban growth boundaries and associated water demands;

iii) Economic forecasts for industrial and commercial water needs;

iv) Opportunities for water conservation;

v) The feasibility of meeting future needs by consolidating or regionalizing water supply services. A feasibility analysis should examine:

- Economic, demographic, socio-political, environmental, regulatory and physiographic trends.

- Opportunities to execute agreements between adjacent water providers for cooperative development and operation of water supply and distribution facilities.

vi) The viability of interconnecting systems and regional management of water supplies. Where water systems abut, or future extensions will abut other systems, local government or district plans should address:

  - The compatibility of system design, transmission sizing and pressure with those of adjacent systems;

  - The compatibility of system operations, including but not limited to rate structures and use of meters;

  - Land ownership patterns (public and private) and associated implications for the consolidation or regionalization of water services; and

  - The effect of water supply authority, county service district or regional water supply system service plans on rural lands

vii) Avoiding reliance upon individual domestic wells or surface water systems where sustainable water supplies are uncertain;

viii) Provision of water services to rural lands. Local governments should assess whether it is appropriate and feasible to expand the urban growth boundary to encompass rural water service areas. If the provision of water service to rural lands could not be accomplished by an expansion of the urban growth boundary, local governments should assess whether the provision of water service to rural lands would be consistent with Goals 14 and 11.

d) Goal 14: *Urbanization* - Local governments should consider the carrying capacity of, and the potential impacts on, surface water and groundwater resources when providing for urban growth. When planning for urban growth, consideration should be given to:

   i) Consistency with the Department's review criteria identified for Goals 5, 6 and 11;

   ii) Developing and implementing short-term plans for directing where and when growth is to occur within the urban growth boundary in order to facilitate orderly and efficient development of water service;

   iii) Future orderly expansion of urban growth boundaries and associated water demands.

11) Through the provisions of the State Agency Coordination Program and other activities, assist local governments and water providers in taking action to coordinate planning, consolidate services and develop regional water supplies.

12) Continue working with regional organizations like the Metropolitan Service District and the Tri-County (Polk, Yamhill, Lincoln) regional water planning committee to plan or coordinate development of long-term water supplies for the region.

13) Coordinate planning and management activities with the Department of Land Conservation and Development and local planning authorities to ensure that coordinated water service planning and the consolidation of water services is consistent with Statewide Planning Goals, in particular Goal 11 (Public Facilities and Services) and Goal 14 (Urbanization).

14) Continue present efforts to coordinate state and local input into development of the annual Corps of Engineers Willamette Basin reservoir operation plan until a state-federal coordination agreement is ratified.

15) Request the Corps to reduce the financial and administrative obstacles to the use of stored water for municipal and industrial purposes.

16) Encourage voluntary, cooperative water conservation practices by increasing public awareness through cooperation and coordination with city, county and regional planning departments and others.

APPENDICIES

APPENDIX A

STATISTICAL SUMMARIES BASED ON MEAN DAILY DISCHARGES
AVERAGE ANNUAL/MEAN MONTHLY DISCHARGE AND MONTHLY DISTRIBUTION AT SELECTED WILLAMETTE BASIN STREAM GAGES

