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INITIAL WATERSHED ASSESSMENT

WATER RESOURCE INVENTORY AREA 23

UPPER CHEHALIS RIVER

Open-File Technical Report 95-03

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ABSTRACT

Actual water use in the Upper Chehalis River watershed, Water Resource Inventory Area (WRIA) 23, is not known. Recorded water rights and registered claims for surface and ground water use equal approximately 937 cubic feet per second (cfs) and 264 cfs respectively, for a total allocation of 1201 cfs. In addition, current applications on file amount to a total request for 34.5 cfs.

For the period 1953-1993, mean-annual streamflow at the Porter gage (12031000), located at the downstream end of WRIA 23 (river mile 33.3), equals 3971.5 cfs. Thus, water-rights-plus-claims equal approximately 30% of mean-annual streamflow. During the same period, the annual 7-consecutive-day lowflow averaged approximately 308 cfs; therefore, water rights and claims exceed the average 7 day lowflow by about 4 time (400%).

Since 1953, mean annual streamflow at the Porter gage has declined by 800 cfs or about 19%. Further up in the watershed, near Grand Mound, streamflow has declined by 200-250 cfs or about 6-8% since 1930. During these periods annual precipitation decreased by 6% and 1% respectively, while recorded water rights above the Porter gage increased by a volume equal to the lost streamflow. This suggests that consumptive water use may partly explain the reduced streamflows at the Porter and Grand Mound gages.

The base flows established by Chapter 173-522 WAC have not been met an average of 77 days per year for the Chehalis River at Porter and 68 days per year at Grand Mound. Base flows are not met an average of 59 days per year on the Newaukum River near Chehalis, and 33 days per year on the Skookumchuck River near Bucoda.

Evaluation of ground water inflows along nearly 60 miles of the Chehalis River demonstrates the critical role that groundwater discharge plays in maintaining summer baseflows in the watershed's rivers. Accordingly, additional consumptive ground water use will further diminish streamflows below the levels set in Chapter 173-522.

Washington State's surface-water-quality standards for temperature, fecal coliform, pH, dissolved oxygen, and other criteria frequently are not met during low-flow periods throughout much of the watershed. In addition, fecal-coliform counts commonly exceed water-quality criteria during the winter.

Fish stocks on two major tributaries, the Skookumchuck and Newaukum Rivers, have been declared critically low by the Department of Fish and Wildlife. Other stocks are greatly reduced from historic levels.

INTRODUCTION

Ecology’s Water Resources Program is responsible for managing the waters of the state to ensure that they are protected and used for the greatest public benefit. An important component of water management is permitting and enforcement of water rights, as authorized by Chapters 90.03, 90.22, 90.44, and 90.54 Revised Code of Washington (RCW).

When considering whether to grant a permit for water use, Ecology must determine that the proposed use passes four statutory tests (RCW 90.03.290): 1) that the use will be beneficial and 2) will be in the public interest, 3) that the water is physically available, and 4) that the proposed use will not impair existing (senior) users or stream baseflows. The axioms of beneficial use and public interest have been defined in regulation. The third and fourth tests comprise a broader evaluation of whether the hydrologic system can perpetually sustain a requested use without impairing senior water users or stream baseflows. In addition Ecology must consider the following factors when making permit decisions: the need to guard against impairment through excessive reductions of streamflow or lowering of ground-water levels, the state'’ non-degradation laws for water quality, and the need to preserve aquatic and riparian habitat. In practice, permit decisions have often been made without enough data to adequately predict long-term effects of the allocations.

As an efficiency measure and to help make better water management decisions, Ecology intends to base future allocation decisions on surveys of the hydrologic condition of entire watersheds.

The objective of this report is to document the status of surface-water and ground-water resources in the Upper Chehalis River watershed, which comprises Water Resource Inventory Area (WRIA) 23. Key water-management issues in the watershed which influence water-right permit decisions are identified and documented. Available information was used to assess hydrological, chemical, and biological conditions which broadly indicate the “health” of the watershed. These conditions included water quantity, hydrogeology, water demand, water quality, and the status of stocks of resident and anadromous fish species. Assessment of these conditions were based on readily available information about water rights and claims, streamflow, precipitation, hydrogeology, ground-water levels, fish stocks, and water quality. We did not conduct field surveys or begin data-collection projects. None of this data was exhaustively checked for accuracy, given the need for timely completion of the project.

WATERSHED DESCRIPTION

GEOGRAPHIC DESCRIPTION

The Upper Chehalis River watershed (WRIA 23) is defined as all lands draining to the United States Geological Survey's (USGS) gage number 12031000 near Porter (Figure 1). Because this gage lies within a narrow valley with well-defined bedrock walls, the gage accounts for the vast majority of the annual runoff from the watershed. Based on a study of the nearby Scatter Creek valley which is underlain by similar glaciofluvial materials, some ground water bypasses the gage by subsurface flow but, very likely, amounts to only a small proportion of the watershed's annual yield (Sinclair and Hirschey, 1992).

A well-developed stream network drains the Upper Chehalis watershed. Major tributaries include the Black River, originating in wetlands near Black Lake, the Skookumchuck and Newaukum Rivers, with headwaters in the foothills of the Cascade Range, the South Fork Chehalis River, Scatter Creek, and Lincoln Creek.

LAND COVER AND LAND USE

The Upper Chehalis watershed encompasses approximately 1,294 square miles, and includes large portions of Grays Harbor, Lewis, and Thurston counties, as well as smaller segments of Pacific and Cowlitz counties (Figure 1). The watershed is bounded by the eastern slopes of the Willapa Hills, the southern and eastern slopes of the Black Hills, and the western part of the Bald Hills. The broad drift plain of the southernmost Puget Sound lowland extends southward into the watershed to join the lowlands along the main stem of the Chehalis River. (U.S. Dept. Agriculture, 1972).

Forest lands cover approximately 77% (996 square miles) of the watershed. The remainder of the watershed consists largely of agricultural land with interspersed urban areas. The fertile alluvial floodplains are used to grow field crops such as hay, vegetables and grains. Other important agricultural activities include rearing of poultry, and beef and dairy cattle (WSU, Dept. of Ag. Economics, 1973).

The major urban areas are Chehalis (pop. 6,000) and Centralia (pop. 12,000). Current population of the watershed is approximately 77,000, and the area is experiencing moderate population growth. The most intensive development is occurring along the I-5 corridor in southern Thurston County.

CLIMATE AND PRECIPITATION TRENDS

Air masses moving in from the Pacific Ocean govern the climate of the watershed, producing a weather pattern typical of the Pacific Northwest maritime region. The area experiences mild temperatures (a basin average of 38° to 40° during January and 59° to 64° during July), wet winters, and dry summers.

The National Weather Service has operated, for various periods, six climate stations within WRIA 23 at Centralia, Chehalis, Dryad, Doty, Oakville, and Rainbow Falls Park (Figure 2). Only the Centralia, Doty, and Oakville stations (Figure 3) have more than 10 years of record and are still active.

Mean annual precipitation across the watershed varies from about 35 to more than 120 inches per year (Figure 2). Because the Willapa Hills shield a major part of the watershed from winter storms, the average annual precipitation for the watershed is relatively low (40-50 inches) and annual runoff is the lowest of all the major watersheds in southwest Washington (Soil Conservation Service, 1975).

Generally speaking, a majority of the annual precipitation falls between October and May, with maximum rainfall during December. July and August are usually the driest months of the year. At Centralia, precipitation records have been kept since 1891 (Figure 3). These records do not indicate a long-term change in precipitation, though annual rainfall has varied by a factor of about three (from 26 to 72 inches) and irregular “cycles”, or groups, of drier and wetter years are evident.

Annual precipitation data from the Centralia gage (Figure 4) and from eight gages in western Washington (Figure 5), including Centralia, indicate periods when precipitation was above or below the regional average. Extended periods of below average precipitation occurred in the 1920’s and 1930’s and again in the late 1940’s. Since the mid-1950’s, precipitation in western Washington has typically been above the long-term mean.

HYDROGEOLOGY

THE HYDROLOGY OF A WATERSHED

The hydrologic cycle depicts the way water endlessly circulates around the earth. In the cycle, water evaporates from the land and ocean and is redeposited on land or water bodies as rain and snow. A portion of the precipitation falling on land evaporates from vegetation or soil, some infiltrates into the soil, and some runs off the land surface into streams. The infiltrating water replenishes soil moisture, which in turn can percolate to the saturated zone to become ground water. Ground water then moves downward and laterally, ultimately discharging at the surface through springs, seeps, and into streams (Figure 6).

For the purpose of this study, the hydrologic cycle of a watershed matches the world-wide hydrologic cycle presented above, except that we add topographic boundaries for the area and consumptive uses of water by people. Thus, the six dominant features of a watershed's hydrologic cycle are:

1) precipitation,
2) evapotranspiration (evaporation plus transpiration),
3) natural ground-water exchange with adjoining watersheds (across the topographic boundary),
4) consumptive water use by people,
5) long-term changes in ground-water storage, and
6) streamflow.

The Natural Water Balance of a Watershed

The long-term, sustained water balance under "natural" conditions may be written as:

$$\mathbf{PRE - ET \pm XAW \pm CGWS = NSF} \quad \text{Equation 1}$$

where "PRE" represents precipitation, "ET" represents evapotranspiration, "XAW" represents ground-water exchange with adjacent watersheds, "CGWS" represents change in ground-water storage, and "NSF" represents natural streamflow (Figure 6). All terms represent average annual values for the purposes of this discussion but could apply to other statistical measures and durations.

Precipitation (PRE) on the watershed is the principal source of replenishment to the water supply of most watersheds.

Evapotranspiration (ET) consists of evaporation from soils, vegetation, lakes, and streams, in addition to transpiration by plants. Evapotranspiration reduces the amount of precipitation which reaches aquifers and streams and constitutes a large percentage of the water balance for most watersheds.

Natural ground-water exchange with adjacent watersheds (XAW) may add to or reduce the water supply of a watershed. In western Washington, natural ground-water exchange between watersheds often represents only a small portion of a watershed's total water supply.

Ground-water storage (GWS) is recharged either by precipitation which percolates down to the water table or by infiltration from streams or other surface water bodies. In the natural cycle, ground water eventually discharges to surface water bodies, except where intercepted by plants or humans. In a few very deep aquifers, ground water may be relatively stagnant. Rates of ground-water recharge vary with annual and seasonal precipitation. Barring long term climatic change or human water use, ground-water storage usually stays within a narrow range, and the average recharge to an aquifer is equivalent in volume to the average discharge from the aquifer to streams or other surface water bodies. Thus, barring long term climate change or excessive water use by humans, "CGWS" equals zero.

Natural streamflow (NSF) consists of the flow remaining after natural upstream gains and losses. We cannot accurately estimate natural streamflow in most watersheds because streamflows generally were not measured prior to land clearing and development of water supplies.

Simple calculations of the soil-water-balance, based on the method of Thornthwaite and Mather (1948), yield average monthly amounts for precipitation, actual ET, and excess soil moisture in WRIA 23 (Figure 7). Precipitation is more abundant in fall and winter when vegetation requires less water. As soils become saturated, excess soil moisture percolates beyond the reach of plant roots to recharge ground-water. During spring and summer, ground-water recharge practically ceases when the rate of ET exceeds precipitation. These alternating cycles are reflected in the low and high seasonal flows in the Chehalis River (Figure 21).

Annual ET losses are roughly one half of the annual precipitation (Figure 7). The remainder is available for streamflow and ground-water recharge. More than 80 percent of the annual precipitation falls between October and April, with much of it running off in streams a short while later. Very little ground-water recharge occurs from May through September, and water levels decline as some of the water drains to streams. These seasonal imbalances lead to large seasonal swings in streamflow and ground-water storage.

The Water Balance as Influenced by Humans

Given the mandate to protect senior water rights, instream baseflows, water quality, and ground-water levels, all of the naturally occurring water in a watershed is not available for allocation. This leads to another equation defining the available water supply for human use.

$$\mathbf{NSF - ISF = RSF} \qquad \text{Equation 2,}$$

"NSF" represents natural streamflow. "ISF" represents in-stream flow (also called base flow) which is reserved for instream needs. Instream flow is intended to serve navigation, recreation, aquatic and riparian ecosystems, fish, wildlife, and esthetics. "RSF" represents remaining streamflow, assuming no water use by humans.

Consumptive water use (CWU), due to diversions of surface water and pumping of ground water, reduces the remaining streamflow (RSF). Consumptive water use refers to that portion of the diverted or pumped water which is removed from the watershed – usually by increasing evapotranspiration (ET), or by exporting water to other watersheds through canals or pipes. The remainder of the water returns to the water supply, though often in a different part of the watershed. It may return by percolation to ground water and, thence, to streams, or it may return by direct discharge from a pipe. This can be represented as:

$$\mathbf{WD - RTF = CWU} \qquad \text{Equation 3}$$

where "WD" represents water diverted (surface water or ground water) and "RTF" represents return flow to the stream.

Adding Equations 2 and 3 yields:

$$\textbf{NSF - ISF - CWU = RSF} \qquad \text{Equation 4}$$

where "RSF" represents remaining streamflow. After satisfying senior water rights (CWU) and in-stream flow rights (ISF), the remaining streamflow (RSF) may be available for appropriation (Equation 4).

The above water-budget equations serve only to illustrate the major components of the hydrologic cycle in WRIA 23. Unfortunately, the equations are too simplistic to use in accurately deriving the available water supply. The complex changes (monthly, seasonal, and annual) in all the components, as well as in the factors influencing them, must be measured and interpreted statistically before reasonably accurate estimates of water availability can be made. Such is not within the scope of this initial watershed assessment.

GEOLOGY AND GROUND WATER

Geologic materials in the watershed consist of three principle types: 1) unlithified alluvium and glaciofluvial sediments, 2) sedimentary rocks, and 3) volcanic rocks. In general, volcanic and sedimentary rocks of Tertiary age underlie the entire basin. The valley bottoms and plains are capped by alluvium and glaciofluvial sediments (Figures 8, 9a, and 9b). These sediments contain most of the easily tapped ground water in the watershed, and provide much higher well yields than the bedrock aquifers. Baseflows[1] for the Chehalis River and its tributaries are derived largely from these sediments.

In the volcanic rocks, ground water occurs predominantly in fractures. Fractures provide little storage space, and the uneven distribution and few interconnections (fissures) between fracture groups limits water production from wells. Both types of bedrock provide sufficient water for homes and stock, and contribute an important, though lesser, portion of baseflow than the unlithified sediments.

The drainage divides which define the perimeter of WRIA 23 are underlain largely by bedrock. Because the bedrock units are not capable of transmitting much ground water, the ground-water divides for WRIA 23 likely coincide with surface-water drainage divides.

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[1] BASEFLOW is that portion of streamflow which is contributed by ground-water discharge. Summer low-flows tend to be 100% baseflow, except where water is released from reservoirs.

INTERACTIONS BETWEEN GROUND WATER AND SURFACE WATER

The hydraulic connection between ground water and surface water is often not appreciated and in some cases may not be well understood. The water recharging an aquifer can either increase ground-water storage (in the short term) or discharge to the surface. Assuming no climate change or excess use of water by humans, ground-water storage does not change appreciably from year to year. Thus, in the long term, ground-water recharge must equal ground-water discharge.

During summer months, when precipitation is scarce, the Chehalis River and its tributaries are maintained largely by ground-water discharge from aquifer storage. Sinclair and Hirschey (1992) measured gains of 3.1 cfs per river mile on the mainstem Chehalis and gains of 1.8 to 28 cfs per river mile along the lower and middle Black River, respectively. Pickett (1994) measured gains of 0 to 20 cfs per river mile, with an average gain of 3.0 cfs per river mile, along about 66 miles of the mainstem Chehalis river. Lowflows on some tributaries (such as the Skookumchuck River) are augmented by storage releases from reservoirs. These releases comprise only a small part of the total flow of the Chehalis River during the summer months.

Because summer baseflows in the Chehalis river watershed are maintained largely by ground water discharge, pumping from wells eventually reduces natural discharge to springs and streams by an amount equal to the consumptive water use. In many cases, pumping intercepts ground water which would have naturally discharged to surface water bodies. In other cases, wells may lie close enough to a stream that pumping captures surface water directly from the stream (Figure 10).

STATUS OF GROUND-WATER

Ground-water levels vary seasonally based on the amount of recharge to and discharge from an aquifer. Ground-water pumping lowers ground-water levels. However, if pumping rates are small relative to the total flow through an aquifer, water levels may change only slightly due to pumping and might not be distinguishable from natural seasonal water level fluctuations.

Ecology maintains a water-level-monitoring network of 12 wells within WRIA 23 (Figure 11). Ten of these wells are located in the Scatter Creek valley, and two are located near Centralia. Hydrographs for selected wells having five or more years of record (Figure 12) indicate no apparent progressive year-to-year declines due to nearby ground-water pumping.

WATER DEMAND

WATER RIGHTS

Little is known about the amount of water used by residents in the Upper Chehalis watershed. Water use records have not been kept consistently over the years, and an accounting of actual use has not been undertaken. There may be a number of illegal water users withdrawing water for irrigation or other purposes, and it is likely that numerous recorded or claimed rights are no longer in use. However, lacking water-use data, we must assume that all recorded water rights and claims are fully in use today and represent consumptive water use.

To evaluate water demand, we tabulated surface-water and ground-water rights using data retrieved from the Water Rights Inventory System (WRIS). For this report, water rights were not verified against paper records or by field checks.

In the following discussion, "Qi" represents the instantaneous withdrawal rate allocated to a water right, expressed in cubic feet per second (cfs). "Qa" represents the annual quantity allocated to a water right expressed in acre-feet per year (a-f/yr).

Past experience comparing quantities from the WRIS database with verified quantities has shown that using the "Qi" for the primary purpose-of-use yields a 1% to 20% (average 10%) difference. This margin of error was considered acceptable for this initial report. Non-consumptive rights, such as for power generation, were included in the totals. "Qi's" were counted at the maximum withdrawal rate for the entire year, even for seasonal rights such as irrigation.

The WRIS data was used without verification to tabulate annual quantities. Four hundred thirty eight of the water rights in WRIS were not assigned annual quantities when the rights were issued. While this tabulation accurately depicts paper records of the rights, the listed total annual quantity is lower than one would expect, had all rights been assigned Qa values at the time of issuance.

Water right allocations for surface and ground-water use within the watershed have increased steadily over time (Figures 13A, 13B, 14A, and 14B). The indicated values represent the primary purpose of use, as a percentage of the total allocated instantaneous quantity, "Qi". Because we evaluated only the primary use, some larger secondary uses, such as irrigation, were not accounted for. Water right uses, instantaneous withdrawals, and annual quantities are shown in Table 1.

To date, 958 surface-water rights have been issued within the watershed totaling an annual withdrawal of 552 cfs and 77,840 acre-feet (Figures 15A, 15D). Eight hundred sixty seven ground-water rights totaling 172,487 gpm (385 cfs) and 73,111 acre-feet have also been issued (Figures 15B, 15C). The distribution of surface-water rights (Figure 15D) tends to follow the major stream valleys as one would expect. The distribution o ground-water rights (Figure 15C) indicates areas of high demand where surface water is unavailable or where surface-water is no longer available for appropriation. The principal areas of ground-water development are the Newaukum valley, the middle and lower parts of the Chehalis valley, the Scatter Creek valley, the floodplains between the lower Black and Chehalis River valley, and the glacial plains of the upper Black River.

As of September 1994, 5 surface-water applications, requesting a total of 0.96 cfs for irrigation, and single and multiple domestic supply were on file with Ecology. Also, as of September 1994, 36 ground-water applications, requesting a total of 33.5 cfs for fish propagation, multiple domestic, municipal, commercial, irrigation, and power production purposes were on file.

Table 1. Water right uses and quantities

	Ground Water Rights		Surface Water Rights	
	Qi (cfs)	Qa (a-f/y)	Qi (cfs)	Qa (a-f/yr)
Domestic Supply	114.56	10,399	13.04	885.32
Stockwater	6.47	493	5.97	122.18
Irrigation	109.35	13,929	188	18,079.13
Municipal	20.18	6,563	40.44	412
Fish Propagation	59.99	28,257	58.40	0
Power	N/A	N/A	152.31	0
Recreation	N/A	N/A	3.64	179.4
Commercial	21.05	11,488	83.7	57,992
Frost Protection	51.07	1,315	N/A	N/A
Other Uses	1.97	667	6.6	170
	385	73,111	552	77,840

CLAIMS

Registered claims can become a water right only through a formal Superior Court adjudication. For a variety of reasons, the amounts 'allocated' under claims in WRIA 23 cannot be determined accurately at this time.

To estimate quantities for claims, an instantaneous withdrawal (Qi) was assigned to each claim as shown below. Then, using the "Qi", an annual quantity (Qa) was calculated to reflect the average annual withdrawal for most domestic, stockwatering, irrigation (Soil Conservation Service, 1994), and incidental uses:

USE	Qi (cfs)	Qa (a-f/yr)
Domestic	0.02	0.5
Stockwater	0.02	0.5
Irrigation	0.02	2.0
Other	0.02	0.5
Municipal	1.0	not calculated

A total of 5,297 claims (500 surface-water claims and 4,797 ground-water claims) have been filed in the watershed. Table 2 shows the uses, instantaneous withdrawals, and annual quantities assigned to the claims.

Table 2. Estimated water quantities for claims.

	Ground Water Rights		Surface Water Rights	
	Qi (cfs)	Qa (a-f/y)	Qi (cfs)	Qa (a-f/yr)
Domestic Supply	92.16	2304	6.58	165
Stockwater	35.98	899.5	5.1	127.5
Irrigation	77.94	7794	41.18	4118
Municipal	2	N/A	N/A	N/A
Other Uses	2.66	1.33	0.9	0.45
	211	10,999	54	4,411

MINIMUM BASE FLOWS

Minimum base flows were established for 14 stream-gaging stations (Figure 16) in WRIA 23 on March 10, 1976. The minimum flows constitute "instream" water rights and are set in Chapter 173-522 WAC (Appendix A). Of the 14 stream-gaging ("control") stations to which base flows were assigned, only 4 – Chehalis River near Porter, Chehalis River near Grand Mound, Newaukum River near Chehalis, and Skookumchuck River near Bucoda – subsequently were gaged continuously.

Under the authority of Chapter 75.20 RCW, "Construction Projects in State Waters," the Departments of Fish and Wildlife may state their objections to water-right applications if issuing a permit would result in lowering streamflow below that necessary to adequately support fish. Water rights may be denied or provisioned with a Surface Water Source Limitation in accordance with Department of Fish and Wildlife recommendations (Appendix B). A total of 266 water rights, primarily for irrigation purposes, have been issued with streamflow provisions. Ecology has not consistently enforced these provisions or the minimum flows of Chapter 173-522 WAC for WRIA 23.

WATER QUALITY

During the summer months, the Chehalis River and many of its largest tributaries often fail to meet water-quality standards for temperature, dissolved oxygen, fecal coliform, pH, and other parameters. Currently, 28 facilities hold permits to discharge waste water to these streams (Francis, 1994). These discharges are permitted on the assumption that the receiving streams contain water of sufficient quantity and quality to assimilate the discharges without violating surface-water-quality standards.

