

EXECUTIVE SUMMARY

BACKGROUND

The Chehalis Basin Partnership is developing a management plan for the Chehalis River Basin, which includes 30 drainage subbasins and two Water Resource Inventory Areas (WRIA 22, the Lower Chehalis Basin, and WRIA 23, the Upper Chehalis Basin). The *Chehalis Basin Level 1 Assessment*, published in December 2000 (Envirovision et al., 2000), presents extensive analysis of the basin characteristics that need to be understood for the planning effort.

Subsequent to the release of the Level 1 Assessment report, the Chehalis Basin Partnership divided the Chehalis Basin into four study areas to simplify planning. To reorganize the Level 1 information by study area, as well as to summarize the data for easier use in the planning process, this Detailed Summary of the Level 1 Assessment has been prepared. Key topics addressed are as follows:

- **Geology/Hydrology**—Promoting the availability and quality of water in the basin will require a good understanding of where the water comes from. Water sources include groundwater in underground aquifers and surface waters in creeks, rivers, lakes and other above-ground water bodies. Geology affects the presence and movement of groundwater. Hydrology is the study of surface water behavior.
- **Water Rights/Water Use**—Ensuring the availability of water in the Chehalis Basin will require detailed information on already-allocated water rights in the basin as well as actual water use. Comparing the water supply in the basins' rivers and streams to the amounts of water allocated by water rights and actually being used will indicate how much water is available for future uses.
- **Water Quality**—The Level 1 report provides an evaluation of existing data that describes current basin water quality.
- **Fish Habitat and Fish Stock Condition**—The Chehalis Basin Plan will present strategies for protecting critical fish species. The Level 1 report summarizes available information on conditions affecting these species.

BASIN-WIDE FINDINGS

The Level 1 Assessment presents some findings that apply to the overall basin rather than to individual subbasins or study areas. The following are the key basin-wide findings related to geology and hydrology:

- Groundwater discharges to the Chehalis River along most of the river's length, making hydraulic continuity an issue everywhere in the watershed.
- Stream-flow records indicate a wide range in annual unit runoff (amount of runoff from one square mile) across the Chehalis Basin. The Level 1 Assessment divides the Chehalis Basin into six areas of approximately

similar hydrology, with annual unit runoff ranging from 3 to 12 cubic feet per second of stream flow per square mile of drainage area (cfs/mi²).

- Long-term trends in climate and stream flow in the Chehalis Basin closely correspond to trends across the Pacific Northwest.

The following are the key basin-wide findings related to water rights and water use:

- Irrigation and domestic use are the primary purpose for the largest number of water rights. Power generation and domestic use are the primary purpose for rights with the highest total instantaneous withdrawal rates. Municipal supply and irrigation are the primary purpose for rights with the highest total annual volume limit.
- The six largest of the 47 commercial water rights in the basin account for 86 percent of the total instantaneous withdrawal allocation.
- The sum of in-stream flow requirements and allocated water rights at Montesano exceeds the river's normal flow (50-percent exceedance) for seven months of the year and the river's low flow (90-percent exceedance) year-round (see Figure ES-1).

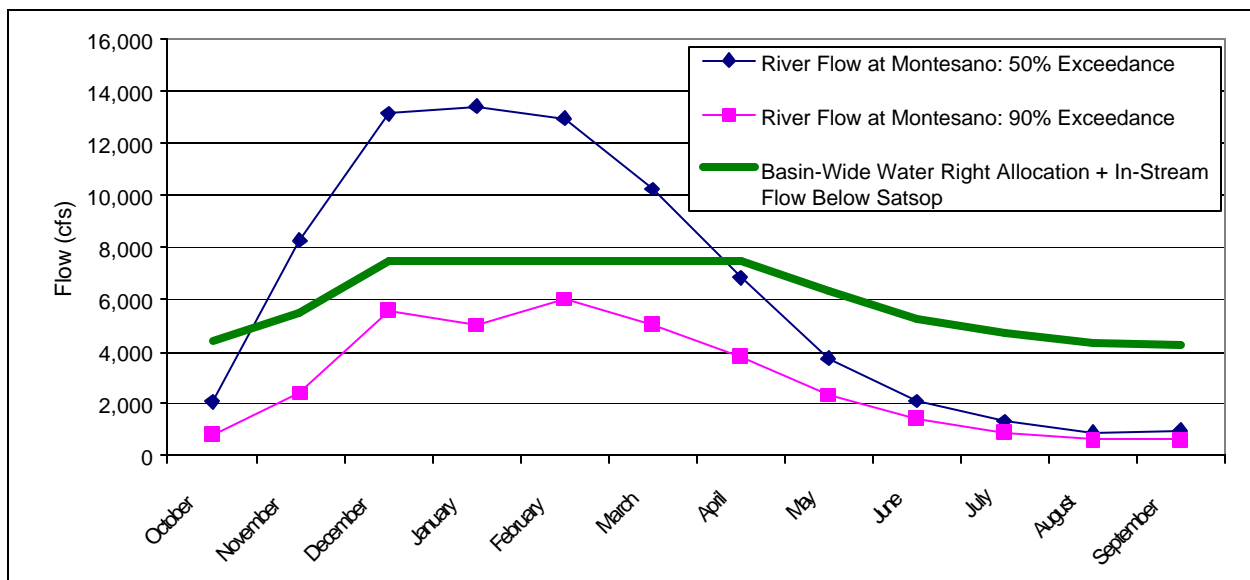


Figure ES-1. Chehalis River Flow at Montesano Compared to Sum of Water Rights and In-Stream Flow

- The maximum-day domestic water demand (double the average demand) for 2000, is well below the total of allocated water rights for domestic use and municipal use. Even with projected population growth through 2020, the maximum-day demand remains well below the allocated water rights.

The following are the key basin-wide findings related to water quality:

- Most of the surface waters in the Chehalis Basin have a state water quality classification of A (excellent). A few reaches of the Chehalis and its tributaries are Class AA (extraordinary) waters or Class B (good) waters.

- Although the waters basin-wide generally attain water quality standards when data are averaged over the long term, individual measurements have failed to meet the standards often enough that 24 water bodies or stream segments in the basin are considered to be impaired and are included on the state's 303(d) listing of impaired water bodies.
- Pollutant concentrations and loads, as well as dissolved oxygen concentrations, are lower during the dry season than during the wet season, and temperatures are higher.
- Pollutant yield (the average loading per acreage) for the Chehalis River is similar to that found in other Western Washington river basins.
- With 83 percent of the basin forested, logging is likely a major contributor of total suspended solids. Agriculture, a contributor of fecal coliform bacteria and nutrients, makes up 11 percent of basin land use. Urban areas, which contribute suspended solids, nutrients and bacteria, make up less than 2 percent of the drainage area upstream of Montesano.

The following are the key basin-wide findings related to critical fish species:

- Stream channels throughout the Chehalis Basin show a consistent pattern of riparian vegetation removal for farming and logging, shade reduction and reduced stream bank stability, high levels of sediment in the water and increased water temperatures.
- In some areas, habitat conditions may be recovering from past damages, especially on state and federal forested lands.
- Of 32 identified salmonid stocks in the basin, 21 are considered healthy, three are considered depressed, seven have a condition that is unknown, and one has a condition that is disputed.

WRIA-WIDE FINDINGS FOR UPPER CHEHALIS BASIN

The Level 1 Assessment presents some findings that apply to the whole Upper Chehalis Basin (WRIA 23) rather than to individual subbasins or study areas. The following are the key findings related to hydrology for WRIA 23:

- The stream-flow gage on the Chehalis River near Porter effectively measures flow for all of WRIA 23, as it is at the point where the river leaves the upper basin.
- Flows measured at the station do not represent natural flows (flows unaffected by human activities), as there are 54 dams in the upper basin, whose effect on downstream flows has not been analyzed.

The following are the key findings related to water rights and water use for WRIA 23:

- Irrigation and domestic use are the primary purposes for the largest number of water rights. Irrigation and power generation are the primary purposes for rights with the highest total instantaneous withdrawal rates. Irrigation, fish propagation and power generation are the primary purposes for rights with the highest total annual volume limit.

- Twenty-two of the 1,828 water rights in the upper basin account for 40 percent of the total allocated instantaneous withdrawal. The largest of these are 140-cfs and 80-cfs rights held by Pacific Power and Light for withdrawal from the Skookumchuck River.
- The sum of in-stream flow requirements and allocated water rights at Porter exceeds the river’s normal flow for seven months of the year and the river’s low flow year-round.
- Figure ES-2 compares upper basin water right allocations to Level 1 estimates of actual consumption for domestic use, irrigation and livestock watering. Allocated rights for each of these purposes greatly exceed the current estimated use.

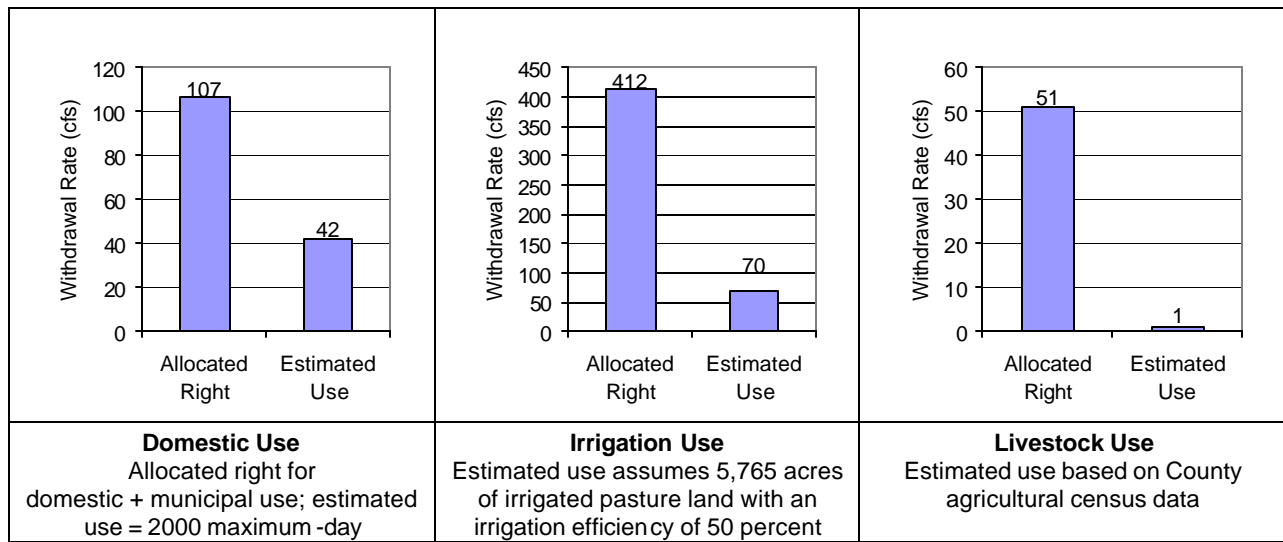


Figure ES-2. Allocated Water Rights and Estimated Actual Water Use in the Upper Chehalis Basin for Domestic, Irrigation and Livestock Uses

The following are the key findings related to water quality for WRIA 23:

- Twenty of the Chehalis Basin’s 24 water bodies on the 303(d) list are in the upper basin.
- Violations of dissolved oxygen standards during the dry season led to a Total Maximum Daily Load (TMDL) study for WRIA 23 in 1994, and temperature standard violations led to another TMDL study in 1999.
- Field observations have indicated that removal of trees and other vegetation along much of the upper river has reduced shading, which contributes to high dry-season temperatures. The TMDL study recommends increasing vegetative shading along the Chehalis River and its tributaries.

The following is the key finding related to critical fish species for WRIA 23 (note that most of the habitat issues are discussed under the “Basin-Wide Findings” section):

- Of the eight Chehalis fish stocks identified in the Level 1 Assessment, five are considered to be healthy. The condition of the other three is unknown.

WRIA-WIDE FINDINGS FOR LOWER CHEHALIS BASIN

The Level 1 Assessment presents some findings that apply to the whole Lower Chehalis Basin (WRIA 22) rather than to individual subbasins or study areas. The following are the key findings related to water rights and water use for WRIA 22:

- Irrigation and domestic uses are the primary purposes for the largest number of water rights. Power generation and domestic use are the primary purposes for rights with the highest total instantaneous withdrawal rates. Municipal uses and power generation are the primary purposes for rights with the highest total annual volume limit.
- Thirty of the 769 water rights in the lower basin account for 90 percent of the total allocated instantaneous withdrawal. The largest of these is a 1,400-cfs right for hydroelectric power generation on the Wynoochee River.
- Figure ES-3 compares lower basin water right allocations to Level 1 estimates of actual consumption for domestic use, irrigation and livestock watering. Allocated rights for each of these purposes greatly exceed the current estimated use.

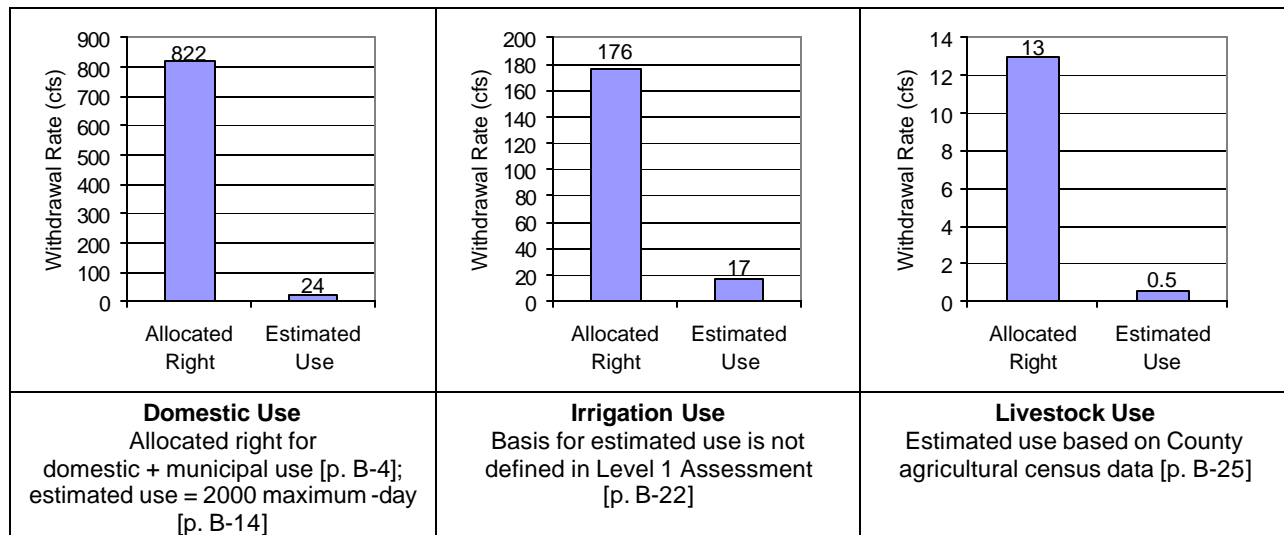


Figure ES-3. Allocated Water Rights and Estimated Actual Water Use in the Lower Chehalis Basin for Domestic, Irrigation and Livestock Uses

The following is the key finding related to critical fish species for WRIA 22 (note that most habitat issues are discussed in the “Basin-Wide Findings” section):

- It was estimated in 1986 that gravel mining removed 10 times as much gravel each year as would be naturally replenished in these river systems. Such operations were reported in 1975 to have seriously reduced available spawning areas for chinook salmon on the Satsop, Humptulips and Wynoochee Rivers.

FINDINGS FOR STUDY AREA 1—GRAYS HARBOR SUBBASINS

Study Area 1 consists of the nine subbasins that drain directly to Grays Harbor or the mouth of the Chehalis River. The major surface water systems in this study area are the Humptulips, Hoquiam and Wishkah Rivers and tributaries south of Grays Harbor. The following are the key findings related to hydrology for Study Area 1:

- Average annual rainfall ranges of 127 inches in the Humptulips drainage basin is the highest annual rainfall of all subbasins in the Chehalis Basin.
- High levels of rainfall throughout the study area lead to correspondingly high levels of runoff.

The following are the key findings related to water rights and water use for Study Area 1:

- Study Area 1 has the lowest total number of rights of all the study areas.
- Rights in the Humptulips drainage basin account for almost half of the instantaneous allocation for the study area and almost two-thirds of the volume allocation.
- From May through October, the Humptulips River in-stream flow requirement alone, without the consumptive allocated water rights, exceeds the river's low flow.

The following are the key findings related to water quality for Study Area 1:

- The Grays Harbor TMDL identifies the Humptulips, Hoquiam, and Wishkah Rivers as major nonpoint sources of fecal coliform to the harbor, although the available water quality records reviewed for the Level 1 Assessment do not indicate a problem with fecal coliform in these rivers.
- Study Area 1 water bodies listed on the state's 303(d) list are the Humptulips River and inner Grays Harbor. A TMDL study has been prepared for the inner harbor and a TMDL for the Humptulips River is being prepared.

The following are the key findings related to critical fish species for Study Area 1:

- The status of four of the 15 stocks identified on the rivers in Study Area 1 is unknown; the status of the other stocks is healthy.
- The Humptulips River has an extensive history of channel modification through gravel removal and the use of splash dams for forestry.
- Small streams tributary to the Wishkah River have good habitat complexity and in-stream structure.
- The Hoquiam River had a history of logging impacts through the 1930s. A diversion dam on the west fork supplies water to the City of Hoquiam.
- Historical channel modifications, mainly splash dams, were reported in the subbasins south of Grays Harbor.

FINDINGS FOR STUDY AREA 2—LOWER CHEHALIS SUBBASINS

Study Area 2 consists of eight subbasins draining to the Chehalis River downstream of Porter. The major surface water systems in this study area are the lower main stem of the Chehalis River, the Wynoochee and Satsop Rivers, and Cloquallum Creek. The following are the key findings related to hydrology for Study Area 2:

- No flow records are available for the lowermost reach of the river.
- The 123-inch average annual rainfall in the Wynoochee subbasin is the second highest of all subbasins in the Chehalis River Basin, with correspondingly high unit runoff of up to 12 cfs/mi².
- Analysis of recorded flows at a gaging station near Aberdeen before and after the completion of the Wynoochee Fish Barrier Dam and the Wynoochee Dam shows that winter peak flows decreased after the dams were put into operation and summer low flows increased.

The following are the key findings related to water rights and water use for Study Area 2:

- The permitted reservoir storage volume for the Wynoochee subbasin represents almost two-thirds of the total storage volume limit for the entire Chehalis Basin. The Wynoochee subbasin also has the largest allocation of instantaneous withdrawal rate, representing more than 40 percent of the total for the entire basin.
- The allocated annual water volume (total volume of permitted water use per year) in the Lower Chehalis Reach 2 subbasin is the largest of all subbasins in the Chehalis Basin, representing more than a quarter of the basin-wide total.
- Significant individual rights in the study area include an 80-cfs groundwater right for held by the Washington Public Power Supply System, a 570-cfs surface water right for multiple domestic use held by the Arrowhead Community Club¹, a 400-cfs right for power generation in the Wynoochee subbasin, and rights of 110 cfs and 45 cfs held by the City of Aberdeen for municipal and commercial/industrial uses.
- In the Cloquallum subbasin, the flow demand (the sum of the in-stream flow requirement and the consumptive allocated water rights) exceeds the low flow from March through November. In the Lower Chehalis Reach 1 subbasin, the demand exceeds the low flow from March through October.
- In the Cloquallum subbasin, estimated domestic water use is about 12 percent of the allocated right. In the Lower Chehalis Reach 1 subbasin, estimated domestic use is about 13 percent of the allocated right and estimated municipal use is about 9 percent of the allocated right.

¹ A Department of Ecology investigation has subsequently revealed that the units for this water right were entered incorrectly in the agency water rights database. The correct value is 570 gallons per minute (or 1.3 cfs) rather than 570 cfs.

The following are the key findings related to water quality for Study Area 2:

- The only Study Area 2 water body listed on the state's 303(d) list is the Lower Chehalis River.
- Total suspended solids concentrations in the Satsop subbasins are second in the Chehalis Basin only to the concentrations in the Humptulips subbasin.
- The Grays Harbor TMDL identifies the Satsop River as a major source of fecal coliform to the harbor, although the available water quality records reviewed for the Level 1 Assessment do not indicate a problem with fecal coliform in this river.
- Temperature has frequently exceeded state standards at the Montesano monitoring station on the Chehalis River. This station also recorded the highest total phosphorus loading and yield of all stations on the Chehalis, as well as the highest yield of inorganic nitrogen, although neither have violated state standards.
- Two water bodies in Study Area 2 are listed on the state's 303(d) list.

The following are the key findings related to critical fish species for Study Area 2:

- The known status of five of the eight fish stocks identified on the Satsop and Wynoochee Rivers is healthy. The status of two of the stocks (Satsop summer chinook and Satsop winter steelhead) is depressed, and the status of Wynoochee spring chinook is disputed.
- The primary habitat problems noted in stream surveys are bank erosion, excessive sediments in the water and reduced tree canopy.

FINDINGS FOR STUDY AREA 3—MIDDLE CHEHALIS SUBBASINS

Study Area 3 consists of three subbasins draining to the Chehalis River from Porter to near Grand Mound. The major surface water systems in this study area are a reach of the main stem of the Chehalis River, the Black River, and Cedar Creek. The following are the key findings related to geology and hydrology for Study Area 3:

- Black Lake previously drained to the Black River but, at least during the dry season, there is no longer a connection between the lake and the river, and the lake drains out of the Chehalis Basin into Percival Creek in Tumwater by way of a constructed drainage ditch.
- The 48-inch average annual rainfall in the Black River subbasin is among the lowest of all subbasins in the Chehalis River Basin. Estimated unit runoff in the study area is relatively low.
- The exchange of groundwater and surface water is significant in the area around the Black River, Middle Chehalis Reach 2 and Scatter Creek. Because of this hydraulic conductivity, the valley floors in this area have been designated critical aquifer recharge areas.

The following is the key finding related to water rights and water use for Study Area 3:

- The Middle Chehalis Reach 2 and Black River subbasins have the highest total number of rights of all subbasins in the Chehalis Basin and a large portion of the total number of rights for many specific purposes.

The following are the key findings related to water quality for Study Area 3:

- The Black River has experienced problems with temperature, dissolved oxygen, total phosphorus, ammonia-nitrogen and fecal coliform.
- Water quality monitoring records from the Porter station indicate problems with temperature and dissolved oxygen.
- Seven water bodies in Study Area 3 are listed on the state's 303(d) list.

The following are the key findings related to critical fish species for Study Area 3:

- Summer temperatures in the Black River and in Scatter Creek are high enough to prevent adult salmon from migrating upstream.
- The primary habitat problems noted in stream surveys are livestock access to streams, bank erosion, and the destruction or loss of bank vegetation.

FINDINGS FOR STUDY AREA 4—UPPER CHEHALIS SUBBASINS

Study Area 4 consists of 10 subbasins draining to the Chehalis River upstream of the Lewis/Thurston County line. The major surface water systems in this study area are three reaches of the main stem of the Chehalis River, the South Fork Chehalis, Newaukum and Skookumchuck Rivers, and Elk and Salzer Creeks. The following are the key findings related to geology and hydrology for Study Area 4:

- Average annual rainfall is 42 inches in the Salzer Creek subbasin, the lowest of all subbasins in the Chehalis River Basin.
- Estimated unit runoff in the study area is relatively low, about 3 to 5 cfs/mi².

The following are the key findings related to water rights and water use for Study Area 4:

- Study Area 4 has the highest total number of rights of all the study areas. More than half of the rights are for irrigation.
- The Skookumchuck subbasin has the second highest storage allocation of all subbasins in the Chehalis Basin, after the Wynoochee subbasin.
- Significant individual rights include a 140-cfs right held by Pacific Power and Light for power generation and an 80-cfs held by Pacific Power and Light for power generation and commercial use.
- In the Chehalis headwaters subbasin, the flow demand (the sum of the in-stream flow requirement and the consumptive allocated water rights) exceeds the low flow in every month except for November, December, February and March. In the Newaukum subbasin, the demand exceeds the low flow in every month except February.

- In the Chehalis headwaters subbasin, estimated domestic water use is about 4 percent of the allocated right and estimated municipal use is 16 percent of the allocated right. In the Newaukum River subbasins, estimated domestic use is as much as 81 percent of the allocated right.

The following are the key findings related to water quality for Study Area 4:

- A 10-mile portion of the main stem of the Chehalis River passing through Centralia and Chehalis, known as the Centralia Reach, has a special water-quality designation. A natural sill in this segment causes water to pool upstream, leading to slow-flowing waters and characteristics more like a lake than a river.
- Thirteen water bodies in Study Area 4 are listed on the state's 303(d) list.

The following are the key findings related to critical fish species for Study Area 4:

- The status of the only identified fish stock specific to Study Area 4 (the Skookumchuck/ Newaukum winter steelhead) is depressed.
- Some peak temperatures in parts of the study area have exceeded the lethal limit for many salmonid species.
- The primary habitat problems noted in stream surveys are bank erosion, loss of canopy and bank vegetation, and livestock access to streams.

LEVEL 1 RECOMMENDATIONS

Based on its review of available data, the Level 1 Assessment provides recommendations for further investigations and analysis to be performed as part of a Level 2 Assessment. Key topics recommended for further evaluation in the Level 1 report are as follows:

- The interaction of groundwater with surface water
- Undepleted stream flows (not affected by human activities) and the influence of dams on flow
- The established requirements for in-stream flows
- The effect of land use on hydrology
- Options for augmenting stream flows
- The accuracy of the Washington State Department of Ecology's Water Rights Accounting and Tracking System
- Actual water use relative to allocated water rights
- Water quality by subbasin
- Pollutant yields in priority subbasins
- The priority of potential water quality improvement actions
- Fish habitat conditions in the basins south of Grays Harbor and in the Wishkah and Hoquiam River basins
- Restoration opportunities for side channels, wetlands and sloughs.

In addition to recommending new analyses, the Level 1 Assessment recommends that long-term water quality monitoring stations be established in one or two places likely to represent a baseline condition that can be used for comparison.

1. INTRODUCTION

BACKGROUND

The Chehalis Basin Partnership is working to develop a management plan for the Chehalis River Basin under Washington State's 2514 Watershed Planning Program (Chapter 90.82 of the Washington Administrative Code). The most significant document prepared to date for the planning process is the *Chehalis Basin Level 1 Assessment*, published in December 2000 (Envirovision Corporation et al., 2000), which presents extensive data and analysis of the basin characteristics that need to be understood for the planning effort.

The Level 1 report generally organizes information by topic—geology, hydrology, water rights, water use, water quality and fish habitat condition—rather than by location, although some location-specific data is provided throughout the document:

- Some data is broken down for each of the 30 subbasins into which the Chehalis River Basin has been divided.
- Some data is broken down by Water Resource Inventory Area (WRIA), which is a planning designation developed by the Washington State Department of Ecology; the Chehalis Basin consists of WRIA 22, the Lower Chehalis Basin, and WRIA 23, the Upper Chehalis Basin.
- Five of the 30 subbasins were selected for detailed evaluation in the Level 1 Assessment, and special sections of the report address conditions in those specific subbasins.

Subsequent to the release of the Level 1 Assessment report, the Chehalis Basin Partnership delineated four study areas within the Chehalis Basin. Planning individually for each of these study areas will simplify the process of creating a watershed plan for Washington's second largest river basin. Because the study areas were defined after completion of the Level 1 Assessment, information in that document is not organized to correspond to the study areas.

Figure 1-1 shows the overall Chehalis River Basin and the delineation of the two WRIsAs, the four study areas, and the 30 subbasins.

PURPOSE OF THE DETAILED SUMMARY

To reorganize the Level 1 information by study area, as well as to summarize the data for easier use in the planning process, this Detailed Summary of the Level 1 Assessment has been prepared. Key findings of the Level 1 Assessment are highlighted, data from the Level 1 report are presented graphically, and potential points of confusion from the Level 1 report are noted.

This document does not present information beyond what was compiled for the Level 1 Assessment. Its purpose is to interpret the significance of Level 1 data for planning purposes and restructure the Level 1 data by study area to set assist in the development of watershed planning recommendations.

ORGANIZATION OF THE DETAILED SUMMARY

The Detailed Summary is organized as follows:

- Chapter 2 (General Concepts) defines technical language and concepts that are fundamental to the specialized disciplines of geology, hydrology, hydrogeology, water rights, water use estimates, water quality, and fish habitat. This chapter is intended as a primer for those unfamiliar with any of these specialized topics. It does not present specific Level 1 findings and can be passed over by readers who are familiar with these topics.
- Chapter 3 (Level 1 Basin-Wide Findings) discusses Level 1 information that applies to the entire Chehalis Basin.
- Chapters 4 and 5 (Level 1 WRIA-Wide Findings) present and discuss data from the Level 1 Assessment that applies specifically to either WRIA 22, the Lower Chehalis Basin, or WRIA 23, the Upper Chehalis Basin.
- Chapters 6, 7, 8, and 9 (Study Areas) present Level 1 information that could be identified to apply specifically to one of the four Watershed Management Plan study areas.
- Chapter 10 (Summary of Recommendations from the Level 1 Assessment) lists specific, unprioritized recommendations that the Level 1 Assessment presents for further studies to be performed during Level 2 of Phase 2 of the Watershed Management Planning process.

Throughout the Detailed Summary, page number references are provided in brackets (e.g., [p. A-32]) to identify where in the Level 1 Assessment the information presented here was found. In most cases, readers may refer to those pages in the Level 1 report to find more detailed explanations of the data presented.

Discrepancy notes, author's notes, and questions are included in blue text throughout this Detailed Summary to document instances where uncertainties arose during review and interpretation of the Level 1 Assessment. These notes are included to assist the user in quickly identifying outstanding issues that may need to be resolved at a later date.

2. GENERAL CONCEPTS

This chapter defines general concepts addressed by the Level 1 Assessment. It defines terms used in this detailed summary, and discusses the significance of data presented in the Level 1 Assessment.

GEOLOGY/HYDROLOGY

The focus of the planning effort for the Chehalis Basin is to promote the availability and quality of water in the basin. This will require a good understanding of where the water comes from. Water sources include groundwater in underground aquifers and surface waters in creeks, rivers, lakes and other above-ground water bodies.

Geology

The geology of an area affects the presence and movement of groundwater. The likelihood of groundwater being available in an area depends largely on how porous and permeable the local rock and soil are. This also determines whether groundwater and surface waters are likely to interact with one another (such interaction is called *hydraulic continuity*). Water flowing from an aquifer to a surface water body is called *inflow*. Where hydraulic continuity occurs, groundwater withdrawals can reduce or deplete the flow in rivers and streams.

The important characteristics of the primary geologic materials in the Chehalis Basin area are as follows:

- Volcanic/sedimentary bedrock—These rock formations, which make up most of the mountains and foothills, are unlikely to hold large contiguous areas of groundwater. Finding any good aquifer in these areas would require expensive exploration. Groundwater in bedrock usually does not interact with surface water.
- Glacial sediments—These layers of sand, gravel, silt and clay deposited by the ancient movement of glaciers are found mostly in the valleys and sometimes in upland areas. Some glacial sediments, such as outwash from glacial streams, are good groundwater sources. Other types of glacial sediments, such as glacial till, are usually not good groundwater sources. Areas of glacial sediment have the potential for hydraulic continuity between surface water and groundwater.
- Alluvial sediments—These sediments deposited by moving water throughout the river valleys are a good groundwater source. Hydraulic continuity with surface water is generally significant in alluvial sediments.
- Marine terrace deposits – Layers of sand and gravel deposited in a beach environment. These deposits do not usually make a good groundwater resource because of their limited extent, typical poor groundwater quality, and salt water intrusion issues.

Hydrology

Hydrology, the study of surface waters, requires information on precipitation, the flow of rivers and streams, and the interaction of surface water and groundwater. The Level 1 Assessment presents a review of records from stream-flow gages on rivers and streams in the Chehalis Basin and from local climate-monitoring stations. The following terms and concepts are important in the review and evaluation of hydrologic records:

- Natural/undepleted flows—This is stream flow of any stream/river system that is not impacted by any human activities or withdrawal. It is the flow that would be seen in any surface water from just natural conditions. In the following circumstances, stream-flow records may not represent natural conditions:
 - The recording gage is downstream of points where the flows are depleted by water removal for human activities
 - The period of recorded measurements is short and corresponds to a time of atypical weather.

Basin planning requires data on the full amount of surface water available under typical weather conditions, so the best records are those from stream-flow gages monitoring undepleted flows over a long period. These gages are called *base gages*.

DISCREPANCY NOTE: THREE TABLES IN APPENDIX A GIVE INFORMATION ON BASE GAGES, BUT THEY DO NOT LIST THE GAGES CONSISTENTLY. TABLE A-10 INCLUDES GAGE 12035500 (SOMEWHERE IN THE WYNOOCHEE SUBBASIN) THAT IS NOT IN TABLE A-8 OR A-9.

- Depleted Stream Flow—Stream flow downstream of a diversion or take-out, like an irrigation ditch. This differs from natural/undepleted flows in that the natural flow is changed by human activities.
- Base flows—Base flow is the level of water carried by a river or stream during the dry season. It is largely provided by groundwater coming to the surface.
- Exceedance value—Long-term stream-flow records can allow estimates of how frequently the flow in a river or stream is above a certain level; these levels vary with rain patterns over the course of a year. If records for many years show that flow in a stream during August is more than 10 cubic feet per second (cfs) 90 percent of the time, then 10 cfs is defined as the stream's 90-percent exceedance value for August. The flow value would be higher during a rainy month such as January or February. The 50-percent exceedance value would be higher than the 90-percent value, because it represents a level of flow that is exceeded only 50 percent of the time. The Level 1 Assessment uses 90-percent exceedance values to represent low flows and 50-percent exceedance values to represent normal flows.
- Unit runoff—Runoff is rainfall that is not absorbed into the ground so it flows overland until it reaches a drainage system or a water body. The amount of flow that a given land area contributes to a river or stream as runoff over a selected period is called unit runoff (often measured in cubic feet per second per square mile, or cfs/mi²). Unit runoff is higher in areas

where there is more rainfall, soils are less permeable, or development has covered large areas with pavement or buildings (impervious areas).

- Effect of dams—Stream-flow data collected by gages downstream of dams differ from natural flows. Peak rainy-season flows are usually lower with a dam than without and low dry-season flows are usually higher.

WATER RIGHTS/WATER USE

Developing a solid plan for ensuring the availability of water in the Chehalis Basin will require detailed information on already-allocated water rights in the basin as well as actual water use. The Level 1 Assessment presents a review of state water-right records. Comparing the amount of water allocated by these rights to the water supply in the basins' rivers and streams is essential to determining how much water is available for future uses. Because many holders of water rights actually withdraw less than their allocated right, it also is useful to estimate actual water use, and the Level 1 Assessment provides estimates of current and future actual use.

Water Rights

The Level 1 review of water rights addresses the following key concepts:

- The location and number of rights issued—The number of allocated water rights in each of the 30 subbasins is identified.
- The water source for each right—Water rights are issued for either groundwater (from a well) or surface water (from a river or stream).
- The amount of water assigned to each right—Amounts are assigned in several ways:
 - The *instantaneous withdrawal rate* is how much water can be taken from the water source at a specific time, measured in cubic feet per second (cfs)
 - The *annual volume limit* is the total amount of water that can be withdrawn in one year, measured in acre-feet (an acre-foot is defined as 1 acre covered with 1 foot of water; 1 acre-foot equals 325,851 gallons)
 - Some water rights are for the long-term storage of water from a source; these rights are assigned with a limit to the total volume of water that can be stored, measured in acre-feet
- The primary purpose of the water right—For long-term water planning, it is useful to know what activities are consuming the most water. Typical primary purposes of water rights are domestic use, irrigation, commercial use, livestock watering, power generation, recreation, fish or wildlife propagation, and municipal supply. For water rights with irrigation as the primary purpose the area of the land to be irrigated, in acres, is defined as part of the water right.
- Whether the water right is consumptive or non-consumptive—Depending on the purpose of a water right, water withdrawn from its source may or

may not be returned to the source. Domestic, agricultural and many other uses use up much or all of the water withdrawn without returning it to the source, and are considered *consumptive*. Hydroelectric power generation and some other uses return most or all of the withdrawn water to the source and are usually considered *non-consumptive*. Even non-consumptive uses may affect the river system if the return flows are downstream from the water intake location, resulting in depleted stream flows for the reach between the intake and the return flow.

