City of Renton
Shoreline Master Program Update
Shoreline Cumulative Effects Analysis

Prepared for

City of Renton
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This report was funded in part by a Grant from the Washington Department of Ecology

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October 2009 | 558-1687-004

CITATION

Parametrix. 20099. Renton Shoreline Master Program Update
Shoreline Cumulative Effects Analysis.
Prepared by Parametrix, Bellevue, Washington.
October 2009.

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ACRONYMS

CAO	Critical Areas Ordinance
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DNR	Washington State Department of Natural Resource
ESA	Endangered Species Act
GIS	Geographic Information Systems
HPA	Hydraulic Project Approval
KCFCZD	King County Food Control Zone District
LWD	Large Woody Debris
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OFM	Office of Financial Management
PAA	Potential Annexation Area
PSRC	Puget Sound Regional Council
RCW	Revised Code of Washington
RM	River Mile
RMC	City of Renton Municipal Code
SEDs	Shoreline Environment Designations
SMA	Shoreline Management Act
SMP	Shoreline Management Plan
SRP	Salmonid Recovery Plan
UGB	Urban Growth Boundary
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WMU	Watershed Management Unit
WRIA	Water Resource Inventory Area

1. SUMMARY

This report supports City of Renton's Shoreline Management Program (SMP) update. The City's SMP, also known as Title 23 of the City of Renton Code (RMC), is being updated to comply with the Washington State Shoreline Management Act (SMA or the Act) requirements (Revised Code of Washington [RCW] 90.58), and the state's shoreline guidelines (Washington Administrative Code [WAC] 173-26, Part III), which were adopted in 2003.

The SMP update process involves the following steps:

1. Reviewing and revising shoreline goals and policies
2. Inventorying and analyzing shoreline conditions
3. Determining shoreline environment designations (SEDs)
4. Assessing cumulative impacts of shoreline development
5. Preparing a restoration plan

This element assesses the cumulative impacts of shoreline development under the revisions to the SMP. This analysis assesses existing trends to assist in developing policies and regulations that will be analyzed prior to adoption.

This work was funded in part through a grant from the Washington State Department of Ecology.

In general, the findings of this analysis, as it applies to Renton Shorelines, are:

- Watershed-wide processes that have changed natural functions within the Cedar River/Lake Washington and Green River/Duwamish Watersheds are a large component of cumulative impacts on ecological processes.
- It is not known at this time whether general trends in ecological degradation are continued. Based on trends of continuing declines in key aquatic species, such as Chinook salmon, Steelhead and Sockeye over several decades the most justifiable conclusion is that existing land use and practices within the watersheds are continuing to degrade habitat and trends will increase unless substantial changes in practices are implemented in many areas.
- Many of the trends are likely to be related to human induced changes in habitat watershed-wide. Actions in Renton, in conjunction with other jurisdictions, are likely to be important to slowing or reversing those trends. Such efforts, however, will be effective only if undertaken watershed-wide and include a variety of measures including:
  - Restoring watershed channel geomorphic conditions through a variety of measures including removal or further setback of flood control levies and control of urban storm runoff;
  - Restoring the water quality functions of wetlands by restoring connections between streams and wetlands by removing barriers, such as flood control structures;
  - Restoring water quality functions of wetlands by restoring wetlands displaced by other uses;
  - Reducing stream temperatures by restoring riparian vegetation;

  - Restoring water quality functions by providing buffer areas in which sediment, nutrients, pathogens and other pollutants can be removed or entrained; and
  - Providing urban stormwater management to address peak flows as well as water quality.
- A particular ecosystem niche that appears to be critical to Chinook salmon, and likely other species in the watershed is the importance of the nearshore areas of Lake Washington to very young salmonids in early lifecycle stages. In these areas, food sources, chemical contaminants and predation within the nearshore of Renton may be critical to this lifecycle stage.
- Specific ongoing contributions to degradation of the nearshore that are present and will likely continue, unless substantial changes are made to physical facilities, include:
  - Shoreline bulkheads have negative impacts on substrate through producing high energy environments because of reflective wave action and also contribute to the absence of shoreline vegetation.
  - The lack of native vegetation on the shoreline likely contributes to the near-shore food chain and also results in higher nearshore temperatures due to the lack of shade.
  - The combined influence of the lack of native vegetation and the presence of ornamental vegetation with typical management practices including use of fertilizers, herbicides, and pesticides which affect not only the nearshore food chain but also have identified impacts on the central nervous system functions of fish, including salmonids.
  - Current moorage facilities contribute to predation and also may cause avoidance behavior in salmonids forcing them out of nearshore environments and into environments where food and shelter are less available and where predation is increased.

There are a large number of regulatory and restoration activities currently underway in the Lake Washington/Cedar River watershed and the Duwamish/Green River watershed. The Renton Shoreline Master Program is one element that will make a positive contribution to altering long-standing trends of human alteration and management of the nearshore and immediately adjacent upland areas. The measures included in these programs, in sum, are designed to address the known mechanisms by which human alterations affect ecological processes and functions.

Based on our current understanding of ecological processes and functions within the affected watersheds, the regulations in the Renton Shoreline Master Program, together with other programs, can be expected to result in no net loss of ecological functions. With the effects of a variety of public and private restoration projects, the ecological processes and functions can be expected to improve over time.

1.1 REPORT PURPOSE

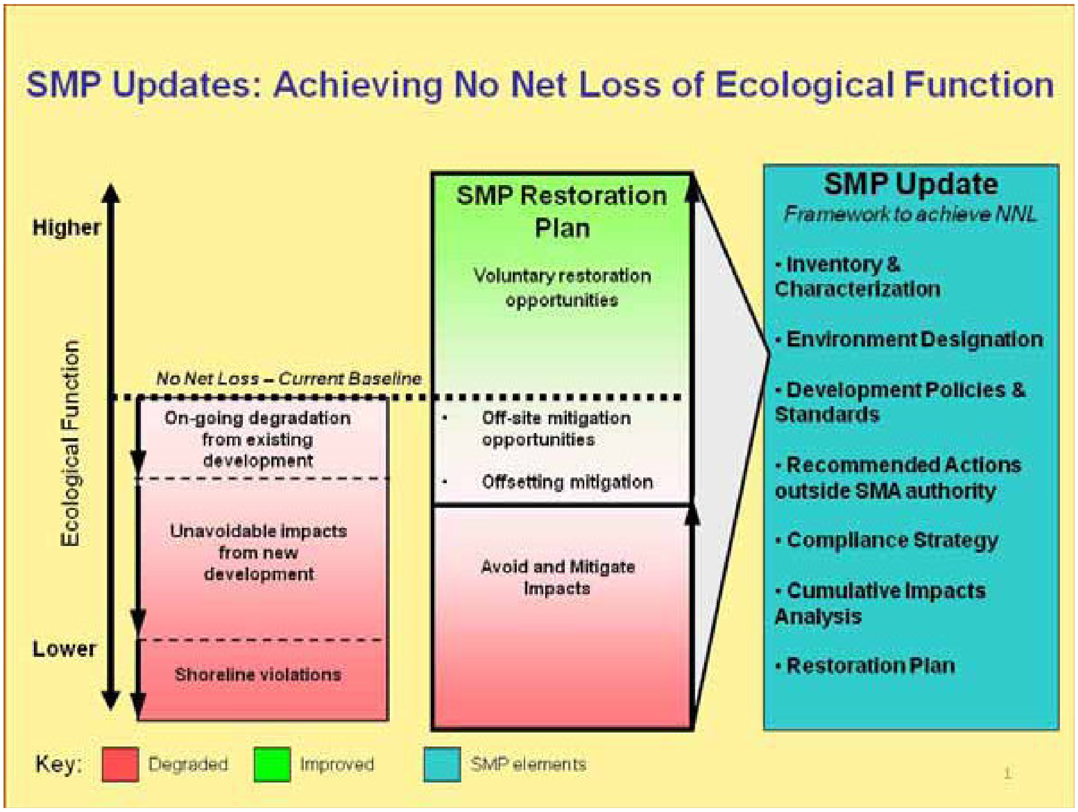
The Shoreline Management Act (SMA) Guidelines (WAC 173-26-18683)(d) require analysis of cumulative impacts “to ensure no net loss of ecological functions and protection of other shoreline functions and/or uses.

The principle that regulation of development shall achieve no net loss of ecological function requires that master program policies and regulations address the cumulative impacts on shoreline ecological functions that would result from future shoreline development and uses that are reasonably foreseeable from proposed master programs.

The guidelines provide specific guidance on the concept of no net loss in WAC 173-26-201(2)(c) and the relation between regulations and other programs:

> When based on the inventory and analysis requirements and completed consistent with the specific provisions of these guidelines, the master program should ensure that development will be protective of ecological functions necessary to sustain existing shoreline natural resources and meet the standard. The concept of "net" as used herein, recognizes that any development has potential or actual, short-term or long-term impacts and that through application of appropriate development standards and employment of mitigation measures in accordance with the mitigation sequence, those impacts will be addressed in a manner necessary to assure the end result will not diminish shoreline resources and values as they currently exist. Where uses or development that impact ecological functions are necessary to achieve other objectives of RCW 90.58.020, master program provisions shall, to the greatest extent feasible, protect existing ecological functions and avoid new impacts to habitat and ecological functions before implementing other measures designed to achieve no net loss of ecological functions.
>
> Master programs shall also include policies that promote restoration of ecological functions, as provided in WAC 173-26-201 (2)(f), where such functions are found to have been impaired based on analysis described in WAC 173-26-201 (3)(d)(i). It is intended that local government, through the master program, along with other regulatory and nonregulatory programs, contribute to restoration by planning for and fostering restoration and that such restoration occur through a combination of public and private programs and actions. Local government should identify restoration opportunities through the shoreline inventory process and authorize, coordinate, and facilitate appropriate publicly and privately initiated restoration projects within their master programs. The goal of this effort is master programs which include planning elements that, when implemented, serve to improve the overall condition of habitat and resources within the shoreline area of each city and county.

The difference between the role of regulatory and non-regulatory programs is illustrated in conceptual form in Figure 1-1, below.



Source: Washington Department of Ecology

Figure 1-1. Achieving No Net Loss Through Regulations and Restoration

An evaluation of cumulative impacts is required to consider the following (WAC 173-26-186(8)):

- Current circumstances affecting the shorelines and relevant natural processes;
- Reasonably foreseeable future development and use of the shoreline; and
- Beneficial effects of any established regulatory programs under other local, state, and federal laws.

This cumulative impacts assessment uses these three considerations as a framework for evaluating the potential long-term impacts on shoreline ecological functions and processes that may result from development or activities under the proposed SMP over time.

1.2 CITY OF RENTON CONTEXT

City of Renton is located within the Lake Washington/Cedar River (Water Resource Inventory Area [WRIA] 8) and the Green/Duwamish River (WRIA 9) watersheds.

WRIA 8 encompasses 692 square miles (Kerwin 2001) and two major subbasins, the Sammamish River and the Cedar River, both of which flow into Lake Washington. WRIA 8 boundaries follow topographic divides between WRIA 7 (Snohomish River) to the north and east, and WRIA 9 (Green/Duwamish Rivers) and Puget Sound to the south and west (Kerwin

2001). The majority (approximately 86 percent) of WRIA 8 is in the Puget Lowlands physiographic region. The upper Sammamish drainage lies in the Cascade foothills, while the upper Cedar River drainage extends through the foothills into the Cascade Mountains. WRIA 8 has a population of about 1.5 million people, the most of any WRIA in the state.

WRIA 9 contains the Green River and its tributaries, including the Duwamish waterway/estuary, and nearby tributaries draining directly to Puget Sound. WRIA 9 is bound topographically by WRIA 8 (Lake Washington/Cedar River) to the north and WRIA 10 (Puyallup River) to the south. The Green River watershed is 462 square miles, and the river itself stretches 93 miles from its source in the Cascade Mountains through the Cascade foothills and Puget Lowlands before emptying into Puget Sound at Elliott Bay. The population of WRIA 9 is approximately 565,000.

The City accounts for less than three percent of the geographical area and its population (80,708) is less than a half of one percent of the population of about two million within WRIAs 8 and 9. The City is also located near the lower end of both WRIAs. Hence, management actions taken within the City limits have a limited effect on overall watershed conditions. However, actions taken to manage reach-scale processes, such as riparian and floodplain functions, could have a larger effect on specific ecological processes and functions, particularly rearing functions of anadromous fish.

The City also lies in the lower portion of May Creek and Springbrook Creek but accounts for a much larger proportion of the total watershed area. As such, management actions for these shorelines conducted within the City may have a more substantial effect on overall watershed conditions and shoreline ecological functions.

Reaches on shorelines within Renton referred to in this report are indicated in Map 1.

1.3 METHODOLOGY

The methodology used in this cumulative analysis is based on:

- Description of current conditions based on the findings outlined in the Inventory/Characterization Report
- Description of foreseeable future development and use of the shoreline through:
  - Projection of the likely effects of future development on shoreline and watershed functions utilizing the “Landscape Analysis” provided in the Inventory and Characterization
  - Projection of the likely beneficial effects of any established regulatory programs under other local, state, and federal laws as well as non-regulatory programs

1.3.1 Current Circumstances Affecting the Shorelines and Relevant Natural Processes

Existing conditions are addressed in the landscape characterization provided in the City of Renton Draft Inventory and Characterization Report (2006). A brief summary of the methodology is provided below. Please refer to Part I of the Inventory and Characterization Report for more detail.

1.3.2 Reasonably Foreseeable Future Development and Use of the Shoreline

Description of foreseeable future development and use of the shoreline through:

- Projection of allowed uses, density, general character of uses and number of units provided by existing zoning on a buildout basis.
- Existing land use patterns affecting cultural and economic trends in response to the opportunities and constraints of the zoning.
- Projection of likely development based on Office of Financial Management (OFM) projections and the City's Comprehensive Plan.

1.3.3 Beneficial Effects of Any Established Regulatory Programs Under Other Local, State, and Federal Laws

The beneficial effects of established regulatory programs consist of the following:

- Provisions of existing county land use and development regulations
- State and federal programs
- The beneficial effects of conservation and restoration programs

1.3.4 General Conclusions

This cumulative effects analysis assesses the probable beneficial effects of:

- The Renton Shoreline Management Program (SMP)
- The proposed King County Shoreline Master Program (SMP) and other jurisdiction SMPs within the Cedar River Watershed
- The proposed Tukwila Shoreline Master Program (SMP) and other jurisdiction SMPs within the Green River Watershed
- The proposed Kent Shoreline Master Program (SMP) and other jurisdiction SMPs within the Springbrook Creek Watershed
- The Renton Critical Areas Regulations adopted in December 2005.
- Other state and federal regulatory programs
- Non-regulatory enhancement efforts

This assessment is based on the description of existing ecological functions in the Inventory and Characterization prepared for the Shoreline Management Plan.

The following is a summary of the major processes affecting shoreline ecological processes and the relative effect of the Shoreline Management Program (SMP) on those functions.

Geology, which generally determines the natural location and transport capacity of earth materials through materials deposition, topography, and landforms, is a process that takes place throughout the landscape. The SMP has little influence on functions related to geology.

Climate, which is generated by the long-term weather patterns of a region, is a process over which lands in SMA jurisdiction have almost no influence.

Vegetation is mainly influenced by geology and climate in terms of establishing native plant communities. Vegetation is important within SMA jurisdiction and on lands outside of SMA jurisdiction. Because it affects overall landscape processes on the watershed level and because of the relatively small amount of land and stream miles within SMA jurisdiction as compared to outside, the effects of vegetation on aquatic systems in most watersheds in City of Renton occur largely outside of SMA jurisdiction.