In a recently completed water-quality study of the Upper Chehalis River watershed, Pickett (1994) recommended that a phased total maximum daily load (TMDL) for ammonia nitrogen (NH_3-N0 and carbonaceous biochemical oxygen demand (CBOD) be implemented for the mainstem Chehalis River between Pe Ell and Porter (Figure 17). The TMDL criteria would apply from May 1 to October 31 each year. A critical component of the recommended TMDL is that no additional loading capacity (dilution capability) is available in the Chehalis River through the 'critical reach' between the Newaukum River confluence and the Skookumchuck River confluence (Figure 17). In addition, Pickett recommended that reaches on 13 tributaries to the Chehalis River be included in the 1994 Section 303(d) listing of water-quality limited streams (Figure 17; Table 3).

Similar problems were identified in the Black River drainage where both wet and dry season TMDL studies have been completed (Coots, 1994 and Pickett, 1994, respectively).

During the wet-season study, nine of 11 sampling sites on the mainstem Black River failed to meet water-quality criteria for fecal coliform. Seven of 10 Black River segments will require load reductions to meet proposed allocations during the wet season. Fecal-coliform violations were also noted during the wet season in Mima Creek and Beaver Creek, both major tributaries to the Black River.

During the dry season (May 1 to October 31), the Black River commonly fails to meet water-quality criteria for dissolved oxygen and temperature while total phosphorous (TP) occurs at levels close to those producing eutrophic conditions (Pickett, 1994) Pickett recommends that a dry season TMDL be established for TP, oxygen demanding materials, and temperature. The TMDL would apply to the Black River between river miles 9.6 and 15.3.

Table 3. Chehalis River Tributaries Exceeding Water Quality Standards (☹ indicates standard exceeded; after Pickett, 1994)

Water Body	Dissolved	Temperature	Fecal	pH
S. Fk. Chehalis R.		☹	☹	
Bunker Cr.	☹		☹	
Stearns Cr.	☹			
Newaukum R.		☹		
Dillenbaugh Cr.	☹	☹	☹	
Salzer Creek	☹	☹	☹	
Skookumchuck R.		☹		☹
Lincoln Creek	☹		☹	
Scatter Cr.		☹	☹	☹
Independence Cr.	☹			
Garrard Cr.	☹			
Black River	☹	☹		

FISHERIES

The streams and rivers of the Upper Chehalis watershed provide important spawning habitat for anadromous fish (fish that enter fresh water from the ocean to spawn). Anadromous species use approximately 800 miles of the watershed's stream channels and include chinook, coho, chum, and steelhead salmon, and sea-run cutthroat trout. Resident cutthroat trout, rainbow trout, and other species also inhabit the watershed. The rivers and streams of the Upper Chehalis watershed contribute significantly to the commercial and sport fishing industry both locally and along the west coast of North America.

Wampler and others (1993), conducted salmon and steelhead habitat surveys for about 1,500 river miles of the Chehalis River watershed (WRIA's 22 and 23). Between March and October, 1992, they completed more than 860 separate surveys and identified 48,000 habitat degradations. Common degradations included canopy and vegetation loss along stream banks, bank erosion by livestock and vehicles, barriers and logjams, excessive stream bed siltation, logging impacts, poor water quality, and water withdrawals among others.

In nearly all of the watershed's streams, low summer flows coupled with habitat degradation, are the critical factors limiting the size of fish populations (Washington Dept. of Fisheries, 1975). Although low summer flows are a natural phenomenon in many streams, they are greatly exacerbated by human-induced changes. Reduced flows may lead to increased water temperatures, decreased dissolved oxygen, and to less available habitat for fish.

Department of Wildlife, et al. (1992) documented and mapped the stream reaches in WRIA 23 where water quality affects fish survival (Figure 19). For approximately 83 percent of the perennial stream reaches in the watershed, water quality either does not limit fish populations or no data are available to make a determination (approximately half of the streams have no data available). Approximately 11 percent of the stream reaches have water quality limiting factors which occur seasonally or are only mildly limiting. Thee areas include the lower portion of the Chehalis River (within the watershed), a portion of the South Fork Chehalis River, Black River, and a portion of Dillenbaugh Creek. Less than one percent of the areas are noted as water quality limiting year around. These include the middle segment of the Chehalis River (between the confluence with the Newaukum River and Centralia), and portions of Scatter Creek, Lincoln Creek, Hanaford Creek, Salzer Creek, and North Fork Newaukum River (Washington Dept. Wildlife, et al. 1993).

Department of Fisheries, et al. (1992) summarized the condition of wild stocks of anadromous fish species throughout Washington. In WRIA 23 the worst conditions are in the Skookumchuck and the Newaukum Rivers which have “depressed” stocks of winter steelhead, while stocks of coho, spring chinook, and fall chinook salmon appear to be healthy (Figures 18 and 19). The status of summer steelhead is not known, though this species was never abundant in the Chehalis system. The “depressed stock” classification indicates that “production is less than expected based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.” The “healthy stock” classification indicates a range “from robust to those without surplus production for harvest” and genetic health may be of concern.

STATUS OF STREAMFLOW

When we measure streamflow today, the measurement reflects the streamflow remaining after consumptive use upstream ("RSF", equation 2). In WRIA 23, we have not applied the accurate methods and time necessary to reconstruct the amount of natural streamflow ("NSF", equation 2), so the streamflow data presently collected downstream of homes, farms, and cities cannot help us to estimate consumptive water use (from "NSF – CWU = RSF"). Even so, we can compare "RSF" to the instream needs and rights as an indicator of the general health of the water resource. We can also examine streamflow over time for indications that consumptive water use may be reducing streamflow.

Streamflow in WRIA 23 tends to vary with precipitation and exhibits a similar large annual variation (Figure 20[2]). The dramatic seasonal swing in streamflow repeats regularly at about the same time each year (Figure 21). The strong correlation of streamflow with precipitation means that we can check both, over time, to see if streamflow is changing in response to factors other than precipitation, though this will not reveal what the other factors might be.

Annual mean streamflow in three streams (the Chehalis, Newaukum, and Skookumchuck Rivers) of WRIA 23 varies by approximately the same pattern from year to year (Figure 22). Linear regression of the annual streamflow values for the Chehalis River near Grand Mound indicates a decrease since 1930 of about 200-300 cfs or about 10% (Figure 23). Linear regression of the annual precipitation values for the same period indicates only a small change of about 1% (Figure 23). For the shorter record of streamflow at the mouth of WRIA 23 (Chehalis River near Porter), annual streamflow **decreased** (as revealed by best-fit regression) by about 800 cfs, or 19%, since 1953 (Figure 24) when gaging began. During the same period, the annual precipitation **decreased** by only about three inches, or about 6% (Figure 24). Interestingly, the amount of ground-water and surface-rights **increased** by about 800 cfs during the same period (Figure 24), with much of the growth occurring between 1966 and 1981. Thus, the records of annual flow for both streamflow gages suggest a cause-and-effect relationship between consumptive water use and reduced streamflow.

[2] Note that the two vertical axes – one for streamflow and one for precipitation – are positioned to bring the two curves together and, thereby, emphasize the similar shapes. However, one inch of precipitation is not equivalent to 1000 cfs, as the graph might suggest.

The lowest 7-day-mean streamflows in the Chehalis River near Grand Mound and near Porter do not exhibit a pattern of reduction as with the annual flows. These lowest flows occur during the summer when streamflow originates largely from ground-water discharge. Comparison of these trends with the long-term precipitation trends at Centralia, indicates little correlation (Figures 25a,b). Apparently, the consumptive water use preferentially depletes the higher flows. One mechanism to explain this might be delays in streamflow effects of pumping wells, assuming higher ground-water withdrawals during the summer.

Ecology, with assistance from other state agencies, established base flows for streams in WRIA 23 (Chapter 173-522 WAC, March 1976) using the method of Garling (1976). This method uses computation of selected percent-of-time-exceedence frequencies (also called flow expectancy or frequency of occurrence) for each day of the year, combined with a subjective stream-classification rating system.

Exceedence statistics for flow in the Chehalis River at Porter (Figure 26), derived from records prior to 1976, indicate the 50% and 90% frequencies for flow rates during 4 periods each month of the year. (The first 3 periods are seven days long, and the last period covers the remainder of each month). The 50% exceedence flow rate approximately equals the median flow of record; in other words, 50% of the flows exceed the value on the y-axis (ordinate), and 50% of the flows are less than the value. Similarly, the 90% exceedence flow rate is exceeded approximately 90% of the time (or 9 out of 10 years, on average) and only the lowest flows are less than this rate. The minimum flows (Figure 26) required at this gage tend to be higher than the 90% exceedence from May through mid-October. During this period, one would expect the flow to drop below the minimum flow more than once in every ten years. The graph of average number of days, during each minimum-flow period when the flows have not been met, confirms the expectation (Figure 27). No doubt this was anticipated when the minimum flows were set, though enforcement by temporary cut-backs in junior water rights during the periods of below minimum flow were also expected.

From 1976 through 1991, the base flows required at the Porter gage (Chapter 173-522 WAC) were never met for an entire year (Table 4). In an average year, the flows were not met during 77 days. For particular base-flow periods (each usually two-weeks long), the number of years in which the base flow was not met ranged from 0 to 12 out of the fourteen years. Approximately the same pattern applies to the other long-term gages in the watershed. Streamflow dropped below base flows during an average of 68 days per year on the Chehalis River near Grand Mound, 59 days per year at the gage on the Newaukum River near Chehalis, and 33 days per year at the gage on the Skookumchuck River near Bucoda (Figure 27).

Table 4. Minimum Flow Excursions, Chehalis River near Porter (12031000, mile 33.3)

Month Days	Jan 1-15	Jan 16-31	Feb 1-15	Feb 16-28	Mar 1-15	Mar 16-31	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun 1-15	Jun 16-30	Jul 1-15	Jul 16-31	Aug 1-15	Aug 16-31	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31
1952	0	0	0	0	0	0	0	14	9	15	15	15	11	16	15	11	15	15	15	16	15	15	4	7
1953	0	0	0	0	5	0	3	11	3	0	0	0	4	11	13	10	2	12	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	6	15	16	7	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	5	14	16	4	1	5	12	4	4	9	0	0	0	0	0	6	0
1957	0	7	0	0	0	0	0	3	12	8	14	11	15	10	0	0	0	9	7	5	10	5	1	1
1958	0	0	0	0	0	0	2	0	7	16	12	15	13	16	15	14	13	1	7	0	4	0	0	0
1959	0	0	0	0	0	0	0	10	0	0	0	0	1	9	7	0	0	0	0	0	0	2	0	0
1960	6	7	0	0	0	0	0	0	0	0	0	0	3	10	7	0	0	0	5	7	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	3	12	10	16	15	2	0	0	6	0	0	5	1	0
1962	0	2	2	0	2	0	0	9	0	0	0	8	6	12	1	0	0	0	0	0	0	0	0	0
1963	0	11	0	0	3	8	0	0	0	7	9	14	1	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	3	3	8	8	2	0	3	0	0	0	0	0	0	0	1	7	0	0
1965	0	0	0	0	1	16	15	8	6	8	15	15	15	16	13	0	12	5	4	0	3	0	1	9
1966	0	0	0	0	0	0	0	8	15	16	15	15	5	12	15	12	11	0	13	4	6	0	0	0
1967	0	0	0	0	0	0	0	0	8	15	14	10	15	16	15	16	10	15	1	0	0	0	0	0
1968	0	0	0	0	0	0	0	1	6	3	0	0	1	4	4	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	8	12	10	7	0	8	0	0	4	0	0	0	1	1	10	0
1970	6	0	0	0	0	3	5	0	0	7	14	15	15	16	15	16	2	0	0	4	4	0	0	0
1971	0	0	0	0	0	0	0	2	9	2	4	0	0	2	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	2	6	15	10	7	1	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	2	13	15	11	9	10	6	0	0	0	0	0	0	0	0	0
Establishment of WAC 173-523																								
1976	0	0	0	0	0	0	0	0	3	9	2	5	0	2	0	0	0	0	0	3	9	15	15	12
1977	15	16	15	7	0	0	9	15	9	5	0	6	10	11	11	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	6	4	1	4	0	1	3	7	2	0	0	0	0	0	0	1	0	0	0
1979	8	4	4	0	0	9	11	5	6	14	15	15	10	16	15	0	0	0	0	0	0	7	1	0
1980	0	0	0	0	0	0	0	2	13	16	11	6	7	7	0	0	0	0	0	11	2	0	0	0
1981	0	6	6	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	7	13	15	15	9	10	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	12	12	13	15	0	0	0	0	0	0	0	0	0	1	0	0	0
1984	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	13	9	0	7	7	2	8	0	11	0	4	8	12	0	0	0	0	0	0	0	0	3	13
1986	2	0	0	0	0	0	12	11	0	2	13	10	13	9	11	14	4	0	0	0	0	2	0	0
1987	0	0	0	0	0	0	8	9	13	16	10	15	15	14	8	0	0	0	14	16	15	15	2	9
1988	11	0	0	2	7	7	0	10	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	6
1989	0	0	6	1	0	0	0	11	15	16	15	15	8	12	8	0	0	0	0	5	5	0	1	12
1990	2	0	0	0	0	0	14	8	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	1	1	6	0	3	1	0	0	0	0	0	0	0	0	0	0

NUMBER OF YEARS FLOWS NOT MET AT LEAST ONCE DURING THE MIN FLOW PERIOD

1952-75	2	4	1	0	4	3	5	12	15	16	17	15	18	18	14	8	9	6	8	5	8	6	6	3
1976-91	5	4	5	3	3	5	7	12	11	12	10	10	10	11	5	1	1	0	1	4	7	4	6	5

PERCENTAGE OF TOTAL YEARS FLOWS NOT MET AT LEAST ONCE DURING THE MIN FLOW PERIOD

1952-75	8	17	4	0	17	12	21	50	62	67	71	62	75	75	58	33	37	25	33	21	33	25	25	12
1976-91	31	25	31	19	19	31	44	75	69	75	62	62	62	69	31	6	6	0	6	25	44	25	37	31

TOTAL NUMBER OF DAYS IN PERIOD FLOWS NOT MET

1952-75	12	27	2	0	11	27	28	80	124	167	171	161	139	197	145	85	78	57	58	36	44	35	23	17
1976-91	38	39	40	10	16	36	60	95	89	121	103	94	90	96	53	14	4	0	14	35	35	39	23	52
1952-91	50	66	42	10	27	63	88	175	213	288	274	255	229	293	198	99	82	57	72	71	79	74	46	69

PERCENTAGE OF TOTAL DAYS IN PERIOD FLOWS NOT MET

1952-75	3	7	1	0	3	7	8	22	34	43	48	45	39	51	40	22	22	16	16	9	12	10	6	4
1976-91	16	15	17	5	7	14	25	40	37	47	43	39	38	38	22	5	2	0	6	14	15	16	10	20
1952-91	8	10	7	2	5	10	15	29	36	45	46	43	38	46	33	15	14	10	12	11	13	12	8	11
	8	10	7	2	5	10	15	29	36	45	46	43	38	46	33	15	14	10	12	11	13	12	8	11

DISCUSSION

Increasing water use eventually causes noticeable changes in a watershed, such as reduced streamflow, reduced wildlife and fish habitat, declines in ground-water levels, degraded water quality or other changes. Recognition of the inevitability of such effects suggests the need to routinely monitor them. As changes are detected, scientists must look for specific causes. For water-resource managers, this means attempting to distinguish between natural causes, such as changing weather patterns, or human influences, such as water use, land use, waste discharge, and forest practices. In general, water-resource management cannot succeed without accurate, thorough information and a thorough understanding of all the relevant hydrologic processes, including biological dependencies and human influences.

Recognizing the above, the legislature enacted Chapter 90.54 RCW, Water Resources Act of 1971, which states in part 90.54.010 (1e), that: "The long-term needs of the state require ongoing assessment of water availability, use, and demand. A thorough inventory of available resources is essential to water resource management." Part 90.54.030, also states that "…the department is directed to become informed with regard to all phases of water and related resources of the state." Much remains to be accomplished in fulfilling these mandates.

Unfortunately, we have not begun to monitor the key aspect of the water budget in WRIA 23, namely, actual water use. Water-use data would help solve at least 4 major water-management problems in WRIA 23. First, without water-use data, water-resource managers must turn to indirect, far less reliable methods for judging how and why a hydrologic system is changing. As a result, their recommendations for corrective action becomes less certain. Second, the system of record keeping for water rights is inaccurate and out-of-date. In other words, we don't know who is still using their water rights or claims and whether the permitted amounts are actually used. As we approach the limits of the water supply and need to start shifting water rights from one use to another, our record keeping must be accurate so as to not hinder this process. Third, the same up-to-date data on who is using water, and how much, would allow for a fair process of relinquishment without conducting an adjudication. Or, if adjudication were necessary, these records would provide most of the information needed. Fourth, if we hope to balance out-of-stream water uses with those required for instream uses, for water-quality dilution requirements, and for protection of senior rights and fisheries, we must reconcile the differences between recorded water rights, or claims, and actual use.

Ecology's past practice of issuing water rights, without knowing how much water is actually used and how much remains unused, carries much the same level of risk as writing checks on a bank account for which we don't know the balance. Yet, under these circumstances, Ecology is expected to make well-informed permit decisions without an accurate, reliable accounting system.

Expanded monitoring of the watershed's hydrology will reveal more clearly the changes caused by land and water-use practices and will allow greatly improved water management.

CONCLUSIONS

The principal conclusions of this investigation of water-resource conditions in WRIA 23 are as follows:

- The natural water supply in the Upper Chehalis watershed is extremely uneven geographically, seasonally, and annually.

- The average annual precipitation ranges from less than 35 inches in the low central portion of the watershed, to more than 120 inches in the western hills. Most of the annual precipitation falls during the months of October through March. Human demands for water generally follow the opposite seasonal pattern, leading to high water use when streamflow and ground-water levels are lowest.

- Population in the Upper Chehalis watershed is increasing more slowly than in neighboring watersheds, however demand for water for domestic supply and industry continues to increase steadily.

- Recorded water rights total 938.5 cubic feet per second (cfs). Current applications for new water rights total 34.5 cfs. Registered claims for water use total 175.24 cfs. We were not able to quantify actual water use, however, recorded water rights and claims probably exceed actual consumptive use. In addition, unauthorized uses may also remove significant volumes of water from the watershed's streams or aquifers.

- Base flows in the streams of WRIA 23 depend solely on ground-water discharge. Because the watershed is largely underlain and bordered by low permeability bedrock, wells in the watershed draw from the same aquifers which naturally discharge to streams. Consumptive use of ground water will eventually diminish streamflow, either by capturing ground water which would have naturally discharged to streams or by inducing water to flow directly from streams to wells.

- The amount of water allocated under rights and claims in WRIA 23, exceeds the average 7-day-lowflow at Porter by about 400%.

- Streamflow at the mouth of this watershed has declined by about 19% since 1953. Farther up in the watershed, near Grand Mound, the streamflow has declined by about 6-8% since 1931. During the same period, precipitation decreased by much smaller percentages. On the other hand, recorded water rights increased by a volume equal to the lost streamflow, suggesting that consumptive water use partly explains the reduced streamflow.

- Minimum flows set by rule frequently are not met during the spring, summer, and fall. On average, the flow in the Chehalis River near Porter drops below the mandated baseflow level for 73 days. Similarly, the streamflow falls below the mandated baseflow level for an average of 68 days per year on the Chehalis River near Grand Mound, for 59 days per year in the Newaukum River near Chehalis, and for 33 days per year in the Newaukum River near Chehalis, and for 33 days per year on the Skookumchuck River near Bucoda. Although minimum flows were established by law, these flow levels have rarely been enforced. In part, this may result from a lack of streamflow gages at ten of the fourteen sites named in Chapter 173-522 WAC.

- Water-quality standards for temperature, fecal coliform, pH, and dissolved oxygen frequently are not met during low-flow periods throughout much of the Chehalis River and its tributaries. The Chehalis River has no further dilution capacity to assimilate wastes generated by new development. Furthermore, the concentrations of compounds and organisms in point and non-point discharges will have to be reduced in order to meet water-quality standards. Continued allocation of water for new requests would further reduce the dilution capacity of the Chehalis River and its tributaries.

- Fish and wildlife habitat is impaired in various areas of the watershed due to seasonal-low flows, high temperatures, and low dissolved oxygen levels. In addition, fish migration is impeded by low flows and obstructions. The Skookumchuck/Newaukum Winter Steelhead are listed as depressed based on chronically low adult escapement. Other anadromous fish species are struggling throughout the watershed, despite the classification of “healthy.” Continued allocation of water for new requests will further reduce the quantity and quality of habitat available to fish.

In order to effectively manage the water resources of WRIA 23, a balance must be struck among the various demands for water. These include consumptive use, fisheries, water-quality maintenance, waste dilution, habitat, recreation, and base flows.

RECOMMENDATIONS

To enable and support a proper accounting system for the water resources of WRIA 23 and to enable a more responsive permitting process, a permanent monitoring program should be established and contain, at least, the following elements:

- Water use and Water levels: Establish data-collection programs for water use and water levels for all major users of ground water within WRIA 23. High-capacity pumping wells should be equipped with a calibrated cumulative-flow meter or equivalent. The meters should be read at least monthly or more frequently if necessary to reflect changes in pumping rates. Static (non-pumping) water levels should be measured in at least one pumping well in each Township on at least a monthly basis. The water-level monitoring should also include a number of non-pumped wells (if possible) at various locations and depths. All wells included in the monitoring network should be tagged and tracked using Ecology's unique well identification number.

- Streamflow gaging: Establish and maintain gages for all control stations for which instream flows have been set (WAC 173-523). Presently, only 4 of the 14 control stations are gaged. The lack of active gages precludes efforts to regulate existing water users to maintain established instream flows. Staff gages and regular observations of the stage would be adequate at some of these sites. Staff gages or recorders on other streams, many never previously gaged, would extend our understanding of the distribution of streamflow in the watershed.

- Metering surface-water use: Based on recorded water rights, implement the metering provision of WAC 508-64 for as many of the larger surface-water rights so as to continually monitor approximately 90% of such use in WRIA 23. Ecology's enforcement personnel should make a concerted effort to identify and seek cooperative cessation of non-permitted water uses. Relinquishment of unused water rights would bring permitted amounts closer to actual water use.

- Mapping locations of point-of diversion for water rights: Using recorded descriptions of the POD locations, plot the locations on 1:24,000-scale maps and digitize the points into ARC-INFO GIS coverages. Link these point locations to the Water Rights Information System database.

- Unique well identifier: Assign and attach Ecology's unique well identifier to newly constructed wells and to older wells as time allows.

