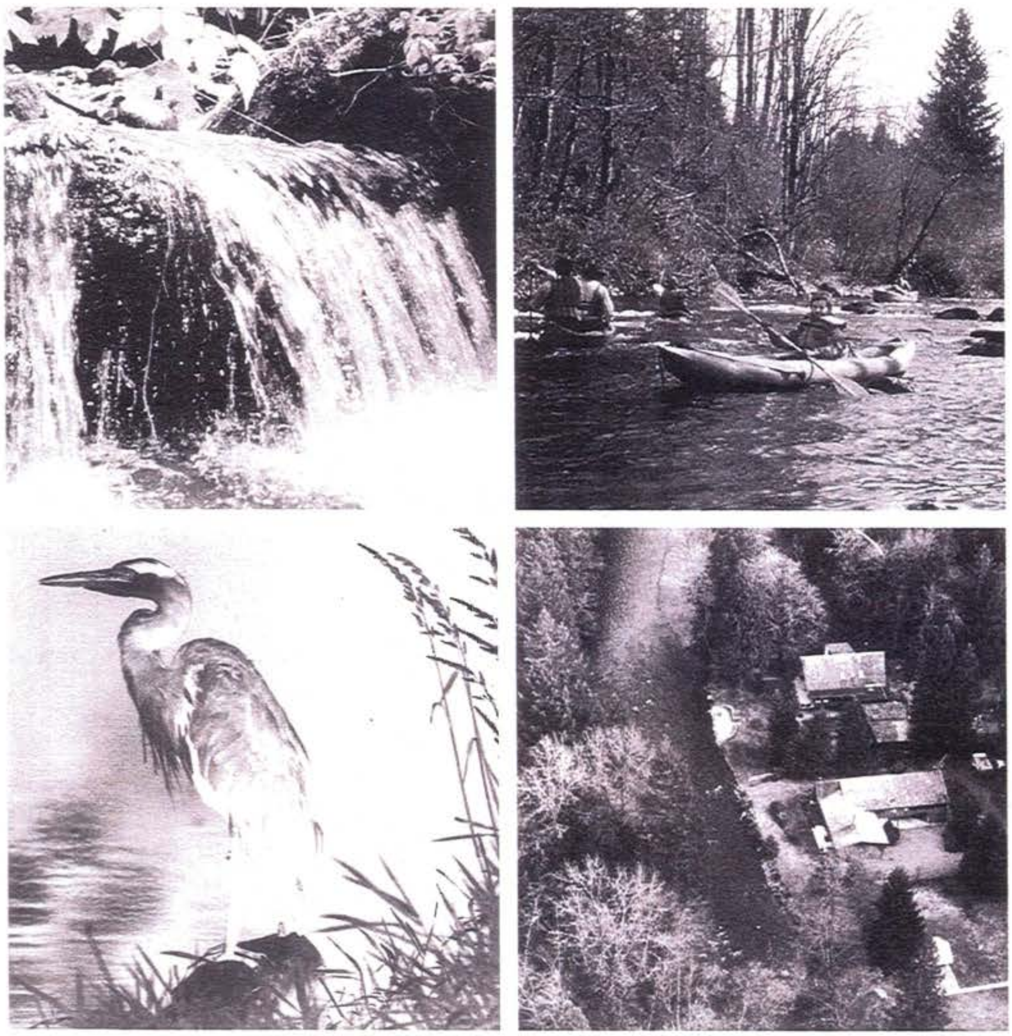
Watershed Management Committee

Lower Cedar River Basin and Nonpoint Pollution Action Plan



King County Department of Natural Resources

Washington State Department of Ecology

Watershed Management Committee

Lower Cedar River Basin and

Nonpoint Pollution Action Plan

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King County Department of Natural Resources
Water and Land Resources Division
700 Fifth Avenue
Suite 2200
Seattle, Washington 98104
(206) 296-6519

Cedar River Watershed Management Committee
City of Renton
King Conservation District
King County
Muckleshoot Indian Tribe
Seattle Public Utilities Department
Trout Unlimited
United States Army Corps of Engineers
Washington Department of Fish and Wildlife
Washington Department of Natural Resources
Washington Department of Transportation
Washington Farm Forestry Association

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Gary Locke

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Department of Natural Resources
Pam Bissonnette, Director

Water and Land Resources Division
Nancy Hansen, Division Manager
Debbie Arima, Assistant Division Manager
Bill Eckel, Regional Water Resources Services Manager

Contributing Staff
Keith Hinman, Basin Planning Program Manager
Roz Glasser, Project Manager
Jean White, Project Manager
John Adams, Planner
Derek Booth, Ph.D., Geologist
Glenn Evans, P.E., Senior Engineer
David Hartley, P.E., Ph.D., Hydrologist
Gino Lucchetti, Senior Ecologist
Kate Rhoads, Senior Water Quality Specialist
Ruth Schaefer, Senior Ecologist

Supporting Staff
Fred Bentler, Planning Support Technician
Anne Biklé, Basin Steward
Rika Cecil, Resource Planner
Karen Goto, P.E., Senior Engineer
Mary Jorgensen, Resource Planner
Ted Krause, Planning Support Technician
Mark Lampard, P.E., Engineer
Barbara Nelson, Technical Writer
Laurel Preston, Graphic Technician
Bill Priest, Ecological Technician
David Rigley, Engineer
Fran Solomon, Ph.D., Senior Engineer
Ruoxi Zhang, Planning Graphic Supervisor

Washington Department of Ecology
Bob Duffy, Environmental Planner
Kitty Gillespie, Project Manager

Watershed Management Committee
David Beedle and Leslie Groce - Muckleshoot Indian Tribe
Paul Crane -- Boeing Company
Nancy Davidson, P.E. - Seattle Public Utilities
Jack Davis - King Conservation District
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Kay Johnson - Renton Chamber of Commerce (retired), Cedar River CAC
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Bob Karinen
Laure Iddings
Ed Matthews
Paul Szewczykowski

Technical Advisors
Carolyn Boatsman - City of Renton
Mike Bonoff, Rand Little, and George Schneider - Seattle Public Utilities Department
Larry Fisher and Hal Michael - Washington Department of Fish and Wildlife
Johnathan Frodge, Ph.D. - King County Department of Natural Resources, Wastewater Treatment Division
Dan Harvey, P.E. - US Army Corps of Engineers
David Jennings, P.E. - City of Renton
Greg Zentner - Muckleshoot Indian Tribe

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Executive Summary

The Cedar River Basin and Nonpoint Pollution Action Plan describes the condition of the basin and proposes solutions to the problems of flooding and declining salmon and steelhead runs. It also recommends preventive measures to protect water quality, groundwater supplies, and habitat as the basin planning area continues to develop. Preventing problems in the watershed will be much more cost-effective over time than trying to correct problems once they occur.

The recommendations in the Cedar River Basin Plan have been prioritized into a *Core Plan* consisting of capital projects and ongoing administration of programs that would, at a minimum, accomplish the Plan's most important goals. This *Core Plan* would:

- Resolve the threat of hazardous flooding for approximately 90 percent of the 130 homes currently at greatest risk;
- Protect the most valuable remaining aquatic habitat sites in the basin planning area, restore those with the best chance for recovery, and help ensure long-term productivity of Lake Washington salmon and steelhead; and
- Maintain the Cedar River's high water quality.

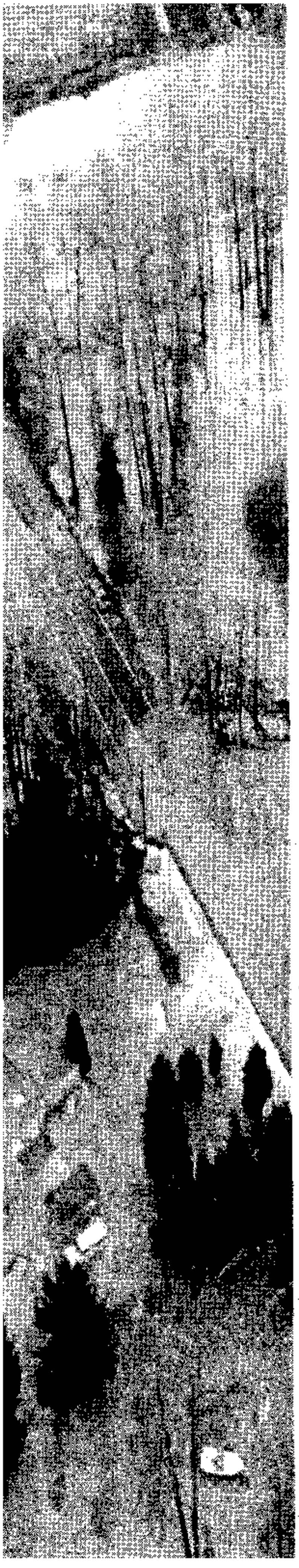
The Cedar River Basin Plan offers a unique opportunity and challenge to meet the needs of urban and rural residents living in the Cedar River basin, and to provide for reduced flood damages and long-term, self-sustaining fish runs.

The Cedar River Basin Plan combines a traditional King County Basin Plan, jointly funded by King County and the City of Renton, with a Nonpoint Source Pollution Action Plan funded by the Washington Department of Ecology and called for by the Puget Sound Water Quality Management Plan. The Basin Plan was prepared under the policy direction of the Cedar River Watershed Management Committee, composed of representatives of local and state government agencies, the Muckleshoot Indian Tribe, and non-governmental organizations. A Citizens Advisory Committee, made up of area residents, also contributed to the development of the Plan. King County's Water and Land Resources Division (formerly Surface Water Management Division) acted as lead in plan preparation.

THE BASIN PLANNING AREA

The Cedar River is one of five major rivers in King County and is the largest tributary to Lake Washington. The river drains an elongated basin of 188 square miles that extends westward from the crest of the Cascades to the southern shore of Lake Washington in the City of Renton. The upper basin, which is almost exclusively owned by the City of Seattle, supplies drinking water for two-thirds of the City of Seattle and its regional customers. It is an unpopulated mountainous area protected from land use change and managed for long-term forestry and wildlife habitat.

The Cedar River Basin Plan focuses on the lower third of the basin where floods and erosion directly impact people and property, and where ongoing development threatens aquatic habitat and the quality and quantity of ground and surface waters. The basin planning area extends from the Landsburg Dam to the river mouth in Renton, a 66-square mile area encompassing both the northern and southern plateaus and the mainstem valley. The lower basin has an extensive surface water system that includes 15 named tributaries, many high-value wetlands, lakes, and the Cedar River itself.



Chapter 1

Introduction

The Major Conditions in the Cedar River Basin

The Major Plan Recommendations

The Basin Planning Area

About the Plan Itself

Chapter 1: An Introduction to the Cedar River Basin and Nonpoint Pollution Action Plan

The Major Conditions in the Cedar River Basin

The Cedar River is one of five major rivers in King County and is the largest tributary to Lake Washington. In many ways, the Cedar River basin is a microcosm of the county's landscape; however, the basin has distinctly different upper and lower areas (see Figure 1-1). The 122-square-mile upper basin lies within Seattle's Cedar River Watershed. It is unpopulated, forested, mountainous land, exclusively owned by the City and protected from land development. In contrast, the 66-square-mile lower basin includes a broad array of natural resources and a spectrum of land uses ranging from the Renton urban center near the mouth of the river, to adjacent suburbanizing areas, to the rural and forest zones abutting the Seattle Watershed. It is within this lower area that the strains of land development pose an ever-growing threat to the lives and property of people who live in the basin and to many of those resources. Consequently, a watershed-wide planning effort that began in 1992 focused on this lower, basin planning area, in an effort to protect private and public property and valuable aquatic resources and to improve on what otherwise might be an unacceptably degraded future for this area.

Analysis of the water resources of the basin, which is documented in the *Cedar River Current and Future Conditions Report*, showed that, among the many significant conditions, three are particularly critical in the Cedar River basin:

1. Serious flooding in the lower Cedar River threatens human lives and takes a substantial toll on homes and businesses. During major storms, residents in more than 100 homes at 12 different areas on the Cedar River are subject to life-threatening flood flows, evacuation routes from many other homes are made impassable, and commercial losses in downtown Renton are substantial. Damage estimates from the last such flood, in 1990, exceeded $11 million. Even during smaller, 10- to 25-year storms, more than 150 homes are subject to serious damage in the lower reaches, despite many miles of levees and revetments constructed during the past 40 years in an attempt to control flooding and erosion.

2. The Cedar River and its tributaries contain much of the best remaining aquatic habitat in the Lake Washington system, although over half of the historic habitat suitable for fish propagation and rearing has been lost or degraded. While most of the habitat alteration occurred prior to 1988, when the largest historic run of sockeye salmon to Lake Washington occurred, ongoing development below Landsburg Dam continues to threaten many high-quality habitats.

In recent years, natural runs of Lake Washington sockeye, coho, and chinook salmon and steelhead trout have declined precipitously. The decline in sockeye since the late 1980s is of particular concern to state and tribal fish managers because of sockeyes' high per fish economic value and because of strong public support for their restoration. The reasons for these declines are not fully understood, but recent studies have focused on poor survival of sockeye in Lake Washington and predation of steelhead by sea lions. Other factors that may contribute to the general decline of all species of salmon include potential passage problems out of Lake Washington, adverse ocean conditions, overharvest in mixed stock fisheries, and widespread degradation of spawning and rearing habitats. Reduced populations and a high degree of uncertainty over causes have led to the filing of petitions requesting that coho salmon and steelhead trout be protected under the federal Endangered Species Act.

This complex set of factors has delayed the construction of large-scale permanent artificial production facilities (e.g., a spawning channel or hatchery) intended to increase sockeye salmon and to resolve needs for mitigation of habitat loss due to the construction of the Seattle Water Department's (SWD) Landsburg Dam in 1901. In the interim, a temporary hatchery was constructed in 1991 at Landsburg and an assessment of limiting factors in Lake Washington (the Lake Washington Ecological Studies) has been initiated. Regardless of the cause of their decline or future fish management actions, recovery and protection of Lake Washington's salmon and steelhead stocks is a high priority and will rely heavily on the protection and restoration of Cedar River habitats.

3. The Cedar River basin is the primary clean water supply for Lake Washington and is a regional source of potable surface and groundwater. However, future development in the basin places this regional resource at increasingly greater risk. The Cedar River basin is the largest and cleanest source of water to Lake Washington, contributing about 50% of the lake's total inflow. Nutrient concentrations, in particular, are currently low in the Cedar River. Virtually all other tributaries to Lake Washington are already heavily urbanized and carry high nutrient concentrations to the lake. As with the other lakes in the Cedar River basin and elsewhere in King County, Lake Washington acts as a sink for pollutants. Therefore, when now-forested areas of the basin are developed, the newly exposed soil, excessive fertilization, and human and animal wastes are forecast to elevate nutrient loading dramatically. For this reason, Lake Washington's future may well hinge on the Cedar River flows remaining clean.

Future development in the lower basin may affect the quality and quantity of groundwater available for water supply. As development increases, pollutants are increased and can contaminate the quality of groundwater. In addition, increases in impervious surface reduce the quantity of recharge. Groundwater quality and quantity are of great importance to the basin residents and nonresidents who drink the water supplied by the City of Renton, City of Kent, small private water purveyors, and individual wells.

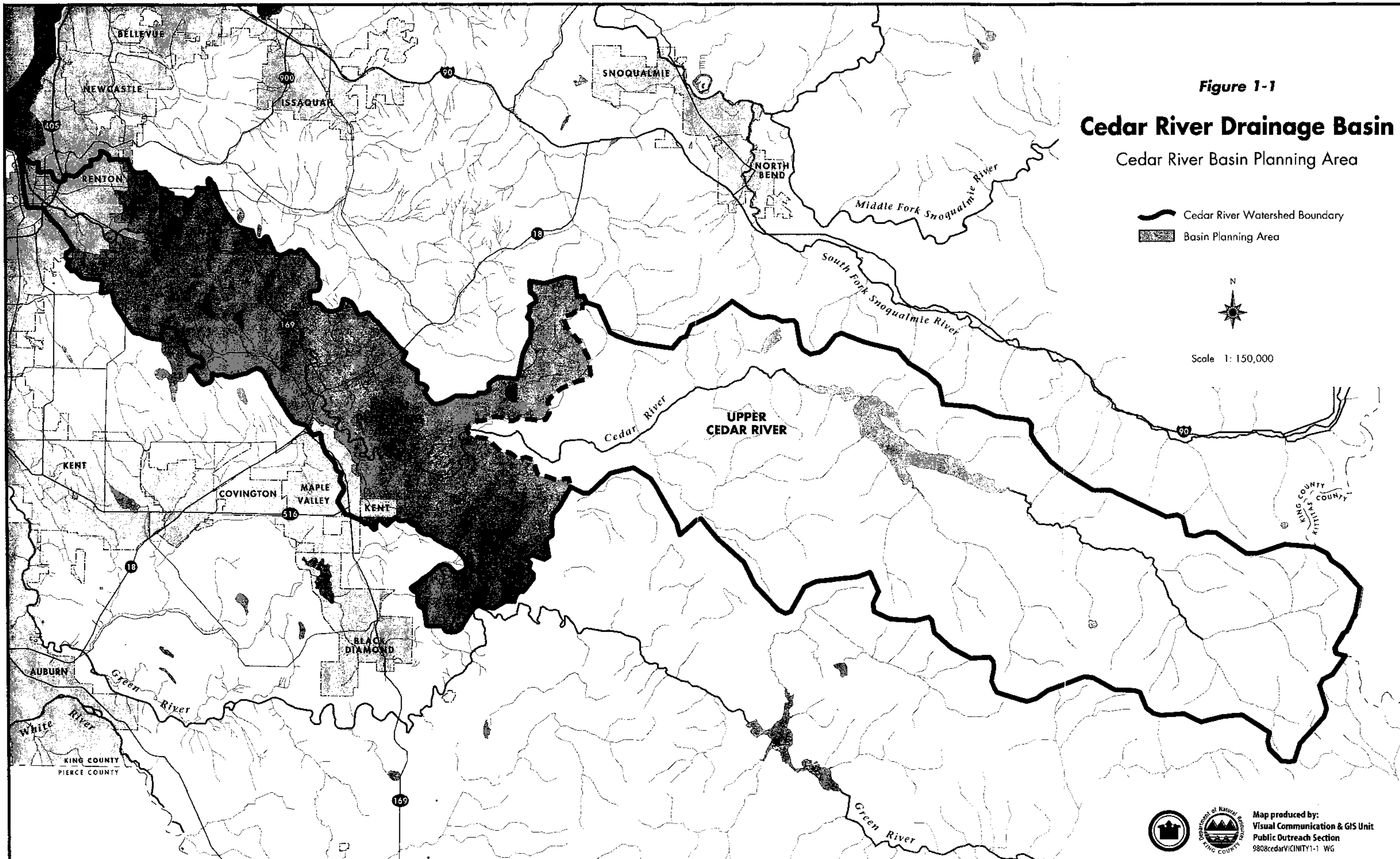


Figure 1-1
Cedar River Drainage Basin
Cedar River Basin Planning Area
Cedar River Watershed Boundary
Basin Planning Area
N
Scale 1: 150,000
BELLEVUE
NEWCASTLE
ISSAQUAH
SNOQUALMIE
NORTH BEND
RENTON
KENT
COVINGTON
MAPLE VALLEY
KENT
BLACK DIAMOND
AUBURN
UPPER CEDAR RIVER
Cedar River
Middle Fork Snoqualmie River
South Fork Snoqualmie River
Green River
White River
Green River
KING COUNTY
PIERCE COUNTY
KING COUNTY
KITTITAS COUNTY
90
900
405
18
169
516
169
Map produced by:
Visual Communication & GIS Unit
Public Outreach Section
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The Major Plan Recommendations

Solutions have been guided by the overriding principle that the Cedar River system should be protected and restored because this is the most cost-effective way to ensure human safety and protect private property and public resources. This approach is pivotal to reducing or eliminating the need for costly new stormwater facilities and additional habitat restoration projects. These measures would surely be required if erosion and flooding worsen, salmon populations decline further, or water quality in the Cedar River or Lake Washington decline. The following major recommendations should ensure a lasting legacy for future generations in the region:

1. REDUCE FLOOD DAMAGE: Eliminate the risk that flooding poses to human lives and reduce the economic and property damage from flooding. The Plan gives preference to flood-hazard *avoidance* over flood *control*, as the means to reduce this risk. The recommended program emphasizes restoration of the floodplain coupled with selected capital projects. The Plan would:

- Selectively remove structures from the most hazardous places in the floodplain;
- Coordinate efforts among local jurisdictions, agencies, tribes, and interest groups to alleviate flooding in the lowermost mile of the Cedar River through Renton;
- Modify or remove levees and revetments to restore natural flood storage and aquatic habitat; and
- Implement a study in cooperation with SWD, the City of Renton, and other affected parties to assess alternative Masonry Dam flood-season operating scenarios and develop flood-season operating guidelines that enhance flood control, improve water supplies, and protect aquatic habitat.

With one exception (Maplewood Levee at river mile 3.6—capital improvement project 3112), new flood-control works are not advocated because of their prohibitive cost, regulatory and permitting difficulties, and ecological consequences.

Although the recommended program may be considered expensive by some, it is believed to be the most appropriate long-term approach, both economically and environmentally, to protect floodplain residents, and maintain and restore the river's valuable aquatic resources.

2. PROTECT AND RESTORE AQUATIC HABITAT: Protect and restore natural salmon runs and other aquatic resources, where feasible, by protecting existing high-quality habitat and restoring degraded habitats. Although current regulations strive to protect streams and wetlands from the direct impacts of new development, substantial habitat degradation has already occurred. New regulations cannot undo past damage, and are only partly effective for mitigating the effects of new development because even well-designed development can have unavoidable adverse consequences. Therefore, the Cedar River Basin Plan (the Plan) also recommends coordinated, long-term measures consistent with state and tribal fish production goals to prevent further degradation and increase the health of aquatic habitat. These measures would:

- Acquire areas with existing or potentially exceptional habitat value;

- Restore habitat through both small- and large-scale projects (including a number of projects that combine resource enhancement with flood-damage reduction) and by coordinating efforts of agencies and volunteers;
- Enhance stormwater control measures; and
- Provide incentives for landowners to protect undeveloped areas, retain forest cover, and restore degraded sites.

The above actions should be undertaken in the near term. However, because aquatic habitat preservation and restoration are necessary to protect the federally guaranteed tribal treaty rights and meet the desire of public agencies, citizen groups, and tribal governments to restore anadromous fish runs to harvestable levels, it is also recommended that production goals be developed for all species in concert. Although it is recognized that the setting of these goals is the responsibility of Washington Department of Fish and Wildlife (WDFW) and the Muckleshoot Indian Tribe (MIT), they should be developed through a public process led by the WDFW in concert with MIT and other affected tribes, the National Marine Fisheries Service, U.S. Fish and Wildlife Service, and all other interested parties including local governments and conservation groups. One possible vehicle for this is the Washington Department of Fish and Wildlife's Integrated Landscape Management Planning process.

Regardless of the method, the process must take several things into account: the results of the Lake Washington Ecological studies; wild salmonid policies and survival needs; ecosystem health concerns; pertinent fish, water, and land-use management policies; and related studies and actions such as habitat conservation planning and establishment of minimum instream flows for the Cedar River by SWD and the U.S. Fish and Wildlife Service, WDFW, MIT, and DOE. Because the ongoing Lake Washington ecological studies are expected to continue until at least 1998, Integrated Landscape Management Planning, or a similar process, may not be initiated until at least that time. At the time of publication of this plan, new minimum instream flows for the river were being considered. Any changes will occur after this plan is drafted, and will have to ensure the habitat, flooding, and water quality goals and objectives of the plan are being met. Depending on interim results of the Lake Washington studies, additional efforts could be implemented to improve salmonid survival prior to 1998. Meanwhile, a limited number of habitat restoration projects could be constructed in a manner consistent with production goals of fish managers and evaluated for fish use in order to assess their effectiveness.

The Water and Land Resources (WLRD) Division has begun to implement the Plan's habitat protection and acquisition recommendations through the Cedar Basin Legacy Program. The Legacy was initiated by the Metropolitan King County Council and the Executive in 1994 to support the Lake Washington study, increase stewardship and public involvement, and to implement emergency habitat protection and restoration measures.

3. MAINTAIN WATER QUALITY: Maintain current water quality in the Cedar River basin by requiring appropriate treatment from new development and reducing pollutants from existing sources. Widespread, individual activities (nonpoint pollution sources) are the cause of most of the water quality problems in the Cedar River basin below the Landsburg Dam. Overfertilized lawns and gardens, malfunctioning septic systems, poor animal-keeping practices, soil erosion, and automobile use throughout the basin all contribute to degradation. Inevitable increases of pollutant loadings cannot be completely mitigated by best management practices (BMPs), which may be either source controls that prevent pollutants from entering waters or treatments to remove water pollutants. Therefore, efforts to modify existing facilities and practices on currently developed land will be necessary to maintain current water quality. Future nutrient loads from the Cedar River, in particular, pose a threat to Lake Washington. The Plan includes three primary approaches to address this complex issue:

- Enhanced stormwater control measures for new development and retrofitting of existing facilities to reduce erosion and flushing of pollutants;
- Specific actions to reduce the most significant existing sources of pollution (increased maintenance of septic tanks, animal waste management, and reduction of pollutants from streets and heavily used transportation corridors); and
- A variety of other efforts, including public education, clean-ups, enhanced enforcement of water quality regulations, and evaluation of progress, to achieve incremental improvement of existing water quality from the wide variety of likely sources.

4. PROTECT AQUIFERS USED FOR DRINKING WATER: Protect basin aquifers to ensure the availability of abundant and clean drinking water and stream base flows through measures that maintain and enhance groundwater recharge and protect water quality. Aquifers critical for drinking water supplies are dependent upon maintenance of adequate quantities of groundwater as well as excellent water quality. Many recommendations in the plan that provide flood control, protect aquatic habitat, and maintain water quality will also protect aquifers because they:

- Prevent loss of groundwater recharge;
- Prevent contamination of aquifers used for drinking water supply; and
- Establish an interagency mechanism to implement, assess, and improve wellhead protection measures and other actions that protect basin groundwater resources.

5. WATERSHED MANAGEMENT: Establish a watershed management program to implement this Plan. With over 150 recommendations and an estimated cost of approximately $60 million, the Cedar River Basin and Nonpoint Pollution Action Plan is a very ambitious effort. Achieving the intended purposes of the recommended actions will require a concentrated and coordinated effort by the basin community and may take several decades. For this reason, the watershed management program includes the following elements, which are described more fully in Chapter 5:

- Encourage a basinwide stewardship ethic to complement and sustain public investments in the recommended capital projects;
- Improve coordination and involvement among agencies, landowners, businesses, and community-action and environmental groups;

- Concentrate funding and implementation efforts on a "Core Plan" of the most necessary and cost-effective recommendations that address the basin's significant flooding, habitat, and water quality problems and aquifer protection needs;
- Find outside funding to supplement local resources and accelerate implementation; and
- Regularly evaluate progress toward achieving the Plan objectives.

This would be achieved by first establishing a *Cedar River Council*, which would represent interests of the public agencies, private groups, and federally recognized tribes. The Council's primary role would be to help implement the Basin Plan through creative partnerships among these groups. Second, a Council Coordinator would be hired to support the Council's work. Third, a Basin Steward would be hired to promote a stewardship ethic in the basin community and prepare annual progress reports to help guide future management efforts.

By approving the Cedar Legacy Project in 1994 to initiate habitat restoration and protection projects in the basin, the Metropolitan King County Council also recognized the value of a Cedar River Council and a Basin Steward. Hence, these two elements are also prominent parts of the Legacy program.

The Basin Planning Area

The Cedar River flows out of the foothills of the Cascade Range and discharges into the southern end of Lake Washington. The river drains an area of 188 square miles, but the 122-square-mile upper basin lies within the City of Seattle Cedar River Watershed. The City's management of the upper basin, including land-use controls, dam operations, and water diversions, are a significant determinant of lower, mainstem water quality, peak flow, base flow, and aquatic habitat conditions as documented in the Cedar River *Current and Future Conditions Report*. (King County, 1993) However, with the exception of Masonry Dam flood season operations, issues of upper basin management are beyond the scope of this plan. They are being addressed by other plans and ongoing processes such as Seattle's Comprehensive Regional Water Supply Plan, and Habitat Conservation Plan, and DOE's Instream Resource Protection Program. The outcome of these plans and processes may impact the lower basin, and thus affect the implementation priorities of the Plan.

This plan addresses the lower, 66 square-mile basin planning area that includes the lower Cedar River and its tributaries, from the Seattle Watershed boundary to the basin outlet at Lake Washington in the City of Renton, 21 river miles downstream (see Figure 1-1). The 1990 census showed a population of 55,400 in the basin planning area, but by the year 2010 this is expected to jump to 93,000, a 68-percent increase.

The valley through which the Cedar River flows was created by the erosive force of the river itself. Near the close of the last glacial era, the elevation of the entire area was about the same as the plateaus, but the river eroded a channel for itself that has expanded into the valley we see today. Prior to flood control and water diversions, the river naturally migrated across the valley floor, eroding the valley sidewalls first on one side and then the other. This is a very slow process that we cannot see easily in any limited number of years of observation. However, aerial photographs reveal obvious abandoned channels that ribbon the entire valley floor. These abandoned channels form the basis of existing aquatic habitat and offer many sites that may be restored.

Looking at these abandoned channels and more recent evidence of inundation in the immediate floodplain, we can see that many structures have been placed in what has been, and what could again be, the path of floodwaters. Along much of the Cedar River, the natural process of migration and floodplain formation has been subdued in the short term by artificial means such as levees and revetments. Several locations along the Cedar River have been damaged by flooding due either to structural failure of levees or to overtopping by flows in excess of design conditions. These locations include the areas behind the Rainbow Bend, Cedar Mountain, Byers Bend, MacDonald, Cedar Grove, Jan Road, Rhode, and Dorre Don levees. In addition, the resulting channel constriction contributes to higher flood stages and increasingly erosive water velocities along the entire Cedar River. As recent flooding in the Mississippi valley demonstrates, there is great danger and high cost in relying on such structures for controlling flood damage. Numerous federal, state, and local flood-control agencies are reconsidering structural techniques for controlling flooding. More reliable management techniques, such as relocating houses and reestablishing the storage and flow-attenuation functions of floodplains, are now recognized with increasing favor nationwide as more cost-effective and environmentally appropriate.

On a smaller scale, similar processes of channel erosion and floodplain formation are occurring in the tributaries to the Cedar River. These tributaries flow out of the gently sloping plateaus, often originating in wetlands, and erode paths down the valley walls. The eroded material is washed down the steep slopes and accumulates within and adjacent to the tributary channel; some is washed all the way into the Cedar River itself. There are three major tributaries, eleven smaller tributaries, and many small channels that only carry water during storms or in the winter months. The planning area contains nine lakes and at least 83 wetlands, most of which are on the poorly drained upland plateaus of the basin. The Cedar River basin is unique in King County for its number of high-quality wetlands.

The Cedar River basin also provides water to three municipal water supplies—the cities of Seattle, Renton, and Kent—and to many small public systems and numerous private wells. Of these, by far the largest is the City of Seattle's protected watershed. The Seattle Public Utilities Department (formerly the Seattle Water Department) sells water to 28 purveyors (cities and water districts), all of which are outside the basin except for one, the Cedar River Water and Sewer District. The City of Kent's water supply within the Rock Creek subarea includes both surface and groundwater sources, and it affects the productivity of this extraordinary stream for salmon and steelhead. The City of Renton depends on a sole-source aquifer that lies largely within urbanizing areas in the lower basin.

The types of land uses in the Cedar River basin vary greatly (Figure 1-2). The areas draining to the Cedar River from the City of Renton are occupied by high-density residential neighborhoods and industry. The plateaus within a few miles of the city are also in high-density uses, with multi- and single family residential neighborhoods and strip malls. This area is within King

County's designated urban growth boundary and is likely to receive increasingly dense future development (Figure 1-3). The remainder of the planning area is fairly rural and is projected to remain in low-intensity land uses. Pockets of higher density, such as the City of Maple Valley, are found in a few scattered locations. Those areas farthest upstream have very little development, and the City of Seattle's watershed, above the Landsburg Diversion Dam, is entirely undeveloped and will remain so.

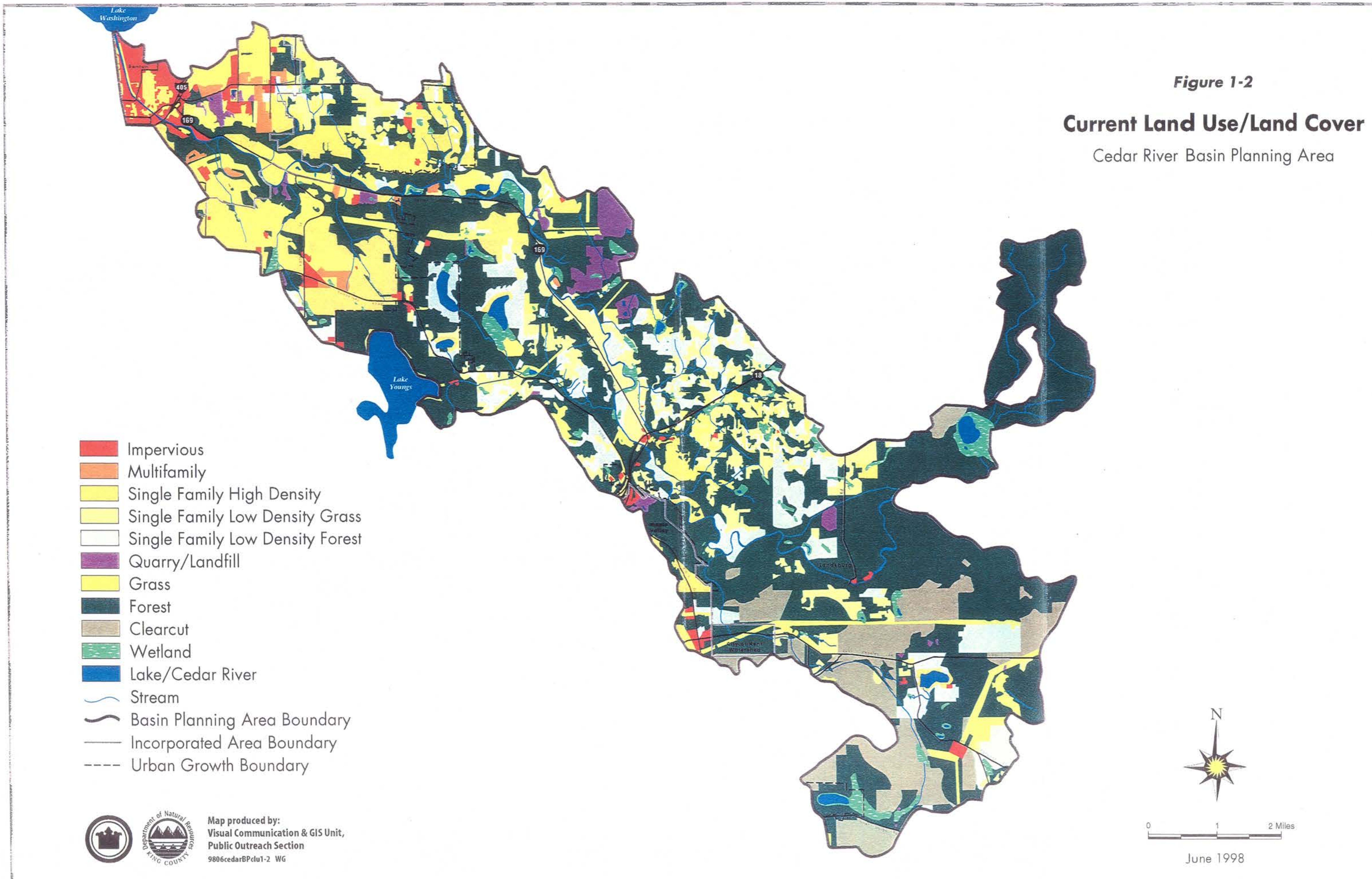

Figure 1-2

Current Land Use/Land Cover

Cedar River Basin Planning Area

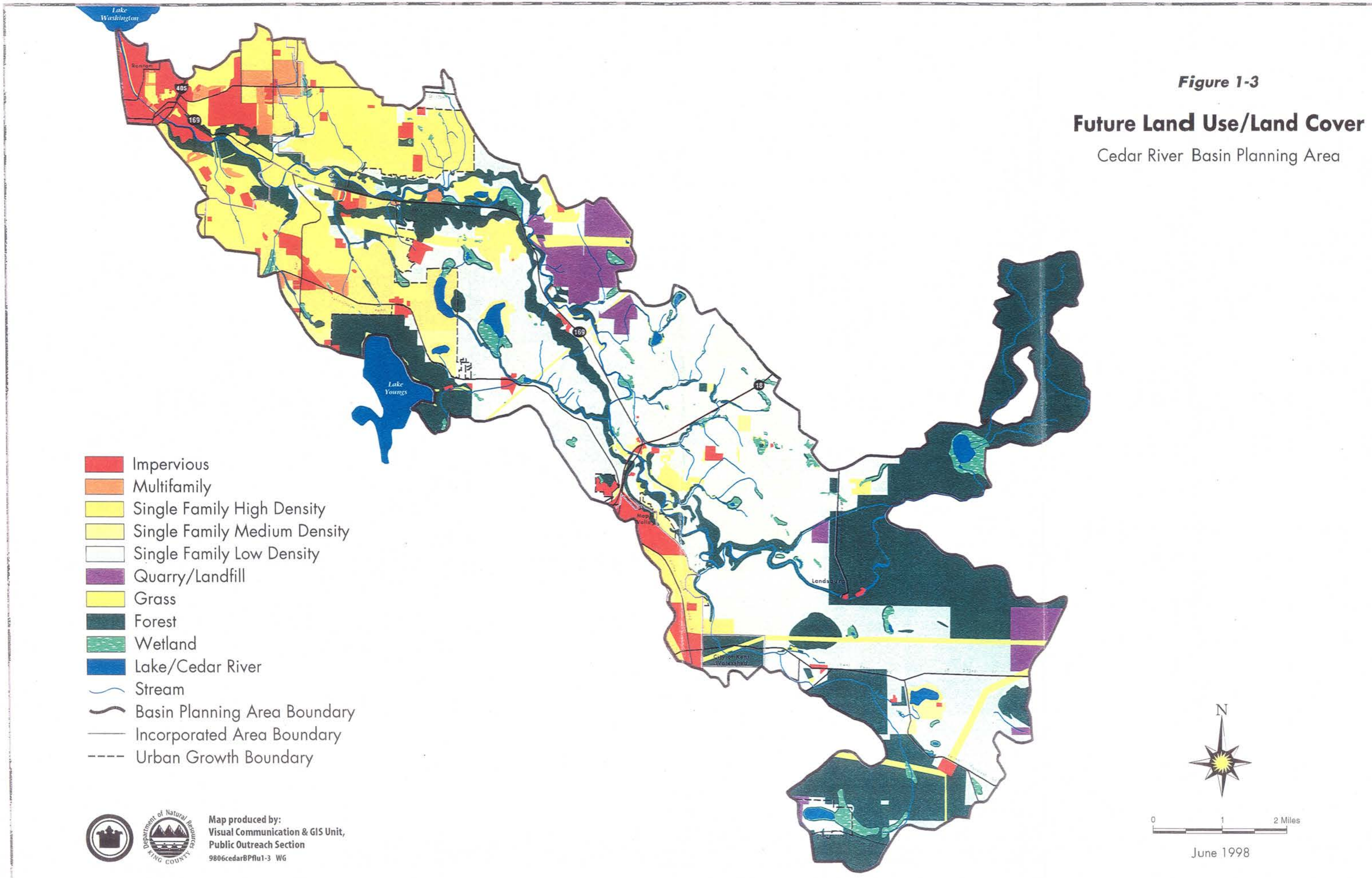

Figure 1-3

Future Land Use/Land Cover

Cedar River Basin Planning Area

About the Plan Itself

This document identifies the basin's surface water problems and, to a limited extent, aquifer protection needs, and it outlines a comprehensive, long-term strategy to address these issues. Recommendations in the Plan fall into two categories: Programmatic and Capital Improvement Projects. Programmatic recommendations cover new initiatives, such as the Cedar River Council and the Basin Steward, and new requirements that would apply to individual development-permit applicants. Capital Improvement Projects range from replacing undersized culverts to relocating inhabited structures most at risk of severe flood damage. The projects are designed to achieve multiple goals wherever possible. The document also proposes priorities for implementing its recommendations.

This Plan combines a "basin plan" and a "nonpoint pollution action plan." Basin plans have been prepared by King County Water and Land Resources for the urbanizing areas of King County over the past seven years; they have traditionally encompassed most of the elements of the watershed management program described above. Nonpoint pollution action plans (Chapter 400-12 WAC) specifically emphasize actions to prevent and remedy pollution from nonpoint sources. This hybrid plan approach is encouraged by state environmental regulation because it results in a more comprehensive, interdisciplinary approach to managing water quality than would generally be possible from either plan alone.

To ensure that the responsible public agencies, tribes, and the residents of the basin agree with the goals and objectives of the recommended management program, two committees were convened to participate. The *Watershed Management Committee* (WMC) is made up of representatives from most agencies with management responsibilities in the planning area (see page ii). This Plan is the product of their efforts, with lead direction from the Basin Planning Unit of King County Water and Land Resources Division. The WMC in turn appointed the members of a *Citizen Advisory Committee* to provide a local perspective on problems and solutions throughout the development of the Plan. The members of this committee represent many interests in the basin, including business, fishing, farming, and environmental concerns.

The Basin Plan's planning and implementation processes comprise the following major tasks:

1. Evaluating current and future basin conditions: WLRD staff conducted this task in 1992 and 1993 which culminated in the publication of the *Cedar River Current and Future Conditions Report*.

2. Defining water resource problems and analyzing possible solutions: WLRD staff developed a range of alternative solutions to address each of the most significant problems identified in the *Current and Future Conditions Report*. The WMC reviewed this analysis and selected its preferred alternatives. These tasks were completed in 1994. In addition, the City of Renton is conducting a hydrogeologic study that will identify critical recharge areas consistent with countywide methodology. This study will produce recommendations for long-term groundwater quantity and quality monitoring.

3. Developing and refining recommendations: The WMC's preferred alternative solutions were further developed by WLRD staff and summarized in the *WMC Draft Basin and*

Nonpoint Pollution Action Plan in February 1995. This Plan and its companion Final Environmental Impact Statement were reviewed by the general public and affected agencies. Their comments were used to refine the Plan's recommendations, culminating the *Watershed Management Committee Proposed Plan* in April 1996.

4. Adopting and implementing the Plan: The Watershed Management Committee Proposed Plan was adopted by the Metropolitan King County Council in July 1997. The cities of Renton and Seattle, the Muckleshoot Tribe, and the Washington Department of Fish and Wildlife concurred with the Plan in early 1998. Plan implementation will take effect as the individual jurisdictions and public agencies adopt changes to their drainage and land-use codes and direct funds, to the extent available, to the recommended projects and programs.

5. Plan Evaluation: Any successful long-term management program requires ongoing support, evaluation, and adjustment. The Basin Steward will track progress in implementing the Basin Plan and will prepare an annual "state of the basin" report for review by the Cedar River Council, the public, and other interested parties.

The programmatic recommendations made in this plan apply specifically to the Cedar River basin planning area, though elements of many could have value elsewhere in the county as well. During Plan preparation, however, a number of additional recommendations were identified that would have application over the county as a whole. Among others, these include 1) giving preference to contractors with certified expertise in sensitive-areas construction when public works contracts for such projects are awarded; 2) simplifying the procedures citizens face when reporting violations of water quality, grading, and other regulations; and 3) relaxing regulatory restrictions on habitat restoration enhancement projects in sensitive areas. WLRD staff will continue to develop these recommendations and will present them to the Metropolitan King County Council in the future.

The plan does not consider the habitat conservation planning (HCP) process of SWD because the HCP's recommendations were not developed at the time of this plan and because the HCP deals primarily with the upper Cedar River basin. The HCP will address to some extent instream flow and habitat restoration issues in the basin planning area, including mainstem areas of the Cedar River. The effect of the HCP on habitat, flooding, water quality, and recreation, especially with respect to minimum instream flows, will have to be assessed separately after the plan is completed. The HCP participants (SWD, U.S. Fish and Wildlife Service, MIT, WDFW, National Marine Fisheries Service, DOE, WLRD) will need to evaluate its effect on the Plan's goals, objectives, and recommendations, and consider downstream river users in addition to fish.

USING THE PLAN

Chapter 2 presents the major goals and recommended approaches of the Plan. Look to this chapter for a bird's-eye view of the most significant elements of the overall Plan.

Chapter 3 summarizes the recommendations that apply to seven specific subareas of the basin planning area. These have been defined as the *Cedar River Mainstem*, which includes the mainstem itself, the land adjacent to the river, and any land on the valley walls and plateaus that is not drained by a major tributary; the *Northern Tributaries*, which are the five northernmost small tributaries closest to Renton; the remaining six small urbanizing subbasins, known as the *Southern Tributaries*; two streams near Maple Valley referred to as the *Middle Tributaries*, and the more rural subbasins of *Peterson Creek, Taylor Creek,* and *Rock Creek.*

Chapter 4 lists and discusses all recommendations, their rationales, and other alternatives that were considered. Use this chapter as a reference section to find greater detail about specific recommendations outlined in the previous two chapters.

Chapter 5 describes the proposed strategy for long-term implementation of the Plan's recommendations. It identifies all programmatic recommendations and capital projects; their cost estimates, funding strategies, and priorities; and the implementation roles of public agencies, MIT, and community groups.

Chapter 2

Goals and Priority Actions

Chapter 2: Goals and Priority Actions

Introduction

OUR VISION FOR THE CEDAR RIVER BASIN

> "Protect, restore, and enhance, where possible, the natural functions of the river and tributary systems in the Cedar River Basin. The intent is to promote human health, public safety, and environmental quality through agency/private partnerships that foster community support and ensure long-term benefits for future generations."
>
> ***The Cedar River Watershed Management Committee***

THE CEDAR RIVER BASIN—A REGIONAL RESOURCE

The Cedar River basin provides clean water, aquatic habitat, recreational opportunity, and valuable commercial and residential areas for over 50,000 basin residents. According to the Seattle Water Department, the upper basin provides fully two-thirds of the water supply for the City of Seattle and its regional customers, which together serve the majority of the residents of King County. This water comes from the City of Seattle's Cedar River Watershed and is diverted from the river at the Landsburg Dam. In addition, water supply in the basin includes the City of Renton sole-source aquifer, City of Kent, and many individual groundwater wells. Below Landsburg in the basin planning area, the Cedar River, wetlands, streams, lakes and their tributary lands continues to supply the lifeblood to a rich aquatic habitat system sustaining relatively diverse and abundant plant and animal life.

Salmon and trout are among the most prominent resources of this system. The most noted species of these fish are sockeye, coho, and chinook salmon, and steelhead and cutthroat trout. The Cedar River also provides habitat for unique populations of pygmy whitefish and bull trout. Pink, chum, and spring chinook salmon stocks are believed to have used the Cedar River prior to its diversion into Lake Washington and construction of the Landsburg Dam. Prior to recent stock declines, this system had been particularly productive of sockeye salmon, supporting the largest run of this species in the contiguous United States.

In addition, the Cedar River basin supplies roughly half of the inflow of water to Lake Washington. The generally high quality and relatively abundant quantity of the river's discharge helped hasten Lake Washington's recovery from accelerated eutrophication after Metro (now King County Wastewater Treatment Division) diverted effluent from the lake in the 1960s. The river continues to be a key determinant of the lake's overall health.

The benefits of the Cedar River basin's water supply and salmonid habitat are more than sufficient to establish the basin as a regionally important asset. However, basin lands also support commercial and industrial uses along the lower reach of the Cedar River in Renton, a smaller commercial area in Maple Valley, and scattered commercial and industrial sites throughout the basin planning area. Basin residents and visitors alike enjoy numerous parks, open spaces, and trails located along the Cedar River and its tributary streams and wetlands. The proximity and access to these natural water courses offer the public a wide variety of recreational opportunities including hiking, wildlife viewing, nature study, fishing, swimming, and boating. These resources represent a bountiful legacy to be enjoyed by current and future generations of this region.

The future of this legacy, however, is not automatically guaranteed. Past land-development practices, future population pressure and its associated demand for water supply, gaps in technical understanding, and perennial competition for scarce water and funding all threaten the long-term viability of the basin's surface-water system. The degradation that has already occurred and the future risks that are most significant tend to cluster into three broad categories: flood hazards, deterioration and loss of aquatic habitat, and degradation of water quality.

The experiences of the November 1990 flood, augmented by additional analysis, have identified over one hundred homes at risk during large floods along the mainstem of the Cedar River. Lesser though still significant flooding problems, such as road flooding and public and private property damage, have also been documented both along the river and within the tributary subareas of the basin planning area. Many of these tributary flooding problems result from increases in storm runoff from areas where land development has converted forest cover to grassed or paved surfaces.

Past land development, including private residential and commercial as well as public works projects, has also degraded aquatic habitat by narrowing and straightening the Cedar River, isolating and de-watering side channels, filling wetlands, channelizing or piping streams, blocking fish passage, and increasing storm flows to erosive levels. The resulting loss of aquatic habitat is a major pressure on the stocks of anadromous salmon, all of which are experiencing precipitous declines in numbers in the Cedar River.

Urbanization has also taken its toll on water quality, especially in the tributary subareas where nonpoint pollutants from sources such as stormwater runoff, malfunctioning septic systems, animal keeping, and eroding soil have degraded many stream reaches and lakes. Loss of base flow, due to decreased groundwater recharge, worsens the problem by concentrating the contaminants. Although these problems have not yet generally been sufficient to impair the beneficial uses of the Cedar River, they threaten the long-term quality of the river and of Lake Washington, which relies on clean water from the Cedar River to maintain the lake's presently good water quality. In addition, the quality of drinking water supply serving the City of Renton is potentially at risk.

Based on past experience with other basins, surface-water and groundwater problems are far more cost-effectively *prevented* before they occur than *solved* after they have occurred. But if problems have already occurred, any successful management effort must first correct those existing problems even as it seeks to avoid future problems. Therefore, the primary goals of the Cedar River Basin Plan (the Plan) are to reduce the existing risk of severe flood damage along the Cedar River mainstem, restore the degraded and lost habitat that once supported the renowned fishery of the Cedar River, and reverse the water quality trends that threaten the historic uses of water in the basin itself and in Lake Washington.

The Plan aims to protect and manage critical water resources of the basin, including rivers, streams, wetlands, lakes, and groundwater. Flood control, the preservation and restoration of aquatic habitat, and protection of water quality, groundwater recharge, and stream base flows must be accomplished within the context of this dynamic and hydraulically continuous system. Human activities in the basin such as removal of natural vegetation, covering with impermeable surfaces, introduction of pollutants, and diversion for water supply affect all components of the water resource system, and cause problems such as flooding, loss of aquatic habitat, declines in water quality and depletion or degradation of aquifers. An integrated approach that addresses the entire watershed is necessary to resolve problems related to water resources.

Appendix A describes the goals and objectives developed by the Watershed Management and Citizens' Advisory committees to resolve problems and ensure the future health of the basin. The remainder of this chapter provides the highlights of this Plan's management strategy—the key actions recommended to achieve the most important goals and objectives.

Flood-Damage Reduction

CONDITIONS

Flooding on the mainstem of the lower Cedar River threatens human lives, damages infrastructure and aquatic habitat, and takes a substantial economic toll on homes and businesses. During major floods, such as the November 1990 event, approximately 430 houses are at some level of significant risk from mainstem flooding; escape routes from many more houses are rendered impassable; and municipal buildings, the Boeing plant, and the airport in Renton are damaged and commercial activity is disrupted. Almost 100 additional houses are protected by levees or revetments that have failed or are at risk of failing during a 100-year flood.[1] Another 200 houses are at risk from significant but less-hazardous flooding.

Traditional attempts to reduce flood *damage* concentrate on flood *control*, typically by confining high flows within the river channel. This approach has led to armoring of more than 60% of the Cedar River's length below Landsburg on at least one bank. Unfortunately, many of these structures have actually increased flood and erosion damage by raising the water surface elevation during floods and increasing flow velocities. They offer landowners an exaggerated sense of safety, which has the effect of encouraging inappropriately intense levels of development in the supposedly "protected" areas. They also create high public maintenance costs and reduce habitat for valuable fish stocks. For example, flood control efforts have contributed to a 56% reduction in mainstem channel area, considerable loss of highly productive off-channel fish habitat, degraded riparian vegetation, and reductions in large pools and large woody debris. These changes result in increases in mainstem water velocities and poor habitat quality, reducing spawning and rearing success of salmonids.

Because flood discharge estimates are statistical probabilities calculated from historical flows, they change over time as new data are incorporated and estimates are refined. The 1990 Thanksgiving Day flood was the largest event recorded on the Cedar River since Masonry Dam was built, and all hydrologic models of the river were revised to reflect it. Various agencies' new estimates of the 100-year event differ from each other for two reasons: 1) estimates of actual flows at given gages may differ due to changes in channel configuration during floods and because there is little opportunity to calibrate gages for accuracy during infrequent, extreme events; and 2) different agencies analyze flows using different assumptions and methods, which may yield differing results even from identical data.

Estimates of the 100-year flood at Renton range from 10,043 cubic-feet-per-second (according to the U.S. Geological Survey) to 12,000 cfs (according to the Army Corps of Engineers). The King County Water and Land Resources Division has estimated the 100-year discharge at Renton to be 11,100 cfs, the value used in this document. In contrast, the estimated discharge used by all

[1] The term "100-year flood" is defined as "the discharge quantity with a 1-percent probability of being equaled or exceeded in a given year." Similarly, a 25-year flood has a 4-percent likelihood and a 5-year flood a 20-percent likelihood in any particular year.

agencies to characterize the November 1990 flood is 10,600 cfs, based on U.S. Geological Survey records. Thus, the November flood may be characterized as between 88% and nearly 106% of the 100-year event. This Plan assumes the November 1990 flood represents approximately 96% of the 100-year flood, or about an 80-year event.

Masonry Dam is the single most important factor influencing Cedar River flows. Flood-peak discharges in the mainstem of the Cedar River are only slightly affected by flows from tributaries within the basin planning area. This is partly due to the small size of the planning area compared to the total area of the Cedar River basin. In addition, differing rainfall and runoff patterns, including rain-on-snow events, generate more runoff per acre from land in the upper portion of the basin than from the planning area. Most significantly, long before peak flows from the upper areas reach Renton, peak flows from tributaries in the planning area have typically passed through into Lake Washington. For this reason, land-use changes in the basin planning area have little effect on mainstem flooding, especially compared to the effects of Masonry Dam operations.

Although operated primarily for water supply rather than flood control, Seattle Water Department's Masonry Dam does provide considerable reduction of flood peaks. The Cedar River's 100-year flood discharge is estimated to be approximately 18,000 cfs without the dam, compared to 11,100 cfs under current conditions. The current operating rule curve for Masonry Dam creates a "flood pocket" of storage during the rainy season that further reduces peak flood flows. Recently, new computer models utilized in combination with snow-pack measurements and weather forecasts have improved the City's potential to avoid floods and secure adequate water supplies.

In contrast to the mainstem, most of the flooding problems identified in the upland tributaries stem from the inundation of roads rather than from damage to occupied structures. Although access to nearly 100 houses is blocked by road flooding in tributary subareas, only 12 houses are subject to flooding and none are exposed to dangerously deep or swift flows.

The source and character of floodwater is another difference between the mainstem and tributary subareas. Most of the water in the mainstem comes from Seattle's Cedar River Watershed. Mainstem flows are therefore determined almost exclusively by rainfall and snowmelt in the watershed and by the City's operation of Masonry Dam, and they are only minimally influenced by land use in the basin planning area. Any future increases in flood damage along the mainstem will be determined largely by whether additional development is permitted in areas already recognized as flood-prone.

In contrast, drainage problems in tributary subareas are directly related to land use—as pastures, lawns, buildings, and pavement increase, the moderating effect provided by the forest they replace is lost. These changes result in higher peak streamflows and longer peak flow durations, which cause increased flooding and erosion damage and degrade salmonid habitat. At the same time, because of decreased storage of storm runoff as groundwater, summer low flows essential to aquatic habitat are reduced.

Projected conditions in tributaries vary by subarea, but substantial increases in flood magnitudes are expected if Plan recommendations are not implemented. Increases would be most dramatic in the eastern, more resource-rich subareas of Peterson, Rock, and Taylor creeks where smaller-scale residential developments are typically not required to provide runoff controls under current County regulations. Additionally, because the current county-wide retention/detention (R/D) base standards do not prevent all stream erosion, urban tributaries with channel stability problems such as Maplewood, Madsen, and Orting Hill creeks would experience significant additional erosion damage and downstream sedimentation problems.

GOALS AND STRATEGIES TO REDUCE FLOOD DAMAGE

In November 1993, the King County Council adopted the *Flood Hazard Reduction Plan* (FHRP), which analyzed flooding problems and potential solutions along the six major rivers in King County, including the Cedar River. The FHRP includes policies to guide floodplain land-use and flood-control activities in the county, and recommends a large number of capital improvement, maintenance, and other flood-damage reduction projects. Its major goals were to 1) reduce flood-related hazards and damages; 2) reduce environmental impacts from controlling floods; and 3) reduce the long-term costs of flood-damage reduction and floodplain management. The goals, policies, and recommendations for the Cedar River floodplain found in the FHRP are the foundation of the flood-damage reduction portion of the Cedar River Basin Plan.

The principal flood-damage reduction goals of this Plan are to eliminate the risk that flooding poses to human lives and to reduce economic and property damage from flooding. Owing to the distribution of flood damage in the basin, the primary efforts are directed along the Cedar River mainstem. Because of the significance of the mainstem for other major goals of this Plan, substantial aquatic habitat and water quality elements are included in these flood-related recommendations wherever possible. In areas where human safety is not at risk, multiple-objective recommendations are preferred to single-objective projects.

The Plan recommends flood-hazard avoidance, with reduced emphasis on new flood-control structures, as the primary strategy for reducing future damage and risk. The main strategies are 1) selectively removing structures from the most hazardous places in the floodplain, defined as those areas where flood flows are very deep or swift; 2) modifying or removing levees and revetments to restore natural flood storage and aquatic habitat; and 3) evaluating possible changes to operation of the Masonry Dam during the flood season. With the exception of Maplewood levee at river mile (RM) 3.6, no new flood-control works are proposed because of prohibitive cost, regulatory and permitting difficulty, and ecological consequences. Studies of the Renton Reach, selected areas of the mainstem, and Masonry Dam are intended to result in actions to reduce flood damage in these areas.

Less-hazardous mainstem flooding problems will be addressed by programs that provide technical, educational, and limited financial assistance to help floodplain residents and responsible agencies reduce flood damage.

Current and future tributary flooding and erosion problems are addressed through a series of capital projects that primarily improve road drainage or raise roads above flood elevations. In addition, the Plan recommends retention and detention (R/D) requirements for new development that would maintain channel stability, protect downstream aquatic resources, and prevent increases in the frequency of tributary flooding.

If all Plan recommendations were implemented, 1) no occupied structures would remain in the most hazardous areas of the floodplain; 2) damage and danger from less-hazardous flooding would be reduced; 3) residents and public safety officials would be better able to prepare for floods and reduce their impacts; 4) projected future increases in flooding and erosion damage in tributary subareas would be substantially reduced, although not entirely eliminated; 5) many areas in the floodplain would have much of their historic functions of floodwater storage, aquatic habitat and groundwater recharge restored; and 6) public cost to maintain flood-control structures would be reduced.

RECOMMENDATIONS TO REDUCE FLOOD DAMAGE

Table 2-1, at the end of this chapter, shows where you can look to find more details about these recommendations.

Mainstem Recommendations

This Plan proposes to eliminate the worst threats to human safety and reduce the worst flood-caused property damage by removing occupied structures from the most hazardous places in the floodplain. It recommends against merely floodproofing houses that are subject to the worst flooding hazards because such an action would encourage residents to continue to inhabit unsafe areas. All identified areas of hazardous flooding are located in the mainstem floodplain.

Removal of structures and purchases of land would not be applied to the most heavily urbanized areas, such as downtown Renton, in recognition of the overriding economic and social impacts that would result. Instead, this Plan supports an ongoing Army Corps of Engineers and the City of Renton study of alternatives to reduce flood damage along the lowest 1.25 miles of the Cedar River within Renton.

County policy, adopted with the *Flood Hazard Reduction Plan*, generally requires that properties proposed for acquisition be acquired on a willing-seller basis. Homeowners will not be penalized by the county for refusal of an offer to purchase his or her property.

Dorre Don: Several houses, a County road, and a County-maintained levee in this neighborhood, located on the right bank of the Cedar River surrounding the railroad bridge at RM 16.4, have been damaged repeatedly by fast, deep floodwaters. This recommendation would purchase and remove the 20 houses in hazardous locations, eliminating the flood threat to these residences. It would also remove the upstream portion of the Lower Dorre Don levee and restore approximately six acres of floodplain to its historic aquatic habitat and floodwater storage functions. In addition, approximately 600 linear feet of Lower Dorre Don Way would be elevated to continue to provide sole access to the remaining eight, less-severely threatened houses.

Rainbow Bend: Approximately 55 mobile homes in the Cedar Grove Mobile Home Park and nine nearby houses on the right bank between RM 10.8 and RM 11.3, below Cedar Grove Road, were damaged by fast, deep flood flows, erosion, and large debris deposits during the November 1990 flood. The houses are subject to hazardous flows when the Rainbow Bend levee overtops;

the mobile home park experiences hazardous flooding during much smaller, more frequent events. This Basin Plan recommendation would purchase and remove all occupied structures from this reach and reestablish this area as functioning floodplain. Because the mobile home park provides affordable housing to low-income families, the Plan follows King County policy in recommending replacement-housing assistance, rather than a simple market-value buyout, to the mobile home residents. One possible strategy is to relocate the mobile home park to the adjacent Stoneway Sand and Gravel site once it has been reclaimed from mining activity.

Elliot Bridge/Lower Jones Road: Below Elliot Bridge (RM 5.4), two left-bank houses were inundated by water over three feet in depth during the November 1990 flood. Upstream, 22 houses between Jones Road and the Cedar River experienced high-velocity flows. Eighteen houses on 156th Place SE are inaccessible when Jones Road floods, at approximately the 2-year event, and 20 additional houses are exposed to less-hazardous flooding during larger floods. This recommendation would purchase and remove the 24 houses in the most hazardous areas and raise approximately 2,300 linear feet of Jones Road to ensure access to 156th Place SE and to reduce flood damage to the less severely threatened houses.

Renton Reach Flood-Damage Reduction Study: A 205 Flood Damage Reduction Study is already underway by the U.S. Army Corps of Engineers and the City of Renton to resolve the severe flooding in the lowermost reach of the Cedar River through downtown Renton, a problem that has progressively worsened through the accumulation of sediment in the channel. Sediment removal is the technique historically used in such areas; other methods under study include constructing levees, widening the channel, elevating bridges to reduce debris accumulation, and flood proofing threatened facilities. The study is being conducted with the involvement of potential permitting agencies, the Muckleshoot Indian Tribe, and other interested groups.

Masonry Dam Study: A cooperative King County/City of Seattle/City of Renton study is needed to analyze the costs and benefits of alternate Masonry Dam operation on water supply, power production, flood control, and fish habitat production.

Other Mainstem Recommendations: Several other capital projects, using a variety of approaches, are recommended where the public benefits clearly outweigh the public cost. Approximately 20 additional houses would be removed from five hazardous locations. Technical and limited financial assistance would be provided to individuals or groups seeking to remove or floodproof less seriously threatened structures within the floodplain. Removing or modifying levees and revetments would lower flood stages enough to reduce hazards in some areas. In others, overbank channels stabilized with bioengineering techniques would also function as side channel habitat for fish and would safely contain and direct overbank flood flows back to the mainstem downstream of the flooded areas, rather than allowing floodwater to spread overland. These methods would also provide additional flood storage volume and reduce excess sediment entering the Cedar River.

Additional programs would seek state and federal funding assistance for flood-damage reduction, provide for flood-damage reduction in high risk areas identified in the future, improve floodplain mapping, and expand existing County flood preparedness and education efforts. A proposed regulation would prohibit development in areas of identified channel migration hazard.

Tributary Recommendations

There are no occupied structures subject to hazardous flooding in the upland tributary subareas, but flood flows prevent the use of arterial and sole-access roads, cause less-hazardous residential damage, and damage valuable aquatic habitat areas. Most of the programmatic tributary flood-reduction recommendations address future rather than current flooding because regulations are more effective in preventing future problems than they are in solving existing problems caused by past development. In addition, three capital projects address the most significant current flooding problems in the tributary subarea.

Forest Incentive Program: Forest retention is an effective way to prevent and reduce flooding and erosion, maintain aquifer levels, preserve base flows, limit fluctuations in lake and wetland levels, maintain water quality, and reduce impacts to aquatic resources. Additionally, native growth and forest retention is highly feasible in rural areas where lots are generally large enough to accommodate both residences and natural, undisturbed vegetation. For this reason, a forest incentive program is recommended to encourage landowners to keep their land in forest.

Stormwater Infiltration: Forest retention (see above) is the preferred method for preserving hydrology and achieving infiltration, but where this is impractical due to high-density zoning, the Plan requires the use of roof downspout systems where soils are appropriate to allow stormwater to infiltrate and recharge local groundwater instead of flowing directly into surface drainage systems. Stormwater infiltration has two primary benefits: 1) reduction in the amount of stormwater released from a developed site and 2) recharge of groundwater and maintenance of stream base flows that benefit aquatic habitat. Peak winter runoff and water quality are also partially controlled by these systems. Although this recommendation is primarily regulatory, it includes educational and public involvement components as well.

Retention/Detention (R/D) Standards: R/D facilities are ponds, tanks, or other stormwater impoundments designed to limit the increases of peak discharges caused by the construction of impervious and landscaped surfaces. Depending on their volume and the design of their outlets, R/D facilities can prevent downstream flooding, reduce stream erosion, limit increases in lake and wetland levels, and improve water quality. Four levels of R/D are recommended as required by specific conditions in each catchment.

Ravine Protection Standard: This recommendation would provide necessary protection for the steep ravines of unnamed tributaries and side slopes of the Cedar River valley walls to prevent erosive runoff caused by new development. Combinations of infiltration, piping of new stormwater discharges, and enhanced R/D facilities are recommended to achieve this goal.

Taylor Creek Realignment: Maxwell Road SE (225th Avenue SE) floods annually in the vicinity of its intersection with SE 206th Street, preventing residential and emergency vehicle access to more than 30 houses, creating a traffic hazard, and causing minor residential damage. Within the project area, the stream is a significant producer of sockeye with up to 225 fish per mile observed spawning in 1994 by the Muckleshoot Indian Tribe staff. The recommended project would realign this reach of Taylor Creek to the east, away from Maxwell Road, and reconnect it with its historical floodplain. The channel would be widened, fenced, and revegetated to provide additional conveyance and floodplain capacity, improved water quality, and aquatic habitat. This project would increase Taylor Creek's flood conveyance capacity to about the 25-year event, and enhance the steam's high fish productivity.

Puget Colony Homes Drainage Improvements: The east fork of Maplewood Creek is carried by pipe through this neighborhood located south of SE 128th Street. This system is adequate to convey only half the flow from a 2-year storm and so frequently floods sole-access roads, crawl spaces, and septic systems in the Puget Colony Homes subdivision. This recommendation would install a larger pipe to improve drainage, and create a new detention pond upstream of the site to prevent the resulting increased flows from further damaging already-eroded downstream reaches of the Maplewood Creek ravine.

Lake Desire Flood-Damage Reduction: East Lake Desire Drive SE, which provides sole residential and emergency access to 39 houses east of Lake Desire, is frequently flooded for long durations because of high lake levels. This recommendation would reduce the access problems by providing low-impact conveyance improvements to the lake's outlet channel.

Aquatic Habitat Protection and Restoration

CONDITIONS

The Cedar River basin offers an excellent opportunity to cost-effectively protect and restore high-quality habitat in a manner consistent with reducing erosion damage and improving water quality. The ability to do this in an area so close to a high-density urban area is rare. Implementation of habitat protection and restoration elements of the Plan will ensure that high-quality habitat will be available in the future. This work would also enhance the recreational and natural scenic value of the river valley.

The Cedar River basin contains some of the highest quality aquatic habitat remaining in King County and supports the largest remaining run of sockeye salmon in the contiguous United States and the largest wild chinook salmon and steelhead trout populations in the Lake Washington basin. Along with Bear Creek, it has been one of the major producers of wild coho salmon in the Lake Washington system. Despite major habitat losses during the last 100 years of development, fish habitat in the Cedar River is still among the best located near the heavily urbanized areas of Puget Sound. In addition, the Cedar River basin contains an important wildlife habitat used by bald eagles, great blue and green herons, deer, beaver, river otter, and, more rarely, mountain lions and black bears. The basin provides habitat for the closest elk herd to downtown Seattle.

In recent years, runs of salmon and steelhead in the Lake Washington basin have declined to record low levels. Runs of sockeye in the river averaged 261,000 fish per year throughout the 1980s, but have declined to under 100,000 in some recent years; the 1995 run was the lowest on record with a return of approximately 26,000. Wild chinook and coho salmon, as measured by the number of spawners returning to all Lake Washington drainages, have dropped to fewer than 2,000 fish per year for each species. For chinook this is about one-third of their historic level, while for coho it is a reduction of almost 95% from their historic high of 30,000 fish in 1970. Wild steelhead have averaged only about 600 fish per year in recent years, well below the desired escapement level of 1,600 fish for the lake system. The 1993-1994 run of wild steelhead dropped to an estimated size of only 70 fish for the entire Lake Washington basin.

The Cedar River basin has experienced dramatic aquatic habitat losses due to a variety of factors. Water diversion for drinking water supply and the construction of dams, levees, and revetments for flood control have reduced the surface area of the mainstem channel by approximately 56%. Many side channel habitats and wetlands have been developed or filled. Streams have been channelized and large woody debris, a critical component of salmonid habitat, has been removed from much of the mainstem channel and many tributary reaches. Over 40% of the basin planning area has been converted from forest to other land uses. This has increased stormwater runoff, erosion, and water pollution, and has decreased stream base flows. As a result, many aquatic habitat functions have been damaged or destroyed.

Stream and wetland habitats in higher-density areas of the valley floor and western plateau areas of the City of Renton and urban King County have been degraded—in some cases severely—due to urban development. Three of the smaller fish-bearing streams in the basin—Madsen, Molasses, and Maplewood creeks—have been severely degraded by increases in stormwater runoff and water pollution caused by urbanization.

Development pressures are encroaching on many high-quality habitat areas that are both productive by themselves and critical links in protecting mainstem habitat. These areas include the lower 1.7 miles of Rock Creek, the Peterson Creek corridor and Peterson Lake, and several high-quality riparian areas along the Cedar River. Existing sensitive areas regulations alone will not protect these areas because of their dependence on factors that are beyond the scope of these regulations, such as preservation of hydrologic source areas upslope from a stream or wetland. Rock, Peterson, and Taylor creeks are expected to see the greatest change in stream habitat due to increases from flooding and runoff and increased human intrusions from new development.

GOALS AND STRATEGIES TO PROTECT AND RESTORE AQUATIC HABITAT

The principal habitat goals of this Plan are to protect and restore stream and wetland habitats critical to the Cedar River's salmon runs and its overall ecological health in a manner consistent with state and tribal fish management goals. Achieving this goal will have the added significant benefit of protecting the health of Lake Washington, the largest lake in western Washington and arguably the most important in many ways. Degradation of the river would damage the salmon resource and the lake condition, which would be expensive and difficult, if not impossible, to fix.

The main habitat strategies of this Plan are: 1) to protect high-quality habitat through open space acquisition and additional development regulations to reduce the effect of new development; 2) where feasible, to restore and enhance streams and wetlands to improve ecological functions and values at selected sites, thereby increasing salmon production potential; and 3) to implement emergency actions to protect the existing production base of salmon and steelhead and identify their limiting factors in Lake Washington.

Although the actions recommended in this Plan cannot by themselves guarantee that Lake Washington salmon and steelhead populations will return to their historic levels, they are important for protecting and restoring the river's long-term productivity for these fish and other aquatic resources. If all elements of this Plan were implemented, all high-quality mainstem habitats and critical tributary habitats would be protected. Existing habitat quality would be ensured for the future and many degraded habitats would be restored to a healthier condition. Additional fish-usable habitat would be made available with the potential to significantly increase sockeye, coho, and chinook salmon and steelhead trout in a manner consistent with restoring ecological health and providing significant benefits in reducing flood hazards, improving water quality, and enhancing the recreational and scenic value of the river. These actions would also prevent public cost for habitat restoration that would otherwise be necessary.

RECOMMENDATIONS TO PROTECT AND RESTORE AQUATIC HABITAT

Because of the variety of high-quality habitats remaining along the Cedar River and some of its tributaries, this Plan emphasizes *protection*. To be fully effective, habitat protection must address protection needs of critical habitats and preservation or restoration of the natural hydrology and water quality. Although such protection can engender significant expense imposed either through acquisition costs or additional development regulations, the outcome is both cheaper and more successful than repairing the degradation that would occur if current trends were allowed to proceed unchecked. Open space acquisitions and regulatory measures intended to reduce the effect of new developments on habitats designated as significant resource areas (SRAs) are the major approaches used. Although habitat protection is the highest habitat priority, protection alone will not ensure long-term health of the river because many of the habitats are in a degraded condition with little hope for recovery without some intervention. Therefore, restoration is meant to complement protection measures by improving existing ecological functions and values at given sites consistent with state and tribal fisheries management goals.

Table 2-1, at the end of this chapter, shows where you can look to find more details about these recommendations.

Basinwide Recommendations

These recommendations for habitat protection and restoration apply in more than one subarea rather than in a specific mainstem or tributary. Full descriptions of these "Basinwide Recommendations" (BWs) and the area-specific recommendations are found in Chapter 4. They can be summarized as follows:

Open Space Acquisitions: Based on habitat value and threat from development, the highest priority open space acquisitions along the mainstem and tributaries were identified. These include the most natural undeveloped areas and those with high restoration value remaining along the Cedar River valley floor. In the tributary subareas, priority acquisition sites include the Rock Creek corridor and Wetlands 14 and 42 in the Peterson Creek subarea. See Tables 4-1 and 4-2 in Chapter 4.

Habitat Restoration Sites: The Cedar River offers numerous opportunities for habitat restoration. In the mainstem subarea, many of these sites are located in the floodplain, adjacent to the river. Typical mainstem projects include groundwater-fed habitats and modification or removal of levees and revetments. On tributary streams, opportunities include channel realignments, stabilization and restoration of eroding ravines, and the enhancement of selected reaches in Peterson and Taylor creeks and the Walsh Lake Diversion Ditch with large woody debris and plantings of conifer trees. Project prioritization has not yet been established, and will depend on many factors including costs, fish stock management goals, permitting concerns, and landowner permission. See Table 4-2 in Chapter 4 for a listing of habitat projects; a separate technical document is being prepared to more fully describe these projects.

Small Scale Watershed Restoration and Enhancement: Many valuable habitat restoration and enhancement projects are never undertaken because they are too small or labor intensive to be treated as typical capital improvement projects. A large number of these projects, listed in Table 4-2 in Chapter 4, would be accomplished more efficiently and inexpensively by volunteer groups or other interested parties, under the coordination of the Cedar River Basin Steward.

Wetland Management Areas: Wetland management areas are proposed for five of the basin planning area's regionally significant resource area (RSRA) wetlands identified as most sensitive to future urbanization impacts. Wetland management area development conditions include subcatchment impervious area limits, cluster development, forest retention, infiltration requirements, and seasonal clearing limits. The purpose of wetland management areas is to minimize the effects of urban development on the functional and structural integrity of selected high-quality wetlands within the basin. In so doing, the range of habitats that support fish, other wildlife, and high water quality can be maintained. In addition, potential damage to both RSRA wetlands and sensitive downstream habitats from pollution, flooding, erosion, and sedimentation can be greatly reduced.

Aquatic Resource Mitigation Bank Sites: Often, mitigation actions are required within the boundaries of a project, where they may not be particularly effective. This recommendation would allow public agencies to fulfill their mitigation obligations in high-quality, off-site mitigation bank sites, where this mitigation would be more functional. A number of such sites are listed in Table 4-2 in Chapter 4.

Mainstem Recommendations

Specific habitat recommendations along the mainstem address the need for emergency actions to protect salmon, especially sockeye, and utilization of floodplain areas for their habitat value when residential buyout is called for. The Plan does not assess the effects or concerns of minimum instream flows for the mainstem. These issues are currently being addressed by the Seattle Public Utilities Department, Muckleshoot Indian Tribe, Washington Department of Fish and Wildlife, Department of Ecology, the National Marine Fisheries Service, and U.S. Fish and Wildlife Service through the habitat conservation planning (HCP) process. The HCP will need to be consistent with the goals and objectives of the plan, especially with respect to mainstem habitat, water quality, and flooding.

Emergency Artificial Salmon Production and Lake Washington Study: Although habitat protection and restoration provide the best long-term direction for achieving the habitat goals of the Plan, the recent dramatic decline of salmon and steelhead in Lake Washington has triggered emergency actions that are supported by the Basin Plan. A temporary sockeye hatchery at Landsburg, and a seasonal fish weir in the lower river to collect broodstock is currently operating and is considered necessary to preserve the existing stock of sockeye until more comprehensive actions can become effective. Depending on fisheries production goals, critically low numbers of coho, chinook, and steelhead may also require some form of direct enhancement in the near future. Additional information is also being collected to assess limiting factors for sockeye and other salmonids in Lake Washington. This information is necessary to evaluate the alternative methods of stock enhancement, such as permanent hatchery facilities, and extensive habitat restoration projects.

Flood-Hazard Relocation Sites: While many of the flood-hazard recommendations offer habitat benefits, two developed floodplain areas (Rainbow Bend and Lower Dorre Don) are highly recommended for open space acquisition and floodplain restoration in conjunction with the flood-hazard reduction recommendations. Because of the high cost of these projects solely as flood-hazard reduction and because of potential habitat and recreation benefits, open space funds should be combined with flood-hazard reduction funds to purchase and restore the land.

Tributary Recommendations

The Plan recommends protection or restoration of high quality tributary structural habitat and preservation of the natural hydrology and water quality. Appropriate ways to restore natural hydrologic processes, such as infiltration by retrofitting roof drains where soils are appropriate, are preferred.

Restoration of Rock Creek Base Flow: Seasonally severe streamflow depletion affects salmonid use in the lower 1.7 miles of Rock Creek. Because of water-right and water-supply elements, this is a complex issue. The hydrologic connection between Rock Creek and the City of Kent's adjacent water-supply facility is the subject of ongoing discussions. Depending on the results of these discussions, several alternatives for increasing Rock Creek's base flows may have to be explored, including an alternative water supply for a portion of the City of Kent's water needs. Correction of a long-standing diversion of water from the headwaters of Rock Creek into the Green River should also improve low-flow conditions.

Regulations for New Development: Recommended changes in regulatory measures for new development include reduced development density along lower Rock Creek and designation of wetland management areas for five RSRA wetlands (BW 3). Regulations to reduce the flooding and water quality consequences of new development proposed for the Peterson and Taylor Creek RSRAs will have significant benefits for these aquatic resources as well. They are described in detail in Chapter 4.

Protection of Water Quality from Nonpoint Source Pollution

CONDITIONS

Mainstem

Based on measured data and biological use of the Cedar River, the water quality in this basin ranges from very good downstream of the upper Jones Road bridge (RM 9.2) to excellent upstream of that point. However, the Cedar River has been designated as "water quality limited" due to sporadic exceeding of the state water quality standard for fecal coliform caused by livestock and human wastes (e.g., malfunctioning septic systems).

Downstream of RM 9.2, urban-related pollutants are a significant concern. In particular, the Logan Street outfall at RM 1.1, which drains a heavily urbanized and industrial area, shows extremely high concentrations of metals that exceed chronic and acute toxicity levels. Sediments from this outfall were classified as "extremely polluted" according to Washington State Department of Ecology guidelines. The source of many of the problems observed at this location could be from the improper disposal of hazardous materials, which the City of Renton is currently investigating. Stormwater contamination problems were indicated at every sampling location in the basin where the outfall drained stormwater from a heavily used transportation corridor.

Tributaries

The majority of the development in the Cedar River basin has occurred on the plateaus in the vicinity of headwaters of the numerous small tributaries. The pollutant inputs from development and associated human activities are washed into the small tributaries, which have relatively small flows and therefore experience greater pollutant concentrations. Although water quality data from the tributaries are sparse, available information indicates that substantial water quality problems likely exist in most of the urbanized subbasins, including Ginger Creek, Maplewood Creek, Molasses Creek, and Madsen Creek. The major sources for toxics are stormwater and drainage associated with automobile usage. This is especially a problem in the urbanized subbasins and anywhere else that an extensive road drainage system discharges into a small stream. Therefore, areas within the urban growth boundary are the highest priority, but this problem cannot be ignored in the remainder of the basin. With projected population growth, potential inputs of pollutant loadings to surface and groundwater will increase significantly.

In the less urbanized subbasins, livestock and failing septic systems are also water quality concerns. Livestock increase nutrient and sediment loads as well as bacterial (fecal coliform) counts and they cause physical destruction of habitat due to bank trampling and elimination of riparian vegetation. Failing septic systems are also a source of fecal coliform bacteria. These conditions are likely to worsen in the future because of trends in the Cedar River basin towards keeping livestock on smaller parcels and the unavoidable aging of septic systems. In the areas surveyed, 40% of the septic systems are more than 20 years old and so are approaching their design lifetime. Repair rates, used as an indicator of failures, exceeded the regional average in areas of Maplewood Heights and Peterson Creek.

Lake Washington

Lake Washington is the principal fresh water receiving body for the Cedar River, which provides at least 50% of the lake's inflow. Total phosphorus (TP) concentrations in the southern end of Lake Washington are determined largely by the quality of the Cedar River inflow and are currently good, measured at about 20 parts-per-billion (ppb). In contrast, higher concentrations have been measured at the lake's northern end (26 ppb). Projected increases in TP loadings from the Cedar River could increase the concentrations in the southern end of the lake, possibly to a level where recreational and aesthetic values of the lake would be compromised. Because the dynamics of nutrient loading and mixing within the lake are only imperfectly understood at this time, there is no certainty in these projections. However, the consequences of increased nutrients would be of regional concern and progressively more difficult to reverse as they developed over time.

GOALS AND STRATEGIES TO MAINTAIN WATER QUALITY

The primary water quality goal of this Plan is to maintain the current generally high quality of surface-water and groundwater in the basin. This requires that future land developments incorporate source control and water quality treatments. However, because these measures are only partially effective, pollutant loadings from existing developments must also be reduced to achieve the goal of nondegradation. Preference should be given to source control measures (i.e. prevention of pollutants entering the water) rather than to treatment measures (i.e. pollutant removal once it has entered the water) because pollutant removal is far less efficient. Although the most acute current sources of water quality pollutants should be obvious high priority targets of any such reduction efforts, an effective program must also include broadly applied efforts that reduce the impacts of land development on water quality throughout the basin.

In order of decreasing priority, the numerous approaches available to maintain or improve water quality fall into the following general categories:

1. **Reduce current sources:** Eliminate pollution from point sources and quasi-point sources, such as the Logan Street outfall and road drainage outfalls.
2. **Prevent future sources:** Control pollution from significant sources through education programs and application of best management practices, such as septic system repairs and manure management.
3. **Treat existing and future sources:** Treatment is used to remove pollutants that have already entered the stormwater, using some combination of biofiltration, infiltration, or wet ponds. Unfortunately, these measures are only partially effective at removing pollutants. Therefore, treatment should not be the sole strategy for water quality protection, because continued degradation would be inevitable. Opportunities to develop and implement promising emerging technologies should be encouraged.

Success in achieving these overall water quality goals will be measurable in terms of both future pollutant loadings to Lake Washington and reduced pollutant concentrations at current problem sites within the basin.

RECOMMENDATIONS TO MAINTAIN WATER QUALITY

Four water quality problems are particularly prominent: total phosphorus loadings into Lake Washington, locally toxic concentrations of urban pollutants in both the mainstem and tributaries, high fecal coliform counts, and localized sediment problems. Maintaining the overall water quality of the basin in the face of continued urban development will require management of a wide variety of pollutants at an increasing number of sites. As a result, the necessary recommendations are varied, particularly because inevitable future increases in most pollutants as a result of development-induced new sources must be balanced by commensurate reductions in pollutants from existing sources.

Table 2-1, at the end of this chapter, shows where to find more details about these recommendations.

Source Controls and Treatment to Reduce Current Total Phosphorus (TP) Loadings[2]: Recommended programs for the reduction of TP loadings include 1) waste management programs for noncommercial livestock operations; 2) sediment control measures, particularly tributary bank stabilization and riparian-zone restoration; 3) education programs for residential BMPs such as proper use of fertilizers; 4) water quality treatment facilities for TP removal (biofiltration, wetponds, infiltration) consistent with the 30-percent removal consistent with the next update to the King County *Surface Water Design Manual*; 5) improved evaluation of TP concentrations in Lake Washington; and 6) measures to correct present septic-system failures.

Source Control and Treatment of Sedimentation: Minimize future sediment loadings (total suspended solids (TSS) and turbidity) to preserve water clarity and protect aquatic habitat, and to reduce the associated loadings of TP. Strategies include 1) minimizing erosion downstream of new development through water-quantity controls; 2) protecting riparian areas and their buffers; 3) control of sediment from construction sites; and 4) sediment removal through treatment BMPs, such as biofiltration swales and detention ponds.

Prevention of Toxic Metal and Organic Pollutants via Source Control: Recommended strategies for urban stormwater quality include education programs for proper use and disposal of pesticides, household hazardous wastes, automotive fluids (oil and antifreeze); and technical assistance to implement commercial BMPs. Unfortunately, a substantial reduction of road drainage toxics would require reduced automobile usage, which is not addressed in this Plan.

Treatment of Toxic Metals and Organics via BMPs: Because substantial reduction of automobile pollutants is beyond the scope of this Plan, treatment BMPs are necessary. These include incorporation of bioswales, wetponds, or other treatment technologies into constructed

[2] There is currently a statewide limit on the phosphorus content of household detergents (Chapter 70.95L RCW, "Detergent Phosphorus Content"). This phosphorus limit will reduce phosphorus loadings to surface and groundwater.

drainage systems, and maintenance of those systems for removal of toxics. In this basin, these programs should be stressed within the urban growth boundary and areas draining to significant resource areas.

Source Controls to Reduce Bacterial Contamination: To meet water quality standards for fecal coliform, recommended strategies include 1) measures to correct and prevent septic system failures; 2) a waste management component to small noncommercial livestock management plans; 3) an educational program for management of domestic pet wastes; and 4) monitoring of the sewer line in Madsen Creek to assure that leakage is not occurring.

Aquifer Protection

CONDITIONS

Water Supply

Numerous residents living both within and outside of the basin are dependent on the groundwater resources of the Cedar River basin. Potable groundwater is supplied by the City of Renton, the City of Kent, many small private purveyors and numerous individual wells. Water quality and quantity are of great importance to the citizens who depend on it. As the population of the region grows, the demand for high quality potable water will increase. Surface-water management will contribute to the continued availability of the valuable water supply contained in the aquifers of the basin.

A shallow, unconfined alluvial aquifer exists in close proximity to the Cedar River. The shallow aquifer is recharged through direct infiltration of precipitation, interflow from surrounding highlands, the river, and upwelling of water from deeper aquifers. This shallow aquifer recharges the Cedar Valley Sole Source Aquifer and a deeper aquifer used for municipal supply by the City of Renton.

The City of Kent also utilizes shallow groundwater from its Clark Springs Source (see *Current and Future Conditions Report*) located in the Rock Creek Subarea to supply over half of its water. An infiltration gallery located in recessional outwash at a few meters of depth underneath and adjacent to Rock Creek allows water to enter the city's system by gravity. Like the creek itself, this source is recharged by percolation of rainfall directly on outwash soils within the subarea, and indirectly by runoff from the subarea's till hillsides that subsequently percolates into lower outwash plain deposits. Kent also has the capability of pumping water at this site from the same recessional outwash deposits.

Water Quality

Groundwater in the basin planning area is highly susceptible to contamination from point and nonpoint pollution sources. Pollutants of particular concern for the preservation of potable water supplies include nitrates, bacteria, and toxics (metals, organics), and sources include human and animal wastes, improper disposal of hazardous wastes, commercial and industrial activities, and automotive use. The groundwater quality in the basin is currently of very high quality. However, the aquifers are becoming more vulnerable to contamination as development increases. Protective measures are needed to assure that the potable water supplies are not compromised.

Water Quantity

Groundwater provides stream base flows during the dry season. Conversion of forested land to agricultural, residential, commercial, and other uses has diminished aquifer recharge and summer base flows of the tributary subbasins in the basin planning area. Where commercial development has replaced forest cover, these losses are caused primarily by impervious surfaces such as roads, roofs, and other structures that effectively cut off penetration and percolation of rainfall into the soil column. In lower-density, rural areas, the dominant land cover change is usually from forest to grass and is accompanied by a reduction in the infiltration capacity of the soil. This results in more winter storm runoff, less groundwater recharge, and less summer and fall base flows in streams, particularly on the dominant till soils found within the basin planning area. Although, the net loss of groundwater recharge within the basin planning area to date is difficult to quantify precisely, hydrologic modeling suggests that it ranges between 5% and 10% and that losses per acre have been most dramatic in the more intensely urbanized western portion of the basin.

The impact of reduced recharge on stream base flows are most critical during the summer and early fall when rainfall is minimal and streams are fed by water that has been stored in aquifers in the previous winter and spring. The net loss of base flow to streams depends on several factors including land use, soils, method of wastewater disposal, and the source of domestic water. Hydrologic modeling indicates that the current, average summer, base flow losses resulting from basin planning area land-use change to be approximately 13% for streams on the western side of the urban growth boundary, 4% for streams on the rural, eastern side, and 6% overall. This represents an average loss of approximately 2.2 cfs to the mainstem Cedar River between July 1 and October 30, less than 1% of the average flow during this period.

In the future, as forest cover diminishes, and the basin is built out, losses to aquifer recharge, stream, and river base flows are estimated to approximately double if recommendations outlined in this basin plan are not implemented. These losses can potentially affect the quantity and quality of salmonid habitat.

GOALS AND STRATEGIES TO PROTECT AQUIFERS AND MAINTAIN BASE FLOWS

This plan recognizes the relationship between surface and groundwater quantity and quality as well as the benefits of comprehensive water resources management. Consequently, the Plan strives to promote a strategy and specific actions that protect both surface and groundwater quality, reduce losses to aquifer recharge and stream base flows, promote public awareness of surface-groundwater interactions, and provide a mechanism for the assessment, improvement, and coordination of basin groundwater management.

RECOMMENDATIONS TO PROMOTE AQUIFER PROTECTION AND MAINTAIN BASE FLOWS

Recommendations that implement this strategy in the Plan will:

1. Promote pollutant source controls that reduce the introduction of contaminants into both surface and groundwater;
2. Require stormwater water quality treatments that remove pollutants from stormwater prior to its discharge to either surface or groundwater;

3. Require stormwater infiltration where feasible to reduce losses of aquifer recharge and stream base flows;
4. Encourage retention of forest cover in rural areas to protect recharge and base flows;
5. Establish the Cedar River Council that will provide broadly based leadership in the management and protection of the basin's aquatic and water resources as well as review and promotion of additional groundwater protection measures as they are developed in the future.

Cedar River Watershed Management Program

BACKGROUND

Management of the Cedar River basin involves a complex mix of jurisdictions and public and private interests, as is true for many large watersheds. Compared to other watersheds, however, the complexity of the Cedar River is further increased by several, often conflicting, factors. These include 1) development pressures resulting from its proximity to a large urban center; 2) the use of large areas of the basin for municipal water supply, even in its urbanizing reaches; and 3) the urgent need to protect its relatively high environmental quality and restore its declining salmonid resource. While the Plan addresses many of the current and potential problems in the basin associated with these factors, new issues and complications will likely arise during its implementation. Therefore, a comprehensive watershed management program is needed to ensure coordinated and aggressive implementation of the adopted Plan and to deal with unforeseen future problems. Such a program would also help to ensure the involvement of all agencies, affected tribes, and other parties in implementing Plan recommendations and, where necessary, develop new and innovative ways to protect the Cedar River basin's valuable natural resources.

GOALS AND STRATEGIES OF THE WATERSHED MANAGEMENT PROGRAM

The goals of the Cedar River watershed management program are to implement the basin plan; coordinate the actions of the many entities (agencies, tribes, and private parties) who have a role to play in basin management; and identify and coordinate future efforts as necessary to protect the people and public resources of the river. Watershed management would entail both short- and long-term strategies for Plan implementation. The primary short-term element is the Cedar River Legacy Initiative, which was adopted in 1994 by the Metropolitan King County Council to accelerate implementation of some of the critical salmonid habitat protection and restoration measures identified in the planning process. The Legacy initiative was implemented due to growing concern over declining salmon and steelhead trout populations.

To guide watershed management efforts over the long term, this Plan proposes a Cedar River Council. This Council would be composed of agencies, affected tribes, and private and public interest groups, to 1) oversee and coordinate Plan implementation; 2) seek additional funding as necessary; 3) develop private partnerships and community stewardship to care for the Cedar River basin; and 4) provide a forum for resolution of new issues or complications in Plan implementation. The Council would provide a necessary forum for engaging public support, resolving policy issues, and adjusting management strategies as warranted by new information or emerging problems. In support of the Council, basin stewardship and public involvement and education programs would be established and an annual report describing the Council's activities and the status of the basin would be developed.

RECOMMENDED ELEMENTS OF THE CEDAR RIVER WATERSHED MANAGEMENT PROGRAM

Table 2-1, at the end of this chapter, shows where you can look to find more details about these recommendations.

Cedar River Legacy Initiative: As mentioned above, the Legacy was initiated in 1994 by the Metropolitan King County Council to implement the most critical salmon and habitat protection and restoration measures prior to final Plan adoption. As a result, several actions were taken:

- 98 acres surrounding Rock Creek were purchased.
- A groundwater-fed sockeye spawning channel was constructed in conjunction with improvements to the Elliot Levee.
- The Cedar River Council was created.
- The Lake Washington Ecosystem Studies continued increasing understanding of sockeye needs and population dynamics.
- Numerous stewardship events were held.

Additional funds will be sought for future years.

Cedar River Council: The Cedar River Council would oversee the Cedar River Legacy and other elements of Basin Plan implementation. It would provide a forum for the public on issues in the watershed, coordinate among agencies and private and public interest groups, and help to raise funds for Plan implementation. Participants would include local, state, federal, and tribal governments and public and private interest groups. A coordinator will be hired to support the Cedar River Council.

Basin Steward: The Basin Steward will work with the public and private interests in the watershed to promote a comprehensive stewardship ethic, assist in plan implementation, and support the Cedar River Council.

Annual Report: An annual report will be made available describing activities of the Cedar River Council, status of Plan implementation, and an overview of resource conditions in the watershed.

Water Resources Education and Public Involvement: This program would provide opportunities for education and public involvement in protecting and restoring the Cedar River aquatic resources.

Relationship of Chapter 2 to Chapters 3 and 4

Chapter 2 is a summary of conditions in the Cedar River basin planning area and of the Basin Plan's **most important** recommendations, presented **by subject**.

Chapter 3 is a summary of **all** Basin Plan recommendations, presented **by geographic area** in which they apply.

Chapter 4 presents **all** Basin Plan recommendations **in their entirety**.

Please refer to Table 2-1 for cross-reference between chapters.

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4

Flooding

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Dorre Don	CIP 3102 Dorre Don Flood Damage Reduction/Floodplain Restoration	X						
Rainbow Bend	CIP 3108 Rainbow Bend Flood-Damage Reduction/Floodplain Restoration	X						
Elliot Bridge/Lower Jones Road	CIP 3111 Elliot Bridge/Lower Jones Road Flood-Damage Reduction	X						
Puget Colony Homes Drainage Improvements	CIP 3120 Puget Colony Homes Drainage Improvements		X					
Taylor Creek Realignment	CIP 3140 Maxwell Road SE Flood Abatement and Taylor Creek Restoration				X			
Retention/Detention Standards	BW 19: Retention/Detention Standards		X	X	X	X	X	X
Ravine Protection Standard	BW 20: Ravine Protection Standard		X	X	X	X	X	X
Stormwater Infiltration	BW 21: Infiltration as a Stormwater Mitigation Treatment		X	X	X	X	X	X
Forest Protection	BW 23: Forest Incentive Program	X	X	X	X	X	X	X
Masonry Dam Study	MS 1: Masonry Dam Operations Study	X						
Renton Reach Flood-Damage Reduction Study	MS 2: Renton Reach Capacity 205 Study	X						
Lake Desire Flood Damage Reduction	CIP 3151 Lake Desire Flood-Damage Reduction					X		
	PC 1: Lake Desire Outlet Channel Maintenance					X		

MS Mainstem
NT Northern Tributaries
ST Southern Tributaries
TC Taylor Creek
PC Peterson Creek
MT Middle Tributaries
RC Rock Creek

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4 (Continued)

Aquatic Habitat

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Wetland Management Areas	BW 3: Wetland Management Areas			X		X		
Open Space Acquisitions	BW 4: Priorities for Open Space Acquisitions	X	X	X	X	X		X
Habitat Restoration Sites	BW 6: Aquatic Resource Mitigation Bank Sites	X	X	X	X	X	X	X
Small Scale Watershed Restoration and Enhancement	BW 5: Small Scale Watershed Restoration and Enhancement		X	X	X	X	X	X
Emergency Artificial Salmon Production and Lake Washington Study	BW 7: Artificial Salmonid Production Measures	X						
	BW 8: Lake Washington Studies	X						
Flood-Hazard Relocation Sites	MS 4: Mainstem Habitat Restoration and Enhancement	X						
Restoration of Rock Creek Base Flow	RC 1: Rock Creek Low Flow Restoration							X
Rock Creek Stewardship	RC 3: Rock Creek Community Involvement and Education							X
Regulations for New Development	BW 19: Retention/Detention Standards		X	X	X	X	X	X
	BW 20: Ravine Protection Standard		X	X				
	BW 21: Infiltration as a Stormwater Mitigation Treatment		X	X	X	X	X	X
	BW 3: Wetland Management Areas			X		X		

***Abbreviations for geographic subareas as presented in Chapter 3.**

MS	**Mainstem**	**ST**	**Southern Tributaries**	**PC**	**Peterson Creek**	**RC**	**Rock Creek**
NT	**Northern Tributaries**	**TC**	**Taylor Creek**	**MT**	**Middle Tributaries**		

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4 (Continued)

Water Quality

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Source Controls and Treatment to Reduce Current Total Phosphorus Loadings (TP)	BW 9: Improvement of Water Quality from Road Drainages and Urban Areas	X	X	X	X	X	X	X
	BW 10: On-Site Septic System Pollution					X		
	BW 11: Livestock Keeping Practices				X	X	X	X
	BW 12: Water Quality Treatment Standards	X	X	X	X	X	X	X
	BW 14: Water Resources Education and Public Involvement		X	X	X	X		X
	BW 20: Ravine Protection Standard		X					
	BW 21: Infiltration as a Stormwater Mitigation Treatment		X	X	X	X	X	X
	BW 22: Erosion and Sedimentation Control Standards		X	X	X	X	X	X
	CIP 3127 Retrofit Retention/Detention Ponds		X	X		X		
Source Control and Treatment of Sedimentation (TSS)	BW 11: Livestock Keeping Practices				X	X	X	X
	BW 19: Retention/Detention Standards		X	X	X		X	X
	BW 20: Ravine Protection Standard		X					
	BW 21: Infiltration as a Stormwater Mitigation Treatment		X	X	X	X	X	X
	BW 22: Erosion and Sedimentation Control Standards		X	X	X	X	X	X

MS Mainstem
NT Northern Tributaries
ST Southern Tributaries
TC Taylor Creek
PC Peterson Creek
MT Middle Tributaries
RC Rock Creek

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4 (Continued)

Water Quality

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Prevention of Toxic Metal and Organic Pollutants via Source Control	MS 9: NPDES Industrial Stormwater Permits	X						
	MS 10: Stormwater Quality in Industrial/Commercial Areas	X						
	BW 9: Improvement of Water Quality from Road Drainages and Urban Areas	X	X	X	X	X	X	X
	BW 12: Water Quality Treatment Standards	X	X	X	X	X		X
	BW 14: Water Resources Education and Public Involvement		X	X	X	X		X
Treatment of Toxic Metals and Organics vs. BMPs	MS 11: Stormwater Treatment of Interstate 405 and SR-169	X						
	BW 9: Improvement of Water Quality from Road Drainages and Urban Areas	X	X	X	X	X	X	X
	BW 12: Water Quality Treatment Standards		X	X	X	X		X
Source Controls to Reduce Bacterial Contamination	ST 1: Madsen Creek Water Quality			X				
	BW 10: On-Site Septic System Pollution	X	X			X	X	X
	BW 11: Livestock Keeping Practices				X	X	X	X

*Abbreviations for geographic subareas as presented in Chapter 3.

MS	Mainstem	ST	Southern Tributaries	PC	Peterson Creek	RC	Rock Creek
NT	Northern Tributaries	TC	Taylor Creek	MT	Middle Tributaries		

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4 (Continued)

Aquifer Protection

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Protect Aquifer Recharge	BW 4: Priorities for Open Space Acquisitions	X	X	X	X	X		X
	BW 17: Aquifer Protection and Base Flow Maintenance	X	X	X				X
	BW 18: Urban Stormwater Management Initiative	X	X	X				
	BW 21: Infiltration as a Stormwater Mitigation Treatment		X	X	X	X	X	X
	BW 23: Forest Incentive Program	X	X	X	X	X	X	X
Protect Aquifer Water Quality	BW 9: Improvement of Water Quality from Road Drainages and Urban Areas	X	X	X	X	X	X	X
	BW 10: On-Site Septic System Pollution	X	X	X		X		X
	BW 12: Water Quality Treatment Standards	X	X	X	X	X		X
	BW 23: Forest Incentive Program	X	X	X	X	X	X	X
	MS 10: Stormwater Quality in Industrial/Commercial Areas	X						
	ST 1: Madsen Creek Water Quality			X				
Groundwater Education and Coordination	BW 14: Water Resources Education and Public Involvement		X	X	X	X	X	X
	BW 15: Cedar River Council	X	X	X	X	X	X	X
	BW 16: Basin Steward Program	X	X	X	X	X	X	X

MS Mainstem
NT Northern Tributaries
ST Southern Tributaries
TC Taylor Creek
PC Peterson Creek
MT Middle Tributaries
RC Rock Creek

Table 2-1 Where to Find Chapter 2 Recommendations in Chapters 3 and 4 (Continued)

Water Management Program

Summary by Topic (See Chapter 2)	Full Text of Recommendation (See Chapter 4)	Summary by Geographic Subarea* (See Chapter 3)						
		MS	NT	ST	TC	PC	MT	RC
Cedar River Legacy Initiative	BW 4: Priorities for Open Space Acquisitions	X	X	X	X	X		X
Cedar River Council	BW 15: Cedar River Council	X	X	X	X	X	X	X
Basin Steward	BW 16: Basin Steward Program	X	X	X	X	X	X	X
Annual Report	BW 16: Basin Steward Program	X	X	X	X	X	X	X
Education and Public Involvement	BW 14: Public Involvement and Education	X	X	X	X	X	X	X

*Abbreviations for geographic subareas as presented in Chapter 3.