The Level 1 Assessment points out a level of uncertainty in assigning locations within the Chehalis Basin to water rights compiled from state records. The uncertainty stems from the fact that the state database locates water rights only within relatively large 40-acre “quarter-quarter sections.” When boundaries of the basin or its subbasins cross through these quarter-quarter sections, it cannot be determined with certainty that the actual point of the water withdrawal is within a specific subbasin [pp. B-1, B-2] or even within the overall Chehalis River Basin.

Other Water Allocations

In some cases, water from a surface or groundwater source must be considered to be allocated and unavailable for future use even without an officially approved water right:

- *Water claims* are claims to water use that were made before Washington State adopted codes formalizing water rights; they represent valid water rights, but are not included in the Level 1 Assessment of water rights.
- *Exempt wells* are wells drawing limited amounts of water for limited uses that are allowed under state law without an official water right. The Level 1 Assessment reviews two approaches to estimating the number of exempt wells in the Chehalis Basin but does not develop actual estimates.
- *In-stream flows* are the flows in a river or stream determined to be necessary to support fish. The state cannot issue new water rights for a surface water source if the sum of the new right and the existing rights would leave flow in the stream below the required in-stream flow. The state Department of Ecology establishes *control points* on streams defining the locations at which the minimum flow must be maintained. Defining minimum levels at these points affects all uses of the water source upstream.

Water Use

Records for actual water use for the Chehalis Basin are generally not available, so the Level 1 Assessment takes a variety of approaches to assessing water use:

- Because domestic water use relates directly to population, the Level 1 Assessment evaluates domestic water use based on population estimates and a calculation of per-capita water demand. Figure 2-1 shows the population projections developed for the Level 1 Assessment. Average-day demand is calculated by multiplying population by the *per-capita demand*.

The Level 1 Assessment defines maximum-day demand as twice the average -day demand.

- No information was available for estimating actual commercial use in the Level 1 Assessment.
- An analysis of irrigation water use provides a rough calculation of demand based on assumptions about climate conditions, the size of the irrigated area, the type of crop irrigated, and efficiency of the irrigation system. The analysis assumes irrigation systems with a 50-percent efficiency, and pasture grass, which has a high consumptive use of water, as the irrigated crop.
- The use of water by livestock is roughly estimated based on agricultural census data of livestock in the counties that make up the largest parts of the Chehalis Basin and standardized values for the daily water consumption of each type of livestock.

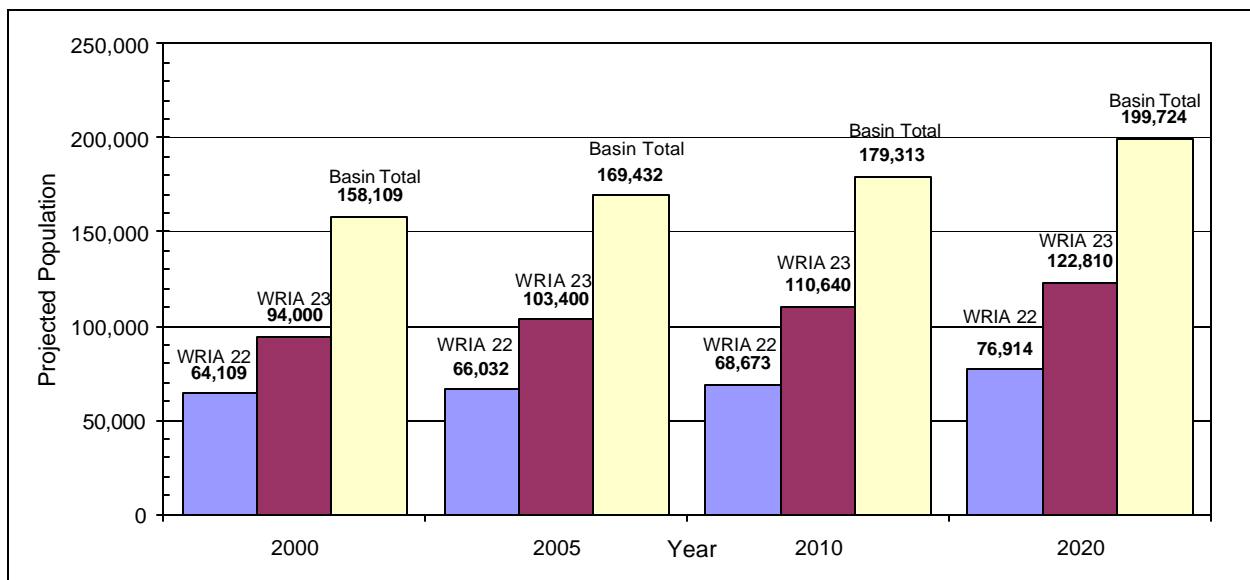


Figure 2-1. Projected Population by WRIA and for the Combined Chehalis Basin [p. B-12]

WATER QUALITY

Promoting the quality of water available in the Chehalis River Basin is one of the key aims of the basin planning effort. Water quality determines whether available water supplies are suitable for the many uses to which they are put. The range of uses includes drinking water, irrigation water and fish habitat. The Level 1 Assessment provides an evaluation of existing data that describes current basin water quality and likely factors that can lead to degradation of the water quality. The available data addresses only the quality of surface waters; no information on groundwater quality is provided.

Water Quality Characteristics

The evaluation focuses on the following water characteristics:

- Temperature—The suitability of surface waters as habitat for fish is strongly dependent on the water temperature. When temperatures become too high, fish cannot survive in the water.
- Oxygen—The level of oxygen dissolved in the water is another essential feature for fish, who require minimum *dissolved oxygen* (DO) levels in order to survive.
- Fecal coliform bacteria—*Fecal coliform* (FC) bacteria, which enter surface waters from human and animal waste, represent a pollutant that can make water unsuitable for many human uses, including domestic use and recreational use.
- Phosphorus—Phosphorus may be present in surface waters in a variety of forms, and is often measured as the combination of all these forms, referred to as *total phosphorus* (TP). Phosphorus is a nutrient for aquatic vegetation, but at high levels it is considered a pollutant that is harmful to overall water quality.
- Suspended solids—Sediment and a number of other undissolved materials in surface water can be harmful to fish and make the water unsuitable for many human uses. These materials are measured in combination as *total suspended solids* (TSS).
- Nitrogen—Like phosphorus, nitrogen, present in a number of forms in surface waters, is a nutrient that degrades water quality when it reaches high levels. The forms of nitrogen addressed by the Level 1 Assessment are all *inorganic nitrogen* (IN) forms.

Water Quality Measurements

Water quality analysis uses a number of ways to measure water quality characteristics. The following are the key measurements reviewed in the Level 1 Assessment:

- Concentration—Measured from individual samples taken from the water body (this is called *ambient monitoring*), concentration is a measure of how much of a substance is present in a given volume of water. Typical units of concentration are milligrams per liter (mg/L) for oxygen, suspended solids, phosphorus and nitrogen, and colonies per 100 milliliters (ml) for fecal coliform bacteria.
- Load—The load is the total amount of a substance being added to the water over a given amount of time. It is calculated from measured concentration and recorded flow rate. Typical units are pounds per day (ppd) for phosphorus, suspended solids and nitrogen, and colony-forming units (cfu) per day for fecal coliform bacteria (“cfu” and “colony” are used interchangeably in the Level 1 report).
- Yield—Yield is a measurement of the load from a given amount of drainage area. It is calculated by dividing the load by the total area contributing to the water body at the point where measurements are being taken. The Level 1 Assessment evaluates the yield of phosphorus, suspended solids and nitrogen in tons per year per square mile.

Factors Affecting Water Quality

To address water quality in the basin planning effort, it will be important to understand the range of factors that can influence water quality for the better or the worse. The Level 1 Assessment reviews the influence of the following:

- **Season**—Many water quality parameters are affected by changes between the warm dry season (defined in the Level 1 Assessment as August 1 through October 31) and the cool wet season (from November 1 through March 31). The air temperature affects the water temperature, and the presence or absence of rainfall runoff affects pollutant loads reaching the streams. Dissolved oxygen usually declines during the dry season because warm water cannot hold as much dissolved oxygen as cold water, because aquatic life consumes more dissolved oxygen during the summer, and because low stream flows during this period do not mix with air as much.
- **Location on the river**—Water quality changes as the river moves from its *headwaters* (the upstream source of the stream) to its mouth. Total pollutant loading generally increases, as more and more area contributes flow to points further downstream, but pollutant concentrations, as well as temperature and dissolved oxygen levels, may go up or down, depending on specific contributing sources along the way, as well as the width, depth and steepness of the river. Much of the water quality analysis presents data at specific *river miles* along the main stem of the Chehalis River (the river mile is the distance of a given point from the river's mouth, measured along the winding river channel). Figure 2-2 shows the location of cities and tributaries compared to river miles.
- **Time period**—Water quality may change over the course of years or decades as a result of changes in activities taking place in the drainage area.
- **Land use**—The type of human activity and land development in a stream's drainage area has a significant impact on water quality. Increased areas of pavement cause increased runoff, which carries pollutants to the stream. Specific land use, such as industry, agriculture or residential uses, generate specific pollutants that make their way to the surface waters.
- **Source type**—The appropriate steps for reducing pollutant loading depend on the type of source contributing the pollutants. Approaches that work for reducing pollution from *point sources* (flows contributed at a single, clearly defined location, such as the discharge from a wastewater treatment plant, factory,) are different from those needed to address *nonpoint source pollution* (pollutants picked up over a wide area and carried to the stream by surface runoff).

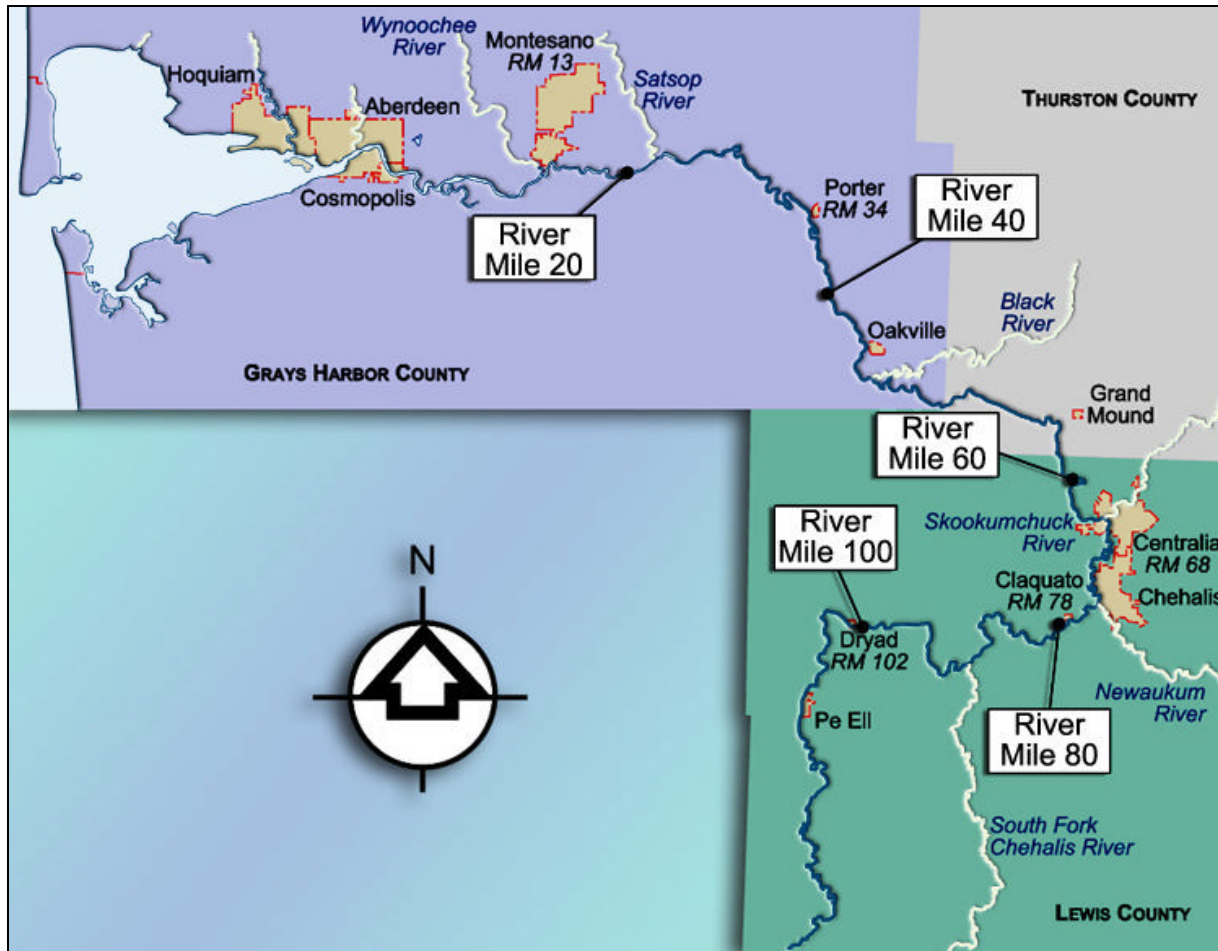


Figure 2-2. River Miles Along the Chehalis River Main Stem [pp. 2-16, C-3]

Regulatory Considerations

Regulatory standards and requirements for water quality have been developed at the state and federal levels. The primary water quality regulations addressed in the Level 1 Assessment are described below.

Washington State Water Classification and Water Quality Criteria

Rivers and streams of Washington are assigned water quality classifications ranging from “extraordinary” to “fair.” These classifications are assigned, not according to actual water quality in the water body, but according to the water quality that must be maintained for the best use of the water (a stream intended to be used for domestic water supply, for example, may have a higher classification than one that is not, even though actual water quality in the two streams may be the same). The state defines water quality criteria that surface waters must meet, based on their assigned classification. These criteria include temperatures and fecal coliform concentrations that must not be exceeded as well as minimum dissolved oxygen concentrations that must be maintained.

Federal Clean Water Act Listing of Impaired Water Bodies

The federal Clean Water Act requires states to maintain lists of water bodies that do not meet defined criteria for water quality. These lists of *impaired* water bodies are commonly called *303(d) lists*, after the section of the Clean Water Act that requires them. The Washington Department of Ecology releases updated 303(d) lists every two years. Water bodies on the list are those that do not meet the state-defined water quality criteria for their classification.

Total Maximum Daily Load Studies

It is the state's responsibility to address water quality problems in the impaired water bodies included on the 303(d) list. A first step often is to conduct a study to establish a *total maximum daily load* (TMDL) for the water body of the water quality parameter that has failed to meet state criteria. TMDL studies recommend guidelines for users of the water body to keep human activities from causing water quality violations. The Level 1 Assessment makes use of much of the water quality data that has been collected for TMDL studies within the Chehalis Basin.

National Pollutant Discharge Elimination System

Municipal and industrial discharge of flow to a surface water is regulated under the National Pollutant Discharge Elimination System (NPDES). Such discharges require a permit from the Washington Department of Ecology. The NPDES permit establishes limits on the concentration and total loading of pollutants that can enter the surface water through the discharge. The Level 1 Assessment uses the limits set in these permits to evaluate potential pollutant loading for the length of the Chehalis River and its tributaries.

FISH HABITAT AND FISH STOCK CONDITION

The Chehalis Basin Plan will include strategies for ensuring the protection of critical fish species that live in the basin. To aid in developing such strategies, the Level 1 Assessment presents a summary of available information on existing basin conditions affecting these species. The summary includes descriptions of the habitat that the fish need to survive and of the known condition of specific fish populations.

Level 1 discussions of fish habitat and fish stock focus on the needs of *salmonids* (the family of fish that includes salmon and trout) while they are living in the basin's rivers and streams. Many of these fish are *anadromous*, which means they spend part of their lives living in saltwater and part in the freshwater rivers and streams. The Level 1 Assessment does not address the needs of these fish during the life stages in which they live in saltwater. Critical fresh water stages include spawning and rearing.

Fish Habitat

The following features are important for maintaining high quality fish habitat:

- Low water temperature—High water temperatures can be lethal to many of the critical fish species living in the Chehalis Basin. The lethal limit for many salmonid species is about 25°C [p. D-17]. Trees and other vegetation

in the areas along the banks of rivers and streams (such areas are called *riparian* areas) provide shade to help keep water temperatures low. Maintaining a minimum level of flow also helps keep temperatures low, as low, slow flows can easily become overheated in warm weather.

- Adequate oxygen level—Fish use dissolved oxygen in the water for respiration and will not survive if the dissolved oxygen level is too low. The generally accepted minimum level of dissolved oxygen for salmonids is 5.0 mg/L [p. D-14].
- Low levels of suspended solids and pollutants—High concentrations of suspended solids and pollutant can be harmful to the health of fish.
- Access for migration—Anadromous fish may travel many miles from the spawning waters where they're born to the saltwaters where they live their adult lives. Physical barriers blocking fish passage along the migration routes, such as dams and some culverts, disrupts the ability of the fish to complete their life cycles.
- Habitat variety—Fish rely on side channels, pools and other diverse regions of streams for resting, feeding, spawning and other vital activities. Such regions are best provided by meandering stream channels and the presence of *large woody debris* (LWD), such as stumps, branches and logs, in the water.
- Spawning beds—Clean gravel is necessary for spawning. Floods can flush gravel away, and low flows can expose gravel beds above the water level, leaving them unusable for spawning.

The following human activities can have significant impacts on the quality of fish habitat:

- Vegetation removal—Many human activities, including agriculture, logging and urban development, involve the removal of trees and other vegetation from riparian areas and from the wider drainage basin. Removing vegetation from the riparian areas leaves the banks of rivers and streams susceptible to erosion, which can alter channel shapes and contribute heavy loads of sediment to the water. Removal of vegetation throughout the watershed allows rainfall to runoff in higher, faster flows, increasing the flow in rivers and streams, with further potential for erosion.
- Road building and urban development—The construction of roads, parking areas and buildings creates areas of impervious surface where rainfall cannot infiltrate into the soil, resulting in increased runoff to streams. This runoff often carries oils and other pollutants that accumulate on the paved surfaces.
- Development of drainage systems—Constructed drainage systems, consisting of ditches and stormwater sewers, concentrates the flow of runoff to streams, leading to high flows at specific locations that can contribute to erosion of stream banks and stream beds.
- Water use—Withdrawal of surface water for domestic use or irrigation lowers stream flows downstream of the point of withdrawal. The use of groundwater sources can lower the water table, which has the potential to

affect low flows in streams where there is hydraulic continuity between groundwater and surface water.

- Livestock rearing—Cattle tend to compact the soils in pastures where they graze, reducing the potential for rainfall infiltration to the soil and increasing runoff to streams. Cattle also remove riparian vegetation and break down stream banks, contributing to erosion and sediment loads to the water.
- Stream channel modifications—Agriculture and urban development sometimes involve straightening stream channels, filling in side channels, constructing dams or stream bank levees, and other modifications of stream channels. Such activities reduce the habitat variety that fish need for their various life stages. They also can alter flows in the stream.

The Level 1 Assessment of habitat condition draws upon information from a stream survey conducted by the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife [p. D-13]. The survey noted problem areas in two ways. Stream segments less than 20 feet long with habitat problems are noted as *point occurrences*, with the segment length not recorded. For longer segments with habitat problems, the length of the problem segment is recorded. Segments are identified by the nature of the habitat problem. Thus, the condition report for a stream might read as follows:

- Bank erosion—89 points and 27.7 miles (meaning 89 past problems and a bigger segment of problem along a 27.7 mile reach)
- Stream canopy reduction—6 points and 11.6 miles
- Excessive sediments—11 points and 9.9 miles.

Fish Stock Condition

Assessment of the condition of fish populations focuses on *stocks*, which are the populations of a particular kind of fish that spawn in a particular lake or stream during a particular season. Chinook salmon, for example, include spring, summer and fall chinook, all spawn in different seasons. Spring chinook salmon in the Chehalis Basin include two stocks: the Chehalis spring chinook (all fish using the Chehalis and its tributaries upstream of Satsop are generally identified as Chehalis) and the Wynoochee spring chinook, using the Wynoochee River stream system.

The health of fish stocks is rated by the following status levels [pp. D-1, D-2]:

- Critical stocks are those that have declined in numbers to the point that the stock is in jeopardy of significant loss or extinction.
- Depressed stocks are those whose production is below expected levels but above the level that threatens permanent damage to the stock
- Healthy stocks are those whose production meets or exceeds the expected level.

3. LEVEL 1 BASIN-WIDE FINDINGS

Much of the information presented in the Level 1 Assessment applies to the entire Chehalis River Basin. This chapter summarizes findings that apply to the overall basin rather than to individual subbasins or study areas.

GEOLOGY/HYDROLOGY

Hydraulic Continuity

Documents reviewed for the Level 1 Assessment indicate that groundwater discharges to the Chehalis River along most of the river's length, making hydraulic continuity an issue everywhere in the watershed. The amount of this inflow varies with location and seasons. One study calculated inflow to the river from its aquifer up to 10.3 cfs per mile of river [p. A-15]. Basin-wide, stream base flow, which is largely attributable to groundwater, averages 63 percent of the total flow in streams [p. A-14].

Stream Flows and Unit Runoff

Stream-flow records are available from 54 gages in the Chehalis Basin—30 in WRIA 23 and 24 in WRIA 22 [p. A-16]. Records from at least one gage are available for all but five of the 30 subbasins that make up the Chehalis Basin (Subbasins 16, 23, 24, 26 and 30). Of these, the Level 1 Assessment identifies 20 as base gages, measuring essentially undepleted or natural flows—11 in WRIA 23 and nine in WRIA 22. The 20 base gages are distributed among 13 subbasins [p. A-35].

[NOTE: SEE THE DISCREPANCY NOTE IN THE HYDROLOGY SECTION OF THE GENERAL CONCEPTS CHAPTER FOR DISCREPANCIES REGARDING THE NUMBER OF BASE GAGES.](#)

Records from the base gages indicate a wide range in annual unit runoff across the Chehalis Basin. Based on the records, the Level 1 Assessment divides the Chehalis Basin into six areas of approximately similar hydrology [p. A-40]:

- Low-lying valleys along the Chehalis and its tributaries:
annual unit runoff of 3 to 4 cfs/mi²
- The upper Chehalis headwaters in the Willapa Hills:
annual unit runoff of 3 to 5 cfs/mi²
- Tributaries with headwaters in the Cascades foothills, such as the Black, Skookumchuck and Newaukum Rivers:
annual unit runoff of 4 to 5 cfs/mi²
- Low-lying tributaries on the north side of Grays Harbor, such as the Hoquiam River and lower Humptulips River:
annual unit runoff of 5 to 8 cfs/mi²
- Satsop River basin:
annual unit runoff of 6 to 7 cfs/mi²
- Humptulips and Wynoochee Rivers upper watersheds:
annual unit runoff of 10 to 12 cfs/mi²

The Level 1 Assessment presents a calculation of exceedance values for the Chehalis River at Montesano, using records from multiple stream gages as well as estimates of unit runoff. Stream flow at Montesano, near the mouth of the Chehalis River, approximates the total river flow contribution for the basin. It does not, however, account for flow in the direct tributaries to Grays Harbor. Figure 3-1 shows the calculated flows for the Chehalis River at Montesano.

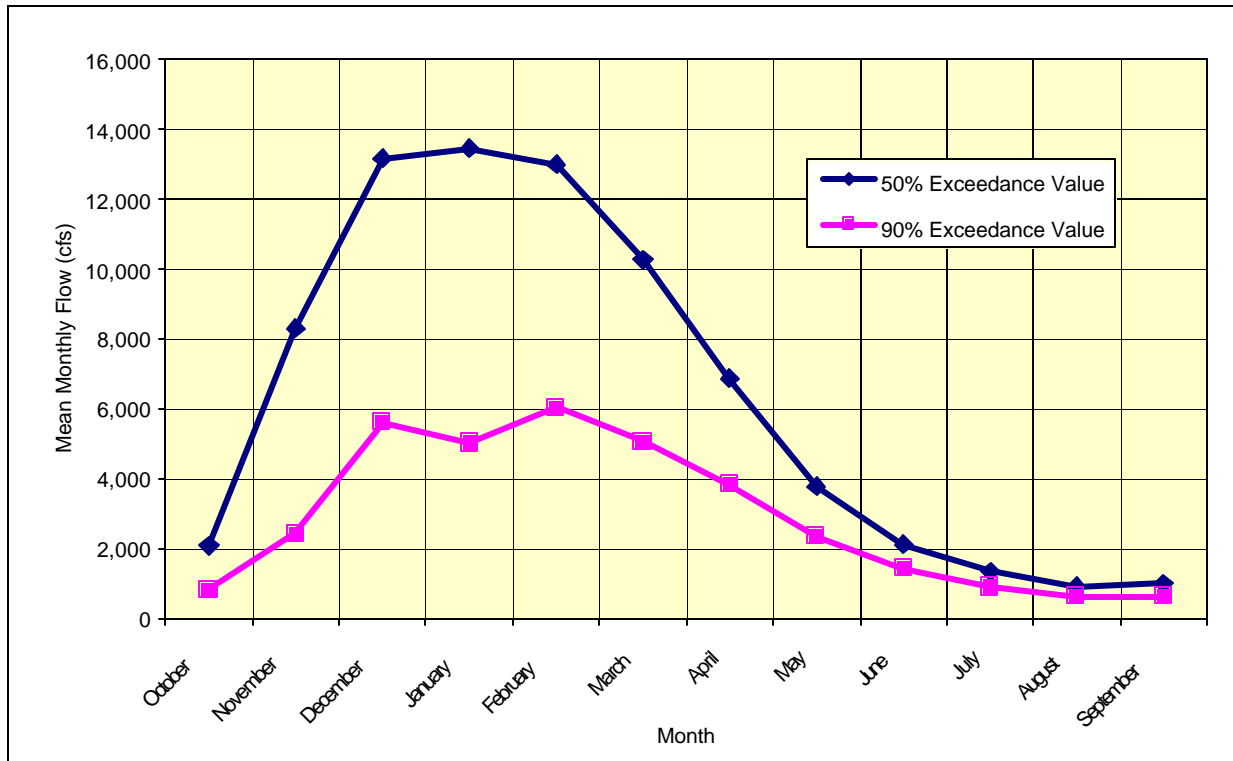


Figure 3-1. Calculated Flows for Chehalis River at Montesano [p. A-29]

Regional Climate Cycle Comparisons

The Level 1 Assessment also presents an analysis comparing rainfall records from two of the 19 climate monitoring stations in the Chehalis Basin to previously identified climate cycles for the Pacific Northwest. The comparison shows that changes from cool, wet periods to warm, dry periods at the two stations (in Aberdeen and Chehalis) closely correspond to the same changes across the region [p. A-31]. A similar analysis for stream-flow records for one base gage (on the Satsop River near Satsop) also found that the records closely correspond to regional climate cycles [p. A-34].

WATER RIGHTS/WATER USE

Water Rights and In-Stream Flows

Figures 3-2 through 3-6 summarize the Level 1 Assessment’s findings of basin-wide water rights.

DISCREPANCY NOTE: DATA FOR THE FOLLOWING CHARTS IS TAKEN FROM LEVEL 1 TABLE 2.3-1, WHICH DOES NOT INCLUDE THE 80-CFS RIGHT FOR THE CENTRALIA STEAM PLANT UNDER THE CONSUMPTIVE CATEGORY OF THERMAL POWER. JOANNE GREENBERG, AUTHOR OF THE LEVEL 1 ASSESSMENT WATER RIGHTS SECTION, CLARIFIED THAT THIS WATER RIGHT IS ACTUALLY FROM THE NISQUALLY RIVER, NOT FROM THE CHEHALIS. IT THEREFORE

REPRESENTS AN IMPORT OF WATER TO THE CHEHALIS BASIN. THIS IS NOT STATED IN THE LEVEL 1 ASSESSMENT HOWEVER. THE TABLE ALSO ASSIGNS THE ENTIRE WRIA 22 POWER GENERATION ANNUAL VOLUME LIMIT OF 54,360 ACRE-FEET TO THE CATEGORY OF THERMAL POWER. CHARTS WILL NEED TO BE UPDATED IF CORRECTIONS ARE MADE TO THE TABLE.

Figure 3-2. Basin-Wide Distribution of Water Rights by Primary Purpose— Number of Rights [pp. 2-10, B-4, B-5]

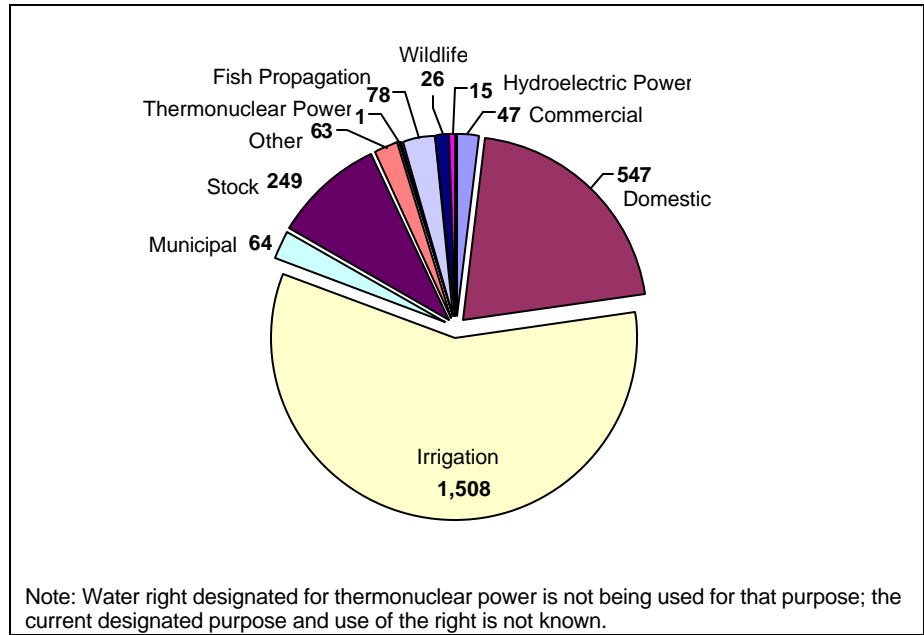


Figure 3-3. Basin-Wide Distribution of Water Rights by Primary Purpose— Instantaneous Withdrawal Rate (cfs) [pp. 2-10, B-4, B-5]

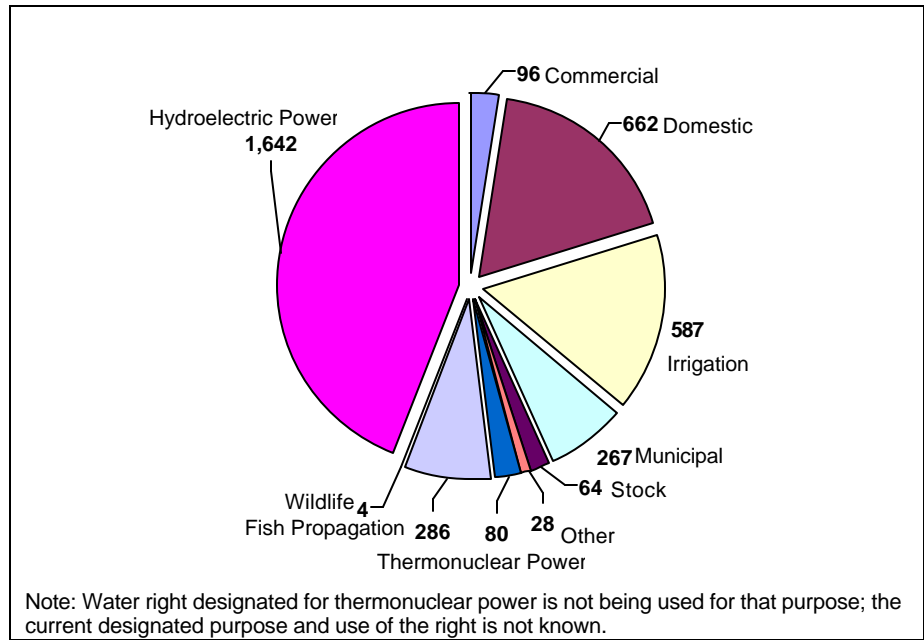
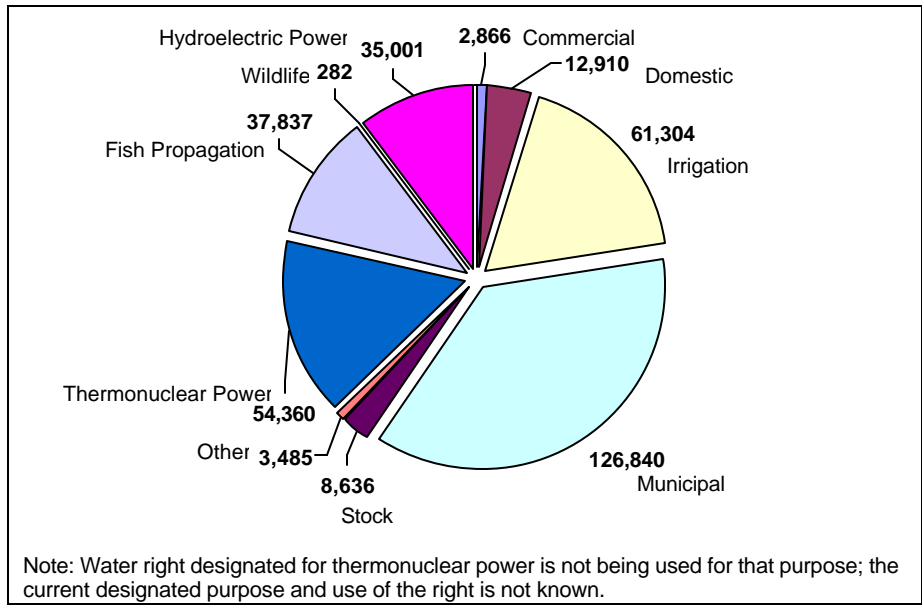


Figure 3-4. Basin-Wide Distribution of Water Rights by Primary Purpose—Annual Volume Limit (acre-feet) [pp. 2-10, B-4, B-5]



NOTE: THE DATA PRESENTED AS “ANNUAL VOLUME LIMIT” IN TABLES THROUGHOUT THE LEVEL 1 REPORT APPEAR TO REPRESENT THE SUM OF TWO COLUMNS IN TABLE B-3 ON PAGE B-8: “ACRE-FEET” AND “STORAGE (ACRE-FEET).” IN DEVELOPING NUMBERS BY STUDY AREA FOR THIS SUMMARY REPORT THIS TOTAL WAS USED, IN ORDER TO REMAIN CONSISTENT WITH THE LEVEL 1 REPORT. HOWEVER, INCLUDING THE STORAGE ALLOCATION MAY NOT BE APPROPRIATE FOR SOME ANALYSES. IT WOULD BE USEFUL TO DO A SECOND COMPILATION WITH THE STORAGE RIGHTS SUBTRACTED.