- Cooperative Research and Information Exchange: Collection of hydrologic data, well tagging, and monitoring of other environmental indicators, such as water quality and fish stocks, would be enhanced by cooperative efforts among state and local agencies, public utilities, and private interests. Many of these groups monitor various aspects of water resources and environmental indicators based on specific interests, and many use GIS methods. Coordinating data collection might reduce duplicative efforts and create common databases for easier access to information and maps.

- Monitor runoff during storms in urban areas: This data is needed to determine whether urban development is increasing peak flows following storms. The impervious surfaces which cause the higher peak flows also tend to reduce ground-water recharge and stream baseflows. If necessary, the data could then be used to design means to reduce peak runoff rates.

- Computer database and mapping system: Routinely enter the data in computers using standard relational databases linked to a geographic-information system (ARC/INFO). Routinely produce maps of the data.

BIBLIOGRAPHY

Beck, R. W., and Associates, 1975. Sewage Drainage Basin Plan for Upper Chehalis Basin (Basin 23). R. W. Beck and Associates, Seattle, WA.

Coots, R., 1994. Black River Wet Season Nonpoint Source Total Maximum Daily Load Study. Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, WA.

Dunne, T. and L. B. Leopold, 1978. Water In Environmental Planning. W. H. Freeman and Co., New York.

Ebbert, J. C. and K. L. Payne, 1984. The Quality of Water in the Principal Aquifers of Southwestern Washington. Water-Resources Investigations Report 84-4093, United States Geological Survey.

Evans, R. L. et al., 1987. Soil Survey of Lewis County Area, Washington. United States Department of Agriculture, Soil Conservation Service.

Francis, H., 1994. Personal communication.

Garling, M. E., 1976. Department of Ecology Streamflow Preservation Program. Water Resource Information System (WRIS) Technical Bulletin No. 11, Olympia, January.

Glancy, P., 1971. Sediment Transport by Streams in the Chehalis River Basin, Washington, October 1961, to September 1965. USGS Water Supply Paper 1798-H. U.S. Government Printing Office, Washington DC.

Heath, R., 1983. Basic Ground-Water Hydrology. USGS Water-Supply Paper 2220, 84 p.

Lewis County Conservation District, 1992. Chehalis River Basin Action Plan, and Technical Supplement. Washington Department of Ecology and Lewis River Conservation District.

Nassar, E. G., 1973. Low-Flow Characteristics of Streams in the Pacific Slope Basins and Lower Columbia River Basin, Washington. Open-File Report, United States Geological Survey, Tacoma, WA.

Pickett, P.J., 1994a. Black River Dry Season Total Maximum Daily Load Study. Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, WA.

Pickett, P. J., 1994b. Upper Chehalis River Dry Season Total Maximum Daily Load Study. Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, WA.

Schlax, W.N., Jr., 1947. Preliminary report on ground-water resources of the Central Chehalis Valley, Washington Department of Conservation & Development, Olympia, WA.

Sinclair, K.A., and Hirschey, S.J., 1992. A Hydrogeologic Investigation of the Scatter Creek/Black River Area, Southern Thurston County, Washington State. Unpublished masters thesis, The Evergreen State College, Olympia, WA.

Soil Conservation Service, 1975. Land and Water Resource Information – Chehalis Subarea. U. S. Dept. Agriculture, Portland, OR.

Soil Conservation Service, 1994. State of Washington Irrigation Guide. United States Department of Agriculture, Soil Conservation Service, Spokane, WA.

Thornthwaite, C. W. and Mather, J. R., 1958. Instructions and tables for computing potential evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publ. in Climatology, V. 10, No. 3.

Wampler, P. L. and others, 1993. Chehalis River Basin Fishery Resources: Salmon and Steelhead Stream Habitat Degradations. Prepared cooperatively by the U.S. Fish and Wildlife Service and Washington Department of Wildlife.

Washington Department of Ecology, 1972. Water Resources of Southwest Washington, the Hydrology and Natural Environment Technical Appendix to the Southwest Washington River Basins Study. Washington Department of Ecology, Olympia, WA.

Washington Department of Ecology, 1975. Water Resources Management Program-Chehalis River Basin (Water Resources Inventory Areas 22 & 23). Washington Department of Ecology, Olympia, WA.

Washington Department of Ecology, 1994. Inventory of Dams in the State of Washington. Washington Department of Ecology, Olympia, WA.

Washington Department of Fisheries, et al., 1975. A Catalog of Washington Streams and Salmon Utilization, Volume 2-Coastal Region. Washington Department of Fish and Wildlife, Olympia, WA.

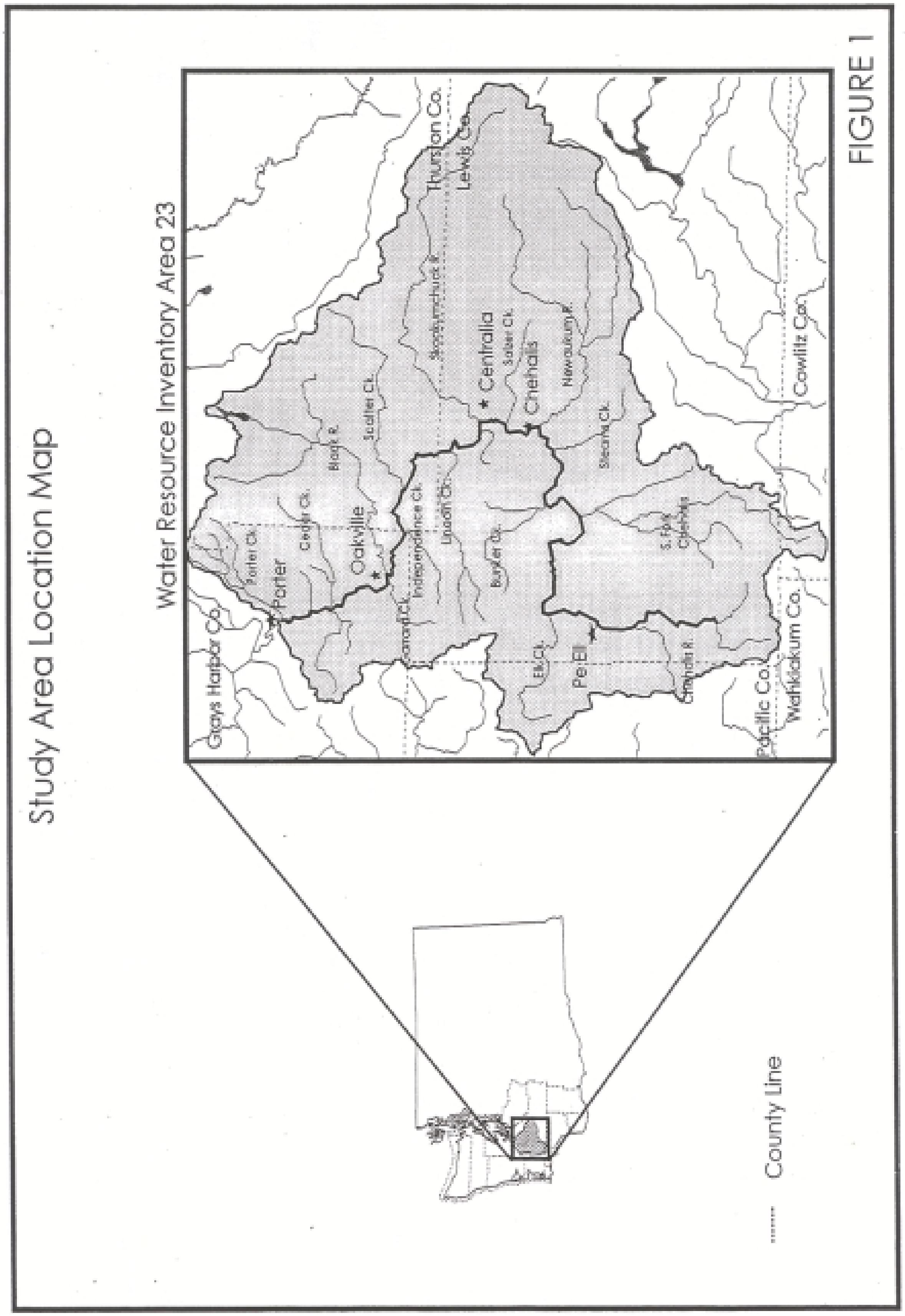
Washington Department of Fisheries, et al., 1992. 1992 Washington State Salmon and Steelhead Stock Inventory, and Appendices. Washington Department of Fish and Wildlife, Olympia, WA.

Washington Department of Game, 1970. Chehalis Basin Study – fish and wildlife appendix. Washington Department of Game, Olympia WA.

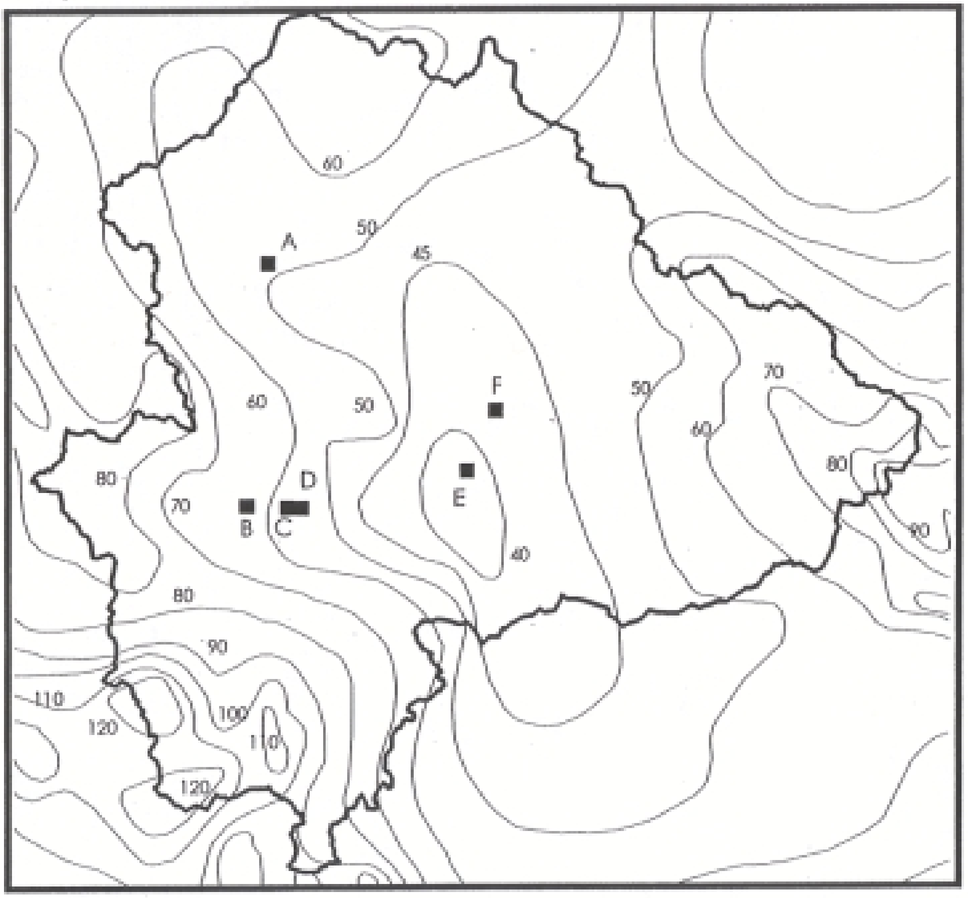
Washington Department of Wildlife, et al., 1992. Washington Rivers Information System Database (WARIS).

Washington State University, Department of Agricultural Economics, 1973. Agricultural Alternatives in Southwest Washington. Washington Department of Ecology, Olympia, WA.

Weigle, J. M. and B. L. Foxworthy, 1962. Geology and Ground-Water Resources of West-Central Lewis County, Washington. Water Supply Bulletin No. 17, Prepared in cooperation with United States Geological Survey Ground Water Branch.


Study Area Location Map
Water Resource Inventory Area 23
Grays Harbor Co.
Thurston Co.
Lewis Co.
Pacific Co.
Wahkiakum Co.
Cowlitz Co.
Porter
Oakville
Centralia
Chehalis
Pe Ell
Porter Cr.
Cedar Ck.
Black R.
Scatter Ck.
Independence Ck.
Lincoln Cr.
Bunker Cr.
Elk Cr.
Chehalis R.
Skookumchuck R.
Salzer Ck.
Newaukum R.
Stearns Ck.
S. Fork Chehalis
County Line
FIGURE 1

National Weather Service Climate Stations and Distribution of Mean Annual Precipitation (Isohyets) for WRIA 23



MAP LABEL	STATION NAME (Period of Record)
A	Oakville (6/48-6/93)
B	Dryad (6/63-1/78)
C	Doty (2/78-6/93)
D	Rainbow Falls Park 2E (6/48-4/63)
E	Chehalis (4/50-9/51)
F	Centralia (1/31-6/93)

60 — Isohyet showing mean annual precipitation in inches.

FIGURE 2

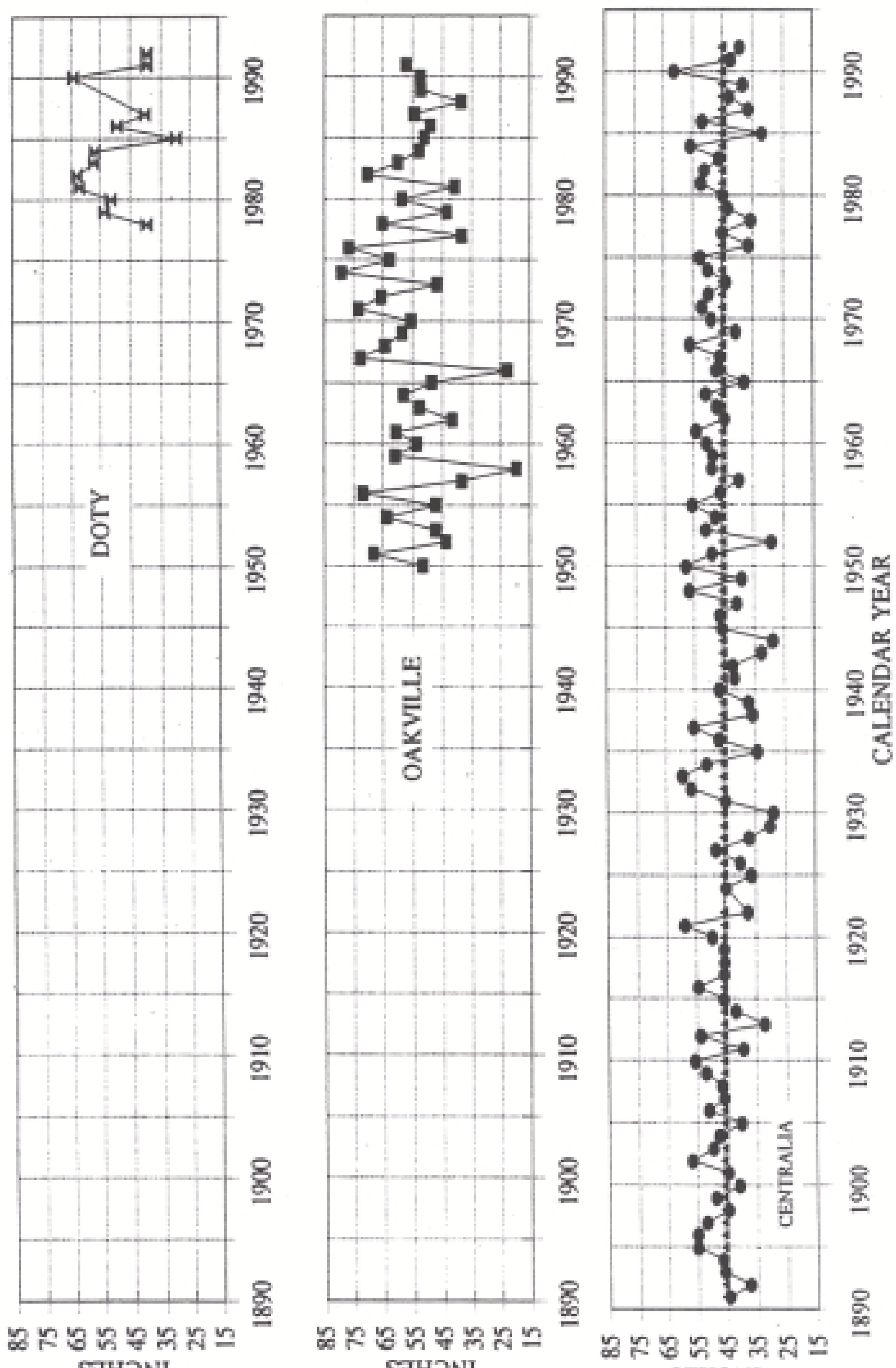


FIGURE 3. ANNUAL PRECIPITATION AT DOTY, OAKVILLE, AND CENTRALIA.

