State of Washington Department of Ecology

WATER RESOURCES INFORMATION SYSTEM

WASHINGTON STATE WATER PROGRAM

BACKGROUND INFORMATION FOR WATER RESOURCES MANAGEMENT PLANNING IN THE WESTERN AND SOUTHERN PUGET SOUND BASINS

by

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PREFACE

The purpose of this technical memorandum is to make available the results of an initial, reconnaissance grade study of the water resources of the Western and Southern Puget Sound Basins, from the viewpoint of water resources management. The report is not intended to be all inclusive and more detailed studies will be made as they are found to be approprate.

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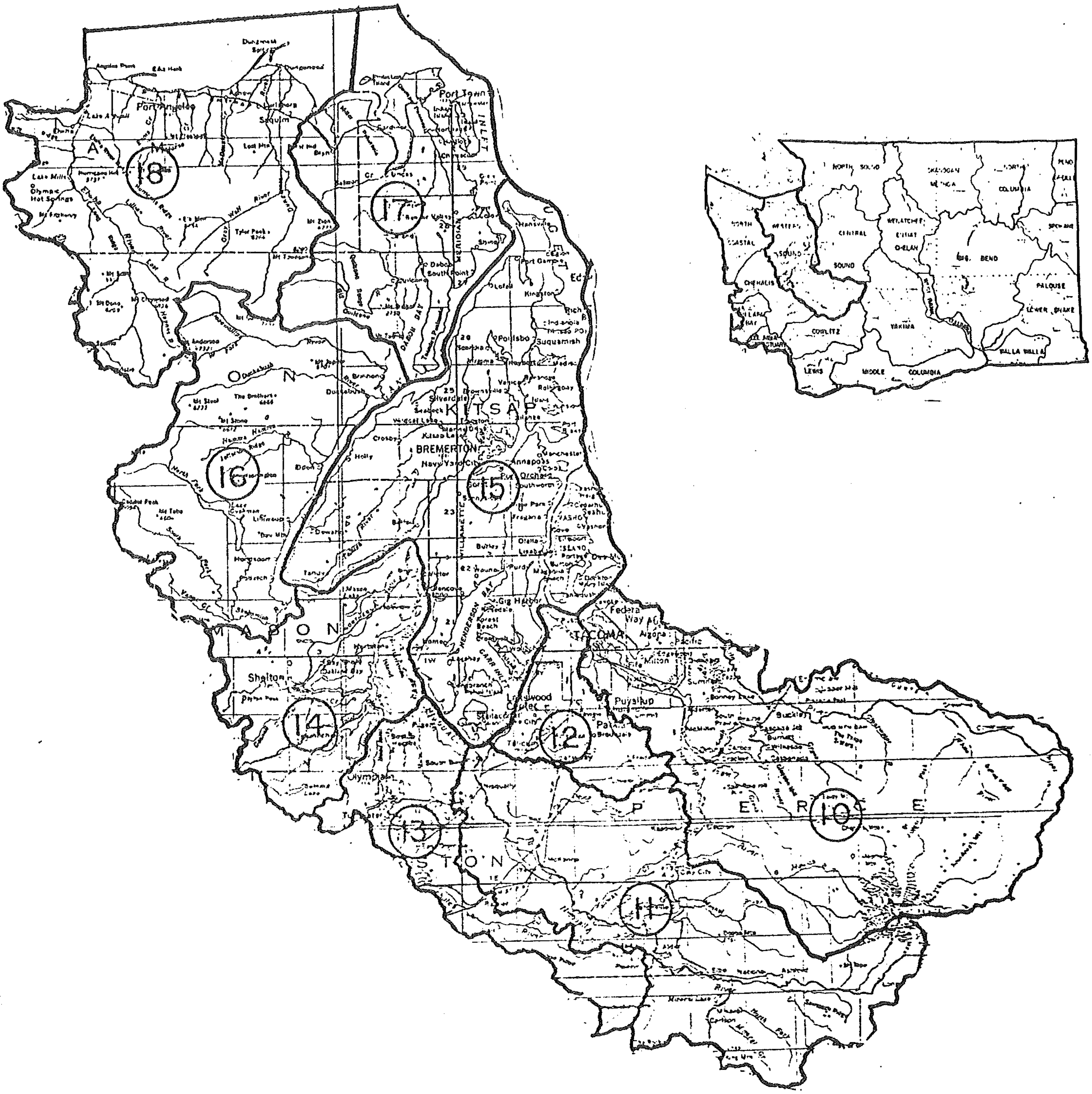
INTRODUCTION

The Western and Southern Puget Sound Basins are the watersheds with rivers and streams which discharge into the southern and western reaches of Puget Sound and Hood Canal, and the Strait of Juan de Fuca east of the Port Angeles area. The Basins swing around the Sound from the Puyallup to the Elwah. The location of the Basins is shown on the following map along with the Basin names.

The purpose of this Technical Bulletin is to present the results of initial studies on the water resources of the Southern and Western Puget Sound area which is oriented toward management planning. The bulletin is organized in such a way that a brief discussion on each basin is presented, followed by Parts I through V, which present information on specific aspects of water resources in the basin. Part I is a reconnaissance report on the availability of surface water for appropriation in the basin. The analysis has been made using rather gross analytical assumptions for the purpose of determining areas where a more detailed study is required. Part II is a brief review of the available information on the ground water in the basins. Part III is a review of flood damage problems in the basin; and, Part IV is an inventory of potential reservoir sites in the basins. The purpose of the inventory to to make it possible to have some idea of the range of alternative sites for reservoirs <u>if</u> reservoirs are required or desired in order to satisfy demanded uses of the water resources. Part V is an initial study of the water supply problem in the Kitsap Peninsula. Part VI is a preliminary report on the status of potential projects in the Basins.



SOUTH AND WESTERN PUGET SOUND

WRIA	Basin Name
10	Puyallup-White
11	Nisqually
12	Chambers-Clover
13	Deschutes
14	Kennedy-Goldsborough
15	Kitsap
16	Skokomish-Dosewallips
17	Quilcene-Snow
18	Elwha-Dungeness

THE BASINS

The following is a brief discussion of the water resources of each basin.

NORTH OLYMPIC PUGET SOUND BASINS

The North Olympic Puget Sound Basins are located in western Washington on the northeastern part of the Olympic Peninsula. The Basin covers a total area of 1,080 square miles, and includes eastern Clallam and northeastern Jefferson counties. It is bordered on two sides by waters of the Strait of Juan de Fuca, and Puget Sound. The western boundary is the western edge of the Elwha Basin. The southern border extends along the natural divide of the Olympic Mountains.

The North Olympic Puget Sound Basins are influenced greatly by the Olympic Mountains. These mountains are of relatively young geologic age, composed of interbedded sedimentary and volcanic rocks; and as such, are very rugged. The most obvious effect is the Olympic Rain Shadow. Weather fronts in this area move from west to east, originating in the North Pacific Ocean. When these fronts hit the western slope of the Olympic Mountains, orographic precipitation occurs, supplying a high rainfall to basins draining to the west. As these fronts eventually reach the eastern regions, a rain shadow effect is created, thus causing the release of only small amounts of moisture. Evidence of this fact may be seen by comparing the rainfall records in the towns of Forks (in the North Olympic Coastal Basin) and Sequim. Although these two towns are only 60 linear miles apart, records show an annual difference in precipitation of 100 inches.

The North Olympic Puget Sound Basins have been divided into major subbasins, termed Water Resource Inventory Areas 17 and 18. The mean annual runoff for each basin is:

Subbasin	Mean Annual Runoff (cfs)	Drainage Area (sq mi)
WRIA 17: Quilcene - Snow		
Big Quilcene River	214	73
Little Quilcene River	54	37
Other Streams	190	172
Total	458	382
WRIA 18: Elwha - Dungeness		
Dungeness River	380	203
Elwha River	1,510	319
Other Streams	462	176
Total	2,352	698

The total mean annual runoff for the North Olympic Puget Sound Basins is 2,810 cfs for a basin area of 1,080 square miles.

Comsumptive water right diversions for the North Olympic Puget Sound Basins in 1970 was:

WRIA 17: Quilcene - Snow	
Surface water	66 cfs
Ground water	11 cfs
Total	77 cfs
WRIA 18: Elwha - Dungeness	
Surface water	712 cfs
Ground water	32 cfs
Total	744 cfs

The total water right diversions for the Basin would be 778 cfs from surface water and 43 cfs from ground water.

The actual diversions are probably signficantly less. The waters of the Dungeness River and other nearby streams are fully appropriated. The amount of appropriated rights for irrigation from the Dungeness River (576 cfs) are already larger than the annual mean flow (380 cfs); hence, it has been closed to further appropriation. The potentially large domestic municipal supplies from the Little Quilcene River in WRIA 17 have caused that stream to be closed. Other streams in the Basin receive relatively little water use.

The amount of land irrigated in the North Olympic Puget Sound Basins was:

WRIA 17:	Quilcene - Snow	1,700 acres
WRIA 18:	Elwha - Dungeness	34,000 acres
	Basin Total (acres)	35,700 acres

Potential irrigated land in the Basins is:

Class 1:	2,400 acres
Class 2:	61,500 acres
Class 3:	148,500 acres
Total:	212,400 acres

Most of the small flooding in the North Olympic Coastal Basin occurs between December and May, usually because of snowmelt and heavy rainfall. Flood water damages are not great in the Basins, mostly affecting roads, agricultrual land, crops, and small dwellings within a few miles of the ocean. The Dungeness Basin sustained $48,000 in damages in the 1949 flood. Two privately owned reservoirs on the Elwha

River, Lake Mills and Lake Aldwell, are primarily used for power production, but do provide some flood control when needed. There is a safety problem with the two Elwha dams.

The existing water quality of the streams in the North Olympic Coastal Basin is generally excellent. In local areas, there are possible problems with irrigation return flow and poor logging practices.

In most cases, ground water quality is ideal. The exceptions are high iron content in local areas and contamination from septic tanks in the towns of Forks and Neah Bay where a high-water table exists.

The areas of considerable instream use are for fisheries production and for production of recreation values.

All major rivers and some smaller streams in the North Olympic Coastal Basin provide a suitable spawning and rearing habitat for fish.

There is an extremely high present and potential recreation use in the Olympic National Park and Forest and the streams and shorelines of the Basin.

WEST SOUND BASINS

The West Sound Basins, Water Resource Inventory Areas 14, 15, and 16, occupy 1,640 square miles of land and inland water. Mean annual runoff varies from 160 inches in the headwaters of the Olympic streams, to 25 inches in the lowland areas of the Kitsap Peninsula. The mean annual runoff from the various basins are:

Basin and Stream	Mean Annual Runoff (cfs)	Drainage Area (sq mi)
WRIA 14: Kennedy - Goldsborough		
Goldsborough Creek	155	55
Kennedy Creek	55	21
All other streams	520	236
WRIA 15: Kitsap		
Union River	75	25
Tahuya River	135	47
All other streams	1,300	596
WRIA 16: Skokomish - Dosewallips		
Duckabush River	470	77
Dosewallips River	610	120
Hamma Hamma River	560	85
Skokomish River	1,245	240
All other streams	725	138
Total for West Sound Basins	5,850	1,640

The water right use within the basins in 1966, excluding those for power and fish propagation are as follows:

Basin	Ground Water (cfs)	Surface Water (cfs)
WRIA 14: Kennedy - Goldsborough	61	91
WRIA 15: Kitsap	60	94
WRIA 16: Skokomish - Dosewallips	3	17
TOTAL	124	202

The surface water rights for the Skokomish - Dosewallips does not include three water rights totaling 300 cfs on the Dosewallips, Hamma Hamma, and Duckabush Rivers as a water supply for Bremerton. They are not presently being used.

Because of a natural water shortage caused by topographic and climatic conditions, and high population density in the Kitsap Peninsula, most current water supplies have reached their limit in this basin. Due to critical low flows, 14 streams have been closed to consumptive diversion, and 19 streams have low flow restrictions on them. Ground-water supplies are not abundant.

In 1970, a total of only 7,200 acres were irrigated in the West Sound Basins, and most of them were in the Kitsap Peninsula. According to the Columbia-North Pacific Study, the potentially irrigable acreage of Class 1, 2, and 3 Lands in the Basin was determined to be less than 5,000 acres.

Flood damages in the Basin are relatively minor. Mot damages occur on the Skokomish River agricultural lands where average annual damages are estimated at $27,000. Tacoma City Light has constructed two dams on the North Fork of the Skokomish River and operates two hydroelectric plants. The combined storage capacity of the reservoirs is 368,000 acre feet. The Cushman Dam has partially regulated flood flows on the North Fork since 1926.

Water quality in the West Sound Basin is generally good, but there are exceptions. Ground-water quality problems are confined primarily to isolated incidences of high iron concentration and saltwater intrusion to aquifers. There is virtually no waste discharge into rivers and streams, but in some populated areas there is a problem of septic tank seepage.

Fish resources and recreational use of the Basins are tremendous. The Olympic Mountains and Peninsula part of the West Sound Basin retain extremely high instream values, and saltwater recreation demand ranks as one of the highest in the State. The future of the West Sound Basins is tied firmly to recreation and fisheries.

NISQUALLY-DESCHUTES BASIN

The Nisqually-Deschutes Basin has an area of 1,025 square miles with a total runoff of 2,690 cfs. The population in the Basin was approxmately 75,000 in 1970 - 42,000 (56 percent) in the cities of Lacey, Olympia, and Tumwater. The Basins are primarily rural. The land use in 1966 was:

Land Use	Nisqually Basin (acres)	Deschutes Basin (acres)	Total Basin (acres)	Percent
Forest	379,700	127,100	506,800	80.0
Rangelend	34,000	9,500	43,500	6.8
Cropland	29,200	16,300	45,500	7.1
Rural nonfarm	6,400	13,500	19,900	3.1
Intensive	5,500	14,400	19,900	3.0
Total	455,800	180,800	635,500	100.0

The runoff from the various streams of the Basin is:

Stream	Drainage Area (acres)	Mean Annual Discharge (cfs)
Nisqually	716	2,090
Deschutes	160	410
Woodland Creek	24	30
Other	125	160

The distribution of the flows through the year is considerably different in the Nisqually as compared to the Deschutes as the Table of the percent of annual for each month given below shows:

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Nisqually	5.6	9.8	13.4	14.2	11.9	5.4	7.6	7.2	7.9	5.5	4.4	6.9
Deschutes	3.9	9.0	13.8	18.0	17.2	11.0	9.7	6.1	3.9	2.8	2.3	2.2

The Nisqually watershed includes mountainous terrain, and a portion of Mt. Rainier with permanent snow fields and glaciers. In contrast, the Deschutes drains a lowland area with rolling hills, and is totally fed by direct runoff and ground water. The annual low seven-day mean flows are:

Stream	Mean Annual	1 in 5-year	1 in 10-year
Nisqually near McKenna	540	445	405
Deschutes near Olympia	96	85	80
Woodland Creek	12.5	9.9	8.8

Two reservoirs are located in the Nisqually - Alder Lake with an active capacity of 180,000 acre-feet, and LaGrande Reservoir with an active capacity of 1,600 acre-feet. These two reservoirs are used as power reservoirs by Tacoma City Light. The National Park Service had a small hydroelectric plant on the Paradise River, and the City of Centralia diverts water from the Nisqually River about 7 miles upstream of McKenna, and discharges through a power plant about 7 miles downstream. The 7-day, 10-year flow of the River reach bypassed by the canal is 42 cfs compared to 405 cfs upstream of the diversion.

Ground water is an important resource in the lowland areas of the Basin. The important lowland aquifers are coarse Quaternary deposits, which are rather continuous over about 570 square miles. The lowland aquifers may recieve about 200,000 acre-feet (280 cfs) of recharge in an average year. Ground water in the mountains is found in valley fill materials and extensive aquifers are not found, although the production is locally important.

In 1966, the water rights, in cfs, were:

	Nisqually		Deschutes	
Use	Ground	Surface	Ground	Surface
Municipal	3.21	25.00	14.87	10.00
Irrigation	37.97	32.13	30.05	35.86
Domestic	22.36	14.31	30.43	4.53
Industrial and Commercial	5.86	236.32	16.59	12.13
Fish Propagation	0.61	13.16	-----	11.32
Stock	5.69	1.76	2.43	0.37
Hydroelectric Power	----	5,633.70	-----	-----
Total	54.73	5,922.85	77.78	78.38

Total water rights are for 6,134 cfs including power. Without power, the total rights are for 500 cfs. Ground water rights are for 132.5 cfs.

The flood plan of the Deschutes River is about 2,700 acres, and contains 1,200 acres of cultivated agricutlural land, urban, suburban, and industrial development; and transporation facilities that are subject to periodic winter and spring flooding.

Development in the lower flood plain incudes a suburban development at Tumwater, and part of the Olympia Brewery plant. Warehouses, water wells, a parking area, and a footbridge at the brewery are within the flood plan, and subject to flood damage. Most of the development in the City of Olympia is outside the flood plain.

The flood plain of the Nisqually River is 9,000 acres. The entire flood plain is subject to periodic spring and winter flooding; however, flood damage is sustained primarily by recreational developments upstream from Alder Reservoir, and agricultural developments in the fertile 3,000 acre delta.

The narrow flood plain, above Alder Reservoir, suffers frequent flooding. The steep gradient of the River results in high velocity flows that carry large quantities of gravel, logs, and other debris. Developments with Mount Rainer National Park, including the Park headquarters at Longmire, and Sunshine Park Campground near the Park entrance, are within the flood plan. From Mount Rainier National Park to Alder Reservoir the stream gradient is less severe. During high flows, heavy deposits of bedload and debris fill the channel, and force the river to spread over the valley floor.

The physical and chemical qualities of rivers, stream, lakes, and ground water in the Nisqually watershed are generally good because the area is sparsely populated. The Nisqually, above Alder Dam, is naturally turbid during the spring peak flow period caused by snowmelt, and the resultant washing down of silt and rock flour. This rock flour or glacial milk from the Upper Nisuqally River remains in suspension in Alder Lake and is discharged into the Lower Nisqually River reaches.

The limited water quality sampling data, taken to date, indicates that, at present, all waters within the basin normally meet the present criteria for thier classification.

The violations to the water quality are caused by occasional high coliform counts in the river and its tributaries which cannot be attributed to a known point source.

The widening of the River, and the resulting shallower depth in the delta area, causes the water temperature to exceed the allowable limit of 60°F. Deposits in the silt of the delta also cause the dissolved oxygen in the water to be less than 60 mg/l.

The occasional high coliform counts in the River may be attributed to numerous nonpoint sources, and may be further avoided by several remedial measures which can be addressed after the nonpoint sources have been identified.

Little water quality data exists for the Deschutes watershed. The existing data indicates that coliform counts are often above standards in the Lower Deschutes. Water quality of Budd Inlet is also very poor.

PUYALLUP BASIN

The Puyallup Basin has an area of 1,217 square miles of land and fresh water. The runoff from the Basin is 3,640 cfs. The various watersheds contribute water as shown below:

Watershed	Drainage Area	Mean Annual Discharge
Puyallup River	948	3,350
White River	470	1,700
Puyallup above White	438	1,600
Chambers Creek	104	110
Sequallitchen Creek	38	40
Other	127	140

A diversion dam on the White River was constructed in 1911 by Puget Sound Power and Light Company, and a flume constructed which has a maximum capacity of 2,000 cfs. The water is stored in Lake Tapps, and is used at Dieringer to generate power, and then returned to the White River. About 21 miles of the White are bypassed by the diversion. The average diversion is about 1,100 cfs. The minimum release at the dam is 30 cfs.

A diversion on the Puyallup River diverts an average of 400 cfs from the River which is then used to generate power at a power plant near Electron - 11 miles downstream. The average flow at the Puyallup, just upstream of the diversion, is 530 cfs. The diversion was constructed in 1904.

In 1942, a flood control reservoir was completed by the Corps of Engineers on the White River near Buckley. The capacity of the reservoir is 106,000 acre-feet. The reservoir is a single-purpose flood control reservoir, although a small amount of flow regulation is done in order for PP&L to divert a larger total volume of water to Lake Tapps.

Over 350,000 people live in the Puyallup Basin, most in the Chambers Creek area. Considerable heavy industry has located in the flood plain of the Puyallup in an area which is now protected by levees and upstream storage.

Ground water supplies are plentiful in much of the lowlands of the Puyallup Basin. The important aquifers in the lowlands occur in coarse quaternary sedimentary deposits which are nearly continuous over 420 square miles. Practically all recharge to the aquifers is by infiltration of precipitation. Aquifers in the lowlands of the Puyallup Basin may recieve an average of 130,000 acre-feet (180 cfs) of recharge annually.

Water rights in the Puyallup Basin, in cfs, are given below.

Use	Surface Water	Ground Water	Total
Municipal	725.45	183.67	909.12
Irrigation	55.59	56.43	112.02
Domestic	84.22	157.39	241.61
Industrial and Commercial	40.00	104.04	144.09
Fish Propagation	70.33	1.35	71.68
Stock	9.28	6.90	16.18
Hydro power	14.49	------	14.49
Recreation and Beautification	20.13	------	20.13
TOTAL	961.73	444.25	1,405.98

The total domestic water use may be higher than the domestic water rights because small domestic wells do not require a water right.

The water quality of the Basin varies considerably. The reach of the Puyallup River from the mouth to Kings Creek has occasional high coliform counts and excessive amount of toxic materials. The White River, from its mouth to Mud Mountain Dam, has excess coliform count and occasional high temperatures. The remainder of the streams in the Puyallup watershed meet the water quality standards.

In general, the streams of the Chambers Creek area do not meet State standards because of high coliform counts and high nutrient loads.

The quality of the waters of the lakes in the lowland portion of the Basin do not meet State standards and are rich in nutrients.

The quality of the ground water in the basin has historcially been of good quality in the lowland area of the Basin. In recent years, there is evidence that the ground waters beneath the unsewered areas of the Basin are being contaminated by domestic sewage.

WATER RESOURCES MANAGEMENT PROBLEMS

The major water resources managment problems in the Western and Southern Puget Sound area are:

1. Water supply for the Kitsap Peninsula
2. Water management in the Dungeness Basin.
3. Water quality management in the Chambers-Clover area.

Information on the water management problems in each basin follows:

NORTH OLYMPIC PUGET SOUND BASIN

The major problem is the management of water resources of the Dungeness Basin. Except for this problem there are no major problem areas, although there are local water availability problems. Other considerations are flood damage reduction in coastal areas, preservation of instream values for critical streams, and maintenance of water quality for the Basin.

The Dungeness River is almost depeleted during low flows due to irrigation demands. Water rights for irrigation, adjudicated in 1924, have been over appropriated. The poor irrigation methods used by irrigators have caused excessive water losses, maldistribution of water, and deterioration of irrigation facilities. Most irrigation return flows empty directly into the ocean and are not returned to the River. For the entire North Olympic Puget Sound Basins, nine streams have been closed to further appropriation and nine streams have been restricted subject to low flows because of either overuse or low summer flows.

Ground water in the Basin has been of sufficient supply in the past and no real problems seem apparent. There is a lack of accurate ground water studies in these basins.

Even though minor flood damages do occur, the areas affected most are: Dungeness Valley, Port Angeles, and the Elwha Valley. Existing measures include two reservoirs on the Elwha River, minor levees on the Dungeness and Elwha River, and flood forecasting and warning system. No flood plain management measure to reduce flood damages have been adopted, and there are no proposed projects underway. No Flood Plain Information Reports have been published as yet.

The major water quality problem is to improve local areas to the point that they meet State and Federal standards, or cease to be a public health hazard. Ground water contamination is a problem in coastal communities with shallow water tables.

Instream values are extremely high in many rivers. There is a conflict between fish requirements and continued irrigation from the Dungeness River. The development of additional lands for irrigation may have a severe impact on fish and wildlife. The North Olympic Puget Sound Basins have one of the highest recreational values in the State.

WEST SOUND BASINS

The basic and most difficult problem encountered in the West Sound Basins is the completely out-of-phase occurrence of water supply to the demand, in the Kitsap Peninsula (WRIA 15). Both surface and ground-water supplies are limited, and because of increasing population density, it will be necessary to find additional supplies of good quality water. Additional storage facilities in the area could help to offset some of this imbalance by as much as 30 percent in some areas. It is known that generally ground-water yeilds are not high and aquifers are not extensive, but this resource will have to be explored.

Development of regional surface supplies for the entire Kitsap Peninsula is likely limited to Gold Creek (a tributary of Tahuya River), Huge Creek, and connection to Tacoma Water Department supplies. Presently, Bremerton's main suppliers, where permitted diversions have been reached, are Union River, Gorst Creek, and Anderson Creek. Also, a thorough study of ground-water availability would be useful.

One future supply source is the large streams draining the eastern slopes of the Olympic Mountains. The City of Bremerton owns water rights on the Duckabush and Hamma Hamma Rivers, totaling 250 cfs. One alternative is a storage project constructed on the Duckabush River upstream of the Falls near Little Hump Tributary. This project would provide approximately 160 MDG to the Bremerton system. Studies must be made to determine if such a project is feasible without being detrimental from an environmental and fisheries standpoint.

Water supplies on the Kitsap Peninsula are marginal. Most of the surface water resources have already been appropriated, and it is entirely possible that water within the available ground water aquifers would not be sufficient for either the 3.5 cfs requirements assoicated with the proposed development of the the Trident base (on Hood Canal) or the resulting increased development.

The main water quality problem is contamination of ground water, especially in the Kitsap Peninusla area. All industrial wastes and most municipal discharges are received by marine waters. Saltwater intrusion has occurred in some areas. During summer low flows, stagnant odor and high iron concentration become a problem in the Union River and other streams. In local areas there can be special septic tank problems.

Floods have been minor but damages do occur. The major flooding area is the Skokomish Valley agricultural area. Peak discharges are appreciably reduced by the Cushman Reservoirs and diversion of flow to the Tacoma City Light powerhouse at Potlatch. Flood Plain Management of the entire flood plains to control future development and prevent high flood damages should be implemented.

Instream values of water are high in the Dosewallips, Duckabush, Hamma Hamma, and Skokomish Rivers. Any large diversions would have a severe impact and water resource projects which would adversely affect the rivers should not be developed.

NISQUALLY-DESCHUTES BASINS

Water resources management problems in the Nisqually-Deschutes Basin are:

1. Conflect over the uses of the waters of the Deschutes River.
2. Conflicts over uses of the Delta of the Nisqually.
3. Potential for improved flood control operations of Alder Lake on the Nisqually.
4. The water quality of both the Nisqually and Deschutes.
5. Sedimentation in Capital Lake (Deschutes Basin).

The Deschutes River has one of the best runs of salmon in the lower Puget Sound area. The run is not a natural run because the River was blocked to salmon by Tumwater Falls until the fish passage facilities were constructed in the late 40's. Because the Deschutes is rain-fed, the summer low flows are quite low which is a likely limiting factor on salmon production. At the same time, the Deschutes could be a source of good quality water for other than instream uses. Consequently, there is a conflict over the uses of the waters of the Deschutes River.

The Delta of the Nisqually River is one of the last remaining delta-type land forms in the Puget Sound, remaining in a nonindustrial state. Over the last few years, there has been a conflict over whether the Delta should be industrial (part) or natural. This conflict appears to have been resolved in favor of remaining somewhat natural by land purchase of the U.S. Government.

Floods occur in the lower Nisqually River. These flood are reduced by the existing operations, and presence of the Alder and LaGrand Reservoirs which are for the purposes of power production. There is a potential for improved flood control operation, but at a cost of power production. The Corps of Engineers is presently reviewing flood control in the Nisqually Basin.

The waters of both the Nisqually and Deschutes often have coliform counts in excess of the state standards. In the Nisqually, below LeGrande Dam, the operations of Alder and LeGrand result in durations of turbid water in excess of the natural time. This is very detrimental for fisheries production.

Capitol Lake is a man-made Lake in the estuary of the Deschutes River which was created by a dam at the mouth of the River. Sediment being transported by the Deschutes River is now being deposited in the Lake instead of being transported out of the estuary. The result is that the Lake is filling with sediment.

PUYALLUP BASIN

The major water resources management problems in the Puyallup Basin are given below:

1. The power diversions from the Puyallup and White Rivers essentially deplete the River just below the point of diversion. In the case of the White River, the diversion capacity is greater than the mean annual discharge. Just above the Electron plant, mean annual flow is 530 cfs, and the average diversion 400 cfs. These diversions are a problem from the viewpoint of fish migration and rearing. The proposed minimum flow for the White River below the diversion is 180 to 190 cfs, with short periods of flows up to 500 cfs during the spawning season. There is no further water to appropriate out of the White River, nor out of the Puyallup River above the Electron Plant.

2. Annual flood damages of about $100,000 occur in the Puyallup Basin, mostly along the Puyallup River upstream of Sumner to two miles above Orting. Some local flooding occurs in other areas.

3. The water quality of the Puyallup River, below Kings Creek and in the White River below Mud Mountain Dam, is not adequate. The water quality of the surface waters of the Chambers Creek area (WRIA 12) is not adequate. The waters of Bonney Lake, Sunrise Lake, and Lake Tapps are also below standard.

4. The quality of the ground waters in the unsewered areas of the Chambers-Clover Creek area (WRIA 12) are not adequate.

The Puyallup Basin is not included in the remaining portion of this report. Analytical problems are more complex and incomplete at this point, but will be dealt with in other reports.

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Pacific Northwest River Basins Commission, *Columbia-North Pacific Region, Comprehensive Framework Study*, 1970.

PART I

RECONNAISSANCE REPORT

ON

SURFACE WATER AVAILABILITY

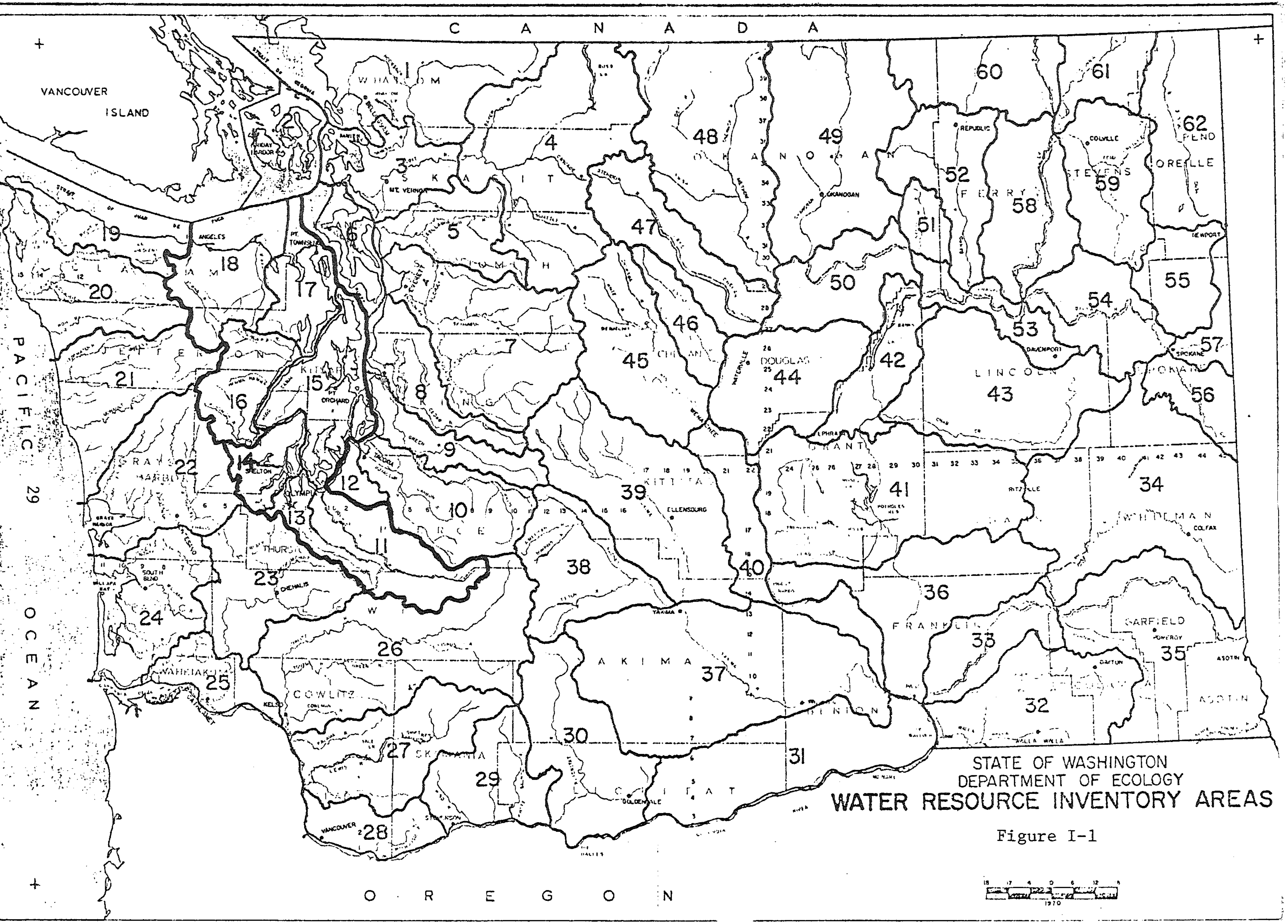
IN THE

WESTERN AND SOUTHERN PUGET SOUND BASINS

INTRODUCTION

The purpose of Part I is to present a general and overall look at surface water availability in the Western Sound Basins. This study area includes Water Resource Inventory Areas 11, 13, 14, 15, 16, 17, and 18. Procedures used are rough and approximate, but serve our purposes at this time. Problem areas in water availability are briefly looked at, but will be delt with more specifically in future reports.

The location of the study area is shown in figure I-1.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CHEHALIS
SOUTH BEND
ANGELES
PT. TOWNSEND
MT. VERNON
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Figure I-1

WATER USE

A compilation of water right records has shown that there is a total of 3,229 water rights in the form of applications, permits, and certificates for the Western Sound Basins. The total appropriaton of these water rights is 1,770.39 cubic feet per second. This figure is only the total paper water right allotment and not actually the amount being used. Actual consumptive use is discussed in the section on water availability.

Water right uses have been divided into three main categories; domestic, municipal-Industrial, and irrigation. Domestic includes all rights for individual or community domestic uses, garden or lawn irrigation, and stock. Municipal-industrial refers to all municipal public uses as well as commercial industrial requirements. Irrigation water rights comprise all consumptive irrigation uses including small single domestic uses that are included in the right. Because we are only concerned with consumptive water use, nonconsumptive or partially consumptive categories were not included in this report. This includes such uses as fish and wildlife propagation, power generation, fire protection, recreation, and beautification.

Water use tables for each basin section are given in the discussion for each section.