Figure 3-5. Basin-Wide Distribution of Water Rights by Type of Right [p. B-9]

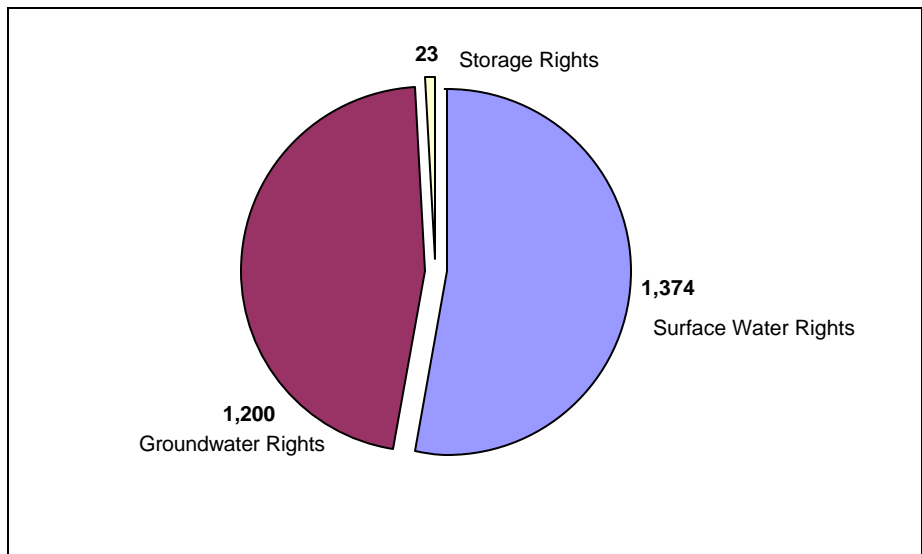
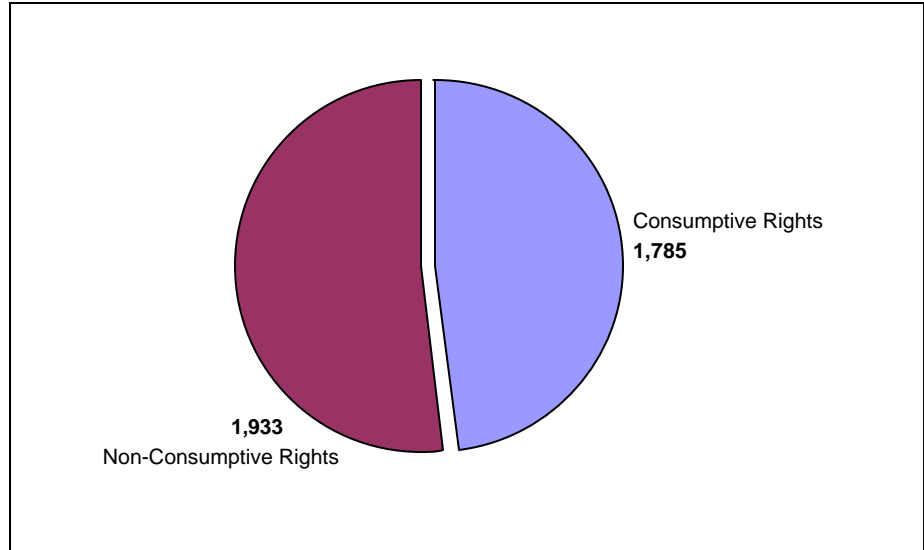


Figure 3-6. Basin-Wide Breakdown of Water Rights into Consumptive and Non-Consumptive Rights; Instantaneous Withdrawal Rate (cfs) [p. 2-10]



Highlights of the basin-wide data on water rights are as follows:

- Irrigation and domestic use are the primary purpose for the largest number of water rights.
- Power generation and domestic use are the primary purpose for rights with the highest total instantaneous withdrawal rates.
- Municipal supply and irrigation are the primary purpose for rights with the highest total annual volume limit.
- The six largest of the 47 commercial water rights in the basin account for 86 percent of the total instantaneous withdrawal allocation. These are issued to Grays Harbor Pulp & Paper (three rights), the Weyerhaeuser Company, the Port of Grays Harbor, and Quiggs Brothers McDonald.

Figure 3-7 shows the in-stream flow requirements for the Chehalis River below Satsop, which is the most downstream control point on the river. Figure 3-8 compares river flows at Montesano to the sum of in-stream flow at Satsop and total allocated water rights for the basin (3,718 cfs). This is an approximate comparison of basin-wide water allocation to basin-wide flow. The sum of in-stream flow requirements and allocated water rights exceeds the river's normal flow (50-percent exceedance) for seven months of the year and the river's low flow (90-percent exceedance) year-round.

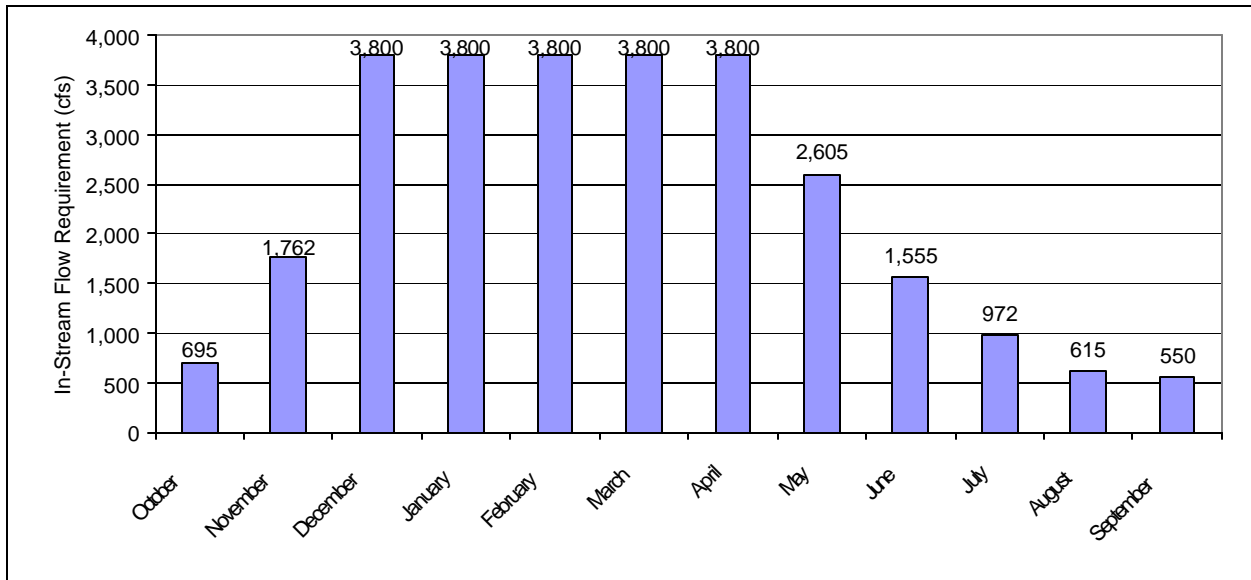


Figure 3-7. In-Stream Flow Requirements for the Chehalis River at Control Point below Satsop [p. 2-7]

DISCREPANCY NOTE: THE DATA USED FOR FIGURE 3-8 IS THE SAME AS USED IN FIGURE 2.2-4 IN THE LEVEL 1 ASSESSMENT. HOWEVER, IT SEEMS THAT WATER RIGHT ALLOCATIONS FOR SUBBASINS 21 THROUGH 30 SHOULD NOT BE INCLUDED, SINCE THEY ARE ALL DOWNSTREAM OF MONTESANO. IT MIGHT ALSO BE APPROPRIATE TO SUBTRACT GROUNDWATER RIGHTS FROM THE ALLOCATED FLOW TOTAL. THE CHART WILL HAVE TO BE REVISED IF THESE CHANGES ARE MADE.

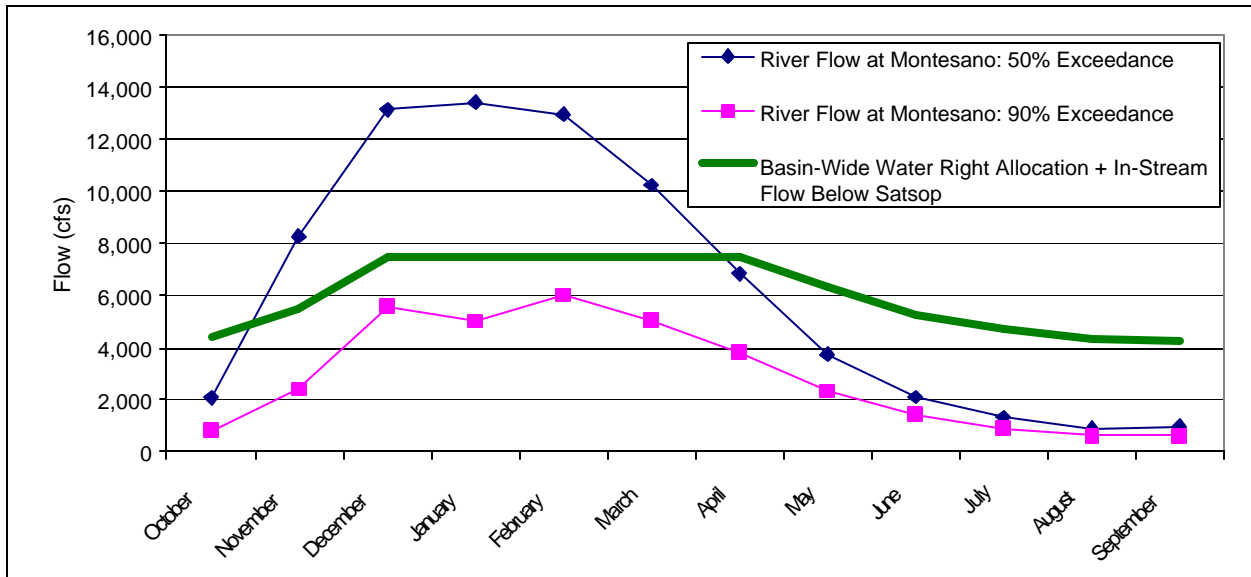


Figure 3-8. Chehalis River Flow at Montesano Compared to Sum of Water Rights and In-Stream Flow [p. 2-7]

Water Use

The Level 1 Assessment presents estimates of domestic water use based on estimated population and calculated values of per-capita water demand. Figure 3-9 presents the domestic water use estimates for the entire Chehalis Basin. The maximum-day demand for 2000, 66 cfs, is well below the total of allocated water rights for domestic use (662 cfs) and municipal use (267 cfs). Even with population growth through 2020, the average-day

demand remains well below the allocated water rights. The maximum-day demand for 2020 would be twice the average-day demand, or 84 cfs, which is still significantly lower than the allocated rights.

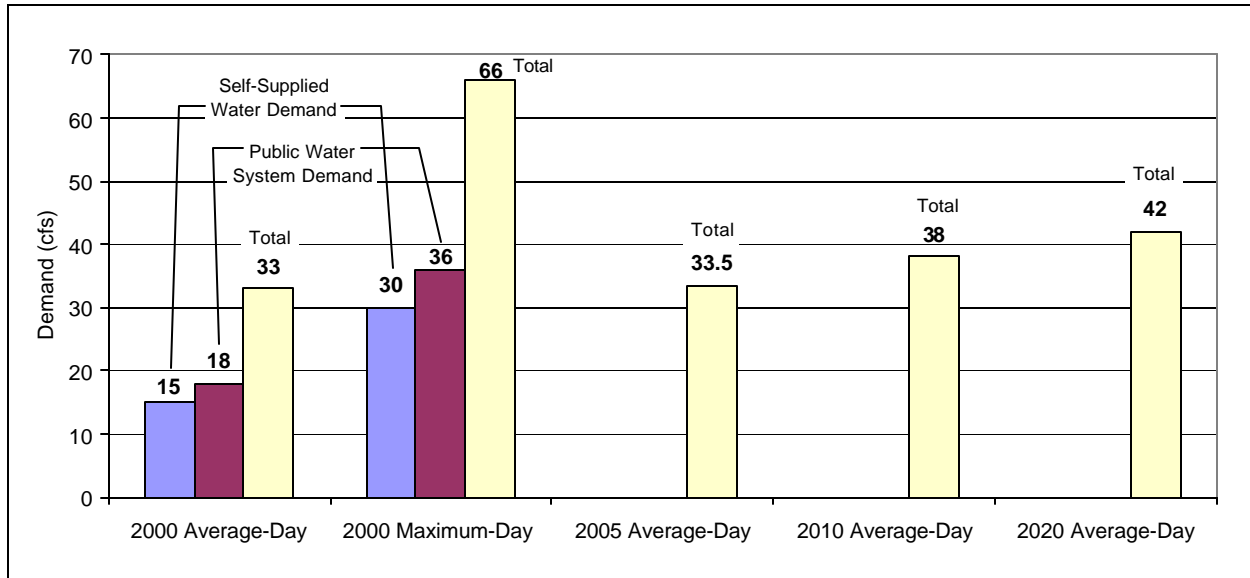


Figure 3-9. Estimated Basin-Wide Domestic Water Use [pp. B-14, B-17, B-18]

WATER QUALITY

The Level 1 Assessment evaluates water quality monitoring data from stations at numerous points along the main stem of the Chehalis River and its tributaries. Where adequate records are available, comparisons are made among data collected in the 1970s, 1980s and 1990s to assess long-term water quality trends. Also presented are breakdowns of the data into wet season and dry season averages.

List of Impaired Water Bodies

Most of the surface waters in the Chehalis Basin have a state water quality classification of A (excellent). A few reaches of the Chehalis and its tributaries are Class AA (extraordinary) waters or Class B (good) waters. These classifications define the water quality standards that must be attained. Although the waters basin-wide generally attain the standards when data are averaged over the long term, individual measurements have failed to meet the standards often enough that 24 water bodies or stream segments in the basin are considered to be impaired and are included on the state's 303(d) listing of impaired water bodies. The following summarizes which standards are violated for the listed water bodies (the total exceeds 24 because some of the listed water bodies violate more than one standard) [p. C-45]:

- 19 violations of standards for fecal coliform
- 11 violations of standards for dissolved oxygen
- 9 violations of standards for temperature
- 1 violation of standards for total phosphorus

- 1 violation of standards for pH.

[DISCREPANCY NOTE: CHAPTER 2 MAKES SEVERAL REFERENCES TO 25 IMPAIRED STREAM SEGMENTS IN THE CHEHALIS BASIN \(PP. 2-16, 2-17\), BUT THE TABLE ON P. C-45 LISTS ONLY 24.](#)

Water Quality Trends

The Level 1 Assessment indicates only one significant trend in the water quality data from the 1970s through the 1990s: at the most upstream monitoring station, in Dryad, the wet-season loading of total suspended solids increased steadily with each decade [p. 2-21].

The data evaluated show expected trends with the seasons: pollutant concentrations and loads, as well as dissolved oxygen concentrations, are lower during the dry season than during the wet season, and temperatures are higher [pp. 2-16 – 2-20]. Pollutant loading generally increases moving downstream from the uppermost monitoring stations, which also is as expected. Figure 3-10 shows the variation in total phosphorus loading with season and with river mile.

Evaluation of pollutant yield (the average loading per acreage) shows that yield for the Chehalis River is similar to that found in other Western Washington river basins, as shown in Figure 3-11.

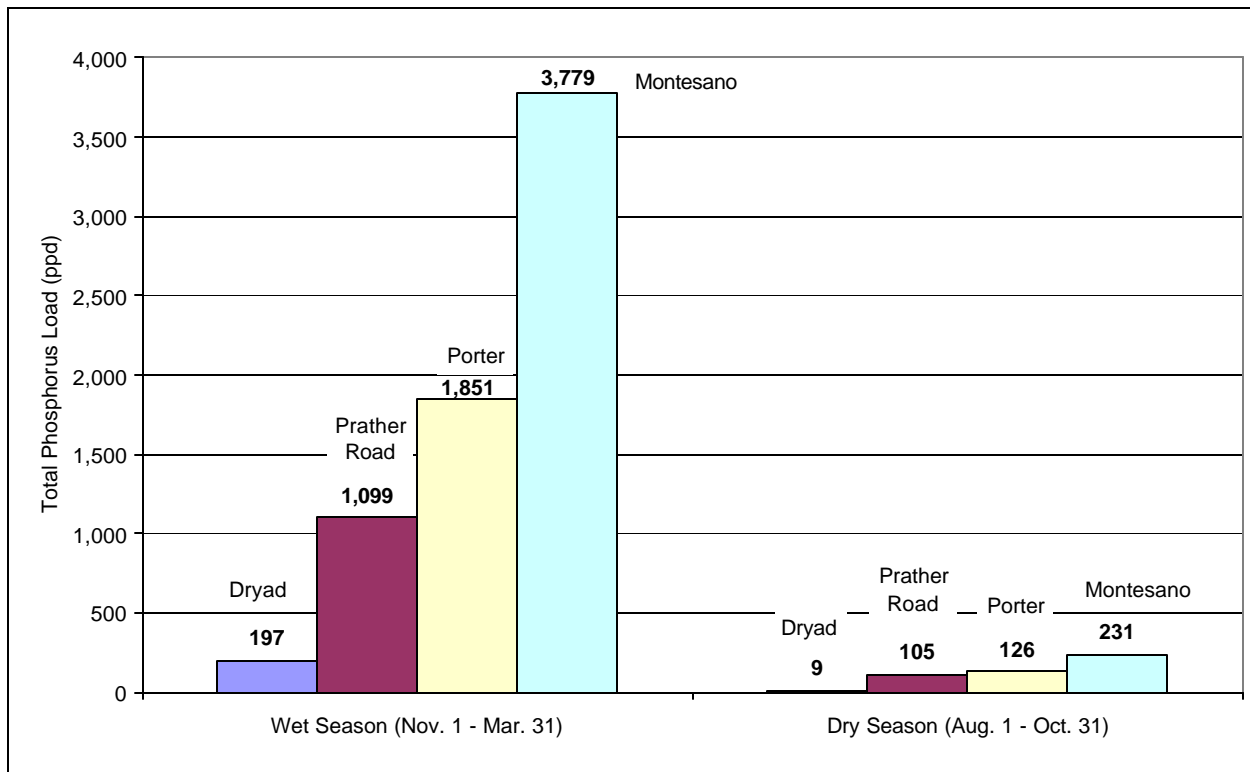


Figure 3-10. Summary of 1990s Total Phosphorus Records [p. C-10]

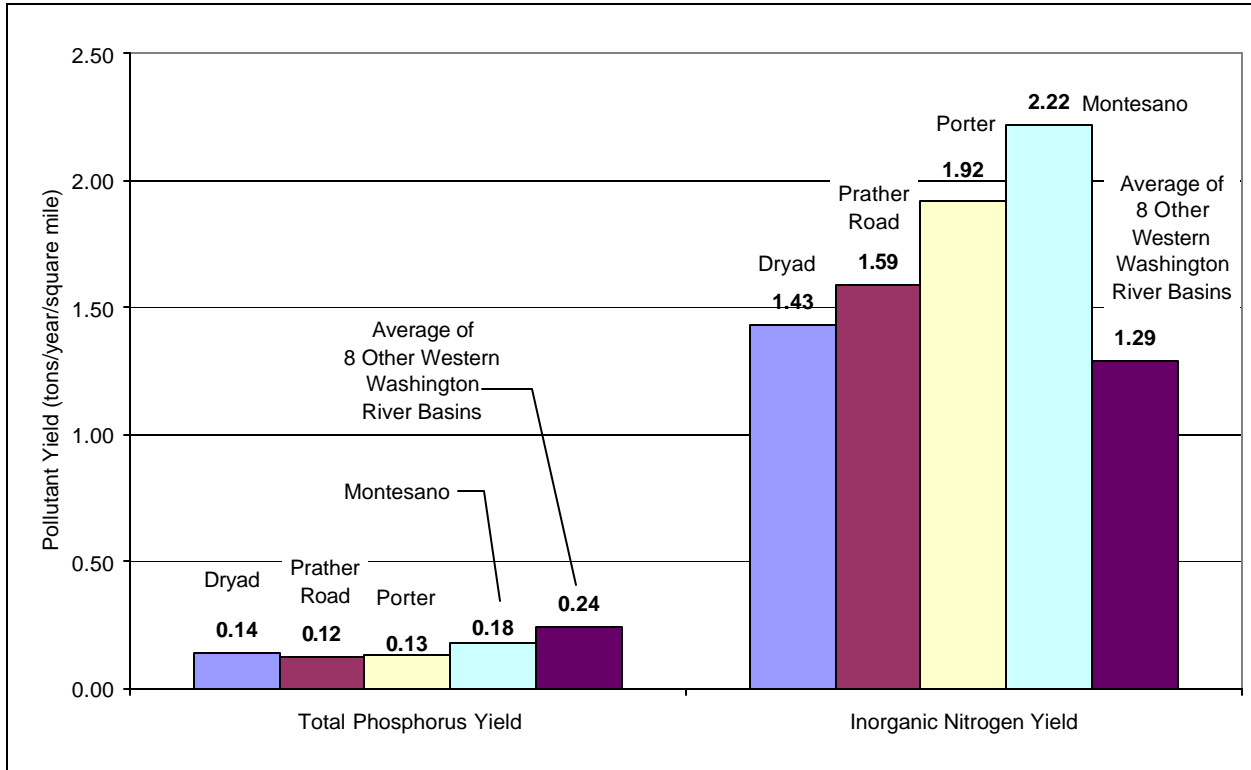


Figure 3-11. Comparison of Chehalis Basin Pollutant Yields to Average for Other River Basins [pp. 2-22, 2-23]

Pollutant Sources

The Level 1 Assessment notes that non-point sources of pollution in the Chehalis Basin include agriculture, logging, urban stormwater and failing septic systems. With 83 percent of the basin forested, logging is likely a major contributor of total suspended solids. Agriculture, a contributor of fecal coliform bacteria and nutrients such as phosphorus and nitrogen, makes up 11 percent of basin land use, and most of it is adjacent to the Chehalis River corridor. Urban areas, which contribute suspended solids, nutrients and bacteria, make up less than 2 percent of the drainage area upstream of Montesano [p. C-48].

Point sources of pollution are evaluated by review of NPDES permits in the basin. The Level 1 Assessment provides a list of entities who have a permitted wastewater discharge within the Chehalis basin. The list includes sewage treatment plant discharges for most Chehalis watershed cities, and thirteen industrial dischargers. The industrial permittees are mining, lumber, seafood, and other food production industries.

The Level 1 Assessment estimates that if all permit holders upstream of Montesano were to discharge flow year-round at their permitted limits, they would contribute 427 ppd of total phosphorus to the Chehalis River. This amounts to 16 percent of the average wet-season phosphorus loading, according to historical records, and almost three times the dry-season loading [p. C-46].

DISCREPANCY NOTE: THE COMPARISON OF NPDES PERMIT LOADING TO HISTORICAL MONTESANO DATA CITED ABOVE WORKS OUT TO AN HISTORICAL AVERAGE PHOSPHORUS LOAD OF 2,669 PPD FOR THE WET-SEASON AND ABOUT 150 PPD FOR THE DRY-SEASON. IT'S NOT CLEAR WHERE THESE VALUES COME FROM. TABLE C-4 ON

PAGE C-10 GIVES WET AND DRY SEASON LOADS AT MONTESANO OF 3,779 PPD AND 231 PPD (FOR THE 1990S). IT WOULD BE NICE TO BE ABLE TO CITE WHAT HISTORICAL DATA THE ABOVE CITATION REFERS TO.

FISH HABITAT AND FISH STOCK CONDITION

Habitat Condition

Stream channels throughout the Chehalis Basin show a consistent pattern of riparian vegetation removal for farming and logging, shade reduction and reduced stream bank stability, leading to bank erosion, high levels of sediment in the water and increased water temperatures. The streams have very little habitat-enhancing large woody debris. Little side-channel and off-stream habitat is present [p. 2-24].

In some areas, habitat conditions may be recovering from past damages, especially on state and federal forested lands, where protection of riparian corridors has become common in recent decades. On agricultural lands, riparian conditions are more dependent on the actions of individual landowners [p. 2-25].

Human activities have affected habitat in the basin for many years. Draining land for farming began in the mid-1800s. In many rivers, woody debris has been removed from stream channels and used to block off sloughs and side channels in an effort to consolidate and straighten the main channel. Brush was removed from many streams in agricultural areas during the 1930s. Riparian-area degradation due to agriculture has been widely documented throughout the basin [p. 2-25]. Gravel mining operations throughout the basin have degraded salmon spawning areas [p. D-12].

The Chehalis River has been surveyed for 111 river miles upstream of its mouth. The following range of habitat problems was identified [p. D-16]:

- Reduced tree canopy—9 points and 104 miles
- Livestock access—1 point and 8 miles
- Bank vegetation destruction or loss—52 points and 22 miles
- Damage from livestock—8 miles
- Bank erosion—69 points and 24.1 miles
- Riprap, dumping and artificial bank protection—65 points and 8 miles
- Excessive sediments in the water—7 miles.

Fish Stock Condition

The Level 1 Assessment identifies 32 stocks of salmonids in the Chehalis Basin. Figure 3-12 shows the identified stocks and the status of each stock's condition. The "disputed" status for Wynoochee spring chinook salmon is based on differing assessments of that stock's condition made in multiple studies. The Level 1 Assessment cites one study that concluded that the Wynoochee spring chinook stock is "at high risk of extinction [p. D-3]."



Figure 3-12. Status of Identified Salmonid Stocks in the Chehalis Basin [p. D-4]

4. LEVEL 1 WRIA-WIDE FINDINGS FOR UPPER CHEHALIS BASIN

This chapter summarizes findings that apply to WRIA 23, the Upper Chehalis Basin.

GEOLOGY/HYDROLOGY

The Level 1 Assessment does not include any WRIA-wide information on geologic characteristics.

The stream-flow gage on the Chehalis River near Porter effectively measures flow for all of WRIA 23, as it is at the point where the river leaves the upper basin. Figure 4-1 shows an average of the 45 years worth of records from the gage. The 50-percent exceedance value for the Porter records for annual average flow is 1,980 cfs, and the 90-percent exceedance value is 370 cfs [p. A-28].

Flows measured at the station do not represent natural flows, as there are 54 dams in the upper basin, whose effect on downstream flows has not been analyzed. The Porter gage records must be considered to be unadjusted to account for the effect of the dams.

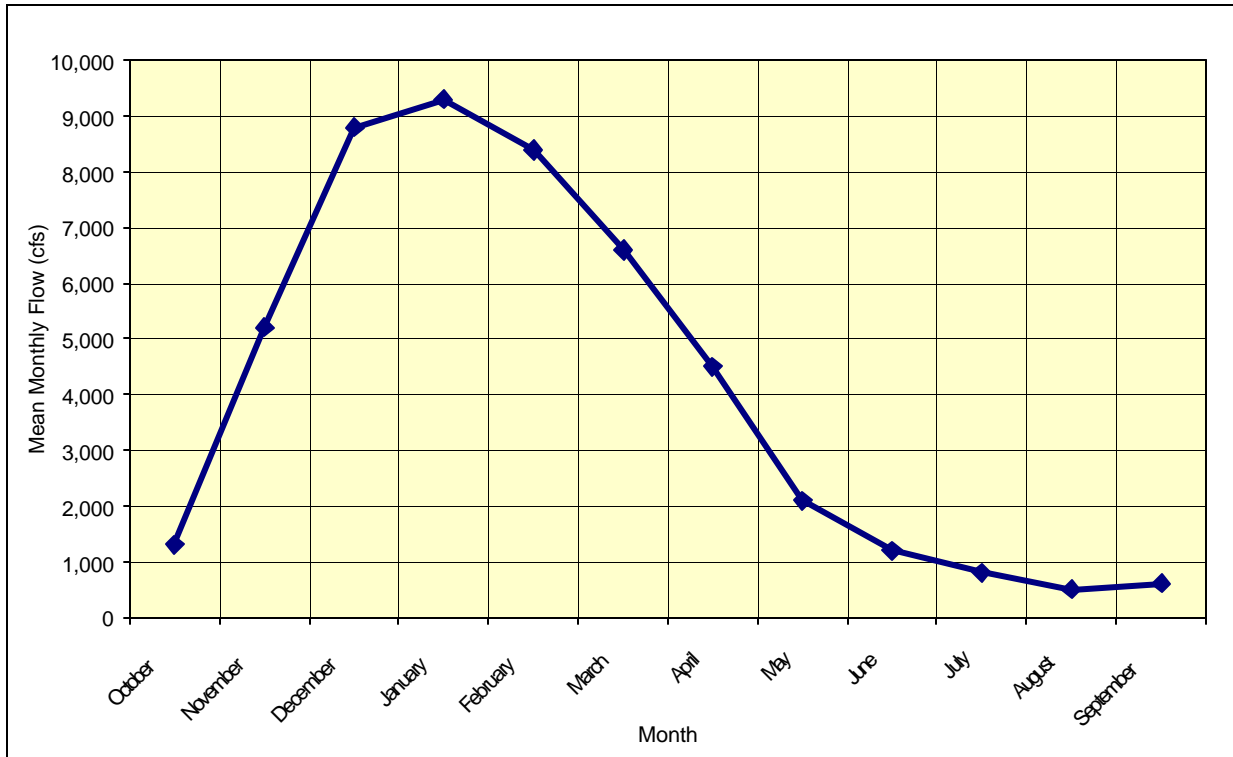


Figure 4-1. Average of Measured Flows for Chehalis River at Porter, 1952-1972 and 1975-1998 [p. A-27]

WATER RIGHTS/WATER USE

Water Rights and In-Stream Flows

Figures 4-2 through 4-6 summarize the Level 1 Assessment's findings of water rights in the upper basin.

DISCREPANCY NOTE: DATA FOR THE FOLLOWING CHARTS IS TAKEN FROM LEVEL 1 TABLE 2.3-1, WHICH DOES NOT INCLUDE THE 80-CFS RIGHT FOR THE CENTRALIA STEAM PLANT UNDER THE CONSUMPTIVE CATEGORY OF THERMAL POWER. JOANNE GREENBERG, AUTHOR OF THE LEVEL 1 ASSESSMENT WATER RIGHTS SECTION, CLARIFIED THAT THIS WATER RIGHT IS ACTUALLY FROM THE NISQUALLY RIVER, NOT FROM THE CHEHALIS. IT THEREFORE REPRESENTS AN IMPORT OF WATER TO THE CHEHALIS BASIN. THIS IS NOT STATED IN THE LEVEL 1 ASSESSMENT HOWEVER.

Figure 4-2. WRIA 23
Distribution of Water Rights
by Primary Purpose—
Number of Rights
[pp. 2-10, B-5]

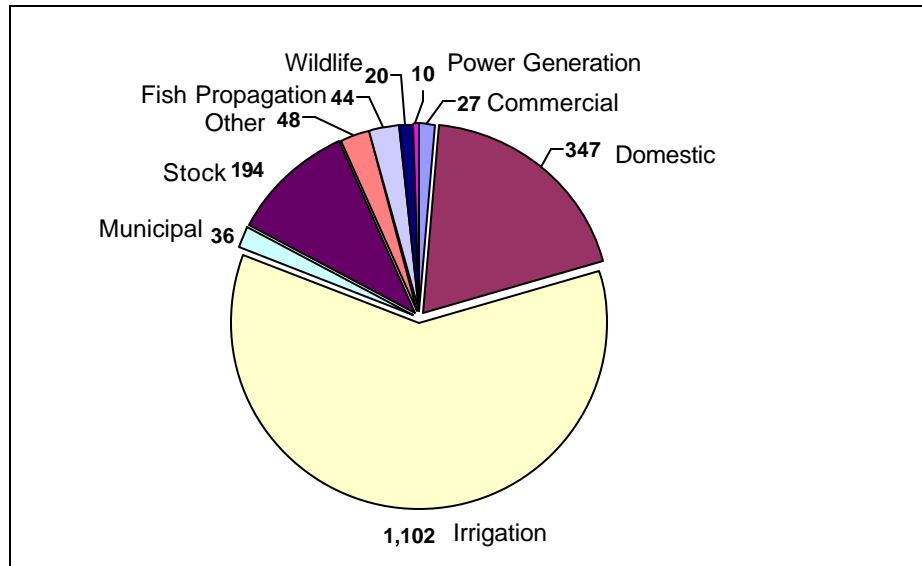


Figure 4-3. WRIA 23
Distribution of Water Rights
by Primary Purpose—
Instantaneous Withdrawal
Rate (cfs)
[pp. 2-10, B-5]

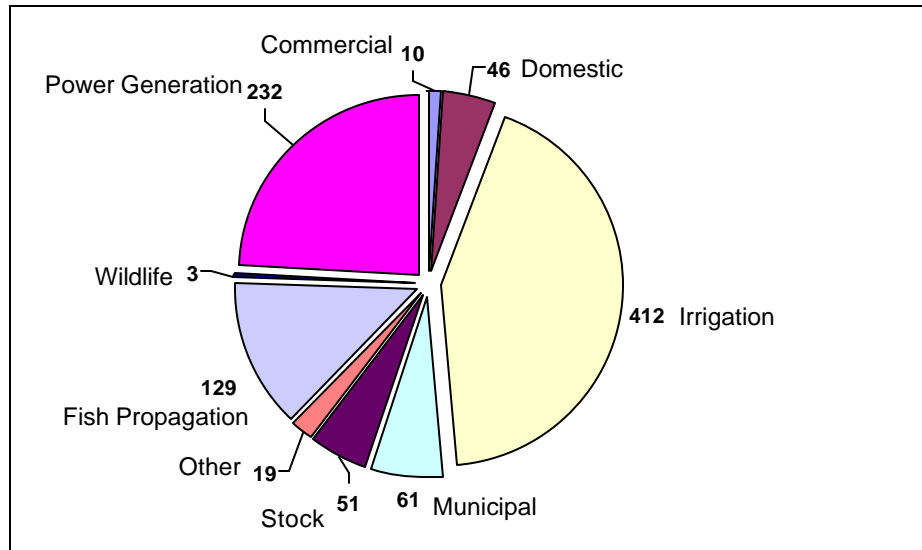


Figure 4-4. WRIA 23
Distribution of Water Rights
by Primary Purpose—
Annual Volume Limit
(acre-feet)
[pp. 2-10, B-5]

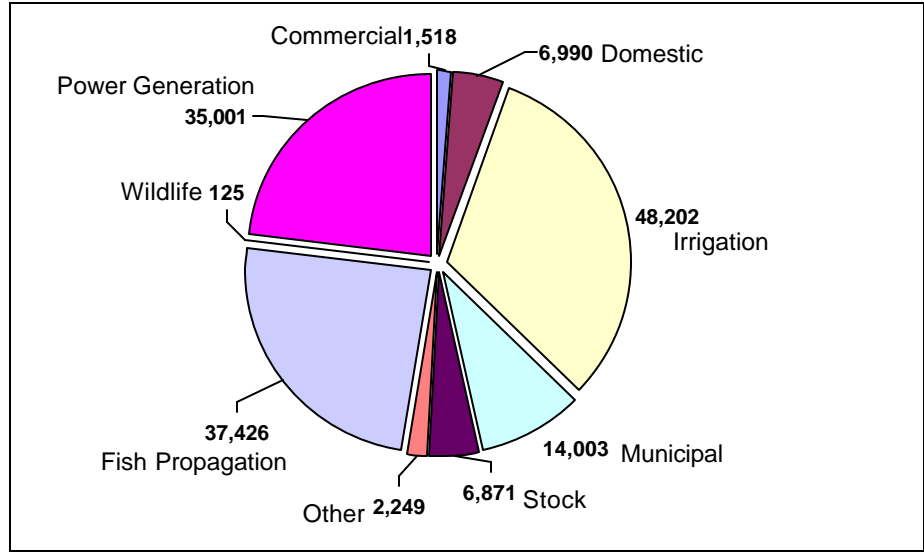


Figure 4-5. WRIA 23
Distribution of Water Rights
by Type of Right
[p. B-9]

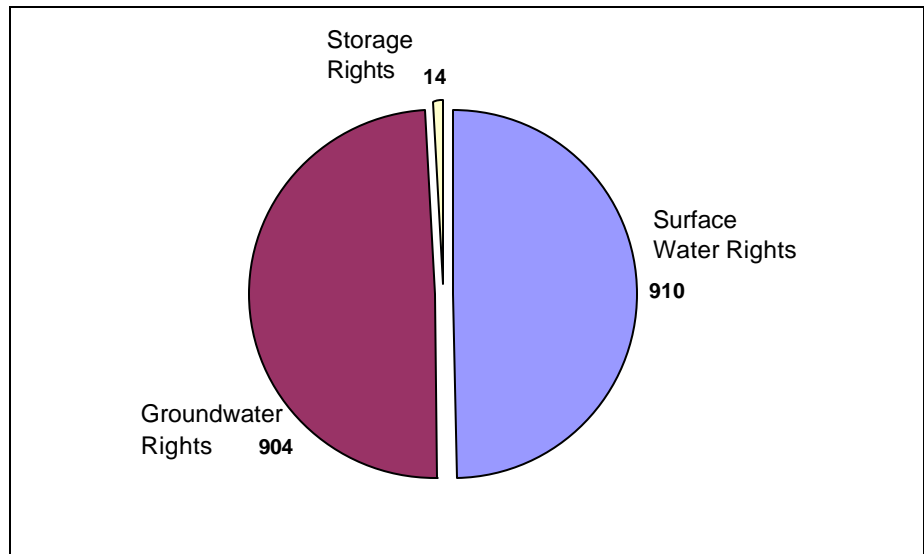
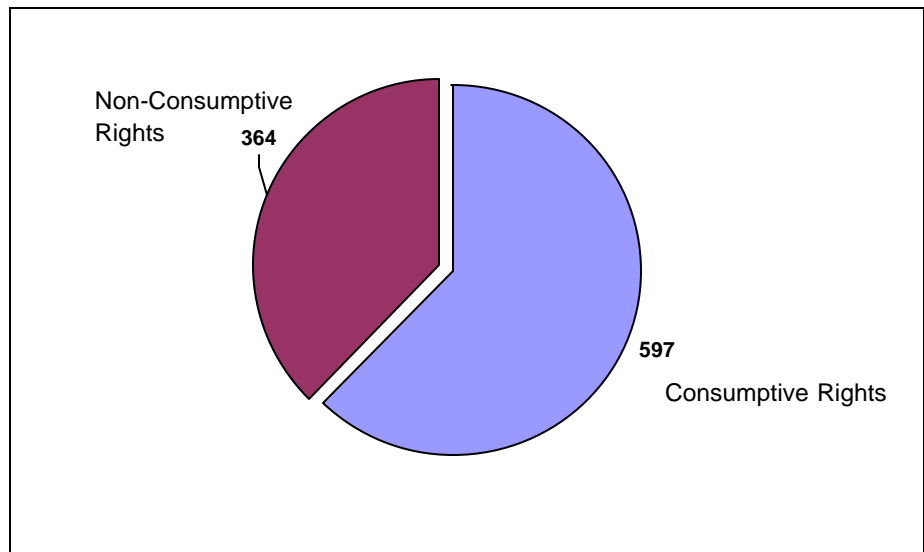


Figure 4-6. WRIA 23
Breakdown of Water Rights
into Consumptive and
Non-Consumptive Rights;
Instantaneous Withdrawal
Rate (cfs)
[p. 2-10]



Highlights of the WRIA-wide data on water rights are as follows:

- Irrigation and domestic use are the primary purpose for the largest number of water rights.
- Irrigation and power generation are the primary purpose for rights with the highest total instantaneous withdrawal rates.
- Irrigation, fish propagation and power generation are the primary purpose for rights with the highest total annual volume limit.