On the Cedar and Green Rivers, the major programs that affect vegetation are King County rural and resource zoning and buffer requirements of the King County Critical Areas Ordinance (CAO) which apply to a much wider area than the SMP. Programs of upstream cities also have an influence, although buffers tend to be smaller and urban areas on the Green River have extensive levee systems. In addition, flood management programs, recently consolidated into the King County Flood Control District, may have a major impact.

On Lake Washington, most native vegetation has been removed or altered to ornamental landscaping, except for:

- Reach C contains:
  - A narrow buffer that has been re-established at the Seahawks Training Center;
  - A vegetation and wetland community that has been re-established on portions of the shoreline at the Quendall Terminals Superfund Site; and
  - A beach and vegetation restoration program that has been developed on public harbor lands which have been withdrawn from leasing by the Department of Natural Resources (DNR) in recognition of the environmental values of the area.
- Reach F in the City of Renton Gene Coulon Park has substantial, although generally narrow areas of shoreline vegetation in the northerly portion of the park.
- Reach I contains public harbor lands in the easterly third of the Boeing site which are currently proposed to be restored by DNR, including removing the existing outfall flume from the former Sheffelton Plant to restore beach conditions.

On Lake Washington, riparian vegetation may play a substantial role in reversing trends of decline of Chinook salmon by providing appropriate nearshore habitat for a critical juvenile lifecycle stage. It also may contribute to other species through restoration of elements of the food chain.

On the Cedar River, most native vegetation has been removed in the central area between Logan Streets and I-405, but several areas of substantial vegetation remain:

- Reach A contains a substantial, although generally narrow area of shoreline vegetation on the east (right) bank in the city park.
- Reach C is primarily native vegetation on the south (left) bank in public open space areas.
- Reach D contains a wide buffer of native vegetation adjacent to the golf course and Ron Regis Park.

The Green River consists largely of the backwaters of the river at the mouth of the Black River and contains relatively little native vegetation and is crossed by two wide railroad corridors.

The Black River/Springbrook Creek is periodically cleared of large diameter vegetation in the portions managed by the Drainage District. Areas with substantial riparian vegetation include:

- Reach A contains the Black River Forest and a narrow riparian vegetation corridor adjacent to the Sewage Treatment Plant extending to Grady Way.
- Reach C contains a riparian corridor of varying width within the Longacres Office Park.

- Reach D contains restored riparian vegetation within the Springbrook Wetland Mitigation Bank.

Hydrology, and specifically the influence of land use, also occurs on a watershed basis. Because the majority of any given watershed is outside of SMA jurisdiction, the major influence on the volume and rate of water transport will take place on tributaries with flows below the 20 cfs SMA jurisdiction threshold.

Infiltration/recharge is largely affected by land use on a watershed basis. Whether the land use or land cover is managed forests, agricultural, large lot rural, or urban development, the change in infiltration, recharge, and other mechanisms will manifest as the result of changes in native forest cover and increase in runoff from loss of vegetation cover over the entire watershed. Changes in infiltration and other hydrology mechanisms occur with a change or loss of native vegetation cover. This change in vegetation cover is due to the land use practices of managed forests, agricultural, large lot rural, or urban development. Because the vast majority of the area of the watershed is outside of SMA jurisdiction, these areas will have the primary influence.

On the Cedar and Green Rivers, the major programs that affect surface runoff and peak flow mechanisms are King County rural and resource zoning and the buffer requirements of the King County Critical Areas Ordinance which apply to a much wider area than the SMP. Programs of upstream cities also have an influence through stormwater management programs.

Localized hydrology on Lake Washington is likely to be an important factor in Sockeye beach spawning and may be locally blocked by armored shorelines.

Sediment delivery mechanisms have wide-ranging impacts on aquatic ecosystems and can limit ecologic function by impairing habitat quality and water quality. Surface erosion and mass wasting are naturally-occurring mechanisms of sediment supply, but each can increase sediment inputs to aquatic ecosystems when the landscape is altered by human use.

On the Cedar and Green Rivers, the major programs that affect sediment delivery mechanisms are King County rural and resource zoning and the buffer requirements of the King County CAO which apply to a much wider area than the SMP. Programs of upstream cities also have an influence through stormwater management programs. Urban areas on the Green River have extensive levee systems largely managed by the King County Flood Control District and have a major impact on sedimentation mechanisms. In urbanized areas, sedimentation is impacted by erosion control programs in clearing and grading codes as well as stormwater management programs.

On Lake Washington, most natural sedimentation processes have been altered in the past by flood control dredging of the Cedar River and dredging of the deltas of streams such as May Creek for other reasons. Local erosion and deposition are also affected by shoreline armoring that limits sediment sources and produces high wave environments that affect the slope and substrate of the nearshore. Dredging in the Cedar River and May Creek deltas has ended and the natural sedimentation dynamic in areas close to those sources will be restored.

Water quality is also likely to be influenced both by changes at the watershed scale that affect nutrient cycling in aquatic ecosystems and by urban stormwater. In the relatively smaller area under SMA jurisdiction, local inputs of herbicides, pesticides, and other chemicals may have an important localized impact.

All the factors affecting nutrient cycling are likely to occur at a watershed level, including fertilizer originating from both agricultural and residential areas, nutrients from septic tanks or sewer system leakage, and changes that affect the nitrogen fixation rates of natural processes. The major factors that influence water quality differ somewhat between the Cedar and Green Rivers because there is much less agriculture in the Cedar River watershed. The total load of pollutants is likely to be influenced by watershed-wide effects, but, in the case of the Cedar River, urban stormwater runoff is likely an important contributor. On the Green River, watershed-wide processes outside of Renton are the predominant source. Springbrook Creek is largely urbanized and urban stormwater is the primary source of most pollutants, although the lack of shading from riparian vegetation affects summer temperature.

Inputs from the watershed as a whole are the most significant source of pollutants for Lake Washington. In the nearshore, however, local sources of herbicides, pesticides, and other chemicals from maintenance of lawns and landscaping adjacent to the shoreline may have a localized impact on nearshore areas important to the food chain and may directly affect the central nervous system of Chinook salmon at a critical lifecycle stage, as well as other species.

Heat and light inputs are affected by surface water, groundwater, and riparian shading. The influence of shading is most substantial on small tributaries, and tributaries may have the greatest influence on larger streams. The major programs that influence heat and light inputs are the riparian buffer requirements of many jurisdictions in the watersheds. An area where localized rather than watershed-wide shading has a substantial influence is in the nearshore of Lake Washington.

2. METHODOLOGY

The analysis of the cumulative effects of the Shoreline Management Program(SMP), together with other programs is summarized in Table 3-8. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Functions. This table considers the type of effects of a variety of human activities on a cross section of ecological functions and assesses the probable beneficial effects of:

- The Shoreline Management Program
- The Critical Areas Regulations adopted in December 2005
- Other state and federal regulatory programs
- Non-regulatory enhancement efforts

This assessment is based on the description of ecological functions in the Inventory and Characterization prepared for the SMP. The "landscape analysis" methodology used in that analysis analyses a number of processes that are important for aquatic resource management—hydrology, sediment, water quality (e.g., nutrients, pathogens, toxins/metals), organic matter, and heat/light. Because that analysis provides the basis of the assessment of cumulative effects, it is summarized below.

2.1 LANDSCAPE CHARACTERIZATION FRESHWATER SHORELINES

The landscape characterization approach used in the Renton Shoreline Inventory and Characterization, August 2009, examines specific processes including the movement of water, sediment, nutrients, pathogens, toxicants, organic matter, and energy or heat that form and maintain the landscape over a large geographic scale. These processes interact with landscape features to create the structure and function of aquatic resources (Ecology 2005).

The analysis uses a coarse-grained approach for integrating landscape processes into shoreline management, restoration planning, and other land use planning efforts (Ecology 2005). The purposes of the analysis are to highlight the relationship between key processes and aquatic resource function and to describe the effects of land use on those key processes. This approach is not intended to quantify landscape processes and functions. Rather, the goal is to: 1) identify and map areas on the landscape important to processes that sustain shoreline resources; 2) determine their degree of alteration; and 3) identify the potential for protecting or restoring these areas.

2.1.1 General Framework and Conceptual Model

The watershed analysis approach attempts to answer four questions:

1. What are the key landscape processes that maintain aquatic/shoreline resources and their functions?
2. Which geographic areas within watersheds are most important for maintaining each key process?
3. How have human activities/land use altered important process areas and to what extent have the key processes been impaired?
4. Which areas have potential for sustaining or improving resource function through protection and/or restoration?

The processes that are most important for aquatic resource management—hydrology, sediment, water quality (e.g., nutrients, pathogens, toxins/metals), organic matter, and heat/light—function in a framework established by process controls, including geology, climate, vegetation, and land use. The processes, which are all related to the transport of materials and energy across the landscape, function through a number of mechanisms that act to input, transport, store, or remove materials and energy. The pathways and magnitude of these mechanisms influence the structure of aquatic systems, including streams, lakes, wetlands, and estuaries.

Geology generally determines the natural location and transport capacity of earth materials through materials deposition, topography, and landforms. Climate is generated by the long-term weather patterns of a region. Factors contributing to regional climate include global, regional, and local wind, moisture, and temperature variations. Climate determines the availability of water in a region—a most important function, because hydrology drives many other processes that influence ecological functions in aquatic systems. In addition, climate affects watershed conditions such as growing season and vegetation, and is a major influence on human population patterns.

Vegetation is mainly influenced by geology and climate, but it is unique in that its feedback relationship with landscape processes is important for maintaining aquatic resources. Vegetation influences hydrology through the interception, evapotranspiration, and infiltration mechanisms (Ziemer and Lisle 2003). Vegetation also affects sediment erosion and transport and is the source of most organic inputs to aquatic systems. Vegetation helps control microclimate, plays a major role in fixing nitrogen and influencing other nutrient and water quality mechanisms, and partly controls light inputs and associated primary production in aquatic habitats. Vegetation helps shape instream habitat conditions by creating habitat; providing food, substrate, and cover for numerous species; and influencing numerous other surface conditions such as channel morphology, channel migration, and avulsion. Vegetation alteration is a primary mechanism through which land uses impact landscape processes.

2.1.2 Characterization Structure

The approach to characterizing landscape-scale processes consisted of several steps, which are described below.

Step 1 – Identify Aquatic Resources and their Contributing Areas

Generally speaking the landscape analysis utilized watersheds identified as Water Resource Inventory Areas (and includes the Cedar River/Lake Washington watershed (WRIA 8) and the Green/Duwamish River watershed (WRIA 9).

In addition, reference is made to the specific streams and lakes under shoreline jurisdiction.

Step 2 –Key Landscape Processes

Processes occurring at the landscape-scale maintain aquatic resources to varying degrees. The Landscape Analysis in the Inventory/Characterization focuses on key processes that are fundamental to the integrity of the ecosystem and can be managed within the context of the available land use plans and regulations The following key processes are critical to sustaining the aquatic resources and likely to be altered by human activity:

- Hydrology
- Sediment
- Water Quality
- Organic Matter

- Heat/Light

Additional background information describing key processes is provided in the Inventory and Characterization.

Step 3 – Map Process-Intensive Areas

The Inventory and Characterization used available geographic information system (GIS) data to identify and map areas within the City that support key processes. The geographic location of these specific features (e.g., depressional wetlands, permeable surficial deposits, or steep gradients) is used to identify process-intensive areas.

Process-intensive areas are the focus of the Landscape Analysis in the Inventory/Characterization because they control how key processes operate. In some cases, the process-intensive areas are areas where inputs to the processes occur (e.g., the steep slopes that generate sediment supply as a result of erosion). For other processes, inputs occur so broadly across the landscape that specific process-intensive input areas are difficult to identify. In those cases, the important process areas are areas that facilitate movement or storage of materials such as water, sediment, or pathogens.

Commonly, multiple processes are present in a single area due to feedback relationships among processes. Storage areas such as depressional wetlands are a good example because they store surface water, which traps sediment and facilitates phosphorus removal and contaminant adsorption, uptake, and storage. The mapping exercise allows us to identify areas where each process occurs as well as areas that support multiple processes and therefore may provide valuable protection and/or restoration opportunities.

Step 4 – Map Process Alterations

This step determines where land uses and/or actions associated with land use have altered naturally occurring processes. Knowing where and how processes have been altered provides insight into the management approaches that may be appropriate for each geographic region. Altered areas may provide opportunities for restoration, while unaltered areas may have potential for conservation or similar protection. Table 2-1 shows the types of alterations identified for each process. The methodology of this cumulative analysis is based on the process changes outlined in Table 2-1.

Hydrology

Land use can greatly change the hydrologic process in a given area. Specifically, the volume and rate of water transport through each flow path can be altered by loss of forest cover and increases in impervious surface. As a result of land use, particularly urbanization, water is redirected from all other runoff pathways. This affects not only peak flows but also groundwater discharge during periods of baseflow.

Infiltration/Recharge

Land use is a predictor of effective impervious area. Impervious surfaces can impact infiltration in all areas of a watershed, but it is particularly detrimental in areas that naturally support high rates of infiltration and recharge (e.g., permeable deposits on low slopes).

Other factors associated with impervious development increase the effective drainage density and route water away from infiltration/recharge pathways toward direct runoff as discussed below under Surface Runoff/ Peak Flows.

Surface Water Storage

The loss of surface water storage potential can increase the volume and shift the timing of flow or increase water level fluctuations in lentic systems. Land use can either directly impact storage through the destruction of storage areas (e.g., floodplains, wetlands, and the hyporheic zone) or indirectly decrease storage by reducing connectivity between the storage areas and streams. Components of reduced connectivity include diked/leveed channels, stream channelization and incision, increased sediment supply, and wetland ditching.

Some of these alterations are more appropriately addressed either in other landscape processes (e.g., sediment supply) or at the reach scale (e.g., channel modifications and incision). Other impacts are difficult to characterize with existing information, such as loss of hyporheic function. Therefore, the alteration of focus for surface water storage is loss of wetland storage and floodplain disconnection.

Surface Runoff/Peak Flows

Surface runoff and peak flow mechanisms are closely linked to the infiltration/recharge mechanism described above because runoff is inversely correlated to infiltration/recharge. Runoff is affected by development that increases drainage density, synchronizing runoff during peak events which consequently increases the magnitude and frequency of peak flows. Ditches in forested and rural areas and storm sewers in urban areas act as conveyance channels, artificially increasing drainage density and improving the efficiency of water delivery to streams.

Groundwater Flow

Precipitation is the primary source of groundwater recharge. Therefore, the primary influence on groundwater flow and discharge is infiltration and recharge. However, alterations to flow paths and groundwater extraction/consumption also influence the availability of groundwater for maintaining ecological functions during the summer low flow period. Draining areas of shallow groundwater via ditching, pumping, or other practices shortens the groundwater flow paths and decreases retention time. Consequently, the efficiency of groundwater discharge increases, and the availability of groundwater for discharge during low runoff periods decreases.

Sediment

Changes in sediment supply have wide-ranging impacts on aquatic ecosystems and can limit ecologic function by impairing habitat quality and water quality. Surface erosion and mass wasting are naturally occurring mechanisms of sediment supply, but each can increase sediment inputs to aquatic ecosystems when the landscape is altered by human use. Loss of forest cover and roads can increase inputs to aquatic systems by increasing rates of mass wasting and surface erosion. Altered hydrology may also increase hillslope inputs to aquatic resources as well as influence rates of instream transport and storage.