GAGE#	GAGE NAME	YRS	DRAIN AREA (MI2)	AVE. ANN. YIELD AF*		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14144800	M. Fk. Willamette R. nr Oakridge	29	258	592000	CFS	348	831	1240	1240	1190	1030	1020	1120	796	415	301	288
					%	3.6	8.4	12.9	12.9	11.3	10.7	10.3	11.6	8.0	4.3	3.1	2.9
14147500	N. Fk. Middle Fk. Willamette R. nr Oakridge	58	246	573100	CFS	267	868	1280	1260	1240	1110	1150	1040	668	298	183	167
					%	2.9	9.0	13.7	13.5	12.1	11.9	11.9	11.2	6.9	3.2	2.0	1.7
14151000	Fall Cr. blw Winberry Cr.	21	186	421000	CFS	727	979	1230	1020	494	413	368	289	265	252	314	617
					%	10.6	13.8	18.0	14.9	6.6	6.0	5.2	4.2	3.7	3.7	4.6	8.7
14152000	Middle Fk. Willamette R. at Jasper	21	1340	3021000	CFS	4240	6480	8160	6730	4230	3560	2910	2920	2810	1930	2360	3660
					%	8.6	12.8	16.6	13.7	7.8	7.2	5.7	5.9	5.5	3.9	4.8	7.2
14152500	Coast Fk. Willamette R. at London	52	72.1	145600	CFS	61	243	404	414	401	348	244	146	77	33	20	22
					%	2.6	10.0	17.1	17.6	15.5	14.8	10.0	6.2	3.2	1.4	0.9	0.9
14143500	Coast Fk. Willamette R. blw Cottage Grove Dam	45	104	201400	CFS	211	348	583	601	437	340	208	137	94	56	110	213
					%	6.4	10.3	17.8	18.3	12.2	10.4	6.1	4.2	2.8	1.7	3.4	6.3
14155500	Row River nr Cottage Grove	38	270	557100	CFS	472	948	1630	1550	1220	974	735	516	319	197	346	353
					%	5.2	10.1	18.0	17.1	12.3	10.7	7.9	5.7	3.4	2.2	3.8	3.8
14156500	Mosby Cr. at Mouth nr Cottage Grove	34	95.3	174600	CFS	77	303	518	554	459	426	271	167	70	22	12	16
					%	2.7	10.3	18.2	19.5	14.7	15.0	9.2	5.9	2.4	0.8	0.4	0.6
14157500	Coast Fk. Willamette R. nr Goshen	37	642	1188100	CFS	811	2030	3640	3570	2900	2330	1560	983	536	284	481	578
					%	4.2	10.2	18.8	18.5	13.7	12.1	7.8	5.1	2.7	1.5	2.5	2.9
14158000	Willamette R. at Springfield	25	2030	3557100	CFS	1410	5220	7180	8980	8890	7630	7080	5400	3930	1600	913	989
					%	2.4	8.7	12.4	15.5	14.0	13.2	11.8	9.3	6.6	2.8	1.6	1.7
14159500	S. Fk. McKenzie nr Rainbow	24	208	592800	CFS	929	1230	1440	1230	716	544	456	742	682	419	613	807
					%	9.6	12.4	14.9	12.8	6.8	5.6	4.6	7.7	6.8	4.3	6.4	8.1
14162200	Blue River at Blue River	19	87.7	344100	CFS	265	669	1080	841	475	383	295	346	249	364	476	240
					%	4.7	11.6	19.3	15.0	7.7	6.8	5.1	6.2	4.3	6.5	8.5	4.2
14162500	McKenzie R. nr Vida	19	930	3056900	CFS	2890	4870	6700	6170	020	4510	4000	4450	3710	2790	2860	2680
					%	5.8	9.5	13.5	12.4	9.2	9.1	7.8	8.9	7.2	5.6	5.8	5.2
14165500	McKenzie R. nr Coburg	19	1337	4360900	CFS	3110	6310	9200	8760	1020	8300	7860	7050	4730	2810	2150	2020
					%	4.4	8.6	13.0	12.4	0 13.1	11.7	10.7	9.9	6.5	4.0	3.0	2.8
14166500	Long Tom R. nr Noti	52	89.3	168800	CFS	42	211	474	583	570	421	254	126	64	29	16	17
					%	1.5	7.4	17.3	21.2	18.9	15.3	9.0	4.6	2.3	1.1	0.6	0.6
14170000	Long Tom R. at Monroe	46	391	581000	CFS	764	978	1860	2210	1730	952	488	235	84	42	81	228
					%	8.1	10.1	19.7	23.4	16.7	10.1	5.0	2.5	0.9	0.5	0.9	2.3

APPENDIX A (continued)

STATISTICAL SUMMARIES BASED ON MEAN DAILY S
AVERAGE ANNUAL/MEAN MONTHLY DISCHARGE AND MONTHLY DISTRIBUTION AT SELECTED WILLAMETTE BASIN STREAM GAGES