WATER AVAILABILITY

For each stream, the amount of water available each month is the 1 in 2 year flow minus the 1 in 10 year flow, less total depletions. To arrive at the actual consumptive use depleted from the stream, conversion factors have been applied to the paper water right uses. For domestic uses, 25 percent of the paper water rights were used. This was done because domestic use does not all accrue at the same time. For irrigation uses, ratios have been computed for each irrigation month in table I-1. In the following table, diversion is the amount of water used per acre per month. Approximately half of this amount is eventually returned to the stream. Of this total return flow, a 50 percent continuous return rate is assumed for each month. Depletion is the diversion less the return flow. The epletion-Diversion Ratio is then applied to the irrigation water right amount for each irrigation month.

TABLE I-1. Irrigation Use Factors for the Western Sound Basins

Diversion		Return Flow					Depletions	
		May	June	July	Aug	Sum	1. ft/ft^2	2. cfs/acre
May	0.04	0.01	-	-	-	0.01	0.03	0.0005
Jun	0.20	0.01	0.05	-	-	0.06	0.14	0.0024
Jul	0.78	-	0.03	0.20	-	0.23	0.55	0.0094
Aug	0.64	-	0.01	0.10	0.16	0.27	0.37	0.0063
Sep	0.00	-	0.01	0.05	0.08	0.14	-0.14	-
Oct		-	-	0.03	0.04	0.07	-0.07	-
Nov		-	-	0.01	0.02	0.03	-0.03	-
Dec		-	-	-	0.01	0.01	-0.01	-

Many streams had no diversions and were not included in the analysis. Some streams with small diversions had total computed depletions less than 0.5 cfs. These were rounded off to 0. See Water Availability tables for each basin section.

BASE FLOWS

For each stream having a control point, base flows were established for the purpose of regulation of water rights.

Because of variable flow and climatic conditions during the irrigation season, the importance of the biological system, and the overall availability of water, a multiperiod framework was proposed for base flows. The flows are based on flows under a natural flow regime. The time period and flow criteria for a nonglacial-fed stream are as follows:

Oct:	1 in 10 year October monthly mean flow.
Nov-Mar:	1 in 10 year November monthly mean flow.
Apr-Jul:	1 in 10 year July monthly mean flow.
Aug-Sep:	1 in 10 year, 7 day annual low flow.

During November through March, the hydrologic base flow is significantly lower than the monthly mean because of direct runoff from rain. Consequently, 1 in 10 year 7-day low flows for the period are the proposed base flows. The equation given above for the period November through March is an estimate of the 1 in 10 year, 7-day low flow, for November through March. These base flows are used strictly for regulation of stream flow and not for determining water availability.

See Water Availability tables for each basin section.

Following is a breakdown of water use and availability by each basin. The breakdown includes:

1. A map of the inventory area indicating locations of gaging stations. In order to obtain a constant reference for frequency analysis, all stations with a drainage area of at least 100 square miles were selected. In addition, a few minor stream stations which appeared to merit analysis were included.

2. A list of water right uses and irrigated acres for each stream. Since many streams in these areas are unnamed or contain few water rights, they have been grouped together by general location and treated as a system.

3. A table showing the monthly amount of water available and base flows, computed by methods described in the preceding sections.

Beginning on page 83, is a list of critical streams for each basin. These are streams that have been closed to further appropriation or have become subject to low flow regulations.

WATER RESOURCE INVENTORY AREA 18

Nearly all irrigation development in this basin has occurred on the Dungeness River alluvial plain. Rights to the use of waters of this river were adjudicated in 1924 in the amount of 579.56 cubic feet per second. Since then a few have been abandoned and others have been granted. Because the mean flow during the irrigation season is approximately equal to present irrigation diversion requirements, there could be little, if any, stream flow left in the river should the irrigators exercise their right and divert the full amount.

Water is supplied to most of the irrigated lands by diversion of natural flows of the Dungeness River through the facilities of nine organized irrigation groups and a number of individual operatiors. The open ditch distribution system of the many different groups have been developed over the years with little reference to an orderly plan of development. Farmers pump from ditches and apply water to their crops by wild flooding and sprinkler application. The result has been a duplication of facilities, excessive water losses, maldistribution of water, and the deterioration of many structures. Most of the return flow from irrigation in the Dungeness River alluvial plain flows directly into the ocean. With future irrigation development expected, it is obvious that serious problems exist in this area, and diversion restrictions will have to be imposed. A readjudication of water rights may be necessary. Already, six streams, including the Dungeness River, have been closed to further appropriation.

The major use of water from the Elwha River is for municipal and industrial uses, as there are only 138 irrigated acres in the valley. Other small creeks in the area supply Port Angeles, especially Morse Creek, which has been closed to further appropriation. The large industrial users are the pulp mills which have water rights totaling over 50 cubic feet per second. See table I-3 on Water Right use.

The many small streams between the Dungeness and Elwha valleys account for significant amounts of irrigation and domestic water use. Most of these have been closed to further appropriation or have become restricted because of low flows. Except for the Elwha River drainage system, this basin has become prone to water supply problems.

The 284 water rights in this basin total over 700 cfs in consumptive use. By far the largest category, irrigation accounts for 643 cfs, followed by commercial-lumber with 40 cfs, municipal with 24.8 cfs, and domestic with 4.16 cfs. Total irrigated acres, according to paper water rights, is 34,000.

TABLE I-2. Base Flows for WRIA 18

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Dungeness	12-0480	114	142	296	95
Elwha	12-0455	441	614	906	300

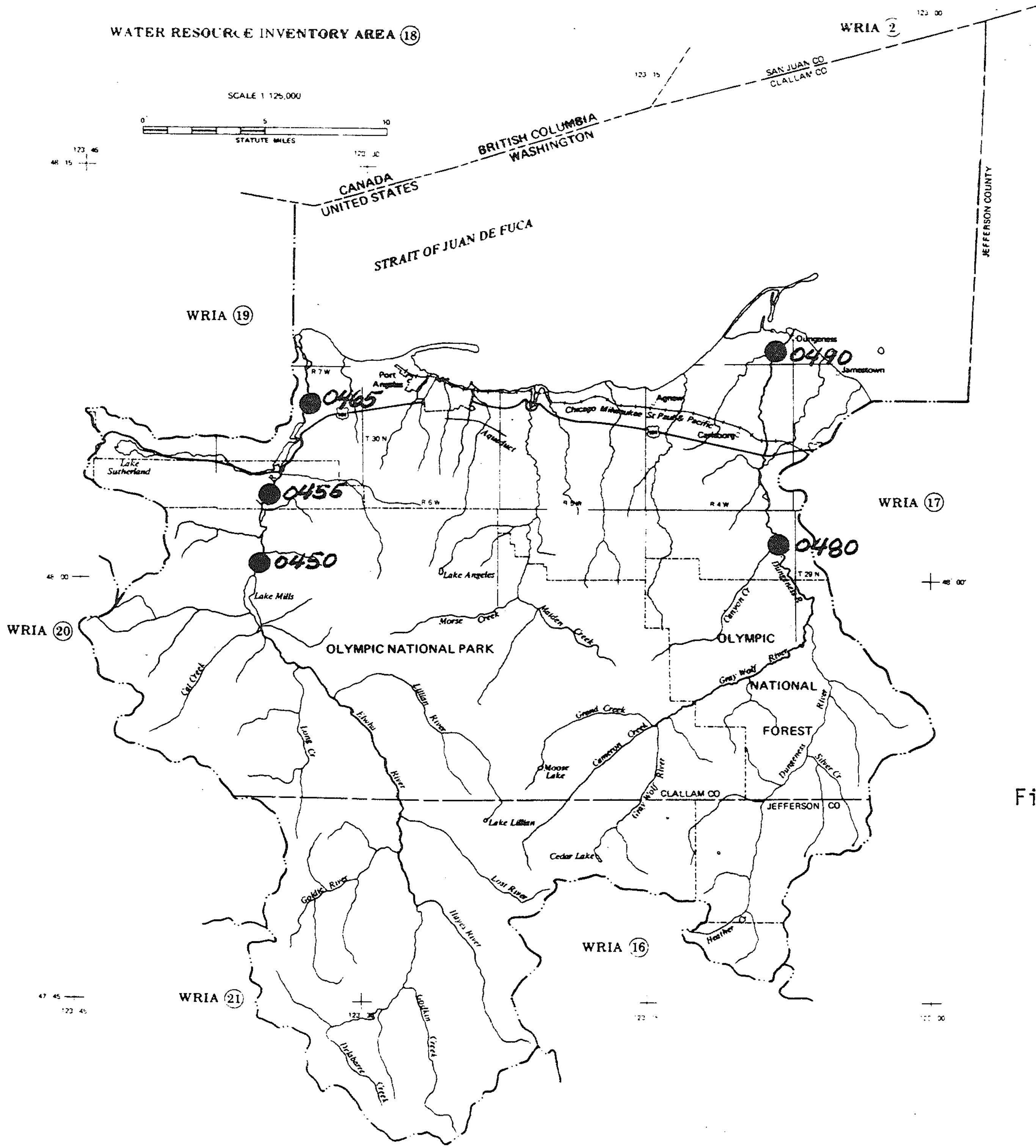

WATER RESOURCE INVENTORY AREA (18)
SCALE 1:125,000
STATUTE MILES
CANADA
UNITED STATES
BRITISH COLUMBIA
WASHINGTON
SAN JUAN CO
CLALLAM CO
JEFFERSON COUNTY
STRAIT OF JUAN DE FUCA
WRIA (2)
WRIA (19)
WRIA (17)
WRIA (20)
WRIA (16)
WRIA (21)
Dungeness
Jamestown
Port Angeles
Agnew
Carlsborg
Chicago Milwaukee St Paul & Pacific
Aqueduct
Lake Sutherland
Lake Mills
Lake Angeles
0490
0465
0456
0450
0480
OLYMPIC NATIONAL PARK
OLYMPIC
NATIONAL
FOREST
Morse Creek
Maiden Creek
Cat Creek
Long Cr
Elwha River
Lillian River
Grand Creek
Cameron Creek
Moose Lake
Lake Lillian
Cedar Lake
Gray Wolf River
Dungeness River
Canyon Cr
Silver Cr
Lost River
Hayes River
Goldie River
Godkin Creek
Buckinghorse Creek
Heather
CLALLAM CO
JEFFERSON CO

Figure I-2

Table I-3. Water Right Use in WRIA 18

Stream or Area	Number of Water Rights: Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Appropriated Quantity - cfs: Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Irr. Acres
Dungeness River	12	1	43	56	.17	1.40	595.30	596.87	29,925
Elwha River	55	1	19	75	3.22	20.00	2.09	25.31	138
Morse Creek	5	5	4	14	.05	23.00	1.90	24.95	190
Seibert Creek	1		4	5	.02		1.25	1.25	103
McDonald Creek	6		6	12	.07		6.20	6.27	450
Cassolary Creek			12	12			9.66	9.66	784
Gierin Cr. & Ditch			10	10			11.37	11.37	1,076
Bell, Lees, Bagley Creeks	15		22	37	.14		8.18	8.32	720
Valley, Dry, Meadow-brook Creeks	15	1	14	30	.18	.40	5.81	6.39	500
Tumwater Creek	13	1	10	24	.19	20.00	1.27	21.46	112
Minor Streams into Puget Sound	8	1	1	9	.12		.22	.34	22
TOTAL	130	9	145	284	4.16	64.80	643.25	712.21	34,020

TABLE I-4a. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Dungeness River.

U.S.G.S. Gage 12-0480 near Sequim.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
ean Discharge	226	329	416	384	388	259	324	589	716	494	261	173
ne in Two Year ischarge (Q_2)	203	285	378	342	339	247	314	568	680	466	248	167
ne in Ten Year ischarge (Q_{10})	114	142	213	181	173	166	227	397	447	296	165	118
$_2 - Q_{10}$	89	143	165	161	166	81	87	171	233	170	83	49
ater Use	1	1	1	1	1	1	1	24	107	418	281	1
ater Available	88	142	164	160	165	80	86	147	126	0	0	48

eriod of Record: 1923-30, 1937-70. Flows in cfs

emarks:

TABLE I-4b. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Elwha River.

U.S.G.S. Gage 12-0455 at McDonald Bridge.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	995	1629	2087	1863	1696	1225	1284	1953	2280	1550	844	611
One in Two Year Discharge (Q_2)	865	1376	1899	1699	1517	1148	1229	1889	2173	1453	802	583
One in Ten Year Discharge (Q_{10})	441	614	1077	961	812	724	834	1346	1444	906	532	396
$Q_2 - Q_{10}$	424	762	822	738	705	424	395	543	729	921	270	187
Water Use	6	6	6	6	6	6	6	6	6	7	7	6
Water Available	418	756	816	732	699	418	389	537	723	914	263	181

Period of Record: 1918-70. Flows in cfs

Remarks:

WATER RESOURCE INVENTORY AREA 17

Water supply in this basin is not extensive, but neither is the present use or future demand. Most of the water rights are for small domestic single or community water supplies. Most of these occur on minor or unnamed streams in the basin.

The largest diversions are for municipal or industrial uses for Port Townsend. These include a right on the Little Quilcene River for 9.56 cfs and a right on the Big Quilcene River for 30.0 cfs.

Although use is relatively small in the basin, the drainage areas and total volume of the streams are also small. Because the small amount of water in the streams are reduced even further by low flows, restrictions have been put on some streams to avoid overappropriation.

A total of 66.69 cfs has been appropriated for consumptive water right use in this basin. Here commercial-industrial uses are the highest, followed by municipal and community domestic. Irrigation rights total 14.61 cfs for irrigation of 1,733 acres. See table I-5.

The largest surface water sources are the Big and Little Quilcene Rivers. They also receive the largest use. The period of record for these rivers is very short. The record for the Big Quilcene is insufficient to use for analysis and there are problems with correlation. There is no low flow problem, however, and the large water right (26 cfs) is for the municipal-industrial uses of Port Townsend. The Little Quilcene has been closed because of high diversions. Mean flows are available but frequency analysis cannot be made at this time.

The 10-year 1- in 7-day low flows for Snow Creek, Chimacum Creek, and Jimmy Come Lately Creek is approximately 1.3 cfs; hence, they are closed or are regulated. All other streams have low flows less than that.

TABLE I-5. Base Flows for WRIA 17

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Little Quilcene	12-0520	-	-	-	7.3
Big Quilcene	12-0528	-	-	-	-

The period of record for streams in this basin are to short for analysis.

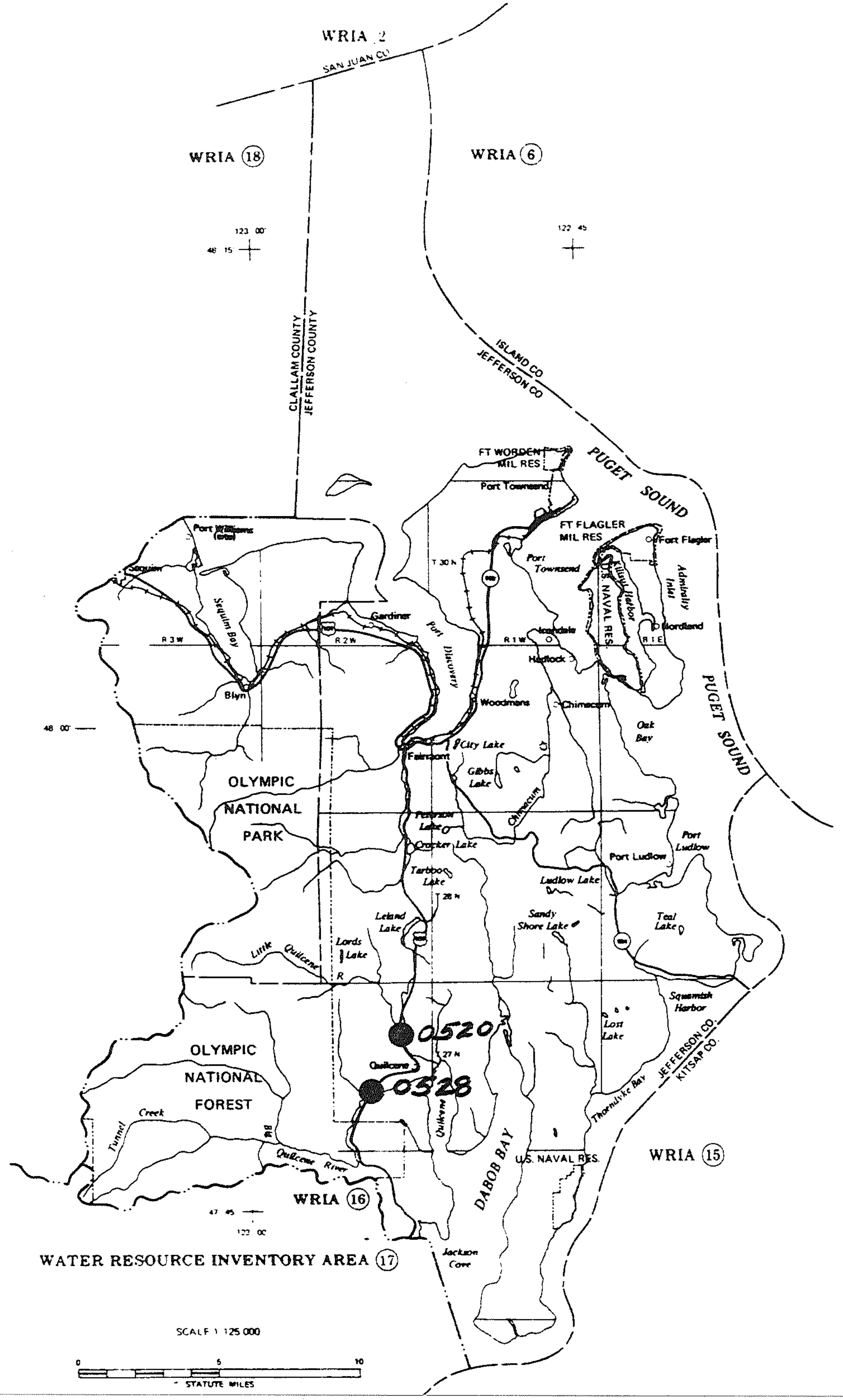

WRIA 2
SAN JUAN CO
WRIA 18
WRIA 6
CLALLAM COUNTY
JEFFERSON COUNTY
ISLAND CO
JEFFERSON CO
FT WORDEN MIL RES
Port Townsend
PUGET SOUND
FT FLAGLER MIL RES
Fort Flagler
Port Townsend
Admiralty Inlet
U.S. NAVAL RES.
Nordland
Sequim
Sequim Bay
Gardiner
Port Discovery
Irondale
Hadlock
Blyn
Woodmans
Chimacum
Oak Bay
PUGET SOUND
Fairmont
City Lake
Gibbs Lake
Chimacum Cr
OLYMPIC NATIONAL PARK
Peterson Lake
Crocker Lake
Port Ludlow
Port Ludlow
Tarboo Lake
Ludlow Lake
Leland Lake
Sandy Shore Lake
Teal Lake
Lords Lake
Little Quilcene R
Squamish Harbor
0520
Lost Lake
Quilcene
0528
OLYMPIC NATIONAL FOREST
JEFFERSON CO.
KITSAP CO.
Thorndyke Bay
Tunnel Creek
Big Quilcene River
Quilcene
DABOB BAY
U.S. NAVAL RES.
WRIA 15
WRIA 16
Jackson Cove
WATER RESOURCE INVENTORY AREA 17
SCALE 1:125 000
STATUTE MILES

Figure I-3

Table I-6. Water Right Use in WRIA 17

Stream or Area	Number of Water Rights				Appropriated Quantity - cfs				Irr. Acres
	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	
Little Quilcene R.	11	1	10	22	.16	9.56	2.03	11.75	184
Big Quilcene R.	7	1	1	9	.41	30.00	.05	30.46	6
Snow Creek	7		5	12	.48		.54	1.02	92
Chimacum Creek	10		9	19	.13		2.87	3.00	295
Johnson Creek	8		7	15	.80		1.68	2.48	205
Jimmy Come Lately C.	4		7	11	.07		.75	.82	74
Minor Streams into Sequim Bay	14		12	26	.35		1.68	2.03	154
Minor Streams into Discovery Bay	6		12	18	.09		1.62	1.71	166
Minor Streams into Hood Canal	74	2	33	109	1.00	7.35	5.07	13.42	557
TOTAL	141	4	96	241	3.49	46.91	14.61	66.69	1,733

TABLE I-7. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Little Quilcene River.

U.S.G.S. Gage 12-0520 near Quilcene.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	22	49	71	88	84	51	66	59	57	35	20	15
One in Two Year Discharge (Q_2)												
One in Ten Year Discharge (Q_{10})												
$Q_2 - Q_{10}$												
Water Use	2	2	2	2	2	2	2	2	2	3	4	2
Water Available												

Period of Record: 1926-27, 1951-57. Flows in cfs

Remarks:

TABLE I-8. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Big Quilcene River.

U.S.G.S. Gage 12-0528 at Quilcene.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
lean Discharge	114	241	250	264	270	333	230	280	264	163	99	64
ne in Two Year ischarge (Q_2)												
ne in Ten Year ischarge (Q_{10})												
$_2 - Q_{10}$												
ater Use	8	8	8	8	8	8	8	8	8	8	8	8
ater Available												

eriod of Record: 1926-27, 1951. Flows in cfs

emarks: The 26 cfs diversion is above the gage; but is applied here.

WATER RESOURCE INVENTORY AREA 16

This basin has the lowest population density, fewest irrigated acres, and smallest amount of water use than any other West Sound Basin. Actual water use is very small (see table I-9), but because of a few large municipal water rights, the total appropriated amount is over 300 cfs. These rights are in application state and are not actually being exercised but are just on record. It appears unlikely they will be used in the future, but were included anyway in domestic use for computing water availability.

There is no water availablility problem in this basin. Two small creeks, McTaggart and Waketichie, are regulated subject to low flows.

Active water rights in this basin total 16.5 cfs. Over half of this amount goes for small community or municipal uses, with irrigation accounting for 4.5 cfs. There are only 157 water rights, 111 for domestic, 9 for municipal, and 37 for irrigation. Approximately 500 acres are irrigated.

TABLE I-9. Base Flows for WRIA 16

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Dosewallips	12-0530	117	153	296	106
Duckabush	12-0540	106	269	89	58
Hamma Hamma	12-0545	92	244	161	43
Skokomish	12-0615	319	909	227	151

Although low flows often become critical in certain small streams in this area, to date none of the streams have been closed to further appropriation and only two water rights carry low-flow diversion restrictions.

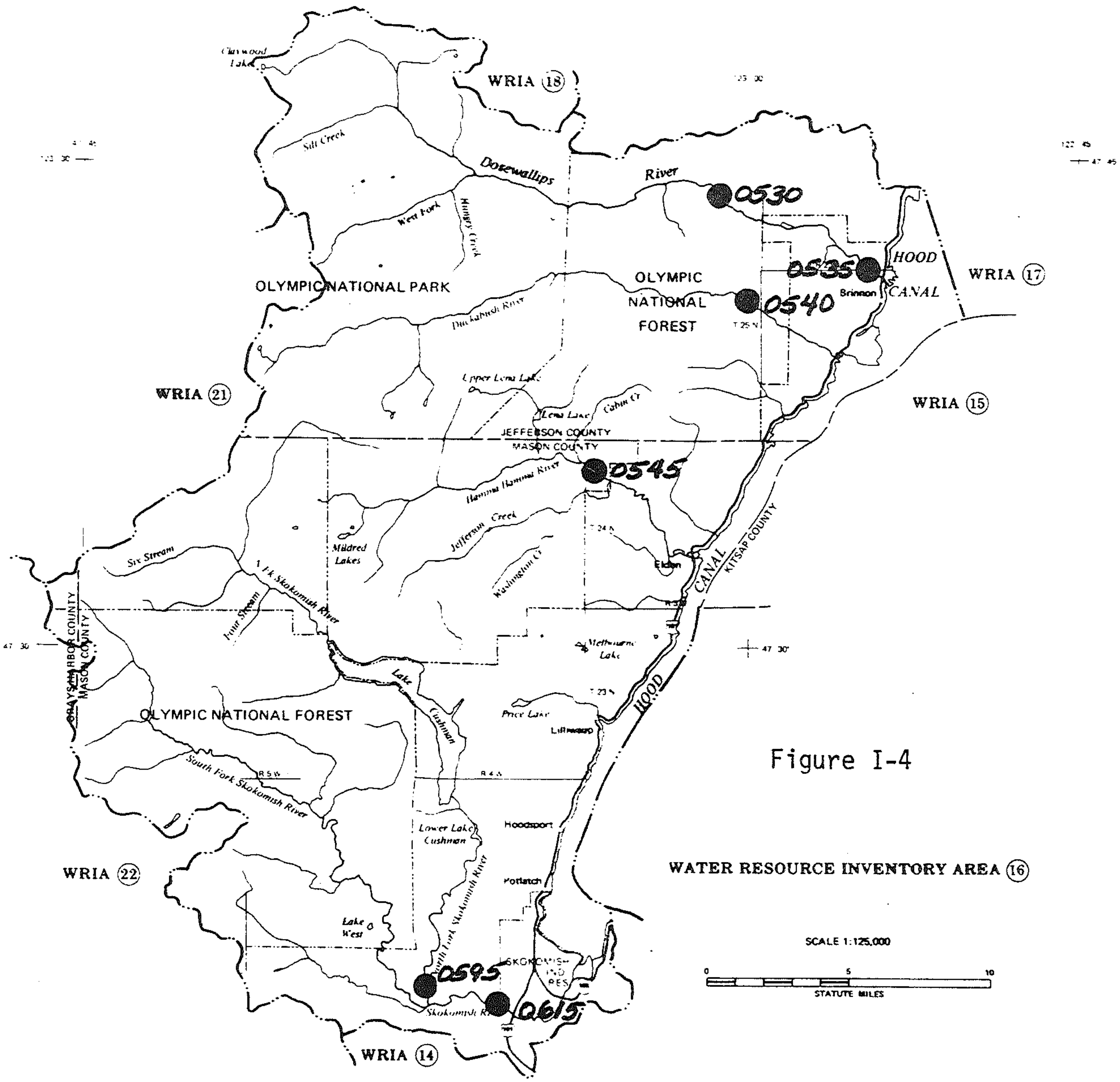


Figure I-4

WATER RESOURCE INVENTORY AREA (16)

Table I-10. Water Right Use in WRIA 16

Stream or Area	Number of Water Rights: Domestic	Number of Water Rights: Municipal/ Comm.-Ind.	Number of Water Rights: Irrigation	Number of Water Rights: Total	Appropriated Quantity - cfs: Domestic	Appropriated Quantity - cfs: Municipal/ Comm.-Ind.	Appropriated Quantity - cfs: Irrigation	Appropriated Quantity - cfs: Total	Irr. Acres
Dosewallips	8	1	2	11	.63	*	.40	1.41	18
Duckabush	5	1	4	10	.13	*	.13	0.30	9.5
Hamma Hamma	3	2	1	6	.10	*	.20	0.30	20
Skokomish	12	2	13	27	.34	3.00	2.29	5.63	176
Minor Streams into Hood Canal	83	3	17	103	1.60	5.72	1.54	8.86	61
TOTAL	111	9	37	157	2.80	8.72	4.56	16.5	540

The following water rights are for the City of Bremerton and Port Townsend but are not presently being used.

* Dosewallips - 50 cfs
* Duckabush - 100 cfs
* Hamma Hamma - 150 cfs

These values have been included when computing water available.

TABLE I-13. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Hamma Hamma River.

U.S.G.S. Gage 12-0545 near Eldon.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
ean Discharge	267	491	528	502	474	316	363	499	473	274	130	104
ne in Two Year ischarge (Q_2)	220	446	502	438	416	295	350	477	449	257	124	94
ne in Ten Year ischarge (Q_{10})	92	244	342	217	208	180	242	323	296	161	84	53
$2 - Q_{10}$	128	202	160	221	208	115	108	154	153	96	40	41
ater Use	37	37	37	37	37	37	37	37	37	37	37	37
ater Available	81	165	123	184	171	78	71	117	116	59	3	4

eriod of Record: 1951-70. Flows in cfs

emarks:

TABLE I-14. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Skokomish River.

U.S.G.S. Gage 12-0615 near Potlach.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	943	1826	2293	2192	2160	1502	1247	930	587	348	237	291
One in Two Year Discharge (Q_2)	760	1640	2184	1952	1964	1385	1197	891	548	333	231	260
One in Ten Year Discharge (Q_{10})	319	909	1480	1051	1107	827	821	596	339	227	173	143
$Q_2 - Q_{10}$	441	731	704	901	857	558	376	295	209	106	58	117
Water Use	1	1	1	1	1	1	1	1	2	5	4	2
Water Available	440	730	702	900	856	557	375	294	207	101	54	115

Period of Record: 1953-70. Flows in cfs

Remarks:

WATER RESOURCE INVENTORY AREA 15

A rapid increase in water utilization has occurred in the Kitsap area in the last few decades, primarily as a result of an accelerated population growth rate. The demand has decreased the available supplies in some areas to the extent that several major surface water sources have been closed to further appropriation. Since much of the area has undergone extensive urbanization, the trend in water use has been primarily toward development of domestic community-domestic, and municipal water supply systems. Water for irrigation, though significant, is of secondary importance in this area.

The Kitsap basin ranks ahead of all other basins in the total number of surface water rights; 1,336 on record as of June 1974. The total quantity under these rights, however, is relatively small - 194 cfs. On a quantitative basis, the most important category is municipal-commercial uses amounting to 97 cfs, and individual community domestic supplies accounting for about 90 cfs. Within the first category are two rights held by the City of Bremerton for a 30-cfs diversion on the Union River, a 30-cfs diversion on the Tahuya River, and rights on Gorst and Anderson creeks.

Unfavorable topographic and climatic conditions in the basin have caused a natural water supply shortage. Most streams are small and ground water aquifers are not extensive. With continued population growth, the Bremerton area will face a serious water shortage in the future. Development of surface supplies for the entire Kitsap peninsula is likely limited to Gold Creek, Huge Creek, and connection to Tacoma's Water Department supplies. Additional storage facilities in the area could help.

One alternative is the large streams draining the eastern slopes of the Olympic Mountains. The City of Bremerton owns water rights on the Duckabush and Hamma Hamma rivers, totaling 250 cfs. A storage project on the Duckabush River has been proposed, but because of its adverse impact upon the environmental and instream values of the region, the possibility of the project is unlikely.

Relative to the water availability of the basin, present water use is high.

TABLE I-15. Base Flows for WRIA 15

Stream and Station		Duration Period Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Dewatto	12-0685	13	39	16	10
Union	12-0635	20	26	20	14
Chico	12-0720	2	14	2	0
Burley	12-0730	22	27	12	11
Mission	12-0650	0	8	0	0
Tahuya	12-0675	0	0	0	0

Figure I-5

WATER RESOURCE INVENTORY AREA (15)

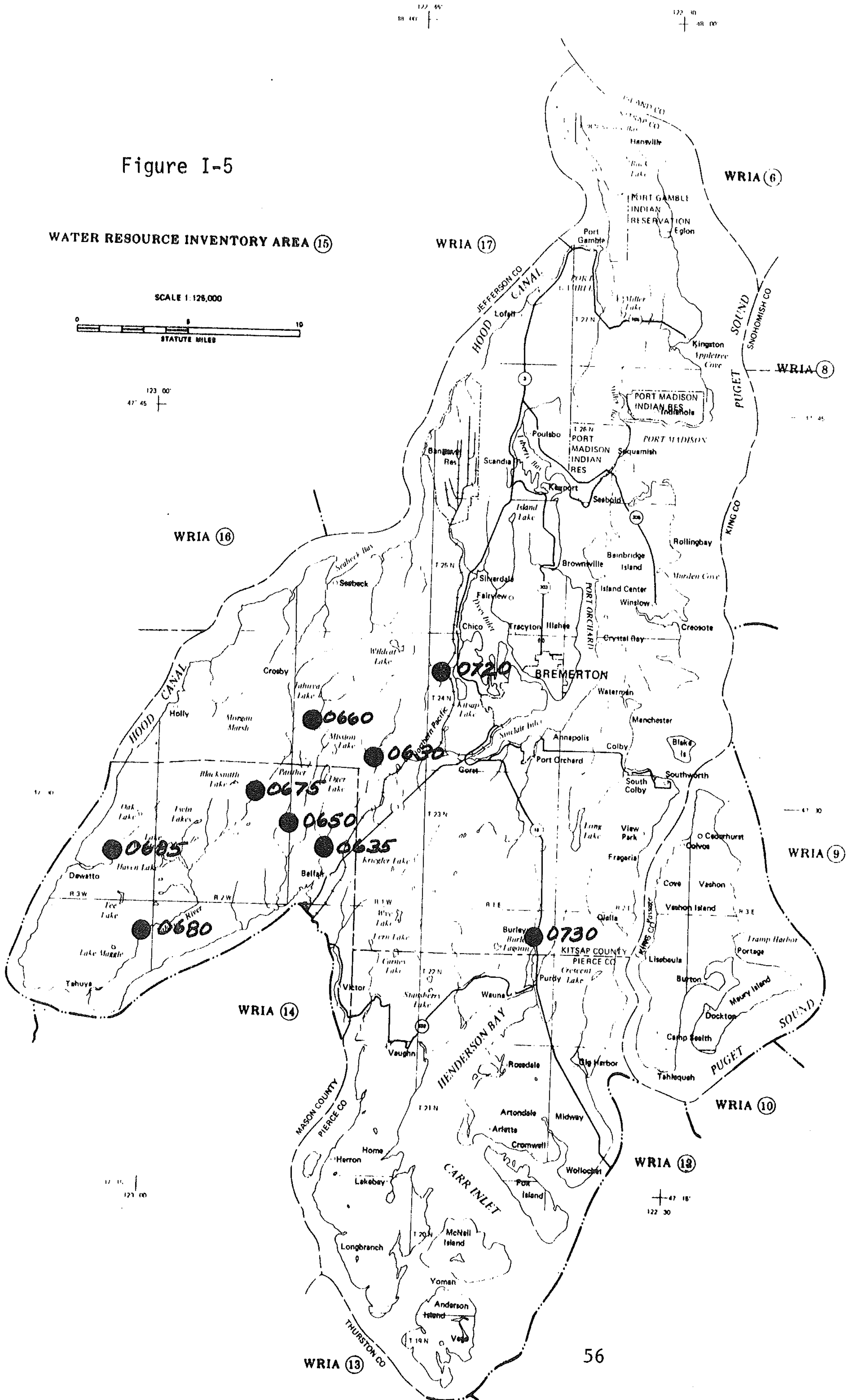


Table I-16. Water Right Use in WRIA 15

Stream or Area	Number of Water Rights				Appropriated Quantity - cfs				Irr. Acres
	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	
Union River	28	7	44	79	.35	41.10	3.58	45.03	276
Chico Creek	25	1	19	45	1.21	20.00	.68	21.89	57
Blackjack Creek	10		24	34	.12		3.77	3.89	452
Dewatto Creek		5	3	8		6.94	.52	7.46	52
Tahuya River	40	2	8	50	.74	30.00	.19	30.93	9.5
Burley Creek	13		18	31	.16		2.85	3.01	328
Mission Creek	7	1	5	13	.08	5.0	.07	5.15	6.5
Vashon Island				164				10.21	275
Minor Streams into Hood Canal				160				7.69	228
Minor Streams into Henderson Bay				256				12.74	985
Minor Streams into Bremerton Area				411				41.06	1,644
Minor Streams into Port Gamble Area				85				5.33	283
TOTAL				1,336				194.39	4,596

TABLE I-17.

FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Dewatto River.

U.S.G.S. Gage 12-0685 near Dewatto.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	32	87	137	162	150	100	59	39	24	18	15	15
One in Two Year Discharge (Q_2)	27	76	131	150	135	93	56	37	24	18	15	15
One in Ten Year Discharge (Q_{10})	13	39	90	90	73	56	37	25	20	16	13	12
$Q_2 - Q_{10}$	14	37	41	60	62	37	19	12	4	2	2	3
Water Use	2	2	2	2	2	2	2	2	2	2	2	2
Water Available	12	35	39	58	60	35	17	10	2	0	0	1

Period of Record: 1947-54, 1958-70. Flows in cfs

Remarks:

TABLE I-18. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Tahuya River.

U.S.G.S. Gage 12-0675 near Belfair.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	13	74	105	124	129	60	35	16	4	1	0	0
One in Two Year Discharge (Q_2)	1	25	101	108	121	55	29	11	3	1	0	0
One in Ten Year Discharge (Q_{10})	0	0	73	53	73	33	13	4	1	0	0	0
$Q_2 - Q_{10}$	1	25	28	55	48	20	16	7	2	1	0	0
Water Use	8	8	8	8	8	8	8	8	8	8	8	8
Water Available	-7	17	20	47	40	12	8	0	0	0	0	0

Period of Record: 1945-56. Flows in cfs

Remarks: The 30 cfs diversion is above the gage; but is applied here.

TABLE I-19 . FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Tahuya River.

U.S.G.S. Gage 12-0660 near Bremerton.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
lean Discharge	7	36	45	53	59	37	16	8	3	2	1	1
ne in Two Year ischarge (Q_2)	3	24	44	47	55	30	14	7	3	1	1	1
ne in Ten Year ischarge (Q_{10})	0	4	31	24	31	13	7	3	1	1	0	0
$2 - Q_{10}$	3	20	13	23	24	17	7	4	2	0	1	1
ater Use												
ater Available												

eriod of Record: 1945-56. Flows in cfs

emarks: Water availability for the Tahuya River has been computed using the downstream gage 12-0675.

TABLE I-20. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Union River.

U.S.G.S. Gage 12-0635 near Belfair.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	35	67	89	110	116	73	49	36	28	23	21	20
One in Two Year Discharge (Q_2)	32	57	84	95	106	68	48	36	28	23	20	20
One in Ten Year Discharge (Q_{10})	20	26	55	45	61	41	37	28	23	20	17	16
$Q_2 - Q_{10}$	12	31	29	50	45	27	11	8	5	3	3	4
Water Use	10	10	10	10	10	10	10	10	11	13	12	10
Water Available	2	21	19	40	35	17	1	0	0	0	0	0

Period of Record: 1947-59. Flows in cfs

Remarks:

TABLE I-21. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Union River.

U.S.G.S. Gage 12-0630 near Bremerton.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	6	20	22	28	26	15	10	6	4	3	3	3
One in Two Year Discharge (Q_2)	4	15	19	22	23	14	9	5	3	2	1	1
One in Ten Year Discharge (Q_{10})	1	4	9	8	10	8	5	2	1	1	0	0
$Q_2 - Q_{10}$	3	11	10	14	13	6	4	3	2	1	1	1
Water Use												
Water Available												

Period of Record: 1945-59. Flows in cfs

Remarks: Water availability for the Union River has been computed using the downstream gage 12-0635.

TABLE I-22. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Chico Creek.

U.S.G.S. Gage 12-0720 near Bremerton.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	10	37	76	91	81	61	31	17	8	3	2	3
One in Two Year Discharge (Q_2)	7	31	70	82	70	56	30	16	8	3	2	2
One in Ten Year Discharge (Q_{10})	2	14	40	43	34	32	19	9	5	2	1	1
$Q_2 - Q_{10}$	5	17	30	39	36	24	11	7	3	1	1	1
Water Use	5	5	5	5	5	5	5	5	5	5	5	5
Water Available	0	12	25	34	31	19	6	2	0	0	0	0

Period of Record: 1947-50, 1961-70. Flows in cfs

Remarks:

TABLE I-23.

FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Burley Creek.

U.S.G.S. Gage 12-0730 at Burley.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
ean Discharge	24	37	34	41	43	36	28	24	19	16	15	17
ne in Two Year ischarge (Q_2)	24	37	34	40	38	34	28	23	19	16	15	17
ne in Ten Year ischarge (Q_{10})	22	27	29	25	20	22	21	17	14	12	13	14
$2 - Q_{10}$	2	10	5	15	18	2	7	6	5	4	2	3
ater Use	0	0	0	0	0	0	0	0	1	2	1	0
ater Available	2	10	5	15	18	2	7	6	4	2	1	3

eriod of Record: 1947-50, 1959-65. Flows in cfs.

emarks:

TABLE I-24. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Mission Creek.

U.S.G.S. Gage 12-0650 near Belfair.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	3	16	31	28	39	19	10	5	1	1	0	0
One in Two Year Discharge (Q_2)	1	15	29	25	37	18	8	3	1	1	0	0
One in Ten Year Discharge (Q_{10})	0	8	18	11	22	10	3	1	0	0	0	0
$Q_2 - Q_{10}$	1	7	11	14	15	8	5	2	1	1	0	0
Water Use	1	1	1	1	1	1	1	1	1	1	1	1
Water Available	0	6	10	13	14	7	4	1	0	0	0	0

Period of Record: 1945-53. Flows in cfs

Remarks:

WATER RESOURCE INVENTORY AREA 14

The major fresh water supplies in the basin are numerous small streams that drain into the inlets and bays of southern Puget Sound. Average mean discharges are quite small. The largest stream is Goldsborrough Creek (a.m.d. 109 cfs) and because it is the main municipal and industrial supplier to Shelton, it is in danger of being overappropriated. The mills in Shelton are the largest water users in the entire basin; irrigation is second. Domestic and municipal uses are relatively minimal, but future supplies will have to come from other streams.

Goldsborrough Creek and Schnieder Creek have been closed to further appropriation.

In this basin, water rights have been issued for a total of 91.12 cfs. Major uses are: commercial and industrial (lumber mills) - 55.5 cfs, irrigation - 20.99 cfs, municipal - 10 cfs, and individual and community domestic - 4.49 cfs. See table I-25 for a geographical breakdown.

WRIA 14 is not a well watered basin. But it is also sparsely populated and areas of water use center around the Shelton area. The only problem of water availability is developing facilities for future demands of Shelton.

TABLE I-25. Base Flows for WRIA 14

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Goldsborrough	12-0675	27	57	26	16

WATER RESOURCE INVENTORY AREA 14

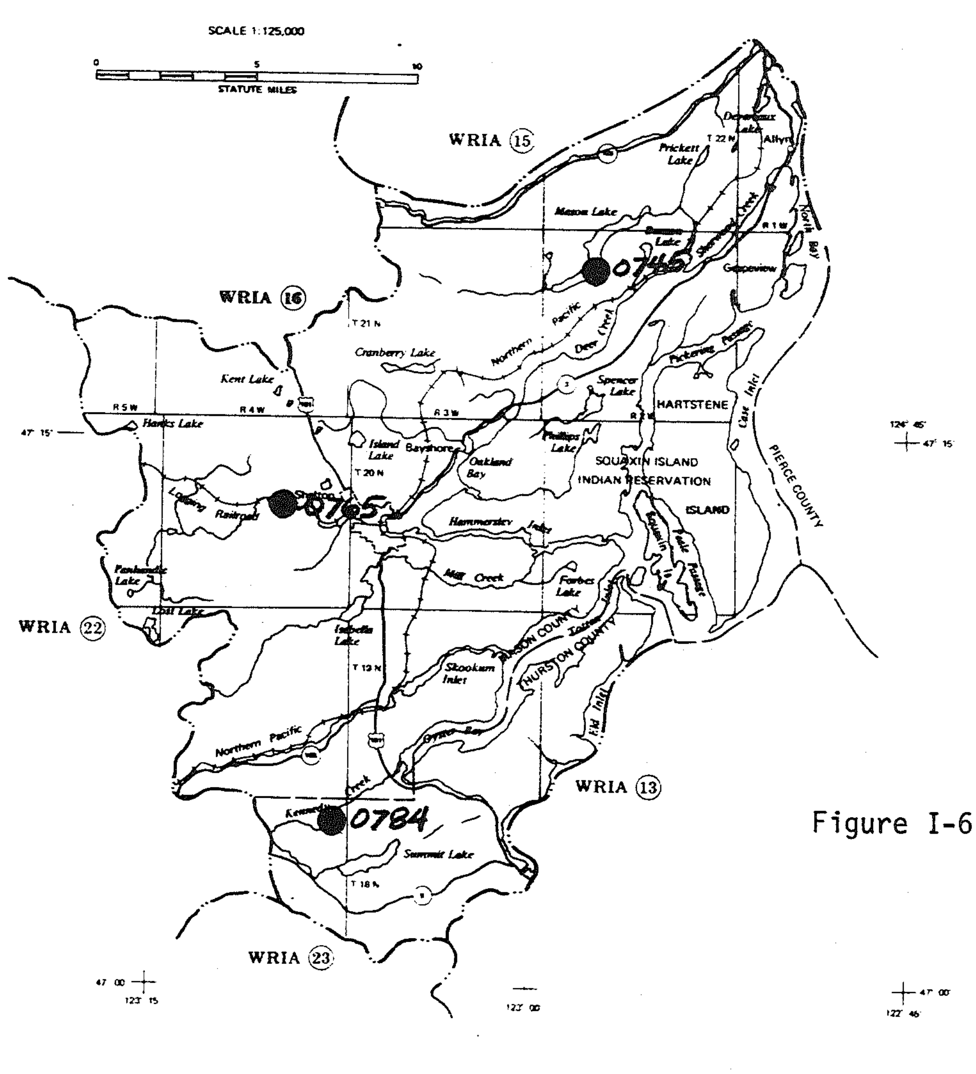


Figure I-6

Table I-26. Water Right Use in WRIA 14

Stream or Area	Number of Water Rights				Appropriated Quantity - cfs				
	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Irr. Acres
Goldsborough Creek	10	5	18	33	.10	55.6	4.33	60.03	410
Kennedy Creek	85		6	91	1.03		1.42	2.45	141
Skookum Creek	2	1	6	9	.02	.04	3.24	3.30	323
Mill-Gosnell Creek	10		17	27	.13		3.38	3.51	365
Sherwood Creek	19	1	2	22	.23	.50	.06	.79	3
Swamp Creek	9		12	21	.09		.45	.54	18.5
Manley Creek	5	1	7	13	.07	.05	.14	.26	12
Minor Streams into Eld Inlet	41	10	21	72	.51	.71	2.58	3.80	240
Minor Streams into Hammersly Inlet	16	4	35	55	.20	5.31	3.78	9.29	343
Minor Streams into Hood Canal	73	10	24	107	1.93	3.20	1.16	6.29	132
Minor Streams into Peale Passage & Skookum Inlet	17	4	14	35	.18	.23	.45	.86	53
TOTAL	287	36	162	485	4.49	65.64	20.99	91.12	2,041

TABLE I-27. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Goldsborough Creek.

U.S.G.S. Gage 12-0765 near Shelton.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	54	145	199	254	241	186	130	74	45	30	25	25
One in Two Year Discharge (Q_2)	49	126	190	237	220	174	125	71	44	30	25	24
One in Ten Year Discharge (Q_{10})	27	59	127	141	125	108	86	49	35	26	21	19
$Q_2 - Q_{10}$	22	67	63	96	95	66	39	22	9	4	4	5
Water Use	14	14	14	14	14	14	14	14	15	17	16	14
Water Available	8	53	49	82	81	52	25	8	0	0	0	0

Period of Record: 1951-70. Flows in cfs

Remarks:

There is extensive water use on the Deschutes River. Table I-29 shows approximately 3 or 4 cfs available during the irrigation months of July and August. This is based on the USGS gage (12-0800) at Olympia. Since 1954, however, the Deschutes River (entire reach) has been closed due to requests by Fish and Game. An application by the City of Olympia for 100 cfs has recently been cancelled by the DOE.

The other major surface water source in the Deschutes Basin, Woodland Creek, has also been closed. This is due primarily to extreme domestic regulation in upstream lakes and heavy irrigation near the mouth. The present water rights total 9.6 cfs while the 1 in 10 year 7-day low flow is 8.8 cfs.

In this basin a total of 59.91 cfs has been appropriated. Of this amount, 39 cfs is allowed to be diverted directly from the Deschutes River. The heaviest water use in the basin is irrigation, with a total of 43.48 cfs or 72 percent. Municipal-industrial supplies account for 12.5 cfs and about 4 cfs for domestic use. Paper water rights show a total of 3,859 acres for the basin.

Ground water supplies will have to be the major source of future supplies, especially for municipal-industrial uses.

TABLE I-28. Base Flows for WRIA 13

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Deschutes	12-0800	97	218	111	80
Deschutes	12-0790	47	118	42	26
Woodland Creek	12-0810	-	-	-	8.8

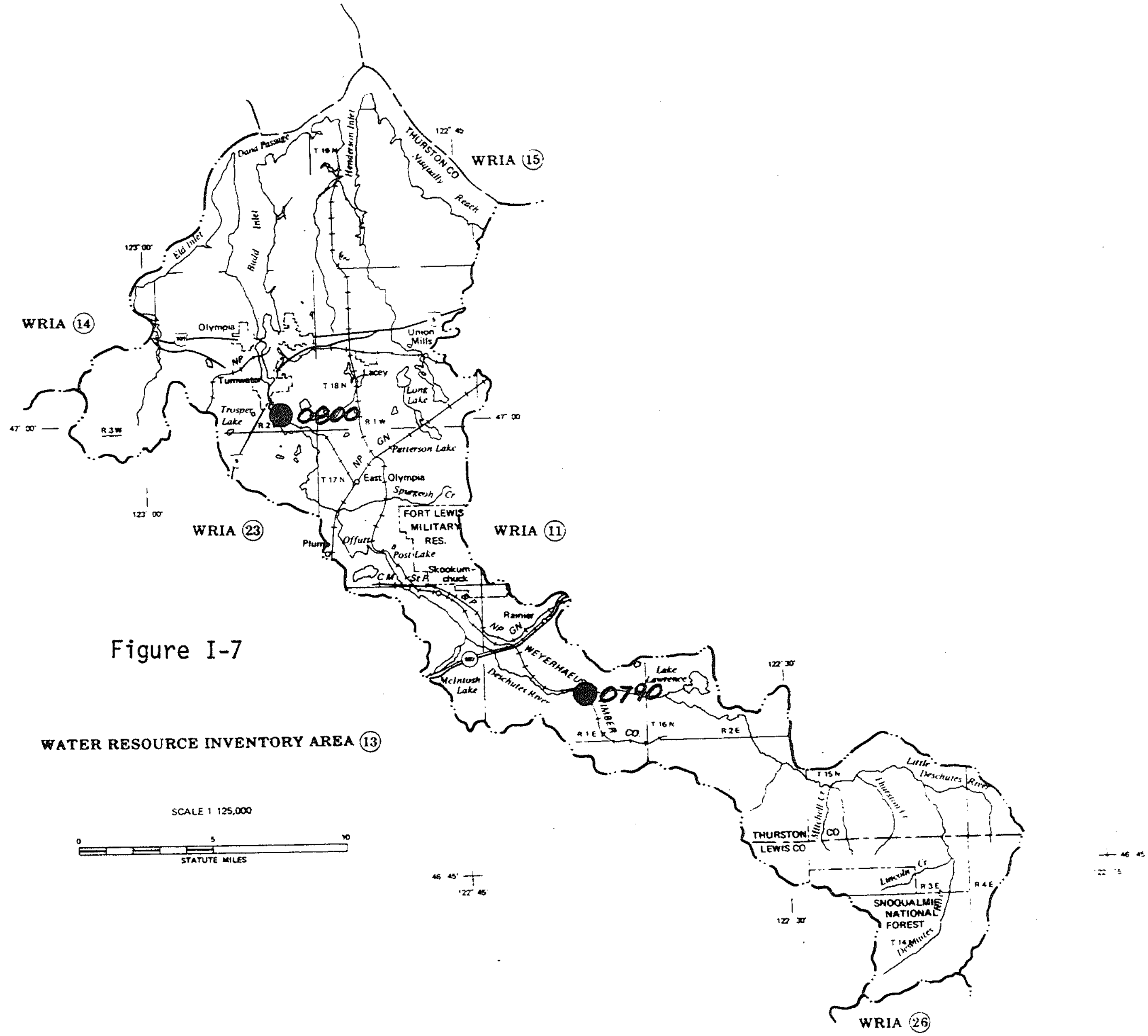

WRIA 15
THURSTON CO
Nisqually Reach
Dana Passage
Henderson Inlet
Budd Inlet
Eld Inlet
WRIA 14
Olympia
Union Mills
Tumwater
Lacey
Long Lake
Trosper Lake
0800
Patterson Lake
East Olympia
Spurgeon Cr
FORT LEWIS MILITARY RES.
WRIA 23
WRIA 11
Plum
Offutt
Post Lake
Skookumchuck
Rainier
WEYERHAEUSER TIMBER CO
McIntosh Lake
Deschutes River
Lake Lawrence
0790
Little Deschutes River
Mitchell Cr
Thurston Cr
THURSTON CO
LEWIS CO
Lincoln Cr
SNOQUALMIE NATIONAL FOREST
WRIA 26
WATER RESOURCE INVENTORY AREA 13
SCALE 1 125,000
STATUTE MILES

Figure I-7

Table I-29. Water Right Use in WRIA 13

Stream or Area	Number of Water Rights				Appropriated Quantity - cfs				Irr. Acres
	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	
Deschutes River*	28	5	84	117	.32	11.81	27.80	39.98	2,146
Woodland Creek	45	1	78	124	.50	.70	8.39	9.59	1,002
Woodards Creek	2		15	17	.02		1.68	1.70	143
Percival Creek	2		17	19	.02		.90	.92	84
McLane Creek	8		11	19	.35		.68	1.03	81
Minor Streams into Eld Inlet				29	.58		.88	1.41	88
Minor Streams into Budd Inlet				54	1.48		1.27	2.75	127
Minor Streams into Henderson Bay				40	.74		1.88	2.62	188
TOTAL				386	4.06	12.51	43.48	59.91	3,859
*above 0790	6	2	15	23	.07	.31	3.8	4.18	447
above 0800	21	2	61	84	.25	10	22.86	33.11	1,550
below 0800	1	1	8	10	.05	1.5	1.14	2.69	149

TABLE I-30.

FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Deschutes River.

U.S.G.S. Gage 12-0800 near Olympia.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	176	491	685	752	874	589	471	313	191	135	109	107
One in Two Year Discharge (Q_2)	164	433	650	698	822	553	456	301	189	134	108	106
One in Ten Year Discharge (Q_{10})	97	218	418	425	507	352	324	207	149	111	91	84
$Q_2 - Q_{10}$	67	215	232	273	315	201	132	94	40	23	17	22
Water Use	3	3	3	3	3	3	3	4	7	19	14	3
Water Available	64	212	229	270	312	198	129	90	33	4	3	19

Period of Record: 1945-54, 1957-54. Flows in cfs

Remarks:

TABLE I-31. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Deschutes River.

U.S.G.S. Gage 12-0790 near Rainier.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	115	351	499	570	524	405	303	166	98	55	42	44
One in Two Year Discharge (Q_2)	99	292	461	508	480	374	290	159	93	54	41	41
One in Ten Year Discharge (Q_{10})	47	118	270	259	272	224	197	109	62	42	31	27
$Q_2 - Q_{10}$	52	174	191	249	208	150	93	50	31	12	10	14
Water Use	0	0	0	0	0	0	0	0	1	3	2	1
Water Available	52	174	191	249	208	150	93	50	30	9	8	14

Period of Record: 1949-70. Flows in cfs

Remarks:

WATER RESOURCE INVENTORY AREA 11

The Nisqually River, with a mean annual discharge of 2,090 cfs, has four main gaging stations. To deterime water availability at each control point, water rights above each gaging station were used. The stations are:

12-0825	Nisqually River near National
12-0865	Nisqually River at La Grande
12-0885	Nisqually River near McKenna
12-0895	Nisqually River at McKenna

See locations in figure I-8.

To complicate matters, there is a power diversion with a water right of 720 cfs that bypasses station 12-0895 and is returned downstream. So much water is diverted that the mean discharge upstream is greater than that at gage 12-0895. In the last few years the Department has been concerned over the salmon kills resulting from the violation of the 200 cfs minimum flow established for this area.

In order to obtain a more accurate accounting of water available, all water right uses that would have been applied to 12-0895 were applied to 12-0885 instead.

The two power reservoirs upstream from 12-0865, Alder Lake and La Grande Reservoir, are owned by Tacoma City Light. They have an active capacity of 180,000 and 1,600 acre feet respectively.

Consumptive water rights for the entire Nisqually basin total 219.57 cfs, with 159 cfs belonging to the Nisqually and its tributaries. The largest use category in the basin is for municipal and industrial use - 171.57 cfs. Most of this is for Olympia's public supply. Irrigation accounts for 44.85 cfs and 4,384 acres, while individual and community domestic total only 3.15 cfs. See table I-33.

McAllister Springs is a main water supply for Olympia. The average annual discharge for a 13-year period was 23.6 cfs, and remains fairly constant. As can be seen from table I-33, appropriated water rights total 60 cfs. Although only a very small amount of this is actually used, the stream should be closed.

Because of heavy irrigation demands, many tributaries to the Nisqually River have been closed or are regulated.

TABLE I-32. Base Flows for WRIA 11

Stream and Station		Duration Period			
		Oct (cfs)	Nov-Mar (cfs)	Apr-Jul (cfs)	Aug-Sep (cfs)
Nisqually	12-0825	270	358	568	178
Nisqually	12-0865	842	1,348	528	410
Nisqually	12-0885	?	?	?	405
Nisqually	12-0895	357	854	92	42

Information for frequency analysis on Gage 12-0885 has not been compiled as yet.

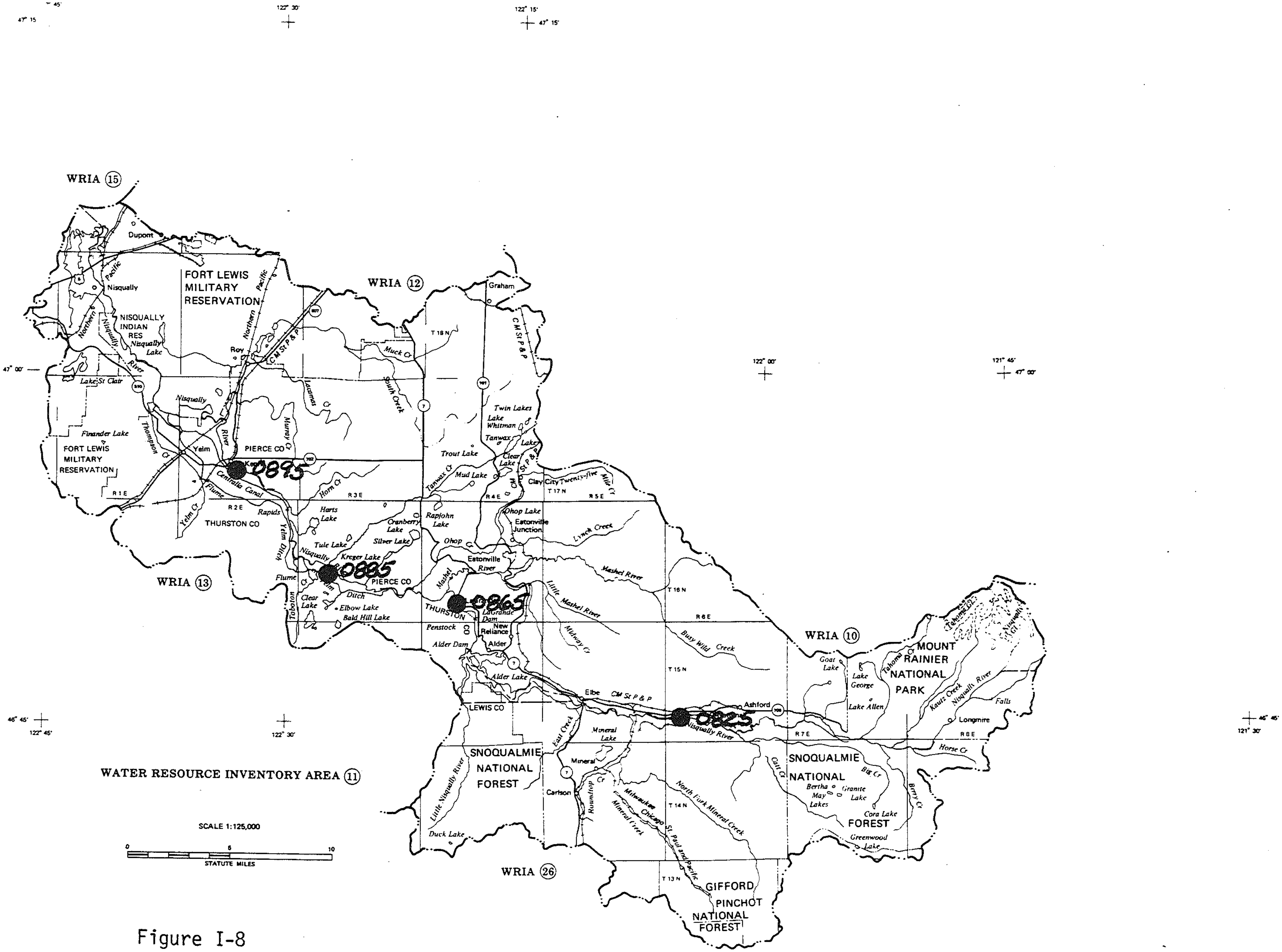

WATER RESOURCE INVENTORY AREA 11
SCALE 1:125,000
STATUTE MILES
WRIA 15
WRIA 12
WRIA 13
WRIA 10
WRIA 26
FORT LEWIS MILITARY RESERVATION
NISQUALLY INDIAN RES
PIERCE CO
THURSTON CO
LEWIS CO
SNOQUALMIE NATIONAL FOREST
MOUNT RAINIER NATIONAL PARK
GIFFORD PINCHOT NATIONAL FOREST
Dupont
Nisqually
Roy
Yelm
Graham
Eatonville
Elbe
Ashford
Mineral
Alder
Longmire
Carlson
Nisqually River
Mashel River
Centralia Canal
Alder Lake
Alder Dam
LaGrande Dam
0895
0885
0865
0825

Figure I-8

Table I-33. Water Right Use in WRIA 11

Stream or Area	Number of Water Rights				Appropriated Quantity - cfs				Irr. Acres
	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	Domestic	Municipal/ Comm.-Ind.	Irrigation	Total	
Nisqually above 0825	22	4	5	31	.40	12.77	.49	13.66	120
Nisqually below 0825	17	4	12	33	.25	.75	1.77	2.77	188
Nisqually below 0865	53	2	28	83	.62	2.55	9.01	12.18	713
Nisqually below 0885	13	4	34	49	.18	.50	13.21	13.89	1,283
Nisqually below 0895	54	1	65	120	.62	100.00	16.37	116.99	1,722
Total Nisqually	159	15	144	318	2.07	116.57	40.85	159.49	3,926
McAllister Creek	8	4	10	22	1.08	55.00	4.00	60.08	458
TOTAL	167	19	154	340	3.15	171.57	44.85	219.57	4,384

TABLE I-34. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Nisqually River.

U.S.G.S. Gage 12-0825 near National.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	524	834	923	817	796	577	802	1102	1119	826	541	437
One in Two Year Discharge (Q_2)	473	732	849	747	729	555	781	1072	1078	798	534	428
One in Ten Year Discharge (Q_{10})	270	358	482	421	419	387	571	790	758	568	426	329
$Q_2 - Q_{10}$	203	374	367	326	310	168	210	282	320	230	108	99
Water Use	3	3	3	3	3	3	3	3	3	3	3	3
Water Available	200	371	364	323	307	165	207	279	317	227	105	96

Period of Record: 1942-70. Flows in cfs

Remarks:

TABLE I-35. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Nisqually River.

U.S.G.S. Gage 12-0865 at LaGrande.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	1270	1695	2034	2425	2210	1618	1459	1203	1031	757	681	886
One in Two Year Discharge (Q_2)	1224	1674	1992	2376	2107	1506	1427	1171	1005	735	675	859
One in Ten Year Discharge (Q_{10})	842	1348	1518	1811	1390	867	1061	866	740	528	564	613
$Q_2 - Q_{10}$	382	326	800	565	717	639	366	305	265	207	111	246
Water Use	0	0	0	0	0	0	0	0	0	2	1	0
Water Available	382	326	800	565	717	639	366	305	265	205	110	246

Period of Record: 1906-11, 1919-31, 1943-70. Flows in cfs

Remarks:

TABLE I-36. FREQUENCY, WATER USE AND AVAILABILITY DATA FOR Nisqually River.

U.S.G.S. Gage 12-0895 at McKenna.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Mean Discharge	790	1550	2036	2702	2193	1517	1290	973	556	351	205	367
One in Two Year Discharge (Q_2)	706	1434	1918	2563	1953	1320	1266	922	514	272	194	311
One in Ten Year Discharge (Q_{10})	357	854	1195	1640	993	584	965	597	298	92	125	141
$Q_2 - Q_{10}$	349	580	723	923	960	736	301	325	216	180	69	170
Water Use												
Water Available												

Period of Record: 1947-70. Flows in cfs

Remarks:

STREAM CLOSURES AND LOW FLOWS

Following is a list and a map, by subbasin, of streams that have been closed to further appropriation, and streams that are subject to low flow regulations. Many of the streams on this list were requested by the State Department of Fisheries. Others have been added recently and the list is continually updated. In cases where there is more than one low flow for a stream, the latest date was used. For complete information and specific details, refer to the PSAAW Study, Appendix III Supplement, listed in the Bibliography.