Mass Wasting

Mass wasting is an important mechanism on the Cedar River. It is less important in the lower Green River because of topography and gradient.

Surface erosion usually occurs as a result of particle entrainment by rainfall and overland flow. Roads are a primary source of increased sediment inputs to aquatic systems via surface erosion in forested environments. Roads within approximately 200 feet of aquatic ecosystems dramatically increase sediment inputs from surface erosion.

Table 2-1. Alterations Associated with Key Processes

Key Landscape Process	Mechanism	Process-intensive areas	Alterations
Hydrology	Infiltration/Recharge	Permeable soils on low slopes Artificial conveyances (indicator is road density)	Impervious area Roads, ditches, storm sewers
	Surface water storage	Depressional wetlands, lakes, and floodplains	Drained or filled depressional wetlands Streams disconnected from floodplains
	Surface runoff and peak flow	Rain-on-snow zones	Loss of hydrologically mature forest cover Road density
	Groundwater flow	Shallow aquifers	Ditched/drained areas with shallow groundwater Consumption
Sediment	Soil erosion	Steep slopes with erodible soils	Native vegetation loss Roads near streams Till agriculture Developing lands
	Mass wasting	Mass wasting hazard areas	Roads in mass wasting hazard areas
	Storage	Depressional wetlands, lakes, and floodplains	Drained or filled depressional wetlands Floodplain disconnection Stream channelization
Water quality	Nutrient sources	Contributing area	On-site septic systems, agriculture (waste and fertilizer), residential areas (fertilizer), riparian disturbance
	Pathogen sources	None	On-site septic systems, agricultural waste
	Toxin/Metal sources	Toxins – none; metals – groundwater	All land uses (non-specific)
	Cycling (storage/transport)		Drained or filled depressional wetlands Riparian disturbance
Organic matter	LWD recruitment (source)	Riparian zones	Loss of mature forest
		Channel migration zones	Bank armoring, dikes/levees, Channelized streams
		Mass wasting areas	Loss of mature forest
Heat/light inputs	Canopy cover	Riparian corridors	Loss of vegetation

Areas of low erosion potential can also be significant sources of sediment, particularly for land uses that directly disturb soil due to clearing for urban uses, or clearing of forest land to convert to agriculture. Till agriculture or bare fallow soil areas can increase surface erosion by 40 to 50 percent.

Bank Erosion

Streams, wetlands, and lakes can store sediment before being transported farther downslope to estuaries and nearshore ecosystems. Channelization and floodplain disconnection cause loss of overbank sediment deposition in the floodplain during peak flows. Draining and filling depressional wetlands can also reduce sediment storage capacity on the landscape. Thus, alterations to surface water storage are also indicative of reduced sediment storage. The residence time of sediment stored in the floodplain may decrease as a result of land use.

Bank erosion is the largest source of increased sediment supply in urbanizing basins. Changes in stream morphology brought on by altered sediment supply-transport processes in streams can include increased bank erosion and channel migration rates. Loss of riparian vegetation also increases the susceptibility of streambanks to fluvial entrainment and mass failures. The alterations that indirectly influence bank erosion are discussed in other sections (riparian condition; surface runoff and peak flows). Consequently, bank erosion is not directly addressed in the alteration analysis, but increases in bank erosion rates are noted in the response section.

Water Quality

Nutrients

Changes to hydrology and sediment supply at the landscape-scale will profoundly influence nutrient cycling in aquatic ecosystems, and alterations to these processes are discussed in previous sections. The Landscape Analysis in the Inventory/Characterization focuses on alterations to nutrient inputs resulting from certain land uses. Fertilizer originating from both agricultural and residential areas can be a potential source of increased nitrogen inputs to both aquatic ecosystems and groundwater. In addition, fecal waste from septic tanks, commercial agriculture, and hobby farms can also contribute excess nitrogen and other nutrients.

Other human impacts that alter aquatic resources influence nutrient retention. Floodplain disconnection and loss of riparian forest cover can limit hyporheic function and nitrogen fixation rates and preclude deposition of sediment and adsorbed phosphorous. Loss of wetlands also decreases rates of nutrient retention via chemical reactions such as denitrification.

Pathogens

Pathogen inputs are primarily associated with human disturbance. Human sources of fecal matter and associated pathogens include on-site septic systems and animal operations such as dairies and hobby farms.

Like all water quality components, pathogen loading is highly correlated to hydrology and sediment processes. Increased inputs and disturbance frequency provide a vehicle for increased pathogen inputs and decreased retention. Decreased removal is indirectly influenced by increased hydrology and sediment fluxes, which result from channelization, wetland destruction, and increases in impervious area.

Toxins/Metals

Many land uses are sources of toxins and increased metal inputs that are harmful to aquatic ecosystems. The types of pollutants typically vary by land use. Urban land uses (e.g., residential, commercial, municipal and industrial) can introduce contaminants such as metals, organic compounds, and pesticides. Heavy metals (e.g., cadmium, copper and zinc) can be released from motor vehicles, building materials and rooftops. Some homeowners and land managers use insecticides, herbicides, and chemical fertilizers for lawn care.

The primary mechanism of contaminant transport from urban and rural lands to the surrounding watershed is runoff. Impervious surfaces (e.g., roads, sidewalks, pavement, and rooftops) are key in the transport of stormwater runoff and associated contaminants.

Rural land uses (e.g., agriculture and forestry) are also potential sources of pesticides. Irrigation and storm events will enhance the movement of pesticides and metals bound to loose organic matter (Nelson and Booth 2002; Hopkinson and Vallino 1995); thus, toxin/metal mechanisms are similar to mechanisms in other water quality processes such as nutrients and sediment mechanisms.

Organic Matter

Riparian forest disturbances reduce woody debris in streams, which in turn leads to adverse changes in channel/habitat-forming processes. In headwater areas, roads may increase the incidence of landslides; however, associated loss of forest cover in these areas decreases large woody debris (LWD) recruitment via landslides. Land use encroachment into riparian zones, reduces forest cover and decreases LWD recruitment potential. Land uses and resource management practices that channelized streams also limit recruitment potential via bank erosion/channel migration.

Heat/Light

The Landscape Analysis in the Inventory/Characterization relies on data that uses percent canopy cover within this range as an indicator of the potential for increased heat/light inputs.

Step 5 – Identify Responses to Process Alterations

Process alterations are sometimes difficult to detect and identify. In most cases one must look to a physical manifestation (which may be referred to as a primary structural response). This physical change may indicate the presence of a process alteration. If that appears to the the case, further investigation or monitoring over time can confirm predictions regarding how the process works in the particular context and provides information regarding the magnitude of the alteration. These responses generally indicate the presence of altered processes but may not represent the full suite of possible responses.

Primary structural responses can also produce secondary structural responses as well as consequent ecological responses. Table 2-2 identifies some of the key primary and indirect functional changes that occur in response to altered processes.

Table 2-2. Key Processes and Responses to Alterations

Process	Mechanism	Primary Structural Response to Impairment	Secondary Responses
Hydrology	Infiltration and Recharge Surface Runoff Surface Water Storage Groundwater	Increased frequency and duration flow; decreased baseflow. Increased peak flow; channel erosion; morphological homogeneity. Increased duration and decreased volume of low flow	Peak flow: Channel incision; loss of habitat complexity; increased bedload transport; decreased biodiversity and productivity; increased redd scour and juvenile flushing Baseflow: Migratory barriers; decreased habitat availability; increased temperature
Sediment Supply	Inputs Storage	Substrate fining; high TSS/turbidity; increased coarse sediment supply Increased channel instability	Reduce hyporheic connection and volume; low B-IBI score; interstitial infilling, degraded spawning grounds; aggrading and entrenching channels.
Water Quality Toxins Phosphorus/Nitrogen Fecal matter	Inputs Storage	Increased concentrations (303(d) listings)	Increased mortality Increased BOD and eutrophication Shellfish contamination Reduced species richness Drinking water contamination
Organic Inputs	LWD inputs	Riparian disturbance; Forest cover loss on landslide-prone areas	Biotic energy loss; Decreased LWD density; Reduced habitat complexity (pool density and quality); Decreased sediment and organic matter storage and sorting; Decreased biodiversity and productivity
Heat/Light	Inputs	Riparian disturbance (decreased shading) Greater temperature extremes (303(d) listings)	Increased primary productivity; Reduced DO; Migration barriers; Reduced species richness; Reduced growth; Increased disease susceptibility; Decreased egg viability

3. ELEMENTS OF CUMULATIVE EFFECTS ANALYSIS

The Shoreline Management Act (SMA) Guidelines (WAC 173-26-18683)(d) require analysis of cumulative impacts "to ensure no net loss of ecological functions and protection of other shoreline functions and/or uses, master programs shall contain policies, programs, and regulations that address adverse cumulative impacts and fairly allocate the burden of addressing cumulative impacts among development opportunities. Evaluation of such cumulative impacts should consider:

- Current circumstances affecting the shorelines and relevant natural processes;
- Reasonably foreseeable future development and use of the shoreline; and
- Beneficial effects of any established regulatory programs under other local, state, and federal laws.

This cumulative impacts assessment uses these three considerations as a framework for evaluating the potential long-term impacts on shoreline ecological functions and processes that may result from development or activities under the proposed SMP overtime.

Current circumstances generally consist of the conditions of the shoreline as documented in the Inventory and Characterization prepared for the SMP update.

Reasonably foreseeable future development and use of the shoreline includes allowed uses within the shoreline as established by the SMP, together with the projection of likely uses expected to develop, and based on current development patterns. Description of foreseeable future development and use of the shoreline through a combination of:

- Projection of allowed uses, density, general character of uses, and number of units provided by existing zoning on a buildout basis.
- Existing land use patterns affecting cultural and economic trends in response to the opportunities and constraints of the zoning.
- Projection of likely development based on Washington State OFM projections and the City's Comprehensive Plan.

The beneficial effects of established regulatory programs include the following:

- Provisions of existing county land use and development regulations
  - Comprehensive Plan polices that directly affect the location and scale of development, through Urban Growth Areas
  - Zoning Regulations
  - Critical Area regulations
  - Flood Damage Prevention regulations
  - Stormwater management provisions i
- State and federal programs
  - Federal and state programs under the Clean Water Act
    - Section 404 and 401 programs
    - National Pollution Discharge Elimination System permits
  - The state Dairy Nutrient Management Act RCW 90.64

  - The Endangered Species Act
- Hydraulic Project approval administered by the Washington Department of Fish and Wildlife
- Programs administered by the Washington Department of Ecology
- The beneficial effects of conservation and restoration programs
  - Implementation of the WRIA 8 and 9 Salmon Recovery Plans
  - Programs administered by other agencies

3.1 EXISTING CONDITIONS

Reference should be made to the City of Renton Draft Inventory and Characterization Report for a detailed description of existing conditions.

3.2 REASONABLY FORESEEABLE FUTURE DEVELOPMENT

This section provides a general assessment of:

- General growth in population and employment projected to 2022.
- Uses allowed in each of the Shoreline Overlay Districts (The equivalent of Shoreline Environmental Designations provided for in WAC 173-26) provided in the Shoreline Management Plan (SMP) together with an overview of the areas with the designation and the range of projected uses.

3.2.1 Future Population and Economic Growth

The 2008 estimate by the state Office of Fiscal Management () population of City of Renton was 78,780 persons in 35,754 housing units. Total employment was 56,416 jobs according to the Puget Sound Regional Council Covered Employment estimates.

Growth in City of Renton since 2000 has been 28,728 with the largest growth spurt occurring between 2007 and 2008 when the City annexed Benson Hill, a community of 16,272 people.

The Puget Sound Regional Council (PSRC) forecast the growth for the City over a 21-year interval from 2001 to 2022 to have an increase of 9,723 households and 33,600 jobs. Growth targets established by the Growth Management Planning Council expect 6,198 households and 27,597 jobs. Under Buildable Lands requirements set by the Growth Management Act, both growth forecasts fall within the estimated land capacity of 11,261 households and 32,240 jobs.

Based on forecasts of population and employment growth, Renton will continue to plan for a 6-year increment increase of 2,778 household units and 9,300 jobs for the 2007 to 2012 Capital Facilities Plan. Reviews and revisions of the Capital Facilities Plan may result if actual growth continues to exceed the forecast growth developed by PSRC.

3.3 TYPICAL EFFECTS OF ALTERNATIONS ASSOCIATED WITH LAND USES

It is important to recognize that the ecological processes and functions that occur within Shoreline Management Act jurisdiction are affected by processes within the entire watershed, not only those that take place within shorelines regulated by the Shoreline Master Plan.

Table 3-2 provides a summary in matrix format of the types of cumulative effects produced by the processes and functions addressed in the landscape analysis and the extent to which the proposed revisions to the SMP addresses those potential effects.

Geology, which generally determines the natural location and transport capacity of earth materials through materials deposition, topography, and landforms, is a process that takes place throughout the landscape. Since the area under direct SMA jurisdiction is a very small part of the overall affected area, non-shoreline areas, and even factors outside of City of Renton are the scale at which this is of most effect. Within the county, there are variations between and within specific WMU. Again, these have an effect on the landscape as a whole and are more affected by the larger areas outside of SMA jurisdiction than those within.

Climate, which is generated by the long-term weather patterns of a region is a process over which lands in SMA jurisdiction have almost no influence.

Vegetation, which is mainly influenced by geology and climate, is important within SMA jurisdiction and on lands outside of SMA jurisdiction. Because it affects overall landscape processes on the watershed level, and because the amount of land and the amount of stream miles outside of SMA jurisdiction is greater, this factor is of greatest importance outside of the influence of vegetation on hydrology through the interception, evapotranspiration, and infiltration mechanisms. The effects of vegetation on sediment erosion and transport; and as the source of organic inputs to aquatic systems is also important locally, but for most watersheds in City of Renton, the majority of this mechanism occur outside of SMA jurisdiction.

Hydrology, and specifically the influence of land use, also occurs on a watershed basis. Because the majority of any given watershed is outside of SMA jurisdiction, the major influence on the volume and rate of water transport will take place on tributaries with flows below the 20 cubic feet per second (cfs) SMA jurisdiction threshold.

Infiltration/recharge is largely affected by land use on a watershed basis. Changes in infiltration and other hydrology mechanisms occur with a change or loss of native vegetation cover. This change in vegetation cover is due to the land use practices of managed forests, agricultural, large lot rural, or urban development. Because the vast majority of the area of the watershed is outside of SMA jurisdiction, these areas will have the primary influence.

The loss of surface water storage potential, which can increase the volume and shift the timing of flow, or increase water level fluctuations in lentic systems is also a cumulative function throughout the watershed. Changes that affect storage potential occur on a greater scale outside SMA jurisdiction, including the elimination of storage areas provided by floodplains, wetlands, and the hyporheic zone as well as indirectly decreasing storage by reducing connectivity between the storage areas and streams.

Surface runoff and peak flow mechanisms, which are closely linked to the infiltration/recharge mechanism described above, are also primarily a watershed function. All the mechanisms that increase impervious surface and that eliminate the natural delays in surface runoff reaching streams (such as ditches in forested and rural areas and storm sewers in urban areas) all relate to the total area affected, and therefore are most influenced by the land outside SMA jurisdiction.