GAGE#	GAGE NAME	YRS	DRAIN AREA (MI2)	AVE. ANN YIELD AF*		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14171000	Marys R. nr Philomath	45	159	334700	CFS	72	483	1070	1210	1070	798	466	223	95	36	18	19
					%	1.3	8.6	19.7	22.2	17.9	14.7	8.3	4.1	1.7	0.7	0.3	0.4
14173500	Calapooia R. at Albany	41	372	648400	CFS	201	1040	2120	2280	1850	1450	914	537	228	84	40	49
					%	1.9	9.5	20.1	21.6	16.0	13.7	8.4	5.1	2.1	0.8	0.4	0.5
14174000	Willamette R. at Albany	19	4840	10793500	CFS	9460	1830	31100	2840	2240	1810	13700	1060	8400	5370	5580	7390
					%	5.4	0	17.7	0	0	0	7.6	0	4.6	3.1	3.2	4.1
							10.1		16.2	11.6	10.3		6.0				
14178000	N. Santiam R. blw Boulder Cr.	61	216	329600	CFS	521	985	1390	1390	1310	1160	1330	1440	1120	637	478	442
					%	4.4	8.0	11.7	11.0	10.0	9.7	10.8	12.1	9.1	5.4	4.0	3.6
14182500	Little N. Santiam R. nr Mehama	56	112	553500	CFS	417	1150	1480	1350	1210	1030	974	814	467	136	65	115
					%	4.6	12.3	16.4	15.0	12.2	11.4	10.5	9.0	5.0	1.5	0.7	1.2
14183000	N. Santiam R. at Mehama	34	655	2542800	CFS	2980	5400	6480	5610	4140	3370	3200	3550	2590	1430	1310	2040
					%	7.2	12.6	15.7	13.6	9.1	8.1	7.5	8.6	6.1	3.5	3.2	4.8
14187500	S. Santiam R. at Waterloo	21	640	2202300	CFS	2250	4900	6730	5790	0	3250	2670	2300	1580	782	816	1420
					%	6.3	13.2	18.8	16.2	10.4	9.1	7.2	6.4	4.3	2.2	2.3	3.8
14189000	Santiam R. at Jefferson	21	1790	5650700	CFS	5220	1160	16700	1500	1130	8970	7010	6460	4410	1980	1800	3350
					%	5.7	0	18.2	0	0	9.8	7.4	7.0	4.6	2.2	2.0	3.5
							12.2		16.3	11.2							
14190500	Luckiamute R. nr Suver	53	240	655700	CFS	190	1120	2130	2280	2090	1460	849	420	198	79	42	55
					%	1.8	10.2	20.0	21.4	17.9	13.7	7.7	3.9	1.8	0.7	0.4	0.5
14190700	Rickreall Cr. nr Dallas	18	27.4	105800	CFS	28	210	378	397	273	249	119	60	21	7.6	4.8	6.6
					%	1.7	11.8	22.0	23.1	14.5	14.5	6.7	3.5	1.2	0.4	0.3	0.4
14191000	Willamette R. nr Salem	19	7280	17820100	CFS	1490	3200	52600	4800	3720	3020	22800	1810	1360	7770	7480	1080
					%	0	0	18.1	0	0	0	7.6	0	0	2.7	2.6	0
						5.1	10.7		16.6	11.7	10.4		6.2	4.5			3.6
14194000	S. Yamhill R. nr Whiteson	47	502	1271000	CFS	371	2150	4250	4470	4060	2940	1650	724	304	107	49	83
					%	1.8	10.1	20.6	21.7	17.9	14.3	7.7	3.5	1.4	0.5	0.2	0.4
14197000	N. Yamhill R. at Pike	25	66.8	175300	CFS	48	260	545	636	556	441	227	111	48	20	11	13
					%	1.7	8.8	19.1	22.3	17.8	15.5	7.7	3.9	1.6	0.7	0.4	0.5
14198000	Willamette R. at Wilsonville	25	8400	21000000	CFS	1360	3110	54000	6050	5260	4030	29900	2370	1480	8020	6570	7840
					%	0	0	15.8	0	0	0	8.5	0	0	2.3	1.9	2.2
						4.0	8.8		17.7	14.0	11.8		6.9	4.2			
14200000	Molalla R. nr Canby	47	323	842600	CFS	444	1500	2290	2430	1920	1710	1470	1110	624	207	105	143
					%	3.2	10.6	16.8	17.8	12.8	12.5	10.4	8.1	4.4	1.5	0.8	1.0

APPENDIX A (continued)

STATISTICAL SUMMARIES BASED ON MEAN DAILY DISCHARGES
AVERAGE ANNUAL/MEAN MONTHLY DISCHARGE AND MONTHLY DISTRIBUTION AT SELECTED
WILLAMETTE BASIN STREAM GAGES

GAGE#	GAGE NAME	YRS	DRAIN AREA (MI2)	AVE. ANN. YEILD AF*		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14202000	Pudding R. at Aurora	36	479	882300	CFS	340	1390	2360	2690	2640	2090	1560	881	419	151	72	91
					%	2.4	9.4	16.4	18.7	16.7	14.5	10.5	6.1	2.8	1.1	0.5	0.6
14207500	Tualatin R. at West Linn	19	706	1109000	CFS	178	1060	3200	4350	4240	2810	1620	691	247	51	14	30
					%	1.0	5.7	17.8	24.1	21.4	15.6	8.7	3.8	1.3	0.3	0.1	0.2
14211000	Clackamas R. nr Clackamas	21	930	2658700	CFS	1610	3870	6910	7020	5500	4620	4300	4210	2660	1360	1000	1070
					%	3.7	8.7	16.0	16.2	11.6	10.7	9.6	9.7	6.0	3.1	2.3	2.4
14211500	Johnson Cr. at Sycamore	47	26.5	39400	CFS	10	73	132	143	121	87	47	24	10	3.0	1.9	2.9
					%	1.6	11.0	20.6	22.3	17.2	13.6	7.1	3.8	1.6	0.5	0.3	0.4
14211720	Willamette R. at Portland	15	11100	24130000	CFS	16900	4330	7320	6300	54900	4420	3380	2420	17400	9450	8350	1210
					%	4.3	0	0	0	12.8	0	0	0	4.3	2.4	2.1	0
							10.7	18.7	16.1		11.3	8.3	6.2				3.0

* The average annaual discgarge as listed by the USGS, or as calculated from the mean daily rate over the period of record.