MS Mainstem
NT Northern Tributaries
ST Southern Tributaries
TC Taylor Creek
PC Peterson Creek
MT Middle Tributaries
RC Rock Creek

Chapter 3

Subarea Recommendations

Chapter 3: Subarea Recommendations

Introduction

This chapter presents the Basin Plan's recommendations by geographic subdivision, or "subarea" (Figure 3-1). These subareas include the *Cedar River Mainstem (MS)*, composed of the mainstem itself, the land adjacent to the river, and any land on the valley walls and plateaus not drained by a major tributary; the *Northern Tributaries (NT)*, which are the five northernmost small tributaries closest to Renton (Maplewood Creek and the Orting Hill, Cedar Grove, Cedar Hills, and Webster Lake tributaries); the remaining four small urbanizing subbasins, known as the *Southern Tributaries (ST)* (Ginger, Molasses, Madsen, and Summerfield creeks); two streams near Maple Valley referred to as the *Middle Tributaries (MT)*, and the more rural subareas of *Peterson Creek (PC), Taylor Creek (TC), and Rock Creek (RC)*, which are large enough to warrant treatment as separate subareas in this Plan.

The purpose of this chapter is to allow Plan users to easily locate recommendations that affect a given area. Also, flooding, aquatic habitat, and water quality problems are closely related, so presenting the Plan's recommendations by drainage basin or stream reach gives the most accurate picture of the Plan's comprehensive approach to solving current problems and avoiding future ones.

Although it is intended to stand alone, this chapter may be most useful when taken together with Chapter 2, which discusses each of the Plan's major goals by topic area—Flooding, Aquatic Habitat, Water Quality, and Watershed Management—in more detail. The most significant of the recommendations found below have already been summarized in Chapter 2. The full text of all recommendations is cataloged in Chapter 4.

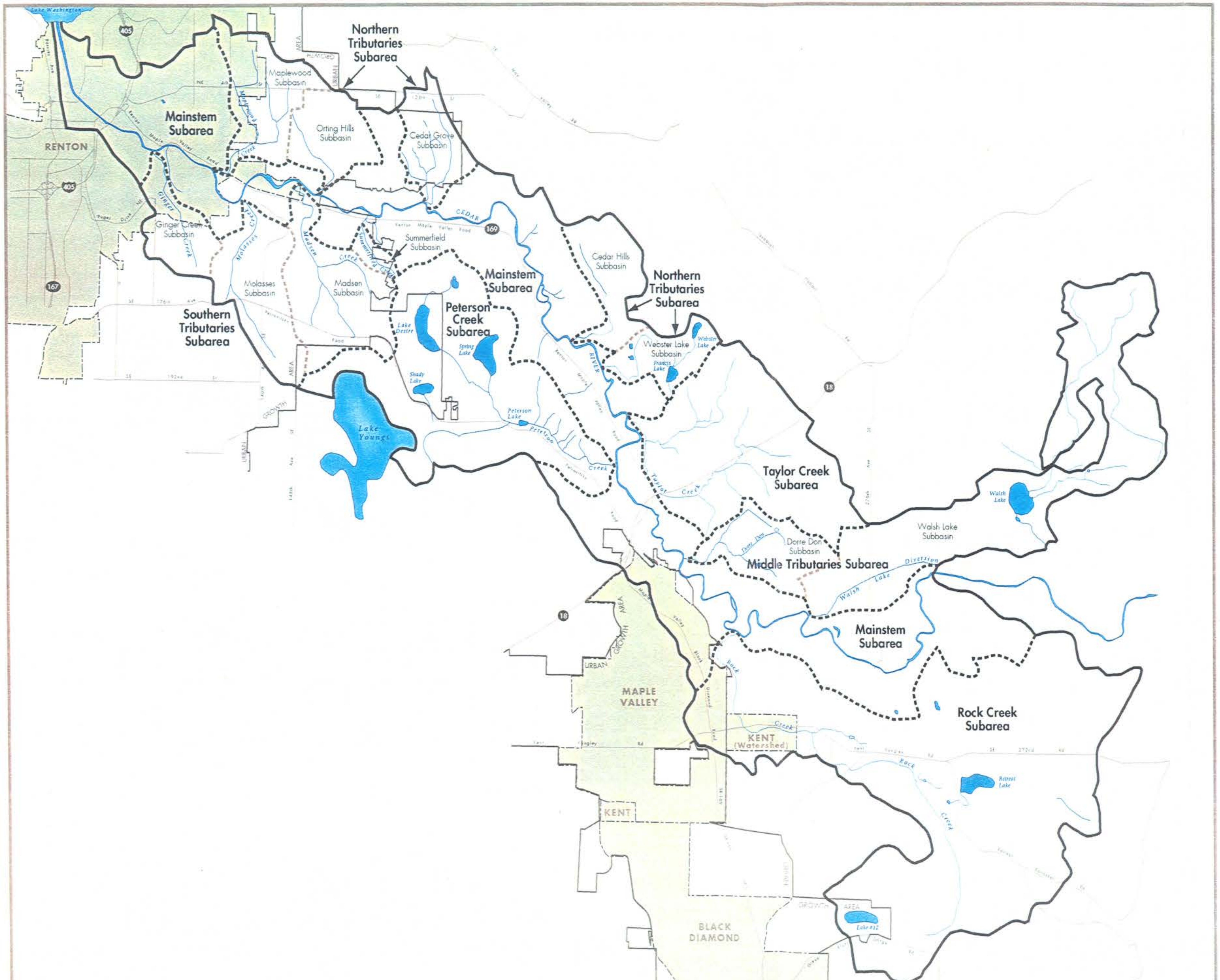

Figure 3-1

Subarea Boundaries

Cedar River Basin Planning Area

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Cedar River Mainstem

INTRODUCTION

The Mainstem subarea consists of the Cedar River valley floor and its steep walls, and the surrounding plateau areas that drain small, unnamed tributaries. The valley extends roughly 17 miles from Renton to Landsburg, varying in width from a few hundred to a few thousand feet. While the Mainstem subarea represents less than 15% of the 66-square-mile basin planning area, it includes the largest and most hazardous flood risk sites and is disproportionately rich in both current and potential future aquatic resources. Therefore, actions in this subarea are given very high priority.

Major human alterations to the Cedar River valley began in the late 1800s and have included logging, railroad construction, agricultural land conversion, dam construction and water diversion, redirection of the river's outlet, construction of levees and revetments, dredging, and more recently, urbanization. These activities have had significant impacts both on flood risks and aquatic habitat. Channelization of the river through Renton and construction of levees and revetments along 14 of the 21 river miles in the Mainstem subarea have encouraged agricultural, residential, and commercial development within the floodplain, placing more property at risk of flood damage.

Flood-control projects have provided limited localized flood protection at the cost of aggravating upstream and downstream flood damages by removing floodplain storage and increasing flood depths and velocities. To date, the most significant flooding damage has occurred in the City of Renton (river mile [RM] 0.0-1.6), along lower Jones Road (RM 5.4-6.0), upstream and downstream of Cedar Grove Road (RM 10.6-12.0), along lower Bain Road (RM 14.6), and in the neighborhood of Dorre Don (RM 15.8-16.4).

Aquatic habitats within the Mainstem subarea have been reduced significantly in both quantity and quality by logging, floodplain development, river engineering, and diversion of river flow. Large woody debris recruitment has declined, meanders and side channels have been cut off, riparian wetlands have been filled, the river has narrowed, and summer flows have been depleted. Generally, these changes have tended to reduce the hydraulic complexity that supports the wide variety of salmonid species and life stages that depend on the river.

The Mainstem subarea recommendations consist of capital improvement projects (CIPs) and programs that focus mainly on the two primary, and often related, issues of flood-damage reduction and aquatic habitat restoration and enhancement. These recommendations strive to:

1. Remove or protect occupied structures from the most hazardous areas;
2. Modify or remove certain existing levees and revetments, allowing the river access to its historical floodplains and restoring floodplain storage;
3. Protect, restore, and enhance existing aquatic habitat; and
4. Prevent siting of additional structures within hazardous areas.

These objectives are consistent with the goals and policies of the King County *Flood Hazard Reduction Plan,* which was adopted by the King County Council in 1993. In fact, the Mainstem subarea recommendations follow many specific solutions outlined by the *Flood Hazard Reduction Plan,* and augment them by adding water quality and aquatic habitat restoration and enhancement components to create a more comprehensive floodplain management program for basin planning area.

As explained in "Mainstem Recommendations," under "Recommendations to Reduce Flood Damage" in Chapter 2, properties proposed for acquisition would be acquired only on a willing-seller basis. Landowners who choose not to sell to the County would not face any penalty or loss of existing benefit as a result of their decision.

SUMMARY OF RECOMMENDATIONS

See Chapter 4 for the complete text of all recommendations, the locations of which are shown on Figures 3-2, 3-3, and 3-4 at the end of this section.

Capital Improvement Projects

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

*** Rainbow Bend Flood-Damage Reduction/Floodplain Restoration (CIP 3108):** Approximately 55 mobile homes in the Cedar Grove Mobile Home Park and nine nearby permanent houses on the right bank between RM 10.8 and RM 11.3, below Cedar Grove Road, were damaged by fast, deep flood flows, erosion, and deposits of large debris during the November 1990 flood. The permanent houses are subject to hazardous flows when the Rainbow Bend levee overtops. The mobile home park, at the downstream, unleveed end of this reach, experiences hazardous flooding during much smaller, more frequent events. Emergency access to and egress from all houses in this reach are frequently blocked by flooding. This area is a high-velocity floodway and presents serious threats to human safety. This recommendation would purchase and remove all occupied structures from this reach and reestablish the floodplain's aquatic habitat and flood storage functions. Because the mobile home park provides affordable housing to low income families, and because King County policy requires relocation assistance and replacement housing when displacements from below-market-rate housing are unavoidable,[3] the Plan recommends offering these services, rather than a simple market-value buyout, to the mobile home residents. A park closure plan would also be developed to include owners and tenants in the planning, design, and implementation of this recommendation. A potential relocation site is the adjacent Stoneway Sand and Gravel mine, once it has been reclaimed.

*** Dorre Don Flood-Damage Reduction/Floodplain Restoration (CIP 3102):** Several houses, a County road, and a County-maintained levee in this neighborhood, located on the right bank of the Cedar River surrounding the railroad bridge at RM 16.4, have been damaged repeatedly by

[3] King County Comprehensive Plan Policy R-108.

debris and fast, deep floodwaters. The Basin Plan's highest-priority flood-damage reduction recommendation would purchase and remove the 20 houses in the most hazardous locations, eliminating the flood threat to these residents. It would also remove the upstream portion of the Lower Dorre Don levee and restore approximately six acres of floodplain to its historic aquatic habitat and floodwater storage functions. In addition, approximately 600 linear feet of Lower Dorre Don Way would be elevated to continue to provide sole access to the remaining eight, less-severely threatened houses.

* **Elliot Bridge/Lower Jones Road Flood-Damage Reduction (CIP 3111):** Below Elliot Bridge (RM 5.4), two left-bank houses were inundated by water over three feet in depth during the November 1990 flood. Upstream, to RM 6.0, 22 houses between Jones Road and the Cedar River experienced erosive, high-velocity flows as is common during large floods. Eighteen houses on 156th Place SE are inaccessible when Jones Road floods, an approximately 2-year occurrence, and 20 additional houses are exposed to less-hazardous flooding during large events. This recommendation would purchase and remove the 24 houses in the most hazardous areas, raise approximately 2,300 linear feet of Jones Road to ensure access to 156th Place SE and to reduce flood damage to the less-severely threatened houses, and restore up to 16 acres of flood storage and habitat area.

* **Ricardi Flood-Damage Reduction/Floodplain Restoration (CIP 3109):** Two houses subject to frequent hazardous flooding would be purchased and removed, and the area restored as open space for aquatic habitat and floodwater storage. Nearly one-half of the estimated cost would be paid by federal and state matching funds.

* **Byers Bend/Cedar Grove Road Flood-Damage Reduction (CIP 3107):** Frequent and severe flood damage to an entire neighborhood would be reduced or eliminated by removing up to eight houses, raising an additional eight houses, improving the Byers Bend levee, and building an overbank conveyance channel along Byers Road to carry floodwater safely back to the Cedar River.

* **Dorre Don Court Flood-Damage Reduction/Floodplain Restoration (CIP 3103):** Three houses subject to hazardous flooding would be removed and the area would be restored as floodplain for aquatic habitat and floodwater storage.

• **Lower Bain Road and Royal Arch Flood-Damage Reduction/Floodplain Restoration (CIP 3104):** Between three and nine houses, typically flooded at about the 10-year event and damaged by hazardous flows during the November 1990 flood, would be removed and floodplain storage and habitat would be reestablished.

• **Maplewood Flood-Damage Reduction (CIP 3112):** Approximately 60 houses in the Maplewood subdivision that are threatened with severe damage during the 100-year flood would be protected by the construction of a 1,200-foot-long levee (to a maximum height of approximately four feet). As mitigation for this activity, a suitable project should be selected and implemented from the mainstem enhancement and restoration projects listed in basinwide recommendation (BW) 6 and Mainstem recommendation (MS) 4 of this Plan.

• **Jan Road Flood-Damage Reduction/Habitat Restoration (CIP 3106):** Frequent damage to roads and houses would be reduced and emergency access to 14 houses would be ensured by constructing a stable overbank conveyance channel to safely direct floodwaters overtopping the Jan Road levee back to the Cedar River.

• **Riverbend Mobile Home Park Revetment Modification (CIP 3110):** The rock revetment on the left bank of this constricted reach of the Cedar River would be recontoured using bioengineering techniques to provide stability and additional conveyance and aquatic habitat.[4] Up to 19 mobile homes nearest the river would be moved or purchased and replaced.

• **Dorre Don Way SE Elevation (Orchard Grove) (CIP 3101):** Approximately 650 linear feet of Dorre Don Way SE would be raised an average of two feet to ensure access to 15 houses in the Orchard Grove neighborhood currently cut off by floodwater at about the 10-year flood event.

• **Getchman Levee Modifications (CIP 3105):** Frequent damage to the Rhode levee, which protects nearly 20 houses, would be reduced by moving the Getchman levee back from the Cedar River and strengthening the faces of both structures using bioengineering techniques. One or two houses at the downstream end of the Rhode levee would be removed.

• **Person Revetment Modifications (CIP 3113):** A private revetment would be recontoured and strengthened using bioengineering techniques to prevent continued release of large quantities of sediment. In addition, a gravel mine-site and landslide scar would be stabilized with vegetation.

• **Arcadia/Noble Flood and Erosion Damage Reduction (CIP 3100):** One house at the downstream end of this frequently damaged revetment would be removed and up to 1,600 linear feet of revetment would be modified using bioengineering techniques.

Programmatic Recommendations

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

* **Open Space Acquisition (BW 4):** Sites in the Cedar River floodplain have been identified and prioritized for acquisition as open space to allow protection or restoration of their aquatic habitat value. See Tables 4-1 and 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their mainstem mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Road/Urban Runoff Water Quality Recommendations (BW 9):** The drainage facilities of I-405 and numerous County roads would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff.

* **Water Quality Treatment Standards (BW 12):** Sphagnum bog water quality treatment standards would be applied to all development in catchment MS 16 that drains to Wetland 38 to

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[4] Bioengineering techniques use materials such as rock, timbers, soil, plants, and natural fabrics to reduce erosion and stabilize steep slopes.

maintain the health of this wetland. Regionally significant resource area (RSRA) stream protection standards would reduce concentrations of toxic metals in catchments draining to river reaches at RM 9.6-10.7, RM 15.7-15.9, and wall base tributaries at RM 11.5 and RM 14.9.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of Plan recommendations.

* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small-scale forestry demonstration site, and individual recognition of good forest stewards.

* **Masonry Dam Operations Study (MS 1):** Masonry Dam operations would be analyzed in cooperation with the Seattle Water Department and affected parties for the purpose of developing flood season operating guidelines that enhance flood control, assure power generation, and improve water supply availability for both instream and consumptive uses.

* **Renton Reach Capacity (MS 2):** The ongoing City of Renton/Army Corps of Engineers study of flood-damage reduction alternatives in the lower Cedar River channel should be supported. Neighboring jurisdictions, tribes, and resource and permitting agencies would be encouraged to participate.

* **Seek State and Federal Funding for Flood-Hazard Reduction Measures (MS 3):** King County, acting as "local sponsor," will continue to request state and federal aid to help reduce flood damage along the Cedar River.

* **Mainstem Habitat Restoration and Enhancement Program (MS 4):** Where consistent with state and tribal goals, aquatic habitat and floodplain areas would be restored or enhanced. Types of projects may include construction of ponds and channels and removal or reconfiguration of levees and revetments. Many such sites are listed in Chapter 4, and they will be more fully described in a separate technical document.

* **Channel Migration Hazard Areas (MS 6):** The risk of severe hazards to human life would be reduced by the limitation of new development in areas where the Cedar River channel is most likely to migrate in the next 100 years.

* **Floodplain Mapping Analysis, Revision, and Distribution (MS 7):** Existing County and federal floodplain maps should be revised to reflect the latest floodplain information, and gages along the Cedar River should be replaced, augmented, or recalibrated to aid in future map revisions.

* **Flood Education (MS 8):** Reduce flood damage by making floodplain residents more aware of safe evacuation routes and the extent of the floodplain, and by teaching them flood protection and damage reduction techniques. This recommendation would expand existing county and City of Renton public education programs in these areas.

* **Debris Flow Protection for Mobile Home Park (MS 12):** Owners of a mobile home park on Tributary 0313, which is at risk of severe damage from debris flows, would be provided with a list of alternative private actions that could be taken to reduce their risk.

• **Salmonid Productivity (BWs 7 and 8*):** These recommendations would support an ongoing study to determine the causes of salmon decline, and would continue to support a temporary sockeye hatchery at Landsburg, and reserve the option to use County open space at RM 9.0 for possible future development as a spawning channel. A final decision to construct a spawning channel at this site will depend on results of the Lake Washington Ecological Studies and additional evaluation of the environmental impact of a spawning channel at this site relative to others, and comparison to other production methods that could produce the desired sockeye fry production with less cost and environmental impact. The final decision will be made by the Cedar River Sockeye Spawning Channel Policy Committee, or its designee.

• **Stormwater Quality (MS 9, 10*, 11):** Extensive source control strategies for cleanup efforts and elimination of stormwater pollutants are recommended for industrial and commercial areas (MS 10). Stormwater discharges from major highways and the Renton Municipal Airport would be addressed by National Pollutant Discharge Elimination System industrial stormwater pollution prevention plans (MS 9, MS 11) and the Washington State Department of Ecology Highway Runoff Program.

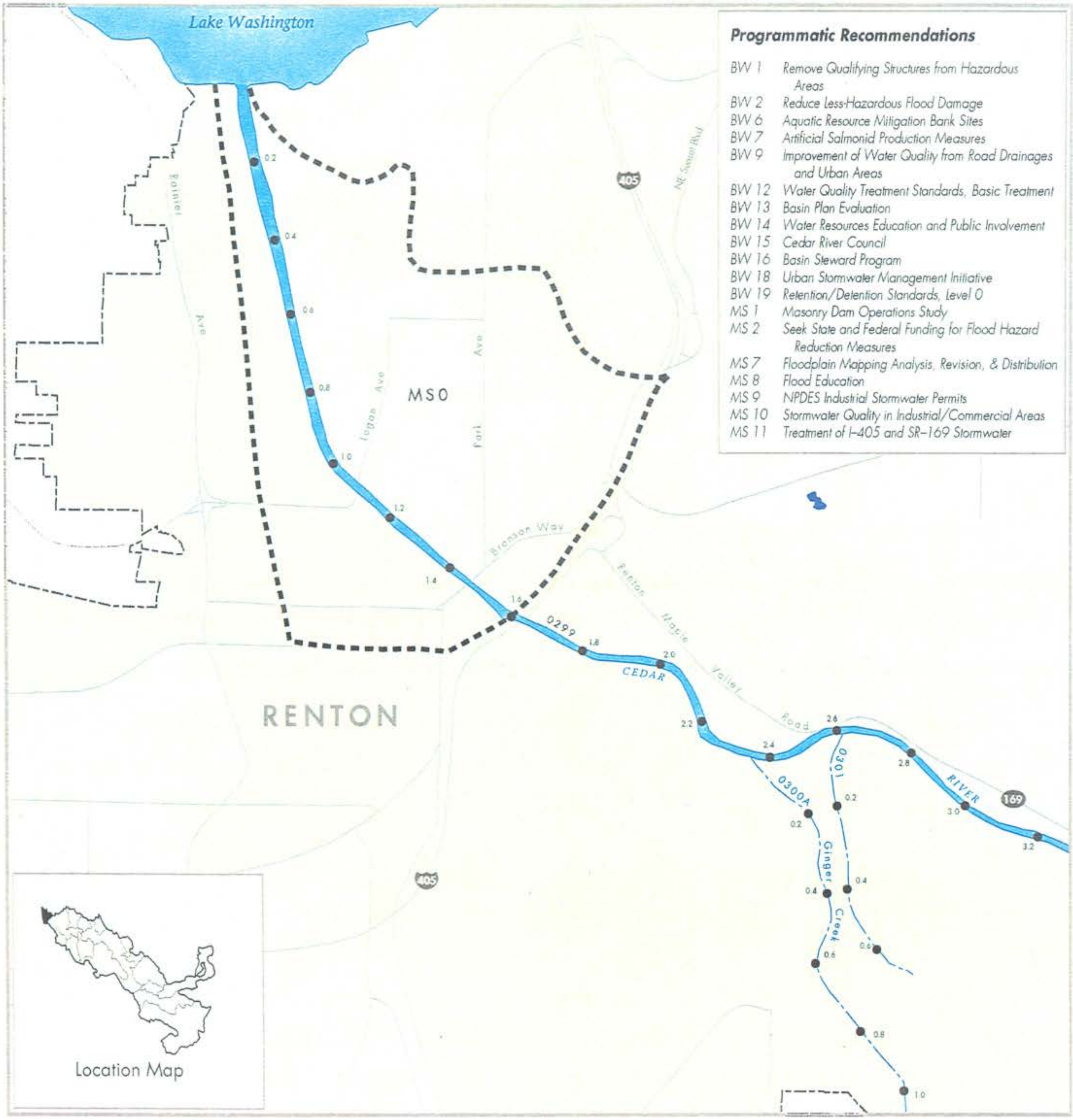
• **Remove Qualifying Structures from Hazardous Areas (BW 1):** Occupied structures at high risk of hazardous flooding, and not included in the CIPs above, would be removed from the floodplain on a willing-seller basis as they are identified and as funding is available.

• **Reduce Less-Hazardous Flood Damage (BW 2):** Occupied structures at risk of less-hazardous flooding, many of which are identified in the full text of this recommendation found in Chapter 4, may be eligible for technical and limited financial assistance for removal or other floodproofing.

• **Modify Levees and Revetments (MS 5):** Selected County-maintained levees and revetments would be modified, relocated, or removed to reestablish aquatic habitat and increase the storage volume of the floodplain.

• **Aquifer Protection (BW 17):** Aquifer recharge and groundwater quality would be protected as a potable drinking water source.

• **Urban Stormwater Management (BW 18):** To promote more efficient use of land in the Renton Urban Growth Area, public/private partnerships would be encouraged to build regional stormwater quality and quantity treatment facilities..



Cedar River Mainstem Reach 1

Figure 3-2

Cedar River Basin Planning Area Recommendations

0299 Stream & Stream Number
Lake/River
3.6 River Mile (RM)
Wetland
Subbasin Boundary
Catchment Boundary
MS0 Catchment Number
Incorporated Area (as of 6/98)

N

0 1/4 1/2 Mile

Map produced by:
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Public Outreach Section
9806cedarBPreach1 3-2 WG

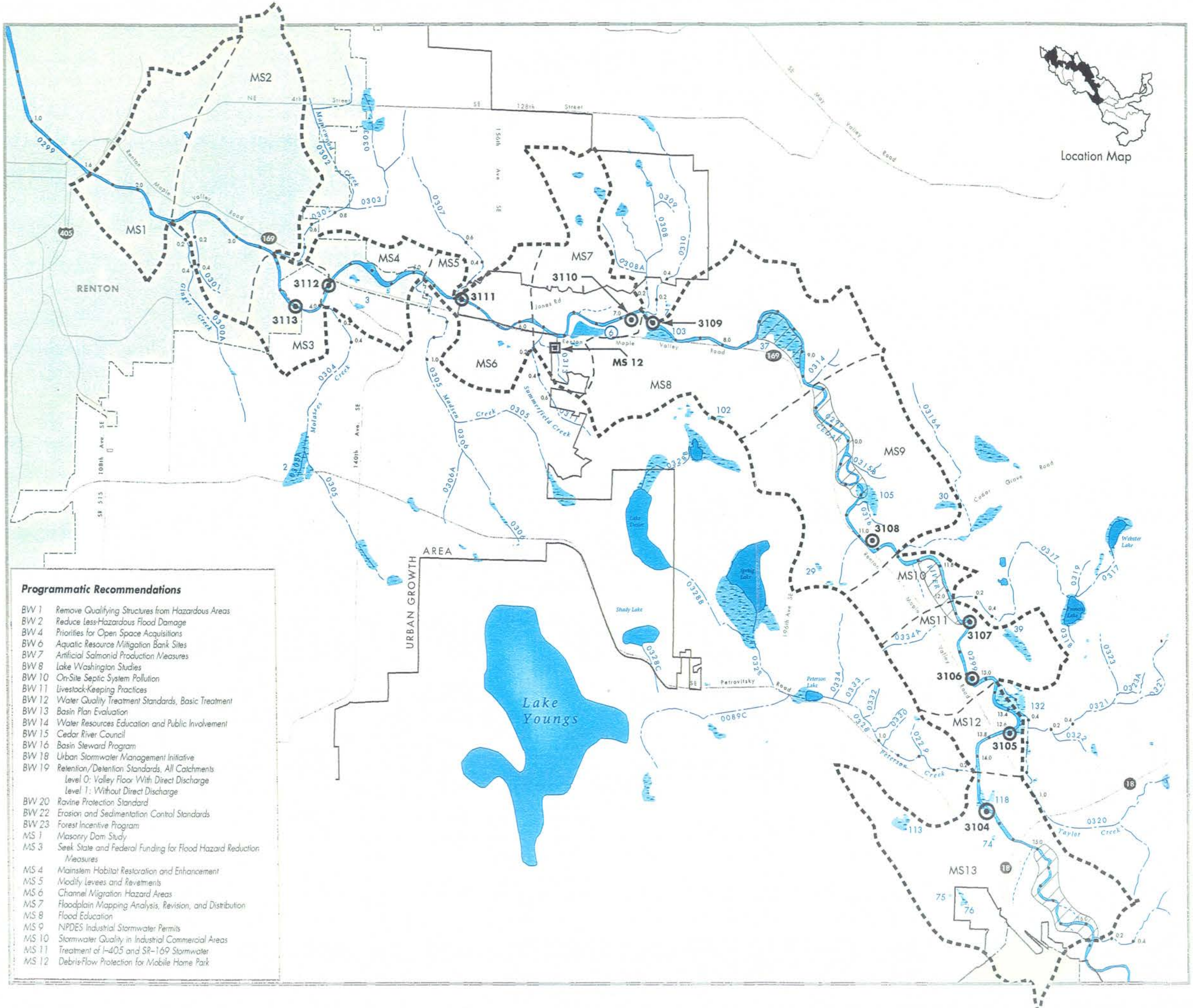

Figure 3-3

Cedar River Mainstem Reach 2

Cedar River Basin Planning Area Recommendations

- Stream & Stream Number
- Unclassified Stream
- Lake/River
- River Mile (RM)
- Wetland & Wetland Number
- Class I Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- MS1 Catchment Number
- Urban Growth Area Boundary (as of 6/98)
- Incorporated Area (as of 6/98)
- 3122 Capital Improvement Project Location & Number

Programmatic Recommendations:

- MS 6: Channel Migration Hazard Areas
- MS 12: Debris Flow Protection for Mobile Home Park

N

0 1/2 1 Mile

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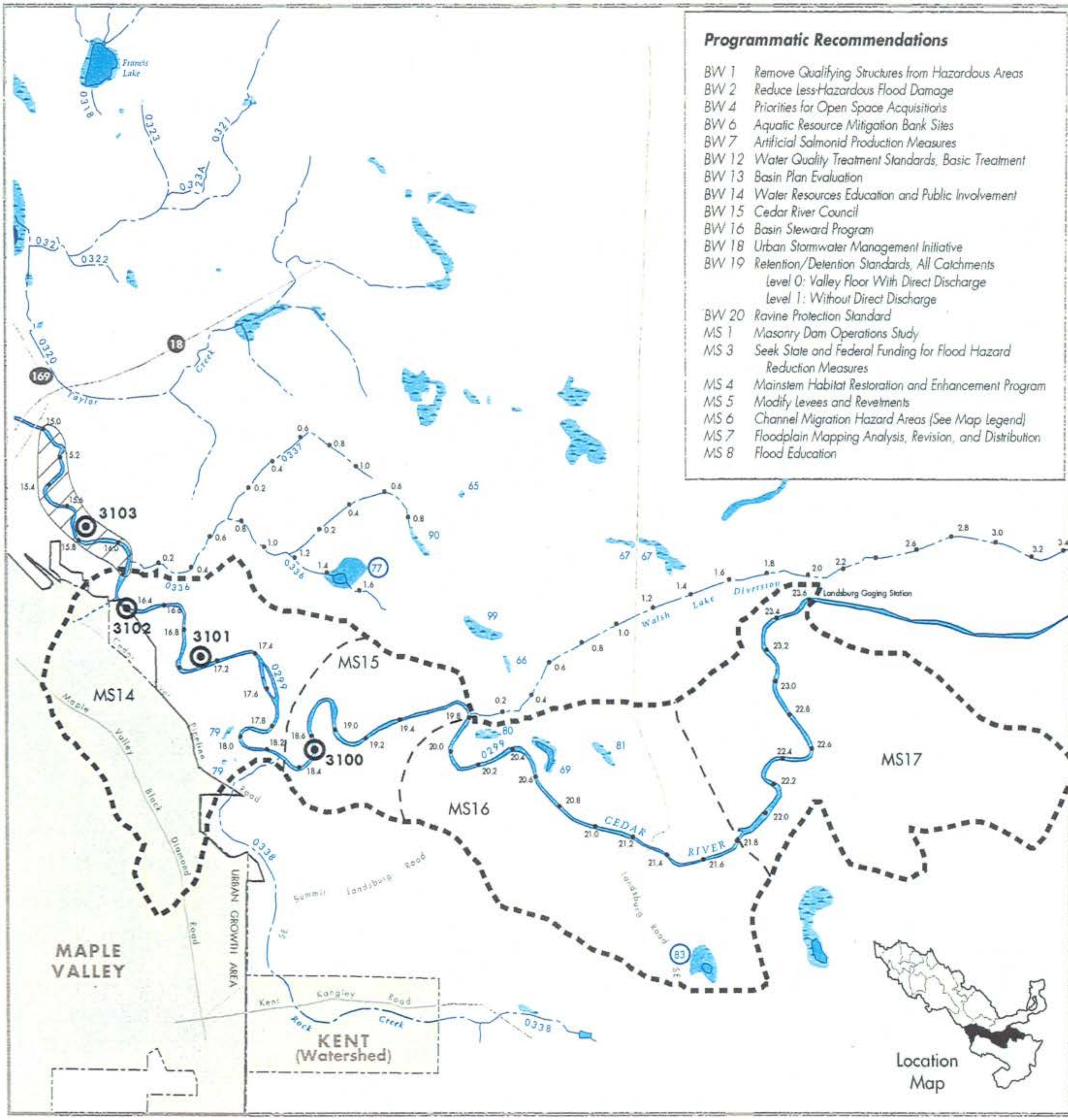

Cedar River Mainstem Reach 3

Figure 3-4

Cedar River Basin Planning Area Recommendations

- 0299 Stream & Stream Number
- Unclassified Stream
- Lake/River
- 3.6 River Mile (RM)
- 77 Wetland & Wetland Number
- (83) Class I Wetland & Wetland No.
- Subbasin Boundary
- Catchment Boundary
- B1 Catchment Number
- 3122 Capital Improvement Project Location
- Incorporated Area (as of 6/98)
- Urban Growth Area Boundary (as of 6/98)

Programmatic Recommendations:

MS 6: Channel Migration Hazard Areas

N

0 1/2 1 Mile

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Northern Tributaries

INTRODUCTION

The Northern Tributaries subarea is composed of the subbasins of Maplewood Creek and the Orting Hill, Cedar Grove, Cedar Hills, and Webster Lake tributaries. They all display the three-part profile typical of the western portion of the basin planning area, originating on the gently sloping plateau above the Cedar River, dropping through steep ravines cut into the valley wall, and finally flowing across the low-gradient valley floor to meet the Cedar River.

Land use is mostly residential, and is generally densest in the west, changing gradually from urban in the Maplewood Creek subbasin to relatively rural in the Webster Lake area. Maplewood Creek and the Orting Hill and Cedar Grove tributaries are inside the urban growth boundary, so most future growth is expected to be concentrated here.

Local drainage problems and minor flooding are fairly common on the poorly drained plateau during larger storms, but hazardous flooding has not been a serious concern here in the past, nor is it expected to be in the future.

In addition to the expected loss of aquatic habitat through encroachment or outright displacement of wetland and stream area by development, some of the undeveloped ravines in this subarea have experienced the loss of previously high-quality habitat as increases in stormwater runoff have accelerated natural rates of erosion and mass wasting. The resulting sediment reduces the flow capacity of the channels, causing flooding and impacting habitat still further.

Water quality in the Northern Tributaries is currently impacted by land development. In the western portion, within the proposed urban growth boundary, development is expected to intensify, further increasing pollutant loadings associated with urbanization—such as road drainage, household hazardous wastes, pesticides, and herbicides. In addition, areas within the Maplewood Creek subbasin have also experienced higher than average septic system failures.

Still, of the entire basin planning area, the East Renton Plateau, which is inside the urban growth boundary and has relatively low-density development, is best suited to higher intensity land uses. This is because it has the lowest resource value of any area in the basin, and it lacks the high quality aquatic resource values that still remain outside the urban growth boundary. If higher density is to be accommodated in this subarea, however, measures such as those that follow will be needed to protect the City of Renton's sole-source aquifer, protect and restore and the remaining wetland and stream resources, and reduce current and projected drainage problems, while allowing available land to be used most efficiently in the future. In addition, any proposal for density changes would require a comprehensive plan amendment involving an environmental review and opportunity for public comment and approval by the City or County council, as appropriate.

The Basin Plan's principal capital recommendation for this subarea would reduce flooding in the Puget Colony Homes subdivision and erosion in Maplewood Creek ravine. Several additional capital projects would reduce less significant flooding and restore or enhance a number of degraded aquatic habitats. Several programmatic recommendations would seek to reduce erosion, habitat damage, and water quality degradation that are projected to occur in this urbanizing subarea.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown on Figures 3-5, 3-6, and 3-7 at the end of this section. Note that some of these recommendations apply in other subbasins and so have already been described earlier in this chapter.

Capital Improvement Projects

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

*** Maplewood Creek Habitat and Drainage Improvements (CIPs 3120*, 3122*, and 3123):** Three interrelated CIPs are recommended for Maplewood Creek (Tributaries 0303, 0304). In the headwaters of the east fork of the creek (Tributary 0303), drainage system improvements would address frequent flooding problems in the Puget Colony Homes subdivision. The solution to the flooding, however, is designed so that there would be no increase in flows to the currently eroding ravine that carries the east fork from the subdivision down the valley wall. The next project would stabilize this ravine to stem erosion and subsequent downstream sedimentation; the same would be done in the steep reaches of the west fork. In the lowest reach, fish passage would be provided by replacing two existing sediment ponds, which capture the eroded sediment, with an improved one that is designed to allow upstream fish passage.

*** Retrofit Retention/Detention (R/D) Ponds (CIP 3127):** Existing R/D facilities would be retrofitted, where feasible, with additional capacity and water quality controls.

*** Tributary 0316A and Wetland 32 Restoration (CIP 3126):** Large woody debris would be placed in the eroded channel, and denuded banks would be revegetated along a half-mile reach to restore the habitat function of this once-productive small stream. The north side of Wetland 32 would be fenced. In addition, related recommendations for management of the Stoneway Gravel Mine (Northern Tributaries recommendation NT 1) would address both habitat and water quality concerns in this tributary.

• **Tributary 0303A Culvert Replacement and Rechanneling (CIP 3121):** A damaged 12-inch culvert would be replaced with a larger size to reduce flooding at the intersection of SE 132nd Street and 146th Avenue SE. Polluted road runoff would be treated by restoring an existing 300-linear-foot storm drain pipe as an open channel.

• **Orting Hill Tributary (0307) Realignment (CIP 3124):** The lowest reach of Orting Hill tributary (Tributary 0307) would be realigned into a new fish-usable channel and constructed wetland complex along lower Jones Road, possibly as mitigation for the construction of the new Elliot Bridge or other road projects in the area.

• **Wetland 36 Restoration and Protection (CIP 3125):** Wetland 36 (Francis Lake) is a Class 1 wetland that provides an excellent opportunity for wildlife habitat restoration and enhancement by voluntary actions or by joint public/private efforts.

Programmatic Recommendations

* **Open Space Acquisition (BW 4):** One site in the Northern Tributaries subarea has been identified for open space acquisition due to its aquatic habitat values. See Tables 4-1 and 4-2 in Chapter 4.

* **Small Scale Watershed Restoration and Enhancement (BW 5):** The Water and Land Resources (WLRD) Division's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16) would undertake small, labor-intensive projects in the Northern Tributaries subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Northern Tributaries subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Water Quality Basinwide Recommendations (BWs 9, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources from highly urbanized systems (BWs 14 and 16).

* **Water Quality Treatment Standards (BW 12):** Sphagnum bog water quality treatment standards would be applied to all development in catchment W4 that drains to Wetland 33 (Webster Lake).

* **Basin Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on structural habitat and water quality.

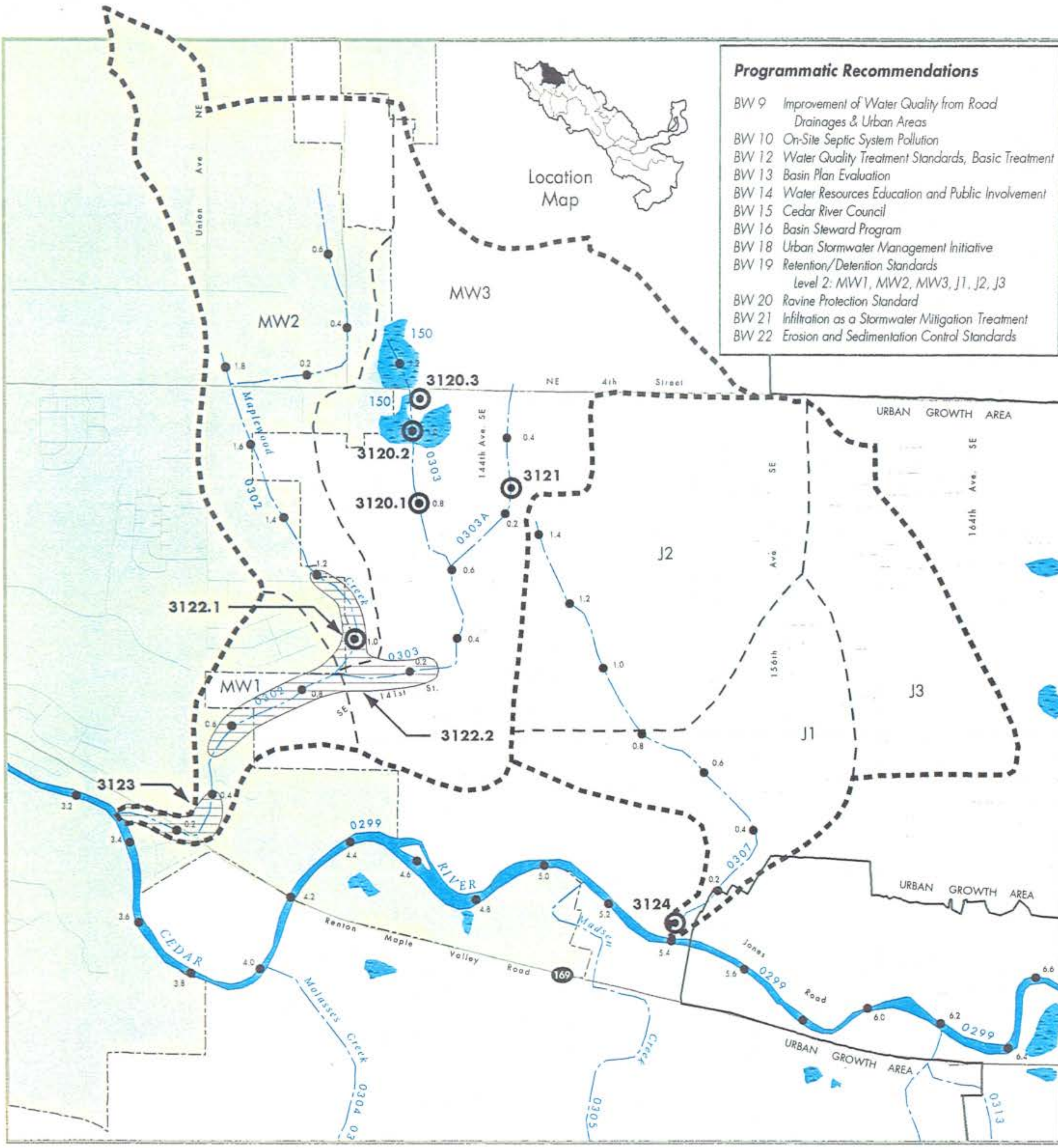
* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

• **Increased R/D and Runoff Controls (BWs 19*, 20, 21, and 22):** Regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19, 20, and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22) are recommended to help reduce the expected future habitat problems associated with the minor flooding and significant erosion in the Maplewood Creek and Orting Hill, Cedar Grove, and Cedar Hills tributary subbasins. See Figure 4-1 and Table 4-3 in Chapter 4.

• **Aquifer Protection (BW 17):** Aquifer recharge and groundwater quality would be protected as a potable drinking water source.

• **Urban Stormwater Management (BW 18):** To promote more efficient use of land in the Renton Urban Growth Area, public/private partnerships would be encouraged to build regional stormwater quality and quantity treatment facilities.

• **On-Site Septic System Pollution (BW 10):** Support Sewer extensions to areas of septic tank failure within the urban growth boundary, where feasible.



Maplewood & Orting Hill Subbasins

Figure 3-5

Cedar River Basin Planning Area Recommendations

0299 Stream & Stream Number
Lake/River
3.6 River Mile (RM)
5 Wetland & Wetland Number
Subbasin Boundary
Catchment Boundary
J3 Catchment Number

Incorporated Area (as of 6/98)
Urban Growth Area Boundary (as of 6/98)

3113 Capital Improvement Project Location & Number
3117 Capital Improvement Project Area & Number

N

0 1/4 1/2 Mile

Map produced by:
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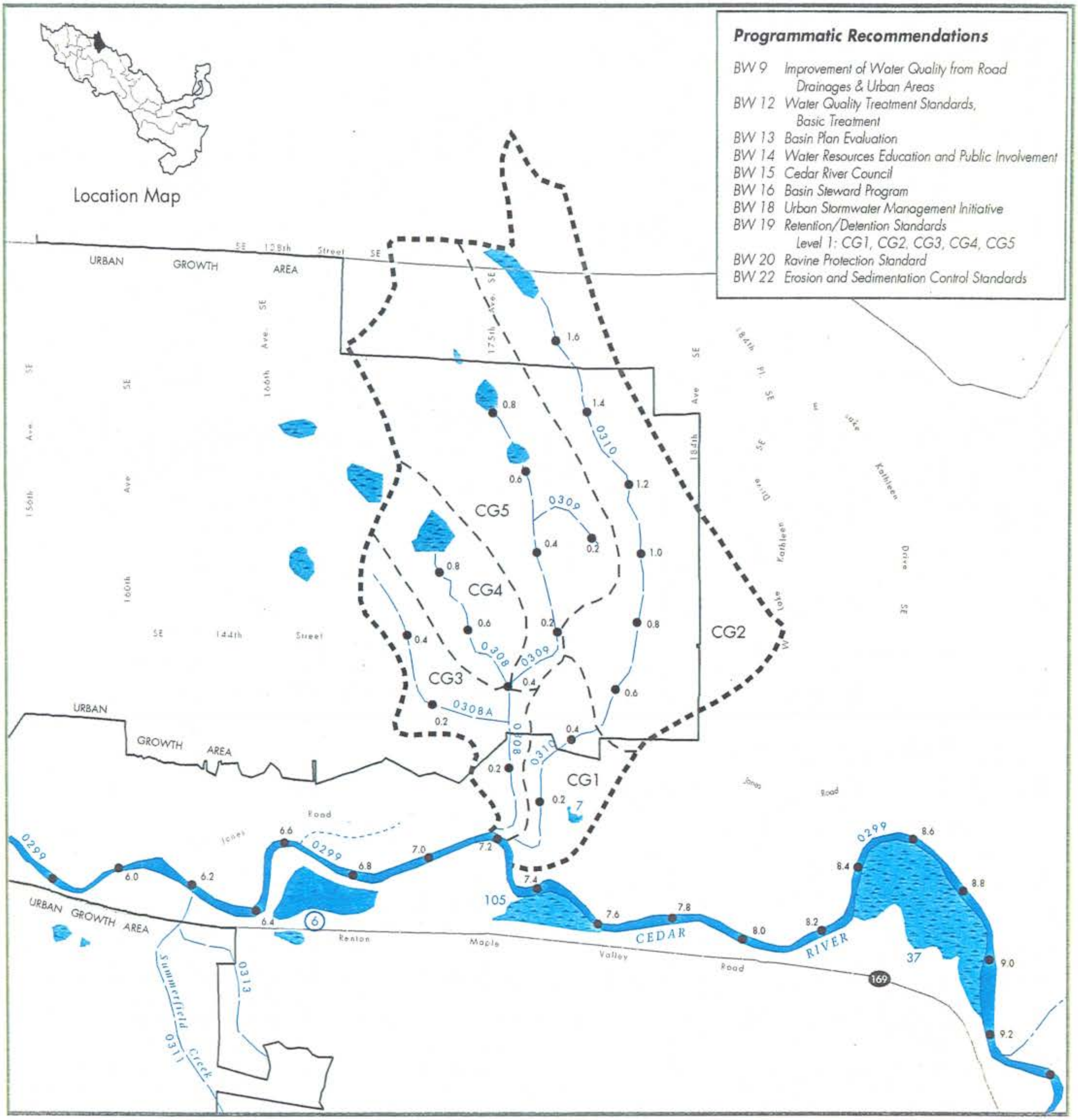
Public Outreach Section
9806cedarBPmaplewood3-5 WG



Cedar Grove Subbasin

Figure 3-6

Cedar River Basin Planning Area Recommendations

- 0299 Stream & Stream Number
- Unclassified Stream
- Lake/River
- 3.6 River Mile (RM)
- 5 Class 1 Wetland & Wetland Number
- 5 Unclassified Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- CG1 Catchment Number
- Urban Growth Area Boundary (as of 6/98)

N

0 1/4 1/2 Mile

Map produced by:
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Public Outreach Section
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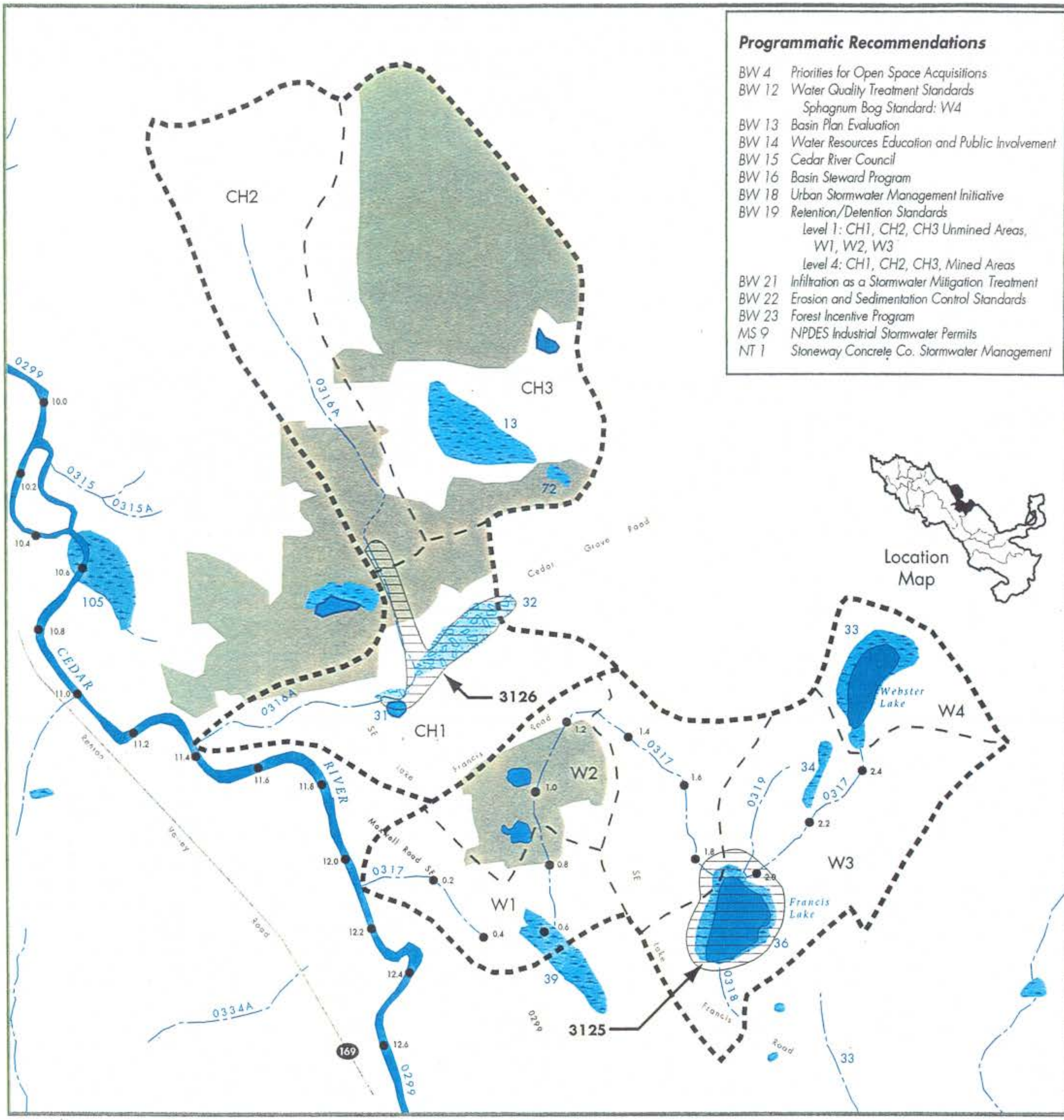

Cedar Hills & Webster Lake Subbasins

Figure 3-7

Cedar River Basin Planning Area Recommendations

- 0299 Stream & Stream Number
- Unclassified Stream
- 3.6 River Mile (RM)
- Lake/River
- 5 Class 1 Wetland & Number
- 5 Class 2 Wetland & Number
- 5 Unclassified Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- CH1 Catchment Number
- Landfill, Quarry Sites, or Compost Facility
- 3125 Capital Improvement Project Location & Number

N

0 1/4 1/2 Mile

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Southern Tributaries

INTRODUCTION

The Southern Tributaries comprise the individual subbasins of Ginger Creek, Molasses Creek, Madsen Creek, and Summerfield Creek. They are characterized by urban uplands on the plateau, steep eroding midslope reaches that retain some good aquatic habitat, and downstream reaches that impinge on valley floor development before crossing SR-169 and joining with the Cedar River mainstem. Except for the forested ravines, land use is almost entirely medium- to high-density residential.

Increasing flows and inadequate drainage facilities have caused flooding problems on the uplands of Molasses Creek and stream channel erosion along several of the channels' midslope reaches, particularly on Madsen and Summerfield creeks. The sediment mobilized by this erosion, in turn, has caused significant damage to aquatic resources and downstream development. Pollution associated with high-density development in Ginger, Molasses, and Madsen creeks threatens water quality; in addition, breaks and leaks in the sewer line that occupies the ravine of Madsen Creek may threaten water quality.

Past drainage projects in this subarea have been extensive, including a reconstructed lower Madsen Creek channel, a sediment pond with "high-flow" bypass farther upstream, and a 1,000+ foot tightline down the ravine of Summerfield Creek. In addition, major capital projects are underway along Madsen Creek: localized sewer line protection and channel stabilization by large woody debris, and an upland R/D pond in Fairwood Golf Course.

The solutions recommended for these subbasins seek to correct the most significant of the flooding and erosion problems; some restoration of aquatic habitat is recommended but limited to locally significant resource area (LSRA) reaches of Madsen and Molasses creeks, and the LSRAs and RSRAs of two upper plateau wetlands. Water quality improvements would be achieved through the application of basinwide urban stormwater best management practices (BMPs) and correction of the high-flow-related erosion in the ravines. Future planned work includes sediment pond, channel, and culvert modifications below the Madsen Creek ravine and channel work farther upstream as part of the sewer line protection project, intended to improve channel stability.

The most noteworthy result of these recommended solutions should be significant reduction, albeit at great expense, of the erosion problem and consequent water quality and aquatic habitat damage in Madsen Creek. One Class 1 wetland is identified for restoration and protection; two very significant flooding problems appear to be amenable to relatively simple and inexpensive solutions. Water quality problems are inferred from the highly urban nature of development in the area and will receive commensurate treatment.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown on Figures 3-8, 3-9, and 3-10 at the end of this section. Note that some of these recommendations apply in other subareas and so have already been described earlier in this chapter.

Capital Improvement Projects

* Denotes core plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

*** Retrofit R/D Ponds with Water Quality Controls (CIP 3127):** Existing R/D facilities in the Ginger, Molasses, and Madsen Creek subbasins would be retrofitted, where feasible, with additional capacity and water quality controls.

*** Fairlane Woods Detention Pond Discharge Improvements (CIP 3130):** The outlet of the Fairlane Woods detention pond would be tightlined to the Cedar River (Cedar RM 3.8) to reduce erosion damage. Alternatively, the overflow riser of the detention pond would be raised to provide less effective, but far less expensive, protection.

*** Lower Madsen Creek Sediment Pond Outlet Improvements (CIP 3137):** The outlet of the lower Madsen Creek sediment pond (RM 0.8) would be reconfigured to reduce fish stranding in the high-flow bypass channel.

*** Molasses Creek LSRA Restoration (CIP 3134):** Restore the salmonid habitat of lower Molasses Creek (RM 0.0-0.8) by placing large woody debris and boulders in the stream channel and improving riparian conditions with plantings in this LSRA.

• **Madsen Creek CIPs (CIPs 3136 and 3137*):** The outlet of lower Madsen Creek sediment pond (RM 0.8) would be reconfigured to reduce fish stranding in the high-flow bypass channel and improve fish access into the Madsen Creek ravine (CIP 3137). To reduce erosive flows in the Madsen Creek ravine and tributaries, two tightlines would be installed in severely eroding ravines (Tributaries 0305A and 0305B), bioengineering techniques using large woody debris and boulders would be used where appropriate for bank stabilization (Tributary 0305, RM 1.4 to 2.2; Tributary 0306, RM 0.0 to 0.3), and Candlewood Ridge Division 1 detention pond (Tributary 0306, RM 0.8) would be increased (CIP 3136).

• **Wetland 16 Buffer Revegetation (CIP 3135):** The west side and outlet area of Wetland 16 would be revegetated to correct local buffer damage.

• **Fairwood Park Division 11 Detention Pond Retrofit (CIP 3133):** An existing detention pond would be expanded to restore required detention, eliminate house flooding, and improve water quality in Fairwood Park Division 11 (Molasses Creek RM 1.0).

• **Elevation of 140th Avenue SE at Wetland 22 (CIP 3131):** The 140th Avenue SE crossing of Wetland 22 (Molasses Creek RM 2.0) would be elevated to prevent road flooding without impacting the hydroperiod of the wetland. This recommendation is being incorporated into King County Roads Division's design of their upcoming road improvements to 140th Avenue SE.

Programmatic Recommendations

* **Wetland 16 Management Area (BW 3):** To help preserve Wetland 16, various buffering, clearing, and detention restrictions would be required of new development in the drainage basin of this RSRA wetland complex.

* **Open Space Acquisition (BW 4):** One site in the Southern Tributaries subarea has been identified for open space acquisition due to its aquatic habitat values. See Tables 4-1 and 4-2 in Chapter 4.

* **Small Scale Watershed Restoration and Enhancement (BW 5):** WLRD's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16), would undertake small, labor-intensive projects in the Southern Tributaries subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Southern Tributaries subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Water Quality Basinwide Recommendations (BWs 9, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources from highly urbanized systems (BWs 14 and 16).

* **Water Quality Treatment Standards (BW 12):** Sphagnum bog water quality treatment standards would be applied to all development in the Molasses Creek catchment (F4) that drains to Wetland 23 and to development in the Madsen Creek catchment (M6) that drains to Wetland 16.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on structural habitat and water quality.

* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

• **Increased R/D and Runoff Controls (BWs 19*, 20, 21, and 22):** Regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19, 20, and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22), are recommended to help reduce the expected future habitat problems associated with the minor flooding and significant erosion in portions of the Molasses, Madsen, and Summerfield Creek subbasins. Detention requirements for Ginger Creek and upper

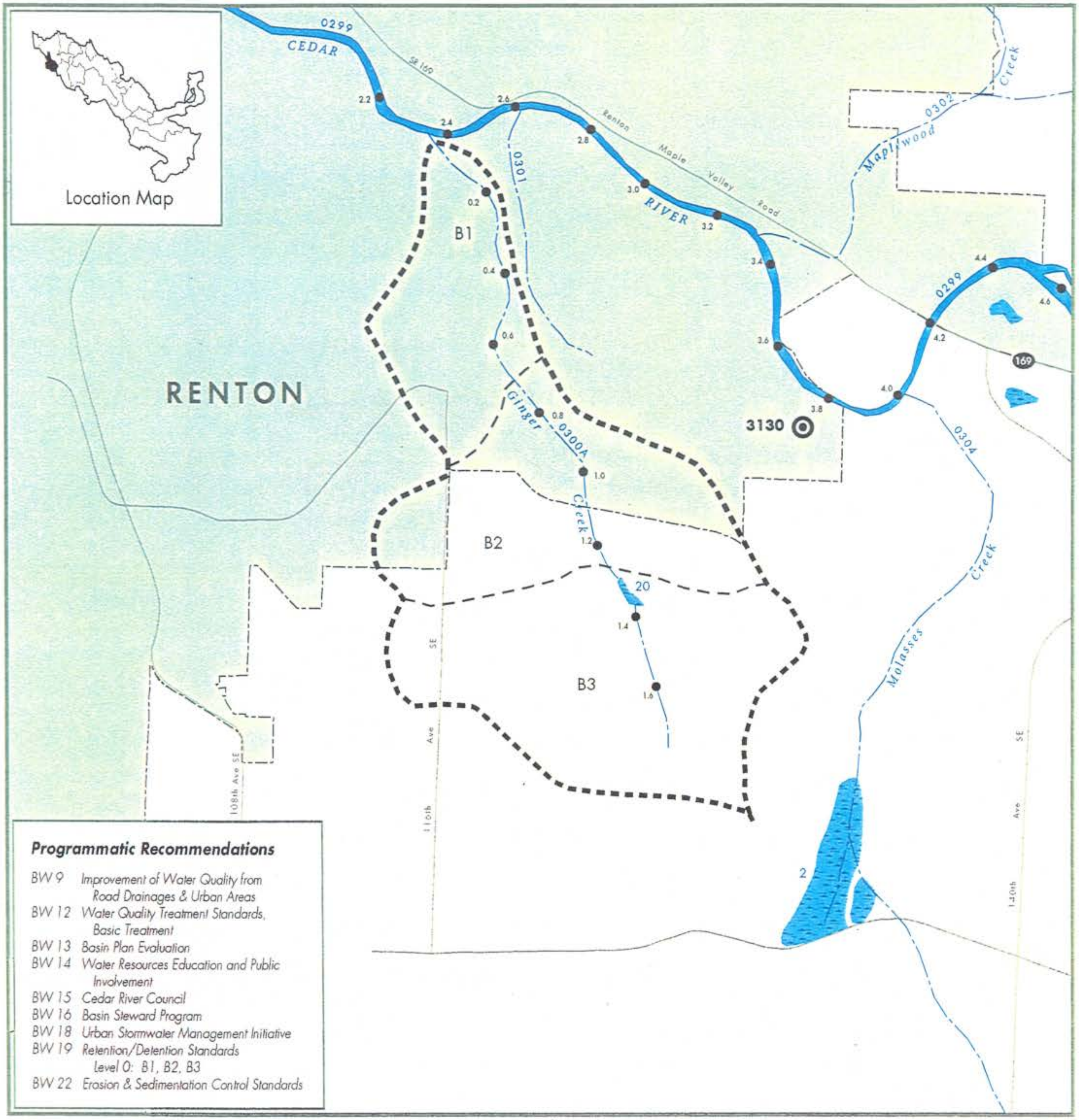
Summerfield Creek would be eliminated because of very limited effectiveness. See Figure 4-1 and Table 4-3 in Chapter 4.

• **Madsen Creek Water Quality (Southern Tributaries Recommendation ST 1):** To prevent long-term pollution of Madsen Creek and the mainstem of the Cedar River, the King County Wastewater Treatment Division (WTD) should develop a routine inspection and monitoring program to identify leaks in the Madsen Creek sewer line. In addition, the Fairwood Golf and Country Club should develop an approved Golf Course Management Plan to reduce contamination of local waters with pesticides and fertilizers.

• **Aquifer Protection (BW 17):** Aquifer recharge and groundwater quality would be protected as a potable drinking water source.

• **Urban Stormwater Management (BW 18):** To promote more efficient use of land in the Renton Urban Growth Area, public/private partnerships would be encouraged to build regional stormwater quality and quantity treatment facilities.

• **On-Site Septic System Pollution (BW 10):** Support sewer extensions to areas of septic tank failure within the urban growth boundary, where feasible.



Ginger Creek Subbasin

Figure 3-8

Cedar River Basin Planning Area Recommendations

- 0299 Stream & Stream Number
- Lake/River
- 3.6 River Mile (RM)
- 5 Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- B1 Catchment Number
- Incorporated Area (as of 6/98)
- 3130 Capital Improvement Project Location & Number

N

0 1/4 1/2 Mile

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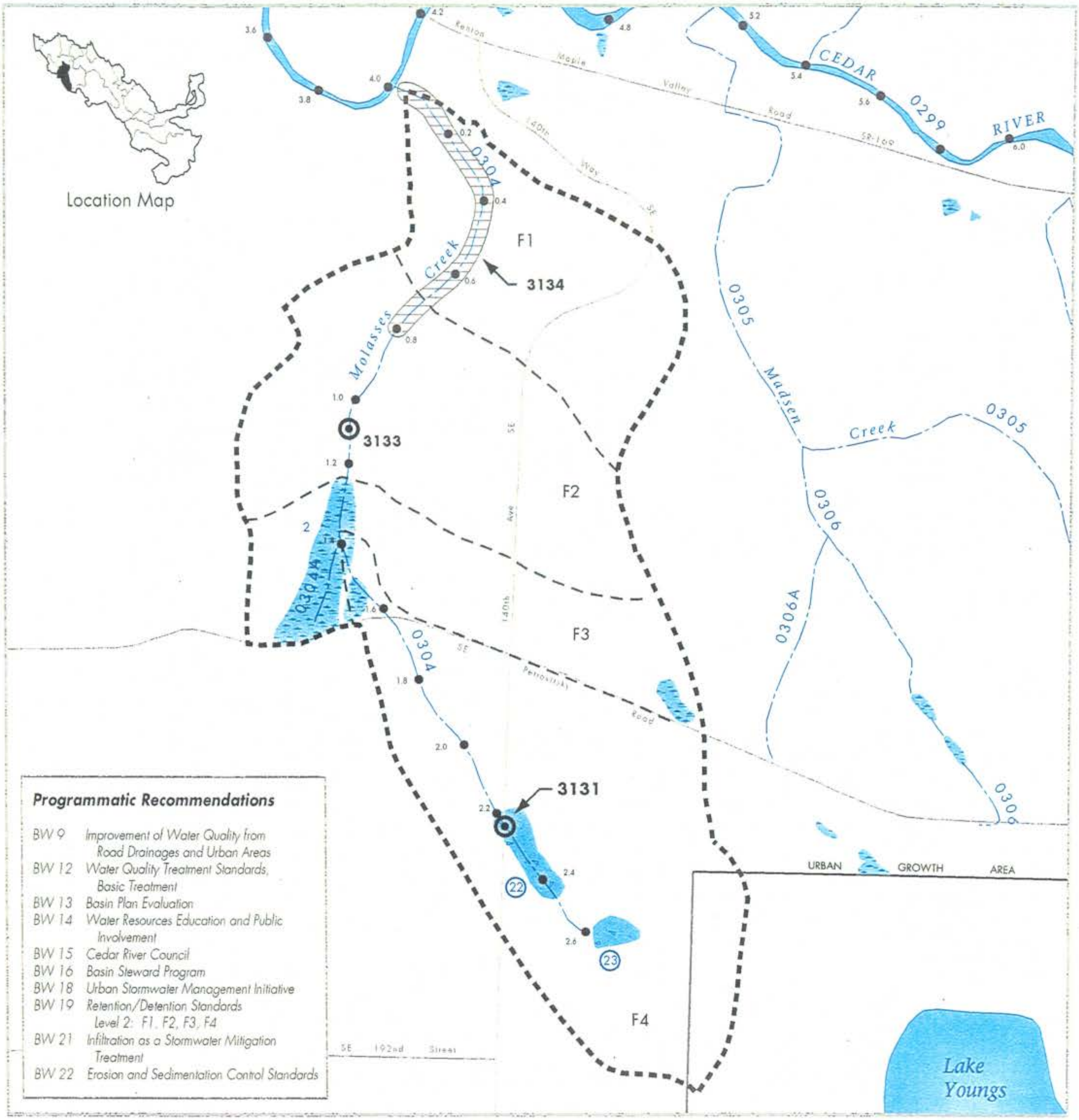


Molasses Creek Subbasin

Figure 3-9

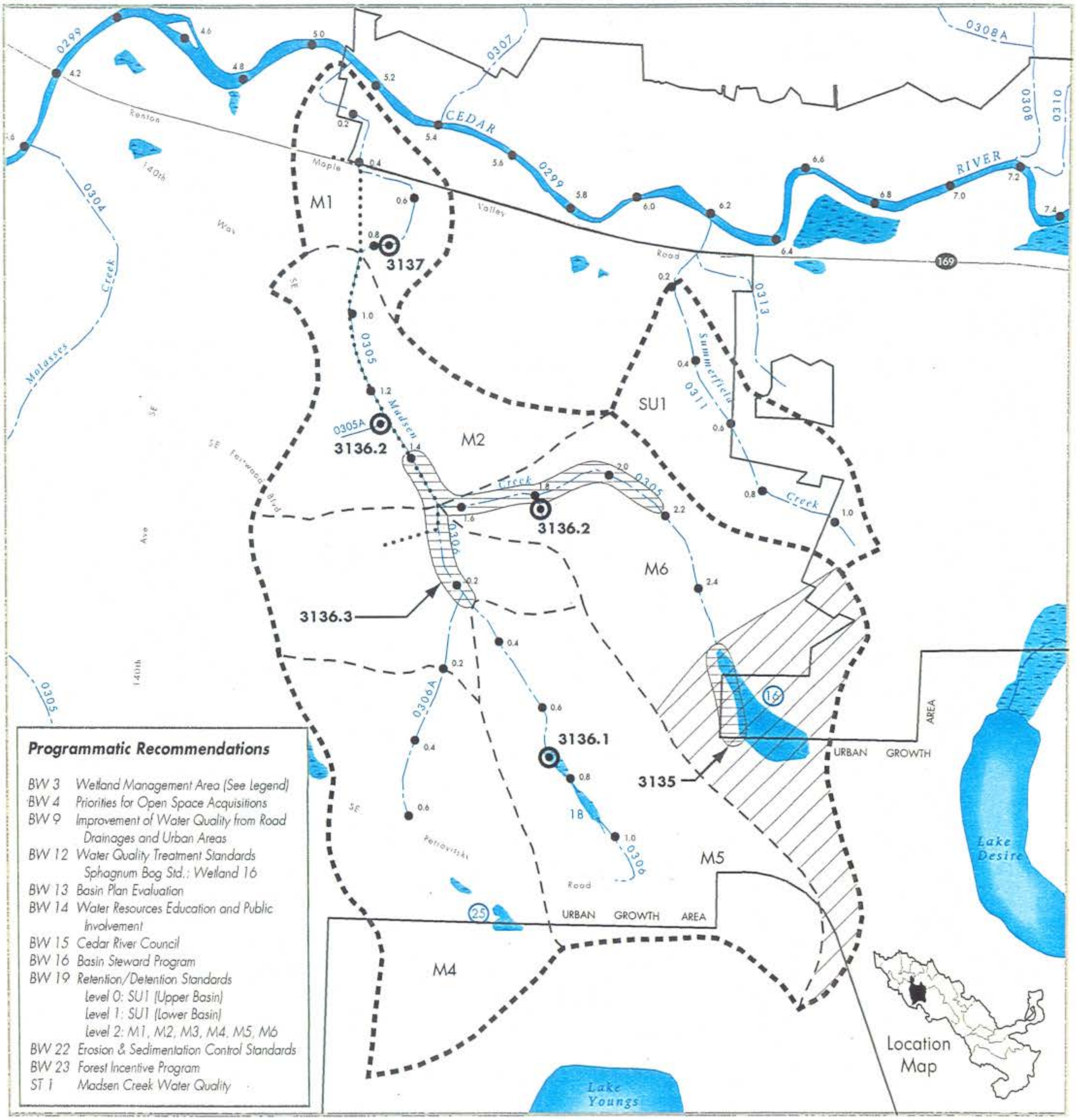
Cedar River Basin Planning Area Recommendations

- 0299 Stream & Stream Number
- Lake/River
- 3.6 River Mile (RM)
- 5 Wetland & Wetland Number
- (5) Class I Wetland & Number
- Subbasin Boundary
- F1 Catchment Boundary & Number
- Urban Growth Area Boundary (as 6/98)
- 1252 Capital Improvement Project Location & Number
- 1252 Capital Improvement Project Area & Number

N

0 1/4 1/2 Mile

Map produced by:
Visual Communication & GIS Unit,
Public Outreach Section
9806cedarBPmolasses3-9 WG



Madsen Creek & Summerfield Subbasins

Figure 3-10

Cedar River Basin Planning Area Recommendations

0299 Stream & Stream Number
3.6 River Mile (RM)
Lake/River
5 Wetland & Wetland Number
5 Class I Wetland & Number
Sewer line
Subbasin Boundary
Catchment Boundary
M1 Catchment Number
Urban Growth Area Boundary (as of 6/98)
1258 Capital Improvement Project Location & Number
1257 Capital Improvement Project Area & Number
BW 3 Wetland 16 Management Area

N

0 1/4 1/2 Mile

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Public Outreach Section
9806cedarBPmadsen3-10 WG

Taylor Creek

INTRODUCTION

The Taylor Creek system, composed of Tributaries 0320 through 0327, drains an area of approximately five square miles, developed almost entirely at rural densities. The generally flat terrain, combined with large expanses of slowly draining glacial till soils, has formed an extensive array of large wetlands. Many of these have been partly converted to pasture. Taylor Creek's gradient is less extreme than that of most of the Cedar River's other tributaries. This low gradient and the relatively low level of development to date have forestalled serious erosion, sedimentation, and stream habitat problems in most of the subarea. However, projected increases in stormwater runoff resulting from future development (15% in 10-year discharges and 35% in 100-year discharges) would likely accelerate these processes significantly. These flow increases are addressed by regulatory recommendations, including retention/detention requirements and clearing restrictions.

Frequent flooding of 225th Avenue SE and Maxwell Road SE is considered to be one of the most significant flooding problems to occur on any tributary in the basin planning area. In the creek's upper reaches, habitat degradation problems have resulted from increases in flows, clearing and landscaping of creek buffers, and poor livestock-keeping practices.

The Taylor Creek subarea has the highest concentration of livestock in the Cedar River basin. Direct access by livestock to the stream and the lack of adequate livestock management have degraded Taylor Creek's water quality. Several roads, including SR-18, drain directly into the stream. The relatively high pollutant loadings from road runoff, combined with the natural softness of the water and low flows, have resulted in high concentrations of toxic metals.

If fully implemented, this Plan would realign lower Taylor Creek to restore significant aquatic habitat and reduce flooding of Maxwell Road, and reduce erosion, restore and preserve additional habitat, and both improve current water quality in the subarea and slow the projected rate of its degradation in the future.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown in Figure 3-11 at the end of this section. Note that some of these recommendations apply in other subareas and so have already been described earlier in this chapter.

Capital Improvement Projects

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

*** Maxwell Road SE Flood Abatement and Taylor Creek Restoration (CIP 3140):** To alleviate almost annual flooding near the intersection of Maxwell Road SE (225th Avenue SE) and SE 206th Street and to restore aquatic habitat in this reach (RM 0.6-1.0), Tributary 0320 would be moved from its current location in a roadside ditch to its historical floodplain to the east and the bridge at SE 206th Street would be enlarged.

*** Taylor Creek Habitat Restoration (CIP 3141 and 3142):** To restore instream aquatic habitat and reduce downstream sedimentation, large woody debris and rocks would be placed in Taylor Creek in appropriate locations. Conifers would be planted in the riparian corridor (Tributary 0320, RM 1.2-1.6) to improve cover and bank stability. Public/private partnerships would be encouraged to fence and restore forested buffers along stream reaches impacted by development (Tributary 0320, RM 1.6 to headwaters). To improve water quality and aquatic habitat, large woody debris should be placed in the channel and the stream corridor should be fenced and planted throughout the lower 0.2 mile of Tributary 0321 (north fork of Taylor Creek).

Programmatic Recommendations

*** Priorities for Open Space Acquisition (BW 4):** One site in the Taylor Creek subarea has been identified for acquisition as open space due to its aquatic habitat value. See Tables 4-1 and 4-2 in Chapter 4.

*** Small Scale Watershed Restoration and Enhancement (BW 5):** WLRD's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16), would undertake small, labor-intensive projects in the Taylor Creek subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

*** Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Taylor Creek subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

*** Water Quality Basinwide Recommendations (BWs 9, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources from highly urbanized systems (BWs 14 and 16).

*** Livestock Keeping Practices (BW 11):** To reduce livestock-caused nonpoint water pollution, King County, the King Conservation District, and other agencies will implement and extended livestock technical assistance, cost sharing, and education program. As part of this program, a model farm would be established in the Taylor Creek subarea as an example to encourage noncommercial animal owners to implement best management practices prior to the 1998 date established by the King County Council for County enforcement of the 1993 livestock restrictions in King County Code Chapter 21.A.30.045-.075.

*** Water Quality Treatment Standards (BW 12):** RSRA stream protection standards would reduce concentrations of toxic metals in Tributary 0320, RM 0.2-0.8.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on localized and downstream structural habitat and water quality.

* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

• **Increased R/D and Runoff Controls (BWs 19*, 21, and 22):** Regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19 and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22), are recommended to help reduce the expected future habitat problems associated with the flooding and erosion in the Taylor Creek subarea. See Figure 4-1 and Table 4-3 in Chapter 4.

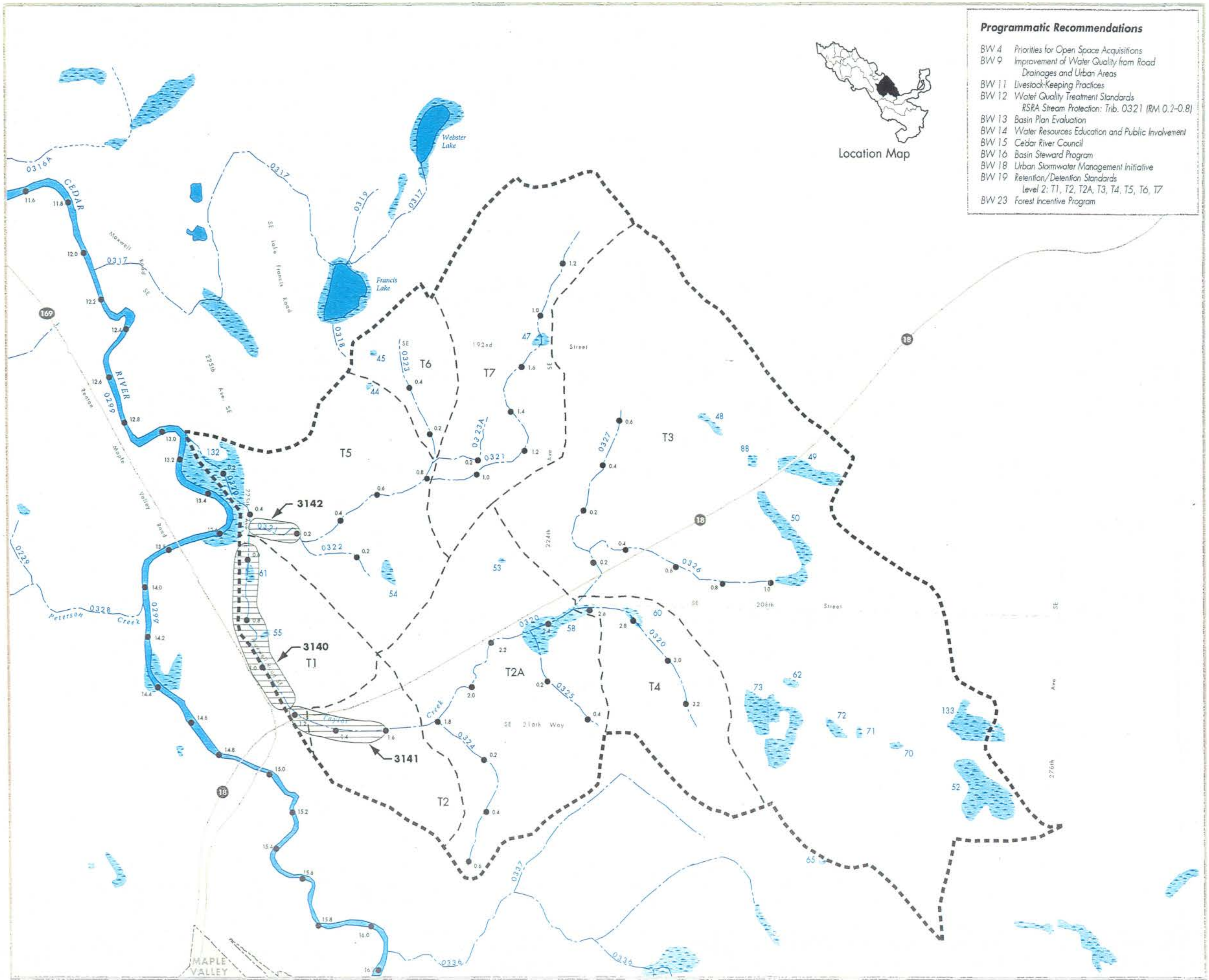

Figure 3-11

Taylor Creek Subarea

Cedar River Basin Planning Area
Recommendations

- Stream & Stream Number
- Lake/River
- River Mile (RM)
- Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- T1 Catchment Number
- 3122 Capital Improvement Project Area & Number
- Incorporated Area (as of 6/98)

N

0 1/4 1/2 Mile

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Peterson Creek

INTRODUCTION

The Peterson Creek subarea is unique among Cedar River subareas in that it contains a series of four large wetlands (14, 15, 28, and 42) and three lakes (Lake Desire, Spring Lake, and Peterson Lake). In addition, Shady Lake and its associated wetlands drain via a short tributary into the middle reach of Peterson Creek. These water bodies, along with extensive areas of forested and low-density residential land use, endow this subarea with a high degree of hydrologic buffering. As a result, most stream and wetland habitats remain in good to excellent condition compared to those in the nearby Molasses Creek and Madsen Creek subbasins. Exceptions include localized disturbance of the Peterson Creek stream corridor below Spring Lake, a quarter-mile-long channelized segment of the creek below Peterson Lake, and areas within the lower 0.7 mile of the creek that have been destabilized by past landslides, erosion, and incision. Significant incision has also occurred in several short tributaries that enter the creek from RM 0.6 to 1.5. Because of this, Peterson Creek has a high sediment load and is one of the larger tributary sources of coarse sediment to the Cedar River.

While peak flows under current conditions have increased only modestly compared to those in the more developed subareas, flows are predicted to increase as significant additional residential development occurs in the future. These flow changes could potentially destabilize sensitive instream and riparian habitat in the steep lower mile of the creek. Wetland encroachment and degradation could also increase, particularly near Lake Desire and Shady Lake.

The only significant flooding problem occurs around Lake Desire and along East Lake Desire Drive SE, which was built north of the lake in Wetland 15. A large uninventoried wetland extends from the outlet of the lake a considerable distance downstream along Tributary 0328B. The flooding conditions near the lake result primarily from flat topography combined with slow drainage through these extensive wetlands.

Septic system failure and, to a lesser extent, livestock-keeping practices have been identified as nonpoint pollution sources in this subarea. However, the threat from development is a more significant problem. The already serious eutrophication of Lake Desire is expected to increase significantly due to surrounding future development at urban densities. Half of the Lake Desire drainage basin and nearly all of the Shady Lake drainage basin lie within the urban growth boundary. Development to urban densities will considerably increase pollutants to these lakes. The Lake Desire Water Quality Management Plan (WLRD, 1995) has analyzed the lake's water quality problems and provided specific management strategies for implementation within the Lake Desire drainage area.

This Plan's proposed capital projects would reduce flooding around Lake Desire, restore and protect two large wetlands, and restore aquatic habitat and reduce erosion in two locations in Peterson Creek. In addition, high-quality habitat areas would be preserved through a suite of public and private actions, and projected increases in erosion damage and water quality degradation would be reduced.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown on Figure 3-12 at the end of this section. Note that some of these recommendations apply in other subareas and so have already been described earlier in this chapter.

Capital Improvement Projects

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

*** Retrofit R/D Ponds (CIP 3127):** Existing R/D facilities would be retrofitted, where feasible, with additional capacity and water quality controls.

*** Wetland 14 and 42 Restoration and Protection (CIP 3150, BW 4, and BW 6):** Property in two wetlands should be acquired, either in fee simple or as a temporary easement, and their natural habitat, water quality, and detention functions should be restored by the following means:

1. Wetland 14 (43-acre former peat mine): Acquire up to 80 acres as open space and restore this wetland to protect the water quality of Lake Desire and enhance fish and wildlife habitat.
2. Wetland 42 (Peterson Lake and associated buffer—up to 145 acres): Acquire as open space and restore to protect the lower Peterson Creek corridor and provide fish and wildlife benefits.

*** Peterson Lake Outlet Channel Restoration and Lower Peterson Creek Habitat Restoration (CIPs 3152 and 3153*):** To restore aquatic habitat and reduce erosion, underplant conifers, and add large woody debris to two reaches of Peterson Creek totaling about one mile, downstream from the outlet channel of Peterson Lake (RM 1.6).

*** Lake Desire Flood-Damage Reduction (CIP 3151):** East Lake Desire Drive SE, which provides sole residential and emergency access to 39 houses east of Lake Desire, is frequently flooded for long durations because of high lake levels. This recommendation would improve channel conveyance, enlarge an outlet culvert, and remove a beaver dam to lower lake levels. Recommendation PC 1, described below, would maintain these improvements.

Programmatic Recommendations

*** Wetland Management Areas (BW 3):** New development in the catchments of Wetlands 14, 15, 28 (Spring Lake), and 42 (Peterson Lake) would be required to provide 65-percent forest retention and 8-percent maximum impervious area, increased detention, roof downspout infiltration where practicable, and seasonal clearing restrictions in order to protect water quality and habitat in these lakes.

* **Open Space Acquisition (BW 4):** Two sites in the Peterson Creek subarea have been identified for open space acquisition due to their aquatic habitat values. See Tables 4-1 and 4-2 in Chapter 4.

* **Small Scale Watershed Restoration and Enhancement (BW 5):** WLRD's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16), would undertake small, labor-intensive projects in the Peterson Creek subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Peterson Creek subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Water Quality Basinwide Recommendations (BWs 9, 10, 11, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources from highly urbanized systems (BWs 14 and 16). Measures to reduce nonpoint pollution from livestock-keeping practices (BW 11) and septic systems (BW 10) would also apply.

* **Water Quality Treatment Standards (BW 12):** Sphagnum bog protection standards would be applied to all development draining to Wetlands 14 and 15 in catchment P7, and Wetland 28 in catchment P3 and P4. Lake protection standards would control total phosphorus (TP) loadings to the Lake Desire catchment (P6). RSRA stream protection standards would be applied to all development draining to Tributary 0328, RM 0.0-1.2.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on structural habitat, water quality, and lake shore flooding.

* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

• **On-Site Septic System Pollution (BW 10):** Support sewer extensions to areas of septic tank failure within the urban growth boundary, where feasible.

• **Increased R/D and Runoff Controls (BWs 19*, 21, and 22):** Regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19 and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22), are recommended to help reduce the expected future habitat problems associated with the flooding and erosion in the Peterson Creek subarea. See Figure 4-1 and Table 4-3 in Chapter 4.

• **Maintain Lake Outlet Channel (PC 1):** Intermittent high water levels in Lake Desire would be moderated by a public/private program to provide limited, low-impact maintenance of the lake's outlet channel.

• **Wetland 42 Reclassification (PC 2):** To provide Wetland 42 with more appropriate protection from encroachment, it should be reclassified from a Class 2 to a Class 1 wetland and its size should be changed from 14 to 23 acres in the *King County Wetlands Inventory.*

• **Shadow Ridge Drainage Study (PC 3):** This WLRD study would develop methods for enhancing the water quality and quantity benefits provided by the R/D facilities upstream of Wetland 14.

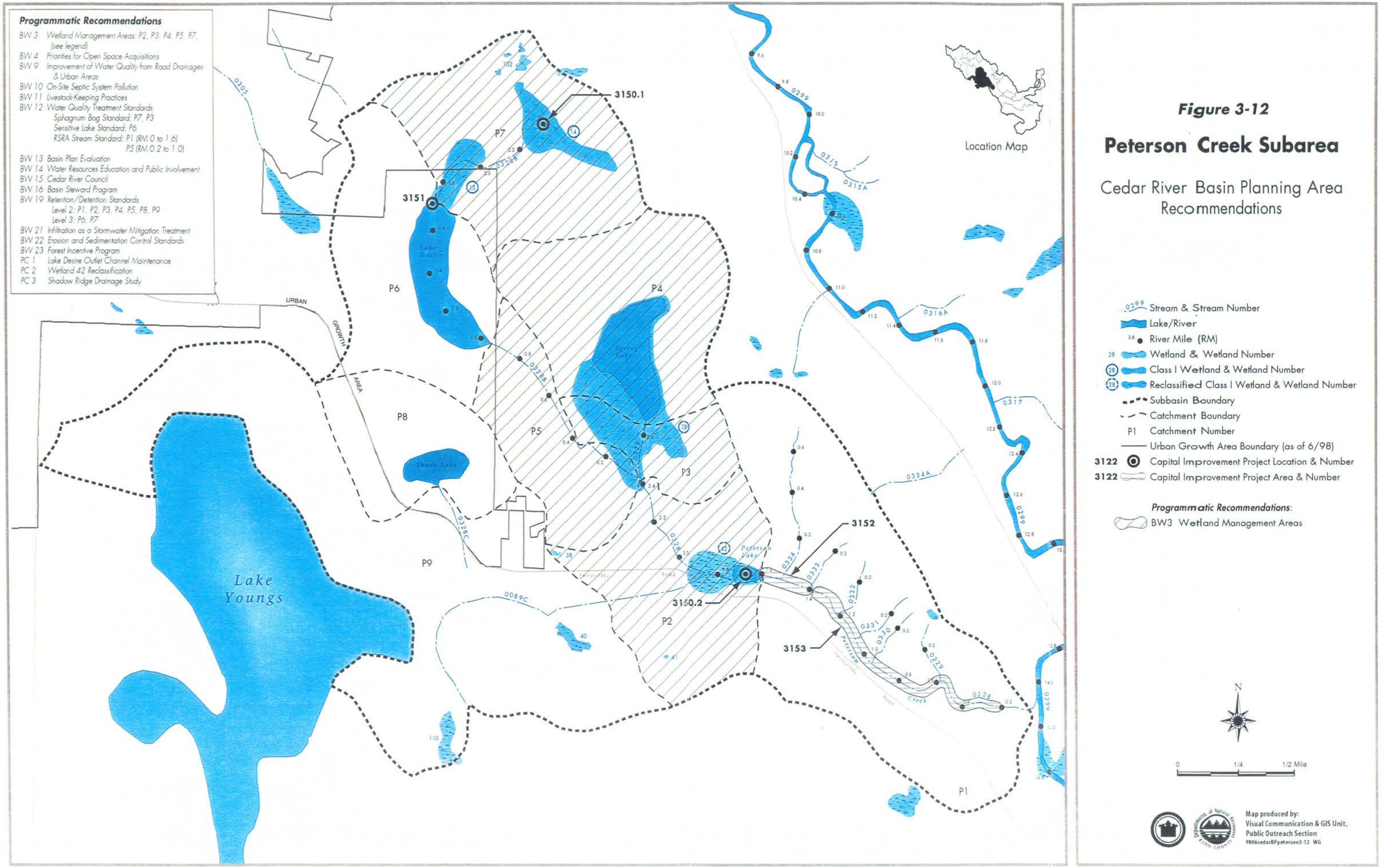


Figure 3-12

Peterson Creek Subarea

Middle Tributaries

INTRODUCTION

The Middle Tributaries include Dorre Don Creek (Tributaries 0336 and 0337) and the Walsh Lake Diversion Ditch (Tributary 0341), located in the northeasternmost part of the basin planning area.

Dorre Don Creek drains 860 acres, of which a majority are undeveloped forested land (75%) and the remainder are primarily devoted to low-density residential uses. The basin lies on the rural side of the proposed urban growth boundary, so future development will be largely of low-density, rural character. Wetland 77, a Class 1 system and locally significant resource area (LSRA), is located on the plateau at the headwaters of Dorre Don Creek at RM 1.4. Although disturbed by past logging, this wetland is currently in good condition and provides excellent wildlife habitat. Use of the Dorre Don drainage system by salmon is limited to winter spawning and refuge in the lower 0.2 miles of the creek. During the dry season, the creek recedes into porous outwash deposits along most of the length of Tributary 0336. In spite of the absence of perennial flow conditions, cutthroat and rainbow trout have been observed as far as 0.8 miles upstream from the mouth of the creek. Presumably these fish rely on upstream wetlands and residual pool habitat during the drier months of the year.

No problems of major significance have been identified in the Dorre Don Creek subbasin except for poor water quality during storm runoff, which appears to be consistent with all other subbasins that have undergone some urbanization. Additionally, minor erosion, flooding, poor livestock-keeping practices, and habitat problems have been identified along this creek. The primary threat to the Dorre Don subbasin lies in projected future development, which could convert 75% of the current forest cover to residential use, causing large increases in peak flow magnitudes and durations, as well as continuing degradation of water quality. These increases are likely to make major problems out of the current minor ones.

The Walsh Lake subbasin includes 4,325 acres of largely (95%) forest land. Eighty percent of the subbasin lies within the City of Seattle's Cedar River Watershed, and so is very unlikely to face development in the future. There is a small amount of existing rural land use in the lower, western portion of the subbasin (catchments W1 and W1A) outside the watershed. During the 1920s, Seattle constructed the 3.5-mile Walsh Lake Diversion Ditch to prevent water from entering the Cedar River above the drinking-water-supply intake because the old Taylor mining town was thought to have degraded mainstem water quality below drinking water standards. The ditch joins the Cedar River below Landsburg at RM 19.6. It flows along a generally mild gradient until it steepens in its lowest half mile to join the Cedar River. Over the decades, flows have eroded a canyon in this lower reach and incision and bank sloughing continue today.

Current water quality in the Walsh Lake Diversion Ditch is generally good and the ditch provides substantial salmonid habitat in spite of its artificial origin, lack of habitat complexity, continuing channel incision, and bank sloughing. These erosional processes provide spawning gravel but also deliver substantial sediment to an alluvial fan at the confluence with the Cedar

River, which acts as a fish barrier during low-flow conditions when water goes subsurface through the deposited gravels. Because land use is not likely to change significantly in the future, the hydrologic regime of the Walsh Lake Diversion Ditch should remain constant. The combination of stable forest cover, outwash geology, good water quality, and current salmonid use suggest that the 3.5-mile Walsh Lake Diversion Ditch has significant potential for habitat enhancement.

The recommendations for these subbasins are mainly programmatic in nature. Their aim is to prevent flooding, accelerated erosion, loss of base flows, and degradation of water quality as these rural subbasins undergo additional development. Additionally, small CIPs are recommended for wetland restoration and enhancement of salmonid habitat in the Walsh Lake subbasin.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown on Figure 3-13 at the end of this section. Note that some of these recommendations apply in other subareas and so have already been described earlier in this chapter.

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

Capital Improvement Projects

• **Wetland 64 Restoration (CIP 3160):** Significant wildlife habitat could be restored and protected through a King County WLRD and volunteer program to revegetate the buffer of Wetland 64, remove trash, post interpretive signs, and encourage neighborhood stewardship of the wetland.

• **Walsh Lake Diversion Ditch Habitat Improvements (CIP 3161):** Erosion in the steepest reach of the ditch would be reduced and habitat would be improved by the addition of large woody debris and streambank plantings. Fish access to the ditch from the Cedar River and the ditch's rearing habitat value could be improved by the diversion of a small amount of water from the Rock Creek tributary that is in the Seattle Water Department's watershed.

Programmatic Recommendations

* **Small Scale Watershed Restoration and Enhancement (BW 5):** WLRD's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16), would undertake small, labor-intensive projects in the Middle Tributaries subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Middle Tributaries subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Water Quality Basinwide Recommendations (BWs 9, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources (BWs 14 and 16).

* **Livestock Keeping Practices (BW 11):** In order to reduce livestock-caused nonpoint water pollution, King County would work with the King Conservation District to develop livestock management plans, and to help livestock owners fund and implement them.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on structural habitat and water quality.

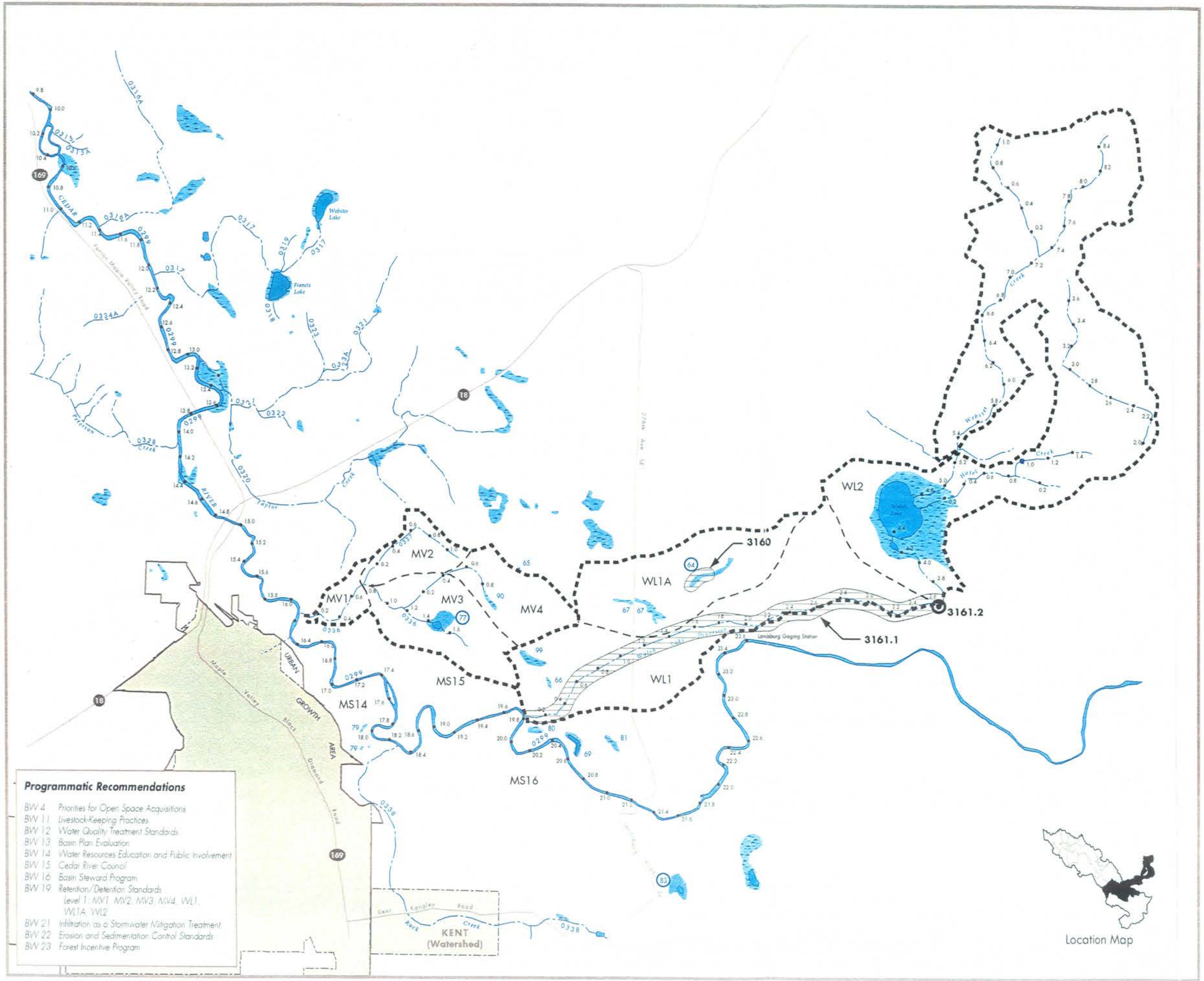
* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

• **Increased R/D and Runoff Controls (BWs 19*, 21, and 22):** Regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19 and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22), are recommended to help reduce the expected future habitat problems associated with the minor flooding and erosion in the Dorre Don and Walsh Lake Diversion Ditch subbasins. See Figure 4-1 and Table 4-3 in Chapter 4.

Figure 3-13

Middle Tributaries Subarea

Cedar River Basin Planning Area Recommendations



- Stream & Stream Number
- Unclassified Stream
- Lake/River
- River Mile (RM)
- Wetland & Wetland Number
- Class I Wetland & Wetland Number
- Subbasin Boundary
- Catchment Boundary
- MV1 Catchment Number
- Incoporated Area (as of 6/98)
- Urban Growth Area Boundary (as of 6/98)
- 3122 Capital Improvement Project Area and Number
- 3122 Capital Improvement Project Location and Number

N

0 1/4 1/2 Mile

Map produced by:
Visual Communication & GIS Unit,
Public Outreach Section
9806cedarBPmidtrib3-13 WG

Rock Creek

INTRODUCTION

At nearly 7,700 acres, the Rock Creek subarea is the largest in the Cedar River basin planning area. It is typified by extensive forests, rural development, mostly flat topography, low-gradient stream channels, and valley floors underlain by extensive deposits of porous glacial outwash gravel. To date, it is the largest subbasin in the entire Lake Washington basin without urban or suburban development. However, aquatic habitats and water quality and quantity in the area around Lake No. 12 (Wetlands 91 and 92) may be threatened by the City of Black Diamond's goal to include portions of this area in its Urban Growth Area.

Rock Creek has exceptionally high natural resource value. It is the single largest source of municipal water for the City of Kent, and with few exceptions, the subarea's stream and wetland habitats are relatively intact. Lower Rock Creek's riparian areas and channel reaches are reminiscent of old growth in structure and complexity, making its aquatic habitat among the best remaining in western King County.

Between RM 0.0 and 2.6, Rock Creek's habitat is classified as a regionally significant resource area (RSRA) because of its habitat quality and current and future potential for salmonid production. The effect of water withdrawals on productivity of this habitat for salmonids is considered to be a very significant problem. Locally significant resource areas (LSRAs) in the Rock Creek subarea include Wetlands 91 (Lake No. 12), 92, 93, and 94. Although somewhat affected by past logging and rural development in buffer areas, Lake No. 12 and its mile-long corridor of downstream wetlands form the largest and most structurally diverse lake/wetland complex in the basin planning area. Another LSRA, Wetland 82 (Hidden Lake) is a large, hydrologically isolated wetland just south of the Seattle Water Department's watershed boundary, which provides outstanding habitat for wildlife.

Rock Creek has been highly regarded by fisheries professionals and local residents alike for its runs of four key species of anadromous salmonids: sockeye, coho, and chinook salmon, and steelhead trout. Stocks of these species have exhibited recent precipitous declines throughout Puget Sound and particularly in the Lake Washington drainage. Water withdrawals in the subbasin, permitted and otherwise, have reduced the typical late-summer and early-fall flows to levels that severely limit migration and spawning of sockeye and chinook salmon. Withdrawals have also dramatically reduced the amount of critical summer and fall rearing habitat for coho salmon and steelhead trout. One major unpermitted diversion below Lake No. 12 was corrected in 1995 by King County WLRD, potentially adding 0.5 to 1.5 cfs to the Rock Creek subarea.

Rock Creek's future as a stream with high aquatic resource value will depend on protection of stream and wetland areas from intensive development and improvement of summer/fall low-flow conditions. For this reason, the recommendations for this subarea are aimed at protecting exceptional water quality and existing habitats from incompatible development and enhancing the productivity of the existing structurally excellent habitat for wild salmonids. The primary recommendation is to restore natural summer/fall flows, and to protect almost two miles of excellent stream habitat through open space acquisition. Area water purveyors and State and Tribal fishery managers should jointly investigate ways to restore historic summer and fall base flows to the lower 1.7 miles of Rock Creek. This would restore a significant amount of high-quality sockeye and chinook salmon spawning habitat and enhance coho salmon and steelhead trout rearing habitat in the Cedar River system. Taken together, the effect of these measures will preserve existing high-quality water and habitat conditions and significantly enhance productivity of Cedar River fish runs.

SUMMARY OF RECOMMENDATIONS

Please see Chapter 4 for the complete text of the following recommendations, the locations of which are shown on Figure 3-14 at the end of this section. Note that some of these recommendations have already been described earlier in this chapter.

* Denotes Core Plan recommendations, which are those recommendations that would accomplish, at a minimum, the major Plan goals (see Chapter 5).

Capital Improvement Projects

There are no capital improvement projects proposed for this subarea.

Programmatic Recommendations

* **Open Space Acquisition (BW 4):** Four sites have been identified for open space acquisition due to their aquatic habitat values. See Tables 4-1 and 4-2 in Chapter 4.