Sediment delivery mechanisms have wide-ranging impacts on aquatic ecosystems and can limit ecologic function by impairing habitat quality and water quality. Surface erosion and mass wasting are naturally occurring mechanisms of sediment supply, but each can increase sediment inputs to aquatic ecosystems when the landscape is altered by human use. Loss of forest cover and roads can increase inputs to aquatic systems by increasing rates of mass wasting and surface erosion. Altered hydrology may also increase hillslope inputs to aquatic resources as well as influence rates of instream transport and storage.

Mass wasting and erosion are both influenced by natural features such as topography and soils, as well as human alternation. Mass wasting is influenced largely by conditions that increase risk of slope failure directly by altering slope properties or indirectly by redistributing excess water to landslide prone areas. Topographic and soil conditions that are higher risk areas for erosion and mass wasting generally occur in areas with greatest relief and are drained by a network of small streams primarily outside of SMA jurisdiction. Influence of human activities such as loss of forest cover and alteration of topography through roads and other human disturbance also occur throughout the landscape.

Bank erosion of streams is one mechanism that may occur at a greater magnitude in streams under SMA jurisdiction because the greater flows result in higher erosive forces. It is not clear, however, whether the cumulative effects of bank erosion on many smaller streams may be of similar or greater magnitude. The loss of stream buffer vegetated areas and of buffers provided by adjacent wetlands and wetlands may store sediment before being transported farther downslope all occur throughout the watershed and may be as substantial outside SMA jurisdiction as within.

In urban areas, bank erosion is the largest source of increased sediment supply in urbanizing basins and is largely caused by changes in stream morphology brought on by altered runoff/infiltration patterns resulting from increased impervious surfaces. This alteration is largely a watershed function rather than one that occurs primarily in SMA jurisdiction. The smaller streams below the 20 cfs threshold are more likely to be affected by changes in stream morphology and become the major sites of increased bank erosion and increased sedimentation.

Water quality is also likely to be influenced more by changes at the watershed scale that affect nutrient cycling in aquatic ecosystems rather than the processes in the relatively smaller area under SMA jurisdiction. All the factors affecting nutrient cycling are likely to occur at a watershed level, including fertilizer originating from both agricultural and residential areas, nutrients from septic tanks or sewer system leakage, and changes that affect the nitrogen fixation rates of natural processes that are affected by loss of floodplain connection, riparian forest cover, and wetlands.

Like all water quality components, pathogen, toxin, and heavy metal loading is highly correlated to hydrology and sediment processes, all of which occur on a watershed scale. Disturbance frequency provides a vehicle for increased pathogen inputs and decreased retention. Decreased removal is indirectly influenced by increased hydrology and sediment fluxes which result from channelization, wetland destruction, and increases in impervious area.

Organic matter inputs relate to the loss of riparian forest disturbances and results in reduction of woody debris in streams, which in turn leads to adverse changes in channel/habitat-forming processes. The process occurs throughout a watershed and LWD from headwater areas may be transported from upstream during peak flow events. On streams under SMA jurisdiction that can be affected by recruitment within the adjacent riparian area. These mechanisms are likely to be primarily affected by riparian buffer areas established in the Critical Area regulations that apply both within SMA jurisdiction and in smaller streams. The overall importance of LWD is a watershed-wide process. The smaller streams below 20 cfs may provide as important functions for aquatic species, and therefore the beneficial effects of LWD may be as important outside SMA jurisdiction as within.

The input of organic material that provides food sources to aquatic species occurs throughout the watershed. The magnitude of flows in a stream influence the extent to which the dominant source of organic inputs and food sources comes from within the aquatic environment or from outside. Larger streams with greater flows within SMA jurisdiction may generate more of the food chain from the aquatic environment, but are also dependent on inputs from smaller tributaries for nutrients and may be degraded by alterations of the inputs from those smaller streams.

Heat and light inputs are affected by surface water, groundwater, and riparian shading. The influence of shading is most substantial on small tributaries and tributaries may have the greatest influence on larger streams. If stream temperature levels are already higher because of loss of groundwater infiltration and loss of shading on tributaries, it is unlikely to be substantially decreased if those features are present in larger flow streams under SMP jurisdiction. Overall, heat and light inputs on streams are likely to be influenced most by conditions on streams outside of SMA jurisdiction.

3.4 EFFECTS OF CURRENT LOCAL REGULATORY PROGRAMS

3.4.1 Comprehensive Plan Urban Growth Areas

City of Renton has designated urban growth areas in cooperative planning efforts with local cities and King County. The Growth Management Act encourages growth within urban growth areas and discourages growth outside them. The Urban Growth Boundary (UGB) divides urban areas with land that must remain rural. The policies in City of Renton for establishing urban growth boundaries include:

- The need to assure logical service boundaries;
- The need to avoid isolated pockets or abnormally irregular boundaries; and
- Consideration of land analysis of residential, commercial, and industrial needs within urban areas.

Between City limits and the Urban Growth Boundary lies Potential Annexation Areas (PAAs) or areas assigned to a city agreeing to annex it sometime in the future. Under King County's Countywide planning policies, urban areas such as PAAs must be part of a city by 2012.

Renton has three PAAs: East Renton Plateau and Fairwood/Petrovitsky designated in 1995, as well as West Hill in 2005. If all three PAAs were annexed, Renton's population would grow to 130,000 from its May 2009 estimate of 82,548. In 2008, a portion of the Fairwood/Petrovitsky PAA came into the city as the Benson Hill Communities annexation, adding 16,272 residents and 4.2 square miles. Currently there are 11 annexations being processed by the City.

3.4.2 Zoning

Zoning Regulations in City of Renton Code Chapter 4 primarily address economic goals and compatibility with other human uses through a variety of mechanisms including:

- Specifying zoning categories with a specific range of allowed uses, generally
- Establishing density regulations, generally minimum lot sizes
- Providing for development standards for specific features of development, including:

- Setbacks
- Open space
- Landscaping
- Parking
- Stormwater

Zoning affects the intensity of urban uses and provides the context for many of the changes in functions of streams and shorelines but generally does not address shoreline issues directly (except in provisions relating to the SMP).

3.4.3 Critical Areas

The City of Renton has adopted Critical Areas Regulations that affect lands outside of SMA jurisdiction and address:

- Geologically hazardous areas
- Frequently flooded areas
- Critical aquifer recharge areas
- Wetlands
- Habitat conservation areas, including streams and lakes and areas associated with priority species

Provisions in the regulations generally:

- Provide for the general prohibition of alteration in those critical areas with ecological importance such as wetlands, streams, lakes, marine shorelines, and wildlife habitat areas.
- Restrict the range of allowed uses.
- Provide for buffers to either protect human health and safety (in the case of geological hazards) or protect ecological functions.

3.4.4 Stormwater

Renton has approved use of the 2009 King County Stormwater Permit Design Manual along with City amendments that include flow control and surface water design standards.

To apply surface water design standards and National Pollutant Discharge Elimination System (NPDES) minimum requirements, all new development regardless of size may be subject to stormwater requirements issued by the City. Site regulation under surface water design includes creation or replacement of impervious surfaces, flow control, and water quality. New developments that create more than 5,000 square feet of new impervious surface trigger drainage review including off-site analyses, erosion and runoff control, and conveyance system design. Runoff treatment for pollution generating impervious surfaces greater than 5,000 square feet includes biofiltration designed for the 2-year storm or an oversized wetpond if the project constructs more than one acre of pollution generating impervious surface.

The Peak Rate Flow Standard is the current flow control standard used by the City which detains runoff from a developed site based on single-event hydrologic modeling. NPDES standards require continuous hydrologic modeling to match flow durations between half of the two-year flow up to the 50-year flow (City Council). To comply, the City requires projects generating more that 0.5 cfs apply duration-based standards for detention facilities. Duration based facilities are larger than Peak Date Standards to account for extended periods of rain which help minimize erosion during flood events.

Duration standards seek to avoid potential disruption to the downstream channels by choosing a “threshold discharge,” below which sediment transport in the receiving channel is presumed not to occur and so postdevelopment flow durations can be increased without concern. This choice can be made by site-specific, but rather expensive, analysis based on stream hydraulics and sediment size or can be applied as a “generic” standard based on predevelopment discharges.

An additional issue that remains with a duration standard is the threshold discharge below which there are “no effects” of flow-duration increase.

Problems with structural approaches to stormwater management include:

- *Point discharge* – The consequences of converting a natural condition of dispersed overland flow into numerous headwaters into a point discharge at a surface-water outfall can result in locally severe erosion and disruption of riparian vegetation and instream habitat (Booth 1990).
- *Groundwater* – Flow durations control will not address changes to groundwater recharge or discharge, because no constructed detention ponds, even the largest designed under this standard, can delay wintertime rainfall sufficiently for it to become summertime discharge.
- *Individual storm hydrographs* – There is no attempt (or ability) to construct detention ponds that match durations for specific storm events or even an entire storm season. Thus the aggregate flow-duration spectrum may be unchanged, but the timing and brevity of any single storm hydrograph may be quite different from the undisturbed condition (Booth 1997).

3.5 EFFECTS OF CURRENT FEDERAL AND STATE REGULATORY PROGRAMS

3.5.1 National Pollutant Discharge Elimination System (NPDES)

The Federal Clean Water Act (CWA) requires states to set standards for the protection of water quality. The mandate of the Federal CWA is administered by the State Department of Ecology in conjunction with state water quality laws. The program regulates activities that result in wastewater discharges to surface water from industrial facilities or municipal wastewater treatment plants as well as non-point pollution. NPDES permits for stormwater discharges have two basic components. Stormwater discharge from construction sites are covered by a Statewide General Permit and require compliance for clearing of sites of five or more acres. NPDES permit requirements for municipal stormwater systems are being phased in with the first phase affecting jurisdictions that serve populations of 100,000 or more.

3.5.2 Section 404 Permit

The Federal CWA also regulates excavation and dredging in waters of the U.S., including wetlands. Certain activities in waters of the U. S., including wetlands and streams may require a permit from the U.S. Army Corps of Engineers (Corps). This requirement is administered by the Corps in conjunction with Section 10 of the Rivers and Harbors Act. As part of the program, the Washington State Department of Ecology is required to certify compliance with water quality standards under Section 401 of the CWA.

3.5.3 Endangered Species Act

The Federal Endangered Species Act (ESA) addresses the protection and recovery of federally threatened and endangered listed species. The ESA is jointly administered by the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service. Specific programs developed or under development in cooperation with the Corps include design standards for docks, contained in the Corps Regional Permit No. 3, that apply to Lake Washington and proposed restrictions on shoreline protection included in a Biological Opinion dated December 13, 2007 (NMFS 2007). Other programs with potential impacts on Renton include the NMFS Biological Opinions on flood control facilities issued September 22, 2008, and addressing certain pesticides issued April 20, 2009. These programs will affect issuance of federal permits, most notably Section 404 Permits.

3.5.4 Washington State Department of Ecology

Ecology has regulatory authority over a wide variety of programs that affect water quantity and quality through the on waters of the state. Some of these programs include:

- Water Pollution Control RCW 90.48 RCW.
- Water pollution control facilities financing RCW 70.146
- Underground petroleum storage tanks RCW 70.148
- Hazardous materials RCW 70.136
- Radioactive waste RCW 70.99
- Hazardous waste management RCW 70.105
- Hazardous waste fees RCW 70.105A
- Hazardous waste cleanup, Model toxics control act RCW 70.105D
- Mixed radioactive and hazardous waste. RCW 70.105E
- Detergent phosphorus content. RCW 70.95L
- Water Rights RCW 90.03-44
- SMA of 1971 RCW 90.58
- Dairy nutrient management RCW 90.64
- Underground storage tanks RCW 90.76
- Ch. 90.82 RCW - Watershed planning RCW 90.82

Many of these programs are administered in coordination to provide multiple benefits, including coordination with the SMA.

3.5.5 Hydraulic Project Approval (HPA)

The Washington Department of Fish and Wildlife (WDFW) regulates activities that use, divert, obstruct, or change the natural flow of the beds or banks of waters of the state and may affect fish habitat. Projects in the shoreline jurisdiction requiring construction below the ordinary high water mark of Puget Sound or streams in the city could require an HPA from

WDFW. Projects creating new impervious surface that could substantially increase stormwater runoff to waters of the state may also require approval.

3.6 ENHANCEMENT PROGRAMS

3.6.1 Salmon Recovery

The WRIA 8 and 9 Salmonid Recovery Plans (SRP) outlines actions necessary to recover ESA-listed salmonid populations, with a particular focus on Chinook salmon, and provides a framework for implementing recommended actions agreed to by local, state, federal, and tribal governments in WRIA 1 (SRP 2005). The draft SRP includes a Salmonid Habitat Restoration Strategy (Version 2.4, 2004) that identifies and prioritizes specific projects to protect and restore habitats and the ecosystem processes essential to the recovery of threatened Chinook salmon and bull trout, along with other salmonids native to the Nooksack watershed.

The Cedar River SRP has the following priorities for the near-term (10-year time frame):

- Hydrology
  - Protect surface and groundwater instream flows during migrant Chinook life stages
  - Establish shoreline native riparian vegetation for runoff infiltration and to maintain cool stream temperatures
- Floodplain Connectivity
  - Setback and remove dikes and levees to help create off-channel habitats and lower flow velocities during high flow periods
- Habitat Quantity
  - Create pool habitats via LWD and shoreline conifer underplanting for future LWD recruitment

The SRP identifies the following projects upstream of Renton that are likely to have beneficial impacts on Chinook Habitat:

- Reach E (R5, River Mile [RM] 4.4-5.8)
  - Remove Buck's Curve Levee and revegetate floodplain to slow river flow and encourage channel diversity
- Reach G (R7, RM 7.3-8.2)
  - Setback or Remove both Cooks/Jefferies and Progressive levees to restore Cedar Rapids Floodplain, increase pools via LWD, and reconnect sub channel
- Reach J (R10, RM 10.2-12.7)
  - Revegetate and reconnect Lion's Club side channel (RM 12) which historically provided Chinook spawning and rearing habitat
  - Remove Cedar Grove Road SE (RM 11) in conjunction with flood buyouts and restore floodplain

    - Setback or remove Rainbow Bend Levee (RM 11.2) to reconnect floodplain; construct side channels and place LWD for pool habitat

- Reach K (R11, RM 12.7)
    - Restore LWD at Taylor Creek confluence and a mile upstream the tributary to aid in fish passage
    - Continue LWD placement at the Petersen (RM 14.1) and Rock Creek (RM 18.2) to both aid in fish passage and create a flow refuge for juvenile fish
- Reach R (R18, RM 20.1)
    - Place LWD, restore vegetation on left bank, and open up Wingert Side Channel for more habitat access

The SRP identifies the following projects within Renton that are likely to have beneficial impacts on Chinook Migration:

- Reach A (Mouth to Logan Avenue bridge)
    - Riparian vegetation enhancements within the scope of existing flood control facilities
    - Removal of hardened shorelines requiring substantial changes to flood control facilities; lessens habitat of prickly sculpin, predator to juvenile salmon
    - Reconfiguration of river to provide more natural stream character, possible after redevelopment
- Reach B (Logan Avenue bridge to 405-bridge)
    - Overhanging vegetation/conifers would provide increased refuge habitat and some food resources; ideal locations for planting vegetation would be the existing paved footpath adjacent to the water and the water's edge along Liberty Park
- Reach C (I-405 bridge to the SR 169 bridge)
    - Removal of hardened banks to replace with a native vegetation buffer
    - Maintenance of existing natural vegetation through removing invasive species, enhancement near I-405 where vegetation removal has taken place
    - Short-term opportunity: non-water-oriented uses including retail, office, or multi-family going in place of a former concrete batch plant where riparian vegetation buffers can be established on private land
- Reach D (SR-169 bridge to Ron Regis Park)
    - Maintaining existing off-channel spawning channels and natural vegetation
    - At RM 4.7, restore side channel downstream of landslide, add LWD along banks of Ron Regis Park and conifer under planting acquiring future LWD

A complete list of near term salmon recovery programs is available at: http://www.sharedsalmonstrategy.org/RecoveryPlan.htm

The Green River SRP has the following priorities for the near-term (10-year time frame):

- Protect existing processes and habitats that are working well;
- Restore processes and habitats that can be returned to good conditions;
- Rehabilitate damaged processes and habitats that can be sustained with on-going efforts; and
- Substitute processes and habitats that are lost.