Twenty-two of the 1,828 water rights in the upper basin account for 40 percent of the total allocated instantaneous withdrawal. The largest of these are 140-cfs and 80-cfs rights held by Pacific Power and Light for withdrawal from the Skookumchuck River. The 80-cfs right is for thermoelectric power generation at the Centralia Steam Plant, which is a highly consumptive use of water [p. B-5].

Figure 4-7 shows the in-stream flow requirements for the Chehalis River at Porter. Figure 4-8 compares river flows at Porter to the sum of required in-stream flow and total allocated water rights for the upper basin (961 cfs). The sum of in-stream flow requirements and allocated water rights exceeds the river's normal flow (50-percent exceedance) for seven months of the year and the river's low flow (90-percent exceedance) year-round.

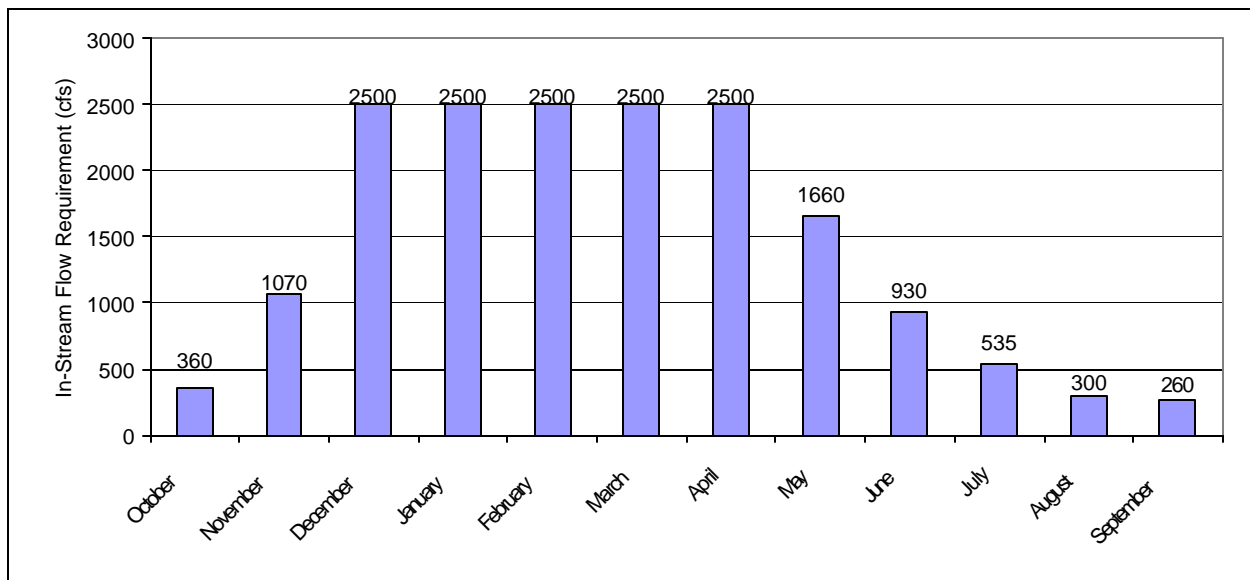


Figure 4-7. In-Stream Flow Requirements for the Chehalis River at Porter Control Point [p. 2-5]

DISCREPANCY NOTE: THE DATA USED FOR FIGURE 4-8 IS THE SAME AS USED IN FIGURE 2.2-3 IN THE LEVEL 1 ASSESSMENT. HOWEVER, IT SEEMS THAT IT MIGHT BE APPROPRIATE TO SUBTRACT GROUNDWATER RIGHTS FROM THE ALLOCATED FLOW TOTAL. THE CHART WILL HAVE TO BE REVISED IF THIS CHANGE IS MADE.

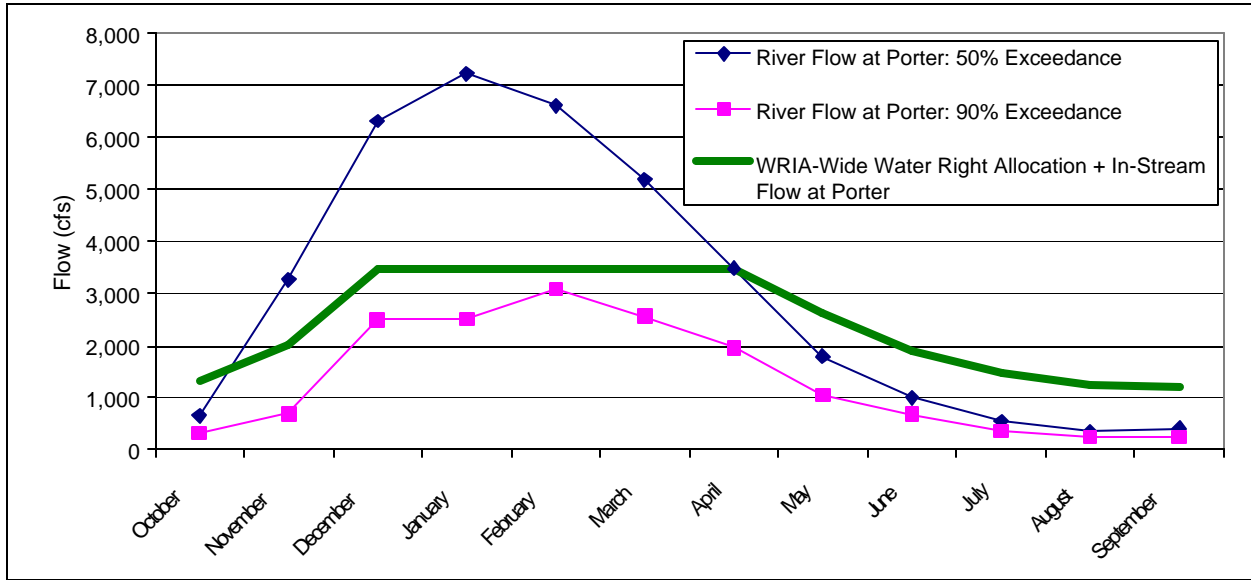


Figure 4-8. Chehalis River Flow at Porter Compared to Sum of Water Rights and In-Stream Flow [p. 2-5]

Water Use

The Level 1 Assessment estimates an average-day domestic water demand in the upper basin of 144 gallons per capita per day (gpcd). Figure 4-9 presents the domestic water use estimates for the upper basin. The maximum-day demand for the year 2000 is 42 cfs, which is less than half the total of allocated water rights for domestic use (46 cfs) and municipal use (61 cfs). With population growth through 2020, the maximum-day demand could be expected to grow to 54 cfs, which is only slightly over half of the allocated rights. Figure 4-10 compares upper basin water right allocations to Level 1 estimates of actual use for domestic use, irrigation and livestock watering. Allocated rights for each of these purposes greatly exceed the current estimated use.

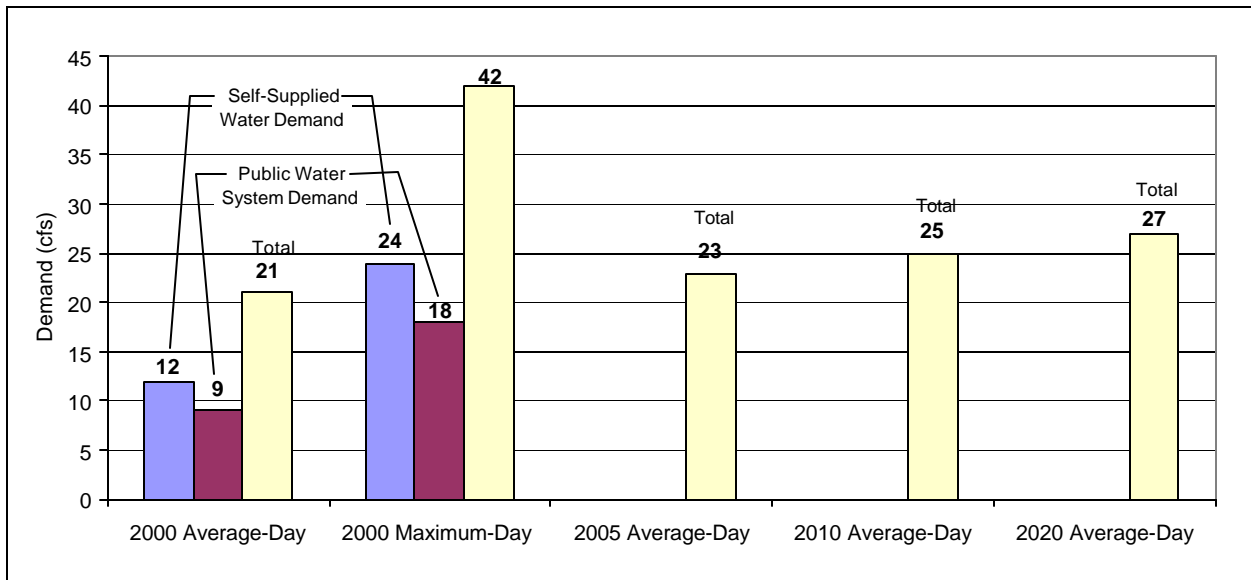


Figure 4-9. Estimated Domestic Water Use in the Upper Chehalis Basin [pp. B-14, B-17, B-18]

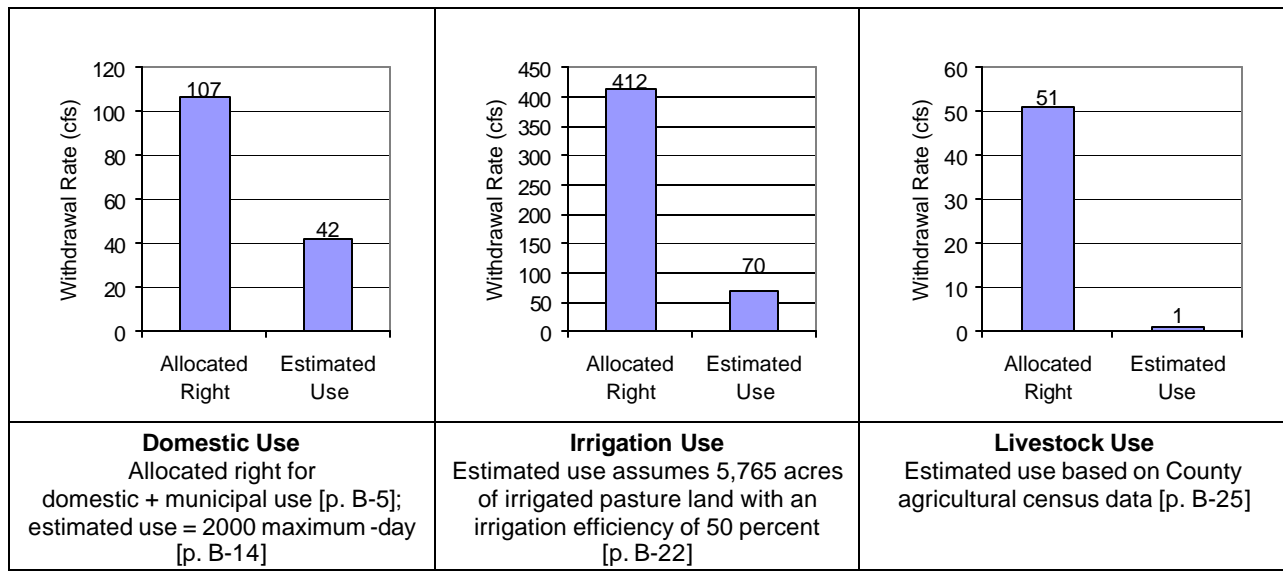


Figure 4-10. Allocated Water Rights and Estimated Actual Water Use in the Upper Chehalis Basin for Domestic, Irrigation and Livestock Uses

WATER QUALITY

Most of the water quality problems in the Chehalis River Basin have been documented in the Upper Chehalis Basin. Twenty of the overall basin's 24 303(d)-listed water bodies are in the upper basin. Violations of dissolved oxygen standards during the dry season led to a TMDL study for WRIA 23 in 1994, and temperature standard violations led to another TMDL study in 1999 [p. C-8].

Data leading to the temperature TMDL study included the state temperature standard being exceeded in the Upper Chehalis Basin for 62 percent of measurements taken in June and 24 percent of those taken in July [p. 2-16]. Field observations have indicated that removal of trees and other vegetation along much of the upper river has reduced shading, which contributes to high dry-season temperatures [pp. 2-15, D-15, D-16]. The TMDL study recommends increasing vegetative shading along the Chehalis River and its tributaries. The Level 1 Assessment notes that the width of the Chehalis River may reduce the effectiveness of planting shade trees but that such efforts along the tributaries may be beneficial [pp. 2-16 – 2-17].

FISH HABITAT AND FISH STOCK CONDITION

Habitat Condition

A survey by the Washington Department of Ecology in the early 1990s took measurements of temperature and dissolved oxygen at 45 sites along the main stem of the Chehalis River from Porter to Pe Ell. Figure 4-11 summarizes the results of that survey. Vertical bars on the graph indicate the range of measurements over the course of the survey at each measurement location.

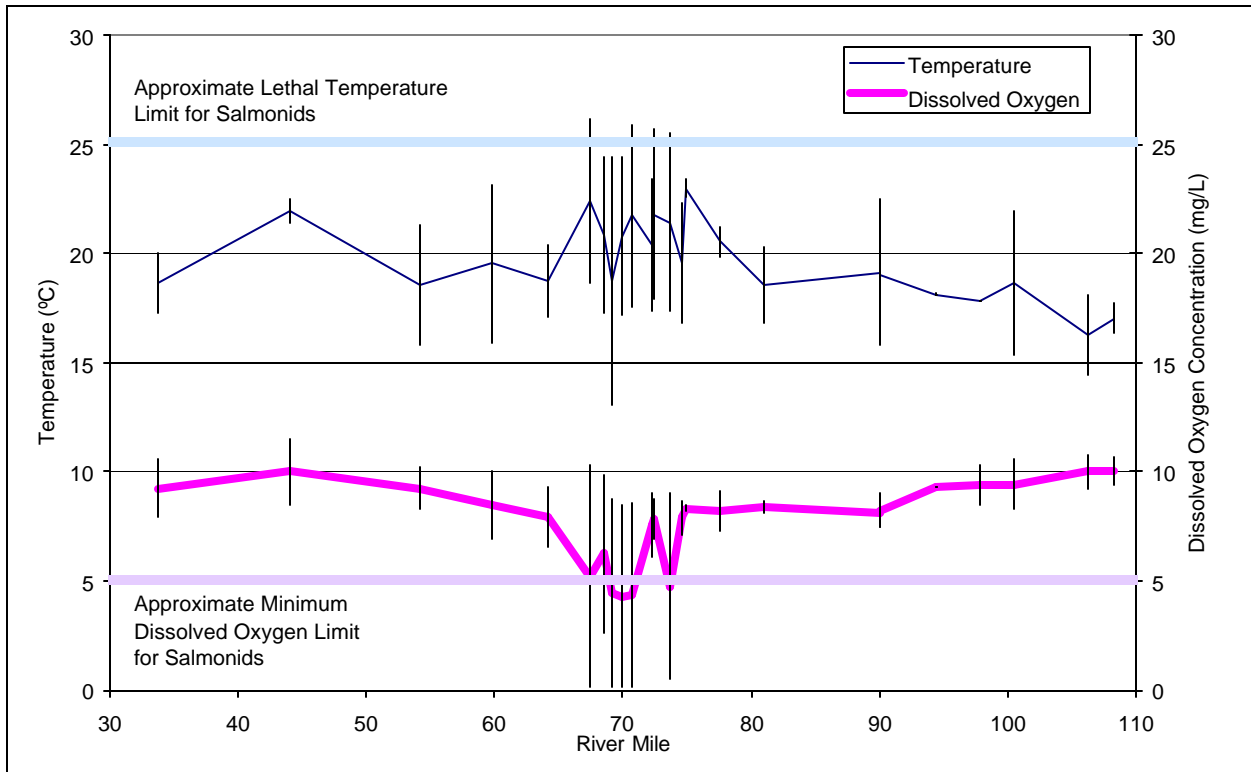


Figure 4-11. Range of Measured Temperatures and DO Concentrations Along Upper Chehalis River [pp. D-16, D-17]

Fish Stock Condition

Most fish stocks that spawn in the Chehalis River watershed upstream of the Satsop River confluence are identified as Chehalis stocks [p. D-2]. These stocks may generally be considered to be associated with the Upper Chehalis Basin. Of the eight Chehalis stocks identified in the Level 1 Assessment, five are considered to be healthy. The condition of the other three stocks is unknown (see Figure 3-12).

5. LEVEL 1 WRIA-WIDE FINDINGS FOR LOWER CHEHALIS BASIN

This chapter summarizes findings that apply to WRIA 22, the Lower Chehalis Basin.

GEOLOGY/HYDROLOGY

The Level 1 Assessment does not include any WRIA-wide information on geologic characteristics.

WRIA-wide flows for the Lower Chehalis Basin cannot be taken from the stream-flow gage records because much of the lower basin drains directly to Grays Harbor and because there are no gages on the Chehalis River below Montesano.

WATER RIGHTS/WATER USE

Water Rights

Figures 5-1 through 5-5 summarize the Level 1 Assessment's findings of water rights in the upper basin.

DISCREPANCY NOTE: DATA FOR THE FOLLOWING CHARTS IS TAKEN FROM LEVEL 1 TABLE 2.3-1, WHICH ASSIGNS THE ENTIRE WRIA 22 POWER GENERATION ANNUAL VOLUME LIMIT OF 54,360 ACRE-FEET TO THE CATEGORY OF THERMAL POWER. CHARTS WILL NEED TO BE UPDATED IF CORRECTIONS ARE MADE TO THE TABLE.

ALSO, THE DATA APPEAR TO BE TAKEN FROM THE WRIA 22 SUBTOTAL LINE FROM TABLE B-3 ON PAGE B-8. THOSE SUBTOTAL VALUES INCLUDE DATA NOT ONLY THE FOR THE NUMBERED SUBBASINS, BUT ALSO FOR A SUBBASIN DESIGNATED, "GH," ASSUMED TO BE GRAYS HARBOR. THERE IS NO EXPLANATION OF HOW THE GH SUBBASIN RELATES TO THE AREA ADDRESSED BY THIS PLAN EXCEPT FOR THE FOLLOWING SENTENCE AT THE BEGINNING OF THE RESULTS SECTION ON PAGE B-3: "BASED ON THE WRA TS DATABASE, THE CHEHALIS BASIN HAD A TOTAL OF 2,597 WATER RIGHTS AND 7,452 CLAIMS, INCLUDING RIGHTS TRIBUTARY TO GRAYS HARBOR." THE GH VALUES ARE INCLUDED IN THE WRIA 22 SUBTOTALS AND THE BASIN-WIDE TOTALS THROUGHOUT THE REPORT, SO IT WOULD BE USEFUL TO UNDERSTAND WHAT THEY REPRESENT.

Figure 5-1. WRIA 22
Distribution of Water Rights
by Primary Purpose—
Number of Rights
[pp. 2-10, B-4]

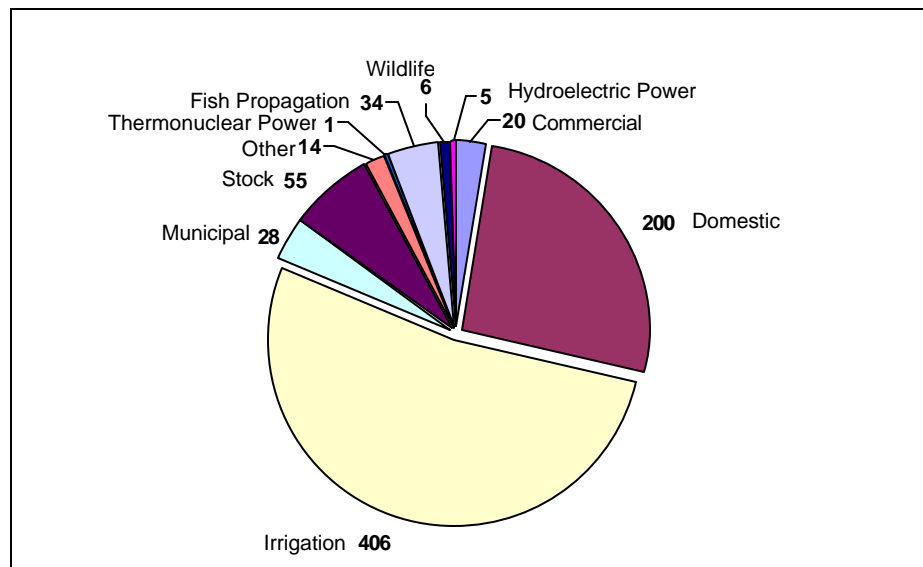


Figure 5-2. WRIA 22
Distribution of Water Rights
by Primary Purpose—
Instantaneous Withdrawal
Rate (cfs)
[pp. 2-10, B-4]

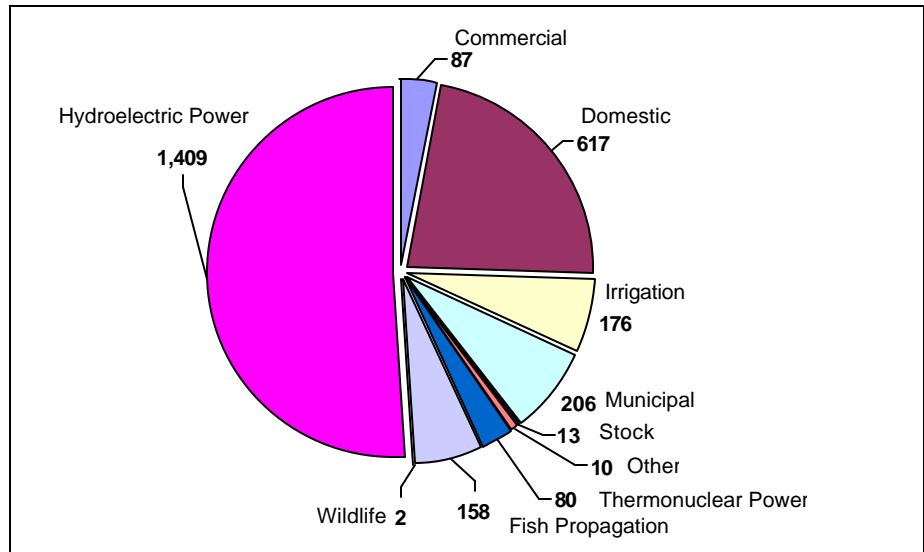


Figure 5-3. WRIA 22
Distribution of Water Rights
by Primary Purpose—
Annual Volume Limit
(acre-feet)
[pp. 2-10, B-4]

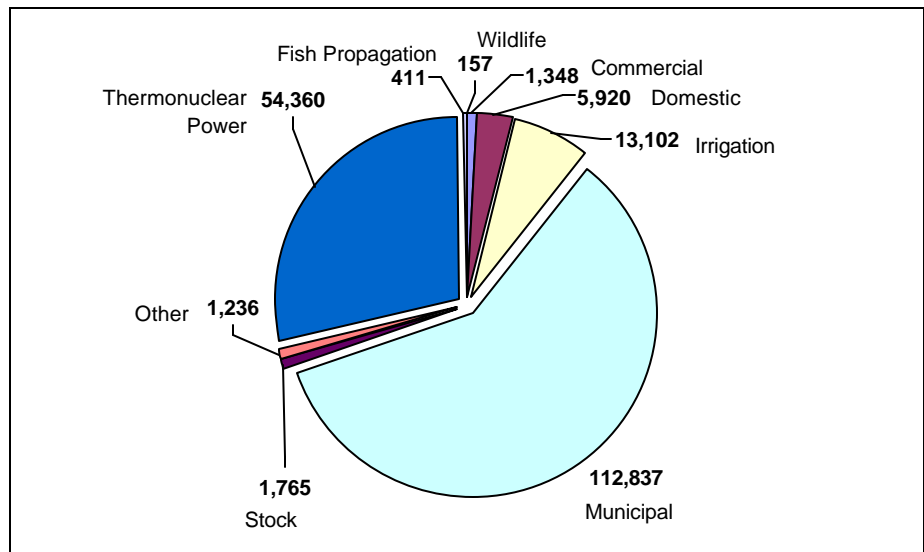


Figure 5-4. WRIA 22
Distribution of Water Rights
by Type of Right
[p. B-9]

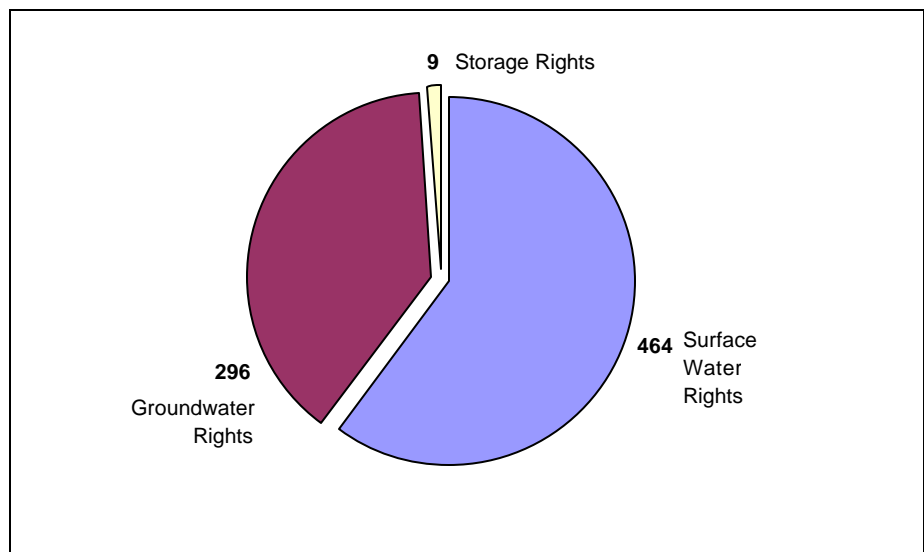
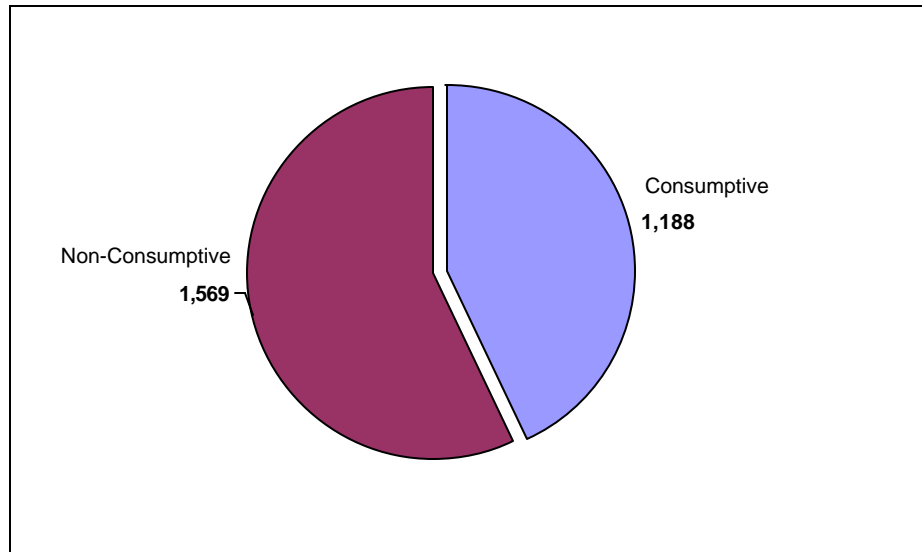


Figure 5-5. WRIA 22
Breakdown of Water Rights
into Consumptive and
Non-Consumptive Rights;
Instantaneous Withdrawal
Rate (cfs)
[p. 2-10]



Highlights of the WRIA-wide data on water rights are as follows:

- Irrigation and domestic uses are the primary purpose for the largest number of water rights.
- Power generation and domestic use are the primary purpose for rights with the highest total instantaneous withdrawal rates.
- Municipal uses and power generation are the primary purpose for rights with the highest total annual volume limit.

Thirty of the 769 water rights in the lower basin account for 90 percent of the total allocated instantaneous withdrawal. The largest of these is a 1,400-cfs right for hydroelectric power generation on the Wynoochee River; this right is about half of the total allocated withdrawal rate in the lower basin. The second largest right is a 570-cfs right for domestic use at the Lake Arrowhead Community Club. The Level 1 Assessment notes that this right is enough to meet the domestic demand of a large city and may be a data entry error. An 80-cfs groundwater right held by the Washington Public Power Supply System is for a thermonuclear power plant that is not in operation; this right might never have been used [p. B-3].

Water Use

The Level 1 Assessment estimates an average-day domestic water demand in the lower basin of 123 gpcd. Figure 5-6 presents the domestic water use estimates for the lower basin. The maximum-day demand for 2000, 24 cfs, is well below the total of allocated water rights for domestic use (616 cfs) and municipal use (206 cfs). With population growth through 2020, the maximum-day demand would grow to 30 cfs, which is still a very small portion of the allocated rights. Figure 5-7 compares lower basin water right allocations to Level 1 estimates of actual use for domestic use, irrigation and livestock watering. Allocated rights for each of these purposes greatly exceed the current estimated use.

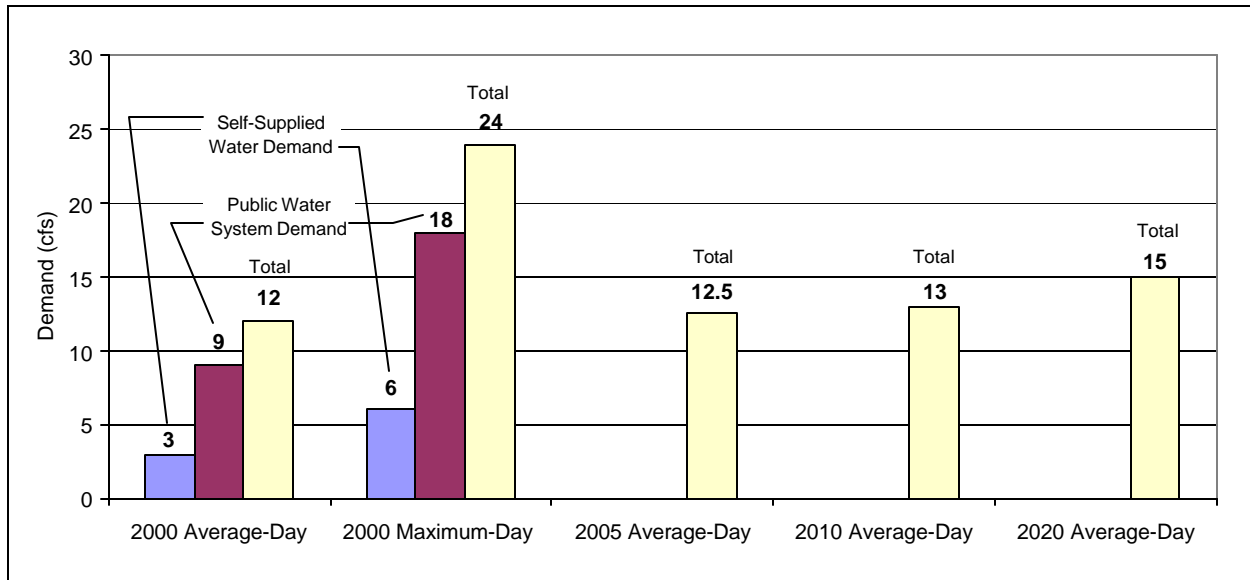


Figure 5-6. Estimated Domestic Water Use in the Lower Chehalis Basin [pp. B-14, B-17, B-18]

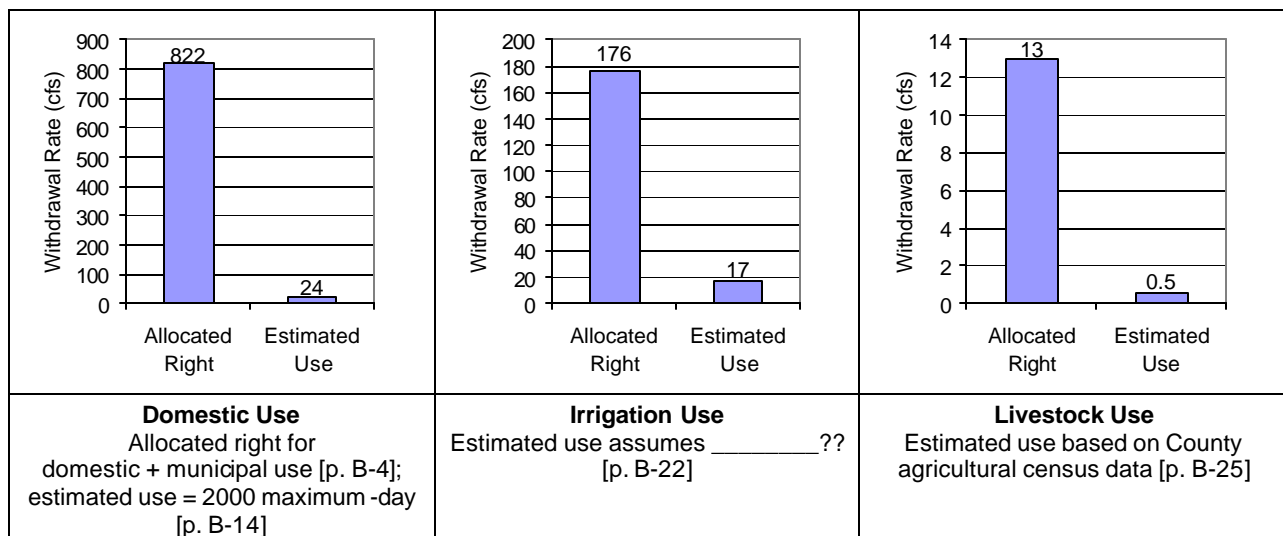


Figure 5-7. Allocated Water Rights and Estimated Actual Water Use in the Lower Chehalis Basin for Domestic, Irrigation and Livestock Uses

DISCREPANCY NOTE: IT IS NOT CLEAR WHAT ASSUMPTIONS ARE USED IN THE ESTIMATE FOR IRRIGATION USE FOR WRIA 22. THE DISCUSSION ON PAGE B-22 REFERS TO "A SIMILAR NUMBER" TO THE WRIA 23 ESTIMATE, BUT THE ESTIMATED USE IS 25% OF THE VALUE FOR WRIA 23, SUGGESTING THAT, ALL OTHER ASSUMPTIONS BEING THE SAME, THE IRRIGATED AREA IN WRIA 22 IS 25% OF THAT IN WRIA 23. THE DISCUSSION NOTES THAT ACREAGE ASSUMED FOR WRIA 23 IS 5,765 ACRES, WHICH CORRESPONDS TO TOTAL IRRIGATED ACRES IN LEWIS COUNTY CITED ON PAGE B-19. BUT A QUARTER OF THAT VALUE IS 1,410 ACRES, WHICH DOES NOT CORRESPOND TO ANY OF THE ACREAGE VALUES FOR WRIA 22 MENTIONED ON PAGE B-19.