* **Small Scale Watershed Restoration and Enhancement (BW 5):** WLRD's existing Small Habitat Restoration Program (SHRP), under the direction of the Cedar River Basin Steward (BW 16), would undertake small, labor-intensive projects in the Rock Creek subarea, using volunteers and other inexpensive labor. See Table 4-2 in Chapter 4.

* **Aquatic Resource Mitigation Bank Sites (BW 6):** This recommendation would allow public agencies to fulfill their Rock Creek subarea mitigation obligations in high-quality mitigation bank sites away from project sites, where such mitigation may be less effective.

* **Water Quality Basinwide Recommendations (BWs 9, 10, 11, 14, and 16):** Road drainage facilities would be maintained and retrofitted with water quality controls to reduce the impacts of contaminated road runoff (BW 9). Educational programs would be established and a Cedar River Basin Steward would provide technical assistance to address nonpoint pollution sources from highly urbanized systems (BWs 14 and 16). Measures to reduce nonpoint pollution from livestock-keeping practices (BW 11) and septic systems (BW 10) would also apply.

* **Water Quality Treatment Standards (BW 12):** RSRA stream protection standards would reduce concentrations of toxic metals in Tributary 0338, RM 0.0-2.5.

* **Basin Plan Evaluation (BW 13):** Evaluate implementation and effectiveness of subarea recommendations in controlling stormwater impacts on structural habitat and water quality.

* **Forest Incentive Program (BW 23):** An incentive program to encourage landowners to retain their forest in the rural areas of the basin will be implemented in order to ensure that the Cedar River has clean, stable streams. Incentives will include tax relief, direct technical assistance, forest stewardship classes, a small scale forestry demonstration site, and individual recognition of good forest stewards.

* **Rock Creek (Tributary 0338) Low-Flow Restoration (RC 1):** In the interest of improving low-flow conditions that are impacting fish runs in Rock Creek, King County should work with the City of Kent to develop alternatives that meet Kent's water-supply needs and increase base flows in the creek to levels that restore the full function and value of its structurally excellent aquatic habitat.

• **Increased R/D and Runoff Controls (BWs 19*, 21, and 22):** If clearing restrictions and open space retention are not required for the Rock Creek subarea, regulatory standards designed to control the peak, volume, and duration of runoff by means of infiltration or detention (BWs 19 and 21), and reduce erosion and sedimentation resulting from clearing and grading activities (BW 22) are recommended to help reduce the expected future habitat problems associated with erosion and sedimentation in the Rock Creek subarea. See Figure 4-1 and Table 4-3 in Chapter 4.

• **Wetland 92 Reclassification (RC 2):** This locally significant mile-long, 94-acre, structurally diverse wetland, located at the headwaters of Rock Creek, would be better protected from encroachment and other impacts if it were correctly classified as a Class 1 wetland in the *King County Wetlands Inventory.*

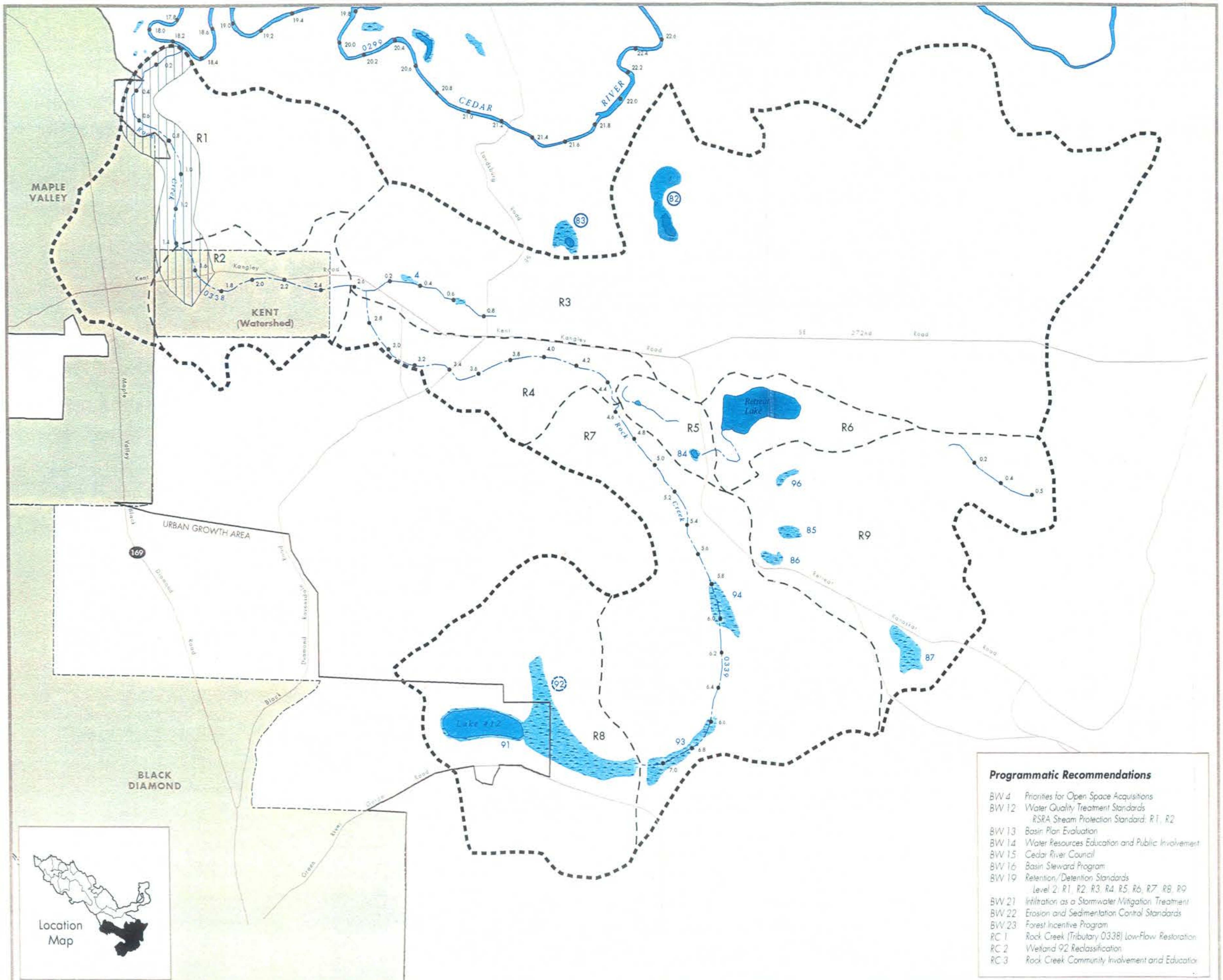
• **Rock Creek Community Involvement and Education (RC 3):** Local residents should be encouraged to protect the Rock Creek RSRA (RM 0.00-2.6) through educational outreach and technical assistance provided by the Basin Steward (BW 16).

• **Aquifer Protection (BW 17):** Aquifer recharge and groundwater quality would be protected as a potable drinking water source.

Figure 3-14

Rock Creek Subarea

Cedar River Basin Planning Area
Recommendations



0299 Stream & Stream Number
Lake/River
3.6 River Mile (RM)
28 Wetland & Wetland Number
28 Class 1 Wetland & Wetland Number
28 Reclassified Class 1 Wetland & Wetland Number
Subbasin Boundary
Catchment Boundary
R1 Catchment Number
Incorporated Area (as of 6/98)
Urban Growth Area Boundary (as of 6/98)

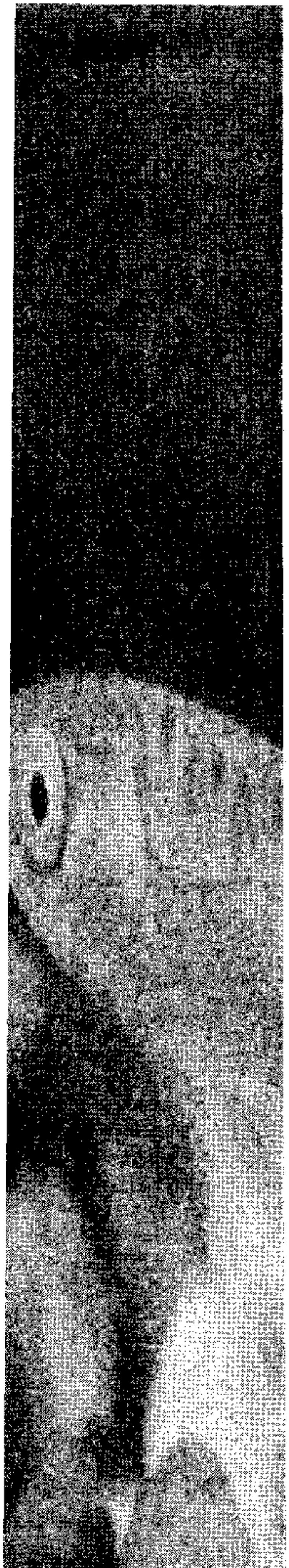
Programmatic Recommendations:

RC1: Tributary 0338 Low Flow Restoration

N

0 1/4 1/2 Mile

Map produced by:
Visual Communication & GIS Unit,
Public Outreach Section
9806cedarBProckck3-14 WG



Chapter 4

Detailed Descriptions of Recommendations

Chapter 4: Detailed Descriptions of Recommendations

Introduction

This chapter contains specific recommendations to address current and future surface-water and groundwater problems and to protect and restore existing resources in the Cedar River basin. These recommendations are based on an analysis of conditions that were identified in the first phase of the planning process and documented in April 1993 in the *Cedar River Current and Future Conditions Report*. They were summarized by subject in Chapter 2 and by geographic subarea in Chapter 3 of this Basin Plan.

The recommendations have prefixes according to the type or location of the action. Each capital improvement project (CIP) has a four-digit number. Programmatic recommendations have either a BW (Basinwide Recommendation) designation or a subarea prefix, such as MS (Mainstem). These subarea prefixes refer to where in the basin planning area the action is to take place.

For planning purposes, the basin planning area was divided into seven subareas (see Figure 3-1 in Chapter 3). These have been defined as the *Cedar River Mainstem* (*MS*), composed of the mainstem itself, the land adjacent to the river, and any land on the valley walls and plateaus that is not drained by a year-round tributary; the *Northern Tributaries (NT)*, which are the five northernmost small tributaries closest to Renton; the remaining six small urbanizing subbasins, known as the *Southern Tributaries (ST)*; two streams near Maple Valley referred to as the *Middle Tributaries (MT)*, and the more rural subbasins of *Peterson Creek (PC), Taylor Creek (TC), and Rock Creek (RC)*, which are large enough to warrant treatment as separate subareas in this plan. To see which recommendations apply to each of the subareas, please see Chapter 3.

For definitions of the acronyms used in the recommendations, please refer to the list of acronyms, located on the inside of the back cover.

LIST OF RECOMMENDATIONS

CAPITAL IMPROVEMENT PROJECTS

BASINWIDE RECOMMENDATIONS

SUBAREA PROGRAMMATIC RECOMMENDATIONS

Capital Improvement Projects

MAINSTEM SUBAREA

3100 Arcadia/Noble Flood and Erosion Damage Reduction (both banks, river mile (RM) 18.2-19.0)

Recommendation: Modify from approximately 1,000 to 1,600 linear feet of revetment on both sides, depending on final design, using bioengineering techniques; purchase and remove one house, if necessary, to allow room for construction.

Discussion: The left-bank Arcadia/Noble revetment was heavily damaged during the November 1990 flood, threatening the six houses behind it with severe flooding and erosion damage. This structure has required frequent County maintenance.

Approximately eight additional parcels suffered less severe erosion or flooding damage in this reach. These would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Providing flood protection by raising and extending levees in this area would obstruct flows in the Federal Emergency Management Administration (FEMA) floodway, and so would be prohibited by the National Flood Insurance Program as well as by the Sensitive Areas Ordinance.

Lead Entity:	WLRD
Cooperating Entities:	COE, MIT
Estimated cost:	$630,000 to $1,200,000 depending on final design.

3101 Dorre Don Way SE Elevation (Orchard Grove) (right bank, RM 17.1)

Recommendation: Raise approximately 650 linear feet of Dorre Don Way SE through the Orchard Grove (or Upper Dorre Don) neighborhood, ensuring emergency and resident access to 15 houses.

Discussion: Eleven of the 15 houses located behind the Orchard Grove levee are within the 100-year floodplain. The two houses nearest the downstream end of the levee are subject to flooding at about the 10-year flood event. The 25-year flood makes Dorre Don Way SE, the sole access to these 15 houses, impassable to residents and emergency services. Because none of the affected houses are subject to hazardous flood flows, simply raising the road should be sufficient to achieve the minimum safety goals of the Plan.

All 11 flooded houses would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Alternatives that would raise or extend the Orchard Grove levee were rejected because they would be very expensive. They would also require placing fill in the zero-rise floodway and so would probably not be permitted.

Lead Entity:	WLRD
Cooperating Entities:	COE, MIT
Estimated Cost:	$200,000

3102 Dorre Don Flood-Damage Reduction/Floodplain Restoration (right bank, RM 16.4)

Recommendation: Purchase and remove 20 houses and restore approximately six acres of floodplain to a more natural condition. Elevate approximately 600 linear feet of Lower Dorre Don Way to one foot above the 100-year flood stage to provide access to the remaining houses.

Discussion: Seventeen houses upstream and three downstream of the Dorre Don railroad bridge are subject to deep, high-velocity water and debris that overtop the King County-maintained levee during large storm events. Dorre Don Way, which provides sole access to all homes, is flooded during the 10-year event.

This project would not only remove people from a highly hazardous area, it would also provide a significant quantity of aquatic habitat. Funding may be available from King County Department of Parks and Recreation to purchase this land as open space.

The remaining seven houses, located below the bridge and inundated by deep but much slower water, would be included in BW 2: Reduce Less-Hazardous Flood Damage. If sufficient funding were available, it is recommended that all 32 houses be purchased and removed, at a cost of approximately $5,800,000.

Merely raising the 20 most severely threatened houses was rejected because it would not reduce current hazards and would encourage continued occupation of this hazardous area. Raising or extending the Dorre Don levee would require placing significant amounts of fill in the regulatory floodplain, and would probably not be permitted under the Sensitive Areas Ordinance (SAO) or the National Flood Insurance Program.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT, WDFW, MSE, TU
Estimated Cost:	$4,900,000

3103 Dorre Don Court Flood-Damage Reduction/Floodplain Restoration (right bank, RM 15.8)

Recommendation: Purchase and remove three houses. Approximately nine acres of floodplain would be restored.

Discussion: These houses are behind a small levee, which is not maintained by King County and which provides little protection from 10-year or greater flows. They are subject to deep, fast flows during the 100-year flood, and there does not appear to be sufficient room to relocate them on their parcels.

Five houses subject to less-hazardous flooding would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Merely raising the severely impacted houses was rejected because it would encourage continued occupation of a hazardous area. Raising or extending the levee would require placing significant amounts of fill in the regulatory floodplain and would probably not be permitted under the SAO.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA
Estimated Cost:	$800,000

3104 Lower Bain Road and Royal Arch Flood-Damage Reduction/Floodplain Restoration (both banks, RM 14.6)

Recommendation: Purchase and remove from three to nine houses, depending on final design. Reestablish up to 13 acres of floodplain storage and habitat.

Discussion: Residential flooding of both banks begins at the 10-year flood. Deep flows damaged houses during the November 1990 flood. The SR-169 bridge at the downstream end of this reach appears to exacerbate backwater flooding in that area.

Approximately 11 houses subject to less-hazardous flooding would be included in BW 2: Reduce Less-Hazardous Flood Damage.

The exact number of houses to be relocated and raised in this reach must be confirmed during the flood audit described in MS 7: Floodplain Mapping Analysis, Revision, and Distribution.

Raising or extending levees enough to provide significant protection would require extensive fill in the regulatory floodway and so would be prohibited by the National Flood Insurance Program as well as by the Sensitive Areas Ordinance.

Merely elevating all affected houses could encourage continued occupation of hazardous areas and was rejected as a blanket solution. Removing all affected houses was considered to be too expensive.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT
Estimated Cost:	$600,000 to $1,950,000 depending on scope.

3105 Getchman Levee Modifications (both banks, RM 13.6)

Recommendation: Move the right-bank Getchman levee back from the Cedar River, stabilize it and the face of the left-bank Rhode levee using bioengineering techniques, and purchase and remove up to two houses. The Rhode levee could also be set back or it could be raised, if exemptions to SAO compensatory storage and zero-rise floodway requirements can be secured as a result of the projected lowering of the 100-year flood stage.

Discussion: The Rhode levee overtopped during the November 1990 flood, damaging sole-access roads and houses with scour and debris deposition. The presence of the Getchman levee on the opposite bank serves to raise the water surface, increase erosive channel velocities, and direct flows against the Rhode levee. Moving the Getchman levee landward and stabilizing it using bioengineering techniques would continue to protect the right-bank houses behind it while relieving damaging stress on the Rhode levee and enhancing approximately two acres of aquatic habitat. The proximity of several houses behind the Rhode levee may limit the amount this structure could be moved back. If raising the Rhode levee is permitted, this would provide added protection to the left overbank area.

Up to 18 houses subject to less-hazardous flooding would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Simply raising houses behind the Rhode levee would not address the high-velocity flows in this area. Similarly, just raising or strengthening the Rhode levee would not reduce the stress directed against it from the opposite bank. Purchase and removal of all affected left-bank houses was rejected as being too expensive.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT
Estimated Cost:	$1,500,000

3106 Jan Road Flood-Damage Reduction/Habitat Restoration (right bank, RM 12.6-13.0)

Recommendation: Construct a stable overbank channel; construct a large multi-culvert crossing under Jan Road, also known as 221st Avenue SE and SE 197th Place.

Discussion: House and private road damage occurs and access is blocked to 14 houses when the Cedar River overtops the Jan Road levee, as it does during approximately a 10-year flood event. This project would reduce the flooding hazards, would ensure access up to at least the 25-year flood, and would provide approximately 22 acres of flood storage and aquatic habitat.

Approximately 14 houses subject to less-hazardous flooding would be included in BW 2: Reduce Less-Hazardous Flood Damage.

If funding is limited, the multi-culvert crossing alone could be constructed and three houses could be raised or relocated on their lots. This alternative would pass overtopping flows while allowing residents access to their houses during floods through at least the 25-year event, for a cost of approximately $175,000.

Raising or extending the Jan Road revetment would require extensive fill in the zero-rise floodplain, and would probably not be permitted. The public benefit from buying and relocating these houses would probably not justify the public expense to do so.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, WDFW, MIT, MSE, TU
Estimated cost:	$4,800,000: alternative $175,000

3107 Byers Bend/Cedar Grove Road Flood-Damage Reduction (left bank, RM 11.8-12.3)

Recommendation: Purchase and remove seven or eight houses (depending on final design), and create an overbank channel along Byers Road to convey flood flows and reduce flooding and erosion damage. Elevate up to eight houses to one foot above the 100-year flood stage, and improve the Byers Bend levee to protect the remaining houses. Either depress the 400 linear feet of Cedar Grove Road west of the bridge to protect it from scour, or raise and armor this piece of road and raise and extend the bridge, depending on funds, the possible realignment of a leachate line, and the preferences of the King County Roads and Engineering Division.

Discussion: King County's MacDonald levee overtops, flooding eight houses, during a 5-year flood. At the 10-year flood stage, Byers Road, which provides sole access to more than 25 houses, overtops. A large portion of the area between Byers Bend and Cedar Grove Road, including another eight houses, is flooded during the 25-year event when the Cedar River overflows its channel below the Byers Curve levee. The 1990 flood exposed many of these houses to deep, fast flows and washed out Cedar Grove Road, damaging the leachate line from the Cedar Grove landfill.

By removing the eight houses subject to deep fast flows, this recommendation would eliminate the most hazardous flood conditions at this location. The proposed flood conveyance channel would reduce flood stages in the river, possibly allowing the construction of levee improvements to protect the remaining houses without violating zero-rise regulations. Aquatic habitat would be increased, and damage to Cedar Grove Road, an important arterial, would be reduced or eliminated, preventing further damage to the leachate line.

The ultimate approach to protecting Cedar Grove Road will be resolved during the final design of this project. It will depend on whether the leachate must be realigned and on how much flood stages can be reduced as a result of the proposed flood conveyance channel.

If available funding were limited, the eight most severely impacted houses should still be removed, Cedar Grove Road should be protected, and Byers Road should be raised to provide minimum 10-year access, at an approximate cost of $2,900,000.

The remaining approximately 20 houses subject to less-hazardous flooding would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Alternatives that would encourage the continued occupation of hazardous areas, and those that would be prohibited by zero-rise regulations, were rejected.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT
Estimated cost:	$12,400,000: alternative $2,900,000

3108 Rainbow Bend Flood-Damage Reduction/Floodplain Restoration (right bank, RM 10.8-11.3)

Recommendation: Purchase and relocate approximately 55 mobile homes, purchase and remove nine permanent houses, and restore approximately 40 acres of floodplain area for habitat and open space benefits.

Discussion: This reach experiences deep, fast flows in both leveed and unleveed areas, even during moderate flood events. During the November 1990 flood, whole cars were buried under debris that overtopped the Rainbow Bend levee, and severe scouring of side channels damaged several residences behind the levee. Emergency access is prevented at about the 10-year event.

The Cedar Grove Mobile Home Park provides affordable housing to low income households. In keeping with King County's policy of providing relocation assistance and replacement housing when displacements from below-market-rate housing are unavoidable, these 55 to 60 units should not merely be removed but should be replaced by similarly affordable units elsewhere in or near the basin planning area. Residents would be advised about available affordable housing and housing financing opportunities and a park closure plan would be developed to involve owners and tenants in the planning, design, and implementation of this recommendation. One potential relocation site that should be considered is the adjacent Stoneway Sand and Gravel mine once it has been reclaimed.

Raising and extending the Rainbow Bend levee was rejected because it would constrict the river at this location, increasing already erosive flow velocities and raising the water surface upstream, and would require placing a significant amount of fill in the floodplain and so would probably not be allowed under the Sensitive Areas Ordinance. It would also be more expensive than the proposed recommendation.

Merely floodproofing these structures was rejected because it would have the effect of encouraging continued habitation of a hazardous area.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT, WDFW, MSE, TU
Estimated cost:	$7,200,000

3109 Ricardi Flood-Damage Reduction/Floodplain Restoration (right bank, RM 7.4)

Recommendation: Purchase and remove two houses. Modify the Ricardi revetment and reestablish the right overbank area as open space and aquatic habitat.

Discussion: These two houses have been repeatedly damaged by floods and erosive flows that leave the river upstream from the Ricardi revetment. They are frequently isolated from emergency access.

This recommendation would remove the houses, remove the Ricardi revetment, and revegetate the overbank channel area to improve its value as aquatic habitat. The estimated cost, below, does not account for approximately $270,000 in expected matching funds from FEMA and the Washington State Department of Community Development, which would lower King County's share to $330,000.

Merely raising these houses was rejected as an alternative because it would encourage continued occupation of a hazardous area. Raising or extending the Ricardi revetment was rejected because of permitting restraints on placing fill in the floodway.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, MIT, WDFW, MSE, TU
Estimated cost:	$600,000

3110 Riverbend Mobile Home Park Revetment Modification (left bank, RM 7.2)

Recommendation: Purchase and replace the 19 mobile homes nearest the Cedar River, and recontour the existing revetment to reduce erosion and flood damage and to enhance floodwater conveyance and aquatic habitat.

Discussion: Several of the mobile homes nearest the river were undermined and nearly destroyed by erosive flows when this reach of the Cavanaugh revetment was damaged during the November 1990 flood.

Approximately 1,000 feet of revetment would be cut back to increase channel capacity by providing a bench at the elevation of ordinary high water. It would then be revegetated using bioengineering techniques for stability and aquatic habitat benefits.

The Riverbend Mobile Home Park provides affordable housing to low income households. In keeping with King County's policy of providing relocation assistance and replacement housing when displacements from below-market-rate housing are unavoidable, these units should not merely be removed but should be replaced by similarly affordable units elsewhere in or near the basin planning area. Relocation and financing advice and a park closure plan process, as in CIP 3108, would be included in this recommendation.

Lead Entity: WLRD
Cooperating Entities: COE, FEMA, MIT, WDFW, MSE, TU
Estimated cost: $2,700,000

3111 Elliot Bridge/Lower Jones Road Flood-Damage Reduction (both banks, RM 5.4-6.0)

Recommendation: Purchase and remove two houses below Elliot Bridge and up to 22 houses above it that are subject to hazardous flooding. Raise 2,300 linear feet of Jones Road to eliminate current road flooding and to protect 20 additional right-bank houses from flooding up to the 100-year event. Remove fill from the left bank and add vegetation to provide additional floodplain storage and riparian habitat, to compensate for flooded area lost when the road is resized. Realign landward onto vacant land approximately 1,800 linear feet of Jones Road, and bench and bioengineer the adjacent Buck Curve/Camp Freeman revetment (including approximately 1,000 linear feet of the length proposed to be raised), to provide additional floodway conveyance capacity, to improve riparian habitat, and to reduce the cost of maintaining the existing bank armoring.

Discussion: Below Elliot Bridge, the two houses nearer the river on the left bank were subject to flood waters over three feet in depth during the November 1990 flood.

Upstream of Elliot Bridge, 22 houses on the right bank between Jones Road and the river experience erosive, high-velocity flows during large flood events including the 1990 flood. Eighteen houses on 156th Place SE experience restricted resident and emergency-vehicle access when Jones Road floods, beginning at about the 2-year event under existing conditions.

Design of this recommendation would be coordinated with King County Roads Services Division to take the proposed replacement of Elliot Bridge into account. Implementation of the left-bank restoration could affect the design of a future habitat restoration project proposed under MS 4: Mainstem Habitat Restoration and Enhancement Program.

If funding is limited, realignment of Jones Road and the left-bank revetment work could be foregone for savings of approximately $1,400,000. Substituting the placement of reflective roadside markers for the elevation of Jones Road would reduce costs by approximately $2,000,000. Eliminating the left-bank revetment work would save approximately $1,200,000.

Below Elliot Bridge, one additional house on the left bank and two on the right experience lower, slower flows. Upstream, on the landward side of Jones Road, approximately 20 additional houses are within the 100-year floodplain. These less-seriously threatened houses would be included in BW 2: Reduce Less-Hazardous Flood Damage.

Floodproofing selected houses riverward of Jones Road was rejected because erosion would continue to threaten this area.

The alternative of merely raising the houses landward of Jones Road was rejected in favor of elevating the arterial because 18 houses are denied emergency vehicle access during floods under existing conditions.

Building a new levee below Elliot Bridge was rejected because of high cost. A new levee on the right bank above the bridge was rejected because at least four houses would have to be purchased and moved, and two more relocated on their lots, to make room for earthwork, raising the cost and reducing the benefit of such an alternative. In addition, new levees would require significant fill within the regulatory floodway, and would probably not be permitted.

Lead Entity:	WLRD, Renton PW
Cooperating Entities:	COE, FEMA, MIT, WDFW, KC Roads
Estimated cost:	$8,700,000 (various combination of alternatives, ranging as low as $4,000,000 for house relocations only, are possible).

3112 Maplewood Flood-Damage Reduction (right bank, RM 3.6-4.2)

Recommendation: Build a 1,200-foot-long levee (to a maximum height of approximately four feet) along the right bank at RM 4.2, below the SR-169 bridge, to protect the Maplewood Subdivision from 100-year flooding. Downstream, regrade 1,600 feet of the right bank to provide additional overbank channel. Revegetate the right bank through this entire reach, a distance of up to 3,600 linear feet. Up to four houses would have to be removed to accommodate the levee. A suitable habitat project would be selected from the opportunities listed in BW 4 or BW 6 to mitigate the fish habitat impacts of building this structure.

Discussion: If not for the emergency construction of a three-foot-high sandbag levee during the November 1990 flood, flows from the Cedar River would have reverted to an historic side channel and cut through the Maplewood Subdivision, likely damaging up to 60 houses. Seepage flooded low areas and at least one basement. Farther downstream, numerous yards abutting the river experienced erosive flows. The portion of the bank downstream from the sandbagged area is poorly protected from erosion by privately placed rubble armoring. The 600-foot-long Erickson revetment, located downstream of the sandbagged area, is no longer maintained by King County.

Replacing the Erickson revetment with a levee extending upstream to the SR-169 bridge would prevent serious damage from future high flows through this dense neighborhood. This action would place fill in the regulatory floodway, however, and could require significant mitigation or some form of compensatory storage or other channel modifications in order to be permitted. Regrading and stabilizing the right bank downstream of the proposed levee would reduce flow velocities and erosion, and would improve aquatic habitat.

If funding is limited, the scope of this project could be scaled back to include only the Erickson levee work, plus integrating channel modifications as described above. The cost for this reduced recommendation would be approximately $1.5 million.

Raising the approximately 60 houses subject to flood flows was rejected because the hazard from deep, fast flows would remain. Relocating them out of the floodplain was rejected as being too expensive.

Lead Entity:	WLRD, Renton PW
Cooperating Entities:	COE, FEMA, MIT
Estimated cost:	$6,500,000: alternative $1,500,000

3113 Person Revetment Modifications (left bank, RM 3.8-4.1)

Recommendation: Set back and bioengineer the existing privately placed revetment and revegetate a gravel mine site and landslide scar behind the revetment.

Discussion: This site has released large quantities of sediment into the lower Cedar River, most recently during a landslide in 1987. This material, especially the finer particles, chokes spawning gravels and causes turbidity in the important spawning areas of the lower mainstem.

The steep face of the left bank has been extensively disturbed by gravel mining operations, seeps and small streams, and natural erosion from high river flows. At the toe of the slope, the mine operator placed a bare rock revetment that extends into the river and has suffered from erosion. It has also been overtopped by periodic small landslides, preventing maintenance access.

Modifying the revetment by cutting back and bioengineering its face and buttressing the slope above it could reduce flow velocities and future erosion at the toe of the bank and would provide riparian vegetation. Revegetating the open landslide scar would help stabilize this steep slope.

If funding is limited, reduce the scope of the earthwork and emphasize revegetation. The property owner may be liable for some of the cost of this recommendation.

Lead Entity:	DDES
Cooperating Entities:	KCPA, Renton PW, COE, FEMA, MIT
Estimated cost:	$800,000

NORTHERN TRIBUTARIES SUBAREA

Maplewood Subbasin

3120 Puget Colony Homes Drainage Improvements

Recommendation: The King County Water and Land Resources (WLRD) Division should make the following improvements in order to address flooding of the Puget Colony Homes subdivision and local water quality and erosion problems:

1. Upgrade the existing conveyance system through Puget Colony Homes (Tributary 0303, RM 0.4-0.8);
2. Deepen and recontour the existing detention pond in Wetland 150 (RM 0.9); and
3. Purchase a filled portion of Wetland 150 for construction of a new 150,000-cubic-foot detention pond (RM 1.1), buffer restoration, and enhancement of degraded portions of the wetland.

Discussion: This solution would address the flooding in the Puget Colony Homes subdivision without accelerating erosion in Tributary 0303 and would provide water quality benefits as well. The subdivision currently experiences impaired residential access and road and septic system flooding on an almost annual basis when the capacity of an undersized storm drain, located between the houses, is exceeded. In addition, contaminated road runoff from SE 128th Street is now inadequately treated by a small detention pond in Wetland 150, an 11-acre, partially forested Class-2 system located immediately north of the subdivision.

The proposed upgrade to the conveyance system would eliminate flooding and septic system inundation up to the 100-year flow. Deepening the existing small detention pond north of the subdivision would provide an additional 20,000 to 40,000 cubic feet of storage with another 150,000 cubic feet provided by the new detention pond to be constructed in the filled portion of Wetland 150. Such additional storage would attenuate discharge peaks by an average of 15% through the 25-year event, thereby helping to reduce damage in the erosion-prone reaches of Tributary 0303. Water quality in Wetland 150, and in this portion of the subbasin in general, would be somewhat improved by the routing of road runoff not currently detained through the 150,000 cubic-foot forebay, and the water quality would also be improved by reducing or eliminating the short-circuiting of flows through the existing pond. The hydrology of Wetland 150 would be somewhat stabilized by attenuation of peak flows in the two detention ponds. Restoration of a buffer and degraded portions of the wetland would improve its wildlife habitat and water quality functions.

This recommendation was chosen from a number of alternatives, which were rejected for various reasons. Upgrading the conveyance system alone ($400K) would address flooding but would increase flows downstream of the subdivision into Tributary 0303, which would exacerbate the significant erosion that currently exists in that stream. It would also do nothing to improve water quality in Wetland 150 nor would it treat runoff from SE 128th Street. Because of the size of the existing small pond, deepening it, coupled with the conveyance upgrade ($500K), would still not provide enough storage to address erosion and water quality without the larger pond.

A regional detention pond located immediately downstream of Puget Colony, as described in the City of Renton's draft "Maplewood Creek Basin Plan," would make the wetland work unnecessary.

Other alternatives were evaluated—including substituting an underground detention tank for the proposed solution ($600K), using an open channel for conveyance ($1,500K), using a bypass pipeline directly to the mainstem ($3,000K), or extending the sanitary sewer service to the area

($1,400K)—but were rejected because of their inability to address all of the concerns or because of their adverse impacts.

Lead Entity:	WLRD
Cooperating Entities:	Renton, SKCDPH, KC Roads, MIT
Estimated Cost:	$800,000.

3121 Tributary 0303A Culvert Replacement and Rechanneling

Recommendation: To alleviate flooding at the intersection of SE 132nd Street and 146th Avenue SE, King County WLRD should replace a damaged 12-inch concrete culvert under SE 132nd Street with a 24-inch concrete culvert. A 300-foot pipe conveying this tributary southward, would be removed to improve the quality of road runoff.

Discussion: During 2-year and larger storm events, water ponds at the inlet of the 18-inch culvert and backs up to the east along the north side of SE 132nd Street, then flows south through a 12-inch culvert at the intersection of SE 132nd Street and 146th Avenue SE and enters the Orting Hill (Tributary 0307) subbasin. The 12-inch culvert is damaged, forcing water over the road at this intersection, blocking the access to 12 houses. Replacing the 12-inch culvert with a 24-inch concrete culvert would solve the road-flooding problem for little cost. Although it would perpetuate the current flow diversion, Tributary 0307 is able to accept the small additional flow with little threat of damage, while Tributary 0303 experiences severe erosion downstream of its confluence with Tributary 0303A and would conceivably suffer from any increase in discharge.

If funding were limited, the 300-foot pipe could be foregone, at a savings of approximately $130,000. Two alternatives that were considered for this solution—upgrading the 18" culvert alone or intercepting and carrying the flows to the upgraded storm drain proposed in CIP 3120—would both accelerate erosion downstream.

Lead Entity:	WLRD
Cooperating Entities:	Renton PW, KC Roads, MIT
Estimated Cost:	$150,000: alternative $20,000

3122 Maplewood Ravine Stabilization

Recommendation: Reduce erosion and subsequent downstream sedimentation and habitat degradation in the Maplewood subbasin by undertaking the following actions:

1. Tightline two daylighted culverts on Tributary 0302 from their outfalls to the main channel (right bank of RM 1.0 and left bank of RM 0.95),
2. Place large woody debris in the channels of both Tributary 0303 (RM 0.0-0.3) and 0302 (RM 0.4-1.2), and
3. Apply local bioengineered slope treatments, such as revegetation, to eroded sites.

Discussion: Capturing the discharges from the two culvert outfalls and tightlining them over the steep, erodible ravine sides could reduce sediment loading in Maplewood Creek by an estimated 5 to 25%. Placement of large woody debris could help reduce downstream sediment delivery and could contribute to the general function and quality of instream habitat.

This solution was chosen from a number of alternatives; reconfiguring the lower half mile of the channel to convey flows and sediment to the Cedar River by alternate means ($500K) or using tightlines ($500K) were rejected because of their high cost and the uncertainty of their effectiveness. Regional retention/detention ponds were considered for the headwaters of Tributaries 0302 and 0303 but were rejected because, although very effective, they would be prohibitively expensive ($5,000K).

Lead Entity:	WLRD
Cooperating Entities:	Renton PW
Estimated Cost:	$150,000

3123 Maplewood Golf Course Reach Improvements

Recommendation: The City of Renton should replace the two existing sediment ponds on Tributary 0302 with one designed to allow upstream fish passage at RM 0.35 and stabilize the eroding banks of the stream above the pond with large woody debris. In addition, the City should consider enhancement of habitat in the reach that passes through the golf course to facilitate upstream fish passage and provide rearing and spawning habitat.

Discussion: The improved sediment pond and stabilized upstream banks would not only allow anadromous fish to pass to upstream reaches, it would reduce the frequency of sediment removal with its associated costs and its habitat impacts. Enhancement of the reach within the golf course (RM 0.2-0.4) would encourage use of the relatively good habitat of the Maplewood ravine by anadromous salmonids.

Lead Entity:	Renton
Cooperating Entities:	WLRD, MIT
Estimated Cost:	$350,000

Orting Hill Subbasin

3124 Orting Hill Tributary (0307) Realignment

Recommendation: Realign the lowermost reach of Tributary 0307 into a new fish-usable channel and a constructed wetland complex along lower Jones Road. (Note: this could be used for mitigation for construction of the new Elliot Bridge or other road projects along Tributary 0307.)

Discussion: Approximately 0.2 miles of the lower-most reach of this stream was placed in a culvert to reduce flooding and erosion concerns along lower Orting Hill road and lower Jones Road. However, the culvert has not worked well, as it requires frequent maintenance and flooding still occurs, and it blocks access for fish into the upper reaches of Orting Hill tributary (Tributary 0307), a small stream with fair to good habitat for cutthroat trout and limited coho salmon potential. A 1993 bank and channel stabilization project in the ravine reach upstream of the culvert has enhanced upstream habitat characteristics with large woody debris (LWD) placement. The culvert also has no value for water quality and disrupts the ecological connectivity of this stream with the mainstem of the Cedar River. To remedy these problems and provide additional new habitat and water quality enhancement, this recommendation proposes a northwesterly diversion of the lower portion of the stream to a flat terrace area along lower Jones Road. This area is currently a field and has potential for conversion to a wetland with fish benefits, particularly for coho salmon, as well as water quality and wildlife benefits. From this point, the stream would cross under the road and enter the Cedar River downstream of the existing Elliot Bridge. This project is currently being considered as mitigation for the proposed upstream relocation of the Elliot Bridge.

Lead Entity:	WLRD
Cooperating Entities:	KC Roads, Renton PW, MIT
Estimated Cost:	$400,000

Cedar Hills and Webster Lake Subbasins

3125 Wetland 36 (Francis Lake) Restoration

Recommendation: The WLRD Division should invite local landowners and community groups to develop and participate in a cooperative public/private project to restore the wetland. Restoration could include the following activities:

1. Locating and blocking old drainage ditches in order to increase soil saturation during the growing season to promote re-establishment of beneficial wetland plant communities and thereby biofiltration and wildlife habitat;
2. Placing large woody debris in shallow shoreline areas;
3. Where there is suitable access for equipment, mounting several artificial snags; alternatively, snags could be created from existing conifers within the wetland buffer;
4. Fencing buffer area(s) to reduce livestock access;
5. Replanting with suitable vegetation; alternatively, allowing the wetland and buffer to revegetate naturally; and
6. Mounting nesting boxes for songbirds and wood ducks.

Discussion: Although the buffer of Wetland 36 has been almost completely removed as a result of agricultural activities, it has good potential for restoration. Activities such as ditching, tilling, and livestock grazing have degraded this 31-acre, Class 1 wetland, which currently supports an unusually large number of wildlife species, including migratory waterfowl, red-tailed hawk, Virginia rail, muskrat, and occasional mink. Its connection with nearby upland and aquatic habitats—including forested lands, Webster Lake, and nearby riparian wetlands—increases the restoration potential of Wetland 36. Moreover, because the area is expected to remain low-density residential, prospects are good for maintaining viable habitat in this part of the basin.

Lead Entity:	WLRD
Cooperating Entities:	DDES, WCC, WFFA, Wetland area residents
Estimated Cost:	$5,000.

3126 Tributary 0316A and Wetland 32 Restoration

Recommendation: Install large woody debris in the stream channel and plant riparian vegetation along the denuded banks (RM 0.6-1.2); fence the north side of Wetland 32 (RM 0.6-0.7) to exclude livestock; and replant the edge of the pond and buffer with suitable vegetation.

Discussion: This relatively simple project, much of which could be accomplished by volunteers using hand tools and simple planting techniques, could greatly improve instream and riparian habitat for depleted Lake Washington salmonid stocks. Because of the anticipated increase in salmon spawning habitat, this project would also improve the winter food source for bald eagles, which feed on fish carcasses in this reach. The effectiveness of this recommendation partly depends on the implementation of NT 1, which recommends that the Stoneway Gravel Mine (upstream of Wetland 32) take measures to protect the quality and quantity of runoff from its site.

Lead Entity:	WLRD
Cooperating Entities:	DDES, KCD, WCC, MSE, MIT, WDFW, WFFA
Estimated Cost:	Stream channel restoration = $30,000; Wetland restoration = $5,000.

3127 Retrofit Retention/Detention Ponds

Recommendation: WLRD should identify existing retention/detention (R/D) facilities for retrofitting with additional capacity and water quality controls. Factors used to prioritize the existing facilities for water quality retrofits should include 1) the ranking of pollutant loadings by tributary as indicated on page 6-44 of the *Cedar River Current and Future Conditions Report*; 2) the existence of significant downstream resource areas; 3) area and uses of land draining into the existing facility, which determine pollutant loadings; and 4) the efficiency of pollutant removals in proposed water quality control.

Discussion: Pollutant loadings increase as development intensifies. Small tributaries within the urbanized subareas are subjected to higher pollutant loadings. This, in combination with the lower flows of these tributaries can result in higher pollutant concentrations, which have the potential to threaten aquatic species and beneficial uses. In urban areas, where source control best management practices (BMPs; e.g., educational programs) may not be sufficient to address the magnitude of pollutant loading, treatment BMPs can provide removal of pollutants. Existing R/D facilities provide the opportunity for retrofitting to include water quality treatment controls. Depending on the site, detention ponds can be retrofitted to include dead storage (wet ponds) and/or biofiltration, and filters can be added to improve water quality. Subbasins that should be targeted for retrofitting include Molasses, Madsen, Maplewood, and Ginger creeks, and the headwaters of Peterson Creek.

Lead Entity: WLRD
Cooperating Entities: Renton PW
Estimated Cost: $500,000

SOUTHERN TRIBUTARIES SUBAREA

3130 Fairlane Woods Detention Pond Discharge Improvements

Recommendation: Tightline the outlet of the Fairlane Woods detention pond to its entry into the Cedar River at RM 3.8 (left bank). If funding is limited, extend the overflow riser in the detention pond outlet structure.

Discussion: The ravine downstream of this pond has been downcut as much as 10 to 15 feet since construction of the Fairlane Woods development. The eroded sand, gravel, and cobble material is deposited at the base of the ravine, where it is carried away by high flows in the Cedar River and contributes to locally high turbidity in the river. The Fairlane Woods detention pond, constructed in 1979, was improperly built and provides less detention volume than was intended. In addition, the pond's overflow riser is three feet too short, causing the pond to go into overflow condition prematurely. Tightlining the discharge to the Cedar River would avoid virtually all sediment-related impacts. Alternatively, increasing the use of the existing pond volume, by extending the overflow riser, would offer some additional protection but the long-term problem would almost certainly continue.

Lead Entity: WLRD
Cooperating Entities: MIT, Fairlane Woods neighborhood, Renton
Estimated Cost: $100,000; Alternate: $2,000.

Molasses Creek Subbasin

3131 Elevation of 140th Avenue SE at Wetland 22

Recommendation: During the road widening of 140th Avenue SE, currently being designed by the King County Roads and Engineering Division, elevate 140th Avenue SE at its crossing of Wetland 22 to one foot above the maximum depth of flooding during the 100-year storm event.

This recommendation has been forwarded to the Roads Division for inclusion into their upcoming project to widen this stretch of road.

Discussion: 140th Avenue SE bisects Wetland 22, a 12-acre Class 1 wetland that provides significant attenuation for flows from the upper reaches of the Molasses Creek drainage. The two segments of the wetland are connected beneath the road by a 24" corrugated metal pipe (CMP). Although this culvert has a theoretical capacity of 28 cubic feet per second (cfs), the overall wetland level rises sufficiently to submerge the road from both sides. This occurs on an almost annual basis. Thus the 140th Avenue SE cross-culvert works more as an equalizer than a conveyor: during larger storms, the water surface elevation is governed by the geometry of the wetland, not by the size of the culvert.

Elevating 140th Avenue SE to one foot above the 100-year water surface elevation is a simple solution that would provide best protection with minimal impact to Wetland 22. Raising the road should not affect the performance of either the cross-culvert or the wetland; if detailed analysis suggests that the capacity of this culvert might be inadequate, it could easily be upgraded to a 48" CMP at minimal additional cost. However, raising of the road may require additional widening of the shoulders, which could encroach into Wetland 22 and its buffer. At some additional cost, this encroachment can be minimized by the use of retaining walls and guardrails.

Increasing the volume of the wetland, to lower the maximum water surface elevation of the 100-year storm event below 140th Avenue SE, was also considered as an option but rejected. The likelihood of success is low, because the wetland level probably reflects the prevailing elevation of the groundwater table almost independent of the volume of the wetland itself. Even if this action were partly successful, the wetland hydroperiod would be altered to the detriment of the wetland plant communities (forested swamp and bog habitats). The cost of wetland expansion would also be quite high.

Lead Entity:	KC Roads
Cooperating Entities:	MIT, WLRD, Renton
Estimated Cost:	$150,000.

3133 Fairwood Park Division 11 Detention Pond Retrofit

Recommendation: Expand the existing detention pond at RM 1.0 on Molasses Creek (Tributary 0304) from 70,000 to 186,400 cubic feet of storage to provide additional detention and water quality enhancement. Acquire a larger easement in Tract A, owned by the plat's Homeowners' Association.

Discussion: Just upstream of the existing detention pond for Fairwood Park Division 11, one house flooded and another was threatened during floods on January 9 and November 24, 1990. Computer simulations indicate these two storms resulted in 5-year peak flow rates here. When the pond was constructed, 25-year storage was anticipated by use of the Seattle Water Department's (SWD) pipeline road as a pond barrier. Although the floor-elevation requirement for the houses was established at two feet above the then-current SWD road elevation, neither the houses nor the pipeline road currently lie at their anticipated elevations (the road is now higher; the houses were constructed lower). A permanent overflow was recently installed, which has alleviated the flooding risk but also has reduced the volume of available storage in the pond. Downstream erosion in the lower Molasses Creek locally significant resource area (LSRA), however, indicates that any increase in peak flow rates would likely have adverse impacts to channel stability. In addition, modeling indicates that a water quality problem is likely to exist in this catchment.

Increased detention could be provided in several alternative ways. Wetland 2, immediately upstream and owned by King County Department of Parks and Recreation as open space, could be modified. However, Wetland 2 is a 37-acre partially forested Class 2 wetland; forested wetlands are particularly sensitive to changes in their hydrology, and so adverse impacts to the wetland would likely accompany any modification to its water-level fluctuations. At the site of the current pond, additional storage could be provided by either raising the overflow and berm of the pond, just upstream of the SWD pipeline road, or by regrading the pond with its current (lowered) spillway elevation. The risks of an increased pond elevation, even with additional protection to SWD's pipeline, were judged unacceptable; regrading of the existing pond appears to be the best method to achieve acceptable performance of this facility. Most of the ultimate cost of the preferred alternative is associated with expansion of pond volume, both the excavation and the need to acquire additional flood easements.

This project offers a wide range of options and similarly varied costs, which could help balance the list of basin capital needs with the (probably insufficient) revenues available to meet all of those needs fully. If less than optimal detention volume is ultimately achieved, however, large woody debris should be incorporated into the downstream channel to help stabilize erosion and sediment deposition to compensate for increased flows resulting from the reduced pond volume.

In addition to the major construction work recommended, signs should be posted and mailers sent out to the residences along the stream and the Fairwood Park Division 11 Homeowners' Association to promote public awareness of the impacts caused by yard wastes in or adjacent to the stream channel, which have significantly degraded this reach of Molasses Creek.

Lead Entity:	WLRD
Cooperating Entities:	SWD, Fairwood Park Div. 11 Homeowners' Assoc., MIT, Renton
Estimated Cost:	$250,000.

3134 Molasses Creek LSRA Restoration

Recommendation: In the lower 0.8 miles of Molasses Creek below the Seattle Water Department pipeline crossing, stabilize the channel and improve habitat by placing large woody debris and boulders in the stream channel, and establish better riparian conditions through conifer plantings where necessary. Much of this work would be focused on the lower 0.2 miles of the stream. In addition, support the ongoing negotiations for remediation and restoration of the Person gravel pit (CIP 3112), being conducted between the landowner and King County's Department of Development and Environmental Services (DDES).

Discussion: This reach of Molasses Creek has been subject to a variety of adverse impacts for many years. It receives high flows from the Fairwood development upstream, and it flows through the very disturbed landscape of a recently active gravel mine. In particular, a lack of instream structure and poor riparian vegetation from RM 0.0 to 0.2 has resulted in degraded, riffle-dominated habitat that seriously reduces the productivity of this locally significant resource area (LSRA) for salmonids. Upstream, hydrologic modeling indicates that the ravine (RM 0.2-0.8) is at risk of severe channel incision; and large amounts of trash are in the stream below a culvert at RM 0.8.

Implementation of this recommendation will require permission from the gravel mine operator. The value for this work would be increased if there was a reduction in future (if not current) flows by upstream drainage regulations and new capital projects. Ideally, a stream management plan can be developed in cooperation with the gravel mine and powerline owners that is compatible both with their needs and with the Plan's habitat goals. Currently, King County has placed an injunction against any further activity on the site and has required reclamation. The outcome of this legal process may affect the feasibility and ease of accomplishing any other action along lower Molasses Creek, particularly in the lowermost 0.2 miles where the channel flows through the mine property itself.

Lead Entity:	DDES
Cooperating Entities:	KCPA, Person Gravel Pit, MIT, MSE, WDFW, Renton
Estimated Cost:	$35,000

Madsen Creek Subbasin

3135 Wetland 16 Buffer Revegetation

Recommendation: The west side and outlet area of Wetland 16 should be revegetated.

Discussion: Wetland 16 is one of the highest quality and most threatened wetlands in the entire basin planning area and is recognized as a regionally significant resource area (RSRA). Local damage to the wetland's buffer could be corrected at relatively minor cost, improving the structure and function of this extraordinary resource (see BW 3).

Lead Entity:	WLRD
Cooperating Entities:	MIT, WCC, WFFA, Wetland neighbors, Renton
Estimated Cost:	$5,000

3136 Upper Madsen Creek Detention and Ravine Stabilization

Recommendation: The following improvements should be made to remedy the effects of urbanization on the tributaries and lower reaches of Madsen Creek:

1. Enlarge Candlewood Ridge Division 1 detention pond (Tributary 0306, RM 0.8);
2. Tightline surface flows of two deeply incised tributary ravines (Tributaries 0305A and 0305B);
3. Stabilize the erosion prone reaches of both east and west ravines using bioengineering techniques. Areas where the King County Wastewater Treatment Division (WTD) sewer line is particularly vulnerable should receive special treatment.

Discussion: In 1976, Metro (now WTD) constructed a sanitary sewer interceptor that enters the channel in the upper ravine and is buried along and adjacent to the stream channel below. This sewer line was exposed in several locations and was damaged in the upper ravine during the January and November 1990 storms. The stream made major geomorphic adjustments in response to these events, including large landslides on the ravine walls and scoured channel beds in the bottom of the upper ravines. The scour and subsequent bank sloughing also continued exposing two 10-inch-diameter high-pressure ductile iron gas lines that had been buried crossing under Tributary 0306 at RM 0.1 in 1956.

The sewer line problem was temporarily stabilized in 1992 but is still in need of a permanent long-term solution. The gas lines have been abandoned and are scheduled for removal in 1995. Fairwood Park Division 21 detention pond in the upper basin (Tributary 0306A, RM 0.1) is currently being enlarged as part of an early start CIP by the WLRD Project Management and Design unit. This pond will reduce flows from the M4 catchment. Construction is due to be completed in 1995.

Two bioengineered stabilization projects using nontraditional designs and construction techniques were installed as demonstrations in 1993. The first project stabilized a steep eroding slope by using large woody debris and plantings at the toe and diverting the stream into a new hand-dug channel away from the eroding toe. The second project added 30 pieces of large woody debris to approximately 500 feet of channel to reduce erosional energy, store sediment in the channel, and create more complex habitat. To date the projects have performed well and were cost-effective compared to more conventional construction designs and techniques. However, the sites have not yet been subject to high flows.

The recommended detention increases for the Candlewood Ridge Division 1 pond, combined with the increased detention in the Fairwood Division 21 pond, would ultimately reduce 2-year peak discharges by about 22% and flow durations by about 27% in the lower ravine. Higher flows would be reduced less and the ponds would overflow at or about the 10-year event. Enlarging the Candlewood pond would present some difficult choices due to the location in and adjacent to the Class 2 Wetland 18. The construction of this pond would require a Public Agency and Utility Exception to the SAO and could possibly require an Environmental Impact Statement. Either one or both of these processes could lead to large cost increases in addition to delays in implementation. Eliminating this element of the recommendation would reduce the estimated cost by approximately $700,000.

Two deeply incised ravines caused by concentration of surface flows from the Fairwood development were identified as major sediment sources to the sediment pond at the mouth of the lower canyon. Tributary 0305A is receiving undetained flows and experiencing severe erosion at its head and downcutting in its ravine. Some of the evulsions caused by the outflows have created cliffs up to 50 feet tall. Due to the inaccessibility of the site and the large scale of the erosion it is believed that bioengineering techniques would be ineffective at slowing the erosive action at these locations. Flows to Tributary 0305B are partially detained in an underground R/D facility and then discharged to the top of its ravine. High-density polyethylene tightlines were determined to be the most cost-effective way to check erosion in these tributaries. In each case the outlets from the tightlines will require the construction of energy dissipaters, complicated by difficult material delivery conditions. The option of adding detention in the basins was not practical due to lack of suitable sites.

Bioengineered channel and sewer line protection is recommended for the eroding portions of Tributaries 0305 and 0306. The success of the demonstration projects has shown that these methods are very effective when properly sited and designed. Areas where the sewer line is particularly vulnerable will require the most attention due to the consequences of relatively undetained high flows and their potential effect on the sewer line.

Alternative investigated solutions included construction of a bypass pipeline down the length of Madsen Creek, which would achieve protection of the sewer pipe from future breakage but would be extremely expensive to construct and maintain and would almost unavoidably damage the remaining good-quality habitat in the Madsen Creek ravine. Alternatively, the sewer line could be abandoned, eliminating the water quality risk from future breakage. The cost of this option, however, is very high and the feasibility of identifying an alternative route is dubious due to the likely reluctance of surrounding residents; this alternative also does not address existing instability in the ravine, which would almost surely require some additional efforts as well.

Lead Entity:	WLRD
Cooperating Entities:	WTD, Fairwood Homeowners' Assoc., MIT, Cedar River Water & Sewer District, Renton
Estimated Cost:	$1,000,000: Alternate $300,000

3137 Lower Madsen Creek Sediment Pond Outlet Improvements

Recommendation: Reconfigure the outlet of the sediment pond at RM 0.8 to limit fish access to the high-flow bypass channel and increase the frequency of low to moderate flows in the low-flow channel.

Discussion: A sediment pond was built at the mouth of the Madsen Creek ravine in the early 1970s to protect the Mobile Home Wonderland mobile home court and SR-169 from flooding. The current capacity of the low-flow channel exiting the sediment pond is about 60 to 100 cfs, which is less than the 2-year discharge of Madsen Creek. The outlet of the pond currently allows some flow into the high-flow channel at much lower discharges. As a result, fish are often drawn into the high-flow channel and then are stranded as the water recedes. In addition, the low-flow channel is deprived of a portion of higher flows that could help in flushing fine sediments.

The recommendation achieves the primary objectives, reducing fish mortality in the high-flow bypass channel and improving the habitat value of the low-flow channel, at lowest cost and requires the least amount of additional work and reconstruction of the stream channel and road crossings. Water quality and habitat functions of the low-flow channel are maintained, and probably enhanced, by this alternative.

More costly alternatives include the routing of significantly more flows into the low-flow channel. This option would undoubtedly improve overall stream function by reducing the need to split flows, but successful implementation would be extremely difficult and costly because it would require the purchase of additional land downstream of the sediment pond and major reconfiguring of the stream crossings under SR-169. This would be extremely difficult because the SR-169 widening project is nearly completed. Acquisition of the field next to the sediment pond is an open space recommendation for restoration of Madsen Creek's lower riparian corridor and floodplain, but is not part of this solution (see BW 4).

Lead Entity:	WLRD
Cooperating Entities:	WDFW, MIT
Estimated Cost:	$10,000

TAYLOR CREEK SUBAREA

3140 Maxwell Road SE Flood Abatement and Taylor Creek Restoration

Recommendation: The following improvements should be made in order to alleviate flooding of Maxwell Road SE and to improve water quality and habitat in Taylor Creek:

1. Widen and revegetate approximately 700 feet of the roadside channel along upper Maxwell Road SE (RM 0.9-1.0);
2. Realign and fence approximately 1,300 feet of the channel near 225th Avenue SE, south of SE 206th Street (RM 0.6-0.8);
3. Raise or relocate two houses;
4. Enlarge the bridge at SE 206th Street (RM 0.8); and
5. Replace a constricting driveway culvert on 225th Avenue SE (RM 0.6).

Discussion: 225th Avenue SE floods almost annually in the vicinity of its intersection with SE 206th Street, preventing access to over 30 houses. Maxwell Road SE (south of SE 208th Street) floods almost as frequently, creating a hazard on this arterial road. Flooding is the result of a combination of backwater from the Cedar River and past channelization of the creek in a roadside ditch. This reach of Taylor Creek supports some of the highest densities of spawning sockeye salmon seen anywhere in the basin planning area. Were the creek allowed to occupy its natural floodplain, unimpinged by residential construction and without the current practice of straightening and narrowing the channel, not only would flooding damage be significantly reduced, but habitat and water quality functions would be enhanced.

Widening and revegetating the reach of stream adjacent to Maxwell Road SE (north of SR-18) would only moderately improve conveyance capacity but would greatly increase the project's water quality and habitat benefits. Realigning eastward the channel currently adjacent to 225th Avenue SE would reconnect Taylor Creek with its historical floodplain, providing an area where stream sediment could be deposited without serious harm to either the natural or built environments. This would also create a wide, well-vegetated riparian wetland corridor, improving habitat and water quality biofiltration. Fencing would ensure protection of the newly realigned channel from livestock.

As part of the realignment project, two homes near the "dogleg" at SE 208th Street and 225th Avenue SE, should be raised to prevent their further flooding or, if necessary, relocated to allow the newly realigned creek to safely flood during large events.

Sediment deposition, which also contributes to flooding, comes from upstream erosion and from washouts that occur when storm flows exceed the capacity of a box culvert under SR-18. Unfortunately, until WSDOT completes its planned improvements to SR-18, projected to be done in the year 2000, the box culvert under SR-18 will continue to flood at storms larger than the 20-year event. The result may be continued sediment deposition and subsequent flooding, despite the efforts of this project.

Although dredging alone, as was done historically, would provide some level of flood relief in the short term, it would need to be repeated periodically and would damage habitat and cause temporary water quality impacts. Even with the proposed project, it is expected that a certain amount of infrequent dredging may be required to keep the lower reaches of the creek from flooding in the long term. In anticipation of this, the overexcavated downstream end of the realigned channel would be sited for easy access. Additional sediment reduction is expected to result from placing large woody debris and revegetating the upstream channel, which is recommended in CIP 3141.

Finally, the bridge at SE 206th Street should be enlarged and the culvert at 20412 225th Avenue SE should be replaced, because they both constrict the channel and raise the water surface during moderate flows. Any impacts to stream or wetland conditions resulting from these changes would be mitigated.

A variety of possible high-flow bypass conveyances composed of pipelines, channels, or combinations of both were analyzed. Three principal alignments to the Cedar River were investigated, but impacts to fish and wetland habitat were judged too severe to warrant further study of these very expensive ($1,000,000 to $2,200,000) alternatives.

Lead Entity: WLRD
Cooperating Entities: KC Roads, MIT, WDFW, GMVAC, MSE, Neighbors
Estimated Cost: 850,000

3141 Taylor Creek Habitat Restoration

Recommendation: In order to restore the habitat quality and reduce downstream sedimentation of the following reaches, King County WLRD should:

1. Place large woody debris and rock in the channel where appropriate to increase channel roughness and instream habitat and plant conifers where necessary to restore the riparian corridor (Tributary 0320, RM 1.2-1.6); and
2. Mail informational flyers to local residents and encourage partnerships with landowners to fence and restore forested buffers along stream reaches impacted by agricultural and rural development (Tributary 0320, RM 1.6 to headwaters).

Discussion: Habitat in the Taylor Creek ravine reach (RM 1.2 -1.6) is being degraded by low-level erosion caused by lack of large woody debris and increased peak flows resulting from upstream development. Above RM 1.6, and in Tributaries 0326 and 0327 where stream gradients are relatively flat, habitat and water quality are locally affected by rural development and agricultural practices that reduce the quality of riparian vegetation through inappropriate landscaping and overgrazing. Instream habitat here and throughout much of the subarea is low in structural complexity, resulting in a reduced ability to store sediments and buffer against environmental stresses.

Increasing channel roughness and complexity by placing large woody debris would help retain spawning gravel in the steeper reaches of Taylor Creek and reduce sedimentation in the lower reaches. This action would impact many private properties and therefore would be difficult to accomplish without a strong public/private partnership responsible for stream protection. Conducting these projects with volunteers would reduce construction costs and support voluntary efforts to reduce livestock effects on riparian areas by stream fencing. (The County requires that streambanks be fenced by the end of 1998.) It should be noted that neither of these solutions is assured of success due to their reliance on relatively new design methods and on the cooperation of the community.

Lead Entity: WLRD
Cooperating Entities: WCC, GMVAC, MSE, WDFW, MIT, WFFA, Neighbors
Estimated Cost: $5,000 to $45,000, depending on community involvement.

3142 Tributary 0321 Habitat Enhancement

Recommendation: King County WLRD should install fencing and place large woody debris and riparian plantings in the stream corridor from RM 0.0 to 0.2.

Discussion: The lowest 0.2 mile of this stream is dominated by pasture, the effects of which, while not severe, could be reduced. This project would increase local habitat value and support the productivity of the regionally significant resource area upstream.

Lead Entity:	WLRD
Cooperating Entities:	WCC, KCD, GMVAC, Neighbors, WFFA, MIT
Estimated Cost:	$30,000

PETERSON CREEK SUBAREA

3150 Wetlands 14 and 42 Protection and Restoration

Recommendation: Two sites in this subarea should be considered for either easement or property acquisition and subsequent restoration.

1. **Wetland 14** (43 acres): Open space acquisition could include up to 80 acres of land, including the 43-acre wetland and adjacent upland areas. Restoration would include improving hydrology to increase ponding and/or soil saturation; establishing a vegetative buffer ranging from 100 to 200 feet in width (with wider areas around the bog segment); installing artificial snags; placing woody debris piles; installing bird nesting boxes; and, where needed, removing fill, regrading, and revegetating.
2. **Wetland 42** (Peterson Lake and its associated buffer area—a total of approximately 30 acres): Open space acquisition could include up to 145 acres, including the 23-acre wetland and adjacent forested uplands. Where compatible with the Seattle Water Department's (SWD) pipeline management needs, restoration should be accomplished by removing trash, building more sensitive trails, encouraging the growth of large coniferous trees in the buffer, and adding of woody debris in areas that currently lack habitat complexity.

Discussion: Although Wetland 14 has been heavily impacted by extensive peat mining, it also contains six acres of pristine forested bog. The wetland lies in a critical area of the subbasin because it forms the head end of Tributary 0328B and is located a short distance upstream of Lake Desire. This RSRA wetland has many positive attributes including areas of mature forested buffer, extensive use by wildlife, and numerous ponds and channels that the current landowner has constructed to achieve a low level of restoration and to provide trout fishing. Because of its strategic location in the subbasin and the potential for significant restoration and expansion of its water quality and hydrologic buffering capacity for downstream areas, especially Lake Desire, protection and restoration of Wetland 14 is a high priority for the subarea (see BW 3).

Peterson Lake (Wetland 42) is part of a unique RSRA wetland/lake complex that contributes to the health of the Peterson Creek subbasin. It is a popular, informal recreation site due to its accessibility from both 196th Avenue SE and Petrovitsky Road. As a result, it is currently subject to trash dumping and other impacts. Activities necessary for the maintenance of the SWD pipeline have affected portions of the eastern buffer and areas around the outlet. Although the

SWD is amenable to some changes in management, some riparian vegetation restoration options are limited by pipeline maintenance needs. In addition, purchase of wetland must recognize the existing and perpetual drainage easement the SWD has obtained in this area. Regardless of these concerns, many opportunities exist to protect and enhance this site for improvement of recreation and habitat value (see BWs 3 and 4).

Lead Entity:	DDES
Cooperating Entities:	
Wetland 14	WCC, WFFA, Wetland Neighbors
Wetland 42	MIT, WLRD
Estimated Cost:	
Wetland 14	$400,000
Wetland 42	$500,000 to $1,400,000

3151 Lake Desire Flood-Damage Reduction

Recommendation: Improve the Lake Desire outlet to lower the maximum surface-water elevation.

Discussion: East Lake Desire Drive SE is the sole-access road for residents of 39 houses located along the eastern shore of Lake Desire. The road was built through Wetland 15, a class 1 RSRA wetland. The road overtops at flows greater than about the 2-year event. Road flooding appears to stem from a combination of increased flows due to development, and from a backwater effect from Lake Desire caused by beaver activity and poor conveyance in the Lake Desire outlet channel, Tributary 0328B.

A combination of removing the beaver dam, enlarging the outlet culvert, and clearing the outlet channel using hand methods would lower lake levels enough to reduce the depth and frequency of road and residential flooding. Methods of discouraging or disabling beaver dams (e.g., a continuing trapping program, installation of perforated pipe) should be employed to prevent future beaver problems. The Lake Desire Community Club should be instructed in nondamaging methods of clearing the outlet downstream of the culvert so maintenance can be performed as needed into the future. (See recommendation PC 1: Lake Desire Outlet Channel Maintenance.) King County Parks should use similar methods to keep the portion of Tributary 0328B flowing as well as possible in keeping with good environmental practices.

Simply raising the road above the lake's flood elevation would solve the worst problem of blocked residential access, but would not address flooding of properties surrounding the lake; this suggestion was given a medium priority by the King County Roads and Engineering Division, and would probably not receive funding in the near future. Berming the road and/or the flooding properties was rejected as being too expensive.

Lead Entity:	KC WLRD
Cooperating Entities:	LDCC, MIT
Estimated Cost:	$25,000 plus up to $10,000 for permitting, etc.

3152 Peterson Lake Outlet Channel Restoration

Recommendation: Underplant conifers and add LWD to the Peterson Creek channel beginning at the outlet of Peterson Lake/Wetland 42 (RM 1.6) downstream to approximately RM 1.2.

Discussion: Since the 1930s and up to 1983, this reach of Peterson Creek was contained in a wood stave pipeline as part of the SWD pipeline right-of-way management activities. Removal of the pipeline has left a significant length of stream dominated by small deciduous trees and almost devoid of LWD. Where private property and water pipeline stability will not be threatened, this project seeks to reverse these conditions by establishing a coniferous understory and by adding LWD for instream cover and hydraulic complexity.

Lead Entity:	WLRD
Cooperating Entities:	SWD, MIT, WCC, WFFA
Estimated Cost:	$30,000

3153 Lower Peterson Creek Habitat Restoration

Recommendation: Between approximately RM 0.6 and 1.2, King County WLRD should incorporate LWD into the channel to increase frequency and quality of pools and to provide for greater retention of spawning gravel.

Discussion: The lower reaches of Peterson Creek lack significant accumulations of LWD, resulting in deficient pool frequency and quality. In addition, in the steeper gradient areas, this lack of LWD results in almost no significant retention of gravel suitable for spawning and has caused the bed to scour down to a relatively stable base of cobble over till. Existing riparian vegetation is dense but still too young to provide natural recruitment of LWD. Until the riparian vegetation matures, this project would provide the channel with LWD.

Lead Entity:	WLRD
Cooperating Entities:	WCC, MSE, MIT, WDFW, WFFA
Estimated Cost:	$50,000

MIDDLE TRIBUTARIES SUBAREA

3160 Wetland 64 Restoration

Recommendation: King County WLRD should work with volunteers to revegetate the wetland buffer, remove trash, and post signs encouraging neighborhood stewardship of the wetland.

Discussion: These simple and inexpensive corrective actions will improve wetland functions and help prevent future damage to this Class-1 LSRA system, which provides significant habitat for migratory waterfowl, other birds, and a variety of mammalian species.

Lead Entity:	WLRD
Cooperating Entities:	WCC, Neighbors, WFFA, MIT
Estimated Cost:	$2,000

3161 Walsh Lake Diversion Ditch Habitat Improvements

Recommendation: In cooperation with the Seattle Water Department, King County WLRD should make the following improvements in order to enhance the instream and riparian habitat of the Walsh Lake Diversion Ditch:

1. Install LWD in the steep, eroding portion of the ravine and utilize volunteers to revegetate streambanks
2. Investigate the potential diversion of additional flows from nearby Rock Creek (Tributary 0345) in the Cedar River Watershed. (Note that the Rock Creek referred to here is located in the Seattle Watershed, while the Rock Creek referred to throughout the rest of the Plan is within the basin planning area.)

Discussion: The placement of large woody debris would accelerate natural, stabilizing processes in the Walsh Lake Diversion Ditch and improve salmonid habitat by dissipating stream energy and adding structural complexity.

An existing fish blockage at the confluence of the ditch and the Cedar River during low-flow periods could potentially be solved by adding flows from Rock Creek. Although the cost of physically diverting this additional flow would be quite modest (approximately $50,000) significant issues related to the removal of water and potential impacts on Rock Creek habitat and municipal water supply would have to be resolved.

Lead Entity:	WLRD
Cooperating Entities:	SWD, MIT, WDFW
Estimated Cost:	$500,000

Basinwide Recommendations

BW 1: Remove Qualifying Structures from Hazardous Areas

Recommendation: King County should establish a voluntary program to purchase and remove from the floodplain occupied structures subject to hazardous flooding, and to convert these areas to parks, open space, aquatic habitat, or other flood-compatible uses.

Discussion: Approximately 130 houses in the Cedar River floodplain have been identified as subject to hazardous flooding conditions. All have been included in the capital improvement project recommendations in this chapter. This recommendation is intended to establish County policy for treating additional houses that are identified in future analyses or as the characteristics of the floodplain change.

There are no universally recognized standards for defining "extreme flood hazard," although simple rules of thumb have been used by designers and regulatory agencies for many years. Because the average adult has difficulty maintaining balance in water at velocities of about three feet per second, and because a water depth of three feet, if unequalized, corresponds to a compressive force of nearly 300 pounds per horizontal foot against the walls of a submerged structure, these or similar values are often used as criteria for identifying areas of high flood hazard.[1]

Although raising or otherwise floodproofing a structure in a high hazard area would address the problem of inundation damage, structures could still be at risk of damage or collapse from high-velocity flows and debris. When restored as active floodplain, these areas can provide floodwater storage, thereby reducing flood damage by moderating flow peaks downstream and water surface elevations upstream during floods. They also provide fish with refuge from high-velocity flows. Floodplain restoration will allow more recharge of the shallow and middle aquifers, especially after a draught year. In addition, removing structures from the floodplain would help protect aquifers used for drinking water since it removes potential sources of contamination associated with residential development. For these reasons, the preferred solution to high flood hazards resulting from deep, fast flow is the total removal of structures from the floodplain.

King County and the City of Renton should establish themselves as local sponsors to enlist the help of the Army Corps of Engineers under Section 205 of the 1948 Flood Control Act. This

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[1] This Plan defines an area as "hazardous" (in order of decreasing severity) if, during the 100-year flood:

1. Floodwater prevents the use of sole-access roads; or
2. Water velocity exceeds three feet per second; or
3. Water depth and velocity combine such that

$$DV^2 \geq 10$$

whereD = water depth (in feet), and
V = water velocity (in feet per second).

could qualify many homes within the floodplain for relocation assistance at little or no cost to residents.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, WDFW, MIT, DDES, CRC, SWD
Estimated Cost:	$118,000 for staff support over 10 years

BW 2: Reduce Less-Hazardous Flood Damage

Recommendation: King County should provide technical and financial assistance to help individuals or groups to implement voluntary programs to floodproof or remove less seriously threatened occupied structures from within the floodplain.

Discussion: Approximately 200 houses in the Cedar River floodplain have been identified as subject to less-hazardous but still significant flood damage that warrants County assistance to reduce. The following recommendation is intended to establish County policy for treating the remaining houses and any additional houses that are identified in the future as analysis progresses or as the characteristics of the floodplain change.

1. **Removal:** As described in BW 1, removing structures from the floodplain provides multiple benefits and is the preferred method of reducing flood damage.

   However, King County is constrained from funding projects whose public costs outweigh their public benefits. In addition, although methods exist for comparing the benefits and costs of floodproofing or removing structures from the floodplain, these methods have traditionally focused on the effects of flooding on structures rather than on the benefits of restoring or enhancing aquatic habitat and flood storage, which are more difficult to quantify.

   As a result, in areas subject to less-hazardous flooding than that described in BW 1, the calculated benefits of reducing flood damage and of reclaiming the floodplain for aquatic habitat and flood storage, while significant, may not justify removing affected structures at public expense. In these areas, King County should provide technical and financial assistance to public or private entities who propose voluntary projects to remove these structures.

2. **Floodproofing:** King County should provide technical and, when possible, limited financial assistance to voluntary public or private programs that floodproof occupied structures located in less-hazardous areas if a) removal of a structure is impractical or undesirable (e.g., if no opportunity for aquatic habitat or floodplain restoration exists); b) the public benefit of floodproofing or relocation outweighs the public cost; and c) the action causes no further elevation of flood stages or reduction of flood storage volume.

   The most commonly used flood-damage reduction procedures are moving the house to another lot, elevating the house on its foundation, moving the house to a less dangerous location on its current lot, berming or other "dry" floodproofing methods of keeping water away from the house, and waterproofing or other "wet" floodproofing methods of reducing damage while allowing floodwater to contact the house.

The actual costs of floodproofing may vary widely among methods and specific structures, as may the benefits from floodproofing or restoring habitat and establishing open space. For this reason, individual houses would be carefully evaluated before being formally recommended for relocation or floodproofing assistance. This evaluation should include analysis using the latest floodplain model and the size, type, and location and configuration of each structure, as well as the level of damage it has experienced during past floods. The Army Corps of Engineers' *Flood Damage Analysis Package*, which combines several related computer programs that take these elements into account to yield an estimate of "Average Annual Flood Damage" for each house, should be used in this analysis.

Structures have been identified as candidates under this program at the following locations:

Arcadia/Noble (both banks, RM 18.2-19.0)
Orchard Grove (also known as "Upper Dorre Don") (right bank, RM 17.0)
Dorre Don (also known as "Lower Dorre Don") (right bank, RM 16.4)
Dorre Don Court (right bank, RM 15.8)
Lower Bain Road/Royal Arch (both banks, RM 13.8-14.8)
Rhode/Getchman Levee (both banks, RM 13.6)
Jan Road (right bank, RM 12.6-13.0)
Byers Bend/MacDonald (left bank, RM 11.8-12.3)
Rainbow Bend (right bank, RM 10.8-11.3)
WPA/Cedar Mountain (left bank, RM 10.6)
Brassfield (right bank, RM 7.0)
Elliot Bridge/Lower Jones Road (both banks, RM 5.4-6.0)
Riviera Apartments (right bank, RM 2.2)

In all, approximately 225 houses and apartment buildings have been identified as being at some level of risk of less-hazardous flooding. Estimates to reduce that flooding range from approximately $3 million to $6 million, depending on treatment methods and the number of structures treated.

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, SWD, WDFW, MIT, CRC, DDES
Estimated Cost:	$118,000 for staff support over 10 years

BW 3: Wetland Management Areas

Recommendation: Catchment areas tributary to five regionally significant resource area (RSRA) wetlands within or near the urban growth boundary shall be subject to special development conditions to protect the functions of these wetlands. Wetland management areas (WMAs) include various provisions such as catchment area limits, cluster development, forest retention, infiltration requirements, and seasonal clearing limits. These measures should be adopted through changes in the appropriate ordinances in conjunction with adoption of this Plan. The King County Department of Development and Environmental Services (DDES) would administer these requirements upon adoption.

Wetlands 14, 15, 16, 28, and 42 Management Areas: New development in catchment areas draining to these wetlands shall provide:

1. 65-percent forest retention and 8-percent maximum impervious area within rural residential zones;
2. Level 2 R/D in catchments of Wetlands 16, 28, and 42. Level 3 R/D in catchments of Wetlands 14 and 15 (see BW 19);
3. Roof downspout infiltration, where practicable (see BW 19);
4. Water quality treatment standards for sphagnum bogs (for Wetlands 14, 15, 16, and 28) or RSRAs (for Wetland 42) (see BW 12); and
5. Seasonal clearing restrictions stating that during the period from October 1 to March 31, bare ground associated with clearing, grading, and other development activity shall be covered or revegetated in accordance with design standards in the *King County Surface Water Design Manual* and left undisturbed until this period ends.

In addition, a program should be conducted by the Basin Steward to educate Fairwood residents in the value and requirements of Wetland 16. King County Parks should insure that the existing upstream biofiltration swale and R/D pond in Petrovitsky Park are retained during development of the new playing field. Further study should be made of potential water quality/storage retrofits to manage and treat existing stormwater entering the wetland from Fairwood, or a pipeline to bypass runoff around the wetland.

All these wetlands except Wetland 28—which is largely within the Lake Desire/Spring Lake King County open space tract—should be evaluated for acquisition under the King County Open Space Program (see BW 4).

Discussion: The purpose of WMAs is to minimize adverse impacts of future urbanization on the functional and structural integrity of the five RSRA wetlands in the basin deemed most vulnerable to urbanization impacts. Such impacts typically include hydrologic disruption; sedimentation; and loss of connectivity with nearby terrestrial, stream, and lake habitats. In addition, these WMAs would also reduce potential damage to property, aquifers, and sensitive habitats downstream from pollution, flooding, erosion, and sedimentation.

A total of nine WMAs have previously been designated in the *East Lake Sammamish Basin Plan*, which is almost entirely within the urban growth boundary. In that basin, WMAs have been shown to be compatible with suburban cluster zoning of one dwelling unit per acre. As such, they are consistent with the environmental protection area and open space retention goals of the Growth Management Act.

Specific percentages for limits on impervious surface area and disturbed ground are based on information derived from the Puget Sound Wetlands and Stormwater Research Program[2] and on a review of observed stream channel conditions presented in the *Soos Creek Basin Current Conditions Analysis* and the *Hylebos Creek and Lower Puget Sound Basins Current and Future Conditions Report*. These studies showed a high degree of correlation between seriously degraded aquatic habitat and contributing impervious areas greater than eight percent. Depending on the specific characteristics of the development in the catchment, this typically corresponds to 40 to 50% urbanized land.

In addition, Basin Plan hydrologic modeling shows that maintenance of soil infiltration and storage capacity through retention of forest vegetation and a rural development pattern in catchments draining to lakes and significant resource area (SRA) wetlands is the most effective way to maintain the hydroperiods of these water bodies.

Wetland 16 is one of the largest and most structurally complex wetlands in the basin planning area. It includes shallow and deep marsh components, as well as forested swamp, scrub-shrub, and bog habitats. The deep marsh contains numerous snags and partially submerged logs that provide excellent habitat for a variety of animals, birds, and possibly warm water fish. Portions of the forested swamp and buffer areas contain accumulations of woody debris in volumes reminiscent of old growth forests.

Water quality modeling indicates that Wetland 16 will undergo a higher percentage increase in metals and total suspended solids than any other Class 1 wetland in the basin planning area. In addition, it forms the principal headwater of Madsen Creek, which has undergone severe damage from increased stormflows, landsliding, and sedimentation. The recommendations would provide increased water quality protection, minimize changes in hydroperiod, and help maintain a wildlife habitat corridor around the wetland. In addition, they would also help protect Madsen Creek from further costly damage.

Alternative stormwater management strategies, particularly infiltration, are not feasible in this area. The clearing restrictions in this recommendation affect less than 100 acres of potentially developable land.

Wetlands 14, 15, 28, and 42: These four wetlands are in the Peterson Creek subarea. They are among the highest quality and most threatened wetlands in the basin planning area because of their close proximity to lakes and future urbanization of direct catchment and headwater areas. These systems also provide significant buffering for downstream water quality and fish habitat. Of special concern is the protection of Wetlands 14 and 15, which lie directly upstream from Lake Desire. The lake already exhibits a serious eutrophication problem due to phosphorus from upper catchment and in-lake sources. These conditions mandate a high level of erosion control at all times of the year, supplemented by even more complete protection in the form of seasonal clearing restrictions.

[2] See "Selected Puget Sound Wetland and Stormwater Research Program Publications" in the Bibliography.

Lead Entity:	DDES
Cooperating Entities:	WLRD
Estimated Cost:	$118,000 for staff support over 10 years

BW 4: Priorities for Open Space Acquisition

Recommendation: Open space acquisitions should emphasize those areas that provide multiple benefits including recreation, habitat, aquifer protection and recharge, and flood-hazard reduction, except where critical, single-purpose values are highly threatened. Where buyout of floodplain areas with floodprone residences is recommended and where significant open space benefits could be obtained, open space funds should be used to acquire the underlying land, provided other local, state, or federal funds will be available to purchase and remove residences and unnecessary flood-control structures.

Table 4-1 identifies potential open space acquisitions and ranks them into High-, Medium-, and Lower-priority categories based on their feasibility, level of threat (i.e., potential for property to be developed in the near future), current or potential recreation, habitat, and flood-hazard reduction values, and programmatic value for meeting the goals of the Cedar River Greenway, Legacy, and Flood Hazard Reduction Programs. Properties recommended for immediate purchase with existing funds are also noted in Table 4-1.

Discussion: Open space can provide a variety of benefits if acquisitions are planned and managed properly. Within the lower Cedar River basin, there are many opportunities for acquiring open space areas for both single and multiple benefits related to recreation, habitat and water quality, and flood hazard. In part, this is true because of the proximity of the Cedar River Regional Trail to the Cedar River. The trail is close to many critical habitats and hazardous floodplain areas that, if acquired, would enhance the scenic qualities of the trail and provide high-quality natural habitat as well as reduce flood hazards.

Examples of multi-purpose acquisitions would be Rainbow Bend, Lower Dorre Don, and Ricardi, each of which have residences placed in highly hazardous and costly-to-maintain floodplain areas. Removal of the residences and restoration of the floodplain would eliminate flood hazards and river maintenance costs as well as provide significant benefits for habitat, water quality and, because they are located near the Cedar River Trail, recreation. Therefore, where buyout of residences is proposed primarily for reduction of flood hazard, but where other significant benefits would accrue, it is recommended that open space funds be used to acquire the land while other funds (e.g., through the COE, FEMA, Cedar River Legacy Initiative) be used to purchase and relocate residences, remove or modify flood-control structures, and conduct floodplain habitat restoration. In this way, open space funds are "leveraged" to provide significantly more benefits than could otherwise be obtained.

Some of the open space recommendations in Table 4-1 are critical mainly for a single purpose. For example, the Wilderness 50/Wilderness Retreat parcel, which was a proposed development along Rock Creek, contains one of the most outstanding stream and riparian habitats remaining in western King County and is of primary importance for its natural habitat value and for protecting the overall integrity of Rock Creek. This parcel ranked high because it is critical for a primary purpose (i.e., habitat) and because it was threatened by a vested alternative land use not conducive to maintaining its existing value. As a result of the development threats and resource value of the high priority sites, several have either been purchased or are being considered for immediate acquisition through the Legacy Program.

Lead Entity:	KCNRD (Office of Open Space)
Cooperating Entities:	CRC, WLRD
Estimated Cost:	$13,700,000 for land acquisition; $85,000 for staff support over 10 years

Table 4-1 Priorities for Open Space Acquisitions

(All parcels listed below warrant acquisition. Prioritization is intended primarily for scheduling purposes.)

Site Name	Location	Size (in acres)	Value *
Highest Priority Recommended Purchases (High Threat/High Value):			
Watkins Property	Mainstem (RM 16.5-16.8)	41	R, H
Landsburg Natural Area (purchased)	Mainstem (RM 21.5)	36	R, H
Lower Rock Creek Properties	Rock Creek (RM 0.0)	4	R, H
Wingert Property	Mainstem (RM 19.8-19.9)	5	R, H
Wilderness 50/Wilderness Retreat (purchased)	Rock Creek (RM 0.4-0.9)	99	R, H
	Subtotal	185	

Site Name	Location	Size (in acres)	Value *
High Priority (Moderate Threat/High Value)			
Peterson Lake/Wetland 42	Peterson Cr. (RM 1.6-2.0)	143	R, H
Belmondo Addition	Mainstem (RM 10.1-10.6)	117	R, H, F
Rainbow Bend Floodplain	Mainstem (RM 10.8-11.2)	30	R, H, F
Lower Taylor Creek/Maxwell Road/255th Ave. SE Properties	Taylor Cr. (RM 0.6-0.8)	5	H, F
Dorre Don LB Meander	Mainstem (RM 15.9-16.2)	21	R, H, F
Lower Dorre Don	Mainstem (RM 16.1-16.5)	5	R, H, F
	Subtotal	321	

Site Name	Location	Size (in acres)	Value *
Medium Priority (Low Threat/High Value)			
Rock Creek/Plum Creek Timber	Rock Creek (RM 0.9-1.1)	40	R, H
Landsburg Oxbow/Wetland 69	Mainstem (RM 20.4-20.6)	7	R, H
Webster Lake/Wetland 33	Trib. 0317 (RM 2.2)	approx. 64	H
LCR Wetland 14/Hamilton Property	Peterson Trib. 0328B (RM 2.2)	81	R, H
BN Nose/Peninsula	Mainstem (RM 17.8-18.7)	10	R, H
Belmondo Conservation Easement	Mainstem (RM 10.1)	15	R, H
Trib. 0316A Mouth	Mainstem (RM 11.5-11.6)	5	H, F
LeRoy's Addition	Mainstem (RM 17.8-18.6)	30	R, H
Roger Lemon Properties/LCR Wetland 32	Trib. 0316A (RM 0.8-1.1)	22	H
	Subtotal	274	

Table 4-1 Priorities for Open Space Acquisitions (Continued)

Site Name	Location	Size (in acres)	Value *
Lower Priority (Low Threat/Low-High Value)			
Upper Rock Creek/LCR Wetland 93	Rock Creek (RM 6.5-7.2)	35	H
Upper Rock Creek/LCR Wetland 92	Rock Creek (RM 7.4-8.2)	85	H
Lower Madsen/Church Property	Madsen Cr. (RM 0.5-0.8)	8	F
Shaw Remainder	Mainstem (RM 19.9-20.2)	20	H
	Subtotal	148	
Total		857-942	

* H = Habitat; F = Flood Reduction; R = Recreation

BW 5: Small-Scale Watershed Restoration and Enhancement

Recommendation: WLRD's small habitat restoration and enhancement program should continue and should expand to include small-scale habitat modification, restoration, and enhancement projects throughout the Cedar River basin. Projects suitable for this program are denoted in Table 4-2 with a "99" suffix.

Discussion: Numerous small-scale, labor-intensive projects or certain portions of larger projects (e.g., fencing, revegetation, placement of woody debris, construction of simple fish-passage devices, installation of bird nesting boxes in wetlands, and retrofitting residential roof-runoff systems to provide infiltration [BW 22]) have been identified in this Basin Plan as suitable ways to enhance and restore aquatic and terrestrial habitats in the basin planning area. These projects are intended to provide incremental benefits to the basin over the life of the Plan by repairing cumulative habitat damage and by preventing problems that may arise in the future. These projects would be done under the leadership of the Basin Steward (BW 16). Many of them also provide opportunities for volunteer participation that would be unavailable under more traditional capital improvement project (CIP) programs.

This recommendation differs from WLRD's traditional CIP programs in several ways. First, regional environmental permits would be sought from the U.S. Army Corps of Engineers (COE), the Washington Department of Fish and Wildlife (WDFW), and DDES for a batch of projects, rather than individual permits for each project.

Second, the Small Habitat Restoration Program would provide dedicated funds and staff to accomplish a large number of small-scale projects over a short period of time. Most traditional WLRD CIP projects, such as detention ponds and bypass pipelines, have complex engineering features and high capital costs. Because of this, existing King County design, permit, and contracting processes tend to be lengthy and complex. A major goal of this program is to rapidly implement multiple small-scale projects (or components of larger projects) within a single river basin. This should reduce permitting costs and accelerate the construction process.

Finally, this program would entail a substantial change in the current single-project permit review process. Establishment of this program may benefit from a formal memorandum of understanding between WLRD and DDES, and possibly other participating agencies. In the past, the COE has granted regional permits to public agencies for multiple habitat restoration projects within certain geographical boundaries such as western Washington. A similar King County regional permit for these projects would likely require approval of the Metropolitan King County Council in the form of an SAO amendment.

Lead Entity:	WLRD
Cooperating Entities:	WCC, KCD, COE, WDFW, DDES, TU, MSE, WFFA, MIT, Renton
Estimated Cost:	Project funded as CIPs

BW 6: Aquatic Resource Mitigation Bank Opportunities

Recommendation: To facilitate large-scale, integrated restoration and enhancement of streams and wetlands in the Cedar River basin, resource agencies should utilize the existing King County Wetland Mitigation Banking Program in the Cedar River basin. Suitable mitigation banking sites are identified as subarea and mainstem CIPs with an '88' suffix in Table 4-2.

Discussion: Under current federal, state, and King County permit programs, development-permit applicants are required to avoid and minimize impacts to sensitive areas to the maximum extent practicable. To compensate for remaining unavoidable impacts, regulators usually prefer on-site mitigation. However, for certain projects, such as road widening, this may lead to replacement of affected aquatic habitats with multiple mitigation sites located along a busy roadway or in other intensively urbanized areas. Even when mitigation ratios exceed 1:1, such small habitat units tend to be more expensive to design, construct, and maintain and are often less functional than larger habitats in areas less subject to disturbance.

In contrast, mitigation banks involve the off-site creation/relocation, restoration, and enhancement of wetlands or streams. The bank "client" is the agency or agencies whose activities will create wetland impacts for which mitigation is being sought through the bank. The project affecting wetlands must be approved through permit review. Credit is created by completing restoration, creation, or enhancement activities to produce viable aquatic resource credits. The credit producer holds the long-term property ownership of the mitigation bank and typically is a government agency or agencies with the most mitigation requirements. Credit is taken based on the acreage, habitat value, and functions created by the bank.

Once a bank is in place and has achieved an acceptable measure of resource functioning, permit applicants would purchase mitigation credits to offset their mitigation requirements and repay the cost of constructing the bank. The key advantage of mitigation banking over the single permit approach is that large sites could be used collectively to compensate, in advance, for a number of development projects, thereby streamlining the permit process. Through effective design, construction, and maintenance, mitigation banks can also provide higher aquatic resource functions than smaller, on-site mitigation projects by avoiding habitat fragmentation, by creating or restoring larger wetland systems or longer stream segments, and by placing their long-term care in the hands of aquatic resource specialists.

Due to rapid growth in the basin, a number of public agencies (e.g., public works departments, water and sewer districts, and schools) have proposed projects with river, stream, and wetland impacts. Even though the King County Sensitive Areas Ordinance (SAO) requires mitigation for actions that impact sensitive areas, for many projects on-site mitigation is impossible, impractical, or ineffective. For many such projects, mitigation banking would be more effective than on-site mitigation.

Under current SAO and other state and federal environmental permit requirements, mitigation banking would entail a substantial change in the current single-project permit review/mitigation process. Establishment of a mitigation banking program will probably be a lengthy process and require the active participation of many local, state, and federal agencies, as well as interested citizen groups, to be successful.

Lead Entity:	DDES
Cooperating Entities:	CRC
Estimated Cost:	$296,000 for staff support over ten years

Table 4-2
Cedar River Basin Open Space, Mitigation Banking, and Restoration Opportunities

'77' Open Space Acquisition Sites
As discussed in BW 4, these sites are recommended for acquisition by the King County Open Space Program.

'88' Mitigation Banking Sites
These are sites that contain degraded but restorable habitat where restoration could be conducted as off-site mitigation for future development projects in the basin (e.g., road and bridge widening projects, utility lines, regional drainage facilities, dredging projects, etc.).

'99' Small-Scale Restoration and Enhancement Sites
These are aquatic CIP projects that contain of elements such as revegetation and fencing, which can be done by WCC crews or volunteers using hand tools.

Mainstem Sites

77/99	Person Revetment Modifications (CIP 3113; left bank, RM 3.8-4.1)
99	Maplewood Heights Homeowners Site Enhancement (right bank, RM 4.6)
99	Upper Elliot/Lower Jones Road Flood-Damage Reduction (CIP 3111; both banks, RM 5.0-6.5)
88/99	Orting Hill Tributary Realignment (right bank, RM 5.4)
88/99	Lower Summerfield Pond and Channel (left bank, RM 5.6)
88/99	Summerfield Pond and Channel (left bank, RM 6.0)
88/99	Herzman Levee Ponds (right bank, RM 6.2)
88/99	Jones Road Wall-base Tributary (right bank, RM 6.8)
88/99	Riverbend Mobile Home Park Revetment Modification (CIP 3110; left bank, RM 7.2)
88/99	Riverbend Ponds (left bank, RM 7.2)
88/99	Wetland 103 Enhancement (left bank, RM 7.5)
88/99	Jeffries/Cook Channel (right bank, RM 7.5-8.5)
88/99	Wetland 37 Enhancement A (left bank, RM 8.3)
88/99	Wetland 31 Enhancement B (left bank, RM 8.5)
88/99	Power Line Habitat (right bank, RM 9.6)
88/99	Project 15 (WPA Levee Habitat; left bank, RM 10.3)
77/99	Tributary 0316 Enhancements (right bank, near mainstem RM 10.5)
77/88/99	Rainbow Bend Flood-Damage Reduction (CIP 3108; right bank, RM 10.6-11.0)
77/99	Tributary 0316A Ponds (right bank, near mainstem RM 11.1)
88/99	Byers Bend Habitat #1 (CIP 3107; right bank, RM 12.2)
88/99	Lower Maxwell Habitat (right bank, RM 12.2)
88/99	Jan Road Habitat (CIP 3106; right bank, RM 12.5)
99	Rutledge-Johnson Pond and Side Channel (left bank, RM 12.6)
99	Lower Taylor Creek Improvements (right bank, RM 12.6)
88/99	Getchman Levee Pond and Side Channel (right bank, RM 13.6-13.8)
99	Bain Road Side Channel Enhancement (right bank, RM 14.4)
99	Witte Road Pond (left bank, RM 14.6)
99	Witte Road Wall-base Tributary (left bank, RM 14.6)

99 Seattle Saddle Club Habitat Restoration (left bank, RM 15.2)
77/99 Dorre Don Meander B (CIP 3103; right bank, RM 15.7)
77/88/99 Dorre Don left bank Meander Habitat/Open Space (left bank, RM 15.8)
77/99 Lower Dorre Don, Lower Pond (right bank, 15.9)
88/99 Dorre Don Flood-Damage Reduction (CIP 3102 right bank RM 16.0)
77/88/99 Lower Dorre Don, Upper Pond (CIP 3102 right bank, RM 16.1)
77/88/99 Watkins Restoration/Open Space (left bank, RM 16.2)
77/88/99 Wetland 79 Habitat Restoration (left bank, RM 17.8)
99 Lower Rock Creek Habitat Restoration (left bank, RM 17.9)
99 Arcadia Wall-base Tributary (left bank, RM 18.2)
99 Wingert Property Habitats (both banks, RM 19.2)
99 Shaw Property Habitat (right bank, RM 19.5)
77/88/99 Landsburg Oxbow (right bank, RM 20.5)

Tributary Sites
99 CIP 3122 Maplewood Ravine Stabilization (Tributary 0302, RM 0.4-1.2; Tributary 0303, RM 0.0-0.3)
99 CIP 3123 Maplewood Golf Course Reach Improvements (Tributary 0302, RM 0.2-0.4)
99 CIP 3126 Tributary 0316A/Wetland 32 Restoration (RM 0.6-1.2)
99 CIP 3125 Wetland 36/Francis Lake Restoration (Tributary 0317, RM 1.5)
99 CIP 3134 Molasses Creek LSRA Restoration (RM 0.0-0.8)
99 CIP 3135 Wetland 16 Buffer Revegetation (Tributary 0305, RM 2.6-2.7)
77/88/99 CIP 3140 Maxwell Road SE Flood Abatement and Lower Taylor Creek Wetland Restoration (Tributary 0320, RM 0.5-1.1)
99 CIP 3141 Taylor Creek Restoration (RM 1.2-1.6)
99 CIP 3142 Tributary 0321 Habitat Enhancement (RM 0.0-0.2)
77/88/99 CIP 3150 Wetlands 14 and 42 Restoration and Protection (Tributary 0328B, RM 2.2, and Tributary 0328, RM 1.6-2.0)
99 CIP 3152 Peterson Lake Outlet Channel Restoration (Tributary 0328, RM 1.2-1.6)
99 CIP 3153 Lower Peterson Creek Habitat Restoration (RM 0.6-1.2)
88 R4 Rock Creek Low-Flow Restoration (Tributary 0339, RM 4.3)
88/99 CIP 3161 Walsh Lake Diversion Ditch Habitat Improvements (Tributary 0342, RM 0.0-0.5)
99 CIP 3160 Wetland 64 Restoration

BW 7: Artificial Salmonid Production Measures

Recommendation: The following measures should be implemented to protect existing sockeye populations and guide future artificial salmonid production measures:

1. Continue to support the operation and evaluation of the temporary sockeye hatchery at Landsburg until at least the spring of 1998, by which time studies of Lake Washington may provide definitive information on limiting factor(s) for sockeye production in the Lake Washington basin (BW 8).
2. Retain the King County Open Space property at RM 9.0 (left bank) of the Cedar River in an undeveloped condition as a potential site for a future sockeye spawning channel or other large-scale salmonid production facility. A final decision to use this or any other high-quality riparian site, however, should be based on further evaluation of the site's existing values as natural open space, riparian floodplain and wetland habitat, and its potential for development of natural salmonid habitat. Consistency with the policies, goals, and objectives of this Plan, the King County *Flood Hazard Reduction Plan*, and the Shoreline Master Program, will also need to be assessed.
3. Identify opportunities and criteria for artificial production measures compatible with sustaining the health of natural fish populations. To achieve this, WDFW, the Muckleshoot Indian Tribe, King County, and other interested parties should formulate a comprehensive fish management and habitat conservation plan for the Lake Washington Watershed. As noted in Chapter 1 of this Plan, WDFW's Integrated Land Management Planning process may be a suitable vehicle for this. Other local governments and interest groups should be included in the development of this Plan to provide additional information and ideas and to achieve regional support for implementation. This initiative would complement the habitat conservation plan being developed by the Seattle Water Department for the upper Cedar River Watershed.

Discussion: This recommendation supports the use of relatively small-scale, temporary artificial production methods, such as the Landsburg sockeye hatchery, for maintaining sockeye production the Cedar River until limiting factors in Lake Washington are determined. Temporary artificial production measures minimize the risk of undesirable consequences, allow resource managers to learn through experience, and preserve options for future fish management. Other salmonid production measures, such as permanent hatcheries and spawning channels or large habitat projects with limited multiple benefits, should be delayed until fish and land management issues are resolved (see below) and until further information concerning limiting factors for critical species is provided.

Protection and restoration of salmon and steelhead trout populations will require cooperation among fish and land managers. Final decisions on fisheries management and artificial production in the Lake Washington drainage are the legal responsibility of the WDFW and the Muckleshoot Indian Tribe. In certain instances, such as endangered species listings, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service are also responsible for the decisions. Conversely, land-use and surface-water management decisions are the responsibility of local government except where federal laws prevail. Protection of public natural resources, such as fish, is a key goal of local governments when assessing the effects of their decisions.

Several issues regarding salmon management and land use need to be resolved to ensure the long-term viability of sockeye, coho, and chinook salmon and steelhead trout in the Lake Washington basin. They include 1) developing compatible land-use and fish management policies to protect, restore, and enhance critical salmonid populations and their habitat in stream systems without adopted basin plans; 2) protecting and, where feasible, restoring natural biodiversity, threatened and endangered species, and ecological health of the Lake Washington ecosystem; 3) establishing multi-species salmonid production goals that reflect current and potential natural habitat and artificial production capabilities; and 4) identifying opportunities and criteria for cost-effective fish habitat restoration and enhancement.

Lead Entity:	WDFW, MIT
Cooperating Entities:	USFWS, TU, MSE, SWD, COE
Estimated Cost:	$118,000 for staff support over 10 years

BW 8: Lake Washington Studies

Recommendation: King County should assist in the funding and oversight of the ongoing interagency studies to identify the causes of salmonid declines in the Lake Washington basin. It is anticipated that these studies will be completed in 1998. Wherever possible, this work should be coordinated with Lake Washington water quality studies by King County Wastewater Treatment Division (WTD), the University of Washington, and others.

Discussion: Since 1993, King County has participated in an interagency effort to assess the condition of Lake Washington and make recommendations for actions to remove or minimize factors affecting the productivity of the Cedar River for anadromous salmonids. To date, funding for this participation has been renewed on an annual basis.

Lead Entity:	WDFW
Cooperating Entities:	USFWS, MIT, SWD, WTD, the University of Washington, TU, Bellevue, Kirkland, Mercer Island, COE, Renton
Estimated Cost:	$500,000 plus $66,000 for staff support over 5 years

BW 9: Improvement of Water Quality from Road Drainage and Urban Areas

Recommendation: The Washington State Department of Transportation (WSDOT), King County WLRD and Roads Divisions, and the City of Renton should emphasize actions that reduce nonpoint pollution from urban runoff, road runoff, and road maintenance activities. These actions should include retrofitting existing facilities with pollutant treatment BMPs (e.g., biofiltration and wetponds), maintenance of the existing stormwater conveyance system for water quality control, and other actions required by the National Pollution Discharge Elimination System (NPDES) Municipal Stormwater Permit for the Cedar Watershed.

Discussion: Recent stormwater samples from urban areas, both commercial and residential, have exceeded the Washington State water quality toxicity standards (Chapter 173-201A WAC). These toxic conditions were attributed to the cumulative effect of the diffuse nonpoint pollutants from road drainage and residential and business activity, but identification of the specific sources of these pollutants was beyond the scope of this Plan. These toxic conditions have not resulted in known fish kills, but they could result in chronic problems in the future, including contamination of the City of Renton's water supply.

The Washington State Department of Ecology (WSDOE) is in the process of issuing an NPDES Municipal Stormwater Permit for the Cedar/Green Watershed. WSDOT should continue their efforts and the City of Renton should participate in the ongoing development of the Cedar/Green NPDES stormwater permit, administered by WSDOE. King County will be preparing a Stormwater Management Program, per NPDES requirements, which will have several stormwater control components. Many of those components are similar to recommendations in this plan.