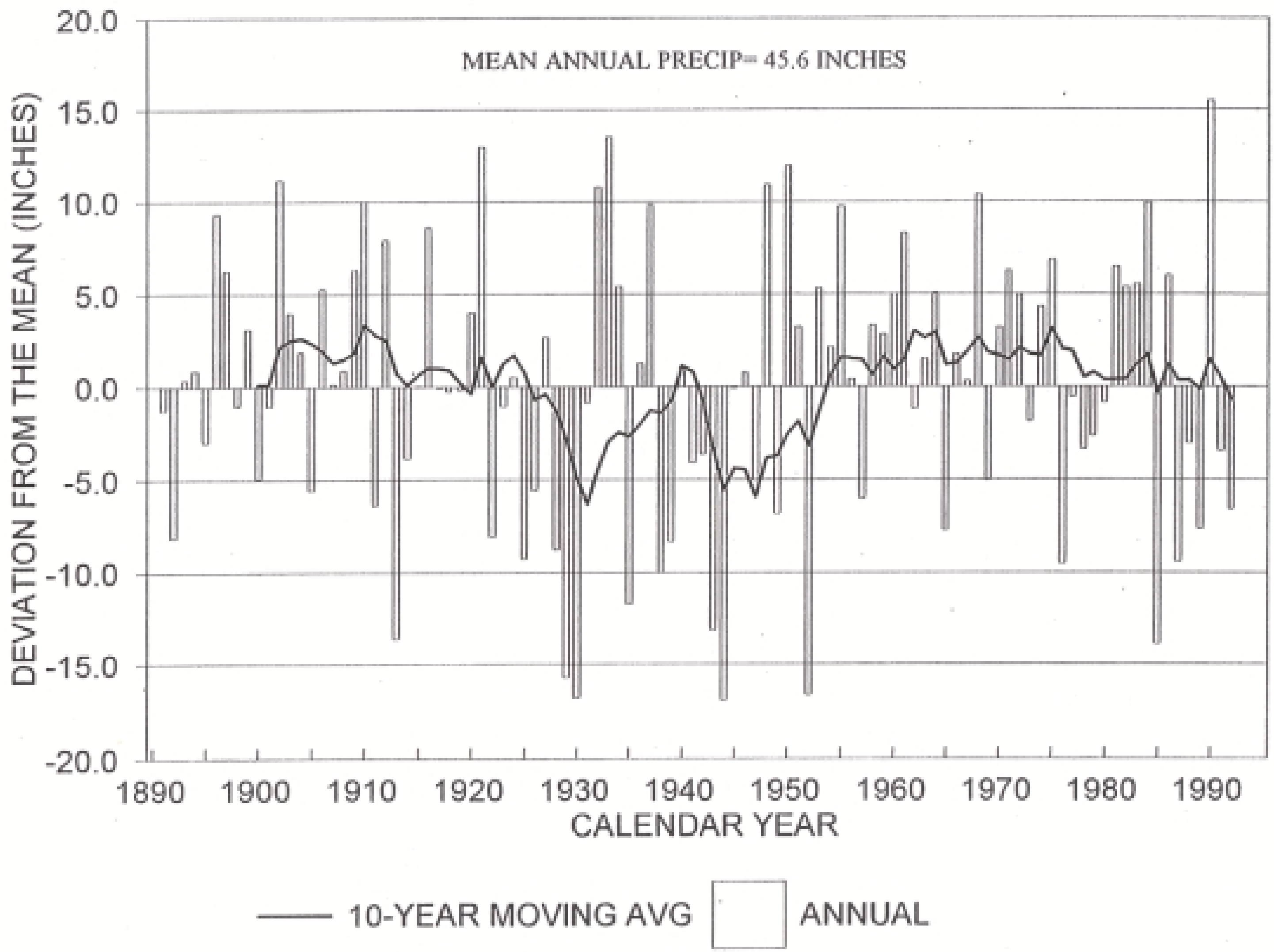


FIGURE 4. PRECIPITATION TREND AT CENTRALIA

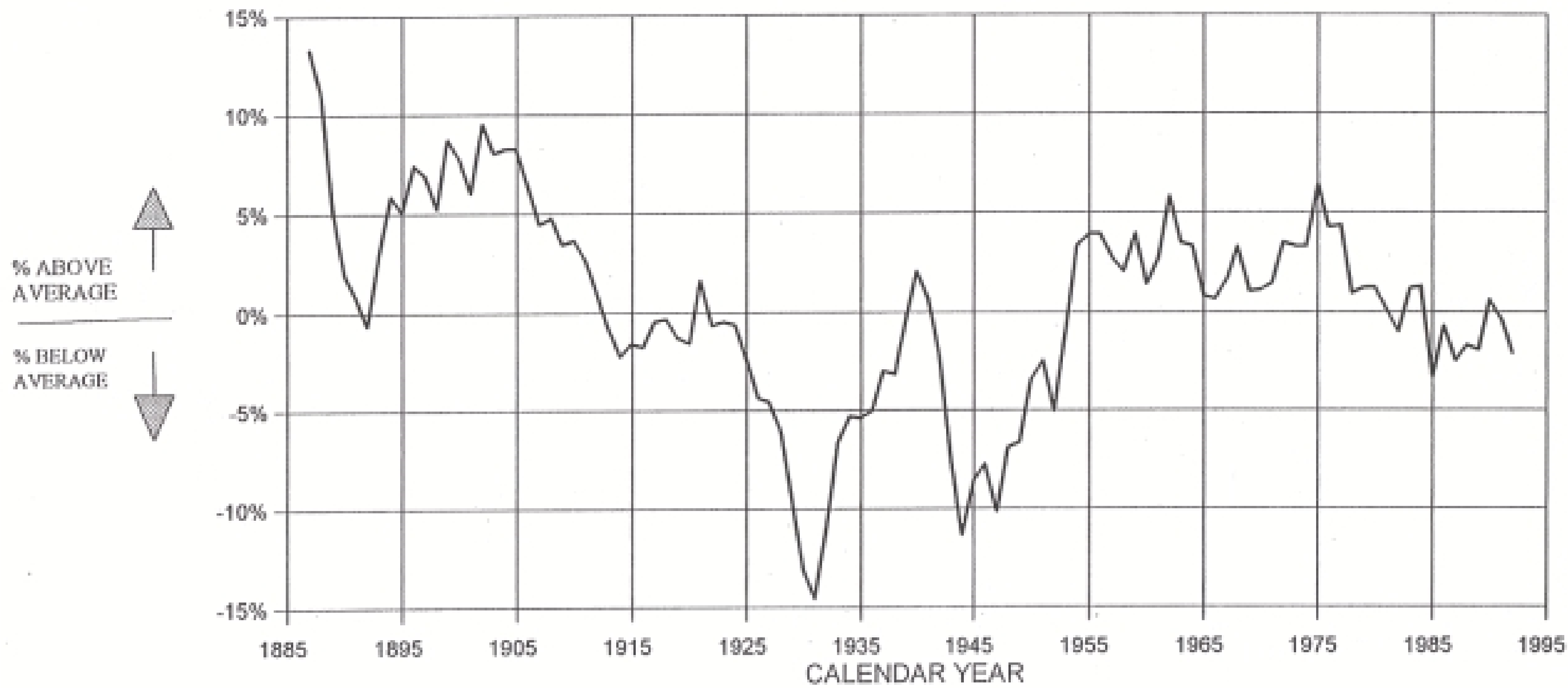


FIGURE 5. PRECIPITATION TRENDS IN WESTERN WASHINGTON

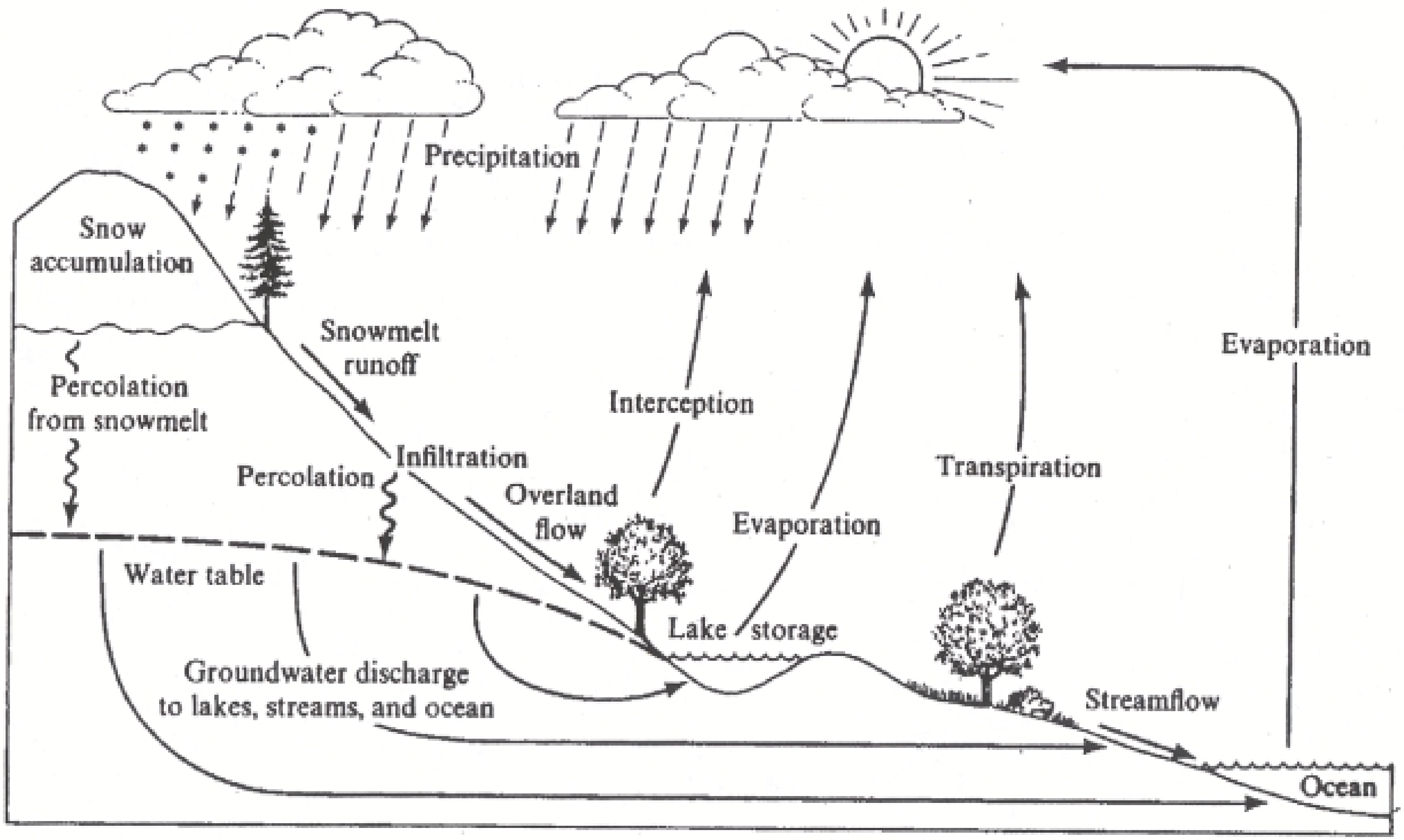


FIGURE 6. The Hydrologic Cycle (from Dunne and Leopold, 1978)

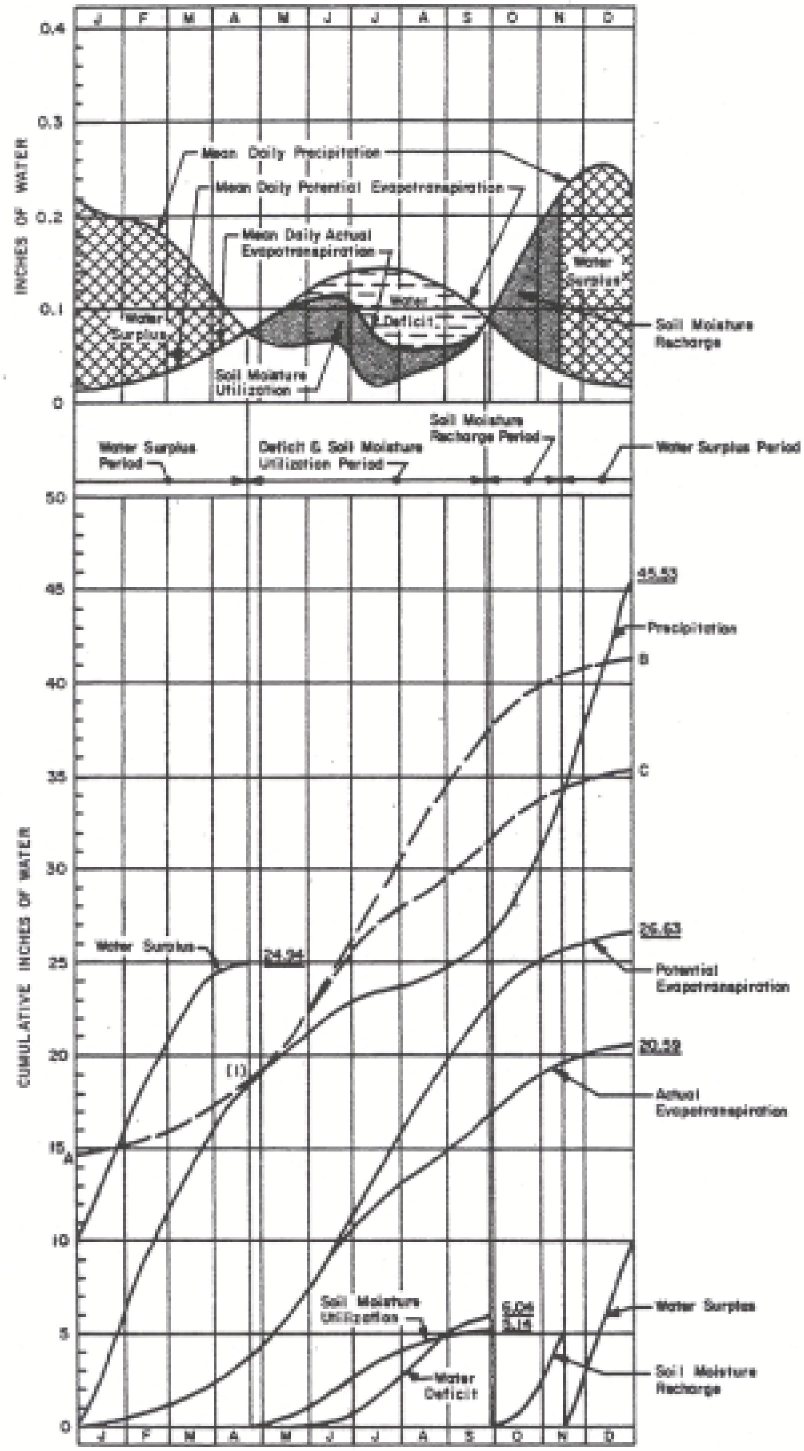


Figure 7. Mean Annual Water Budget at Centralia, Root Zone Water Capacity of 6 Inches (from Washington Dept. of Ecology, 1972).

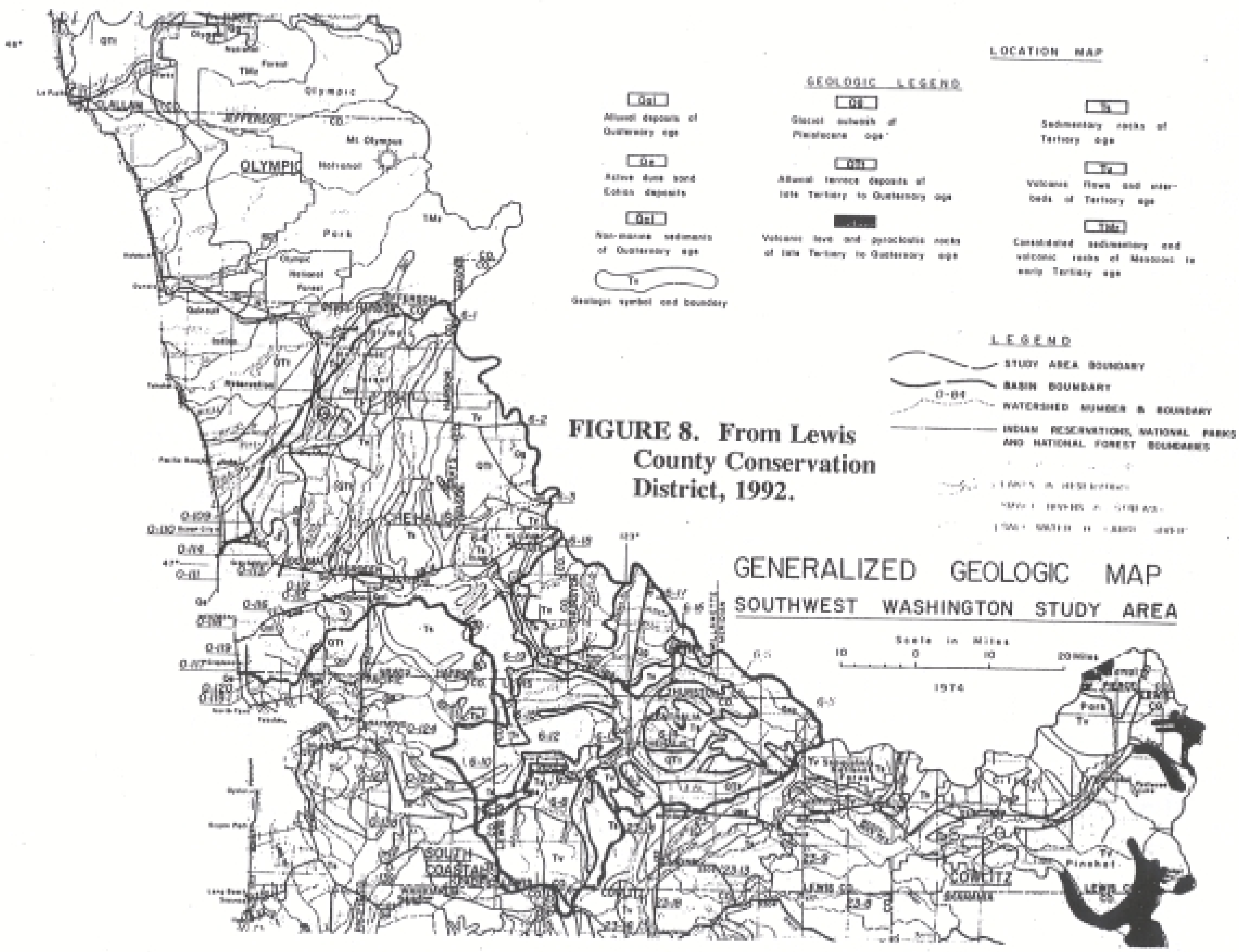
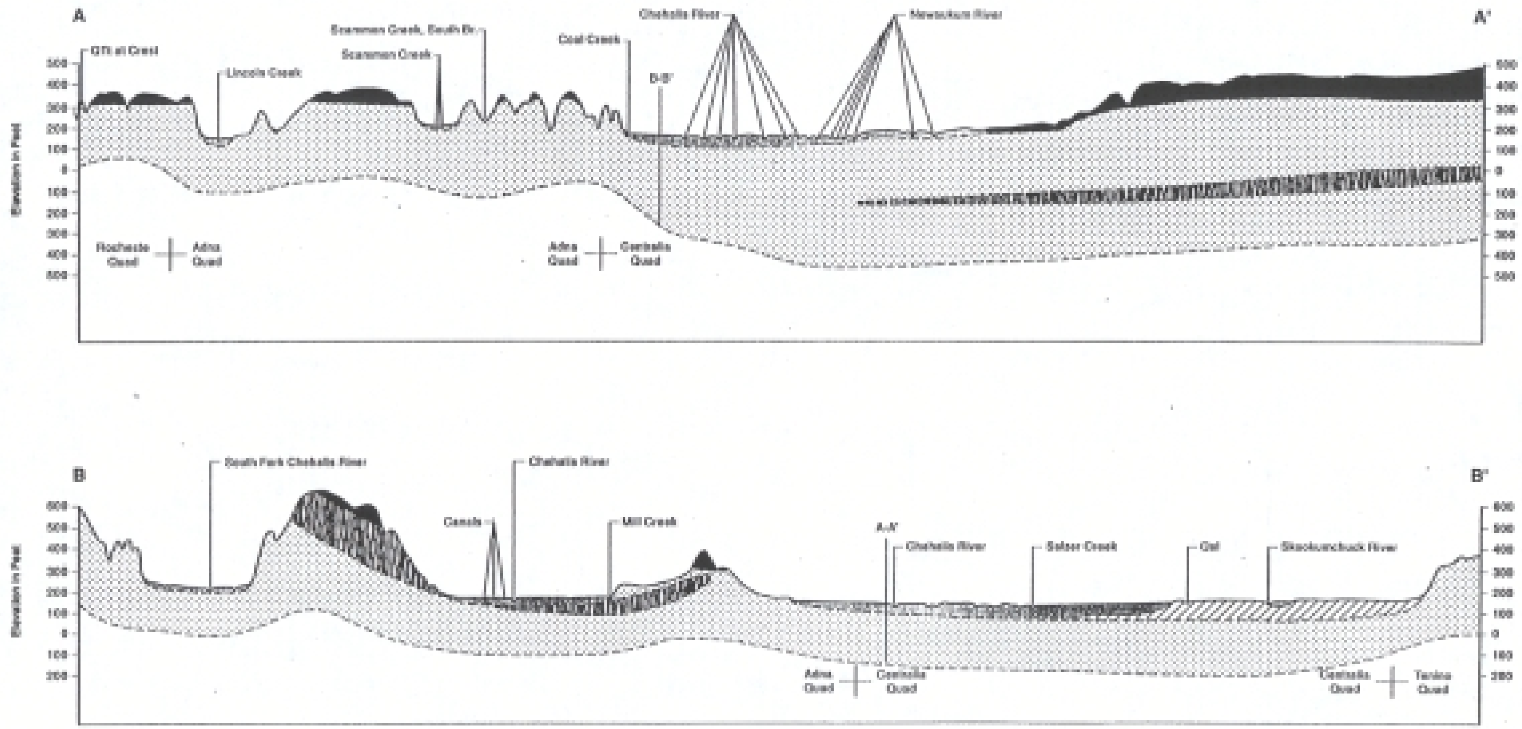


FIGURE 8. From Lewis County Conservation District, 1992.



NOTE

Approximate correlation with Geologic Map, Figure 8

LEGEND

- Qal — Alluvial and valley fill deposits
- QTt — Terrace deposits
- Qg — Outwash deposits from Vashon Glacier and smaller alpine glaciers
- T — Marine and non-marine sediments and sedimentary rock
- B — Basalt, volcanic flows

0 1 2
Horizontal Scale in Miles

GENERALIZED GEOLOGIC CROSS SECTIONS
UPPER CHEHALIS WRIA23

FIGURE 9A

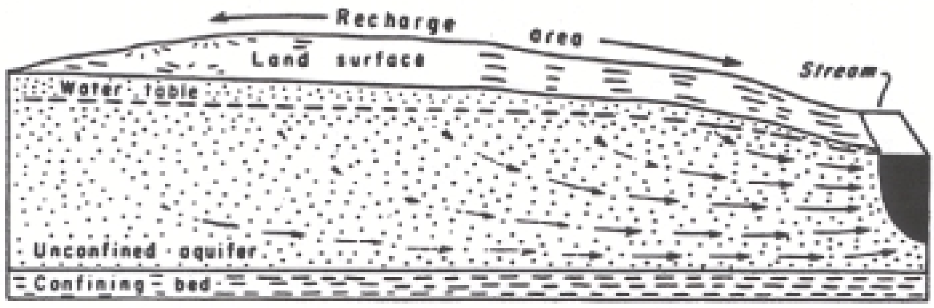
Recent Quaternary Age Deposits	Hydrogeologic Characteristics
Qal Alluvial and valley fill deposits QTt Terrace Deposits Qg Outwash deposits from Vashon Glacier and smaller alpine glaciers	The recent quaternary sediments consist of unconsolidated and interbedded clay, silt, sand and gravels associated with alluvial, terrace and valley fill deposits including limited glacial outwash (as opposed to larger expanses of glacial outwash materials not confined to valleys, such as are located in the Scatter Creek area). These deposits are generally less than 100 feet thick and are the uppermost strata where they occur. In general, glacial outwash sediments form productive aquifers consisting of coarse grained sand and gravel such as in the Skookumchuck valley. The alluvial, terrace and valley fill deposits generally contain larger amounts of fine grained sediments, yielding small to moderate supplies of water to wells. Locally, especially in the southeastern portion of the WRIA, sand and gravel strata within the terrace and alluvial deposits form productive aquifers which can yield significant quantities of water to wells, such as in the Napavine area. Water quality in these sediments is generally of good quality, suitable for most purposes. In some areas, groundwater may contain high iron.

Tertiary Age Sediments and Bedrock Underlying Recent Deposits	Hydrogeologic Characteristics
T Marine and non-marine sediments and sedimentary rock B Basalt, volcanic flows	The older tertiary sediments underlie the more recent Quaternary deposits (where they occur) and consist of grey to blue fine grained silts and clays with occasional sand and gravel strata of marine and non-marine origin. With depth, the sediments become more consolidated, forming shales and siltstones. Within these rocks, basalt flows of volcanic origin can be found at various depths. The non-marine sequence of sediments generally overlies the marine strata, and can be greater than 200 feet thick in some places. The marine sequences may be greater than 1,000 feet in thickness. Groundwater yields in the tertiary sediments are generally low, except in sand and gravel layers located within the finer grained matrix, which form limited confined aquifers. This is especially evident in the lower Newaukum Valley between and Napavine and Chehalis, where numerous buried sand and gravel strata under confined conditions has formed the Newaukum Artesian Basin. Groundwater quality in the tertiary sediments and rock units is generally of poorer quality than in the recent quaternary sediments. Water quality decreases with depth, exhibiting high sodium chloride content within the marine deposits and to a lesser extent within the non-marine units.