STREAM CLOSURES IN THE ELWHA-DUNGENESS BASIN (WRIA-18)

Subregion and Stream Name	Tributary of	Date of Closure
Elwha-Dungeness		
Bagley Creek	Strait of Juan de Fuca	11-4-48 (Irrigation only)
Canyon Creek	Dungeness River	3-4-47
Dungeness River	Strait of Juan de Fuca	9-19-45
McDonald Creek	Strait of Juan de Fuca	6-18-46
Morse Creek	Strait of Juan de Fuca	4-11-72
Lees Creek	Strait of Juan de Fuca	12-18-73
Siebert Creek	Strait of Juan de Fuca	10-19-72

LOW FLOWS IN THE ELWHA-DUNGENESS BASIN (WRIA 18)

Stream	Tributary of	Date	Low Flow (cfs)
Peabody Creek	Strait of Juan de Fuca	12-26-46	0.1
Tumwater Creek	Strait of Juan de Fuca	10-21-57	2.0

STREAM CLOSURES IN THE QUILCENE BASIN (WRIA 17)

Subregion and Stream Name	Tributary of	Date of Closure
Chimacum Creek	Port Townsend	4-3-46
Contractors Creek	Port Discovery	7-10-73
Little Quilcene River	Quilcene Bay	8-21-52

LOW FLOWS IN THE QUILCENE BASIN (WRIA 17)

Stream	Tributary of	Date	Low Flow (cfs)
Andrews Creek	Crocker Lake	2-8-57	1.5
Jimmy Come Lately Creek	Sequim Bay	6-18-46	1.0
Salmon Creek	Discovery Bay	2-16-46	2.0
Snow Creek	Discovery Bay	3-5-46	1.5
Tarboo Creek	Tarboo Bay	-	3.0
Unnamed Creek	SW1/4 16 28N 1E	-	0.3
Unnamed Creek	SE1/4 1 29N 3W	-	0.5

There are no closures in the Skokomish-Doesewalips Basin (WRIA 16). The two low flow streams are:

Stream	Tributary of	Date	Low Flow (cfs)
McTaggart	N. F. Skokomish River	2-9-53	2.0
Waketichie	Hood Canal	7-27-59	0.6

STREAM CLOSURES IN THE KITSAP BASIN (WRIA 15)

Subregion and Stream Name	Tributary of	Date of Closure
West Sound Basin		
Barker Creek	Dyes Inlet	2-21-61
Bear Creek	Burley Creek	11-20-50
Blackjack Creek	Sinclair Inlet	8-9-45
Burley Creek	Burley Lagoon	1-5-50
Clear Creek	Dyes Inlet	7-27-53
Dogfish Creek	Liberty Bay	8-21-53
Dutchers Creek	Case Inlet	3-10-54
Huge Creek	Minter Creek	12-2-59
Judd Creek	Quartermaster Harbor	5-10-51
Minter Creek	Henderson Bay	11-27-44
Mission Creek	Hood Canal	8-4-54
Salmonberry Creek	Long Lake	1-7-48
Seabeck Creek	Seabeck Bay	8-27-54
Stansbury Lake		7-7-66
Unnamed Stream (20-24-1E)	Kitsap Lake	12-8-52
West Creek	Hood Canal	11-3-48
Wildcat Creek	Chico Creek	11-3-52
Chico Creek	Chico Bay	1-14-36
Lake Christine	Tahuya River	10-10-72

LOW FLOWS IN THE KITSAP BASIN (WRIA 15)

Stream	Tributary of	Date	Low Flow (cfs)
Jod Creek	Christansen Cove	11-3-48	Bypass 1/2 low flow
Little Mission Creek	Hood Canal	11-7-58	Bypass 1/2 low flow
Union River	Hood Canal	3-30-64	5.0
Dogfish Creek	Liberty Bay	9-2-59	1.5
Gamble Creek	Port Gamble	5-24-54	0.5
Hall Creek	Hood Canal	11-3-48	Bypass 1/2 low flow
Hoddy Creek	Hood Canal	11-3-48	Bypass 1/2 low flow
Kochs Creek	Dyes Inlet	9-2-49	Bypass 1/2 low flow
Little Shoefly Creek	Hood Canal	9-2-64	1.0
Scandia Creek	Liberty Bay	10-27-52	1.0

Nine unnamed streams (see PSAAW Study, Appendix III, for details)

STREAM CLOSURES IN THE KENNEDY-GOLDSBOROUGH BASIN (WRIA 14)

Subregion and Stream Name	Tributary of	Date of Closure
Goldsborough Creek	Oakland Bay	4-21-52
Schneider Creek	Totter Inlet	5-4-53

LOW FLOWS IN THE KENNEDY-GOLDSBOROUGH BASIN (WRIA 14)

Stream	Tributary of	Date	Low Flow (cfs)
Gosnell Creek	Isabella Lake	1-3-62	10.0
Jarrell Creek	Jarrell Cove	7-7-59	0.30
Johns Creek	Oakland Bay	5-1-61	4.0
Kennedy Creek	Totter Inlet	10-15-53	3.0
Skookum Creek	Skookum Inlet	7-14-58	3.0
Unnamed Stream	NW1/4 34 20N 3W	11-28-55	0.5

EXISTING CLOSURES IN THE NISQUALLY-DESCHUTES BASIN (WRIA 11 and 13)

Subregion and Stream Name	Tributary of	Date of Closure
Deschutes River	Capitol Lake	7-6-54
Eaton Creek	Lake St. Clair	12-1-53
Muck Creek	Nisqually River	4-15-49
Ohop Creek	Nisqually River	2-15-52
Swift Creek	McLane Creek	
Unnamed Stream	Midway Creek	5-4-64
Woodard Creek	South Bay	12-8-50
Yelm Creek	Nisqually River	8-7-51
Woodland Creek	Hinderson Inlet	1-22-51
Percival Creek	Capitol Lake	9-26-72
Woodward Creek	Woodward Bay	9-23-46
Midway Creek	Little Mashel	4-28-69

EXISTING LOW FLOWS IN THE NISQUALLY-DESCHUTES
BASIN (WRIA 11 and 13)

Stream	Tributary of	Date	Low Flow (cfs)
Deschutes Subbasin			
Ayers Creek	Deschutes River	1-17-50	1.0
Patterson Lake outlet	Long Lake	1-26-54	1.0
Spurgeon Creek	Deschutes River	4-27-53	1.5
McLane Creek	Eld Inlet		0.5
Unnamed Stream	Woodland Creek	10-31-50	0.5
Unnamed Stream	Gull Harbor	3-25-55	1.0
Unnamed Stream	Deschutes River	6-10-54	Bypass 1/2 low flow
Unnamed Stream	Deschutes River	6-17-54	Bypass 1/2 low flow
Unnamed Stream	Deschutes River	12-1-53	Bypass 1/2 low flow
Nisqually Subbasin			
Lacamas Creek	Roy Lake	6-18-54	1.0
Mashell River	Nisqually River	7-10-53	15.0
Thompson Creek	Nisqually River	4-10-57	1.0
Toboton Creek	Nisqually River	1-19-48	Bypass 1/2 low flow
Unnamed Stream	Nisqually River	2-10-50	3.0
Unnamed Stream	Nisqually River	12-27-51	0.75
Unnamed Stream	Nisqually River	1-9-64	0.50

For figures I-9 through I-15, the following symbols are used:

————STREAMS closed to further appropriation

.........STREAMS with low flow restrictions

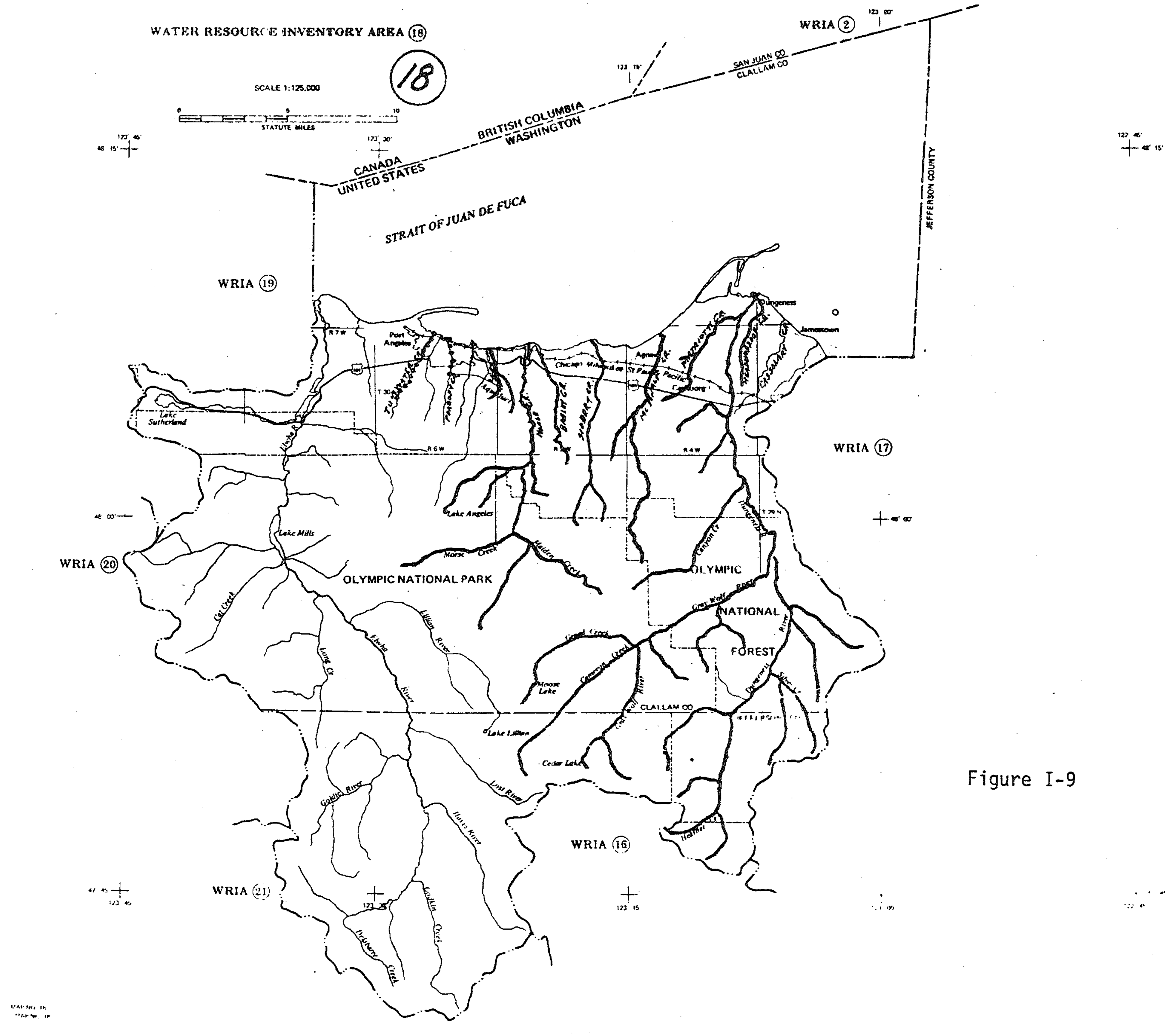

WATER RESOURCE INVENTORY AREA (18)
18
SCALE 1:125,000
STATUTE MILES
WRIA (2)
SAN JUAN CO
CLALLAM CO
BRITISH COLUMBIA
WASHINGTON
CANADA
UNITED STATES
STRAIT OF JUAN DE FUCA
JEFFERSON COUNTY
WRIA (19)
Dungeness
Jamestown
Port Angeles
Lake Sutherland
Lake Angeles
Lake Mills
WRIA (17)
WRIA (20)
OLYMPIC NATIONAL PARK
OLYMPIC NATIONAL FOREST
Morse Creek
Grey Wolf River
Moose Lake
CLALLAM CO
Lake Lillian
Cedar Lake
Lost River
WRIA (16)
WRIA (21)
Elwha River
Lillian River
Cat Creek
Goldie River
Hayes River
Long Cr

Figure I-9

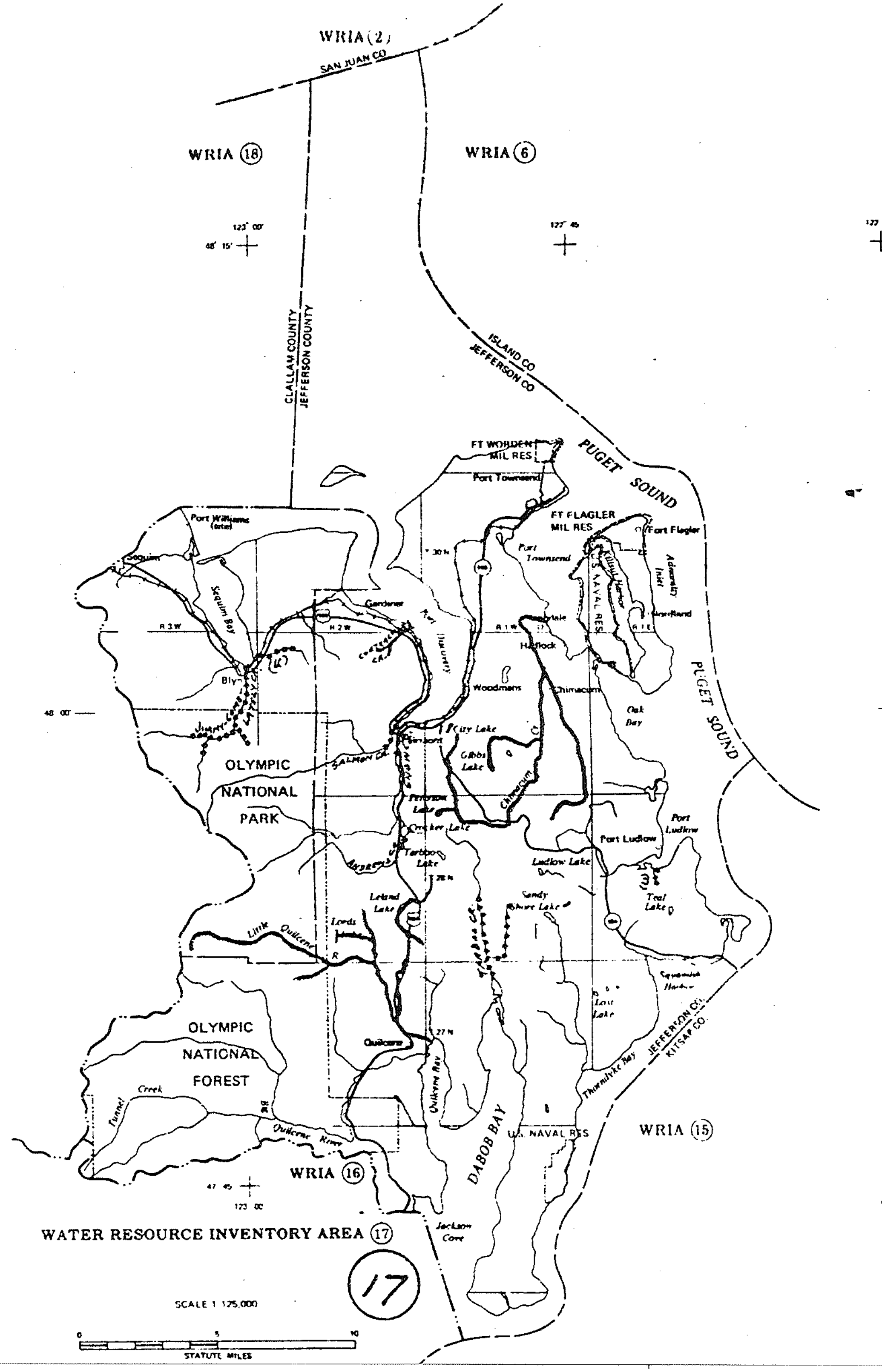

WRIA (2)
SAN JUAN CO
WRIA (18)
WRIA (6)
CLALLAM COUNTY
JEFFERSON COUNTY
ISLAND CO
JEFFERSON CO
FT WORDEN MIL RES
Port Townsend
PUGET SOUND
FT FLAGLER MIL RES
Fort Flagler
Port Williams
Sequim
Sequim Bay
Gardiner
Blyn
Woodmans
Chimacum
Irondale
Hadlock
Port Townsend
Admiralty Inlet
Oak Bay
PUGET SOUND
OLYMPIC NATIONAL PARK
Salmon Cr.
City Lake
Gibbs Lake
Peterson Lake
Crocker Lake
Tarboo Lake
Ludlow Lake
Port Ludlow
Teal Lake
Leland Lake
Sandy Shore Lake
Little Quilcene R
Quilcene
OLYMPIC NATIONAL FOREST
Quilcene River
Tunnel Creek
Quilcene Bay
DABOB BAY
U.S. NAVAL RES
Jackson Cove
Thorndyke Bay
Squamish Harbor
Lou Lake
JEFFERSON CO
KITSAP CO
WRIA (15)
WRIA (16)
WATER RESOURCE INVENTORY AREA (17)
17
SCALE 1:125,000
STATUTE MILES

Figure I-10

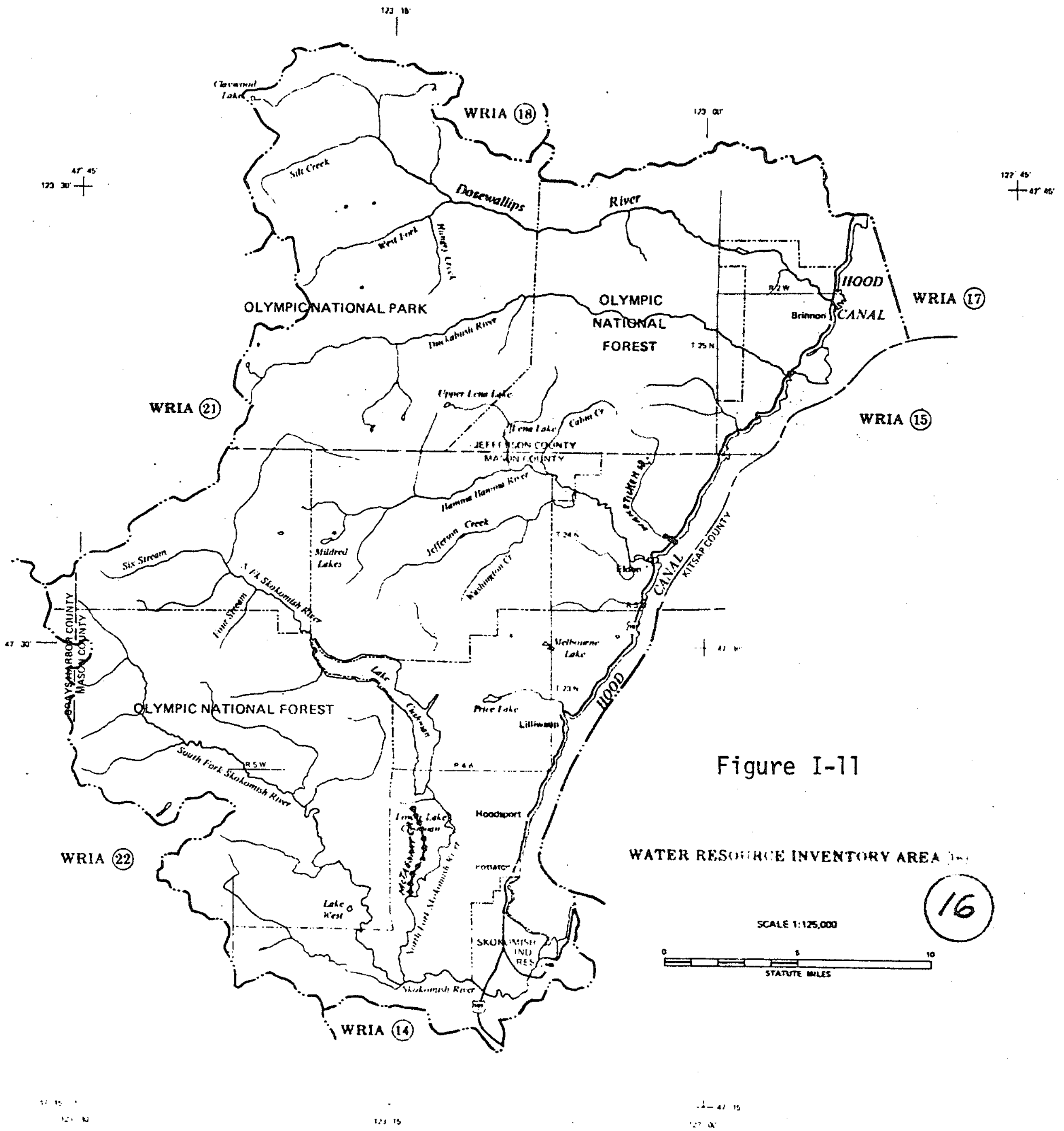
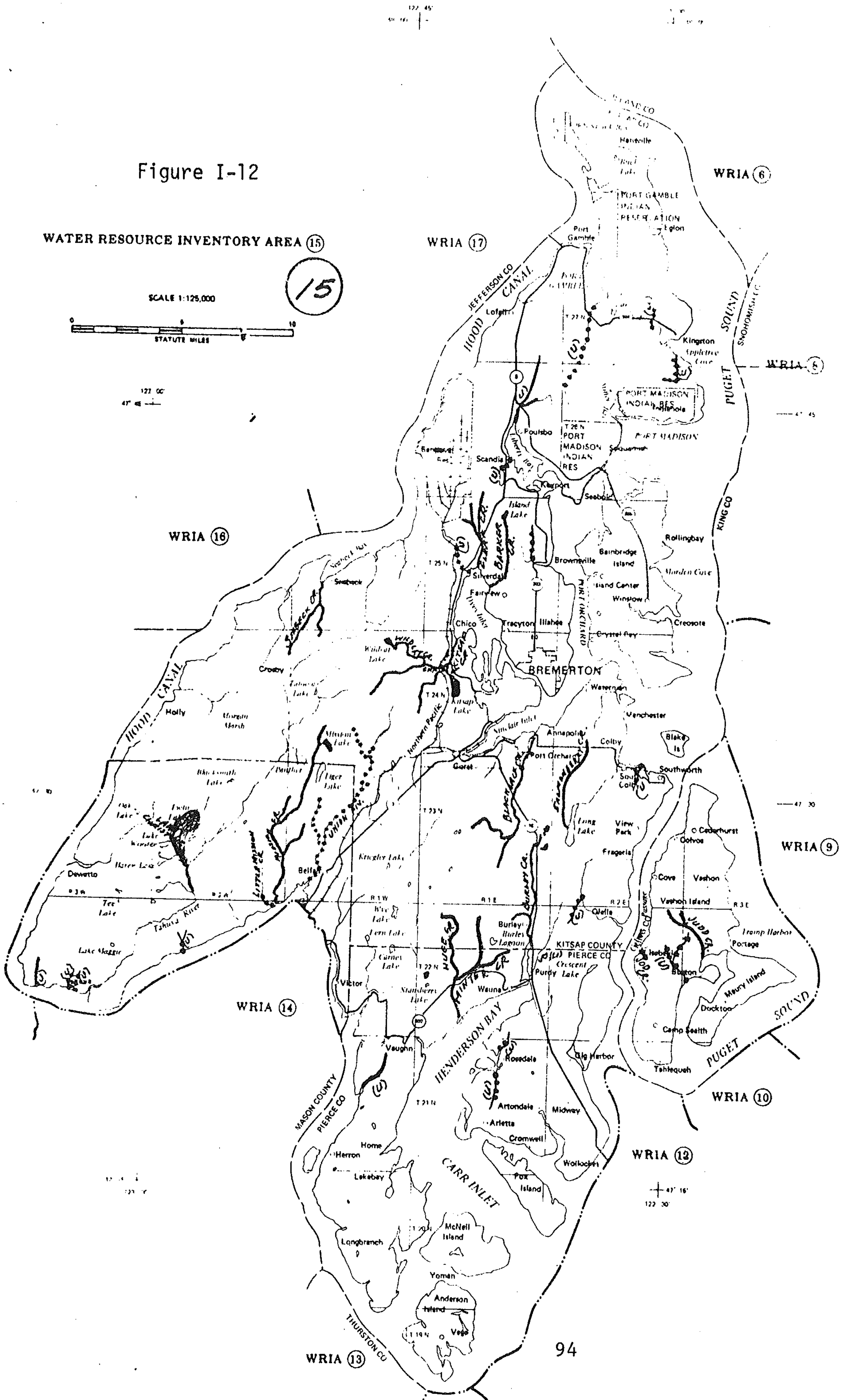

WRIA 18
WRIA 17
WRIA 15
WRIA 21
WRIA 22
WRIA 14
Dosewallips River
HOOD CANAL
Brinnon
OLYMPIC NATIONAL PARK
OLYMPIC NATIONAL FOREST
JEFFERSON COUNTY
MASON COUNTY
KITSAP COUNTY
GRAYS HARBOR COUNTY
Eldon
Hoodsport
Lilliwaup
SKOKOMISH IND RES
Skokomish River
South Fork Skokomish River
Lake Cushman
WATER RESOURCE INVENTORY AREA 16
SCALE 1:125,000
STATUTE MILES

Figure I-11

Figure I-12



WATER RESOURCE INVENTORY AREA 15
SCALE 1:125,000
STATUTE MILES
WRIA 6
WRIA 17
WRIA 5
WRIA 16
WRIA 9
WRIA 14
WRIA 10
WRIA 12
WRIA 13
HOOD CANAL
PUGET SOUND
JEFFERSON CO
SNOHOMISH CO
KING CO
KITSAP COUNTY
PIERCE CO
MASON COUNTY
THURSTON CO
PORT GAMBLE INDIAN RESERVATION
PORT MADISON INDIAN RES
Port Gamble
Hansville
Eglon
Kingston
Indianola
Poulsbo
Suquamish
Scandia
Keyport
Seabold
Rollingbay
Bainbridge Island
Brownsville
Silverdale
Fairview
Seabeck
Chico
Tracyton
Illahee
Winslow
Creosote
Crosby
BREMERTON
Holly
Manchester
Colby
Blake Is
Annapolis
Port Orchard
Gorst
Southworth
Dewatto
Belfair
Olalla
Burley
Vashon
Vashon Island
Cove
Fragaria
Cedarhurst
Maury Island
Portage
Dockton
Camp Sealth
Tahlequah
Victor
Vaughn
Wauna
Purdy
Rosedale
Gig Harbor
Artondale
Midway
Arletta
Cromwell
Wollochet
Fox Island
Home
Herron
Lakebay
Longbranch
McNeil Island
Yoman
Anderson Island
Vega
HENDERSON BAY
CARR INLET

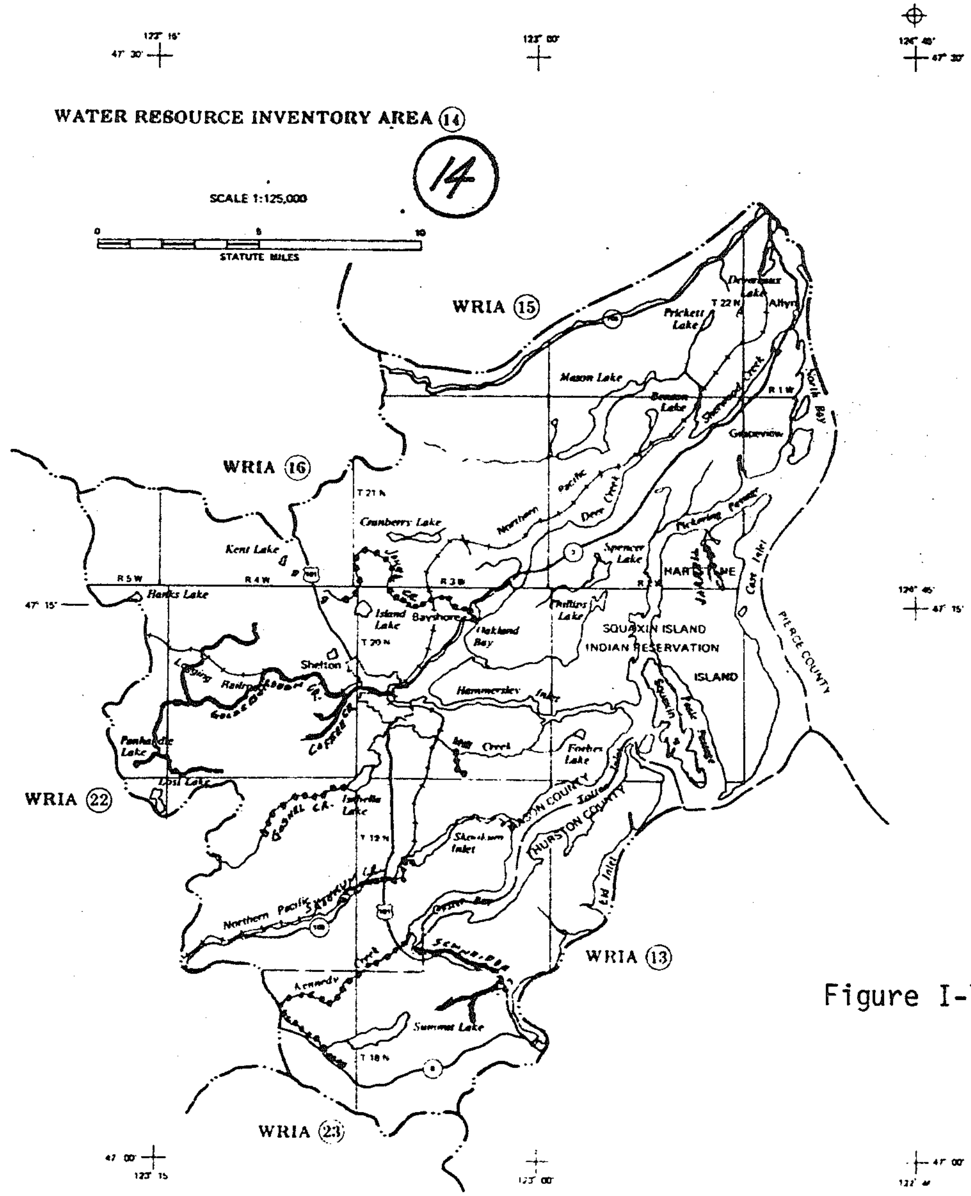

WATER RESOURCE INVENTORY AREA 14
SCALE 1:125,000
STATUTE MILES
WRIA 15
WRIA 16
WRIA 22
WRIA 13
WRIA 23
Mason Lake
Prickett Lake
Benson Lake
Allyn
Grapeview
North Bay
Cranberry Lake
Kent Lake
Hanks Lake
Island Lake
Bayshore
Shelton
Oakland Bay
Phillips Lake
Spencer Lake
Case Inlet
SQUAXIN ISLAND
INDIAN RESERVATION
ISLAND
PIERCE COUNTY
Hammersley Inlet
Forbes Lake
Panhandle Lake
Lost Lake
Isabella Lake
Skookum Inlet
MASON COUNTY
THURSTON COUNTY
Northern Pacific
Summit Lake
Deer Creek

Figure I-13

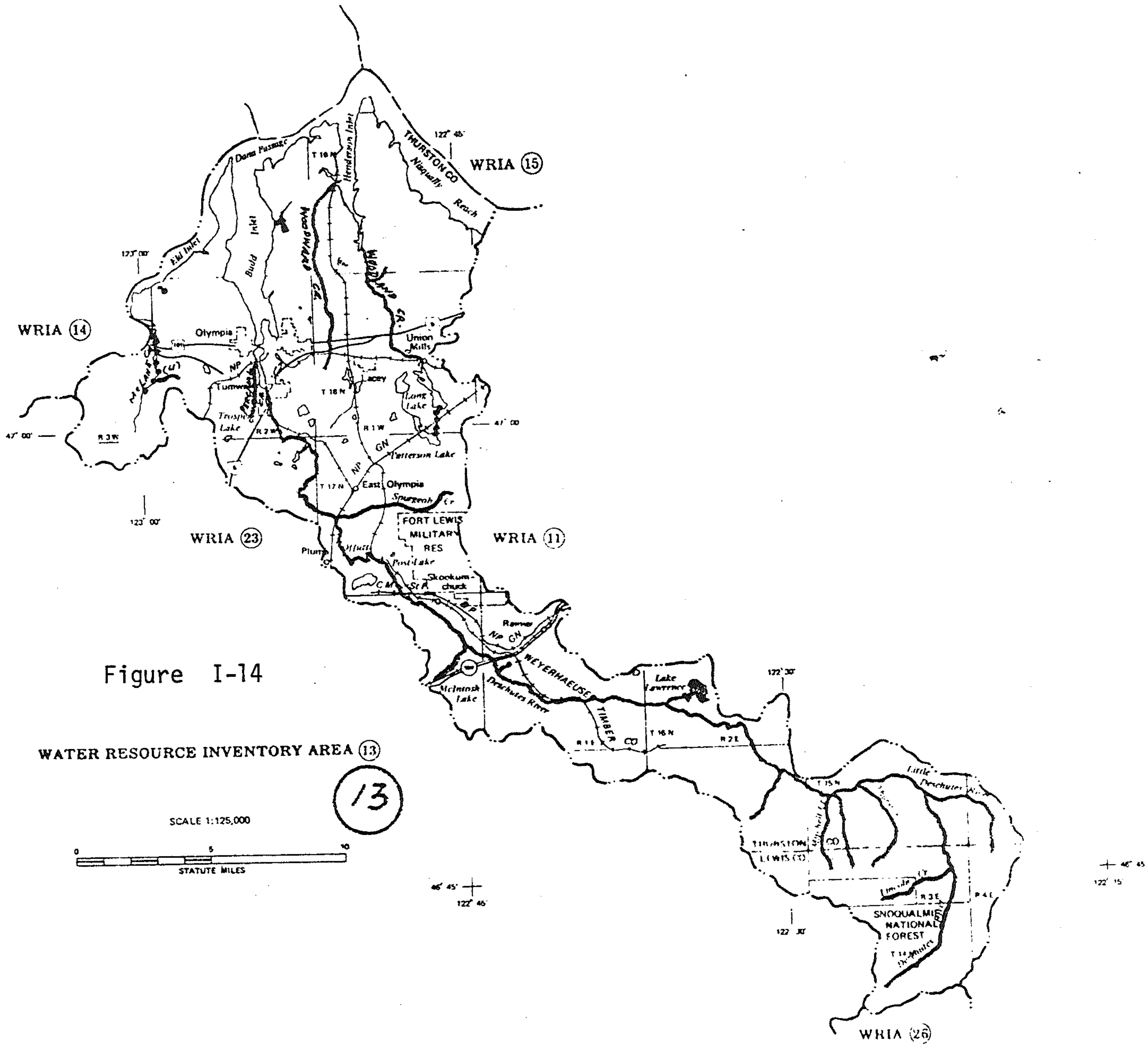

WRIA (15)
WRIA (14)
WRIA (23)
WRIA (11)
WRIA (26)
THURSTON CO
Nisqually Reach
Dana Passage
Eld Inlet
Budd Inlet
Henderson Inlet
Olympia
Union Mills
Tumwater
Lacey
Long Lake
Patterson Lake
East Olympia
FORT LEWIS MILITARY RES
Post Lake
Skookum-chuck
Rainier
McIntosh Lake
Deschutes River
WEYERHAEUSER TIMBER CO
Lake Lawrence
Little Deschutes River
THURSTON CO
LEWIS CO
SNOQUALMIE NATIONAL FOREST
WATER RESOURCE INVENTORY AREA (13)
13
SCALE 1:125,000
STATUTE MILES

Figure I-14

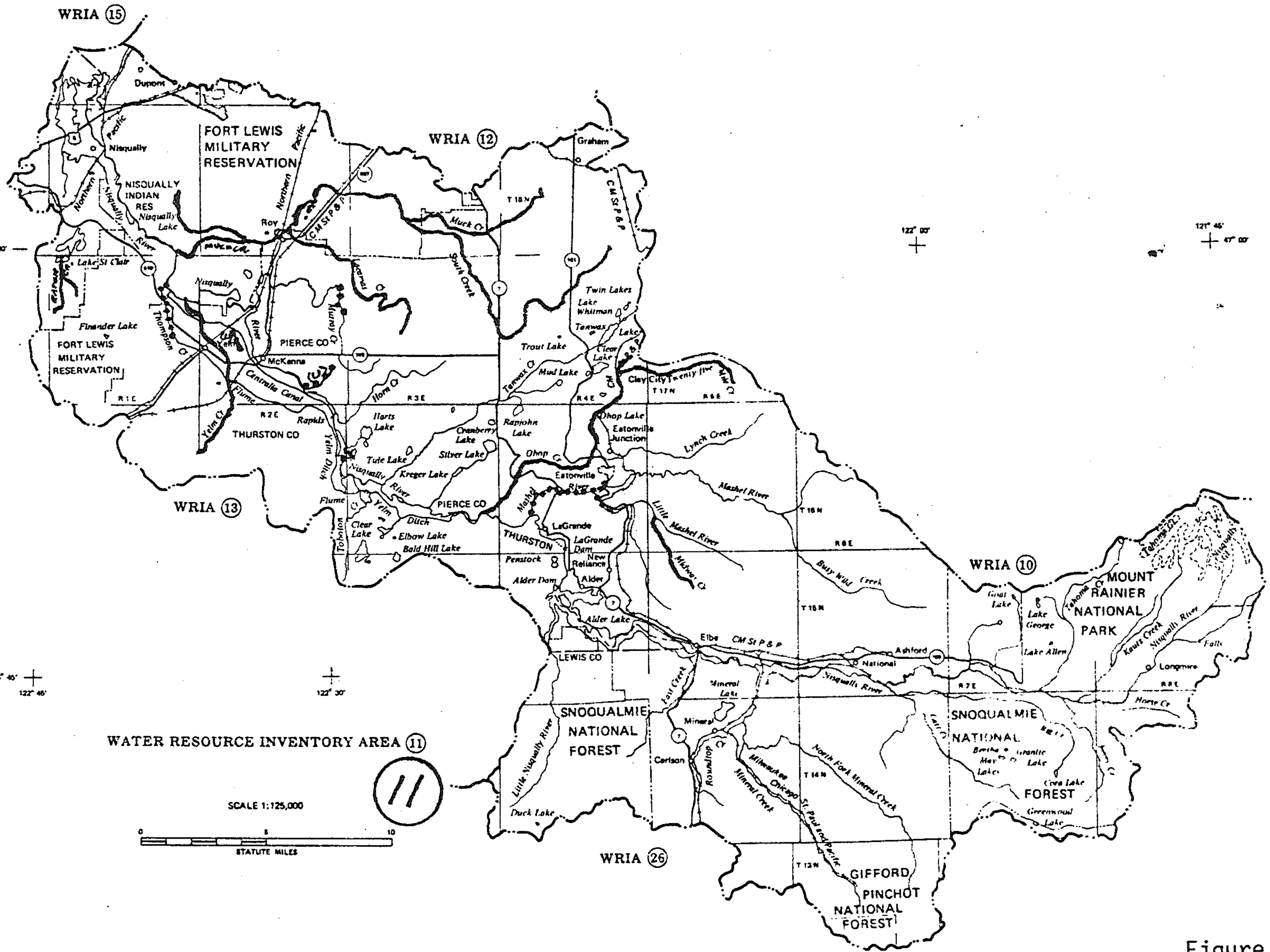

WRIA 15
WRIA 12
WRIA 13
WRIA 10
WRIA 26
FORT LEWIS MILITARY RESERVATION
NISQUALLY INDIAN RES
Dupont
Nisqually
Roy
Graham
PIERCE CO
THURSTON CO
McKenna
Yelm
Eatonville
Eatonville Junction
LaGrande
LaGrande Dam
New Reliance
Alder
Alder Dam
Alder Lake
Elbe
Ashford
National
Longmire
Mineral
Carlson
LEWIS CO
MOUNT RAINIER NATIONAL PARK
SNOQUALMIE NATIONAL FOREST
GIFFORD PINCHOT NATIONAL FOREST
Nisqually River
Mashel River
Little Mashel River
Lynch Creek
Ohop Lake
Centralia Canal
Yelm Ditch
Tule Lake
Kreger Lake
Silver Lake
Clear Lake
Elbow Lake
Bald Hill Lake
Trout Lake
Mud Lake
Twin Lakes
Lake Whitman
Rapjohn Lake
Mineral Lake
Lake St Clair
Muck Cr
South Creek
CM St P & P
WATER RESOURCE INVENTORY AREA 11
11
SCALE 1:125,000
STATUTE MILES

Figure I-15

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Pacific Northwest River Basins Commission. Puget Sound Task Force, Comprehensive Study of Water and Related Land Resources, Puget Sound and Adjacent Waters, Appendix IV, 1970.