Source: USGS, Statistical Summaries of Streamflow Data in Oregon. Volume 1-Monthly and Annual Streamflow and Flow duration Values.
USGS Open-file Report 90-118. 1990

APPENDIX B

SURFACE WATER
WILLAMETTE BASIN WATER RIGHTS
BY SUBBASINS OR DRAINAGE
(CUBIC FEET PER SECOND)

SUBBASINS/DRAINAGE	AGRIC	INDUS	MUNIC	DOMES	REC	MISC.	TOTAL RIGHTS OF RECORD
Coast Fork Willamette River	93.05	43.51	31.70	1.00	0.16	0.92	170.34
MIiddle Fork Willamette River	35.73	26.26	22.56	6.56	0.06	92.06	186.23
McKenzie River	235.44	10,075.31	304.08	6.32	0.89	266.68	10,888.72
Long Tom River	195.82	31.58	0.45	2.90	0.08	4.83	235.66
Marys River	90.78	11.38	15.74	3.96	1.21	12.23	135.30
Calapooia River	150.53	181.22	1.25	0.63	4.00	0.51	338.14
Santiam River	629.00	2,,017.64	242.85	18.84	35.14	372.50	3,315.97
N. Santiam River	370.82	1535.63	149.66	9.31	27.41	328.68	2,421.51
S. Santiam River	246.44	481.31	90.10	8.92	7.73	11.52	876.02
Luckiamute River	156.74	5.50	8.50	7.98	0.54	2.78	182.04
RickreallCreek	42.77	0.23	15.27	1.46	0.11	0.82	60.66
Yamhill River	467.00	13.05	41.79	18.45	6.52	8.36	559.96
Molalla River	380.56	17.73	43.82	4.39	9.53	7.25	463.28
Pudding River	271.32	1.85	15.27	1.36	3.75	3.63	297.18
Clackamas River	71.13	156.10	301.30	5.95	1.80	179.34	715.62
Johnson Creek	15.72	4.10	0.00	0.34	0.00	3.65	23.80
Tualatin River	722.34	37.22	330.10	13.54	4.20	86.47	1,193.87
Kellogg Creek	20.93	0.01	0.00	0.28	0.12	4.06	25.40
Willamette River (mains tem)	840.28	1,324.78	424.83	15.23	125.05	24.72	2,754.89
Scappoose Creek	7.54	4.20	14.00	0.56	0.05	0.03	26.37
Milton Creek	0.83	0.00	70.50	0.09	0.00	0.25	71.67

APPENDIX B

GROUNDWATER
WILLAMETTE BASIN WATER RIGHTS
BY SUBBASINS OR DRAINAGE
(CUBIC FEET PER SECOND)

SUBBASINS/DRAINAGE	AGRIC	INDUS	MUNIC	DOMES	REC	MISC.	TOTAL RIGHTS OF RECORD
Coast Fork Willamette River	18.27	1.91	6.68	0.57	0.00	0.08	27.52
Middle Fork Willamette River	18.82	0.03	27.86	0.16	0.00	0.00	46.86
McKenzie River	49.75	2.19	26.90	0.96	0.00	0.45	80.25
Long Tom River	62.80	1.20	1.93	0.29	0.00	0.08	66.30
Marys River	15.35	0.58	3.33	0.09	0.00	0.00	19.46
Calapooia River	44.83	0.17	0.67	0.00	0.00	0.00	45.67
Santiam River	376.21	5.71	64.33	1.15	0.02	0.45	447.87
N. Santiam River	134.59	3.54	58.26	0.02	0.00	0.12	196.52
S. Santiam River	147.26	2.17	3.98	0.75	0.02	0.33	154.50
Luckiamute River	2.65	0.00	0.00	0.00	0.04	0.00	2.69
Rickreall Creek	21.37	0.22	0.00	0.04	0.18	0.07	21.89
Yamhill River	59.85	2.04	5.36	0.00	0.08	0.05	67.38
N. Yamhill River	0.80	0.00	0.45	0.00	0.00	0.00	1.25
S. Yamhill River	16.00	0.08	2.01	0.00	0.00	0.00	18.09
Molalla River	771.83	27.45	48.59	4.56	0.14	1.97	854.54
Pudding River	681.12	27.14	43.17	4.56	0.14	1.91	758.05
Clackamas River	32.61	0.32	6.53	1.79	0.00	0.97	42.21
Johnson Creek	27.73	5.02	3.21	3.38	0.00	1.23	40.58
Tualatin River	88.68	2.54	23.70	1.26	0.01	1.91	118.10
Kellogg Creek	3.69	0.68	7.09	0.12	0.00	1.28	12.86
Willamette River (main stem)	3,165.85	140.49	497.71	40.83	1.35	59.76	3,905.99
Scappoose Creek	0.37	0.22	0.89	0.00	0.00	0.00	1.48
Milton Creek	1.18	0.00	0.00	0.00	0.00	0.00	1.18

APPENDIX C
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

KEY	
DEQ	Dept. of Environmental Quality
ODFW	Dept. of Fish & Wildlife
PRD	Parks & Recreation Dept.