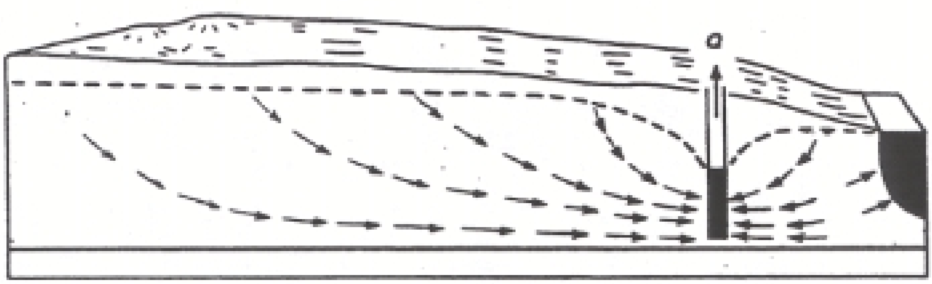
LEGEND
GENERALIZED GEOLOGIC CROSS SECTIONS
UPPER CHEHALIS WRIA23

Job No. 07927-007-005

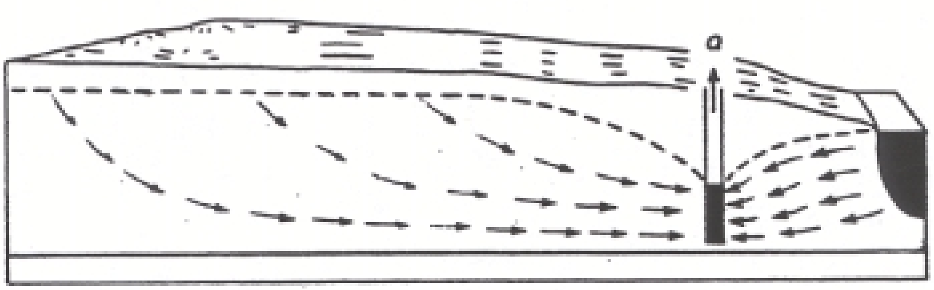
FIGURE 9B



(a) Undisturbed flow of ground water to stream
Discharge = Recharge



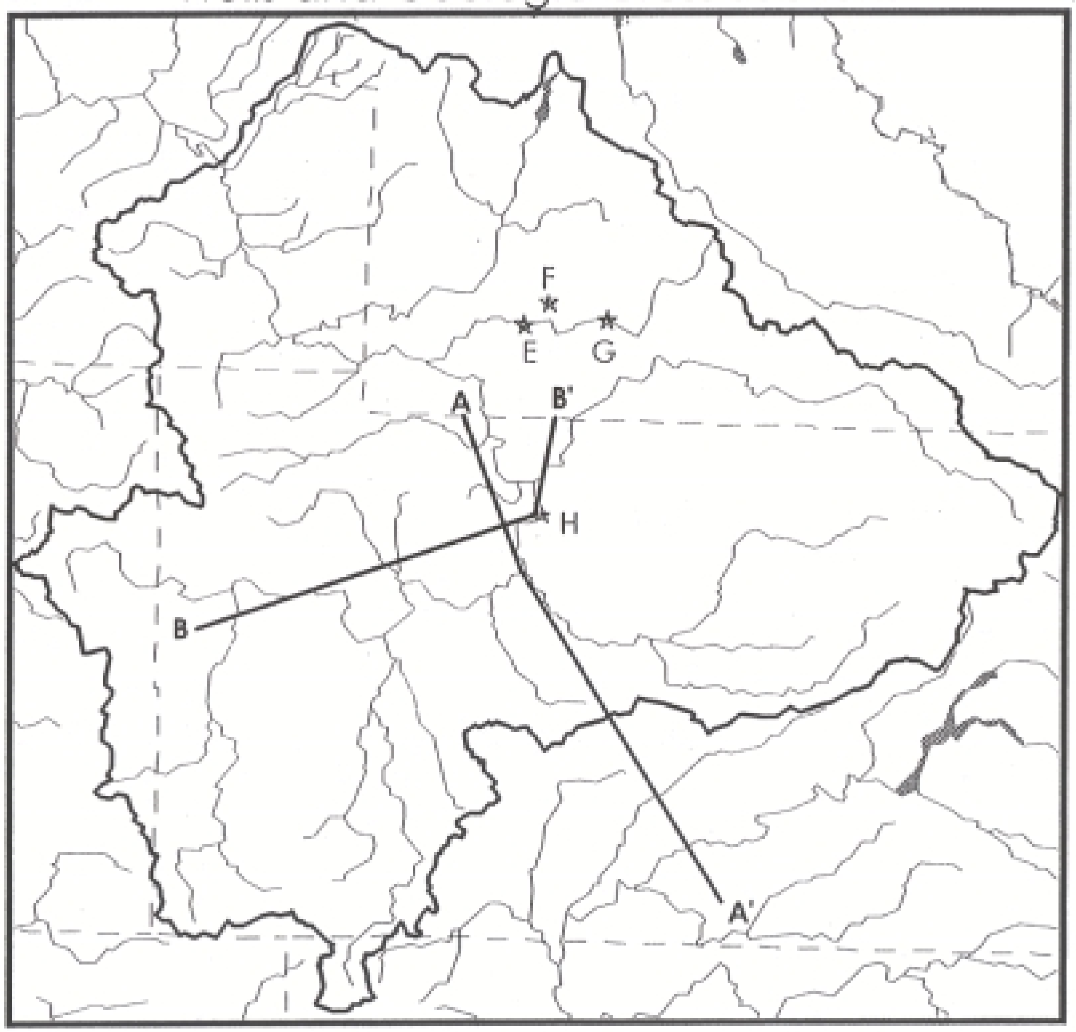
(b) Well reduces ground-water storage and captures ground-water discharge to stream.
Withdrawal = reduction in storage + reduction in discharge



(c) Well reduces ground-water discharge and captures streamflow by inducing flow from stream toward well (steady-state).
Withdrawal = reduction in discharge + increase in recharge

FIGURE 10. TWO MECHANISMS OF STREAMFLOW CAPTURE BY WELLS (adapted from Heath, 1983)

Location of Selected Water -Level Monitoring Wells and Geologic Cross Sections



MAP LABEL	WELL NUMBER
E	THR115
F	THR007
G	THR001
H	LEW003
A —— A'	Cross Section

FIGURE 11

Hydrographs for Selected Wells

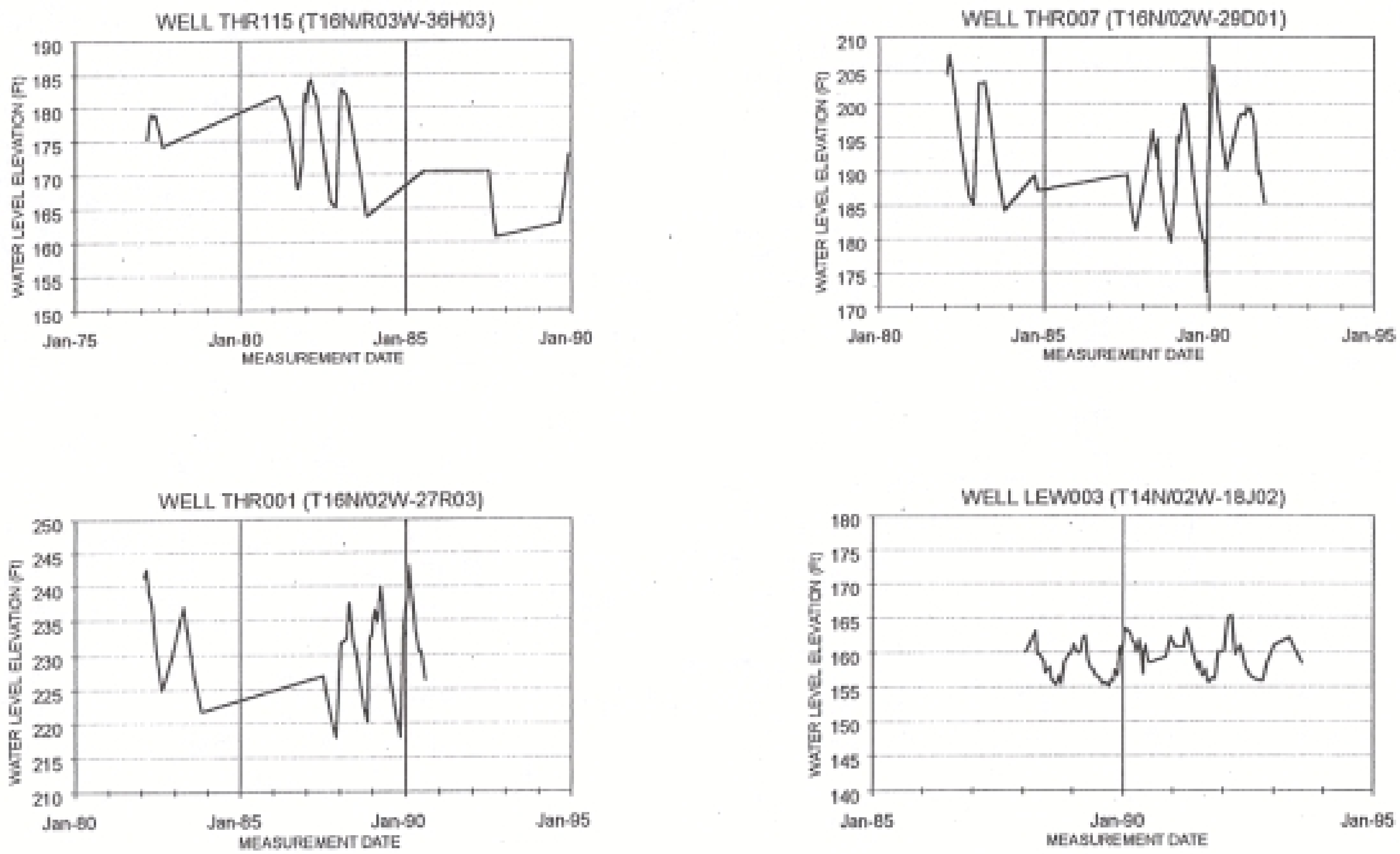


FIGURE 12

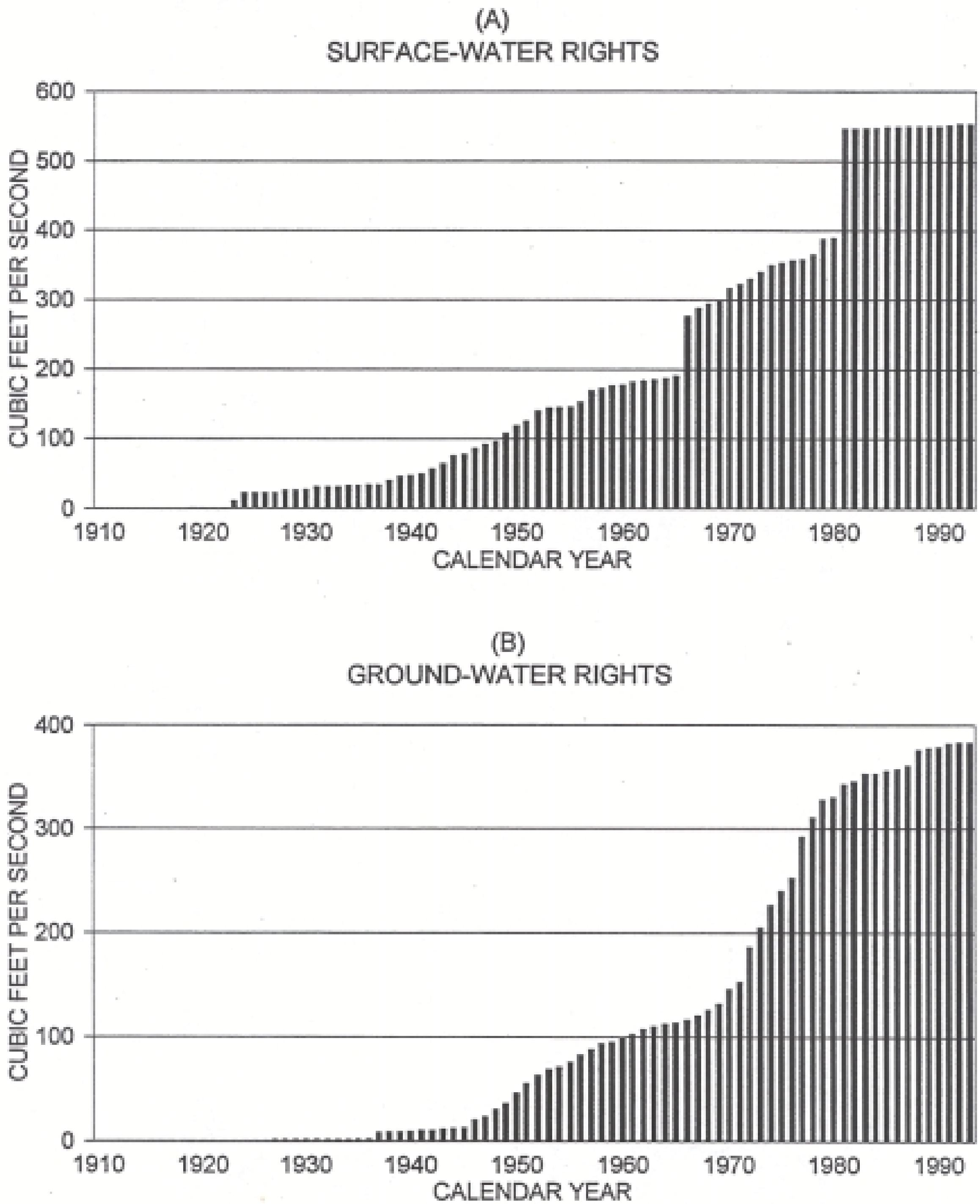
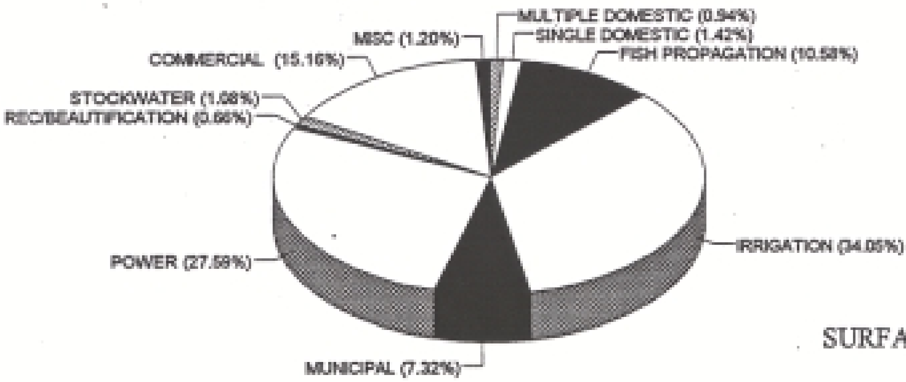
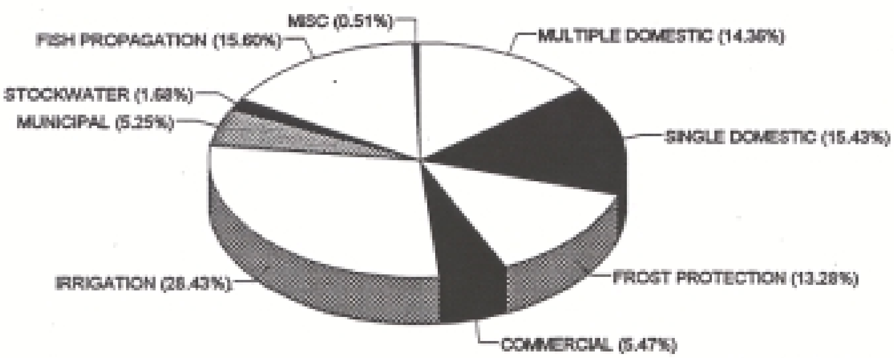


FIGURE 13. CUMULATIVE GROWTH IN WATER RIGHTS, WRIA 23.



SURFACE-WATER RIGHTS
(A)



GROUND-WATER RIGHTS
(B)

FIGURE 14. PRIMARY PURPOSE OF
USE FOR WATER RIGHTS, WRIA 23

Surface Water Rights and Claims by Township and Range

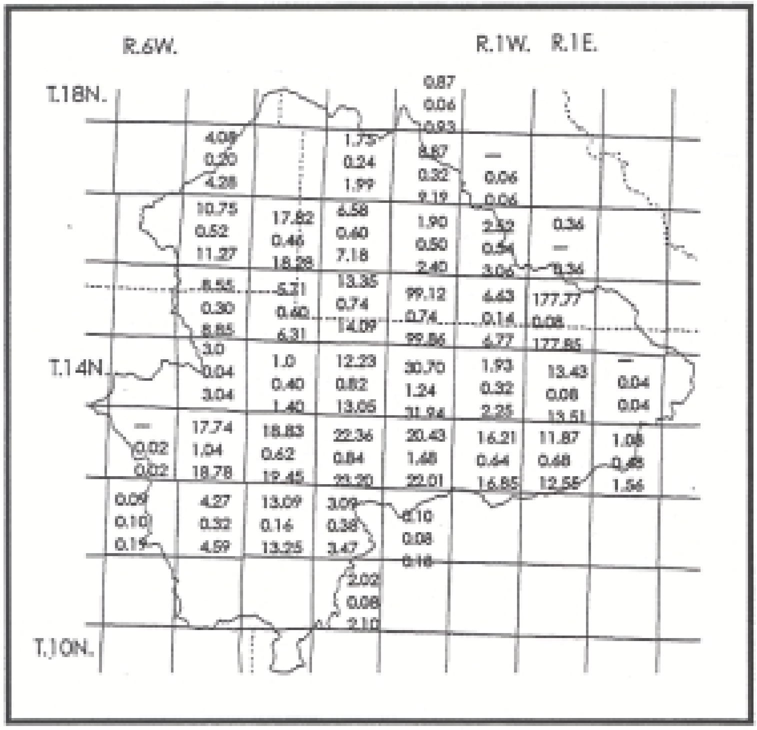


FIGURE 15A

Ground Water Rights and Claims by Township and Range

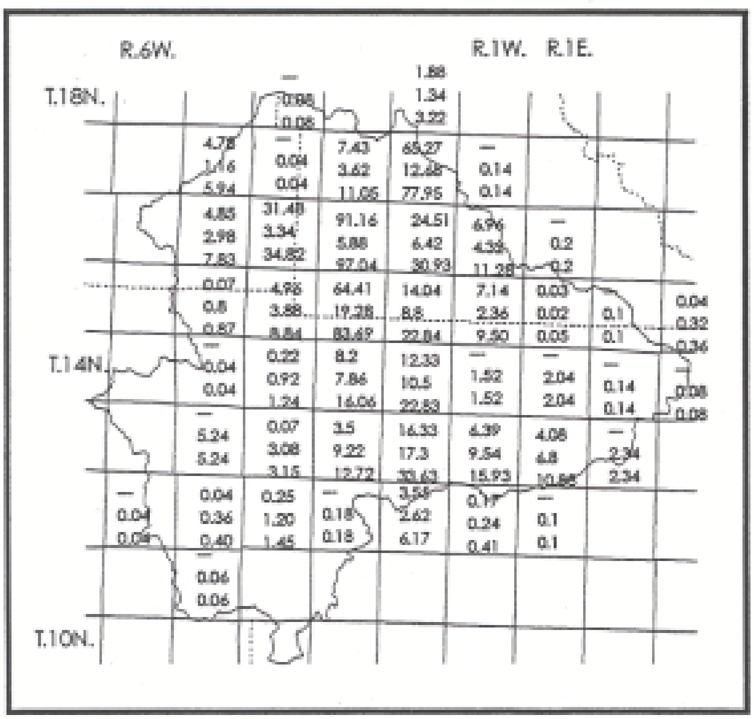
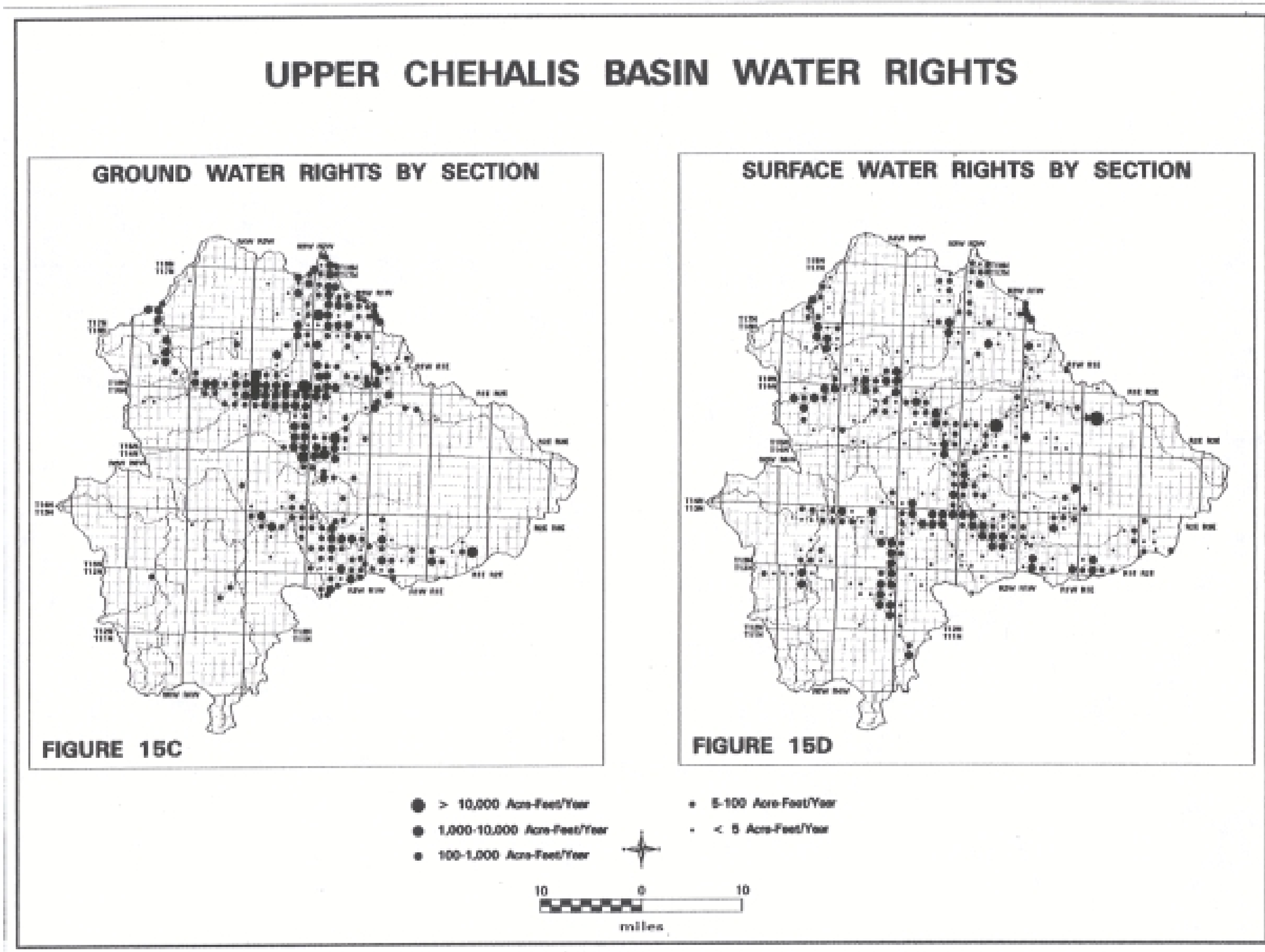


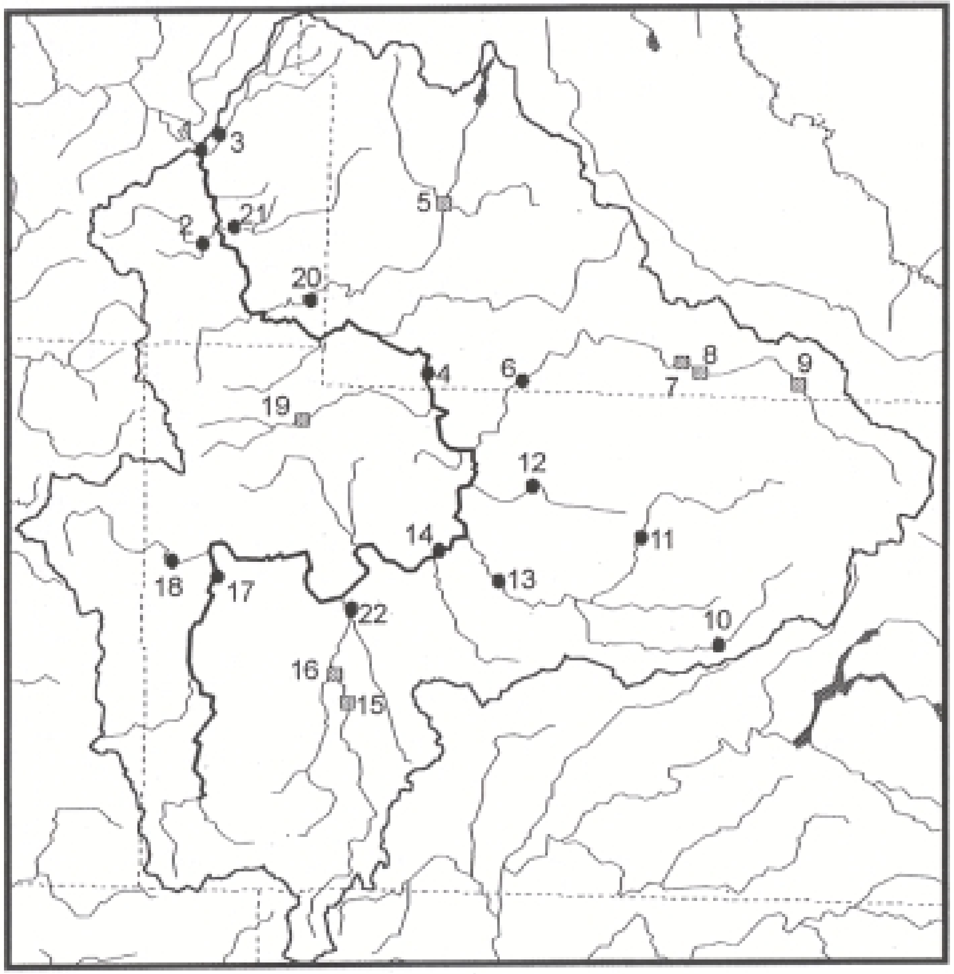
FIGURE 15B

NOTE:

The indicated quantities are listed in cubic feet per second (cfs), and represent the total permitted and claimed quantities for the referenced Township and Range combination. The permitted quantity is listed first followed by the claimed quantity. The bottom figure is the sum of claimed and permitted rights.