U.S. Department of the Interior, Geologic Survey, Municipal, Industrial, and Irrigation Water in Washington, 1970, 21 pp.

U.S. Geological Survey, Compilation of Records of Surface Waters of the United States, Part 12, 1900-1970.

Washington (State). Department of Conservation. Water Supply Bulletin #18, Water Resources and Geology of Kitsap Peninsula and Certain Adjacent Lands, 1965, 308 pp.

PART II

REVIEW REPORT

ON

GROUND-WATER AVAILABILITY

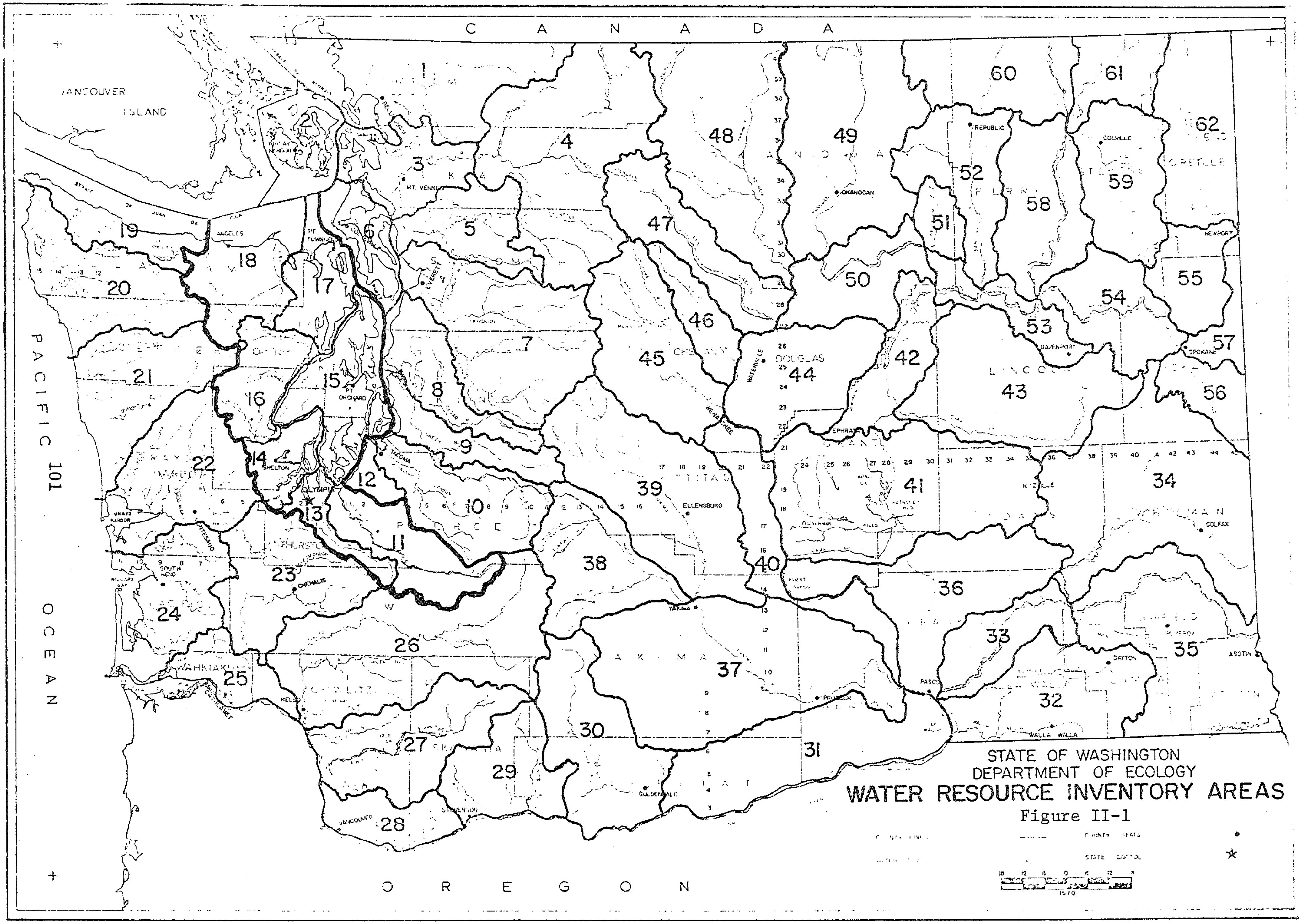
IN

THE WESTERN SOUND BASINS

INTRODUCTION

The purpose of this report is to present a general and overall review of ground-water availability in the Western Sound Basins, which includes the following subbasins: Nisqually-Deschutes, West Sound, and Elwha-Dungeness. Specific information on aquifers and ground-water geology have been omitted, but publication with specific information are given to you in the bibliography. An attempt was made to outline the ground-water problems to the extent there is a problem.

The locations of the basins are shown in Figure II-1.


CANADA
VANCOUVER ISLAND
PACIFIC OCEAN
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OREGON
STRAIT OF JUAN DE FUCA
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MT. VERNON
EVERETT
PT. TOWNSEND
PT. ANGELES
ORCHARD
TACOMA
SHELTON
OLYMPIA
CHEHALIS
SOUTH BEND
KELSO
VANCOUVER
STEVENSON
GOLDENDALE
YAKIMA
ELLENSBURG
WENATCHEE
WATERVILLE
EPHRATA
RITZVILLE
COLFAX
POMEROY
DAYTON
ASOTIN
WALLA WALLA
PASCO
PROSSER
DAVENPORT
SPOKANE
NEWPORT
COLVILLE
REPUBLIC
OKANOGAN
DOUGLAS
WAHKIAKUM
STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
WATER RESOURCE INVENTORY AREAS
Figure II-1
COUNTY SEATS
STATE CAPITOL
1970

GROUNDWATER USE

A summary of groundwater Rights (from Columbia-North Pacific Study) is given in Table II-1. Municipal and individual-community domestic uses account for most of the ground water. Irrigation is the second largest use. Ground-water use varies from 94 cfs in the Deschutes River Valley to 3 cfs in the Dosewallips, Hamma Hamma, and Duckabush rivers. Domestic use is highest in WRIA 15, the Kitsap area, and irrigation use is highest in the Nisqually River Valley.

A 1974 tabulation of individual water rights (Table II-2) was used to determine irrigated acreage and ground water used for irrigation. There is a total of approximately 12,500 acres irrigated by ground water in the Western Sound Basins; most of this occurring in the Nisqually-Deschutes Subbasin.

A summary of groundwater right claims is given in Table II-3. As can be seen, there is a tremendous amount of potential ground-water use. Most of the claims are for domestic use, which includes public supply, individual domestic, and industrial uses. Most of these claims are from the Kitsap Peninsula.

TABLE II-1

SUMMARY OF GROUND-WATER RIGHTS 1966

SUBBASIN	WRIA	MUNICIPAL	IRRIGATION	DOMESTIC	INDUST./COMM.	STOCK	TOTAL
Nisqually-Deschutes	11	3.21	37.97	22.36	5.86	5.69	75.09
	13	14.87	30.05	30.43	16.59	2.43	94.37
West Sound	14	9.24	5.08	20.10	27.59	2.22	64.23
	15	8.98	8.79	35.65	7.95	0.14	61.51
	16	0.0	0.11	2.99	0.0	0.0	3.10
	17	4.95	4.65	3.34	0.0	2.44	15.38
Elwha-Dungeness	18	1.57	16.00	13.29	0.04	0.96	31.86
Total		42.82	102.65	128.16	58.03	13.88	345.54

Quantities in cubic feet per second (cfs).

TABLE II-2 - GROUND-WATER USE AND IRRIGATED ACREAGE

Subbasin	WRIA	Ground-Water Rights 1974 Ac.ft/yr.	Ground-Water Rights 1974 Irr. ac.	SCS Study 1968 Irr. ac.
Nisqually-Deschutes	11	17,308	5,120	3,330
	13	43,195	2,855	1,700
West Sound	14	18,787	524	50
	15	34,288	1,651	450
	16	623	21	0
	17	5,407	750	500
Elwha-Dungeness	18	13,321	1,632	0
Total		132,929	12,553	6,030

TABLE II-3 - SUMMARY OF GROUND-WATER CLAIMS 1974

Subbasin	WRIA	Dom.	Number of Claims Stock	Irr.	Other	Total	Irr. Ac.
Nisqually Deschutes	11	1434	462	193	41	2139	5824
	13	2395	400	248	76	3119	1519
West Sound	14	1561	130	161	44	1896	656
	15	5261	647	634	135	6677	2442
	16	235	23	24	10	292	1501
	17	704	81	75	28	888	309
Elwha-Dungeness	18	936	153	185	24	1298	707
Total		12526	1896	1517	358	16309	12958

WATER AVAILABILITY

Future water requirements for the Western Sound will be determined by the rate of growth of population, industry, and agriculture, and the efficiency with which the available water is used. Individual and small rural community systems have been predominately served by wells, and this trend is expected to intensify. Problems are present, especially in the Kitsap Peninsula, but generally adequate ground-water resources do exist.

Following is a brief breakdown by basin of ground-water resources and problem areas.

NISQUALLY - DESCHUTES

Recessional outwash, which covers most of the lowlands, is the most important aquifer in the basin, and moderate to large supplies of water can be drawn from this material. Ground water in mountain areas is confined to valley fill material, and extensive aquifers are not found but production is important locally. Practically all recharge to aquifers in the lowlands is by precipitation. These aquifers may receive 200,000 acre-feet of recharge in an average year. Most of the ground water is discharged naturally into the Nisqually and Deschutes rivers and their tributaries. Most of the ground water pumped is used for irrigation, principally near Yelm. Sources of greatest yield are the industrial and public supply wells at Dupont and Yelm, and from the springs at the head of McAllister Creek. Although ground water presently supplies more than 85 percent of all water used in the basin, adequate supplies of usable ground water are available; particularly in the flood plain of the Nisqually River, and to a lesser extent, the Deschutes flood plain.

WEST SOUND

Ground-water supplies are plentiful in some parts of the West Sound Subbasin, and poor in others. The mountainous area of the Olympic National Park consists principally of consolidated sedimentary and volcanic rocks. Yields here are low, but population is sparse and so is water demand. The most productive aquifers are the coarse Quaternary deposits found in the lowland areas near the town of Shelton. Wells in parts of the Kitsap Peninsula, however, are likely to have extremely low yield. Due to poor geologic, topographic, and climatological conditions, there is a water supply problem. This is increased by a rapid growth rate in the Kitsap area. Surface water sources in the Kitsap area are also quite poor. Practically all natural recharge is from precipitation, which ranges from 20 inches in the northern lowlands to 60 inches in the southern lowlands. Aquifers are generally thin and not very extensive. A problem in groundwater development is the contamination of fresh water aquifers in areas near Puget Sound as a result of saltwater intrusion. This problem is further accented with increasing population density. At present, the main considerations for future supplies have been proposed storage developments in or outside the peninsula.

ELWHA-DUNGENESS

Ground-water supplies are plentiful in a few places in both the mountains and the lowlands of the subbasin. Virtually all of the ground water in the lowlands is drawn from sands and gravels deposited by the northward flowing streams or by glacial action. Generally, this material is permeable enough to allow moderate yields of ground water.

Natural precipitation is the chief source of recharge to the aquifers. Runoff from the Olympic Mountains may also contribute substantial amounts of recharge, as the annual precipitation in the Sequim-Dungeness area is low, but the groundwater supply is quite abundant. Irrigation, which has caused a rise in the water table of as much as three feet in some areas during the summer months, is an important secondary source of recharge. Under present conditions, additional irrgation supplies are desirable and no further surface water supplies are available. Ground-water development could be enhanced by a more efficient distribution system.

NOTE: For specific information see:

1. Water Supply Bulletin #10 and #29
   "Geology & Ground Water Resources of Thurston County"
   "Geology & Related Ground Water Occurrences in S.E. Mason County
2. Water Supply Bulletin #11
   "Geology and Ground Water Resouces of the Sequim Dungeness Area
3. Water Supply Bulletin #18
   "Water Resources and Geology of the Kitsap Peninsula"

PART III

RECONNAISSANCE REPORT

ON

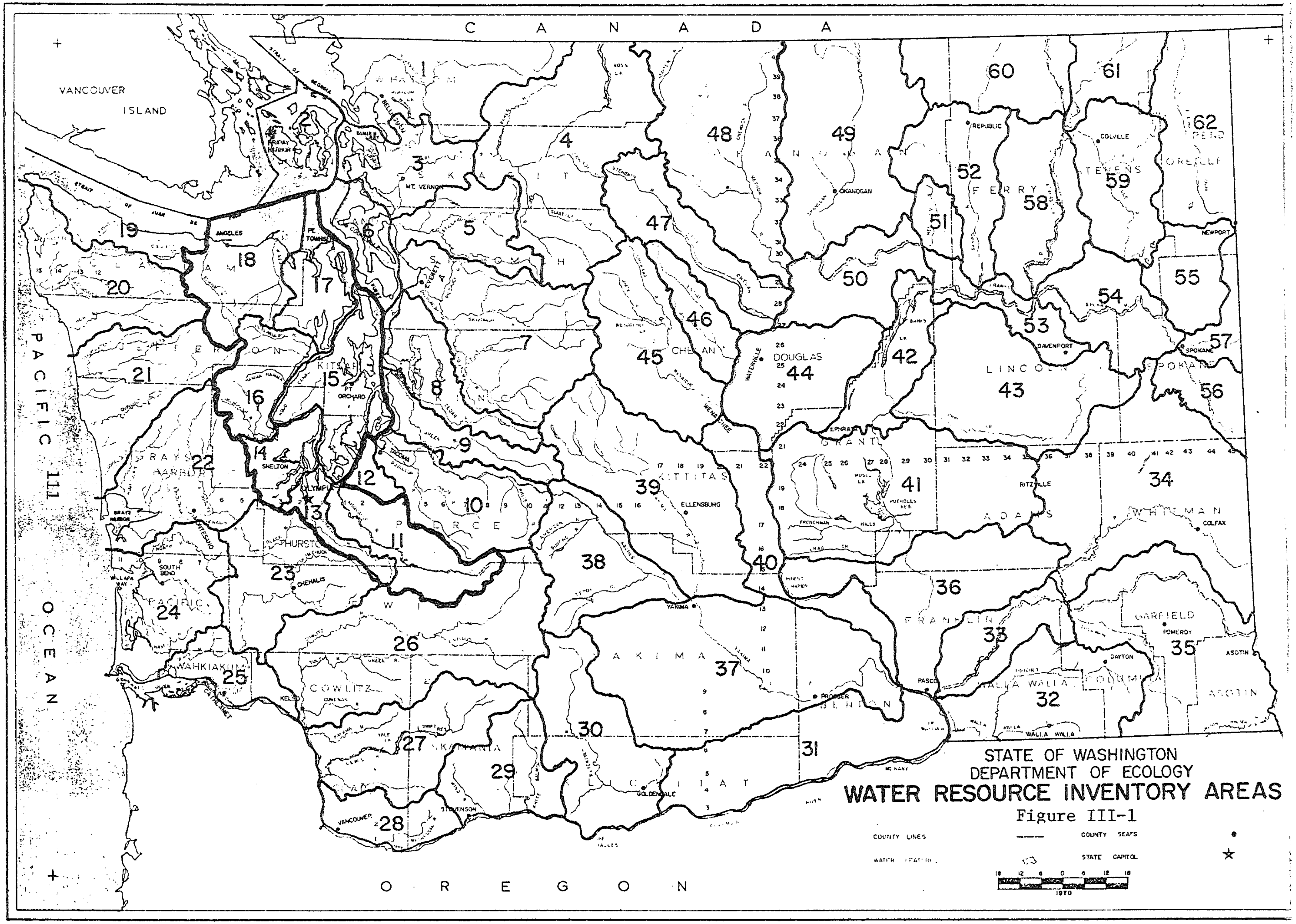
FLOOD DAMAGE REDUCTION

IN THE

WESTERN SOUND BASINS

INTRODUCTION

The purpose of this report is to present a general and overall view of flood problems in the Western Sound Basins. This includes three subbasins: the Nisqually-Deschutes, the West Sound area, and the Elwha-Dungeness. The location of the basins is shown in figure III-1. Most of the information is from the report for the Puget Sound and Adjacent Waters Study. The costs are for a base period between 1966 and 1970.


CANADA
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PACIFIC OCEAN
VANCOUVER ISLAND
STRAIT OF JUAN DE FUCA
STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
WATER RESOURCE INVENTORY AREAS
COUNTY LINES
COUNTY SEATS
WATER FEATURES
STATE CAPITOL
1970
Figure III-1

NISQUALLY-DESCHUTES BASIN

NISQUALLY RIVER

The Nisqually River flood plain totals 9,000 acres. The entire flood plain is subject to periodic spring and winter flooding; however, flood damage is sustained primarily by recreational developments upstream from Alder Reservoir and agricultural developments in the fertile, 3,000-acre delta.

The narrow flood plain above Alder Reservoir suffers frequent flooding. The steep gradient of the river results in high velocity flows that carry large quantities of gravel, logs, and other debris. Developments within Mount Rainier National Park, including the park headquarters at Longmire and Sunshine Park Campground near the park entrance, are within the flood plain. From Mount Rainier National Park to Alder Reservoir, the stream gradient is less severe. During high flows, heavy deposits of bedload and debris fill the channel and force the river to spread over the valley floor. Developments include the park's entrance facilities, summer homes, the Nisqually Park subdivision and Gateway Inn Resort. Transportation facilities include State Highway 7, a county road, and a railroad.

The Alder and LaGrande hydroelectric projects do not provide flood control storage but reservoir operations do reduce flood discharges. Alder Reservoir is approximately seven miles long, covers 3,100 acres, and has a storage capacity of 232,000 acre-feet. The LaGrande project generates power and reregulates discharges from Alder Dam. The reservoir is about one and a half miles long, covers 45 acres, and has a storage capacity of 2,700 acre-feet.

Worst floods occur during winter months due to abundant precipitation at lower elevations, and sometimes during May and June because of snowmelt in the higher elevations. About 18,000 cfs at McKenna is considered to represent the zero damage flow. The largest floods for the period of record at McKenna are shown in table III-1.

TABLE III-1. Major floods and damages - McKenna

Date or Frequency	Peak Discharge (cfs)	Average Recurrence Interval (Years)	Current Estimated Damages
January 29, 1965	25,700	20	$140,000
December 23, 1964	22,300	13	50,000
November 23, 1959	20,500	10	40,000
50-year flood	33,000*	50	475,000
100-year flood	39,500*	100	930,000

*Estimate in PSAAW report

Average annual flood damages are estimated to be $31,000 for the Nisqually River flood plain, most of which are agricultural lands and buildings in the delta. Under 1966 conditions, the damage that would result from a 100-year frequency flood is estimated to be $930,000. Table III-2 lists the categories of general flood damages.

TABLE III-2. Flood damage distribution - Nisqually River

Category	Percent of Total Damage
Agriculture	36
Buildings and equipment	17
Parks and fish habitats	16
Transportation facilities	14
Other	17
Total losses and damages	100%

Overbank flooding occurs frequently above Alder Reservoir, but occurs about once every seven years below the reservoir. The flood of December 22, 1933, had an estimated peak discharge of 42,000 cfs at the rivermouth and inundated most of the delta. Damage begins when the flow exceeds 18,000 cfs on the gage at McKenna. When the flow exceeds 26,000 cfs, major damages and losses result from erosion.

Some protective measures do exist, such as levees, bank protective works, and flood forcasting. However, there is no flood plain regulations and management program in effect as yet.

DESCHUTES RIVER

The 2,700-acre Deschutes River flood plain contains 1,200 acres of cultivated agricultural land, urban, suburban and industrial development, and transportation facilities that are subject to periodic winter and spring flooding. The Deschutes River is primarily a rainfed stream and has a high base flow during the winter months. Peak flows may occur from November through March and are characterized by sharp, extreme rises followed by a recession almost as rapid.

The mean discharge at Olympia was 390 cfs for the period 1931-1960. About 3,500 cfs at Olympia may be considered to represent zero damage flow. Since 1945, this flow has been exceeded at least 14 times. Major damage begins when the flow exceeds 5,400 cfs. Major floods and damages are given in Table III-3.

TABLE III-3. Major floods and damages - Olympia

Date or Frequency	Peak Discharge (cfs)	Recurrence Interval (Years)	Estimated Damages*
January 26, 1964	6,650	18	$130,000
December 13, 1955	6,080	12	90,000
November 26, 1962	5,000	5	30,000
50-year flood	7,900	50	240,000
100-year flood	8,800	100	340,000

*1966 Prices and Conditions

The average annual flood damages for the Deschutes River flood plain are estimated to be $26,000. Most of these damages are to roads, railroads, bridges, buildings, summer homes, residences, the Olympic Brewery, a fish egg-taking station, and water wells. Damages resulting from a 100-year frequency flood are estimated to be $340,000. Table III-4 lists areas of flood damage.

TABLE III-4. Flood damage distribution - Deschutes River

Category	Percent of Total Damage
Buildings and equipment	49
Transportation facilities	26
Agriculture	20
Other	5
Total Losses and damages	100%

The Deschutes River is primarily a rainfed stream. During the summer, discharges and velocities are low. Heavy precipitation in the winter months causes sudden rises and overbank flows. There are no storage reservoirs in the basin to regulate streamflow, and very little bank protection or other flood control works along the river. Flood plain management could control developments in the flood plain and minimize future flood damages.

WESTERN SOUND

Flood damages in this subbasin are relatively minor, especially in the Kitsap Penninsula where there are no large streams. There has been little or no protective works constructed on these rivers, and very little development has occurred. This has helped to reduce damages and flood plain management should be implemented to ensure that future damages remain minor.

SKOKOMISH

The most serious flood problem area is the Skokomish Valley agricultural lands. The flood plain totals 4,600 acres, and although flooding is frequent, most of the land is used exclusively for pasture. Flooding occurs during winter months and resulting average annual damages are only about $27,000.

Swift tributary streams deposit large quantities of gravel and debris in the Skokomish River. High velocity flows for several miles downstream from the mouths of the tributaries causes the formation of debris jams that contribute to erosion and flooding in the flood plain almost every winter. Discharges of 13,000 cfs on the Skokomish and 11,000 cfs on the South Fork are considered to be zero damage flows. The zero damage flow for the Skokomish River has been exceeded at least 29 times since 1943.

Tacoma City Light has constructed two dams on the north fork of the Skokomish River and operates two hydroelectric plants. The combined storage capacity of the reservoirs is 368,000 acre feet. The Cushman Dam has partially regulated flood flows on the north fork since 1926.

HAMMA HAMMA

The 66-acre flood plain of the Hamma Hamma River extends approximately one mile upstream from the mouth. With the exception of 26 acres of pasture land, this area is undeveloped. Because of limited development, flood damage is relatively minor ($800 annually), but the flood plain has an excellent recreation potential and development is sure to increase.

DUCKABUSH

The Duckabush River contains a 70-acre flood plain containing a few summer homes. A discharge of 4,200 cfs measured at the gage near Brinnon is considered to be zero damage flow. Average annual damages are estimated to be $3,000. Most of this damage is sustained by summer homes and recreational facilities.

DOSEWALLIPS

The flood plain of the Dosewallips River extends approximately five miles upstream from the mouth and comprises 250 acres of land, including 47 acres within the Dosewallips State Park. The 30-acre campground has 156 tent and trailer spaces, roadways, parking areas, electricity, water and sanitary facilities. Overbank flooding occurs about once every two years, with damages primarily to facilities in Dosewallips State Park. Average annual damages are estimated to be $11,600; and the 100-year flood to be $124,000. Flooding is aggravated by the deposition of debris, log jams, the formation of gravel bars, and the growth of trees in the channel. Overbank flooding begins when discharges exceed 4,200 cfs.

QUILCENE RIVER BASINS

The flood plain of the Big Quilcene River comprises 171 acres and includes a portion of the town of Quilcene. Average annual damages are $8,500. Most of the damage is to buildings and equipment. The Army Corps of Engineers has published a Flood Plain Information Report on the lower two miles of the Big Quilcene River.

The Little Quilcene River is a small stream with a steep gradient. Its flood plain contains 93 acres. Most of this is cultivated with a few dwellings. Average annual damages are estimated at $100.

TABLE III-5. Major floods and estimated damages - West Sound Basins

Date or Frequency	Peak Discharge (cfs)	Average Recurrence Interval (Years)	Current Estimated Damages
Skokomish River (Potlatch gage)			
November 3, 1955	27,000	22	$125,000
January 15, 1961	26,400	20	114,000
April 30, 1959	23,600	11	71,000
November 20, 1959	22,100	8	56,000
50-year flood	30,500	50	191,000
100-year flood	34,000	100	266,000
Hamma Hamma River (Eldon gage)			
November 3, 1955	5,810	7	$ 1,600
January 29, 1960	5,410	6	1,100
January 15, 1961	4,920	5	1,000
50-year flood	9,900	50	7,200
100-year flood	11,600	100	7,900
Duckabush River (Brinnon gage)			
November 26, 1949	8,960	50	$ 30,000
January 29, 1960	6,500	8	6,000
December 2, 1941	6,080	6	4,000
100-year flood	10,000	100	49,400
Dosewallips River (Brinnon gage)			
November 26, 1949	13,200	83	$137,000
November 5, 1934	10,900	36	108,000
November 3, 1955	8,050	11	56,000
50-year flood	11,700	50	117,500
100-year flood	13,600	100	142,000
Big Quilcene River (Quilcene gage)			
December 1, 1966	2,760	5	$ 2,040
10-year flood	3,400	10	35,800
100-year flood	6,000	100	99,000
Little Quilcene			
February 13, 1954	820	--	--

Table III-6 gives a breakdown of flood damage distribution for the West Sound Basin.

TABLE III-6. **Flood damage distribution (in percent)**

	Agricultural	Buildings and Equipment	Transportation Facilities-Recreation	Other	Total
Skokomish	33	53	5	9	100
Hamma Hamma	31	14		55	100
Duckabush		94		6	100
Dosewallips		27	65		100
Big Quilcene		86	6	8	100
Little Quilcene	10	77		13	100

DUNGENESS RIVER

The flood plain of the Dungeness River contains approximately 2,900 acres. Developments in this area include highly productive agricultural lands, homes and farm buildings; a State fish hatchery, the water supply intake structure for the town of Sequim; the community of Carlsborg, and a summer home subdivision. The river is spanned by U.S. Highway 101, two railroads, and five county bridges. Dairying and the raising of beef cattle are the principal agricultural pursuits, and most of the land is in seeded pasture and hay to support these activities. Along the lower reaches of the stream, the land is irrigated by means of diversion works and ditches.

A flow exceeding 6,000 cfs causes major damage and has occurred at least five times. See table III-7.

TABLE III-7. Major floods and damages - Gage near Sequim

Date or Frequency	Peak Discharge (cfs)	Average Recurrence Interval (Years)	Current Estimated Damages
	14,600*	100	$600,000
	11,700*	50	330,000
November 27, 1949	6,820	11	48,000
November 3, 1955	6,750	11	43,000
February 11, 1924	6,340	10	32,000

*Estimate

The greater part of flood damages in the agricultural setting of the Dungeness Basin is to land, crops, farm buildings, and dwellings. See table III-8. Average annual flood damages are estimated to be $24,000.

TABLE III-8. Flood damage distribution - Dungeness Basin

Category	Percent of Total Damage
Agricultural	32
Buildings and equipment	28
Transportation facilities	31
Other	9
Total Losses and damages	100%

About $450,000 has been spent on levee construction and bank protection, but as yet these measures have not stopped the erosion caused by debris and log jams.

ELWHA RIVER

The Elwha River, emerging from glaciers in the Olympic Mountains, has a flood plain of 750 acres, most of which is used for agriculture. During recent years, a discharge of 9,000 cfs measured at the McDonald Bridge gage was determined to be zero damage flow. During the period of record, the river has exceeded this flow at least 40 times. Some of the larger flows are given in table III-9.

TABLE III-9. Major floods and damages - McDonald Bridge

Date or Frequency	Peak Discharge (cfs)	Average Recurrence Interval (Years)	Current Estimated Damages
November 18, 1897	41,600	100	$ 51,000
March 27, 1901	33,600	40	29,000
March 11, 1900	30,200	24	21,000
November 26, 1949	30,000	25	21,000
December 21, 1933	26,700	16	14,500

Most damages are sustained by agricultural lands and associated improvements. Average annual flood damages are estimated at $4,000. Major flood discharges on the Elwha River do not seriously disrupt the economy of the basin because the principal transportation systems are not effected, very few homes are within the flood plain, and damaged facilities can be restored rapidly.

TABLE III-10. Flood damage distribution - Elwha River

Category	Percent of Total Damage
Agriculture	19
Buildings and equipment	40
Transportation facilities	24
Other	17
Total losses and damages	100

The Crown Zellerbach Corporation owns and operates hydropower installations at Lake Mills and Lake Aldwell. While no firm flood control storage is provided, the Lake Mills reservoir is drawn down about 10 to 15 feet when a flood is expected to make 4,000 to 6,000 acre-feet of storage available. This amount of storage reduces peak discharges of moderate floods, but has little effect during major floods.

Levee construction, undertaken in 1951 and 1964, has provided some flood damage reduction; but flood plain management measures have not been adapted as yet.

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Puget Sound Task Force - Pacific Northwest River Basins Commission, Puget Sound and Adjacent Waters, Appendix XII, 1970.

PART IV

SUMMARY OF EXISTING AND POTENTIAL RESERVOIR SITES IN THE WESTERN AND SOUTHERN PUGET SOUND BASINS

INTRODUCTION

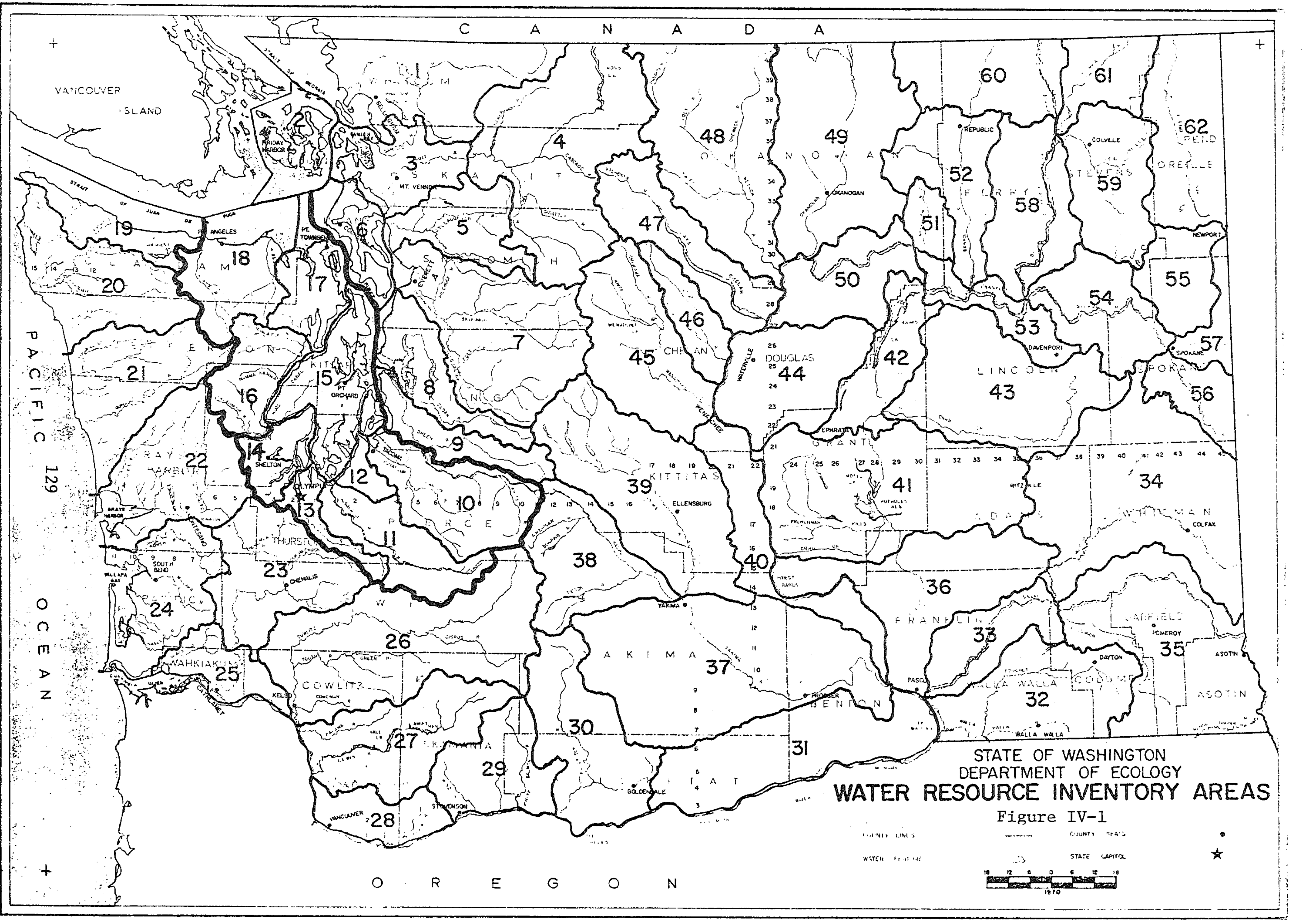
The following report lists an inventory of existing and potential reservoir sites in the Western Sound Basins. This includes the Puyallup, Nisqually, Deschutes, the West Sound (WRIA 14, 15, 16, 17), and the Elwha-Dungeness Basins. All potential reservoirs have a storage capacity of at least 1,000 acre feet.