In addition, the SRP identifies projects including tasks such as:

- Levee setbacks on the Green River mainstem;
- Removal of bulkheads or replacement with softer forms of shoreline protection in marine nearshore habitats;
- Planting native vegetation and installation of large woody debris in freshwater habitats;
- Side channel reconnection in freshwater habitats;
- Side channel reconnection in freshwater habitats; and
- Introduction of spawning gravel in the Green River mainstem (WRIA 9).

The SRP provides important scientific and technical information about the restoration priorities in City of Renton. Although, salmon-focused by definition, the SRP recognizes the need to restore the landscape processes that form habitats to which wild salmonid stocks are adapted. The SRP authors clearly acknowledge the relationship between recovery of threatened salmonids and broader ecosystem restoration goals.

A complete list of near term salmon recovery programs is available at:

http://www.sharedsalmonstrategy.org/plan/vol2.htm

3.6.2 King County Floodplain Management

King County adopted the 2006 Flood Hazard Management Plan that identified the need for an integrated countywide flood control program through formation of a flood control zone district to address subregional flood risk and infrastructure needs on tributaries and in local jurisdictions.

In 2007 the King County Council established the King County Food Control Zone District (KCFCZD) which included transfer of the assets of the previously-existing 10 individual flood control zone districts to the new countywide district and established a countywide tax assessment.

The county is currently prioritizing potential projects along the Cedar River. Some examples of projects under consideration include:

- Johnson Levee Setbacks to address channel constriction; facility vulnerability at Cedar River Trail and SR-169. This project will remove portions of both levees that solely protect open space land.
- Rainbow Bend Levee Setback and Floodplain Reconnection addresses channel constriction and facility vulnerability at the Cedar River Trail and SR-169. This project will set back the levee to achieve improved conveyance and floodplain capacity.

- Elliott Bridge Levee Setback and Acquisition (Cedar Elliott Bridge) to address overtopping levee; seepage, repetitive loss properties. The project includes property buyouts and levee setback.
- WPA Levee Setback and Acquisition (Cedar WPA) to address overtopping levee; channel migration hazards; facility vulnerability. The project involves acquiring homes in floodway and floodplain and setback or removal of a revetment, restoration and revegetation of the floodplain.
- Lower Lions Club to Cedar Grove Road (Cedar Lower Lions) to address overtopping levee; repetitive loss properties. The project involves acquisition of flood-prone homes.
- Brassfield Revetment Setback and Acquisition (Cedar Brassfield) to address channel constriction.

3.6.3 Puget Sound Partnership

In response to the challenges facing the Sound, in 2007 the Legislature created the Puget Sound Partnership to reverse Puget Sound's decline and restore it to health by 2020. This agency replaced the Puget Sound Action Team created in 1996, to protect and restore Puget Sound and its spectacular diversity of life now and for future generations. The Partnership has developed the following priorities in its Action Plan:

Priority A: Protect the intact ecosystem processes, structures, and functions that sustain Puget Sound. Avoiding problems before they occur is the best and most cost-effective approach to ecosystem health.

Priority B: Restore the ecosystem processes, structures, and functions that sustain Puget Sound. Protecting what we have left is not sufficient, and significant effort at an unprecedented scale is needed to undo past damage.

Priority C: Prevent water pollution at its source. Many of our efforts have focused on cleaning up degraded waters and sediments, but insufficient resources have been devoted to stopping pollutants before they reach our rivers, beaches, and species.

Priority D: Work together as a coordinated system to ensure that activities and funding are focused on the most urgent and important problems facing the region. Many of the programs and laws now used to regulate or support activities in Puget Sound were established on a piecemeal basis to address individual problems. Strategies that will help to address problems more effectively at an ecosystem scale include improved coordination of land use planning, water supply, ecosystem protection, transportation, and species recovery plans. The Action Agenda calls for the reform of environmental regulatory programs as well as improvements to the capacity of local partners to implement actions and compliance efforts across Puget Sound.

Priority E: Build an implementation, monitoring, and accountability management system.

3.6.4 Washington Department of Natural Resources

The Washington State Department of Natural Resources (DNR) manages state lands including forests, farms, commercial properties, and underwater lands under state ownership. Much of this land is dedicated to supporting trusts for specific public institutions like schools and universities.

DNR's aquatic lands are managed to provide access to the waters of the state - rivers, lakes, streams and Puget Sound. DNR also works to serve the continuation of navigation and commerce. Aquatic lands in Lake Washington include all lands beyond the inner harbor line. DNR issues leases for uses within harbor lands, including permits for docks and other over-water structures that extend beyond the Inner Harbor Line.

Two examples of management programs on uplands within harbor areas include:

- A beach and vegetation restoration program in Reach C on public harbor lands at the former Barbee Mill site which have been withdrawn from leasing by the DNR in recognition of the environmental values of the area;
- Public harbor lands in the easterly third of the Boeing site in Reach I which are currently proposed to be restored by the DNR, including removing the existing outfall flume from the former Sheffelton Plant to restore shoreline nearshore conditions.

3.6.5 WDFW

The Washington Department of Fish and Wildlife (WDFW) is a state leader in providing technical support staff as well as funding to salmon recovery efforts. A complete list of WDFW's activities is available at their website at http://www.wdfw.wa.gov.

4. CUMULATIVE EFFECTS ANALYSIS

4.1 QUALITATIVE ANALYSIS OF PROGRAM EFFECTS

The major conclusions of this cumulative analysis of the effects of the October 2009 proposed Shoreline Master Program (SMP) are:

- A large component of cumulative impacts on ecological processes results from watershed-wide processes that have changed natural functions within the Cedar River/Lake Washington and Green River/Duwamish Watersheds.
  - Hydrology in the Cedar River/Lake Washington system is largely affected by land use upstream from Renton. The volume is affected by forest cover and hydrologic cycles. The amount of water diverted by the City of Seattle for regional water supply also affects hydrology. Impacts of runoff in Renton is a minor component of the total hydrological inputs of water to the system. The amount of land within Shoreline Management Act (SMA) jurisdiction is very small compared to the total. The major influences on hydrology are maintenance of forest cover, which largely depends on commercial forest land and the extent to which forest cover is changed in rural lands.
  - Infiltration/Recharge is important on both a watershed level and within localized areas. Overall the amount of infiltration into aquifers is a function of maintaining the natural hydrology of forest land cover. The amount of land within SMA jurisdiction is very small compared to the total area of the watershed. The localized movement of water within the shallow aquifer may affect water temperature in nearstream environments. The major influence is the type of and use and associated impervious surface and the related issue of whether runoff is conveyed to surface water, or whether a component is infiltrated to groundwater.
  - Surface Runoff/Storage/Peak Flows mechanisms are closely linked to the infiltration/recharge mechanism described above since runoff is inversely correlated to infiltration/recharge. Runoff is affected by development that increases drainage density, synchronizing runoff during peak events and consequently increases the magnitude and frequency of peak flows. The loss of surface water storage potential through the destruction of storage areas such as floodplains, wetlands, and the hyporheic zone or indirectly by reducing connectivity between the storage areas and streams. Components of reduced connectivity include diked/leveed channels; stream channelization and incision; increased sediment supply; and wetland ditching. This is largely a watershed-wide function. In Renton, which is near the bottom of the watershed, there is little opportunity to affect this mechanism.
  - Groundwater Flow is affected primarily by infiltration and recharge. However, alterations to flow paths and groundwater extraction/consumption also influence the availability of groundwater for maintaining ecological functions during the summer low flow period. On a localized basis, shoreline structures such as bulkheads can limit interflow into streams and lakes and affect temperature and oxygenation important to localized processes such as the food chain and fish spawning. has an influence on that major influences on hydrology are

maintenance of forest cover, which largely depends on commercial forest land and the extent to which forest cover is changed in rural lands.

- It is not known at this time whether general trends in ecological degradation are continuing or whether the cumulative effect of all the programs outlined above is influencing a change. It will probably take several decades to determine whether trends continue to be negative or stabilize or improve. Based on trends of continuing declines in key aquatic species, such as Chinook salmon, Steelhead, and Sockeye over several decades, the most justifiable conclusion is that existing land use and practices within the watersheds are continuing to degrade habitat and trends will increase unless substantial changes in practices are implemented over extensive portions of both watersheds and stream and lake shorelines. The influence of the proposed SMP on shoreline vegetation, armoring, and in-water structure will influence this trend to the extent that it results in a change over time in a substantial proportion of the shoreline. It is likely that educational and voluntary efforts, particularly provision of native vegetation on shorelines will have a greater impact in the short term than changes affected by regulations. It is also probable that short term improvements can occur most readily by public action on publicly owned shorelines (and dedicated open space) within the city and annexation area, which is about 25 percent of the Lake Washington shoreline, about half of the Cedar River shoreline frontage, and about 40 percent of the Springbrook Creek shoreline.
- Although the component of change in Renton may be a small part of the watershed, if similar efforts are made in other jurisdictions, the overall impact will be perceptible change and is likely to be important to slowing or reversing those trends. Such efforts, include:
  - Restoring watershed channel geomorphic conditions through a variety of measures including:
    - Removal or further setback of flood control levies which is likely to be accomplished primarily by the King County Flood Control Zone District (KCFCZD)
    - Control of urban storm runoff which is likely to be a very slow incremental change through regulation sin areas already developed since new requirements will be implemented only with substantial changes in impervious surfaces, which often does not occur in fully developed areas.
  - Improving water quality through urban stormwater management which is likely to occur faster than flow control, since standards are generally implemented at a lower threshold of change of use under water quality laws.
  - Restoring the water quality functions of wetlands by restoring connections between streams and wetlands by removing barriers, such as flood control structures which will occur largely through public efforts.
  - Restoring water quality functions of wetlands by restoring wetlands displaced by other uses, which will occur largely through public efforts.
  - Reducing stream temperatures by restoring riparian vegetation. This will likely be accomplished in series of small incremental change when implemented through regulations in areas already developed, because new requirements will be implemented only with substantial changes in uses. It may occur more rapidly on publicly owned shorelines, but still is likely to take several decades.

  - Restoring water quality functions by providing buffer areas in which sediment, nutrients, pathogens, and other pollutants can be removed or entrained, which also is likely to be a slow incremental change.
  - Improving water quality through urban stormwater management which is likely to occur faster than flow control, since standards are generally implemented at a lower threshold of change of use under water quality laws.
- Changes in existing patterns which contribute to degradation of the shoreline environment on Lake Washington are likely to occur very slowly from regulatory provisions in the SMP on private shoreline frontage because implementation of new requirements will be required only with substantial changes in existing development. This is especially critical because about three quarters of the Lake Washington shoreline in Renton is private and the majority is single family lots.
  - Shoreline bulkheads have negative impacts on substrate through producing high energy environments because of reflective wave action and also contribute to the absence of shoreline vegetation. Replacement of bulkheads is required only with substantial increases in intensity of use. Voluntary replacement of bulkheads is likely to be rare because of cost.
  - The lack of native vegetation on the shoreline contributes to the absence of a nature near-shore food chain and also results in higher nearshore temperatures due to the lack of shade as well as water quality degradation from fertilizers, herbicides, and pesticides which affects not only the nearshore food chain but also have identified impacts on the central nervous system functions of fish, including salmonids. Installation of native vegetation is required at a lower level of change of use, but still is likely to result in relatively little change in the short term. Enforcement of conditions also is likely to be difficult and may lead to reversion in some cases to lawn and ornamental vegetation. Opportunities for voluntary installation of native vegetation is likely to be more common because the cost is relatively low, but likely will take extensive public education and technical assistance.
  - Current moorage facilities contribute to predation and also may cause avoidance behavior in salmonids forcing them out of nearshore environments and into environments where food and shelter are less available and where predation is increased. Replacement of docks is required only with substantial increases in intensity of use and is likely to be rare in the short term. The lifespan of docks is generally limited to a couple decades and will result in replacement over a longer period. Voluntary replacement of docks is likely to be rare because of cost.
- The nearshore areas of Lake Washington to very young salmonids in early lifecycle stages are particularly important in Renton since this function occurs most intensely near the mouths of salmon-bearing streams. The nearshore areas are largely degraded and therefore provide limited functions for food sources, temperature and protection from chemicals, largely because of the alteration of the shoreline through armoring and the lack of native vegetation. As outlined above, change on private shoreline frontage is likely to be very slow from implementation of new regulations since new requirements will be implemented only with substantial changes in existing development. This is especially critical because about three quarters of the Lake Washington shoreline in Renton is private and the majority is single family lots.

4.2 MATRIX SUMMARY OF CUMULATIVE EFFECTS

The matrix below assesses the beneficial impacts of the proposed Shoreline Management Plan and other programs.