WATER QUALITY

The Level 1 Assessment does not present any water quality information that is distinctly applicable WRIA-wide to the Lower Chehalis Basin.

FISH HABITAT AND FISH STOCK CONDITION

Habitat Condition

The lower reaches of the Chehalis, Humptulips, Satsop and Wynoochee Rivers have experienced extensive gravel mining over the years. It was estimated in 1986 that gravel mining removed 10 times as much gravel each year as would be naturally replenished in these river systems. Such operations were reported in 1975 to have seriously reduced available spawning areas for chinook salmon on the Satsop, Humptulips and Wynoochee Rivers.

Fish Stock Condition

The Level 1 Assessment does not present any fish stock information that is distinctly applicable WRIA-wide to the Lower Chehalis Basin.

6. STUDY AREA 1— GRAYS HARBOR SUBBASINS

STUDY AREA DESCRIPTION

[NOTE: THE LEVEL 1 MAP OF THIS STUDY AREA SHOWS SEVERAL AREAS SURROUNDING GRAYS HARBOR THAT ARE NOT INCLUDED IN NUMBERED SUBBASINS.](#)

Study Area 1 consists of the nine subbasins that drain directly to Grays Harbor or the mouth of the Chehalis River. Figure 6-1 shows the subbasins included in this study area. The major surface water systems in this study area are as follows:

- The Humptulips River (Subbasin 25), which has its headwaters in the Olympic Mountains and flows into Grays Harbor
- The Hoquiam River (Subbasins 22, 23 and 24), which has its headwaters in the Olympic Mountains and flows into the inner estuary of Grays Harbor
- The Wishkah River (Subbasin 21), which has its headwaters in the Olympic Mountains and flows into the mouth of the Chehalis River
- Tributaries south of Grays Harbor, including the Johns River, which flows into Grays Harbor and the Elk River, which flows into the South Bay of Grays Harbor (Subbasins 26, 27, 28 and 29).

The nine delineated subbasins in the study area have a combined drainage area of 504 square miles. Elevations range from sea level to 4,397 feet, with subbasins north of Grays Harbor extending into the Olympic Mountains; the highest point is in the Humptulips River drainage basin [pp. A-22, A-23].

Study Area 1 includes Hoquiam, the third largest city in the Chehalis Basin, and part of Aberdeen, which is the largest city in the basin [p. 1-4]. Figure 6-2 summarizes land use information for Study Area 1 presented in the Level 1 Assessment (no land use data is provided for the subbasins south of Grays Harbor).

[NOTE: AREAS DESIGNATED "CITY LIMITS" ON MAPS PREPARED FOR THIS SUMMARY REPORT INCLUDE THE PLACES THAT WERE SHOWN AS "MUNICIPALITIES" ON THE LEVEL 1 MAPS. SOME OF THE SE AREAS ARE NOT ACTUALLY INCORPORATED AREAS. "MUNICIPALITY" OR "CITY LIMITS" MAY NOT BE AN ACCURATE TERM FOR THESE AREAS, BUT IS HAS BEEN RETAINED FOR CONSISTENCY.](#)

Subbasin 25, the Humptulips River drainage basin, is one the five subbasins selected for detailed analysis in the Level 1 Assessment.

INSERT FIGURE 6-1

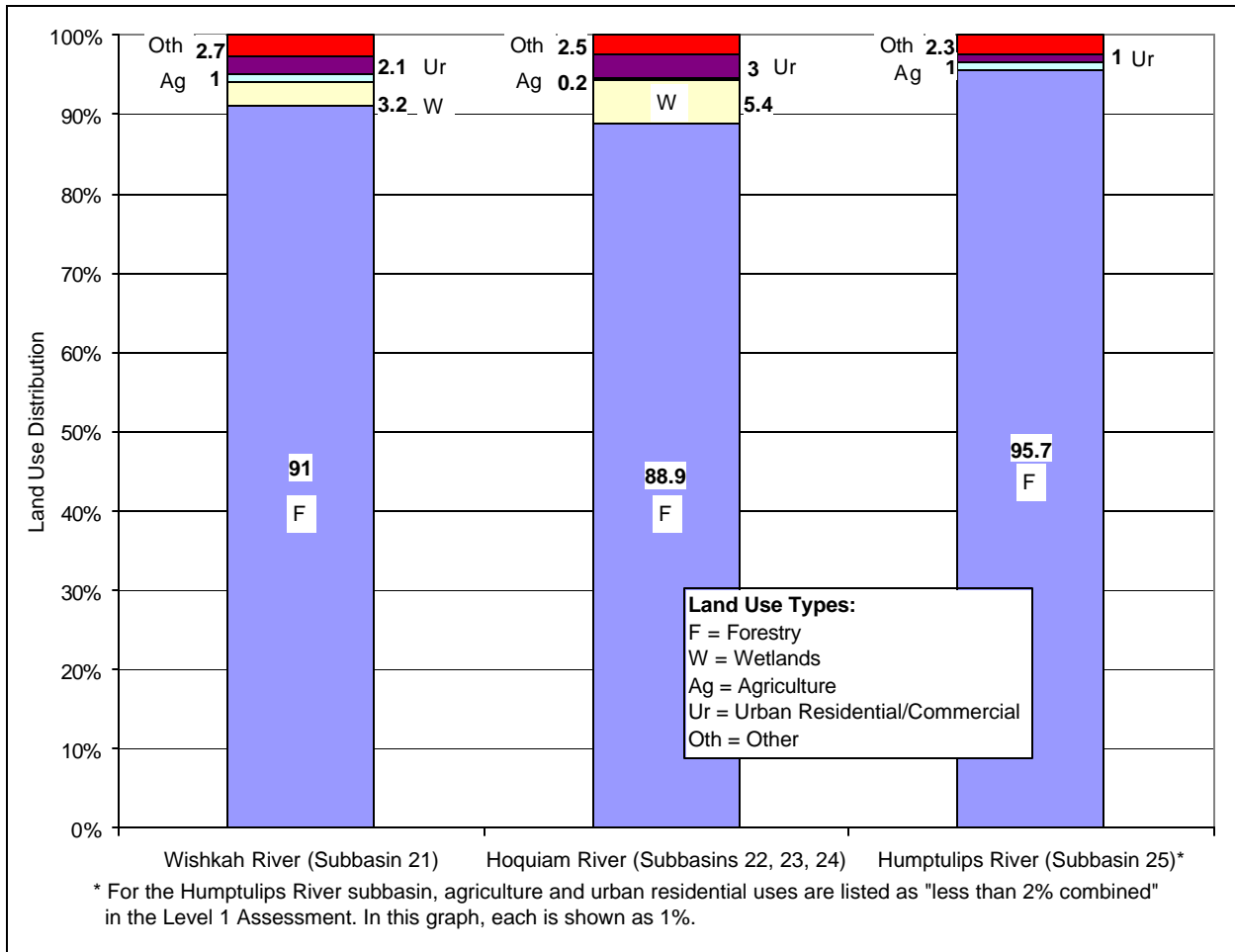


Figure 6-2. Land Use Distribution in Study Area 1 (Data Not Provided for South Harbor Subbasins) [pp. C-39 – C-42]

NOTE: THE ABOVE GRAPH IS TAKEN FROM THE LAND USE SUMMARIES PROVIDED BY SUBBASIN IN THE LEVEL 1 REPORT'S APPENDIX C-WATER QUALITY. ONLY A FEW OF THE SECTIONS THERE GIVE PERCENTAGES OF WETLANDS. THE LEVEL 1 REPORT DOES NOT DESCRIBE WHETHER WETLANDS ARE A SEPARATE LAND USE CATEGORY OR AN OVERLAY TO OTHER CATEGORIES. THEY ARE PRESENTED HERE AS A SEPARATE CATEGORY.

GEOLOGY/HYDROLOGY

Geologic Features and Groundwater

The Level 1 Assessment outlines the following key geological features of subbasins in Study Area 1 [pp. A-11, A-12]:

- The upper portion of the Humptulips drainage basin features volcanic rock.
- The lower portion of the Humptulips drainage basin features alluvial and glacial sediments.
- The Hoquiam drainage basin generally consists of underlying non-marine sedimentary rock; alluvial sediments are present on the bottom of the river valley.

- The Wishkah drainage basin is underlain by sedimentary rock in its upper and lower portions and by old alluvial sediments in the middle portion. The upper portion also features glacial sediments.
- Marine terrace deposits make up most of the subbasins south of Grays Harbor, with alluvial sediments on the bottoms of creek and river valleys.
- The volcanic and sedimentary rock and marine terrace deposits over most of this study area offer little potential for groundwater aquifers. Some small aquifers are likely present in the areas of alluvial sediments.

Rainfall, Runoff and Stream Flows

Historical rainfall and stream flow data for Study Area 1 are scarce because few monitoring stations have been established in the study area. The only base gage in Study Area 1 identified in the Level 1 Assessment is on the Humptulips River.

DISCREPANCY NOTE: THE LEVEL 1 GIVES CONFLICTING INFORMATION ON CLIMATE AND FLOW GAGING STATIONS:

- MAP 4 SHOWS THREE GAGING STATIONS AND FOUR CLIMATE STATIONS IN STUDY AREA 1, BUT THE TABLES ON PAGES A-18 AND A-21 LIST FOUR GAGING STATIONS AND FIVE CLIMATE STATIONS.
- DEPENDING ON WHETHER THE MAP OR THE TABLE IS CORRECT, EITHER FIVE OR SIX SUBBASINS IN STUDY AREA 1 HAVE NO GAGING STATIONS. BUT PAGE A-35 SAYS ALL BUT FIVE OF THE 30 SUBBASINS OVERALL HAVE STREAM FLOW RECORDS AND LISTS THE MISSING FIVE AS DECKER CREEK, M FK HOQ., E. FK. HOQ, ELKS RIVER AND LOWER CHEHALIS, ONLY THREE OF WHICH ARE IN STUDY AREA 1. THAT LEAVES TWO OR THREE SUBBASINS IN STUDY AREA 1 THAT SUPPOSEDLY HAVE STREAM FLOW RECORDS BUT FOR WHICH NO GAGING STATIONS ARE NOTED.
- THE TABLE ON PAGES A-22, A-23 GIVES ANNUAL PRECIPITATION FOR EVERY SUBBASIN, BUT IT'S NOT CLEAR WHERE THAT INFORMATION IS FROM, GIVEN THAT THERE ARE SO FEW CLIMATE STATIONS.
- THERE IS AT LEAST ONE GAGING STATION LISTED ON PAGE A-18 AND SHOWN ON MAP 4 THAT APPEARS TO BE OUTSIDE THE CHEHALIS BASIN (STATION 12016500). IT DOESN'T SEEM THAT THIS STATION SHOULD BE INCLUDED IN THIS STUDY.
- ALSO, SEE THE DISCREPANCY NOTE IN THE HYDROLOGY SECTION OF THE GENERAL CONCEPTS CHAPTER FOR DISCREPANCIES REGARDING THE NUMBER OF BASE GAGES.

Average annual rainfall for Study Area 1 ranges from just over 70 inches in the subbasins south of Grays Harbor to 127 inches in the Humptulips drainage basin, the highest annual rainfall of all subbasins in the Chehalis Basin [pp. A-22, A-23].

Generally high levels of rainfall throughout the study area lead to correspondingly high levels of runoff. The estimated unit runoff for the Humptulips basin is 10 cfs/mi², which also is among the highest in the Chehalis Basin [p. A-39]. Other Study Area 1 subbasins north of Grays Harbor have an estimated unit runoff of 5 to 8 cfs/mi². The Level 1 Assessment does not provide unit runoff estimates for subbasins south of Grays Harbor, citing insufficient stream flow data [p. A-40].

The Level 1 Report's detailed analysis of the Humptulips drainage basin (Subbasin 25) includes estimates of flow exceedance values for the Humptulips. Figure 6-3 shows these estimates.

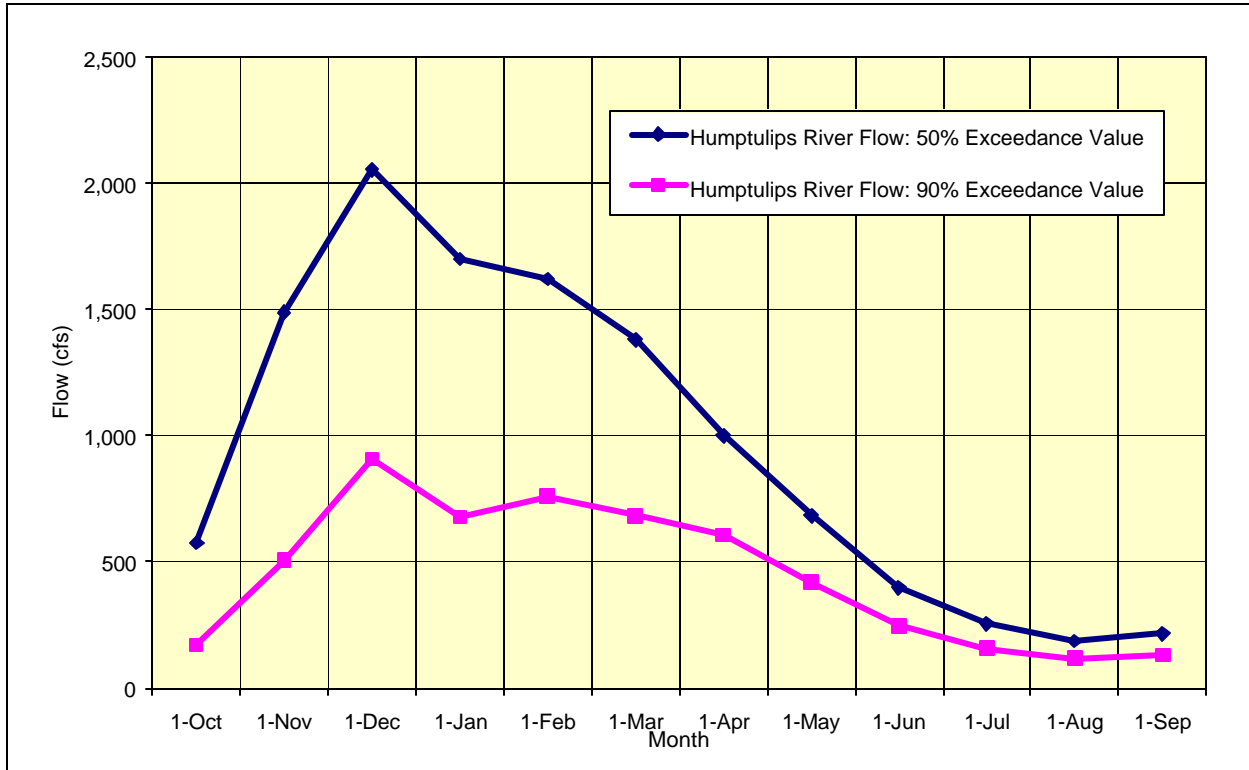


Figure 6-3. Estimated Humptulips River Flows at Gaging Station 12039000 [p. 3-47]

WATER RIGHTS/WATER USE

DISCREPANCY NOTE: THE FOLLOWING CHARTS ARE BASED ON NUMBERS FROM THE TABLES IN LEVEL 1 APPENDIX B. VALUES FOR THE SUBBASIN LABELED "GH" IN THE TABLES ARE NOT INCLUDED, BECAUSE THE LEVEL 1 IS UNCLEAR ABOUT WHAT THAT REPRESENTS. IT EVIDENTLY STANDS FOR GRAYS HARBOR, BUT IT IS PRESENTED SEPARATE FROM THE NUMBERED SUBBASIN DATA. SEE RELATED NOTE AT THE BEGINNING OF THE WATER RIGHTS DISCUSSION FOR WRIA 22.

Figures 6-4 and 6-5 show the distribution of water rights in Study Area 1 by primary purpose and by type, respectively. Key findings of the Level 1 Assessment review of water rights in Study Area 1 are as follows:

- The total instantaneous withdrawal rate for allocated rights in Study Area 1 is 180.73 cfs and the total annual volume limit is 1,805 acre-feet [p. B-8].
- Study Area 1 has the lowest number of rights (139) of all the study areas.
- Rights in the Humptulips drainage basin (Subbasin 25) account for almost half of the instantaneous allocation for the study area and almost two-thirds of the volume allocation: 86.55 cfs and 1,102 acre-feet [p. B-8]. This includes one large right for 20 cfs held by the City of Ocean Shores, which represents a diversion of water out of the Chehalis Basin, and seven rights totaling 57.1 cfs for fish propagation, which is a non-consumptive use [p. 3-48].

DISCREPANCY NOTE: THE VALUE OF 1,102 ACRE-FEET IN THE ABOVE PARAGRAPH IS THE SUM OF 633 ACRE-FEET AND 469 STORAGE ACRE-FEET FOR SUBBASIN 25, TAKEN FROM THE TABLE ON PAGE B-8. ON PAGE 3-48, A VOLUME LIMIT OF 1,496 ACRE-FEET IS SHOWN, WHICH IS THE SUM OF THE 633 AND 469 FOUND IN THE APPENDIX B TABLE WITH AN ADDITIONAL 394 ACRE-FEET. IT IS UNCLEAR WHERE THE EXTRA VALUE OF 394 WAS FOUND.

Figure 6-4. Study Area 1
Distribution of Water Rights
by Primary Purpose—
Number of Rights
[p. B-8]

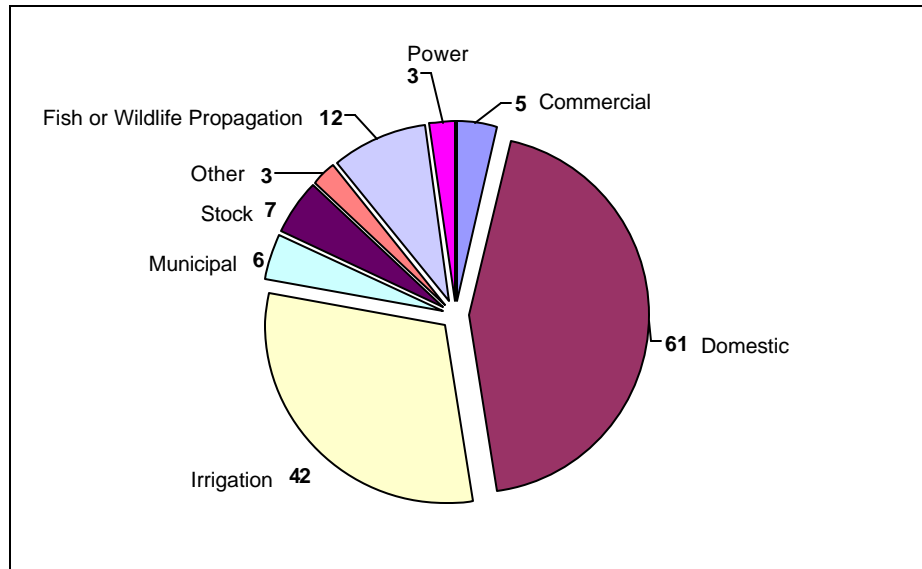
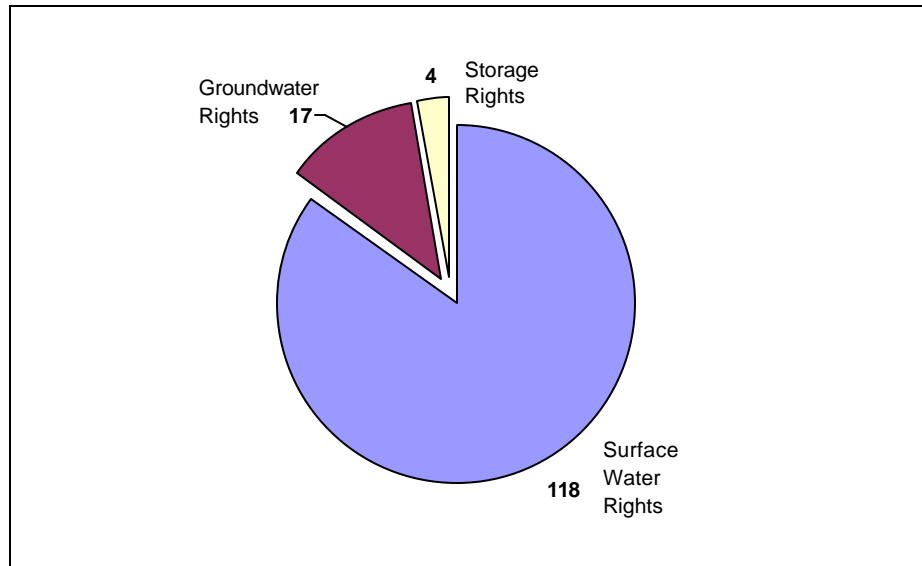


Figure 6-5. Study Area 1
Distribution of Water Rights
by Type of Right—
Number of Rights
[p. B-9]



- Other subbasins with significant portions of the water rights allocations are as follows:
 - Subbasin 21 (Wishkah)—22.94 cfs and 193 acre-feet [p. B-8]
 - Subbasin 22 (main stem Hoquiam)—60.17 cfs and 191 acre-feet [p. B-8]; this includes one large right for 35 cfs for commercial and industrial use [p. B-3].
- The largest irrigation right is for 5.5 cfs from North Bay [p. B-3].

The Level 1 detailed evaluation of Subbasin 25 provides the monthly in-stream flow requirements for the control point on the Humptulips River. Figure 6-6 compares the estimated flow in the river to the sum of the required in-stream flow and the consumptive allocated water rights for the subbasin (29.41 cfs). From May through October, the in-stream flow requirement alone, without the consumptive allocated water rights, exceeds the

90-percent exceedance flow [p. 3-47]. The amount of diverted flow on the river is not great, leaving little potential to enhance the flow to meet the regulatory in-stream requirement.

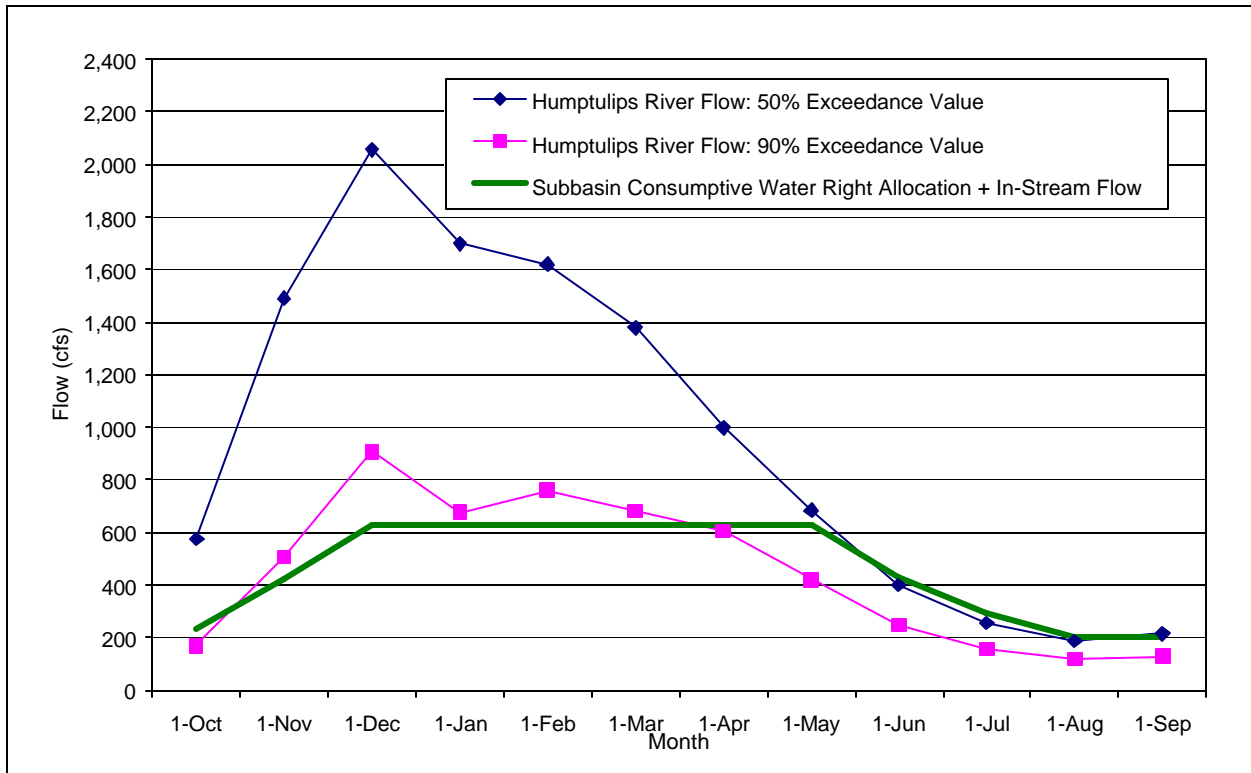


Figure 6-6. Humptulips River Flow Compared to Sum of Water Rights and In-Stream Flow [pp. 3-47, 3-48]

The detailed evaluation of the Humptulips subbasin also provides rough estimates of domestic and irrigation water use. The Level 1 Assessment concludes that domestic use in this subbasin is about 3 or 4 percent of the allocated right and that irrigation demand is at least 132 acre-feet per year (depending on irrigation system efficiency) less than the allocated right of 486 acre-feet per year [pp. 3-50, 3-51].

DISCREPANCY NOTE: THE ABOVE REFERENCE TO DOMESTIC USE AS A PERCENT OF ALLOCATED RIGHT IS BASED ON THE STATEMENT ON PAGE 3-50, COMPARING ESTIMATED USE OF 0.12 - 0.14 CFS TO "THE COMBINED MUNICIPAL AND DOMESTIC WATER RIGHT (OF) 3.52 CFS." ALTHOUGH THE DOMESTIC ALLOCATION OF 0.64 CFS IS EXPLAINED ON THE PREVIOUS PAGE, THERE IS NO REFERENCE TO MUNICIPAL RIGHTS ANYWHERE IN THE DETAILED EVALUATION FOR THIS SUBBASIN, SO IT'S NOT CLEAR WHERE THE 3.52 CFS VALUE COMES FROM. TABLE 3.6-3 ON PAGE 3-53 COMPARES THE ESTIMATED USE JUST TO THE ALLOCATED DOMESTIC RIGHT OF 0.64 CFS, AND, BASED ON THAT COMPARISON THE SUMMARY BELOW THE TABLE NOTES THAT DOMESTIC USE IS APPROXIMATELY 20 PERCENT OF THE WATER RIGHTS ALLOCATION.

WATER QUALITY

Water bodies in Study Area 1 have a state water quality classification of Class A (excellent) except as follows [pp. C-6, 2-23]:

- Class AA (extraordinary): the upper Humptulips River and the West Fork Wishkah River
- Class B (good): the lower Hoquiam River, the first 6 miles of the Wishkah River, and inner Grays Harbor.

Water quality information for Study Area 1 is limited in the Level 1 Assessment. The report draws on the following sources of information:

- Limited ambient water quality monitoring records from 1972-1974 and 1976-1977 for a station at river mile 12.3 on the Wishkah River [p. C-39]
- Limited ambient water quality monitoring records from 1972-1974 and 1993-1994 for a station at river mile 9.3 on the West Fork of the Hoquiam River [p. C-40]

DISCREPANCY NOTE: THE PERIOD OF RECORD FOR THE HOQUIAM STATION IS LISTED AS BEGINNING IN 1972 ON P. C-40, BUT THE START IS LISTED AS 1973 IN THE TABLE ON P. C-3.

- Ambient water quality monitoring records from 1971 through the present (with an interruption from 1974 through 1979) for a station at river mile 23.6 on the Humptulips River, near Montesano [p. C-41]
- A TMDL report for Grays Harbor prepared in 2000 to address failure to meet fecal coliform standards for the inner harbor [p. 2-23].

Based on these sources, the Level 1 Assessment presents the following key information related to water quality:

- Available water quality records indicate “relatively good” water quality for the Wishkah River [p. C-39], “very good” water quality for the Hoquiam River [p. C-40] and some failure to achieve standards for the Humptulips River [p. C-41].
- The Grays Harbor TMDL identifies the Humptulips, Hoquiam, and Wishkah Rivers as major nonpoint sources of fecal coliform to the harbor, although the available water quality records reviewed for the Level 1 Assessment do not indicate a problem with fecal coliform in these rivers [pp. C-39, C-40, C-42].
- Study Area 1 water bodies listed on the state’s 303(d) list are the Humptulips River (for fecal coliform and temperature) and inner Grays Harbor (for fecal coliform and pH) [p. C-45]. A TMDL study has been prepared for the inner harbor and preparation of a TMDL for temperature is underway for the Humptulips River.

DISCREPANCY NOTE: MAP 7 OF THE LEVEL 1 REPORT SHOWS A 303(D)-LISTED LOCATION IN THE SOUTH BAY OF GRAYS HARBOR, WHICH IS NOT INCLUDED IN TABLE C-11.

- The Humptulips subbasin has the highest average annual yields of total phosphorus (0.2 tons/year/square mile) and total suspended solids (186 tons/year/square mile) of all yields calculated for the Chehalis Basin, and the lowest average annual yield of inorganic nitrogen (1.15 tons/year/square mile) [pp. 3-53, C-11].

Figure 6-7 summarizes water quality monitoring results for the Wishkah, Hoquiam and Humptulips Rivers for temperature, dissolved oxygen, total suspended solids, and fecal coliform count.

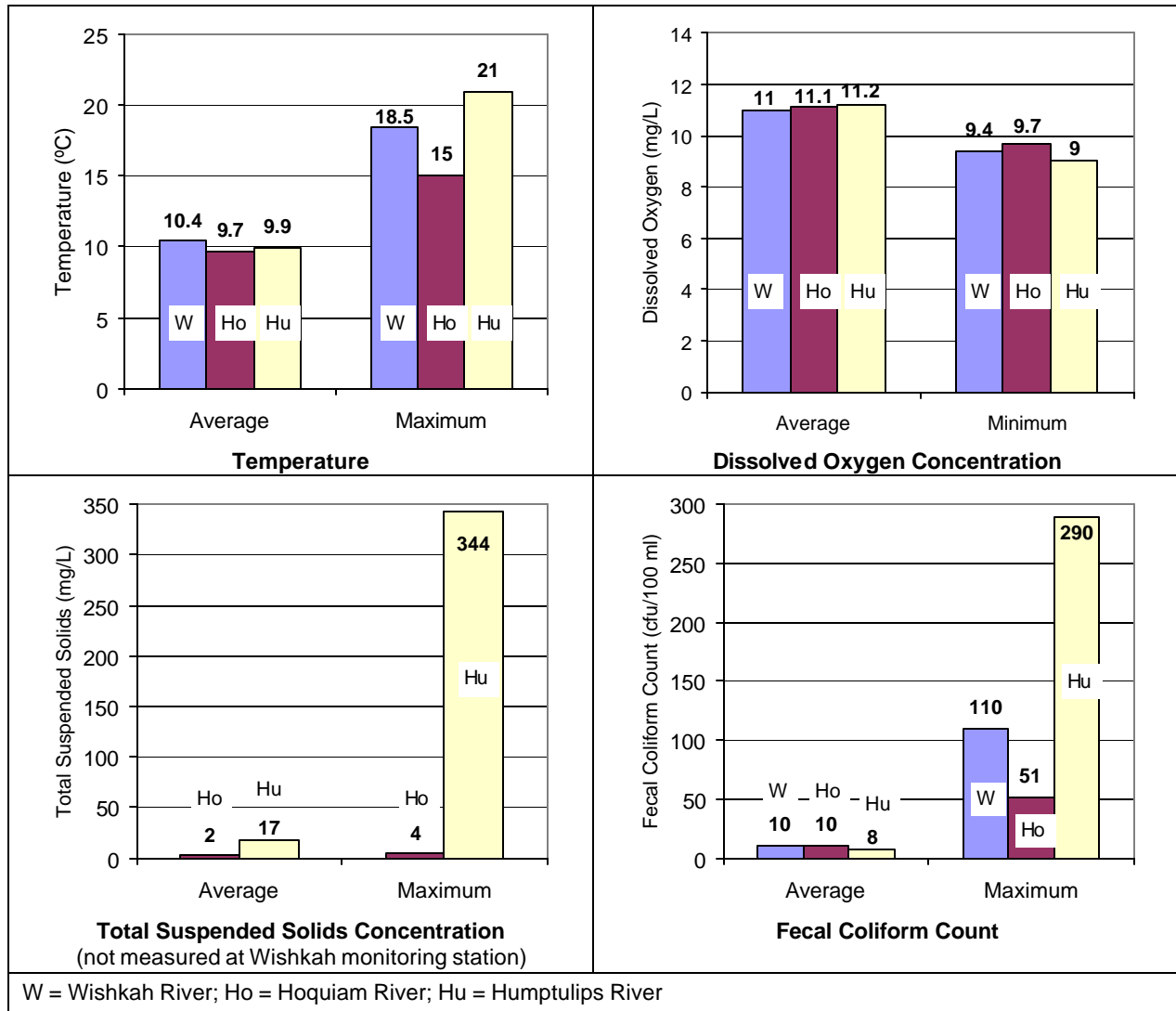


Figure 6-7. Summary of Study Area 1 Ambient Water Quality Monitoring; Hoquiam and Humptulips Data from 1990s Only [p. C-13]

FISH HABITAT AND FISH STOCK CONDITION

The known status of the 15 fish stocks identified on the rivers in Study Area 1 is healthy (see Figure 3-12), but the status of four of the 15 stocks is unknown.