There is currently an ongoing process to map the stormwater drainage network and identify and correct illicit hookups within unincorporated King County. Mapping within the unincorporated urban growth boundary should be the first priority within the basin. The information developed through the NPDES program should be used together with land-use and water quality data to help prioritize the retrofitting of the drainage network to provide water quality treatment. Roads Division, Renton, and WSDOT should continue the ongoing practice of retrofitting existing road drainage systems for water quality treatment in conjunction with all road widening and improvement projects.

Stormwater conveyance systems have historically been designed and maintained for the most efficient and reliable conveyance of flows. These systems also convey pollutants into streams, wetlands, lakes, aquifers, and ultimately, Puget Sound. Roadside ditches and catch basins can remove many pollutants before they reach the natural drainage system. There are numerous places in the basin where road runoff is discharged into water bodies with little or no treatment. Individually these discharges may be insignificant, but the annual cumulative effect of untreated stormwater can be substantial. Ongoing maintenance of the stormwater conveyance system should encourage Integrated Pest Management, "Owner Will Maintain," and "Adopt-a-Ditch" programs; minimize sediment exposure; and maximize biofiltration efficiencies. Ongoing programs to identify appropriate frequencies for contaminated sediment removal should minimize water quality impacts. Disposal of the residual (sediment and decant) should be coordinated with the *Model Plan for Regional Vactor Waste Disposal*. Maintenance activities in significant resource areas should reflect the sensitivities of these areas.

As part of the ongoing public involvement and education program, WLRD should coordinate with the City of Renton and the local Hazardous Waste Management Program to provide education and technical assistance on the reduction of nonpoint pollution (e.g., cleaning chemicals, hazardous wastes, pesticides, pet wastes, used motor oil, and antifreeze) from commercial and residential sources in the urban areas (see also BW 14, which addresses public involvement and education). Businesses using septic systems should receive high priority.

Lead Entities:	WLRD, KC Roads
Cooperators:	WSDOT, Renton PW, SKCDPH, KCSWD
Estimated Cost:	$296,000 for staff support over 10 years

BW 10: On-Site Septic System Pollution

Recommendation: Within the urban growth boundary (UGB), areas with chronic septic system problems should receive priority for connection to sanitary sewer systems when connection is feasible. In rural areas, the Seattle-King County Department of Public Health (SKCDPH) should enhance current efforts to assure proper long-term operation of on-site septic systems and identify and reduce on-site system failures within Cedar River basin. Depending on availability of funding, this should be accomplished by increased education, pursuing changes to existing regulations, and identifying funding sources for system maintenance and repair.

SKCDPH should evaluate designating "areas of special concern" in the Cedar River basin and imposing more stringent requirements such as operation, maintenance, and inspection programs or more stringent corrective measures, consistent with new state regulations (Chapter 246-272 WAC). These areas could include frequently flooded areas and critical recharge areas such as the East Renton plateau, the Cedar River valley floor, and the Lake Desire subbasin.

Discussion: Failing on-site septic systems may result in increased loadings of nutrients and pathogens to surface waters. Groundwater may be contaminated by existing systems that appear to be functioning properly if those systems were installed in highly permeable soils. Contaminated groundwater may in turn, recharge either surface waters or aquifers used for drinking water. Septic systems have been identified as a potential pollutant source in the Cedar River basin (*Current and Future Conditions Report*), especially in the Maplewood Heights and Lake Desire subareas and along the mainstem. State water quality standards for fecal coliforms (FC, an indicator of the presence of pathogens) are periodically exceeded in the Cedar River. As a result, the Cedar River has been listed by WSDOE as "water quality limited." This listing could result in the imposition of total maximum daily loads (TMDLs) for the Cedar River. Implementation of comprehensive management plans, such as this one, that address the sources of FC could preclude the need for TMDLs. Sources of FC include human and animal wastes; therefore, a comprehensive management plan would have to address on-site sewage as well as animal (livestock and domestic) sources. In addition, the reduction of nutrient loadings to Lake Washington is considered a high priority.

On-site septic systems should continue to be the preferred method of treatment in the rural areas. Properly operated and maintained septic systems provide effective removal of nutrients and provide groundwater recharge for water supplies and streamflows. Title 13 of the King County Code should be amended to require as-builts for on-site systems, with system locations recorded on property deeds. This would allow entry of this information into the County's Geographic Information System and development of a computerized on-site septic system database. Through such parcel-based record keeping, septic system performance could be significantly improved.

Lead Entity:	SKCDPH
Cooperating Entities:	LDCC, SLCC, Renton PW
Estimated Cost:	$332,000 for staff support over 5 years

BW 11: Livestock-Keeping Practices

Recommendation:

1. The King Conservation District (KCD) should continue to provide technical and funding assistance to owners, and establish model farms and recognition programs consistent with the King County Livestock Ordinance (#11168; KC Chapter 21A.30). A pilot program for this effort should focus on the Taylor Creek subarea.

2. The King County Solid Waste Division (KCSWD), in cooperation with SKCDPH, KCD, and WLRD, should continue to assess the feasibility of incorporating farm animal manure into the existing KCSWD yard waste composting program or development of a separate composting program specifically for animal manure. Concurrent with the pursuit of an animal waste disposal program, Washington State University Cooperative Extension should provide information to farm and pasture owners about existing manure processing opportunities in King County. A program to achieve this objective should be coordinated with the pilot program recommended for Taylor Creek in #1 above.

Discussion: Livestock management has been identified as a significant problem in parts of the Cedar River basin. Most of the small noncommercial farms within the basin are located in the Taylor Creek and Dorre Don subbasins. Poorly managed livestock-keeping activities and pastures are a significant source of nutrients, solids, and fecal material in the Cedar River basin. Livestock-keeping practices can also harm the quality of aquatic habitat when streambanks are trampled and riparian vegetation is destroyed, reducing the capacity of riparian vegetation to filter out pollutants (sediment and nutrients). Pasture management problems include overgrazing and improper waste management.

State water quality standards for fecal coliform (FC, an indicator of the presence of pathogens) are periodically exceeded in the Cedar River. As a result, the Cedar River has been listed by WSDOE as "water quality limited." This listing could result in the imposition of TMDLs (Total Maximum Daily Loads) for the Cedar River. Implementation of comprehensive management plans, such as this one, that address the sources of FC could preclude the need for TMDLs. Sources of FC include human and animal wastes; therefore, a comprehensive management plan would have to address on-site sewage as well as animal (livestock and domestic) sources. In addition, the reduction of nutrient loadings to Lake Washington is considered a high priority.

The King County Council Livestock Ordinance #11168 of December 1993 provides a 5-year period from date of passage for landowners to comply with the ordinance. As part of the ordinance, a Council oversight committee will be developed to recommend sources of funding for the KCD to provide farm plans and other implementation actions, such as education, monitoring, and owner cost sharing. To date, the County has partially funded fence construction restricting livestock from streams and wetlands as part of earlier basin plans. The ordinance is part of the King County zoning code and enforcement of the ordinance will be through DDES. The detailed enforcement mechanism will be further developed before the 1998 enforcement date and will be either complaint-driven or proactive, depending on funding.

In addition to these fencing funds, which are not enough to finish all needed fencing, the County Council has authorized and funded three pilot projects dealing with excess manure generated by over 30,000 horses, and assorted other livestock on small farms throughout the county. The three pilot projects include a curbside manure pickup service as part of the existing yard waste recycle program, an exchange program between manure owners and gardeners, and a drive-in manure drop-off collection day event. KCD, Washington State University, King County Cooperative Extension Service, and the KCSWD are cooperating to run these programs in 1995. Establishment of model farms and recognition programs are part of the KCD's unfunded programs.

Lead Entity:	KCD
Cooperating Entities:	WLRD, KCSWD, SKCDPH, GMVAC, CES, MIT
Estimated Cost:	$118,000 for staff support over 10 years

BW 12: Water Quality Treatment Standards

Recommendation: The *King County Surface Water Design Manual* should be amended to be consistent with the water quality requirements of the *WSDOE Puget Sound Stormwater Manual*. Proposed development projects shall provide on-site water quality control of surface runoff through a combination of water quality source controls, spill controls, high-use-site water quality treatment, and area-specific water quality treatment facilities (described below). Performance goals and requirements shall be met when applicable. These measures and the facilities below are consistent with Core Requirement #8: Water Quality Control of the 1996 proposed *King County Surface Water Design Manual.*

The recommended water quality treatment standards for each subarea are noted on the subarea maps in Chapter 3. It should be noted that the maps refer to the catchments in which the standard applies; however, the standard may not apply to the entire catchment. The following text should be used to clarify the specific area.

1. **Basic Treatment Areas:** The basic water quality treatment requirement shall be applied to areas where a general, cost-effective level of treatment is desired and where more intensive, targeted removal is not need to protect the receiving water body. Treatment facilities in the basic water quality menu have a goal of 80-percent removal of total suspended solids (TSS) and include facilities such as wetponds, combined R/D and wetponds, constructed wetlands, biofiltration swales and filter strips, sand filters, and, under appropriate soil conditions, infiltration facilities. This basic treatment shall apply to all areas within the Cedar River basin where sensitive lake, RSRA stream reach, or sphagnum bog wetland standards do not apply.

2. **Area-Specific Water Quality Treatments:** Area-specific requirements shall be applied based on the sensitivities of receiving waters. Special water quality requirements shall be applied to sites within the catchments that drain to sensitive lakes, RSRA stream reaches, and sphagnum bog wetlands. In areas that may have overlapping standards, the most protective standard shall prevail. This order is 1) sphagnum bog wetlands, 2) sensitive lakes, and 3) RSRA stream reaches. The basic water quality treatment requirements shall apply in all other areas.

   a. Sphagnum Bog Wetland Treatment Area - Sphagnum bog protection measures shall be applied to areas identified below as well as sites identified through a project site evaluation. Sphagnum bog wetlands are extremely sensitive to changes in alkalinity and nutrients from surface-water inputs. The treatment goals for protection of sphagnum bog wetlands include control of nutrients, alkalinity, and pH. Treatment options include infiltration or a combination of three treatment facilities in series, one of which must be a sand filter and one of which must be either a leaf compost filter or a constructed wetland. Sphagnum bog wetlands identified in the *King County Wetlands Inventory* include Wetlands 14, 15, 16, 22, 25, 28 (Spring Lake), 33 (Webster Lake), 82, and 83. Wetlands 22 and 25 have already been altered as R/D ponds and have no remaining sphagnum plant community; therefore, these requirements no longer apply.

   b. Sensitive Lake Treatment Areas - Sensitive lake catchments are those that have high resource value and a combination of water quality characteristics and subbasin development potential that makes them particularly prone to eutrophication induced by development. The lake protection menu includes facilities larger than the basic menu or combinations of two treatment facilities in series to provide a goal of 50-percent annual average total phosphorus removal. Lake protection standards shall apply to Lake Desire (catchment P6) consistent with the Lake Desire Management Plan (1995).

   c. RSRA Stream Reaches – Treatment facilities shall be utilized in the land area that drains directly to designated regionally significant resource area (RSRA) stream reaches. The stream protection facilities have a treatment goal of 50-percent reduction of total zinc. Zinc was chosen as an indicator for a wider range of metals typically found in urban runoff and potentially toxic to fish and other aquatic life. Treatment facilities were chosen for their ability to remove metals in excess of removals expected from the basic water quality menu. Stream protection facilities include the use of constructed wetlands, sand filter, or a combination of two treatment facilities in series, one of which is either a sand filter or a compost filter.

      Designated RSRAs include:

Rock Creek (Tributary 0338)	RM 0.0 - 2.5
Peterson Creek (Tributary 0328)	RM 0.0 - 2.6
Peterson Creek (Tributary 0328B)	RM 0.0 - 2.2
Taylor Creek (Tributary 0321)	RM 0.2 - 0.8

The City of Renton should adopt stormwater standards to meet those in the WSDOE *Puget Sound Stormwater Manual* and the Puget Sound Water Quality Management Plan. Alternative methods of protecting water quality other than through the strict use of on-site control should be investigated.

Discussion: Water quality treatment standards in the *King County Surface Water Design Manual* (*Design Manual*) are currently being updated to meet Washington State Department of Ecology (WSDOE) requirements. This Plan has identified specific areas in the Cedar River basin where the proposed water quality menus should apply. Implementation of these water quality controls is designed to be consistent with the WSDOE *Puget Sound Stormwater Manual.*

Control of TP from developing lands has been identified as one of the key water quality goals for protecting the basin's surface-water and groundwater resources and Lake Washington from degradation. In addition, control of metals such as zinc and copper in areas with high fish habitat value would help to protect these resources. By designating appropriate areas of the basin for different levels of protection, it is possible to target water quality treatment requirements to preserve the health of these resources.

Water quality source control and spill control BMPs should be emphasized to prevent contaminants from coming into contact with rainfall or runoff. It is much more efficient and cost-effective to prevent contamination from occurring than removing the contaminant once it has entered the drainage system (treatment). Source control BMPs include structural (e.g., car wash pads connected to sewers) or nonstructural (e.g., covering storage piles with plastic) measures that prevent rainfall and runoff from coming into contact with pollutants. Spill control BMPs (e.g., tee sections in catch basins) prevent discharge of pollutants (vehicular use or chemicals) into the drainage system.

Lead Entity:	DDES
Cooperating Entities:	WLRD, Renton PW, SKCHD, LDCC, SLCC
Estimated Cost:	Covered by existing programs

BW 13: Basin Plan Evaluation

Recommendation: A Basin Plan evaluation program will be conducted to monitor and improve CIPs, programs, and regulations to more efficiently meet Plan goals. The representatives from affected agencies and tribes should establish a jointly funded basinwide data collection and management program. This effort should review and summarize existing information and provide baseline scientific information sufficient to evaluate the success of Plan implementation. Where needed, adaptive management approaches to implementation will be recommended to the Basin Steward and appropriate agencies. Possible elements of the evaluation program include:

1. Annual review of development activity and compliance with relevant regulations in the most sensitive subareas.
2. Annual review of completed capital projects to determine compliance with design specifications and to ensure optimal performance.

3. Annual compilation and review of the City of Renton, MIT, U.S. Geological Survey (USGS), WDFW, and WTD/WSDOE data on mainstem flows, fish returns, channel scour, stream juvenile outmigrant production, and water quality in the basin and in Lake Washington.
4. Annual analysis should be performed of four to five core monitoring sites to evaluate rainfall, discharge, channel morphology, and water quality on selected tributaries. Likely sites include Taylor, Madsen, Maplewood, and Peterson creeks, where significant existing or potential problems have been identified and extensive management activities are recommended by this Plan.
5. Biannual assessment of physical habitat conditions and species use on selected tributary reaches, where existing resource value is very high or where substantial capital costs for resource enhancement are proposed. Likely sites include Maplewood, Madsen, Peterson, Taylor, and Rock Creeks, and the Walsh Lake Diversion Ditch. Similar assessment should be made of Class 1-rated Wetlands 2, 16, 28, 37, 91, and 92.
6. Update of the King County and City of Renton Wetlands Inventories and the King County Sensitive Area Folio stream and wetland maps to improve the accuracy of the wetlands inventory and appropriately classify the wetlands and unclassified streams throughout the basin planning area. Once the comprehensive update is completed, new wetland and stream information should be added to the King County Geographic Information System on an ongoing basis.
7. Evaluate the results of future studies within the basin (including the hydrogeological study, the Masonry Dam operations study, and the Seattle Water Department Habitat Conservation Plan) to determine if recommendations and priorities should be changed.

In addition, evaluation of the performance of specific capital projects should be included in the work program and budget of those projects, as administered by the Plan Capital Improvement Projects Unit. The effect of changes in minimum instream flows on habitat and water quality should be assessed as necessary to ensure compliance with the Plan's goals and objectives. Technical review and oversight of the basin plan evaluation should include representatives from affected agencies and tribes. The Basin Steward (BW 16) would use this information to write an annual "state-of-the-basin" report and make recommendations.

Discussion: A strategic approach to basin plan evaluation is recommended. Qualitative field observations should be made at selected core monitoring sites. For example, instream plant and animal abundance can be used to evaluate general water quality and aquatic ecosystem health without using more expensive water quality sampling and laboratory analysis. If a significant worsening of conditions is detected, more extensive quantitative analysis can then be used to identify the cause(s) and to make recommendations. Basin information and recommendations would be integrated into the annual "state of the basin" report.

An evaluation program is important because it helps document the progress of implementation and the effectiveness of the Plan recommendations. This information is necessary to guide and ensure that Plan objectives are being met in an effective manner. Such documentation may be critical for watershed management efforts elsewhere in the region.

An evaluation program offers the primary opportunity to adjust the original management recommendations and so achieve the most cost-effective approaches to meeting the goals of the Plan. It should be noted that Plan management recommendations are based in large part on information collected in 1991 and 1992, locally updated in 1993, yet projects and regulatory recommendations are not likely to take effect until 1996 or later. While this time lag is unavoidable, the Plan should not ignore its potential consequences. Activities beyond the scope of this Plan can affect the Plan goals. For example, changes in minimum instream flows as a result of the Seattle Water Department's Habitat Conservation Plan (HCP) may have an effect on habitat and water quality in the basin planning area. The HCP should be consistent with the Plan's goals and objectives.

Evaluation can reveal unanticipated development patterns or channel conditions, and it can demonstrate where basin conditions are not responding as expected. Updating aquatic resource inventories will ensure that management is based on current information. Without such feedback, the likelihood of long-term success of the management plan is judged to be low. Evaluation, typically an "afterthought" to a plan or project, should be recognized as a critical element of such efforts.

Lead Entities:	WLRD, Renton
Cooperating Entities:	Renton PW, MIT, SWD, USGS, WDFW
Estimated Cost:	$296,000 for staff support over 10 years

BW 14: Water Resources Education and Public Involvement

Recommendation: A Water Resources Education and Public Involvement Program should be developed and implemented to provide comprehensive water resource education and public involvement opportunities that protect aquatic habitat, prevent flooding problems, promote water quality, and enhance groundwater recharge. This program should be developed by the WLRD Basin Steward and staff from participating entities with approval by the Cedar River Council. It should coordinate and enhance the efforts of King County, the City of Renton, and other entities in the basin. The program's priorities should be the following surface-water and groundwater issues in the basin:

1. Nonpoint sources of pollution, including use and disposal of chemicals, transportation-generated contaminants, and septic systems in the urbanized portions of the Ginger, Molasses, Maplewood, and Madsen Creek subbasins and Renton's commercial core (see BWs 9 and 10);
2. Livestock-keeping practices in the rural Taylor and Dorre Don Creek subbasins (see BW 11);
3. Stewardship skills to protect the high resource values in the Peterson and Rock Creek subareas and along the Cedar River mainstem (see BWs 3, 4, 5 and 6; PC 1; and RC 1);
4. Flood risks and emergency response programs along the Cedar River mainstem (see MS 8); and
5. Protecting the quality and quantity of groundwater supplies for human consumption and aquatic habitat.

Discussion: Public involvement and education is essential to improving basin conditions because it is a primary means of reaching the growing basin population, especially in highly developed areas, but also in more rural subbasins.

The Plan offers an excellent opportunity for many agencies to integrate their public involvement and education efforts. Benefits would include greater efficiency and cost savings, wider public identity with the Cedar River basin, and a more comprehensive program. Joint development by participating agencies ensures that the program will utilize the array of resources available and encourage agencies to participate in implementation. Approval by the Cedar River Council assures that the program is consistent with the needs of implementing entities and other members of the basin community. The education program should coordinate with other natural resource education efforts dealing with soil and water conservation, forest stewardship, hazardous waste management and water quality control to mutually benefit all such programs.

The most populated areas in the Cedar River basin drain to Maplewood, Madsen, Molasses, and Ginger creeks and the Orting Hill Tributary. Regulations for these subbasins would be costly to administer and largely ineffective for existing development, while land acquisition costs and the extent of build-out makes regional stormwater controls cost-prohibitive there. Increasing public education efforts in these areas provides the only feasible means of influencing people to replace practices that increase flood damage or harm aquatic habitat with those that enhance drainage system health such as reducing the use of harmful household chemicals, regularly maintaining septic systems, reducing contaminants from automobile use, and infiltrating roof and landscape runoff.

In less developed systems, such as Peterson, Taylor, and Rock creeks where more rural lifestyles prevail, education efforts would also be effective in reaching residents to minimize stormwater runoff and reduce septic system failures, while enhancing and protecting ecosystem health and thereby reducing future public costs for CIPs. To support stewardship efforts, BW 11 recommends a demonstration site where citizens could view livestock-keeping BMPs and stream and wetland restoration techniques.

Public education programs seek to minimize threats to public safety, property, and aquatic resources from flood damage; prevent water quality degradation and habitat loss; and promote recharge and protection of groundwater. These programs should also promote leadership in protecting and enhancing basin resources through broad public education efforts that include residents, developers, construction contractors, and agency development inspection staff. The specific issues addressed and approaches used should be recommended to the Cedar River Council following discussions with these and other entities: SKCDPH, KCD, MIT, COE, Washington State University Cooperative Extension, Trout Unlimited, and other Puget Sound salmon enhancement groups, service clubs, and outreach efforts in the basin.

Examples of current public involvement activities include stream and wetland revegetation projects; storm drain stenciling; interpretive and litter signage; and adopt-a-stream programs that include monitoring of water quality, fish runs, precipitation, or the effectiveness of mitigation measures (see the BWs 5, 6, and 8 and capital project recommendations). As the present basin population of over 55,000 increases to 75,000 by the year 2000, and to 95,000 by 2010, a knowledgeable public will play an increasingly important role in protecting and restoring surface-water systems.

Lead Entities:	WLRD, Renton
Cooperating Entities:	CRC, KCSWD, Local hazardous waste management programs, MIT, SWD, WTD, SCS, USGS, WDFW, WSDOE, WCC, basin interest groups, private industry, MSE, TU, WFFA, DDES
Estimated Cost:	$212,000 for staff support over 10 years

BW 15: Cedar River Council

Recommendation: A Cedar River Council should be established to provide a forum for leadership and broad participation in implementing the Cedar River Basin Plan. The Council should be staffed by a full-time coordinator.

Discussion: A Cedar River Council would form a cooperative public/private sector alliance with a common interest in protecting and enhancing the watershed and implementing the Plan. The Council would provide a forum in which all entities, including the public, could participate in the process.

A literature review indicates that watershed management bodies fall within a continuum between traditional agency technical groups and citizen coordinating councils. Technical management groups are primarily agency staff whose emphasis is on designing pre-determined capital projects for implementation. Due to this narrow focus, agencies have been largely unsuccessful in educating and engaging the public in the implementation process and have typically shown little initiative in seeking community resources that might accomplish more with less public expense. In contrast, citizen coordinating bodies generally do not include agency staff and tend to focus on public education. Because they are poorly connected to agency resource management and funding decisions, they tend to have little effect on the types of projects implemented.

Based on a thorough review of the activities of over 35 watershed councils nationwide, four key roles appear to be especially helpful in expediting implementation of this Basin Plan:

1. Building public/private partnerships and fund-raising;
2. Fostering environmental stewardship;
3. Facilitating interagency coordination; and
4. Providing a forum for broad participation and leadership in watershed management issues.

In addition, staffing and funding have been shown to be critical to the success of watershed councils. For this reason, creation of a Cedar River Council Coordinator position is recommended. The Coordinator would have the following responsibilities:

1. Providing administrative support in coordinating meetings;

2. Identifying and pursuing outside funding;
3. Coordinating with the Basin Steward Program (BW 16);
4. Facilitating communication between the Council and basin residents; and
5. Assembling and maintaining an information database to support Council activities.

Lead Entity:	WLRD
Cooperating Entities:	Renton, KCD, KCNRD MIT, SWD, TU, COE, USFWS, WDFW, private industry, basin interest groups, MSE, DDES
Estimated Cost:	$850,000 for staff support over 10 years

BW 16: Basin Steward Program

Recommendation: Implementing entities should designate staff to assist the WLRD Basin Steward in supporting the Cedar River Council, implementing plan projects, and developing the public education program (BW 14). The WLRD Cedar River Basin Steward priorities should include the following:

1. Provide landowners and other basin residents with detailed information about CIPs, open space acquisitions (BW 4) in their community, gather their comments on project designs, and assist in developing easement and land purchase agreements;
2. Coordinate habitat restoration efforts with natural resource agencies and community groups;
3. Work with the Cedar River Council Coordinator on actions affecting the Council (BW 15);
4. Develop and coordinate the public involvement and education program described in BW 14;
5. Respond to citizen and agency concerns and inquires; and
6. Assist in gathering information for the Basin Plan Evaluation program and prepare an annual "state of the basin" report (BW 13).

Discussion: To help implement and coordinate the range of recommendations in the Plan, the steward should function, in part, as a liaison among basin residents, the public at large, and entities with interests in the Cedar River basin. In doing so, the Steward would play a central role in coordinating implementation actions among all public and private basin community members. The intent of this approach is twofold: to expedite completion of the Plan's projects and acquisitions, and to build a self-sustaining stewardship network where the basin community can cooperatively act in advancing the Plan's goals and objectives, with minimum regulation. Another critical role of the Steward is to work with the Cedar River Council Coordinator in keeping the Council informed about implementation progress through the annual "state of the basin" report.

The annual report would track Basin Plan implementation progress and recommend new strategies, such as plan amendments or revisions to the CIP list, in response to changing needs and conditions in the basin. The report would be available to the public and other interested parties.

Lead Entity:	WLRD
Cooperating Entities:	CRC, Community interest groups, Renton, KCD, KCNRD DDES, MIT, SWD, TU, COE, USFWS, WDFW, MSE, WFFA, WCC, private industry, basin interest groups.
Estimated Cost:	$850,000 for staff support over 10 years

BW 17: Aquifer Protection and Base Flow Maintenance

Recommendation: To protect the water quality of aquifers, maintain groundwater recharge and stream base flows, and improve the coordination of water and aquatic resource management in the Cedar River basin, the following measures should be taken:

1. Renton and King County should convene a multi-agency, interjurisdictional technical committee composed of representatives of groundwater purveyors and other appropriate participants to:
   a) Review the basin groundwater purveyors' wellhead protection programs to identify elements, actions, and recommendations that are relevant to basin watershed management.
   b) Assess the overall effectiveness, comprehensiveness, and coordination of groundwater management and protection activities within the basin.
   c) As indicated by the review and assessment (items a and b above), make recommendations to the Cedar River Council on the integration of groundwater management goals, strategies, objectives, and actions into the basin's watershed management program.
2. Aquifer recharge and stream base flows should be protected within the basin planning area by infiltrating stormwater runoff wherever feasible, by encouraging retention of forest cover, and by limiting impervious surfaces (see BW 21: Infiltration as a Stormwater Mitigation Treatment, and BW 23: Forest Incentive Program).
3. Aquifer water quality should be protected by reducing the introduction of pollutants into drainage waters (see BW 9: Improvement of Water Quality from Road Drainages and Urban Areas, BW 10: On-Site Septic System Pollution, MS 10: Stormwater Quality in Industrial/Commercial Areas, and ST 1: Madsen Creek Water Quality) and by treating stormwater to remove pollutants (see BW 12: Water Quality Treatment Standards, and MS 11: Treatment of Interstate 405 and SR-169 Stormwater) in both existing and new development.
4. Public awareness of the relationship of surface and groundwater and involvement in protection and conservation of surface and groundwater resources should be enhanced (see BW 14: Water Resources Education and Public Involvement and BW 16: Basin Steward Program).

Discussion: The Cedar River basin is a major source of groundwater-based drinking water for the cities of Renton and Kent as well as numerous, small public and private water systems within the basin. The number of people served by these systems as well as the number of systems will grow as development proceeds to planned levels. Groundwater is not only a significant basin resource in its own right; it is also strongly connected to both surface-water quantity and quality and to land use. Land-use regulation and land-use activities have a significant impact on whether groundwater remains a source of clean water for people, fish, and wildlife.

Given its broad representation, the Cedar River Council has the potential to pursue an adaptive management strategy that can assess and promote actions recommended by wellhead protection programs and other processes targeted specifically for the protection of groundwater as they are developed in the future. Groundwater purveyors in the basin are required by the Washington State Department of Public Health (WSDPH) to develop Wellhead Protection Programs to identify pollutant sources within the area that contributes to the well and to notify those responsible, either individuals or regulatory agencies, of the need to take steps to protect the water supply. Development of proactive management strategies for pollution prevention is an optional component of a wellhead protection program. The City of Renton is currently preparing a wellhead protection program. In addition, the City of Kent and several small private purveyors within the basin are in the process of developing these plans. Additionally, a very limited hydrogeological study conducted by WLRD and the City of Renton is currently underway. The study will summarize what is known about basin aquifers and develop recommendations regarding future groundwater data collection and analysis needs.

This plan recognizes the connection of surface and groundwater quantity and quality. Hydrologic modeling shows that recharge of groundwater in the basin planning area has been reduced by between 5% and 10% and that the loss will double in the future as the basin planning area builds out. Reductions in recharge affect stream base flows and potentially reduce the amount of drinking water available in basin aquifers, and can reduce the quantity and quality of salmonid habitat. Base flow reductions are especially critical to aquatic habitat in the summer and early fall when rainfall is minimal and streams are fed by water that has been stored in aquifers in the previous winter and spring. The net loss of base flow to streams depends on several factors including land use, soils, method of wastewater disposal, the source of domestic water, and irrigation practices.

Hydrologic modeling indicates that the average summer base flow losses resulting from forest conversion to current basin planning area land cover have totaled approximately 13% for streams on the western side of the urban growth boundary, 4% for streams on the rural, eastern side, and 6% overall. This represents an average loss of approximately 2.2 cfs - slightly less than 1% of mean flow (255 cfs) of the mainstem Cedar River between July 1 and October 30. At future buildout, in the absence of actions recommended by this plan, losses of mainstem base flows will more than double, as will losses to tributary subbasin streams. In some subbasin tributary streams, projected, future, unmitigated base flow reductions are more extreme. For example, Maplewood Creek is estimated to lose 20% and rural, resource-rich Peterson Creek and Taylor Creek will lose 16% and 23% respectively. However, with implementation of the stormwater infiltration and forest incentive program recommended in this Plan, these future losses can be reduced.

Pollutants associated with activities throughout the basin can adversely affect the quality of groundwater. Efforts to reduce the introduction of pollutants into the surface water (source control) and removal of pollutants from stormwater (treatment) will also reduce the introduction of pollutants to aquifers. Pollutants of particular concern for the preservation of potable water supplies include nitrates, bacteria, and toxics (metals, organics), and sources include human and animal wastes, improper disposal of hazardous wastes, commercial and industrial activities, and automotive use.

The Plan's education program should include a water resource component that stresses the interconnections between surface and groundwater, pollutant sources and transport, potential aquifer contamination, the importance of comprehensive management programs, and their role in preventing problems. The education activities carried out by the basin steward and public involvement programs should strive to convey these connections and their relationship to the well-being of basin residents and aquatic resources. See BW 19: Retention/Detention Standards, BW 20: Ravine Protection Standard, and BW 21: Infiltration as a Stormwater Mitigation Treatment.

Lead Entities:	Renton and King County.
Cooperating Entities:	Kent, WSDOE, MIT, USGS, WDFW, SWD, and others as noted in referenced basinwide recommendations.
Estimated Cost:	$100,000 for staff support over 3 years

BW 18: Urban Stormwater Management Initiative

Recommendation: King County and the City of Renton should initiate an urban stormwater program that helps minimize costs and land areas required to meet stormwater treatment goals and objectives described in this Basin Plan. The program would apply to all areas of Ginger Creek, Molasses Creek, Madsen Creek, Maplewood Creek, and Orting Hill subbasins and the Mainstem subarea that are within the Renton Urban Growth boundary (Figure 4-1) and should do the following:

1. Promote economically viable land-development practices that reduce the rate and quantity of stormwater runoff, protect surface and groundwater quality, and minimize or eliminate losses of groundwater recharge. Techniques to accomplish these objectives include:
    a) Reduction of stormwater runoff peaks and volumes by constructing less impervious and semi-pervious area through clustered housing units, reduced street widths, multiple-use buildings, and other methods.
    b) Lowering pollutant loadings to streams by covering parking areas, connecting vehicle wash pads to sewers, and promoting new technologies to clean and filter street runoff.
    c) Preserving or increasing groundwater recharge by infiltrating stormwater runoff, retaining forest cover, and other appropriate measures.
2. Encourage use of shared treatment facilities by neighboring development projects through developer education programs explaining their benefits and through expedited permit review processes;

3. Perform a joint King County/City of Renton study to analyze the feasibility of regional treatment facilities (e.g., tightlines, R/D ponds, infiltration ponds) that would identify potential sites, designs, and environmental impacts; and
4. Publish and distribute (King County/City of Renton jointly) a pamphlet on urban stormwater treatment options in the Cedar River basin that includes basic information and guidance on techniques, siting, permitting, and information sources.

Discussion: This program is designed to promote efficient utilization of land and accommodate population growth within the Renton urban growth boundary in compliance with the intent of the Growth Management Act while also meeting the surface and groundwater treatment and resource protection goals described in this Plan (see BWs 9, 12, 19, 20, and 21).

Reducing impervious area per capita or per residential unit (# 1 above) would lower the costs of drainage facilities by downsizing conveyance, R/D, and water quality structures and BMPs. Clustering of development reduces street lengths and roof area per residential unit while providing greater green space, thereby enhancing the urban environment.

Source control BMPs (# 1 above) prevent rainfall and runoff from coming into contact with pollutants. This method of water quality control is less costly and more effective than treatment to remove pollutants from runoff water after contact has occurred. If source control methods are diligently applied it may be possible to reduce the size or number of water quality treatment facilities.

Infiltration of roof downspout runoff (# 1 above) would be encouraged through outreach and education. Revisions to the 1990 *Surface Water Design Manual* will make this technique much more widely applicable and will allow "detention credits" that reduce the size of R/D facilities. Information about the hydrologic, land-use efficiency, and cost benefits of this technique needs to be developed and widely disseminated to the public and the development community.

Shared treatment facilities (# 2 above) would take advantage of economies of scale and facility siting opportunities to reduce construction costs and land consumption by stormwater quality and quantity treatment facilities. Information on shared facilities needs to be more widely available to the public and the development community.

Regional stormwater facilities (# 3 above) have the potential to reduce overall costs, minimize land consumption, and encourage land development in a targeted area; however, financing, siting, design, land acquisition, and permitting are often beyond the capability of individual private developers or public agencies given competing demands for limited funds. For this reason, King County and the City of Renton should undertake a phased study of regional facilities. If initial findings identify appropriate sites and potentially cost-effective alternatives, partnerships with private developers should be pursued to assist in detailed design, financing, and construction of projects.

There are currently several techniques and approaches that can reduce the amount of land consumed by stormwater-quantity and quality control facilities. Revisions to the 1990 *Surface*

Water Design Manual and recommendations made in this Basin Plan will probably increase those opportunities. Yet, documentation of these techniques is scattered within various manuals and plans and is not necessarily focused on the Cedar River basin or urban growth areas. In order to gain wider acceptance and application of these approaches, King County and the City of Renton should publish guidelines in a pamphlet or other suitable format (# 4 above) that utilizes basin-specific information garnered from the basin-planning process to promote their appropriate use within the UGB.

Lead Entity:	DDES, Renton
Cooperating Entities:	WLRD
Estimated Cost:	$296,000 for staff support over 10 years

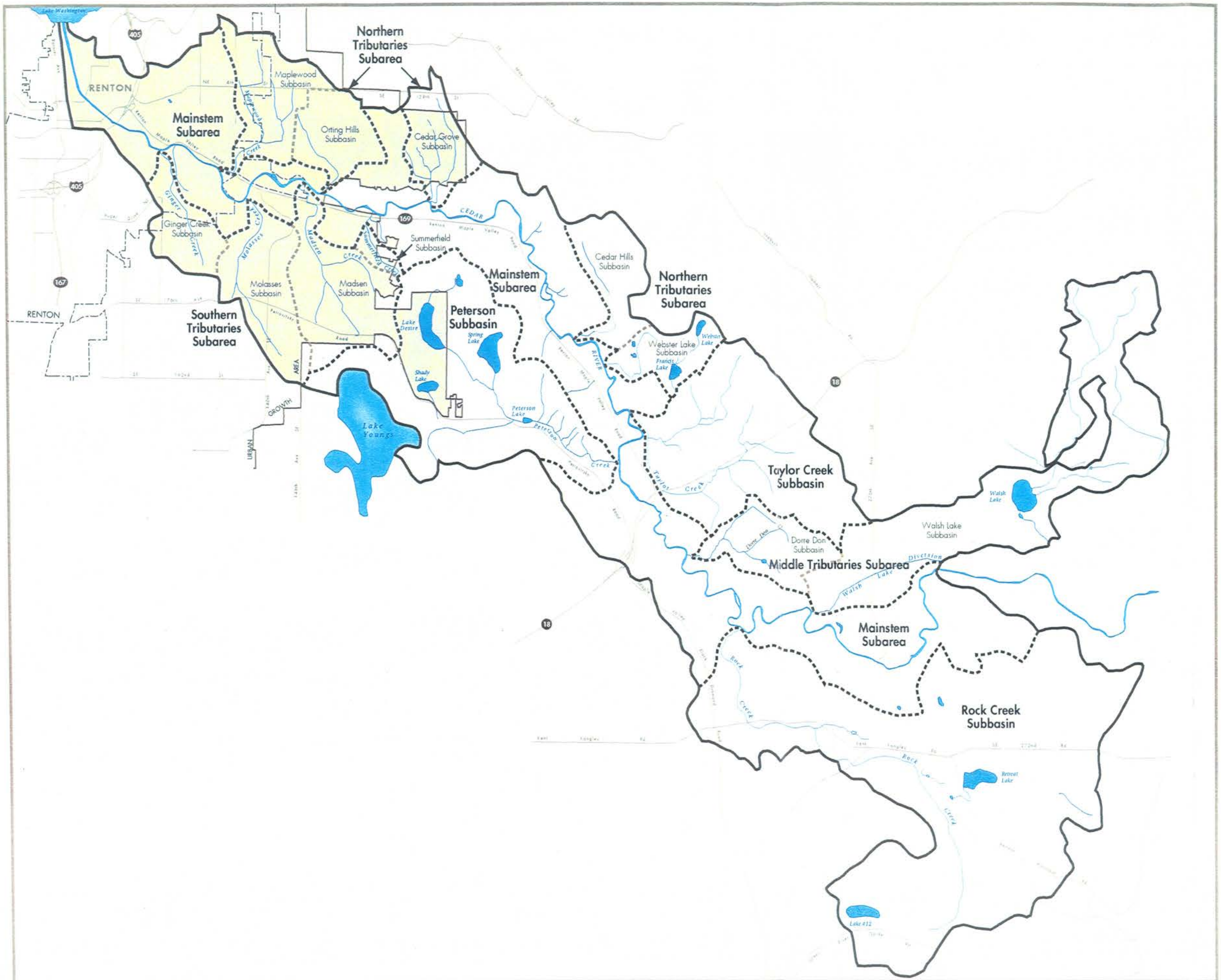


Figure 4-1

Renton Urban Growth Area

Cedar River Basin Planning Area

BW 19: Retention/Detention Standards

Recommendation: New development shall not allow undetained or inadequately detained runoff to increase downstream flooding, erosion, and sedimentation, or damage downstream aquatic resources. To prevent these problems, all runoff from newly constructed impervious surfaces shall be retained, preferably infiltrated, on-site to the maximum extent feasible (see also BW 21). Retention and infiltration of stormwater using infiltration basins, dispersion trenches, splash blocks, and other techniques shall be utilized to the maximum extent allowed by the *King County Surface Water Design Manual*. A qualified soils engineer, geo-technical engineer, or geologist shall certify that the project design maximizes the use of on-site stormwater retention and infiltration. All runoff that is not infiltrated shall be controlled with one of four levels of R/D facility consistent with current and future resources and problems in the different tributary subbasins as summarized by catchment in Table 4-3. Within the urban area under its jurisdiction, the City of Renton may opt to apply alternative stormwater control measures such as regional detention ponds, tightlines, or other innovative means (see BW 18: Urban Stormwater Management Initiative) in place of the on-site detention requirements shown in Table 4-3. Any alternative measures allowed will be demonstrably comparable or superior to the requirements shown in Table 4-3 in terms of the level of protection and benefits they provide to the immediate downstream drainage system and Cedar River basin at large. This recommendation shall apply to the entire basin planning area including all tributary subbasins except those plateau areas that drain directly over the steep mainstem valley side walls or via short, steep, unnamed tributaries traversing the valley walls as specified in BW 20: Ravine Protection Standard.

R/D Levels are defined as follows:

Level 0 - No R/D Facilities Required. In conformance with the Direct Discharge provisions of Section 1.2.3 of the 1990 King County *Surface Water Design Manual* (*Design Manual*), R/D requirements may be waived in catchments assigned Level 0 R/D if a regional facility has adequate capacity or discharge to a "Receiving Water" is possible. Additionally, in tributary catchments where an analysis conducted as part of this Basin Plan suggests that the risks of not providing Level 1 detention are very low in caparison with the costs of providing detention, it is recommended that no R/D facilities be required for future development. Appropriate water quality requirements, as stated in the *Design Manual*, however, still apply.

See Table 4-3 for catchments where Level 0 R/D is allowed.

Level 1 - 2-10 Peak Flow Frequency R/D Standard. Runoff from all development projects in catchments assigned Level 1 R/D that is not treated by infiltration shall be detained by R/D ponds that meet a minimum (Level 1) peak flow reduction standard. Upon inclusion of the King County Runoff Time Series (KCRTS) in the revised *Design Manual* that will replace the 1990 manual, ponds shall be designed as follows:

1. Ponds shall be designed using KCRTS such that post-development 2-year and 10-year discharges shall not exceed their pre-development level. A 20-percent volumetric safety factor should be added to ponds meeting these criteria.

In the interim until the revised manual with KCRTS is adopted:

2. The 7-day Design Storm Method shall be used to size ponds that reduce post-development 2-year and 10-year peak discharges to their respective pre-development levels. A 30-percent volumetric safety factor shall be added to ponds using the 7-day Design Storm Method.

See Table 4-3 for catchments where Level 1 R/D is required.

Level 2 - Peak Flow Duration Control R/D Standard. Runoff from all development proposals in catchments assigned Level 2 R/D that is not treated by infiltration shall be detained by R/D facilities that meet a minimum (Level 2) peak flow duration standard. Upon inclusion of the King County Runoff Time Series (KCRTS) in the revised *Design Manual*, which will replace the 1990 manual, ponds shall be designed as follows:

1. KCRTS shall be used to design ponds such that post-development flow durations shall not exceed pre-development flow durations above 50% of the pre-development 2-year, 10-year, 25-year, and 50-year peak annual flow levels. A 10-percent volumetric safety factor shall be added to facilities meeting these criteria.

In the interim until the revised manual with KCRTS is adopted :

2. Ponds shall be designed using the Soil Conservation Service-Santa Barbara Urban Hydrograph, 24-hour Storm Method described in the 1990 *Design Manual* such that post-development 2-year, 10-year, and 100-year storm flows do not exceed pre-development storm flows equaling 50% of the 2-year, 2-year, and 10-year flows, respectively. A 30-percent volumetric safety factor shall be added to facilities meeting these criteria.

See Table 4-3 for catchments where Level 2 R/D is required.

Level 3 - Lake and Wetland Peak Stage Frequency and Duration R/D. Runoff from all development proposals in Level 3 catchments that is not treated by infiltration shall be detained by R/D facilities that meet a minimum (Level 3) open water peak stage frequency and duration control standard. Upon inclusion of the King County Runoff Time Series (KCRTS) in the revised *Design Manual*, which will replace the 1990 manual, ponds shall be designed as follows:

1. KCRTS shall be used to design ponds such that post-development flow durations shall not exceed pre-development flow durations above 50% of the pre-development 2-year, 10-year, 25-year, and 50-year peak annual flow levels and post-developed 100-year peak hourly discharge shall not exceed the pre-developed 100-year level. A 10-percent volumetric safety factor shall be added to facilities meeting these criteria.

In the interim until the revised manual with KCRTS is adopted:

2. Ponds shall be designed using the Soil Conservation Service-Santa Barbara Urban Hydrograph, 24-hour Storm Method described in the 1990 *Design Manual* such that post-development 2-year, 10-year, and 100-year storm flows do not exceed pre-development

storm flows equaling 50% of the 2-year, 2-year, and 10-year flows, respectively. A 40-percent volumetric safety factor shall be added to facilities meeting these criteria.

See Table 4-3 for catchments where Level 3 R/D is required.

Level 4 - Special R/D Requirements (Large Site Drainage Review in revised manual). Stormwater runoff from Level 4 catchments shall be custom-designed to achieve specific goals such as restoration of streamflow characteristics that have been radically altered by surface mining activities.

See Table 4-3 and specific subbasin descriptions for designation of areas requiring Level 4 R/D and a description of special R/D requirements.

Relationship to Other Drainage Codes and Standards:

The Retention/Detention Standard is intended to supplement existing County drainage requirements and work in concert with other recommendations of this Plan, specifically:

1. **Levels of R/D Requirements.** The flexibility to apply different levels of R/D facility performance to achieve suitable levels of downstream protection depending on basin problems and conditions is specifically recognized in Section 3.3 of the 1990 *Design Manual.*
2. **Thresholds and Exemptions for R/D Requirements.** Levels 1, 2, 3, and 4 drainage requirements listed above may be waived only for development proposals that construct less than 5,000 square feet of impervious surface area or increase 100-year peak flow rate by less than 0.1 cfs. This threshold and exemption substitutes for those listed in Section 1.1.1 of the 1990 *Design Manual* and is consistent with the proposed 1996 manual update. Upon adoption of the replacement to the 1990 *Design Manual*, this threshold may be raised to 10,000 square feet of impervious area as provided for under "Small Site Drainage Review" in the new manual.
3. **Relationship to Water Quality and Infiltration.** Before discharging into a natural stream or other water body, runoff must receive water quality treatment according to Core and Special Requirements in the current *Design Manual* or as superceded by the revised *Design Manual.*
4. **Relationship to the Ravine Protection Standard (BW 20).** The Ravine Protection Standard shall take precedence over the R/D standards cited in Table 4-3 and shown in Figure 4-2 for properties that drain via steep unnamed tributaries or directly over steep valley walls as described in BW 20. See also the Landslide Hazard Drainage Area requirements of the revised *Design Manual.*

Discussion:

General - The R/D standards described in this recommendation are designed to work in combination with other recommendations in this Plan including the BW 20: Ravine Protection Standard, BW 21: Infiltration as a Stormwater Mitigation Treatment, and specific subbasin recommendations to achieve the off-site drainage mitigation described under Core Requirement

#2, Task 5 of the 1990 *Design Manual* or as superceded by the revised *Design Manual*. This is accomplished by reviewing conditions downstream of every subbasin catchment as documented in the *Cedar River Current and Future Conditions Report* and melding this information with other programmatic and CIP recommendations contained in this Plan to determine appropriate levels of R/D requirements. The range of these requirements spans performance or design criteria for runoff control that are both less stringent and more stringent than the single standard typically required by the County because additional knowledge gained from the basin-planning process allows the prescription of more selective, effective, and efficient R/D mitigation.

Description of levels and method of level selection - Levels 0 through 4 represent increasingly stricter R/D standards. Level 1 and Level 2 R/D are required for the vast majority of catchments as shown in Table 4-3. Each level is discussed below in numerical order.

Level 0 R/D drainage areas have been identified where new development may qualify for an R/D exemption. To qualify for this exemption, new development projects in Level 0 areas must demonstrate to the satisfaction of DDES that the exemption will not result in either the aggravation or creation of a significant drainage or water quality problem. If this can not be demonstrated, then Level 1 R/D requirements shall be applied to the project. The following Level 0 areas have been identified within the Cedar River Basin:

1. Cedar River valley floor areas of mainstem catchments 1 through 17 where direct discharge to a "receiving water" may be allowed as provided in the *Design Manual*;
2. The upper portion (approximately 70 acres) of Summerfield subbasin where new development may be able to connect to an existing King County regional tightline that was designed with sufficient capacity to accommodate future development and non-erosively conduct flows from the plateau to the Cedar River, a "receiving water" as designated in the *Design Manual*;
3. Ginger Creek subbasin. Less than 10% of this highly urbanized, 634-acre subbasin is available for future development. Hydrologic analysis indicates that exemption of all future development from R/D requirements will not increase peak flows in the creek by more than 10% over current conditions. This potential increase in peak discharge is not expected to cause any significant flooding or erosion problems in the creek. The creek system does not support any significant resource areas (SRAs).

Level 1 R/D is designed to prevent new development from causing increases in the magnitude and frequency of downstream flooding problems. Both KCRTS and the 7-day Design Storm Method anticipate the intent of the *Design Manual*, which is to actually maintain post-development 2-year through 10-year peaks at their pre-development levels considering realistic precipitation conditions in this region. Analysis shows that the two alternative design methods result in ponds of very similar size. Under ideal conditions, ponds designed by these two methods will mitigate peak discharges from the 2-year to approximately the 100-year return period. However, experience shows that performance in the field is generally far from ideal because of imperfect siting, construction, maintenance, and other factors. The volumetric safety factors are applied so as to achieve 2-year to 10-year peak flow control under realistic, field conditions.

The content and intent of Level 1 R/D requirements are similar to previous Plans, except that KCRTS has been substituted for continuous hydrologic simulation using the Hydrologic Simulation Program FORTRAN computer model. KCRTS is designed to bring the accuracy of continuous hydrologic modeling to R/D design in a highly accessible, user-friendly software package, which should greatly reduce design costs.

In assigning R/D requirements to catchments, Level 1 or higher was chosen wherever potential future development was of sufficient magnitude to cause an increase of greater than 10% in the magnitude of 2-, 5-, 10-, 25-, and 100-year peak creek flows. The cost of Level 1 R/D is highly variable but may amount to several thousand dollars per residential lot. However, considering past experiences of flood damages in this basin, and large projected increases in creek flows in all subbasins except Ginger Creek (see Figure 4-2) absent Level 1 mitigation, the benefits in prevented damage are estimated to substantially outweigh the costs of mitigation and properly allocate those costs to the source of additional load to the drainage system.

Level 2 R/D is designed to prevent the initiation or aggravation of existing channel erosion and instability. It is a durational standard that limits the time span during which post-developed flows exceed an erosion-causing threshold to its predeveloped level. Level 2 R/D may double the size of R/D facilities and substantially increase per lot costs over Level 1 R/D. Therefore, Level 2 R/D is required only in catchments where the additional downstream damage or lost value of not requiring Level 2 R/D is judged to be substantially greater than the cost of providing it. Typically, this occurs in one or a combination of the following circumstances:

1. Where the *Cedar River Current and Future Conditions Report* has identified existing downstream erosion, channel stability, or other flooding problems associated with excessive water levels that will be significantly aggravated in the absence of upstream Level 2 R/D protection and are likely to cause damages requiring substantial public and/or private expense;
2. The *Cedar River Current and Future Conditions Report* has identified downstream regionally significant resource areas (RSRAs) that will be significantly damaged in the absence of upstream Level 2 R/D protection; or
3. There are substantial existing or proposed channel stabilization, stream habitat, drainage, or other public projects that will be significantly damaged by increases in erosive flows in the absence of upstream Level 2 R/D protection.

Level 3 R/D represents a variant of Level 2 R/D that is effective in mitigating increases in peak water level frequencies and durations of lakes, closed depressions, and open water wetlands. It is only recommended when application of lesser R/D standards is expected to result in significant or widespread damage to aquatic resources, homes, or shoreline property.

Level 3 R/D is recommended in catchments P6 and P7 because of current road and property flooding problems around the shoreline of Lake Desire. These problems may be solved in the future as a result of a project to raise the road (see CIP 3151) and a program to maintain the lake's outlet channel (see PC 1). If future monitoring indicates that implementation of these measures has solved the lake level problems, then R/D requirements should be changed to allow either direct discharge of stormwater to the lake by pipeline, or Level 2 R/D. Water quality requirements would not be affected by this change.

Level 4 R/D (Large Site Drainage Review in revised the manual) is customized R/D for rare, specialized situations in which standards that control the magnitude of peak discharges or their durations such as Level 1 and Level 2 R/D do not provide adequate mitigation for current or anticipated future problems. Level 4 is performance oriented and is only recommended within one subbasin of the Planning area.

In the Cedar Hills subbasin, special analysis and design are required to restore creek flows that have been drastically altered by surface mining. This includes not only winter, peak flow mitigation, but seasonal flow patterns including summer base flows. Level 4 R/D mitigation should be coordinated with water quality restoration for maximum efficiency. In recognition of the level of analysis and review required to meet restoration objectives, it is recommended that any subdivision of previously surface mined land be required to perform a Master Drainage Plan. This proposal is justified in order to achieve a reasonable level of restoration of streamflow that would otherwise not occur as the result of standard subdivision drainage review.

Lead Entity:	DDES
Cooperating Entities:	KCDNR, WLRD, Drainage Investigation & Regulations Unit to provide technical support and review as needed for Level 4 requirements
Estimated Cost:	$59,000 for staff support over 10 years

Table 4-3 Tributary R/D Requirements - Justification by Specific Catchment

Subbasin and Catchment	Trib #	R/D Level	Justification	Comment
Mainstem Cedar River MS1 through MS15	0299	0*	Insignificant benefit of R/D. Cedar River is a designated receiving water.	Applies to valley floor lands with direct discharge to Cedar River. Otherwise Level 1 applies on valley floor. For plateaus see BW 20.
Mainstem Cedar River MS16, MS17	0299	0*	Insignificant benefit of R/D. Cedar River is a designated receiving water.	Level 0 only with direct discharge to Cedar River, otherwise, Level 1 required.
Ginger Creek B1, B2, B3	0300A	0*	Insignificant benefit of R/D. Limited future development. Less than 10% increase in future peak flows. No significant current R/D in place. No significant current problems. No SRAs present. Ample conveyance capacity.	Require downstream analysis to intersection of Lake Youngs Way SE and Royal Hills Drive SE. Small but nonzero risk of increased channel erosion.
Maplewood Creek MW1, MW2, MW3	0302 0303	2	Avoid future aggravation of significant current erosion problems. Protect recommended $500,000 channel stabilization/habitat project.	Basin on urban side of UGB. Low projected % future forest cover.
Molasses Creek F1, F2, F3, F4	0304	2	Protect SRA stream habitat. Prevent aggravation of current stream stability problems.	Basin on urban side of UGB. Low projected % future forest cover.
Madsen Creek M1, M2, M3, M4, M5, M6	0305 0306	2	Protect large public investment in stream and sewer line stabilization and LSRA stream habitat and wetland.	History of catastrophic landsliding and sediment transport. Continued risk of future problems.
Orting Hill J1, J2, J3	0307	2	Prevent future public expense from aggravation of current stream stability problems.	History of small problems and drainage projects to stabilize channel and improve habitat. Urban side of UGB. Large future development potential.
Summerfield SU1-upper	0311	0*	Regional tightline serves upper half of subbasin.	Approximately upper 50% of subbasin can be served by existing tightline.
Summerfield SU1-lower	0311	1	SWDM peak flow standard. Adequate given reduction in creek flows resulting from tightline construction.	Tightline intercepts flow from upper half of subbasin.
Cedar Grove CG1, CG2, CG3, CG4, CG5	0308 0309 0310	1	SWDM peak flow standard. No significant problems or SRAs.	Some risk of future channel erosion.
Cedar Hills CH1, CH2, CH3-unmined	0316A	1	SWDM peak flow standard.	
Cedar Hills CH1, CH2, CH3-mined	0316A	4	Special design/Master Drainage Plan for all subdivisions regardless of size. Also known as Large Site Drainage Review in the revised *Design Manual*.	Master Drainage Plan process recommended for custom design to restore pre-mine water quality and quantity that has been radically degraded by mining.

* R/D exemption subject to DDES approval as per Basinwide Level 0 R/D standards.

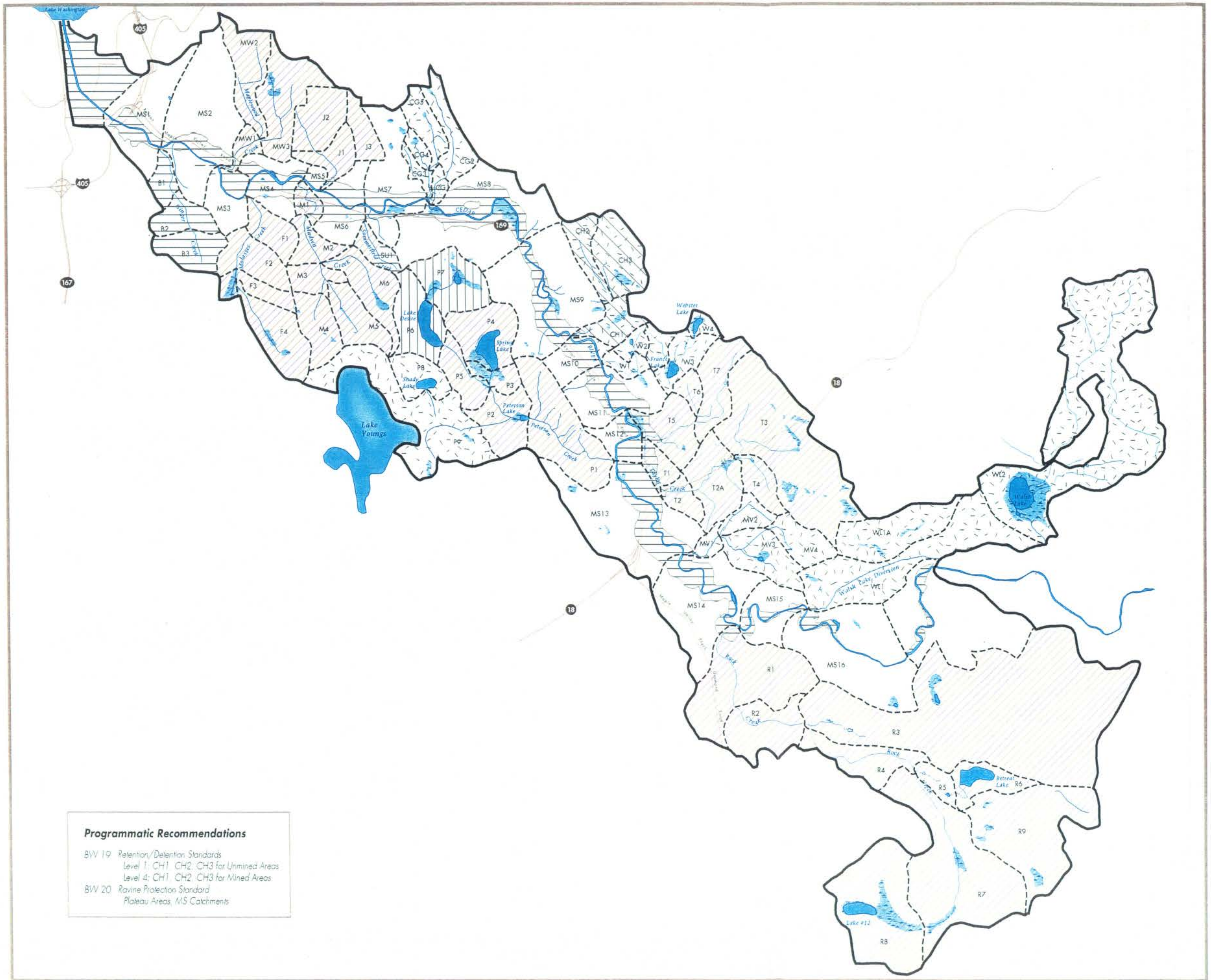
Table 4-3 Tributary R/D Requirements - Justification by Specific Catchment (Continued)

Subbasin and catchment	Trib #	R/D Level	Justification	Comment
Webster Lake W1, W2, W3	0317	1	SWDM peak flow standard. No SRAs downstream of lakes. Minor current erosion problems. Some risk of future erosion and channel stability problems.	Some risk of future erosion and channel stability problems.
Taylor Creek T2, T2A, T3, T4	0320 to 0327	2	Limit aggravation of current significant flooding and erosion problem. Protect recommended public investment in flood and habitat projects (see Taylor Creek projects).	
Taylor Creek T1, T5, T6, T7	0320 to 0327	2	Protect RSRA stream habitat. SWDM peak flow standard. Adequate to protect resources with forest retention and low-density development.	
Peterson Creek P1, P2, P3, P4, P5	0328 to 0334	2	Protect RSRA stream and wetland habitat from sedimentation resulting from erosion of small steep ravines (0329-0334).	
Peterson Creek P6, P7	0328 to 0334	3	Reduce R/D requirement to Level 2 or direct discharge by pipe if monitoring indicates that CIP 3151, PC 1, and other measures have solved shoreline flooding problem.	
Peterson Creek P8, P9	0328 to 0334	2	Prevent sediment and phosphorus transport to Peterson Lake.	
Dorre Don MV1, MV2, MV3, MV4	0336 0336A 0337	1	SWDM peak flow standard.	Some risk of future erosion and flooding problems.
Rock Creek R1, R2, R3, R4, R5, R6, R7, R8, R9	0338 0339	2	Protect RSRA stream habitat	Stormwater infiltration feasible in most catchments.
Walsh Lake WL1, WL1A, WL2	0341	1	Adequate protection. Very high current and future forest cover.	Current erosion problems in ditch not related to limited residential development.

Figure 4-2

Tributary Retention/ Detention Standards for New Development

Cedar River Basin Planning Area Recommendations



Stream
Lake/River
Wetland
Basin Boundary
Catchment Boundary
MS2 Catchment Number

Level 0
Level 1
Level 2
Level 3
Level 4

NOTE: Refer to Chapter 3 for more detailed maps and information.

N

0 1 2 Miles

Map produced by:
Visual Communication & GIS Unit,
Public Outreach Section
9806cedarTRIBrdSTDS4-2 WG

BW 20: Ravine Protection Standard

Recommendation: For those properties on slopes and plateaus that drain directly over the steep side slopes of the mainstem, Cedar River valley, or via steep, unnamed tributaries, new development shall not allow undetained or inadequately detained runoff to flow down the steep side slopes of the Cedar River valley. To accomplish this objective, one of three alternatives must be used; in order of decreasing preference they are:

1. **On-Site Retention.** All runoff from newly constructed impervious surfaces shall be retained on-site to the maximum extent feasible, consistent with underlying zoning (see also BWs 19 and 21). The current limitations on infiltration, stated in section 1.2.3 of the 1990 *Design Manual*, should be reevaluated in subsequent updates of the *Design Manual*. More permissive retention criteria should be applied once adopted.

2. **Piping.** Runoff from all development proposals, except single-family building permits and those that achieve 100-percent on-site retention, shall be conveyed downslope to the Cedar River valley via continuous pipeline(s) and retained on a site as near the valley sidewall as possible, if feasible. Connection into an existing pipeline by subsequent downslope development projects is required if feasible.

   The discharge of all pipelines shall be nonerosive, flowing either directly into the Cedar River or to an open channel that is demonstrably stable from the point of discharge to the river. If discharge is made into a natural open channel upstream of the Cedar River, peak rate control of the pipeline discharge to at least Level 1 standards (see BW 19) shall be required. All outfalls shall comply with existing Shoreline and wetland regulations.

   Pipeline installation shall be above ground wherever feasible and shall be above ground over all Erosion or Landslide Hazard Areas as defined by King County's Sensitive Areas Ordinance. Pipeline routes shall avoid ravine valleys wherever feasible.

3. **Enhanced R/D.** New developments that cannot achieve 100-percent on-site stormwater retention and are not required to construct a new pipeline or connect to an existing one (in # 2 above) shall provide on-site detention to Level 2 of BW 19: Retention/Detention Standards, presuming that the downstream analysis shows no resulting problems.

   Before discharging into a natural stream or water body, runoff shall receive water quality treatment according to Core and Special Requirements in the *Design Manual*. Water quality treatment shall be achieved by infiltration or other methods of on-site retention if feasible and permitted by drainage regulations or as described in BW 12: Water Quality Treatment Standards.

The drainage requirements listed in # 1-3 above may be waived only for development proposals that construct less than 2,000 square feet of impervious surface area. This threshold substitutes for those listed in Section 1.1.1 of the 1990 *Design Manual*. The applicable impervious area shall exclude the area of driveways for single-family residential building permits and short plats. This threshold may be lowered upon adoption of small-site detention standards by the WLRD Division.

Relationship to Other Drainage Codes and Standards. The Ravine Protection Standard is intended to supplement existing County drainage requirements and to work in concert with other recommendations of the Cedar River Basin Plan. In particular:

1. Because of the very low percentage of the river's tributary area affected by this recommendation, peak rate runoff control (Core Requirement #3 of the *Design Manual*) is not required for piped discharges, unless the discharge point is **not** the Cedar River, a designated "receiving water." All facilities must convey the 100-year 24-hour design storm.
2. All water quality treatment must occur prior to final discharge, as described in BW 12: Water Quality Treatment Standards.
3. Discharge of runoff at the natural location (Core Requirement #1 of the *Design Manual*) may be waived without need for a WLRD variance for pipelines constructed in order to satisfy this recommendation.
4. The threshold for imposition of these drainage controls is lowered from those of the *Design Manual* to include all projects with 2,000 square feet or more of impervious surface. This threshold may be further reduced upon adoption of any subsequent update to the *Design Manual*. Any waiver from this standard is by site-specific review through the WLRD Division variance procedure.
5. This recommendation supersedes the "West Cedar River Valley Ridge Critical Drainage Area," a Public Rule effective May 24, 1989, that will be repealed upon the effective date of this Basin Plan.

Administration. Upon adoption of this Plan by the Metropolitan King County Council, this standard will be administered by DDES as an amendment to the *Design Manual*.

Discussion: Erosion of the Cedar River valley sidewalls is an observable, historic condition that has natural causes but which has been dramatically accelerated by human activity. It has resulted in numerous examples of downstream property damage and temporary road closures. The sediment so eroded is then transported into the Cedar River, where it degrades aquatic habitat and water quality. In recognition of these problems, King County established the "West Cedar River Valley Critical Drainage Area" in 1989, which applied equivalent stormwater management requirements over part of the area covered by this recommendation. Since the time of that Critical Area designation, additional investigations for this Basin Plan and additional new development have demonstrated that the problem is not limited to one area alone.

In contrast to the *East Lake Sammamish Basin Plan*, which also established an area of "ravine protection," this recommendation establishes the desired performance (i.e., no inadequately detained runoff draining over the steep slopes) but does not mandate the type of engineering structure to achieve this goal. In both plans the preference is for on-site retention, but here the local geology is not favorable for infiltration except north of the Cedar River in and near Renton (catchments MS1 and MS2). If on-site retention is not feasible for the entire stormwater volume, the next most favored option in both plans is piping, because the certainty of achieving nonerosive discharge by this strategy is high. However, in some cases the distances between affected parcels and the Cedar River valley, onto which the pipelines must discharge, are very great and will render pipes financially unfeasible. Enhanced R/D, whose specific requirements are outlined in BW 19, is the best (and only feasible) option in such cases.

The consequences of inadequate stormwater management in these areas is readily visible along the Cedar River valley, because much of the existing development was constructed without adequate controls. The most spectacular example enters the Cedar River from the left bank at RM 3.8, where the Maplewood slide was possibly triggered or at least amplified by uncontrolled runoff in a channel originating in catchment MS 3. Other examples include a long history of complaints of upstream sedimentation from the property owner at RM 12.1 on the mainstem, ultimately necessitating a pipeline constructed in 1992 for over $200,000 at public expense; and many small- to medium-sized debris fans that covered part or all of SR-169 and Jones Road SE, most recently during the storms of 1990.

The intent of this recommendation is to ensure that the cost of stormwater management is borne by the projects that create the potential problems, not the downstream property owners who must otherwise receive those problems. Based on site-specific analyses for the equivalent recommendation in the *East Lake Sammamish Basin Plan*, this recommendation could add up to several thousand dollars per residential lot to the existing cost of stormwater management. Based on the experience in this basin, however, even greater costs are likely to be borne, over time, by downstream property owners and the public in the absence of adequate stormwater management.

Lead Entity:	DDES
Cooperating Entities:	KCDNR, WLRD, Drainage Investigation & Regulations Unit to provide technical support and review as needed
Estimated Cost:	Costs are included in BW 19

BW 21: Infiltration as a Stormwater Mitigation Treatment

Recommendation: The following measures are recommended to promote stormwater infiltration for the purposes of reducing flood damage, recharging aquifers, preserving base flows, protecting aquatic habitat, and improving water quality throughout the Planning area:

1. For new development, retention and infiltration of stormwater using infiltration basins, dispersion trenches, splash blocks, and other techniques shall be utilized to the maximum extent allowed by the *King County Surface Water Design Manual*. A qualified soils engineer, geo-technical engineer, or geologist shall certify that the project design maximizes the use of on-site stormwater retention and infiltration (see also BW 19).
2. The Basin Steward (BW 16) should assist in implementing a program to retrofit existing structures so that roof runoff is infiltrated. This could be a component of the Small-Scale Watershed Restoration and Enhancement Program (BW 5) in existing residential areas, with the goal of improving hydrologic conditions in salmonid-bearing, urbanized tributaries such as the Madsen, Maplewood, and Molasses Creek subbasins. The program should include:

a) Provide educational opportunities and information to homeowners on the benefits of infiltration to stream, wetland, and lake hydrology and habitat;

b) Conduct small cooperative projects with homeowners on suitable sites to take roof runoff off-line from the surface drainage system for infiltration into retrofitted roof downspout systems; and

c) Identify and carry out additional innovative, cooperative projects with homeowners to augment infiltration and reduce direct stormwater runoff, such as the re-routing of roof runoff to abandoned septic systems in urban areas that have recently been connected to a sanitary sewer.

Discussion: This recommendation is intended to preserve, as much as possible, the undisturbed hydrologic regime of wetlands, lakes, aquifers, and streams—including maintenance of groundwater recharge and stream base flows, attenuation of flood flows, and improvement of water quality. As noted in the 1990 *Design Manual*, stormwater infiltration is by far the most effective mechanism in preventing adverse impacts to the surface-water system. Additionally, medium-textured soils possess physical, chemical, and biological characteristics that make the soil an effective treatment medium for metals and other pollutants.

To date, infiltration technology has not been widely implemented as a runoff mitigation technique partly because restrictive language in the *Design Manual* has limited its application to coarse-textured soils covering a small minority of urbanizing lands in King County. It is anticipated that the next manual revision will relax those restrictions to make infiltration techniques much more widely applicable. However, infiltration for new projects anticipates the revised *Design Manual*, but substitutes the manual's preference for infiltration to a "requirement where feasible" because of a basin-wide need to promote recharge of groundwaters and prevent further degradation of base flows and protect habitat in both the tributaries and mainstem of the Cedar River.

In urbanized subareas in the Cedar River basin, roof downspouts are often directly connected to the surface drainage system. Therefore, roof runoff contributes to rapid rises in streamflow and aggravates current flooding and erosion problems. An education and action program that includes infiltration of residential roof runoff would help citizens understand their drainage system and accept a share of responsibility for both downstream resources and problems. Remedial rerouting of roof runoff to the soil profile would alleviate current problems associated with peak flows and enhance stream base flow. As sewer service is extended to currently unsewered areas, groundwater-fed base flows will suffer a loss of percolation as septic drain fields are abandoned. Re-routing of stormwater to abandoned septic systems would provide a low-cost opportunity to compensate for this loss.

Lead Entity:	WLRD
Cooperating Entity:	DDES
Estimated Cost:	Included in BW 16

BW 22: Erosion and Sedimentation Control Standards

Recommendation: King County is currently conducting a comprehensive temporary erosion and sedimentation control (TESC) program, in lieu of seasonal clearing requirements, to control erosion and sedimentation from construction sites. Should this evaluation show that the TESC program is not as effective as seasonal clearing and grading restrictions, then seasonal clearing and grading restrictions should be required within the Cedar River basin.

Discussion: The TESC program is evaluating the effect of bare ground construction on erosion and the impacts of erosion, sediment, and phosphorus loadings on fish populations, aquatic habitat, and water quality. The program includes both education and enforcement of current regulations.

Construction-related activities can release fine sediment into streams and wetlands at a rate over 1,000 times that of fully forested ground. In western Washington, most of that release occurs when rainfall is greatest. Conscientious application of the erosion control measures encouraged by the TESC program can reduce this sediment release by 50 to as much as 90%; equivalent reductions can be achieved by simply covering a construction site during the wettest six months of the year.

Each method has advantages and disadvantages; in particular, seasonal restrictions are simple to enforce, reliable, and highly effective, but they also may place greater economic and logistic burdens on developers. Where greatest certainty of effectiveness is needed—particularly adjacent to the basin's highest quality wetlands and RSRA stream reaches (identified in BW 3 and corresponding subarea sections)—seasonal clearing restrictions are the favored approach unless and until the TESC program is proven to be at least as effective.

Lead Entity:	DDES
Cooperating Entity:	WLRD
Estimated Cost:	Included in existing programs

BW 23: Forest Incentive Program

Recommendation: An incentive program to encourage landowners to retain their forest in the rural areas of the basin should be implemented. Retaining forest cover in the long term is the best way to ensure that the Cedar River has clean, stable streams. The intent is not to discourage harvesting of marketable timber, but to encourage replanting of trees after harvesting so the land stays in forest use over the long term rather than being converted to other uses.

The forest incentive program should include the following elements:

1. Tax Relief - Landowners should be assisted in preparing applications for Timber Land and Public Benefit Rating System current use taxation programs. The Public Benefit Rating System should be modified to give extra points for forest retention. Legislation will be pursued with King County Council to make this change to the Public Benefit Rating System.
2. Direct Assistance - A new forester position should be created, consistent with the Farm and Forest Initiative currently being developed by King County, to give technical assistance on

forestry practices and permit requirements and to provide tax reduction program information. The forester would also assist with timber management plans and site restoration, and would work out of the King County Department of Natural Resources (KCDNR).

3. Stewardship Classes and Master Forester Program - More low cost forestry classes should be offered in the Cedar River basin in cooperation with the Washington State Department of Natural Resources (WSDNR), the King County Department of Development and Environmental Services (DDES), Washington State University Cooperative Extension, King Conservation District (KCD), and KCDNR. Landowners participating in these classes develop their own forest management plan for their land. A program similar to the "master gardener" program should be developed for forestry in conjunction with the stewardship classes. "Forest Advisors" would be trained in forest best management practices and then commit to doing community service to share their knowledge with other landowners in the basin.

4. Demonstration Site - A working forest demonstration site should be developed so that landowners can see first hand small scale forest management practices. The site would show alternative forest practices (shelterwood or selective cuts) appropriate for sites adjoining residential land uses and document the costs and returns of harvesting so interested landowners can see what profit they can realistically expect from a small scale forest operation. To be done collaboratively by DDES, KCDNR, KCD, and King County Parks and Cultural Resources.

5. Individual Recognition - Good forest stewards should be recognized for their efforts through signage on or near their property and through recognition events and press coverage in local papers. To be done collaboratively by the WSDNR, DDES, and KCDNR.

6. Simplified Permitting Process - The King County clearing permit process should be streamlined and more convenient for landowners with approved forest management plans. DDES and KCDNR will cooperatively pursue any required code amendments and procedural changes.

During the first five years the forest incentive program should be evaluated by the Cedar River Council in cooperation with the community to see if it is effectively meeting the goal of retaining long-term forest uses in the Cedar basin and thereby maintaining clean, stable streams in the basin.

Discussion: Retention of forest cover in the Cedar River basin is the best way to ensure that the Cedar River has clean, stable streams. On typical forested land in the Cedar River basin, only 24% of the rain falling on forested land appears as storm runoff in streams. When land is converted to grass cover, the stormwater runoff entering streams nearly doubles. Therefore retaining land in forest cover will reduce increases in peak flows in the tributaries. It will also reduce erosion, sedimentation and water quality degradation in the tributaries and mainstem, and protect the quality and quantity of groundwater in the basin.

In working with the community to develop the forest incentive program, WLRD staff found that most property owners felt that tax relief would be a key incentive to encourage landowners to keep their land in forest uses over the long term. The existing Timber Land and Public Benefit Rating System programs, administered by the KCDNR, reduce the tax rate for landowners to reflect the "current use" of their land rather than the usual "highest use." The agreement between the landowner and the county is for 10 years, although it automatically extends beyond this period. Certain penalties and/or back tax payments may be due upon withdrawal from the programs.

Forest lands between 5 and 20 acres are eligible for the Timber Land program. The average assessed value in King County for Timber Lands was $124 per acre in 1995. Using the average county levy rate of $12.02 per $1,000 of assessed value, the owner of 20 acres of forest land enrolled in the Timber Land program would pay approximately $30 in property taxes.

Under the Public Benefit Rating System program reduction in taxable value ranges from 50% to 90%. The Public Benefit Rating System has no acreage limit, so it can meet the needs of smaller property owners. The current use taxation value under the Public Benefit Rating System is determined by a scoring system based on an assessment of the property's natural resource and open space qualifications. Some high priorities of the program are active or passive recreation areas, watershed or groundwater recharge areas, and significant wildlife or plant life. In order to increase the incentive for landowners to keep their land in forest under the Public Benefit Rating System, the Plan recommends that the scoring system be modified to give extra points for forest retention.

To make the Timber Land and Public Benefit Rating System programs more accessible, landowners could get information about the programs and assistance in filling out the applications from the proposed forester position.

Other incentives that appealed to landowners were technical assistance and education about how to manage their forest land. Forest Steward Classes are already taught by the WSDNR and DDES. More classes should be offered in the Cedar River basin. Also landowners wanted their good stewardship of their land and forest to be recognized and the permitting process to be simplified.

This incentive based approach for stream protection is unprecedented in King County. This issue is being addressed with forest protection regulations in the Bear Creek and Issaquah Creek basins. During the first five years, when the Cedar River Council evaluates the success for the incentive approach for maintaining forest cover, the following indicators of success should be considered:

1. Number of:
    a) Forest management plans adopted and acreage covered by these plans
    b) Acres enrolled in Timber Land or Public Benefit Rating System programs
    c) Forested acres converted to other uses and amount of forest retained on converted lands
    d) Community stewardship hours volunteered to forest restoration
    e) Landowners successfully completing forest stewardship classes

2. Amount and distribution of forest area compared to the beginning of the Forest Incentive Program
3. Amount and distribution of forest area in the Cedar River basin compared to Bear and Issaquah Creeks, where a regulatory approach was applied
4. Changes in the stability of streams, tributary flooding, water quality, and groundwater quality and quantity.

Lead Entity:	KCDNR
Cooperating Entities:	WSDNR, DDES, KCD, Washington Farm Forest Association, Washington State University Cooperative Extension
Estimated Cost:	$2,124,000 for staff support over a 10-year period.

Subarea Programmatic Recommendations

CEDAR RIVER MAINSTEM

MS 1: Masonry Dam Operations Study

Recommendation: The City of Seattle, King County, and the City of Renton should conduct a study of Masonry Dam operations with participation of the Muckleshoot Indian Tribe, resource agencies, and other interested parties. The goal of the study would be to find and specify flood season operating guidelines that enhance flood control, assure power generation, improve water supply availability for both instream and consumptive uses; and to identify and quantify trade-offs, costs, risks, and liabilities of such flood operating guidelines to beneficiaries of the dam's operations.

Discussion: Seattle Water and City Light operate Masonry Dam for water supply, and secondarily for hydroelectric power generation, instream flow maintenance, and flood control. These objectives are sometimes in conflict with each other. Operation of Masonry Dam is the most significant controllable factor in determining flow rates in the Cedar River. A study of Masonry Dam operations may produce alternative flood season operating regimes that could provide enhanced flood control and improved water supply availability for both instream and consumptive uses. However, the existence of viable alternative operating guidelines that significantly improve the achievement of the operating objectives is not guaranteed. Additionally, if they do exist, their implementation may require resolution of complex technical, financial, policy, and regulatory issues. Due to this complexity, a phased study that provides timely decision points and allows for adaptive scoping is considered to be the most cost-effective approach. Study objectives for the first phase are listed below. Results of the initial study phase are expected to determine the value of proceeding further and to contribute to the objectives and scoping of the next phase.

Phase-1 Study Objectives

1. To involve and gain acceptance from stakeholders in the process of developing, evaluating, and selecting new guidelines for operating Masonry Dam;
2. To develop a methodology for placing value on the benefits and risks associated with individual operating objectives (water supply, power generation, flood control, and instream resource protection) so that trade-offs can be quantified and evaluated;
3. To educate the public on Masonry Dam operations and to promote understanding of the relationships and trade-offs between each of the operating objectives and other competing uses and constraints on dam operations;
4. To evaluate the effectiveness of the baseline operating scheme (as presented in the SWD Operations and Maintenance Handbook) in achieving the operating objectives;

5. To develop and evaluate alternatives to the baseline operating scheme which strive to more effectively achieve the operating objectives; and
6. To develop recommendations on study termination or continuance to the next phase. If continuation is recommended, to develop a preliminary scope and cost estimate for the following:
    a. Refinement of recommended new operating guidelines
    b. Development of an implementation strategy covering such items as
        - allocation of costs, risks, and liability
        - interagency communications
        - public involvement
        - environmental impact analysis.

Lead Entity:	SWD
Cooperating Entities:	WLRD, Renton, COE, Seattle City Light
Consultative Entities:	MIT, WDFW, USFWS
Estimated Cost:	$66,000 for staff support over 5 years

MS 2: Renton Reach Capacity 205 Study

Recommendation: This plan supports any flood damage reduction program in the Renton Reach that:

1. Establishes and maintains channel capacity at the 100-year discharge;
2. Minimizes the frequency at which channel maintenance must recur; and
3. Minimizes the area of aquatic habitat that is disrupted or otherwise impacted by sediment removal.

The ability to meet these goals will be substantially improved if the quantity of sediment entering the Cedar River, particularly from upstream sources, is significantly reduced. This could be achieved through other Basin Plan recommendations that encourage floodplain restoration and reduce erosion (see BW 1, 5, 6, 19-23; MS 4-6; and NT 1). Relaxing the first goal for the very largest (and most infrequent) discharges may dramatically improve attainment of the second and third goals; these alternatives should be thoroughly investigated.

Discussion: Flooding in downtown Renton causes significant economic and social hardship. Given the channel geometry of the Renton Reach, adjacent development, and the proximity of Lake Washington, periodic sediment removal in this area may be required. At the request of the City of Renton, the U.S. Army Corps of Engineers is (COE) conducting a flood-damage reduction study along the lower 1.25 miles of the Cedar River, under Section 205 of the 1948 Flood Control Act. In November 1993, the COE completed a favorable preliminary assessment of costs and benefits of a dredging project that would achieve flood-damage reduction. Renton and the COE have entered into a cost sharing agreement for the $800,000 study, which was completed in 1997.

The simple dredging alternative considered in the preliminary assessment could achieve the primary goal of flood-damage reduction. However, a more complex analysis of sediment sources (particularly the Maplewood landslide at RM 3.9) reconfigured Renton Reach channel geometry, and benefits and impacts at different levels of flood protection should produce a broader range of alternatives. A wide range of alternatives should be considered, individually and in combination. Reasonable alternatives should include a minimum of the following:

- Reconfiguring the channel to optimize sediment transport through the reach;
- Full channel dredging (widening and/or deepening);
- Minor channel dredging (widening and/or deepening);
- Maintaining levees;
- Installing a sediment trap;
- Adjusting existing bridges;
- Monitoring the frequency, need, and impacts of future maintenance.

Participation of resource and permitting agencies at early stages in the flood-damage reduction study should be encouraged in order to achieve a satisfactory balance among each of the project goals.

Lead Entity:	COE
Cooperating Entities:	Renton, FEMA, SWD, WDFW, MIT, WLRD, CRC, DDES
Estimated Cost:	$66,000 for staff support over 5 years

MS 3: Seek State and Federal Funding for Flood Hazard Reduction Measures

Recommendation: King County should act as the "local sponsor" to enlist the technical and financial help of the Army Corps of Engineers, FEMA, the State of Washington Department of Community Development, and other outside agencies to reduce flood damage in the Cedar River basin. A fund should be created to be used as a local match to attract federal and state funding for flood hazard reduction measures.

Discussion: At the time of publication of this Basin Plan, the Army Corps of Engineers' Seattle District has begun the reconnaissance phase of a flood-damage reduction study conducted under Section 205 of the federal Flood Control Act, at King County's request. The reconnaissance phase, conducted at 100-percent federal expense, will gather all available information on flooding along the Cedar River. Federal funding may be eliminated before this study's recommendation can be designed and implemented. If not, and if it is found that there is a federal interest in further participation, a feasibility study could follow, conducted at 50-percent federal expense and consisting of design and all further activities required to reach a conclusion on federal participation in the implementation of flood-damage reduction projects. Up to 75% of construction costs of selected projects could be paid from federal funds, with the remainder paid by the County. Similar programs are offered by FEMA and the State of Washington. A local fund for flood hazard reduction programs would help to leverage federal and state grants.

Lead Entity: WLRD
Cooperating Entities: COE, FEMA, SWD, WDFW, MIT, CRC, DDES, Renton
Estimated Cost: $66,000 for staff support over 5 years; $2,000,000 for local flood disaster assistance fund

MS 4: Mainstem Habitat Restoration and Enhancement Program

Recommendation: King County should develop and implement a program to take advantage of habitat restoration and enhancement opportunities along the Cedar River.

Discussion: Many opportunities exist along the Cedar River mainstem to restore or enhance habitats that have been lost or degraded by flood control, floodplain development, and water diversions. This program would identify and implement projects that enhance existing habitats or, where valley morphology indicates, excavate new fish-usable habitats in old river channels. Projects should be conducted such that human health and safety are not threatened; fish species dynamics are balanced with the goals of fisheries management agencies and realistic habitat production capabilities; and other critical habitats, such as wetlands, are not adversely affected.

Although the primary goal of these projects is to increase salmonid production through improvements in the quality and quantity of aquatic habitat, a major underlying goal is to improve ecosystem health. This would be achieved by restoring or enhancing water quality and wetland and wildlife functions, reducing flooding and erosion, increasing connectivity between the river and its floodplain, and providing for natural open spaces along the Cedar River corridor. The types of possible projects range in scope from large-scale floodplain restoration, which would entail land purchases and habitat creation, to excavation of groundwater-fed habitats in old river channels and restoration and enhancement of existing habitats through revegetation and addition of large woody debris (LWD).

The potential opportunities identified to date are listed and described below. These were developed through field and map reconnaissance of valley morphology, flooding history, and development along the Cedar River. Although the list is comprehensive in its scope, there may be additional opportunities and this program should be flexible to allow for new ideas. In addition, many issues, such as landowner agreements, in-depth analysis of site conditions, management and regulatory concerns regarding potential effects on existing salmonid stocks, wetland impacts, and work in shoreline areas will need to be resolved prior to implementation of any given project. A technical report providing background, conceptual designs, costs, and benefits to fish habitat used in developing the list will be published as a supplement to this Basin Plan. A summary of this technical report can be found in Appendix E, "Estimation of Salmonid Production Potential and Costs of Fish Habitat Restoration Opportunities in the Lower Cedar River."

Lead Entity: WLRD
Cooperating Entities: COE, FEMA, SWD, WDFW, MIT, CRC, DDES, Renton
Estimated Costs: As noted, plus $330,000 for staff support over 5 years

Summary of Mainstem Habitat Restoration and Enhancement Opportunities

Projects are listed below from upstream to downstream. (The asterisk * denotes projects that must be analyzed during design for risk of damage from channel migration. See recommendation MS 6: Channel Migration Hazard Areas.) See technical supplement "Salmonid Habitat Restoration and Enhancement Opportunities in the Lower Cedar River" for a more thorough discussion of background, conceptual plans, costs, and benefits.

Landsburg Oxbow Habitat Enhancement (right bank, RM 20.5): Construct a pipe to divert water from downstream of Landsburg into Wetland 69, and provide a fish passable outlet into the river. Estimated cost: $800,000

Shaw Property Habitat (right bank, RM 19.8): Excavate a groundwater habitat in the vicinity of Wetland 80. Estimated cost: $500,000

Wingert Property Habitats (both banks, RM 19.7): Excavate two groundwater-fed ponds along the landward side of the King County trail on the former Burlington Northern Railroad right-of-way, and connect them to the Cedar River via a new culvert under the existing trail embankment. Excavate a string of small groundwater-fed pools in an existing side channel, and underplant conifers. Estimated cost: $300,000

Arcadia Wall-Based Tributary (WBT) Habitat (left bank, RM 18.4): Add large woody debris (LWD), clean substrates, and deepen small pools in an existing WBT. Install a new culvert under SE 250th Street to allow fish passage from the Wall-base tributary to existing ponds, enhance upstream habitat with LWD, and improve riparian vegetation. Estimated cost: $100,000

Rock Creek Habitat Restoration (left bank, RM 18.3): Enlarge an existing off-channel pond and connect it with Rock Creek near its confluence with the Cedar River. Excavate additional groundwater-fed habitat adjacent to Rock Creek. Estimated cost: $100,000

Wetland 79 Habitat Restoration (left bank, RM 18.0): Enlarge and deepen the upper portion of Wetland 79 and connect it to an existing private pond. Upgrade an existing culvert to make it passable to fish, add LWD, and plant conifers. Estimated cost: $400,000

* Watkins Floodplain Habitat/Open Space (left bank, RM 16.6): Excavate groundwater-fed habitat in the floodplain. Estimated cost: $500,000

Lower Dorre Don Habitat (right bank, RM 16.4): Excavate groundwater-fed habitat. (Note: This project could be expanded if the "Dorre Don Flood-Damage Reduction/Floodplain Restoration" recommendation, CIP 3102, is implemented.) Estimated cost: $100,000

Dorre Don Creek Habitat (right bank, RM 16.2): Excavate a groundwater-fed habitat linked with Tributary 0336 ("Dorre Don tributary"). Estimated cost: $200,000

* Dorre Don Left Bank Meander Habitat (left bank, RM 16.0): Improve an existing groundwater-fed side channel with LWD and the addition of pools and excavate additional groundwater-fed habitats. Estimated cost: $500,000

* Dorre Don Meander B Habitat (right bank, RM 15.87): Excavate groundwater-fed habitat. (Note: This project could be expanded if the "Dorre Don Court Flood-Damage Reduction/Floodplain Restoration" recommendation, CIP 3103, is implemented.) Estimated cost: $100,000

Seattle Saddle Club Habitat (left bank, RM 15.8): Excavate groundwater-fed habitat, improve an existing pond, and add connecting channels. Estimated cost: $200,000

Witte Road WBT Ponds (left bank, RM 15.2): Excavate three groundwater-fed ponds and connect to the WBT described above. Estimated cost: $200,000

Witte Road WBT (left bank, RM 15.1): Enhance an existing WBT by underplanting conifers and adding LWD. Educate residents about the tributary's existence and care. Estimated cost: $200,000

Witte Road Pond (left bank, RM 15.0): Excavate a groundwater-fed pond and connecting channel. Estimated cost: $300,000

Bain Road Side Channel Enhancement (right bank, RM 14.84): Enhance an existing off channel habitat. Estimated cost: $50,000

Getchman Levee Habitat (right bank, RM 13.4-13.6): Add LWD, underplant conifers, and enlarge and deepen a spring-fed tributary to Taylor Creek behind the Getchman levee. Excavate groundwater-fed habitat and connect it to the tributary. Estimated cost: $300,000

Lower Taylor Creek Improvements (right bank, RM 13.2): Enhance existing habitat by adding LWD and underplanting conifers in the Cedar River floodplain at the mouth of Taylor Creek and excavate groundwater-fed habitat connected to Taylor Creek. Estimated cost: $500,000

Rutledge-Johnson Levee Habitat (left bank, RM 13.0): Excavate a new groundwater-fed habitat and enhance existing side channel habitat behind the Rutledge-Johnson levee. Estimated cost: $100,000

Jan Road Revetment Habitat (right bank, RM 13.0): Excavate groundwater-fed habitat behind the Jan Road revetment. (Note: This project could be changed significantly or eliminated by the construction of the conveyance channel described in "Jan Road Flood-Damage Reduction," CIP 3106.) Estimated cost: $500,000

* Jan Road Floodway/Byers Bend Habitat (right bank, RM 12.4): Excavate groundwater-fed habitat connected to an existing WBT. Estimated cost: $800,000

* Byers Bend Floodway Habitat (left bank, RM 11.8-12.2): Groundwater-fed habitat could be added to the proposed floodway along Byers Road described in the "Byers Bend Flood-Damage Reduction" recommendation, CIP 3107. Estimated Cost: $500,000

Renton Lions Club Side Channel (left bank, RM 11.8-12.0): Enhance instream and riparian habitat in an existing groundwater-fed side channel. Estimated cost: $100,000

Tributary 0316A Floodplain Habitat (right bank, RM 11.4): Excavate groundwater-fed habitat and connect it to the lower reach of Tributary 0316A. Estimated cost: $100,000

* Rainbow Bend Habitats (right bank, RM 10.8 and 11.0): Excavate groundwater-fed habitat in forested areas around existing floodplain development. (Note: These projects and the following one could be altered in size and shape if the Cedar Grove Mobile Home Park and other floodplain residences were relocated as described in "Rainbow Bend Flood-Damage Reduction," CIP 3108.) Estimated cost: $400,000

* Tributary 0316 Enhancements (right bank, RM 10.6): Improve the valley floor portion of this stream for rearing and adult holding by excavating pools, adding LWD, underplanting conifers in the riparian zone, and removing trash from the stream. Conduct a habitat workshop, post signs, and mail fliers to nearby residents to promote public awareness of impacts caused by human access. Estimated cost: $100,000

* WPA Levee Habitat (left bank, RM 10.6): Excavate groundwater-fed habitat behind the WPA levee. Alternately, the WPA levee could be shortened by about 400 feet and approximately five acres of new mainstem riparian habitat could be created. Estimated cost: $200,000. Alternative cost: $1,700,000

Bonneville Power Administration Power Line Habitat (right bank, RM 9.6): Excavate small groundwater-fed habitat under the Bonneville Power Administration powerlines. Estimated cost: $100,000

Progressive Investment Levee Modification (left bank, RM 9.0): Recontour and revegetate a 2000-foot-long revetment. This bank, which is armored with bare rock, provides no shade, food, or fish habitat. Replacing it with a bioengineered face will enhance the riparian habitat and reduce erosive flows in the Cedar River. Estimated cost: $900,000

Wetland 37 Enhancement B (left bank, RM 8.8): Excavate groundwater-fed habitat upstream of Wetland 37A habitat. Estimated cost: $200,000

Wetland 37 Enhancement A (left bank, RM 8.4): Excavate groundwater-fed habitat in the vicinity of Wetland 37. Estimated cost: $700,000

Jeffries/Cook Levee Habitat (right bank, RM 7.5-8.3): Excavate groundwater-fed habitat behind the Jeffries/Cook levee. Estimated cost: $1,500,000

Wetland 103 Enhancement (left bank, RM 7.4): Excavate four small fish-usable ponds and connecting channels in Wetland 103. Estimated cost: $100,000

Ricardi Revetment Habitat (right bank, RM 7.4): Excavate groundwater-fed habitat behind the Ricardi revetment. (Note: The configuration of this project will be dictated by implementation of the "Ricardi Flood-Damage Reduction" recommendation, CIP 3109.) Estimated cost: $500,000

Riverbend Habitat (left bank, RM 7.2): Excavate groundwater-fed habitat east of the Riverbend Mobile Home Park. Estimated cost: $500,000

Jones Road Wall-Base Tributary Enhancement (right bank, RM 6.6): Enhance a wetland for fish use, and improve wall-base channel habitat. Estimated cost: $100,000

Herzman Levee Habitat (right bank, RM 6.4): Excavate groundwater-fed habitat. Estimated cost: $600,000

Upper Summerfield Pond and Channel (left bank, RM 6.0): Excavate groundwater-fed habitat in King County open space. Estimated cost: $500,000

Lower Summerfield Floodplain Habitat (left bank, RM 5.6): Excavate groundwater-fed habitat in King County open space. (Note: This project would be affected by the removal of left bank fill as proposed in the "Elliot Bridge/Lower Jones Road Flood-Damage Reduction" recommendation, CIP 3111.) Estimated cost: $400,000

Maplewood Heights Homeowners' Site Enhancement (right bank, RM 4.6): Enhance and expand the existing groundwater-fed habitat. Estimated cost: $160,000

Upper Elliot Levee Habitat Restoration (left bank, RM 4.4): Construct a groundwater-fed habitat and new outlet channel for existing pond. Estimated cost: $400,000

MS 5: Modify Levees and Revetments

Recommendation: King County should remove or relocate County-maintained levees and revetments to reestablish aquatic habitat and increase the storage volume of the floodplain, where the public benefit from doing so would outweigh the public cost.

Discussion: By constraining high discharges within the river channel, levees 1) increase the flow peaks experienced in downstream areas; 2) raise the water surface in upstream areas; 3) increase flow velocities, erosion, and sediment deposition in adjacent areas; and 4) reduce the aquatic habitat and water quality benefits provided by an active floodplain.

Traditional bare rock levees and revetments require fairly costly regular maintenance, usually consisting of replacing rock and eliminating vegetation that provides shade, shelter, and food for fish. In addition, levees and revetments may give residents an unrealistic feeling of protection from large flood events.

Where gains in aquatic habitat, basinwide flood-damage reduction, and savings in future maintenance expense outweigh costs to do so, existing levees should be shortened, lowered, relocated, or removed to reduce water surface elevations in adjacent and upstream areas and to reduce velocities and provide flood storage and aquatic habitat along the Cedar River corridor. Revetments that qualify should be removed or "benched" to allow more conveyance area for flood flows, and bare rock faces of levees and revetments should be modified using the techniques described in King County's *Flood Hazard Reduction Plan* and *Guidelines for Bank Stabilization Projects* to reduce maintenance costs and restore aquatic habitat elements.

The 100-year flood event should be used as the basis for calculating costs and benefits.

Levees and revetments for analysis (excluding those included in capital improvement projects) have been identified at:

Rutledge/Johnson Levee (left bank, RM 13.0)
WPA (Cedar Mountain) Levee (left bank, RM 10.6)
Upper Jones Road Revetment (left bank, RM 9.3)
Progressive Investment Levee (left bank, RM 8.6-9.0)
Lower Cavanaugh Levee (left bank, RM 6.5)
Herzman Levee (right bank, RM 6.4)

Lead Entity:	WLRD
Cooperating Entities:	COE, FEMA, SWD, WDFW, MIT, CRC, DDES, Renton
Estimated Cost:	118,000 for staff support over 10 years

MS 6: Channel Migration Hazard Areas

Recommendation: In those areas where the Cedar River channel is most likely to migrate within the next 100 years, construction of new structures shall not be permitted. Subdivision of existing parcels should be allowed only if at least 5,000 square feet of buildable land outside of the channel migration hazard area is available on each of the proposed lots.

The locations of the recognized channel migration hazard areas include the Wetland 37 site (RM 8.5-9.0, left bank), the site of recent channel changes above the upper Jones Road bridge (RM 9.3-10.6), and the Dorre Don area (left bank, RM 15.0-16.2). In addition, areas where paths of historic channel migration are blocked only by levees of uncertain permanence (given existing levee elevation or long-term maintenance commitment) should be recognized and evaluated on a case-by-case basis (notably, the Lions Club levee at RM 11.8-12.1 plus areas behind any structures currently proposed for abandonment in the *Flood Hazard Reduction Plan*). Areas where floodwaters have access to now-abandoned channels of the Cedar River should also be recognized as areas of moderate channel migration hazard and regulated in accord with the proposed county-wide channel migration ordinance and public rule, when adopted.

Discussion: Channel migration is one of the most hazardous, but least well recognized, phenomena associated with development near a large river. Not identified by typical floodplain mapping, it nonetheless can have even more damaging effects than a large flood, because the affected property is not merely inundated but eliminated altogether. Channel migration zones cannot be predicted with absolute certainty. However, the historical record of past channel locations (and thus channel migration rates), coupled with information on the location of abandoned channels (which favor shifting) and revetments and levees (which inhibit shifting), allow for good estimates of the river's likely course into the future.

In conjunction with channel migration studies of other rivers in King County, a set of ordinance changes and a new Public Rule is being developed. The intent is to clearly establish channel migration as a type of flood hazard under the County's Sensitive Areas Ordinance (SAO) (KCC 21A.24). The present status of channel migration hazard is vague in the current SAO. While it appears to fall within the landslide hazard definition, it is a flood-related hazard. The recommendations of this Basin Plan are equivalent to the proposed regulation of "severe" channel migration hazard areas, as defined by the current draft language of the proposed Public Rule. The three locations along the Cedar River specified above meet the current proposed definition of the severe hazard areas. Other severe hazard areas along the Cedar River are present but likely confined to a narrow strip of land adjacent to the river and so are already regulated by the SAO buffer requirements for Class 1 streams and rivers and the Shoreline Master Program. "Moderate" hazard areas, also recognized by the proposed public rule, can and should be identified along the Cedar River once the county-wide definition and applicable regulations are settled. The urgency of such an identification, however, is not great.

Regulation of channel migration areas is a necessary component of floodplain management. Without it, new development can be subject to substantial risk that may be completely unrecognized at the time of construction. Typically, as the problem becomes manifest by the progressive movement of the channel towards a structure, only one of two options remain. One is to follow the "no action" alternative; namely, the private property loss is acknowledged, albeit at substantial cost to the landowner. Much more commonly, however, some form of bank protection is rapidly constructed, at either public or (additional) private expense, which may protect the misplaced structure but which also has substantial resource impacts and may affect the downstream pattern of channel erosion and deposition.

The current configuration of the Cedar River is, in fact, a testament to this second approach to channel migration hazard. As a result of this past approach, the Plan must now propose a multi-million dollar program, at public expense, to partially reverse its consequences on aquatic resources and on misplaced private development. Regulation of channel migration hazards seeks to prevent new, at-risk development and the associated costs of public disaster assistance, private property damage, and aquatic habitat destruction. As such, it complements recommendation BW 2: Reduce Less-Hazardous Flood Damage.

The specific areas noted share certain characteristics. Each channel migration zone is largely, but probably not completely, contained by the 100-year floodplain. In addition, the land is largely or entirely undeveloped at the present time, but further subdivision of existing lots is possible.

On the other hand, certain marked differences do exist. The Wetland 37 site (RM 8.5-9.0) is in public ownership and so private developments are not at risk. The Jones Road and Dorre Don areas (RM 9.3-10.5 and 15.0-16.2, left bank) are privately held and potentially at risk, although most current and past property owners have obviously recognized the risk by avoiding construction to date in the most hazardous areas. The Rainbow Bend, Tributary 0316, and WPA Levee mainstem habitat enhancement and restoration sites are located in the Jones Road area; the Watkins, and the Dorre Don Left Bank Meander and Meander B projects, together with a potential open space acquisition site, are located in the Dorre Don area. These projects would not be undertaken if, during their design, the risk of their being damaged by channel migration were judged to be significant. The Lions Club site is at a lower level of concern because of the protection afforded by the damaged Lions Youth Camp levee. A number of existing houses rely on this structure for channel migration protection, as do several large, potentially subdividable parcels. The Jan Road Floodway/Byers Bend and Byers Bend Floodway habitat projects are located here, and will be analyzed for risk during their design.

Lead Entity:	DDES
Cooperating Entities:	WLRD, FEMA, Renton
Estimated Cost:	$37,000 for staff support over 1 year

MS 7: Floodplain Mapping Analysis, Revision, and Distribution

Recommendations: Floodplain analysis and mapping should be kept current as conditions change on the Cedar River.

