FINAL

SHORELINE INVENTORY & ANALYSIS REPORT

FOR THE CITY OF KENT'S SHORELINES:
GREEN RIVER, BIG SOOS CREEK, LAKE MERIDIAN, LAKE FENWICK, GREEN RIVER NATURAL RESOURCES AREA POND, SPRINGBROOK CREEK, AND JENKINS CREEK

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FINAL

SHORELINE INVENTORY and ANALYSIS REPORT for City of Kent's Shorelines: Green River, Big Soos Creek, Lake Meridian, Lake Fenwick, Green River Natural Resources Area Pond, Springbrook Creek, and Jenkins Creek

Project: Comprehensive Shoreline Master Program Update

- **Task 2: Shoreline Inventory**
- **Task 3: Shoreline Analysis & Characterization**

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1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The City of Kent (City) obtained a grant from the Washington Department of Ecology (Ecology) in 2007 to conduct a comprehensive Shoreline Master Program (SMP) update. The first steps of the update process are to inventory and characterize the City's shorelines as defined by the state's Shoreline Management Act (SMA) (RCW 90.58). The inventory and characterization were conducted according to direction provided in the Shoreline Master Program Guidelines and project Scope of Work promulgated by Ecology, and include areas within current City limits and minimally the established Potential Annexation Areas (PAAs). This shoreline inventory and characterization will describe existing conditions and assess ecological functions and ecosystem-wide processes operating in the shoreline jurisdiction. This analysis will serve as the baseline from which future development actions in the shoreline will be measured. The Guidelines require that the City demonstrate that its updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline due to its implementation. Ideally, the SMP in combination with other City and regional efforts will ultimately produce a net improvement in shoreline ecological functions.

A list of potential information sources was compiled and an information request letter was distributed to potential interested parties and agencies that may have relevant information (Appendix A). Collected information was supplemented with other resources such as City documents, scientific literature, personal communications, aerial photographs, internet data, and a brief physical inventory of the City's shorelines.

1.2 SHORELINE JURISDICTION

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the state are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater and lakes whose area is greater than 20 acres. Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom… Any city or county may also include in its master program land necessary for buffers for critical areas (RCW 90.58.030)"

In addition, rivers with a mean annual cfs of 1,000 or more are considered shorelines of statewide significance.

The City's Shoreline Master Program was most recently amended in 2004, although major substantive amendments have not occurred since 1999. Areas of the shoreline were designated as Urban-River Resources (applied to the Green River), Urban-Stream Corridor (applied to Soos Creek), and Urban-Lake Residential (applied to Lake Meridian) (see Figures 1a[1] and 2).

The City's shoreline boundaries have been updated (subject to City Council and Ecology approval) concurrent with this assessment (Figure 1b). Several changes have been made to the maps based on new information regarding associated wetlands, waterbody size (area and flow), and location of floodways and floodplains. Lake Fenwick, the Green River Natural Resources Area (GRNRA) pond, Springbrook Creek, and Jenkins Creek are new additions to shoreline jurisdiction. A large area of floodway and contiguous floodplain associated with the junction of Mill Creek Auburn[2] and the Green River has also been included in shoreline jurisdiction. Other mapped floodways along the Green River have not been added to shoreline jurisdiction, consistent with RCW 90.58.030(2)(vi)(g), which excludes those floodways that are not flooded with reasonable regularity. The Green River levee system effectively prevents flooding of a "reasonable regularity" in all mapped floodway areas but for the Mill Creek Auburn/Green River confluence. Neither of the Mill Creeks contain sufficient flows to meet shoreline jurisdiction criteria.

During the review of aerial photographs, GIS mapping, and a field visit, it was determined that Lake Fenwick is larger than 20 acres (just over 23). GIS mapping also shows that the combined area of the two primary GRNRA cells is slightly more than 50 acres. As part of the shoreline jurisdiction assessment, Springbrook Creek, Big Soos Creek and Jenkins Creek were reviewed. Recent USGS mapping of the 20 cfs cut-off points and USGS field notes identified small segments of Springbrook and Jenkins Creeks that meet shoreline criteria. The extent of Big Soos Creek shoreline jurisdiction did not change appreciably. Except for changes related to addition of the extensive Green River/Mill Creek Auburn floodway, a description of the changes and jurisdiction assessment process and results is included in Appendix B.

1.3 STUDY AREA

The City of Kent is located in south King County. The City is surrounded by six incorporated cities (Des Moines, Auburn, SeaTac, Tukwila, Federal Way, Renton and Covington), with pockets of unincorporated King County to the northeast, east and south. Interstate 5 (I-5) and State Route (SR) 167 pass through the City from north to south at the western and central portions of the City.