5. REFERENCES

See the Renton Shoreline Master Program Inventory/Characterization for all references.

http://rentonwa.gov/business/default.aspx?id=15508

http://rentonwa.gov/uploadedFiles/Business/EDNSP/planning/Renton%20SMP%20IC%20REVISED%2010-09-09b.pdf?n=1154

Table 4-1. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Hydrology	Surface runoff and peak flow	Watershed Conditions Overall watershed size, influence of non-local precipitation and weather events	The watershed size affects the structure and pattern of streamflows in a variety of ways. Smaller stream systems tend to react to precipitation patterns on a local level. Single storm events generally affect the entire small stream system at once. Larger systems with a greater geographical coverage tend to have tributaries that are affected differentially by precipitation patterns.	Not influenced.	Not influenced.	Not influenced.
Hydrology	Surface runoff and peak flow	Watershed Conditions Headwaters	Stream headwaters tend to consist of many channels, many with low and intermittent individual flows. These tributaries cumulatively provide a substantial component of surface flows for lowland Puget Sound streams (Booth 2002).	Small tributaries, intermittent streams usually eliminated by development – replaced by enclosed systems (recent development incorporates detention/ treatment, unless exempt).	<u>Watershed Level:</u> Cedar River and Green River watersheds largely under Federal Forest Service jurisdiction and timber management and similar programs. <u>Reach Level:</u> Small stream headwaters remaining within Renton are protected by vegetated buffers in CAO to the extent that they were not previously displaced or headwaters placed in piped stormwater systems. This is a relatively small contribution.	<u>Watershed Level:</u> Cedar River and Green River watersheds largely under Federal Forest Service jurisdiction and timber management and similar programs. <u>Reach Level:</u> As with existing regulations, small stream headwaters remaining within Renton are protected by vegetated buffers in CAO to the extent that they were not previously displaced or headwaters placed in piped stormwater systems. Regulations in the SMP will make no contribution since the SMP does not affect small streams.
Hydrology	Surface runoff and peak flow	Watershed Conditions Native Vegetation	Native vegetation influences the patterns by which precipitation reaches surface water. Vegetation cover affects the rate of runoff, infiltration, and the resistance of soils to erosion from a variety of sources. Each of these factors has an impact on stream morphology and stability. Native vegetation is adapted to regional weather, geologic, and soil conditions, as well as use as habitat by a variety of species and therefore will function as a complete system.	Alteration of native vegetation accompanies development but is not necessarily directly correlated with land use or density. Agriculture can clear native vegetation completely. Large lot development can negatively impact native vegetation and allow nonnative vegetation to colonize an area. Higher-density development generally is accompanied by greater clearing and impervious surfaces, but may incorporate areas of open space and be integrated with a basinwide system of preserving riparian corridors.	<u>Watershed Level:</u> Cedar River and Green River watersheds have largely been altered in the past 150 years. Remaining vegetation adjacent to streams is protected by King County and other upstream jurisdiction CAO regulations that require maintaining existing buffering vegetation based on stream classification. The loss of native vegetation from the area outside buffers generally will result in a substantial change in runoff character. <u>Reach Level:</u> Small stream headwaters remaining within Renton are protected by vegetated buffers in CAO to the extent that they were not previously displaced or headwaters placed in piped stormwater systems.	<u>Watershed Level:</u> The Renton SMP and those of other jurisdictions will have little influence given the degree of alteration of the Cedar River and Green River watersheds and the small proportion under SMP jurisdiction. Enhanced CAOs that require maintaining existing buffering will result in less of a change for new development, however the loss of native vegetation from the area outside buffers generally will result in a substantial change in runoff character. <u>Reach Level:</u> Small stream headwaters remaining within Renton are protected by vegetated buffers in CAO to the extent that they were not previously displaced or headwaters placed in piped stormwater systems. Regulations in the SMP will make a limited contribution since the SMP does not affect most of the watershed.
Hydrology	Infiltration/ Recharge	Watershed Conditions Changes in Peak Flows	Natural watersheds tend to be primarily pervious surfaces with native vegetation also influencing the rate of runoff and infiltration. Increasing amounts of impervious surfaces resulting from human development tends to shift a watershed to a greater proportion of overland runoff with resulting effects on streamflow, morphology, and stability. Storm events and seasonal water flow affect the amount of water conveyed by a given stream. The change in peak flow would alter the morphology of the stream, generally resulting in a wider, shallower stream channel with differences in pool/riffle length and depth and water velocity on a seasonal basis.	Development leads to increased impervious surfaces, which alters the flow regime, disrupting natural stream morphology. Channelization and damming compound alterations in stream morphology.	<u>Watershed Level:</u> Cedar River and Green River urban development is present largely in lower watersheds. Outside of stream buffers, impervious surface varies by development intensity. King County and other upstream jurisdictions do not regulate impervious surface for water cycle functions. In urban areas impervious surface is generally addressed by stormwater management standards for detention and treatment to meet water quality standards. Most existing development is not subject to stormwater management standards. <u>Reach Level:</u> Most of the city is developed and impervious surface is established. In most cases, stormwater management facilities are not in place for existing development. Lower reaches of Cedar River are subject to water quality treatment but not detention standards.	The SMP regulations will contribute to this very slightly. Future stormwater management programs will reduce the extent to which new development impacts runoff and peak flows. The effects on the extensive areas of existing impervious surface will be slight in the short term. They may make a positive contribution to a slight degree over the longer term as more redevelopment occurs, however the threshold for implementing flow control is a relatively large change in impervious area which will not occur on most sites.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Hydrology	Groundwater flow	Watershed Conditions Runoff/Interflow/Change in Base Flows	Surface water runoff includes water that travels over the land surface and through channels to reach a stream. However, streamflow also consists of interflow, which is shallow subsurface flow from precipitation that infiltrates into the soil surface and travels by means of gravity toward a stream channel. Interflow is often a substantial component of base flows in low-precipitation periods	Development leads to increased impervious surfaces, which increases surface runoff and decreases infiltration and interflow. Decreased interflow may reduce the natural base flow of smaller stream systems.	Watershed Level: Cedar River and Green River urban development is present largely in lower watersheds. In large rivers, interflow is not likely to be a significant factor for flows but may contribute to lower temperatures except locally. Reach Level: Most of the city is developed and the transition from infiltration to surface flow is established. May Creek and other smaller streams are likely more dependent on interflow for low summer flows and especially maintaining temperature suitable for aquatic habitat. Existing development likely has reduced interflow. On Lake Washington, local shoreline protection may affect the localized movement of groundwater to beach sediments and affect sockeye beach spawning success.	Watershed Level: The SMP regulations will contribute to this very slightly because of the small area influenced Future stormwater management programs will reduce the extent to which new development impacts runoff and peak flows by encouraging infiltration. The effects on the extensive areas of existing impervious surface will be slight in the short term. They may make a positive contribution to a slight degree over the longer term as more redevelopment occurs, however the threshold for implementing flow control is a relatively large change in impervious area which will not occur on most sites. Reach Level: Most of the city is developed and the transition from infiltration to surface flow is established. The SMP buffers on May Creek may be beneficial, however most of the area within Renton is public and not subject to development. CAO regulations may have a positive influence on undeveloped smaller streams that are likely more dependent on interflow for low summer flows and especially maintaining temperature suitable for aquatic habitat. On Lake Washington, new regulations for shoreline protection requiring soft solutions may improve the localized movement of groundwater to beach sediments and affect sockeye beach spawning success, however positive change through retrofitting is likely to occur on a very slow basis as properties redevelop. Observable change likely will take several decades.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Water Quality	Nutrient sources Chemical pollutants	Watershed Conditions Pollutant-Generating Pervious Surfaces	On-site septic systems, agriculture (waste and fertilizer), residential areas (fertilizer), and riparian disturbance are nutrient and chemical pollutant sources impacting water quality.	Pervious surfaces such as lawns and pastures can be an unnatural source of nutrients and other pollutants that can degrade water quality in streams and wetlands. Nutrients result from a variety of sources, including fertilizers, used in agriculture or landscaping; and discharge from on-site sewage treatment or leakage from sewer piles. Chemical contaminants result from a variety of sources, including fertilizers, herbicides, and pesticides used in agriculture or landscaping; contaminants washed off roadways; accidental spills; and discharge from on-site sewage treatment of leakage from sewer piles.	<u>Watershed Level:</u> The Cedar River and Green Rivers are positively influenced by upstream forest cover although there are extensive areas of pollutant generating agriculture, ornamental vegetation and impervious surfaces associated with a variety of applications of chemicals. <u>Reach Level:</u> Most of the city is developed with extensive areas of Most of the city is developed and the transition from infiltration to surface flow is established and pollutant loads are established. lawn associated with application of fertilizers, herbicides and pesticides that flow into the stormwater system and into surface water. Lake Washington water quality is largely determined by watershed level inputs. Adjacent lawn and ornamental vegetation discharge chemicals to the nearshore and adversely affects on the aquatic environment, especially salmonids in nearshore areas. May Creek has substantial upstream rural pasture areas with potential contributions of nutrients and contaminants. Springbrook Creek has almost no upstream forest cover and is primarily influenced by extensive areas of pollutant generating impervious surfaces.	<u>Watershed Level:</u> The Renton SMP, and those of other jurisdictions are likely to affect watershed conditions only slightly because they don't affect the vast majority of the area and existing land alteration. Future stormwater management programs will reduce chemical contaminants from pervious areas on an incremental basis as redevelopment occurs, since the threshold for implementing water quality controls is lower. <u>Reach Level:</u> Most of the city is developed and the amount of lawn and associated with application of fertilizers, herbicides and pesticides. Lake Washington water quality will continue to be largely determined by watershed level inputs. The SMP will only slightly and incrementally change adjacent lawn and ornamental vegetation to native buffers and the resulting reduction in chemical discharge to the nearshore will occur only incrementally. The SMP will improve buffers on the Cedar River, and Springbrook Creek within the city incrementally as land redevelops and reduce chemical discharge very little in the short term and slightly in the long term. On May Creek the SMP will preserve buffers. Substantial upstream rural pasture areas contributions of nutrients and contaminants may be reduced by King Co. CAO buffers or farm management plans
Water Quality	Pollutant load	Watershed Conditions Runoff - Impervious Surfaces Roadways, Driveways, Parking	Impervious surfaces related to roadways, driveways and parking areas tend to produce pollution loading of chemicals, heavy metals, and particulates from sources related to vehicular use.	Roadways and driveways generally increase with single family density. Multifamily driveways and parking area is determined more by development type, especially provision of garages rather than surface parking	<u>Watershed Level:</u> Cedar River and Green River urban development is present largely in lower watersheds. In large rivers, localized pollutants are diluted to an extent by the higher quality flows from upstream watersheds, however the pollutant load from impervious surfaces is substantial <u>Reach Level:</u> Most of the city is developed and the transition from infiltration to surface flow is established and pollutant loads are established. Lake Washington water quality is largely determined by watershed level pollutant load, except for localized near shore area. The Cedar and Green Rivers are relatively less affected by pollutant loads due to high upstream volumes. May Creek has a substantial but relatively smaller upstream watershed. Springbrook Creek and other smaller streams are likely highly affected by pollutant loads from impervious surfaces.	<u>Watershed Level:</u> Cedar River and Green River urban development is present largely in lower watersheds. In large rivers, localized pollutants are diluted to an extent by the higher quality flows from upstream watersheds. Future stormwater management programs will reduce chemical contaminants from pervious areas on an incremental basis as redevelopment occurs, since the threshold for implementing water quality controls is lower. <u>Reach Level:</u> Most of the city is developed and the transition from infiltration to surface flow is established and pollutant loads are established. Lake Washington water quality will continue to be largely determined by watershed level inputs. The SMP will only slightly and incrementally change impervious surface as land redevelops and some impervious areas are replaced by native vegetation buffers. The reduction in chemical discharge to the nearshore will occur only incrementally. The SMP will result in relatively small improvements to the Cedar and Green Rivers pollutant discharge from impervious surfaces are compared to upstream volumes. The SMP is not likely to substantially change impervious surfaces in May and Springbrook Creeks.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Water Quality	Pollutant load	Watershed Conditions Runoff - Impervious Surfaces Roofs	Runoff from roof area is categorized separately because the pollutant load from roofs is generally less than impervious surfaces used by automobiles.	Roof area is generally a function of density, although moderate densities with large structures can have similar roof areas as higher density shared -wall townhomes.	Watershed Level: Cedar River and Green River development is largely rural in upper reaches where roof area is not a significant component. Urban development is largely present largely in lower watersheds. Where urban development is most intense roofs may be a large component and contributes to change in interflow but generally do not contribute to pollutant load. Reach Level: Impacts of roofs as a substantial component of impervious surface is present largely in the downtown areas where discharge is largely to the Cedar River or Lake Washington. Springbrook Creek reaches are moderately affected by roof area as compared to roadways, driveways, and parking.	The SMP will have little influence on roof runoff as a component of flows because of the small area under SMP jurisdiction.
Water Quality	Temperature	Water Quality Temperature	Stream temperatures vary seasonally and daily within watersheds and are influenced by climate, elevation, extent of riparian vegetation, and groundwater inputs. Lower stream temperatures are generally associated with better water quality (higher dissolved oxygen) and promote greater biological diversity (Allen 1995).	Runoff from impervious surfaces and/or discharge of warmer water from detention ponds can increase water temperatures, thus lowering dissolved oxygen and reducing biological diversity. The removal of riparian vegetation via clearing and development activities can increase stream temperatures.	Watershed Level: In large systems temperature is influenced by a wide range of factors. Surface water from headwater forests provide low temperature inputs. Reach Level: Most of the city is developed and the influence of runoff on temperature is well established over most of the city. Lake Washington temperature is influenced both by watershed level inputs and surrounding urbanization. Solar radiation in the absence of shading can have adverse effects on the most susceptible shallow nearshore areas. The Cedar and Green Rivers are relatively less affected by localized higher temperature inputs due to higher upstream volumes. May Creek has a substantial but relatively smaller upstream watershed and is relatively susceptible to inputs from high temperature stormwater runoff, however most of the reaches in the city are densely vegetated. Springbrook Creek is largely urbanized and substantially affected by higher temperature stormwater.	Watershed Level: The Renton SMP and CAO and those of other jurisdictions will have some influence over the long term from requiring buffers in new development. The change in existing developed areas will occur only incrementally as redevelopment occurs. Future stormwater management programs may reduce temperature to the extent that infiltration is encouraged. Reach Level: Most of the city is developed and the influence of runoff on temperature will not be affected much by the SMP or CAO On Lake Washington temperature in the nearshore from solar radiation may be affected incrementally by buffer requirements, however the change is likely occur incrementally as properties redevelop. Observable change likely will take several decades. Voluntary actions and actions on public land is likely to take place sooner and more extensively. The Cedar and Green Rivers will continue to be relatively less affected by localized higher temperature inputs due to higher upstream volumes, however SMP buffers will improve local nearshore conditions. May Creek has a substantial but relatively smaller upstream watershed and is relatively susceptible to inputs from high temperature stormwater runoff. Springbrook Creek vegetation coverage will be affected by the SMP only at the point that a vegetation management plan likely accompanied by widening the channel is required by the SMP in the future. It is likely that the availability of funding for the Drainage District will be an important factor.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Sediment	Storage	Water Quality Sediment/Turbidity	Suspended sediment consists of small particles that may be rapidly transported downstream and deposited on floodplains, overbank storage, or between gravel on the creek bed (Salo-Cundy 1987). Increased turbidity can increase the temperature of the water because particles suspended in the water absorb the sun's heat more than pure water. Increases in fine sediment can also clog spawning gravel and reduce habitat. Turbidity is the measurement of the suspended particles in the water.	Loss of riparian areas through development, runoff from impervious surfaces, construction activities, logging practices, and streambank erosion can increase sedimentation to streams, increasing turbidity.	Watershed Level: In the overall watershed, widespread changes from native forest cover have lead to substantial increases in erosion and sedimentation and therefore turbidity. Reach Level: Most of the city is developed and the influence of runoff on sedimentation relates to volumes, soils, and susceptibility of watercourses to erosion. Lake Washington turbidity is largely determined by watershed level inputs. Surrounding urban development likely contributes substantially as do river and stream inputs The Cedar and Green Rivers are affected by widespread land use changes. May Creek is subject to substantial sedimentation from erosion on urbanized tributaries. Springbrook Creek is low gradient and experiences little channel erosion but is substantially affected by stormwater inputs.	Watershed Level: The SMP of Renton and other jurisdictions will have relatively little influence on the overall watershed, changes from native forest cover that have lead to substantial increases in erosion and sedimentation and therefore turbidity. Reach Level: The SMP will have little influence on sedimentation because it will not affect most of the city where soils, and susceptibility of watercourses to erosion affects the
Sediment	Storage	Channel Conditions and Dynamics Width/Depth Ratio	Stream width and depth is a function of flow magnitude, size and type of transported sediment, and the bed and bank materials. Channel width tends to increase downstream. The width/depth ratio varies with channel slope, bank erodability, degree of entrenchment, and velocity (Rosgen 1996).	Width and depth ratios can be changed through channelization, loss of riparian vegetation, flood control structures and other alteration and may result in increases in flood frequency and magnitude.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in stream channel alteration. Stormwater management standards for new development affect less altered steams in less developed areas but have limited effect on previously developed areas. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control. May Creek is largely unaltered in channel character, except where street crossings have established set points limiting channel migration. Springbrook Creek has been substantially altered little channel erosion but is substantially affected by stormwater inputs.	Watershed Level: The SMP of Renton and other jurisdictions will have little influence on watershed level changes in stream structure have resulted in stream channel alteration. Stormwater management standards for new development will influence less altered steams in less developed areas but will have limited effect on previously developed areas because thresholds for installing flow control are relatively high. Reach Level: The SMP will not influence most of the city where widespread alteration of stream channels at every stream size. The SMP will have some affect on the Cedar River through buffer requirements. The KCFCZD programs to set back flood control levees will have some affect on the Cedar and Green Rivers. The SMP is likely to avoid changes in the May Creek channel character. The SMP is likely to provide some motivation to improving the Springbrook Creek channel, but will probably not have as much influence as public restoration resources that may become available to the Drainage District.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Sediment	Soil Erosion	Channel Conditions and Dynamics Streambank Condition	Streambank condition is affected by a number of related parameters such as the amount and type of riparian vegetation, adjacent land use activities, floodplain connectivity, and man-made structures.	Degradation of streambanks through development (e.g., riprap), channelization, or reduced riparian vegetation can lead to erosion, which has secondary effects such as increased turbidity and sedimentation.	<u>Watershed Level:</u> In the overall watershed, widespread changes in vegetation cover has resulted in pervasive changes in erosion and sedimentation throughout the system. Stormwater management standards for new development affect less altered steams in less developed areas but have limited effect on previously developed areas. <u>Reach Level:</u> Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The Cedar Rivers has been replaced by a constructed channel in the central part of the city with substantial riparian vegetation east of I-405 and some riparian vegetation downstream of Logan Ave. May Creek has among the least altered stream channel and riparian vegetation. Springbrook Creek has been substantially altered little channel erosion but is substantially affected by stormwater inputs. Lake Washington shorelines have substantially altered riparian vegetation in most areas.	<u>Watershed Level:</u> The SMP in Renton and other jurisdictions will have relatively little influence because most streams are not covered by SMP jurisdiction. New stormwater management standards for new development will result in less effect on existing less altered steams in less developed areas but will have limited effect on previously developed areas because the threshold for flow control is relatively high. <u>Reach Level:</u> Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The SMP will not affect erosion in the Cedar Rivers constructed channel in the central part of the city. Future soft shoreline protection on redeveloped sites east of I-405 combined with enhanced riparian vegetation will likely maintain existing stability. The SMP will contribute to maintaining May Creek has among the least altered stream channels and riparian vegetation. Springbrook Creek will continue to be little affected by channel erosion under the revised SMP. The SMP will incrementally require Lake Washington shorelines that have been armored to use softer solutions and will incrementally result in more native vegetation, over the long-term of several decades.