1. **Flood Audit:** King County, in conjunction with the Corps of Engineers and the City of Renton, should perform an area-wide flood audit of properties and structures, confirming the actual area and depth of flooding experienced during the November 1990 flood.
2. **Replace Stage Gages:** Replace, augment, or recalibrate existing mainstem stage gages and confirm the rating curves used to estimate peak flows on the Cedar River.
3. **Map Revision:** Using the information gathered from the flood audit, new or recalibrated stage gages, and from new survey where necessary, King County and the Cities of Seattle and Renton should fund a mapping process to reflect changes in the regulatory floodplain caused by changes in the flood frequency analysis, in the river channel, and in adjacent land uses that have occurred since the most recent Federal Emergency Management Agency (FEMA) floodplain analysis (1989). The revised floodplain information should be made available to the development and regulatory community as printed maps, computer disks, and by means of the County's Geographic Information System as it is developed.

4. **Request FEMA Flood Insurance Rate Map (FIRM) Revision:** WLRD should present FEMA with information regarding the changes described in # 3, above, and request that they revise their FIRMs of the Cedar River regulatory floodway and floodplain.

5. **Masonry Dam Impact Analysis:** Before instituting changes in the operating strategy for its Masonry Dam, the City of Seattle should perform an analysis of resulting changes to the floodplain, complete all appropriate State Environmental Protection Act analyses identifying impacts, and request revisions to the applicable FIRMs.

Discussion:

1. **Flood Audit:** The analysis performed by WLRD staff for the *Cedar River Current and Future Conditions Report* reveals conflicts between the modeled floodplain, the floodplain as observed during the November 1990 flood, and the FEMA FIRMs, which are used to regulate the use of the floodplain. A door-to-door survey of floodplain residents would bring those discrepancies into sharp focus and would contribute immeasurably to the accuracy and level of understanding of the floodplain. This information could be used to revise regulatory maps, as described below, and to educate residents of their specific degree of danger from flooding, as described in MS 8: Flood Education.

2. **Replace Stage Gages:** The wooden staff gages currently along the mainstem of the Cedar River were placed in 1967 to measure river stage and yield, via their rating curves, the associated discharge. These gages are read visually after the flood peak has passed, with the peak stage indicated by mud or debris on the gage or by relating an indicator on nearby ground to an elevation on the gage. A rating curve relating discharge to stage has been prepared for each gage. These discharges are used to calibrate floodplain models at known points, helping improve the overall accuracy of the model. New crest stage gages, which directly record stage peaks automatically and are more accurate than the existing staff gages, should be installed to either supplement or replace the existing gages.

   Changes in the river and its floodplain resulting from sediment deposition, channel migration, and land-use changes are another source of error in estimating river discharge from gage readings. New rating curves should be prepared both for the new gages and for any existing gages that remain in place. This would ensure the greatest possible accuracy of future revisions of the floodplain model.

3. **Map Revision:** To successfully design, permit, regulate, and protect development in the Cedar River floodplain, developers and reviewing agencies must be able to determine whether sites under consideration are located in areas at risk of flooding and, if so, what degree of risk is involved. Risk is assessed as a statistical function of many meteorological, geological, hydrological, hydraulic, and land-use variables. However, these variables change, and our understanding of them improves over time. Therefore, this risk must periodically be reexamined to accurately reflect current information and physical conditions.

   The *King County Flood Hazard Reduction Plan* makes the following recommendations: "A sampling of cross-sections and topographic points should be re-surveyed every five years to monitor changes in the basin and to update the hydraulic model accordingly. Major land cover changes should also be evaluated for their effect on hydrologic and hydraulic model results. In addition, if new information becomes available and suggests that the models are in error in some respect—for example, a major flood reveals errors in the floodplain maps—this should trigger a reevaluation of the data and model. When warranted, new data should be collected (e.g., a limited survey to correct a topographic map error). Also, if major storm events occur, the new data should be evaluated to see if they affect model calibration."

   In order to most accurately identify and reduce high risk or harmful activities in flood-hazard areas, and conversely to allow full use of areas not at risk, the existing HEC-2 hydraulic model (or its successor) and the resulting printed and electronic maps of the floodplain should be updated to reflect changing physical and hydrologic conditions in the Cedar River system. This analysis should be performed two ways, as a realistic representation of the floodplain as it actually exists (the method used to map the floodplain in this Basin Plan), and using FEMA's procedures that modify the result to reflect the loss of levees that do not meet FEMA's freeboard and construction minimums.

4. **Request FEMA FIRM Revision:** The 100-year floodway and floodplain, as defined by FEMA in its FIRMs, are used by DDES for regulatory and permitting purposes. FEMA's most recent analysis, published in 1989, used 8,530 cfs (gaged at Renton) to represent the 100-year discharge. The November 1990 flood was estimated at 10,600 cfs at Renton. This event caused a revision in the flood frequency curve, raising the estimated 100-year discharge to 11,100 cfs at Renton, a 30-percent increase.

   Basin Planning Program staff have reflected this increase in their floodplain analysis. This analysis and the flood of November 1990 identified a number of locations where significant changes should probably be made to the regulatory floodplain. The specific changes would need to be determined using FEMA's floodplain analysis procedures, described above. Because FEMA has limited resources to perform this analysis, it would probably occur sooner if undertaken by WLRD, with help from the Cities of Renton and Seattle.

5. **Masonry Dam Impact Analysis:** The operation of Masonry Dam is the most significant controllable factor determining discharge rates in the Cedar River. The Seattle Water Department may decide to revise its operation of Masonry Dam at some future time as a result of the regional impacts of recent events such as the November 1990 floods and the

drought of 1992. Because such a revision would change the Cedar River's peak discharge return pattern, and would therefore change the level of risk faced by development in the floodplain, the Water Department should work with interested parties such as the City of Renton and King County to assess potential effects on the floodplain before implementing changes in its dam operations. State Environmental Protection Act impact analyses should be performed before changes are instituted, and the revised discharge frequency analysis should be presented to FEMA for incorporation into its FIRMs.

Lead Entity:	WLRD
Cooperating Entities:	FEMA, COE, SWD, Renton, DDES, USGS
Estimated Cost:	$250,00 plus $73,000 for staff support for 1 year

MS 8: Flood Education

Recommendations: King County, the Seattle Water Department, and the City of Renton should continue their current coordination of flood warning activities, and should institute a series of new programs to inform floodplain residents of their risk of flood damage and to help them reduce that risk.

1. **Signage:** A permanent system of signs along roads within the City of Renton and the unincorporated portion of the Cedar River basin should be established to notify residents of a) locations of repeated flooding, b) evacuation routes, c) areas of potential road closures in the event of flooding, and d) the need to establish alternate travel routes before flooding occurs.
2. **Floodplain Resident Notification:** King County, in conjunction with the Corps of Engineers and the City of Renton, should use the results of the flood audit and floodplain mapping revisions recommended in MS 7: Floodplain Mapping Analysis, Revision, and Distribution, to inform residents and responsible agencies of the level of damage expected at each parcel, and of which evacuation routes would be open, for given stages of the Cedar River.
3. **Sandbag Supply:** King County and the City of Renton should establish numerous sites throughout the basin where sandbags and sand are easily available to residents, but where the resulting traffic congestion will not interfere with emergency services.
4. **Flood Protection Training:** King County should offer courses training residents how to protect their lives, buildings, and possessions before and during a flood.
5. **Telephone Tree:** King County, the City of Renton, and the SWD should establish a phone tree among floodplain residents to disseminate flood emergency information.

Discussion: Specific flood management programs adopted by King County in its *Flood Hazard Reduction Plan* and proposed in this Basin Plan will help reduce flood damage but will not eliminate it. The potential for property damage and hazards to human life and health will remain as long as people live, work, and seek recreation in the floodplain. Fortunately, most hazards are confined to certain discrete areas; many could be avoided if people were given adequate advance notice and were made aware of dangerous conditions. Although the flood warning system improvements described in the *Flood Hazard Reduction Plan* would provide residents with much of this necessary information, the actions proposed above could provide an additional measure of safety.

1. **Signage:** King County Roads and Engineering Division staff currently place temporary warning and closure signs during periods of road flooding. Permanent signs in areas of chronic flooding (especially signs noting water depth during past floods) would serve to warn residents of the extent of repeated flooding, remind them to seriously consider the threat of flooding, and prepare for its occurrence. Such signs would also warn motorists that certain areas should not be relied on for evacuation but should be approached cautiously during heavy rain storms and flood warning periods, to prevent accidents that might otherwise occur before Roads Division staff could place the temporary signs.

2. **Floodplain Resident Notification:** The Army Corps of Engineers' Seattle District has developed a computer program that can correlate river stage gage readings with floodwater depths at individual residences. Program inputs include a calibrated HEC-2 backwater model such as the one developed by WLRD for the *Cedar River Current and Future Conditions Report* and survey information describing locations and elevations of roads and occupied structures in the floodplain. Outputs can include reports for individual residents that help relate stages at the Landsburg gage to depths of flow relative to their finished floor elevations and to depths of flow along public roads within the floodplain. Residents and public emergency service providers can use this information to predict the level of flooding to prepare for and to plan evacuation routes, if necessary. In addition, the door-to-door interviews with residents would provide information valuable in updating and calibrating the HEC-2 floodplain model as described in MS 7: Floodplain Mapping Analysis, Revision, and Distribution.

3. **Sandbag Supply:** The King County Public Works Department Sandbag Policy Summary (Revised 10/30/92) reads:

    1. The Department of Public Works keeps a supply of sandbags for its use but shares these bags with citizens during emergencies. The Department encourages citizens to be prepared by obtaining sand and bags from commercial sources prior to a flood.
    2. During an emergency, the Department will make sand and bags available to citizens only under the following conditions:

        A. Citizens may pick them up at any Roads and Engineering (Roads) Division maintenance shop. (Note: County personnel will not fill the bags with sand!)

        B. Roads Division maintenance crews will attempt to deliver sand and bags to designated fire stations so they will become more accessible.

        C. Citizen requests for special on-site delivery will be referred to a central contact in the Roads Division. The contact person will determine whether to deliver sand and bags based on the immediacy of the threat to life and property and the availability of crews to deliver the materials. The requester will be notified whether the materials will be delivered and will be given an estimated delivery time by the Roads Division.

    This policy should be revised because it impairs fire stations' ability to operate effectively during a flood emergency. Fire stations were originally selected as distribution points because they are publicly owned, centrally located, and have shelter and restroom facilities for the volunteers who help fill and distribute the bags. However, fire station personnel report that the traffic and congestion that result from filling and distributing sandbags are hazardous and interfere with the fire stations' ability to respond to emergency calls. King County Public Works should locate safer sites for filling and distributing sandbags that still meet the volunteers' requirements.

4. **Flood Protection Training:** King County currently provides a brochure describing emergency procedures, phone numbers, and preparedness tips for floodplain residents. A new, more detailed flood-hazard brochure is being prepared for release in 1995. This brochure should become the basis for expanding annual flood awareness meetings to provide more detailed information and demonstrations on floodproofing techniques, emergency preparedness, County sandbag policy, and other information, such as how to fill and place sandbags. Courses should be offered at least once a year in both Renton and Maple Valley and publicized well-enough that all floodplain residents are aware of them.

5. **Telephone Tree:** A voluntary telephone tree among residents in the floodplain would augment the existing County flood warning system at minimal cost. Flood emergency information from the King County Flood Warning Center would be given to key floodplain residents, who would in turn contact others in the phone tree. The telephone tree would be established by the WLRD Division, the City of Renton, and the Seattle Water Department through a series of informational meetings with interested residents.

Lead Entity:	WLRD
Cooperating Entities:	KC Roads, Renton PW, KCOEM, SWD
Estimated Cost:	\$35,000, plus \$31,000 for staff support for 1 year

MS 9: National Pollutant Discharge Elimination System (NPDES) Industrial Stormwater Permits; Boeing Commercial Airplane Group and Renton Municipal Airport.

Recommendation: The Boeing Commercial Airplane Group and lease holders of the Renton Municipal Airport should develop and implement Stormwater Pollution Prevention Plans (SPPP) per NPDES for Washington State Department of Ecology (WSDOE) review and approval. The SPPP should emphasize source control measures, especially for de-icing, aircraft washing, equipment and engine cleaning, and fueling activities.

Discussion: WSDOE regulates activities and sets effluent criteria for airport activities through the NPDES permitting program. WSDOE has issued a general stormwater industrial permit to Boeing Commercial Airplane Group, which is in the process of preparing an SPPP in compliance with NPDES permit requirements. WSDOE does not typically review these plans unless a problem occurs. However, since semivolatile organics were detected in the sediments at stormwater outfalls from the Boeing Commercial Airplane Group and the Renton Municipal Airport, source control measures should be addressed in the SPPPs of the lessees. WSDOE should review and condition the SPPP to assure that it sufficiently addresses airport activities such as de-icing, fueling, aircraft washing, engine cleaning, and other potential contaminants.

The Renton Municipal Airport does not currently engage in any activity that requires the Airport to obtain a NPDES permit. It is the responsibility of individual lease holders to obtain and prepare SPPPs for regulated activities for which they are individually responsible. The airport management periodically prepares recommended BMPs and disseminates them to airport leaseholders. These BMPs should be adopted as airport policy and adopted by City Council action as enforceable rules of conduct at the airport.

Lead Entity:	WSDOE
Cooperating Entities:	Renton PW
Estimated Cost:	No cost to King County

MS 10: Stormwater Quality in Industrial/Commercial Areas

Recommendation: The City of Renton should continue current efforts to control pollutant sources in the industrial/commercial areas of Renton. Priority should be placed on eliminating contamination from the Logan Street Outfall. This should include systematic monitoring and tracking programs to identify contaminant sources.

The City of Renton should provide technical assistance to business owners through programs such as Bellevue's "Business Partners for Clean Water" or King County WLRD's "Businesses for Clean Water." The City should include all affected entities in these efforts.

Discussion: Commercial and industrial land uses create opportunities for contaminants to enter the drainage system. Pollutants such as oils, antifreeze, and chemicals are often used and stored in large quantities in these areas. Source control BMPs such as proper storage and disposal of these pollutants help assure that they are not washed into storm drains. Technical assistance to businesses would identify practices with high polluting potentials and would suggest appropriate BMPs. Addressing problems at the source provides the best mechanism for reducing pollutant loadings and eliminating impacts to surface and groundwater.

The Logan Street outfall has been identified as a problem area. An analysis of sediments from this outfall showed very high levels of total phosphorus (TP); fats, oils and grease; volatiles; and metals (copper, lead, and zinc). The City of Renton has conducted a survey to identify illicit hookups to the stormwater system. This survey has identified businesses and made BMP recommendations for improved water quality. However, a more thorough tracking and monitoring program is necessary to assure that the problems are solved. The City of Renton should consider these areas a high priority in implementation of future NPDES municipal stormwater activities.

Lead Entity:	Renton PW
Cooperating Entities:	WSDOE, WLRD
Estimated Cost:	No cost to King County

MS 11: Treatment of Interstate 405 and SR-169 Stormwater

Recommendation: The Washington Department of Transportation should evaluate the effectiveness of its I-405 detention pond for stormwater quality control. If it is determined that this structure does not provide stormwater treatment, WSDOT should explore other methods to retrofit the stormwater drainage system for water quality control. When and if funding from the State legislature is authorized for implementation of the Puget Sound Highway Runoff Program (WAC 173-270) and NPDES requirements, the I-405 drainage to the Cedar River should receive priority for retrofit of the stormwater drainage system.

WSDOT should provide stormwater treatment for drainage from SR-169 entering Cavanaugh Pond, and evaluate alternative solutions having the least impact on Cavanaugh Pond.

Discussion: Stormwater from the outfall at I-405 exceeds State toxic criteria for metals (copper, lead, and zinc). Sediments were in the "Moderately Polluted" range for these metals according to the WSDOE guidelines for sediments. This outfall collects stormwater from sections of I-405 and urban residential areas within Renton and may be a candidate for a regional treatment facility. WSDOT has installed a spill detention pond for the isolation and removal of contaminants spilled on I-405. This pond may not effectively remove metal contaminants from highway runoff.

Cavanaugh Pond has been identified as a Significant Resource Area and is sensitive to contamination from SR-169 runoff. Treatment of drainage to Cavanaugh Pond should meet the stream protection standards of BW 12: Water Quality Treatment Standards.

Lead Entity:	WSDOT
Cooperating Entities:	WSDOE, Renton PW
Estimated Cost:	No cost to King County

MS 12: Debris Flow Protection for Mobile Home Park (Left Bank, RM 6.2)

Recommendation: Conduct a study of alternatives to reduce the risk of debris flow damage to a mobile home park on Tributary 0313, particularly construction of a setback berm on the right bank of the channel through the upper trailer park, or an overflow channel at the upper end of the alluvial fan, to direct flow to the valley floor. The results should be provided to the mobile home park owner for private action.

Discussion: Some recent, low-level flooding has occurred in this location, and there is a poorly documented history of much more damaging flows in the past. The risk does not appear great enough to require public action at this time, but conducting this study at public expense and making the results available to the private landowner most affected would offer a practical mechanism to improve the long-term safety of residents.

Lead Entity:	WLRD
Cooperating Entities:	KCPA, Mobile home park owner
Estimated Cost:	$37,000 for staff support over 1 year

NORTHERN TRIBUTARIES

NT 1: Stoneway Concrete Company Stormwater Management

Recommendation: Stoneway Concrete Company should comply with all requirements of the National Pollutant Discharge Elimination System (NPDES) industrial stormwater general permit for stormwater discharges associated with the sand and gravel operations located on Cedar Grove Road. Stoneway Concrete Company should prepare and implement a Stormwater Pollution Prevention Plan (SPPP) that specifically addresses proper operation and maintenance of on-site drainage BMPs to assure that sediments do not leave the site. This SPPP should be reviewed and approved by WSDOE.

Discussion: Stoneway Concrete Company is a major source of sediment to Tributaries 0316 and 0316A from erosion of exposed gravel mine surfaces and improper operation and maintenance of sediment control facilities. Typically, WSDOE does not review these plans unless a problem occurs. In light of these problems, however, WSDOE should review and approve the SPPP to assure that it sufficiently addresses sediment control measures.

Lead Entity:	WSDOE
Cooperating Entities:	WLRD
Estimated Cost:	No new cost to King County

SOUTHERN TRIBUTARIES

ST 1: Madsen Creek Water Quality

Recommendation: In recognition of high fecal coliform and pesticide concentrations observed in Madsen Creek, the following measures should be taken:

1. The King County Wastewater Treatment Division (WTD) should develop a routine inspection and monitoring program to identify leaks in the Madsen Creek sewer line.
2. The Fairwood Golf and Country Club should develop an approved Golf Course Management Plan consistent with the *Golf Course BMPs Manual*.
3. WTD and Fairwood Golf and Country Club should work with the Muckleshoot Indian Tribe's fisheries staff to develop monitoring programs for Madsen Creek.

Discussion: The Cedar River has been classified as "water quality limited" with respect to fecal coliform contamination. Existing and planned work in the Madsen Creek ravine (see CIP 3136) should reduce the risk of sewer line leaks and breaks but will not eliminate them altogether. Thus, a routine inspection program is necessary to provide low-cost early warning of problems. It should be supplemented with monitoring of fecal coliform concentration upstream and downstream of the exposed sewer line to insure protection and confirm in-channel sources, if any. The pesticide 2,4-D was detected in sediments downstream of the golf course. Pesticides should be used in accordance with a comprehensive golf course management plan using the King County *Water Quality Best Management Practices Manual* and the *Golf Course BMPs Manual* as guidance.

Lead Entity:	WLRD/WTD
Cooperating Entities:	Fairwood Golf & Country Club, MIT, Fairwood Homeowners' Assn.
Estimated Cost:	$29,000 for staff support over 2 years

PETERSON CREEK

PC 1: Lake Desire Outlet Channel Maintenance

Recommendation: King County should develop and implement a public/private cooperative plan to provide limited, ad hoc maintenance of outlet channel conveyance with minimal disturbance to downstream sensitive areas.

Discussion: Lake Desire drains through a 30-inch culvert into a 3,000-foot-long, low-gradient segment of Tributary 0328B and uninventoried wetlands within the King County Lake Desire/Spring Lake Open Space. This tributary, the culvert, and the area upstream have historically been cleared of debris, vegetation, and beaver dams by residents. Recently, SAO stream and wetland protection requirements have discouraged this activity. Increased lake levels and durations of high water can be attributed to this reduction in clearing and to increased development upstream of the lake.

King County WLRD and King County Department of Parks and Recreation will cooperate on removal of beavers and dams upstream of the outlet culvert. This requires a permit from the WDFW and contracting an approved trapper or wildlife control company to remove the animal. Live trapping and relocation of beavers to suitable receiving areas will be the preferred method of removal. Because this location appears to be very attractive to beavers, beaver removal will probably have to be undertaken every few years as new dams appear.

After initial removal of the beavers and their dam, local residents (most likely the Lake Desire Community Club) should maintain the channel upstream of the culvert. This work should be limited to the removal of debris that causes a visible backup of water to the lake and should not include dredging or other alteration to the channel bed or banks. Frequency of debris removal upstream of the culvert will be at the discretion of residents but will take precedence over any downstream maintenance that should be the responsibility of the County.

Maintenance of the culvert should be done at the discretion of the County, and only if upstream flow depth in the outlet culvert exceeds 27 inches, 24 hours after upstream debris has been cleared. This assures that all appropriate efforts at maintaining upstream conveyance have been made and that high lake levels persist prior to initiating downstream maintenance. Downstream maintenance should be limited to debris removal aimed at limited enhancement of conveyance without causing significant erosion or other serious disturbance to the riparian ecosystem. Any downstream maintenance activity within King County Open Space must be agreed to by the King County Department of Parks and Recreation.

Lead Entity:	WLRD
Cooperating Entities:	KC Roads, KCNRD, LDCC, WDFW, KC Dept. of Parks and Recreation
Estimated Cost:	$15,000 for staff support over 1 year

PC 2: Wetland 42 Reclassification

Recommendation: Wetland 42 should be reclassified as a Class 1 wetland.

Discussion: The *King County Wetlands Inventory* currently classifies Wetland 42, which includes Peterson Lake, as a Class 2 system. This wetland consists of several acres of shallow and deep open water, extensive scrub-shrub habitats northwest and southeast of Petrovitsky Road, and emergent and forested areas. The wetland is fed by Peterson Creek, and both the stream and lake provide high-quality salmonid and wildlife habitat. Although the wetland inventory lists the size of Wetland 42 as 14.5 acres, its actual size—including a four-acre segment between the Lake Youngs water-supply pipeline and Petrovitsky Road and another portion of the wetland north of 192nd Avenue SE—appears to be closer to 23 acres.

Because of its size, habitat complexity, and extensive open water, Wetland 42 meets the criteria of a Class 1 wetland, and therefore should be reclassified as such.

Lead Entity:	DDES
Cooperating Entities:	WLRD
Estimated Cost:	Covered by existing programs

PC 3: Shadow Ridge Drainage Study

Recommendation: King County WLRD should conduct a study of stormwater detention and water quality treatment effectiveness of existing R/D facilities in developments upstream of Wetland 14 (mainly in the "Shadow Ridge" plats) to determine if these facilities provide adequate detention and water quality protection for sensitive areas downstream (Wetlands 14 and 15 and Lake Desire). If not, the study should describe options for reducing stormwater impacts on these RSRAs.

Discussion: Development of upslope areas, particularly in the Shadow Ridge subdivision, may be having adverse impacts on Wetlands 14 and 15 and Lake Desire, with implications for the future of wetland and lake protection and restoration efforts. If problems are found, the study should identify potential solutions, including pond/swale expansions or other functional modifications.

Lead Entity:	WLRD
Cooperating Entities:	Neighborhood
Estimated Cost:	$37,000 for staff support for 1 year

ROCK CREEK

RC 1: Rock Creek (Tributary 0338) Low Flow Restoration

Recommendation: In order to address the low-flow problems that limit salmonid use of the lower 1.7 miles of this otherwise high-quality habitat, King County WLRD should:

1. Cooperate with the City of Kent to further clarify the relationship between the Clark Springs water diversion and Rock Creek low-flow conditions using the results of a hydrogeologic study that is currently being conducted as part of the City's wellhead protection program;
2. Jointly monitor with the City of Kent the feasibility and fish habitat benefits of an experimental low-flow augmentation program; and
3. Depending on the results of the City's hydrogeologic study and the success of the experimental low-flow augmentation program, continue cooperation to develop a long-term strategy to meet municipal water supply and habitat needs using wells, diversion scheduling, storage, seasonal shifting of sources, or other options.

Discussion: Fish habitat utilization in the lower 1.7 miles of Rock Creek has been greatly reduced because of permitted water withdrawals by the City of Kent at its Clark Springs facility and, to a lesser degree, by an unpermitted diversion of water to the Green River from Wetland 93. The City has withdrawn water since the 1930s, but in recent years withdrawals have increased while creek flows have declined during the dry season months of September and October, when chinook and sockeye salmon normally migrate to spawn. For example, in October 1992, flow in the structurally excellent habitat of Rock Creek was too shallow for significant spawning by chinook and sockeye salmon. At the same time, the quantity and quality of rearing habitat available for juvenile coho salmon and steelhead trout was greatly reduced. Local residents have also reported that in the mid-1980s the lower reaches of the stream went dry for periods of a day or so in late summer, leaving many fish stranded.

The City of Kent has responded to these problems by agreeing to consider low-flow issues in their ongoing hydrogeologic study of the Clark Springs site and by initiating an experimental program of flow augmentation. This program will seek to maintain at least 3.0 cfs in Rock Creek by distributing diversions among gravity and well diversion systems. The stream will be monitored to determine if this Plan is adequate to restore Rock Creek's chinook and sockeye spawning potential and for its effect on summer low flow rearing habitat. King County WLRD will cooperate with the City in reviewing study results, monitoring creek flows, evaluating benefits to fish habitat, and assessing the practicality of low-flow augmentation given the City's primary responsibility to maintain adequate water supply.

The feasibility of the experimental low-flow augmentation program should be enhanced by the elimination of the small diversion ditch that drains Wetland 93 (about a mile downstream of Lake No. 12) in the headwaters of the Rock Creek subbasin. This diversion was eliminated by King County WLRD in 1995, adding approximately 0.5 to 1.5 cfs to the mean annual flow of the creek.

Depending on the results of the hydrogeologic study and the success of short-term measures, long-term strategies to meet the City of Kent's water supply needs and restore low flows and aquatic habitat should be developed. The range of opportunities includes (but is not limited to) seasonal or locational shifting of water withdrawals, a greater use of wells (depending on hydrologic connectivity to Rock Creek and the Cedar River), and securing alternate water sources. Although it appears that a technically feasible solution may be available, and that such a solution could have great value in increasing fish production in the Cedar River, it must be recognized that complex resource management, legal, and engineering challenges may be involved. To facilitate resolution of these issues, the process should be guided by the Cedar River Council with the full participation and cooperation of the City of Kent.

Lead Entity:	WLRD
Cooperating Entities:	City of Kent
Estimated Cost:	$5,000 to fill in the Wetland 93 diversion ditch; $66,000 for staff support over 5 years. Total cost to all parties for restoring adequate base flow to Rock Creek is unknown at this time, but may be well in excess of $1 million depending on the long term strategy required.

RC 2: Wetland 92 Reclassification

Recommendation: Wetland 92 should be reclassified as a Class 1 wetland.

Discussion: Wetland 92 extends nearly one mile from the outlet of Lake No. 12 to RM 4.6 on Rock Creek west of 290th Avenue SE. At 94 acres, it is the largest wetland in the Planning area, and one of the most structurally diverse. The *King County Wetlands Inventory* describes it as being composed of forested and scrub-shrub habitats. As noted in the *Cedar River Current and Future Conditions Report* it also contains emergent habitat segments and two small open water ponds. As such, it meets criterion 1c of the *King County Wetlands Inventory* wetland rating system: "Wetlands equal to or greater than ten acres in size and having three or more wetland classes, one of which is open water." Because of these attributes and its critical location at the headwaters of Rock Creek, this wetland deserves reclassification as a Class 1 system.

Lead Entity:	DDES
Cooperating Entities:	WLRD
Estimated Cost:	Covered by existing programs.

RC 3: Rock Creek Community Involvement and Education

Recommendation: Local residents should be encouraged to protect the high ecological value and water quality of Rock Creek through educational outreach programs and technical assistance provided by the Basin Steward (BW 16), including information about the King County Public Benefit Rating System.

Discussion: Rock Creek constitutes the most significant tributary habitat for salmonids in the Planning area, and one of the best remaining aquatic habitats in the entire Lake Washington basin and western King County. The education and support of the local community will be critical in protecting Rock Creek for future generations. The Tahoma School District has expressed strong interest in adopting Rock Creek and enlisting the community to help teachers and students become stewards of Rock Creek. This partnership should continue to be supported by the Basin Steward.

Lead Entity:	WLRD
Cooperating Entities:	Neighborhood, Tahoma School District
Estimated Cost:	Included under BW 16

Chapter 5

Implementation Strategy

Chapter 5: Implementation Strategy

Introduction

The Cedar River Basin and Nonpoint Pollution Action Plan (the Plan) proposes over 150 actions to reduce flood damage; protect, restore, and enhance aquatic habitat; protect groundwater supplies; and maintain water quality in the Cedar River basin at an estimated cost of approximately $85 million.[7] Although the County, Renton, and other participating entities are committed to solving these problems, this sum far surpasses available local resources that can be identified, even over the long term. Consequently, Plan implementation must involve setting priorities, using available funds efficiently, and seeking outside funding sources. This chapter describes the implementation strategy to achieve these objectives over approximately 10 years.

Priority Setting: Balancing Competing Needs

The first steps toward prioritizing Plan recommendations were taken during preparation of the *Cedar River Current and Future Conditions Report*, when existing and projected problems in the basin planning area were ranked according to their significance. Because of the number of problems identified, only those from the highest two (of four possible) significance levels were chosen to be addressed in the Plan.

Recommended solutions to the selected problems were prioritized in order to 1) identify the most urgent and cost-effective set of actions needed; 2) assess where implementors should direct the basin's limited resources; and 3) determine whether these actions, taken as a whole, strike an appropriate balance between competing needs—correction of the most critical current conditions and prevention of new problems throughout the basin planning area.

If *fully implemented*, the Plan would: 1) eliminate all identified flooding threats to human life by removing or relocating the approximately 150 houses and mobile homes exposed to hazardously deep and fast floodwaters, while restoring approximately 95 acres of former floodplain storage and aquatic habitat; 2) resolve the basin planning area's most significant local flooding and drainage problems; 3) restore 16 degraded wetlands and 7.5 miles of stream; 4) significantly reduce the rate of habitat and water quality degradation caused by continuing development in the basin planning area; and 5) provide protection of aquifers used for potable water supplies.

Full implementation of the Plan would preserve the Cedar River's vital contribution to maintaining the water quality in Lake Washington, provide protection of aquifers used for potable water supply, and should provide sufficient aquatic habitat and water quality benefits to

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[7] This estimate does not include the cost of implementing a current Army Corps of Engineers study of ways to reduce flood damage in the City of Renton.

maintain the river as a healthy ecosystem and to protect critical salmon and steelhead habitat for the future.

By contrast, if *none* of the Plan's recommendations were implemented, mainstem and tributary flooding would continue, leaving the residents of nearly 300 homes at their existing level of risk from floods. In addition, the majority of aquatic habitats, including some of the best habitats remaining in western King County, would degrade; groundwater quality of the Cedar River Sole Source Aquifer and other basin aquifers would decline; the generally good surface-water quality would decline throughout the basin planning area; and the Cedar River's value to Lake Washington would diminish.

These two extremes define a range of implementation options. At a minimum, assuming that the currently identified local funds (approximately $4 million) were the only resources available and that capital projects were given priority over recommended programs, one of two alternatives could be selected:

1. One large mainstem flooding problem (such as Dorre Don) could be partially resolved, removing from the floodplain fewer than 10% of the residents identified as being at risk from hazardous flooding; or
2. The majority of recommended tributary capital projects could be implemented, restoring aquatic habitat and water quality and resolving the majority of significant local drainage problems in the basin planning area's tributary subareas.

It is assumed that the majority of the Plan's programmatic recommendations could also be accomplished under these scenarios, but this will not be certain until the implementing agencies have reviewed the final Plan and have made commitments to specific actions.

The Watershed Management Committee (WMC) determined that neither alternative would adequately address their goals and objectives for the basin planning area, and chose instead to identify a "*Core Plan*" (see Table 5-1 at the end of this chapter), consisting of the capital and programmatic recommendations that would accomplish, at a minimum, the most important of these goals. This combination of capital and programmatic recommendations has an estimated cost of approximately $66 million. The *Core Plan* would:

1. Implement the most cost-effective of the Plan's mainstem flood-damage reduction recommendations, concentrating on those that eliminate the most hazardous flooding conditions; affect the largest number of residents; and yield the greatest benefits to habitat, water quality, recreation, and other public activities. This element would resolve the threat of hazardous flooding for approximately 90% of those inhabitants currently at risk;
2. Protect the most valuable remaining aquatic habitat sites in the basin planning area, restore those with the best chance for recovery, and help ensure long-term productivity of Lake Washington salmon and steelhead;
3. Accomplish the majority of the Plan's water quality correction and prevention measures; and
4. Significantly reduce the rate of habitat and water quality degradation, the worsening of existing flooding problems, and the creation of new problems, through preventive programs.

It must be emphasized, however, that the remaining "non-core" recommendations are also considered important to the safety and health of the Cedar River basin and should not be disregarded simply because their benefits may be more localized or less dramatic. All Plan recommendations achieve important objectives and are judged to be cost-effective ways to resolve problem conditions deemed at least 'very significant" in the *Cedar River Current and Future Conditions Report*. If funding is available, every effort should be made to implement the Plan's remaining recommendations.

SELECTION OF CORE PLAN RECOMMENDATIONS

Three equally weighted primary criteria were used by the WMC to rank the Plan's recommendations. The first, "problem significance," reflected the severity and the urgency of the identified problems. Because of the difficulty in comparing widely different types of problems, threats to human life were ranked equally with severe threats to high-value resource areas. The second criterion, "solution effectiveness," reflected the degree to which a recommendation would solve or prevent an identified problem, the feasibility of implementation (e.g., landowner willingness to participate, ease of obtaining necessary construction permits), and cost-effectiveness—the benefit achieved per unit cost. The third criterion, "multiple benefits," reflected a recommendation's combined effects on flood damage, aquatic habitat, water quality, and recreation and other public uses.

Other prioritizing elements included 1) the existence of a prior commitment by the County or other entity to address a given problem; 2) cost; 3) the possibility of outside funding sources; 4) open space benefits; and 5) high visibility of a solution or strong community support for it. These five elements were combined as one criterion, which was weighted equally with the primary criteria.

COST ASSUMPTIONS

The cost estimates shown in Table 5-1 are preliminary, and are shown in 1994 dollars. Costs for capital projects and open space acquisition include project design, land acquisition, permits, construction, and post-construction evaluation but do not include project maintenance. Costs for programs, studies, and regulations include set-up costs where applicable, plus incremental additional county staff, including benefits, needed to implement each recommendation over its (typically 10-year) life, assuming a 5-percent annual discount rate.

BALANCING PLAN ELEMENTS

The WMC evaluated the Core Plan to verify that its recommendations addressed the Plan's goals and objectives (Appendix A in *Appendices to the Cedar River Basin and Nonpoint Pollution Action Plan*, this document's companion volume) in a balanced way. This evaluation was a final check that the prioritizing process and the selection of Core Plan elements yielded an equitable outcome, though it did not dictate the inclusion or rejection of any specific recommendation.

Recommendations were compared by geography (mainstem vs. tributaries); type of problem (flooding vs. habitat and water quality); and type of solution (capital vs. programmatic). The comparisons acknowledged the multi-objective nature of the recommendations (i.e., a $2 million flood-damage reduction project may incorporate $150,000 for habitat and water quality benefits as well).

When evaluated geographically, Core Plan recommendation costs were apportioned with approximately $54.5 million, or 82%, for mainstem/valley floor projects (Figure 5-1), with the remaining $12 million, or 18%, being directed to the tributary areas.

When compared by type of problem, approximately $38.5 million, or 58% of costs (Figure 5-2), were earmarked for the reduction and prevention of current and projected future flood damage, while $28 million, or 42%, would restore and protect aquatic habitat and water quality.

Finally, a comparison of types of solution showed approximately $37.5 million, or 56% of Core Plan funds, earmarked for capital improvement projects (Figure 5-3), while about $29 million, or 44%, would be directed toward programmatic recommendations. This ratio reflects the Plan's balance between solving current problems by building capital improvement projects and preventing future problems through regulations, education, and by means of public/private stewardship of the basin's resources.

The success of implementing the Lower Cedar River Basin and Nonpoint Pollution Action Plan is dependent upon the predictable funding of ongoing programmatic activities that address critical flood control, water quality, and habitat protection in the basin. These programs should be funded annually from the Surface Water Management fund along with contributions from the Roads CIP, Parks CIP, Wastewater Treatment funds, and other relevant funding sources, including regional funding sources. The programs that address the highest priority needs for the basin include the following:

- Open Space Acquisitions
- Small Scale Watershed Restoration and Enhancement
- Lake Washington Studies
- Basin Plan Monitoring and Evaluation
- Cedar River Council
- Basin Steward
- Forest Incentive Program
- Local matching funds for State and Federal Funding for Flood Hazard Reduction
- Mainstem Habitat Restoration and Enhancement
- Tributary 0338 (Rock Creek) Low Flow Restoration
- Aquifer Protection and Base Flow Maintenance.

These programs should be funded at a base level of $1.3 million annually, with additional contributions appropriated to enhance acquisition and restoration efforts.

Sharing Implementation Roles

A strong public, community, and private partnership program and aggressive funding strategies are essential ingredients in successfully implementing the Core Plan. Interest groups, governments, the private sector, and individuals each have something to contribute to projects and programs, whether it is donated labor, equipment, or direct cash contributions. These resources could determine whether many of the recommended projects become a reality. Seeking outside funds in the form of grants could stretch available local dollars and expedite implementation activities. In return, an equally important long-range goal could be achieved—gaining a sense of community responsibility for the basin and its resources.

Figure 5-1 Comparison of Core Plan Costs: Tributary Areas vs. Mainstem Areas

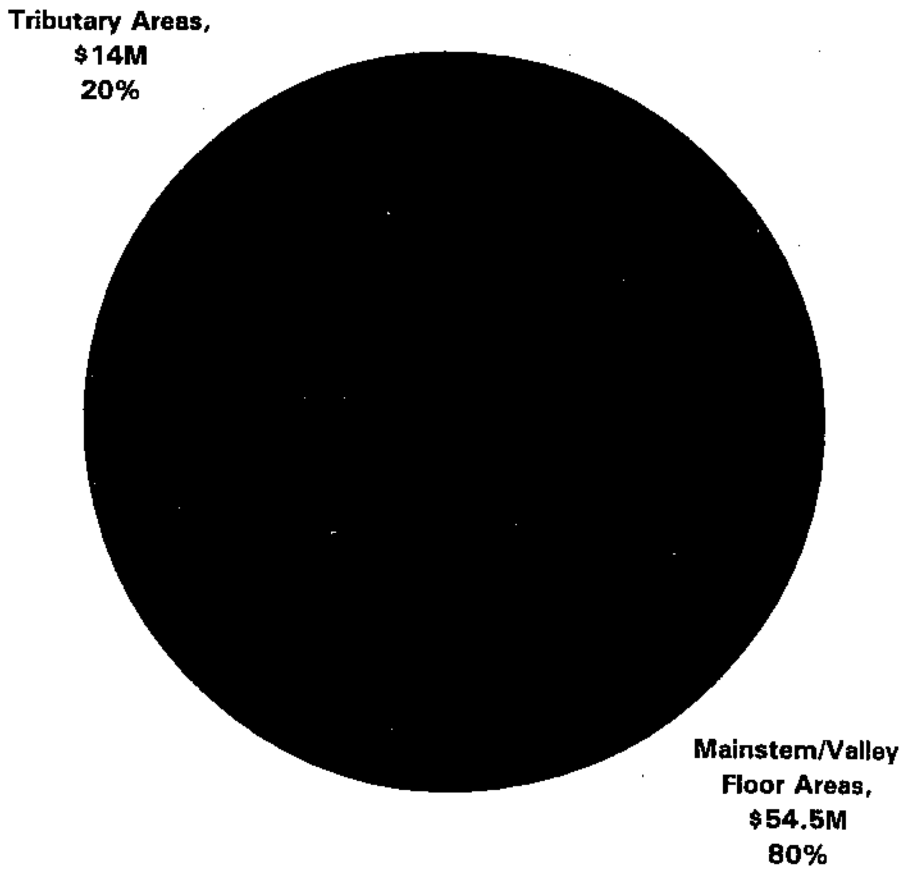


Figure 5-2 Comparison of Core Plan Costs: Flood Damage vs. Habitat and Water Quality

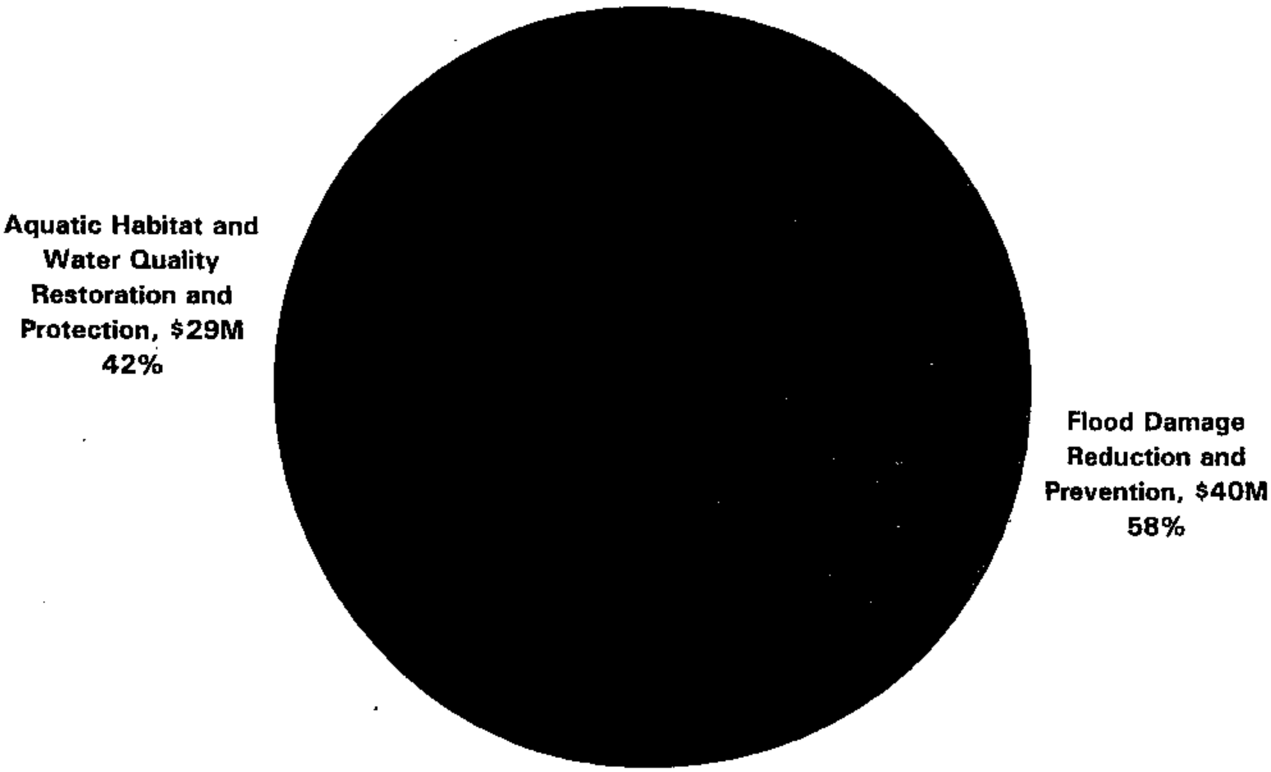
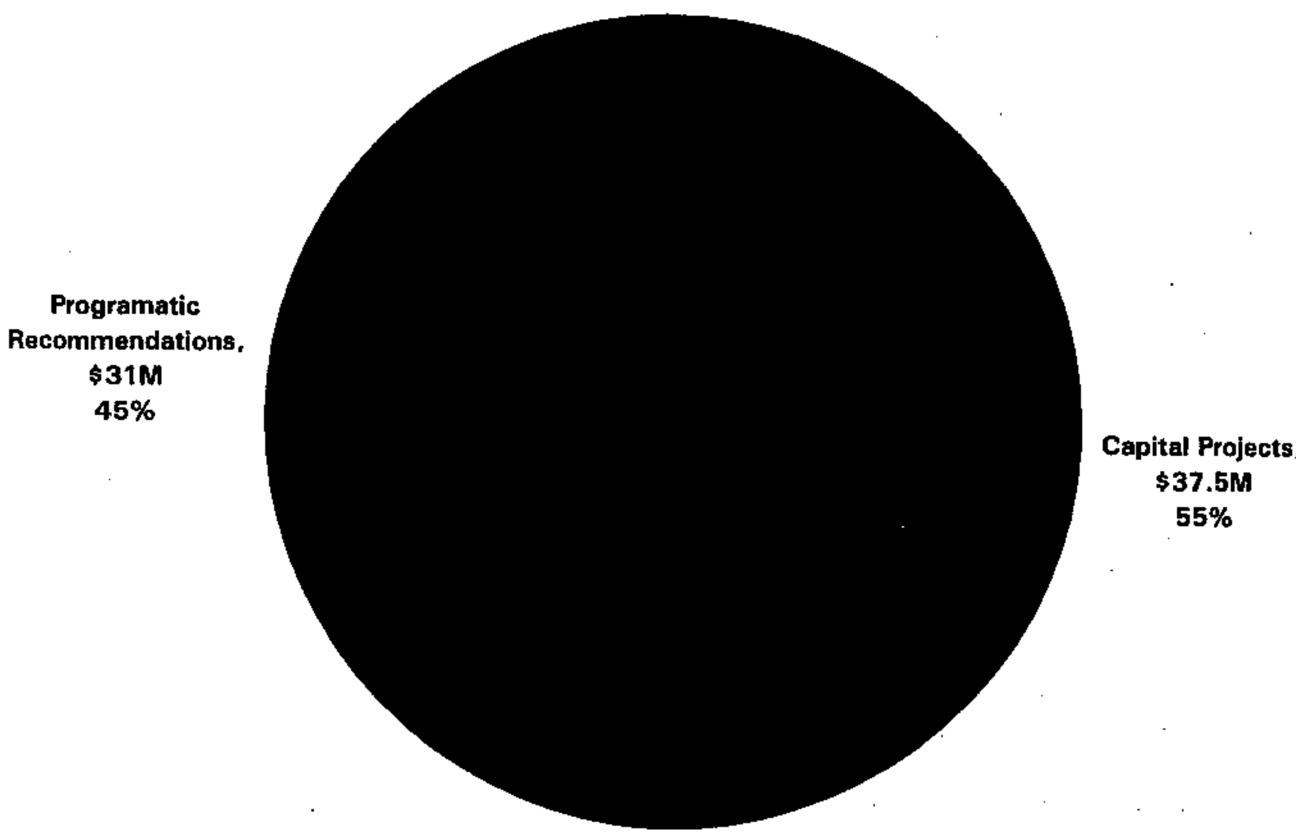


Figure 5-3 **Comparison of Core Plan Costs: CIPs vs. Programmatic Recommendations**



PUBLIC/PRIVATE PARTNERSHIPS

Central to this strategy is the formation of public/private partnerships, where private sector resources could be combined with those of agencies and interest groups. A primary role of the watershed management program would be to coordinate and integrate human and fiscal contributions to use these resources most effectively. Entities and groups that could be potential Plan implementation partners are listed in Table 5-1. Through the watershed management program, participation of the private sector and other groups and individuals in the basin community would be actively sought.

A critical aspect of these partnerships is their value in helping to coordinate project and program implementation. Virtually all projects involving work in or near surface waters require permits from Washington Department of Fish and Wildlife and the U.S. Army Corps of Engineers who coordinate comments from other affected jurisdictions, such as Renton and the Muckleshoot Indian Tribe, interested groups, and the public. Because permit processes can be slowed by conflicting agency and public comment, the watershed management program could provide a forum for resolving these issues to expedite these processes.

Implementation of many Plan projects could be aided significantly by the technical expertise of the partners and by a host of interest groups such as the Mid-Sound Fisheries Enhancement Group and Trout Unlimited, neighborhood organizations like the Maplewood Homeowners' Association, the private sector, and individuals interested in seeing that the Plan is successfully carried out.

Because the Plan is a complex, multi-year strategy, it will be important to have an effective ongoing mechanism to coordinate actions, respond to new information, and address interagency policy questions about flooding, habitat, and water quality. These issues could include finding ways to achieve greater consistency in administering regulations among agencies; developing better incentives to protect floodplain, habitat, and water quality functions and values; and a suite of other management questions likely to arise from the Masonry Dam Operation Study (MS 1), the Lake Washington Studies (BW 8), the Artificial Salmonid Production Measures (BW 7), and the Basin Plan Evaluation (BW 13).

FUNDING OPTIONS

To help fund implementation, a number of state and federal grant opportunities are available for the flood/safety, habitat enhancement, and water quality projects. While grants are expected to provide most of the funding to implement these projects, the process of securing grants is generally very competitive due to limited agency resources. The Plan funding strategy would use a portion of locally available monies to leverage additional sums from available grant programs.

Federal agencies offering or administering grants primarily for the Plan's flood safety and habitat enhancement projects include the U.S. Army Corps of Engineers, Federal Emergency Management Administration, Environmental Protection Agency, U.S. Fish and Wildlife Service, and the Department of Agriculture. Water quality projects could qualify for grants offered by Washington Department of Ecology and the Environmental Protection Agency. In addition, private foundations could be sources of additional funding. Foundations that could support Plan projects include the Wetlands Conservation Council and National Fish and Wildlife Foundation.

Implementing any regional stormwater facilities developed under BW 18: Urban Stormwater Management Initiative, may require a special financing strategy due to the large scale and high cost of such projects. Because these projects are not expected to be eligible for grants, they are likely to require substantially more local funding than other recommended projects.

A major Plan expenditure is land acquisition, particularly properties targeted for open space (BW 4) and the removal of houses in hazardous areas. Land acquisition costs are based on fee simple purchases, but other approaches could be taken to minimize public expense, while compensating landowners for conserving priority resource lands. Education programs would be provided to landowners who are interested in exploring these possibilities.

Implementation Process: Long-Term Watershed Management

The Plan is a blueprint for action to resolve existing problems and prevent future problems from occurring. Coordinating the partnership network discussed above, bringing the public into the process, evaluating progress, and adjusting priorities and strategies to reflect ongoing experience are all essential to effectively managing implementation actions. These activities can help address the many uncertainties expected such as funding, permit processes, landowner participation, and community commitment. An ongoing watershed management program is proposed to oversee implementation, coordinate the actions and involvement of public and private parties, seek funding, promote public stewardship, and respond flexibly to new information and opportunities. The Cedar River Council (BW 15) and the Basin Steward Program (BW 16) would be central in knitting together the efforts of diverse entities into an effective whole. As implementation progresses, a balance between disciplines (i.e., water quality, flooding, and aquatic habitat) needs to be maintained to assure completion of the plan's multi-objective approach.

RELATIONSHIP OF THE PLAN TO OTHER WATERSHED MANAGEMENT ACTIVITIES

The Cedar River Legacy Program

Under the Cedar River Legacy, the County has begun early implementation of several Plan recommendations. The purpose of the Legacy is to take early action to improve habitat for rapidly declining salmonid populations, participate in gathering information to understand possible links between this decline and the health of Lake Washington, and to begin the community education programs. The actions taken include certain habitat enhancement projects and open space acquisitions, the Lake Washington Studies, hiring of a Basin Steward (BW 16), and establishing the Cedar River Council (BW 15), all of which will continue after Plan adoption and into implementation.

Other Related Watershed Management Activities

Many of the entities who have helped prepare the Plan are also involved in resolving other surface and/or groundwater management issues in the basin. Table 5-2 (shown at the end of this chapter) identifies these issues and the entities involved.

These programs and studies are not specifically addressed in the Plan for several reasons: The Water and Land Resources Division has not been a party to the discussions, it is too early in the process to identify how the Plan could help, or the issue involved may be beyond the scope of the Plan. However, to the extent possible, the Plan attempts to anticipate their resource needs. Since the Plan will have been completed prior to these other efforts, it would be the responsibility of the agencies involved to consider the Plan's goals and objectives in their findings and recommendations. Policy conflicts that may arise between the Plan and these efforts would be addressed by the Cedar River Council.

ROLES OF THE WATERSHED MANAGEMENT PROGRAM

The Cedar River Council would provide several important support functions in Plan implementation. Key among these would be encouraging public, private, and community partnerships to mobilize other human and financial resources to support the Plan projects and programs; fostering public education and stewardship; and providing a forum for the public and implementing partners to coordinate resources and discuss issues. As the forum for discussing basin issues, the Council would also mediate and resolve disputes among competing interests. The Council would incorporate a dispute resolution process within its by-laws. The Council's priority projects would reflect the core recommendations identified in Table 5-1.

The Basin Steward's education and public involvement activities (BW 16) would expand from their current emphasis on habitat in the Legacy Initiative to address the core issues identified in Table 5-1. The Steward would also provide information and technical assistance on water quality and flood-damage reduction techniques to encourage voluntary improvements in land practices and reduce the need for regulatory controls. Special attention would be given to the information needs of landowners in and around proposed capital improvement project sites and to implementing the Small-Scale Watershed Restoration and Enhancement Program (BW 5).

GUIDING DEVELOPMENT THROUGH REGULATION

The King County Department of Development and Environmental Services and the City of Renton Planning/Building/Public Works Department will be the lead agencies in drafting and implementing the Plan regulations adopted for their respective governments. The critical ordinances to establish wetland management areas, control stormwater quality and volumes, and protect channel migration hazard areas are identified in Table 5-1. All proposed ordinances must be approved by the County and/or City Council before implementation.

In the Plan there are seven recommendations that have regulatory components:

- BW 3: Wetland Management Areas
- BW 12: Water Quality Treatment Standards
- BW 19: Retention/Detention Standards
- BW 20: Ravine Protection Standard
- BW 21: Infiltration as a Stormwater Mitigation Treatment
- BW 22: Erosion and Sedimentation Control Standards
- MS 6: Channel Migration Hazard Areas.

CAPITAL IMPROVEMENT PROJECT IMPLEMENTATION

Assuming adequate funding is available, the Core Plan capital improvement projects would be implemented in the order identified in Table 5-2, beginning with capital improvement project (CIP) 3108: Rainbow Bend Flood-Damage Reduction and Habitat Restoration. However, because just the top four priority projects are estimated to cost over $20 million, funding limits will probably dictate deviation from this order.

As previously noted, many other factors can also affect the timing and sequence of project implementation. At a minimum, two years would be needed to obtain funding, prepare permit applications, and complete construction of major capital projects. Most would require work in surface waters where State law limits the "construction window" to a few months of the year to protect salmonids. Many of the projects require work within the 100-year floodplain, within sensitive areas, or within Shorelines of the State. These projects are affected by the Army Corps of Engineers' regulation of both excavation and filling within waters of the United States, including wetlands; and King County's regulation of activities within sensitive areas under the Sensitive Areas Ordinance and the Shoreline Master Program. Approval of these projects can take up to six months, particularly if the approval is first denied and must be appealed. Hence, these projects are phased accordingly. This Plan establishes the ambitious goal of completing the 16 core projects within 10 years. Achievement of this goal is dependent on the availability of funding.

WORKING WITH LANDOWNERS

A pivotal component of successfully implementing the capital improvement projects is establishing a cooperative working relationship with people in the vicinity of the project. The Basin Steward would work closely with property owners and other residents from the project design phase through project construction to ensure they have input in its design and they are informed about project goals and property acquisition process. All reasonable efforts would be made to reach equitable purchase agreements that could also accommodate special landowner needs, such as a desire to live out their life on the property before the County would exercise full use of it.

In cases where landowners were unwilling to sell or where a purchase agreement were delayed enough to jeopardize the project or its funding, the project would be postponed until landowner participation was sufficient to warrant proceeding and new funds were available. Landowners who choose not to sell to the County would not face any penalty or loss of existing benefit as a result of their decision.

Residents of mobile home parks and other affordable housing would be advised about available replacement housing and housing financing opportunities. Park closure plans would be developed to involve owners and tenants in the planning, design, and implementation of recommendations to relocate mobile homes.

EVALUATING PROGRESS AND IMPLEMENTING MANAGEMENT STRATEGY

As implementation of the recommended projects and programs proceeds, it will be necessary for the participating entities and the basin community to determine how well the Plan goals are being met. The Basin Steward would prepare annual reports for the Cedar River Council and the general public. An annual "state of the basin" report (see BW 16) would describe the effectiveness of the Plan projects and programs in reducing flood damage, improving the health of aquatic resources and fish habitat, and maintaining water quality based on field assessments of basin conditions. The report would also identify improvements and new problems in the basin and recommend adjustments in the watershed management program.

Table 5-1 Cedar River Basin Plan Recommendations

No.	Recommendation (In Priority Order)	Issues Addressed	Cost Estimate (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, etc.) see back inside cover for key to acronyms
CORE PLAN CAPITAL IMPROVEMENT PROJECT RECOMMENDATIONS				
3108	Rainbow Bend Flood Damage Reduction/Floodplain Restoration	F/H	$7,200	COE, FEMA, MIT, MSE, TU, WDFW
3102	Dorre Don Flood Damage Reduction/Floodplain Restoration	F/H	$4,900	COE, FEMA, MIT, MSE, TU, WDFW
3140	Maxwell Road SE Flood Abatement and Taylor Creek Restoration	F/H	$850	GMVAC, Immediate Neighborhood, KC Roads, MIT, MSE, TU, WDFW
3111	Elliot Bridge Lower Jones Road Flood Damage Reduction	F/H	$8,700	COE, FEMA, KC Roads, MIT, Renton Public Works, WDFW
3120	Puget Colony Homes Drainage Improvements	F/WQ	$800	KC Roads, MIT, Renton PW, SKCDPH
3127	Retrofit Retention/Detention Ponds	WQ	$500	Renton PW
3150	Wetland 14 and 42 Protection and Restoration	H	$400	WCC, WFFA, Wetland Neighbors
3109	Ricardi Flood Damage Reduction/Floodplain Restoration	F/H	$600	COE, FEMA, MIT, MSE, TU, WDFW
3130	Fairlane Woods Detention Pond Discharge Improvements (Alternate)	F/H	$2	Fairlane Woods Neighborhood, MIT
3107	Byers Bend/Cedar Grove Road Flood Damage Reduction	F/H	$12,400	COE, FEMA, MIT
3122	Maplewood Ravine Stabilization	F/H	$150	Renton PW
3137	Lower Madsen Creek Sediment Pond Outlet Improvements	H/WQ	$10	WDFW, MIT
3103	Dorre Don Court Flood Damage Reduction/Floodplain Restoration	F/H	$800	COE, FEMA
3126	Tributary 0316A and Wetland 32 Restoration	H	$35	DDES, KCD, MIT, MSE, WCC, WDFW, WFFA
3142	Trib 0321 Habitat Enhancement	H/F	$30	GMVAC, Immediate Neighborhood, KCD, MIT, WCC, WFFA
3153	Lower Peterson Creek Habitat Restoration	H	$50	MSE, MIT, WCC, WDFW, WFFA
3141	Taylor Creek Habitat Restoration	H	$45	GMVAC, Immediate Neighborhood, MIT, MSE, WCC, WDFW, WFFA
3134	Molasses Creek LSRA Restoration	H	$35	DDES(lead), KCPA, MIT, MSE, Person Gravel Pit, WDFW
	CORE PLAN CIP SUBTOTAL	**=**	**$37,507**	(K$)

Table 5-1 Cedar River Basin Plan Recommendations Continued

No.	Recommendation (In Priority Order)	Issues Addressed	Cost Estimate (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, etc.) see back inside cover for key to acronyms
NON CORE CAPITAL IMPROVEMENT PROJECT RECOMMENDATIONS				
3136	Upper Madsen Creek Detention and Ravine Stabilization	H/F	$1,000	Cedar River Water and Sewer District, Fairwood Golf &Country Club, Fairwood Homeowners Assn., KCWPC, MIT
3151	Lake Desire Flood Damage Reduction	F	$35	LDCC, MIT
	Lake Desire flood control and water quality projects	F, WQ	$125	LDCC, MIT
3121	Trib 0303A Culvert Replacement and	F	$150	KC Roads, MIT, Renton PW
3104	Lower Bain Road and Royal Arch Flood Damage Reduction/Floodplain Restoration	F/H	$1,950	COE, FEMA, MIT
3112	Maplewood Flood Damage Reduction Alternative	F	$1,500	COE, FEMA, MIT, Renton PW
3135	Wetland 16 Buffer Revegetation	H	$5	MIT, WCC, WFFA, Wetland Neighbors
3106	Jan Road Flood Damage Reduction/Habitat Restoration	F/H	$4,800	COE, FEMA, MIT, MSE, TU, WDFW
3110	Riverbend Mobile Home Park Revetment Modification	H/F	$2,700	COE, FEMA, MIT, MSE, TU, WDFW
3124	Orting Hill Tributary (0307) Realignment	H	$400	KC Roads, Renton PW, MIT
3101	Dorre Don Way SE Elevation (Orchard Grove)	F/H	$200	COE, MIT
3123	Maplewood Golf Course Reach Improvements	F/H	$350	MIT, Renton (Lead)
3152	Peterson Lake Outlet Channel Restoration	H	$30	MIT, SWD, WCC, WFFA, WDFW
3133	Fairwood Park Division 11 Detention Pond	F	$250	Fairwood Home Owners Assn., MIT
3105	Getchman Levee Modifications	F/H	$1,500	COE, FEMA, MIT
3131	Elevation of 140th Ave SE at Wetland 22	F	$150	KC Roads (lead), MIT, Renton
3100	Arcadia/Noble Flood and Erosion Damage Reduction	F/H	$1,200	COE, MIT
3113	Person Revetment Modification	H/F	$800	COE, DDES (lead), FEMA, KCPA, MIT, Renton PW
3160	Wetland 64 Restoration	H	$2	MIT, WCC, Wetland Neighborhood, WFFA
3161	Walsh Lake Diversion Ditch Habitat Improvements	H	$50	MIT, WDFW
3125	Wetland 36 (Francis Lake) Restoration	H	$5	DDES, WCC, WFFA Wetland Area Residents

NON CORE CIP SUBTOTAL = $17,202 (K$)

FULL PLAN CIP TOTAL = $54,709 (K$)

Table 5-1 Cedar River Basin Plan Recommendations Continued

No.	Recommendation	Issues Addressed	One Time Costs (K$)	10 Year Administrative Costs (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, *etc.*) see back inside cover for key to acronyms
CORE PLAN PROGRAMMATIC RECOMMENDATIONS					
BW 3	Wetland Management Areas	H/WQ	N/A	$118	DDES (lead)
BW 4	Priorities for Open Space Acquisitions	H	$13,700	$85	CRWC, KCNRD
BW 5	Small Scale Watershed Restoration and Enhancement	H/WQ		$0	COE, DDES, KCD, MIT, MSE, TU, WCC, WDFW, WFFA
BW 6	Aquatic Resource Mitigation Bank Sites	H	N/A	$296	DDES (lead), CRWC
BW 8	Lake Washington Studies	H/WQ	$500	$66	WDFW (lead), Bellevue, COE, Kirkland, KCWPC, Mercer Island, MIT, Renton PW, TU, USF&WS, UW
BW 9	Improve Water Quality from Roads and Urban Areas	WQ	N/A	$296	KC Roads, KCSWD, Renton PW, SKCDPH, WSDOT
BW 10	On-Site Septic System Pollution	WQ	N/A	$332	SKCDPH (lead), LDCC, Renton PW, SLCC
BW 11	Livestock Keeping Practices	H/WQ	N/A	$118	CES, GMVAC, KCD, KCSWD, MIT
BW 12	Water Quality Treatment Standards	WQ	N/A	$0	DDES (lead), LDCC, Renton PW,
BW 13	Basin Plan Evaluation	H/WQ/F	N/A	$296	MIT, Renton PW, SWD, USGS, WDFW
BW 14	Water Resources Education and Public Involvement	F/H/WQ	N/A	$212	Basin Interest Groups, CRWC, KCSWD, KCWPC, MIT, MSE, SCS, SWD, TU, USGS, WDFW, WCC, WFFA, WSDOE, Private Industry
BW 15	Cedar River Watershed Council	F/H/WQ	N/A	$850	Basin Interest Groups, COE, KCD, KCNRD, MIT, MSE, Private Industry, Renton, SWD, TU, USF&WS, WDFW
BW 16	Basin Steward	F/H/WQ	N/A	$850	COE, CRWC, Community Interest Groups, DDES, KCD, KCNRD, MIT, MSE, Renton, SWD, TU, USF&WS, WDFW, Private Industry
BW 17	Aquifer Protection and Baseflow Maintenance	H/WQ	N/A	$100	Renton and King County (leads), Kent, WSDOE, MIT, USGS, WDFW, SWD
BW 19	Retention/Detention Standards	F/H	N/A	$59	DDES (lead)
BW 23	Forest Incentive Program	H	N/A	$2,124	KCDNR, WSDNR, DDES, WFFA
MS 1	Masonry Dam Operation Study	F/H	N/A	$66	SWD (Lead), COE, MIT, Renton, USF&WS, WDFW
MS 2	Renton Reach Capacity 205 Study	F	N/A	$66	Renton (lead), COE, CRWC, FEMA, MIT, SWD, WDFW, DDES
MS 3	Seek State and Federal Funding for Flood Hazard Reduction Measures Using Local Disaster Assistance Funds	F, WQ	$2,000	$66	COE, CRWC, FEMA, MIT, SWD, WDFW, DDES, WA State Emergency Management

Table 5-1 Cedar River Basin Plan Recommendations Continued

No.	Recommendation	Issues Addressed	One Time Costs (K$)	10 Year Administrative Costs (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, *etc.*) see back inside cover for key to acronyms
MS 4	Mainstem Habitat Restoration and Enhancement	H/F	$10,000	$332	COE, CRWC, FEMA, MIT, SWD, WDFW, DDES
MS 6	Channel Migration Hazard Areas	F	N/A	$37	DDES (lead), FEMA
MS 7	Flood Plain Mapping Analysis, Revision, and Distribution	F/H	$250	$73	COE, DDES, FEMA, Renton PW, SWD, USGS
MS 8	Flood Education	F	$35	$31	KCOEM, KC Roads, Renton PW, SWD
MS 10	Stormwater Quality in Industrial/Commercial Areas	WQ	N/A	$0	Renton (lead), Area Businesses , WSDOE
MS 12	Debris Flow Protection for Mobile Home Park	F	N/A	$37	Mobile Home Park Owner, KCPA
RC 1	Trib. 0338 Low Flow Restoration	H	N/A	$66	KENT
	Groundwater Flooding Analysis--Identify strategies to address both existing and potential groundwater flooding	F, WQ	$500	N/A	KC Roads
RC 3	Rock Creek Community Involvement and Education	H/WQ	N/A	$15	Neighborhood, Tahoma School District

CORE PLAN PROGRAMMATIC ONE TIME COSTS =	**$26,985**	
CORE PLAN PROGRAMMATIC ADMINISTRATIVE COSTS =	**$6,594**	(K$)
CORE PLAN PROGRAMMATIC SUBTOTAL =	**$33,579**	

Table 5-1 Cedar River Basin Plan Recommendations Continued

No.	Recommendation	Issues Addressed	One Time Costs (K$)	10 Year Administrative Costs (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, *etc.*) see back inside cover for key to acronyms
NON-CORE PROGRAMMATIC RECOMMENDATIONS					
BW 1	Remove Qualifying Structures from Hazardous Areas	F/H/WQ	N/A	$118	COE, CRWC, FEMA, DDES, MIT, SWD, WDFW
BW 2	Reduce Less Hazardous Flood Damage	F/H/WQ	N/A	$118	COE, CRWC, FEMA, DDES, MIT, SWD, WDFW
BW 7	Artificial Salmonid Production Measures	H	N/A	$118	COE, MIT, MSE, SWD, TU, USF&WS, WDFW
BW 18	Urban Stormwater Management Initiative	H	N/A	$296	DDES, Renton (leads)
BW 20	Ravine Protection Standard	F/WQ/H	N/A	$0	DDES (lead)
BW 21	Infiltration as a Stormwater Mitigation Treatment	F/WQ/H	N/A	$0	DDES
BW 22	Erosion and Sedimentation Control Standards	F/H/WQ	N/A	$0	DDES (lead)
MS 5	Modify Levees and Revetments	F/H/WQ	N/A	$118	COE, CRWC, FEMA, DDES, MIT, SWD, WDFW
MS 9	NPDES Industrial Stormwater Permits for Boeing Commercial Airplane Group and Renton Municipal Airport	WQ/F	N/A	$0	WSDOE, Renton PW
MS 11	Stormwater Treatment of I-405 and SR-169	WQ		$0	WSDOT (lead), WSDOE, Renton PW
NT 1	Stoneway Concrete Company Stormwater Management			$0	WSDOE
ST 1	Madsen Creek Water Quality	WQ	N/A	$29	KCWPC, KC Roads, Fairwood Golf and Country Club, Fairwood Homeowners Association
PC 1	Lake Desire Outlet Channel	F	N/A	$15	KC Roads, LDCC, WDFW, KCNRD, KCPCR
PC 2	Wetland 42 Reclassification	H	N/A	$0	DDES (lead)
PC 3	Shadow Ridge Drainage Study	WQ/F	N/A	$37	Neighborhood
RC 2	Wetland 92 Reclassification	H/WQ	N/A	$0	DDES (lead)

NON CORE PROGRAMMATIC ONE TIME COSTS =	$0	
NON CORE PROGRAMMATIC ADMINISTRATIVE COSTS =	$850	(K$)
NON CORE PROGRAMMATIC SUBTOTAL =	$850	

FULL PLAN PROGRAMMATIC ONE TIME COSTS =	$26,985	
FULL PLAN PROGRAMMATIC ADMINISTRATIVE COSTS =	$7,443	(K$)
FULL PLAN PROGRAMMATIC TOTAL =	$34,428	

Table 5-1 Cedar River Basin Plan Recommendations Continued

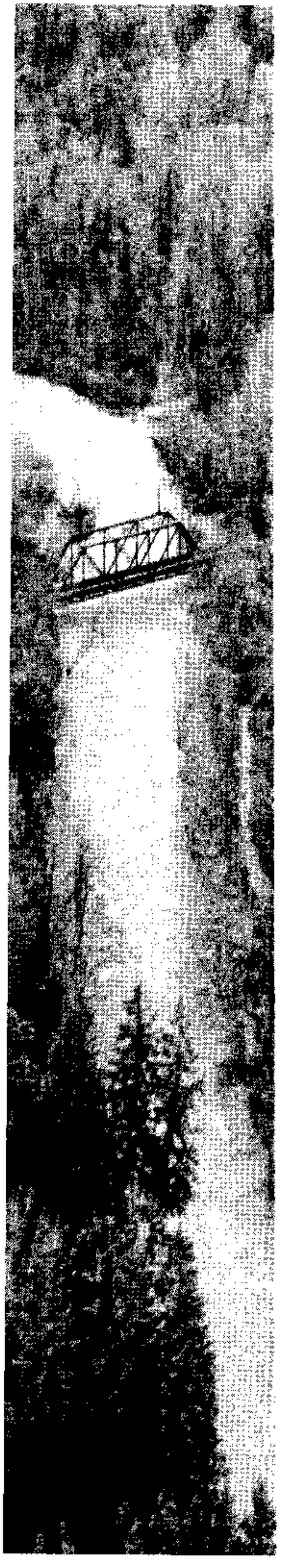
No.	Recommendation	Issues Addressed	One Time Costs (K$)	10 Year Administrative Costs (K$)	Potential SWM Partners (Contributors of Funds, Technical Expertise, Labor, Materials, Equipment, *etc.*) see back inside cover for key to acronyms
COMBINED CIP AND PROGRAMMATIC COST SUMMARY					
		FULL PLAN TOTAL COST =		$89,137	
		CORE PLAN TOTAL COST =		$71,086	(K$)
		NON CORE TOTAL COST =		$18,052	

Table 5-2
Other Surface and Groundwater Management Activities in the Cedar River Basin

Activity	Entities Involved	Purpose
Cedar River/Sammamish Watershed Assessment	WSDOE (lead)	Determine the status of water resources in the watershed to assist in making water rights permit decisions
King County Groundwater Studies	SKCHD (lead), WSDOE, affected water purveyors	Determine potential influences on the quality or quantity of county groundwater supplies and identify protective management strategies
King County Critical Recharge Areas Ordinance	DDES (lead),SKCHD, WSDOE, affected water purveyors	Implement management strategies to protect the quality and quantity of county groundwater supplies
Lower Puget Sound Groundwater Model	USGS (lead)	Develop a computerized model of groundwater movement in the Lower Puget Sound Basin to assist in regional planning and management of groundwater resources.
Petition to list salmon stocks as endangered	NMFS (lead), USF&WS	Determine whether depleted salmon stocks warrant listing under the federal Endangered Species Act
Renton Aquifer Studies	Renton (lead), WSDOE, SKCHD, WLRD	Determine potential influences on the quality or quantity of Renton's sole source aquifer & identify protective management strategies
Upper Cedar Watershed Habitat Conservation Plan	SWD (lead), MIT, WSDOE, USF&WS, WLRD	a. Develop a management plan to meet water supply needs, harvest timber, and protect threatened & endangered species and other wildlife b. Fulfill SWD's mitigation responsibility for the fishery impacts of the Landsburg Diversion c. Determine target low flow volumes to support salmonid spawning needs in the Cedar mainstem
Wellhead Protection Programs	Ecology (lead), WSDPH, affected water purveyors	Prepare management plans for areas contributing to wellheads

Entity Key:

DDES - King County Department of Development and Environmental Services
MIT - Muckleshoot Indian Tribe
NMFS - National Marine Fisheries Service
SKCHD - Seattle-King County Health Department
SWD - Seattle Water Department
WLRD - King County Water and Land Resources Division
WDFW - Washington Department of Fish & Wildlife
WSDOE - Washington Department of Ecology
WSDPH - Washington State Department of Health
USF&WS - US Fish and Wildlife Service
USGS - US Geologic Survey



Appendices

Appendix A: Cedar River Basin Plan Watershed Management Committee Vision, Goals, and Objectives

Appendix B: Addendum to Bedload Transport Analysis

Appendix C: Hydrology and Forest Retention

Appendix D: Significant Resource Area Map, Definitions, and List

Appendix E: Estimation of Salmonid Production Potential and Costs of Fish Habitat Restoration Opportunities in the Lower Cedar River

Appendix F: Bibliography

Appendix A: Cedar River Basin Plan Watershed Management Committee Vision, Goals, and Objectives

Plan Vision Statement

When adopted, the Cedar River Basin and Nonpoint Pollution Action Plan should protect, restore, and enhance, where possible, the natural functions of the river and tributary systems in the Cedar River Basin to promote human health, public safety, and environmental quality through agency/private partnerships that foster community support and ensure long-term benefits for future generations.

Goals and Objectives

Plan Goal: Protect human health and safety while enhancing and restoring the aquatic resources in the tributaries and the mainstem of the Cedar River Basin.

FLOOD DAMAGE REDUCTION

(These goals and objectives include applicable policies adopted in the 1993 King County Flood Hazard Reduction Plan.)

Goal: Achieve an acceptable level of flooding which minimizes threats to human life, occupied structures, and significant aquatic resources, while enhancing aquatic habitat, and returning sediment deposition patterns and flow attenuation capacity of the system to more natural conditions.

Objectives:

FL-1 Utilize the Masonry Dam/Morse Lake project for flood control in the mainstem to the extent feasible, consistent with water supply, hydropower and other operating criteria of the Seattle Water Department;

FL-2 Discourage new development and discourage redevelopment in the floodplain, except where structures within the floodplain are necessary or desirable consistent with policies of the King County Flood Hazard Reduction Plan Executive Proposal (January 1993);

FL-3 Enhance groundwater recharge;

FL-4 Reestablish floodplain areas by relocating flood-prone structures and modifying or removing levees and revetments, and reduce sedimentation in flood-prone areas;

FL-5 Maintain/enlarge culverts to permit passage of peak tributary flows;

FL-6 Maintain and or enhance the natural hydrologic functions of streams and wetlands;

FL-7 Reduce clearing of vegetation and allowable impervious surface areas;

FL-8 Minimize the use of structural drainage controls to situations where non-structural methods are expected to be ineffective;

FL-9 King County should be the lead jurisdiction, with the exception of dam operations, in managing and coordinating services before, during, and after flood emergencies;

FL-10 Establish on-site detention standards to moderate peak flows to the capacity of receiving channels; and

FL-11 Educate the development community and the general public in appropriate techniques for maintaining and enhancing healthy stream and riparian habitat.

EROSION AND SEDIMENTATION

Goal: Reduce increased impacts from human-induced erosion and sedimentation to maximize channel capacity and habitat benefits while achieving more natural sediment deposition patterns.

Objectives:

ES-1 Restore or enhance significant unstable or enlarging stream/river channels and banks to improve habitat and threats to public safety;

ES-2 Restrict site clearing, especially in erosion or landslide prone areas;

ES-3	Reduce increased sediment inputs through the use of erosion control Best Management Practices in land development, forest practices, animal-keeping practices, other land-use activities;
ES-4	Prohibit new development in active channel migration zones to provide adequate flood/sediment conveyance;
ES-5	Encourage groundwater recharge to reduce the erosion potential of overland flows;
ES-6	Attenuate peak flows that destabilize channel conditions;
ES-7	Reestablish or widen riparian vegetative buffers, where needed;
ES-8	Increase the ability of the mainstem and stream channels to absorb erosive peak flow energy and to store and to route sediment;
ES-9	Where sediment deposition is expected, irrespective of improvements in upstream management, establish criteria for maintenance dredging to remove accumulations to restore flood conveyance;
ES-10	Manage steep slope drainage to reduce uncharacteristic landslide conditions;
ES-11	Educate the development community and the general public in soil conservation techniques; and
ES-12	Emphasize the use of minimal intervention techniques such as removal of sediment deposition barriers, vegetative plantings, addition of large woody debris, and other effective and low maintenance techniques.

AQUATIC HABITAT

Goal: Attain and maintain a highly diverse and self-sustaining continuity of aquatic habitats which support all aquatic species and also help support terrestrial wildlife.

Objectives:

AH-1	Protect, preserve, and enhance aquatic and riparian habitat in tributary and mainstem environments to support diverse and self-sustaining fish populations;

AH-2	Increase adult salmon and steelhead populations to maximum production levels allowable by the Lake Washington - Cedar River ecosystem when considering both natural and artificial propagation;
AH-3	Provide fish mitigation/enhancement project proposals that are compatible with fish agency/tribal management goals;
AH-4	Support efforts to restore salmonid populations through habitat restoration, harvest management, and artificial production in a manner that helps insure their long term reproductive fitness;
AH-5	Protect/enhance riparian buffers from further decline through land use measures, regulatory controls, and incentive programs;
AH-6	Improve enforcement of environmental protection regulations;
AH-7	Minimize stream crossings to where such crossings are necessary to ensure adequate fish passage and require mitigation for riparian or stream impacts;
AH-8	Encourage forest practices that protect aquatic systems and attendant wildlife;
AH-9	Protect unique aquatic environments such as bogs, fens, and riverine habitats from development impacts;
AH-10	Remove key fish passage barriers;
AH-11	Reduce the effects of destabilizing flows in tributary and mainstem habitats;
AH-12	Establish development standards that do not permit more runoff, or less groundwater recharge, than under pre-developed conditions;
AH-13	Coordinate with the Department of Ecology and water purveyors in the basin to recommend measures that provide reliable low flows to support successful salmonid spawning, incubation, rearing, and transportation while maintaining adequate water resources for public and private use;
AH-14	Where low flow needs are now, or in the future, insufficient to meet aquatic habitat needs, coordinate with water purveyors in the basin to identify development standards and other measures that encourage groundwater recharge, water conservation, and, if needed, supplementation of or alternative sources of supply;
AH-15	Maintain clean streambed gravels for fish spawning and rearing habitat;

AH-16 Allow for changes that improve fish/habitat management as new information becomes available;

AH-17 Emphasize the use of minimal intervention techniques that work with natural stream processes such as revegetation, addition of large woody debris, and other effective and low maintenance techniques;

AH-18 Utilize land use and/or density controls or other measures to protect and reestablish the basin landscape continuity and the connections among mainstem and tributary floodplain, streams, lake, and wetland habitats as greenways throughout the basin;

AH-19 Encourage the use of greenways for multiple purposes, including floodplain management, ecological benefits, and cultural and public recreational activities;

AH-20 Integrate park, recreation, and trail facilities into greenway plans where uses are compatible;

AH-21 Identify voluntary approaches that encourage priority lands to remain undeveloped;

AH-22 Educate the development community and the general public about appropriate clearing and grading techniques to encourage groundwater recharge, reduce runoff, and enhance habitat;

AH-23 Involve the public in localized resource stewardship projects; and

AH-24 Coordinate with the King County and City of Renton Park and Recreation Plans to identify ways that maximize public access to the aesthetic values and recreation opportunities healthy habitat affords.

WATER QUALITY

Goal: Maintain the quality of surface and groundwater for public health and enjoyment and for the productivity of aquatic habitats.

Objectives:
(Note: see also Erosion and Sedimentation section for objectives to correct erosion problems)

WQ-1 Meet or exceed state water quality standards or other appropriate water quality criteria for beneficial uses;

WQ-2 Remedy poor quality runoff from major roads and commercial and industrial areas through retrofitting Best Management Practices;

WQ-3 Correct septic system failures in high-risk areas through enforcement of regulations to maintain, repair, and/or replace failing or pre-failing systems;

WQ-4 Where corrective action for failing or pre-failing septic systems described in WQ-3 is inadequate resolve area-wide threats in a timely fashion, establish required regular maintenance and inspection programs for septic systems;

WQ-5 Remedy nonpoint source pollution from animal-keeping practices through the use of riparian buffers, fencing livestock from stream, manure management, animal-density limitations, and other appropriate Best Management Practices in coordination with other King County rural policy efforts;

WQ-6 Incorporate water quality controls into retention/detention facilities;

WQ-7 Protect and improve surface and groundwater quality by eliminating the threat of hazardous waste from underground storage tanks and small quantity generators of hazardous wastes;

WQ-8 Prepare an emergency response program for hazardous materials spills;

WQ-9 Enhance riparian vegetation to maximize natural cleansing by increasing contact of stormwater with riparian corridors;

WQ-10 Strictly enforce water quality regulations particularly at major sources that can affect priority resource areas, including Significant Resource Areas and aquifer recharge zones;

WQ-11 Use land use and density regulations to prevent incompatible uses from impacting priority resource areas;

WQ-12 Coordinate with the King County and City of Renton Park and Recreation Plans to identify ways to maximize public access to the aesthetic values and recreation opportunities clean water and healthy habitat afford; and

WQ-13 Educate the development community and the general public in appropriate techniques for maintaining and enhancing water quality.

PLAN IMPLEMENTATION

Goal: A flexible, well-coordinated, implementation program among agencies, public interest groups, the private sector, and the general public, where roles and responsibilities are clearly defined, where costs are equitably distributed among implementing and responsible entities, and where the public is closely involved in the process.

Objectives:

PI-1 Agree on appropriate implementation roles, including a lead entity for all public and private implementing entities;

PI-2 Agree upon the implementation priorities and their implementation schedule;

PI-3 Agree upon an equitable approach to sharing project and program costs;

PI-4 Seek outside sources of funding through grants and other programs means to offset costs;

PI-5 Coordinate measures to protect critical habitat into comprehensive plans in compliance with requirements of the Growth Management Act;

PI-6 Seek multiple objectives in planned projects to provide multiple benefits, including reduced flood damage; improved sediment management; enhancement/protection of aquatic habitat, water quality, water supplies, open space, recreation to increase the utility of projects and their potential funding base;

PI-7 Develop cooperative agreements with implementing entities which specify roles, responsibilities, schedules, and cost-sharing methods to achieve Plan recommendations;

PI-8 Develop a means to regularly monitor implementation to ensure that objectives for water quality, peak flow controls, and aquatic habitat are being met according to schedule; and

PI-9 Specify when the Plan will be reviewed with opportunities for public comment to ensure it is being implemented as intended and to make appropriate changes as new information becomes available.

Appendix B: Addendum to Bedload Transport Analysis

In the Cedar River Current and Future Conditions Report, an analysis of sediment movement along the mainstem Cedar River was made, based on a combination of observed distribution of gravel bars, measured rates of channel infilling, sieved sediment samples, and sediment-transport calculations. Review of those data for this basin plan, however, revealed that the sediment sizes were incorrectly tabulated in the report and these incorrect sizes were subsequently used in the transport calculations. The actual measured sizes, in fact, were systematically 2 times (for subsurface sediment) or 1.4 times (for surface sediment) the values used (Table 1 and Figure 1, "Median Sediment Diameters"). As a result, the calculated bedload transport rates should have been substantially smaller (because any given flow is calculated to be less able to move larger sediment).

Owing to the nature of the Cedar River system and the magnitude of the error, however, the fundamental conclusions of the report are unchanged:

1. The Cedar River is a supply-limited system, in that substantially more coarse sediment could be moved by the river along most of its length than is being currently supplied (by tributaries, landsliding bluffs, and eroding banks). The excess transport capacity is not four-fold, however (as reported in the Conditions Report), but only about two-fold.
2. The ability of the Cedar River to transport bedload sediment declines rapidly in the lowermost two miles of channel above Lake Washington. Interestingly, the predicted average rate of deposition is the same in both the previous and the current analysis—10,000 tons per mile of channel per year (Figure 2, "Predicted Annual Bedload..."). The only significant difference between the two analyses lies in the amount of sediment that could be transported downstream of RM 0.55, were the sediment supply in fact unlimited.
3. The estimated annual quantity of sediment that passes the I-405 bridge across the Cedar River, over 10,000 cubic yards (about 7,000 tons), is unchanged by the revised data. Deposition occurs along the downstream river channel and on the delta at the mouth of the Cedar River.
4. The previously reported disparity between the WLRD and Harza sediment-size data in the lower channel was an artifact of our erroneous tabulation; in fact, despite different investigators at different times collecting at different flow stages, the data are virtually identical (Figure 3, "Renton Reach").
5. The Bagnold sediment-transport equation does not appear to work satisfactorily for the very coarse median grain sizes (over 60 mm) found above RM 7.0 on the Cedar River, substantially underpredicting the likely supply rate in a reach where significant sediment accumulation is in fact not observed. The reason for this problem lies in the dramatic calculated drop-off in transporting capacity below about 2000 cfs (Figure 4, "Bedload Sediment Rating Curves"), reflecting near-threshold conditions for sediment transport predicted by the Bagnold equation but in fact probably not occurring in the river itself.

TABLE B-1 CEDAR RIVER SEDIMENT DATA (REVISED)
Collected September 1992

Station #	River Mile	Surface (diameters (mm))			Subsurface			
		16%	50%	84%	16%	50%	84%	% sample of largest clast
1	0.27	6.2	17.6	28.7	1.4	7.2	9.8	1.4%
2	0.55	4.4	10.7	32.5	0.8	9.4	18.0	1.2%
3	1.0	<2	12.7	27.6	1.4	8.2	18.1	1.2%
4	1.2	6.2	16.6	33.1	1.4	8.2	17.7	1.3%
5	2.2	8.9	34.2	65.4	1.2	18.2	37.0	2.6%
6	4.0	23.9	53.3	120.5				
7	4.4	20.4	48.2	106.4	1.4	13.6	45.3	3.4%
8	4.8	30.5	71.0	122.5				
9	5.9	31.4	72.8	114.3	2.4	23.0	61.7	6.2%
10	6.8	25.9	62.8	155.4	6.6	53.0	90.2	7.3%
11	7.4	50.5	114.8	180.7	8.2	73.0	96.2	6.2%
12	8.9	24.0	56.3	128.4	11.4	72.0	60.1	3.7%
13	11.2	47.4	57.6	86.0				
14	11.5	32.1	70.5	155.7	5.0	60.3	56.2	6.2%
15	13.1	27.6	76.3	140.4	5.4	67.0	83.3	4.3%
16	15.5	24.0	75.5	138.7	5.4	70.6	93.5	5.0%
17	17.0	16.0	49.0	107.0	3.4	41.6	60.7	7.0%
18	18.2	41.2	94.8	203.4	6.2	43.6	68.3	4.8%
19	19.6	24.2	141.4	199.4	4.2	68.6	81.5	12.9%
20	20.1	26.7	88.4	193.2				
21	20.8	24.9	89.2	185.7				

Appendix C: Hydrology and Forest Retention

Technical Note 1: Upland Flooding and Channel Stability

INTRODUCTION

Analysis of the hydrologic benefits of forest cover has motivated the development of incentives for landowners to keep their land in forest uses in the Cedar River Basin Plan.

There are several reasons to preserve forest cover in the basin. Relative to other land covers, forests intercept and evaporate more rainfall, provide more soil storage, retain and trap more sediments, and purify contaminated water. Forests generate smaller storm flows and larger base flows than other land covers. Stormwater detention usually is not required for small-scale rural development even though rural development can produce large increases in storm flows if large percentages of area are converted from forest to grass. Consequently, forest preservation is an effective way to prevent hydrologic disruption from rural areas. For these reasons, the WLRD basin planning program seeks to maintain as much forest cover as possible in lands converted from forest to non-forest uses.

SCOPE OF TECHNICAL NOTE

This technical note focuses on "on-site" runoff and erosion potential of flows discharging from a representative, basin area. It is intended to shed light on localized drainage impacts from a project or collection of projects. As such, it examines only a portion of the suite of impacts (flooding, erosion, base flow, surface and groundwater quantity, and water quality) that forest retention is intended to prevent or partially mitigate. These other impacts are discussed elsewhere. For example, another note, Technical Note 2, "routes" the flow increases discussed in this note **downstream** to estimate erosion impacts of forest retention and clearing in four Cedar River subbasin ravines.

LAND COVER ASSUMPTIONS

The following simulations have been designed to test the hydrologic value of these forest retention prescriptions in the Cedar River basin. The simulations consider several development scenarios of 100 acre tracts of forest on two different soil types, till, and outwash. Undisturbed, forested till soils generally have a relatively porous surface layer that is underlain by glacially compacted material of very low permeability at about two to three feet of depth. Surface runoff is infrequent and relatively low in quantity on undisturbed till soils. These soils predominate in all of the rural subbasins except for Rock Creek where glacial outwash soils are the norm. Outwash soils are typically very porous sand and gravel based soils that hardly ever yield surface runoff in their undisturbed state. The two soil types will be discussed separately at first and then compared. The scenarios considered are as follows:

Symbol	Description
F	All forest (no development) - 100 acres forest
R-65	Rural, 1du/5 acres (20 houses), 65% forest retention - 65 acres forest - 31 acres grass - 4 acres impervious
R-50	Rural 1du/5 acres (20 houses), 50% forest retention. - 50 acres forest - 46 acres grass - 4 acres impervious
R-30	Rural 1du/5 acres (20 houses), 30% forest retention. - 30 acres forest - 66 acres grass - 4 acres impervious

Each of these scenarios was run for both till and outwash soils using hydrologic parameters determined from subbasin model calibrations using in-basin stream flow and rainfall data.

The "F" (all forest) scenario is a base case for comparison of the other development scenarios. The "R" rural options illustrate a range of impacts that depend upon the amount of forest cover remaining.

The runoff from these scenarios was modeled using HSPF (Hydrologic Simulation Program - FORTRAN). This model is a nationally and internationally accepted watershed modeling tool that has been used extensively for surface water design, planning, and management by numerous local and regional agencies and companies over the last decade.

SOIL PARAMETER ASSUMPTIONS

The till simulations were conducted with two sets of calibration parameters reflecting both low and high of till-soil infiltration rates determined through hydrologic model calibration of seven tributary streams within in the lower Cedar River basin. The use of two different sets of infiltration parameters reflects variations noted using field rainfall and stream flow data. Till soils are the dominant soils in almost all tributary subbasins in the Basin Planning Area. Only one set of parameters was used for outwash soil because Cedar River subbasin calibrations did not evidence significant hydrologic variations among soils mapped as outwash. Only in Rock

Creek subbasin do outwash soils predominate. Grass cover represents a hydrologic land use category that includes lawns, pastures, and other vegetated surfaces where forest cover has been significantly disturbed by some combination of clearing, grubbing, grading and replanting with non-forest vegetation.

RAINFALL TIME SERIES ASSUMPTIONS

A 43-year period of runoff was simulated using 15-minute time increments. The 15-minute precipitation totals were derived from long term, hourly records of the NOAA gage at Landsburg. The 15-minute variations in rainfall were generated using distributions of seasonal patterns derived from shorter-term King County rain gage records. A 15-minute record was considered necessary in a peak flow analysis to correctly simulate upland channels where storm flows hydraulically concentrate over relatively short time periods. Landsburg rainfall amounts were reduced by 10% to reflect average observed precipitation conditions in the rural portion of the Cedar Basin Planning Area.

METHOD OF COMPARISON AND ACCURACY OF RESULTS

The scenarios were compared with respect to peak annual flow frequencies determined by fitting simulated annual peaks to a Log-Pearson III distribution using a Weibell plotting position as recommended by WRC Bulletin 17-B. In addition, the ratio of each scenario's 2-year peak discharge to the 100%-forested 10-year peak discharge was used as an indicator of channel stability.

Calibration and validation model runs indicate that the HSPF subbasin models calculate peak flows that are generally within 10% of measured peak flows near subbasin outlets. These results suggest that the model is a suitable and sufficiently accurate tool for the comparative flood frequency analysis presented in this note.

BENEFITS OF FOREST RETENTION ON TILL SOIL

Figures 1 and 2 show the peak flood flows for various recurrence intervals for each scenario. Peak flows increase as the amount of forest conversion increases. Without active detention or infiltration efforts, any and all development increases peak flows. Past studies by WLRD indicate that, from a stream erosion and channel modification standpoint, the threshold level for hydrologic change may be the recurrence of the 10-year forested flow every 2 years in the post-developed state. When the pre-development, 10-year flow occurs more commonly than every two years, the stream falls apart. The channel is scoured, habitat is degraded, and incision occurs. Without mitigation, this threshold is matched by rural development that clears between 35% and 50% depending on the till soil characteristics. With regard to this threshold, the F-65 scenario is marginally effective for tills with high runoff potential, and sufficient for tills of low runoff potential. Scenarios with lower amounts of forest cover generally lead to unstable conditions.

All clearing scenarios cause increases in peak annual flows to some degree. For example, even with 65% forest (R-65), peak annual flows tend to increase by about 40% for till soils with low runoff potential and by 80% for till soils with high runoff potential. Corresponding increases for the other scenarios are 64% and 119% for the R-50, and 100% and 173% for the R-30 scenarios.

BENEFITS OF FOREST RETENTION ON OUTWASH SOILS

Peak flows generated by porous outwash soils are consistently smaller than peaks from less permeable till soils with equal levels of development. However, percentage increases in peaks caused by forest conversion are much greater on outwash than on till soils. For example, the average increase in flood flows across all return periods is 214% for the R-65 scenario and increases to 400% for the R-30 scenario. At a subbasin scale where both types of soil may be present, development on outwash soils is more benign from the point of view of peak flows and channel erosion because downstream flooding is determined by absolute flow quantities. Increases in these flow quantities should be minimized, and this might suggest that development on outwash soils would be preferred if peaks flows were the controlling concern. At the local scale, however, development on outwash may be more destructive, especially in headwater areas where channels begin. Here, a channel in outwash may be sized for a 3 cfs two-year flow, and may not be capable of handling a tripling of that two-year flow. On the other hand, retention-detention ponds in outwash soils are aided by the high infiltration capacities of these soils.

The local problems of development on outwash soils are clearly illustrated by Figure 3. Each of the development scenarios causes large percentage increases in flows relative to the forested condition. Considering flow increases on a percentage basis, all development scenarios on outwash without detention significantly increase local flows. There is no reasonable development scenario in which the post-developed 2-year flow does not grossly exceed the forested 10-year flow. This is because forested outwash soils do not produce any sharp runoff peaks in response to even large rainstorms. Forested outwash soils produce base (subsurface) flows all year round; rainstorms merely elevate the level of the base flows.

While forest retention on outwash soils reduces runoff, no amount of forest retention will contain hydrologic change within the threshold discussed above. This would be of concern in a headwater channel (first order channel) located in outwash. When channels begin in outwash, development must include active detention or infiltration to protect the channels. Additionally, the relatively rapid infiltration and lateral transmission of water and contaminants in outwash soils suggests that protection of shallow water supply wells would be enhanced by the preservation of forest cover.

CONCLUSIONS

1. On till soils, annual flood peaks increase by from 17% to 27% of their forest values for each additional 10% of forest conversion to grass cover. The range of increase reflects the variation in till soil hydrologic characteristics noted in the Cedar River basin.

2. Increases in peak flows on outwash soils are much greater than for till soils. Peak flows increase by 53% of their forested value for each additional 10% of forest conversion to grass.
3. 65% forest retention is effective in maintaining stability of upland channels over the hydrologic range of till soils in Cedar River basin.
4. 65% forest retention reduces annual peak flows significantly on outwash soils, but does not prevent the head end of first order channels from exceeding the channel stability limit. Protection of channel stability by forest cover in outwash areas is expected to improve at larger, subbasin scales because of mixing of flows from till areas and dampening by channel routing.