The study area for this report includes all land currently within the City's proposed shoreline jurisdiction, as well as minimal treatment of shorelines in the PAA currently regulated under King County's SMP (Figure 1b). The latter includes the south half of Lake Fenwick, all of Panther Lake, and portions of the Green River at the south end of the City. The lineal feet of

[1] **All figures are included in Appendix C at the end of this report.**

[2] The City includes two Mill Creeks. One of the Mill Creeks flows south from the City of Auburn and joins the Green River, and is referenced in this report as Mill Creek Auburn. The second Mill Creek originates within the City of Kent, and generally traverses the City from southeast to northwest, joining Springbrook Creek just inside City limits. The second Mill Creek is referred to as Mill Creek Kent.

shoreline subject to the City's updated SMP encompasses approximately 124,337 lineal feet (23.5 miles) of stream, river and lakeshore (each bank of the streams is counted separately). The PAA shoreline area, although minimally discussed in this report, will continue to be regulated by King County's recently updated SMP until they are annexed by the City of Kent. That area encompasses approximately 31,466 lineal feet (6.0 miles) of shoreline.

1.4 DUWAMISH/GREEN RIVER WATERSHED (WRIA 9)

1.4.1 Geographic Context

Located within Water Resource Inventory Area (WRIA) 9, the Duwamish/Green River is 93 miles long with a drainage area of 566 square miles in King County. The river headwaters in the Cascade Mountains about 30 miles northeast of Mount Rainier and flows north and west into the Duwamish River before entering Puget Sound at Elliott Bay in Seattle. The Green River watershed is further divided into five discrete sub-watersheds (Exhibit 1). While the part of the Soos Creek subbasin within the City is considered to be part of the Middle Green, all of the Green River mainstem within the City of Kent lies within the Lower Green River Sub-watershed. Shoreline characteristics along the Green River mainstem in Kent are strongly influenced, however, by ecological processes at work in the Middle and Upper Green River subwatersheds as well.

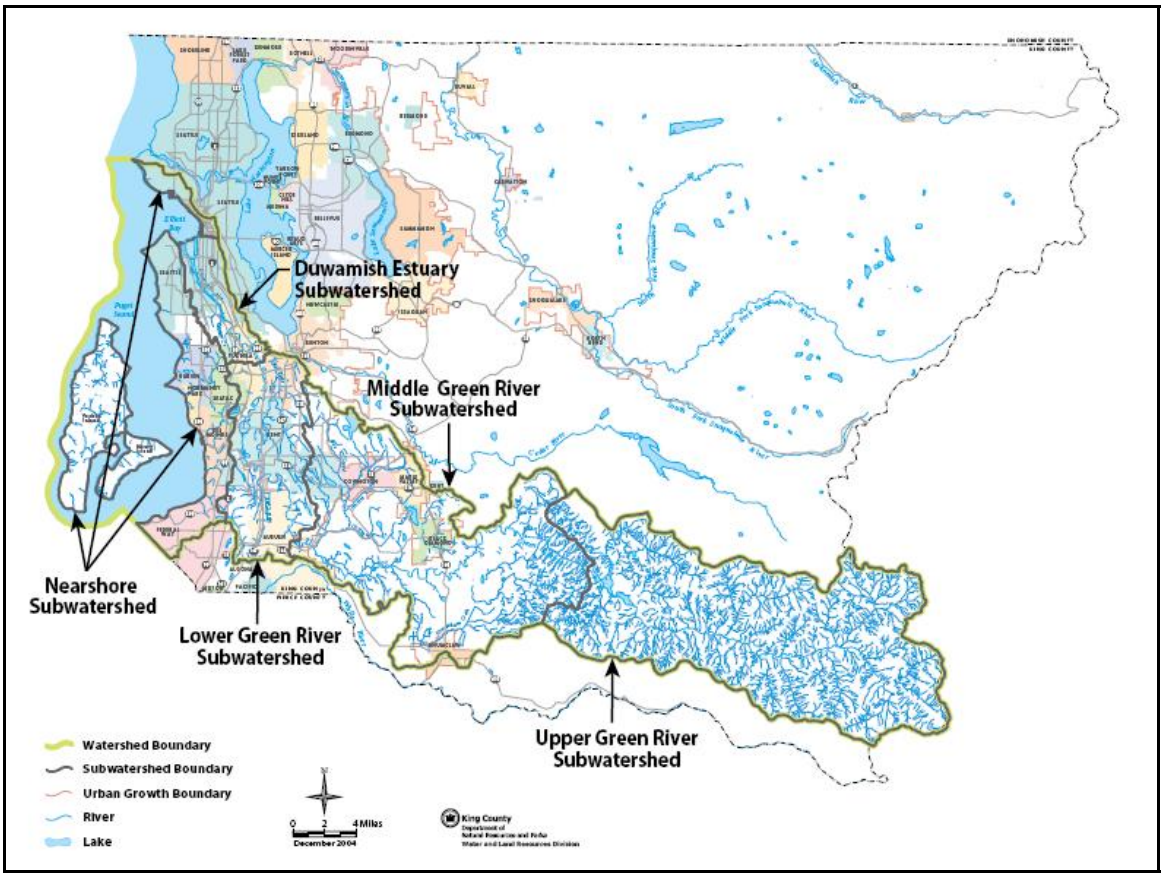


Exhibit 1. Overview of the Green River watershed and its subwatershed boundaries. (http://dnr.metrokc.gov/wlr/watersheds/green/pdf/green-river-watershed-map.pdf)