Stream Name	Agency
Columbia Subbasin	
Columbia Slough > Columbia R	DEQ
Springbrook Cr > Lake Oswego	DEQ
Johnson Cr > Willamette R	DEQ
Clackamas River Subbasin	
Rock Cr > Clackamas R	ODFW
Richardson Cr > Clackamas R	ODFW
Foster Cr > Clackamas R	ODFW
Deep Cr > Clackamas R	ODFW
Tickle Cr > Deep Cr	ODFW
Eagle Cr > Clackamas R	ODFW
N Fk Clackamas R > Clackamas R	ODFW
Fish Cr > Clackamas R	ODFW
Roaring R > Clackamas R	ODFW
Sandstone Cr > Clackamas R	ODFW
Oak Grove Fk > Clackamas R	ODFW
S Fk Eagle Cr > Eagle Cr	ODFW
Memaloose Cr > S Fk Clackamas R	ODFW
Shellrock Cr > Oak Grove Fk	ODFW
Stone Cr > Oak Grove Fk	ODFW
Cooper Cr > Oak Grove Fk	ODFW
Crater Cr > Oak Grove Fk	ODFW
Collowash R > Clackamas R	ODFW
Nohorn Cr > Hot Sprs Fk Collowash R	ODFW
Hugh Cr > Nohorn Cr	ODFW
Camp Cr > Last Cr	ODFW
Rhododendron Cr > Clackamas R	ODFW
Tumble Cr > Rhododendron Cr	ODFW
Fawn Cr > Clackamas R	ODFW
Tualatin River Subbasin	
Tualatin R > Willamette R	DEQ, PRD
Rock Cr > Tualatin R	DEQ
Beaverton Cr > Rock Cr	DEQ
Dairy Cr > Tualatin R	DEQ
McKay Cr > Tualatin R	DEQ
Gales Cr > Tualatin R	DEQ
Scoggins Cr > Tualatin R	ODFW

APPENDIX C (continued)
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

Stream Name	Agency
Molalla - Pudding River Subbasin	
Molalla R >Willamette R	PRD
Pudding R > Molalla R	PRD
Butte Cr > Pudding R	PRD
Abiqua Cr > Pudding R	PRD
Silver Cr > Pudding R	PRD
Drift Cr > Pudding R	ODFW
Gribble Cr > Molalla R	ODFW
Woodcock Cr > Milk Cr	ODFW
Nate Cr > Milk Cr	ODFW
Randall Cr > Nate Cr	ODFW
Canyon Cr > Milk Cr	ODFW
Bee Cr > Canyon Cr	ODFW
Jackson Cr > Milk Cr	ODFW
Mill Cr > Milk Cr	ODFW
Dickey Cr > Molalla R	ODFW
Cedar Cr > Molalla R	ODFW
N Fk Molalla R > Molalla R	ODFW
Trout Cr > Molalla R	ODFW
Pine Cr > Molalla R	ODFW
Gawley Cr > Molalla R	ODFW
Table Rock Fk > Molalla R	ODFW
Ogle Cr > Molalla R	ODFW
Coast Range Subbasin	
Yamhill River Drainage	
Yamhill R > Willamette R	DEQ, PRD
N Yamhill R > Yamhill R	DEQ, PRD
Panther Cr > N Yamhill R	ODFW
Baker Cr > Panther Cr	ODFW
Turner Cr > N Yamhill R	ODFW
Cedar Cr > N Yamhill R	ODFW
Haskins Cr > N Yamhill R	ODFW
Fairchild Cr . N Yamhill R	ODFW
S Yamhill R > Yamhill R	DEQ, PRD
Deer Cr > S Yamhill R	DEQ
Mill Cr > S Yamhill R	DEQ
Gooseneck Cr > Mill Cr	ODFW
Wind Cr > Mill Cr	ODFW
Coast Cr > Willamina Cr	ODFW
Canada Cr > Coast Cr	ODFW
Burton Cr > Coast Cr	ODFW
E Fk Willamina Cr > Willamina Cr	ODFW
Gold Cr > S Yamhill	ODFW
Salt Cr > S Yamhill R	DEQ
Cosper Cr > S Yamhill R	ODFW
Rowell Cr > S Yamhill R	ODFW
Rock Cr > S Yamhill R	ODFW