It should be kept in mind that this report is strictly a summary of all possible sites. Evaluation of these sites may take place in the future. Many of the sites may be found to be economically infeasible and environmentally unsound.

RESERVOIR CATEGORIES

Reservoirs are used for a number of purposes. Flood control, power production, and water supply are the main ones, but often these uses are combined to create a multipurpose reservoir. An example of a multipurpose reservoir is a flood control project designed to reduce flood discharge, but which also serves as a water supply, or a hydroelectric project that also provides some flood control. Most of the reservoirs are multipurpose.

A pumped-storage project utilizes two reservoirs. It functions as an energy accumulator by pumping excess water, either during high flows or off-peak hours from a lower to a higher reservoir. The stored water can then be returned later to generate power during peak-load periods or by supplementing low flows when it is most needed.



CANADA
OREGON
PACIFIC OCEAN
VANCOUVER ISLAND
STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
WATER RESOURCE INVENTORY AREAS
Figure IV-1
STATE CAPITOL
1970

PUYALLUP BASIN

There are two existing reservoirs and sixteen potential reservoir sites in this basin. A list of these sites is given in Tables IV-1, IV-2, and IV-3. Figure IV-2 shows their location.

NISQUALLY-DESCHUTES BASINS

A total of six potential reservoir sites and two existing reservoirs are listed in Tables IV-4, IV-5, and IV-6. There is some concern over any proposed site of the Deschutes River because of instream values and environmental damage. Figures IV-3 and IV-4 show locations.

WESTERN SOUND BASINS

Data on the two existing reservoirs are listed in Table IV-7. Seventeen potential flood control or multipurpose reservoirs are listed in Table IV-8. Because of extremely high aesthetic reasons, as well as high instream values, these proposed sites should not be developed. The major rivers the sites are located on are proposed to be designated as wild and scenic rivers. Potential pumped-storage sites are listed in Table IV-9. Figures IV-5, IV-6, and IV-7 show locations of potential sites.

ELWHA-DUNGENESS BASINS

Existing reservoirs are listed in Table IV-10. Potential sites are given in Tables IV-11 and IV-12. Most of these sites, especially on the Elwha River, will never be developed. The proposed sites are within the Olympic National Park. Locations are shown in Figure IV-8.

TABLE IV-1. Existing Reservoirs in the Puyallup Basin

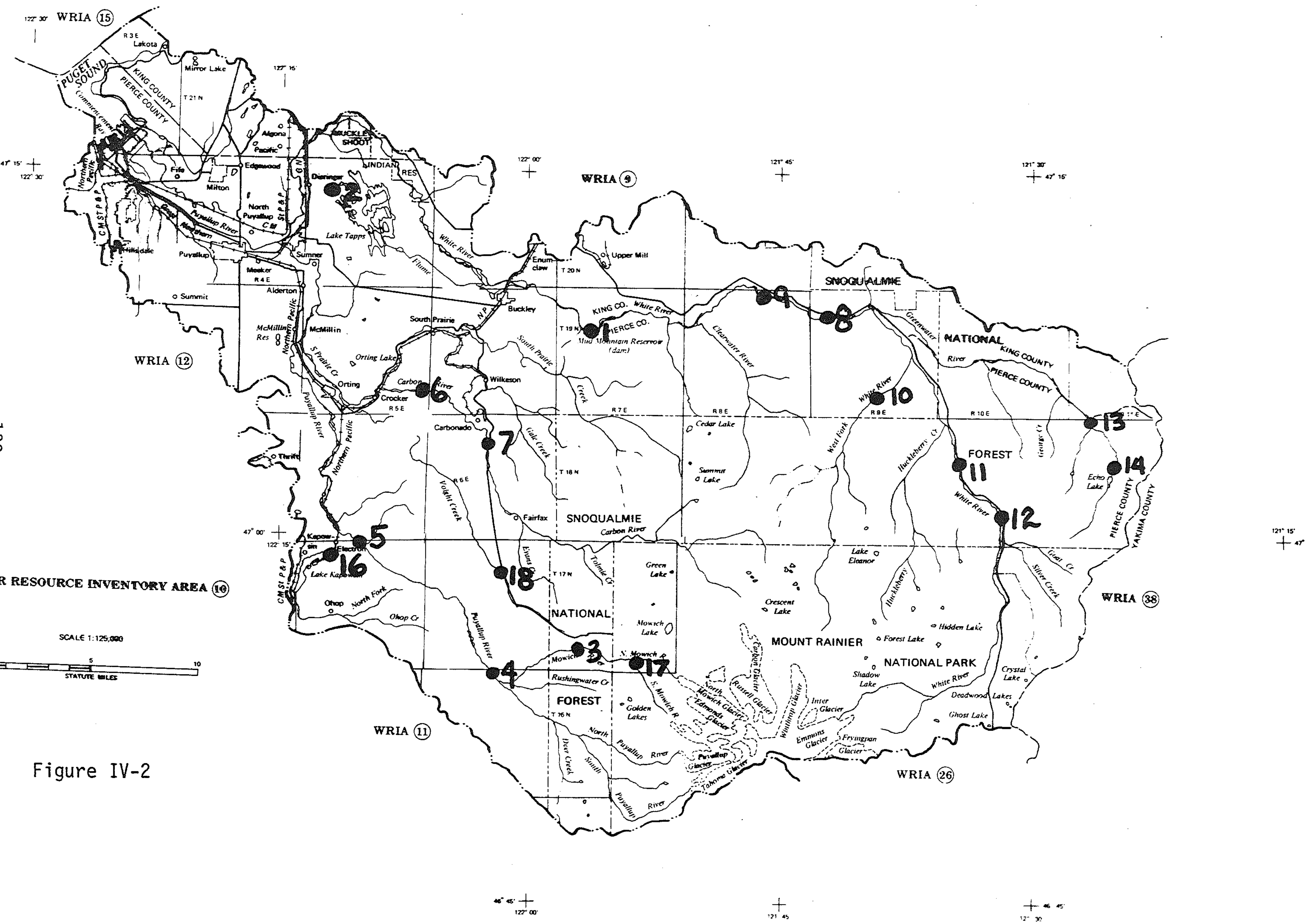
Map No.	Name	Location Stream	Storage (ac.-ft.) Active	Total	Dam Ht.	Use	Owners
1.	Mud Mt.	Puyallup R.	106,000	106,000	425	Flood Control	Corps of Engineers
2	Lake Tapps (White R. Proj.)	White R.	44,000	46,000	---	Power	Puget Sound Power & Light

Table IV-2. Potential Storage Sites in the Puyallup Basin, Multipurpose

Map No.	Project Name	River	Proposed Storage (ac.-ft.)	Source of Information
3	Mowich #1	Mowich	---	Puget Sound and Adjacent Waters Study, 1970
4	Mowich #1A	Puyallup	---	
5	Orting	Puyallup	25,000	
6	Mile 9.2	Carbon R.	---	
7	Fairfax	Carbon R.	98,000	
8	Deadman Flat	White R.		
9	Twin Creek	White R.	20,000	
10	W. Fk. Mouth	W. Fk Wht to R.	---	
11	Huckleberry	White R.	---	
12	E. Fk. Rainier	White R.	---	
13	Lost Creek	Greenwater R.	---	
14	Echo Lake	Greenwater R.	13,900	
15	White River	White R. ---	---	

TABLE IV-3. Potential Pumped-Storage Sites in the Puyallup Basin

Map No.	Site	Weekly Storage (ac.-ft.)	Hydraulic Cap. (cfs)	Source of Information
16	Kapowsin	14,800	12,200	Corps of Engineers Report, 1972
17	Mowich Lk.	7,100	5,900	
18	Voight Ck.	14,900	12,100	
		28,500	24,000	



WATER RESOURCE INVENTORY AREA 10

Figure IV-2

NISQUALLY BASIN

TABLE IV-4. Existing reservoirs in the Nisqually-Deschutes Basins

Map No.	Name	Location Stream	Storage (acre-ft) Active	Storage (acre-ft) Total	Dam Ht.	Owners
1	La Grande	Nisqually R.	1,600	2,700	212	City of Tacoma
2	Alder Lake	Nisqually R.	180,000	232,000	330	City of Tacoma

TABLE IV-5. Potential storage sites in the Nisqually-Deschutes Basins - Flood Control purposes

Map No.	Project Name	River	Total Storage (acre-ft)	Source of Information
3	Park Junction	Nisqually	--	Puget Sound and Adjacent Waters Study, 1970
4	Ohop	Ohop Cr.	20,000	
5	Nisqually R. Mile 31	Nisqually R. and Deschutes	--	
6	Nisqually R. Mile 41	Nisqually R.	--	
7	Shell Rock Ridge	Deschutes	48,000	

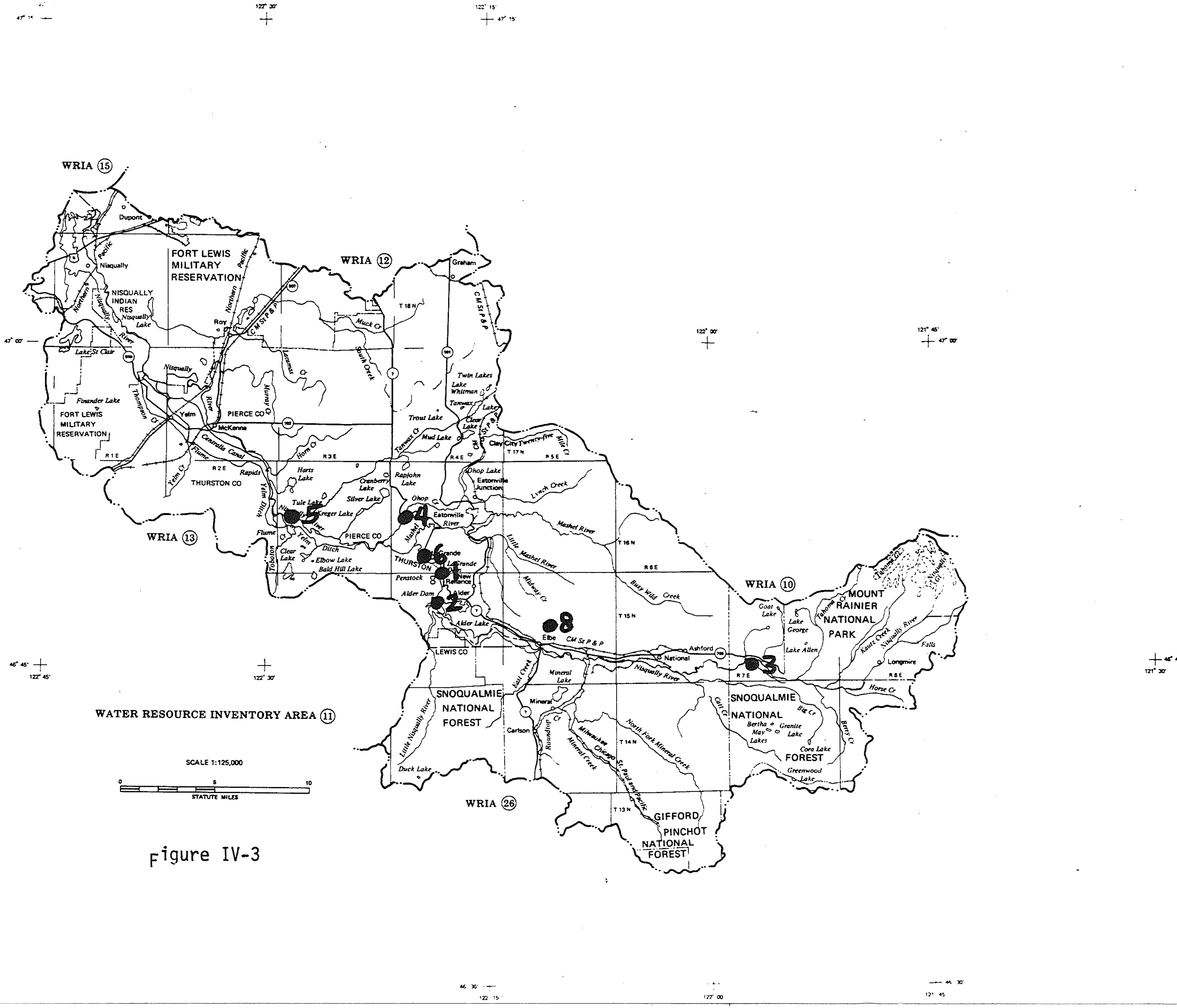
TABLE IV-6. Potential pumped-storage sites in the Nisqually-Deschutes Basin

Map No.	Site	Weekly Storage (acre-ft)	Hydraulic Capacity -CFS	Source of Information
8	Beamer Cr.	14,600	12,100	U. S. Army Corps of Engineers Report, 1972

THE WEST SOUND BASINS

TABLE IV-7. Existing reservoirs in the West Sound Basins

Map No.	Name	Location Stream	Storage (acre-ft) Active	Storage (acre-ft) Total	Dam Ht.	Owners
1	Cushman Res. 1	N. F. Skokomish	360,000	453,000	275	City of Tacoma
2	Cushman Res. 2	N. F. Skokomish	2,000	8,000	235	City of Tacoma


WRIA 15
WRIA 12
WRIA 13
WRIA 10
WRIA 26
FORT LEWIS MILITARY RESERVATION
NISQUALLY INDIAN RES
Dupont
Nisqually
Roy
Yelm
McKenna
Graham
THURSTON CO
PIERCE CO
LEWIS CO
Eatonville
La Grande
Alder
Alder Lake
Elbe
National
Ashford
Longmire
Mineral
Carlson
MOUNT RAINIER NATIONAL PARK
SNOQUALMIE NATIONAL FOREST
GIFFORD PINCHOT NATIONAL FOREST
Nisqually River
Mashel River
Little Mashel River
Lynch Creek
Busy Wild Creek
Mineral Creek
North Fork Mineral Creek
Little Nisqually River
Centralia Canal
Yelm Ditch
WATER RESOURCE INVENTORY AREA 11
SCALE 1:125,000
0 5 10
STATUTE MILES
1
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3
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8

Figure IV-3

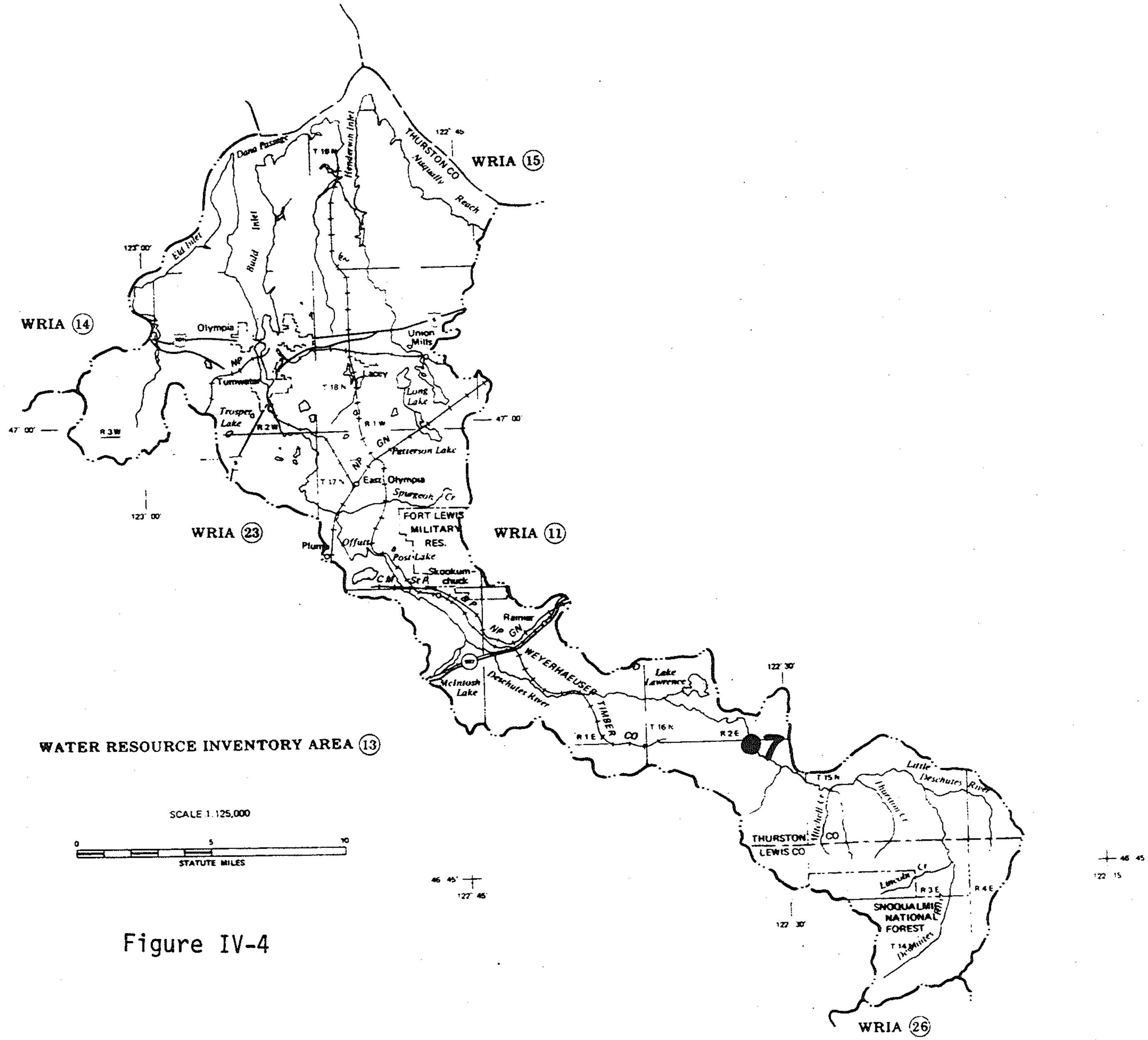

WRIA (15)
WRIA (14)
WRIA (23)
WRIA (11)
WRIA (26)
THURSTON CO
Nisqually Reach
Dana Passage
Henderson Inlet
Budd Inlet
Eld Inlet
Olympia
Union Mills
Tumwater
Lacey
Long Lake
Trosper Lake
Patterson Lake
East Olympia
FORT LEWIS MILITARY RES.
Offutt
Post Lake
Skookumchuck
Plum
Rainier
McIntosh Lake
Deschutes River
WEYERHAEUSER TIMBER CO
Lake Lawrence
Little Deschutes River
Thurston Cr
Mitchell Cr
THURSTON CO
LEWIS CO
Lincoln Cr
SNOQUALMIE NATIONAL FOREST
Deschutes
WATER RESOURCE INVENTORY AREA (13)
SCALE 1:125,000
STATUTE MILES

Figure IV-4

TABLE IV-8. Potential storage sites in West Sound Basins

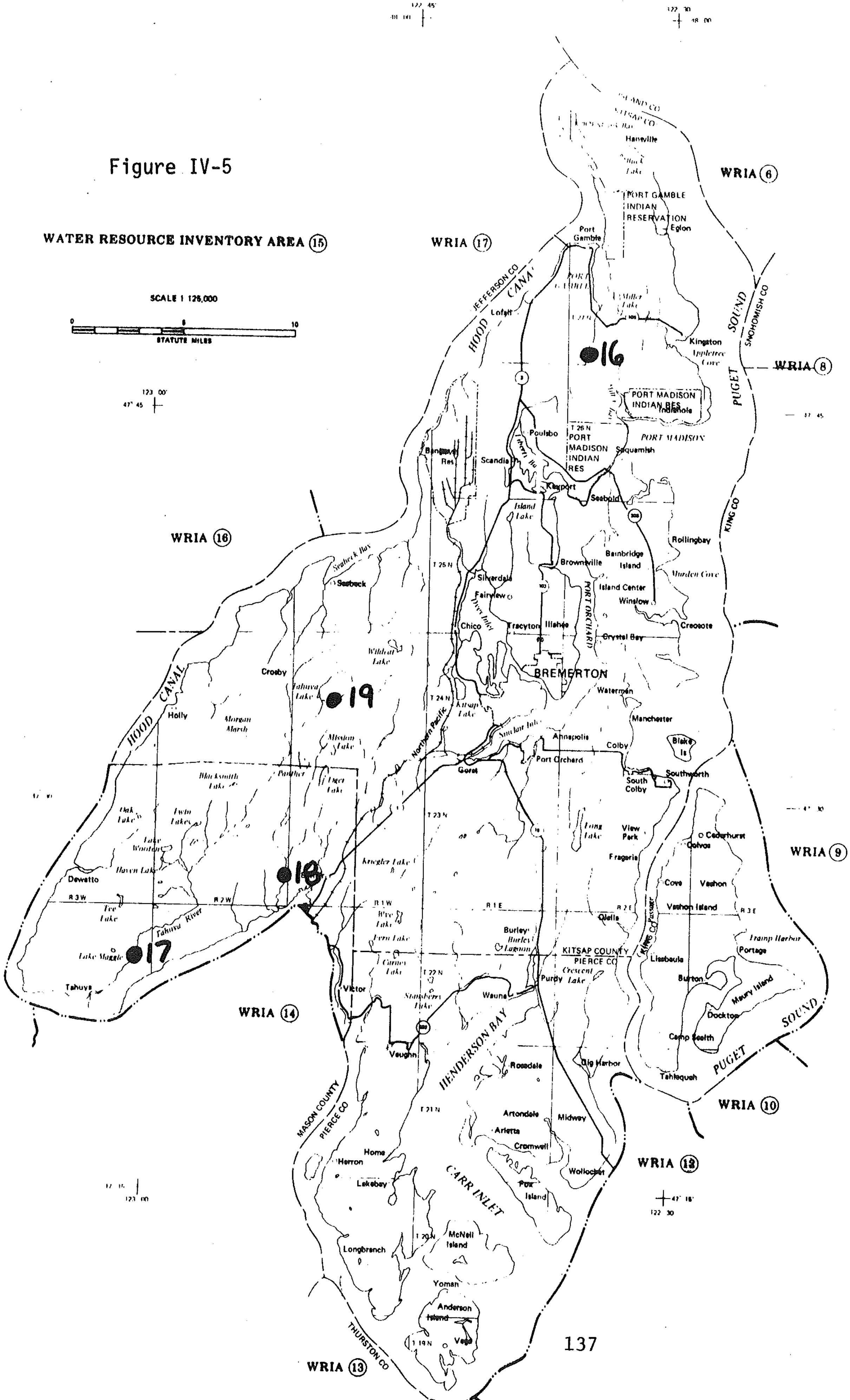
Map No.	Project Name	River	Total Storage (acre-ft)	Source of Information
3	Seven Streams	N.F. Skokomish	--	Puget Sound and Adjacent Waters Study, 1970
4	Staircase	N.F. Skokomish	--	
5	Brown Cr.	S.F. Skokomish	365,000	
6	USGS site 9 (Hamma Hamma)	Hamma Hamma R.S.	19,000	
7	Duckabush 15A	Duckabush	73,000	
8	USGS site 14A (Big Hump)	Duckabush	230-270	
9	USGS site 13	Duckabush	--	
10	USGS site 12	Dosewallips	120,000	
11	USGS site 11	Dosewallips	--	
12	USGS site 10	Dosewallips	--	
13	USGS site 18	Big Quilcene R.	250,000	
14	Tunnel Cr.	Big Quilcene R.	--	
15	USGS site 16	Big Quilcene R. 11.1	--	
16	Gamble Cr.	Gamble Cr.	20,000	
17	Tahuya R.	Tahuya R.	111,000	
18	Mission Cr.	Mission Cr.	9,500	
19	Gold Cr.	Gold Cr.	9,700	

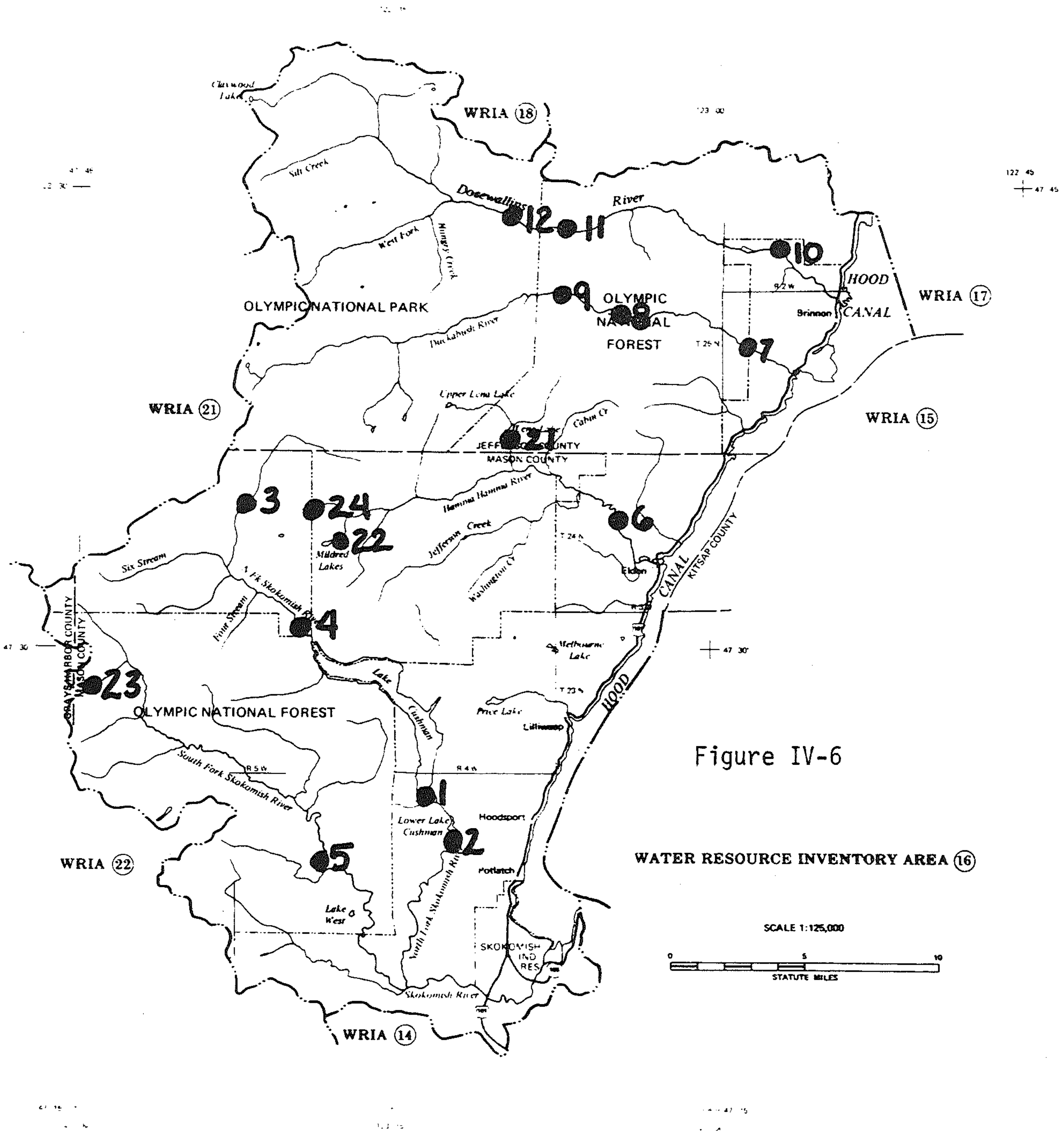
TABLE IV-9. Potential pumped-storage sites in the West Sound Basin

Map No.	Site		Weekly Storage (acre-ft)	Hydraulic Capacity-CFS	Source of Information
20	Hamma Hamma	(1)	7,500	6,200	U. S. Army Corps of Engineers Report, 1972
		(2)	44,300	36,800	
21	Lena Lake	(1)	13,100	11,000	
		(2)	25,800	21,700	
22	Mildred Lk.	(1)	5,500	4,600	
		(2)	32,400	26,900	
23	Pine Lakes	(1)	13,200	11,000	
		(2)	25,600	21,400	

Figure IV-5

WATER RESOURCE INVENTORY AREA (15)




WRIA 18
WRIA 17
WRIA 15
WRIA 21
WRIA 22
WRIA 14
Dosewallips River
OLYMPIC NATIONAL PARK
OLYMPIC NATIONAL FOREST
HOOD CANAL
Brinnon
Duckabush River
Upper Lena Lake
Cabin Cr
JEFFERSON COUNTY
MASON COUNTY
Hamma Hamma River
Jefferson Creek
Washington Cr
Mildred Lakes
Six Stream
N Fk Skokomish River
Four Stream
Eldon
KITSAP COUNTY
Melbourne Lake
Lake Cushman
Price Lake
Lilliwaup
GRAYS HARBOR COUNTY
MASON COUNTY
South Fork Skokomish River
Lower Lake Cushman
Hoodsport
Potlatch
Lake West
SKOKOMISH IND RES
Skokomish River
Silt Creek
West Fork
Hungry Creek
Claywood Lake
WATER RESOURCE INVENTORY AREA 16
SCALE 1:125,000
0
5
10
STATUTE MILES
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23
24

Figure IV-6

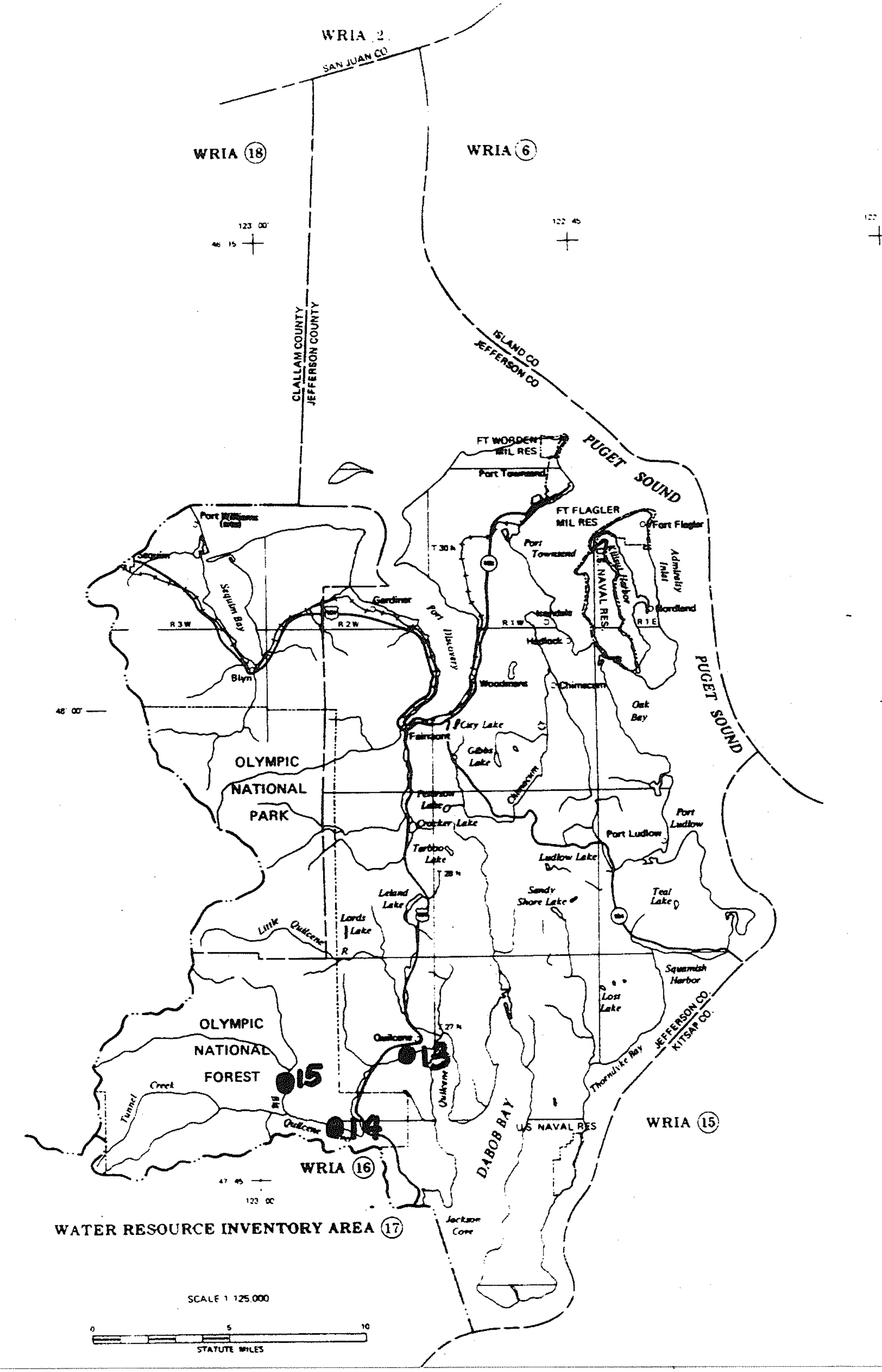
WRIA 2
SAN JUAN CO
WRIA 18
WRIA 6
CLALLAM COUNTY
JEFFERSON COUNTY
ISLAND CO
JEFFERSON CO
PUGET SOUND
FT WORDEN MIL RES
Port Townsend
FT FLAGLER MIL RES
Fort Flagler
Admiralty Inlet
Nordland
U.S. NAVAL RES.
Sequim Bay
Gardiner
Port Discovery
R 3 W
R 2 W
R 1 W
R 1 E
Blyn
Hadlock
Chimacum
Oak Bay
PUGET SOUND
OLYMPIC NATIONAL PARK
Fairmont
Cary Lake
Gibbs Lake
Crocker Lake
Tarboo Lake
Port Ludlow
Ludlow Lake
Sandy Shore Lake
Teal Lake
Leland Lake
Lords Lake
Little Quilcene R
Squamish Harbor
Lost Lake
OLYMPIC NATIONAL FOREST
Quilcene
Tunnel Creek
Quilcene
DABOB BAY
Thorndyke Bay
JEFFERSON CO.
KITSAP CO.
U.S. NAVAL RES
WRIA 15
WRIA 16
Jackson Cove
WATER RESOURCE INVENTORY AREA 17
SCALE 1 125,000
STATUTE MILES
15
13
14