Figure 1. FLOW BENEFITS OF FOREST PROTECTION
100-acre till soil site, high runoff

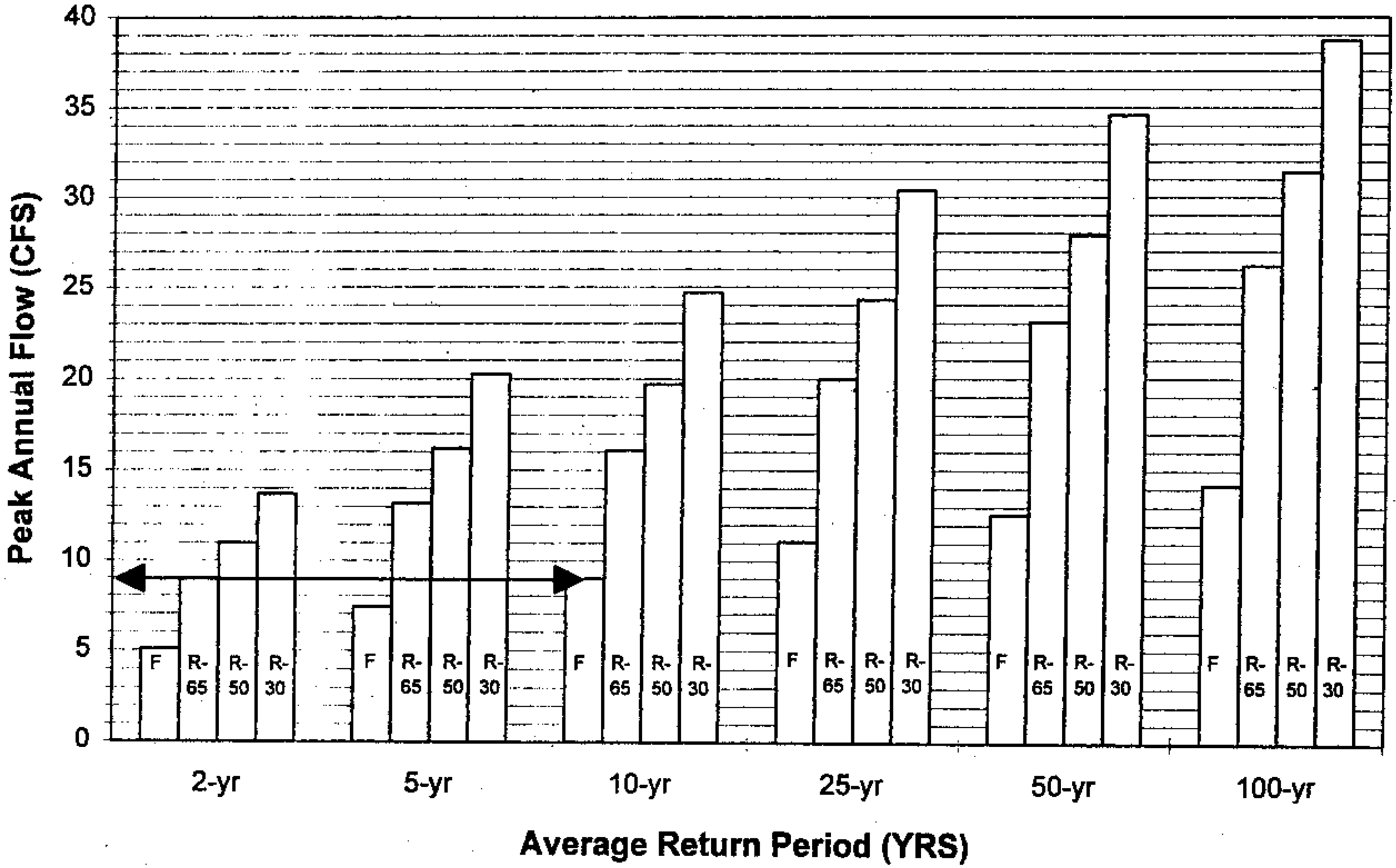


Figure 2. FLOW BENEFITS OF FOREST PROTECTION
100-acre till soil site, low runoff

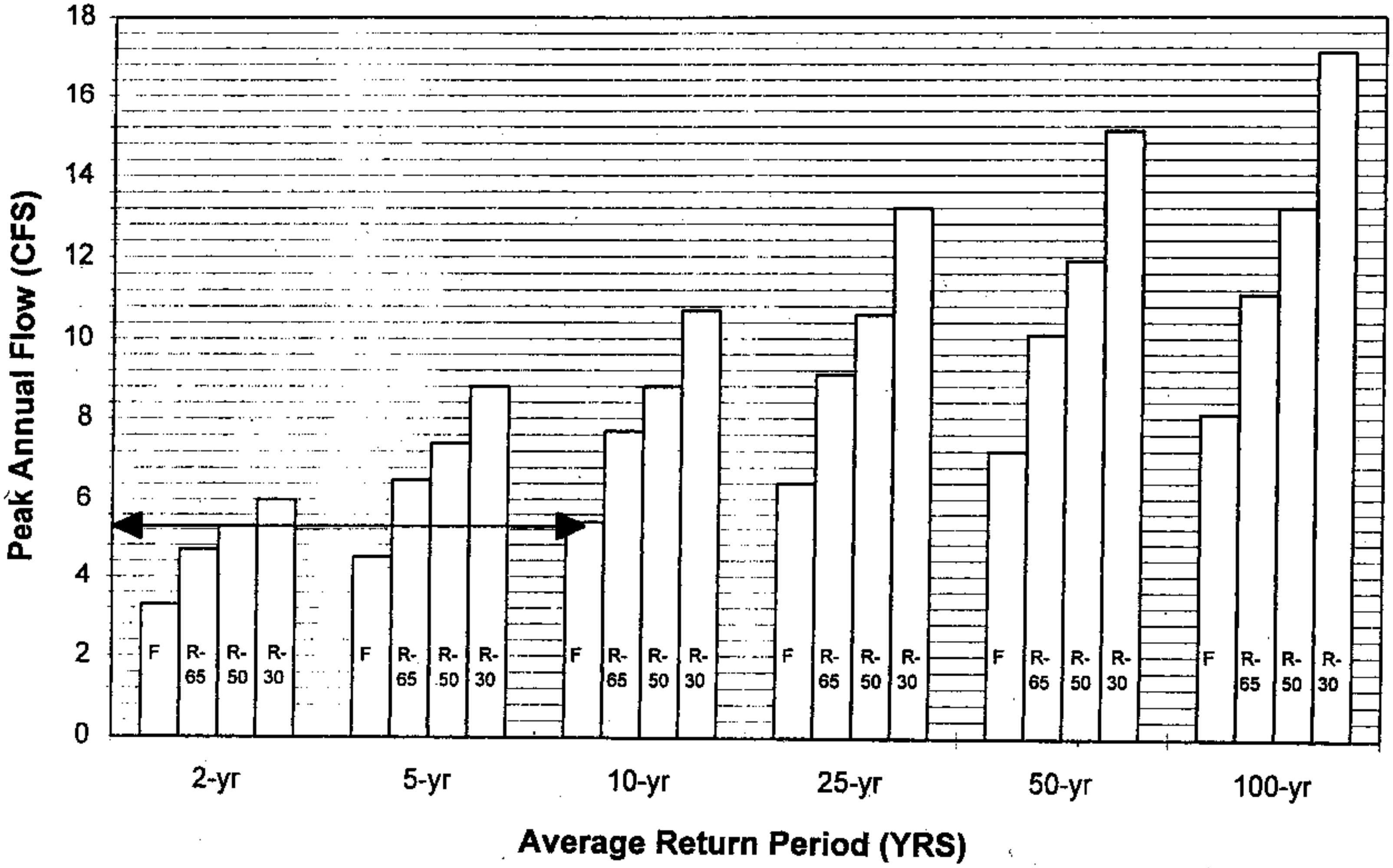
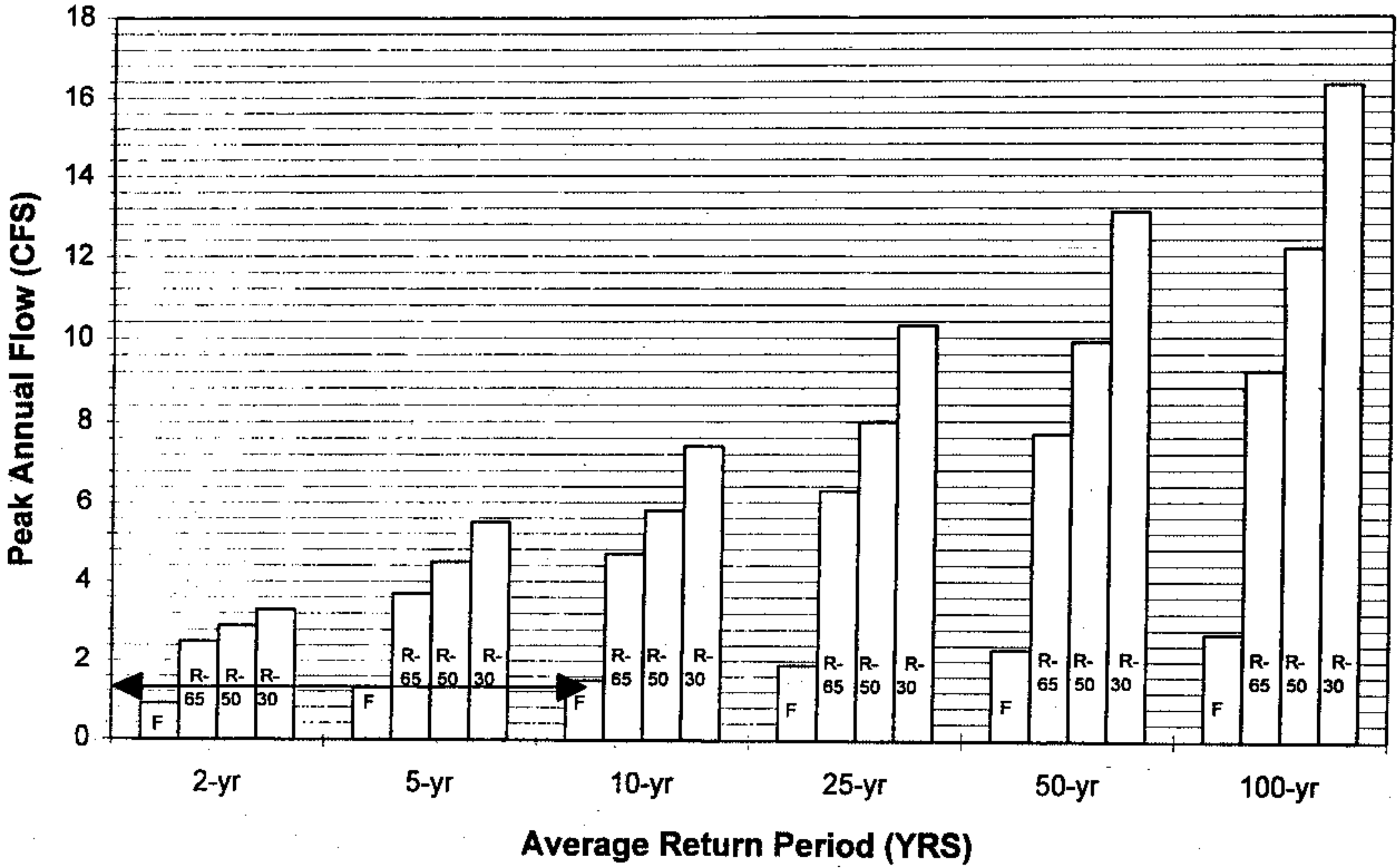


Figure 3. FLOW BENEFITS OF FOREST PROTECTION
100-acre outwash soil site



Technical Note 2: Downstream Analysis
Peterson, Rock, and Taylor Creek Ravines

INTRODUCTION

Technical Note 1 discussed the hydrologic characteristics of typical 100-acre upland sites in the Cedar River basin planning area. This section analyzes the hydrologic impact of different development scenarios on specific rural subbasins and focuses attention on hydrologic changes in ravines near the subbasin outlets. Thus, the effects of different land use scenarios are tracked or "routed" through specific subbasin drainage systems to downstream "points of interest"—the ravine reaches of Taylor Creek, Peterson Creek, and Rock Creek.

LAND COVER ASSUMPTIONS

For each subbasin five different scenarios were modeled reflecting different levels of forest clearing and development. The assumptions and conditions underlying each scenario are as follows:

> **Forest:** This scenario is used as a base case. Cover is assumed to be strictly forests and wetlands with no grass or impervious area. For simplicity, channel networks and routing elements are assumed to be the same as those observed in the field under current conditions.
>
> **1992:** This scenario reflects land cover and development conditions determined from analysis of 1992 air photos. As of 1992, approximately 30% of Taylor Creek was cleared of forest cover, 15% of Peterson Creek, and 8% of Rock Creek subbasins.
>
> **2012-65:** This scenario is based on the Comprehensive Plan projections of population and household increases by the year 2012 in the rural portions of the Soos Creek and Tahoma Raven Heights Community Planning Areas. In this scenario the number of rural households are assumed to be proportional to the rural residential area in each subbasin. On this basis, Taylor Creek is projected to accommodate 46 new households, Peterson Creek 54, and Rock Creek 96 by the year 2012. Each household is assumed to locate on a 5 acre lot consistent with predominant zoning. This scenario represents a 2012 projection with 65 % forest protection. Newly developed land is assumed to be 65% forested, 31% grass, and 4% impervious. No additional forest clearing or forest restoration on existing developed lots is projected. As a result of these assumptions, subbasin clearing increases by less than 5% in each subbasin.
>
> **2012:** This is the same as the 2012-65 scenario except that zero residual forest is assumed on new lots. Therefore they are assumed to be 4% impervious and 96% grass. This scenario results in increases in basin clearing of approximately 5% over the 2012-65 scenario.

BO-65: This scenario assumes full buildout as allowed by current zoning with retention of a total of 65% of forest cover existing in rural residential zones as of 1992. No restoration of land areas converted prior to 1992 is included. Forest production zones are assumed to remain forested. Rural development is assumed to include 4% impervious area on average.

BO-SAO: This scenario reflects buildout as allowed by current zoning with no forest protection except as provided by the SAO. Also, as in the BO-65 scenario, land zoned as forest production is assumed to remain forested.

Land converted to rural residential use is assumed to include 4% impervious area. This scenario results in nearly total (90%) clearing of the Taylor Creek which includes only small amounts of SAO constrained lands and no forest production zoning. In contrast, buildout in Rock Creek results in only slightly over 50% total clearing. Buildout in Peterson Creek subbasin results in nearly 65% subbasin clearing. Although the subbasin contains no forest production lands, total clearing is not as high as Taylor Creek because of lakes, wetlands, and County open space that will remain forested.

Note that both year 2012 scenarios include the same amount of total impervious area and only differ in the amount of total forest converted to non-forest (grass) cover. This is also true of the two buildout scenarios.

MODELING ASSUMPTIONS

The hydrologic simulations utilized the calibrated HSPF subbasin models that are based on rainfall and runoff data for each creek and reflect mapped drainage, topography, and soils conditions. Hydrologic parameters that are specific to each subbasin were estimated during model calibration. Continuous model runs were conducted on an hourly time step using 43 years hourly precipitation data from the NOAA gage at Landsburg. Correction factors were applied to the Landsburg hourly gage totals based on correlation and regression with short term King County precipitation gages. Non-rural development was minimal in these predominantly rural subbasins. Any non-rural development projected to occur in the subbasins was assumed to be fully mitigated and was therefore not represented in the simulations. Therefore results reflect only the impact of rural, residential development as described above.

COMPARISON METHOD

Point of Interest: Subbasin streamflows in ravine reaches of each tributary subbasin were the focus of the analysis. Ravine reaches are steep portions of the stream system that carry stream flow down the valley wall of the Cedar River. Taylor Creek has two such ravine sections on separate creek branches near the outlets of catchment T2 and T5. Each of these was modeled and analyzed separately. Peterson Creek and Rock Creek ravine flows were analyzed at outlets of catchment P1 and R1 respectively. Ravines were chosen as focal points because they are generally near subbasin outlets and reflect aggregate impacts of all upstream changes. As such they represent a contrasting 'whole subbasin' evaluation of management actions to upland analysis that is more indicative of local impacts of land development. Additionally, ravines are steep reaches where channel incision and erosion problems may first begin and subsequently propagate upstream.

Relative Stream Erosivity: The erosive potential of flows at each location was computed using the concept of threshold discharges. Threshold discharges are flow levels that are large enough to move streambed sediment and therefore begin the process of channel scour and downstream sedimentation. In subbasins dominated by lower permeability, till soil geology such as Taylor and Peterson Creek this flow is estimated to be approximately 50% of the forested 2-year discharge at the location of interest. In porous, outwash soil-dominated subbasins such as Rock Creek, forested flows are dominated by groundwater discharge and 50% of the 2-year flow occurs much too frequently (more than 10% of the time in an average year) to be a threshold discharge. For Rock Creek, 100% of the forested 2-year flow was used as the threshold. The actual amount of erosion caused by effective discharges (ones larger than the threshold discharge) is a function of the magnitude of the flow multiplied by the amount of time it persists. The sum of all these products over a simulation period represents the amount of erosive work that the stream channel experiences. In this analysis each of these sums was normalized by the sum resulting for 100% forested conditions and plotted on a potential erosion graph with the corresponding percentage of subbasin clearing. The resulting curves provide a means of assessing the relationship of estimated ravine erosion to total upstream clearing for each particular subbasin ravine that also accounts for the particular hydrologic and hydraulic characteristics of each subbasin such as precipitation, soils, and drainage network features.

In addition to plotting the variation of ravine erosion as a function of total upstream forest conversion, an analysis was made to determine the amount of rural development that would cause accelerated destabilization of the ravines. As mentioned in the upland analysis this is estimated to occur when the 2-year return period discharge equals or exceeds the forested 10-year discharge. This line is plotted as a thick vertical line on the potential erosion graphs (Figures 1 through 4).

RESULTS OF ANALYSIS

Results of simulation and analysis are shown in Figures 1 through 4. On each figure a vertical line is plotted to show at what point in subbasin clearing and development 2-year flow equals the forested 10-year flow and severe channel instability occurs. This line estimates the point at which land-use-induced incremental damage as represented by relative erosivity values greater than 1.0 accelerates to cause severe channel destabilization and degradation. Discussion of each subbasin ravine follows:

Western branch (catchment T5) of Taylor Creek. The average rate of increase of channel erosion is approximately 13% for every 10% of the basin cleared for low-density development. As of 1992, erosive potential was approximately 20% greater than under fully forested conditions. 2012 scenarios increase potential erosion by 2% to 8% depending on the amount of forest retained. At buildout with 65% forest retention, relative erosivity has increased by 40% compared with 1992 conditions; however, the ravine remains on the stable side of the severe instability line. In the absence of forest retention, relative erosivity increases by 94% compared to 1992, and the system becomes unstable.

Eastern branch (catchment T2) of Taylor Creek. The average rate of increase of channel erosion is approximately 16% for every 10% of the basin cleared for low-density development. As of 1992, erosive potential was approximately 46% greater than under fully forested conditions. 2012 scenarios increase potential erosion by 5% to 15% depending on the amount of forest retained. At buildout with 65% forest retention, relative erosivity has increased by 30% compared with 1992 conditions; however, as in the case of the western branch, eastern ravine remains on the stable side of the severe instability line. In the absence of forest retention, relative erosivity increases by 95% compared to 1992, and the system becomes unstable.

Peterson Creek below Peterson Lake (catchment P1). The average rate of increase of channel erosion is approximately 12% for every 10% of the basin cleared for low-density development. As of 1992, erosive potential was approximately 25% greater than under fully forested conditions. 2012 scenarios increase potential erosion by 4% to 12% depending on the amount of forest retained. At buildout with 65% forest retention, relative erosivity has increased by 20% compared with 1992 conditions. In the absence of forest retention, relative erosivity increases by 64% compared to 1992, but the system does not go into accelerated instability. These stability results contrast with the Taylor Creek ravines because increases in peak flows are attenuated by four lakes upstream of the ravine. Ravine destabilization evidently is not a problem in the Peterson Creek system. However, erosion and sedimentation of both upstream lakes and the ravine reach in P1 would be expected. In the latter case, sedimentation would result from the delivery of eroded material from several steep side channels that enter the north side of Peterson Creek below Peterson Lake and receive no significant attenuation. The estimated stability point of these channels is also indicated on Figure 4. Upstream sediment delivery with associated nutrient loading is also recognized as a current problem in the Lake Desire catchment.

Rock Creek Ravine (catchment R1). The average rate of increase of channel erosion is approximately 10% for every 10% of the basin cleared for low-density development. As of 1992, erosive potential was only 7% greater than under fully forested conditions because little forest conversion had occurred within the basin. The 2012 scenarios increase potential erosion by 2% to 5% depending on the amount of forest retained. At buildout with 65% forest retention, relative erosivity has increased by 17% compared with 1992 conditions. In the absence of forest retention at buildout, it increases by 42% above the 1992 level and the system is predicted to become unstable. However, in contrast to the Taylor Creek ravines, the instability limit occurs at slightly less than 40% basin clearing as opposed to around 60%. This results from apparent susceptibility of the outwash soils in the Rock Creek basin to flow increases as described in the upland analysis. The future hydrologic regime of Rock Creek benefits significantly from forest production zoning that maintains long-term forest cover.

CONCLUSIONS

1. Peak flows increase progressively with forest conversion to low density residential uses causing between 10% and 16% increases in channel erosion and downstream sedimentation for every 10% of basin clearing.

2. The percentage of clearing that causes ravine instability depends on subbasin drainage and soils characteristics. In Taylor Creek it appears to occur at approximately 60% of upstream clearing. In Peterson Lake it is much higher (87%) because of hydrologic buffering by lakes. In Rock Creek, it is much lower (39%) because of the hydrologic characteristics of outwash soils.
3. Simulations based on Comprehensive Plan assumptions of rural household growth by the year 2012 result in relatively small amounts of subbasin clearing and erosion and sedimentation impacts to subbasin ravines.
4. Results for buildout scenarios suggest that 65% forest retention will allow incremental increases in erosion and sedimentation, but will also maintain stable channel conditions in the ravines of all three subbasins. In both the Taylor Creek and Rock Creek ravines, buildout results in unstable conditions in the absence of forest retention.
5. The Peterson Creek ravine is protected from hydraulically induced instability by peak flow attenuation in upstream lakes. However, incremental increases in ravine erosion still occur, and the ravine is projected to receive large increases in sediment loading from steep side channels in the P1 catchment. In addition, upstream lakes may be at risk from sedimentation and pollutant loadings even though the ravine is partially protected by their presence.

FIGURE 1. EROSION POTENTIAL IN TAYLOR CK RAVINE
CATCHMENT T5 OUTLET

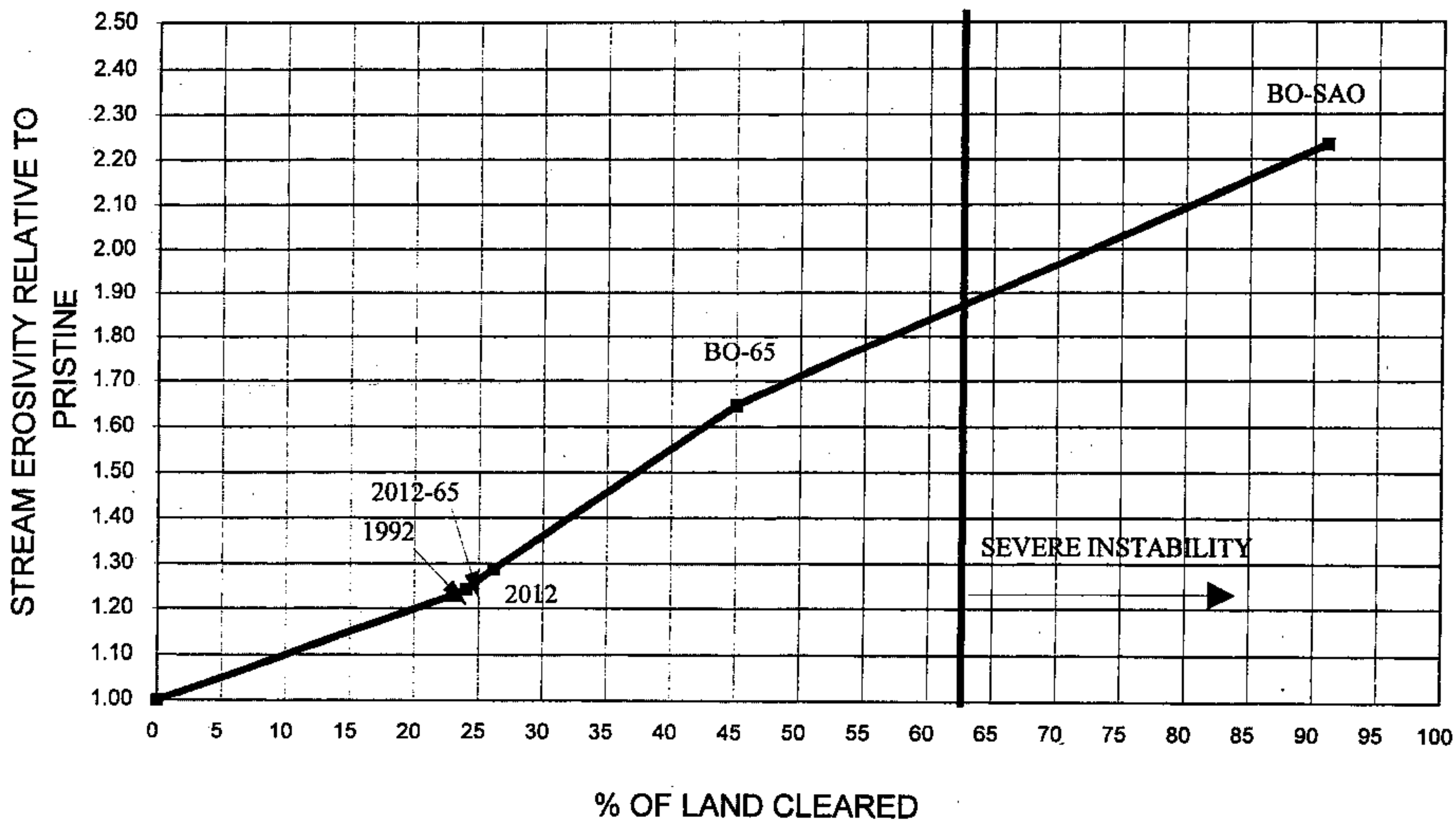


FIGURE 2. EROSION POTENTIAL IN TAYLOR CK RAVINE CATCHMENT T2 OUTLET

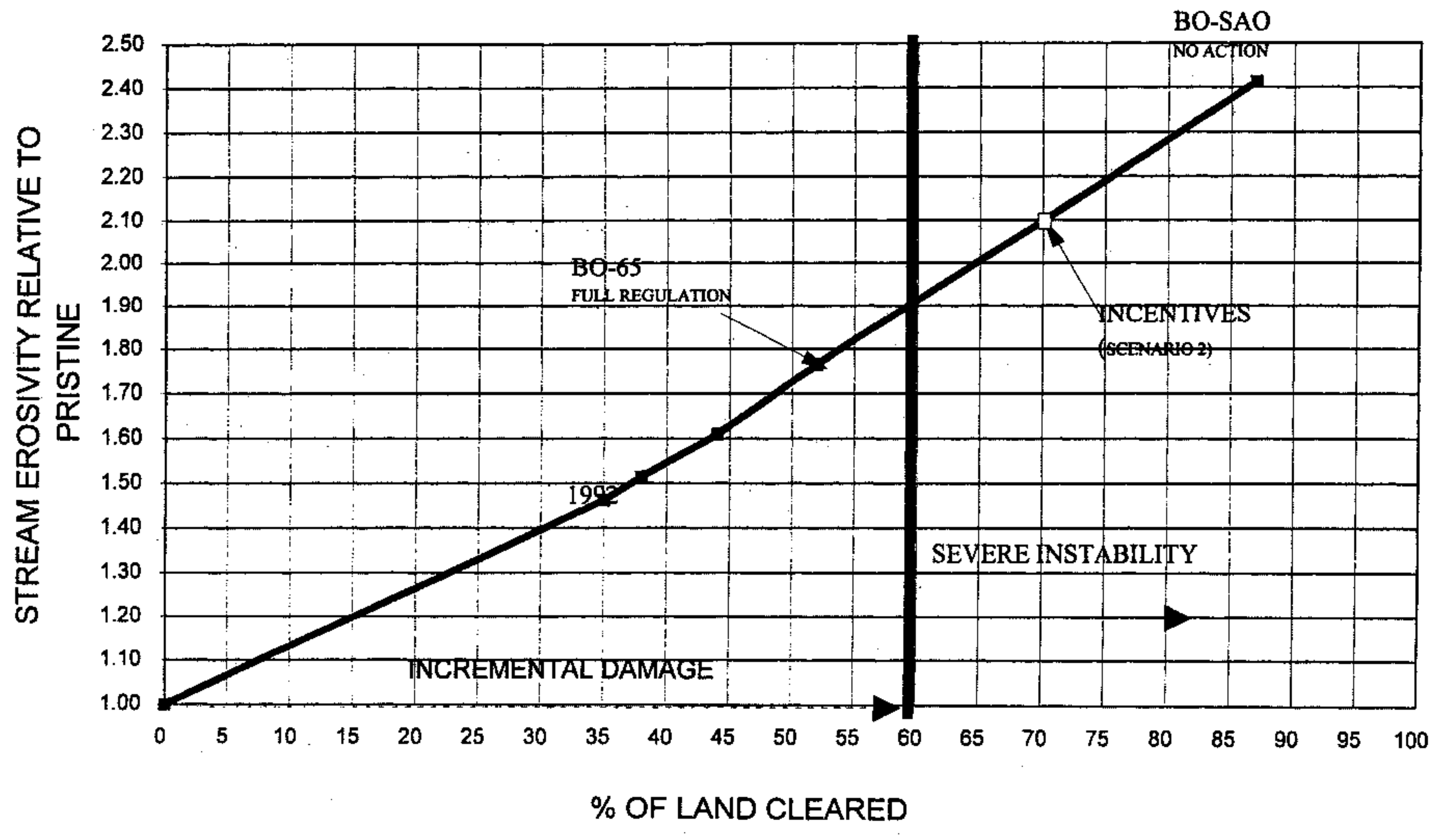


FIGURE 3. EROSION POTENTIAL OF FLOWS DOWNSTREAM OF PETERSON LAKE

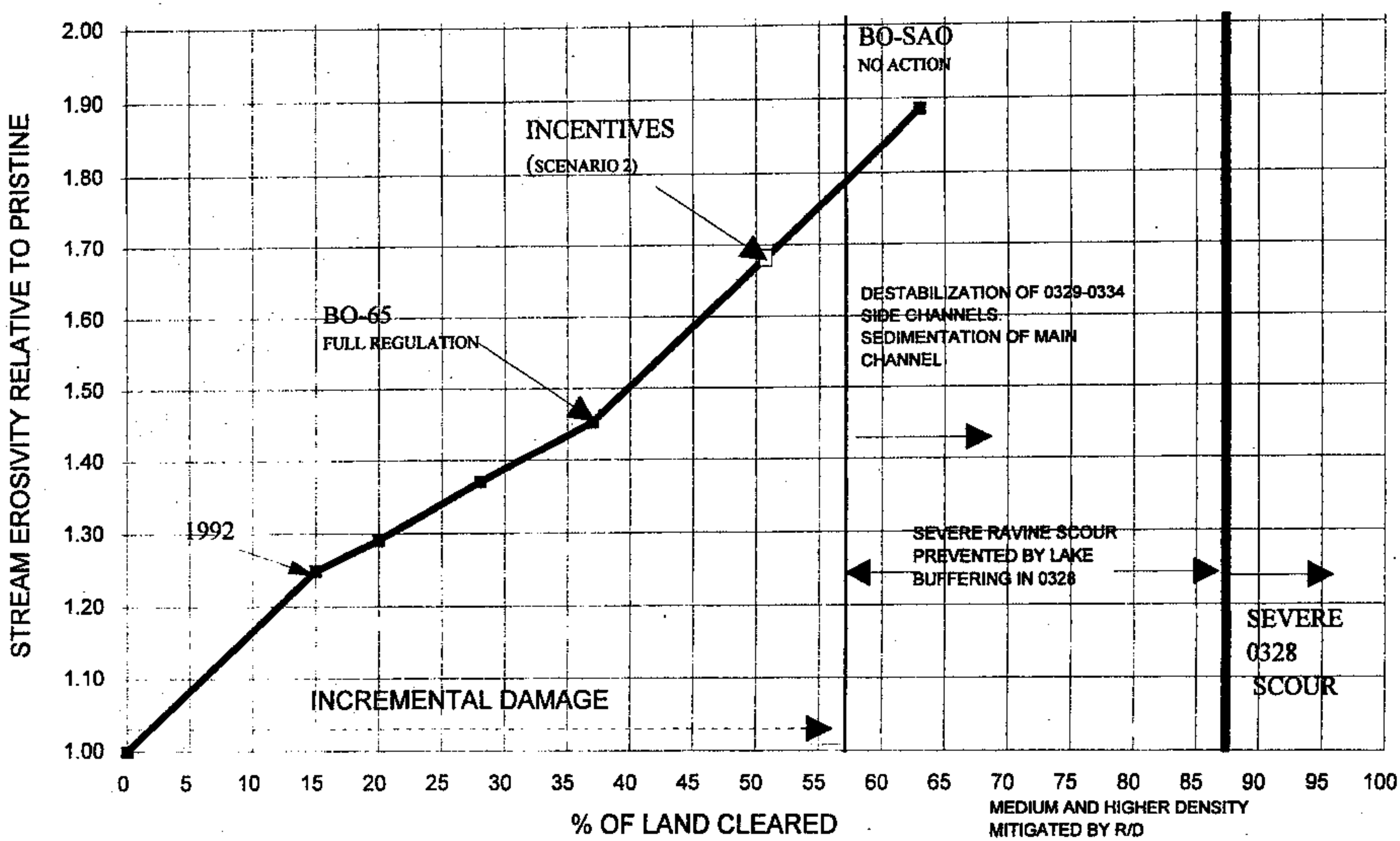
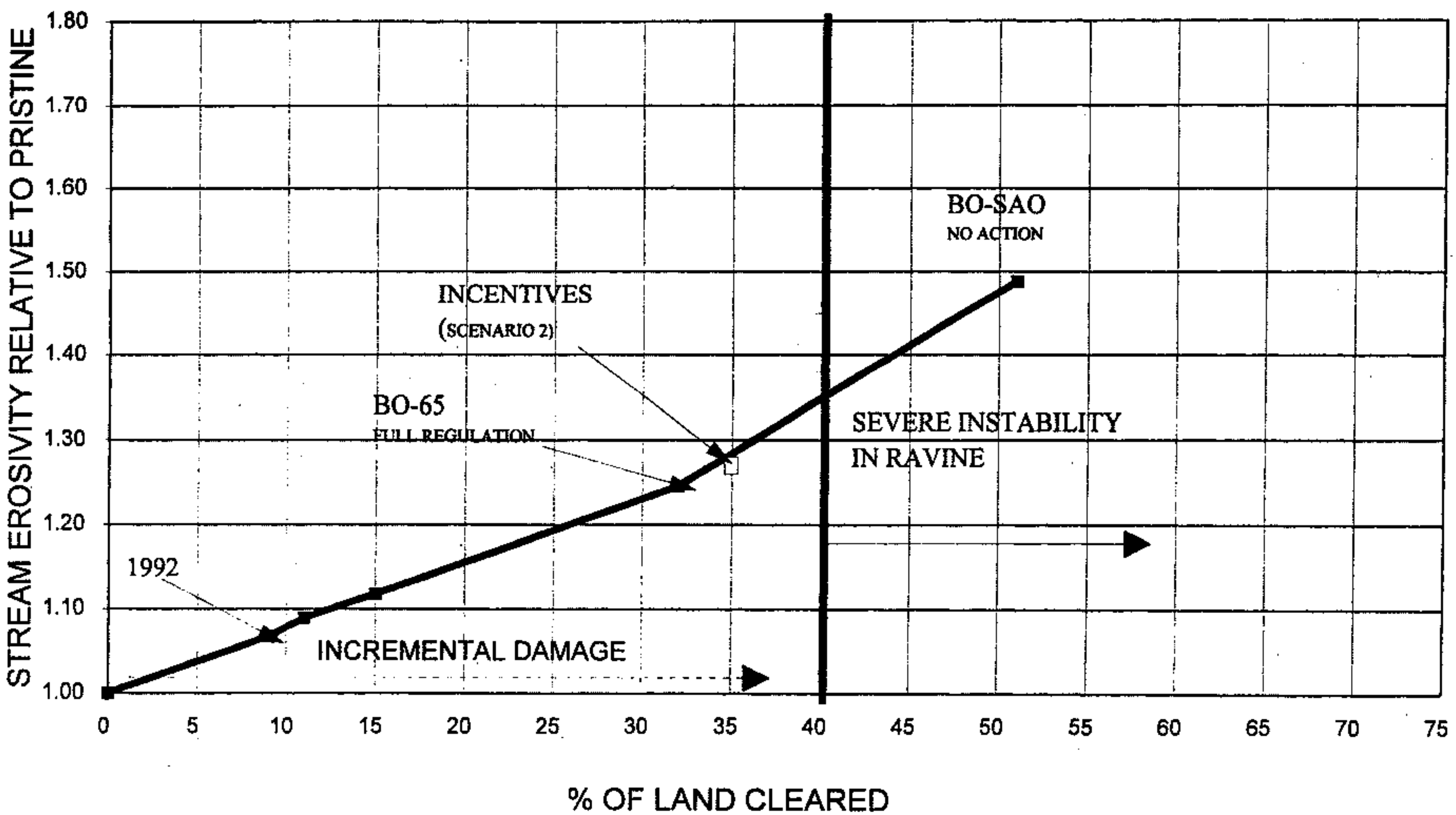


FIGURE 4. EROSION POTENTIAL IN LOWER ROCK CK



Appendix D: Significant Resource Area Map, Definitions, and List

Definitions

Regionally Significant Resource Areas (RSRAs) contribute to the resource base of the entire southern Puget Sound region by virtue of exceptional species and habitat diversity and abundance, when compared to aquatic and terrestrial systems of similar size and structure elsewhere in the region. RSRAs may also support rare, threatened, or endangered species or communities.

Although typically found together, any of the following criteria are sufficient to recognize RSRAs in the watersheds of King County:

1. Watershed functions are not appreciably altered from predevelopment conditions as measured by corridor integrity, hydrologic regime, sediment movement, and water quality.
2. The diversity and abundance of aquatic or terrestrial habitats are of consistently high quality and are well dispersed throughout the system.
3. Aquatic and terrestrial life, particularly salmonids, exhibit abundance and diversity consistent with undisturbed habitats, and they make a significant contribution to the regional resources of Puget Sound.

Locally Significant Resource Areas (LSRAs) also contribute to the resource base of the region but at a lower level of both abundance and diversity compared to RSRAs. LSRAs are, however, significant within a particular basin, providing habitat that is important for plants and animals.

Because aquatic systems require adequate functioning of all elements to contribute significantly to system productivity, all of the following criteria are necessary to recognize LSRAs in the watersheds of King County:

1. Watershed functions have been altered from clearing and filling, but corridor integrity, hydrologic regime, sediment movement, and water quality are adequate for spawning and rearing of salmonids or for maintenance of other plant and animal species; **and**
2. The diversity and abundance of aquatic and riparian habitats are good but not exceptional; instability, damage, and stream alterations are evident but confined to localized sites; **and**
3. Aquatic and terrestrial life, particularly salmonids, are supported at one or more species and life stages at population levels that may be low but are sustainable.

Significant Resource Areas (SRAs)

Areas identified as RSRAs and LSRAs in the Cedar River Basin below the Landsburg Diversion Dam are listed below. These RSRAs and LSRAs were identified in the *Cedar River Current and Future Conditions Report* (1993). Cedar River mainstem habitat from the mouth to the Landsburg Dam (RM 0.0 to RM 21.7) contributes to the river's status as a fishery resource of regional significance. However, it is withheld from this list pending a designation by the WMC that reflects both its productivity and highly managed state.

Tributary Reaches

RSRA
Rock Creek (Tributary 0338): RM 0.0 to 2.5
Peterson Creek (Tributary 0328): RM 0.0 to 2.6 (part of RSRA Wetlands 28, 42)
Peterson Creek (Tributary 0328B): RM 0.0 to 2.2 (part of RSRA Wetlands 14, 15, 28)
Taylor Creek (Tributary 0321): RM 0.2 to 0.8

LSRA
Maplewood Creek (Tributary 0302): RM 0.5 to 1.1
Maplewood Creek (Tributary 0303): RM 0.0 to 0.2
Molasses Creek (Tributary 0304): RM 0.2 to 0.8
Madsen Creek (Tributary 0305): RM 0.8 to 2.15
Madsen Creek (Tributary 0306): RM 0.0 to 0.25
Tributary 0316: RM 0.0 to 0.3 (part of LSRA Wetland 105)
Tributary 0316A: RM 0.0 to 0.45
Taylor Creek (Tributary 0320): RM 1.2 to 3.2 (*Note*: Taylor Creek below Maxwell Road RM 0.4 is part of a Cedar River RSRA Wetland 132.)
Taylor Creek (Tributary 0326): RM 0.0 to 0.7
Walsh Lake Diversion Ditch (Tributary 0441): RM 0.0 to 4.0

Valley-Floor Stream Habitats

RSRA
RB[a] Percolation Side Channel at RM 4.7 to 4.8
LB Percolation Side Channel at RM 4.6 to 4.8
LB Percolation Side Channel at RM 7.5 (part of RSRA Wetland 103)
RB Percolation Side Channel at RM 9.5
RB Percolation Side Channel at RM 10.1
LB Wall-Base Tributary (McDaniel's Side Channel) at RM 11.5
RB Percolation Side Channel at RM 13.4 (adjacent to RSRA Wetland 132)
LB Wall-Base Tributary at RM 14.9
LB Percolation Side Channel at RM 15.9
LB High-Flow Side Channel at RM 17.2 to 17.4
LB Percolation Side Channel at RM 17.7

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[a] All right and left bank designations are made assuming the observer is facing downstream.

LB Side Channel at RM 19.0
LB Percolation Side Channel at RM 19.7
RB Percolation Side Channel at RM 20.0 (adjacent to RSRA Wetland 80)

LSRA
RB Wall-Base Tributary at RM 12.5
RB Side Channel at RM 15.7 to 15.9
LB Wall-Base Tributary at RM 16.2
LB Wall-Base Tributary at RM 18.3

Wetlands

Class 1 Wetlands: Consistent with past basin plans, many of the Class 1 rated (i.e., "unique and outstanding") wetlands, including all bogs and fens, are categorized as RSRAs. The rest of the Class 1 wetland systems are categorized as LSRAs due to past land-use impacts.

In accordance with the SRA criteria, fourteen of the Cedar River basin's fifteen Class 1 wetlands are designated as SRAs. Wetland 25, a Class 1 system in the upper headwaters of Madsen Creek, has been subjected to complete buffer removal and partial filling. It also serves as an R/D facility. As a result of these alterations, it no longer meets the SRA criteria.

Class 2 Wetlands: A number of Class 2 wetlands are within stream corridor SRAs. As such, they are assigned the same SRA designations as the adjoining streams. Their protection is critical in maintaining fish and wildlife habitat, water quality, and stormflow attenuation in these systems.

RSRA
Cedar River Mainstem: Wetlands 69, 80, 132, 37, 103, and 6[*]
Peterson Creek Subbasin: Wetlands 14[*B], 15[*F] (and Lake Desire), 28[*F] (encompasses Spring Lake), and 42 (encompasses Peterson Lake)
Madsen Creek Subbasin: Wetland 16[*B]
Webster Lake Subbasin: Wetland 33[*B] (encompasses Webster Lake)
Taylor Creek Subbasin: Wetland 132 (also adjoins Cedar River mainstem)
Walsh Lake Subbasin: Walsh Lake
Middle Cedar River Subbasins: Walsh Lake and surrounding uninventoried wetlands, and Wetland 83[*B]

LSRA
Cedar River Mainstem: Wetlands 118 and 105
Molasses Creek Subbasin: Wetlands 22[*], 23[*], and 2
Cedar Grove Subbasin: Wetland 13[*]
Webster Lake Subbasin: Wetland 36[*] (encompasses Francis Lake)
Walsh Lake Subbasin: Wetland 64[*]
Taylor Creek Subbasin: Wetland 58
Rock Creek Subbasin: Wetlands 82[*] (Hidden Lake), 91 (encompasses Lake No. 12), 92[F], 93, and 94
Middle Cedar River Subbasins: Wetland 77[*]

[[*] = Class 1 wetland [B] = Bog [F] = Fen]

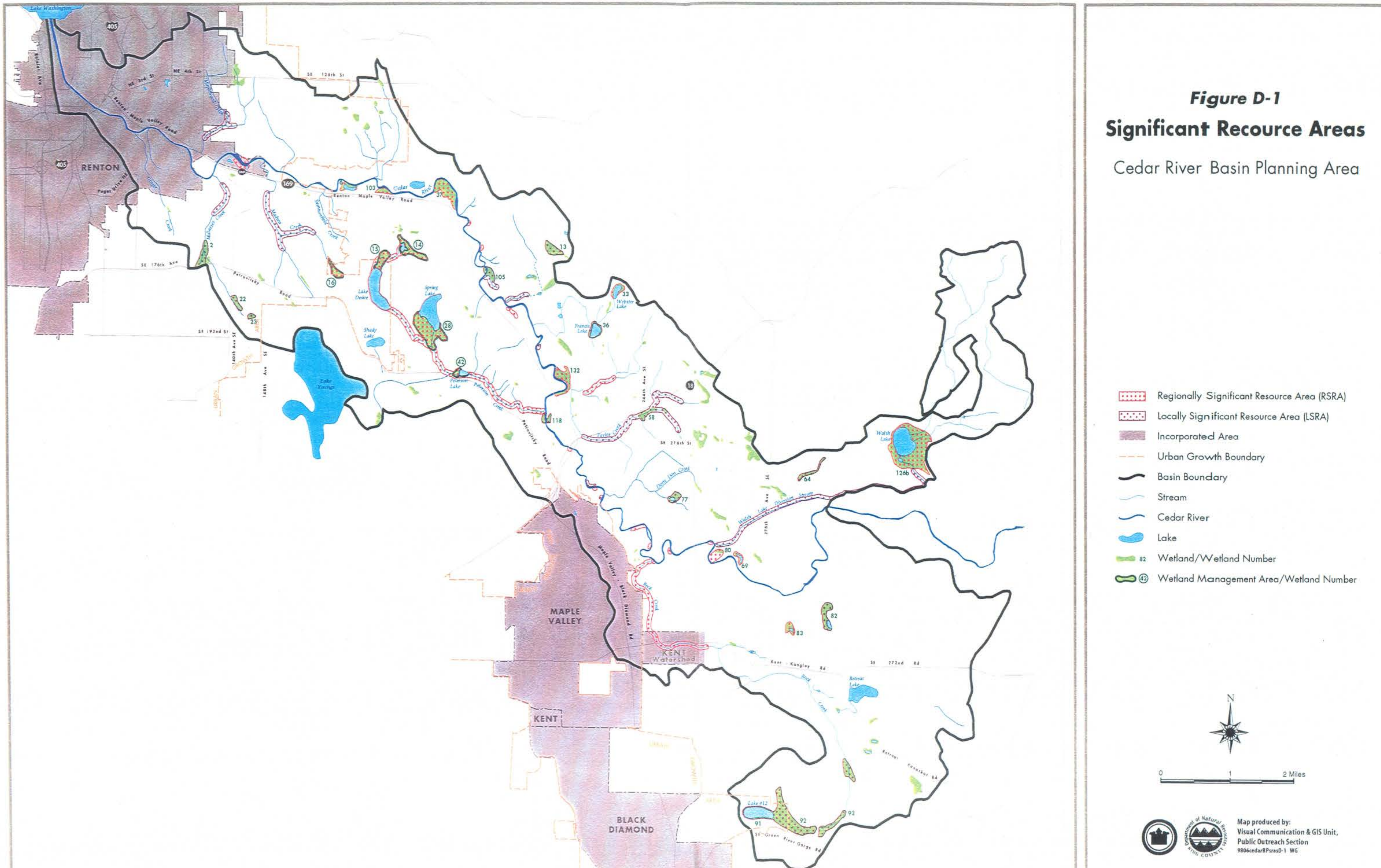

Figure D-1

Significant Recource Areas

Cedar River Basin Planning Area

Appendix E: Estimation of Salmonid Production Potential and Costs of Fish Habitat Restoration Opportunities in the Lower Cedar River

Executive Summary

The Cedar River is one of the most productive salmon and trout streams in the state. To help ensure sustainability of the fish runs and increase them, habitat restoration[9] measures were assessed for the lower 22 miles of river as part of the Lower Cedar River Basin and Nonpoint Pollution Action Plan. The proposed projects would increase the river's natural production potential for salmon and trout in a manner consistent with restoring its ecological health, protecting its high water quality—essential also for maintenance of Lake Washington—and reducing the costs and hazards of flooding. The projects would also be consistent with wild and native fish protection under Washington State's Wild Salmonid Policy and the federal Endangered Species and Clean Water Acts. Benefits for non-salmonid fish and wildlife, water quality, recreation, aesthetics, flood reduction, and the overall quality of life were not assessed but are likely to be very high because the Cedar River has high resource value and is near a high-density urban area.

Potential habitat projects were identified along the edge of the mainstem channel, on the valley floor, and in tributaries. Projects in the mainstem would reduce the costs and hazards of flooding while enhancing edge habitat by removing or modifying some levees and revetments and adding habitat elements such as large woody debris, boulders, and native riparian vegetation. The valley floor projects would enhance or create off-channel habitat, much of it groundwater-fed, reconnecting the river with its floodplain and providing stable spawning gravel, juvenile rearing, and flood refuge habitat. The tributary projects would increase potential habitat productivity by adding large woody debris to the channel to improve channel stability, retain spawning gravel, and increase fish hiding cover. In one tributary—the Walsh Lake Diversion—a fish passage barrier would be modified and upstream habitat enhanced to make over four miles of stream and many acres of excellent wetland productive for anadromous salmon. In Rock Creek,[10] one of the best stream habitats remaining in the Puget Sound lowlands, the recommended project would restore part of the stream's base flow, which municipal water diversions reduced, thus increasing its already high value for spawning and rearing habitat.

[9] For this report, restoration includes actions that may also be defined as rehabilitation or enhancement.

[10] WRIA #08.0338. Enters the Cedar River approximately 3 miles *downstream* from Landsburg. Not to be confused with WRIA #08.0345, also called Rock Creek, which is entirely in the City of Seattle's municipal watershed and enters the Cedar River approximately 2 miles *upstream* of Landsburg.

A total of 73 habitat restoration projects were assessed. However, because not all restoration possibilities were explored, conservative values for habitat area and production were generally applied. This report presents a conservative estimate of the total potential for habitat restoration in the basin. Of those assessed, twelve projects would enhance 1.65 hectares (4.1 acres) of edge habitat along 4.1 kilometers (2.6 miles) of the mainstem river channel, and ten projects would restore 7.0 hectares (17.3 acres) of stream habitat in almost 22 kilometers (13.75 miles) of tributary channels. Fifty-one projects would enhance or create 16.1 hectares (about 40 acres) of habitat on the valley floor.

For each species, information on fish production and survival was obtained from the scientific literature and the knowledge of local biologists. These values were then applied to estimates of pre- and post-project habitat area to estimate the annual production that could result from each habitat project. To reflect the potential variability in production, a high and low range of production was also estimated for each species based on variability of data from a wide range of studies on the production value of habitat restoration. All estimates assume that projects will be constructed and will perform as described, and that the habitat will be adequately seeded with spawners.

Based on this approach, it is projected that the proposed projects, when fully functional, would annually produce about 35.1 million emergent sockeye fry (range 20 to 44.8 million), 93,600 coho smolts (range 53,000 to 192,000), 10,000 chinook smolts (range 5,000 to 25,000), 940 steelhead smolts (range 535 to 1475), and 29,000 cutthroat smolts (range 22,000 to 55,700). Total cost to construct these projects is estimated at $60.25 million.[11] However, 87% of the fish, including 30.4 million sockeye fry and 60,500 coho smolts, could be produced for only 25% ($14.7 million) of the total capital cost if all valley floor projects were constructed. Tributary projects would cost about 18% of the total and would produce about 13% of the fish, but a large majority of tributary gains, including almost 4.0 million additional sockeye fry, could result if two projects—Rock Creek base flow restoration and Walsh Lake Diversion enhancement—were completed at a cost of about $7.4 million.

Long-term (50-year) costs were estimated to assess cost-effectiveness for producing juvenile salmonids. The additional costs for long-term maintenance and monitoring are about $10.2 and $2.5 million, respectively, making the total long-term cost of the proposed projects $72 million. Assuming no production value in the first year of project life and a two-generation (6 to 10 years depending on the species) build-up time thereafter to reach average production, the total cost per juvenile salmonid (fry and smolts combined) would be $0.042. Valley floor projects were the most cost-effective, producing juveniles at an average of $0.013. Tributaries would produce juveniles at an average cost of $0.05.

Projects along the mainstem and in heavily urbanized tributaries were judged to be the least cost-efficient from strictly a fish production standpoint. The average cost per juvenile from mainstem projects was about $90; for the urban tributaries, it was $40. Mainstem costs are high because many of those projects entail the expensive process of acquisition and removal of homes and retrofitting or removal of levees and revetments. They would be pursued chiefly as a broader flood hazard reduction and floodplain restoration strategy rather than for their fish production value alone. Projects in urban tributaries are expensive because cutthroat trout are the only

[11] All costs in 1998 dollars.

salmonid species expected to be produced in significant numbers; other species, such as coho and sockeye salmon, are greatly reduced or eliminated in streams heavily impacted by urban development. Projects in urban tributaries would be done chiefly to reduce erosion.

The primary factors considered necessary for successful implementation are the need to ensure adequate instream flows for the proper functioning of habitat in the Cedar River and the need to incorporate the proposed projects into an ecosystem-based adaptive management approach. Given the region's current extreme pressures for urban growth, this approach should place higher priority on funding for habitat protection (including acquisition of critical headwater, riparian and floodplain areas in the Lake Washington watershed) than on restoring habitat or boosting fish production by artificial means. Both restoration and artificial propagation should be done only in incremental and experimental stages so that funds are not needlessly spent. This will also reduce the risk of failure or unintended adverse effects, such as exceeding the carrying capacity of the natural waters.

No dedicated funding exists to implement these projects. Some projects, such as modifications of levees and revetments, may be done gradually as part of local or federal government repair and maintenance programs. Many others, however, have no funding mechanism to ensure their construction. These include projects with the greatest value for sockeye and broad ecological values, such as the valley floor groundwater-fed habitats, enhancement of the Walsh Lake Diversion channel, and flow restoration on Rock Creek. Combined, these could annually produce 34.3 million sockeye fry (98% of the total) at a capital cost of $21.2 million, about 35% of the total capital cost.

Also crucial for successful implementation is the support of landowners. Many of the proposed projects are located on private land, so the owners' support will be essential. In some instances, such as the more expensive mainstem projects where buyout and removal of existing homes is proposed to achieve both floodplain restoration and flood hazard reduction goals, considerable negotiation and creative solutions, such as life leases, may be necessary to achieve long-term goals and landowner desires. All project costs include compensation as required by law for the use of private property for such purposes. Many landowners have expressed concern about the ramifications of these types of projects, primarily eviction from homes (condemnation for habitat or flood hazard reduction goals is not current County policy), their effect on regulatory buffers (they would *not* necessarily increase), and on public access (it would *not* be a requirement on private land).

Regardless, most landowners contacted to date in the basin have expressed strong support for the goal of helping the Cedar River and its fish, and many view the proposed habitat as desirable features to have on their land. However, many landowners have not yet been contacted about the possibilities for restoration on the properties. Numerous potential habitat sites on the valley floor (19 out of 51) are considered at risk of being committed to other uses, such as clearing, if landowners are not contacted soon.

Several examples of habitat restoration exist in the lower Cedar River to help demonstrate the types of projects proposed. Five such projects are described in detail at the end of this report. They include four groundwater-fed habitats, one major levee reconstruction using bioengineering principles, one project to enhance tributary using large woody debris and riparian plantings, and one project to reconnect an oxbow pond to the river.

Introduction

The Cedar River, one of Washington State's most productive salmon streams, is the largest natural producer of sockeye south of British Columbia. It is the primary source of naturally spawning chinook salmon and steelhead trout in the Lake Washington ecosystem, and together with Bear Creek, the major producer of wild coho salmon. When runs are plentiful, the Cedar River sockeye support the state's single most valuable sport fishery and are an important economic and cultural resource for treaty tribes. The Cedar River is one of the Puget Sound rivers least affected by hatcheries, having no permanent hatchery and, in recent years, no regular outplantings of fish other than sockeye fry from the interim hatchery at the Landsburg Diversion Dam located at river-kilometer (RK) 35 (river mile 21.8). The river's steelhead and chinook have special significance because they appear to be relatively unaffected by past hatchery outplantings (Myers et al 1998; WDFW 1994) and therefore are more likely part of the original native salmonid community of the lake than other basins in the watershed.

In addition to fish, the Cedar River provides about two-thirds of the municipal water for the City of Seattle and its wholesale customers, and almost half the inflow for Lake Washington. Lake Washington is the state's second largest lake and arguably the most valuable lake due to its size, high resource and recreational value, high water quality, and proximity to the state's most populated area. Many boaters, rafters, swimmers, wildlife-watchers, hikers, and other recreational users value both the Cedar River and Lake Washington's natural attributes.

The Lower Cedar River Basin and Nonpoint Pollution Action Plan (King County 1997) outlines many actions for protecting and restoring salmon and steelhead habitat, reducing flood hazards, and preserving the river's high water quality. The following report discusses estimates of the fish that could result from the plan's projects and their associated costs. The projects are all consistent with the plan's flood hazard reduction and water quality goals. Because they restore habitat for naturally spawning salmonid stocks, they are also consistent with Washington State's Wild Salmonid Policy and the federal Endangered Species and Clean Water acts. As a sub-stock of Puget Sound fall chinook, Cedar River chinook are likely to be included in a final listing under the federal Endangered Species Act; this listing was proposed in February 1998.

The information in this report can be used to help (1) identify and prioritize mitigation opportunities and develop a basin-wide aquatic habitat mitigation bank[12]; (2) set management goals related to fish habitat, stocking, and harvest for the Lake Washington Basin; (3) plan salmon and trout stock restoration; (4) integrate habitat and open-space projects; and (5) evaluate alternatives for protecting or restoring threatened or endangered species.

This report provides the most thorough assessment of salmonid habitat restoration for any watershed in King County and probably for Washington State. Planning such as this is complex, however, and conditions will change. Users of this information are encouraged to take an adaptive approach, considering new opportunities as they arise and using the results of ongoing monitoring and research. Another report that describes the adult salmonid production and economic benefits that could be derived from these projects, and that describes project design and implementation in more detail is scheduled for completion in 1998.

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[12] Nothing in this report is meant to imply responsibility for funding or implementation.

Background

PHYSICAL DESCRIPTION OF THE WATERSHED

The Cedar River is Lake Washington's largest tributary. The river's drainage basin covers about 487 kilometers (188 mi.^{2}), has its highest elevation at about 1,650 meters (5,400 ft) at the crest of the Cascade Mountains, and provides about half the lake's water supply (Chrzastowski 1983; King County 1993a). The lower Cedar River extends from the river's mouth to the Lake Young's Pipeline crossing (RK 34.9) located a short distance downstream from the Landsburg Diversion Dam. The lower river drains about 171 km^2 (66 mi.^{2}) below this point. The dam has blocked upstream migration of anadromous salmonids since 1901. Below the dam anadromous salmonids can access about 82 km of stream channel in the mainstem and 16 tributaries (Tables 1 and 2). The lower river has a mean gradient of 0.44%, descending 152.6 meters in the 34.9 km between the foot of the dam (elev. 159 m) and Lake Washington (elev. 6.4 m).

FACTORS AFFECTING CEDAR RIVER SALMONIDS

Salmonids from the Cedar River Basin are adversely affected by (1) urban and rural development (Lucchetti and Fuerstenberg 1993; Booth and Jackson 1994; May et al. 1997); (2) Lake Washington conditions, such as navigation lock operations, water quality (Solomon 1994), planktonic food supply, and organisms that prey on and compete with juvenile sockeye (Fresh 1994); (3) overharvest of wild salmonid stocks, largely the result of mixed stock fisheries (Wright 1993); and (4) climatic fluctuations that adversely affect ocean upwelling and stream discharge (Pearcy 1992; Lawson 1993). Other adverse, human-generated factors for salmon and trout include introduced fishes (e.g., predation and competition by bass and yellow perch in the lake), water diversions and flow regulations, riparian clearing and overgrazing, and interactions with hatchery stocks. In addition, sea lions prey on migrating steelhead at the Ballard Locks (Fraker 1994).

VALUE OF CEDAR RIVER RESTORATION FOR INCREASING ADULT PRODUCTION

The proposed projects address only the freshwater stream habitat factors affecting Cedar River salmonids. The resulting habitat modifications have the potential to increase juvenile salmonid production which in turn could lead to an increase in adult returns. However, the number of fry or adults produced is only partly a function of stream habitat. Enough spawners must return to seed the habitat. Adult returns are only partially dependent on stream habitat or on the number of fry or smolt produced. Conditions in the lake, ship canal, H. M. Chittenden Locks, estuary, and ocean can all affect the adult returns for the Cedar River.

There even exists the potential for intergenerational feedback that could reduce productivity of successive year classes. Schmidt et al. (1993) and Schmidt and Kyle (1993) found that sockeye production dropped in lakes on Kodiak Island and the Kenai Peninsula of Alaska in years after high fry abundance. They attributed the production losses to overcropping of zooplankton by large year classes of sockeye fry produced by the previous year's high spawner escapement. Due to its mesotrophic (moderate nutrient) condition, Lake Washington is undoubtedly much more productive than the oligotrophic (low nutrient) Alaska sockeye lakes studied by these authors. However, it is also populated by many more fish species, particularly longfin smelt, which do not exist in Alaska lakes but are known to feed on the same food as sockeye salmon juveniles in Lake Washington (Chigbu 1994). Moreover, the population of longfin smelt in Lake Washington has increased dramatically since the late 1970s (Fresh 1994).

HABITAT PROBLEMS

Since the mid-1800s, humans have altered much of the Cedar River basin. Logging and coal mining were early impacts. Abandoned mine shafts and tailings still pose hazards that limit land use at several locations. Logging removed much of the mature conifer forest, leaving immature and deciduous trees in their place.

More recently, urban and rural development has harmed fish habitat, mainly by changing storm runoff, often dramatically, but also by encroaching on riparian areas and stream channels. The results include increased flooding and erosion and degraded water quality (Booth 1991; Lucchetti and Fuerstenberg 1993; King County 1993a). The impacts of urbanization have been especially acute in Madsen, Maplewood, and Molasses Creeks in the lower part of the basin, and in the lower 6 km of the mainstem channel. Despite these changes, much of the basin remains relatively rural. Under the 1994 King County Comprehensive Plan, it should stay that way until the year 2014. But Metropolitan King County's population growth exerts strong pressure to develop and there are provisions for expanding the Urban Growth Boundary.

Several major stream manipulations have damaged fish habitat since the early 1900s. The Cedar River originally flowed into the Black River—Lake Washington's original outlet—which flowed south to join the Green River. These rivers combined to form the Duwamish River, which flows into Elliott Bay of Puget Sound. In 1916, the Lake Washington Ship Canal and the H. M. Chittenden Locks were constructed to connect Lake Washington with Puget Sound. This lowered the lake's average surface level by 3 meters, drying the upper reaches of the Black River as well as many wetlands and springs along the lake shore (Chrzastowski 1983). At about the same time, the Cedar River's lower 2.5 km was diverted away from the Green River and into Lake Washington to facilitate operation of the Ship Canal and commercial development of a wetland at the confluence of the Black and Cedar Rivers, now downtown Renton. The immediate effects on fish runs in the Lake Washington watershed were not recorded (Ajwani 1956) but were likely major, including loss of chum and pink salmon populations, separation of the original Green River stocks of salmon and steelhead, and the temporary reduction of fish runs because Lake Washington's outlet changed.

Floodplain development, water diversions, and flow regulation have also greatly influenced salmonid habitat. Operation of the water supply dams by the City of Seattle is the major regulator of both minimum and flood flows in the Cedar River. Since 1901, the City of Seattle has diverted 27.7% of the mean annual flow at the Landsburg Diversion Dam (RM 21.7; David

Hartley, KCDNR, pers. comm). The dam has also blocked fish from migrating into about 16 miles of stream.

Water withdrawals, flow regulation, and flood control levees and revetments reduced mainstem channel surface area below the dam by about 56% between 1865 and 1988 (King County 1993a; Perkins 1994). Also, floodplain development has straightened and constricted the main channel by filling in many side channels or cutting them off from the mainstem. Lost were many off-channel habitats including side channels, oxbow ponds, and spring-fed tributaries that existed on the valley floor (King County 1993a). These habitats are extremely important for salmon, especially sockeye (Burgner 1991) and coho, and for cutthroat (Sedell et al. 1983; Cederholm and Scarlett 1981; Peterson 1982; Scarlett and Cederholm 1984; Swales et al. 1985; Moore and Gregory 1988; Swales and Levings 1989).

TYPES OF PROJECTS

Cedar River fish habitat can be restored and enhanced in three landscape settings: (1) along the mainstem river channel; (2) in tributaries of the mainstem; and (3) on the mainstem valley floor. The work proposed for each setting would restore some of the connectivity and complexity of aquatic habitats that human activities have destroyed.

Mainstem projects will be located primarily at flood control facilities that the County owns or maintains, with the main method of design being *bioengineering* (use of native materials for stabilization) of levees and revetments resulting in improved instream habitat and restored riparian vegetation along the river's edge. Some levees and revetments will be removed or set back from the river's edge to establish mature riparian forests. Where this is not feasible, the projects will, at a minimum, add instream structure and establish moderate levels of riparian vegetation where little of either now exists.

Valley floor projects will include enhancing and reconnecting existing side channels, wall-based tributaries, and oxbow ponds, as well as creating new habitats of these types. By reconnecting the river with its floodplain, these projects can help restore the river's ecological health while significantly boosting production of economically valuable salmonids, mainly sockeye and coho. In contrast to mainstem and tributary projects, the valley floor projects generally will not directly benefit public health or safety, nor directly protect property. It is not essential that buildings or roads be moved to create these habitats. However, if some buildings could be moved, even more habitat could be created and greater ecological benefits obtained.

Tributary projects include restoring habitat complexity and enabling fish to use existing habitat by improving flow and access. Large woody debris (LWD) installations and riparian plantings will stabilize the channel, reduce sedimentation, retain spawning gravel, and increase structural complexity. Projects will focus on streams that drain ravines with immature riparian forests and little streamside development. Exceptions are Rock Creek and the upper reaches of the Walsh Lake Diversion.

Rock Creek has excellent structural habitat and spawning gravel, but is hampered by artificially low flows caused by municipal water diversion. Thus, the proposal for Rock Creek is to restore base flow in late summer and early fall, the time of most pronounced diversion effects and of sockeye and chinook spawning.

The Walsh Lake Diversion is a 6.7 km diversion channel dug in 1931 and 1932 to divert contaminated water away from Seattle's drinking water supply. Primarily cutthroat trout use it, but also some coho—the few that can pass a reach of swift current at RK 1.0. Providing for fish passage and improving habitat conditions in the diversion channel can restore much fish habitat.

Methods

SELECTION OF PROJECT SITES

Habitat projects were identified by King County natural resource staff during the development of the Lower Cedar River Basin and Nonpoint Action Plan (King County 1997), a multi-agency document that describes current and potential surface water and groundwater problems and solutions in the lower Cedar River. King County staff surveyed stream channels and wetlands in 1992, and conducted follow-up studies from 1993 to 1995 to locate areas where fish habitat might be restored or improved. Maps, aerial photographs, and input from agency technical staff aided in the process. Floodplain maps and low-elevation, oblique air photos were used to locate suitable sites for creating groundwater-fed ponds and channels, typically in undeveloped low-lying areas.

ESTIMATING ANNUAL PRODUCTION POTENTIAL (APP)—GENERAL PROCEDURE

Annual production potentials (APPs) for the pre- and post-treatment condition were estimated by combining site specific information on existing (or predicted) spawning and rearing habitat quality and quantity with productivity values reported for similar sites in the literature. In general, calculation of an APP entailed (1) classifying a project's pre- or post-treatment fish habitat area as either pond or channel; (2) further classifying its primary function as either spawnable or non-spawnable; and (3) multiplying habitat area created or enhanced by emergent fry or smolt production values from the literature depending on expected species utilization and the type of habitat being proposed. The production values used for each species are summarized in Table E-3. The rationale for their use is described in greater detail below. The APP attributable to the proposed projects was calculated as the difference between pre- and post-project APP estimates.

For each project site and species that occupies it (or will), high and low estimates of pre- and post-project APP were also estimated. For sockeye, this entailed developing a range of egg deposition rates based on predicted female spawner densities and a range of egg-to-fry survival rates based on data from similar types of habitat. For the other species, the range was based on the variability of data summarized by Koning and Keeley (1997) from studies on the effectiveness of habitat restoration for increasing salmon and trout production in streams throughout the Pacific Northwest. Table E-4 summarizes their data and statistical properties, including sample means, standard deviations, and coefficients of variation. Where variability of the data was relatively low (i.e., coefficient of variation < 100%), high and low APPs were estimated by multiplying the average value in Table E-3 by the respective coefficient of variation for pre- and post-project data. Where it was high, both the high and low APPs were estimated by interpolating between the sample mean and the highest and lowest value in the data set, respectively.

APPs were calculated for five species of salmonids. For four of these—coho, chinook, steelhead, and cutthroat—APPs were based on smolt production. The number of smolts emigrating from a system is usually determined by freshwater rearing conditions because they reside for extended periods in streams, small lakes, or ponds. Sockeye also rear in freshwater but because their fry migrate almost immediately to Lake Washington upon emergence from the gravel, their APP was based on the number of emergent fry produced from the amount of spawning substrate each project would provide.

Reconnaissance surveys suggested that three fish-bearing tributaries evaluated—Madsen, Maplewood, and Molasses Creeks—are likely to harbor primarily cutthroat trout regardless of the proposed project type. These streams drain heavily urbanized basins which, like other areas in the Puget Sound region, alter conditions in associated streams in ways that favor cutthroat trout over other species (May et al 1997; Lucchetti and Fuerstenberg 1993).[13]

This report relies heavily on information compiled and analyzed in Koning and Keeley (1997). Their work was part of the most comprehensive assessment available of habitat rehabilitation in the Pacific Northwest (see Slaney and Zaldokis 1997) and was developed to guide extensive fish habitat rehabilitation work proposed as part of British Columbia's "Forest Renewal" program. Their contribution to Slaney and Zaldokis (1997) was to assess the effectiveness of fish habitat rehabilitation procedures for increasing salmonid production. Because their analysis used results from studies throughout the Pacific Northwest, their recommended values were considered appropriate when local data were not available.

ESTIMATING PROJECT HABITAT AREA

For each project site, estimates were made of the area of existing and potential fish habitat. For tributary and mainstem channels, and for existing side channels and wetlands, measurements of length, wetted width, and gradient were either measured directly during foot surveys in summer 1992 or 1993, or from USGS or other suitable maps. The exception was Rock Creek, for which widths were obtained from early-November 1991 data in the technical appendix of the Wilderness 50/Wilderness Retreat EIS (King County 1993).

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[13] Regardless of their fish value, tributary projects in urban streams could help to reduce channel erosion and downstream flooding, and are therefore considered valuable for achieving broader surface water management goals.

For projects that require construction of new habitat, primarily valley floor groundwater-fed ponds and channels, surface area was estimated from conceptual drawings made on overlays of 1988 U.S. Army Corps of Engineers floodplain maps. The drawings indicate channels, ponds, or combinations of these that could be dug at each site and connected to the main channel. The dimensions and types of new habitat proposed depended on the amount of undeveloped land, site morphology and topography, and the author's knowledge of similar existing habitats in the Cedar River system and elsewhere in Washington and British Columbia. For newly dug groundwater-fed *channels*, production estimates assumed 3 m wetted width and excavation to 0.5 m below the adjacent riverbed. Pond widths varied, averaging about 30 m (range 15 to 46 m)[14]. Average pond depth will be 1.5 m. Spawnable *ponds* were assumed to have 6 m wide spawning beaches along the riverward edge.

Estimating affected area for mainstem habitat posed some difficulty because the habitat improvements contemplated will not directly affect the entire site, but only the area in the vicinity of the engineered structures, principally LWD but in some cases rock deflectors placed at the site. The primary treatment will be logs anchored into the river's edge. Logs will have attached root boles extending about 3 m into the river providing hydraulic diversity for fish hiding and resting cover and improved bank stability. In some places, rock deflectors will be used instead, as these pose less hazard to boaters than LWD. The LWD and rock deflectors will extend about 3 m into the river. This value was used as the minimum channel width affected where a flood control facility will remain. Where an entire levee or revetment is to be removed or set back, the affected width was increased by 50% to 4.5 m, based on the premises that these sites would have a much greater degree of forest regrowth and natural LWD accumulation, and that there will be much less human pressure to intensively manage the site for safety or maintenance reasons. As a result, their functional width is expected to be greater than where a flood facility remains.

ESTIMATING PROJECT VALUE FOR SOCKEYE FRY

Habitat Area Limitations to Sockeye Production: Mainstem projects were assumed to have no direct value for sockeye production because these projects will tend to cause gravel to scour rather than deposit. This assumption is probably conservative because recent observations of mainstem channel response to bioengineered levees and revetments indicate that adding instream structure contributes to the formation of gravel bars and gravel retention within the overall affected reach of river.

Because of their limited utility as sockeye spawning area, headwater reaches (e.g., Rock Creek above RK 2.7 and Walsh Lake Diversion above RK 6.7) and reaches having a gradient greater than 5.6%[15] were excluded from analysis.

[14] As a substitute for ponds, which were incorporated in these designs to increase habitat diversity and to provide greater multiple purpose, parallel (forked) channels with equivalent spawnable area could be dug, generally at much less cost, within the proposed pond footprint.

[15] This is the gradient of the lowermost reach of the Walsh Lake Diversion (RK 0.0-0.3), the steepest tributary reach in which sockeye spawn in the lower Cedar River.

New groundwater-fed channels and ponds were assumed to have the potential for sockeye spawning *except* at poorly drained sites with little or no upwelling potential. These sites were not selected to provide spawning habitat for sockeye but to provide off-channel rearing for coho and cutthroat.

For *groundwater-fed channels* with good gravel and upwelling characteristics, 75% of the channel area was assumed to be spawnable. For *groundwater-fed ponds* deemed to have spawning potential, it was assumed that spawning would occur in 75% of a 6 m wide area along the riverward side of the pond (i.e., the side where upwelling is most likely to occur). These estimates take into account edge effects and pockets of poor substrate and therefore may be considered conservative.

Sockeye Female Spawner Density: The APPs for emergent sockeye fry were assessed for three levels of female spawner density to estimate fry production potential. The estimates assumed a constant fecundity of 3,588 eggs/female (Hiser *ca* 1970) and an egg deposition rate of 95% (Seattle Water Department 1990). Spawner density and egg-to-fry survival rates were allowed to vary (see below).

A value of 0.83 females/m^2 was used as the moderate spawner density expected per area of spawning gravel. This is the value Ames (1997) considered appropriate for estimating production potential in the Cedar River above Landsburg. He modified the optimal spawner density of 0.66 females/m^2 recommended by the International Pacific Salmon Fisheries Commission for Fraser River tributaries to account for the smaller-bodied Cedar River sockeye.

For comparison, low and high spawner densities were set at 0.40 and 1.3 females/m^2, respectively. The low level is slightly less than the average female spawner density of beach spawning sockeye in Baker Lake, Washington (Gary Sprague, WDFW, pers. comm.). Baker Lake sockeye are purposely kept at low spawner densities due to that stock's high susceptibility to IHN virus infection. Their susceptibility to IHN is due to the prolonged adult holding period and the warm temperatures they encounter. This is unlike conditions expected in the proposed habitat where fish are not likely to enter until late October or early November and should spawn within a week or two of entry.

The high female spawner density was estimated as the midpoint between the average female spawner density and density at which fry production starts decreasing with increasing egg deposition in the Weaver Creek Spawning Channel (Seattle Water Department 1990). This point is estimated to be about 1.30 females/m^2, assuming fry production declines when egg deposition increases beyond 6,000 eggs/m^2 (about 1.7 females/m^2). King County spawner survey data from 1996 indicates that spawner densities in the recently constructed Elliot Groundwater Channel averaged 1.2 to 1.3 females/m^2, despite low spawner escapement for that year. Thus the high female spawner density is attainable even at low system-wide escapement levels.

Sockeye Fry APP from Valley Floor Projects: For valley floor projects with spawning potential, the sockeye fry APP was the product of the amount of spawning substrate times the egg deposition rate at varying female spawner densities and corresponding sockeye egg-to-fry survival rates (ETFs). ETFs for valley floor habitats were assumed to be inversely proportional to female spawner density for groundwater-fed habitats, mainly due to redd superimposition and other effects of crowding.

Due to a lack of information on sockeye production from groundwater-fed habitat channels, ETFs were set at 50% of those measured in the Weaver Creek Spawning Channel (WCSC) at corresponding egg deposition levels. Chart 6-1 of the Cedar River Sockeye Project Final Siting Report (Seattle Water Department 1990) summarizes data for WCSC and was used to visually estimate ETFs at varying levels of egg deposition corresponding to the range of female spawner densities. The resulting ETFs were set at 24, 30, and 36 percent for high, moderate, and low female spawner densities, respectively (Table E-3).

Data on sockeye and chum salmon ETF rates and female spawner density in spawning channels and the more natural groundwater-fed channels are summarized in Table E-4. For sockeye, there is no clear guidance for an appropriate ETF because they are all derived from spawning channels that are more artificial than proposed in this report. The closest approximation to the type of proposed groundwater-fed habitat with respect to water flow may be the Baker Lake spawning beaches, where upwelling is artificially achieved by a manifold of pipes which distribute water underneath a gravel bed. In contrast, the Weaver Creek and Nadina spawning channels rely on flow-through of surface water, which is less favorable for egg irrigation than upwelling. Regardless, ETFs tend to be consistently high for sockeye, averaging 56% (range 25-91%). They are inversely correlated with spawner density.

The survival data set for the WCSC was considered the most useful because it was developed over many years and spans a wide range of spawner densities. However, the WCSC differs from the proposed projects in that its flow, spawner density, and predators are highly controlled, and it can be cleaned periodically. Thus, using unaltered WCSC rates for the proposed valley floor groundwater-fed channels is not appropriate, which is why they were reduced by 50%.

Data for chum salmon are provided for comparison only; they were not considered appropriate for calculations on sockeye because of species differences (e.g., chum are much larger), watershed differences (the Satsop River is an unregulated river and prone to more dramatic flooding than the Cedar), and a lack of specific information on the area of spawnable substrate for the groundwater-fed chum spawning channels. However, the ETFs used for this report are well within the observed range for chum salmon in groundwater-fed channels constructed along the Satsop River in Washington State and the lower Fraser River of British Columbia, further suggesting that they are reasonable for this exercise.

Sockeye Fry APP from Tributary Projects: The moderate pre-project fry APP for tributaries was the product of the amount of spawning substrate multiplied by egg deposition (varying with female density) and a range of tributary ETFs. For tributaries, ETFs were assumed to be more a function of flood intensity due to redd scour rather than female spawner density. Tributary ETFs were 5.6, 8.4, and 11.6 percent. These values were developed from the literature by the City of Seattle (1990: Table 3-4) to compare the relative survival benefits of hatcheries and artificial spawning channels versus survival in a natural river environment.

Spawning substrate area was estimated as 5, 10, or 20% of the wetted area under summer base flows (when foot surveys were conducted). These estimates were based on qualitative visual assessments of the area with suitable depth, gradient, and substrate for sockeye spawning.

Because sockeye will generally spawn at higher stream flows, this is likely a highly conservative estimate of spawnable area.[16]

The pre-project APP for tributaries was multiplied by 4.3 to estimate the post-project value. The multiplier is half that recommended by Koning and Keeley (1997) as the value of adding stream habitat complexity for increasing sockeye production. Their multiplier was reduced because it was based on results from projects that were much more engineered (e.g., log weir and deflector installations) than the proposed approach of adding unanchored LWD in natural distributions. The proposed approach is much less costly and disruptive to stream channels and banks but also less likely to produce the same level of results.

Exceptions to this approach were for Rock Creek and the Walsh Lake Diversion (WLD). For these streams, the tributary ETFs were used only for their high gradient reaches (Rock Creek from RM 0.0 to 0.7; WLD from RM 0.0 to 0.6). For the low gradient reaches (Rock from RM 0.0 to 1.7; WLD from RM 0.6 to 4.2), the valley floor ETFs were used because Rock Creek is known to have very high quality, stable spawning gravel and, if enhanced properly, it is believed the WLD would, too.

The post-project fry APP for Rock Creek was estimated as four times higher than the pre-project fry APP because for the first half of the potential spawning time, adult sockeye are denied access due to low flows, and for the second half of the spawning, when flows are adequate to allow spawner entry, about half the channel remains unusable due to low flows. Thus, current spawning usage is estimated to be only one-fourth of the stream's full potential. For the WLD above the barrier at RM 0.6, there is currently no sockeye use. Thus post-project values for the WLD are the product of egg-to-fry survival rates times the proposed area of spawning gravel after enhancement.

Sockeye Fry APP from Mainstem Projects: No value for sockeye fry production was given for these projects.

ESTIMATING PROJECT VALUE FOR COHO SMOLTS

Habitat Area Limitations to Coho Production: Coho are ubiquitous in non-urbanized fish-bearing streams below barriers. Therefore no habitat area limitations were applied to calculations of their production potential. A gradient-based production model was developed to estimate production in tributaries, because coho are more productive in channels with low to moderate gradients. For mainstem projects, the literature-reported values of coho productivity were reduced by 50% to represent generally lower coho productivity in mainstem rivers. Lister and Walker (1966) found coho smolt production from the Big Qualicum River to be about half the value estimated by Chapman (1964) for small streams.

Coho Smolt APP from Valley Floor Projects: Due to concerns of staff from the Washington Department of Fish and Wildlife about excessive coho predation on sockeye fry, coho smolt

[16] For the Walsh Lake Diversion's upper reaches, it was assumed that a 20% spawnable substrate was attainable because of its low gradient.

production potential was estimated differently depending on whether sockeye spawning was the primary objective for a habitat project. Where sockeye spawning was the primary objective, it was assumed that habitat complexity formed by large woody debris and boulders, which is highly desirable for coho and cutthroat production, was lacking in pre-project habitat and would be avoided in the post-project condition to reduce predation pressures by coho and cutthroat on emerging sockeye fry. Thus, for *spawnable* valley floor habitat, pre- and post-project area estimates were multiplied by the same smolt production values to reflect an increase in habitat area only.

A moderate production value of 0.381 smolts/m^2 was used for pre- and post-project spawnable habitats. This was determined by averaging the smolt production values for off-channel ponds and side channels in Koning and Keeley (1997), and then multiplying the average value by 0.56, the inverse of the multiplier (1.8) that Koning and Keeley used to calculate the value of adding habitat complexity to stream channels.

To estimate a range of production potential, coho smolt production values from 15 different valley floor-type projects (ponds and side channels combined) from Koning and Keeley (1997) were reviewed (Table E-4). The values ranged from 2.8 to 0.013 smolts/m^2. Coefficients of variation were high, so the interpolated high and low values were used. As with the average coho smolt APPs, these were adjusted downward by 0.56 to account for low habitat complexity in both the pre- and post-project condition.

For valley floor habitats where sockeye spawning is not the primary goal, pre-project habitat was assumed to be lacking in structural complexity and was multiplied by the same range of values as for spawnable habitat (see above). For post-project habitat, a moderate rate of 0.68 smolts/m^2 was used based on the average of off-channel ponds and side channels in Koning and Keeley (1997). To estimate the post-project range of production potential, the same procedure as above was used but without the downward adjustment for low habitat complexity.

Potential Coho Smolt APP from Tributary Projects: To estimate pre-project coho smolt APP in tributary reaches in non-urban areas, a model relating smolt production to stream gradient in small streams of Puget Sound was developed from data in Baranski (1989). His data indicate that the greatest number of smolts per unit of rearing area occurs at bed slopes of about 1.5%. This led to the following equations:

Tributaries $\leq$ 1.5% slope: $Y = (0.060341)(10^{0.472X})$; $r^2 = 0.995$

Tributaries > 1.5% slope: $Y = (0.49482)(10^{-0.2045X})$; $r^2 = 0.9965$

where Y = number of smolts/m^2, and X = % slope of stream reach

These equations are shown graphically in Figure E-1. Because Baranski's data were obtained from streams with land uses similar to those in the rural portions of the lower Cedar River (i.e., extensive past logging, low levels of agriculture, rural residential development), the derivative models are considered appropriate approximations of the average pre-project coho smolt production.

For each tributary project reach, post-project coho smolt APP was calculated by multiplying the slope-based production factor by the reach area, the result being multiplied by 1.8 to account for increases in productivity due to increased habitat complexity (Koning and Keeley 1997). This may be conservative in view of 6- to 20-fold increases in winter abundance of coho juveniles that occurred after adding LWD in selected reaches of Porter Creek, Washington (Cederholm et al. 1997).

For Rock Creek, coho smolt APP was estimated differently because of its high quality habitat and because the restoration objective is to increase base flows, not habitat complexity. For all reaches of Rock Creek, the pre-project value was multiplied by two to estimate the post-project APP. This was done to account for the anticipated doubling of Rock Creek's summer and early fall low-flow surface area when the project reestablishes natural base flow. Additionally, for the low gradient reach (RK 1.1 to 4.0), the post-project coho production value for non-spawnable valley floor habitat was used because the stream is largely spring-fed and the habitat already has high complexity.

High and low values of coho smolt APP for tributaries were estimated by assessing variability of age 0+ coho densities before and after addition of habitat complexity in eight streams, two in Oregon and six in British Columbia. These data are summarized in Koning and Keeley (1997) and presented in Table E-4. The coefficient of variation for both treated and untreated conditions averaged about 50%. Assuming this relationship would hold for smolts, a variation (+/-) of 50% of the moderate level of production potential was used to estimate high and low coho smolt APPs.

Coho Smolt APP from Mainstem Projects: For reasons noted earlier, one-half the pre-project coho smolt value recommended in Koning and Keeley (1997) was used to estimate the pre-project moderate level coho smolt APP of mainstem habitat. The resultant value, 0.165 smolt/m^2, is close to the average value (0.179 smolt/m^2) estimated by Beechie et al. (1994) for coho production in the Skagit River mainstem. Post-project gains were estimated by multiplying pre-project estimates by 1.8 to account for increased habitat complexity (Koning and Keeley 1997). As with tributary estimates, high and low production potentials for mainstem coho smolts were estimated as 50% (+/-) of the moderate level.

ESTIMATING PROJECT VALUE FOR CHINOOK SMOLTS

Habitat Area Limitations to Chinook Production: Mainstem channels are the preferred habitat for chinook, so no limitations for chinook use of the lower Cedar River were identified. In contrast, valley floor projects are likely to produce few chinook because they comprise mainly groundwater-fed ponds and channels and the smaller side channels not commonly used by chinook salmon. However, some valley-floor habitats (i.e., the large side channels, outlets of groundwater channels) may provide limited spawning or juvenile rearing habitat for chinook, as well as refuge from floods. With the exception of Rock Creek, chinook were assumed to be confined to the lowermost reaches of tributaries on or adjacent to the valley floor of the mainstem. For Rock Creek, potential chinook use was extended up to RM 1.7, above which natural flows are expected to be too low for passage. Past spawner surveys by WDFW identified low to moderate use of Rock Creek by chinook as recently as 1985; since then, flow reductions have prevented chinook spawning migration. To further reflect the lower productivity of tributaries for chinook, the value of the multiplier for increased habitat complexity was reduced by half from that applied to mainstem projects.

Chinook Smolt APP from Valley Floor Projects: No significant production gains for chinook are expected from these projects (see above).

Chinook Smolt APP from Tributary Projects: For chinook-bearing tributary reaches, the moderate level pre-project chinook smolt APP was estimated by multiplying habitat area by 0.025 smolts/m^2, which was derived by reducing the mainstem production value (see below) by half because chinook are much less common in small than in large channels. To further anticipate relatively low chinook usage of tributaries, the post-project APP was estimated by multiplying the pre-project value by 4.65, half of the value Koning and Keeley (1997) estimated to be the production value of increases in mainstem habitat complexity. The exception to this was Rock Creek, where pre-project chinook production was assumed to be nil due to water withdrawals. Here, the post-project (i.e., restored base flow) production potential of chinook smolts was estimated by multiplying the area of the lower two reaches by the post-project tributary chinook smolt value (i.e., the pre-project value multiplied by 9.3). Rock Creek was considered sufficiently large and of high enough habitat quality that application of the full value of the habitat multiplier for a mainstem channel was appropriate. The upper reach of Rock Creek (above RK 2.7) was excluded because natural autumn flows are too low.

High and low values of chinook smolt APP from tributaries were estimated using data summarized in Koning and Keeley (1997) for pre- and post-treatment (i.e., before and after addition of habitat complexity) densities of age 0+ chinook (Table E-4). The coefficients of variation (CV) for densities before and after treatment were 58% and 170%, respectively. Assuming this relationship would hold for smolts, a range (+/-) of 58% was used to estimate high and low pre-project APPs. Because the CV for data from treated streams was greater than 100%, the post-project high and low APPs were calculated by picking the midpoint between the mean and the high and low data points.

Chinook Smolt APP from Mainstem Projects: The moderate level pre- and post-project chinook smolt APPs for mainstem areas were estimated by multiplying the affected surface area by 0.05 and 0.46 smolts/m^2, respectively, as recommended by Koning and Keeley (1997). The post-project value reflects the 9.3-fold increase in production potential estimated by Koning and Keeley to be the value for increased mainstem habitat complexity for chinook. High and low estimates were derived as they were for tributaries.

The post-project smolt production may be conservative. Using fish-weeks (a rough estimate of smolt number), Hayman et al. (1996) estimated chinook smolt production from natural banks along the Skagit River as 0.91/m^2 compared to 0.28/m^2 from hydromodified (e.g., armored) banks. According to Eric Beamer of the Skagit Systems Cooperative (pers. comm.), the relative value of LWD microhabitats—which is predominately what would be created—far exceeds the three-fold difference between natural and hydromodified banks and, for the Skagit River, is probably higher than the factor used by Koning and Keeley. For further comparison, the post-project values are also well within the range (0.008 to 1.75 smolts/m^2) of spring chinook smolt production values summarized by Warren (1994). Spring chinook typically have stream-type life histories in which freshwater rearing lasts one to two years, so their smolt production is expected to be much less than for Cedar River chinook, which are primarily the ocean-type life history in which most juveniles migrate as age 0+ fish.

ESTIMATING PROJECT VALUE FOR STEELHEAD

Habitat Area Limitations to Steelhead Production: As with chinook, no limitations for steelhead use of mainstem habitat were identified because the entire Cedar River mainstem is accessible. For tributaries, it was assumed that steelhead would use them primarily for rearing as far up as the upstream end of the mainstem valley wall ravines through which they flow (Steve Foley and Curt Kraemer, WDFW, pers. comm.). For valley floor projects, no value for steelhead was assigned, although at least two existing side channels and the lower reach of Taylor Creek, contained in Wetland 132, are likely steelhead habitat. There is also evidence (Larry Cowan, WDFW, pers. comm.) that groundwater-fed channels (but not ponds) are used by overwintering steelhead.

Steelhead Smolt APP from Valley Floor Projects: To be conservative, no value for steelhead was attributed to these projects.

Steelhead Smolt APP from Tributary Projects: Moderate level pre- and post-project APPs for steelhead smolts were estimated by multiplying the surface area of steelhead bearing tributary reaches by 0.03 and 0.069 smolts/m^2, respectively. The moderate pre-project smolt APP was estimated by multiplying the average parr densities for Zone 4 reaches (1.0 to 3.0% gradient) of Snow Creek and tributaries to the Green and Puyallup Rivers (Gibbons et al. 1985) by a parr-to-smolt survival rate of 30% as recommended by Curt Kraemer, WDFW. Post-project APP was estimated by multiplying the pre-project value by 2.3, based on the value of increasing habitat complexity for steelhead estimated by Koning and Keeley (1997). For Rock Creek, the post-project value (i.e., pre-project times 2.3) was used as the pre-project value, since habitat is already very good. It was then doubled to estimate post-project APP, reflecting a doubling in potential productive rearing area due to increased summer and fall flows. Subsequent production rates are about two times higher than those Koning and Keeley (1997) estimated for mainstem habitats. This is consistent with a 1.5- to 2-times greater parr density of steelhead in tributary reaches than in mainstem channels (Gibbons et al. 1985).

High and low APPs were estimated based on the variability of steelhead parr densities for ten streams summarized by Koning and Keeley (1997) and shown in Table E-4. Coefficients of variation for steelhead densities before and after treatment were the same, 57%. This value was applied to the pre- and post-treatment moderate estimates to obtain high and low APP estimates.

Steelhead Smolt APP from Mainstem Projects: The moderate level pre- and post-project steelhead smolt APPs were estimated by multiplying the affected mainstem surface by 0.01 and 0.023 smolts/m^2, respectively. Koning and Keeley's (1997) estimate of pre- and post-project (pre-project times 2.3) steelhead smolt production were used as the basis for the moderate level of post-project production because they were derived for mainstem rivers. The pre-project smolt production level is relatively close to the levels one would estimate using parr densities for Zone 3 (0.51 to 1.0% gradient) mainstem reaches of the Tolt and Green Rivers (Gibbons et al.

1985) and a parr-to-smolt survival rate of 30%. High and low estimates were derived using the same approach as for tributaries (see above).

ESTIMATING PROJECT VALUE FOR CUTTHROAT SMOLTS

Habitat Area Limitations to Cutthroat Production: Cutthroat inhabit all but the smallest and steepest channels, including those in heavily urbanized subbasins; therefore, no habitat area limitations for them were considered. As with coho, a gradient-based production model was developed to estimate production in tributaries.

Cutthroat Smolt APP from Valley Floor Projects: For each project, cutthroat smolt APP was estimated as 25% of coho production. This value is uncertain due to a lack of data on cutthroat smolt production for these types of habitat. However, based on casual observations of cutthroat in these habitats, this approach is believed to be conservative. As with coho, high and low production potentials were estimated as 50% variations (+/-) of the moderate level.

Cutthroat Smolt APP from Tributary Projects: As with coho, a slope-based production model was developed to estimate the average pre-project cutthroat APP (see Figure E-1). Peak cutthroat smolt production was set at 3% stream gradient based on the assumption that they are more abundant than coho smolts at higher stream gradients. Also, the maximum density of cutthroat was set at 25% of the maximum for coho (Figure E-1). Based on these assumptions, a fifth-order polynomial curve was constructed to reflect the hypothesized cutthroat smolt production expressed as a function of stream gradient. The equation is expressed as:

$$Y = (3.1990e^{2}) - (1.3352e^{2X}) + (6.0645e^{2X\wedge 2}) - (2.1687e^{2X\wedge 3}) + (2.6824e^{3X\wedge 4}) - (1.1171e^{4X\wedge 5})$$

where Y = cutthroat smolts/m^2; X = % slope of stream reach; e = natural logarithm

This is shown graphically in Figure E-1. An r^2 value is not shown as the curve was not constructed from a data set. Post-project APP was estimated as 1.7 times the pre-project level, based on the multiplier for resident cutthroat developed by Koning and Keeley (1997). The life history of cutthroat in the Cedar River is not well known. There appear to be at least three types: stream residents, adfluvial, and sea-run, the latter of which are believed to be uncommon in the system (Bob Pfeiffer, WDFW, pers. com.). It was assumed that cutthroat in the smaller tributaries are predominately stream resident and adfluvial fish and that the multiplier estimated by Koning and Keeley (1997) for resident cutthroat trout would be applicable. High and low APPs were estimated as 50% variations (+/-) of the moderate level.

Potential Cutthroat Trout Smolt Production from Mainstem Projects: For want of data, mainstem cutthroat APPs were estimated as 25% of coho potential. As with coho, high and low production potentials were estimated as 50% variations (+/-) of the moderate level.

ESTIMATION OF LONG-TERM PRODUCTION

To assess long-term cost per fish produced, an estimate of cumulative fish production over the 50-year life of the project was made using the average APP values. A build-up time to full production of each species was assumed to require two generations starting after the first year of construction. Production was increased in equal increments over the two generations. For sockeye, steelhead, and cutthroat, a generation was four years; for coho, three years; for chinook, five years. The actual build-up time could be longer or shorter depending on juvenile-to-adult survival rates. Sockeye, chinook, coho, and steelhead are all currently at depressed levels.

ESTIMATION OF PROJECT COSTS[17]

Capital and long-term costs were estimated for each project. For tributary and mainstem projects, capital costs were estimates published in the Lower Cedar River Basin and Nonpoint Pollution Action Plan (King County 1997) with exceptions for projects on Rock Creek and the Walsh Lake Diversion. For Rock Creek, the cost was based on securing enough water to increase existing base flows by 3 cfs (equivalent to about 1.94 million gallons/day in delivery capacity for a water supply system). This would be needed to ensure a minimum base flow in Rock Creek of approximately 4.5 cfs, the point at which sockeye enter the creek in good numbers. This was also presumed to be the minimum flow needed for chinook migration and spawning. A cost of $3.25 million/MGD (Joan Kersnar, Seattle Public Utilities, pers. comm., cited in Masonry Dam Flood Operations Study, Draft Report, November 1997) was used to estimate the total cost of obtaining additional flow.

For Walsh Lake Diversion, costs included those to modify the passage barrier at RM 0.6 (roughly estimated at $50,000) and to enhance 75% of the upstream channel between the barrier and Walsh Lake (RM 4.2). It was assumed that 25% of the channel would be left unaltered due to concerns about the stability of a containment dike. For the remaining channel, construction costs were based on placement of spawning gravel (52,048 cubic yards assuming a width of about 3 m and 20% spawnable bed), LWD (893 pieces at 1 piece per two channel widths), and plantings of bare-root conifer saplings (5355 trees at 1 tree/m^2). Construction costs were then multiplied by standard additional costs (see below).

For valley floor projects, capital costs were estimated for the following categories: individual construction items (e.g., costs of substrate excavation and hauling or of acquiring and placing LWD); sales tax (8.2% of construction total); contingency (20%); design and project management (15% of total construction costs, including tax and contingency); contract management and inspection (16.702% plus a lump sum of $8,462 per project regardless of project size); and right-of-way cost for developable land ($40,000/acre) and for conservation easement ($5,000/acre). All construction costs are conservative—that is, higher than anticipated volumes and quantities were generally applied.

[17] All capital costs are in 1998 dollars. Where conversion was necessary, a 3% annual inflation factor was applied.

Although the projects are expected to last much longer, a 50-year design life was used to estimate long-term costs and production benefits. This time frame was selected for several reasons. It is the typical management time frame for Habitat Conservation Plans (HCPs), which are currently being used by private and public entities seeking relief from the federal Endangered Species Act, and many of the proposed projects could be used as part of a HCP. Many habitat projects in the Cedar River basin and in other areas in the Pacific Northwest have functioned well for over 25 years with no sign of wearing out. Also, many of the potential restoration sites were relatively stable during floods in 1990, 1995, and 1996, comprising the flood of record for the Cedar River and the wettest winter on record. Furthermore, unlike typical engineered structures, which rely on materials that wear out, the proposed projects should actually increase in durability because of the extensive use of native vegetation that will grow and enhance stability and ecological value of the projects over time rather than wear out.

Post-construction costs were broken into three components: project monitoring, inspection, and maintenance. For project monitoring, four staff-days per project per year for five years would be needed to assess project performance. For valley floor habitats with spawning potential, this would entail weekly spawner counts over a two-month period for the first five years of the project. Each visit will require one-half staff day at $200 per half-day (including indirect costs) plus a $25 transportation cost. For tributary and mainstem projects, monitoring is envisioned as two days per project per year for fish population assessment and habitat mapping. To reflect the need for additional monitoring data, particularly sockeye egg-to-fry survival rates, on the performance of the large (over $200,000 capital cost) groundwater-fed channels, an additional $5,000/year for fry trapping for three years was added to the monitoring cost. Inspection costs were figured at a rate of four half-day site visits per year in the first five years plus a $25 per visit transportation cost, and two half-day site visits plus transportation costs for each of the following 45 years.

For long-term maintenance, a 50-year potential cost equal to 20% of the capital cost was used. Half of this was based on the assumption that every five years after construction, maintenance costs equaling 1% of the project capital cost would accrue. The other half of the maintenance cost was for rehabilitation of the channel in case unforeseen problems, such as erosion due to severe flooding, should occur. Many groundwater-fed channels have been built in British Columbia and Washington, but good information on maintenance costs is lacking. The available information suggests, however, that if the channel is properly sited and constructed, maintenance costs can be quite low. Beaver dams are the predominant problems in these areas, but they are relatively easy to remove.

For the tributary projects, maintenance costs are also probably conservative. In King County, installations of natural LWD and riparian plantings have required little or no maintenance. For the mainstem bioengineered projects, such as the Elliot and Hamakami Levees, King County experience suggests that some maintenance is necessary, but it is much less than for the traditional rock levees.

ASSESSMENT OF LAND OWNERSHIP AND RISK OF LOST OPPORTUNITY

Land ownership was assessed for each project in order to determine the relative risk of losing the opportunity for habitat restoration. Projects were judged low in risk of lost opportunity when they were on public land, where landowner willingness was known to be high, or when they were located in sensitive areas, such as riparian buffers or wetlands, with little or no future development potential. Those projects situated in rural residential areas or in areas where land clearing and other activities have recently been observed were subjectively judged at moderate to high risk depending on the degree of non-conforming activity and the extent to which the landowners were known to be willing to cooperate. In many cases landowner willingness was unknown.

Results

NUMBER AND AREA OF HABITAT PROJECTS

A total of 73 projects were evaluated. Table E-6 provides a description of each project, and Table E-7 summarizes the amount of new or enhanced habitat by project type. The 12 mainstem projects would modify 4,100 m of riverbank and enhance about 16,555 m^2 of edge habitat. The 10 tributary projects would affect about 21.7 km of channel and result in 70,187 m^2 of enhanced tributary habitat, of which 6,373 m^2 (9%) is expected to be spawning substrate for sockeye. The 51 valley floor projects would result in 158,840 m^2 (40.3 acres) of new or enhanced off-channel habitat, of which 39,174 m^2 (25%) is predicted to be spawnable by sockeye. The vast majority (about 89% or 140,732 m^2) of valley floor habitat would be new ponds and channels. The remainder (18,108 m^2) would be enhancement of existing valley floor ponds and channels. Of the new valley floor habitat, 83,176 m^2 would be new ponds expected to have suitable gravel and upwelling for spawning. These new ponds would furnish 13,458 m^2 of spawnable gravel for sockeye (about 16% of the total area of new ponds). An additional 22,203 m^2 of spawnable gravel for sockeye would be created within 29,604 m^2 of new channels in the valley floor. Enhancement of existing habitat would result in 3,514 m^2 of spawnable gravel for sockeye, about 9% of the total additional sockeye spawning area.

Although substantial, the amount of habitat described here does not represent the full potential for habitat restoration in the lower Cedar River. Several projects not originally identified in our original surveys have since come to light. For example, in 1997 the City of Renton proposed building two groundwater-fed channels to mitigate for city activities. King County Department of Natural Resources wants to construct a groundwater-fed channel on a site that was recently flooded and subsequently purchased by the County. There is strong interest in conducting additional buyouts coupled with setback or removal of flood control facilities if funds for such projects should become available. These actions would make available additional area for habitat development. Similarly, small amounts of additional tributary habitat could be enhanced, and many more mainstem flood control facilities could be improved to create additional production potential.

Additional gains in habitat could be had by increasing the width and, in some cases, the length of the proposed channels. This could be done at relatively small incremental cost.

PROJECT VALUE FOR FISH PRODUCTION

The predicted APPs of the proposed projects are summarized for each species in Table E-7. Actual production will vary depending on many factors, such as number of spawners and how projects are actually constructed.

Sockeye Fry: The projects would produce 35.1 million emergent sockeye fry annually, with a likely range of about 20 to 45 million fry (Table E-7). The majority (30.4 million) would be produced in new groundwater-fed habitats on the valley floor. The remainder (4.7 million) would result from enhancing tributaries, primarily by increasing spawning flows in Rock Creek, making the Walsh Lake Diversion within the City of Seattle's Municipal Watershed accessible for sockeye spawning, and adding spawning gravel and large woody debris to the diversion channel.

Coho Smolts: The predicted moderate level coho APP resulting from the proposed projects would be about 93,600 smolts, ranging from 53,000 to 192,000 (Table E-7). As with sockeye, valley floor habitats would produce the greatest average number (60,491) of smolts, followed by tributary and mainstem enhancements which would potentially produce 30,741 and 2,371 smolts, respectively.

Chinook Smolts: A moderate level APP of 9,996 chinook smolts would result from the proposed projects. APP for chinook smolts would range from about 7,300 to 26,300. The majority (and average of 6,870 smolts annually) would be due to enhancements of mainstem edge habitat. Tributary enhancements would account for 3,126 chinook smolts annually, almost entirely by restoring base flows in Rock Creek (Table E-7).

Steelhead Smolts: The moderate APP value of the proposed projects for steelhead smolts would be 939 (ranging from 485 to 1,462), the majority of which (723 smolts annually) would be produced by tributary projects, mostly due to flow restoration in Rock Creek, and the rest (215 smolts) from mainstem enhancements (Table E-7).

Cutthroat Smolts: The cutthroat trout smolt APP value of the proposed projects would be 28,757, ranging from about 22,000 to 55,700 annually (Table E-7). The valley floor projects would provide the greatest number (15,123 smolts). Tributary and mainstem enhancements would have the potential to annually produce 13,041 and 593 smolts, respectively.

PROJECT COSTS

The combined capital and long-term cost of all projects covered in this report is estimated at $72.0 million, the majority of which will be capital expenditures of $60.2 million (Table E-8). Allowances for maintenance over a 50-year period contribute $10.2 million. Fifty-year inspection and monitoring are estimated at $2.5 million. The average 50-year cost per juvenile salmonid produced (combined fry and smolt) is estimated at $0.042, ranging from an average of

$0.013 per juvenile produced from valley floor projects to $0.050 and $90.378 per juvenile produced from the proposed tributary and mainstem habitat projects, respectively.

Over half (58%) of the costs are due to mainstem projects, but these will contribute less than 1% of potential salmonid production. Cost of mainstem projects is high because they include residential buyout and relocation, which is needed in order to remove or extensively modify some levees and revetments. If these costs were reduced (i.e., facilities modified without buyouts) or covered from other sources (such as FEMA), the cost per fish of work that is directly related to habitat would be greatly reduced. Nevertheless, the mainstem projects would still be far more costly than others because production gains would be lower.

Valley floor projects are projected to produce 87% of the fish over the 50-year period but would account for only about 25% of the total 50-year cost. The most cost-effective valley floor projects are the groundwater-fed habitats which would produce mainly sockeye; 19 of these would produce fish at costs less than $0.02 per fish.

Tributary projects would cost approximately $10 million. Fifty-year costs per fish would range from a low of $0.0045 per fish for enhancements of the Walsh Lake Diversion to a high of $120.895 for restoration of the South Fork of Madsen Creek. The high cost for producing fish in urban tributaries ($3.113 to $120.895 per fish) is due mainly to the assumption that they would produce only modest numbers of cutthroat trout because of the impact of urbanization. About 70% of the cost of tributary projects would be used to buy water (almost 2 MGD) in order to add 3 cfs to Rock Creek during critical low flow periods; despite this, Rock Creek is expected to produce fish at a favorable cost ($0.135 per fish) over the 50-year life of the project.

LAND OWNERSHIP AND OPPORTUNITY RISK

Table E-11 summarizes ownership and risk of lost opportunity. Landowner willingness is also shown, but as no formal landowner survey has been done, there are many projects for which willingness is unknown, and for those private sites where landowners have shown interest, few formal agreements have been made. A formal landowner survey of prospective project sites is highly recommended to verify the level of willingness.

Of the 51 sites with potential for valley floor projects, at least 19 are considered to be at moderate to high risk of not being available in the future for restoration. Many of these sites have substantial restoration value for sockeye production. Regardless of their fish production value, acquisition of many of the sites would also increase the effective buffer between the river and human activity, thus providing additional benefits. The tributary and mainstem projects are at predominately low risk of being lost to future development activities, most being protected by sensitive area buffers and steep slopes or pre-existing easements.