The Level 1 detailed evaluation of the Humptulips subbasin presents the following key findings about fish habitat along the Humptulips:

- Upstream of the confluence of the river’s east and west forks, spawning gravels are adequate, the relative amount of pool habitat for summer rearing is high, the amount of in-stream large woody debris is low in some areas, and summer water temperatures near the confluence pose risks to juvenile steelhead and chinook salmon [p. 3-54].
- The river has an extensive history of channel modification through gravel removal and the use of splash dams for forestry. From the late 1950s

through 1985, gravel removal is estimated to have lowered the river bed about 0.1 feet per year [p. 3-54].

- 1988 aerial photos of about 10 miles of the lower river show 36 percent of the riparian area to be intact, 55 percent to be altered, and 9 percent to be absent [p. 3-13].

Key information on habitat in the other subbasins in Study Area 1 is as follows:

- Small streams tributary to the Wishkah river have good habitat complexity and in-stream structure. The amount of large woody debris is low in the river itself, and the potential for future input of large woody debris is limited. Habitat conditions along the river generally appear to be recovering from the impact of past land uses [p. D-30].
- The Hoquiam River had a history of logging impacts through the 1930s. A diversion dam on the west fork supplies water to the City of Hoquiam [p. D-31].
- Historical channel modifications were reported, mainly splash dams, in the subbasins south of Grays Harbor. Current conditions in these subbasins have not been documented [pp. D-31, D-32].

7. STUDY AREA 2— LOWER CHEHALIS SUBBASINS

STUDY AREA DESCRIPTION

Study Area 2 consists of eight subbasins draining to the Chehalis River downstream of Porter. Figure 7-1 shows the subbasins included in this study area. The major surface water systems in this study area are as follows:

- The lower main stem of the Chehalis River, divided into two reaches: Lower Reach 1, from Porter to the confluence with the Satsop River (Subbasin 19) and Lower Reach 2, downstream of the Satsop River (Subbasin 30)
- The Wynoochee River (Subbasin 20), which has its headwaters in the Olympic Mountains and flows into the Chehalis River near Montesano at river mile 14
- The Satsop River and tributaries (Subbasins 15, 16, 17 and 18), which have headwaters in the Olympic Mountains and flow into the Chehalis River between Montesano and Elma
- Cloquallum Creek (Subbasin 14), which flows into the Chehalis River near Elma at river mile 25.

The Satsop and Wynoochee Rivers are the largest tributaries to the Chehalis River [p. 1-4].

The study area has a combined drainage area of 721 square miles. Elevations range from sea level to 4,981 feet, with subbasins north of the Chehalis River extending into the Olympic Mountains; the highest point is in the Wynoochee River drainage basin [pp. A-22, A-23].

Study Area 2 includes part of Aberdeen, which is the largest city in the Chehalis Basin. Figure 7-2 summarizes land use information for Study Area 2 presented in the Level 1 Assessment (no land use data is provided for Subbasin 19, Lower Chehalis Reach 1).

Subbasins 19 (Lower Chehalis Reach 1) and 14 (Cloquallum Creek) are among the five subbasins selected for detailed analysis in the Level 1 Assessment.

INSERT FIGURE 7-1

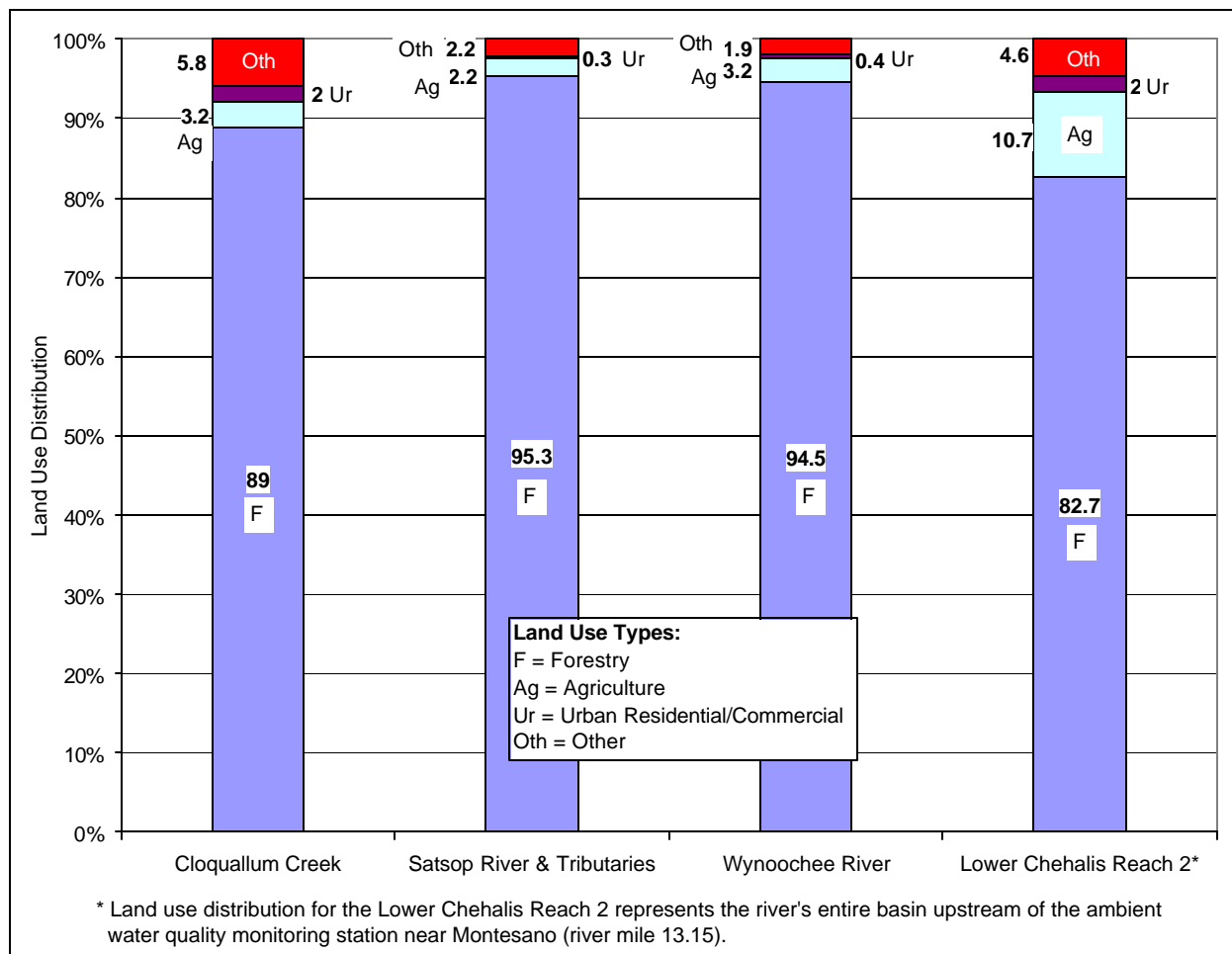


Figure 7-2. Land Use Distribution in Study Area 2 (Data Not Provided for Lower Chehalis Reach 1) [pp. C-37, C-38, C-39, C-44]

GEOLOGY/HYDROLOGY

Geologic Features and Groundwater

The Level 1 Assessment outlines the following key geological features of subbasins in Study Area 2 [pp. A-9, A-10, A-12]:

- The Cloquallum Creek subbasin generally consists of underlying glacial till in the upper reaches, marine sedimentary rocks at lower elevations in the upper reaches, and glacial and alluvial sediments in the lower reaches. There is likely a surface aquifer associated with the Chehalis River valley within 10 to 20 feet of the surface.
- The Satsop subbasins include volcanic rock underlying the Satsop River's headwaters, glacial till underlying the upper reaches of the main stem's tributaries, and marine sedimentary rock underlying the hill slopes. Bedrock in the middle fork and main stem subbasins likely holds a shallow aquifer, as does the glacial till in the east fork and Decker Creek subbasins.

A very high percentage of flow in the east fork subbasin is from groundwater input.

- Volcanic rock underlies the upper reaches of the Wynoochee subbasin, with marine sedimentary rock and alluvial sediments underlying the lower areas. A significant shallow aquifer is likely in the lower basin.
- The Lower Chehalis River valley floor consists of alluvial sediments, mixed with some glacial material along Lower Reach 1. Hill slopes in the Lower Chehalis subbasins consist of glacial sediments and sedimentary rock. The valley floor holds a well-developed aquifer.

Rainfall, Runoff and Stream Flows

The most downstream flow monitoring station and control point for regulated in-stream flows on the Chehalis River are near the Chehalis' confluence with the Satsop River, about 20 miles upstream of the river's mouth. No flow records are available for the lowermost reach of the river. The tidal influence of Grays Harbor extends upstream about 13 miles, to near Montesano.

[NOTE: PLEASE SEE THE DISCREPANCY NOTE/QUESTION ON CLIMATE AND GAGING STATIONS IN THE DISCUSSION FOR STUDY AREA 1.](#)

Base gages in Study Area 2 identified in the Level 1 Assessment include six in the Wynoochee subbasin, two in the Satsop subbasins, and one in the Cloquallum subbasin [p. A-39].

[NOTE: SEE THE DISCREPANCY NOTE IN THE HYDROLOGY SECTION OF THE GENERAL CONCEPTS CHAPTER FOR DISCREPANCIES REGARDING THE NUMBER OF BASE GAGES. DEPENDING ON WHICH TABLE IS REFERRED TO, THERE ARE EITHER FIVE OR SIX BASE GAGES IN THE WYNOOCHEE SUBBASIN.](#)

Average annual rainfall for Study Area 2 ranges from 59 to 75 inches in the lowest subbasins (Cloquallum Creek and Lower Chehalis River) and from 98 to 123 inches in the higher basins (Satsop and Wynoochee). The 123-inch average annual rainfall in the Wynoochee subbasin is the second highest of all subbasins in the Chehalis River Basin, with correspondingly high unit runoff of up to 12 cfs/mi². The Satsop subbasins have the second highest unit runoff in the study area, an estimated 6 to 7 cfs/mi². Estimated unit runoff in the study area's lower subbasins is 3 to 4 cfs/mi² [pp. A-22, A-23, A-40].

The Level 1 Assessment presents an estimate of exceedance flows at Montesano. The estimated Montesano flows are discussed in Chapter 3 of this detailed summary (Basin-Wide Findings) because they represent flow from almost all of the Chehalis River Basin. The Level 1 Assessment includes similar estimates for Subbasins 14 and 19 (Cloquallum Creek and Lower Chehalis Reach 1), which are two of the subbasins evaluated in detail. Figures 7-3 and 7-4 show the estimated flows for these subbasins.

As a demonstration of the potential effect of dams on stream flow, the Level 1 Assessment provides a brief analysis of recorded flows at the gaging station above Save Creek near Aberdeen before and after the completion of the Wynoochee Fish Barrier Dam (1972) and the Wynoochee Dam (1973). The comparison shows that winter peak flows decreased after the dams were put into operation and summer low flows increased [pp. A-29, A-30].

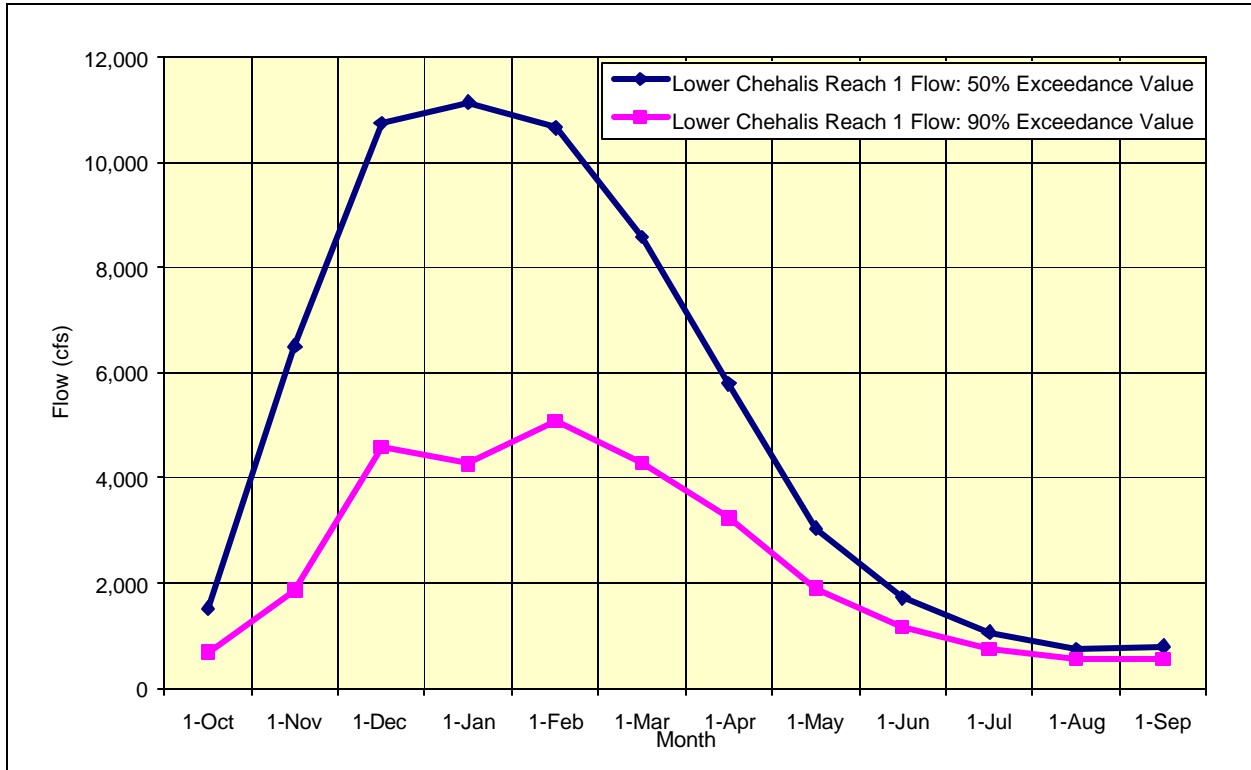


Figure 7-3. Estimated Lower Chehalis Reach 1 Flows [p. 3-36]

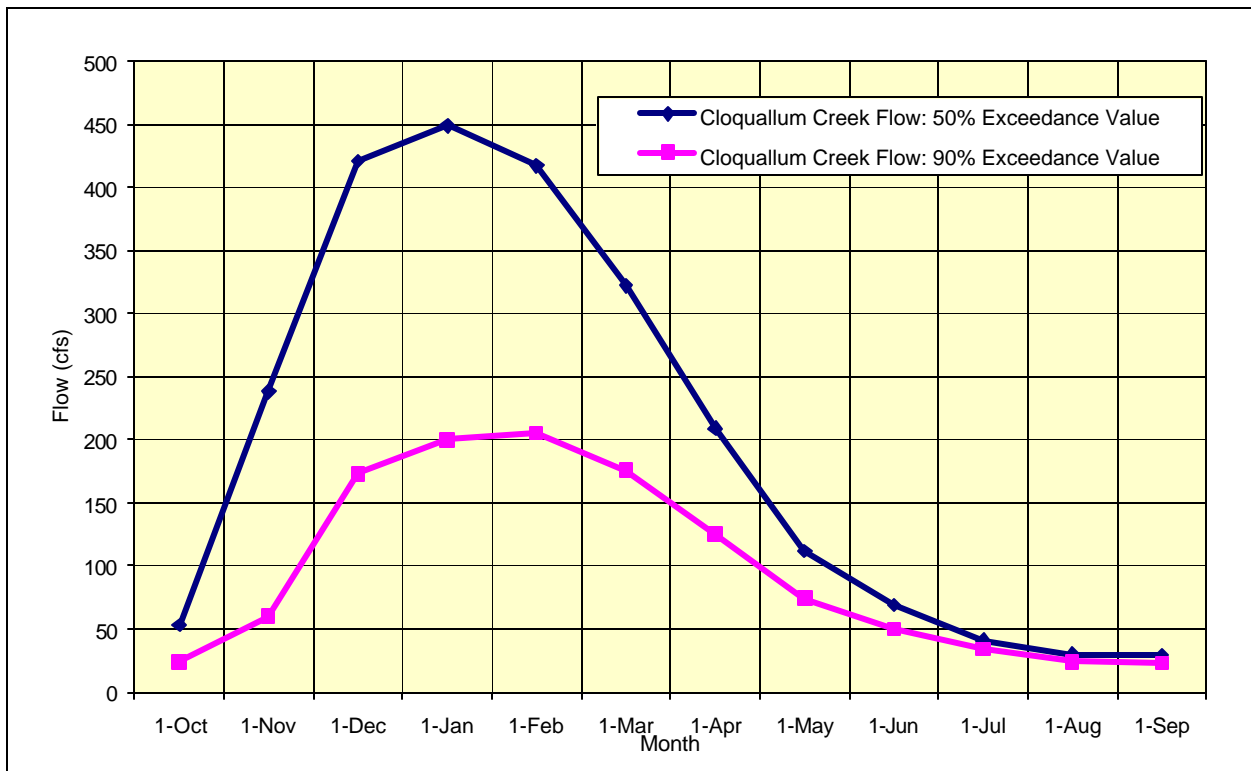


Figure 7-4. Estimated Cloquallum Creek Flows at Gaging Station 12032500 [p. 3-28]

WATER RIGHTS/WATER USE

Figures 7-5 and 7-6 show the distribution of water rights in Study Area 2 by primary purpose and by type, respectively.

Figure 7-5. Study Area 2
Distribution of Water Rights
by Primary Purpose—
Number of Rights
[p. B-8]

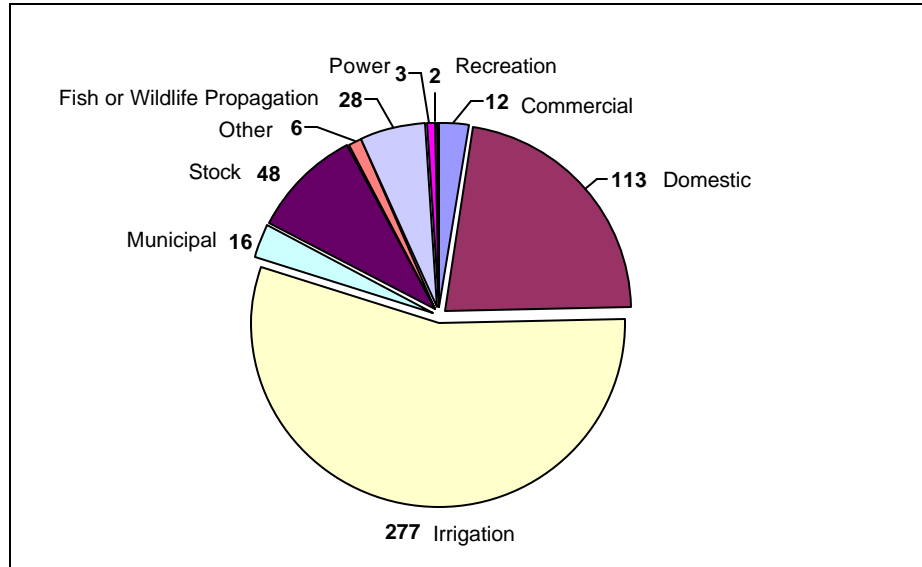
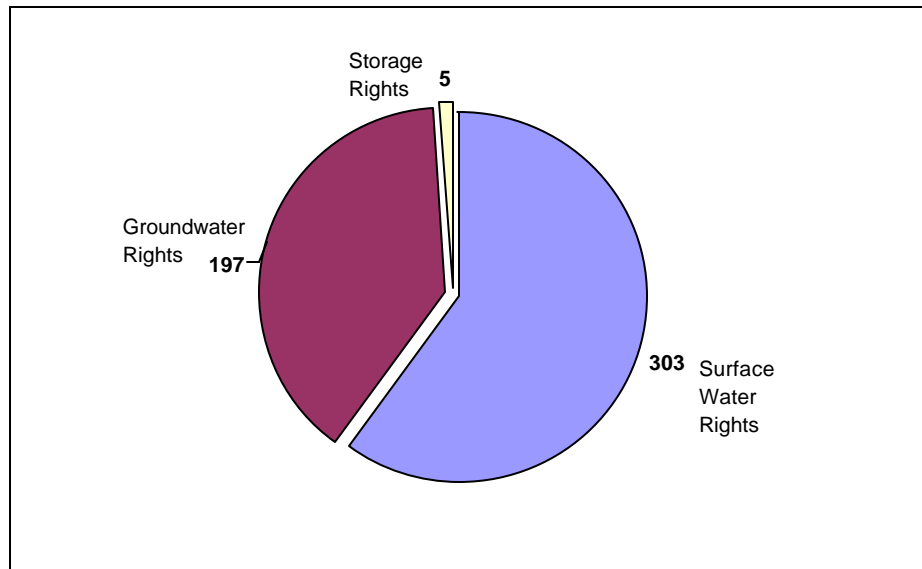


Figure 7-6. Study Area 2
Distribution of Water Rights
by Type of Right—
Number of Rights
[p. B-9]



Key findings of the Level 1 Assessment review of water rights in Study Area 2 are as follows:

- The total instantaneous withdrawal rate for allocated rights in Study Area 2 is 2,470.89 cfs and the total annual volume limit is 184,714 acre-feet [p. B-8].
- The total storage volume limit for the Wynoochee subbasin (70,050 acre-feet) represents almost two-thirds of the total storage volume limit for the entire Chehalis Basin (106,895 acre-feet) [p. B-8]. The storage right is

primarily for Wynoochee Lake, a reservoir on the Wynoochee River with a capacity of 70,000 acre-feet [p. 1-5].

- The Wynoochee subbasin also has the largest allocation of instantaneous withdrawal rate (1,574 cfs), representing more than 40 percent of the total for the entire basin (3,718 cfs), as well as one of the largest total allocations for annual volume limit (36,129 acre-feet) [p. B-8].
- The allocated annual volume limit in Lower Chehalis Reach 2 (Subbasin 30) is the largest of all subbasins in the Chehalis Basin (60,603 acre-feet). It represents more than a quarter of the basin-wide total (236,625 acre-feet) [p. B-8].
- Significant individual rights in the study area include the following [p. B-3]:
 - A groundwater right for approximately 80 cfs held by the Washington Public Power Supply System in the Satsop subbasin (Subbasin 18); this right may never have been used
 - A 570-cfs surface water right for multiple domestic use in the Satsop subbasin (held by the Lake Arrowhead Community Club); this right is anomalously large for its stated purpose and the allocation may be listed in error²
 - A 1,400-cfs right for power generation in the Wynoochee subbasin; although this right is non-consumptive, it does divert significant water from the Wynoochee River
 - Two rights in the Wynoochee subbasin held by the City of Aberdeen in the Wynoochee subbasin for municipal and commercial/industrial uses, of 110 cfs and 45 cfs.

The Level 1 detailed evaluations of Subbasins 14 and 19 provide the monthly in-stream flow requirements for the control points on Cloquallum Creek and on the Chehalis River below Satsop. Figures 7-7 and 7-8 compare the estimated stream flows to the sum of the required in-stream flow and the consumptive allocated water rights for the subbasins (17.28 cfs for Cloquallum and 71 cfs for Lower Chehalis Reach 1). In the Cloquallum subbasin, the flow demand (the sum of the in-stream flow requirement and the consumptive allocated water rights) exceeds the 90-percent exceedance flow from March through November. In the Lower Chehalis Reach 1 subbasin, the demand exceeds the 90-percent exceedance flow from March through October.

NOTE: THE DESCRIPTION OF IN-STREAM FLOWS IN THE DETAILED EVALUATION OF LOWER CHEHALIS REACH 1 DOES NOT SPECIFY THE CONTROL POINT LOCATION. FIGURE 7-8 BELOW ASSUMES THAT IT IS THE CONTROL POINT BELOW SATSOP, BASED ON COMPARISON OF THE NUMBERS IN TABLE 3.5-1 AND ON FIGURE 2.2-4 (THE INTRODUCTION TO FIGURE 2.2-4, ON PAGE 2-6, STATES THAT THE IN-STREAM FLOWS SHOWN ARE FOR THE CONTROL POINT BELOW SATSOP, AND THE VALUES IN THE FIGURE SEEM TO BE AVERAGES OF THE BEGINNING-OF-THE-MONTH AND END-OF-THE-MONTH VALUES SHOWN IN TABLE 3.5-1).

² A Department of Ecology investigation has subsequently revealed that the units for this water right were entered incorrectly in the agency water rights database. The correct value is 570 gallons per minute (or 1.3 cfs) rather than 570 cfs.

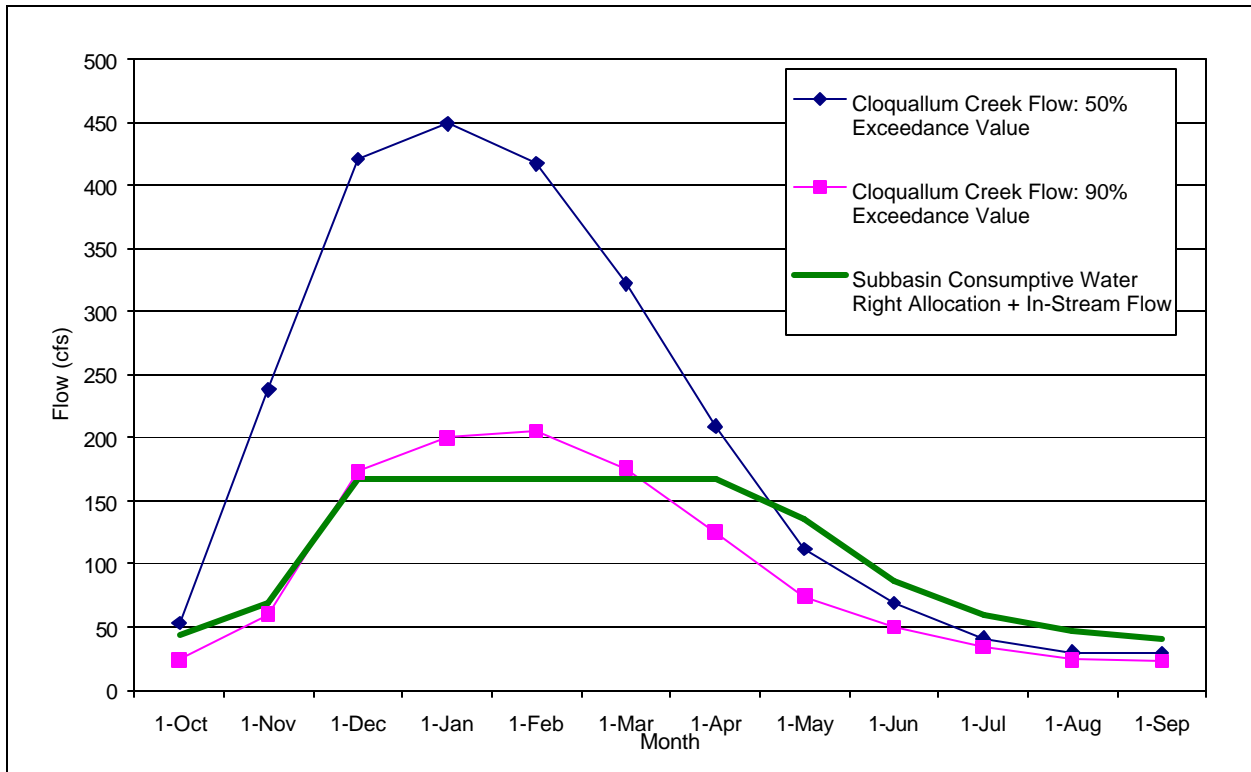


Figure 7-7. Cloquallum Creek Flow Compared to Sum of Water Rights and In-Stream Flow [pp. 3-28, 3-31]

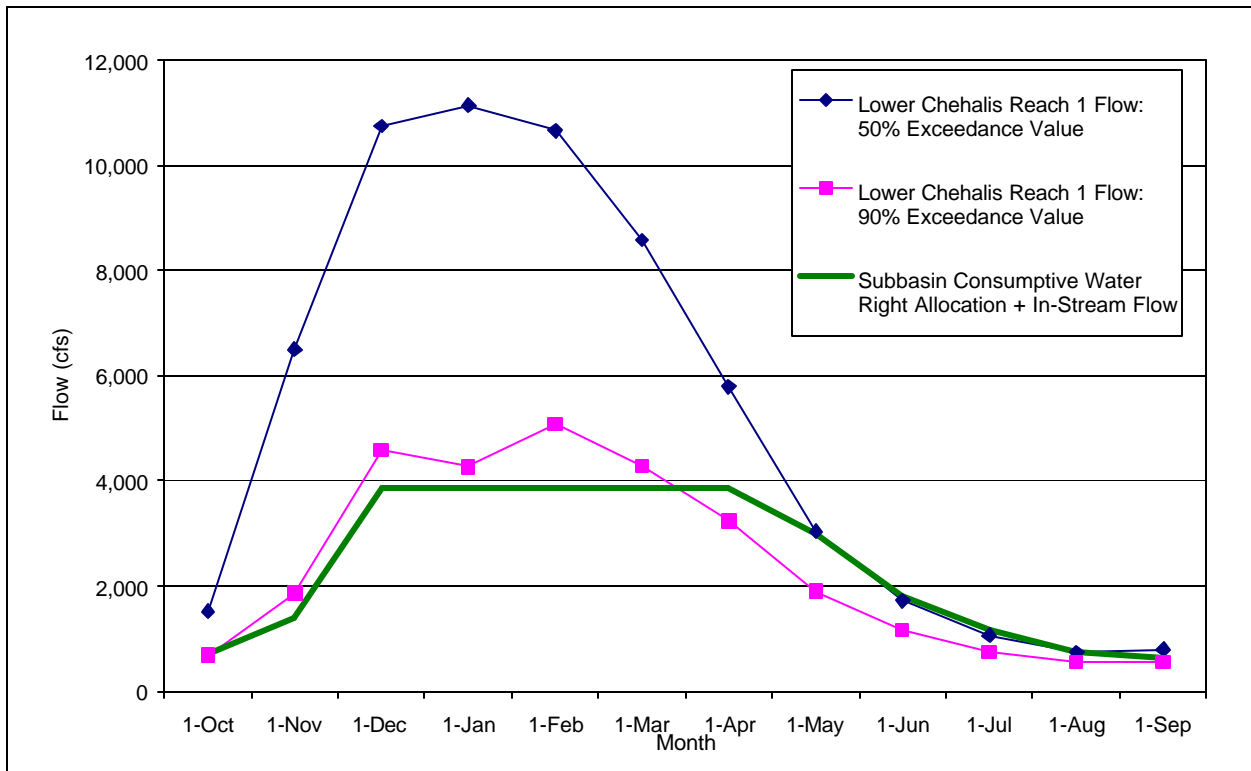


Figure 7-8. Lower Chehalis Reach 1 Flow Compared to Sum of Water Rights and In-Stream Flow [pp. 3-36, 3-42]

The detailed evaluations of the Cloquallum and Lower Chehalis Reach 1 subbasins provide rough estimates of water use for both subbasins. The Level 1 Assessment concludes the following:

- In the Cloquallum subbasin, estimated domestic use is about 12 percent of the allocated right. Estimated irrigation demand is between 145 acre-feet and 258 acre-feet per year (depending on crop type), amounting to 24 to 42 percent of the allocated irrigation right of 617 acre-feet per year [pp. 3-29, 3-30].
- In the Lower Chehalis Reach 1 subbasin, estimated domestic use is about 13 percent of the allocated right and estimated municipal use is about 9 percent of the allocated right [p. 3-43]. Estimated irrigation demand is between 4,800 acre-feet per and 16,000 acre-feet per year (depending on crop); the allocated irrigation right is only 7,575 acre-feet, less than half the high-end estimate of demand [p. 3-40].

DISCREPANCY NOTE: THE ALLOCATED RIGHT OF 7,575 ACRE-FEET CITED ABOVE IS FROM THE LAST PARAGRAPH ON P. 3-40 OF THE LEVEL 1 REPORT; HOWEVER, TWO PARAGRAPHS ABOVE THAT, THE REPORT GIVES THE ANNUAL VOLUME LIMIT AS 6,716.95 ACRE-FEET. THESE TWO VALUES MAY BE ACCOUNTING FOR TWO DIFFERENT THINGS, BUT IT IS NOT CLEAR WHAT THOSE TWO THINGS ARE. THE PERCENTAGES FOR DOMESTIC AND MUNICIPAL USE ARE GIVEN IN THE SUMMARY ON PAGE 3-43, BASED ON THE NUMBERS IN TABLE 3.5-3, THE LEVEL 1 ASSESSMENT DOES NOT PROVIDE AN EXPLANATION OF WHERE THE USE NUMBERS IN THE TABLE CAME FROM.

WATER QUALITY

Water bodies in Study Area 2 have a state water quality classification of Class A (excellent) except for the middle, east and west forks of the Satsop River, which are rated Class AA (extraordinary) [p. C-6].

Water quality information for Study Area 2 in the Level 1 Assessment is taken from the following sources of information:

- Ambient water quality monitoring records from 1971-1972 and 1974-1976 for a station at river mile 3.0 on Cloquallum Creek [p. C-36]

DISCREPANCY NOTE: THE CLOQUALLUM CREEK MONITORING STATION IS NOT INCLUDED AMONG THE MONITORING STATIONS ASSESSED IN THE TABLE ON P. C-3.

- Ambient water quality monitoring records from 1970 through 1993 for a station at river mile 2.7 on the Satsop River [p. C-37]

DISCREPANCY NOTE: THE PERIOD OF RECORD GIVEN FOR THE SATSOP STATION ON P. C-37 DIFFERS FROM THE PERIOD SHOWN IN THE TABLE ON P. C-3.

- Ambient water quality monitoring records from 1972-1974 and 1976-1977 for a station at river mile 13.6 on the Wynoochee River [p. C-38]
- Ambient water quality monitoring records from 1970-1971 and 1977-1992 for a station at river mile 13.15 on the Chehalis River [p. C-38]
- A TMDL report for Grays Harbor prepared in 2000 to address failure to meet fecal coliform standards for the inner harbor [p. 2-23].

Based on these sources, the Level 1 Assessment presents the following key information related to water quality:

- Cloquallum Creek water quality generally achieves standards, except for occasion excursions in pH and peaks in phosphorus and nitrogen concentrations [p. C-36].
- Total suspended solids concentrations in the Satsop subbasins are second in the Chehalis Basin only to the concentrations recorded in the Humptulips subbasin. Total phosphorus concentrations in the Satsop subbasins are low. The Grays Harbor TMDL identifies the Satsop River as a major source of fecal coliform to the harbor, although the available water quality records reviewed for the Level 1 Assessment do not indicate a problem with fecal coliform in this river [pp. C-37, C-38].
- Wynoochee subbasin water quality was generally good over the period of record, although this may not represent current conditions [p. C-38].
- Temperature has frequently exceeded state standards at the Montesano monitoring station on the Chehalis River. This station also recorded the highest total phosphorus loading and yield of all stations on the Chehalis, as well as the highest yield of inorganic nitrogen. Fecal coliform counts exceeded standards on numerous occasions [pp. C-43, C-44].

DISCREPANCY NOTE: THE ABOVE POINT ABOUT PHOSPHORUS YIELD, TAKEN FROM THE APPENDIX C DISCUSSION OF SUBBASIN 30, SEEMS TO CONTRADICT A COMMENT IN THE DETAILED EVALUATION OF SUBBASIN 19, WHICH SAYS THAT FOR MONTESANO, YIELDS WERE LOW FOR TP [P. 3-43].

- The only Study Area 2 water body listed on the state's 303(d) list is the Lower Chehalis River, which is listed for fecal coliform and temperature [p. C-45].

DISCREPANCY NOTE: THE ABOVE POINT ABOUT 303(D) LISTINGS IS BASED ON THE SUBBASIN DESIGNATIONS USED IN THE TABLE LISTING 303(D) WATER BODIES ON PAGE C-45. HOWEVER, MAP 7 OF THE LEVEL 1 REPORT, WHICH SHOWS LISTED WATER BODIES, INDICATES ADDITIONAL SITES WITHIN THIS STUDY AREA, IN MCCLEARY, JUST NORTH OF MONTESANO, AND ON A TRIBUTARY TO THE MIDDLE FORK SATSOP.