APPENDIX C (continued)
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

Stream Name	Agency
Cow Cr > Rock Cr	ODFW
Joe Day Cr > Rock Cr	ODFW
Rogue R > S Yamhill R	ODFW
Agency Cr > S Yamhill R	ODFW
Ead Cr > S Yamhill R	ODFW
Pierce Cr > S Yamhill R	ODFW
Hanchet Cr > S Yamhill R	ODFW
Kitten Cr > S Yamhill R	ODFW
Rickreall Creek Drainage	
Rickreall Cr > Willamette R	DEQ
Bashaw Cr > Keesneck L	DEQ
Luckiamute River Drainage	
Luckiamute R > Willamette R	DEQ, PRD
Little Luckiamute R > Luckiamute R	PRD
S Fk Pedee Cr > Pedee Cr	ODFW
N Fk Pedee Cr > Pedee Cr	ODFW
Rittner Cr > Luckiamute R	ODFW
Clayton Cr > Rittner Cr	ODFW
Sheythe Cr > Rittner Cr	ODFW
Mayfield Cr > Luckiamute R	ODFW
Price Cr > Luckiamute R	ODFW
Marys River Drainage	
Marys R > Willamette R	DEQ, PRD
Rock Cr > Greasy Cr	ODFW
Oak Cr > Marys R	DEQ, ODFW
Woods Cr > Marys R	ODFW
Blakesly Cr > Marys R	ODFW
TumTum R > Marys R	ODFW
Mulkey Cr > TumTum R	ODFW
Shotpouch Cr > TumTum R	ODFW
W Fk Marys R > Marys R	ODFW
Oleman Cr > W Fk Marys R	ODFW
Santiam River Subbasin	
Santiam R > Willamette R	DEQ, PRD
N Santiam R > Santiam R	PRD, ODFW
Stout Cr > N Santiam R	ODFW
Little N Santiam R > N Santiam R	PRD
Rock Cr > N Santiam R	ODFW
Mad Cr > N Santiam R	ODFW
S Santiam R > Santiam R	DEQ, PRD
Thomas Cr > S Santiam R	PRD, ODFW
Neal Cr > Thomas Cr	ODFW
Crabtree Cr > S Santiam R	PRD, ODFW
Ames Cr > S Santiam R	ODFW

APPENDIX C (continued)
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

Stream Name	Agency
Wiley Cr > S Santiam R	ODFW
Little Wiley Cr > Wiley Cr	ODFW
M Santiam R > S Santiam R	PRD
Quartzville Cr > M Santiam R	PRD
Calapooia River Subbasin	
Calapooia R > Willamette R	DEQ, PRD, ODFW
Oak Cr > Calapooia R	DEQ
Long Tom River Subbasin	
Long Tom R > Willamette R	DEQ, PRD, ODFW
Ferguson Cr > Long Tom R	ODFW
Bear Cr > Long Tom R	ODFW
Amazon Cr > Long Tom R	DEQ
Noti Cr > Long Tom R	ODFW
Poodle Cr > Noti Cr	ODFW
McKenzie River Subbasin	
McKenzie R > Willamette R	DEQ, PRD, ODFW
Mohawk R > McKenzie R	PRD, ODFW
McGowan Cr > Mohawk R	ODFW
Parsons Cr > Mohawk R	ODFW
Cartwright Cr > Mohawk R	ODFW
Mill Cr > Mohawk R	ODFW
Cash Cr > Mohawk R	ODFW
Shotgun Cr > Mohawk R	ODFW
Drory Cr > Mohawk R	ODFW
Camp Cr > McKenzie R	ODFW
Holden Cr > McKenzie R	ODFW
Finn Cr > McKenzie R	ODFW
Indian Cr > McKenzie R	ODFW
N Fk Gate Cr > Gate Cr	ODFW
S Fk Gate Cr > Gate Cr	ODFW
Ennis Cr > McKenzie R	ODFW
Quartz Cr > McKenzie R	ODFW
Elk Cr > McKenzie R	ODFW
Blue R > McKenzie R	PRD, ODFW
Simmonds Cr > Blue R	ODFW
Quartz Cr > Blue R	ODFW
Lookout Cr > Blue R	ODFW
McCrea Cr > Lookout Cr	ODFW
Tidbits Cr > Ore Cr	ODFW
Cook Cr > Blue R	ODFW
Quentin Cr > Blue R	ODFW
S Fk McKenzie R > McKenzie R	PRD, ODFW
French Pete Cr > S Fk McKenzie R	ODFW
Rebel Cr > S Fk McKenzie R	ODFW
Augusta Cr > S Fk McKenzie R	ODFW