Figure IV-7

ELWHA - DUNGENESS BASIN

TABLE IV-10. Existing reservoirs in the Elwha-Dungeness Basins

Map No.	Name	Location Stream	Storage (acre-ft) Active	Total	Dam Ht.	Source of Information
1	Mills Lake	Elwha R.	26,000	39,000	200	Crown-Zellerbach
2	Aldwell Lk.	Elwha R.	3,000	30,000	110	Crown-Zellerbach

TABLE IV-11. Potential storage sites in the Elwha-Dungeness Basins

Map No.	Project Name	River	Total Storage (1,000 ac-ft)	Source of Information
3	Delabarre Cr.	Elwha R.	---	Puget Sound and Adjacent Waters Study, 1970
4	Godkin Cr.	Elwha R.	---	
5	Press Valley	Elwha R.	72	
6	Grand Canyon	Elwha R.	---	
7	Geyser Basin	Elwha R.	87	
8	Lk. Sutherland	Indian Cr.	30	
9	Upper Dungeness	Dungeness	---	
10	Grey Wolf	Dungeness	116	
11	Carlsborg	Dungeness		
12	Caraco Cr.	Dungeness	25	
13	Finn Hall	Dungeness	---	

TABLE IV-12. Potential pump-storage sites in the Elwha-Dungeness Basin

Map No.	Site	Weekly Storage (acre-ft)	Hydraulic Capacity (cfs)	Source Information
14	Hayes-Godkin	10,700	9,000	U.S. Army Corps of Engineers Report, 1972

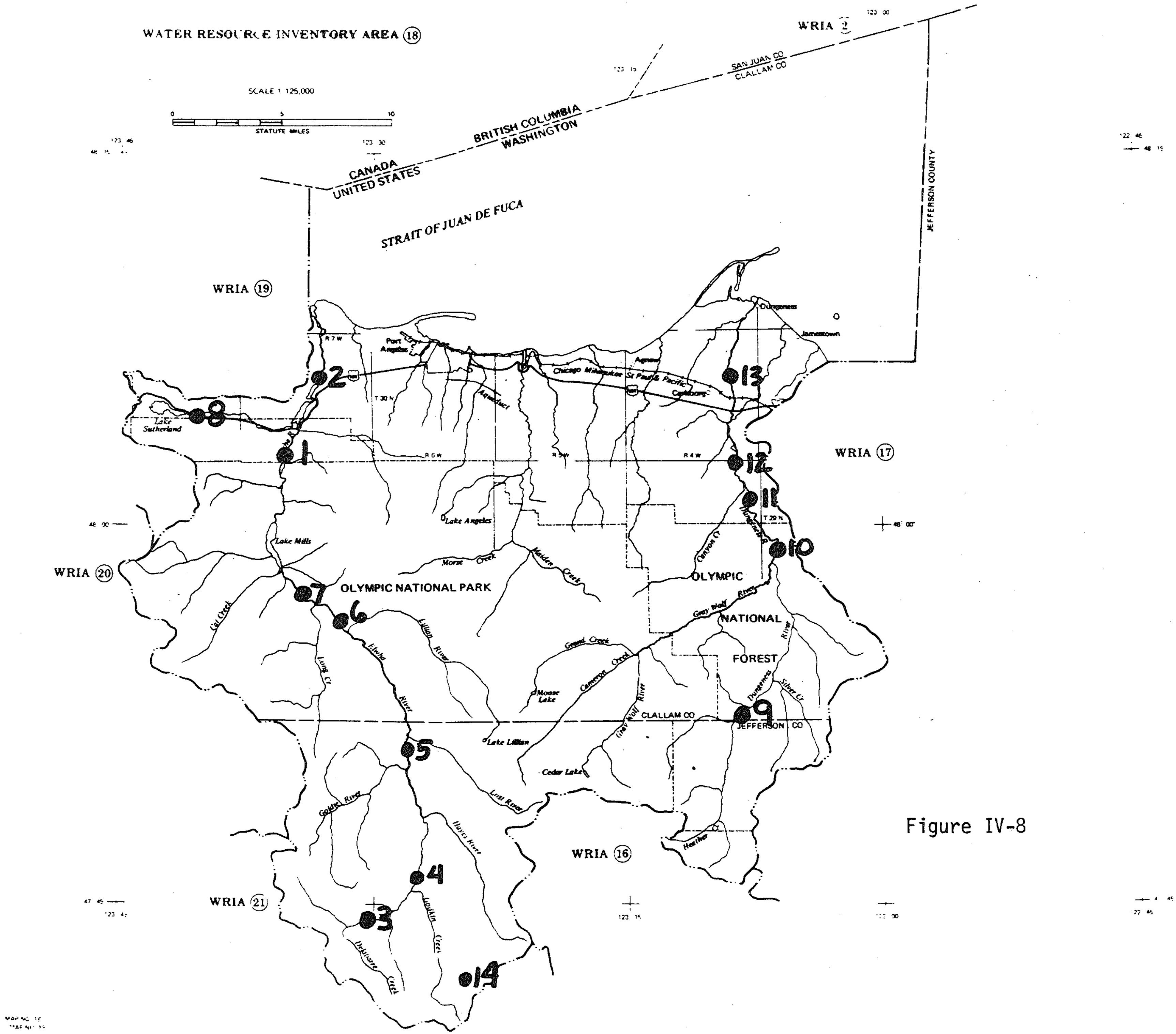
WATER RESOURCE INVENTORY AREA (18)
SCALE 1:125,000
STATUTE MILES
WRIA 2
SAN JUAN CO
CLALLAM CO
BRITISH COLUMBIA
WASHINGTON
CANADA
UNITED STATES
STRAIT OF JUAN DE FUCA
JEFFERSON COUNTY
WRIA 19
WRIA 20
WRIA 17
WRIA 16
WRIA 21
Port Angeles
Dungeness
Jamestown
Agnew
Carlsborg
Chicago Milwaukee St Paul & Pacific
Aqueduct
Lake Sutherland
Lake Angeles
Lake Mills
OLYMPIC NATIONAL PARK
OLYMPIC NATIONAL FOREST
Morse Creek
Maiden Creek
Canyon Cr
Gray Wolf River
Lillian River
Elwha River
Cat Creek
Long Cr
Grand Creek
Cameron Creek
Moose Lake
Lake Lillian
Cedar Lake
Lost River
Goldie River
Hayes River
Dungeness River
Silver Cr
Heather
CLALLAM CO
JEFFERSON CO
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure IV-8

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PART V

POPULATION PROJECTIONS

AND

FUTURE WATER REQUIREMENTS

FOR THE

KITSAP BASIN

POPULATION PROJECTIONS AND FUTURE WATER REQUIREMENTS FOR THE KITSAP BASIN

General factors indicate that a period of rapid growth is at hand in the Kitsap Peninsula, especially in and around the urban Bremerton-Port Orchard area. Principally, these are:

(1) Desirability of the area for residential development.

(2) Extensive waterfront areas, the impact of the Tacoma Narrows, Fox Island, and Hood Canal bridges.

(3) Expansion of industry.

(4) The impact of the proposed Trident Nuclear Sub Base.

A detailed look at future population and water requirements is necessary.

Population Projections

Population projections for the Kitsap Basin (WRIA 15) were computed from a number of sources (see following pages). The population data were tabulated by county. Conversion into the Water Resource Inventory Area was accomplished by estimating the 1970 population in the Inventory Area using County Subdivision Statistics (Bureau of Census). The percentage of county population in the basin is:

	Kitsap County	Gig Harbor Peninsula (Pierce)	Vashon Island (King)	Southwest Kitsap (Mason)
1970 Population	101,732	10,065	6,516	3,445
% of County	100	2.5	0.56	16.5

Assuming population growth will remain geographically constant, the percentages were applied to county projection figures to estimate future populations.

TABLE V-1. POPULATION PROJECTIONS - KITSAP BASIN (WRIA 15)

Source	Sub-division	1970	1975	1980	1985	1990	1995	2000	2010	2020
OPP&FM	Kitsap County	101,732	101,970	107,220	111,000	114,650	118,100	121,200		
	Pierce County	10,065	10,200	10,900	11,700	12,520	13,200	13,850		
	King County	6,516	6,550	6,940	7,520	8,080	8,480	8,860		
	Mason County	3,455	3,540	3,910	4,270	4,650	5,020	5,380		
	TOTAL	121,768	122,260	128,970	134,500	139,900	144,800	149,300		
BPA	Kitsap County	101,732	107,400	115,700	126,200	136,800		158,500	183,200	211,800
	Pierce County	10,065	10,760	11,780	13,060	14,300		16,900	19,900	23,400
	King County	6,516	6,450	6,960	7,580	8,200		9,450	10,800	12,300
	Mason County	3,455	3,640	3,950	4,700	4,820		5,700	6,700	7,800
	TOTAL	121,768	128,250	138,390	151,540	164,120		190,550	220,600	255,300
Pacific Northwest Bell	Kitsap County	101,752	102,600	107,700	116,000					
	Pierce County	10,275	10,300	10,720	11,450					
	King County	6,477	6,520	6,860	7,390					
	Mason County	3,451	3,610	3,960	4,450					
	TOTAL	121,950	123,030	129,240	139,290					
Puget Sound Governmental Conference	Kitsap County	101,700	110,000			136,000				
	Pierce County	10,280	10,430			13,430				
	King County	6,480	6,470			8,270				
	Mason County*	3,450	3,600			4,800				
	TOTAL	121,910	130,500			162,550				

*Estimated

The OPP&FM projections are considered to be the most realistic if it were not for the impact of a Trident Base in the basin. It is suggested that this source be used as a base line for further computations.

Table V-2 gives a breakdown of urban center population projections; taken from Kitsap County Comprehensive Water and Sewerage Plans, 1970.

TABLE V-2. KITSAP COUNTY POPULATION GROWTH IN THE URBAN CENTERS

Urban Center	1968	1975	1990
Burley	400	650	1,100
Bremerton	41,730	50,450	56,230
Brownsville	480	650	1,370
Camp Union	100	120	160
Chico	1,270	1,500	2,530
Erland Point	730	940	2,860
Gorst	850	950	1,450
Hansville	320	330	600
Holly	130	160	200
Indianola	620	640	960
Kingston	820	860	1,570
Long Lake	550	800	2,000
Manchester	1,550	1,700	2,200
Olalla	190	280	760
Port Gamble	470	490	800
Port Orchard	10,250	11,400	17,000
Poulsbo	5,450	5,680	9,610
Seabeck	490	570	720
Silverdale	1,250	1,510	2,920
Southworth	3,850	4,050	5,500
Suquamish	1,070	1,120	1,920
Tracyton	970	1,230	2,070
Winslow	2,290	2,790	5,120
Urban Total	75,830	88,870	119,650

Kitsap Basin Service Area Populations

The current population of the service areas shown in Figure V-1 are listed in the table below where they have been projected at a rate of two percent per year to provide a population basis for estimating future water demand. The service or "water use area" boundaries coincide with the county census divisions that were used as population study areas.

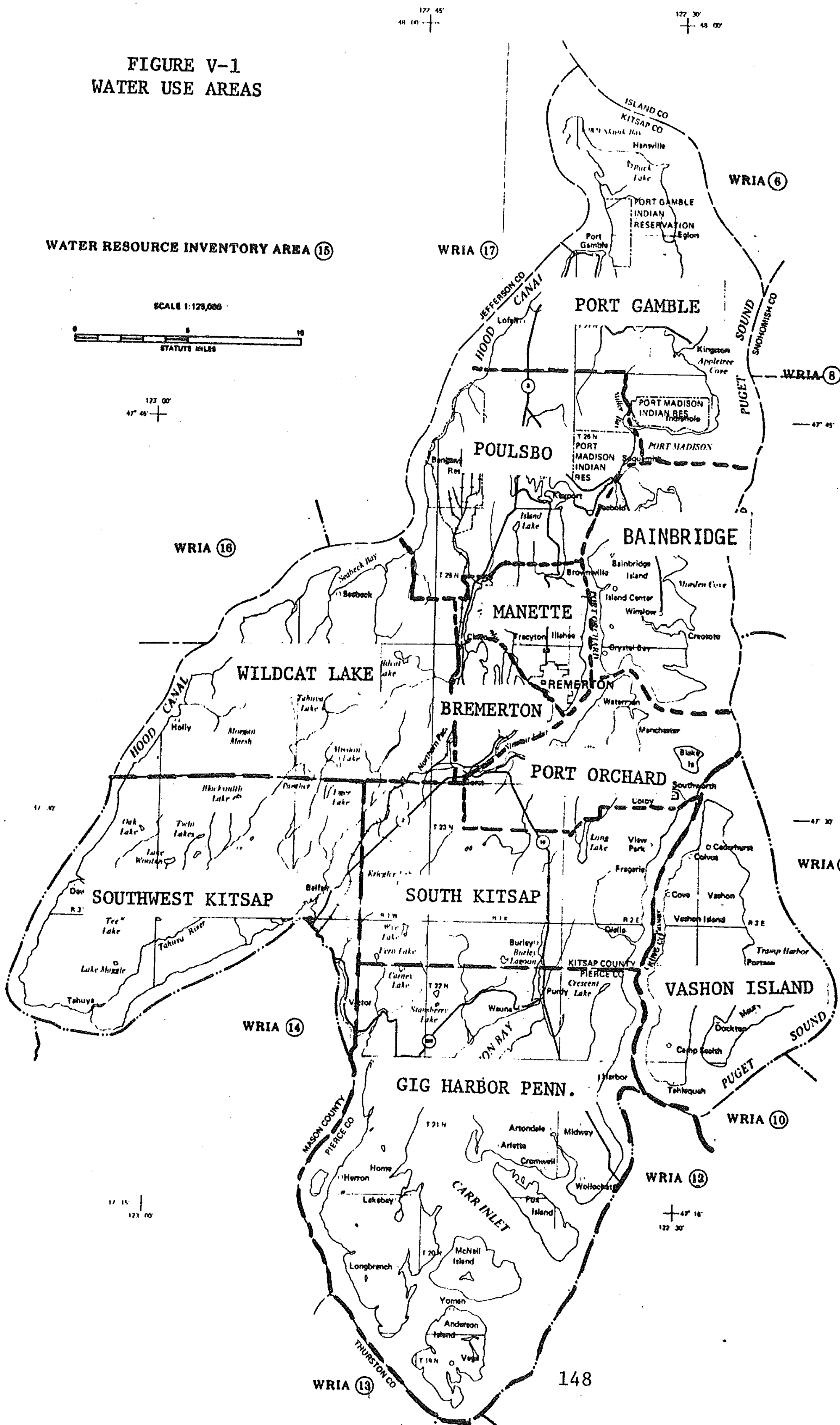
TABLE V-3. PROJECTED SERVICE AREA POPULATIONS

Service Area	1969	1985	2000	2015
Bainbridge	7,400***	10,200	13,700	18,400
Belfair	2,700**	3,700	5,000	6,700
Bremerton	36,100*	49,500	66,700	90,000
Hoodsport	1,000**	1,400	1,900	2,500
Manette	22,100***	30,200	40,900	55,000
Port Orchard	3,900*	5,300	7,200	9,700
South Kitsap	3,800***	5,200	7,000	9,400
Twanoh	700**	1,000	1,300	1,700
Union	300**	400	600	700
Vashon	5,500*	7,500	10,200	13,700
Wildcat Lake	1,700***	2,300	3,100	4,200
SW Kitsap	3,450	4,300	5,400	7,000
Gig Harbor Peninsula	10,100	11,700	13,850	18,000

*Populations, Counties, and Muncipalities, State of Washington, 1968, Washington State Planning and Community Affairs Agency.
**Estimated from United States Census of Population 1960, U.S. Department of Commerce, Bureau of Census.
***Estimated from Comprehensive Water Study of Kitsap County, 1966, Hill and Ingman.

The Kitsap Basin will shortly be facing a serious water shortage problem. With future growth and development of the area, demand is increasing. This increase is confronted with a small supply. Streams are generally small and ground water aquifers are not extensive. Most water resources have already been appropriated.

FIGURE V-1
WATER USE AREAS



Publicly owned water systems in Kitsap County include four municipal systems serving the incorporated areas of the county and 16 water districts. The total population served by these publicly owned systems is estimated to be 82,000; or some 80 percent of the estimated population of Kitsap County.

Privately owned water systems include nonprofit cooperatives and corporations as well as privately held companies and corporations. A tabulation of 150 privately owned systems shows a total connected population of slightly over 10,000.

Existing water systems in the county utilize both surface and ground waters, obtaining their supplies from a variety of sources which includes springs, wells, streams, rivers, and lakes.

The City of Bremerton, with the largest supply system in the county, draws water from seven wells, and surface water is provided by Union River, Gorst Creek, Anderson Creek, and other small streams. Cascade Dam, above McKenna Falls, diverts water from the Union River, and at the present time, supplies Bremerton's average water requirement of 6.5 mgd.

The rest of the basin has depended mainly on ground water from wells and springs. Port Orchard and Poulsbo presently have supplies of 2.6 mgd and 0.8 mgd respectively. These supplies are considered to be adequate only to about 1980. Bainbridge Island lacks productive quantities of water. Western and Southern Kitsap Peninsula have relied upon shallow ground water supplies and small surface sources. Salt water intrusion has resulted in some areas because of over pumping.

SURFACE WATER RESOURCES

The topography and geology of Kitsap County is such that stream drainage basins are quite small and precipitation is less than in other parts of the Pacific Northwest. The resulting low stream flows, typical of Kitsap County, become even lower during the dry months of the year.

Of 426 separate stream systems on the greater Kitsap Peninsula, only 12 have drainage areas greater than 10 square miles, and most of the remainder have less than a square mile. All 12 of the large stream systems occur either wholly or in part in Kitsap County. Although a number of applications have been made for diversion of relatively large amounts of water from these streams, the City of Bremerton's Union River dam and reservoir is the only major surface water development in the entire county.

GROUND-WATER RESOURCES

Evaluations of ground-water resources in the county have been made to determine the location and extent of productive aquifers considered to be suitable for development as regional supplies.

The total amount of recharge for all of Kitsap County was estimated to be about 126 million gallons per day. Although estimates of ground-water usage indicated that less than 10 percent of this recharge is being used, only a small portion of the remainder is available in any quantity and an even smaller portion is to be had in productive amounts.

AVERAGE DOMESTIC DEMAND

The average per capita water consumption in the City of Bremerton was given as 155 gallons per day by the Puget Sound Task Force in Puget Sound and Adjacent Waters Comprehensive Water Resources Study, Appendix VI and was given as 145 gallons per day by Hill and Ingman, Consulting Engineers, in their Comprehensive Water Study of Kitsap County. Using a median value of 150 gallons per capita per day for the industrialized Bremerton service area and a lesser value of 100 gallons per capita per day for the other service areas, the average daily water requirement for each of the service areas, based on the population listed in Table V-3, is as follows:

TABLE V-4. PROJECTED AVERAGE DAILY WATER DEMAND, MGD

Service Area	1969	1985	2000	2015
Bainbridge	0.74	1.02	1.37	1.84
Belfair	0.27	0.37	0.50	0.67
Bremerton	5.32	7.35	10.00	13.50
Hoodsport	0.10	0.14	0.19	0.25
Manette	2.21	3.02	4.09	5.50
Port Orchard	0.39	0.53	0.72	0.97
South Kitsap	0.38	0.50	0.70	0.94
Twanoh	0.07	0.10	0.13	0.17
Union	0.03	0.04	0.06	0.07
Vashon	0.55	0.75	1.02	1.37
Wildcat Lake	0.17	0.23	0.31	0.42
SW Kitsap	0.34	0.43	0.54	0.70
Gig Harbor Peninsula	1.0	1.17	1.38	1.80
TOTAL	11.57	15.67	20.91	28.20

PEAK DOMESTIC DEMAND

Water use varies throughout the year, however and it is, therefore, necessary to consider the peak daily rate at which these service areas will consume water. Such use is generally at a rate between two and five times greater than the mean annual rate--depending upon such factors as climate, extent of industry and service area size. For the purposes of this report, a uniform factor of 2.5 is felt to be sufficiently accurate for projecting the peak day water demand in each of the service areas in the vicinity of Bremerton. Fig. V-1 shows the location of the major service areas.

TABLE V-5. PROJECTED PEAK DAILY WATER DEMAND, MGD

Service Area	1969	1985	2000	2015
Bainbridge	1.85	2.55	3.42	4.60
Belfair	0.67	0.93	1.25	1.68
Bremerton	13.30	18.40	25.00	33.80
Hoodsport	0.25	0.35	0.47	0.62
Manette	5.52	7.55	10.02	13.75
Port Orchard	0.97	1.33	1.80	2.43
South Kitsap	0.95	1.3	1.75	2.35
Twanoh	0.175	0.25	0.33	0.43
Union	0.07	0.10	0.15	0.18
Vashon	1.37	1.87	2.55	3.42
Wildcat Lake	0.42	0.57	0.77	1.05
SW Kitsap	0.85	1.08	1.35	1.75
Gig Harbor Peninsula	2.50	2.93	3.45	4.50
TOTAL	28.93	39.18	52.28	70.56

The projections in the following table are progressively higher than those in Table V-4. These figures were tabulated from information in the Puget Sound and Adjacent Waters Comprehensive Water Resources Study, Appendix VI.

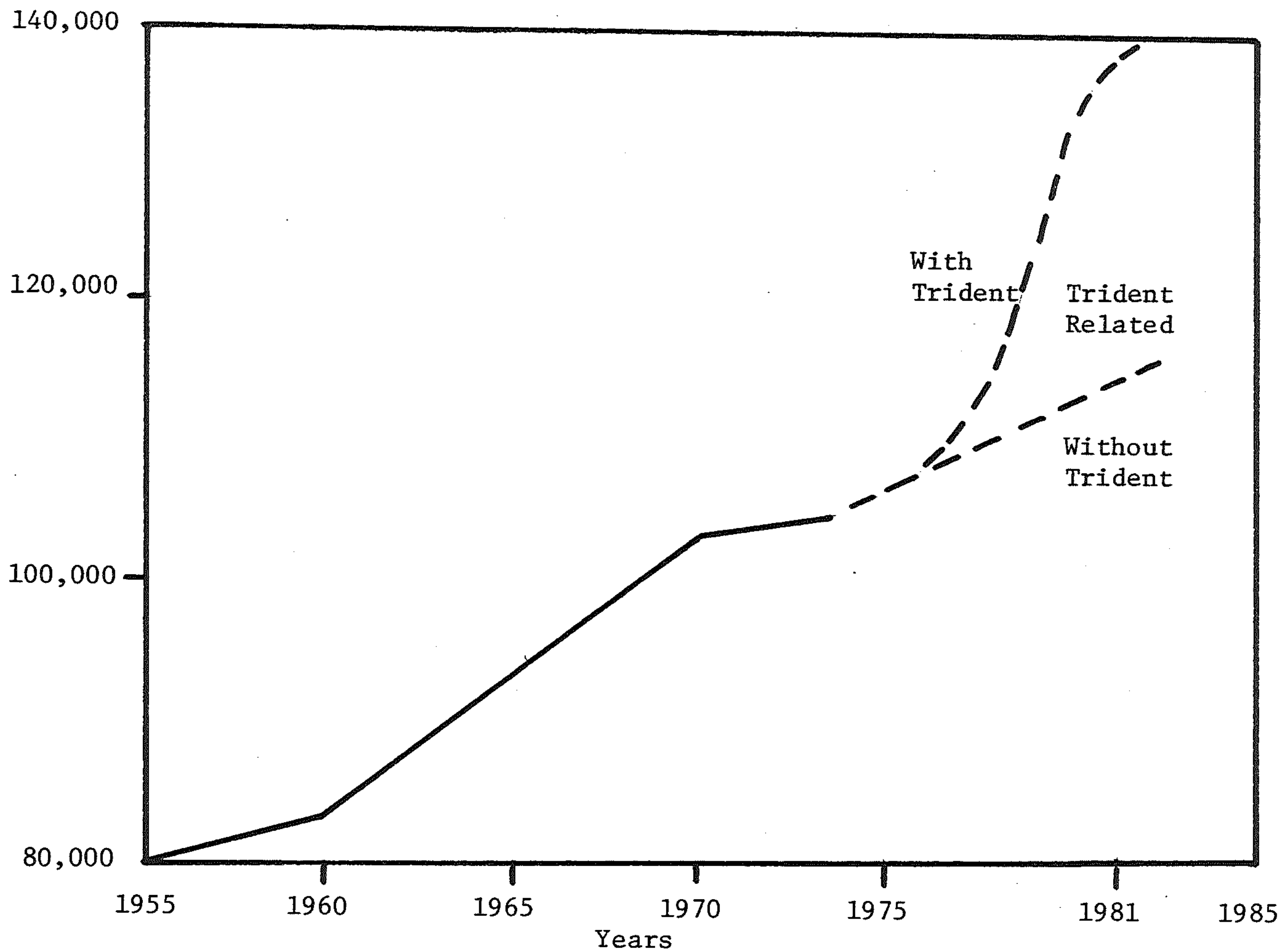
TABLE V-6. PROJECTED AVERAGE DAILY WATER USE BREMERTON SYSTEM (MGD)

	1965	1980	2000	2020
Population served	42,000	70,000	116,700	169,500
Municipal Use				
Surface	5.35	12.00	22.00	35.00
Ground	1.15	1.30	2.40	4.00
Total	6.50	13.30	24.40	39.00
Industrial Use				
Surface	2.40	3.50	5.00	7.00
Ground	0.50	0.50	1.00	1.50
Total	2.90	4.00	6.00	8.50
TOTAL WATER USE	9.40	17.30	30.40	47.50

Total water requirements in the basin are expected to reach 70 mgd by the year 2020. This is an increase of 450 percent over present requirements. Surface water sources are expected to supply 70 percent of the projected water needs.

With the advent of the proposed Trident Nuclear Support Site at Bangor, future population and water demands are drastically changed. Table V-7 gives population projections to 1981 (Trident completion), and Fig. V-2 graphically demonstrates these projections.

FIGURE V-2. POPULATION PROJECTIONS, KITSAP COUNTY



Depending on which source is used to project population, the added impact of Trident brings approximately a 23.7 percent increase (27,048 people) to the 1981 county population. This increase excludes the unknown amount of population increase associated with the development and surrounding growth of Trident.

TABLE V-7. KITSAP COUNTY CUMULATIVE POPULATION 1974-1981

Year	Without Trident[1*]	Trident-Related	Total with Trident
1974	104,300	288	104,588
1975	105,500	1,356	106,856
1976	106,700	2,928	109,628
1977	108,000	7,880	115,880
1978	109,300	13,840	123,140
1979	110,600	20,920	131,520
1980	111,900	24,740	136,640
1981	113,900	27,048	140,948

1* Table 30 on page 177 of the Trident Final EIS. Projections did not include a factor for recent rapid growth caused by the expansion of activities at the Puget Sound Naval Shipyard.

Operations phase growth is based on the data used in the Navy's environmental impact statement. Construction phase growth was computed using the following assumptions: (1) 30 percent of the construction work force will migrate to the county and (2) 20 percent of these workers will bring their families. An average of two children per household is projected.

Using the average per capita use of 100 gpd (from PSAAW), the added 27,048 people associated with Trident would require an additional 2.7 mgd. The Naval EIS suggests the Trident Base will need 2.2 mgd. Table V-8 gives a breakdown of water demands suggested in the EIS.

TABLE V-8. AVERAGE WATER DEMANDS FOR 1981

GENERAL CENSUS DISTRICT DISTRIBUTION	FORECAST WITHOUT TRIDENT		FORECAST WITH TRIDENT	
	Population	Average Daily Demand (1,000 gals)	Population	Average Daily Demand (1,000 gals)
Bremerton	46,900	7,000	48,700	7,300
Port Orchard	15,900	2,400	17,100	2,600
Poulsbo	9,700	1,500	12,800	1,900
Bainbridge Island	10,400	1,600	11,000	1,600
Brownsville-Tracyton	10,700	1,600	16,000	2,400
Bangor-Seattle	7,600	1,100	8,800	1,300
Suquamish	1,800	300	2,000	300
Seabeck	1,700	300	1,900	300
North Kitsap	2,400	400	2,700	400
Burley	4,000	600	4,500	700
South Kitsap	2,800	400	3,200	500
TRIDENT			12,200	2,200
Total Kitsap	113,900	17,200	140,900	21,700

The reliability of these figures are in question. The following excerpt from a letter to the TRIDENT TASK FORCE from the Department of Ecology explains the Department's position.

> "It should be emphasized that water supplies on the Kitsap Peninsula are marginal. Most of the surface water resources have already been appropriated and it is entirely possible that water within the available ground water aquifers would not be sufficient for either the 2.2 mgd requirements of the Trident base or the expected outside development."

Potential Water Supply Sources

Following is an inventory of proposed future water supply sources for the Kitsap Basin.

TABLE V-9. POTENTIAL SURFACE WATER STORAGE SITES

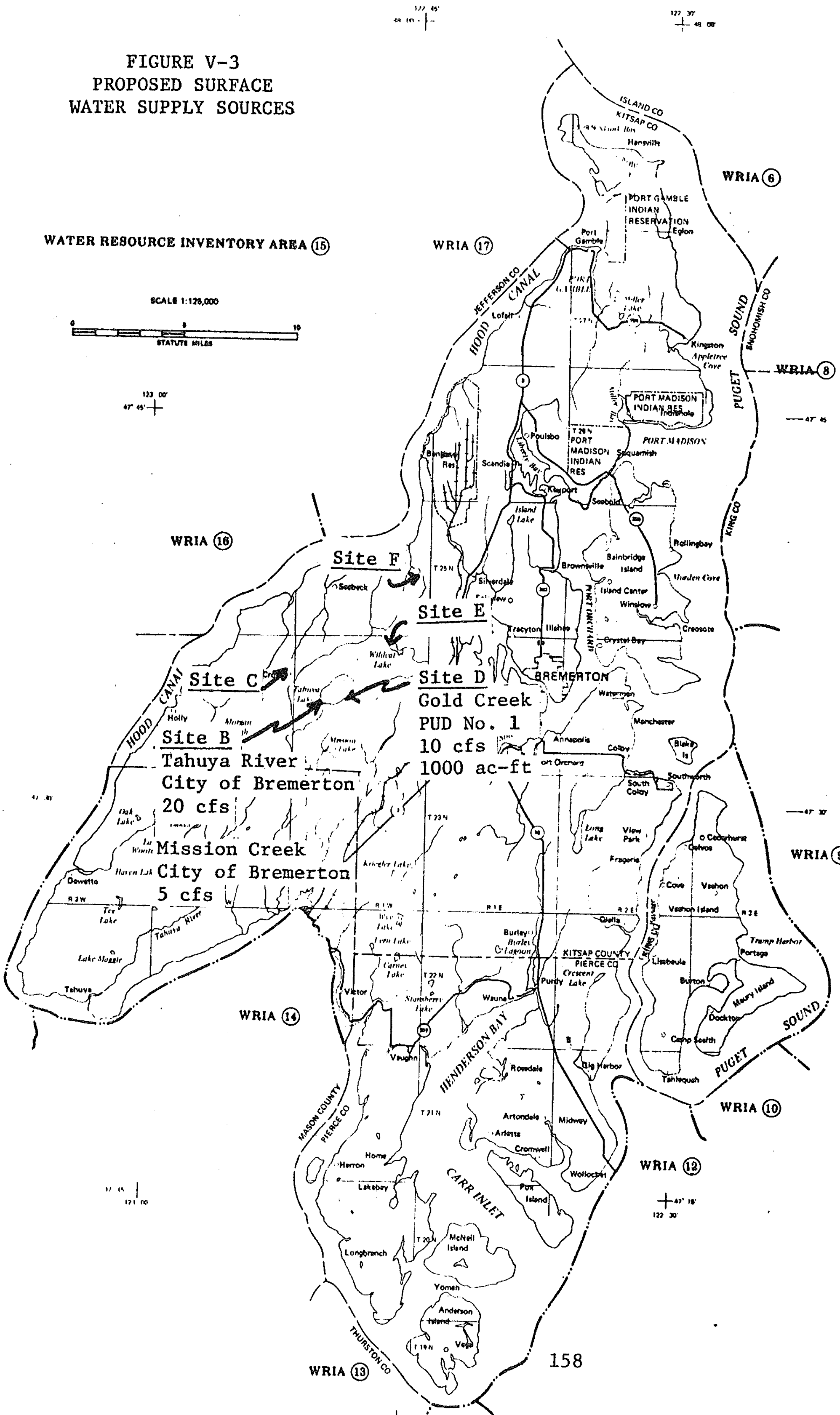
Storage Sites	Location	Water Surface Elevation	Storage Volume (acre-ft.)
A	Duckbush River	700	17,000
B	Tahuya River (including Mission Creek	600	2,400
C	Morgan Marsh	520	2,000
D	Gold Creek	800+	2,700
E	Lost Creek	600+	7,750
F	Near Seabeck	520+	4,500
G	Hamma Hamma River	1,110	4,500
H	Jefferson Creek	1,840	6.200
I	Lilliwaup Creek	-	-

See Figures V-3 and V-4 for location. Specific information on each site can be found in the various sources, which are listed in the bibliography. Hydrologic data on the surface and ground water resources of the Kitsap Basin and Olympia Mountain streams have been compiled and the results given in publications listed in the bibliography.