Figure 7-9 summarizes water quality monitoring results for the Satsop and Wynoochee Rivers and the Chehalis River at Montesano for temperature, dissolved oxygen, total suspended solids, and fecal coliform count.

FISH HABITAT AND FISH STOCK CONDITION

The known status of five of the eight fish stocks identified on the Satsop and Wynoochee Rivers is healthy (see Figure 3-12). The status of two of the stocks (Satsop summer chinook and Satsop winter steelhead) is depressed, and the status of Wynoochee spring chinook is disputed. One source has identified this stock as being "at a high risk of extinction" [p. D-3].

Table 7-1 summarizes the habitat problems identified in stream surveys conducted in Study Area 2 (the Level 1 Assessment does not provide specific survey results for Lower Chehalis Reach 2/Subbasin 30). In addition to the stream survey results, the Level 1 Assessment presents the following key findings about fish habitat in Study Area 2:

- 1988 aerial photos of about 7 miles of lower Cloquallum Creek and Wildcat Creek (a tributary) show 17 percent of the riparian area to be intact, 71 percent to be altered, and 12 percent to be absent [p. 3-13].

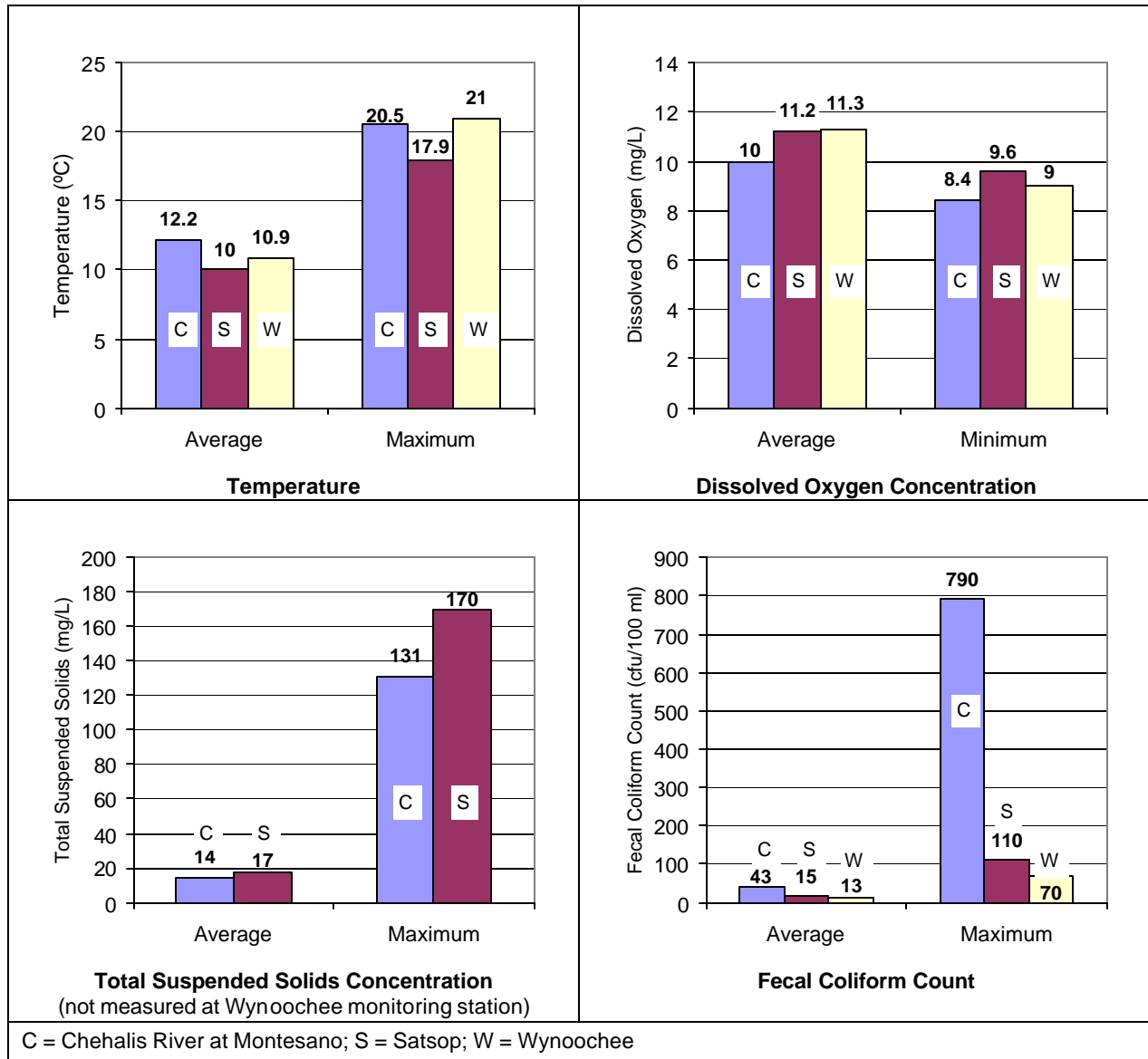


Figure 7-9. Summary of Study Area 2 Ambient Water Quality Monitoring; Chehalis and Satsop Data from 1990s Only [pp. C-9, C-13]

- 1988 aerial photos of about 14 miles of the lower Chehalis River between the Porter and the mouth of the Satsop River show 9 percent of the riparian area to be intact, 45 percent to be altered, and 28 percent to be absent [p. 3-13].
- Low levels of large woody debris have been noted in some areas of the Satsop and Wynoochee subbasins [pp. D-28, D-30].
- A 1994 study identified 28 sites along the Chehalis River between the Satsop and Wynoochee Rivers where land use actions had isolated off-channel areas from the main river channel [p. 3-44].

TABLE 7-1.
HABITAT PROBLEMS IDENTIFIED BY STREAM SURVEYS IN STUDY AREA 2

	Cloquallum Creek [p. D-27]		Satsop River [p. D-30]		Wynoochee River [p. D-28]		Lower Chehalis Reach 1 [p. D-28]	
	Points	Miles	Points	Miles	Points	Miles	Points	Miles
Total Length of Stream Surveyed		94		246		160		42
Identified Habitat Problems								
Reduced tree canopy from forestry			12	21	24	28	1	23.3
Reduced tree canopy from agriculture							9	5.3
Beaver dams potentially partially passable					35			
Bank vegetation destruction or loss	1	41.8	2	38.8				
Log jams potentially blocking migration			74					
Bank erosion	173	10.5	428	57	219	71.65	53	0.3
Riprap, dumping and artificial bank protection	108	2.2						
Excessive sediments in the water	12	16			17	3.5	1	16.2

8. STUDY AREA 3— MIDDLE CHEHALIS SUBBASINS

STUDY AREA DESCRIPTION

Study Area 3 consists of three subbasins draining to the Chehalis River from Porter to near Grand Mound. Figure 8-1 shows the subbasins included in this study area. The major surface water systems in this study area are as follows:

- The reach of the main stem of the Chehalis River designated as Middle Reach 2, between Porter and the Lewis/Thurston County line (Subbasin 13)
- The Black River (Subbasin 11), which originates in wetlands near Black Lake and flows into the Chehalis River near Oakville; Black Lake previously drained to the Black River but, at least during the dry season, there is no longer a connection between the lake and the river and the lake drains out of the Chehalis Basin into Percival Creek in Tumwater by way of a constructed drainage ditch [p. 2-2]
- Cedar Creek (Subbasin 12), which flows into the Chehalis River at river mile 39, between Oakville and Porter.

The study area has a combined drainage area of 402 square miles. Elevations range from 25 to 2,660 feet, the highest point is in the Middle Chehalis Reach 2 subbasin [p. A-22]. Figure 8-2 summarizes land use information for Study Area 3 presented in the Level 1 Assessment.

Study Area 3 does not include any of the five subbasins selected for detailed analysis in the Level 1 Assessment.

INSERT FIGURE 8-1

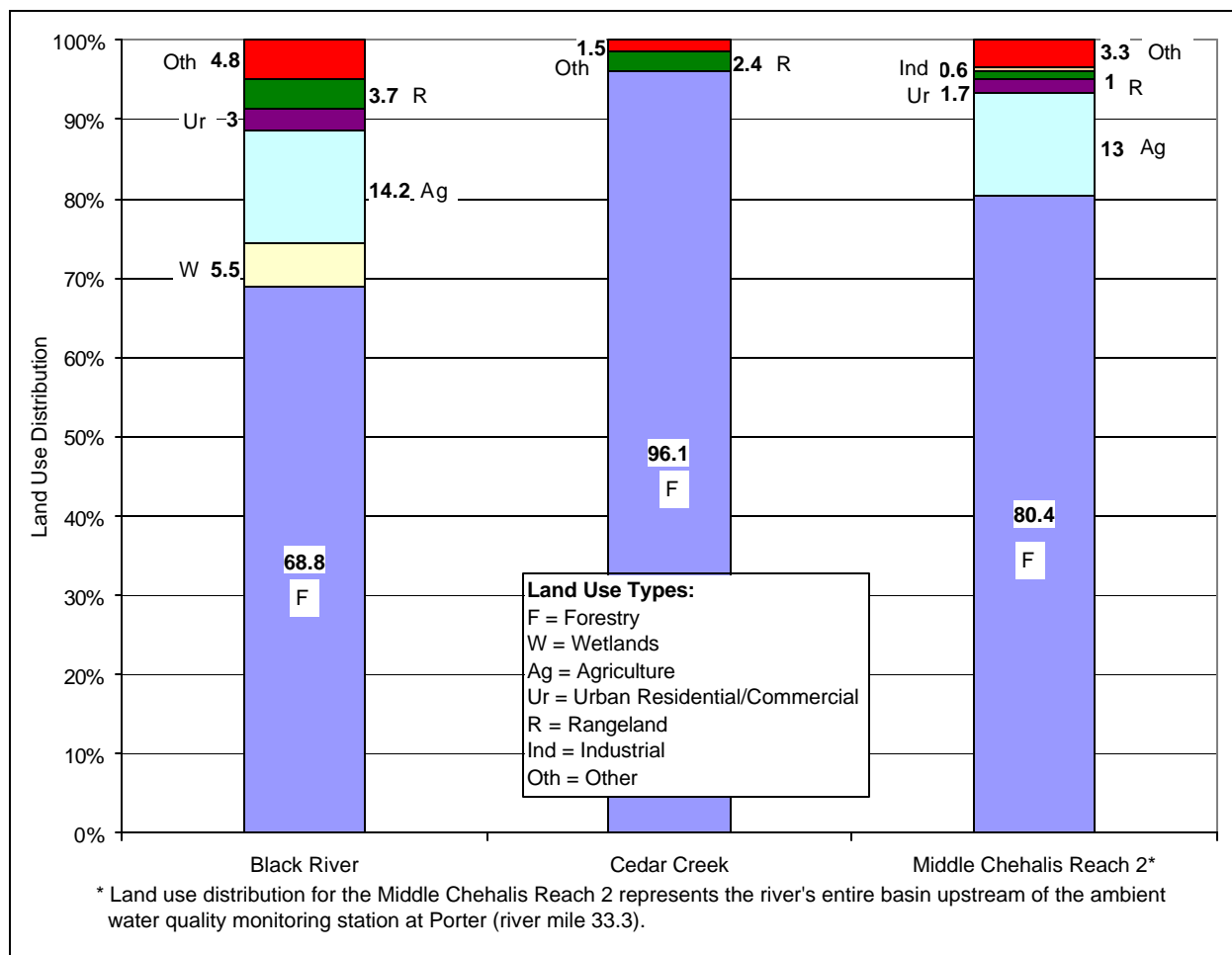


Figure 8-2. Land Use Distribution in Study Area 3 [pp. C-30, C-34, C-35]

GEOLOGY/HYDROLOGY

Geologic Features and Groundwater

The Level 1 Assessment outlines the following key geological features of subbasins in Study Area 3 [pp. A-8, A-9]:

- Most of the Black River subbasin consists of glacial sediments underlying alluvial sediments. A significant aquifer is associated with the glacial sediments.
- The Cedar Creek subbasin is primarily volcanic rock, with limited marine sedimentary rock. Aquifer development is minimal.
- The Middle Chehalis Reach 2 subbasin is primarily glacial sediment, with some sedimentary rock on hills in the south part of the subbasin. An extensive and productive aquifer is associated with the glacial sediments.

Rainfall, Runoff and Stream Flows

Two of the base gages identified in the Level 1 Assessment are in the Middle Chehalis Reach 2 subbasin [p. A-39].

[NOTE: PLEASE SEE THE DISCREPANCY NOTE/QUESTION ON CLIMATE AND GAGING STATIONS IN THE DISCUSSION FOR STUDY AREA 1.](#)

Average annual rainfall for Study Area 3 ranges from 48 to 54 inches. The 48-inch average annual rainfall in the Black River subbasin is among the lowest of all subbasins in the Chehalis River Basin. Estimated unit runoff in the study area is relatively low, about 3 to 5 cfs/mi² [pp. A-22, A-40].

The Level 1 Assessment presents an estimate of exceedance flows at Porter. Because these flows represent the entire Upper Chehalis Basin (WRIA 23), they are described in this summary report's chapter on WRIA 23 (Chapter 4).

Because of the permeability of glacial and alluvial sediments that are present, the exchange of groundwater and surface water is significant in the area around the Black River, Middle Chehalis Reach 2 and Scatter Creek. Because of this hydraulic conductivity, the valley floors in this area have been designated critical aquifer recharge areas. Along a 26-mile reach of the Chehalis River extending downstream of the Thurston/Lewis County border flow to the river from the surrounding aquifer has been measured to be as high as 10.3 cfs per river mile [p. A-15].

WATER RIGHTS/WATER USE

Figures 8-3 and 8-4 show the distribution of water rights in Study Area 3 by primary purpose and by type, respectively.

Figure 8-3. Study Area 3 Distribution of Water Rights by Primary Purpose—Number of Rights [p. B-8]

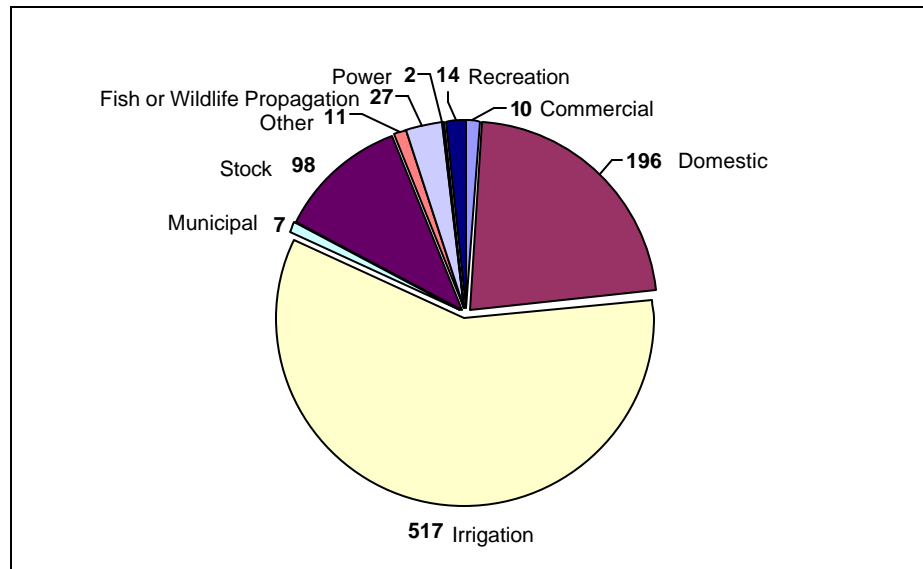
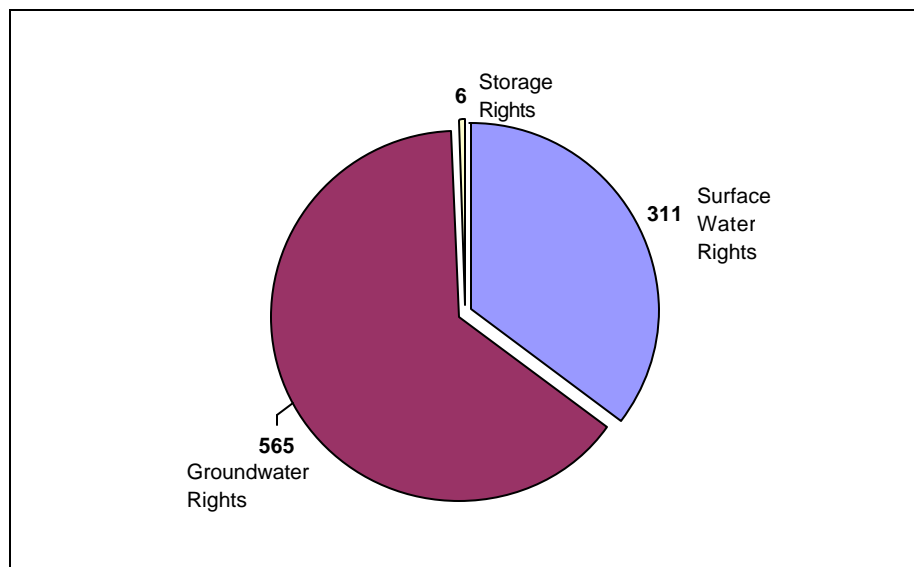


Figure 8-4. Study Area 3
Distribution of Water Rights
by Type of Right—
Number of Rights
[p. B-9]



Key water rights information for Study Area 3 from the Level 1 Assessment are as follows:

- The total instantaneous withdrawal rate for allocated rights in Study Area 3 is 393.31 cfs and the total annual volume limit is 75,599 acre-feet [p. B-8].
- The Middle Chehalis Reach 2 subbasin has the second highest annual volume limit allocation (41,768 acre-feet) of all subbasins in the Chehalis Basin [p. B-8].
- The Middle Chehalis Reach 2 and Black River subbasins have the highest total number of rights of all subbasins in the Chehalis Basin and a large portion of the total number of rights for many specific purposes, as shown on Figure 8-5.
- The Level 1 Assessment does not identify any significant individual rights as being located in Study Area 3.

The Level 1 Assessment’s comparison of stream flows at Porter to water right allocation and in-stream flow requirements represents the entire Upper Chehalis Basin; therefore, this summary report presents that information in the chapter on WRIA-wide findings for the upper basin (Chapter 4). The Level 1 Assessment does not include any information on water use that is specific to Study Area 3.

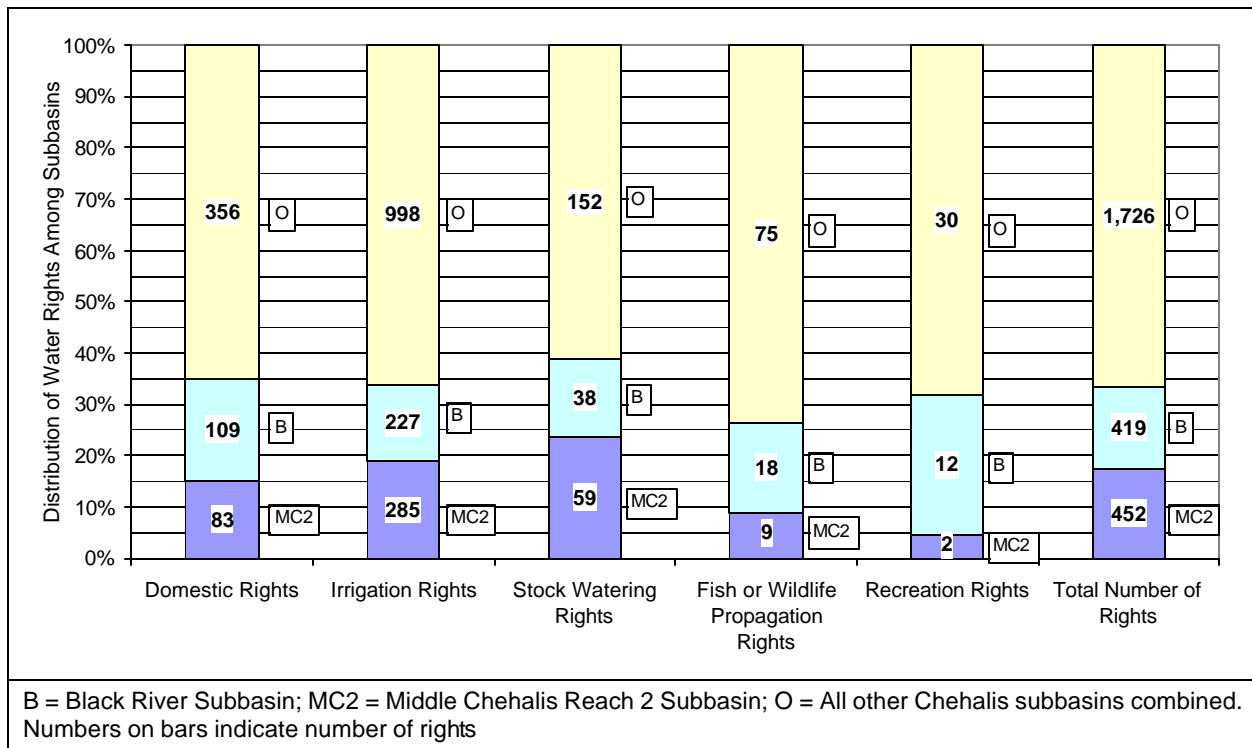


Figure 8-5. Number of Water Rights in Two Subbasins of Study Area 3 Compared to the Rest of the Chehalis Basin [p. B-8]

WATER QUALITY

All water bodies in Study Area 3 have a state water quality classification of Class A (excellent).

Water quality information for Study Area 3 in the Level 1 Assessment is taken from the following sources of information:

- Ambient water quality monitoring records from 1990 through 1997 for a station at river mile 7.1 on the Black River [p. C-32]
- Ambient water quality monitoring records from 1970 through the present for the Porter station at river mile 33.3 on the Chehalis River [p. C-34]
- A TMDL report for the Upper Chehalis River prepared in 1994 to address deficient levels of dissolved oxygen [p. C-8]
- A TMDL report for the Upper Chehalis River prepared in 1999 to address dry-season temperature exceedances [p. C-8]
- A TMDL report for the Black River prepared in 1994 to address wet-season fecal coliform levels [p. C-31]
- A TMDL report for the Black River prepared in 1994 to address numerous dry-season pollutant issues [p. C-31]
- A water quality screening study of the Black River prepared in 1990 [p. C-30].

[DISCREPANCY NOTE: APPENDIX C MENTIONS ANOTHER BLACK RIVER WATER QUALITY STUDY CONDUCTED IN 1990-91 \[P. C-30\] BUT DOES NOT PROVIDE A SPECIFIC REFERENCE FOR IT.](#)

Based on these sources, the Level 1 Assessment presents the following key information related to water quality:

- The Black River has experienced problems with temperature, dissolved oxygen, total phosphorus, ammonia-nitrogen and fecal coliform. Improved farming practices recommended in the wet-season TMDL for the river appear to be reducing the fecal coliform problems. The dry-season TMDL has recommended control of pollutant sources and replanting of shade trees in riparian areas to reduce water temperatures [pp. C-30, C-31, C-32].
- No water quality monitoring data is available for Cedar Creek, but, according to one of the Upper Chehalis TMDL studies, the water quality in this subbasin is generally good [pp. C-33, C-34].
- Water quality monitoring at Porter indicates conditions for the entire Upper Chehalis Basin, not just for the Middle Chehalis Reach 2 subbasin. Records from the Porter station indicate problems with temperature and dissolved oxygen. Implementation of recommendations from the Upper Chehalis TMDL studies is expected to reduce water quality problems.
- Seven water bodies in Study Area 3 (four in the Black River subbasin and three in the Middle Chehalis Reach 2 subbasin) are listed on the state's 303(d) list. Two of these are listed for temperature, three for dissolved oxygen, and five for fecal coliform [p. C-45].

[DISCREPANCY NOTE: THE ABOVE POINT ABOUT 303\(D\) LISTINGS IS BASED ON THE TABLE LISTING 303\(D\) WATER BODIES ON PAGE C-45. THE LISTED WATER BODIES THERE DO NOT SEEM TO CORRELATE PRECISELY TO THE LOCATIONS SHOWN IN MAP 7 OF THE LEVEL 1 REPORT.](#)

Figure 8-6 summarizes water quality monitoring results for the Black River and the Chehalis River at Porter for temperature, dissolved oxygen, total suspended solids, and fecal coliform count.

FISH HABITAT AND FISH STOCK CONDITION

No fish stocks identified in the Level 1 Assessment are specifically identified with the subbasins in Study Area 3. Fish stocks present in this study area are discussed in the chapter on basin-wide Level 1 findings.

Table 8-1 summarizes the habitat problems identified in stream surveys conducted in Study Area 3 (the Level 1 Assessment does not provide specific survey results for Lower Chehalis Reach 2/Subbasin 30). In addition to the findings shown in the table, the Level 1 Assessment notes that summer temperatures in the Black River and in Scatter Creek are high enough to prevent adult salmon from migrating upstream.

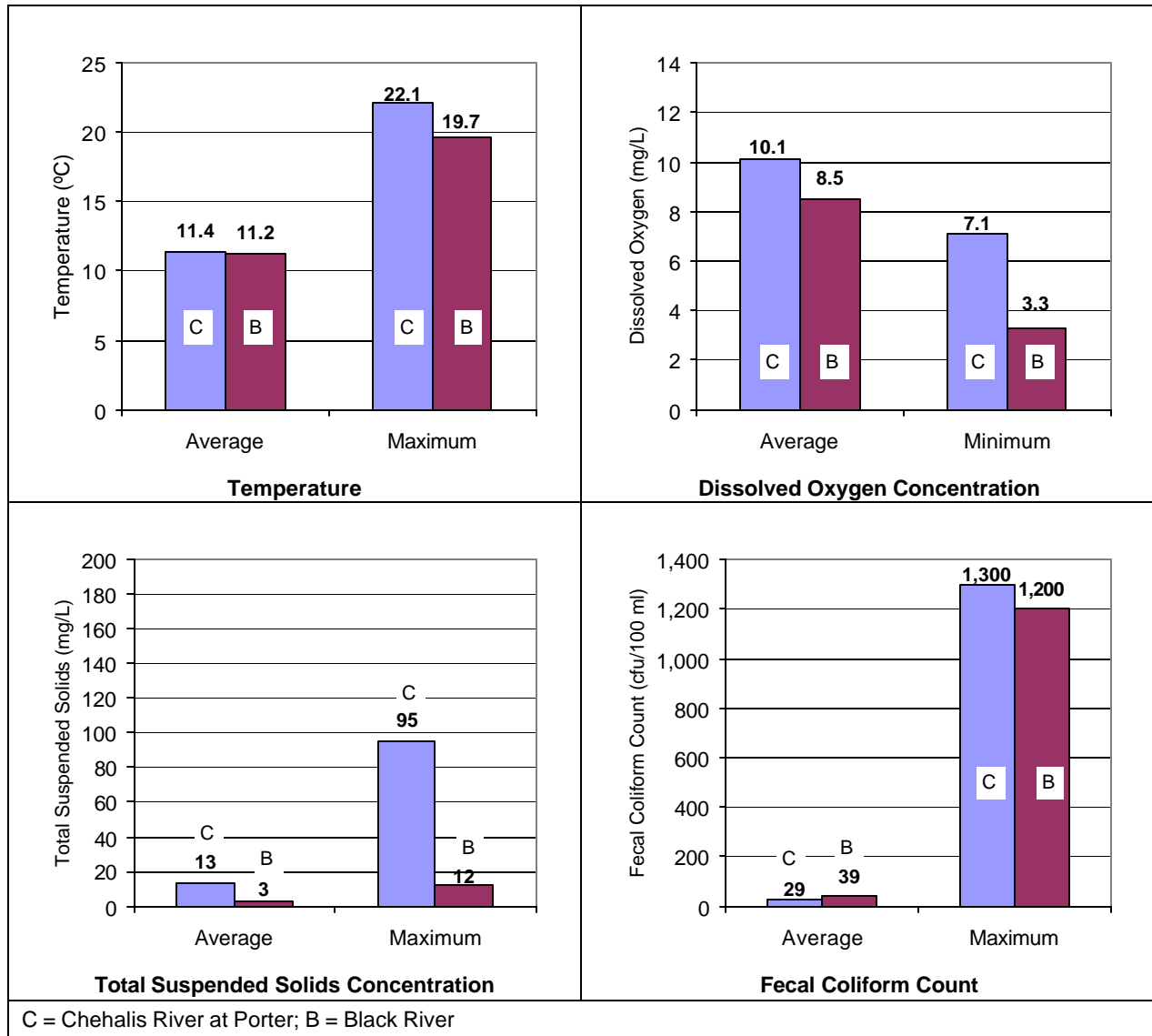


Figure 8-6. Summary of Study Area 3 Ambient Water Quality Monitoring for the 1990s [pp. C-9, C-13]

TABLE 8-1.
HABITAT PROBLEMS IDENTIFIED BY STREAM SURVEYS IN STUDY AREA 3

	Black River [p. D-25]		Cedar Creek [pp. D-25, D-26]		Middle Chehalis Reach 2 ^a [pp. D-26, D-27]	
	Points	Miles	Points	Miles	Points	Miles
Total Length of Stream Surveyed		88		38		111
Identified Habitat Problems						
Livestock access to streams	6	23.9	2	2.5	6	21.1
Bank destruction by livestock	73	6.2			67	3.2
Reduced tree canopy from agriculture	2	18			1	17.6
Bank vegetation destruction or loss	1	16.7	6	2.2	91	26.4
Miscellaneous pollution input sources			12			
Bank erosion	82	7.2	52	0.6	188	14.1
Excessive sediments in the water					7	18.1

a. The Level 1 Assessment presents stream survey results for Middle Chehalis Reach 2 in three areas: Porter; Scatter Creek; and Rock-Garrard. Results shown in this table represent the sum of the three areas.

9. STUDY AREA 4— UPPER CHEHALIS SUBBASINS

STUDY AREA DESCRIPTION

Study Area 4 consists of 10 subbasins draining to the Chehalis River upstream of the Lewis/Thurston County line. Figure 9-1 shows the subbasins included in this study area. The major surface water systems in this study area are as follows:

- The following three reaches of the Chehalis River main stem:
 - The headwaters, upstream of the confluence with Elk Creek in the community of Doty and extending into the Willapa Hills (Subbasin 1)
 - The Upper Chehalis River, between the confluences with Elk Creek and the Newaukum River at the City of Chehalis (Subbasin 4)
 - Middle Chehalis Reach 1, from the Newaukum River to just below the Lewis/Thurston County line (Subbasin 10)
- The South Fork Chehalis River, which flows into the main stem from the south at river mile 88 (Subbasin 3)
- Elk Creek, which flows into the Chehalis River at Doty, at river mile 102 (Subbasin 2)
- The Newaukum River, which has its headwaters in the foothills of the Cascade Mountains and flows into the Chehalis River near the City of Chehalis (Subbasins 5, 6 and 7)
- Salzer Creek, which flows into the Chehalis River near the border between the Cities of Chehalis and Centralia (Subbasin 8)
- The Skookumchuck River, which has its headwaters in the foothills of the Cascade Mountains and flows into the Chehalis River in the City of Centralia at river mile 67 (Subbasin 9).

The study area has a combined drainage area of 891 square miles. Elevations range from 120 to 3,812 feet; the highest point is in the Skookumchuck River subbasin [pp. A-22]. Study Area 4 includes Centralia and Chehalis, the second and fourth largest cities in the Chehalis Basin, respectively. Figure 9-2 summarizes land use information for Study Area 4 presented in the Level 1 Assessment.

The Chehalis Headwaters Subbasin (Subbasin 1) and Newaukum River Subbasin (Subbasins 5, 6 and 7, evaluated together) are among the five subbasins selected for detailed analysis in the Level 1 Assessment.

[DISCREPANCY NOTE: ALTHOUGH THE DETAILED EVALUATION OF THE NEWAUKUM RIVER IN THE LEVEL 1 ASSESSMENT IS TITLED "SUBBASIN 7: LOWER NEWAUKUM RIVER," THE INFORMATION IN IT APPEARS TO CONSISTENTLY INCLUDE ALL THREE NEWAUKUM SUBBASINS.](#)

INSERT FIGURE 9-1

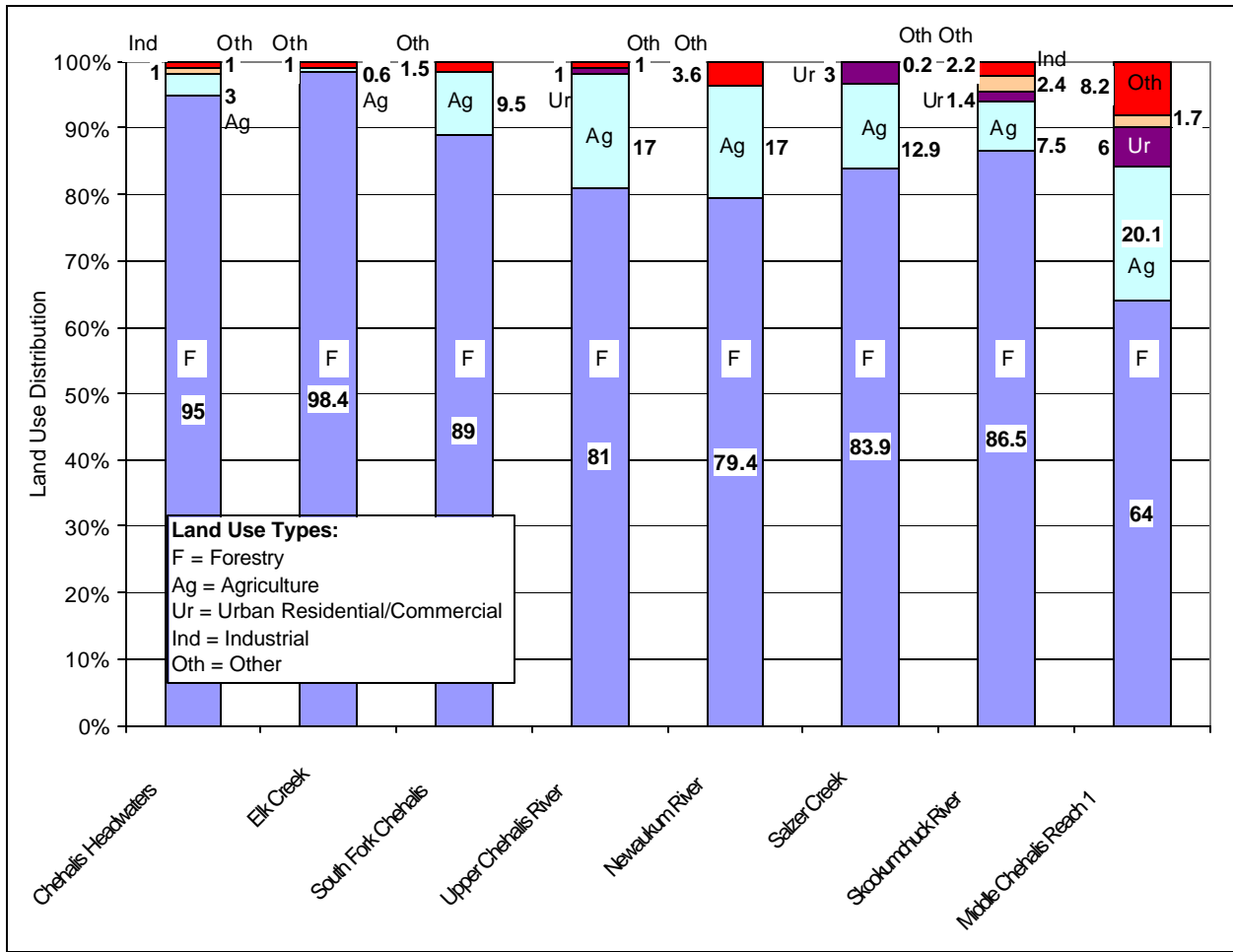


Figure 9-2. Land Use Distribution in Study Area 4 [pp. C-16, C-17, C-19, C-21, C-23, C-24, C-26, C-29]

GEOLOGY/HYDROLOGY

Geologic Features and Groundwater

The Level 1 Assessment outlines the following key geological features of subbasins in Study Area 4 [pp. A-6, A-7, A-8]:

- The Chehalis headwaters, Elk Creek, South Fork Chehalis, Upper Chehalis River and Skookumchuck subbasins consist primarily of volcanic rock and marine sedimentary rock, with some alluvial sediments on the valley bottoms. The only likely significant aquifers in these subbasins are in the valley bottoms of the South Fork Chehalis and Upper Chehalis subbasins.
- The Newaukum subbasins are a diverse mix of glacial sediments and sedimentary rock, with volcanic rock in higher areas and alluvial sediments on the valley floor of the South Fork Newaukum. Significant groundwater near the surface is likely only in the areas of alluvial sediments. A deeper aquifer is likely in the glacial sediments.