Sediment	Storage	Channel Conditions and Dynamics Floodplain Connectivity	Floodplain connectivity is important to dissipate energy during flooding events to reduce erosion and degradation of the stream channel. In addition, floodplain connectivity generally maintains a high groundwater table that provides a hydrologic link between the stream and wetlands and maintains wetland functions and native riparian vegetation and succession.	Development (fill and/or levees) in floodplains reduces the ability of the floodplain to attenuate floods and dissipate energy. This generally results in erosion and channel incision, which lowers the groundwater table and disconnects wetlands and riparian vegetation from the stream.	<u>Watershed Level:</u> In the overall watershed, widespread flood control structures and development in the floodplain have narrowed the floodplain and altered natural floodplain functions. <u>Reach Level:</u> Most of the city is developed with widespread alteration of floodplains The Cedar Rivers has been replaced by a constructed channel in the central part of the city. A relatively natural floodplain is present upstream of SR 169. May Creek has among the least altered floodplains Springbrook Creek has been substantially altered for flood conveyance. Lake Washington shorelines are managed for a high water cycle opposite natural conditions with no floodplain	The SMP of Renton and other jurisdictions will contribute over the long term to maintaining floodplain connectivity. Actions by the KCFCZD will have more extensive input through setting back existing levees.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Aquatic Habitat		Channel Conditions and Dynamics Aquatic Habitat Elements - Substrate	The stream bottom substratum is critical habitat for salmonid egg incubation and embryo development, as well as being habitat for benthic macroinvertebrates. Streambed quality can be degraded by deposition of fine sediment, by streambed instability due to high flows, or both. Although the redistribution of streambed particles is a natural process in gravel-bed streams, excessive scour and degradation often result from excessive flows.	Stream channel morphology can be affected by shifts in the hydrologic regime due to increases in impervious surfaces, which changes the amount and patterns of runoff and streamflows. Higher flows generally lead to changes in channel character, higher stream erosion rates, increases in sedimentation, and disconnections from the floodplain with resulting loss of flood storage. In general, these changes compound each other in an urban environment. Increased scour and erosion are particularly relevant to substrate.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in stream substrate alteration. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size with resulting changes in substrate. The Cedar and Green Rivers have been substantially altered by channelization. Cedar River substrate is fairly intact upstream of I-405. May Creek is largely unaltered in channel character and substrate, except for sediment from upstream erosion. Springbrook Creek has been substantially altered with pervasive structural changes including substrate.	Watershed Level: The SMP in Renton and other jurisdictions will have some influence on stream channel morphology by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally. New stormwater management standards for new development will result in less effect on existing less altered steams in less developed areas but will have limited effect on previously developed areas because the threshold for flow control is relatively high. Actions by the KCFCZD will have more extensive input through setting back existing levees. Reach Level: Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The SMP will not affect erosion in the Cedar Rivers constructed channel in the central part of the city. Future buffers and soft shoreline protection on redeveloped sites east of I-405 combined with enhanced riparian vegetation will likely restore streambed quality somewhat. The SMP will contribute to maintaining May Creek has among the least altered stream channels. Springbrook Creek will continue to be little affected by under the revised SMP because of its low gradient. The SMP will incrementally require Lake Washington shorelines that have been armored to use softer solutions and will incrementally improve substrate.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Aquatic Habitat		Channel Conditions and Dynamics Aquatic Habitat Elements – Pool Frequency	Pools are areas of deeper, low-velocity water between riffles (fast moving, shallow water). Pools provide resting habitat for fish as they migrate upstream, as well as rearing habitat and shelter for fry.	Human development with resulting changes in the hydrologic regime can cause channelization of streams, causing a loss of pool habitat.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in loss of pool habitat. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size with resulting changes in structure. The Cedar and Green Rivers have been substantially altered by channelization with little complexity, including pools. Cedar River structure is less altered upstream of SR 169. May Creek is less altered in channel character and has more natural features such as pools. Springbrook Creek has been substantially altered with pervasive structural changes including loss of most pools.	Watershed Level: The SMP in Renton and other jurisdictions will have some influence on stream channel morphology and therefore pool habitat by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally. Actions by the KCFCZD will have more extensive input through setting back existing levees. Reach Level: The SMP will contribute to pool habitat on the Cedar River Actions by encouraging actions such as setting back existing levees. The SMP will contribute to maintaining May Creek has among the least altered stream channels. The SMP will provide support for naturalizing the Springbrook Creek channel, however opportunities for Watershed Level: The SMP in Renton and other jurisdictions will have some influence on stream channel morphology and therefore off-channel habitat by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally. Actions by the KCFCZD will have more extensive input through setting back existing levees. Reach Level: Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The SMP will contribute to off-channel habitat on the Cedar River Actions by encouraging actions such as setting back existing levees. The SMP will contribute to maintaining May Creek has among the least altered stream channels and maintain pool habitat. The SMP will provide support for naturalizing the Springbrook Creek channel, however opportunities for pool habitat may be limited.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Aquatic Habitat	LWD recruitment (source)	Channel Conditions and Dynamics Aquatic Habitat Elements – Pool Quality	LWD performs several critical functions in forested lowland streams, including dissipation of flow energy, protection of streambanks, stabilization of streambeds, storage of sediment, and providing in-stream cover and habitat diversity (Bisson et al. 1987; Masser et al. 1988; Gregory et al. 1991). Salmon rear primarily in pools with high habitat complexity, with abundant cover, and where large woody debris (LWD) is the main structural component (Bisson et al. 1988). Some species of salmon rely heavily on small lowland streams and associated off-channel wetland areas during their rearing phase (Bisson et al. 1988). Cutthroat and salmon are sympatric in many small streams in the Pacific Northwest, and as such, are potential competitors (adult cutthroat also prey on juvenile coho). In general, habitat, rather than food, is the limiting resource for most salmonids in the Pacific Northwest region (Groot and Margolis 1991).	Clearing for pasture, crops, or lawn removes woody vegetation recruitment. Immature forest lacks the potential for mature trees to fall and provide woody vegetation recruitment. Channel clearing and channelization removes LWD. Human development with resulting changes in the hydrologic regime can lead to stream channelization, dredging, and degradation of the riparian zone, resulting in loss of pool frequency and quality. Reduction of riparian cover can lead to a loss of LWD recruitment, resulting in a degradation of pool habitat.	Watershed: The area and maturity of trees adjacent to the water is greatly reduced. The effects of human alteration on this function occur throughout the watershed. The influence of the area under shoreline jurisdiction if minor compared to the scale of the watershed processes. Reach Level: Most of the city is developed with little potential for growth or recruitment of LWD. The Cedar and Green Rivers have been substantially altered and have limited riparian vegetation and potential for LWD. Cedar River vegetation is less altered on the right bank upstream of I-405 and upstream of SR 169. May Creek is less altered in channel character and has more potential for LWD, except in areas devoted to pasture. Springbrook Creek has been substantially altered and managed to produce little LWD potential. Lake Washington has little mature vegetation providing LWD potential.	It will be many decades before SMP buffer requirements have an influence on LWD because of the time required to grow trees to maturity.
Aquatic Habitat		Channel Conditions and Dynamics Aquatic Habitat Elements – Off-Channel Habitat	Salmon rely heavily on small lowland streams and associated off-channel wetland areas during their rearing phase (Bisson et al. 1988). Off-channel habitats (such as sloughs, beaver ponds, wetlands, and other permanently or seasonally flooded lands) are important rearing areas for juvenile salmonids	Urbanization of streams may cause stream channelization, reducing off-channel habitat.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in loss of off-channel habitat. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size including loss of off-channel habitat. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of off channel habitat. Such facilities have been constructed on the Cedar River upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for stream dynamics to produce off-channel habitat. Springbrook Creek has been substantially altered with little off-channel habitat. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for off-channel habitat.	Watershed Level: The SMP in Renton and other jurisdictions will have some influence on stream channel morphology and therefore off-channel habitat by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally. Actions by the KCFCZD will have more extensive influence through setting back existing levees. Reach Level: Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The SMP will contribute to off-channel habitat on the Cedar River Actions by encouraging actions such as setting back existing levees. The SMP will contribute to maintaining May Creek has among the least altered stream channels. The SMP will provide support for naturalizing the Springbrook Creek channel, however opportunities for off-channel habitat may be limited. The SMP regulations will not likely increase the amount of off-channel habitat on Lake Washington. Restoration activities may lead to enhancement of such habitat.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Heat/light inputs	Canopy cover	Riparian Buffers	Helps maintain cool water temperatures through provision of shade and creation of a cool and humid microclimate over the stream.	The loss of riparian buffers through urbanization and agriculture can change natural stream functions, and lead to a loss in shade and cooler temperature areas adjacent to streams.	Watershed: The area and maturity of trees adjacent to the water is greatly reduced. The effects of human alteration on this function occur throughout the watershed. The influence of the area under shoreline jurisdiction if minor compared to the scale of the watershed processes. Reach Level: Most of the city is developed with little potential for shade from mature trees. The Cedar and Green Rivers have been substantially altered and have limited riparian vegetation and potential for shade from mature trees. Cedar River vegetation is less altered on the right bank upstream of I-405 and upstream of SR 169. May Creek is less altered in channel character and has more potential for shade from mature trees, except in upstream areas devoted to pasture. Springbrook Creek has been substantially altered and managed to produce little potential for shade from mature trees. Lake Washington has little mature vegetation providing shade from mature trees. This may adversely affect nearshore habitat areas critical to juvenile salmon lifecycle stages.	Watershed Level: The SMP in Renton and other jurisdictions will contribute to long term re-establishment of tree canopy by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally and tree growth will required decades. Actions by the KCFCZD will contribute to establishing canopy through setting back existing levees. Reach Level: Most of the city is developed with widespread alteration of vegetation adjacent to streams and lakes. The SMP will contribute to long term re-establishment of tree canopy by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally, tree growth will required decades and provisions to maintain existing shoreline views will limit canopy, especially on Lake Washington.
Organic matter		Riparian Buffers	Organic matter is important to the ecosystem in the form of leaves, branches, and terrestrial insects and is an important element of the food chain in streams and nearshore habitat in lakes.	The loss of riparian buffers through urbanization and agriculture can change natural stream functions and reduce the contribution of organic matter.	Watershed: The loss of riparian buffers adjacent to the water has been greatly reduced by human alteration occur throughout the watershed. The influence of the area under shoreline jurisdiction if minor compared to the scale of the watershed processes. Reach Level: Most of the city is developed with little potential for organic input from riparian vegetation to support the food chain. The Cedar and Green Rivers have been substantially altered and have limited riparian vegetation and potential for organic input from riparian vegetation to support the food chain. Cedar River vegetation is less altered on the right bank upstream of I-405 and upstream of SR 169. May Creek is less altered and has more potential for organic input from riparian vegetation to support the food chain, except in upstream areas devoted to pasture. Springbrook Creek has been substantially altered and managed to produce little potential for organic input from riparian vegetation to support the food chain. Lake Washington has little vegetation at the water's edge providing organic input from riparian vegetation to support the food chain.	Watershed Level: The SMP and CAO in Renton and other jurisdictions will contribute to long term re-establishment of riparian buffer and related food chain functions by requiring buffers for new development and substantial redevelopment, although change from regulations will occur only incrementally and tree growth will required decades. Reach Level: The SMP will contribute to long term re-establishment of buffers for new development and substantial redevelopment, although buffer depth will be limited where single-family lots are limited in depth.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Terrestrial Habitat		Riparian Buffers Longitudinal Dimension/ Connectivity	The longitudinal continuity of the riparian corridor is at least as important as its lateral width. Continuity along corridors links a variety of upland areas, links different types of riparian vegetation communities, and provides for movement to respond to local disruptions in productivity due to flooding, fire, local predation pressure, and human disturbance. A nearly continuous riparian zone is the typical natural condition in the Pacific Northwest (Naiman 1992).	The riparian corridor in urban watersheds can become fragmented from a variety of human influences; the most common and potentially damaging is the enclosing of streams in piped conveyance systems that remove most ecological functions from the areas enclosed. Ditching and canalization are nearly as damaging. Road crossings can be similarly disruptive, depending on the character and frequency of crossings.	Watershed: The loss of riparian buffers adjacent to the water is greatly reduced. The effects of human alteration on this function occur throughout the watershed. There is little potential for continuous animal movement along most stream corridors The influence of the area under shoreline jurisdiction if minor compared to the scale of the watershed processes. Reach Level: Most of the city is developed with little potential for riparian vegetation to support corridors for animal movement and use. The Cedar and Green Rivers have been substantially altered and have limited riparian vegetation and potential for riparian vegetation to support corridors for animal movement and use. Cedar River vegetation is less altered on the right bank upstream of I-405 and upstream of SR 169. May Creek is less altered and has more potential for riparian vegetation to support corridors for animal movement and use. Springbrook Creek has been substantially altered and managed to produce with little potential for riparian vegetation to support corridors for animal movement and use. Lake Washington has little continuous vegetation at the water's edge providing little potential to support corridors for animal movement.	Watershed Level: The SMP and CAO in Renton and other jurisdictions will contribute to long term re-establishment of riparian buffer and related connectivity; however existing human occupancy may reduce use by wildlife. Reach Level: The SMP will contribute to long term re-establishment of buffers with longitudinal connectivity on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for longitudinal connectivity.
Water quality	Cycling (storage/ transport)	Wetland Function Water Quality – Capture of Sediments - Settlement Time	Pollutants that are in the form of particulates (e.g., sediment, or phosphorus that is bound to sediment) will be retained in a wetland with greater detention time. Wetlands with no outlet are the most effective in this, followed by wetlands with an outlet that flows only seasonally, followed by wetlands with year-round outlet but with longer times that water is retained and sediment can settle (Adamus et al. 1991).	The loss of wetlands through development and agriculture allows particulates to enter stream systems and degrade those systems at a higher rate.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	Watershed Level: Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to maintaining functions of existing wetlands, including entrapment of sediments. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. Reach Level: The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Water quality	Cycling (storage/ transport)	Wetland Function Water Quality – Capture of Sediments – Persistent Vegetation	Plants enhance sedimentation by acting like a filter and causing sediment particles to drop to the wetland surface (Adamus et al. 1991).	Wetland function can be reduced through direct displacement and through off-site factors that reduce function. Urban development and agriculture can increase the amount of sediments entering the wetland and adjacent stream systems and affect the soil substrate and affect the type of vegetation by changing the conditions under which different plants compete with one another.	<u>Watershed Level:</u> In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. <u>Reach Level:</u> Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	<u>Watershed Level:</u> Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to maintaining functions of existing wetlands, including capture of sediments through persistent vegetation. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. <u>Reach Level:</u> The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.
Water quality	Cycling (storage/transp ort)	Wetland Function Water Quality – Removal of Nutrients – Soils – Anoxic Conditions	Clay soils, organic soils, and periods of anoxia in the soils are all good indicators that a wetland can remove a wide range of pollutants from surface water. The uptake of dissolved phosphorus and toxic compounds through adsorption to soil particles is highest when soils are high in clay or organic content (Mitsch and Gosselink 1993). Removal of nitrogen from the aquatic system (denitrification) is done by bacteria that live only in the absence of oxygen (Mitsch and Gosselink 1993).	Loss of function can occur through displacement and through change in runoff patterns or the type and amount of pollutants that enter a system. Degradation can occur due to changes in the hydrologic conditions maintaining soil type or to a pollutant load that is greater than the capacity of the system to process nutrients.	<u>Watershed Level:</u> In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. <u>Reach Level:</u> Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	<u>Watershed Level:</u> Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to maintaining functions of existing wetlands, including uptake of dissolved phosphorus and toxic compounds through adsorption to soil particles. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. <u>Reach Level:</u> The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Water quality	Cycling (storage/transport)	Wetland Function Water Quality – Removal of Nutrients – Soils – Seasonal Ponding	The highest levels of nitrogen transformation occur in areas of the wetland that undergo a cyclic change between oxic (oxygen present) and anoxic (oxygen absent) conditions. The oxic regime is needed so certain types of bacteria will change nitrogen that is in the form of ammonium ion (NH_4^+) to nitrate, and the anoxic regime is needed for denitrification (changing nitrate to nitrogen gas) (Mitsch and Gosselink 1993).	Development and increases in impervious surfaces may lead to changes in hydrologic regime that change the patterns of seasonal ponding to either year-round ponding, deeper ponding, or ponding of a different duration. This can change the balance of functions provided.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	Watershed Level: Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to maintaining functions of existing wetlands, including nitrogen transformation. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. Reach Level: The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.
Water quality	Cycling (storage/transport)	Wetland Function Water Quality – Wetland Function Relative to Pollutant Load	The opportunity for wetlands to improve water quality in a watershed is related to the amount of pollutants that come into the wetland relative to the size and vegetation community within the wetland. Qualitatively, the level of pollutants can be correlated with the level of disturbance and type of development in the landscape. For example, relatively undisturbed watersheds will carry much lower sediment and nutrient loads than those that have been impacted by development, agriculture, or logging practices (Hartmann et al. 1996; Reinelt and Horner 1995). The character and persistence of pollutants resulting from logging, agriculture, and urban development differ substantially.	Development can increase impervious surfaces, funneling pollutants into wetlands. Wetlands that have been reduced in size are less able to carry sediment and pollutant loads and improve water quality than larger wetlands.	Watershed Level: In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. Reach Level: Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	Watershed Level: Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to reducing the adverse water quality impacts of urban runoff and resulting pollutant loads through maintaining functions of existing wetlands, including capture of sediments uptake of dissolved phosphorus and toxic compounds through adsorption to soil particles, and nitrogen transformation. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. Reach Level: The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Water quality	Cycling (storage/transport)	Wetland Function Water Quality – Wetland Function Relative to Pollutant Load – Urban Runoff – Residential Lawns in Direct Proximity	See above.	Residential lawns and landscaping as well as commercial development and special uses such as golf courses adjacent to wetlands contribute overland runoff with pesticides, nutrients, and sediments in quantities that can exceed the wetland's capacity to process nutrients and other contaminants. The effects depend on type and amount of fertilizers and pesticides applied. The presence or absence of an intervening buffer of native vegetation to filter or capture sediments or nutrients affects the pollutant load. Type of buffer vegetation, distance, and slope affect the effectiveness of buffers.	<u>Watershed Level:</u> In the overall watershed, widespread changes in stream structure have resulted in loss of wetland function. <u>Reach Level:</u> Most of the city is developed with widespread alteration of stream channels at every stream size including loss of wetland function. The Cedar and Green Rivers have been substantially altered by channelization and levees to address flood control with consequent loss of wetland function. More potential is present upstream of SR 169. May Creek is largely unaltered in channel character with public open space providing potential for preservation of wetlands, except for alteration for rural uses in upstream reaches. Springbrook Creek has been substantially altered with wetland area except those constructed as part of development or a wetland bank. Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for adjacent wetlands.	<u>Watershed Level:</u> Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to reducing the adverse water quality impacts of urban runoff from residential Lawns in direct proximity through maintaining functions of existing wetlands, including capture of sediments uptake of dissolved phosphorus and toxic compounds through adsorption to soil particles, and nitrogen transformation. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. <u>Reach Level:</u> The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.
Water quality	Discharge to wetlands	Wetland Function Water Quality – Wetland Function Relative to Pollutant Load – Roadways, Driveways, Parking Areas With Direct Discharge	See above.	Roads, driveways, and parking lots that discharge directly, without detention and treatment, generate pollutants (including sediment, nutrients, chemicals, and heavy metals) that can exceed the wetland's capacity to process nutrients and other contaminants.	<u>Watershed Level:</u> In the overall watershed, widespread changes in land use have resulted from urbanization. In existing development there is little treatment of automobile related pollutants. <u>Reach Level:</u> Most of the city is developed with impervious surfaces. Most vehicle related pollutants are not treated.	<u>Watershed Level:</u> Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to reducing the adverse water quality impacts of urban runoff from automobile related pollutants through maintaining functions of existing wetlands, including capture of sediments uptake of dissolved phosphorus and toxic compounds through adsorption to soil particles, and nitrogen transformation. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. <u>Reach Level:</u> The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
Hydrology	Surface runoff and peak flow	Wetland Function Surface runoff and peak flow – Direct Conveyance From Areas With Detention/Treatment	See above.	Detention and treatment systems can change the peak discharge rates from impervious surfaces, but do not change the overall increase in runoff and therefore the duration of flows. Treatment facilities vary in effectiveness in nutrient and chemical removal. The effectiveness of detention/treatment is affected by long-term investment in maintenance. Although beneficial even with detention/treatment, wetland function can be degraded by hydrologic, sediment, and pollutant loads.	Watershed Level: In the overall watershed, widespread changes in the water cycle due to urbanization and the increase in runoff is only partially offset by structural features such as stormwater detention and treatment.	Watershed Level: Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to reducing the adverse effects of surface runoff and peak flow .through maintaining functions of existing wetlands, including water storage. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. Reach Level: The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.
Hydrology	Surface runoff and peak flow	Wetland Function Reduction in Stream Velocity and Flooding – Headwater Wetlands	Wetlands found in the headwaters of streams are important in reducing peak flows because they slow down and desynchronize the initial peak even in cases where surface water storage is limited (Brassard et al. 2000).	Development often displaces small wetlands that may not be identified because local regulations exclude small wetlands from preservation. They also may be overlooked if vegetation has been altered or if field surveys are not detailed.	Watershed Level: In the overall watershed, widespread changes land use have resulted in loss of headwater wetlands.	Watershed Level: Critical Area protection of existing wetlands in Renton and other jurisdictions will contribute to reducing the adverse effects of initial peak flows .through maintaining functions of existing wetlands, including desynchronize the initial peak. Actions by the KCFCZD may have more extensive influence through setting back existing levees and allowing re-establishment of wetland areas. Reach Level: The SMP will contribute to preservation of existing wetlands and may lead to additional wetland restoration programs on the Cedar River upstream of I-405 on May Creek upstream of I-405 and on Springbrook Creek upstream of I-405. The character of existing development on Lake Washington provides few opportunities for establishing wetlands except through restoration programs.
Hydrology	Surface runoff and peak flow	Wetland Function Reduction in Stream Velocity and Flooding – Storage Capacity	The amount of water a wetland stores is important in reducing peak flows and desynchronizing the simultaneous discharge from a single precipitation event in a basin. The volume of storage of flood waters directly influences effectiveness in flood reduction.	Large areas of impervious surface may produce runoff volumes that far exceed the natural flows under which wetlands evolved and may change physical character through erosion of channels through wetlands, subject wetlands to more frequent inundation, and increase sediment deposition that may reduce storage capacity and change vegetation communities.	Watershed Level: In the overall watershed, widespread changes land use have resulted in changes of hydrology that effect the hydroperiod of many wetlands. This is less pronounced for recent development.	Watershed Level: SMPs and Critical Area protection of existing wetlands in Renton and other jurisdictions will not do much to affect changes in hydroperiod through runoff from impervious surfaces given the large amount of existing impervious surface not affected by regulations. Reach Level: The SMP and other regulation swill have little beneficial impact because additional wetland area is unlikely to be developed.
???hydrology from here down???	Wetland Function	Wetland Function Reduction in Lake Fringe Erosion	Wetlands with shoreline plants provide a physical barrier to waves and protect the shore from erosion. This protection consists of both shoreline anchoring and the dissipation of erosive forces (Adamus et al. 1991). Extensive, persistent (especially woody) vegetation provides protection from waves and currents associated with large storms that would otherwise penetrate deep into the shoreline (Adamus et al. 1991). Emergent plants provide some protection but not as much as the stiffer shrubs and trees.	Clearing, bulkheading, and fill for lawns or other shoreline access to lakes removes wetlands and their functions.	Lake Washington shorelines have been substantially altered by lowering the water level, widespread shoreline stabilization and interference with delta formation providing little potential for retention of establishment of adjacent wetlands.	Watershed Level: SMPs is likely to protect few shoreline wetlands because few have been retained. Reach Level: The SMP and other regulation swill have little beneficial impact because additional wetland area is unlikely to be developed.