UPPER CHEHALIS BASIN WATER RIGHTS
GROUND WATER RIGHTS BY SECTION
FIGURE 15C
SURFACE WATER RIGHTS BY SECTION
FIGURE 15D
> 10,000 Acre-Feet/Year
1,000-10,000 Acre-Feet/Year
100-1,000 Acre-Feet/Year
5-100 Acre-Feet/Year
< 5 Acre-Feet/Year
10
0
10
miles

Location of Stream Gages and IRPP Stations



MAP LABEL	GAGING STATION	(period of record)
1	12031000	Chehalis R. @ Porter (1952-72;1975-present)
2	12030000	Rock Ck. @ Cedarville (1942-71)
3	12030900	Porter Ck. @ Porter (1942-49)
4	12027500	Chehalis R. @ Grand Mound (1928-present)
5	12029000	Black R. @ Littlerock (1942-50)
6	12026400	Skookumchuck R. @ Bucoda (1967-present)
7	12026150	Skookumchuck R. (1929-33;1939-present)
8	12026000	Skookumchuck R. @ Centralia (1929-34;1940-69)
9	12025700	Skookumchuck R. @ Vail (1967-present)
10	12024000	S. Fk. Newaukum R. (1944-49;1957-71)
11	12024500	N. Fk. Newaukum R. (1944;1957-66)
12	12025300	Salzer Ck. (1968-71)
13	12025000	Newaukum R. (1929-31;1942-81;1982-present)
14	12023500	Chehalis R. @ Chehalis (S) (1910-11)
15	12020900	S. Fk. Chehalis R. (1965-80)
16	12021000	S. Fk. Chehalis R. (1942-50;1961-65)
17	12020000	Chehalis R. near Doty (1939-present)
18	12020500	Elk Ck. @ Doty (1942-50;1967-70)
19	12027000	Lincoln Ck. near Rochester (1942-50)
20	12029200	Black River @ Littlerock
21	12030500	Cedar Ck. near Cedarville (1944)
22	12021630	S. Fk. Chehalis R.

● Indicates Gages With IRPP Flows

▫ Indicates Gages Without IRPP Flows

FIGURE 16

FIGURE 17. STREAMS WITH IMPAIRED WATER QUALITY (303D LISTING)

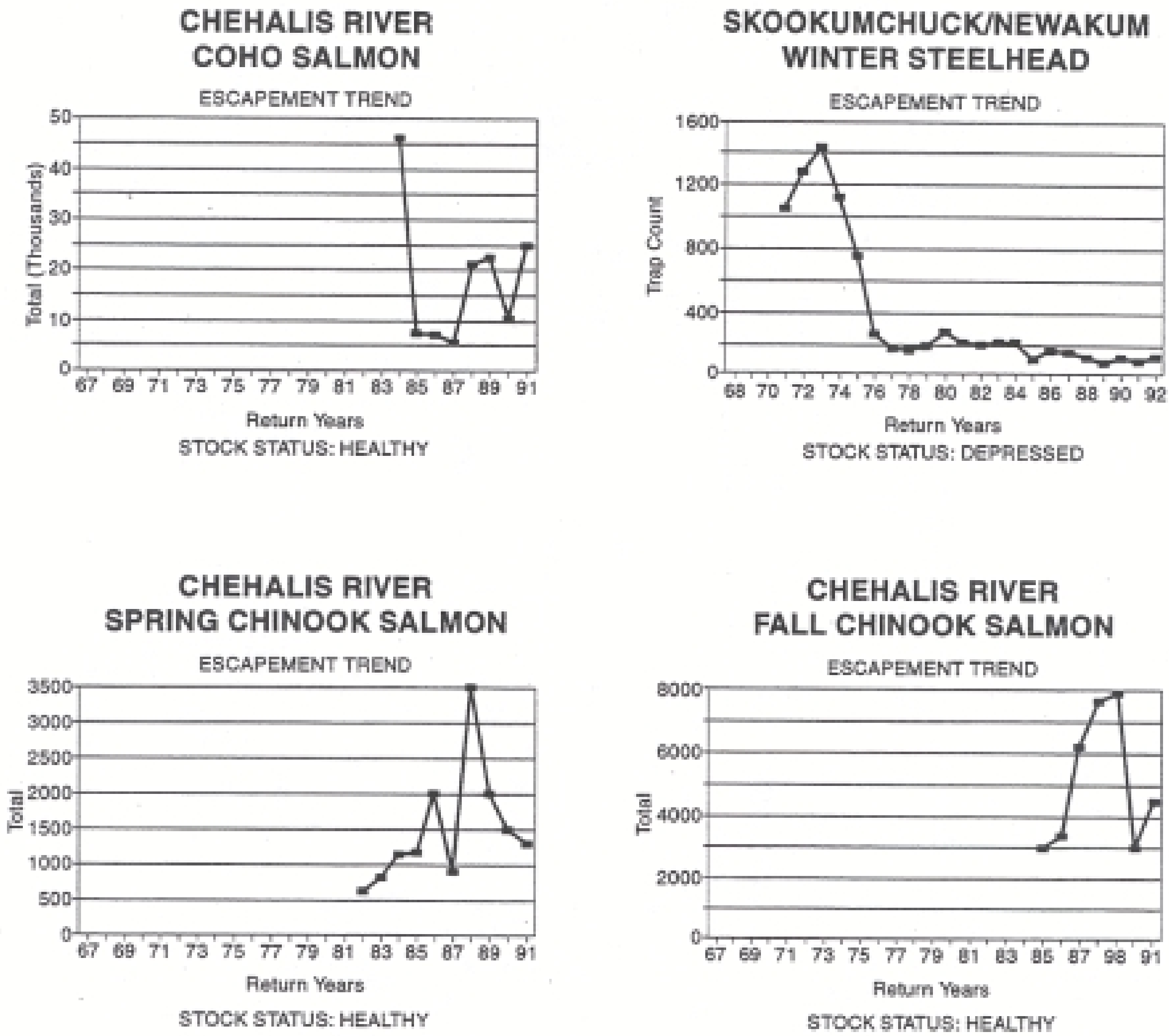
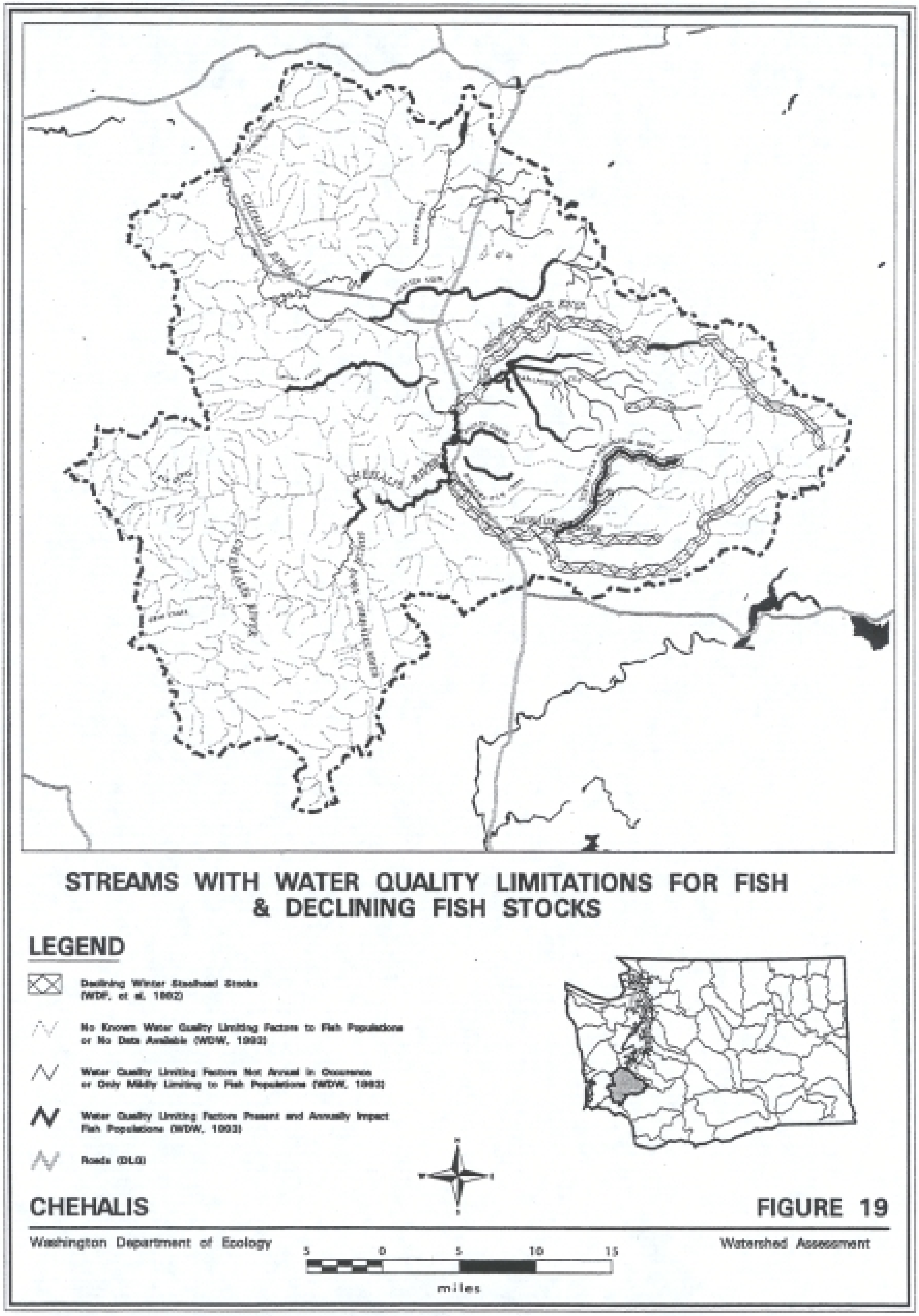


FIGURE 18. ESCAPEMENT ESTIMATES FOR SELECTED SALMON STOCKS IN WRIA 23 (WA. DEPT. WILDLIFE, ET AL., 1992)


STREAMS WITH WATER QUALITY LIMITATIONS FOR FISH
& DECLINING FISH STOCKS
LEGEND
Declining Winter Steelhead Stocks (WDF, et al. 1992)
No Known Water Quality Limiting Factors to Fish Populations or No Data Available (WDW, 1993)
Water Quality Limiting Factors Not Annual in Occurrence or Only Mildly Limiting to Fish Populations (WDW, 1993)
Water Quality Limiting Factors Present and Annually Impact Fish Populations (WDW, 1993)
Roads (DLG)
CHEHALIS
FIGURE 19
Washington Department of Ecology
Watershed Assessment
5 0 5 10 15
miles

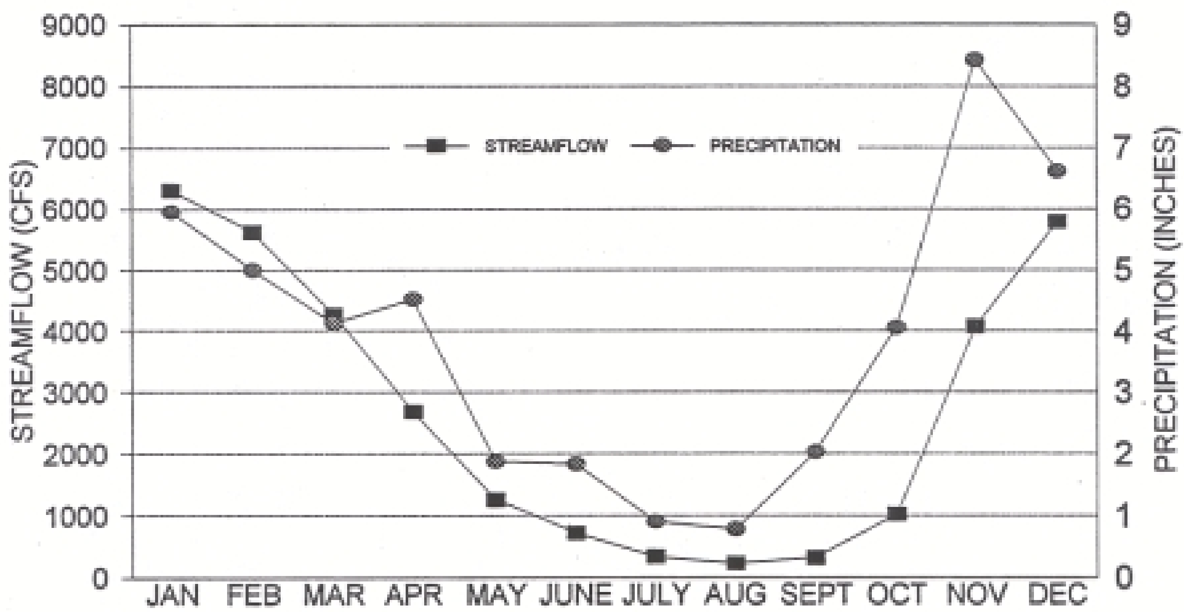


FIGURE 20. MEAN MONTHLY STREAMFLOW IN CHEHALIS RIVER NEAR GRAND MOUND (12027500, MILE 59.9) and MEAN MONTHLY PRECIPITATION AT WEYERHEAUSER CLIMATE STATION NEAR GRAND MOUND

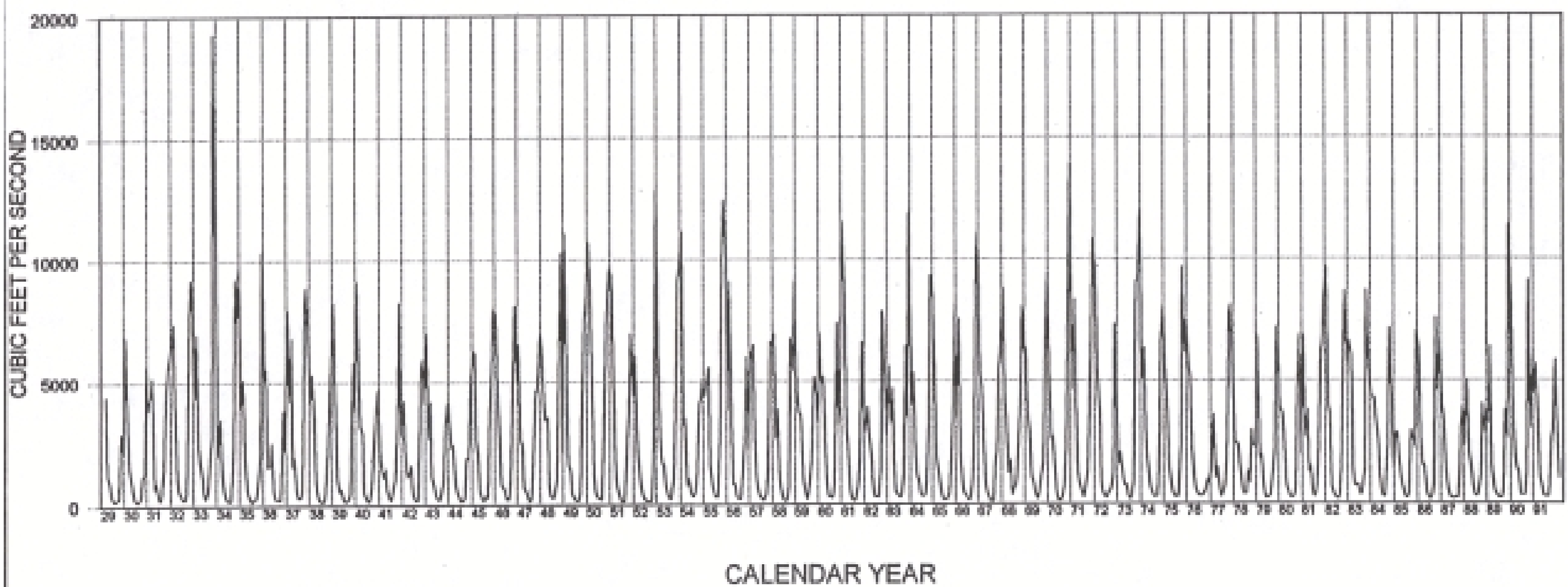


FIGURE 21. MONTHLY MEAN STREAMFLOW, CHEHALIS RIVER NEAR GRAND MOUND (12027500, MILE 59.9)

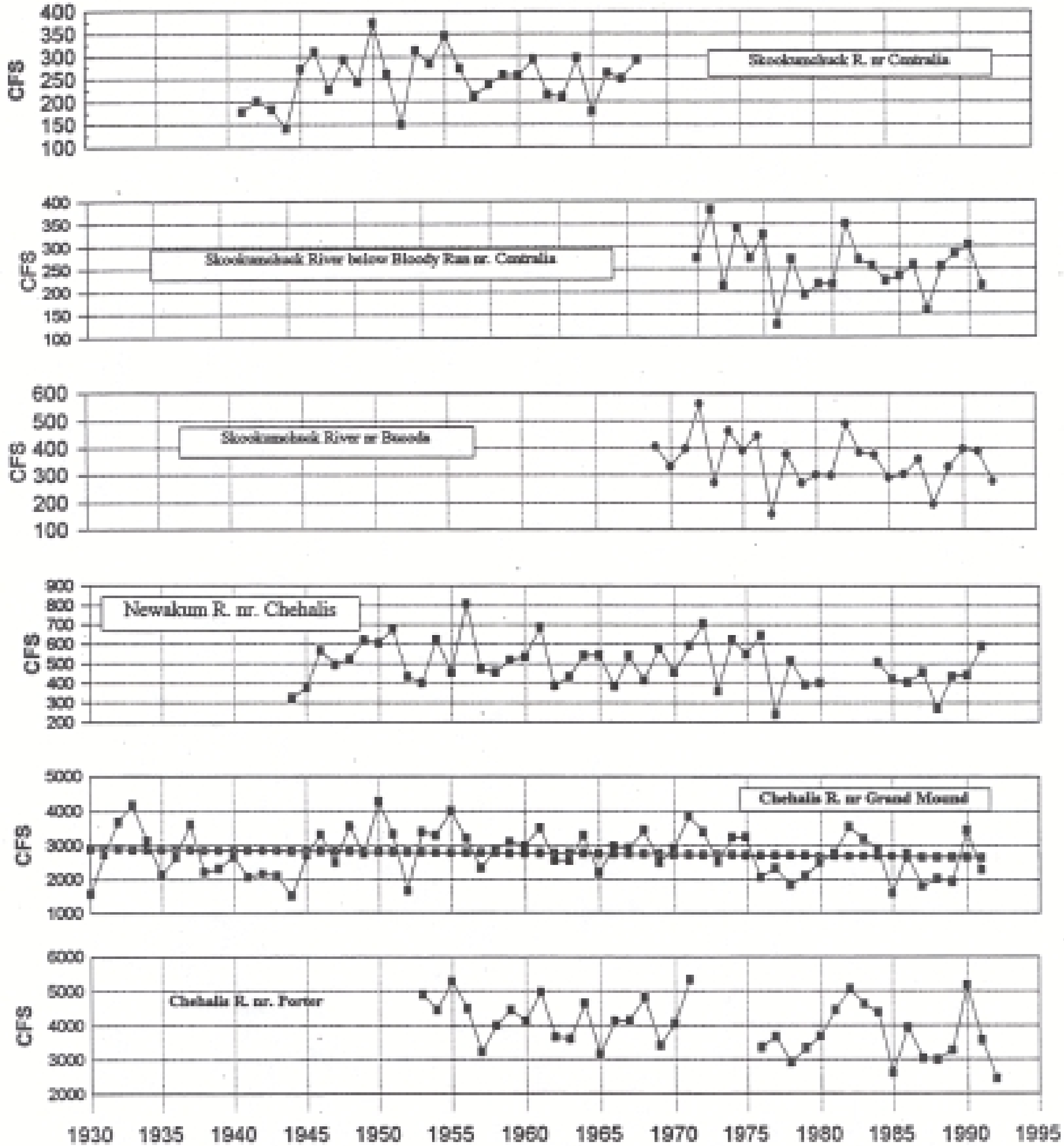


FIGURE 22. ANNUAL MEAN STREAMFLOW FOR CHEHALIS R. NR. PORTER (12031000, MILE 33.3), CHEHALIS R. NR. GRAND MOUND (12027500, MILE 59.9), NEWAUKUM R. NR. CHEHALIS (12025000, MILE 4.1), SKOOKUMCHUCK R. NR. BUCODA (12026400, MILE 6.4), SKOOKUMCHUCK R. BELOW BLOODY RUN CR. NR. CENTRALIA (12026150, MILE 20.7), SKOOKUMCHUCK R. NR. CENTRALIA (12026000, MILE 22.0)

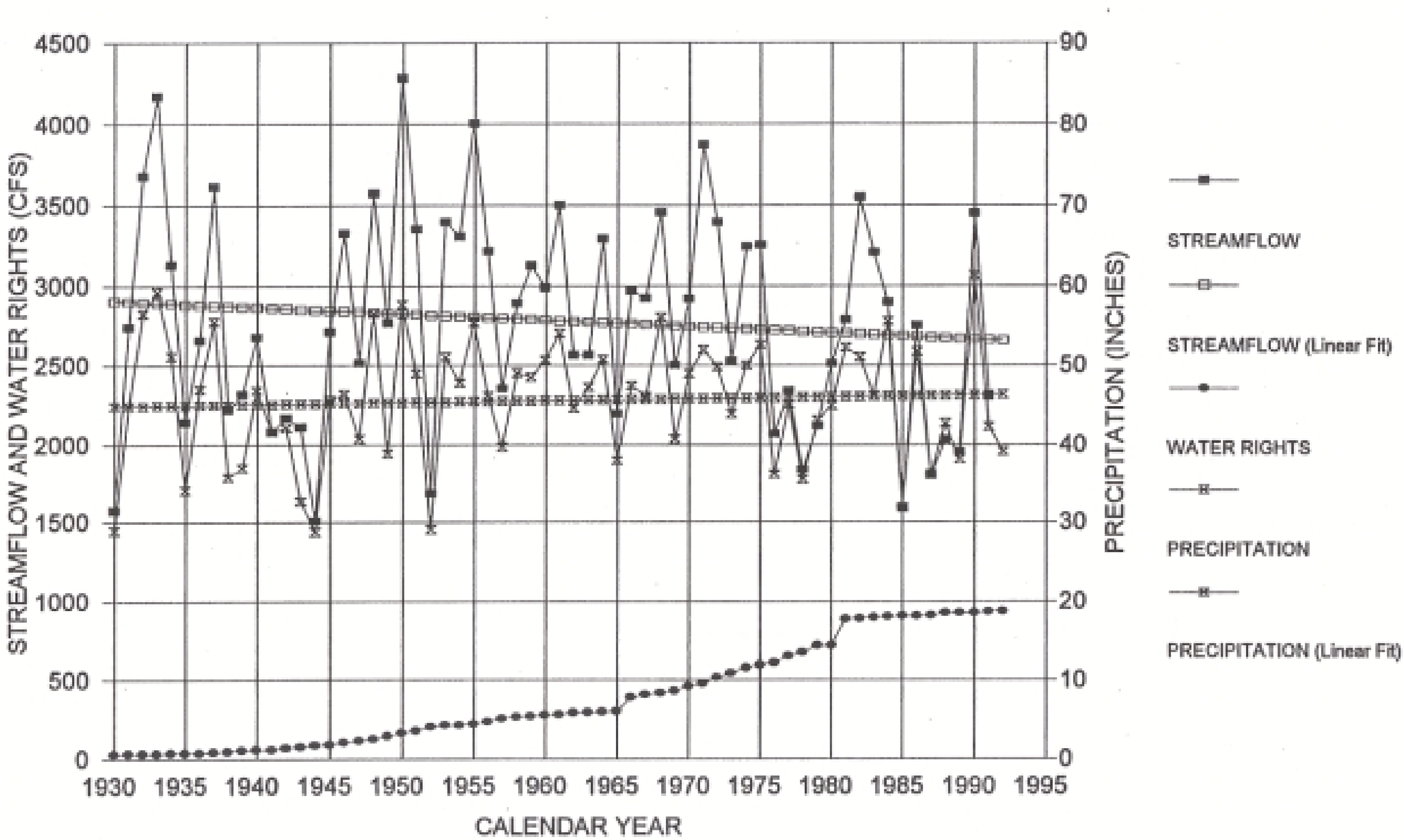


FIGURE 23 ANNUAL MEAN STREAMFLOW IN CHEHALIS RIVER NEAR GRAND MOUND (12027500, MILE 59.9), ANNUAL INCREASE IN WATER RIGHTS IN WRIA 23, AND ANNUAL PRECIPITATION AT CENTRALIA.