Relative scale of the valley floor projects ranges from small (7 projects) to large (21 projects). Most of the tributary projects are considered small to medium scale; the Walsh Lake Diversion and Rock Creek projects are large scale. In the case of Rock Creek, adjacent property owners would not be materially affected. However, for enhancements of the Walsh Lake Diversion, landowners, principally the City of Seattle and a few streamside homeowners, would be affected by construction activities.

Discussion

FACTORS AFFECTING PROJECT SUCCESS AND IMPLEMENTATION

Watershed Geology and Groundwater Hydrology: The proper geology and hydrology are critical for the success of many of the projects described in this report. While these factors will not be known in detail until further surveys are made, prospects for success look good. Past glaciation and subsequent river meandering that began shaping the basin some 14,000 years ago created a valley floor of porous, relatively silt-free gravel and cobble, which forms an extensive, shallow aquifer under the valley floor. Most of the proposed valley floor projects will capitalize on this favorable situation, which was confirmed in 1997 at four potential habitat sites (RM 5.6, 6.0, 8.4, and 19.9) by collection of well data along the valley floor. The numerous small ponds and wells built by landowners in the Cedar River lowlands further corroborate this.

Tributaries also benefit from the favorable geology as they generally drain flat plateaus in their headwaters. These plateaus are dominated by wetlands, lakes, and moraines of porous sand and gravel left behind by the glaciers. Provided the tributary drainage area remains mostly forested and not paved, these attributes tend to dampen stream flow response to storms.

Land Use: Despite the development pressure it receives due to its proximity to the Pacific Northwest's most densely populated urban area, much of the lower Cedar River basin has remained relatively well-suited for habitat restoration. The river's present water quality and that of its four main fish-bearing tributaries—Rock, Taylor, and Peterson Creeks, and the Walsh Lake Diversion—is good to excellent and they have fair to excellent channel habitat and stability and mostly intact forested riparian areas. The excellent water quality in the mainstem should persist because the upper basin is wholly within the City of Seattle's Municipal Watershed and therefore protected from development. In addition, the four main fish-bearing tributaries and all mainstem reaches above approximately RM 5.0 are zoned primarily for rural development and are expected to remain so until the year 2014 as part of the Growth Management Act (GMA).[18] Therefore, the dramatic changes in flow regime and water quality, which dense urbanization can cause and which would reduce the success of habitat projects, are not anticipated. As a result, much of the best fish habitat is not yet irreparably damaged, and there is cause for guarded optimism that the many opportunities identified in this report will not fail due to excessive changes to stream hydrology and erosion due to land development.

Such optimism is warranted only for the near term. The GMA has provisions for changing the Urban Growth Boundary prior to 2014, and even under existing zoning, aquatic habitat could be degraded and restoration opportunities lost as landowners act on their desire to clear and develop rural land. Even under existing rural zoning, habitat conditions could degrade if landowners do

[18] The recently incorporated City of Maple Valley drains primarily to the south to Soos Creek.

not properly protect riparian areas and forest cover or if they create too much impervious surface and/or direct excess flow into stream channels without first detaining and wherever possible infiltrating runoff. Actions must be taken soon to work with landowners to avoid these impacts and to protect and restore the habitat values of their land. To accomplish this, the public will have to be better educated and agency efforts better coordinated to build the support and provide the necessary funds in time to protect not only the Cedar River, but the other highly productive fish habitats in King County.

Minimum Instream Flows: Provision for adequate instream flows is a critical element for the success of most projects proposed in this report. The Cedar River's mainstem flow, which is regulated by the City of Seattle, supports significant fish production in the mainstem channel and recharges the groundwater needed for the proper functioning of off-channel habitats. These flows are most critical for chinook, steelhead, and sockeye, which rely primarily on mainstem habitats. Maintenance of adequate mainstem flows has further importance for sockeye because they would use the groundwater-fed channels extensively for spawning, egg incubation, and fry emergence and emigration.

The most critical periods for flow maintenance for chinook are approximately mid-September through October when they are spawning, and late January through mid-June when their juveniles are emerging, rearing, and migrating to the lake. For steelhead, instream flows are most critical from April though early June when their eggs are developing in river gravel. Because steelhead spawn at relatively high flows in the late winter and early spring, many of the gravel bars in side-channels in which they spawn could be dewatered if flows are not maintained.

Critical flow periods for sockeye are from mid-October to early November when sufficient flow is needed for adults to enter and spawn in off-channel habitats (typically a week or two after mainstem spawning peaks) and from late April through late May when river flows are dropping but fry are still emerging and migrating to the lake. Fry survival during migration to the lake is highly dependent on in-river flows, with higher flows resulting in better survival (Seiler 1995).

The proposed design parameters for valley floor and mainstem habitat projects are believed to be adequate to ensure high productivity under the current flow regime. The future is uncertain, however, and it will be critical for agencies regulating river flow to identify and maintain the proper instream flows that maintain fish and properly functioning aquatic and riparian habitats.

Private Landowner Considerations: Private landowner support will be crucial. Thus far, landowners have raised the following concerns: (1) public access to their property or on adjacent properties; (2) the potential exclusion of certain passive recreational uses of the site, such as walking near the habitats for personal enjoyment; (3) an increase in regulatory burden of riparian buffers; (4) rotting salmon carcass odors and interactions between pets and carcasses; and (5) the threat of condemnation and eviction from their property. Despite these concerns, most landowners contacted in the planning process have expressed general support for the projects; many individuals view the creation of fish habitat as an economic and aesthetic improvement. Under current law landowners must be compensated for use of their property for the types of projects proposed in this report. Furthermore, current County policy does not provide for the condemnation of property for habitat restoration purposes. A variety of measures, such as acquisition of future options and life leases, may be more acceptable to landowners and may be used to achieve long-term habitat goals where landowners are currently unwilling.

Public Landowner Considerations: By improving fish and wildlife habitat, the proposed projects are expected to enhance the natural open space values of public lands. The permission and cooperation of King County, which manages most of the public land in question, will have to be obtained. This will entail review and possible modification of existing management plans. Critical issues include responsibility for maintenance and impacts on public access and other potential open space uses.

Implementation Issues: Many of the proposed projects would require significant additional planning prior to implementation. King County's experience indicates that for all but the simplest of capital projects, at least two years is required for permitting, design, and construction. One recent improvement in implementing the proposed projects is that the permitting process, although still complex and time consuming, has been improved to facilitate projects and reduce the costs of projects such as these.

Several other factors need to be addressed, however, before project implementation is assured. For example, mainstem river projects will require interaction with user groups (mainly boaters) concerned about the safety of areas in which large woody debris is installed. Prior to construction of groundwater channels, additional information about each site should be collected, including confirmation of appropriate hydrology and substrate. Negotiations with landowners will be required to obtain construction and conservation easements for most of the projects. These can be time consuming and could add an additional one to two years for implementation. And despite high interest and support, some landowners could refuse to cooperate or may choose to postpone the work.

Spawning Escapement Needs: Adequate spawning escapement is needed to achieve the juvenile production potential estimated in this report. Table E-12 summarizes rough estimates of the number of adults of each species that it would take to achieve each level of production potential. For sockeye, the moderate value would require about 90,000 adults, roughly 25% of the current escapement goal for the system. For chinook and steelhead the escapement needs would be 80 and 64 fish, respectively, representing about 1.5 and 25% of their respective escapement goals. There are no known escapement goals for cutthroat trout, but their numbers appear to be stable or increasing in the watershed, probably due to favorable habitat conditions (they do relatively well in urban streams) and possibly due to lack of competing salmonids such as coho salmon.

The most dramatic spawner requirement relative to current escapement goals would be for coho salmon. About 18,500 adults would be needed to seed the proposed habitats, roughly 1.2 times more fish than the current escapement goal (15,000) for Lake Washington. Although high, this is not an unlikely number for the watershed. For example, in 1970 a spawning escapement of 30,000 wild coho was recorded. Assuming a 60% harvest rate (typical for coho), the actual run size for that year could have been 75,000 adults. The number of smolts produced by the projects would also not be out of line with estimates of Lake Washington's natural smolt production capacity. Zilges (1975) estimated that Lake Washington could produce as many as 722,000 coho smolts.

Regardless, in recent years the numbers of all adult salmon returning to Lake Washington have generally been far less than spawner escapement goals due to a variety of factors such as poor ocean survival, mortality at the Ballard locks, and degradation of freshwater habitat. The problems at the Ballard Locks are being fixed and freshwater habitat problems are being addressed by a series of habitat protection and restoration efforts such as described in this report. Unless ocean conditions improve, however, escapement goals may not improve enough to adequately seed the projects.

IMPLEMENTATION STRATEGY AND MONITORING

Several factors related to the prioritization of system-wide fish production needs and project timing and monitoring need to be addressed before large-scale implementation of the proposed projects is undertaken. A comprehensive, long-term adaptive management approach in which funding for the protection of existing high quality habitats and native fish stocks is prioritized above habitat restoration or artificial production is strongly recommended. The protection of existing high quality habitats and native fish stocks is critical to success regardless of the mode of production. Furthermore, historical efforts to increase salmon production in the Pacific Northwest via habitat restoration or artificial methods have often not been successful and in some instances have caused costly impacts and unintended biological and physical consequences (National Research Council 1996).

Problems typically arise from our poor understanding of the structure and function of the ecosystem and its components. We do not fully understand what limits fish production in the Lake Washington ecosystem. The productivity of the lake is a critical uncertainty: there is growing evidence that the lake's food supply for juvenile salmon, especially sockeye, is being overcropped at critical times of the year. Predation may be another limiting factor.

The rate at which projects are implemented should not overwhelm our ability to evaluate their success and, if necessary, modify project design and objectives based on new information. Even if adequate funding and personnel were available to do all projects simultaneously, it would be prudent to spread them out over time, prioritizing those sites that are most at risk of being lost to private development or converted to other uses. In the long run, the most successful long-term programs are adaptive, incremental, diversified, balanced, and patient.

Monitoring is critical to a successful adaptive management strategy, and all projects proposed in this work include both intensive short-term and less intensive long-term monitoring. At a minimum, each project would be monitored for five years for fish use (surveys of juveniles and spawners) and habitat conditions. Semi-annual monitoring would be conducted every year of the fifty-year project life. This level of monitoring should provide adequate information to know whether performance goals are being met and how well the habitats perform at critical times, such as during floods and droughts. Additional funding is proposed to assess whether groundwater-fed channels are performing as well as predicted, particularly for sockeye egg-to-fry survival. There is always the potential for additional outside funding to conduct more rigorous evaluations about how projects are functioning.

FUNDING FOR IMPLEMENTATION

Funding for the proposed work is problematic. No single funding source exists, and what funds are available (e.g., the Cedar River Legacy) are severely limited and mostly allocated toward protection measures, such as acquisition of critical habitat areas. Some projects, such as improvements to tributary channels and modifications of flood control facilities, could be accomplished as maintenance and repair projects under surface water management activities conducted by King County, the U.S. Army Corps of Engineers, or the City of Renton. However, funding is extremely limited in the lower Cedar River due to the area's low population density, which results in a low capacity for the bonding required to generate funding. In addition, projects such as restoration of valley floor habitats, restoration of Rock Creek base flow, and enhancement of the Walsh Lake Diversion do not readily fall under the mandate of local surface water management. It would take a concerted and creative effort on the part of local, state, and federal agencies to find the funding necessary to implement these projects in a timely fashion. One mechanism originally envisioned to implement many of these projects was as mitigation required under local, state, or federal law. This has already happened in the case of the City of Renton's proposals to excavate groundwater-fed habitat and enhance river edge habitat to mitigate for city activities.

HABITAT RESTORATION EXPERIENCE IN THE LOWER CEDAR RIVER

Habitat restoration has been a major management objective in the lower Cedar River since 1994, when the Cedar River Legacy fund was established by King County. The primary use of these funds is the protection of high quality habitat, mainly through land acquisition and conservation easements. A secondary objective is to implement habitat restoration demonstration projects, including creation of groundwater-fed habitats, reconnection of off-channel habitats, and rehabilitation of tributaries.

King County's approach to river management has evolved rapidly with development of new bioengineering techniques, such as use of stable large woody debris and of conifer plantings, to provide habitat and prevent flood damage. Although they should not be used in lieu of more comprehensive floodplain restoration, river bioengineering techniques offer unique solutions to habitat and flooding problems.

Since 1994, King County has constructed five major projects in the lower Cedar River. These include excavation of two groundwater-fed habitats, restoration of a levee using bioengineering techniques, restoration of fish passage into an oxbow pond, and the addition of natural LWD in a tributary channel. Numerous small habitat projects have also been implemented in the basin. Two additional significant pieces of groundwater-fed fish habitat were inadvertently created by private landowners over twenty years ago as a result of gravel mining and trout pond construction in the valley floor; they are still highly productive. Taken together, these projects illustrate the broad potential for habitat restoration in the basin.

Elliott Groundwater Channel (RM 4.0, Left Bank): King County created this 700-foot-long channel on park land owned by the City of Renton in late summer 1995 with funds from the County's Cedar River Legacy program. Predicted construction cost was about $350,000, but the actual cost was about $280,000. Significant cost savings were realized by using the excavated gravel for a nearby levee repair. Conversely, permitting costs were very high due to the unfamiliarity of regulatory agencies with this type of project. Permitting problems and associated costs have been much reduced since this habitat was built.

Sockeye migrated into the channel and started spawning on about November 6, 1995, five weeks after project construction. Despite an extremely low escapement of sockeye (only about 26,000 fish), that year's peak count of sockeye spawners was 53. That winter, 1995-96, was the Puget Sound region's wettest on record. The river experienced two floods of about 20- to 25-year recurrence, which inundated the channel both times. The channel remained intact, but some damage occurred because its extensive stabilization plantings had not yet rooted. The channel was repaired and design modifications were made in summer 1996 at a cost of $90,000. It has performed well since, and the bioengineered bank protection has taken hold quickly. Peak sockeye spawner counts were 456 in 1996 and 336 in 1997. Assuming a two-week spawner life, the estimated total number of spawners in 1996 was 1,500, equal to about 1.2 females/m^2 of spawnable substrate.

Vandalism has been minimal at Elliott, but two known poaching incidents occurred in December 1997. Future management activities planned by the County at this and other sites include coordination with law enforcement agencies and volunteer groups to ensure regular visits and thereby reduce the likelihood of poaching and vandalism.

Elliott Levee Restoration (RM 6.0: Left Bank): Constructed in 1995, this project is a short distance upstream of the Elliott Groundwater Channel. The original Elliot Levee, constructed in the early 1960s, subsequently failed on at least two separate occasions, the last in the November 1990 storm, the largest flood on record for the Cedar River. King County wanted to abandon the levee unless high maintenance costs and adverse habitat impacts could be avoided. The City of Renton argued that reconstruction was necessary to protect the Maplewood Golf Course. As a compromise, a new levee was designed to provide the flood protection and habitat benefits desired by the two local governments. .

The new design called for a levee that would be set back from the river, creating a wider floodplain between the levee face and the river's edge. The levee was stabilized by vegetated *geogrids*, a combination of plantings, soils, and rock held together in part by natural fiber, biodegradable fabric. It was designed to overtop and to dissipate river energy during floods. To further stabilize the bank and add habitat value, about 50 large conifer logs (approximately 8.3 m long by 0.75 m dia.) with root wads were embedded into the bank at the river's edge. The County chose to reconstruct the levee and the Elliott Groundwater Channel at the same time (1995) to reduce costs and maximize restoration benefits.

The levee was restored with County and federal funds at a cost of about $300,000 and was put to the test the following winter, being subjected to the wettest winter on record including two 20- to 25-year floods. Compared to the performance of the previous levee, it sustained relatively minor damage. Five logs that were washed out were replaced with rock deflectors, and a small portion of the setback levee required reconstruction and design modification to allow for the free passage of flood waters. Repairs were made in summer 1996 at a cost of about $64,000. Subsequent observations have revealed high numbers of juvenile and adult salmonids utilizing the LWD compared to adjacent rock levees.

Experience with the reconstructed Elliott Levee and other bioengineered flood control facilities in King County indicates that they have lower maintenance costs, improved flood protection, and increased fish and wildlife benefits. The principal concern has been boater safety, particularly with LWD placement that could lead to boaters being swept into or under the logs and root wads. The County has established a boater safety committee to ensure safe configuration and placement of LWD along river margins.

Cavanaugh Pond (RM 6.0: Left Bank): Originally excavated during a gravel mining operation, this 14-acre pond was abandoned in the early 1970s. Since then, the pond has become surrounded by dense vegetation, including a maturing deciduous forest, and is now used by a diverse and abundant fish and wildlife community that is remarkable given its proximity to the Renton City limits (3.2 km). King County acquired the pond and surrounding area in the mid-1980s. Sockeye spawn along the pond's entire shoreline, but most heavily (as many as 3 to 4 fish/m^2) along a levee that separates the pond from the river. Peak sockeye spawner counts have averaged 1500 fish between 1993 and 1997 (range 3012 in 1994 to 305 in 1997; the latter value was affected by poor visibility during survey). Juvenile coho and cutthroat trout use the pond, and during major floods it is a refuge for chinook and steelhead. Wildlife observed on the site include amphibians, deer, beaver, river otters, trumpeter swans, bald eagles, great blue and green herons, wood ducks, and other waterfowl.

Ricardi Pond (RM 7.3: Right Bank): This pond was excavated in summer 1997 after two flood-damaged homes were removed. Exclusive of the acquisition and removal of the homes, the cost to construct the pond, connect it to the river, and revegetate the surrounding area was about $150,000. The original design called for connecting the pond to an outlet channel that would drain toward a downstream connection with the river, thereby inducing groundwater-fed upwelling in the pond. But due to a reluctant landowner (who has since agreed to a buyout), the County could not purchase the easement for the pond outlet called for in the original design within the time frame of available funding. As a result, the pond was connected to the river by a shorter channel, creating a backwatered habitat instead of the more desirable groundwater-fed pond. Even so, a peak of 31 sockeye was observed during the fall following construction, suggesting that some upwelling is present.

McDaniel's Pond and Channel (RM 11.5: Left Bank): In 1975, a local landowner attempting to excavate a pond struck a great deal of shallow groundwater that was under pressure. To drain the water and prevent localized flooding, the State forced him to build an emergency channel that followed an old river swale to a junction with the river about 0.5 km downstream from his pond. Many sockeye began spawning in the pond and its outlet channel in the fall of the same year. Peak sockeye spawner counts in the ensuing years have averaged about 620 fish between 1994 and 1997 (range 1395 in 1994 to 172 in 1997). Coho, cutthroat, and other wildlife also use it. Additional habitat enhancement opportunities at this location include excavating an additional pond and adding spawning gravel to the outlet channel. Some of the latter work was accomplished as a small habitat project in summer 1996.

Walsh Lake Diversion Restoration: (RM 19: Right Bank): This channel enters the Cedar River about two kilometers below the Landsburg Diversion Dam. It was constructed in 1931 and 1932 by the City of Seattle to transport water of poor drinking water quality away from the water intake at Landsburg. At the time, the stream's water was impaired due to high organic content and sewage contamination from a small coal mining and logging town (Taylor Townsite), since abandoned. Salmonids and other fishes have populated the diversion. A high velocity chute at RK 1.0 blocks access by anadromous salmonids to at least 4 miles of stream habitat and many acres of lake and wetland habitat. The provision of fish passage and enhancement of the upstream channel between the barrier and Walsh Lake[19] is one of the more significant projects recommended in this document.

The lower 0.4 km of the Walsh Lake Diversion, which flows across King County open space, lacks LWD, and its riparian area is dominated by a deciduous forest that is unlikely, at least in the near term, to produce the desired type and amount of LWD. As a consequence, King County, the U.S. Environmental Protection Agency, the Mid-Sound Fisheries Enhancement Group, and numerous volunteers installed about 85 pieces of unanchored LWD in natural configurations and restocked the riparian area with conifer trees at a cost of about $50,000. The LWD is intended to promote pool formation and to retain spawning gravel. The plantings should ensure a long-term supply of coniferous LWD.

Project impacts are being monitored by pre- and post-project mapping of instream habitat and LWD, sockeye spawner surveys, and assessment of conifer sapling survival. Post-project data have not been completely analyzed, but adult and juvenile salmonids have been observed actively using the LWD for cover, and additional woody debris has accumulated, anchored by the introduced pieces. Approximately 75 to 90% of the conifers appear to have survived the first two years following planting.

Conclusions

Several cost-effective opportunities to restore habitat in the lower Cedar River have been identified. These would have the potential to produce emergent sockeye fry, and smolts of chinook and coho salmon and steelhead and cutthroat trout. Many of these projects would also significantly benefit other fish and wildlife species, water quality, and floodplain restoration efforts. They would increase the overall ecological health and quality of life along the Cedar River and help sustain fish production into the foreseeable future. Many of these projects are time-sensitive: they are on private land where the owners may in time be motivated to convert their property to other uses. Therefore, the opportunities could be lost if not acted upon soon.

If all the projects assessed in this report were constructed and adequate spawning escapement achieved, the predicted value of the work in terms of fish production would be about 35 million emergent sockeye fry, 93,600 coho smolts, 10,000 chinook smolts, 940 steelhead smolts, and 29,000 cutthroat smolts. Long-term (50-year) production is estimated at 1.9 billion emergent sockeye fry, 5.6 million coho, 0.9 million chinook, 98,000 steelhead, and 1.25 million cutthroat. The methods used to estimate the production potential and costs of each project were

[19] Although not assessed in this report, enhancements, including the removal or reduction of non-native fishes, could also be made to Walsh Lake to benefit salmonid production and provide broad ecological health benefits. The lake is part of a large (105 acre) wetland complex that is probably the best preserved habitat of its kind in the Puget Sound lowlands.

conservative. Since the report's data were collected, several more projects have been identified. Also, many of the projects could be increased in size and additional benefits gained at relatively little added cost.

The projects required to produce these numbers could be constructed for about $60.25 million. However, approximately 87% of the fish, including 30.4 million sockeye fry and 60,500 coho smolts, could be produced for only 25% ($14.7 million) of the capital cost if all valley floor projects were constructed. Long-term costs (maintenance allowance, plus monitoring and inspection) would add an additional $6.2 million, raising the total 50-year cost to $60.4 million (in 1998 dollars) and cost per fish, on average, to $0.032. The lowest cost per fish is $0.01 for valley floor projects, and the highest is $29.158 for mainstem projects. The latter are expensive because of the high cost of buyout of floodplain development.

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List of Tables and Figures

Table E-1. General physical data for the Cedar River Basin.

Basin	Area (km^2)	Land elevation (m) Highest	Lowest	Diff.	Channel length (km) Mainstream	Tributaries	Mean Annual Discharge (ft^3/sec)
Upper	316	1,261	159*	1,102	~26	unknown	682
Lower	171	~300	6.4**	~294	34.9	47.6	638
Total	487			1,255	~61		

* Apron at toe of Landsburg Dam.
** Mean elevation of Lake Washington.

Table E-2. Stream channels accessible to anadromous salmonids in the Lower Cedar River Basin.

Stream	WRIA[a] number	Length (km)	Width[b] (m)	Area (ha)	Upper extent of species use (km)a Coho	Chi-nook	Steel-head	Cut-throat	Sock-eye
Upper Cedar River (main)		~26							
Lower Cedar River (main)		34.9	33.5	116.9	34.9	34.9	34.9	34.9	34.9
Maplewood Creek[b]	0302	2.9	~1.3	0.38	1.45	0.0	1.45	1.45	0.0
Maplewood Creek trib.[b]	0303	2.6	~1	0.26	0.65	0.0	0.65	0.65	0.0
Molasses Creek	0304	4.2	~2	0.84	1.28	0.0	1.28	1.92	0.32
Madsen Creek	0305	4.8	~1	0.48	3.52	0.0	2.4	4.16	1.28
Madsen Creek tributary	0306	1.6	~0.5	0.08	0.64	0.0	0.0	0.96	0.0
Unnamed tributary	0316	0.8	~0.5	0.04	0.32	0.0	0.0	0.32	0.0
Unnamed tributary	0316A	1.3	~0.5	0.06	1.3	0.16	0.52	1.3	0.16
Taylor Creek	0320	5.3	~2.5	1.33	5.12	1.92	5.12	5.12	3.84
Taylor Creek tributary	0321	1.3	~1.8	0.23	1.28	0.0	1.28	1.28	0.0
Taylor Creek tributary	0323	0.4	~1	0.04	0.0	0.0	0.0	0.32	0.0
Taylor Creek tributary	0326	1.1	~1	0.11	1.12	0.0	1.12	1.12	0.0
Peterson Creek	0328	4.2	~2	0.84	4.32	0.64	2.24	4.32	2.56
Peterson Creek tributary	0328B	3.5	~1	0.35	3.2	0.0	3.2	3.2	0.0
Unnamed creek	0336	2.6	~1.5	0.39	0.4	0.0	0.4	0.4	0.4
Rock Creek	0338	4.3	~4.5	1.94	4.24	2.72	2.72	4.24	2.72
Walsh Lake Diversion	0341	6.8	~3	2.04	8.32	0.32	0.96	8.32	6.4
Lower Cedar Basin Totals		82.6		126.31	71.97	40.02	59.76	73.83	53.54

[a] Known or suspected historic distribution based on flow, gradient, substrate, and barriers.
[b] Assuming barrier dams above golf course are removed.

Table E-3

Biological performance values used for estimating salmonid production potential of Cedar River habitat projects.

	Production Level	Females/m^2 spawnable gravel	Egg deposition/m^2 spawnable gravel	Egg-to-Fry Survival Rate	Fry/m^2 of spawnable gravel
Sockeye - Valley Floor GW Channel	Moderate	0.83	2829	0.30	849
	Low	0.40	1363	0.36	491
	High	1.30	4431	0.24	1063
Sockeye - Tributary Channel (gradients < 5.6%)	Moderate	0.83	2829	0.08	238
	Low	0.40	1363	0.06	76
	High	1.30	4431	0.12	514

Comments:

Average female spawner density from Ames (1997). Used to establish mitigation goal for Landsburg Diversion.

Low female spawner density based on Baker Lake beach spawner data; high value based on interpolation between moderate value and point of diminishing fry production for increasing egg deposition in Weaver Creek Spawning Channel.

Fecundity is 3,588eggs/female (Hiser *ca* 1970); Egg deposition rate is 95% (Seattle Water Department 1990)

Egg-to-fry survival rates for GW channels are 50% of rates for corresponding female densities in the Weaver Creek Spawning Channel (see Chart 6-1 Seattle Water dept. 1990); for tributaries used comparative data in Seattle Water Department (1990).

Species- Habitat		Smolt/m^2 Pre-Project	Smolt/m^2 Post-Project	Comments
Coho -Mainstem	Moderate	0.179	0.322	Mainstem assumed half as productive as tributary.
	Low	0.090	0.161	Post-Project 1.8X pre- (K&K 1997)
	High	0.269	0.483	Low/High values are 50% (+/-) variations of average.
Coho - Tributary	Moderate	Gradient-Based	1.8X Pre-	Gradient-based model based on data from Baranski (1989); peak at 1.5% slope.
	Low	50%<Mod	1.8X Pre-	Post-Project multiplier from Koning and Keeley (1997)
	High	50%>Mod	1.8X Pre-	Low/High values are 50% (+/-) variations of average.
Coho- GW-Spawn Ponds & Channels (Low Complexity)	Moderate	0.381	Same as Pre-	Gain due only to increase in habitat area. Post-project condition will remain
	Low	0.220	Same as Pre-	low in habitat complexity to reduce sockeye fry predation by coho and cutthroat trout.
	High	0.888	Same as Pre-	Average value from Koning & Keeley (1997); corrected for low habitat complexity.
Coho- GW-Nonspawn Ponds & Channels (High Complexity)	Moderate	0.381	0.680	Post-Project is avg. of off-channel ponds and side channels in K&K (1997)
	Low	0.220	0.392	Pre-project = 0.56X post-project; correction for low habitat complexity.
	High	0.888	1.585	Low/High from Table 4 calculation.
Chinook - Mainstem	Moderate	0.0500	0.465	Moderate value and multiplier from K&K (1997)
	Low	0.0289	0.236	Avg. Post-Project = 9.3X pre- (Koning and Keeley 1997)
	High	0.0789	1.165	Pre-project range based on 58% (+/-) of average.
				Post-project range based on mid-point of high and low data points and mean.
Chinook - Tributary	Moderate	0.0250	0.233	Assume tributaries half as productive as mainstem.
	Low	0.0145	0.118	Post-Project 4.65X pre- (half of mainstem effectiveness)
	High	0.0395	0.582	Range same as for mainstem.
Steelhead - Mainstem	Moderate	0.010	0.023	Moderate= avg. parr densities for Zone 3 mainstem reaches (Gibbons et al 1985)
	Low	0.006	0.013	times 30% parr-to-smolt survival rate. Zone 3 is gradient range of 0.5 to 1%.
	High	0.016	0.036	Post-Project 2.3X pre- (K&K 1997). Low/High are 57% variations of moderate.
Steelhead - Tributary	Average	0.030	0.069	Moderate = avg. parr densities for Zone 4 tributary reaches (Gibbons et al 1985)
	Low	0.017	0.040	times 30% parr-to-smolt survival rate. Zone 4 tributary gradient range is 1-3%.
	High	0.047	0.108	Post-Project 2.3X pre- (K&K 1997). Low/High are 57% variations of average.
Cutthroat - Tributary	Moderate	Gradient-Based	1.7X Pre-	Model assumes peak productivity at 3% gradient & max. production @ 0.25X coho.
	Low	50%<Mod	1.7X Pre-	Multiplier for resident cutthroat (K&K 1997)
	High	50%>Mod	1.7X Pre-	Range same as for coho.
Cutthroat - All Other Habitats	Moderate	0.25XCoho	0.25XCoho	Conservatively assumed production = 0.25X that of coho.
	Low	0.25XCoho	0.25XCoho	Range same as for coho.
	High	0.25XCoho	0.25XCoho	

Table E-4

Fish production data and calculated values used for estimating range of fish production. Data adapted from Koning and Keeley (1997).

	coho smolts/m^2 from valley-floor habitats			age 0+ coho/m^2 of stream habitat		age 0+ chinook/m^2 of stream habitat		steelhead parr/m^2 of stream habitat	
	side-channels	*Off-channel ponds*		*untreated*	*treated*	*untreated*	*treated*	*untreated*	*treated*
	0.20	0.43		0.18	0.49	0.05	0.08	0.06	0.02
	0.46	0.12		0.45	0.90	0.06	0.17	0.05	0.04
	0.27	0.02		0.89	1.50	0.14	0.41	0.02	0.08
	0.01	2.79		0.57	0.93	0.03	0.01	0.07	0.17
	1.62	0.96		0.69	0.99	0.09	2.71	0.02	0.18
	0.15			0.47	1.51			0.02	0.11
	0.48			0.38	0.28			0.04	0.18
	2.01			0.28	0.34			0.09	0.11
	1.34							0.03	0.09
	0.17							0.03	0.03
mean	0.67	0.86		0.49	0.87	0.07	0.68	0.04	0.10
standard deviation	0.71	1.14		0.23	0.48	0.04	1.15	0.02	0.06
coefficient of variation (CV)	106%	132%		46%	55%	58%	170%	57%	57%
Calculated Values*			Avg. **						
Low	0.34	0.44	0.39	na	na	na	0.34	na	na
High	1.34	1.83	1.59	na	na	na	1.69	na	na

* Calculated when CV >100%; value = mid-point between mean and the highest and lowest data points, respectively.

** Combined average of side channels and ponds used for estimating high and low production.

Table E-5

Reported literature values for egg-to-fry survival rates and female spawner densities for sockeye and chum salmon. Survival rates based on downstream migrant trapping except for Upper Pitt River which is survival to the late-eyed stage.

Egg-to-fry survival (%) and female spawner densities for sockeye and chum salmon.

		Egg-to-Fry Survival (%)			Females/m^2		
	Project	Avg.	Max	Min	Avg.	Max	Min
Sockeye	Weaver Cr. Sp. Ch. (1965-1984) [4]	64.2	89.5	25.1	0.83	1.6	0.06
	Baker Lk Beaches [3]	50	91	30	0.43	0.71	0.14
	Nadina Sp. Ch. (1973-1987)	54.3	71.5	41.2	0.31	1.13	0.15
	Average	**56.2**	**84.0**	**32.1**	**0.52**	**1.15**	**0.12**
Chum	BC GW-Ch. (All)	16.3	48	2.5	0.8	2.8	0.03
	BC GW-Ch. (< or = 0.5 Fem/m^2)	23	48	12	0.3	0.5	0.1
	Satsop GW-Ch.	40	55	15	0.15	0.24	0.07
	Average	**26.4**	**50.3**	**9.8**	**0.4**	**1.2**	**0.1**
	Abernathy Sp. Ch [2]	82.1	unk	unk	unk	unk	unk
	Jones Cr. Sp. Ch. [2]	30	unk	unk	unk	unk	unk
	Big Qualicum Sp. Ch. [2]	74	85.7	64.2	unk	unk	unk
	Average	**62.0**					

Percent egg-to-fry survival relative to female spawner density for sockeye and chum salmon.

	Sockeye				Chum	
Females/m^2 total habitat	Weaver Cr. Spawning Channel (SWD 1990)	Baker Lake Beaches (Sprague Pers Comm.)	General Canadian Data (SWD 1990)	Upper Pitt River - Corbold Creek Channel (Foy et al, 1996 Memo) 1	British Columbia Chum (Bonnell 1991)	Satsop Chum (Cowan 1991)
0.15		77			35	40
0.3	75	68		87	25	
0.34		66	69			
0.7		45	56			
0.83	60				15	
1			43		12	
1.3	48				8	

1) Survival to late eyed stage based on hydraulic sampling (Foy et al 1996)
2) From reports cited in Salo (1991)
3) Exclude years of mech failure and years with innacurate fecundity estimates
4) Includes years after flood damage

Table E-6

Project description and habitat dimensions for Cedar River habitat opportunities.

Valley Floor Habitat Projects

Project Name	Project Description	Primary Benefit from New or Existing Fish Habitat	Primary Habitat Objective	Left or Right Bank	River Mile	Spawnable Substrate for Sockeye (m^2)	Area of Habitat with Spawning Potential (m^2)	Area of Habitat without Spawning Potential (m^2)	Total Habitat Created or Enhanced (m^2)
Elliott Wetland Enhancement	Deepen portions of wetland, add LWD, expose gravel in channel	New	GW-Nonspawn	LB	4.5	185	207	2,791	2,998
Lower Summerfield	Dig GW pond and channel	New	GW-Spawn	LB	5.4	1,769	3,798	0	3,798
Upper Summerfield	Dig side channel and two ponds	New	GW-Spawn	LB	6.0	1,880	6,947	0	6,947
Herzmann Levee	Dig two ponds and side channel behind levee	New	GW-Spawn	RB	6.2	865	1,830	0	1,830
Lower Jones Road	Deepen and enlarge wetland, improve channel	New	GW-Nonspawn	RB	6.8	0	0	4,816	4,815
Upper River Bend	Dig GW pond, channel, underplant conifers	New	GW-Spawn	LB	7.2	838	2,583	0	2,583
Ricardi Tributary Ponds	Build GW-fed pond, add LWD, dig pools in existing channel	New	GW-Spawn	RB	7.3	279	2,806	915	3,721
Jeffries/Cook Revetment	Dig two ponds and channel, possibly tie into Ricardi pond (#7)	New	GW-Spawn	RB	7.3	4,076	15,803	0	15,803
Wetland 103	Dig four ponds, channel	New	GW-Nonspawn	LB	7.5	0	0	1,739	1,739
Wetland 37-A	Dig GW channel	New	GW-Spawn	LB	8.2	1,212	5,338	0	5,338
Wetland 37-B	Dig 2 GW ponds with separate channels, next to 37A	New	GW-Spawn	LB	8.3	2,098	5,002	0	5,002
Powerline Habitat	Dig two GW ponds, outlet channel	New	GW-Spawn	RB	9.5	325	834	0	834
WPA/Cedar Mountain Levee	Dig GW pond and channel behind levee	New	GW-Spawn	LB	10.3	781	3,249	0	3,249
Lower Rainbow Bend	Dig GW pond	New	GW-Spawn	RB	10.6	881	1,852	0	1,852
Upper Rainbow Bend	Dig GW pond, channel	New	GW-Spawn	RB	10.7	1,377	3,121	0	3,121
Tributary 0316A	Dig and connect three ponds	New	GW-Nonspawn	RB	11.1	0	0	1,203	1,203
Byers Bend Channel	Dig GW pond, channel	New	GW-Spawn	LB	11.5	2,389	5,347	0	5,347
McDaniels New Pond	Dig a GW pond	New	GW-Spawn	LB	11.6	450	3,034	0	3,034
Jan Road Floodway Channel	Dig two GW channels (connect to Project 22) and two ponds	New	GW-Spawn	RB	12.2	2,433	5,089	0	5,089
Jan Road Ponds	Dig and connect five ponds	New	GW-Nonspawn	RB	12.2	0	0	1,112	1,112
Jan Road Levee	Dig GW pond, channel	New	GW-Spawn	RB	12.5	1,468	6,789	0	6,789
Rutledge/Johnson Levee Pond	Dig GW pond, connect to existing side channel (Ref37)	New	GW-Spawn	LB	12.6	348	1,241	0	1,241
Wetland 132 Ponds	Dig two ponds and channels	New	GW-Nonspawn	RB	12.6	0	0	4,880	4,880
Getschmann Levee Pond	Dig GW pond and connect to side channel	New	GW-Spawn	RB	13.6	828	3,151	0	3,151
Witte Road GW Channel	Dig fish-usable GW channel	New	GW-Spawn	LB	14.8	995	1,328	0	1,328
Seattle Saddle Club	Dig two GW ponds, improve existing pond, add connecting channels	New	GW-Spawn	LB	15.2	841	2,208	0	2,208
Dorre Don Court	Dig one GW pond, two channels	New	GW-Spawn	RB	15.7	415	963	0	963
Dorre Don Left Bank Side Channel Ponds	Dig two GW ponds, outlet to channel (#37)	New	GW-Spawn	LB	15.8	1,083	3,078	0	3,078
Dorre Don Left Bank Meander	Dig pond, channel	New	GW-Spawn	LB	15.8	744	1,125	0	1,125
Lower Dorre Don - Lower Habitat	Construct pond, realign tributary 0336	New	GW-Spawn	RB	15.9	829	2,929	0	2,929
Lower Dorre Don - Upper Habitat	Dig GW pond and outlet channel	New	GW-Spawn	RB	16.1	687	1,530	0	1,530
Orchard Grove Left Bank Habitat	Dig two GW ponds, two channels	New	GW-Spawn	LB	16.2	1,858	6,854	0	6,854
Heath/O'Keefe	Excavate upper part of Wetland 79, GW channel to private pond	New	GW-Spawn	LB	17.8	813	1,218	0	1,218
Wetland 79	Make culvert passable, add LWD, underplant conifers	New	GW-Nonspawn	LB	17.8	279	1,088	1,368	2,456
Lower Rock Creek Pond Access	Install culvert under 252th to two existing ponds, underplant conifers	New	GW-Nonspawn	LB	17.9	0	0	458	458
Lower Rock Creek Pond Enlargement	Enlarge existing GW pond (see project VF-46)	New	GW-Nonspawn	LB	17.9	0	0	830	830

Table E-6

Project Name	Project Description	Cedar River Mile Entry	Project Reach Location (Trib RM)	Reach Gradient (%)	Avg. Channel Width (m)	Proportion Spawnable Bed for Sockeye	Channel Area w/ Sockeye Spawning Habitat (sq. m)	Channel Area w/out Sockeye Spawning Habitat (sq. m)	Total Channel Area (sq. m)	Spawnable Substrate for Sockeye (sq. m)
Madsen Creek Bio-Stabilization and Habitat Rehabilitation	Reduce erosion and rehabilitate habitat with LWD and conifer underplanting	5.10								
Reach A			0.0 - 0.85	0.9	2.25	NA - Urban	0	3,132	3,132	0
Reach B			0.85 - 1.55	4.7	2.25	NA - Urban	0	2,547	2,547	0
Reach C			1.55 - 2.1	5.3	0.81	NA - Urban	0	717	717	0
Madsen Total							0	6,396	6,396	0
S.F. Madsen Creek Bio-Stabilization and Habitat Rehabilitation	Reduce erosion and rehabilitate habitat with LWD and conifer underplanting	5.10								
Reach A			0.0 - 0.4	7	1.98	NA - Urban	0	1,275	1,275	0
S. F. Madsen Total							0	1,275	1,275	0
Trib 0316A Bio-Stabilization and Habitat Rehabilitation	Reduce erosion and rehab habitat in ravine (Reach A&B) w/ LWD and conifer underplanting; restore pond and channel habitat in Wetland # 32 (Reach C)	11.40								
Reach A			0.0 - 0.1	3.7	1.52	0.10	245	0	245	24
Reach B			0.3 - 0.6	7.5	1.52	0.00	0	[illegible]	[illegible]	0
Reach C			0.6 - 1.2	0.7	1.52	0.00	0	9,181	9,181	0
Trib 0316A Total							245	[illegible]	[illegible]	24
Taylor Creek Improvements	Realign channel along Maxwell Rd (Reach A) & reduce erosion and rehab habitat in ravine (Reach B)	12.10								
Reach A			0.5 - 0.7	2.8	2.70	0.20	[illegible]	0	[illegible]	174
Reach B			1.2 - 1.8	2.7	2.70	0.05	2,608	0	2,608	130
Taylor Cr. Total							3,478	0	3,478	304
Taylor Trib 0321 Habitat Rehabilitation and Enhancement	Rehabilitate habitat near mouth (Reach A) and enhance high quality ravine habitat (Reach B)	13.10								
Reach A			0.0 - 0.2	4	1.66	0.10	531	0	531	53
Reach B			0.2 - 0.8	3.6	1.95	0.10	1,884	0	1,884	188
Taylor Trib 0321 Total							2,415	0	2,415	242
Peterson Cr. Rehabilitation and Enhancement	Enhance high quality ravine habitat (Reach A& B) and rehabilitate habitat at outlet of Peterson Lk (Reach C)	14.10								
Reach A			0.8 - 1.0	2.5	2.99	0.05	1,926	0	1,926	96
Reach B			1.0 - 1.4	0.4	2.99	0.10	1,926	0	1,926	193
Reach C			1.4 - 1.8	0.4	2.99	0.10	963	0	963	96
Peterson Cr. Total							4,814	0	4,814	385
Rock Creek Flow Restoration	Restore summer/fall baseflows (~ 3cfs) for spawning and rearing (Reaches A&B) and enhance Reach C	18.25								
Reach A			0.0 - 0.7	3.6	3.81	0.10	4,294	0	4,294	429
Reach B			0.7 - 1.7	0.8	5.18	0.20	8,335	0	8,335	1,667
Reach C			1.7 - 2.5	0.5	2.00	0.00	0	3,861	3,861	0
Rock Creek Total							12,629	3,861	16,490	2,096

Table E-6

		Primary Benefit from New or Existing Fish Habitat	Primary Habitat Objective	Left or Right Bank	River Mile	*Spawnable Substrate for Sockeye (m^2)*	Area of Habitat with Spawning Potential (m^2)	Area of Habitat without Spawning Potential (m^2)	Total Habitat Created or Enhanced (m^2)
New Rock Creek Ponds	Dig two GW ponds	New	GW-Nonspawn	LB	17.9	0	0	915	915
Arcadia WBT	Channel improvements: remove lining, add LWD, dig three pools	New	GW-Nonspawn	LB	18.2	0	0	275	275
Upper Arcadia WBT Access	Install passable culvert, improve two ponds, add LWD and riparian vegetation	New	GW-Nonspawn	LB	18.2	0	0	2,639	2,639
Wingert Ponds	Dig two GW ponds and channel, install culvert, add LWD, plant conifers	New	GW-Spawn	LB	19.5	665	3,153	0	3,153
Wetland 70	Dig GW pond, outlet channel	New	GW-Spawn	RB	19.6	934	3,478	0	3,478
Landsburg Oxbow (Wetland 69)	Divert Landsburg water oxbow lake, percolating along NE shore	New	GW-Spawn	RB	20.5	837	5,582	3,904	9,486
Total of New Valley Floor Habitat						**35,660**	**112,779**	**27,952**	**140,732**
Maplewood Heights Homeowners Site - Side Channel Enhancement	Dig beaded channel and divert spring into it, add LWD	Existing	GW-Nonspawn	RB	4.4	0	0	3,391	3,391
Tributary 0316 Enhancement	Restore riparian vegetation, add LWD, dig pools	Existing	GW-Nonspawn	RB	10.5	0	0	595	595
McDaniels Creek Enhancement	Enhance cover and riparian condition	Existing	GW-Spawn	LB	11.5	498	664	435	1,099
Wetland 132 Enhancement	Add LWD, underplant conifers	Existing	GW-Nonspawn	RB	12.0	0	0	2,256	2,256
Rutledge/Johnson Side Channel	Enhance habitat	Existing	GW-Nonspawn	LB	12.6	0	0	1,098	1,098
Getschmann Levee Channel Enhancement	LWD, conifer additions, channel to Taylor Creek	Existing	GW-Nonspawn	RB	13.6	309	412	0	412
Royal Arch Oxbow Enhancement	Add LWD, underplant conifers	Existing	GW-Nonspawn	RB	14.4	0	0	3,752	3,752
Witte Road Channel Enhancement	Increase habitat complexity in GW channel	Existing	GW-Nonspawn	LB	14.6	688	915	0	915
Dorre Don Left Bank Side Channel Enhancement	Channel improvements	Existing	GW-Nonspawn	LB	15.8	1,647	2,196	0	2,196
Spoerer WBT Enhancement	Enhance WBT with pools, LWD, and revegetate	Existing	GW-Nonspawn	LB	17.0	0	0	755	755
Wingert Side Channel Enhancement	Dig pools, add LWD and boulders, underplant conifers	Existing	GW-Nonspawn		19.5	374	498	1,152	1,650
Total of Existing Valley Floor Habitat						**3,514**	**4,685**	**13,423**	**18,108**
Total of All Valley Floor Habitat						**39,174**	**117,464**	**41,376**	**158,840**

Tributary Projects.

Project Name	Project Description	Cedar River Mile Entry	Project Reach Location (Trib RM)	Reach Gradient (%)	Avg. Channel Width (m)	Proportion Spawnable Bed for Sockeye	Channel Area w/ Sockeye Spawning Habitat (sq. m)	Channel Area w/out Sockeye Spawning Habitat (sq. m)	Total Channel Area (sq. m)	Spawnable Substrate for Sockeye (sq. m)
Maplewood Creek Stabilization and Habitat Rehabilitation	Reduce erosion and rehabilitate habitat with LWD and conifer underplanting	3.33								
Reach A			0.45 - 0.9	6.9	1.98	NA - Urban	0	1,434	1,434	0
Reach B			0.9 - 1.15	7.5	1.28	NA - Urban	0	515	515	0
Maplewood Total							0	1,949	1,949	0
Molasses Creek Bio-Stabilization and Habitat Rehabilitation	Reduce erosion and rehabilitate habitat with LWD and conifer underplanting	4.00								
Reach A			0.0 - 0.1	3.7	2.53	NA - Urban	0	407	407	0
Reach B			0.1 - 0.4	6.2	2.53	NA - Urban	0	1,222	1,222	0
Reach C			0.4 - 0.8	7	2.53	NA - Urban	0	1,629	1,629	0
Molasses Total							0	3,258	3,258	0

Table E-7

Amount of salmonid habitat from habitat projects in the Lower Cedar River Basin.

	New Habitat (m^2)	Enhanced Habitat (m^2)	Total (m^2)
Mainstem			
Spawnable	0	0	0
Sockeye Spawn Area	*0*	*0*	*0*
Non-Spawnable	0	16,555	16,555
Mainstem Sub-Total =	**0**	**16,555**	**16,555**
Valley Floor			
Ponds			
Spawnable	83,176	0	83,176
Sockeye Spawn Area	*13,458*	*0*	*13,458*
Non-Spawnable	20,041	6,165	26,206
Total VF Pond Area	**103,217**	**6,165**	**109,382**
Channels			
Spawnable	29,604	4,685	34,288
Sockeye Spawn Area	*22,203*	*3,514*	*25,716*
Non-Spawnable	7,912	7,258	15,170
Total VF Channel Area	**37,515**	**11,943**	**49,458**
Valley-Floor Sub-Total			
Spawnable	112,779	4,685	117,464
Sockeye Spawn Area	*35,660*	*3,514*	*39,174*
Non-Spawnable	27,952	13,423	41,376
Total VF Habitat Area	**140,732**	**18,108**	**158,840**
Tributary			
Ponds			
Spawnable	0	0	0
Sockeye Spawn Area	*0*	*0*	*0*
Non-Spawnable	0	7,866	7,866
Total Trib. Pond Area	**0**	**7,866**	**7,866**
Channels			
Spawnable	0	43,798	43,798
Sockeye Spawn Area	*0*	*6,373*	*6,373*
Non-Spawnable	0	26,389	26,389
Total Trib. Channel Area	**0**	**62,321**	**62,321**
Tributary Sub-Total			
Spawnable	0	43,798	43,798
Sockeye Spawn Area	*0*	*6,373*	*6,373*
Non-Spawnable	0	34,255	34,255
Total Tributary Habitat Area	**0**	**70,187**	**70,187**
Total for All Habitat Created or Enhanced			
Spawnable	112,779	48,483	161,262
Sockeye Spawn Area	35,660	9,887	45,547
Non-Spawnable	27,952	64,233	92,186
Combined Totals	**140,732**	**104,850**	**245,582**

Table E-6

Project Name	Project Description	Cedar River Mile Entry	Project Reach Location (Trib RM)	Reach Gradient (%)	Avg. Channel Width (m)	Proportion Spawnable Bed for Sockeye	Channel Area w/ Sockeye Spawning Habitat (sq. m)	Channel Area w/out Sockeye Spawning Habitat (sq. m)	Total Channel Area (sq. m)	Spawnable Substrate for Sockeye (sq. m)
Walsh Lake Diversion Enhancement	Rehabilitate lower reaches (A&B); improve fish passage (~RM 0.6) and enhance upper reaches (C,D, & E) for spawning and rearing	19.80								
Reach A			0.0 - 0.2	5.6	2.90	0.05	963	0	963	48
Reach B			0.2 - 0.6	4.7	2.90	0.05	1,926	0	1,926	96
Reach C			0.6 - 1.9	0.9	2.90	0.20	6,258	0	6,258	1,252
Reach D			1.9 - 3.6	0.4	2.90	0.20	8,184	0	8,184	1,637
Reach E			3.6 - 4.2	0.2	2.90	0.10	2,888	0	2,888	289
Walsh Lk. Diversion Total							20,219	0	20,219	3,322
	Tributary Total						**43,798**	**26,389**	**70,187**	**6,373**

Mainstem Projects.

Project Name	Project Description	Left or Right Bank	River Mile	Affected Channel Length (m)	Active Channel Width (m)	Total Active Channel Area (m^2)	Channel Width Affected by Project (3 or 4.5 m)	Area of Channel Affected by Project (m^2)	Percent of Channel Affected by Project
Person Revetment	Restore river edge and riparian habitat.	LB	4.0	244	33.5	8171	3.00	732	9%
Lower Jones Road	Buyout 22 Homes, remove revetment, restore river edge and riparian habitat.	RB	6.8	762	33.5	25534	4.50	3430	13%
Riverbend Trailer Park	Buyout row of homes adjacent to river, setback revetment, restore river edge and riparian habitat.	LB	7.0	244	33.5	8171	3.00	732	9%
Ricardi	Restore river edge and riparian habitat.	RB	7.5	122	33.5	4085	4.50	549	13%
Progressive Investment	Remove revetment, restore river edge and riparian habitat.	RB	8.5	427	33.5	14299	4.50	1921	13%
WPA -Cedar Mountain	Restore river edge and riparian habitat.	LB	10.5	335	33.5	11235	4.50	1509	13%
Rainbow Bend	Restore 40 acres of floodplain, remove homes, remove revetment, restore river edge and riparian habitat.	RB	11.0	244	33.5	8171	4.50	1098	13%
Jan Road Levee	Restore river edge and riparian habitat.	RB	13.0	213	33.5	7149	3.00	640	9%
Rutledge - Johnson	Setback levee, restore river edge and riparian habitat.	LB	13.5	305	33.5	10213	3.00	915	9%
Getchmann	Setback levee, restore river edge and riparian habitat.	RB	13.6	305	33.5	10213	3.00	915	9%
Dorre Don Court	Restore about 5 acres of floodplain, remove homes at high flood hazard, remove revetment, restore river edge and riparian habitat.	RB	16.2	152	33.5	5107	4.50	686	13%
Dorre Don	Restore about 5 acres of floodplain, remove homes at high flood hazard, remove revetment, restore river edge and riparian habitat.	RB	16.2	762	33.5	25534	4.50	3430	13%
	Mainstem Total			**4116**		**137881**		**16555**	**12%**

Table E-8

Annual production potential (APP) of juvenile salmonids from habitat projects in the lower Cedar River.

Sockeye Fry APP

	LOW	Moderate	HIGH
Mainstem	0	0	0
Valley Floor			
New Spawnable	17,290,354	29,897,905	37,462,435
New Nonspawnable	*213,094*	*368,474*	*461,703*
Total New Habitats	17,503,448	30,266,379	37,924,137
Existing Spawnable	84,209	145,612	182,454
Existing Nonspawnable	*0*	*0*	*0*
All Existing Habitats	84,209	145,612	182,454
Total for Valley Floor	**17,587,657**	**30,411,991**	**38,106,591**
Tributary	**2,474,818**	**4,696,719**	**6,739,491**
Total	**20,062,475**	**35,108,710**	**44,846,083**

Coho Smolt APP

	LOW	Moderate	HIGH
Mainstem	1,185	2,371	3,556
Valley Floor			
New Spawnable	25,341	43,936	102,423
New Nonspawnable	*6,285*	*10,897*	*25,402*
All New Habitats	31,626	54,833	127,825
Existing Spawnable	50	87	203
Existing Nonspawnable	*3,213*	*5,571*	*12,988*
All Existing Habitats	3,264	5,658	13,191
Total for Valley Floor	**34,889**	**60,491**	**141,016**
Tributary	**16,908**	**30,741**	**47,649**
Total	**52,982**	**93,603**	**192,221**

Chinook Smolt APP

	LOW	Moderate	HIGH
Mainstem	3,435	6,870	17,176
Valley Floor			
New Spawnable	0	0	0
New Nonspawnable	*0*	*0*	*0*
All New Habitats	0	0	0
Existing Spawnable	0	0	0
Existing Nonspawnable	*0*	*0*	*0*
All Existing Habitats	0	0	0
Total for Valley Floor	**0**	**0**	**0**
Tributary	**1,563**	**3,126**	**7,814**
Total	**4,998**	**9,996**	**24,990**

Steelhead Smolt APP

	LOW	Moderate	HIGH
Mainstem	123	215	338
Valley Floor			
New Spawnable	0	0	0
New Nonspawnable	*0*	*0*	*0*
All New Habitats	0	0	0
Existing Spawnable	0	0	0
Existing Nonspawnable	*0*	*0*	*0*
All Existing Habitats	0	0	0
Total for Valley Floor	**0**	**0**	**0**
Tributary	**412**	**723**	**1,136**
Total	**535**	**939**	**1,474**

Cutthroat Trout Smolt APP

	LOW	Moderate	HIGH
Mainstem	296	593	889
Valley Floor			
New Spawnable	6,335	10,984	25,606
New Nonspawnable	*1,571*	*2,724*	*6,351*
All New Habitats	7,906	13,708	31,956
Existing Spawnable	13	22	51
Existing Nonspawnable	*803*	*1,393*	*3,247*
All Existing Habitats	816	1,415	3,298
Total for Valley Floor	**8,722**	**15,123**	**35,254**
Tributary	**6,521**	**13,041**	**19,562**
Total	**22,060**	**28,757**	**55,705**

APP All Species

	LOW	Moderate	HIGH
Mainstem	5,039	10,049	21,959
Valley Floor			
New Spawnable	17,322,030	29,952,825	37,590,463
New Nonspawnable	*220,950*	*382,095*	*493,456*
All New Habitats	17,542,980	30,334,920	38,083,919
Existing Spawnable	84,272	145,721	182,708
Existing Nonspawnable	*4,017*	*6,964*	*16,234*
All Existing Habitats	88,289	152,685	198,942
Total for Valley Floor	**17,631,269**	**30,487,605**	**38,282,861**
Tributary	**2,500,221**	**4,744,350**	**6,815,652**
Total	**20,143,051**	**35,242,004**	**45,120,472**

Table E-9

Annual production potential for habitat projects in the lower Cedar River.

	Annual Production Potential					
	Sockeye Fry	Coho Smolt	Chinook Smolt	Steelhead Smolt	Cutthroat Smolt	Total Juveniles per Year
Valley Floor Projects						
Maplewood Heights Homeowners Site - Side Channel Enhancement	0	1,322	0	0	331	1,653
Elliot Wetland Enhancement	131,767	79	0	0	20	131,866
Lower Summerfield	1,493,177	1,446	0	0	362	1,494,985
Upper Summerfield	1,409,022	2,645	0	0	661	1,412,328
Herzman Levee	819,156	697	0	0	174	820,027
Lower Jones Road	0	1,834	0	0	458	2,292
Ricardi Tributary Ponds	236,707	1,069	0	0	267	238,043
Jeffries/Cook Revetment	3,459,196	6,018	0	0	1,504	3,466,718
Upper Riverbend	702,666	987	0	0	247	703,900
Wetland 103	0	1,182	0	0	296	1,478
Wetland 37 - A	1,029,082	2,033	0	0	508	1,031,623
Wetland 37 - B	1,754,802	1,905	0	0	476	1,757,183
Power Line Habitat	275,832	318	0	0	79	276,229
WPA/Cedar Moutain Levee	646,285	1,237	0	0	309	647,831
Tributary 0316 Enhancement	0	178	0	0	44	222
Lower Rainbow Bend	586,176	743	0	0	186	587,106
Upper Rainbow Bend	1,168,587	1,188	0	0	297	1,170,072
Tributary 0316A	0	818	0	0	205	1,023
Byers Bend Channel	2,455,742	2,036	0	0	509	2,458,287
McDaniels Creek Enhancement	145,612	87	0	0	22	145,721
McDaniels New Pond	381,842	1,155	0	0	289	383,286
Jan Road Ponds	0	756	0	0	189	945
Jan Road Floodway Channel	2,065,176	1,942	0	0	485	2,067,603
Jan Road Levee Pond	1,245,745	2,585	0	0	646	1,248,977
Rutledge/Johnson Side Channel	0	329	0	0	82	411
Rutledge/Johnson Levee Pond	294,990	473	0	0	118	295,581
Wetland132 Enhancement	0	675	0	0	169	844
Wetland 132 Ponds	0	3,325	0	0	831	4,157
Enhancement	0	123	0	0	31	154
Getchman Levee Pond	531,621	1,200	0	0	300	533,121
Royal Arch Oxbow Enhancement	0	1,122	0	0	281	1,403
Witte Road Channel Enhancement	0	274	0	0	68	342
Witte Road GW Channel	844,073	505	0	0	126	844,704
Seattle Saddle Club	799,051	841	0	0	210	800,102
Dorre Don Court	352,280	367	0	0	92	352,739
Dorre Don Left Bank Side Channel Enhancement	0	657	0	0	164	821
Dorre Don Side Channel Ponds	927,763	1,172	0	0	293	929,228
Dorre Don Left Bank Meander	631,107	428	0	0	107	631,643
Lower Dorre Don - Lower Habitat	788,112	1,115	0	0	279	789,507

Table E-9

	Annual Production Potential					
	Sockeye Fry	Coho Smolt	Chinook Smolt	Steelhead Smolt	Cutthroat Smolt	Total Juveniles
Lower Dorre Don - Upper Habitat	582,846	583	0	0	146	583,574
Orchard Grove Left Bank Meander	1,405,332	2,648	0	0	662	1,408,643
Spoerer WBT Enhancement	0	397	0	0	99	497
Wetland 79	236,707	939	0	0	235	237,881
Heath/O'Keefe	775,007	464	0	0	116	775,587
Lower Rock Creek Pond Access	0	174	0	0	44	218
Lower Rock Creek Pond Enlargement	0	354	0	0	89	443
New Rock Creek Ponds	0	348	0	0	87	436
Arcadia WBT	0	82	0	0	21	103
Upper Arcadia WBT Access	0	1,005	0	0	251	1,256
Wingert Ponds	734,031	1,201	0	0	300	735,531
Wingert Side Channel Enhancement	0	494	0	0	123	617
Wetland 70	792,375	1,324	0	0	331	794,030
Landsburg Oxbow (Wetland 69)	710,122	3,612	0	0	903	714,637
Valley Floor Sub-Total	**30,411,991**	**60,491**	**0**	**0**	**15,123**	**30,487,605**
Tributary Projects						
Maplewood	0	0	0	0	187	187
Molasses	0	0	0	0	495	495
Madsen	0	0	0	0	1,441	1,441
S. Fork Madsen	0	0	0	0	123	123
Trib 0316A	19,192	1,043	22	29	302	20,587
Taylor Cr.	238,635	2,544	79	136	1,343	242,738
Taylor Trib 0321	189,393	1,126	0	0	941	191,460
Peterson Cr.	302,019	3,002	0	150	998	306,169
Rock Creek	1,137,623	11,710	2,936	296	4,394	1,156,960
Walsh Lake Diversion	2,809,856	11,317	88	113	2,818	2,824,192
Tributary Projects Sub-Total	**4,696,719**	**30,741**	**3,126**	**723**	**13,041**	**4,744,350**
Mainstem Projects						
Person Revetment	0	105	304	10	26	444
Lower Jones Road	0	491	1,423	45	123	2,082
Riverbed Trailer Park	0	105	304	10	26	444
Ricardi	0	79	228	7	20	333
Progressive Investment	0	275	797	25	69	1,166
WPA -Cedar Mountain	0	216	626	20	54	916
Rainbow Bend	0	157	455	14	39	666
Jan Road Levee	0	92	266	8	23	389
Rutledge - Johnson	0	131	380	12	33	555
Getchmann	0	131	380	12	33	555
Dorre Don Court	0	98	285	9	25	416
Dorre Don	0	491	1,423	45	123	2,082
Mainstem Projects Sub-Total	**0**	**2,371**	**6,870**	**215**	**593**	**10,049**
Total for All Projects	**35,188,710**	**93,603**	**9,996**	**939**	**28,757**	**35,242,004**

Table E-10

Long term (50-yr) costs and salmonid production potential for habitat projects in the Lower Cedar River Basin. All costs in 1998 dollars.

	Project Cost				50-yr Production Potential						
	Capital Cost	50-yr Maintenance & Rehab	50-yr Insp. & Monitoring	50-yr Total	Sockeye Fry	Coho Smolt	Chinook Smolt	Steelhead Smolt	Cutthroat Smolt	Total Juveniles	Long-term (50-yr.) Cost per Fish
Valley Floor Projects											
Maplewood Heights Homeowners Site - Side Channel Enhancement	$290,043	$58,009	$23,400	$371,451	0	60,801	0	0	2,353	63,154	$5.882
Elliot Wetland Enhancement	$558,791	$111,758	$23,400	$693,949	6,016,815	3,624	0	0	512	6,020,952	$0.115
Lower Summerfield	$495,873	$99,175	$53,400	$648,448	68,309,122	66,500	0	0	9,402	68,385,024	$0.009
Upper Summerfield	$617,143	$123,429	$53,400	$793,972	64,459,230	121,627	0	0	17,196	64,598,053	$0.012
Herzman Levee	$315,277	$63,055	$53,400	$431,732	37,474,338	32,042	0	0	4,530	37,510,910	$0.012
Lower Jones Road	$89,138	$17,828	$23,400	$130,365	0	84,307	0	0	11,919	96,226	$1.355
Ricardi Tributary Ponds	$238,644	$47,729	$53,400	$339,773	10,828,762	49,131	0	0	6,946	10,884,839	$0.031
Jeffries/Cook Revetment	$1,618,576	$323,715	$53,400	$1,995,692	158,249,560	276,699	0	0	39,120	158,565,379	$0.013
Upper Riverbend	$465,516	$93,103	$53,400	$612,019	31,258,106	45,392	0	0	6,418	31,309,916	$0.020
Wetland 103	$133,513	$26,703	$23,400	$183,615	0	54,357	0	0	7,685	62,041	$2.960
Wetland 37 - A	$477,854	$95,571	$53,400	$626,824	45,778,711	93,468	0	0	13,215	45,885,394	$0.014
Wetland 37 - B	$336,226	$67,245	$53,400	$456,871	78,062,352	87,581	0	0	12,382	78,162,315	$0.006
Power Line Habitat	$93,316	$18,663	$23,400	$135,380	12,270,407	14,298	0	0	2,065	12,286,770	$0.011
WPA/Cedar Moutain Levee	$168,962	$33,792	$53,400	$256,154	28,749,995	56,874	0	0	8,041	28,814,910	$0.009
Tributary 0316 Enhancement	$79,314	$15,863	$23,400	$118,577	0	8,182	0	0	1,157	9,339	$12.697
Lower Rainbow Bend	$118,861	$23,772	$23,400	$166,033	26,076,059	34,178	0	0	4,832	26,115,069	$0.006
Upper Rainbow Bend	$363,713	$72,743	$53,400	$489,856	51,984,594	54,637	0	0	7,725	52,046,956	$0.009
Tributary 0316A	$139,948	$27,990	$23,400	$191,337	0	37,613	0	0	5,318	42,931	$4.457
Byers Bend Channel	$606,757	$121,351	$53,400	$781,508	109,243,662	93,613	0	0	13,235	109,350,510	$0.007
McDaniels Creek Enhancement	$100,265	$20,053	$23,400	$143,718	18,795,538	4,005	0	0	566	18,800,110	$0.008
McDaniels New Pond	$258,198	$51,640	$53,400	$363,237	16,986,240	53,123	0	0	7,510	17,046,873	$0.021
Jan Road Ponds	$126,804	$25,361	$23,400	$175,564	0	34,753	0	0	4,913	39,666	$4.426
Jan Road Floodway Channel	$513,220	$102,644	$53,400	$669,264	91,869,364	89,279	0	0	12,622	91,971,265	$0.007
Jan Road Levee Pond	$570,563	$114,113	$53,400	$738,075	55,416,978	118,870	0	0	16,806	55,552,653	$0.013
Rutledge/Johnson Side Channel	$70,703	$14,141	$23,400	$108,243	0	15,105	0	0	2,136	17,241	$6.278
Rutledge/Johnson Levee Pond	$90,720	$18,144	$23,400	$132,264	13,122,641	21,729	0	0	3,072	13,147,442	$0.010
Wetland 132 Enhancement	$101,093	$20,219	$23,400	$144,712	0	31,036	0	0	4,388	35,424	$4.085
Wetland 132 Ponds	$426,074	$85,215	$23,400	$534,689	0	152,892	0	0	21,616	174,508	$3.064
Getschmann Levee Channel Enhancement	$70,258	$14,052	$23,400	$107,709	11,666,685	5,550	0	0	801	11,673,036	$0.009
Getchman Levee Pond	$230,510	$46,102	$53,400	$330,012	23,699,778	55,221	0	0	7,800	23,762,800	$0.014
Royal Arch Oxbow Enhancement	$59,949	$11,990	$23,400	$95,338	0	51,610	0	0	7,297	58,907	$1.618
Wine Road Channel Enhancement	$214,773	$42,955	$23,400	$281,127	25,910,234	12,588	0	0	1,780	25,924,601	$0.011
Wine Road GW Channel	$250,043	$50,009	$53,400	$353,452	37,548,601	23,217	0	0	3,282	37,575,101	$0.009
Seattle Saddle Club	$152,685	$30,537	$23,400	$206,622	35,545,783	38,660	0	0	5,466	35,589,908	$0.006
Dorre Don Court	$153,046	$30,609	$23,400	$207,055	15,671,189	16,861	0	0	2,384	15,690,434	$0.013
Dorre Don Left Bank Side Channel Enhancement	$213,390	$42,678	$53,400	$309,468	62,184,561	30,211	0	0	4,271	62,219,043	$0.005
Dorre Don Side Channel Ponds	$210,302	$42,060	$53,400	$305,762	41,271,519	53,893	0	0	7,619	41,333,032	$0.007
Dorre Don Left Bank Meander	$145,247	$29,049	$23,400	$197,697	28,074,800	19,698	0	0	2,785	28,097,283	$0.007
Lower Dorre Don - Lower Habitat	$269,082	$53,816	$53,400	$376,298	35,059,180	51,284	0	0	7,251	35,117,715	$0.011
Lower Dorre Don - Upper Habitat	$149,930	$29,986	$23,400	$203,316	25,927,904	26,789	0	0	3,787	25,958,480	$0.008
Orchard Grove Left Bank Meander	$540,437	$108,087	$53,400	$701,924	62,516,212	121,759	0	0	17,214	62,655,185	$0.011
Spoerer WBT Enhancement	$151,997	$30,399	$23,400	$205,796	0	19,064	0	0	2,582	21,647	$9.507
Wetland 79	$69,127	$13,825	$23,400	$106,352	10,529,919	43,178	0	0	6,104	10,579,201	$0.010
Heath/O'Keefe	$253,923	$50,785	$53,400	$358,108	34,476,185	21,317	0	0	3,014	34,500,517	$0.010
Lower Rock Creek Pond Access	$28,741	$5,748	$23,400	$57,889	0	8,010	0	0	1,133	9,143	$6.332
Lower Rock Creek Pond Enlargement	$53,126	$10,625	$23,400	$87,151	0	16,288	0	0	2,303	18,591	$4.688

Table c-10

	Project Cost				50-yr Production Potential						
	Capital Cost	50-yr Maintenance & Rehab	50-yr Insp. & Monitoring	50-yr Total	Sockeye Fry	Coho Smolt	Chinook Smolt	Steelhead Smolt	Cutthroat Smolt	Total Juveniles	Long-term (50-yr.) Cost per Fish
New Rock Creek Ponds	$67,371	$13,474	$23,400	$104,246	0	16,021	0	0	2,265	18,286	$5.701
Arcadia WBT	$27,565	$5,513	$23,400	$56,478	0	3,776	0	0	534	4,310	$13.103
Upper Arcadia WBT Access	$124,865	$24,973	$23,400	$173,238	0	46,214	0	0	6,534	52,747	$3.284
Wingert Ponds	$275,420	$55,084	$53,400	$383,904	32,653,351	55,206	0	0	7,805	32,716,362	$0.012
Wingert Side Channel Enhancement	$104,423	$20,885	$23,400	$148,708	14,101,963	22,699	0	0	3,209	14,127,872	$0.011
Wetland 70	$422,665	$84,533	$53,400	$560,598	35,248,792	60,892	0	0	8,609	35,318,293	$0.016
Landsburg Oxbow (Wetland 69)	$994,164	$198,833	$53,400	$1,246,396	31,589,757	166,083	0	0	23,481	31,779,321	$0.039
Valley Floor Sub-Total	**$14,698,142**	**$2,939,628**	**$1,960,200**	**$19,597,970**	**1,488,628,889**	**2,781,807**	**0**	**0**	**386,988**	**1,491,797,684**	**$0.013**
Tributary Projects											
Maplewood	$168,825	$16,883	$23,400	$209,108	0	0	0	0	8,083	8,083	$25.870
Molasses	$39,393	$3,939	$23,400	$66,732	0	0	0	0	21,436	21,436	$3.113
Madsen	$562,750	$56,275	$23,400	$642,425	0	0	0	0	62,436	62,436	$10.289
S. Fork Madsen	$562,750	$56,275	$23,400	$642,425	0	0	0	0	5,314	5,314	$120.895
Trib 0316A	$50,648	$5,065	$23,400	$79,112	853,749	47,944	960	1,230	13,077	916,959	$0.086
Taylor Cr.	$1,012,950	$101,295	$23,400	$1,137,645	10,615,693	116,982	3,409	5,829	58,221	10,800,135	$0.105
Taylor Trib 0321	$33,765	$3,377	$23,400	$60,542	8,425,153	51,762	0	0	40,775	8,517,690	$0.007
Peterson Cr.	$90,040	$9,004	$23,400	$122,444	13,435,311	138,011	0	6,456	43,263	13,623,042	$0.009
Rock Creek	$6,900,000	$0	$23,400	$6,923,400	50,607,110	538,444	126,169	12,734	190,431	51,474,889	$0.135
Walsh Lake Diversion	$574,005	$57,401	$23,400	$654,806	124,996,374	520,342	3,775	4,842	122,147	125,647,479	$0.005
Tributary Sub-Total	**$10,861,075**	**$309,513**	**$234,000**	**$10,538,638**	**208,933,398**	**1,413,485**	**134,313**	**31,091**	**565,185**	**211,877,464**	**$0.050**
Mainstem Projects											
Person Revetment	$900,400	$180,080	$23,400	$1,103,880	0	4,818	13,049	1,596	1,022	20,484	$53.891
Lower Jones Road	$9,791,850	$1,958,370	$23,400	$11,773,620	0	22,583	61,166	7,479	4,789	96,017	$122.620
Riverbed Trailer Park	$3,038,850	$607,770	$23,400	$3,670,020	0	4,818	13,049	1,596	1,022	20,484	$179.168
Ricardi	$675,300	$135,060	$23,400	$833,760	0	3,613	9,786	1,197	766	15,363	$54.272
Progressive Investment	$976,934	$195,387	$23,400	$1,195,721	0	12,647	34,253	4,188	2,682	53,770	$22.238
WPA -Cedar Mountain	$1,913,350	$382,670	$23,400	$2,319,420	0	9,937	26,913	3,291	2,107	42,248	$54.901
Rainbow Bend	$8,103,600	$1,620,720	$23,400	$9,747,720	0	7,227	19,573	2,393	1,533	30,725	$317.252
Jan Road Levee	$488,467	$97,693	$23,400	$609,560	0	4,216	11,418	1,396	894	17,923	$34.010
Rutledge - Johnson	$697,810	$139,562	$23,400	$860,772	0	6,022	16,311	1,994	1,277	25,605	$33.618
Getchmann	$1,688,250	$337,650	$23,400	$2,049,300	0	6,286	16,311	1,994	1,277	25,868	$79.222
Dorre Don Court	$900,400	$180,080	$23,400	$1,103,880	0	4,517	12,233	1,496	958	19,203	$57.484
Dorre Don	$5,514,950	$1,102,990	$23,400	$6,641,340	0	22,583	61,166	7,479	4,789	96,017	$69.168
Mainstem Sub-Total	**$34,690,161**	**$6,938,032**	**$280,800**	**$41,908,993**	**0**	**109,266**	**295,226**	**36,098**	**23,116**	**463,706**	**$90.378**
Total for All Projects	**$60,249,378**	**$10,187,173**	**$2,475,000**	**$72,045,601**	**1,697,562,279**	**4,304,558**	**429,539**	**67,189**	**975,289**	**1,703,338,854**	**$0.042**

Table E-11

Land ownership and risk of lost opportunity for lower Cedar River habitat projects.

Valley Floor Projects.

Project Name	Public or Private	Primary Land Owner	Estimated Number of Owners	Relative Scale of Project	Relative Landowner Willingness (known or perceived)	Potential Risk of Opportunity Loss Due to Future Development	Comments
New Valley Floor Habitat							
Elliott Wetland	Public	Renton	1	medium	medium	low	Would complement previous flood plain restoration work; Renton may want site for future mitigation needs
Lower Summerfield	Public	King Co.	1	large	high	low	KC Open Space
Upper Summerfield	Public	King Co.	1	large	high	low	KC Open Space
Herzmann Levee	Private	multiple	2 to 5	large	high	low	Primary landowner very willing
Lower Jones Road	Private	multiple	2 to 5	medium	unknown	moderate	One landowner likely willing; others unknown
Upper River Bend	Private	single	1	large	unknown	moderate	Landowner willingness unknown
Ricardi Tributary Ponds	Private	single	1	large	unknown	low	Acquisition of site by KC likely in near term
Jeffries/Cook Revetment	Private	single	1	large	unknown	high	Landowner willingness unknown
Wetland 103	Public	King Co.	1	medium	high	low	KC Open Space
Wetland 37-A	Public	King Co.	1	large	high	low	KC Open Space
Wetland 37-B	Public	King Co.	1	large	high	low	KC Open Space
Powerline Habitat	Private	single	1	medium	unknown	low	Acquisition of site by KC likely in near term
WPA/Cedar Mountain Levee	Private	single	1	large	unknown	moderate	Acquisition of site by KC likely in near term
Lower Rainbow Bend	Private	multiple	2 to 5	large	unknown	moderate	Landowner willingness unknown
Upper Rainbow Bend	Private	multiple	2 to 5	large	unknown	moderate	Landowner willingness unknown
Tributary 0316A	Private	multiple	2 to 5	small	moderate	low	Landowner willingness unknown
Byer's Bend Channel	Private	multiple	> 5	large	unknown	high	Landowner willingness unknown
McDaniels New Pond	Private	single	1	medium	high	moderate	Primary landowner has cooperated in previous small project, likely willing
Jan Road Floodway Channel	Private	multiple	> 5	large	unknown	moderate	Landowner willingness unknown
Jan Road Ponds	Private	multiple	2 to 5	medium	unknown	moderate	Landowner willingness unknown
Jan Road Levee	Private	single	1	large	unknown	low	Landowner willingness unknown
Rutledge/Johnson Levee Pond	Private	single	1	medium	high	low	Acquisition of easement by KC likely in near term
Wetland 132 Ponds	Private	single	1	medium	unknown	low	Landowner willingness unknown
Getschmann Levee Pond	Private	single	1	large	moderate	moderate	Landowner has expressed willingness; KC may acquire easement in near term
Witte Road GW Channel	Private	multiple	2 to 5	large	moderate	moderate	Primary landowner has expressed willingness
Seattle Saddle Club	Private	multiple	2 to 5	large	unknown	moderate	Landowner willingness unknown
Dorre Don Court	Private	single	1	medium	high	low	Primary landowner has expressed willingness
Dorre Don Left Bank Side Channel Ponds	Public	King Co.	1	medium	high	low	KC Open Space
Dorre Don Left Bank Meander	Public	King Co.	1	medium	high	low	KC Open Space
Lower Dorre Don - Lower Habitat	Private	single	1	medium	unknown	high	Landowner willingness unknown
Lower Dorre Don - Upper Habitat	Private	single	1	medium	unknown	low	Landowner willingness unknown
Orchard Grove Left Bank Habitat	Private	single	1	large	unknown	moderate	Site may become KC open space as part of mitigation of upslope development
Heath/O'Keefe	Public	King Co.	1	medium	high	low	KC has conservation easement for majority of site
Wetland 79	Public	King Co.	1	medium	high	low	KC has conservation easement for majority of site
Lower Rock Creek Pond	Public	King Co.	1	small	high	low	KC Open Space
Lower Rock Creek Pond Enlargement	Public	King Co.	1	small	high	low	KC Open Space
New Rock Creek Ponds	Public	King Co.	1	small	high	low	KC Open Space

Table E-11

Project Name	Public or Private	Primary Land Owner	Estimated Number of Owners	Relative Scale of Project	Relative Landowner Willingness (known or perceived)	Potential Risk of Opportunity Loss Due to Future Development	Comments
Arcadia WBT	Private	multiple	2 to 5	small	moderate	low	Primary landowner has cooperated in previous small project, likely willing
Upper Arcadia WBT Access	Private	multiple	2 to 5	medium	moderate	moderate	One landowner likely willing; others unknown
Wingert Ponds	Private	single	1	large	unknown	low	Acquisition of site by KC likely in near term
Wetland 70	Public	King Co.	1	large	high	low	KC Open Space
Landsburg Oxbow (Wetland 69)	Private	single	1	large	unknown	low	Acquisition of site by KC likely in near term
Existing Valley Floor Habitat							
Maplewood Heights Homeowners Site - Side Channel Enhancement	Private	single	1	medium	high	low	Primary landowner has expressed willingness
Tributary 0316 Enhancement	Private	multiple	2 to 5	medium	moderate	low	Primary landowner has cooperated in previous small project, likely willing
McDaniels Creek Enhancement	Private	multiple	2 to 5	medium	high	low	Primary landowner has expressed interest and cooperated in previous small project
Wetland 132 Enhancement	Private	multiple	2 to 5	medium	unknown	low	Landowner willingness unknown
Rutledge/Johnson Side Channel	Private	single	1	medium	moderate	low	Acquisition of easement by KC likely in near term
Getchmann Levee Channel Enhancement	Private	multiple	2 to 5	medium	moderate	moderate	Primary landowner has expressed willingness
Royal Arch Oxbow Enhancement	Private	single	1	small	unknown	moderate	Landowner willingness unknown
Witte Road Channel Enhancement	Private	single	1	medium	high	low	Primary landowner has expressed willingness
Dorre Don Left Bank Side Channel Enhancement	Public	King Co.	1	medium	high	low	KC Open Space
Spoerer WBT Enhancement	Private	single	1	small	low	high	Landowner willingness unknown
Wingert Side Channel Enhancement	Public	King Co.	1	medium	high	low	Acquisition of site by KC likely in near term
Tributary Projects.							
Maplewood Creek Stabilization and Habitat Rehabilitation							
Reach A	Private	single	1	medium	high	low	Primary landowner has expressed willingness
Reach B	Private	multiple	2 to 5	medium	high	low	Primary landowner has expressed willingness
Molasses Creek Bio-Stabilization and Habitat Rehabilitation							
Reach A	Private	single	1	medium	unknown	low	Landowner willingness unknown
Reach B	Private	multiple	> 5	medium	unknown	low	Landowner willingness unknown
Reach C	Private	multiple	> 5	medium	unknown	low	Landowner willingness unknown
Madsen Creek Bio-Stabilization and Habitat Rehabilitation							
Reach A	Private	multiple	> 5	medium	high	low	Landowner willingness likely high due to channel erosion problems
Reach B	Private	multiple	> 5	medium	high	low	Landowner willingness likely high due to channel erosion problems
Reach C	Private	multiple	> 5	medium	high	low	Landowner willingness likely high due to channel erosion problems
S.F. Madsen Creek Bio-Stabilization and Habitat Rehabilitation							
Reach A	Private	multiple	> 5	medium	high	low	Landowner willingness likely high due to channel erosion problems
Trib 0316A Bio-Stabilization and Habitat Rehabilitation							
Reach A	Private	multiple	2 to 5	medium	unknown	moderate	Landowner willingness unknown
Reach B	Private	multiple	2 to 5	medium	unknown	low	Landowner willingness unknown
Reach C	Private	single	1	medium	high	moderate	Primary landowner has cooperated in previous small project, likely willing

Table E-11

Project Name	Public or Private	Primary Land Owner	Estimated Number of Owners	Relative Scale of Project	Relative Landowner Willingness (known or perceived)	Potential Risk of Opportunity Loss Due to Future Development	Comments
Taylor Creek Improvements							
Reach A	Private	multiple	> 5	medium	moderate	moderate	Landowner willingness unknown
Reach B	Private	multiple	> 5	medium	moderate	moderate	Landowner willingness unknown
Taylor Trib 0321 Habitat Rehabilitation and Enhancement							
Reach A	Private	multiple	2 to 5	small	high	moderate	Primary landowners has cooperated in previous small project, likely willing
Reach B	Private	multiple	> 5	medium	high	moderate	Primary landowners has cooperated in previous small project, likely willing
Paterson Cr. Rehabilitation and Enhancement							
Reach A	Private	multiple	> 5	medium	high	low	Primary landowner has expressed willingness
Reach B	Private	multiple	> 5	medium	moderate	moderate	Landowner willingness unknown
Reach C	Private	King Co.	1	medium	high	low	KC Open Space
Rock Creek Flow Restoration							
Reach A	Public & Private	multiple	> 5	large	high	low	Project not expected to affect property
Reach B	Public & Private	multiple	> 5	large	high	low	Project not expected to affect property
Reach C	Public & Private	multiple	> 5	large	high	low	Project not expected to affect property
Walsh Lake Diversion Enhancement							
Reach A	Public	King Co.	1	small	high	low	KC Open Space
Reach B	Public & Private	multiple	2 to 5	medium	unknown	low	City of Seattle holds right-of-way easement; some private landowners adjacent to channel
Reach C	Public & Private	multiple	2 to 5	large	unknown	low	City of Seattle holds right-of-way easement; some private landowners adjacent to channel
Reach D	Public	Seattle	1	large	unknown	low	Within City of Seattle Watershed
Reach E	Public	Seattle	1	large	unknown	low	Within City of Seattle Watershed

Mainstem Projects.

Person Revetment	Public	King Co.	1	large	high	low	King County maintained facility
Lower Jones Road	Public	King Co.	1	large	unknown	low	King County maintained facility
Riverbend Trailer Park	Public	King Co.	1	large	unknown	low	King County maintained facility
Ricardi	Public	King Co.	1	large	high	low	King County maintained facility
Progressive Investment	Public	King Co.	1	large	high	low	King County maintained facility
WPA -Cedar Mountain	Public	King Co.	1	large	high	low	King County maintained facility
Rainbow Bend	Public	King Co.	1	large	moderate	low	King County maintained facility
Jan Road Levee	Public	King Co.	1	large	high	low	King County maintained facility
Rutledge - Johnson	Public	King Co.	1	large	high	low	King County maintained facility
Getchmann	Public	King Co.	1	large	high	low	King County maintained facility
Dorre Don Court	Public	King Co.	1	large	low	low	King County maintained facility
Dorre Don	Public	King Co.	1	large	low	low	King County maintained facility

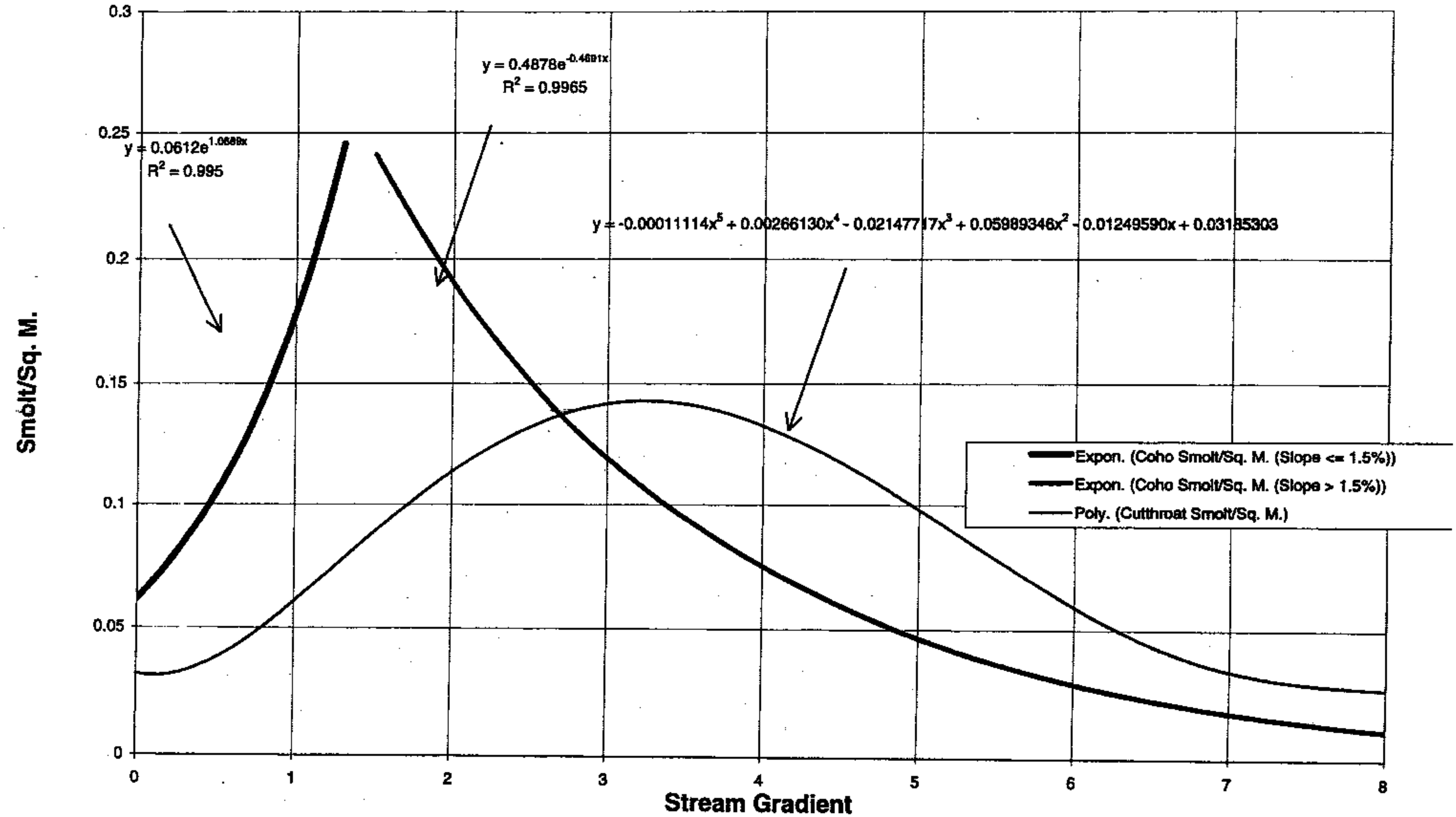
Table E-12

Number of spawners needed to achieve juvenile production estimates.

	Production Level		
	Low	Moderate	High
Sockeye	50,224	89,232	119,810
Coho	10,466	18,490	37,970
Chinook	40	80	200
Steelhead	32	64	100
Cutthroat	553	1,022	1,981

Assumptions
General: Sex ratio of 1:1 for all species.
Sockeye: Fecundity = 3,588 eggs/female; egg-to-fry survival rates varied by female spawner density and location (see Table 3).
Coho: Fecundity = 2,500 eggs/female and egg-to-fry and fry-to-smolt survival rates of 27 and 1.5%, respectively (see Sandercock 1991)
Chinook: Fecundity = 5,000 eggs/female and a egg-to-smolt survival of 5% (see Healy 1991).
Steelhead: Fecundity = 3,500 eggs/female and egg-to-fry and fry-to-smolt survival rates of 6.5 and 12.9, respectively (Ward and Slaney 1993)
Cutthroat: Assume fecundity is half (1250) that of coho and egg-to-fry and fry-to-smolt survival rates of 30 and 13%, respectively.

Pre-project Coho and Cutthroat Smolt Production Potential as a Function of Stream Gradient[1]



1 - Coho curves based on Baranski (1989); cutthroat curve based on theoretical relationship with coho and gradient.

Cedar River Habitat Opportunity Concept Reports

Users of these reports should note the following:

- This information is provided for planning purposes only; landowner agreements and additional site analysis and design work are recommended before actual construction.
- The names and addresses of property owners have not been provided to protect landowner privacy.
- Recent changes to King County's Sensitive Areas Ordinance have made many of the actions proposed in wetlands much more permissible than when these projects were originally conceptualized. However, project mangers should recognize that the proposed projects are intended to enhance the diversity and quality of wetland species and communities as well as increase fish production.
- Where sockeye and coho salmon and cutthroat trout are expected to be the primary fish species, elements contributing to habitat structure complexity (e.g., large woody debris, boulders) are expected to be used sparingly in order to reduce production and sockeye fry predation potential of coho and cutthroat.
- The following descriptions of valley floor (VF) and tributary (TR) projects are organized by river mile (RM) moving upstream. Mainstem project descriptions can be found in the main body of the Basin Plan and are not repeated here.

Valley Floor Projects **Page**

Valley Floor Projects (cont.) **Page**

Tributary Projects **Page**

Tributary Projects (cont.) **Page**

Cedar River Habitat Opportunity Concept Reports

Maplewood Heights Homeowners Site—Side Channel Enhancement (VF-01)

Project Location: Cedar River/RB at RM 4.5

Opportunity/Problem: Fish usable habitat could be increased by excavation of deep (> 1 m) pools in the side channel along the north valley wall, addition of large woody debris (LWD), and diversion of nearby springs to the channel. In addition the floodplain is dominated by deciduous trees (red alder) and lacks coniferous understory for long-term succession.

Project Concept: 1) Improve floodplain vegetation and structural habitat by removing invasive plants, underplanting with conifers, and incorporating large woody debris [A significant amount of conifer underplanting and invasive plant removal was accomplished by the end of 1995.]; 2) Enhance existing fish usable habitat by creating pools at least 1 m in depth and adding LWD for cover in the existing open water areas; 3) Increase fish usable habitat in the channel along the base of the north valley wall by excavating a series of pools and a connecting fish-passable channel upstream of existing open water habitat; and 4) Increase available water to fish habitat by diverting water from springs along the Punnit-Briggs revetment via a pipe or other suitable conveyance mechanism to fish habitat along the north valley wall.

Primary Fish Benefit: New overwintering habitat would be created and existing overwintering habitat would be enhanced for coho salmon and cutthroat trout. Diversion of spring water to the site would enhance both summer and winter fish habitat. The site could also function as flood refuge for all salmon.

Other Benefits: Improvement of floodplain vegetation and habitat structural diversity would increase long-term stability of the site under future flooding and enhance wildlife and wetland values. Diversion of spring water would reduce the effect of seasonal low flows on the site and increase wetland and wildlife values during that time.

Existing Salmonid Use: Juvenile coho salmon were observed in ponded areas of the site in June 1992. Based on observations elsewhere in the Cedar River Basin, it is expected that cutthroat trout would also inhabit the site. A small number of spawning sockeye salmon have been observed by King County staff (Andy Levesque) in the gravel-bedded portion of the riverward channel.

Existing Fish Habitat[20]**:** Existing overwintering habitat is 2,604 m^2, consisting of 1,627.5 m^2 of pond (106.75 m X 15.25 m) and 976.5 m^2 (320.25 m X 3 m) of channel area.

New Fish Habitat: A total of 831.43 m^2 of overwintering habitat would be created consisting of approximately four pools with a total surface area of 465.43 m^2 (four each at 15.25 m X 7.63 m), and 366 m^2 of channel (122 m X 3m) extending upstream in the north side channel.

Site Characteristics: Site is within 100-year floodplain. Wetlands are present. Vegetation is dominated by deciduous trees.

[20] Measurements based on U.S.C.O.E. maps (1:200) unless otherwise noted.

BACKGROUND: This site is an alder dominated floodplain across from the mouth of Madsen Creek and immediately downstream of the Punnit-Briggs revetment. Two main side channels and a small third channel exist on the floodplain coalescing into one channel with a significant amount of pond surface. Surface flow is present year-round in the lower reach of the channel and much of the channel area has surface flow during winter wet periods. The northern portion of the site is owned by the Maplewood Heights Homeowners Association and is reserved as an undevelopable open space tract. The Homeowners Association has indicated a willingness to allow habitat work to occur provided the natural features of the site are not degraded and the steep north valley wall is not destabilized. The southern, riverward side channel and portion of the floodplain is owned by the City of Renton, who would like to use their portion of the site for possible future mitigation needs. A series of springs emanate from the north valley wall behind the Punnit-Briggs revetment about 900 feet upstream of the floodplain. These springs have had year-round significant flow in 1992 and 1993.

PROJECT ISSUES/LIMITATIONS: The site is in the 100-year floodplain and gets frequent flooding but was not significantly altered by the large November 1990 storms. The site can be readily accessed via the Punnit-Briggs revetment but will require permission and possibly some easements from residents who live along the revetment. Wetland and wildlife values should be enhanced when combined with the recommended revegetation, LWD additions, and proper construction supervision.

Elliot Wetland Enhancement (VF-02B)

PROJECT LOCATION: Cedar River/LB at RM 4.4

OPPORTUNITY/PROBLEM: A pond and channel riparian wetland located behind and immediately downstream of the Elliot Levee could be enhanced for fish and wetland values.

PROJECT CONCEPT: Deepen portions of the wetland by at least 1 m, add LWD to the open water and riparian areas of the wetland, and excavate the upstream portion of the channel behind the upper levee to expose additional gravel substrate and intercept shallow groundwater suitable for sockeye spawning.

PRIMARY FISH BENEFIT: Existing overwintering habitat for coho salmon and cutthroat trout would be enhanced and new habitat would be provide. A small amount of new sockeye spawning habitat would be created in the channel area behind the upstream portion of the levee.

OTHER BENEFITS: Improvement of floodplain vegetation and an increase in structural diversity would enhance floodplain and wetland functions. The site is frequented by the public for fish observation as well as other wildlife viewing and passive recreation. The site is adjacent to the City of Renton's Golf Course and park complex and only a short distance from the Cedar River Trail.

EXISTING SALMONID USE: Coho salmon fry and cutthroat trout have been observed using the existing habitat.

EXISTING FISH HABITAT: Existing overwintering habitat is approximately 2,791.21 m^2 consisting of 2,093.52 m^2 (91.5 m X 22.88 m) of pond habitat and 697.69 m of channel habitat (152.5 m X 4.58 m).

NEW FISH HABITAT: A total of 209.31 m^2 (45.75 m X 4.56 m) of new spawnable sockeye habitat would be created.

Site Characteristics: The site is a degraded riparian wetland within the frequent floodplain of the Cedar River. Vegetation is dominated by immature trees and invasive shrubs such as Japanese knotweed.

Background: This is a pond and channel wetland complex existing behind and immediately downstream of the Elliot levee. Much of the open water area was constructed about the time of the Elliot Levee construction (ca., 1975) to provide fish habitat and a site for artificially holding and spawning salmon. The wetland is much degraded because of failure of the levee, which has resulted in sediment deposition, and poor riparian vegetation due to flood disturbance and subsequent establishment of invasive plants. This project would be suitable when, if ever, permitting allows modification of wetlands for ecological restoration purposes and if WDFW allows enhancement of coho salmon when they are in sympatry with sockeye salmon.

The site is owned by the City of Renton and is within the 100-year floodplain between the City of Renton Municipal Golf Course and the mainstem channel. The downstream forested terrace, which is dominated by deciduous trees, mainly cottonwood, and dense patches of blackberries, is the site of a groundwater-fed channel, which was constructed in 1995.

Project Issues/Limitations: Construction on this site will require an interlocal agreement with the City of Renton. Shoreline and wetland functions are expected to be enhanced. Because of its coho salmon value, WDFW is not likely to support this project until Cedar River sockeye populations are recovered.

Lower Summerfield (VF-04)

Project Location: Cedar River/LB at RM 5.4

Opportunity/Problem: A groundwater-fed channel could be constructed in a publicly-owned floodplain along the lower Cedar River.

Project Concept: Excavate a groundwater-fed pond and channel on public open space along the Cedar River and underplant the floodplain with conifers.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The site is adjacent to the Cedar River Trail and offers passive recreation opportunity, however little use of the site is believed to exist because of dense underbrush.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: None.

New Fish Habitat: New groundwater-fed habitat for sockeye, coho and cutthroat is estimated at 3,798 m^2, consisting of a 2,196 m^2 pond (122 m X 18 m) and a 1,602 m^2 channel (534 m X 3 m).

Site Characteristics: No inventoried or otherwise large or significant wetlands present; lies within 10-year floodplain. Vegetation dominated by deciduous forest including many large cottonwoods.

Background: The site is owned by King County and adjacent to the Cedar River Trail.

Project Issues/Limitations: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. It will also require permission from King County Parks Department. Because of its sockeye value, this project should receive strong support from WDFW.

Upper Summerfield (VF-05)

Project Location: Cedar River/LB at RM 6.0

Opportunity/Problem: A groundwater-fed pond and channel could be constructed in a publicly owned floodplain along the Cedar River.

Project Concept: Excavate two groundwater-fed ponds and connecting channels on and underplant the floodplain with conifers.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The site is adjacent to the Cedar River Trail and offers passive recreation opportunity, however little use of the site is believed to exist because of dense underbrush.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed sockeye, coho, and cutthroat habitat is estimated at 6,946.5 m^2, consisting of two ponds totaling 5,940 m^2 (one at 137 m x 30 m and one at 61 m X 30 m) and 1,006.5 m^2 of channel (335.5 m X 3 m).

Site Characteristics: No inventoried wetlands are known to exist on the site. Most of the habitat would be constructed outside of the 100-year floodplain. Vegetation is dominated by deciduous forest.

Background: The site is immediately downstream of Cavanaugh Pond. It is owned by King County and adjacent to the Cedar River Trail.

Project Issues/Limitations: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW.

Herzmann Levee (VF-06)

Project Location: Cedar River/RB at RM 6.2

Opportunity/Problem: A groundwater-fed pond and channel could be constructed behind the Herzmann Levee.

PROJECT CONCEPT: Excavate a groundwater-fed pond and channel on private property behind the Herzmann Levee and underplant the floodplain with conifers.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 1,830 m^2, consisting of one narrow pond totaling 915 m^2 (61 m X 15 m) and 915 m^2 of channel (305 m X 3 m).

SITE CHARACTERISTICS: No inventoried or otherwise large, significant wetlands are present. Lies within the 100-year floodplain but is well protected behind the Herzmann Levee. There is a deciduous forest. Based on examination of shallow holes dug by a landowner in preparation for a drain field, underlying substrates are coarse river gravel and groundwater was at a depth of about 4 feet.

BACKGROUND: The site is behind, and well protected by, the Herzmann Levee, which is across the river from Cavanaugh Pond. The proposed channel would extend from the pond into a swale that parallels the river in the forested floodplain downstream of the levee. As recently as 1997, the primary landowner has expressed a high degree willingness to grant an easement and allow excavation of groundwater-fed habitat.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW.

Lower Jones Road (VF-07)

PROJECT LOCATION: Cedar River/RB at RM 6.8

OPPORTUNITY/PROBLEM: A spring-fed tributary in the Cedar River floodplain along the lower Jones Road has poor fish access due to a malfunctioning fish ladder. In addition, stream and wetland habitats could be much enhanced and increased in area.

PROJECT CONCEPT: This project would 1) deepen, add LWD, and revegetate two existing wetland ponds located above and below the private drive at 1607 SE Jones Road; 2) restore riparian vegetation, add LWD and spawnable gravel, and excavate pools in the stream channel; and 3) repair a small fish ladder at the mouth of the stream.

PRIMARY FISH BENEFIT: Modifications would primarily benefit the spawning and rearing of coho salmon and cutthroat trout. Residents have observed small numbers of sockeye using the channel in the past and these fish may also be significantly enhanced.

OTHER BENEFITS: Since the proposed actions would restore riparian vegetation and increase structural diversity of wetland and stream channel areas, wildlife, water quality, and overall wetland functions would be expected to increase in this area.

EXISTING SALMONID USE: No significant use by coho or sockeye salmon has been observed since about 1990. Residents report that sockeye and coho used the stream at least into the 1980s. Loss of these fish may be due to the failure of a fish ladder, which was constructed at the mouth of this stream in 1990 as mitigation for three large homes located on the lower portion of the stream channel, or habitat degradation caused about the time of the construction. According to Larry Fisher, Regional Habitat Biologist, WDFW, the ladder has not worked since shortly after it was constructed.

EXISTING FISH HABITAT: Not applicable because habitat is not currently utilized or is only rarely used.

NEW FISH HABITAT: A total of 802.5 m^2 of year-round coho and cutthroat habitat would be made available and enhanced. Pond habitat would consist of 457.5 m^2 (two ponds at 30.5 m X 15 m each) and channel area would be 345 m^2 (230 m X 1.5 m).