- The Salzer Creek subbasin is primarily marine sedimentary rock with alluvial sediments in the valley bottoms, where groundwater has been tapped at depths of 20 to 30 feet.
- The Middle Chehalis Reach 1 subbasin has sedimentary rock in higher areas and a thick mix of glacial and alluvial sediments on the valley floor, where a significant shallow aquifer is present.

Rainfall, Runoff and Stream Flows

There is one base gage in each of the Chehalis Headwaters, Elk Creek, South Fork Newaukum, Lower Newaukum and Middle Chehalis Reach 1 subbasins; the South Fork Chehalis and Skookumchuck subbasins each have two base gages [p. A-39].

[NOTE: PLEASE SEE THE DISCREPANCY NOTE/QUESTION ON CLIMATE AND GAGING STATIONS IN THE DISCUSSION FOR STUDY AREA 1.](#)

Average annual rainfall for Study Area 4 ranges from 42 inches in the Salzer Creek subbasin, the lowest of all subbasins in the Chehalis River Basin, to 89 inches in the Chehalis Headwaters subbasin. Estimated unit runoff in the study area is relatively low, about 3 to 5 cfs/mi² [pp. A-22, A-40].

The Level 1 Report’s detailed analyses of the Chehalis headwaters and Newaukum subbasins include estimates of flow exceedance values for the Chehalis River at the community of Doty and for the Newaukum River near Chehalis. Figures 9-3 and 9-4 show these estimates.

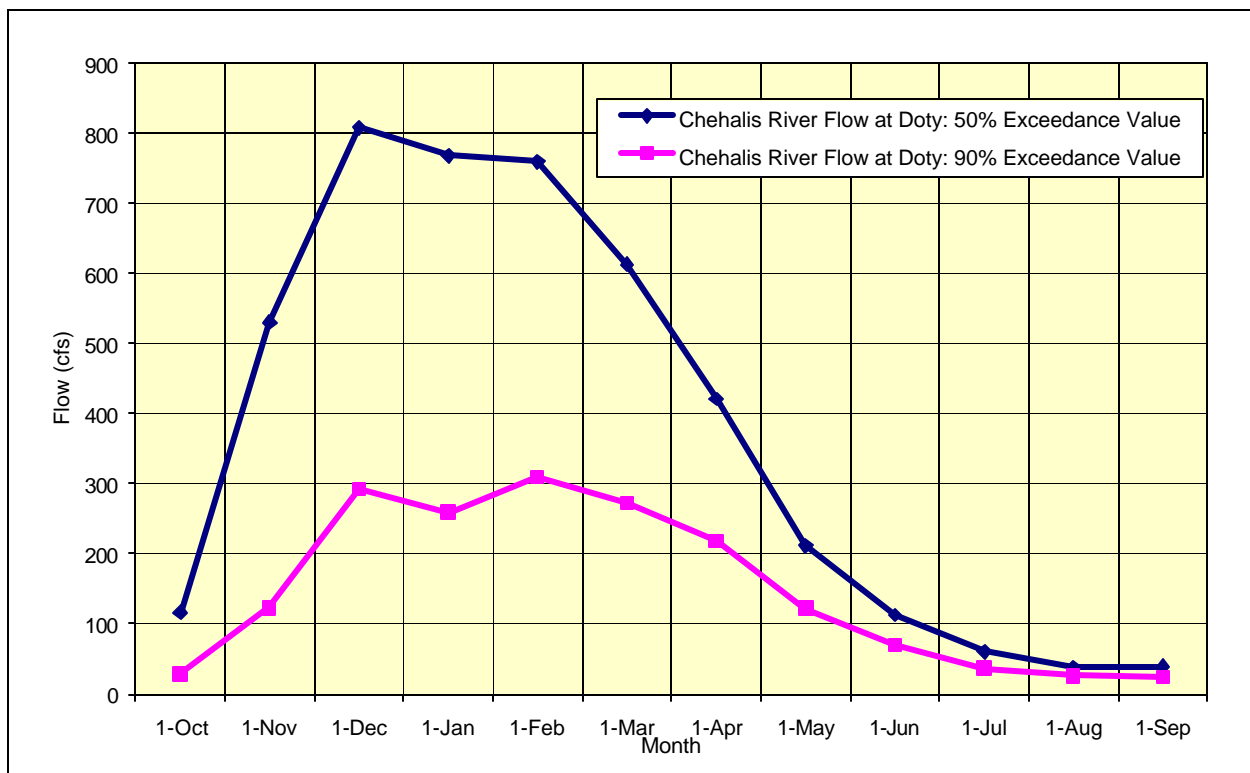


Figure 9-3. Estimated Chehalis River Flows at Gaging Station 12020000 [p. 3-4]

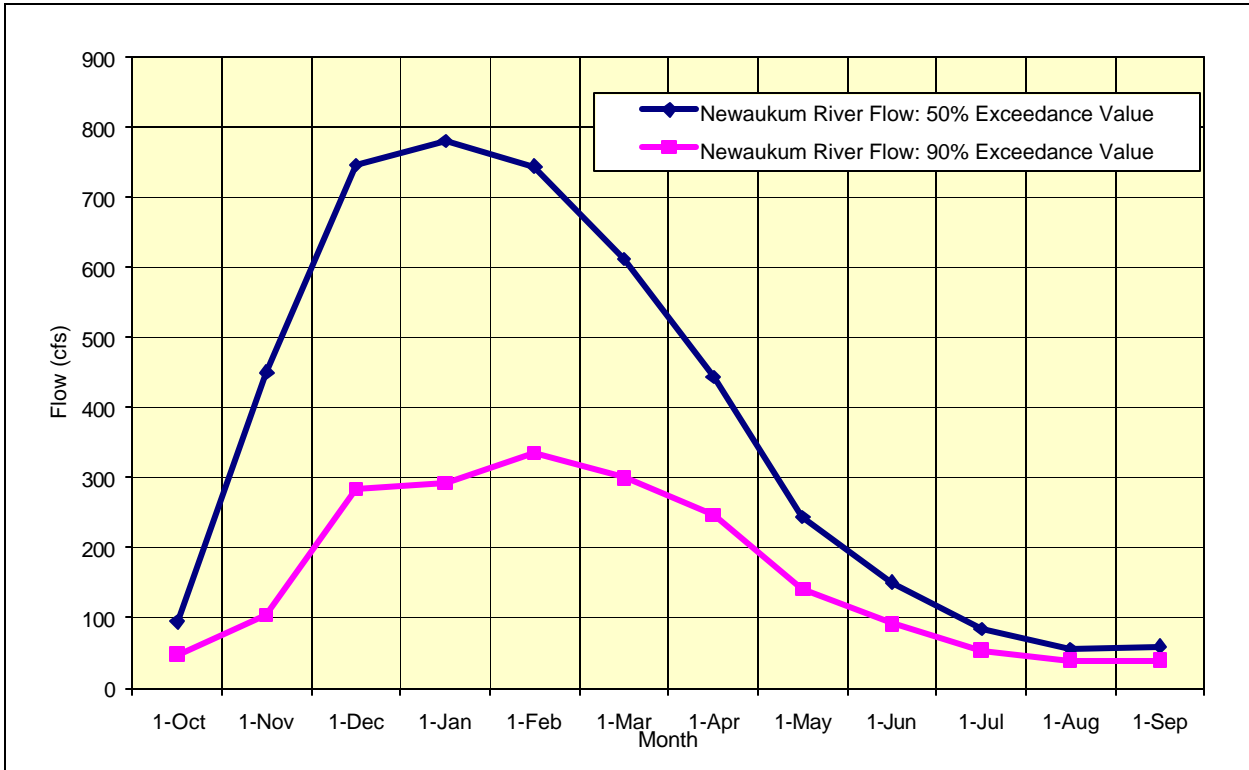


Figure 9-4. Estimated Newaukum River Flows at Gaging Station 12025000 [p. 3-17]

WATER RIGHTS/WATER USE

Figures 9-5 and 9-6 show the distribution of water rights in Study Area 4 by primary purpose and by type, respectively.

Figure 9-5. Study Area 4 Distribution of Water Rights by Primary Purpose—Number of Rights [p. B-8]

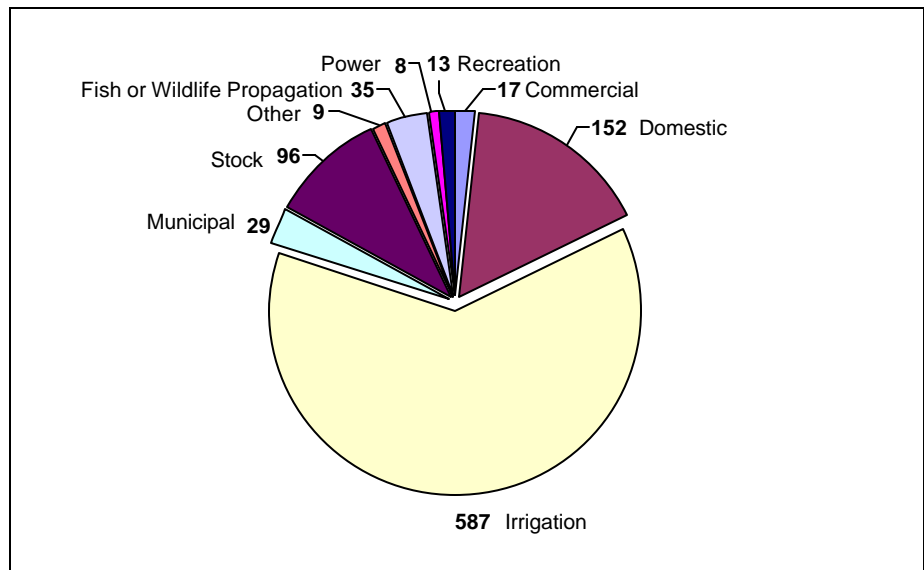
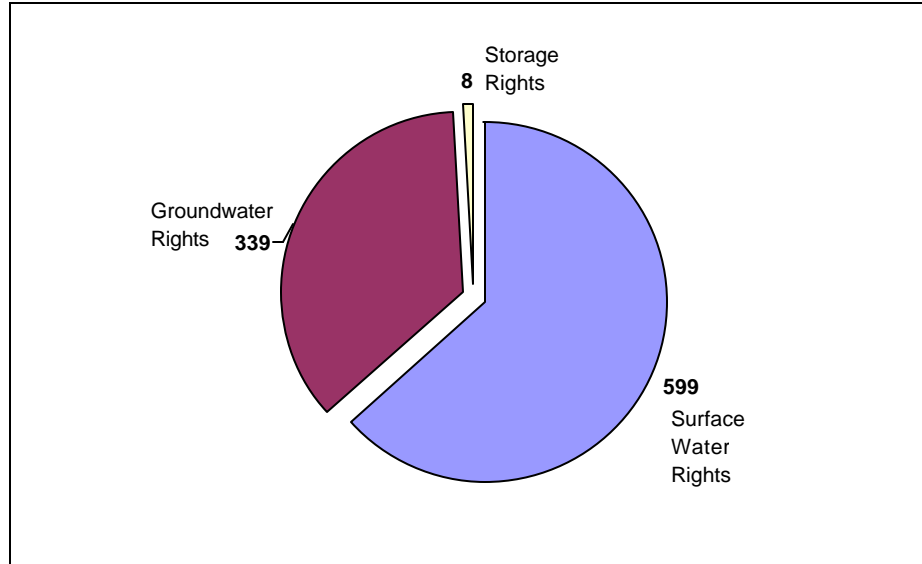


Figure 9-6. Study Area 4
Distribution of Water Rights
by Type of Right—
Number of Rights
[p. B-9]



Key findings of the Level 1 Assessment review of water rights in Study Area 4 are as follows:

- The total instantaneous withdrawal rate for allocated rights in Study Area 4 is 567.94 cfs and the total annual volume limit is 41,367 acre-feet [p. B-8].
- Study Area 4 has the highest total number of rights (946) of all the study areas. More than half of the rights (587) are for irrigation.
- The Skookumchuck subbasin has the second highest storage allocation (35,399 acre-feet) of all subbasins in the Chehalis Basin, after the Wynoochee subbasin [p. B-8].

NOTE: THE LARGE STORAGE RIGHT ALLOCATION MENTIONED ABOVE IS BELIEVED TO BE MOSTLY, IF NOT ENTIRELY, FOR THE SKOOKUMCHUCK RESERVOIR, BUT THE LEVEL 1 REPORT DOES NOT STATE THIS.

- The Skookumchuck subbasin has the highest total instantaneous withdrawal allocation (312.87 cfs) of all subbasins in WRIA 23 [p. B-8]. Significant individual rights in this subbasin include the following [p. B-4]:
 - A 140-cfs right held by Pacific Power and Light for power generation
 - An 80-cfs held by Pacific Power and Light for power generation and commercial use; intended for thermoelectric power generation at the Centralia Steam Plant, this right is for a highly consumptive use.

The Level 1 detailed evaluations of the Chehalis headwaters and Newaukum River provide monthly in-stream flow requirements for control points at the outlets to these subbasins. Figures 9-7 and 9-8 compare the estimated stream flows to the sum of the required in-stream flow and the consumptive allocated water rights for the subbasins (7 cfs for the Chehalis headwaters and 69 cfs for the Newaukum River). In the headwaters subbasin, the flow demand (the sum of the in-stream flow requirement and the consumptive allocated water rights) exceeds the 90-percent exceedance flow in every month except for November, December, February and March. In the Newaukum subbasin, the demand exceeds the 90-percent exceedance flow in every month except February.

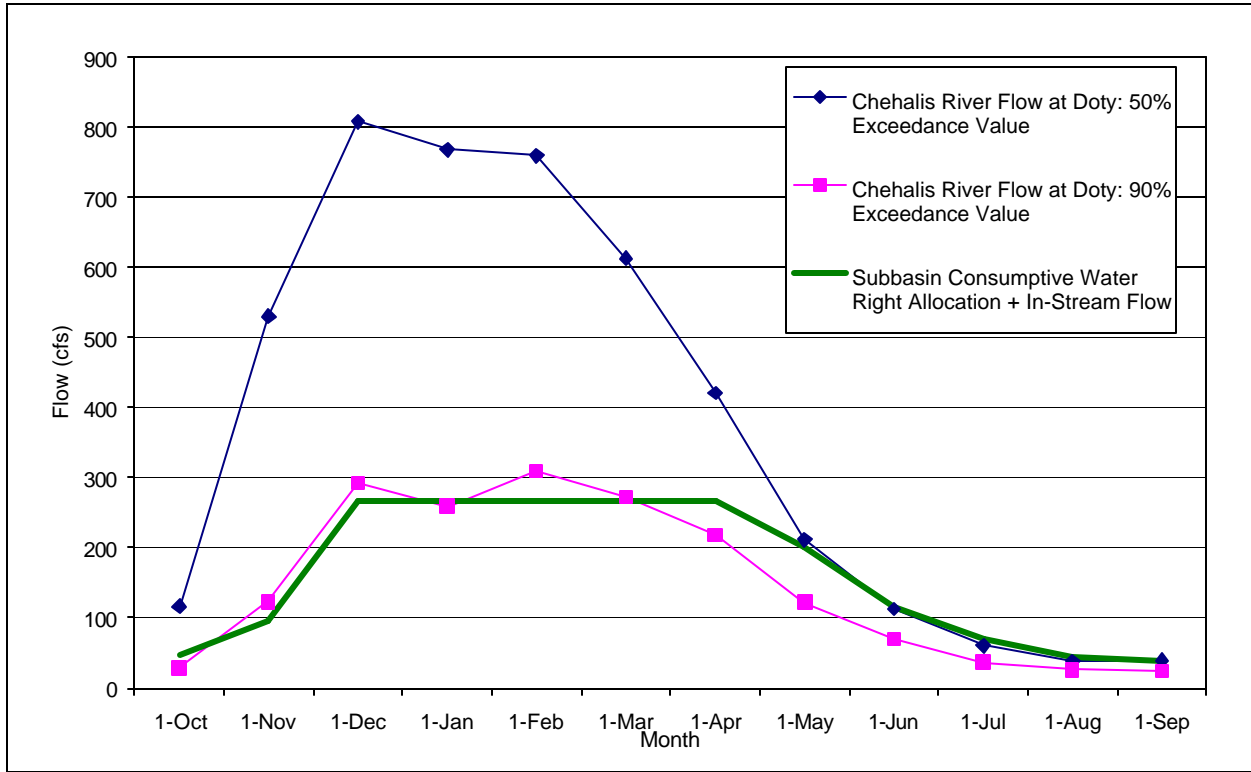


Figure 9-7. Chehalis Flow at Doty Compared to Sum of Water Rights and In-Stream Flow [pp. 3-4, 3-9]

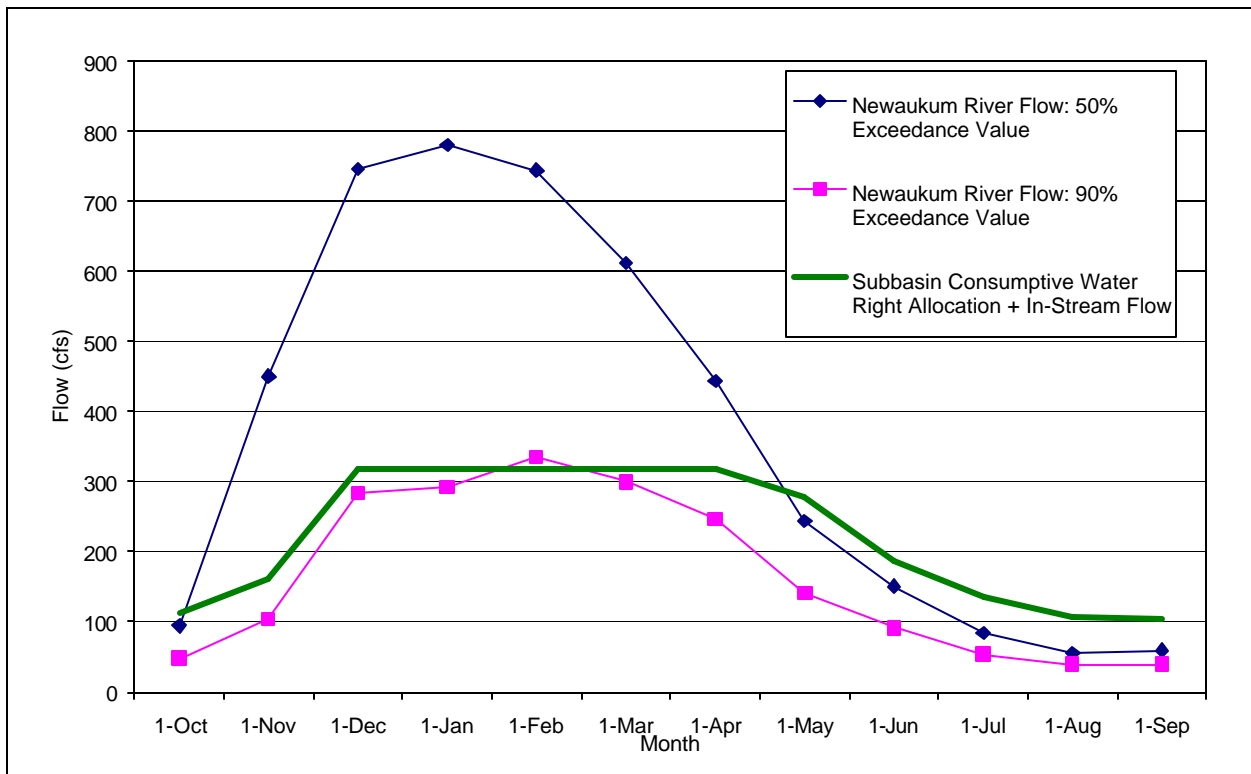


Figure 9-8. Newaukum River Flow Compared to Sum of Water Rights and In-Stream Flow [pp. 3-17, 3-22]

The detailed evaluations of the Chehalis headwaters and Newaukum River subbasins provide rough estimates of water use for both subbasins and of domestic use for the Cloquallum subbasin. The Level 1 Assessment concludes the following:

- In the Chehalis headwaters subbasin, estimated domestic use is about 4 percent of the allocated right and estimated municipal use is 16 percent of the allocated right. Estimated irrigation demand is 424 acre-feet per year; the known allocated irrigation right is 250 acre-feet per year, but annual volume limits were not available for all irrigation rights identified in the subbasin [p. 3-11].
- In the Newaukum River subbasins, estimated domestic use is as much as 81 percent of the allocated right. Estimated irrigation demand is more than 14,000 acre-feet per year (depending on crop); the allocated irrigation right is only 6,384 acre-feet, less than half the estimate of demand [p. 3-23].

WATER QUALITY

Water bodies in Study Area 4 have a state water quality classification of Class A (excellent) except for the Chehalis headwaters and the upper Skookumchuck River, which are rated Class AA (extraordinary) and a portion of the main stem of the Chehalis River passing through the Cities of Centralia and Chehalis, which has a special water-quality designation. The special 10-mile main-stem segment, known as the Centralia Reach, extends from river mile 65.8 to river mile 75.2. A natural sill in this segment causes water to pool upstream, leading to slow-flowing waters and characteristics more like a lake than a river. The nature of this condition has led to development of special water quality standards [p. C-6].

Water quality information for Study Area 4 in the Level 1 Assessment is taken from many sources of information:

- Ambient water quality monitoring records from 1977 to the present for a station at river mile 101.7 on the Chehalis River at Dryad [p. C-15]
- Ambient water quality monitoring records from 1996 through 1997 for a station at river mile 77.7 on the Chehalis River at Claquato [p. C-19]
- Ambient water quality monitoring records from 1977 through 1993 for a station at river mile 67.5 on the Chehalis River, near the downstream end of the Centralia Reach [p. C-26]
- Ambient water quality monitoring records from 1996 through 1997 for a station at river mile 3.0 on the south fork of the Chehalis River [p. C-18]
- Ambient water quality monitoring records from 1992 through 1993 for a station at river mile 0.1 on the Newaukum River [p. C-21]
- Ambient water quality monitoring records from 1972 through 1977 for a station at river mile 4.5 on the Newaukum River [p. C-21]
- Ambient water quality monitoring records from 1974 through 1975 for a station at river mile 11.1 on the Newaukum River [p. C-21]
- Ambient water quality monitoring records from 1992-1993 and 1996-1997 for a station at river mile 2.3 on the Skookumchuck River [p. C-25]

- A TMDL report for the Upper Chehalis River prepared in 1994 to address deficient levels of dissolved oxygen [p. C-8]
- A TMDL report for the Upper Chehalis River prepared in 1999 to address dry-season temperature exceedances [p. C-8]
- Numerous special water quality studies prepared during the 1980s and 1990s [p. C-24].

Based on these sources, the Level 1 Assessment presents the following key information related to water quality:

- The Dryad station has had significant exceedances for maximum fecal coliform concentrations and high levels of total suspended solids. Temperature exceedances at the station have been frequent [p. C-16].
- Water quality in the South Fork Chehalis subbasin is degraded for temperature and fecal coliform [p. C-19].
- Water quality in the Upper Chehalis River subbasin is degraded for temperature, dissolved oxygen, fecal coliform and total phosphorus [p. C-21].
- Water quality in the Newaukum River subbasins is degraded for temperature and fecal coliform [p. C-23].
- Numerous water quality problems have occurred in the Salzer Creek subbasin, and studies have identified specific sources of many of these problems. Actions have been taken to address some, but not all of the identified problems [p. C-24].
- Water quality problems related to temperature, total phosphorus and inorganic nitrogen have been noted in the Skookumchuck River subbasin [p. C-26].
- The Centralia Reach has experienced abundant water quality problems, including problems with temperature, dissolved oxygen, fecal coliform, total phosphorus and ammonia-nitrogen. An example of water quality problems in this reach can be seen in the recorded temperature and dissolved oxygen measurements shown in Figure 4-11 of this summary report; temperatures are generally high in this reach and dissolved oxygen levels are generally low, but measurements for both cover a wide range. Water quality problems in the Centralia Reach were identified long ago and have been studied extensively [p. C-29].
- The Upper Chehalis temperature TMDL recommended additional shade and stipulated that no additional reductions of base flow to the river be allowed. The Upper Chehalis dissolved oxygen TMDL recommended reductions in oxygen-depleting contaminants.
- Thirteen water bodies in Study Area 4 are listed on the state's 303(d) list: five in the Middle Chehalis Reach 1 subbasin and three in the Upper Chehalis, and one each in the Elk Creek, South Fork Chehalis, North Fork Newaukum and Salzer Creek subbasins. Five of these are listed for temperature, eight for dissolved oxygen, and 11 for fecal coliform [p. C-45].

Figure 9-9 summarizes water quality monitoring results for the South Fork Chehalis, Newaukum and Skookumchuck Rivers and the Chehalis River at Dryad, Claquato and Centralia for temperature, dissolved oxygen, total suspended solids, and fecal coliform count.

FISH HABITAT AND FISH STOCK CONDITION

The status of the only identified fish stock specific to Study Area 4 (the Skookumchuck/Newaukum winter steelhead) is depressed (see Figure 3-12).

Table 9-1 summarizes the habitat problems identified in stream surveys conducted in Study Area 4.

In addition to the stream survey results, the Level 1 Assessment presents the following key findings about fish habitat in Study Area 4:

- 1990 aerial photos of about 5 miles of the Chehalis main stem extending upstream and downstream from Pe Ell show 31 percent of the riparian area to be intact, 66 percent to be altered, and 3 percent to be absent [p. 3-13].
- 1990 aerial photos of about 25 miles of the Newaukum River extending upstream from the river's mouth show 24 percent of the riparian area to be intact, 50 percent to be altered, and 26 percent to be absent [p. 3-13].
- Some peak temperatures in parts of the study area have exceeded the lethal limit for many salmonid species [p. D-17].
- During summer, the deeper waters of the Centralia Reach have been found to have little or no dissolved oxygen [p. D-17].
- Thirteen potential fish passage barriers at culverts have been identified in the Newaukum River drainage [p. D-22].
- Streams lack large woody debris in many parts of the Study Area [pp. D-19, D-21, D-22, D-24].

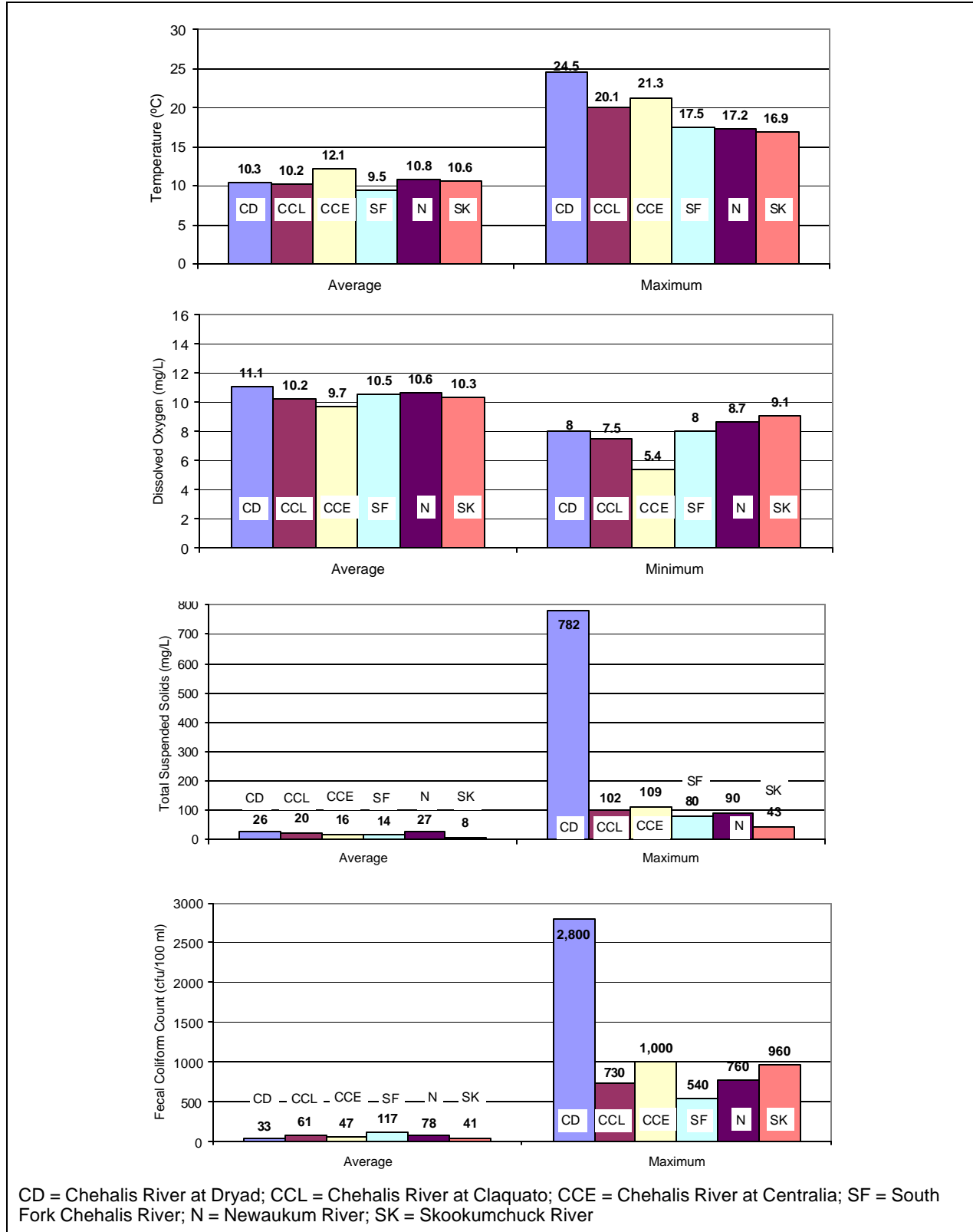


Figure 9-9. Summary of Study Area 4 Ambient Water Quality Monitoring for the 1990s (Data from the 1970s for Chehalis River at Claquato) [pp. C-9, C-13]

INSERT TABLE 9-1

10. SUMMARY OF RECOMMENDATIONS FROM LEVEL 1 ASSESSMENT

Based on its review and evaluation of available data describing the Chehalis River Basin, the Level 1 Assessment provides recommendations for further investigations and analysis to be performed as part of a Level 2 Assessment. These new studies would provide missing information that is needed for the Chehalis Basin planning effort. The Level 1 recommendations are summarized below.

GEOLOGY

The following work is recommended to provide a thorough set of information on geology in the basin:

- Investigate the interaction of groundwater with surface water in portions of the basin that have not been studied. Develop a hydrologic water balance for each subbasin to identify subbasin-specific issues related to groundwater and stream flow interactions [p. 4-2].
- Conduct three-dimensional modeling of some subbasins as required. Modeling should focus on subbasins with significant groundwater withdrawals where some information on aquifer/geologic systems is available and where new fisheries work identifies flow limitations on fish habitat [p. 4-2].

HYDROLOGY

The following work is recommended to provide a thorough set of information on hydrology in the basin:

- Evaluate undepleted stream flows in the 25 subbasins other than those chosen for detailed evaluation to allow comparison of flow to allocated water. Priority for this analysis should be given to subbasins where low flows have been identified as a limiting factor for fish or where in-stream flows are difficult to meet [p. 4-2].

Estimates of undepleted flow may require additional investigation into the influence of upstream dams on stream flow records, and documentation of the amount of upstream diversions [p. 4-2].
- Re-examine in-stream flow targets, especially where it appears that targets are not met by naturally existing stream flows [p. 4-2].
- Perform more detailed investigation of hydrologic changes resulting from land use changes. This investigation should assess changes in land use and watershed conditions over the length of the gage records as well as against historical (pre-gage) conditions [p. 4-3].

WATER RIGHTS/WATER USE

The following work is recommended to provide a thorough set of information on water rights and water use in the basin:

- Investigate options for augmenting stream flows. For example, where agricultural uses are on the decline, some rights may be relinquished or conservation techniques may be implemented to save water. In subbasins with storage rights or a reservoir, opportunity may exist to augment low flows downstream of the storage location [p. 4-3].
- Develop comparison graphs of allocated water (both out-of-stream demands and in-stream demands) versus “natural” stream flow to assist in prioritizing future efforts. Determine the potential for flow enhancement by comparing consumptive allocated amounts to monthly exceedance flow values for subbasins where this has not already been done [p. 4-3].
- Refine estimates of actual water use versus water rights. Priority for this analysis should be given to the largest individual rights or those that together represent 90 percent of the allocated water. Determine the status of the rights that may not have been developed [p. 4-4].
- Obtain service area boundaries for public water systems and plot them to determine the subbasin locations of place of use. Obtain actual use records, if available [p. 4-4].
- Determine the actual irrigated area in each WRIA and in each subbasin by engaging the Chehalis Basin Partnership to assist in developing communication with the farm community. This may require an intensive field and aerial photo survey [p. 4-4].
- Investigate the status of larger rights to understand the actual and consumptive use of the water withdrawn [p. 4-4].
- Conduct additional mapping of water rights for subbasins with larger allocations (e.g., the Newaukum River subbasins) [p. 4-4].
- Give priority for analysis of water rights to subbasins undergoing rapid development that also have high agricultural use. This analysis should include quantifying actual water use in agricultural areas and quantifying exempt well use [p. 4-4].
- Update and revise the data base for the Washington State Department of Ecology’s Water Rights Accounting and Tracking System (WRATS) [p. 4-4].

WATER QUALITY

The following work is recommended to provide a thorough set of information on water quality in the basin:

- Enhance monitoring of water quality in areas where data does not exist or water quality is degraded (e.g., the South Bay tributaries, the Wynoochee River, and the Wishkah River) [p. 4-5].

- Rank subbasins for priority evaluation based on the level of water quality impairment and the relationship with other technical issues [p. 4-5].
- Develop a pollutant yield analysis for priority subbasins based on detailed hydrologic assessments. This analysis should be used to identify major pollution sources and prioritize improvement actions [p. 4-5].
- Examine recommendations from the Grays Harbor bacteria TMDL for fecal coliform load reduction against other watershed priorities for rivers that already have low concentrations [p. 4-5].
- Prioritize water quality improvement actions and accompany them with verification monitoring to assess their effectiveness [p.4-5].
- Establish long-term water quality monitoring stations in one or two places likely to represent a baseline condition that can be used for comparisons [p. 4-5].

FISH HABITAT

The following work is recommended to provide a thorough set of information on fish habitat in the basin:

- Assess current habitat conditions, problems and opportunities for the South Bay tributary streams, and the Wishkah and Hoquiam Rivers [p. 4-6].
- Assess formerly connected side channels, wetlands, and sloughs in the Chehalis River valley upstream of the existing survey to identify additional restoration opportunities, such as reconnection of wetlands or channels, as well as other habitat improvements. One area for consideration is the reach between Satsop and Doty [p. 4-6].