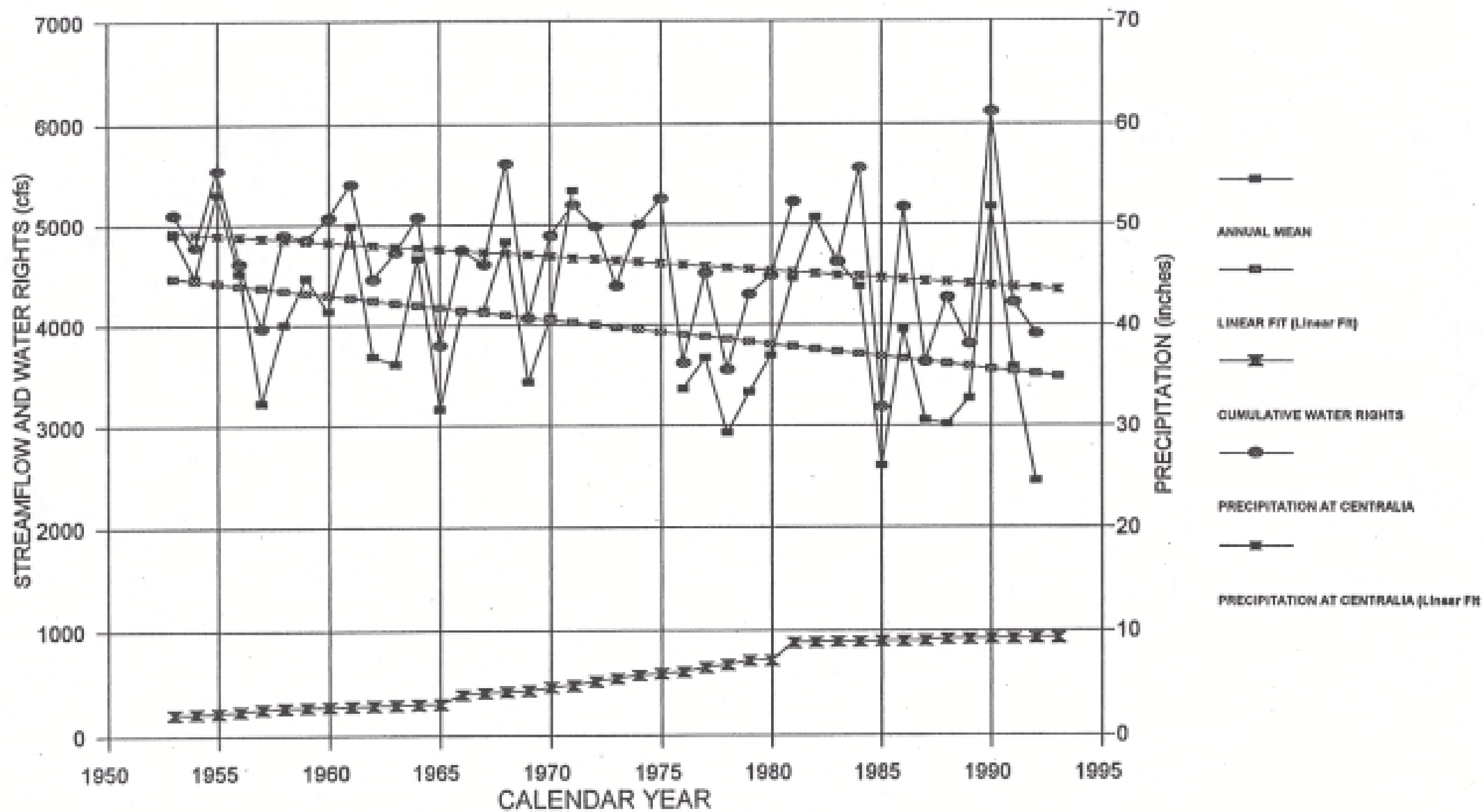
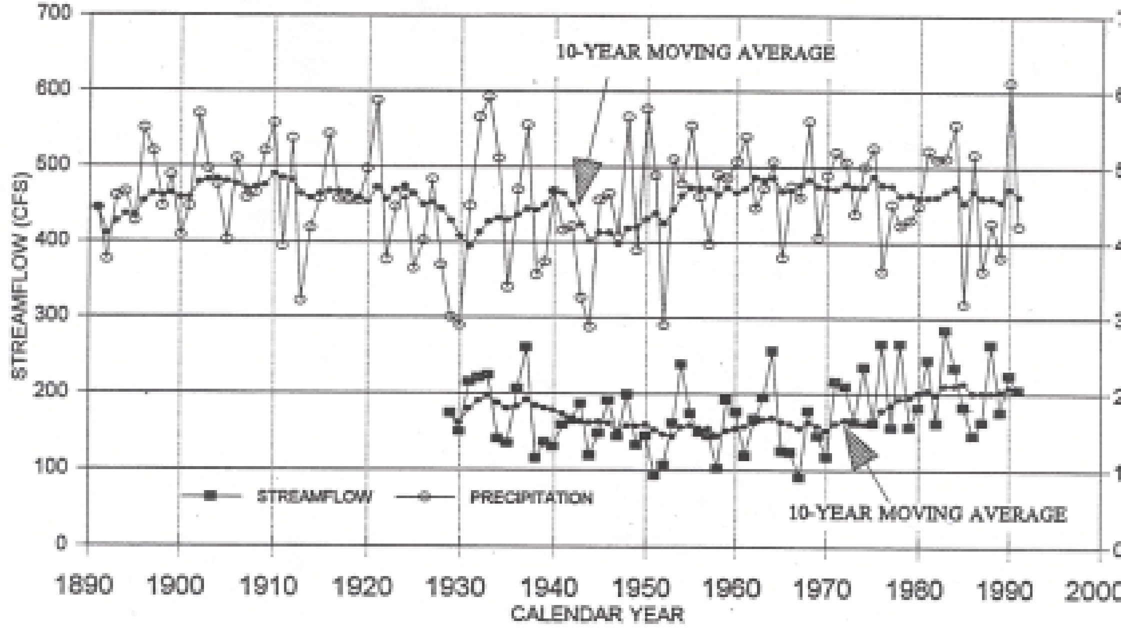


FIGURE 24 ANNUAL MEAN STREAMFLOW AND ANNUAL INCREASE IN WATER RIGHTS UPSTREAM OF GAGE ON CHEHALIS RIVER NEAR PORTER (12031000, MILE 33.3), AND ANNUAL PRECIPITATION AT CENTRALIA.



LOWEST 7-DAY-MEAN STREAMFLOW, CHEHALIS RIVER NEAR GRAND MOUND (12027500, MILE 59.9) AND ANNUAL PRECIPITATION AT CENTRALIA

(A)

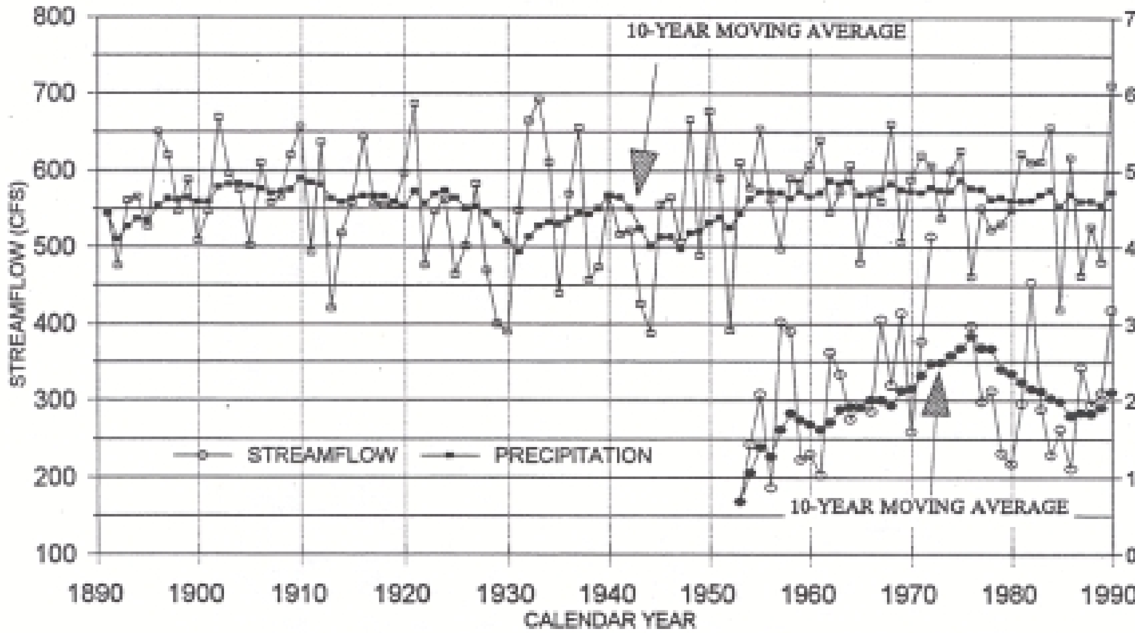


FIGURE ??. LOWEST 7-DAY-MEAN STREAMFLOW, CHEHALIS RIVER NEAR PORTER (12031000, MILE 33.3) AND ANNUAL PRECIPITATION AT CENTRALIA

(B)

FIGURE 25. LOWEST 7-DAY-MEAN STREAMFLOW AT TWO GAGES ON CHEHALIS RIVER COMPARED TO ANNUAL PRECIPITATION AT CENTRALIA.

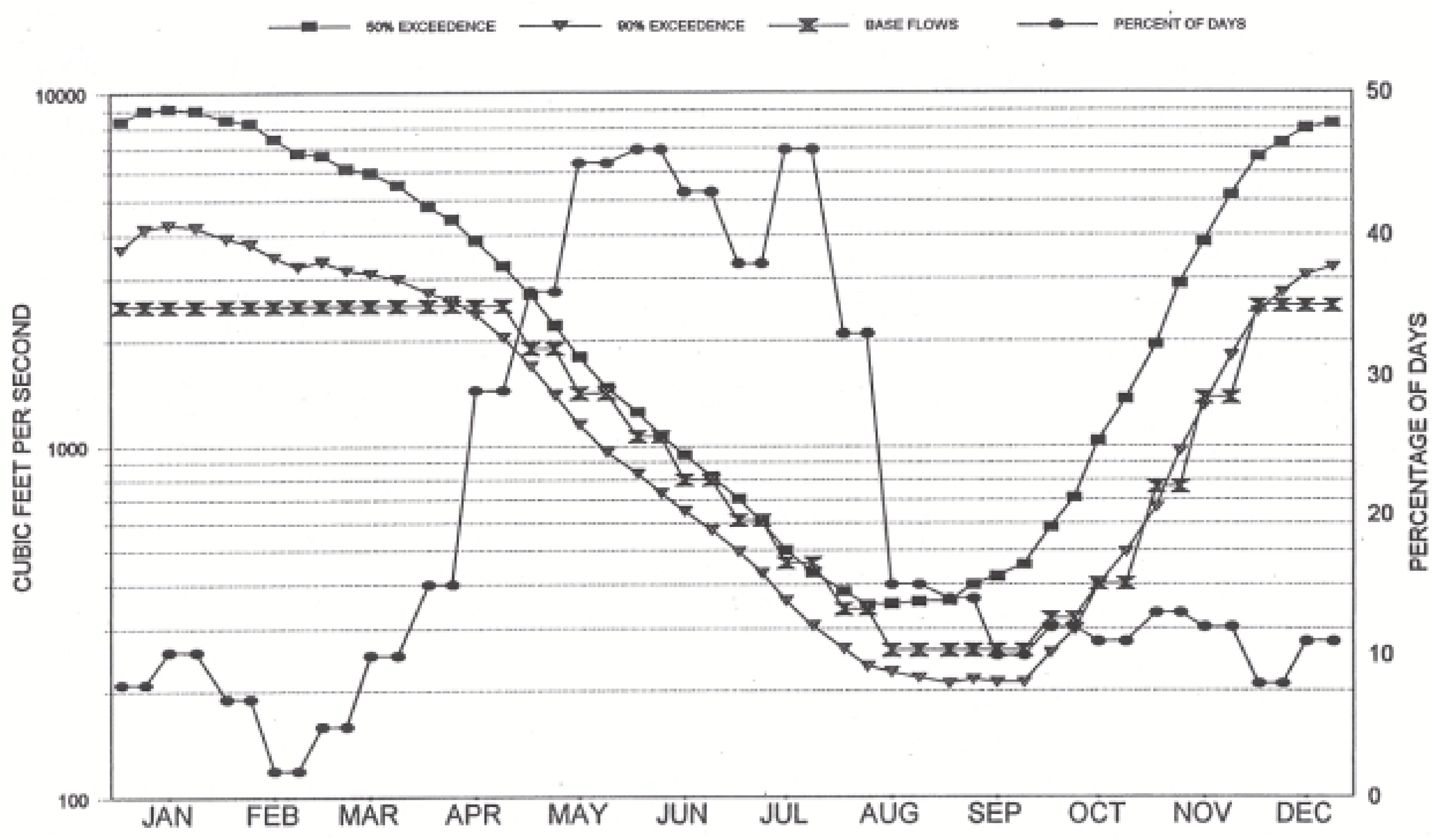
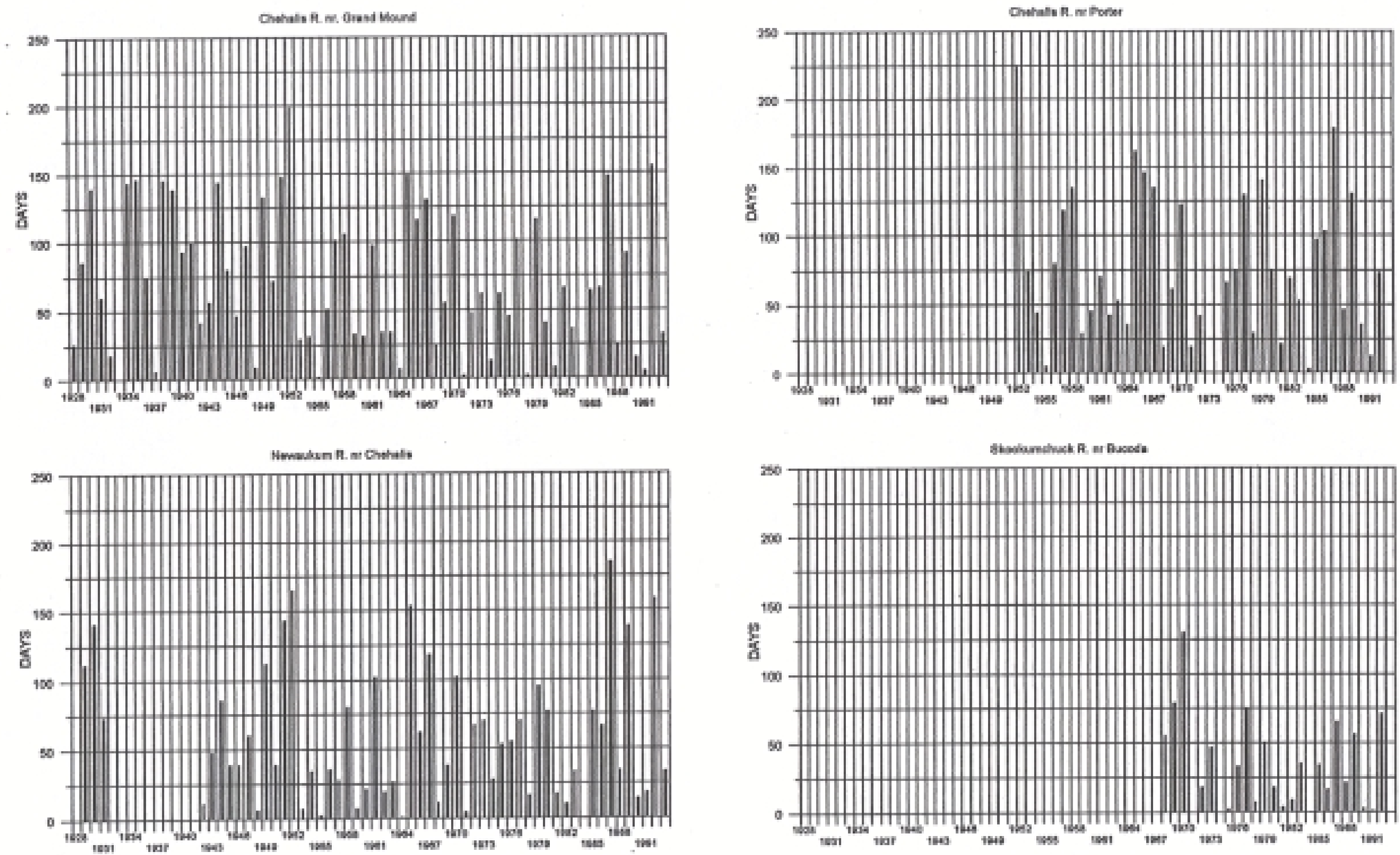


FIGURE 26. EXCEEDENCE AND MINIMUM STREAMFLOWS AND PERCENTAGE OF DAYS MINIMUM STREAMFLOWS NOT MET DURING EACH PERIOD, CHEHALIS RIVER NEAR PORTER (12031000, MILE 33.3)

FIGURE 27. NUMBER OF DAYS EACH YEAR WHEN BASE FLOWS NOT REACHED



APPENDIX C. PERCENTAGE OF WATER RIGHTS USING 90% OF THE WATER VOLUME

Of the 867 ground-water rights in WRIA 23, the largest 419, or about 50%, account for 90% of the registered (not actual) water use (Figure 27). The 419th largest water right was issued for 84 gpm, or about 0.19 cfs.

Of the 958 surface-water rights in WRIA 23, the largest 298 rights, or about 30% of the total number, account for 90% of the registered water use (Figure 27). The 298nd largest water right was issued for 0.3 cfs.

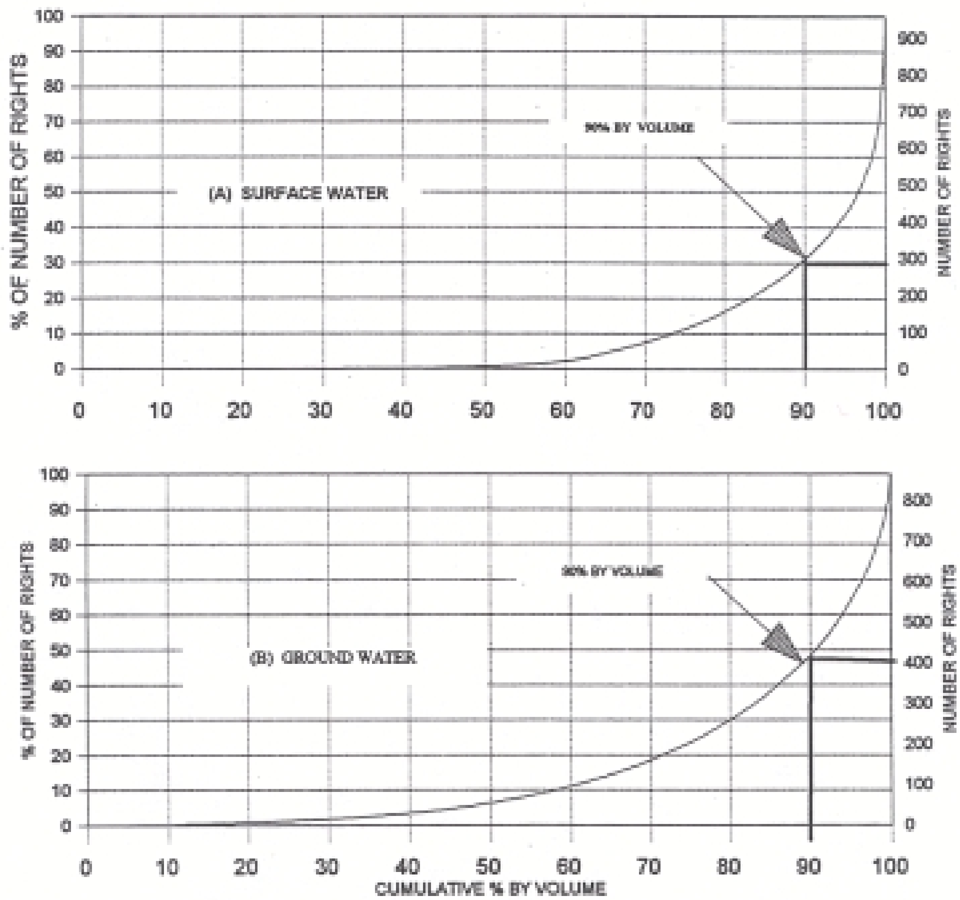


FIGURE 28. CUMULATIVE WATER VOLUME ASSIGNED TO WATER RIGHTS (ARRANGED LARGEST TO SMALLEST) VERSUS THE CUMULATIVE NUMBER OF WATER RIGHTS.