SITE CHARACTERISTICS: Much of the stream is within or surrounded by wetland. Vegetation is a mix of lawn and dense shrub and deciduous trees. The site lies outside the 100-year floodplain. Spring-flow is significant (at least 0.5 cfs) year-round.

BACKGROUND: This small tributary collects springs emanating from the north valley wall and flowing under Jones Road. Habitat quality in the channel has been degraded because much of it has been encroached upon and modified by landscaping efforts of local landowners. The lower reach in particular has been channelized and flows through a large area of lawn between three new homes. Of the two wetland ponds, the one immediately upstream of the private drive is still in an undeveloped setting while the one downstream of the private drive is highly artificial and may have been excavated. The owners of the property with the lowermost pond indicated that salmon used to use the stream and that there have been trout in their pond in past years. However, salmon have not been observed since about 1990, following the modification of the lower channel area and failure of a small fish ladder at the stream's mouth. The landowners have expressed an interest in improving their stream and pond for fish.

PROJECT ISSUES/LIMITATIONS: The biggest problem with this project may be in obtaining landowner permission, because many landowners have landscaped portions of the streambank and may be disinclined to change. Several landowners have indicated an interest in enhancing the stream for fish, however.

Ricardi Tributary Ponds (VF-08B)

PROJECT LOCATION: Cedar River/RB at RM 7.3

OPPORTUNITY/PROBLEM: A spring-fed stream on the floodplain behind the Ricardi Levee could be enhanced and a groundwater-fed pond constructed at the head end of the spring.

PROJECT CONCEPT: Construct a groundwater-fed pond at the head of the spring-fed tributary and underplant conifers in the floodplain, and add LWD and excavate small pools in the existing channel.

PRIMARY FISH BENEFIT: Channel enhancements would benefit year-round coho and cutthroat rearing and the pond would provide sockeye spawning habitat and coho and cutthroat rearing habitat.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance other wildlife values and existing wetland functions.

EXISTING SALMONID USE: Coho salmon and cutthroat trout. No sockeye have been observed to use the channel.

EXISTING FISH HABITAT: About 915 m^2 of channel (305 m X 3 m) would be enhanced for year-round coho salmon and cutthroat trout rearing.

NEW FISH HABITAT: An additional 2,790.75 m^2 (61 m X 45.75 m) of groundwater-fed pond habitat for sockeye and coho salmon and cutthroat trout would be created by construction of a new pond.

SITE CHARACTERISTICS: The stream has associated, but uninventoried, wetlands. The surrounding vegetation is dominated by deciduous trees and dense underbrush. Lies within the 100-year floodplain.

BACKGROUND: The spring drains private property in the floodplain behind the Ricardi Levee. A companion pond (VF-08A) was constructed in 1997 as part of a habitat restoration and floodplain buyout program.

PROJECT ISSUES/LIMITATIONS: Acquisition of much of the site is anticipated by end of 1998. Some work could be done on adjacent land not currently being considered for acquisition. Because of its high coho value, this project may not receive support from WDFW until Cedar River sockeye populations are restored.

Jeffries/Cook Revetment (VF-09)

PROJECT LOCATION: Cedar River/RB at RM 7.3

OPPORTUNITY/PROBLEM: An extended groundwater-fed channel running parallel to the river and two ponds could be constructed behind the Jeffries/Cook Revetment.

PROJECT CONCEPT: Excavate two groundwater-fed ponds and a long connecting channel on private property behind the Jeffries/Cook Revetment and underplant the floodplain with conifers. The channel would empty into the Cedar River at the upstream end of the Ricardi Levee.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 15,809.5 m^2 consisting of two large ponds totaling 11,692 m^2 (one at 122 m X 38 m and one at 84 m X 84 m) and 4,117.5 m^2 of channel (1,372.5 m X 3 m).

SITE CHARACTERISTICS: Lies outside the 100-year floodplain. No inventoried or otherwise large or significant wetlands are known to exist on the site. Vegetation is thinned riparian forest with use by horses.

BACKGROUND: The site is located behind the Jeffries/Cook Revetment. The land is private with the dominant upland use being a horse farm easily viewed along the Jones Road. There is a large existing pond on an upper terrace of the farm; this pond has year-round water indicating that shallow groundwater is available and potentially providing additional habitat value if connected with the proposed project. The land on which the ponds and channel would be excavated is dominated by deciduous forest that has been thinned, presumably for low-intensity horse use. Most of the proposed habitat is outside the 100-year floodplain.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. The landowner has not yet been contacted about this project. Because of its sockeye value, this project should receive strong support from WDFW.

Upper Riverbend (VF-10)

PROJECT LOCATION: Cedar River/LB at RM 7.2

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be excavated in the undeveloped area upstream of the Riverbend Mobile Home Park.

PROJECT CONCEPT: Excavate a groundwater-fed pond and outlet channel on private property at the upstream end of the Riverbend Mobile Home Park and underplant the surrounding floodplain with conifers.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and help to protect the mobile home park. Excavation of the pond and channel will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The upstream part of the site is on public open space and next to the Cedar River Trail.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 2,592.5 m^2, consisting of one large pond of 1,860.5 m^2 (61 m X 30.5 m) and an 732 m^2 channel (244 m X 3 m).

SITE CHARACTERISTICS: No inventoried wetlands are known to exist on the site, which lies outside 100-year floodplain. Vegetation is a mix of deciduous forest and cleared field.

BACKGROUND: The site is in the undeveloped area at the upstream end of the Riverbend Mobile Home Park. The land on which the pond and channel would be excavated is undeveloped and dominated by deciduous forest which has been thinned.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. The landowner has not been contacted about this project. Because of its sockeye value, this project should receive strong support from WDFW.

Wetland 103 (VF-11)

PROJECT LOCATION: Cedar River/LB at RM 7.5

OPPORTUNITY/PROBLEM: Enhance stream and wetland habitat and increase fish-usable area in Lower Cedar River Wetland 103.

PROJECT CONCEPT: This project would 1) deepen portions of the wetland to create about approximately four small ponds with depths of three feet or more and associated connecting channels; 2) add LWD to the open water and riparian areas of the wetland to increase cover and structural diversity; and 3) remove invasive plants and restore with native vegetation as needed.

PRIMARY FISH BENEFIT: This project would provide enhance existing and provide new overwintering habitat for coho salmon and cutthroat trout.

OTHER BENEFITS: Improvement of floodplain vegetation and an increase in structural diversity would enhance floodplain and wetland functions. The site is adjacent to the Cedar River Trail and has high potential for passive recreational value.

EXISTING SALMONID USE: None on the proposed project site. However, in May 1992, coho fry were observed in pools in a side channel on the edge of the wetland.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: About 1,738.5 m^2 of coho and cutthroat overwintering habitat would be created consisting of four ponds totaling 1,372.5 m^2 (a total pond length of 91.5 m and average width of 15 m) and 366 m^2 of channel habitat (122 m X 3 m).

SITE CHARACTERISTICS: The site lies within the 100-year floodplain and proposed actions would occur within Lower Cedar Wetland 103, a six-acre Class 2 forested wetland complex. Vegetation is deciduous forest.

BACKGROUND: The entire site is in public ownership and lies within the 100 year floodplain between the Cedar River Trail and the river.

PROJECT ISSUES/LIMITATIONS: Shoreline and wetland permits will be required. Wetland functions should be enhanced by this work. Because of its coho salmon value, WDFW is not likely to support this project very strongly until Cedar River sockeye populations are restored.

Wetland 37-A (VF-12)

PROJECT LOCATION: Cedar River/LB at RM 8.3

Opportunity/Problem: A groundwater-fed pond and channel could be excavated on a large publicly owned, forested floodplain.

Project Concept: Excavate a groundwater-fed pond and outlet channel in the floodplain downstream of LCR Wetland 37A

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding. Excavation of the pond and channel will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The site is adjacent to the Cedar River Trail and has very high potential for passive recreation.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 5,338 m^2, consisting of one large pond 4,651 m^2 (152.5 m X 30.5 m) and a 687 m^2 channel (229 m X 3 m) leading to the river.

Site Characteristics: Site is actually downstream of Wetland 37, although some small wetlands may be present. The site lies within the 100-year floodplain, and contains mixed conifer and deciduous forest with some large trees.

Background: This is the largest tract of publicly owned natural open space along the Cedar River below the mouth of Rock Creek. It was identified as the preferred site for a sockeye spawning channel, and the Cedar River Basin Plan specifically recommends keeping options open (i.e., not developing) this land for any other purpose until a final decision on the channel is reached.

Project Issues/Limitations: Construction on this site must be delayed until a final decision on constructing a sockeye spawning channel is made. Should the spawning channel not be built on this site, this project should receive strong support from WDFW because of its sockeye value.

Wetland 37-B (VF-13)

Project Location: Cedar River/LB at RM 8.3

Opportunity/Problem: Connecting with the channel described in Project VF-12, two groundwater-fed ponds and an extended outlet channel could be built in the downstream portion of this wetland.

Project Concept: Excavate two small groundwater-fed ponds and an extended outlet channel paralleling the river and connecting with the outlet channel of project VF-12.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding. Excavation of the pond and channel will enhance wildlife and wetland values. The site is adjacent to the Cedar River Trail and has very high potential for passive recreational use.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 5,726 m^2, consisting of two small ponds totaling 3,713 m^2 (one at 76 m X 30.5 m and one at 45.75 m X 15 m) and a 2,013 m^2 channel (671 m X 3m) connecting to the outlet channel of project VF-12.

SITE CHARACTERISTICS: Wetland 37 extends onto the site, which lies within the 100-year floodplain. Mixed forest is present.

BACKGROUND: The site is on the largest publicly owned tract of natural floodplain left in the Cedar River below Rock Creek. A sockeye spawning channel has been proposed for this same site. The Cedar River Basin Plan recommends that this site be kept undeveloped for anything else until a final decision on the channel is made. This decision is anticipated in 1998 or 1999, when a series of studies on factors limiting sockeye production in Lake Washington are expected to be completed.

PROJECT ISSUES/LIMITATIONS: Work will require a shoreline permit. Should the spawning channel not be built on this site, this project should receive strong support from WDFW because of its sockeye value.

Power Line Habitat (VF-14)

PROJECT LOCATION: Cedar River/RB at RM 9.6

OPPORTUNITY/PROBLEM: Groundwater-fed habitat could be excavated in undeveloped valley-floor space underneath the BPA power lines.

PROJECT CONCEPT: Excavate two groundwater-fed ponds and an outlet channel on the right bank of the Cedar River in the right-of-way beneath the BPA transmission lines crossing the Cedar River at about RM 9.6.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding. Excavation of the pond and channel will enhance wildlife values by creating greater habitat diversity and, for some animals, providing food or nutrient value from fish. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 846 m^2 consisting of two small ponds totaling 686 m^2 (total pond length of 45 m X 15 m) and 160 m^2 of channel (53 m X 3 m).

SITE CHARACTERISTICS: No wetlands are obvious on this site. Vegetation has been cleared and is dominated by invasive scrub/shrub species (e.g., scotch broom).

Background: The land on which the pond and channel would be excavated is undeveloped and dominated by shrub. Most of the proposed habitat is outside the 100-year floodplain.

Project Issues/Limitations: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. The landowner has not yet been contacted about this project. Because of its sockeye value, this project should receive strong support from WDFW.

WPA/Cedar Mountain Levee (VF-15)

Project Location: Cedar River/LB at RM 10.3

Opportunity/Problem: A groundwater-fed pond and channel could be excavated behind the WPA/Cedar Mountain Levee.

Project Concept: Excavate a groundwater-fed pond and an outlet channel behind the WPA/Cedar Mountain Levee connecting to the left bank side channel in the Belmondo reach of the Cedar River.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The site is adjacent to the Cedar River Trail and could offer passive recreation opportunity; however, little use of the site is believed to exist because of dense underbrush.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,248.5 m^2, consisting of one pond totaling 2,791 m^2 (91.5 m X 30.5 m) and a 457.5 m^2 outlet channel (152.5 m X 3 m).

Site Characteristics: The site lies within the 100-year floodplain and is dominated by a deciduous forest.

Background: The site is at the upstream end of the Belmondo Reach of the Cedar River, which is the most unaltered and natural reach of river below Rock Creek. This area is a high priority for open space acquisition in the basin and is adjacent to the Cedar River trail. The proposed project would complement the natural attributes of this high quality area. A private pond has already been excavated to the south of the proposed pond site. It is part of the landscaping of a newer home behind the WPA levee. This project would connect with and enhance the outlet channel of that private pond before emptying into a left bank side channel of the river.

Project Issues/Limitations: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Landowner interest has not been determined. Because of its sockeye value, this project should receive strong support from WDFW.

Tributary 0316 Enhancement (VF-16)

Project Location: Cedar River/RB at RM 10.5

Opportunity/Problem: A small spring-fed stream behind the Cedar Grove Mobile Home Park lacks deep pools and LWD and has riparian vegetation dominated by non-native invasive plants. Residents of the mobile home park have encroached upon the habitat and are interested in ways to make it better for fish.

Project Concept: Restoring riparian vegetation, add LWD and excavate pools in the channel, and educate residents of the Cedar Grove Mobile Home Park about protecting this habitat. This would be a good project for a volunteer group.

Primary Fish Benefit: Overwintering habitat for coho salmon and cutthroat trout.

Other Benefits: Since the proposed actions would restore riparian vegetation and increase structural diversity of the stream channel, wildlife and floodplain functions would be expected to increase in this area.

Existing Salmonid Use: Coho fry have been observed. Cutthroat trout would also be expected to use this type of habitat, although none have been directly observed.

Existing Fish Habitat: A total of 595 m^2 of channel habitat (396.5 m X 1.5 m) would be enhanced for coho overwintering.

New Fish Habitat: No new habitat is proposed.

Site Characteristics: No large or otherwise inventoried wetlands are present but stream is on the upstream edge of Wetland 105. The site lies within the 10-year floodplain. Riparian vegetation is dominated by blackberry, knotweed, and mixed deciduous and conifer trees. A small amount of riparian clearing has occurred. Year-round flow exists but is very small in summer.

Background: This small stream starts its fish-bearing habitat where it reaches the valley floor at the entrance to the Cedar Grove Mobile Home Park. It then flows behind the park before emptying into the Cedar River. The tributary has year-round flow, although it can be very small in the summer. Most of the water in the channel appears to be derived from springs emanating from the north valley wall, although it may also be intercepting some shallow groundwater. As part of the Rainbow Bend floodplain, this channel is within the 10 year floodplain and serves as the high flow, valley-wall return channel for flood flows. Habitat quality in the channel is relatively poor because much of it has been encroached upon and modified by landscaping efforts and it has probably been ditched. The stream is further threatened by expansion of the Stoneway Gravel Mining operations which cleared the upland areas overlooking the stream and will be excavating large quantities of gravel in the future. If the stream is in fact derived solely from the valley walls, then Stoneway's operations could affect future flows by removing the gravel aquifers for the springs. In August 1994, King County partly completed this project by excavating two small pools, adding LWD, and revegetating the channel at the entrance to the park. This was a planned "early action" project that became more necessary after oil pollution leaked from an upstream construction company site.

Project Issues/Limitations: Future work will need to consider the effects of Stoneway's gravel mining on stream flows and water quality, especially sediment. If work is considered stream enhancements by regulators, then permits should not be a significant problem. Because of its coho value, this project would not be strongly supported by WDFW until Cedar River sockeye populations are restored.

Lower Rainbow Bend (VF-17)

PROJECT LOCATION: Cedar River/LB at RM 10.6

OPPORTUNITY/PROBLEM: Excavate a groundwater-fed pond and channel on the lower Rainbow Bend floodplain near the site of the Cedar Grove Mobile Home Park.

PROJECT CONCEPT: Excavate a groundwater-fed pond and an outlet channel in the undeveloped forested floodplain of lower Rainbow Bend riverward of the mobile home park.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding, and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. Although this project is not dependent upon floodplain buyout, buyout and restoration of the entire Rainbow Bend floodplain is the highest recommendation in the Cedar River Basin Plan. Should this occur, this habitat would be readily accessible for passive recreation due to proximity to the Cedar River Trail, which is directly across the river. However, little use of the site is believed to exist at this time.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 1,952 m^2, consisting of one pond of 1,403 m^2 (61 m X 23 m) and a 549 m^2 outlet channel (183 m X 3 m).

SITE CHARACTERISTICS: No inventoried or otherwise large significant wetlands are on the site, which lies within the 10-year floodplain. Vegetation is mixed forest with mostly deciduous trees.

BACKGROUND: Buyout and restoration of the Rainbow Bend floodplain is the highest recommended project for the Cedar River Basin Plan (see the Plan for more details about flooding and proposed flood hazard reduction project), although it will undoubtedly take many years to occur—if it occurs at all.

PROJECT ISSUES/LIMITATIONS: Although not necessary, it may be best to delay this project until it is determined whether buyout of the entire floodplain is likely to occur. Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW.

Upper Rainbow Bend (VF-18)

PROJECT LOCATION: Cedar River/RB at RM 10.7

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be constructed in the undeveloped, forested floodplain of upper Rainbow Bend.

PROJECT CONCEPT: Excavate a groundwater-fed pond and an outlet channel in the undeveloped forested floodplain of upper Rainbow Bend.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding, and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. Although this project is not dependent upon floodplain buyout, it would benefit the project by reducing concerns over residential impacts and would make the site public property. Should this occur, this habitat would be accessible for passive recreation due to proximity to the Cedar River Trail, which is directly across the river. Little use of the site is believed to exist at this time.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,120.5 m^2, consisting of one pond 1,748 m^2 (76 m X 23 m) and a 1,372.5 m^2 outlet channel (457.5 m X 3m).

SITE CHARACTERISTICS: The site lies within the 100-year floodplain, and vegetation is dominated by deciduous forest.

BACKGROUND: The site is the upper portion of the Rainbow Bend Floodplain. Buyout and restoration of this area is the highest recommended project for the Cedar River Basin Plan, although it will undoubtedly take many years to occur—if it occurs at all. See the Basin Plan for more details about flooding and flood hazard reduction recommendations.

PROJECT ISSUES/LIMITATIONS: Although not necessary, this project should be delayed until it is clear whether buyout of the entire floodplain is likely to occur. Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW.

Tributary 0316A (VF-19)

PROJECT LOCATION: Cedar River/RB at RM 11.1

OPPORTUNITY/PROBLEM: Overwintering habitat for coho salmon could be constructed in an isolated floodplain wetland directly upstream of the mouth of Tributary 0316A.

PROJECT CONCEPT: This project would: 1) excavate approximately three small ponds and associated connecting channels in a wall-based, spring-fed wetland; 2) restore floodplain vegetation with conifer underplanting and other suitable vegetation; and 3) add LWD in an inside meander bend directly upstream of the mouth of Tributary 0316A. The habitat would be connected to lower Tributary 0316A.

PRIMARY FISH BENEFIT: Modifications would primarily benefit the overwintering of coho salmon and cutthroat trout.

OTHER BENEFITS: Since the proposed actions would restore riparian vegetation and increase structural diversity of the stream channel, wildlife and floodplain functions would be expected to increase in this area.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new overwintering habitat for coho salmon and cutthroat trout is estimated at 1,203 m^2, consisting of three small ponds totaling 855 m^2 (total pond length of 114 m X 7.5 m average width) and a 348 m^2 connecting and outlet channel (116 m X 3m).

Site Characteristics: Forested wetland is present at base of north valley wall. Small perennial springs emanate from valley wall. The site lies within 100-year floodplain. Forest is immature deciduous trees.

Background: The site is within a very isolated floodplain upstream from Tributary 0316A and across the river from the McDonald Levee. Elk tracks and scat were observed here in summer 1992, making it the closest known presence of wild elk to Seattle.

Project Issues/Limitations: Construction on this site will require a shoreline permit and permits for work in wetlands. Because of its coho value, this project would not receive strong support from WDFW at this time until Cedar River sockeye populations are restored.

Byers Bend Channel (VF-20)

Project Location: Cedar River/LB at RM 11.5

Opportunity/Problem: As part of a flood hazard reduction project to construct a floodway along Byer's Bend Road, a groundwater-fed channel would be excavated within the floodway corridor.

Project Concept: Excavate a groundwater-fed pond and channel within the floodway proposed as a flood hazard reduction project in the Cedar River Basin Plan and the King County Flood Hazard Reduction Plan. The floodway would parallel the Byers Bend Road and would be contoured and designed to provide for both aquatic and riparian habitat when not conveying flood flows.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. This habitat is adjacent to the Cedar River Trail and would enhance the scenic view from the trail but would probably provide only minor passive recreational benefit because of its proximity to developed areas of the floodplain.

Existing Salmonid Use: None. The habitat is considered new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 5346.5 m^2, consisting of one pond totaling 1,860.5 m^2 (61 m X 30.5 m) and a 3,486 m^2 channel (1,162 m X 3 m).

Site Characteristics: Small wetlands and winter springs are present in the swale that would form the basis of the floodway and habitat. The site lies within the 100-year floodplain. Vegetation is pasture, scrub-shrub, and occasional trees.

BACKGROUND: The site runs parallel to the Byers Bend Road. The flooding concerns and floodway recommendation are discussed in detail in the Cedar River Basin Plan. Until about 15 years ago, the naturally occurring swale, which is the basis for the channel and floodway, had sufficient surface flow for steelhead spawning as observed by Andy LeVesque (King County WLRD). Limited surface flow still exists but, based on anecdotal information, appears to be much diminished from about 15 years ago and is insufficient for salmon spawning. Possible explanations for flow reductions include the obstruction or use of shallow groundwater by surrounding residential development or the mid-1970s construction of two large private groundwater-fed ponds on property between the river and the Byers Bend Road. These ponds, discussed in project VF-21B, are highly successful in attracting spawning sockeye salmon.

PROJECT ISSUES/LIMITATIONS: Construction on this site may be dependent on construction of the proposed floodway (cost estimated at up to $12 million). Other possible limitations pale beside this problem. Because of its sockeye value, however, this project should receive strong support from WDFW.

McDaniel's Creek Enhancement (VF-21A)

PROJECT LOCATION: Cedar River/LB at RM 11.5

OPPORTUNITY/PROBLEM: An artificially created spring-fed tributary along SE 184th Street could be enhanced for sockeye spawning and coho salmon and cutthroat trout rearing.

PROJECT CONCEPT: This project would 1) restore riparian vegetation, add LWD and spawnable gravel, and excavate pools in the stream channel; and 2) fence livestock from the lower reaches of the channel downstream of the Renton Lion's Club Park. A pilot project to restore a limited amount of spawning gravel and riparian vegetation within the reach of stream owned by the Lions' Club was implemented in 1996. Additional work of this nature, could be a very good project for a volunteer group to implement. The club has been very supportive of this type of effort.

PRIMARY FISH BENEFIT: Modifications would increase spawning area for sockeye salmon and enhance rearing habitat for coho salmon and cutthroat trout.

OTHER BENEFITS: Wildlife and water quality would be enhanced by these actions.

EXISTING SALMONID USE: Sockeye salmon spawn extensively in gravel bedded portions of the channel. The channel also gets used for spawning and rearing by coho salmon and cutthroat trout.

EXISTING FISH HABITAT: The channel provides about 869 m^2 of coho and cutthroat rearing habitat (579.5 m X 1.5 m), all of which would be enhanced. About 50 percent of this is spawnable for sockeye salmon.

NEW FISH HABITAT: No new coho or cutthroat trout habitat is proposed. About 229 m^2 (152.5 m X 1.5 m) of new spawnable substrate for sockeye would be created by gravel addition.

SITE CHARACTERISTICS: Lies within the 100-year and possibly the 10-year floodplain. A small riparian wetland is located in the lower reaches of the channel. Vegetation is a mix of lawn, scrub-shrub, deciduous trees, and overgrazed forested banks.

BACKGROUND: This small stream begins in two groundwater-fed ponds built by G.T. McDaniel (recently deceased) in about 1975. According to Mr. McDaniel and other local residents, a great deal of pressurized groundwater was intercepted while he was building a trout pond. To accommodate the new surface water, McDaniel built a channel to the river following a swale that returned to the river at the upstream end of the McDonald Levee. Since that time, the channel has been well used by salmon, especially sockeye. However, many areas of the channel could be much improved for spawning and rearing purposes. Thousands of sockeye salmon migrate through the channel to spawn in the groundwater ponds at the head of the channel (see VF-21B for a project to construct an additional groundwater-fed pond on Mr. McDaniel's property). The stream has significant year-round flow, with minimum summer flows estimated to be about one cfs. Habitat quality throughout almost all the channel is of intermediate quality because of landscaping efforts and poor riparian vegetation. The lower reach is degraded by livestock access, with cows often walking in the stream and damaging redds, rearing habitat, and water quality.

PROJECT ISSUES/LIMITATIONS: All of the work should be considered stream enhancement, thereby alleviating many permitting issues. The Renton Lion's Club has been very enthusiaistic about the proposed work and has incorporated restoration goals in their recently adopted land use plan. The landowner along the lower part of the channel (downstream of the Lions Club) have not been willing to let any work occur so far, however, in part because they feel the channel was wrongly placed on their property and now they have a property burden that did not historically exist. They would like to see the channel completely redirected off their property. This is not a very likely alternative due to the difficulty and mitigation required in relocating streams, especially ones as productive as this. The support of Mr. McDaniel's heirs is uncertain.

McDaniel's New Pond (VF-21B)

PROJECT LOCATION: Cedar River/LB at RM 11.5

OPPORTUNITY/PROBLEM: An additional groundwater-fed pond for sockeye salmon on this property would expand an existing set of groundwater habitats that currently includes two ponds and connecting channels heavily used by spawning sockeye salmon.

PROJECT CONCEPT: Excavate an additional groundwater-fed pond on this property.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,034 m^2, consisting of one pond of 2,806 m^2 (61 m X 46 m) and a 228 m^2 outlet channel (76 m X 3 m).

SITE CHARACTERISTICS: The site lies within the 10-year floodplain, and vegetation is an open field with a few trees.

BACKGROUND: Existing groundwater-fed ponds and channels were built by G.T. McDaniel (recently deceased) in about 1975. According to Mr. McDaniel and other local residents, a great deal of pressurized groundwater was intercepted while he was building a trout pond. To accommodate the new surface water, McDaniel built a channel to the river following a swale that returned to the river at the upstream end of the McDonald Levee. Since that time, the habitat has been well used by salmon, especially sockeye.

PROJECT ISSUES/LIMITATIONS: Since there are no known wetlands on the site, permits should be relatively easy to obtain. Because of its sockeye value, WDFW should be highly supportive of this project.

Jan Road Ponds (VF-22)

PROJECT LOCATION: Cedar River/RB at RM 12.2

OPPORTUNITY/PROBLEM: A series of small ponds and channels could be excavated in the floodplain along the base of the north valley wall directly upstream of the steep bank at Byer's Bend.

PROJECT CONCEPT: Excavate a series (five or so) of small ponds and connecting channels on the right bank floodplain upstream of Byer's Bend. Connect this habitat to a valley floor spring-fed stream that enters the river directly upstream of the steep bank at Byer's bend. Project VF-23, the Jan Road Floodway, would also connect to the river at this point.

PRIMARY FISH BENEFIT: New overwintering habitat for coho salmon would be created.

OTHER BENEFITS: Wildlife should benefit by these actions. No inventoried or large, significant wetlands are present on the site, so wetland values should increase by exposing groundwater.

EXISTING SALMONID USE: None.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: A total of 1,111.5 m^2 of overwintering habitat for coho salmon and cutthroat trout would be created consisting of 562.5 m^2 of ponds (five at 15 m X 7.5 m) and 549 m^2 of channel (183 m X 3 m).

SITE CHARACTERISTICS: Lies within the 10-year floodplain. Small wetlands are probably present but have not been confirmed. Vegetation is mixed deciduous and conifer forest.

BACKGROUND: Construction of this habitat is proposed for the base of the north valley directly upstream of the steep bank at Byer's Bend. The outlet channel for these ponds would connect with an existing spring that parallels the Cedar River on the right bank above the Byer's Bend steep bank. This is the same point at which the Jan Road Floodway channel would reenter the Cedar River (see Project VF-23).

PROJECT ISSUES/LIMITATIONS: Although no large or inventoried wetlands occur at this site, there are likely wetlands present, so wetland permitting will probably be an issue. No landowners have been contacted at this site. Because of its coho values, this project would probably not be supported by WDFW until sockeye populations in the Cedar River are recovered.

Jan Road Floodway Channel (VF-23)

PROJECT LOCATION: Cedar River/RB at RM 12.5

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be constructed in the corridor designated as the Jan Road Floodway.

PROJECT CONCEPT: Excavate a groundwater-fed pond and channel within floodplain swale that would form the basis for the corridor for the Jan Road Floodway, proposed in the Cedar River Basin Plan and the King County Flood Hazard Reduction Plan.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are in the project area, however, several degraded wetlands are known to exist; the proposed project could increase the quality and quantity of wetland habitat in the project area.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 5,099 m^2, consisting of one pond totaling 2,318 m^2 (76 m X 30.5 m) and a 2,781 m^2 channel (927 m X 3 m).

SITE CHARACTERISTICS: Lies within the 10-year floodplain. Wetlands are present in pastures. Vegetation is mix of pasture, scrub shrub, and deciduous forest.

BACKGROUND: The site is within the floodplain along the north valley wall downstream of SE 197th Place (a.k.a. the Jan Road) and the mouth of Taylor Creek. The Cedar River Current and Future Conditions Report and the Basin Plan describe the flooding concerns and floodway project in detail. The channel would follow a floodplain swale, which is most likely an old river channel. The pond at the head of the channel would start in a very wet pasture with some spring seepage; wetland plants such as sedges and bulrushes are present.

PROJECT ISSUES/LIMITATIONS: Shoreline and wetland issues will be present for this project. Landowner support is unknown. Because of its sockeye value, however, this project should receive strong support from WDFW. Unlike the Byer's Bend floodway, this habitat would not be as dependent on construction of the floodway, since the level of residential development is not as significant and removal of residences would not be necessary.

Jan Road Levee Pond (VF-24)

PROJECT LOCATION: Cedar River/RB at RM 12.5

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be constructed behind the Jan Levee.

PROJECT CONCEPT: Excavate a groundwater-fed pond and an outlet channel in a forested floodplain behind the Jan Road Levee.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 6,789 m^2, consisting of one pond totaling 6,039 m^2 (198 m X 30.5 m) and a 750 m^2 outlet channel (250 m X 3 m).

SITE CHARACTERISTICS: Located along the edge of the 25-year floodplain. No inventoried wetlands are known to exist on the site, but small ones may be present. Deciduous forest present.

BACKGROUND: The site is on private land behind the Jan Levee, which extends along the right bank of the Cedar River downstream from the mouth of Taylor Creek.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW. The landowner willingness is unknown.

Rutledge/Johnson Side Channel (VF-25)

PROJECT LOCATION: Cedar River/LB at RM 12.6

OPPORTUNITY/PROBLEM: A left bank side channel behind the Rutledge/Johnson Levee could be enhanced and better protected from surrounding land uses.

PROJECT CONCEPT: This project would remove an artificially placed partial barrier of gravel and cobble, fence off grazed areas, improve riparian vegetation, add LWD, deepen existing pools and educate local residents about habitat protection.

PRIMARY FISH BENEFIT: Overwintering habitat for coho and cutthroat would be enhanced.

OTHER BENEFITS: Wildlife and water quality would be enhanced by these actions.

EXISTING SALMONID USE: Coho and sockeye salmon and cutthroat trout use this side channel.

EXISTING FISH HABITAT: The channel has about 3660 m^2 of overwintering habitat (366 m X 10 m) would be enhanced for coho and cutthroat trout use.

NEW FISH HABITAT: No new habitat would be created.

SITE CHARACTERISTICS: Lies within the 100-year floodplain. Wetlands are present. Mixed rural residential land use includes encroachments on the channel. Vegetation is mixed deciduous forest and field.

BACKGROUND: The site is on private land within the 100-year floodplain and behind the Rutledge/Johnson Levee, located across the river from the mouth of Taylor Creek. Based on a survey in May 1992, there are a variety of impacts to the channel including localized grazing and a gravel berm across the stream apparently used to drive across the channel. There is almost no woody debris in the channel. An uninventoried wetland exists along the channel.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and a permit to work in wetlands. Because of its sockeye value, this project should receive strong support from WDFW. Landowner willingness is unknown.

Rutledge/Johnson Pond (VF-26)

PROJECT LOCATION: Cedar River/LB at RM 12.6

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be constructed in a forested floodplain behind the Rutledge/Johnson Levee.

PROJECT CONCEPT: Excavate a groundwater-fed pond and outlet channel connecting to the existing left bank side channel behind the downstream end of the Rutledge/Johnson Levee and underplant conifers in the floodplain.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. Existing wetland habitat could be enhanced.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 1,241 m^2 consisting of one pond totaling 1,058 m^2 (46 m X 23 m) and a 183 m^2 outlet channel (61 m X 3 m).

SITE CHARACTERISTICS: Lies within the 10-year floodplain. Wetlands are present. Vegetation is dominated by a deciduous forest.

BACKGROUND: The site is on private behind the Rutledge/Johnson Levee, which extends along the left bank of the Cedar River across from the mouth of Taylor Creek.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. Because of its sockeye value, this project should receive strong support from WDFW. The landowner willingness is unknown.

Wetland 132 (VF-27)

PROJECT LOCATION: Cedar River/RB at RM 12.6

OPPORTUNITY/PROBLEM: Wetland 132, including the lower most reach of Taylor Creek, could be enhanced with addition of LWD and conifer underplanting.

PROJECT CONCEPT: Add LWD to lower Taylor Creek channel and underplant riparian areas with conifers.

PRIMARY FISH BENEFIT: Rearing habitat for coho salmon and steelhead and cutthroat trout would be enhanced.

OTHER BENEFITS: By increasing structural diversity and conifer density, wildlife and wetland conditions would be enhanced.

EXISTING SALMONID USE: Lower Taylor Creek is used by all species of salmonids. Sockeye salmon spawn extensively in gravel bedded portions of the channel near the mouth, and they migrate though the reach to spawn upstream. Habitat is suitable for spawning and rearing by chinook and coho salmon and steelhead and cutthroat trout.

EXISTING FISH HABITAT: About 2,256 m^2 (564 m X 4 m) of coho, steelhead, and cutthroat trout habitat would be enhanced.

NEW FISH HABITAT: No new habitat is proposed.

SITE CHARACTERISTICS: Lies within the 10-year floodplain of the Cedar River. Wetland 132 is a large wetland contiguous with the Cedar River and lower Taylor Creek. Vegetation is dominated by large deciduous trees.

BACKGROUND: Taylor Creek is one the main tributaries of the lower Cedar River. It flows across the valley-floor through lower Cedar River Wetland 132 before emptying into the river. According to the 1990 King County Wetlands Inventory, this is a 26-acre forested and scrub-shrub wetland.

PROJECT ISSUES/LIMITATIONS: Shoreline permits will be required. If this work can be considered stream enhancement, many wetland permitting issues may be alleviated. None of the landowners has been contacted to date. There may also be flooding concerns if LWD additions are sufficient to create a backwater effect; this will have to be analyzed and could be a issue under current zero-rise regulations. Although this project is not sockeye oriented, WDFW may still be supportive since it has the potential to enhance rearing habitat for steelhead trout.

Wetland 132 Ponds (VF-28)

PROJECT LOCATION: Cedar River/RB at RM 12.6

OPPORTUNITY/PROBLEM: Wetland 132 could be modified to increase its structural diversity and create new fish-usable habitat.

PROJECT CONCEPT: 1) On the right bank of lower Taylor Creek excavate two ponds; 2) on the left bank excavate and connect approximately eight small ponds; and 3) add LWD and underplant conifers or other native vegetation as needed. See Project VF-27 for enhancement of lower Taylor Creek.

PRIMARY FISH BENEFIT: New overwintering habitat for coho salmon would be created.

OTHER BENEFITS: By increasing structural diversity and conifer density, wildlife and wetland conditions would be enhanced.

EXISTING SALMONID USE: None. This is new fish-usable habitat.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: This project would create 3,316.5 m^2 of coho overwintering habitat, consisting of 2,062.5 m^2 of pond habitat (two ponds in the right bank riparian area measuring 91.5 m X 15 m each, and up to eight ponds in the left bank riparian area measuring 46 m X 15 m each) and 1,254 m^2 of channel (418 m X 3m).

Site Characteristics: Lies within the 10-year floodplain. Wetland 132 is present. Vegetation is deciduous forest with many large cottonwood trees.

Background: This work would all occur in LCR Wetland 132. According to the 1990 King County Wetlands Inventory, this is a 26 acre forested and scrub-shrub wetland contiguous to the Cedar River and dominated by deciduous trees. The property is privately owned.

Project Issues/Limitations: Shoreline permits and permits for work in wetlands will be required. None of the landowners has been contacted to date. Because of its coho value, WDFW would probably not support this project until sockeye populations are restored to desired levels.

* Project VF-29 has been combined with VF-28

Getchman Levee Channel (VF-30)

Project Location: Cedar River/RB at RM 13.6

Opportunity/Problem: An existing groundwater-fed channel behind the Getchman Levee could be enhanced and better protected from land uses.

Project Concept: This project would add LWD, underplant with conifers, and excavate localized areas of the channel as needed only to ensure adequate depth for access into the channel. This channel would serve as the access channel for the Getchman Levee groundwater-fed pond habitat recommended in VF-31

Primary Fish Benefit: Modifications would primarily increase overwintering habitat for coho salmon. However, they would also provide greater protection for sockeye spawning from landowner activities.

Other Benefits: By increasing structural diversity and conifer density, wildlife and wetland conditions would be enhanced.

Existing Salmonid Use: Sockeye spawn extensively in this small channel and coho salmon and cutthroat trout are likely to use it as overwintering habitat.

Existing Fish Habitat: About 412 m^2 of coho overwintering channel habitat (412 m X 1 m) would be enhanced.

New Fish Habitat: No new habitat is proposed.

Site Characteristics: The site is entirely within the area identified as LCR Wetland 132 (see projects VF-27 and 28 for other work in Wetland 132). Perennial springs exist on site, probably fed by seepage under the levee. Vegetation is deciduous trees, shrubs, and grass.

Background: This small channel, which is fed by springs that emanate from under the Getchman Levee, empties into Taylor Creek shortly downstream from Maxwell Road. The area behind the Getchman Levee was included in the boundary of LCR Wetland 132 by the 1990 King County Wetland Inventory. The property is privately owned, and this portion of the wetland has been encroached upon by residential development and clearing activities. Recently the landowner has modified the channel (i.e., cleared vegetation in and around the channel). The stream is heavily used by sockeye. Based on brief site visit in December 1994, several hundred salmon may be using this channel for spawning.

Project Issues/Limitations: Excavation would be confined to existing channel areas, so work may be permissible under a stream enhancement permit. Landowner permission may be an issue, although the landowner has indicated an interest in improving his site for fish. Because of its coho value, WDFW would probably not support this project very strongly until sockeye populations in the Cedar River are restored.

Getchman Levee Pond (VF-31)

Project Location: Cedar River/RB at RM 13.8

Opportunity/Problem: A groundwater-fed pond could be excavated behind the upper end of the Getchman Levee and connected to an existing groundwater-fed access channel.

Project Concept: Excavate a groundwater-fed pond on the valley-floor behind the Getchman Levee and connect to an existing groundwater-fed channel (see VF-30 for recommendations for enhancements of this channel). This project will require coordination with modifications to the Getchmann Levee to reduce localized flooding impacts on the opposite (left) bank of the river.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding. Creation of the pond and channel will enhance wildlife values.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,151 m^2, all of which is pond habitat (137 m X 23 m).

Site Description: The site is located outside the 100-year floodplain. It is upstream of Wetland 132, but small wetlands are likely present. Vegetation is deciduous forest.

Background: The site is on private property. According to the 1990 King County Wetlands Inventory, the area proposed for excavation is within the boundary of LCR Wetland 132. However, much of the site appears to be well drained and does not exhibit strong wetland characteristics. Sockeye salmon use the existing groundwater-fed channel that would provide access into the pond.

Project Issues/Limitations: Final location of the pond (either directly behind the upstream end of the levee or set back on the floodplain) will depend on the final design for modifications of the Getchmann Levee, proposed in the Basin Plan. Construction on this site will require a shoreline permit and probably permits for work in wetlands since the project may lie partly or fully within the delineated boundaries of LCR Wetland 132. Because of its sockeye value, this project should receive strong support from WDFW. The landowner willingness is unknown.

Royal Arch Oxbow Enhancement (VF-32)

PROJECT LOCATION: Cedar River/RB at RM 14.4

OPPORTUNITY/PROBLEM: A right bank oxbow pond could be enhanced for coho overwintering with better riparian vegetation and addition of LWD.

PROJECT CONCEPT: Add LWD and underplant conifers.

PRIMARY FISH BENEFIT: Overwintering habitat for coho salmon and cutthroat trout would be enhanced.

OTHER BENEFITS: Floodplain stability and wildlife would be enhanced.

EXISTING SALMONID USE: Coho and cutthroat overwintering.

EXISTING FISH HABITAT: A total of 3,751.5 m^2 of coho overwintering habitat would be enhanced, consisting of 3,660 m^2 of pond habitat (244 m X 15m) and 91.5 m^2 (91.5 m X 1 m) of channel habitat.

NEW FISH HABITAT: None.

SITE CHARACTERISTICS: Lies within the 10-year floodplain. Wetlands associated with the pond are expected to be present. Vegetation is dominated by shrubs and deciduous trees.

BACKGROUND: This small pond, apparently a remnant side channel, lies parallel to the Cedar River in the upstream reaches of the area commonly known as Royal Arch.

PROJECT ISSUES/LIMITATIONS: Because the actions are relatively minor, permitting should not be a significant problem. Landowner interest is unknown. Because of its coho value, this project may not be strongly supported by WDFW until sockeye populations are restored.

Witte Road Channel Enhancement (VF-33)

PROJECT LOCATION: Cedar River/LB at RM 14.6

OPPORTUNITY/PROBLEM: A perennial spring-fed channel at the base of the Cedar River Trail berm upstream of the river crossing at Maple Valley could be enhanced.

PROJECT CONCEPT: Add LWD and underplant with conifers (see also Project VF-34, which would excavate a new channel in an upstream swale and connect with this channel).

PRIMARY FISH BENEFIT: Modifications would enhance year-round habitat for coho salmon and cutthroat trout.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and enhance wildlife values. The site is adjacent to the Cedar River Trail, and improvements may contribute to the scenic value of the trail. However, public access to the site would probably be discouraged due to surrounding residential development.

EXISTING SALMONID USE: Sockeye and coho salmon and cutthroat trout use this channel.

EXISTING FISH HABITAT: There is about 915 m^2 of channel habitat (305 m X 3 m) that would be enhanced for coho salmon and cutthroat trout.

New Fish Habitat: No new habitat is proposed.

Site Characteristics: No significant wetlands are present. Flow is perennial and significant (at least 2 cfs).

Background: This channel starts north (riverward) of the point where SE Witte Road crosses under the Cedar River Trail. It lies at the upstream base of the Cedar River Trail high berm, immediately upstream of the SR 169 Highway bridge at Maple Valley. The channel appears to have been formed by past flood scour at the base of the berm. In its current configuration, it intercepts a significant amount (2 cfs or more) of shallow groundwater and returns that water as surface runoff along the base of the berm to the Cedar River. The property is private, although the channel may actually be on the Cedar River Trail right-of-way. In 1994, the landowners expressed a high degree of interest in improving their property for fish.

It is important to note that this channel is the downstream end of a much longer floodplain swale that extends over one-quarter mile upstream to the downstream end of the Seattle Saddle Club, west of SE 228th Street. (Project VF-34 would excavate a groundwater-fed channel in this swale and connect it with this existing channel.)

Project Issues/Limitations: Because the proposed actions are relatively minor, permitting should not be a significant problem. Landowner interest is believed to be high. If the channel were within the Cedar River Trail right-of-way, landowner complications would be reduced. Because of its coho value, the WDFW would probably not support this project until sockeye runs in the Cedar River have rebounded.

Witte Road GW Channel (VF-34)

Project Location: Cedar River/LB at RM 14.8

Opportunity/Problem: An extended groundwater-fed channel could be constructed in an existing forested floodplain swale between Witte Road and the river.

Project Concept: Starting at the downstream area of the Seattle Saddle Club, west of SE 228th Street, excavate a groundwater channel in an existing floodplain swale ultimately connecting with the spring-fed stream channel at the base of the Cedar River Trail berm (see Project VF-33 for enhancement of the stream) and restore floodplain vegetation along the channel.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding. Vegetation improvements and excavation of the channel will enhance wildlife. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The site is can be viewed from the Cedar River Trail, however public access to the site would probably be discouraged due to surrounding residential development.

Existing Salmonid Use: None or very little depending on water levels. There are some areas of the swale that have scoured and created seasonal surface water and coho fry have been observed stranded in a few pools.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed channel habitat for sockeye, coho, and cutthroat is estimated at 1,326 m^2 (442 m X 3 m).

Site Characteristics: Small wetlands are present. Occasional surface water is present through at least early summer (not checked for anything later). Vegetation is combination of minor artificial landscaping and small trees and shrubs.

Background: In its current configuration, the existing swale intercepts a small amount of water and there are only a few seasonal pools. Some salmonid fry were observed stranded in these pools in May 1992, but the pools are far from the mainstem and of poor quality for rearing or overwintering. The property is private, but in conversations in 1994, the landowner at the downstream end of the project, where it would connect with Project VF-33, expressed a high degree of interest in improving their property for fish.

Project Issues/Limitations: Shoreline and wetland permits will be required. With exception of one of the landowners, interest in this work is unknown. Because of its sockeye value, the WDFW would probably support this project.

Seattle Saddle Club (VF-35)

Project Location: Cedar River/LB at RM 15.2

Opportunity/Problem: An existing floodplain pond could be deepened and two additional ponds could be excavated in forested floodplain between the Seattle Saddle Club and the river.

Project Concept: Excavate two new ponds and deepen an existing one, excavate connecting and outlet channels, and underplant conifers on the floodplain between the Seattle Saddle Club (located west of SE 228th Street) and the river.

Primary Fish Benefit: Sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. Small wetlands appear to be present but no inventoried wetlands exist on the site, thus making the excavation to surface water a potential net gain of wetland habitat.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 2,208 m^2, consisting of three ponds totaling 1,605 m^2 (one at 46 m X 15 m and two at 30.5 m X 15 m each) and 603 m^2 of channel (201 m X 3 m).

Site Characteristics: Lies within the 10-year floodplain. Small wetlands are present. The site is forested with deciduous trees.

Background: The site is on private land owned primarily by the Seattle Saddle Club.

Project Issues/Limitations: Construction on this site will require shoreline and wetland permits. Landowners have not yet been contacted. Because of its sockeye value, this project should receive strong support from WDFW.

Dorre Don Court (VF-36)

PROJECT LOCATION: Cedar River/RB at RM 15.7

OPPORTUNITY/PROBLEM: Downstream of Dorre Don Court is a floodplain wetland pond that could be enhanced and made fish accessible, and additional channel habitat could be excavated

PROJECT CONCEPT: This project would 1) deepen and make fish-accessible an existing wetland pond; 2) excavate new channel area south of the pond; and 3) add LWD and underplant conifers in the floodplain adjacent to Rafter Park and immediately downstream of Dorre Don Court SE.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding. Revegetation and excavation of the pond and channel will increase habitat diversity for wildlife and will enhance structural diversity and increase surface water available for wetland development thereby enhancing wetland values.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 963 m^2, consisting of one pond totaling 690 m^2 (46 m X 15 m) and a 273 m^2 channel (91 m X 3 m).

SITE CHARACTERISTICS: Lies within the 100-year floodplain. A significant, but uninventoried, wetland pond is present. Vegetation is dense deciduous forest.

BACKGROUND: The site has a wetland pond with an outlet that is rarely connected with the river. It is actually at the downstream end of a stable island bounded by the Cedar River to the south and a very stable, relatively large side channel to the north. The outlet of the pond flows into the side channel a short way upstream from its reconnection with the main channel. The County-owned Rafter park is along the right bank of the Cedar River; however, none of the proposed work extends onto the public property. Upstream of the proposed project is the floodplain development known as Dorre Don Court. The houses closest to the project are proposed for buyout under the Cedar River Basin Plan due to their frequent flooding.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline and wetland permits. Landowners have not yet been contacted. Because of its sockeye value, this project should receive strong support from WDFW.

Dorre Don LB Side Channel Enhancement (VF-37)

PROJECT LOCATION: Cedar River/LB at RM 15.8

OPPORTUNITY/PROBLEM: An existing channel in the left bank floodplain across the river from the Dorre Don development could be enhanced and better protected from existing land uses. The majority of this floodplain area is expected to be acquired as open space by the end of 1998.

PROJECT CONCEPT: This project would: 1) deepen the lower two thirds of the side channel to intercept additional groundwater; 2) add LWD and boulders to enhance pools and increase cover;

and 3) revegetate disturbed areas. Project VF-38 would construct groundwater habitats to connect with this side channel.

PRIMARY FISH BENEFIT: Coho salmon and steelhead and cutthroat trout would be the main beneficiaries of this work.

OTHER BENEFITS: This project would improve floodplain stability, water quality and wildlife values.

EXISTING SALMONID USE: Sockeye and coho salmon and steelhead and cutthroat trout use this channel. Because of its size, chinook salmon are likely to spawn in it when water levels are adequate.

EXISTING FISH HABITAT: The channel provides about 2,196 m^2 of habitat (732 m X 3 m) that would be enhanced for coho, steelhead, and cutthroat.

NEW FISH HABITAT: No new habitat is proposed.

SITE CHARACTERISTICS: The channel has perennial flow. No inventoried or otherwise large wetlands are associated with the channel, although small ones appear to be present. Vegetation is a mix of second-growth conifers and deciduous trees.

BACKGROUND: The side channel flows along the base of the left bank terrace of the floodplain across from lower Dorre Don. It is a significant flood flow channel and outlines a meander bend that is well forested with a mix of deciduous and conifer trees. A right bank spring emanates on the floodplain and enters the side channel about mid-way in the floodplain. Part of Project VF-38 recommends excavating this spring to create groundwater-fed habitat.

PROJECT ISSUES/LIMITATIONS: Since the proposed work is relatively minor and can be considered stream enhancements, permit concerns should be relatively few. Because of its steelhead value, this project should receive support from WDFW.

Dorre Don LB Side Channel Ponds (VF-38)

PROJECT LOCATION: Cedar River/LB at RM 15.8

OPPORTUNITY/PROBLEM: Two new groundwater-fed ponds could be constructed in the floodplain across the river from Dorre Don and connected with the left bank side channel (see Project VF-37 for enhancements of the side channel). The majority of the surrounding floodplain is expected to be acquired as open space by the end of 1998.

PROJECT CONCEPT: This project would 1) excavate two new groundwater-fed ponds in existing shallow floodplain swales and connect them with the Dorre Don left bank side channel; and 2) underplant conifers in the floodplain.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding. Revegetation and excavation of the floodplain and pond and channel areas will increase habitat diversity for wildlife and increase surface water available for wetland development thereby enhancing wetland values.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,078 m^2, consisting of two ponds totaling 2,730 m^2 (two at 91 m X 15 m each) and 348 m^2 (116 m X 3 m) of channel habitat.

SITE CHARACTERISTICS: Lies within the 25-year floodplain. Small wetlands are present. Vegetation is thinned-out conifer and deciduous trees.

BACKGROUND: A right bank spring emanates on the floodplain and enters the side channel about mid-way on the floodplain; this would be one of the areas excavated for fish-usable habitat.

PROJECT ISSUES/LIMITATIONS: Shoreline and wetland permits will be necessary. Because of its sockeye value, this project should receive support from WDFW.

Dorre Don LB Meander (VF-39)

PROJECT LOCATION: Cedar River/LB at RM 15.8

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could construction in shallow floodplain swale across the river from Dorre Don.

PROJECT CONCEPT: Excavate a groundwater-fed pond and channel in the LB floodplain across from Dorre Don and underplant conifers in the floodplain. Excavation would occur in a shallow floodplain swale and connect with the river across from Dorre Don Court.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding. Revegetation and excavation of the floodplain and pond and channel areas will increase habitat diversity for wildlife and increase surface water available for wetland development thereby enhancing wetland values.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 1,125 m^2, consisting of one small pond totaling 225 m^2 (15 m X 15 m) and a 900 m^2 channel (300 m X 3 m).

SITE CHARACTERISTICS: Lies within the 10-year floodplain. No obvious wetlands are present. Vegetation is dense shrubs and deciduous trees.

BACKGROUND: This habitat would be constructed in the forested floodplain across from Lower Dorre Don. The floodplain is bounded by the LB side channel and the river (see Projects VF-37 and 38 for other projects in this floodplain). No inventoried or otherwise large significant wetlands exist on the site although small wetland pockets may be present.

Project Issues/Limitations: Shoreline and possibly wetland permits will be necessary. Landowner interest is unknown. Because of its sockeye value, this project should receive support from WDFW.

Lower Dorre Don—Lower Habitat (VF-40)

Project Location: Cedar River/RB at RM 15.9

Opportunity/Problem: A groundwater-fed pond and connecting channel to Tributary 0336 could be constructed in an undeveloped field at the downstream base of the Cedar River Trail berm in the lower Dorre Don development.

Project Concept: Excavate a groundwater-fed pond and connecting channel to Tributary 0336 on private property immediately downstream of the Cedar River Trail crossing. The excavation would occur in a field near the base of the high berm.

Primary Fish Benefit: Sockeye salmon is expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat. The project would be easily viewed from the Cedar River trail, although access would probably not be encouraged the residential nature of the area.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 2,929 m^2, consisting of one pond totaling 2,014 m^2 (53 m X 38 m) and 915 m^2 of channel (305 m X 3 m).

Site Characteristics: Lies within the 10-year floodplain. No wetlands present. The site is heavily disturbed from past clearing.

Background: Although the site is within the 10-year floodplain, the berm protects it from erosion. Tributary 0336 flows onto the valley floor immediately downstream of the field/site and receives some use by spawning sockeye; this stream would serve as the outlet to the river from the pond.

Project Issues/Limitations: Construction on this site will require a shoreline permit. The site is well drained and no significant wetlands appear on the site although small ones may be present. The site is in private ownership and landowner willingness is unknown at this point. Because of its sockeye value, this project should receive strong support from WDFW.

Lower Dorre Don—Upper Habitat (VF-41)

Project Location: Cedar River/RB at RM 16.1

OPPORTUNITY/PROBLEM: A groundwater-fed pond and channel could be excavated in an undeveloped area at upstream base of the Cedar River Trail berm in the Lower Dorre Don development

PROJECT CONCEPT: Excavate a groundwater-fed pond and connecting channel to the river on private property at the upstream base of the Cedar River Trail crossing.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. Enhancement could benefit an existing wetland by adding structural diversity and improving vegetation. The site is adjacent to the Cedar River Trail, however public access to the site would be discouraged due to surrounding residential development unless it was acquired as publicly available open space. (Note: This area is recommended for acquisition as part of a flood hazard reduction program.)

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of new groundwater-fed habitat for sockeye, coho, and cutthroat use is estimated at 1,530 m^2, consisting of one pond totaling 1,035 m^2 (69 m X 15 m) and 495 m^2 of channel (165 m X 3 m).

SITE CHARACTERISTICS: Lies within the 10-year floodplain. A wetland is present at the base of the berm. Vegetation is dense deciduous forest and field.

BACKGROUND: The site is in a forested area at the upstream base of the high berm in the Lower Dorre Don floodplain development. A small depression and probable wetland have formed at the base of the berm. Although it is within the 10-year floodplain, there was no major damage of the existing habitat after the November 1990 storm; however, many houses along the river were heavily damaged. This upstream portion of Lower Dorre Don floodplain is the second highest priority in the Cedar River Basin Plan and, as a part of a larger flood hazard reduction project, is on the open space acquisition list. The Cedar River Current and Future Conditions Report and the Basin Plan discuss flooding problems and recommendations for this area in greater detail.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit. A probable but as yet uninventoried wetland exists at the base of the berm, making wetland permitting a likely issue. The site is in private ownership and landowner willingness is unknown at this time. However, the property is part of a commonly held open space area for the residents, so they may be interested in such a project if the area is not acquired. Because of its sockeye value, this project should receive strong support from WDFW.

Orchard Grove Left Bank Groundwater Habitat (VF-42)

PROJECT LOCATION: Cedar River/LB at RM 16.2

OPPORTUNITY/PROBLEM: Two groundwater-fed ponds and connecting channels could be constructed in an undeveloped forested floodplain across the river from the Orchard Grove development.

PROJECT CONCEPT: Excavate two groundwater-fed ponds and connecting channels and underplant conifers in the left bank floodplain across the river from the Orchard Grove development.

PRIMARY FISH BENEFIT: Sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. No inventoried wetlands are known to exist on the site, making the excavation to surface water a potential net gain of wetland habitat.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 6,954 m^2, consisting of two ponds totaling 5,490 m^2 (two at 61 m X 45 m each) and 1,464 m^2 of channel (488 m X 3 m).

SITE CHARACTERISTICS: Lies within the 100-year floodplain. Small wetlands are probably present. Vegetation is deciduous forest with dense understory.

BACKGROUND: The site is a privately owned, undeveloped forested floodplain across from the Orchard Grove riverside development. The floodplain is part of large parcel that is a high priority for open space acquisition in the Cedar River Basin Plan.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require a shoreline permit and possibly a wetlands permit since it is likely that small wetlands exist on the site. The site is privately owned, and landowner willingness is not yet known. Because of its sockeye value, this project should receive strong support from WDFW.

Spoerer Wall-Based Tributary Enhancement (VF-43)

PROJECT LOCATION: Cedar River/LB at RM 17.0

OPPORTUNITY/PROBLEM: A perennial spring-fed stream on this property could be enhanced for coho overwintering.

PROJECT CONCEPT: In a small spring-fed stream on the Cedar River floodplain, this project would: 1) excavate approximately four pools; 2) add LWD; and 3) underplant conifers.

PRIMARY FISH BENEFIT: Coho salmon and cutthroat trout would benefit from an increase in overwintering habitat.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. The spring is within an uninventoried wetland that could be enhanced structurally with the proposed project.

EXISTING SALMONID USE: Coho salmon and cutthroat trout.

EXISTING FISH HABITAT: About 305 m^2 of channel habitat (305 m X 1 m) would be enhanced for coho overwintering.

New Fish Habitat: An additional 450 m^2 of new overwintering habitat for coho and cutthroat would be created, consisting of four pools (four at 15 m X 7.5 m each).

Site Characteristics: Lies within the 25-year floodplain. Wetlands are present throughout the site. Vegetation ranges from very lush forested wetland to thinned-out trees. Flow is perennial but very small in the summer.

Background: The landowner has expressed an interest in enhancing his property for fish. The site has an upper and lower terrace, both of which are generally well forested except where the landowner has selectively removed trees and shrubs and replanted with grass. The spring-fed stream flows along the base of the lower terrace and has year-round flow but summer flows are small. A wetland is contiguous with the channel.

Project Issues/Limitations: Construction on this site will require a shoreline permit and possibly permits for work in wetlands if they exist on the site. It may also require resolution of permit violation issues that are pending on this property. If these are resolved, however, a project acceptable to the landowner may be possible, for he has indicated a willingness to help fish. Because of its coho value, this project would not be strongly supported by WDFW until sockeye populations in the Cedar River are restored.

Heath/O'Keefe (VF-45)

Project Location: Cedar River/LB at RM 17.8

Opportunity/Problem: Fish-usable groundwater-fed habitat could be excavated in the upstream edge of the wetland and along the base of the Cedar River Trail.

Project Concept: Excavate new groundwater-fed habitat in the upper end of Lower Cedar River Wetland 79 and along the base of the Cedar River Trail berm. See Project VF-44 for recommendations to improve fish access, and restore vegetation in this wetland.

Primary Fish Benefit: Because significant new amounts of spawnable substrate would be created, sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Improvement of floodplain vegetation will increase site stability under future flooding and excavation of the pond and channel, and will enhance wildlife values. Excavation to groundwater, LWD additions, and revegetation could enhance the structural diversity of the wetland as well as create new fish-usable habitat. The site is adjacent to the Cedar River Trail, and may contribute to scenic values, but public access to the site would be discouraged due to surrounding residential development.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: The total amount of potential new groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,645 m^2, consisting of two channels (one at 152.5 m X 15 m along the base of the south valley wall and one at 91 m X 15 m along the base of the Cedar River Trail berm).

Site Characteristics: The site is within the 100-year floodplain. Rock Creek may be a significant source of its groundwater. Vegetation ranges from landscaped to mixed deciduous-conifer forest.

Background: Wetland 79 is a 0.3-acre oxbow of the Cedar River. As recently as fall 1990, sockeye salmon spawned in the upstream end of the wetland (Heather Stout, King County WLRD). In the late 1970s and early 1980s, this wetland was the site a major steelhead enhancement effort being conducted by Trout Unlimited. A pond was constructed by the upstream landowner for personal use and for TU's use as a short-term rearing for steelhead. The landowner recalls steelhead trout, and sockeye and coho salmon migrating up to her property to spawn in the 1970s. She says there was a significant amount of spring water flowing into the wetland from a site on her property on the south valley wall. Since then the spring has dried up for unknown reasons. Regardless, significant amounts of water flow out of the wetland indicating that it is being fed with shallow groundwater. Also since the late 1970s, the upper part of the wetland, which is underlain with cobbles and gravel, has become covered with muck. Residential development and landscaping by the landowner adjacent the lower wetland has encroached on the wetland, although much of it is still intact and in relatively good condition.

Project Issues/Limitations: Construction on this site will require shoreline and wetland permits. It will also require easements from the landowners, both of whom have expressed a strong desire to enhance fish in the wetland. Because of its sockeye value, this project would probably be supported by WDFW.

Lower Rock Creek Pond Access (VF-46)

Project Location: Cedar River/LB at RM 17.9

Opportunity/Problem: A pond in the Cedar River floodplain next to lower Rock Creek is not accessible to fish use due to an impassable berm.

Project Concept: Connect the isolated pond to lower Rock Creek by either removing a portion of the berm or installing a fish passable culvert. Enhance structural characteristics of the pond by adding LWD and underplanting conifers. A companion project, VF-47, would increase the size of the pond by excavating to the north (downstream).

Primary Fish Benefits: Coho salmon and cutthroat trout would benefit from newly available year-round habitat.

Other Benefits: Wildlife and wetland values would be enhanced. Wetland area would increase because pond surface would rise by up to two feet based on differential between Rock Creek and the pond during the summer. Because the pond is adjacent to and visible from the Cedar River Trail, restoration of fish and wildlife as well as vegetation would enhance the scenic value of the trail for many users.

Existing Salmonid Use: None.

Existing Fish Habitat: None due to lack of access.

New Fish Habitat: The project would provide 465 m^2 of new year-round habitat for coho and cutthroat. All habitat would be pond (30.5 m X 15.25 m).

Site Characteristics: Lies within 100- to 25-year floodplain and within shoreline of the Cedar River and Rock Creek. Significant wetland habitat present. Vegetation is dominated by immature mixed forest.

BACKGROUND: This parcel was acquired for open space in 1997. According to the 1990 King County Wetlands Inventory, the pond is part of Lower Cedar River Wetland 79, the majority of which is located on the opposite (south) side of the Cedar River Trail berm (see Projects VF 44 and 45). It is separated from Rock Creek by a small vegetated berm about 6 feet high. Of unknown origin, the berm appears to have been constructed to contain Rock Creek. It also served as an access road for the previous landowner. No obvious springs or other groundwater sources appear to provide significant inflow to the pond. Because of this, and a lack of clean gravel substrate, sockeye are not expected to spawn in this habitat. There is water in the pond year-round, but wetted surface area shrinks to about one-third of its winter area during the summer, at which time the pond surface elevation is as much as two feet lower than Rock Creek. If the berm is breached at its closest point to the channel, it would raise the summer surface elevation of the pond by two feet and increase surface area accordingly, provided water does not seep out faster than the inflow. A pump test of water into the pond should be conducted to ensure that the pond would hold additional water.

PROJECT ISSUES/LIMITATIONS: Construction on this site will require shoreline and wetland permits. Because of its coho value, this project would not be strongly supported by WDFW until sockeye populations in the Cedar River are restored.

Lower Rock Creek Pond Enlargement (VF-47)

PROJECT LOCATION: Cedar River/LB at RM 17.9

OPPORTUNITY/PROBLEM: Contingent on implementing Project VF-46, the Lower Rock Creek Pond could be enlarged to provide significant fish-usable wetland area.

PROJECT CONCEPT: Deepen and enlarge the Lower Rock Creek Pond by excavating to the north (downstream).

PRIMARY FISH BENEFIT: Coho salmon and cutthroat trout would benefit from new year-round habitat.

OTHER BENEFITS: Pond surface area and overall wetland area would be increased with a concomitant increase in wildlife values. Because the pond is adjacent to, and visible from, the Cedar River Trail, this work would enhance the scenic value of the trail.

EXISTING SALMONID USE: None.

EXISTING FISH HABITAT: None.

NEW FISH HABITAT: This project would provide 930 m^2 of new year-round coho habitat, all of which is pond (30.5 m X 30.5 m).

SITE CHARACTERISTICS: Lies within 25- to 100-year floodplain and within shoreline of the Cedar River and Rock Creek. Significant wetland habitat present (LCR Wetland 79). Vegetation is immature mixed forest riparian area.

BACKGROUND: The project area was acquired as open space in 1996. The pond is part of Lower Cedar River Wetland 79, most of which is located on the opposite (south) side of the Cedar River Trail berm (see Projects VF 44 and 45). Connection of the existing pond with Rock Creek (as proposed in Project VF-46) should be completed before this project is undertaken. Construction of

Project VF-46 may reduce the amount of excavation necessary, since the pond could rise by up to two feet and thus surface area would increase without additional excavation.

PROJECT ISSUES/LIMITATIONS: Construction will require shoreline and wetland permits. Because of its coho value, this project would not be strongly supported by WDFW until sockeye populations in the Cedar River are restored.

New Rock Creek Ponds (VF-48)

PROJECT LOCATION: Cedar River/LB at RM 17.9

OPPORTUNITY/PROBLEM: Two fish-usable wetland ponds, one on each bank of Rock Creek, could be excavated and connected to Rock Creek near its confluence with the Cedar River.

PROJECT CONCEPT: On the right bank, directly upstream of a small bridge, an existing pond and connecting channel would be deepened to increase depth and intercept additional groundwater. On the left bank, a new wetland pond and connecting channel would be excavated in the lowest part of the wetland. As an alternative to some excavation a small weir could be excavated across Rock Creek to provide a backwater under winter flows. LWD would be added to both new habitats; however, conifer underplanting is not necessary because of existing high quality second-growth conifers.

PRIMARY FISH BENEFIT: New overwintering habitat for coho salmon and cutthroat trout would be provided.

OTHER BENEFITS: Wetland structure (not area) would be increased with a concomitant increase in wildlife values. Because the ponds are adjacent to, and visible from, the Cedar River Trail, this work would enhance the scenic value of the trail.

EXISTING SALMONID USE: None.

EXISTING FISH HABITAT: None.

NEW FISH HABITAT: This project would provide 1,116 m^2 of overwintering coho habitat comprised of two ponds 30.5 m X 15.25 m each in size.

SITE CHARACTERISTICS: Located adjacent to LCR Wetland 79, outside of Cedar River 100-year floodplain and within shoreline of Rock Creek. Significant forested wetland habitat is present. The site is heavily forested with many second-growth fir and cedar trees, some of which are relatively large.

BACKGROUND: This site was acquired in 1998 as public open space. The property spans Rock Creek and is directly upstream of the property on which projects VF-46 and 47 are proposed. Wetland and topographic survey was done in 1994 in anticipation of constructing the right bank ponds in 1994.

PROJECT ISSUES/LIMITATIONS: Construction will require shoreline and wetland permits. Because of its coho value, this project would not be strongly supported by WDFW until sockeye populations in the Cedar River are restored.

Arcadia Wall-Based Tributary (VF-49)

PROJECT LOCATION: Cedar River/LB at RM 18.2

OPPORTUNITY/PROBLEM: Downstream of 250th Ave SE, a wall-based, spring-fed tributary flowing out of the Arcadia residential development along the south valley wall of Cedar River has pools that have filled in with sediments, lack LWD for cover, and have less-than-optimum riparian vegetation.

PROJECT CONCEPT: Enhance the habitat of this spring-fed tributary by deepening existing pools, adding LWD, and restoring riparian vegetation. Work in the upper half of the channel was accomplished in 1996.

PRIMARY FISH BENEFIT: Year-round rearing habitat of coho salmon and cutthroat trout would be enhanced.

OTHER BENEFITS: Improvement of floodplain vegetation will increase site stability under future flooding. The spring is within an uninventoried wetland that could be enhanced structurally with the proposed project.

EXISTING SALMONID USE: Coho salmon and cutthroat trout regularly use this tributary. Adult sockeye salmon and steelhead trout have also been seen on rare occasions.

EXISTING FISH HABITAT: About 279 m^2 of channel habitat (183 m X 1.5 m) would be enhanced for coho and cutthroat.

NEW FISH HABITAT: No new habitat would be created.

SITE CHARACTERISTICS: The area is within the shoreline and 10-year floodplain of the Cedar River. Riparian wetlands are present. Riparian vegetation ranges from deciduous forest on the left bank to artificial landscaping, scrub shrub, and deciduous forested on the right bank.

BACKGROUND: This small tributary collects spring flow emanating from the south valley wall and percolating under 250th Avenue SE. Above this road is considerable pond and channel habitat that is blocked by road fill through which a fish-passable culvert was never provided (see Project VF-50 about making this road crossing fish-passable). The tributary has significant year-round flow estimated to be at least one cfs or greater, with higher flows in the winter. Habitat quality in the channel is lacking mainly in structural diversity and some pools have filled in with muck, which may have been deposited after the 1990 floods that significantly flooded this area. About 60 m of the stream's right bank immediately downstream of 250th Avenue SE are hardened in decorative concrete. Despite this, the habitat is of generally good quality due to stable flows, high water quality, and relatively good riparian vegetation along the left bank. The upper half of the channel was enhanced in 1996.

PROJECT ISSUES/LIMITATIONS: Because much of the work has already been accomplished, only the lower half of the stream channel is expected to require additional significant work. However, interest of the downstream landowner is not known at this time. Because of the project's coho value, it is unlikely that WDFW will support this work until Cedar River sockeye populations are restored.

Upper Arcadia Wall-Based Tributary Access (VF-50)

PROJECT LOCATION: Cedar River/LB at RM 18.2

Opportunity/Problem: Two spring-fed ponds and connecting channel habitat are blocked to anadromous fish by road fill under 250th Ave SE, which was never fitted with a fish-passable culvert.

Project Concept: Install a fish passable culvert under 250th Ave and work with landowners to enhance spring-fed pond and channel habitats with LWD and riparian revegetation. See Project VF-49 for enhancements of the Arcadia tributary downstream of 250th Ave SE.

Primary Fish Benefit: New year-round groundwater-fed habitat for coho salmon and cutthroat trout rearing would be provided.

Other Benefits: The habitat is within an uninventoried wetland that could be enhanced structurally and better protected with the proposed project.

Existing Salmonid Use: Trout have been stocked in the ponds. It is unknown whether they are reproducing naturally.

Existing Fish Habitat: None.

New Fish Habitat: This project would provide 2,627.25 m^2 of new year-round habitat for coho salmon and cutthroat trout consisting of 2557.5 m^2 of pond habitat (one pond 45.75 m X 45.75 m and another of 30.5 m X 15.25 m) and 69.75 m^2 of channel habitat (45.75 m X 1.5 m).

Site Characteristics: The site lies outside the Cedar River floodplain. Significant wetlands are present. Landscaping ranges from rough lawn to scrub-shrub to deciduous forest.

Background: The ponds and channel are fed by springs emanating from the south valley wall, percolating under 250th Avenue SE. The habitat upstream of the road is dominated by two ponds, both of which appear to have been largely artificially excavated from spring-fed wetlands. The owner of the lower pond has stocked trout and is interested in rearing fish and would like to see the road become fish-passable. Interest of the owner of the upper pond to providing fish passage is not known at this time. The springs have year-round flow, and water quality in the ponds appears to be good enough for year-round salmonid rearing. Despite landowner impacts, the habitat is of generally good quality due to stable flows, high water quality, and good riparian vegetation along the left bank and along much of the right bank.

Project Issues/Limitations: Because there is no significant modification (i.e., excavation) planned for the wetlands and there are no shoreline issues, permitting may not be a significant concern. Obtaining landowner permission, however, has been a problem to date, since modifications to 250th Avenue SE, a private road, would require approval of all the landowners (about 15 residences). They were not inclined to allow this work to happen in 1994. As a result, this project has been put on hold until landowner concerns can be better addressed. Because of the project's coho value, it is unlikely that WDFW will support this work until Cedar River sockeye populations are restored.

Wingert Ponds (VF-51)

Project Location: Cedar River/LB at RM 19.5

Opportunity/Problem: Two groundwater-fed ponds and connecting channels could be excavated in depression behind the Cedar River Trail berm downstream of the Landsburg trestle.

PROJECT CONCEPT: At the base of the south (landward) side of the Cedar River Trail berm, excavate two groundwater-fed ponds and a connecting channel in an existing depression. Install a fish passable culvert under the trail and add LWD and underplant with conifers.

PRIMARY FISH BENEFIT: Because significant new amounts of stable, spawnable substrate would be created, sockeye salmon are expected to be the primary species benefiting from this project.

OTHER BENEFITS: Wildlife and wetland values will increase considerably on the site. Wetlands have formed at the base of the berm; these can be enlarged and enhanced. The Cedar River Trail is adjacent to this project.

EXISTING SALMONID USE: None. The habitat is new.

EXISTING FISH HABITAT: Not applicable.

NEW FISH HABITAT: New groundwater-fed habitat for sockeye, coho, and cutthroat estimated at 3,199.2 m^2, consisting of two ponds totaling 3,069 m^2 (Total pond length = 168 m: one at 99 m X 15 m and one at 69 m X 23 m) and a 130 m^2 outlet channel (43 m X 3 m).

SITE CHARACTERISTICS: Significant uninventoried wetlands are present, formed in part by disruption of surface flow from local springs by the berm. No floodplain is present. The forested terrace is dominated by mixed forest, including large firs, cedars, and cottonwoods.

BACKGROUND: A portion of this site has been acquired as open space. The depression in which excavation would occur has a significant wetland formed in part by a spring that emerges from the south valley wall.

PROJECT ISSUES/LIMITATIONS: Because of work in wetlands, permitting issues may be a significant concern. Given the project's sockeye value, WDFW would probably support this work.

Wingert Side Channel Enhancement (VF-52)

PROJECT LOCATION: Cedar River/LB at RM 19.5

OPPORTUNITY/PROBLEM: Structural habitat in a left bank side channel across from the mouth of Walsh Lake Diversion Ditch could be enhanced with excavation of pools, addition of LWD and boulders, and more coniferous vegetation.

PROJECT CONCEPT: In the upper two thirds of the channel, excavate about five pools, and add or manipulate boulders to create beneficial scour patterns for pool maintenance and fish cover. In addition, add LWD and underplant with conifers throughout the side channel

PRIMARY FISH BENEFIT: Coho salmon and steelhead and cutthroat trout would benefit from greater structural diversity of overwintering habitat. Sockeye, which spawn in the lower third of the channel, would benefit from bed stabilization provided by roughness elements.

OTHER BENEFITS: Floodplain stability and wildlife values will be enhanced. The site is adjacent to the Cedar River Trail, and this work may contribute to the trail's fish and wildlife observation value.

EXISTING SALMONID USE: Coho and sockeye salmon, and steelhead and cutthroat trout.

EXISTING FISH HABITAT: About 1,674 m^2 of existing habitat (275 m X 6.06 m) would be enhanced for coho, steelhead and cutthroat trout. The lower third (83 m X 6.06 m) of the channel would be enhanced for sockeye salmon.

New Fish Habitat: No new habitat will be created.

Site Characteristics: The site is completely within the floodplain and is a natural flood channel. No large or inventoried wetlands are present, although small wetland pockets are believed to be present. Riparian vegetation is a mix of small and immature deciduous and coniferous trees.

Background: This site has been acquired as open space. Although the side channel receives significant flows, it is relatively stable due to its protection by the trail berm.

Project Issues/Limitations: If heavy equipment is necessary, access will be difficult, requiring crossing the river near the mouth of the Walsh Lake Diversion or traversing a very steep slope off the berm. Because of the project's sockeye and steelhead value, WDFW may support this work.

Wetland 70 (VF-53)

Project Location: Cedar River/RB at RM 19.6

Opportunity/Problem: A fish-usable wetland pond and channel habitat could be created along the Cedar River Trail in public open space, starting in Lower Cedar River Wetland 70 and connecting with the Cedar River upstream of the last trail bridge before Landsburg.

Project Concept: A groundwater-fed wetland pond would be excavated in LCR Wetland 70 and outlet into a channel following a floodplain swale to the Cedar River.

Primary Fish Benefit: Because significant new amounts of stable, spawnable substrate would be created, sockeye salmon are expected to be the primary species benefiting from this project.

Other Benefits: Wildlife and wetland values would increase considerably on the site.

Existing Salmonid Use: None. The habitat is new.

Existing Fish Habitat: Not applicable.

New Fish Habitat: New groundwater-fed habitat for sockeye, coho, and cutthroat is estimated at 3,487.5 m^2 consisting of one pond totaling 2,790 m^2 (91.5 m X 30.5 m) and a 697.5 m^2 outlet channel (228.75 m X 3 m).

Site Characteristics: LCR Wetland 70 is present in the area proposed for pond excavation. The site is well protected and probably outside the 100-year floodplain, but it is above the area that formal floodplain mapping has been done. Vegetation is very dense, consisting of a mix of second-growth deciduous and coniferous trees.

Background: This site is on public property and adjacent to the Cedar River Trail.

Project Issues/Limitations: Wetland modification will be an issue here because of the size and significance of the wetland. Because of the project's sockeye value, WDFW should be highly supportive of this work.

Landsburg Oxbow (VF-54)

Project Location: Cedar River/RB at RM 20.5

Opportunity/Problem: A large oxbow pond (Wetland 69) is inaccessible to anadromous salmonids because it does not have sufficient inflow to maintain a regular outlet connection with the river.

Project Concept: Bring Cedar River water to the oxbow pond via a pipeline buried under the Cedar River Trail. Along the east shore of the pond, spawning gravel would be placed and the flow would be directed under the gravel to provide a shoreline spawning area for sockeye. A possible intake for the pipe would be at the pipeline crossing at Landsburg in order to provide gravity feed, although a closer point of diversion would reduce construction costs significantly. Nothing else is recommended because of the site's existing high quality.

Primary Fish Benefit: Coho salmon and cutthroat trout would benefit by having access to year-round habitat. Sockeye would benefit from new amounts of spawnable stable substrate.

Other Benefits: Wildlife and wetland values will increase considerably on the site. The Cedar River Trail is adjacent to this project. The site is on a priority list for open space acquisition.

Existing Salmonid Use: A few resident, possibly stocked, trout have been seen in the pond. A possible bass was also observed in a pond survey in summer 1994.

Existing Fish Habitat: Not applicable for anadromous salmonids.

New Fish Habitat: For coho and cutthroat trout, 10,759 m^2 of new year-round groundwater-fed habitat would be made available consisting of one pond totaling 10,698 m^2 (350.75 m X 30.5 m) and a 61 m^2 outlet channel (61 m X 1 m). For sockeye, a spawning bed totaling 1,116.3 m^2 (183 m X 6.1m) would be constructed.

Site Characteristics: The habitat is LCR Wetland 69 and has many excellent features, including a heavily vegetated riparian area, numerous snags and pieces of LWD, large boulders, and at least one perennial spring.

Background: The Landsburg Oxbow is on the priority acquisition list for the Cedar River. It is isolated from the mainstem river channel because it receives too little inflow to have an outlet except under very wet periods. The only significant surface water source is a perennial spring providing one or more cfs of water located along the north shore of the pond. In summer and fall, the water level drops to about two feet below the culvert outlet under the Cedar River Trail. The culvert is very flat and would be fish passable with sufficient flow; however, the mouth of the small, faint channel from the culvert outlet to the river would need work to make it fish passable. In a 1994 survey of the pond, WLRD found the substrate to be boulder and cobble dominated covered with a thin layer of fine organic material; no pockets of gravel were identified. Water depths, temperature, and pond habitat structure was felt to be excellent for fish and wildlife. The north and east shore of the pond are protected from development by very steep, but relatively stable, till slopes.

Project Issues/Limitations: The most significant issue with this project will probably be the diversion of enough water to fill the pond and provide an outlet from the mile of river between the intake and the point of return. Further analysis will be required to determine if the tradeoff is worthwhile. Placement of a gravel bed may be considered "fill" and thus be an issue with respect to wetland modification. However, the overall size and functional value of the wetland should increase significantly along the flat western shore of the pond with the addition of more water and salmon carcasses. Because of the project's combined sockeye and coho value, WDFW may be supportive, assuming instream flow issues on the Cedar River are resolvable.

Maplewood Creek Stabilization and Enhancement (TR-01)

Project Location: Maplewood Cr./RM 0.45-1.15

Opportunity/Problem: Maplewood Creek ravine, upstream of the City of Renton's Maplewood Golf Course, suffers from accelerated erosion due to urban runoff and inadequate channel roughness. In addition to the other recommendations in the Cedar River Basin Plan to reduce urban stormwater effects on this stream, channel and riparian actions are recommended to protect and enhance the channel in order to both reduce erosion concerns and restore habitat. To obtain the full benefits of this project, it is assumed that the City of Renton will remove the fish migration barriers as described in the Cedar River Basin Plan.

Project Concept: Add LWD and improve riparian conditions by planting conifers where necessary throughout the ravine (RM 0.45-1.15).

Primary Fish Benefit: Structural rearing habitat for primarily cutthroat trout and some coho. However, no coho benefits were estimated in production calculations because of the degree of urbanization.

Other Benefits: Erosion and downstream sedimentation would decrease, thus reducing water quality impacts on the Cedar River and flooding and sedimentation in the golf course.

Existing Salmonid Use: Non-migratory cutthroat trout are present below the two forks and extend into the eastern fork. A large debris dam, which is storing a large amount of sediment, appears to be impassable for trout access into the western fork. Coho salmon have not had access to this stream since the 1930s, when an impassable water supply dam was constructed at the mouth of the Maplewood ravine.

Existing Fish Habitat: 1,948 m^2 of fish habitat would be enhanced.

New Fish Habitat: None. (Assumes fish migration barriers will be removed as is currently proposed by the City of Renton.)

Site Characteristics: The ravine is dominated by mixed forest and moderate to low levels of woody debris.

Background: See the Cedar River Current and Future Conditions Report and Basin Plan.

Project Issues/Limitations: Permission from the Maplewood Heights Homeowners Association and other landowners will be necessary. The Association has expressed willingness to enhance their stream for increased stability and habitat benefits.

Molasses Creek Stabilization and Enhancement (TR-02)

Project Location: Molasses Creek/RM 0.0-0.8

Opportunity/Problem: Lower Molasses Creek suffers from accelerated erosion due to urban runoff and inadequate channel roughness which in turn has degraded habitat for cutthroat trout and sockeye and coho salmon and steelhead which have been known to use the channel in the past. In addition to the enhanced stormwater detention for new upstream development, the Cedar River Basin Plan recommends localized channel and riparian actions to protect and enhance existing channel to both reduce erosion concerns and restore habitat.

PROJECT CONCEPT: Add LWD and improve riparian conditions by planting conifers where necessary throughout the lower 0.8 miles of stream. The lower 0.2 miles will require the most work and will require working with the local developer/landowner. Some work in this lower reach has already been accomplished by the developer.

PRIMARY FISH BENEFIT: Structural rearing habitat for coho and cutthroat would be enhanced and stability of potential sockeye spawning substrate in the lower 0.2 mi. would be increased. Due to the high degree of urbanization in the Molasses Creek drainage, however, only cutthroat production value was ascribed in estimating production value.

OTHER BENEFITS: Erosion and downstream sedimentation would decrease, thus reducing localized flooding and water quality impacts on the Cedar River.

EXISTING SALMONID USE: No significant use by coho or sockeye salmon has been observed since about the mid-1980s. Cutthroat trout exist throughout the channel, including stream and wetland areas above the impassable culvert at RM 0.8.

EXISTING FISH HABITAT: 3,259 m^2 of cutthroat habitat and marginal coho habitat would be enhanced.

NEW FISH HABITAT: 407 m^2 of potential habitat for sockeye spawning would be restored.

SITE CHARACTERISTICS: The ravine reach (0.2-0.8) is dominated by mixed forest and moderate to low levels of woody debris; the lower reach has received some riparian plantings and LWD elements as mitigation for a local development. The channel could use additional and much larger LWD pieces, however, and riparian vegetation is dominated by small deciduous trees.

BACKGROUND: See the Cedar River Current and Future Conditions Report and Basin Plan for Molasses Creek conditions.

PROJECT ISSUES/LIMITATIONS: Permission from the local developer/landowners will have to be obtained.

Madsen Creek Biostabilization (TR-04)

PROJECT LOCATION: Madsen Creek (0305)/RM 0.85-2.1

OPPORTUNITY/PROBLEM: Habitat in the Madsen Creek ravine suffers from impacts of inadequately controlled urban runoff and actions related to the placement and management of a sewer line along the stream. These impacts have resulted in extensive erosion, loss of channel roughness and habitat complexity, and an immature riparian forest.

PROJECT CONCEPT: Add LWD and underplant conifer trees throughout the ravine.

PRIMARY FISH BENEFIT: Structural rearing habitat primarily cutthroat but also potentially for some limited numbers of coho and steelhead, would be enhanced. Due to urban impacts, only cutthroat value has been ascribed in estimating potential fish production value.

OTHER BENEFITS: Erosion and water quality problems in Madsen Creek and to a small degree in the Cedar River would be reduced. Wildlife in the ravine will benefit from greater structural diversity of cover in and along the stream channel.

Existing Salmonid Use: Cutthroat are the predominate users of this stream, although historically this reach of Madsen Creek also produced coho salmon and steelhead trout.

Existing Fish Habitat: 3,264 m^2 of coho/steelhead/cutthroat habitat would be enhanced.

New Fish Habitat: None.

Site Characteristics and Background: See the Cedar River Current and Future Conditions Report and the Basin Plan for a discussion of Madsen Creek conditions. Some of the proposed work has already been implemented as part of ongoing efforts to stabilize the stream channel to reduce threats to a King County sewer pipeline and to residences on bluffs overlooking the ravine.

Project Issues/Limitations: Work will need to be coordinated with or done as a part of proposed efforts to further stabilize the ravine.

South Fork Madsen Creek Biostabilization (TR-05)

Project Location: South Fork Madsen Creek (0306)/RM 0.0-0.4

Opportunity/Problem: Habitat in the South Fork of Madsen Creek ravine suffers from erosion and habitat degradation caused by urban runoff, inadequate channel roughness, and an immature riparian forest. In addition to the enhanced stormwater detention for new development, the Cedar River Basin Plan recommends channel and riparian actions to protect and enhance the existing channel to both reduce erosion concerns and restore habitat.

Project Concept: Add LWD to increase channel roughness and underplant conifer trees throughout the ravine.

Primary Fish Benefit: Structural rearing habitat for coho, steelhead, and cutthroat would be enhanced. Due to urban impacts, only cutthroat value has been ascribed in estimating potential fish production value.

Other Benefits: Erosion and water quality problems in the South Fork of Madsen Creek would be reduced. Wildlife in the ravine will benefit from greater structural diversity of cover in and along the stream channel.

Existing Salmonid Use: Cutthroat are the predominate users of this stream although historically, the South Fork Madsen Creek was historically a minor producer of coho salmon and steelhead trout.

Existing Fish Habitat: 1,275 m^2 of cutthroat habitat but also some habitat with limited potential coho and steelhead habitat.

New Fish Habitat: None.

Site Characteristics and Background: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Madsen Creek conditions.

Project Issues/Limitations: Work will need to be coordinated with or done as a part of proposed efforts to further stabilize the ravine.

Lower Tributary 0316A Biostabilization (TR-06)

Project Location: Tributary (0316A)/RM 0.0-0.6

Opportunity/Problem: Habitat in this stream is degraded due to inadequate channel roughness, and an immature riparian forest.

Project Concept: Add LWD to increase channel roughness and underplant conifer trees throughout the lower reaches of this stream.

Primary Fish Benefit: Structural rearing habitat for coho, steelhead, and cutthroat would be enhanced and stability of sockeye spawning substrates would be enhanced.

Other Benefits: Erosion and water quality problems in the Cedar River would be reduced. Wildlife in the ravine will benefit from greater structural diversity of cover in and along the stream channel. The proposed lower tributary 0316A open space acquisition site is adjacent to the lower reach of this tributary and would be enhanced.

Existing Salmonid Use: Cutthroat and coho salmon are the predominate users of this stream, although historically it also produced sockeye salmon and steelhead trout.

Existing Fish Habitat: 1,468 m^2 of coho/steelhead/cutthroat habitat would be enhanced.

New Fish Habitat: None.

Site Characteristics and Background: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Tributary 0316A conditions.

Project Issues/Limitations: Use of unanchored LWD is still experimental and should be applied with caution.

Upper Tributary 0316A Enhancement (TR-07)

Project Location: Tributary (0316A)/RM 0.6-1.2

Opportunity/Problem: Habitat in this stream and wetland complex is degraded due to inadequate channel roughness, an immature riparian forest, and impacts by livestock.

Project Concept: Fence off areas subject to livestock access, add LWD to increase channel roughness, and revegetate riparian areas.

Primary Fish Benefit: Structural rearing habitat for coho, steelhead, and cutthroat would be enhanced and sockeye spawning substrates would be stabilized.

Other Benefits: Erosion and water quality problems in the Cedar River would be reduced. Wildlife in the ravine will benefit from greater structural diversity of cover in and along the stream channel. The upper tributary 0316A open space acquisition site is adjacent to this reach and would be enhanced.

Existing Salmonid Use: Cutthroat and coho salmon are the predominate users of this stream, although historically it has also produced sockeye salmon and steelhead trout.

Existing Fish Habitat: 1,468 m^2 of coho/steelhead/cutthroat habitat would be enhanced.

New Fish Habitat: None.

SITE CHARACTERISTICS AND BACKGROUND: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Tributary 0316A conditions.

PROJECT ISSUES/LIMITATIONS: Use of unanchored LWD is still experimental and should be applied with caution. This reach is also impacted by the Stoneway gravel mining operation, which has reduced base flows and led to increased turbidity and deposition of fine sediments.

Taylor Creek/Maxwell Road (TR-08)

PROJECT LOCATION: Taylor Creek (0320)/RM 0.5-0.7

OPPORTUNITY/PROBLEM: This reach of Taylor Creek has degraded habitat due to its confinement to a roadside ditch along the Lower Maxwell Road and livestock impacts. This condition also contributes to significant road flooding. The Cedar River Basin Plan recommends a set of actions including channel relocation to an adjacent wetland where a formal floodplain and wetland area would be established.

PROJECT CONCEPT: Relocate lower Taylor Creek away from Maxwell Road and establish a natural floodplain and riparian wetland for the channel.

PRIMARY FISH BENEFIT: Better quality spawning and rearing habitat for coho, sockeye, and chinook salmon and steelhead, and cutthroat trout would be provided than currently exists in the roadside ditch.

OTHER BENEFITS: The Cedar River Basin's most significant tributary flooding problem would be fixed and erosion and water quality impacts caused by livestock access would be solved.

EXISTING SALMONID USE: All species of anadromous salmonids use this stream reach.

EXISTING FISH HABITAT: 869 m^2 of coho/steelhead/cutthroat habitat would be enhanced.

NEW FISH HABITAT: Due to relocation and incorporation of channel meanders, and additional 10 percent (88 m^2) of habitat would be created.

SITE CHARACTERISTICS AND BACKGROUND: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Taylor Creek and the recommendation for relocation.

PROJECT ISSUES/LIMITATIONS: Land will need to be acquired. There are concerns that relocation should not be implemented until more is known about the hydrologic effects of changing the SR 18 crossing. The Muckleshoot Indian tribes are also concerned that a new channel would not be as productive for sockeye salmon.

Taylor Creek Ravine (TR-09)

PROJECT LOCATION: Taylor Creek (0320)/RM 1.2 – 1.8

OPPORTUNITY/PROBLEM: This reach of Taylor Creek has degraded habitat due to its lack of in-channel LWD and coniferous trees in much of the riparian area. This condition results in lower quality habitat (fewer and shallower pools, poor retention of spawning gravel) than would otherwise be expected and contributes to downstream flooding due to erosion of banks and poor in-channel retention of bedload.

Project Concept: Add LWD to stabilize bed and gravel and replant understory with conifers to stabilize banks and provide long-term LWD recruitment.

Primary Fish Benefit: Better quality spawning and rearing habitat for coho and sockeye salmon and steelhead, and cutthroat trout would be provided than currently exists in the roadside ditch. Chinook salmon are occasionally seen in Taylor Creek as well; therefore, there may be limited value to chinook salmon spawning and rearing as well.

Other Benefits: The Cedar River Basin's most significant tributary flooding problem would be reduced, and a local population of mussels would benefit.

Existing Salmonid Use: All species of anadromous salmonids use this stream reach.

Existing Fish Habitat: 2,608 m^2 of stream habitat would be enhanced.

New Fish Habitat: None.

Site Characteristics and Background: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Taylor Creek.

Project Issues/Limitations: Construction easements will be required. This type of project is gaining widespread acceptance in permitting and among landowners.

Taylor Creek Tributary Enhancements (TR-10)

Project Location: Taylor Creek Tributary (0321)/RM 0.0-0.8

Opportunity/Problem: This high quality (RSRA) tributary habitat would benefit from fencing, addition of LWD, and riparian plantings in its lower (RM 0.0-0.2) reach, and LWD additions only in its high quality ravine habitat (RM 0.2-0.8).

Project Concept: Reduce the impact of grazing on the lower reaches of the channel by fencing and enhancing riparian and instream habitat. Within the ravine habitat, add LWD to increase habitat quality, particularly the availability of large deep pools and hiding cover.

Primary Fish Benefit: Better quality spawning and rearing habitat for coho salmon and cutthroat trout would be provided.

Other Benefits: The proposed work would contribute to the long-term health and protection of the stream and reduce the future likelihood of a problem occurring.

Existing Salmonid Use: Coho salmon and cutthroat trout with some potential for steelhead juvenile rearing and sockeye salmon spawning.

Existing Fish Habitat: 2,415 m^2 of stream habitat would be enhanced.

New Fish Habitat: None.

Site Characteristics and Background: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about this tributary to Taylor Creek.

PROJECT ISSUES/LIMITATIONS: Construction easements will be required. This type of project is gaining widespread acceptance in permitting and among landowners.

Peterson Lake Outlet Channel (TR-11)

PROJECT LOCATION: Peterson Creek (0328)/RM 1.4–1.6

OPPORTUNITY/PROBLEM: This reach of Peterson Creek was left in a ditch-like condition following its removal from a pipe originally built and maintained by the City of Seattle. The channel was left in a condition of poor habitat and almost no LWD. This reach was subsequently purchased by King County to protect the generally high quality of Peterson Creek and Peterson Lake.

PROJECT CONCEPT: Add LWD to increase habitat quality, particularly the availability of spawning gravel, large deep pools, and hiding cover.

PRIMARY FISH BENEFIT: Better quality spawning and rearing habitat for sockeye and coho salmon and cutthroat trout and improved steelhead rearing habitat would be provided.

OTHER BENEFITS: The proposed work would contribute to the long-term health and protection of the stream and the recently acquired open space, and reduce the future likelihood of a problem occurring.

EXISTING SALMONID USE: Sockeye and coho salmon and steelhead and cutthroat trout.

EXISTING FISH HABITAT: 963 m^2 of stream habitat would be enhanced.

NEW FISH HABITAT: None.

SITE CHARACTERISTICS: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Peterson Creek.

BACKGROUND: Prior to about 1980, this channel was confined in a pipe by the City of Seattle to ensure stability of its pipeline.

PROJECT ISSUES/LIMITATIONS: Consistent with the Peterson Lake Site Management Plan. Construction easements will be required. This type of project is gaining widespread acceptance in permitting and among landowners.

Peterson Creek Ravine (TR-12)

PROJECT LOCATION: Peterson Creek (0328)/RM 0.6-1.4

OPPORTUNITY/PROBLEM: Improve existing habitat and reduce erosion problems in the ravine of Peterson Creek.

PROJECT CONCEPT: Add LWD to increase habitat quality, particularly the availability of spawning gravel and pool habitat.

PRIMARY FISH BENEFIT: Better quality spawning and rearing habitat for sockeye and coho salmon and cutthroat trout and improved steelhead rearing habitat would be provided.

OTHER BENEFITS: The proposed work would contribute to the long-term health and protection of the stream and reduce the future likelihood of a problem occurring.

EXISTING SALMONID USE: Sockeye and coho salmon and steelhead and cutthroat trout. Chinook have been observed in the lower reaches.

EXISTING FISH HABITAT: 3,851 m^2 of stream habitat would be enhanced.

NEW FISH HABITAT: None.

SITE CHARACTERISTICS: See the Cedar River Current and Future Conditions Report and Basin Plan for information about Peterson Creek.

BACKGROUND: This reach is currently well forested and has almost no streamside development. This project would accelerate the LWD loading process for the channel.

PROJECT ISSUES/LIMITATIONS: Construction easements from private landowners will be required. This type of project is gaining widespread acceptance in permitting and among landowners.

Rock Creek Base Flow Restoration (TR-13)

PROJECT LOCATION: Rock Creek (0338)/RM 0.0-1.7

OPPORTUNITY/PROBLEM: The City of Kent has a permitted water right that reduces Rock Creek's late summer/early fall flows to levels that prevent any chinook and most sockeye from spawning and that reduce rearing habitat for coho salmon and steelhead trout during the critical low flow months.

PROJECT CONCEPT: Restore late summer and early fall base flows to provide for chinook and sockeye salmon spawning and increased rearing for coho salmon and steelhead and cutthroat trout. Possible sources of additional flow include 1) additional capacity in City of Seattle's system; 2) diverting flow from Cedar River at Landsburg (RM 21.0) and returning it at the mouth of Rock Creek (RM 18.0); 3) flow augmentation well; or 4) reduce City of Kent's seasonal water need.

PRIMARY FISH BENEFIT: All species of salmon and trout would benefit.

OTHER BENEFITS: The proposed work would contribute to the long-term health and protection of the stream and enhance the publicly owned open space along the creek.

EXISTING SALMONID USE: Sockeye and coho salmon and steelhead and cutthroat trout. Last chinook observed was in 1985.

EXISTING FISH HABITAT: 16,489 m^2 of stream habitat would be enhanced.

NEW FISH HABITAT: None.

SITE CHARACTERISTICS: See the Cedar River Current and Future Conditions Report and the Basin Plan for information about Rock Creek.

BACKGROUND: Rock Creek is the best tributary habitat in the Cedar River and among the best remaining in lowland Puget Sound.

PROJECT ISSUES/LIMITATIONS: This project will be difficult to accomplish due to the politics of water supply.

Walsh Lake Diversion Ditch (TR-14)

PROJECT LOCATION: Walsh Lake Diversion Ditch (0341)/RM 0.6-4.2

OPPORTUNITY/PROBLEM: A sizable ditch originally dug to take water of poor drinking water quality out of the City of Seattle's municipal watershed could be a significant producer of anadromous fish with modification of a passage barrier and addition of spawning gravel and LWD.

PROJECT CONCEPT: Modify passage barrier at approximately RM 0.6 and, where stability of the ditch can be assured, add spawning gravel and LWD to increase habitat quality, particularly the availability of spawning gravel and pool habitat.

PRIMARY FISH BENEFIT: Better quality spawning and rearing habitat for sockeye and coho salmon and cutthroat trout and improved steelhead rearing habitat would be provided.

OTHER BENEFITS: The proposed work would contribute to the long-term health and protection of the stream and reduce the future likelihood of a problem occurring.

EXISTING SALMONID USE: Sockeye and coho salmon and steelhead and cutthroat trout. Chinook have been observed in the lower reaches.

EXISTING FISH HABITAT: Existing habitat is primarily used for resident fish only, however recent surveys have found that some coho salmon are negotiating the barrier and spawning and rearing upstream.

NEW FISH HABITAT: 17,329 m^2 of stream habitat would be enhanced for anadromous fish production.

SITE CHARACTERISTICS: See the Cedar River Current and Future Conditions Report and Basin Plan for information about WLDD. Additional information should be available upon publication of the City of Seattle's Habitat Conservation Plan.

BACKGROUND: This reach is currently well forested and has almost no streamside development.

PROJECT ISSUES/LIMITATIONS: City of Seattle would need to provide permission.

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
BW	Basinwide Recommendation
CES	Cooperative Extension Service (Washington State)
cfs	cubic feet per second
CIP	Capital Improvement Project
CMP	Corrugated Metal Pipe
COE	U.S. Army Corps of Engineers
CRC	Cedar River Council
DDES	Department of Development and Environmental Services (King County)
EPA	Environmental Protection Agency (United States)
FC	Fecal Coliforms
FEMA	Federal Emergency Management Administration
FHRP	Flood Hazard Reduction Plan
GMVAC	Greater Maple Valley Area Council
HEC-2	Hydrologic Engineering Center model version 2
KC Roads	King County Roads Division
KCD	King Conservation District
KCDNR	King County Department of Natural Resources
KCNRD	King County Natural Resources Division
KCOEM	King County Office of Emergency Management
KCPA	King County Prosecuting Attorney's Office
KCRTS	King County Runoff Time Series
KCSWD	King County Solid Waste Division
LDCC	Lake Desire Community Club
LSRA	Locally Significant Resource Area
LWD	Large Woody Debris
MDP	Master Drainage Plan
MIT	Muckleshoot Indian Tribe
MOU	Memorandum of Understanding
MS	Mainstem Subarea
MSE	Mid-Sound Fisheries Enhancement group
MT	Middle Tributaries
NT	Northern Tributaries
PC	Peterson Creek
ppb	Parts Per Billion
R/D	Retention/Detention
RC	Rock Creek
Renton PW	Renton Department of Public Works
RM	River Mile
RSRA	Regionally Significant Resource Area
SAO	Sensitive Areas Ordinance (King County)
SKCDPH	Seattle-King County Department of Public Health
SCS	Soil Conservation Service (United States)
SHRP	Small Habitat Restoration Program
SLCC	Shady Lake Community Council
SPPP	Stormwater Pollution Prevention Plan
SPU	Seattle Public Utilities Department (formerly Seattle Water Department)
SRA	Significant Resource Area
ST	Southern Tributaries
SWDM	Surface Water Design Manual
TC	Taylor Creek
TESC	Temporary Erosion and Sedimentation Control
TMDL	Total Maximum Daily Loads
TU	Trout Unlimited
UGB	Urban Growth Boundary
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WBT	Wall-Based Tributary
WCC	Washington Conservation Corps
WDFW	Washington Department of Fish and Wildlife (formerly WDW and WDF)
WFFA	Washington Farm Forestry Association
WLRD	Water and Land Resources Division (King County) (formerly Surface Water Management)
WMA	Wetland Management Area
WMC	Watershed Management Committee
WTD	Wastewater Treatment Division (King County)
WSDNR	Washington State Department of Natural Resources
WSDOE	Washington State Department of Ecology