Table 3-4. Matrix for Evaluation of Cumulative Effects of Shoreline Management Plan on Ecological Productivity (continued)

Key Landscape Process	Mechanism	Feature and/or Parameter Influenced	Physical or Biological Function	Sources of Human Disturbance	Current Trends or Effect of Current Regulations	Affects of Proposed Shoreline Master Program and other Programs
BLANK	Wildlife Habitat	Buffers Habitat – Presence and Area	The area of buffer present increases the total area available as habitat. Many species require a minimum area for breeding, escape, cover, and food production. Generally, larger species require a larger area for food production based on their biomass. Species further up the food chain, such as carnivores, may require a larger area for prey species to be present at densities that make predation practical. Specific species also vary greatly in the specific habitat needs for various functions.	Areas retained in natural or open space in agricultural, rural, or urban areas may be below the threshold of size or complexity to provide all life-cycle functions of breeding, rearing, and food production for a species, and if so, they may be functionally unusable for that species.	Watershed: The loss of riparian buffers adjacent to the water is greatly reduced. The effects of human alteration on this function occur throughout the watershed. There is little potential for continuous animal movement along most stream corridors The influence of the area under shoreline jurisdiction if minor compared to the scale of the watershed processes. Reach Level: Most of the city is developed with little potential for riparian vegetation to support corridors for animal movement and use. The Cedar and Green Rivers have been substantially altered and have limited riparian vegetation and potential for riparian vegetation to support corridors for animal movement and use. Cedar River vegetation is less altered on the right bank upstream of I-405 and upstream of SR 169. May Creek is less altered and has more potential for riparian vegetation to support corridors for animal movement and use. Springbrook Creek has been substantially altered and managed to produce with little potential for riparian vegetation to support corridors for animal movement and use. Lake Washington has little continuous vegetation at the water's edge providing little potential to support corridors for animal movement.	Watershed Level: SMPs and Critical Area protection of and enhancement of buffers is likely to increase habitat, but is likely to be localized with little potential for animal movement on lake shorelines. Reach Level: The SMP and other regulation in conjunction with public ownership are likely to preserve habitat in May Creek and the Cedar River upstream of I-405.
BLANK	Wildlife Habitat	Buffers Habitat – Proximity Impacts	Species that are sensitive to proximity impacts such as noise or light may not occupy otherwise suitable habitat that is subject to those features.	Noise, light, and other proximity impacts result in direct disturbance to species using the habitat.	Watershed: The widespread conversion to urban use has produced proximity impacts, even in those cases where buffers are provided resulting in a general transition to human tolerant species.	Watershed Level: Little impact on the watershed level. Reach Level: SMPs and Critical Area protection of and enhancement of buffers is likely to reduce proximity impacts to habitat somewhat. In cases where shoreline oriented development is practical and implemented, buffers will be less, and not required in some cases.
BLANK	Wildlife Habitat	Buffers Habitat – Predation – Habitat Diversity	Habitat provides for a complex balance between prey and predators. A variety of factors may affect this balance.	Natural predators tend to be more mobile than prey species and move more readily between habitat areas. The isolation of prey species in small areas with limited ability for refuge may increase predatory efficiency such that a balance between predation and replacement may not be maintained.	Watershed: The widespread conversion to urban use has fragmented habitat, even in those cases where open space is provided resulting in general predator pressure on native species.	Watershed: The widespread conversion to urban use that has fragmented habitat, is unlikely to affect predator relations. Reach Level: The SMP and other regulation in conjunction with public ownership may preserve enough habitat in May Creek and the Cedar River upstream of I-405 to provide for a balance between prey and predators.
BLANK	Wildlife Habitat	Buffers Habitat – Predation – Domestic and Feral	Under natural conditions, predators cannot exceed the food supply provided by prey. Domestic animals such as cats may increase the total predator population far beyond the normal balance because pets receive their food from humans and therefore the predator population is not affected by the prey population.	Domestic animals such as dogs and cats may increase the total population of predators in an area beyond natural levels such that a balance between predation and replacement of prey species may not be maintained. Habitat conditions may be adequate to maintain a population of a specific species, but they will not persist due to predation.	Watershed: The widespread conversion to urban use has resulted in additional pressure from domestic animals and tends to further depress population of native species.	Watershed: The SMP and other regulation are not likely to make a substantial change in domestic animal predation patterns on a watershed level. Reach Level: The SMP and other regulation in conjunction with public ownership may preserve enough habitat in May Creek and the Cedar River upstream of I-405 to provide for refuge for some prey species, despite pressure from domestic animals.