APPENDIX C (continued)
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

Stream Name	Agency
Roaring R > S Fk McKenzie R	ODFW
Elk Cr > S Fk McKenzie R	ODFW
Lost Cr > McKenzie R	ODFW
Scott Cr > McKenzie R	ODFW
Olallie Cr > McKenzie R	ODFW
Kink Cr > McKenzie R	ODFW
Coast Fork Willamette River Subbasin	
C Fk Willamette R > Willamette R	DEQ, PRD
Row R > C Fk Willamette R	PRD, ODFW
Mosby Cr > Row R	ODFW
Rat Cr > Row R	ODFW
Smith Cr > Row R	ODFW
Teeter Cr > Smith Cr	ODFW
Sharps Cr > Row R	ODFW
Martin Cr . Sharps Cr	ODFW
Layng Cr > Row R	ODFW
Brice Cr > Row R	ODFW
Champion Cr > Brice Cr	ODFW
Wilson Cr > C Fk Willamette R	ODFW
Saroute Cr > C Fk Willamette R	ODFW
Big R > C Fk Willamette R	ODFW
Middle Fork Willamette River Subbasin	
M Fk Willamette R > Willamette R	PRD, ODFW
Fall Cr > M Fk Willamette R	PRD, ODFW
Winberry Cr > Fall Cr	ODFW
N Fk Winberry Cr > Winberry Cr	ODFW
S Fk Winberry Cr > Winberry Cr	ODFW
N Fk Fall Cr > Fall Cr	ODFW
Portland Cr > Fall Cr	ODFW
Alder Cr > Fall Cr	ODFW
HeHe Cr > Fall Cr	ODFW
Pernot Cr > HeHe Cr	ODFW
Gold Cr > Fall Cr	ODFW
Delp Cr > Fall Cr	ODFW
Lost Cr > M Fk Willamette R	PRD, ODFW
Guiley Cr > Lost Cr	ODFW
N Fk M Fk Willamette R > M Fk Willamette R	PRD, ODFW
Christy Cr > N Fk M Fk Willamette R	ODFW
Fisher Cr > N Fk M Fk Willamette R	ODFW
Salmon Cr > M Fk Willamette R	PRD, ODFW
Wall Cr > Salmon Cr	ODFW
Black Cr > Salmon Cr	ODFW
Salt Cr > M Fk Willamette R	ODFW
Eagle Cr > Salt Cr	ODFW
S Fk Salt Cr > Salt Cr	ODFW
Hills Cr > M Fk Willamette R	ODFW

APPENDIX C (continued)
CANDIDATE STREAMS FOR INSTREAM WATER RIGHTS

Stream Name	Agency
Larison Cr > M Fk Willamette R	ODFW
Packard Cr > M Fk Willamette R	ODFW
Big Willow Cr > M Fk Willamette R	ODFW
Coffeepot Cr > M Fk Willamette R	ODFW
Windfall Cr > m Fk Willamette R	ODFW
Buck Cr > M Fk Willamette R	ODFW
Coal Cr > M Fk Willamette R	ODFW
Simpson Cr > M Fk Willamette R	ODFW
Staley Cr > M Fk Willamette R	ODFW
Swift Cr > M Fk Willamette R	ODFW

APPENDIX D

STATE SCENIC WATERWAY FLOW ASSESSMENT SUMMARY

(CUBIC FEET PER SECOND)

Clackamas River

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Big Bottom Section												
Average Flow	632	641	510	620	687	472	293	264	261	292	473	625
Scenic Flow	360	360	360	360	360	360/240	150	150	150/240	240	360	360
Collowash Section												
Average Flow	2593	2981	2329	2674	2740	1709	943	781	400/791	1026	2130	2951
Scenic Flow	1000	1000	1000	1000	1000	1000/640	400	400	640	640	1000	1000
Three Lynx Section												
Average Flow	2593	2981	2329	2674	2740	1709	943	781	791	1026	2130	2951
Scenic Flow	2000	2000	2000	2000	2000	750	750	750	750	750	2000	2000
South Fork Section												
Average Flow	190	190	140	170	170	100	50	40	40	60	130	190
Scenic Flow	75	75	75	75	75	50/30	25/20	15	15	15/20	75	75
North Fork Section												
Average Flow	220	220	170	190	200	120	60	50	50	70	100	220
Scenic Flow	-	-	-	-	-	-	-	-	-	-	-	-

South Fork McKenzie River

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Above Cougar Reservoir												
Average Flow	882	982	737	883	965	614	309	245	232	282	589	931
Scenic Flow	1500	1500	1500	1500	1500	250	250	200	200/250	250	1500	1500
Below Cougar Reservoir												
Average Flow	1190	545	410	418	635	575	425	613	827	878	1290	1364
Scenic Flow	400	400	400	400/500	500	500/400	250	250/500	500	500	400	400