Appendix A Chapter 173-522 WAC, Water Resources Program in the Chehalis River Basin, WRIA-22 and 23.

Chapter 173-522 WAC
WATER RESOURCES PROGRAM IN THE CHEHALIS RIVER BASIN, WRIA-22 AND 23

WAC 173-522-010 General provision. These rules, including any subsequent additions and amendments, apply to waters within and contributing to the Chehalis River Basin, WRIA-22 and 23 (see WAC 173-500-040). Chapter 173-500 WAC, the general rules of the Department of Ecology for the implementation of the comprehensive water resources program, applies to this chapter 173-522 WAC. [Order 75-31, § 173-522-010, filed 3/10/76.]

WAC 173-522-020 Establishment of base flows. (1) Base flows are established for stream management units with monitoring to take place at certain control stations as follows:

STREAM MANAGEMENT UNIT INFORMATION

Control Station No. Stream Management Unit Name	Control Station by River Mile and Section, Township and Range	Affected Stream Reach Including Tributaries
12.0200.00 Chehalis River Conf. w/Elk Creek	101.8 14-13-5W	From confluence with Elk Creek to head-waters except Elk Cr.
12.0205.00 Elk Creek	2.5 18-13-5W	From confluence with Chehalis River to head-waters.
12.0216.30 So. Fork Chehalis R.	0.3 24-13-4W	From mouth to head-waters.
12.0235.00 Chehalis River	77.6 2-13-3W	From confluence with Newaukum River to confluence with Elk Cr., excluding Elk Creek, and Newaukum Rivers.
12.0240.00 S. Fork Newaukum R.	22.8 28-13-1E	From confluence with Lost Creek to head-waters, excluding Lost Creek.
12.0245.00 N. Fork Newaukum River	6.6 35-14-1W	From mouth to head-waters.
12.0250.00 Newaukum River	4.1 9-13-2W	From mouth to confluence with Lost Cr. on S. Fork Newaukum River, excluding N. Fork Newaukum River.
12.0253.00 Salzer Creek	3.8 22-14-2W	From mouth to head-waters.
12.0264.00 Skookumchuck River	6.4 12-15-2W	From mouth to head-waters.
12.0275.00 Chehalis River at Grand Mound	59.9 22-15-3W	From confluence with Newaukum River to confluence with Prairie Creek.
12.0292.00 Black River	4.1 33-16-4W	From mouth to head-waters.
12.0305.00 Cedar Creek	1.1 14-16-5W	From mouth to head-waters.
12.0309.00 Porter Creek	1.3 22-17-5W	From mouth to head-waters.
12.0310.00 Chehalis River at Porter	33.3 28-17-5W	From confluence with Prairie Creek near Grand Mound to confluence with Porter Creek including Prairie Creek.
12.0325.00 Cloquallum Creek	1.9 36-18-6W	From mouth to head-waters.
12.0342.00 East Fk. Satsop R.	15.9 15-19-6W	From confluence with Dry Run Cr. to head-waters excluding Dry Run Cr.
12.0343.00 Decker Creek	0.3 31-19-6W	From mouth to head-waters.
12.0345.00 Middle Fk. Satsop R.	0.4 36-19-7W	From mouth to head-waters.
12.0350.00 Satsop River	2.3 36-18-7W	From mouth to confl. with Dry Run Cr. on East Fk. Satsop R.
12.0350.02 Chehalis R. below confl. w/Satsop R.	20.0 7-17-6W	From confluence with Porter Ck. to just below confl. with Satsop River.
12.0374.00 Wynoochee River	5.9 27-18-8W	From mouth to head-waters.

Control Station No. Stream Management Unit Name	Control Station by River Mile and Section, Township and Range	Affected Stream Reach Including Tributaries
12.0380.00 Wishkah River	16.2 22–19–9W	From influence of mean annual high tide at low base flow levels to headwaters. Excluding E. Fk. Wishkah River.
12.0382.90 E. Fk., Wishkah R.	0.9 36–19–9W	From mouth to headwaters.
12.0385.00 W. Fk. Hoquiam River	9.4 14–18–10W	From mouth to headwaters.
12.0385.80 Middle Fk. Hoquiam R.	1.6 4–18–10W	From mouth to headwaters.
12.0386.60 East Fork Hoquiam	7.1 8–18–9W	From mouth to headwaters.
12.0390.00 Humptulips River	24.8 17–20–10W	From influence of mean annual high tide at low base flow levels to headwaters.
12.0174.00 Elk River	3.0 3–16–11W	From influence of mean annual high tide at low base flow levels to headwaters.
12.0175.00 Johns River	6.0 21–16–10W	From influence of mean annual high tide at low base flow levels to headwaters.
12.0180.00 Newskah Creek	3.5 32–17–9W	From influence of mean annual high tide at low base flow levels to headwaters.
12.0185.00 Charley Creek	2.0 21–17–9W	From influence of mean annual high tide at low base flow levels to headwaters.

(2) Base flows established for the stream management units in WAC 173–522–020(1) are as follows:

BASE FLOWS IN THE CHEHALIS RIVER BASIN
(In Cubic Feet per Second)

Month	Day	12.0200.00 Chehalis R. nr. Elk Cr.	12.0205.00 Elk Cr.	12.0216.30 So. Fk. Chehalis R.	12.0235.00 Chehalis R.
Jan.	1	260	100	200	700
	15	260	100	200	700
Feb.	1	260	100	200	700
	15	260	100	200	700
Mar.	1	260	100	200	700
	15	260	100	200	700
Apr.	1	260	100	200	700
	15	260	100	200	700
May	1	195	76	145	525
	15	146	57	105	400
June	1	108	43	75	300
	15	82	32	55	230
July	1	62	25	40	175
	15	46	19	29	130
Aug.	1	37	16	21	98
	15	31	14	15	75
Sep.	1	31	14	15	75
	15	31	14	15	75
Oct.	1	39	15	21	92
	15	49	17	28	115
Nov.	1	88	31	56	215
	15	150	56	105	390
Dec.	1	260	100	200	700
	15	260	100	200	700

Month	Day	12.0240.00 Newaukum R. S. Fork	12.0245.00 Newaukum R. N. Fork	12.0250.00 Newaukum R.	12.0253.00 Salzer Cr.
Jan.	1	125	62	250	11
	15	125	62	250	11
Feb.	1	125	62	250	11
	15	125	62	250	11
Mar.	1	125	62	250	11
	15	125	62	250	11
Apr.	1	125	62	250	11
	15	125	62	250	11
May	1	110	47	210	5.8
	15	88	36	160	2.8
June	1	70	27	118	1.4
	15	56	21	90	.73
July	1	45	16	68	.38
	15	36	12	52	.20
Aug.	1	29	9	38	.10
	15	27	7	35	.05
Sep.	1	27	7	35	.05
	15	27	7	35	.05
Oct.	1	33	8.4	43	.14
	15	40	10	54	.40
Nov.	1	58	19	91	1.35
	15	85	34	150	3.9
Dec.	1	125	62	250	11
	15	125	62	250	11

Month	Day	12.0264.00 Skookumchuck River	12.0275.00 Chehalis R. at Grand M.	12.0292.00 Black R.	12.0305.00 Cedar Cr.
Jan.	1	160	1300	200	90
	15	160	1300	200	90
Feb.	1	160	1300	200	90
	15	160	1300	200	90
Mar.	1	160	1300	200	90
	15	160	1300	200	90
Apr.	1	160	1300	200	90
	15	160	1300	200	90
May	1	160	1000	170	70
	15	130	780	145	54
June	1	103	600	120	40
	15	83	460	104	31
July	1	67	355	88	24
	15	54	275	75	19
Aug.	1	43	210	70	14
	15	35	165	66	11
Sep.	1	35	165	66	11
	15	35	165	66	11
Oct.	1	35	200	68	13.8
	15	35	250	70	17
Nov.	1	59	440	100	30
	15	96	760	140	52
Dec.	1	160	1300	200	90
	15	160	1300	200	90

Month	Day	12.0309.00 Porter Cr.	12.0310.00 Chehalis R. at Porter	12.0325.00 Cloquallum Creek	12.0342.00 Satsop R. E. Fork
Jan.	1	90	2500	150	280
	15	90	2500	150	280
Feb.	1	90	2500	150	280
	15	90	2500	150	280
Mar.	1	90	2500	150	280
	15	90	2500	150	280
Apr.	1	90	2500	150	280
	15	90	2500	150	280
May	1	56	1900	118	240
	15	35	1420	92	210
June	1	29	1060	70	175
	15	24	800	55	152
July	1	21	610	43	130
	15	17	460	34	112
Aug.	1	14.2	340	29	104
	15	12	260	24	95
Sep.	1	12	260	24	86
	15	12	260	24	80
Oct.	1	13.3	320	27	80
	15	15	400	30	80
Nov.	1	28	760	52	125
	15	50	1380	88	185
Dec.	1	90	2500	150	280
	15	90	2500	150	280

Month	Day	12.0343.00 Decker Cr.	12.0345.00 Satsop R. M. Fork	12.0350.00 Satsop R. nr.	12.0350.02 Chehalis R. Satsop
Jan.	1	130	260	1100	3800
	15	130	260	1100	3800
Feb.	1	130	260	1100	3800
	15	130	260	1100	3800
Mar.	1	130	260	1100	3800
	15	130	260	1100	3800
Apr.	1	130	260	1100	3800
	15	130	260	1100	3800
May	1	115	203	910	2910
	15	103	160	750	2300
June	1	91	125	600	1750
	15	81	98	500	1360
July	1	72	78	425	1085
	15	64	61	360	860
Aug.	1	56	48	300	680
	15	50	38	260	550
Sep.	1	50	38	260	550
	15	50	38	260	550
Oct.	1	54	41	280	640
	15	58	45	300	750
Nov.	1	77	83	475	1305
	15	100	145	720	2220
Dec.	1	130	260	1100	3800
	15	130	260	1100	3800

Month	Day	12-0374.00 Wynoochee River	12-0380.00 Wishkah R.	12-0382.90 Wishkah R. E. Fk.	12-0385.00 Hoquiam R. W. Fk.
Jan.	1	560	135	33	32
	15	560	135	33	32
Feb.	1	560	135	33	32
	15	560	135	33	32
Mar.	1	560	135	33	32
	15	560	135	33	32
Apr.	1	560	135	33	32
	15	560	135	33	32
May	1	560	135	33	32
	15	560	113	27	26
June	1	450	95	21	20
	15	360	80	17	16

Month	Day	12-0374.00 Wynoochee River	12-0380.00 Wishkah R.	12-0382.90 Wishkah R. E. Fk.	12-0385.00 Hoquiam R. W. Fk.
July	1	290	68	14	12.8
	15	230	57	11.3	10
Aug.	1	185	47	9	8
	15	150	47	9	8
Sep.	1	150	47	9	8
	15	150	47	9	8
Oct.	1	150	53	10.4	9.4
	15	230	60	12	11
Nov.	1	360	91	20	19
	15	560	135	33	32
Dec.	1	560	135	33	32
	15	560	135	33	32

Month	Day	12-0385.80 Hoquiam R. M. Fk.	12-0386.60 Hoquiam R. E. Fk.	12-0390.00 Humptulips River	12-0174.00 Elk River
Jan.	1	27	44	600	50
	15	27	44	600	50
Feb.	1	27	44	600	50
	15	27	44	600	50
Mar.	1	27	44	600	50
	15	27	44	600	50
Apr.	1	27	44	600	50
	15	27	44	600	50
May	1	27	44	600	43
	15	21	38	500	37
June	1	16	33	400	31
	15	12.2	29	325	26
July	1	9.5	25	265	22
	15	7.4	22	215	19
Aug.	1	5.6	19	170	16
	15	5.6	19	170	16
Sep.	1	5.6	19	170	16
	15	5.6	19	170	16
Oct.	1	6.7	19	205	20
	15	8.0	25	250	25
Nov.	1	15	34	390	32
	15	27	44	600	40
Dec.	1	27	44	600	50
	15	27	44	600	50

Month	Day	12-0175.00 Johns River	12-0180.00 Newskah Creek	12-0185.00 Charley Creek
Jan.	1	70	17	14
	15	70	17	14
Feb.	1	70	17	14
	15	70	17	14
Mar.	1	70	17	14
	15	70	17	14
Apr.	1	70	17	14
	15	50	17	14
May	1	50	13.4	11
	15	42	10.7	8.6
June	1	35	8.3	6.7
	15	29	6.5	5.4
July	1	24	5.2	4.2
	15	21	4.1	3.3
Aug.	1	17	3.2	2.5
	15	17	2.5	2
Sep.	1	17	2.5	2
	15	17	2.5	2
Oct.	1	17	3.2	2.6
	15	24	4	3.5
Nov.	1	35	8.4	7.1
	15	49	17	14
Dec.	1	70	17	14
	15	70	17	14

(3) Base flow hydrographs, Appendix 1, pages 19-23 in the document entitled "Water Resources Management Program in the Chehalis River Basin" dated November, 1975 shall be used for definition of base flows on those days not specifically identified in WAC 173-522-020(2).

(4) All rights hereafter established shall be expressly subject to the base flows established in WAC 173-522-020(1) through WAC 173-522-020(3).

(5) At such time as the Departments of Fisheries and/or Game provide specific information substantiating the need for flows higher than the flows set forth in WAC 173-522-020(2), the Department of Ecology agrees to proceed with setting minimum flows as provided under chapter 90.22 RCW within one year from the time of said request, unless agreement to another time frame is reached between parties. [Order 75-31, § 173-522-020, filed 3/10/76.]

WAC 173-522-030 **Future allocation of surface water for beneficial uses.** The department has determined that there are public waters available, subject to base flow, for allocation to beneficial uses from all streams within the Chehalis Basin; except for those streams and times declared closed in WAC 173-522-050. The department shall maintain a current tabulation of the amount of water that is available for appropriation at each stream management unit specified under WAC 173-522-020(1). [Order 75-31, § 173-522-030, filed 3/10/76.]

WAC 173-522-040 **Priority of future rights during times of water shortage.** (1) Rights established in the future pertaining to waters available for allocation in WAC 173-522-030 shall be subject to a priority of use. Rights for domestic use, including irrigation of lawn and noncommercial garden not to exceed one-half acre, and livestock use excluding feedlot operation, shall be superior to all other consumptive and nonconsumptive uses.

(2) As between rights established in the future within a priority of use, the date of priority shall control with an earlier-dated right being superior to those rights with later dates.

(3) Additional water use priorities may be promulgated, when required, in the future. [Order 75-31, § 173-522-040, filed 3/10/76.]

WAC 173-522-050 **Streams closed to further consumptive appropriations.** The department, having determined there are no waters available for further appropriation through the establishment of rights to use water consumptively, closes the following streams to further consumptive appropriation. An exception is made for domestic and normal stockwatering where there is no alternative source of water supply.

Surface Water Closures

STREAM	DATE OF CLOSURE	PERIOD OF CLOSURE
Beaver Creek, Tributary to S. Fk., Newaukum River	12-5-52	1 May-31 Oct.
Beaver Creek, Tributary to Black River	10-28-52	" "
Bunker Creek	1-17-50	" "
Dempsey Creek	11-15-74	" "
Dillenbaugh Creek	8-21-72	" "
Hanaford Creek	5-7-52	" "
Hope Creek & Garrard Creek	8-28-73	" "
Kearney Creek	10-27-52	" "
Lincoln Creek	11-5-48	" "
Middle Fork, Newaukum R.	4-7-50	" "
Mill Creek	3-21-52	" "
Mox Chehalis	4-25-57	" "
Salmon Creek	12-18-56	" "
Rock Creek	4-11-73	" "
Scatter Creek	7-20-50	" "
Stearns Creek	4-28-53	" "
Wildcat Creek	10-28-52	" "
Williams Creek	5-6-52	" "
Wynoochee River	3-9-62	" "
Black River	Date of Adoption	1 July-30 Sept.
Skookumchuck River	" "	" "
S. Fk. Chehalis River	" "	" "
Salzer Creek	" "	1 June-30 Sept.

NOTE: Affected reach is from mouth to headwaters and includes all tributaries in the contributing drainage area unless specifically excluded.

[Order 75-31, § 173-522-050, filed 3/10/76.]

WAC 173-522-060 **Effect on prior rights.** Nothing in this chapter shall be construed to lessen, enlarge, or modify the existing rights acquired by appropriation or otherwise. [Order 75-31, § 173-522-060, filed 3/10/76.]

Appendix B. Chapter 75.20 RCW, Construction Projects in State Waters.

Chapter 75.20 RCW
CONSTRUCTION PROJECTS IN STATE WATERS

Sections

RCW 75.20.040 Fish guards required on diversion devices——Penalties, remedies for failure. A diversion device used for conducting water from a lake, river, or stream for any purpose shall be equipped with a fish guard approved by the director to prevent the passage of fish into the diversion device. The fish guard shall be maintained at all times when water is taken into the diversion device. The fish guards shall be installed at places and times prescribed by the director upon thirty days' notice to the owner of the diversion device. It is unlawful for the owner of a diversion device to fail to comply with this section.

Each day the diversion device is not equipped with an approved fish guard is a separate offense. If within thirty days after notice to equip a diversion device the owner fails to do so, the director may take possession of the diversion device and close the device until it is properly equipped. Expenses incurred by the department constitute the value of a lien upon the diversion device and upon the real and personal property of the owner. Notice of the lien shall be filed and recorded in the office of the county auditor of the county in which the action is taken. [1983 1st ex.s. c 46 § 70; 1955 c 12 § 75.20.040. Prior: 1949 c 112 § 45; Rem. Supp. 1949 § 5780–319.]

RCW 75.20.050 Review of permit applications to divert or store water——Water flow policy. It is the policy of this state that a flow of water sufficient to support game fish and food fish populations be maintained at all times in the streams of this state.

The director of ecology shall give the director of fisheries and the director of wildlife notice of each application for a permit to divert or store water. The director of fisheries and director of wildlife have thirty days after receiving the notice to state their objections to the application. The permit shall not be issued until the thirty–day period has elapsed.

The director of ecology may refuse to issue a permit if, in the opinion of the director of fisheries or director of wildlife, issuing the permit might result in lowering the flow of water in a stream below the flow necessary to adequately support food fish and game fish populations in the stream.

The provisions of this section shall in no way affect existing water rights. [1988 c 36 § 32; 1986 c 173 § 7; 1983 1st ex.s. c 46 § 71; 1955 c 12 § 75.20.050. Prior: 1949 c 112 § 46; Rem. Supp. 1949 § 5780–320.]

RCW 75.20.060 Fishways required in dams, obstructions——Penalties, remedies for failure. A dam or other obstruction across or in a stream shall be provided with a durable and efficient fishway approved by the director. Plans and specifications shall be provided to the department prior to the director's approval. The fishway shall be maintained in an effective condition and continuously supplied with sufficient water to freely pass fish. It is unlawful for the owner, manager, agent, or person in charge of the dam or obstruction to fail to comply with this section.

If a person fails to construct and maintain a fishway or to remove the dam or obstruction in a manner satisfactory to the director, then within thirty days after written notice to comply has been served upon the owner, his agent, or the person in charge, the director may construct a fishway or remove the dam or obstruction. Expenses incurred by the department constitute the value of a lien upon the dam and upon the personal property of the person owning the dam. Notice of the lien shall be filed and recorded in the office of the county auditor of the county in which the dam or obstruction is situated. The lien may be foreclosed in an action brought in the name of the state.

If, within thirty days after notice to construct a fishway or remove a dam or obstruction, the owner, his agent, or the person in charge fails to do so, the dam or obstruction is a public nuisance and the director may take possession of the dam or obstruction and destroy it. No liability shall attach for the destruction. [1983 1st

APPENDIX C. PERCENTAGE OF WATER RIGHTS USING 90% OF THE WATER VOLUME

Of the 867 ground-water rights in WRIA 23, the largest 419, or about 50%, account for 90% of the registered (not actual) water use (Figure 27). The 419th largest water right was issued for 84 gpm, or about 0.19 cfs.

Of the 958 surface-water rights in WRIA 23, the largest 298 rights, or about 30% of the total number, account for 90% of the registered water use (Figure 27). The 298nd largest water right was issued for 0.3 cfs.

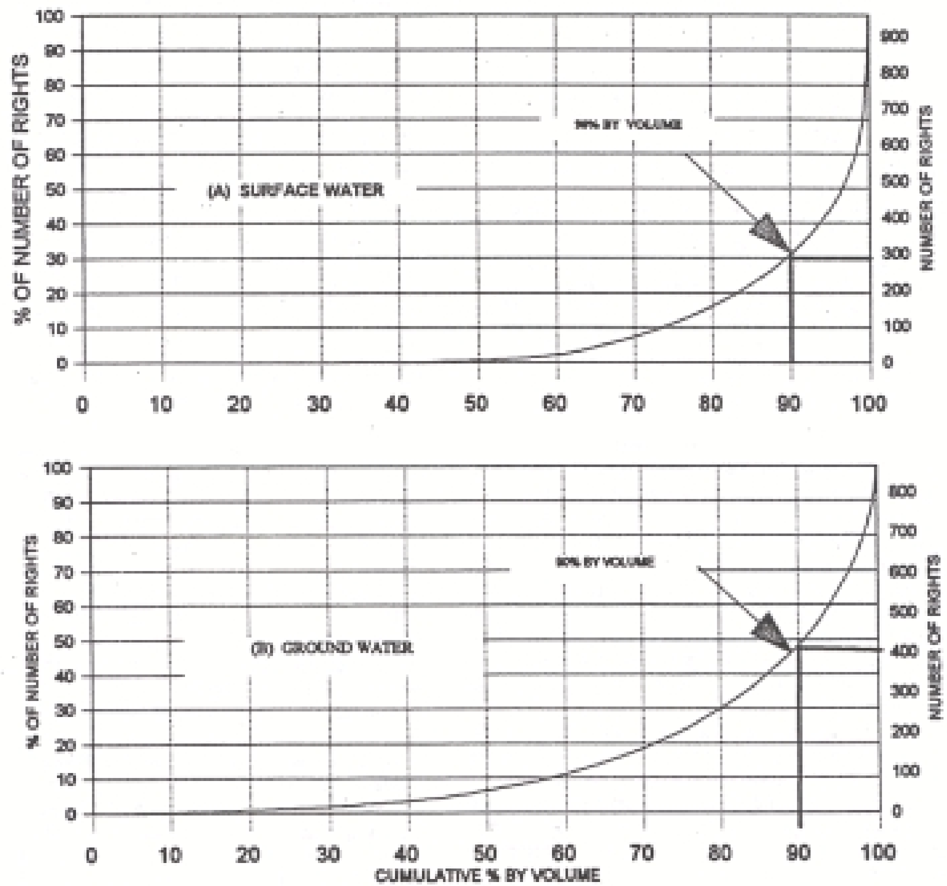


FIGURE 28. CUMULATIVE WATER VOLUME ASSIGNED TO WATER RIGHTS (ARRANGED LARGEST TO SMALLEST) VERSUS THE CUMULATIVE NUMBER OF WATER RIGHTS.