Hamma Hamma River Development

The City of Bremerton, with rights on the Hamma Hamma for 100 cfs and Jefferson Creek for 10,000 acre-feet, has proposed a system that includes two upstream rockfill dams on Jefferson Creek with a concrete arch dam and intake located below them on the Hamma Hamma River. For transmission, the system would employ a reinforced concrete pipeline extending from

FIGURE V-3
PROPOSED SURFACE
WATER SUPPLY SOURCES



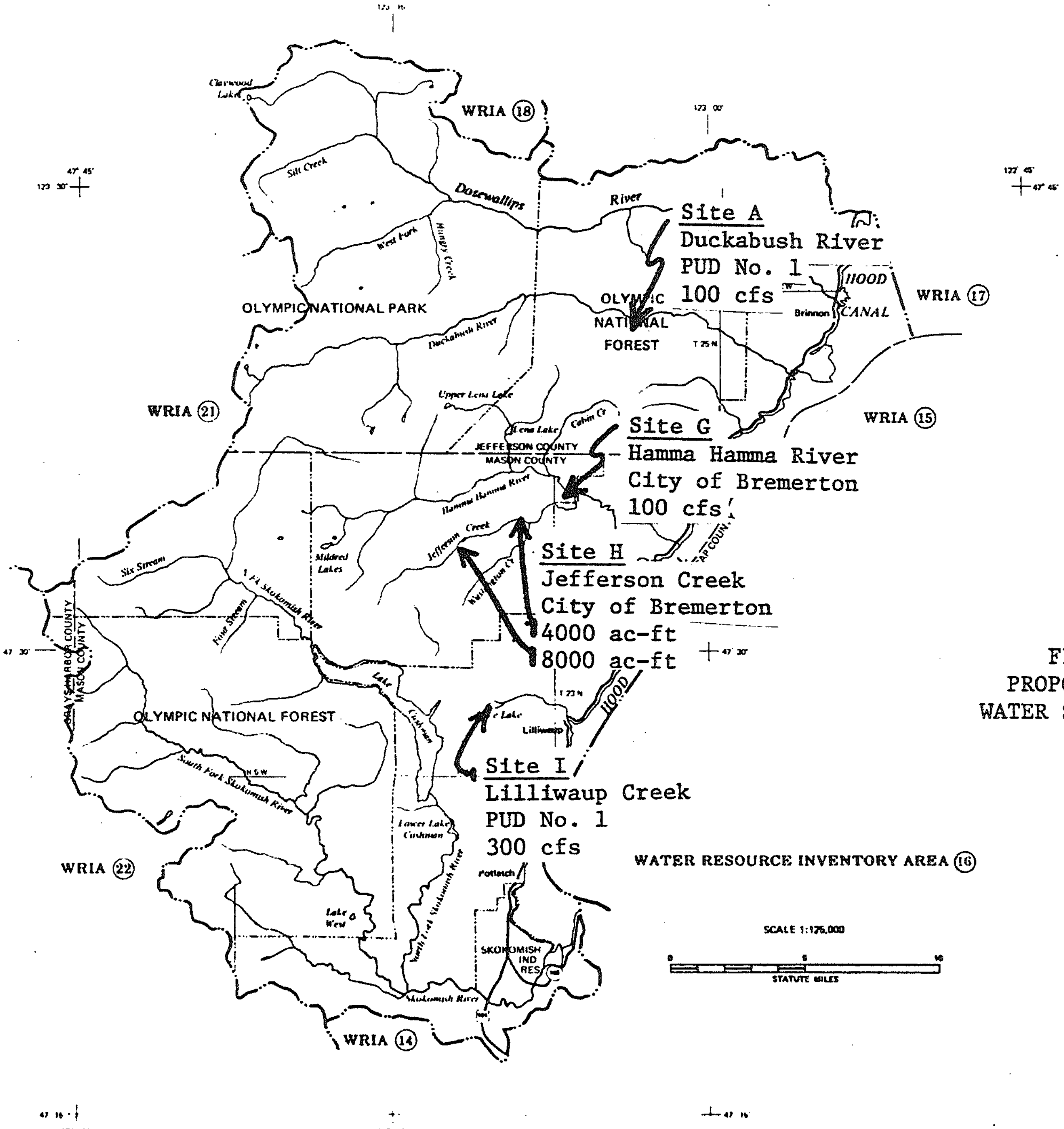


FIGURE V-4
PROPOSED SURFACE
WATER SUPPLY SOURCES

the arch dam to the City of Bremerton with pipe lines under Hood Canal and a pump station on the east bank of the canal. For a capacity of 40 MGD and a continuous utilization rate, the cost is estimated to be $10,863,000. For specific details, see the bibliography.

At this time the Hamma Hamma River system is blocked to migrating fish by a series of falls that start about one mile from tidewater. The State Department of Fisheries has considered the construction of a fish ladder around these falls to open up the upper reaches to anadromous fish; but, before any firm recommendations can be made, a feasibility study would be needed to weigh the benefit of such a project against the cost. Should the upper reaches of the river be opened up, they would probably be attractive to Coho and Steelhead. However, the full potential of the upstream areas for spawning fish is difficult to determine. As an alternative to a fish ladder, the Department of Fisheries has also considered the hauling of migrants, in trucks, to a site above the falls and perhaps a similar system for downstream migration.

The lower mile fo the river is apparently a prime spawning bed for pink and Chum salmon. In 1967, returns of 4,000 pinks were recorded and a return of 6,000 Chums estimated. Based on a three-to-one harvest ratio, this would indicate that a total harvest of 30,000 fish resulted from the spawning bed in the lower mile of this river. In addition, there appeared to be some Coho and Fall Chinook spawning in the lower reaches of this river. The value of these fish, based on present State standards of approximately $5 per caught fish, would be about $150,000 per year.

Duckabush River Development

A preliminary report on the Duckabush Reservoir Site calls for construction of a dam at Little Hump and transmission of water across Hood Canal to the Union River Reservoir or Lake Tahuya. The PUD #1 has a right on the river of 100 cfs with a downstream minimum flow of 65 cfs (1 in 10 year discharge for September). The dam site is above the falls, which is currently the limit of fish migration. The Department of Fisheries has not yet determined flow requirements on the river.

Tahuya River and Mission Creek Development

The proposed diversion on the Tahuya River is for 20 cfs. During August, a flow of only about 3 to 4 cfs was observed at the proposed diversion point approximately a mile and a half below Tahuya Lake. The proposed diverison at Mission Creek is for 5 cfs at a point immediately below the outlet of Mission Lake. In mid-August, site investigation indicated that there is no late summer flow in Mission Creek.

The Tahuya River and Mission Creek are extremely important, in the views of the Department of Fisheries, for Coho, Chinook, and Chum. In addition, there appears to be a good run of Steelhead and some sea run Cutthroat. The reaction of the Department of Fisheries to any diversion without substantial upstream storage would be completely unacceptable.

On both of these streams, recreational development has progressed to the point that potential water storage sites are limited and water treatment requirements will likely be very extensive. Moreover, the value of these streams as a fishery resource is well established and their development would certainly require provision of features that would preserve it.

Other Developments

Upon further appraisal by consulting engineers, sites C, E, F, and I have been eliminated. Lost Creek, on which there is an application to divert 20 cfs, was found to dry up during the summer. The application has been cancelled.

The 16.5 MGD which could be developed from Lilliwaup Creek was not sufficient to warrant transmission to Kitsap County. The 300 cfs application for diversion has been cancelled.

Gold Creek, on which the District applied for diversion of 10 cfs and storage of 1,000 acre-feet, had an average discharge of 5.95 cfs for a 19-year period of U.S. Geological Survey measurements. It was estimated that a supply of 2.4 mgd could be developed after allowance was made for nominal evaporation and seepage, and 0.3 cfs for fish life. Gold Creek appears to be potentially suitable as a regional supply source, although the amount of water available is not large.

Further Considerations

Because of the possibility of environmental damage and the impact on instream values to the rivers as well as possible strong public opposition, the proposed development on the Hamma Hamma and Duckabush rivers may not be a real possibility. Further water supplies for the Kitsap Basin would then be limited to Gold Creek and Huge Creek and the expansion of existing sources. A possible alternative not yet considered is connection to the Tacoma Water Department supplies.

The Gig Harbor area will probably connect in the near future. As the comparative cost of transporting water across the Narrows Bridge is relatively small, the proposal of extending the pipeline to the Bremerton-Port Orchard service area could be a viable alternative. The advantages of this type of system is the minimizing of environmental damage by sharing of sources, and relatively low cost development.

In order to complete a study required to allocate the water resources of the Kitsap Basin, or supplies from other basins to uses in the Kitsap Basin, the following information is needed:

1. A summary of water use and availability for the Tacoma Water System will have to be made to determine the amount of water that can be used to supplement the City of Bremerton. This will include a tabulation of future use as well as present water rights and expected additional sources on the Green river.

2. Depending on various sources, future water needs and capabilities are different. A concise summary of existing and future requirements for the Bremerton area is necessary. This should include an inventory of the capabilities of existing supplies as well as the expansion of those supplies.

3. There is a need for an in-depth evaluation of all alternatives. This is something that will have to be dealt with in the near future.

4. Minimum and/or base flows need to be established on all streams of the basin.

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PART IV

STATUS SUMMARY

OF

POTENTIAL PROJECTS

This part is a preliminary report on the status of potential projects in the Western and Southern Puget Sound Basins. A revised edition will be forthcoming and may be obtained from: Manager, Water Resources Information System, Department of Ecology, Olympia, Washington 98504.

State of Washington Department of Ecology

WATER RESOURCES INFORMATION SYSTEM

Project Summary No. 4

STATUS SUMMARY OF POTENTIAL PROJECTS IN THE WESTERN AND SOUTHERN PUGET SOUND BASIN

PRELIMINARY

JANUARY, 1975

OLYMPIA, WASHINGTON

98504

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STATUS SUMMARY

OF

POTENTIAL PROJECTS

PURPOSE:

This report is intended to provide a compilation of potential federal projects and major private projects in Washington State related to water resources. The status summary in no way attempts to evaluate advantages or disadvantages of a project, but merely attempts to provide information about the project. The project inventory serves three main functions. First, it provides some idea of the total scale of potential project development in a river basin. Second, it provides information for developing policy and allocating the remaining public waters in a river basin. Third, it provides comparative information on project development for improved formulation of additional project proposals in a river basin. The project inventory is designed to be used as a planning tool to give a basic picture of proposed project development in the river basin planning areas of the State of Washington.

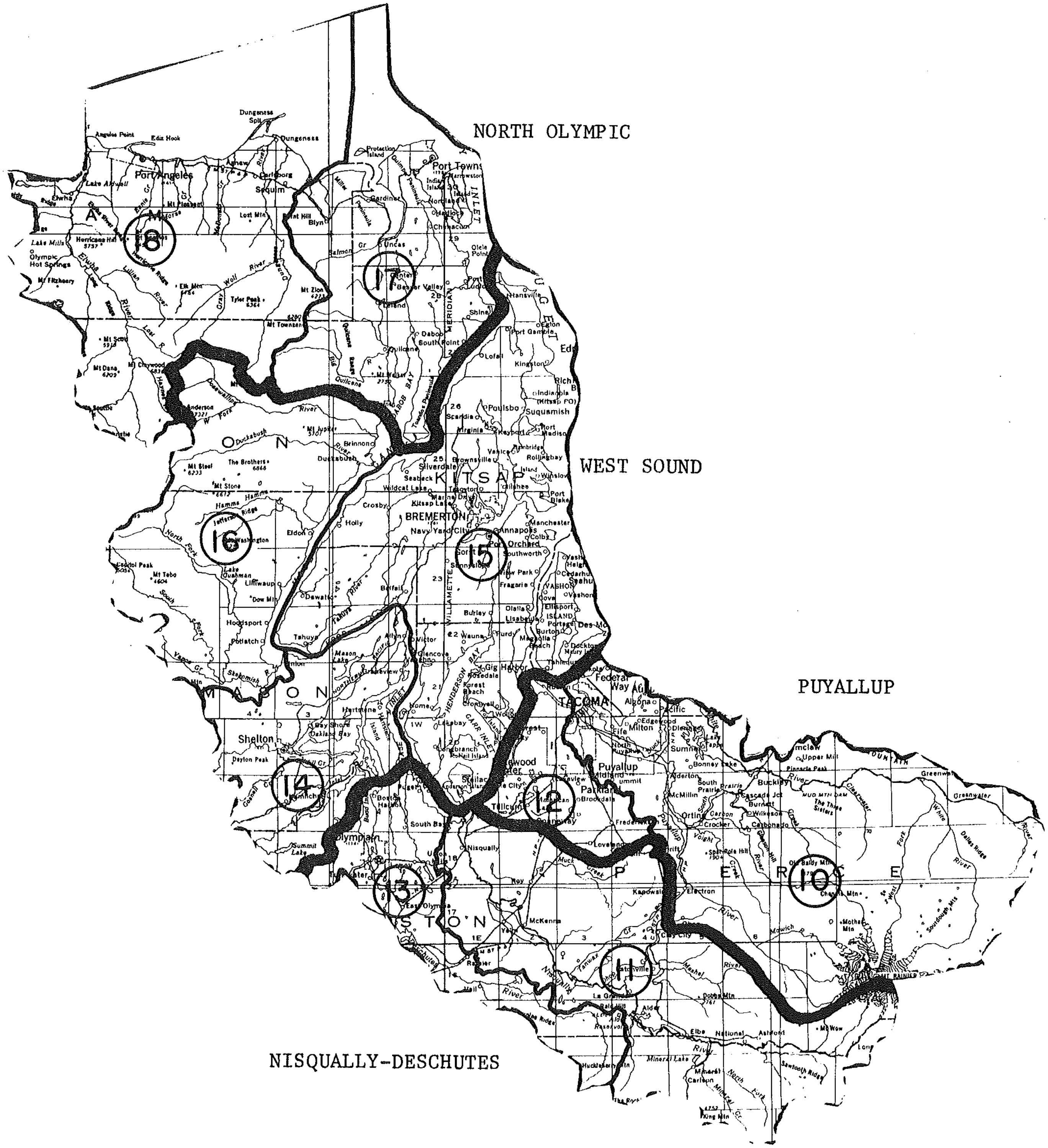
SCOPE:

A summary description, status and cost is presented for potential federal projects and major private projects that are water related and are currently being considered for development in Washington. The information is compiled from the latest reports available.

WESTERN AND SOUTHERN

PUGET SOUND BASIN

WRIA'S 10, 11, 12, 13, 14, 15, 16, 17, 18



NORTH OLYMPIC BASIN

U.S. Army Corps of Engineers

1. EDIZ HOOK, WASHINGTON

Description: Ediz Hook is in an active state of erosion due to lack of adequate feed material and is in danger of breaching. This project will maintain the integrity of Ediz Hook and nearby Port Angeles Harbor. Provides for construction of 10,000 lineal feet of rock revetment, together with initial beach replenishment and annual nourishment.
Status: Authorized 1974.
Cost: Estimated total cost (1974) $5,760,000.
Source: Pacific Northwest Waterways Association. Pacific Northwest Water Resources Development Potential. May, 1974.

U.S. Soil Conservation Service

1. CHIMACUM CREEK WATERSHED
PL566 Project

Description: The project is a combination of land treatment measures and structural measures for flood prevention and drainage improvement. The structural measures would be 15.1 miles of channel for increased capacity for flood flows and to serve as outlets for on-farm drainage systems and for improved management of cropland through flood hazard reduction and improved drainage conditions.
Cost: Estimated total cost (1956 figures) $196,361.
Status: Proposed.
Source: Jefferson County, WA. Soil Conservation District and Drainage District No. 1 of Jefferson County. Watershed Work Plan for Chimacum Creek Watershed Jefferson County, Washington. May, 1956.

U.S. Bureau of Reclamation

1. SEQUIM PROJECT, WASHINGTON

Description: The Sequim Project is in the northeast corner of the Olympic Peninsula in Clallam County, Washington. The selected plan of development provides for a closed-pipe distribution system to provide water at sprinkler-head pressure for an irrigable area of 18,970 acres. These lands are now in various stages of development, ranging from

uncleared timbered tracts to lands now irrigated but varying widely in adequacy of water supply. Under the project plan, all lands would have an adequate and dependable water supply at a pressure permitting sprinkler application. The water supply is limited by the minimum natural flows of the Dungeness River during the irrigation season, because no suitable storage sites are available. Water for the Project would be provided by direct diversion of natural flows into gravity canals, one on each side of the river, leading to two regulating reservoirs, beyond which water would be conveyed in pipe. Four small acres of the Project lie at elevations which require pumping to achieve adequate pressure. Centrifugal pumps would be installed on the laterals serving these areas.
Status: Project Planning.
Cost: Estimated total construction cost (1950) $4,759,000.
Source: U.S. Bureau of Reclamation. Region I. Sequim Project, Washington. Project Planning Rept. No. 1-1.3-1. August, 1951.

M & I WATER SUPPLY PROJECTS

1. EAST JEFFERSON COUNTY M & I WATER SUPPLY

Description: There are two sites that could reasonally be used for impounding on the Big Quilcene River, the Bark Shantz Shelter site at the confluence of Townsend Creek and the Sink Lake site at the head of Townsend Creek. Such a storage facility would have to contain at least 30 MG to assure a firm supply of 4 MGD. At the Bark Shanty site 30 MG of storage would be created by a dam of 30 feet with a crest length of 300 feet, and at the Sink Lake site it would be provided by a dam of 20 feet with a crest length of 700 feet.
Status: Not available.
Cost: The cost for either structure would be about the same. Total estimated cost (1969) $736,000.
Source: Kramer, Chin & Mayo. A Comprehensive Water and Sewage Plan for Jefferson County, Washington. Nov., 1969.

WEST SOUND BASIN

U.S. Army Corps of Engineers

1. HAMMERSLEY INLET, WASHINGTON

Description: Channel was completed in 1915 except for one hardpan shoal which limits the controlling depth to 10 feet. The project would involve deepening the shoal to 13 feet.
Status: Inactive. Authorized 1910.
Cost: Not available.
Source: Pacific Northwest Waterways Association. Pacific Northwest Water Resources Development Potential. May, 1974.

U.S. Soil Conservation Service

1. SKOKOMISH RIVER WATERSHED
PL566 Watershed Project

Description: The main problem of the people along the Skokomish River is protection from frequent floods. The construction of Cushman Reservoir and the completion of the reservoir on the South Fork of the Skokomish River will to some extent flood flows.

The proposed South Fork Reservoir, as originally planned by the City of Tacoma, will be formed by a concrete arch dam about 312 feet high, with an earth dam 65 feet high closing a saddle in the reservoir rim, and will store about 225,000 acre-feet to elevation 735 feet. The dam will be located about 11 miles upstream from the south of the South Fork and control the run-off from 65 square miles. The reservoir will be connected with Cushman Reservoir No. 1 by a tunnel 12 feet in diameter, at elevation 615 feet. In normal operation the water surface in the two reservoirs would be at the same elevation, but the connecting tunnel would be provided with gates so that the reservoirs could be operated independently.
Status: Proposed.
Cost: Not available.
Source: U.S. Soil Conservation Service. Report of Field Examination Skokomish River Watershed Mason County, Washington. Feb., 1958.

2. GOLDSBOROUGH CREEK WATERSHED
PL566 Watershed Project

Description: Goldsborough Creek Watershed is in Mason County, outlets through the City of Shelton into Oakland Bay and Hammersley Inlet. Flooding causes agricultural, urban and industrual damage.

Land treatment measures that are needed and included for application during and following the project construction period are those necessary to provide for the conservation, development, and improvement of lands within the watershed area. These measures consist of conservation cropping systems, installation of drainage mains and laterals, tile and subsurface drains, grassed waterways, pasture renovation and planting, wildlife habitat management, and improvement, stream channel stabilization, irrigation systems, irrigation water management, and land smoothing.

About 900 acres of agricultural cropland will be benefited by a combination of flood control and drainage channels. Proposed by this plan is the improvement of five miles of channel. Most of the work consists of cleanout or enlargement and stabilization of existing channels. Realinement or relocation of some channels may be necessary.

A floodwater storage reservoir is proposed in section 21, approximately four miles west of Shelton. This reservoir would temporarily impound water until the channel downstream from the damsite would contain the flow.

Preliminary investigation has shown that approximately 11,200 acre feet could be stored between the elevations of 213 and 240, and that 1,120 surface acres would be covered at elevation 240. The flooded depth at the damsite would be 27 feet. The length of the dam required at this point would be approximately 500 feet. This much flood storage should provide the city of Shelton and its urban area with adequate flood protection for the 100-year storm.

Status: Proposed.

Cost: Estimated total cost (1967) $1,720,825.

Source: U.S. Soil Conservation Service. Watershed Investigation Report on Goldsborough Creek, Puget Sound Area, Mason County, Washington. 1967?

M & I WATER SUPPLY

1. DUCKABUSH RIVER WATER SUPPLY

Description: Involves the diversion of 100 cfs and minimum flow of 65 cfs for downstream use and fish life. This yield requires storage of 17,000 acre-feet for annual refill of the reservoir. A dam at Little Hump, impounding water to elevation 700, could provide this storage in the Natural Basin between Big and Little Humps. The dam site is above the upstream limits of fish migration. For staged construction and added safety, transmission piping was planned as two parallel lines, including the underwater crossing of Hood Canal.

Status: Not available.

Cost: Not available.

Source: (1) Hill & Ingman. Kitsap County Comprehensive Water Study, an Engineering Report for Public Utility District No. 1 of Kitsap County on Water Supply, Transmission and Storage. Sept., 1966.
(2) Hill, Ingman, Chase & Co. A Water Supply Feasibility Study of the Duckabush River. April, 1970.

2. GOLD CREEK DEVELOPMENT

Description: This development would supply Western Kitsap County which could be served by gravity with impoundment to elevation 808. Downstream topography provides a favorable route for transmission pipelines.
Status: Not available.
Cost: 1966 price levels. Construction of the dam and reservoir is estimated at $326,000.
Source: Hill & Ingman. Kitsap County Comprehensive Water Supply; An Engineering Report for Public Utility District No. 1 of Kitsap County on Water Supply, Transmission and Storage. Sept., 1966.

3. HAMMA HAMMA RIVER

Description: This development proposes a system that includes two upstream rockfill dams on Jefferson Creek with a concrete arch dam and intake located below them on the Hamma Hamma River. A pipeline of reinforced concrete extending from the arch dam to the city of Bremerton with pipe lines under Hood Canal and a pump station on the east bank of the canal would be used for transmission.
Status: Not available.
Cost: Total estimate $10,863,000.
Source: Kramer, Chin & Mayo. A Water Supply Study for the City of Bremerton, Hamma Hamma River, Tahuya River, Mission Creek. Nov., 1969.

PUYALLUP BASIN

U.S. Army Corps of Engineers

1. PUYALLUP RIVER BASIN FLOOD CONTROL PROJECT

Description: Additional flood control is needed in the basin. Areas within and adjacent to the basin have a need for additional water for various conservation uses during summer. Drainage in the lower valley is a problem because of urban development and increased runoff.
Status: Feasibility (underway, scheduled completion 1977)
Cost: Not available.
Source: Pacific Northwest Waterways Association. Pacific Northwest Water Resources Development Potential. May, 1974.

U.S. SOIL CONSERVATION SERVICE

1. Pacific - Algona Watershed
PL566 Watershed Project

Description: The flood plain along the west side of the White River is the main flood - inundated area. Sources of flooding are rainfall within the watershed, and outflow from the high hills lying west of the damaged area. Water flows onto the flood plain from both overland and sub-surface sources originating near the base of the hills. Land treatment measures to help the flooding problem include conservation cropping systems, installation of drainage mains and laterals, tile and surface drains, grassed waterways, pasture renovation and planting, wildlife habitat management and development, stream channel improvement, sprinkler irrigation systems, irrigation water management, and land smoothing.

The principal structural measures needed in this watershed are improved channels to carry away the excess flood and drainage water. Due to the high degree of urbanization in the northern part of the watershed, much of the drainage will need to be through underground pipes. Improvements are proposed for 12 miles of channels, and of this 12 miles, 2.4 miles will be underground pipelines.
Status: Proposed.
Cost: Total estimated Cost (1970) $594,130.
Source: U.S. Soil Conservation Service. Watershed Investigation Report on Pacific-Algona Puyallup Basin, Puget Sound Area, King and Pierce Counties, Washington. June, 1970.

2. <u>ALDERTON, McMILLIAN, RIVERSIDE AND SALMON SPRINGS, WATERSHED</u>
PL566 Watershed Project

Description: The Alderton, McMillian, Riverside, and Salmon Springs Watershed lies east of Puyallup near the conflux of the Stuck (White) and Puyallup Rivers, and includes the town of Sumner. These four drainages are similar in nature. The upper portion of each watershed consists of the hills lying adjacent to the Puyallup River. Their principal channels lie on the flood plain of the Puyallup. They are under four miles in length and their principal channels flow north. Each of the channels is in an agricultural area that is beginning to urbanize.
Land treatment measures that are needed and included for application during the progress construction period are those necessary to provide for the conservation, development, and improvement of the lands within the watershed area. Such measures include conservation cropping systems, installation of drainage mains and laterals, tile and surface drains, grassed waterways, pasture renovation and planting, wildlife habitat and development, stream channel improvements, sprinkler irrigation systems, irrigation water management, and land smoothing.
The project is designed for flood prevention in agricultural and urban areas, and drainage of agricultural lands. The principal structural measures needed consist of a series of flood channels to carry away the excess water. The works of improvement will consist of 11-1/2 miles of improved and stabilized channel and four outlet structures. The outlet structures would contain flood gates and possibly pumps. Much of the work would be the enlargement and realinement of existing inadequate channels.
Status: Proposed.
Cost: Total estimated cost for structural measures (1967) $279,104.
Source: U.S. Soil Conservation Service. <u>Watershed Investigation Report on Alderton, McMillian, Riverside, and Salmon Springs Puyallup Basin, Pierce County, Washington</u>. 1967?

3. <u>CLEAR CREEK WATERSHED</u>
PL566 Watershed Project

Description: Clear Creek Watershed is located along the eastern edge of the city of Tacoma and immediately south of the Puyallup River. The main sources of damage to the lowlands are runoff from the upper portions of the watershed, and rainfall falling on the flatland of the bottom.
Land treatment measures that are needed and that are included for application during the project construction period are those necessary to provide for the conservation, development, and improvement of lands within the watershed area. Included in these measures are conservation cropping systems, the installation of drainage mains and laterals, tile and surface drains, grassed waterways, pasture renovation and planting, wildlife habitat and development, stream channel stabilization, sprinkler irrigation systems, irrigation water management, and land smoothing.
The works of improvement will consist of 21 miles of improved and stabilized channel, and one outlet structure consisting of floodgates and pumps. Channel size and depth varies throughout the watershed; however, generally these channels are small. In some instances, it may

be possible to construct the ditches for outlets using concrete pipe at a lesser expense than would be required for open ditches. The outlet structure--gates and pumps--is expected to be of a size to handle floods that would generate within this watershed.
Status: Proposed.
Cost: Estimated cost of structural measures (1967) $1,900,660.
Source: U.S. Soil Conservation Service. Watershed Investigation Report on Clear Creek, Puyallup Basin, Puget Sound Area Pierce County, Washington. 1967?

4. HYLEBOS CREEK WATERSHED
PL566 Project

Description: This watershed is located between Seattle and Tacoma and outlets into Commencement Bay at Tacoma. Flooding is a problem because of the rain falling within the watershed and flowing out over the flood plain of the Puyallup River. Principal damages are the inundation of farmlands and residences.
Land treatment measures that are needed and that are included for application during the project construction period are those necessary to provide for the conservation, development, and improvement of lands within the watershed area. Included in these measures are conservation cropping systems, the installation of drainage mains and laterals, tile and surface drains, grassed waterways, pasture renovation and planting, wildlife habitat and development, stream channel stabilization, sprinkler irrigation systems, irrigation water management, and land smoothing.
Preliminary investigations indicate that structural works and channel improvements are needed to prevent flooding. It is anticipated that five miles of main channel and the lower portions of the three branch channels will need to be enlarged and deepened.
Culverts and bridges under old Highway 99 and under Interstate 5 will have to be lowered to provide for increased flow and lower grades.
Status: Proposed.
Cost: Estimated total cost (1967) $1,180,845.
Source: U.S. Soil Conservation Service. Watershed Investigation Report on Hylebos Creek, Puyallup Basin, Puget Sound Area Pierce and King Counties, Washington. 1967?

5. WAPATO CREEK WATERSHED
PL566 Project

Description: The watershed lies east of Tacoma and north of Puyallup. Wapato Creek flows parallel to the Puyallup River, approximately one mile to the north. It flows northwest and outlets into Commencement Bay. Wapato Creek is subject to flooding. Its channel is flat and meandering. In many places the existing channel is choked with debris and sediment. Outflows are restricted by high tides, and by much plant growth, trees and willows within the channel banks.
Land treatment measures that are needed and are included for application during the project construction period are those necessary to provide

for the conservation, development, and improvement of the lands within the watershed area. These measures include conservation cropping systems, installation of drainage mains and laterals, tile and surface drains, grassed waterways, pasture renovation and planting, wildlife habitat and development, stream channel improvement, sprinkler irrigation systems, irrigation water management, and land smoothing.
The project is designed for flood prevention in agricultural and urban areas, and drainage of agricultural lands. The principal structural measures needed consist of a series of flood channels to carry away the excess water. The works of improvement will consist of seven miles of improved and stabilized channel and one outlet structure with floodgates and pumps. Much of the work would consist of enlarging and realining the existing inadequate channels. Realinement of the channel is needed primarily to shorten the overall length, and to improve the gradient of the stream. Realinement would also provide a less expensive channel due to the lesser number of feet or cubic yards of excavation required, and would decrease the right-of-way problems. Several highway and railway crossings could be eliminated. The outlet structure would consist of floodgates or flapgates to permit low tide outflows, and a pumping plant to exhaust the water from the watershed into Commencement Bay during storm tides or high tides.
Status: Proposed.
Cost: Total estimated structural cost (1967) $979,310.
Source: U.S. Soil Conservation Service. Watershed Investigation Report on Wapato Creek, Puyallup Basin, Puget Sound Area, Pierce County, Washington. 1967.

6. CLOVER CREEK WATERSHED
PL566 Project

Description: The watershed heads about 10 miles southeast of Tacoma and 5 miles south of Puyallup. It flows west into Chambers Creek and outlets into Puget Sound south and west of Tacoma. The basic problem in the Clover Creek Watershed and the contributing watersheds of Leach and Chambers Creeks is restricted flow in existing channels. Another problem is the sedimentation and pollution which collects in Steilacoom Lake.
Land treatment measures that are needed and included for installation during the project construction period are those necessary to provide for the conservation, development, and improvement of lands within the watershed area; such as conservation cropping systems, drainage mains and laterals, tile and surface drains, grassed waterways, some supplemental irrigation, and land smoothing. An educational program and possible a few laws would be helpful in controlling the erosion from new construction.
The works of improvement will primarily consist of 14 miles of improved and stabilized channels. The necessary water control structures will be in addition to the channel work, and will consist primarily of riprapped areas, drop structures, and gradient stabilization measures for the prevention of erosion and control of high flows.
Status: Proposed.
Cost: Total estimated structural cost (1967) $855,625.

CLOVER CREEK WATERSHED (con't)

Source: U.S. Soil Conservation Service. Watershed Investigation Report on Clover Creek, Puget Sound River Basin, Pierce County, Washington. 1967?

M & I WATER SUPPLY

1. TACOMA PORT INDUSTRIAL AREA

Description: A second transmission line from the present Green River System to bring water from Tacoma's present headworks into the Port Industrial area. This proposed pipeline will utilize some of the existing facilities near the Headworks with new construction beginning just downstream from the present Purification Plant. In order to accommodate the additional diversion, the existing Headworks and upper tunnel system will have to be modified. New facilities constructed will include a 20-MGD plant for turbidity removal during flood stages and a 100-MG main transmission line to carry the water in a westerly direction to a 25-MG terminal reservoir near Federal Way. From this reservoir a transmission main will serve Tacoma and the Port Industrial area.
Expansion of the Green River system will require certain modification of the present diversion dam and portions of the first 3,300 feet of piping and tunnel system. The modification of the existing system would include raising the diversion dam between five and six feet, alteration of the intake structure and replacement of tunnel No. 3, which now has a reduced cross sectional area, with an 84-inch diameter steel pipeline. The remaining portions of these upper transmission facilities are in good condition and the Department has recently completed relining the connecting concrete pipelines and the stilling basin. These modifications will increase the present capacity of this system from 111 cfs to 250 cfs.
Status: Not available.
Cost: Total construction cost (1969) $486,000.
Source: Pierce County, WA. Dept. of Public Utilities. A Comprehensive Water Supply Study and Plan for Pierce County and Vicinity. Sept., 1969.

2. SOUTH FORK SKOKOMISH RIVER

Description: Development of the South Fork of the Skokomish River would supply M & I Water Supply to the Gig Harbor Peninsula.
Approximately 90 MGD, or 139 cfs, would be required from the River to serve the areas mentioned previously. The diversion of 90 MGD from this source would require the construction of a diversion dam with low flow augmentation storage and about 54 miles of transmission main.
The ultimate cost would eventually include turbidity treatment plant facilities. The proposed system has the advantage of having complete gravity operation and good water quality at the source. The disadvantage of such a system would be the long transmission line necessary to convey the water. However, future studies may indicate the development of this source is the only reasonable solution to the water supply problems of the area.

SOUTH FORK SKOKOMISH RIVER (con't)

Status: Not available.
Cost: Total cost (1969) 40.5 million dollars.
Source: Pierce County, WA. Dept. of Public Utilities. A Comprehensive Water Supply Study and Plan for Pierce County and Vicinity. Sept., 1969.

NISQUALLY-DESCHUTES BASIN

U.S. Army Corps of Engineers

1. OLYMPIA HARBOR, WASHINGTON. ENTRANCE CHANNEL & TURNING BASIN

   Description: The remaining work to complete this authorization is to widen the west side of the inner entrance channel 200 feet and enlarge the west and south side of the turning basin by 200 feet. The overall project is 83% complete. The uncompleted work was deferred for restudy.
   Status: Deferred for restudy. 1968.
   Cost: 1957 estimated cost $373,000.
   Source: Pacific Northwest Waterways Association. Pacific Northwest Water Resources Development Potential. May, 1974.

2. POTENTIAL PUMPED STORAGE PROJECTS

   (See page 14)

POTENTIAL PUMPED STORAGE PROJECTS

No.	Site	Plant Capacity MW	Head Ft.	Penstock Length Ft.	Weekly Storage Ac. Ft.	Hydraulic Capacity cfs	Drawdown, Ft. Lower	Drawdown, Ft. Upper	Invest. Cost $/KW	Capacity Cost $/KW-Year	Special 1/ Land Designation
PUYALLUP BASIN											
91	Kapowsin	1,000	1,120	7,900	14,800	12,200	24	33	150	8.80	
92	Mowich Lake	1,000	2,320	10,000	7,100	5,900	57	52	115	6.70	NP
		3,000			21,300	17,600	131	139	90	5.40	
93	Voight Creek	1,000	1,130	5,100	14,900	12,100	51	58	155	9.10	
		2,000			28,500	24,000	136	83	125	7.40	
WEST SOUND BASINS											
94	Hamma Hamma	1,000	2,200	17,400	7,500	6,200	49	73	130	7.60	NP
		6,000			44,300	36,800	132	163	100	6.00	
95	Lena Lake	1,000	1,250	6,100	13,100	11,000	53	86	125	7.30	
		2,000			25,800	21,700	92	156	105	6.10	
96	Mildred Lakes	1,000	2,990	13,600	5,500	4,600	43	45	120	7.20	NP
		6,000			32,400	26,900	139	145	85	4.90	
97	Pine Lakes	1,000	1,250	11,400	13,200	11,000	52	87	175	10.20	
		2,000			25,600	21,400	82	160	139	8.16	
NISQUALLY-DESCHUTES BASINS											
98	Beaver Creek	1,000	1,130	6,700	14,600	12,100	36	61	145	8.50	

Source: U.S. Army Corps of Engineers. North Pacific Division. Pumped-Storage Potential of the Pacific Northwest. Portland, OR. Jan., 1972.