McKenzie River

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Belknap Section												
Average Flow	1206	1217	1071	1110	1243	1022	823	723	673	691	922	1188
Scenic Flow	800	800	800	800	800	800	750	650	650/750	750	800	800
Clear Lake Section												
Average Flow	508	530	471	566	686	543	391	306	257	251	361	535
Scenic Flow	-	-	-	-	-	-	-	-	-	-	-	-
Tamolitch Falls Scetion												
Average Flow	-	-	-	-	-	-	-	-	-	-	-	-
Scenic Flow	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D (continued)

STATE SCENIC WATERWAY FLOW ASSESSMENT SUMMARY
(CUBIC FEET PER SECOND)

North Fork of the Middle Fork Willamette River

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Plateau Creek Section												
Average Flow	693	776	573	663	604	350	165	105	92	135	411	719
Scenic Flow	150	150	150	150	150	350	165	105	100/150	150	150	150
Westfir Section												
Average Flow	1226	1374	1014	1174	1068	620	290	185	160	238	728	1273
Scenic Flow	1500	1500	1500	1500	1500	620	290	185	160/200	200	1500	1500

Little North Fork Santiam RIver

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average Flow	600	570	440	445	380	185	50	25	40	150	550	660
Scenic Flow	180	180	180	180	180	180/60	40	40	100/180	180	180	180

APPENDIX E

STREAMS WITHDRAWN FROM FURTHER APPROPRIATION

Withdrawn by Legislative Order

Marion County

1 - Silver Creek

Clackamas & Multnomah Counties

2 - Johnson Creek

Columbia County

3 - McNulty Creek
4 - Milton Creek

Withdrawn by State Engineer's Order

Clackamas County

5 - Corral Creek
6 - Currin Creek
7 - Hatton Creek
8 - Memaloose Creek
9 - South Fork Clackamas River
10 - Rock Creek
11 - Wade Creek (also known as Stuby Creek)

Columbia County

12 - Little Creek

Lane County

13 - Coyote Creek

Linn County

14 - Second Periwinkle Creek also known as Cox Creek and Ash Creek

Marion County

15 - Croisan Creek
16 - Drift Creek
17 - Mill Creek
18 - Pringle Creek
19 - Unnamed Stream including tributaries, a tributary of the Pudding River, flowing through section 5, T5S, R2W, WM, and sections 29, 30 and 32, T5S, R1W, WM, except for storage and appropriation of stored water.

APPENDIX E (continued)

STREAMS WITHDRAWN FROM FURTHER APPROPRIATION

20 - Unnamed Stream including tributaries, tributary of Brush Creek, in sections 4, 9 and 10, T7S, R1W, WM, except for storage and appropriation of stored water.

Multnomah County

21 - Unnamed Stream including tributaries, a tributary of the Columbia River, in section 25, T1N, R2E, WM, and sections 19 and 20, T1N,, R3E, WM, except for storage and appropriation of stored water.

Polk County

22 - Unnamed Stream including tributaries, a tributary of Spring Valley Creek, in section 24, T6S, R4W, WM, and section 19, T6S, R3W, WM, except for storage and appropriation of stored water.

Washington County

23 - Unnamed Stream including tributaries, a tributary of the Tualatin River, flowing through sections 10, 15, and 21, T1S, R3W, WM, except for storage and appropriation of stored water.

24 - Unnamed Stream including tributaries, a tributary of Dairy Creek, in sections 32, 33, 34 and 35, T1N, R3W, WM, except for storage and appropriation of stored water.

25 - Unnamed Stream including tributaries, a tributary of the Tualatin River, flowing through the northeast part of T2S, R3W, WM, and sections 5 and 6, T2S, R2W, WM, except for storage and appropriation of stored water.

26 - Unnamed Stream including tributaries, a tributary of the Tualatin River, in the south part of T1S, R2W, WM, except for storage and appropriation of stored water.

27 - Unnamed Stream including tributaries, a tributary of the Tualatin River, in sections 19, 29, 30, 31 and 32, T1S, R3W, WM, except for storage and the appropriation of stored water.

28 - Clear Creek and Eiler Creek, including tributaries, a tributary of Gales Creek, west of the N-S line between T1N, R4W & R5W, WM. City of Forest Grove permit #12034 to the exclusion of all subsequent appropriations.

APPENDIX E (continued)

STREAMS WITHDRAWN FROM FURTHER APPROPRIATION

29 - Unnamed branch of Clear Creek within sections 18, 19, 29 and 30 of T1N, R4W, WM. City of Forest Grove permit #13944 to the exclusion of all subsequent appropriations.