1.4.2 Historic Geology, Topography, and Drainage Patterns

The Lower Green River Subwatershed is composed of continental glacial till, while the underlying geology of the Upper and Middle Green River Subwatersheds is characterized by Puget Group hard rock (Furstenberg et al. 1996). Landscape characteristics in the Green River basin were heavily influenced by glacial erosion that occurred during the Pleistocene Epoch, from about 1 million years to approximately 12,000 years ago (Booth 1994; Collins et al. 2003; Collins and Sheikh 2005). During this glaciation, the Puget Lobe of the Cordilleran ice sheet created a number of north-south trending trough-like valleys that are prominent landscape features throughout the Puget Sound region today (Booth 1994; Booth et al. 2003). In lower valley segments of the Puget Lowland (such as in the Lower Green River Subwatershed), these troughs typically have a low gradient with valley bottom widths that are quite broad (3-5 km). A significant portion of the City of Kent is situated within one of these broad, north-south oriented, glacially formed valley bottom areas.

Following the Pleistocene Epoch glacial erosion described above, the Green River valley floor at Kent was part of the prehistoric Duwamish Embayment, an inlet of Puget Sound. At that time, the shoreline of Puget Sound was approximately 15 miles south of the where Kent now exists. Then, around 5,000 years ago, the valley was subjected to the Osceola Mudflow, which swept down from the slopes of Mount Rainier through the valley of the White River. This major geological event covered the lowlands from Enumclaw to approximately 4 miles north of Auburn with mudflow deposits up to 75 feet thick, well into the present Lower Green River sub-watershed (Mullineaux 1970). The lower Green River valley has also been affected by a subsequent series of mid-Holocene lahars emanating from Mt. Rainier (Dragovich et al. 1994; Zehfuss et al. 2003). The combined effect of these events was that enormous volumes of sediment were deposited in the lower Duwamish River valley, eventually filling in the prehistoric Duwamish Embayment to form a broad lowland valley characterized by meandering river channels and extensive wetlands. As the valley filled with sediment, the mouth of the river moved northwards to its present location approximately 15 miles north of Kent. In total, the fill resulted in an increase in river length of about 31 miles. Post-glacial fluvial sedimentation during the Holocene Epoch further affected the local topography and landscape features of the Green River valley (Collins et al. 2003; Collins and Sheikh 2005). The Green River meandered through the broad, low gradient glacial valley, gradually mobilizing and depositing sediments that formed natural levees on either side of the river's meander belt. The distance between these natural levees was much narrower than the glacially formed valley bottom width, which resulted in a complex of broad, frequently flooded wetland areas that occupied the low-lying margins within the floodplain (Perkins 1993; Collins and Sheikh 2005). A large portion of Kent now occupies the broad, low-lying valley bottom, which was formerly the site of the frequently flooded wetland complex adjacent to the Green River meander belt.

Water from smaller tributaries such as Springbrook Creek entering the valley from the east, unable to reach the Green River mainstem due to the natural levees, historically fed into the wetland complexes and gradually moved north, carving small north-south channels through the wetlands before discharging to the Black River (north of Kent) and eventually flowing back into the Green River mainstem. The wetland complexes in present-day Kent were also periodically augmented and recharged by floodwaters coming down from the upper White River and Green River basins (Collins and Sheikh 2005). Because of the complex channel network and frequent

overbank flooding, the Green River mainstem and the wetland complex formerly occupying the low-lying areas of the valley bottom were hydrologically linked.

1.4.3 Major Land Use Changes and Current Shoreline Condition

The Green River mainstem is one of the most hydrologically altered large river systems in the Puget Sound ecosystem. A combination of historic events has dramatically affected the hydrology of the Duwamish/Green River basin. Foremost among these events were the diversion of the White River in 1906 into the Puyallup River for flood control purposes, followed in 1916 by diversion of the Cedar/Black River into Lake Washington to facilitate navigation through the Ship Canal (Exhibit 2). The Green/Duwamish estuary has been largely eliminated over time with the growth of the City of Seattle and associated waterfront development activities. Over 97 percent of the historic estuary area has been either filled, armored, or dredged, and the lower Duwamish River is now a highly industrial area with few natural habitat features (Kerwin and Nelson 2000). Construction of Tacoma Water's Headworks Diversion Dam in 1911 and the Howard A. Hanson Dam (HHD) in 1962 have also resulted in major hydrologic flow modifications and water withdrawals in the watershed (Grette and Salo 1986).

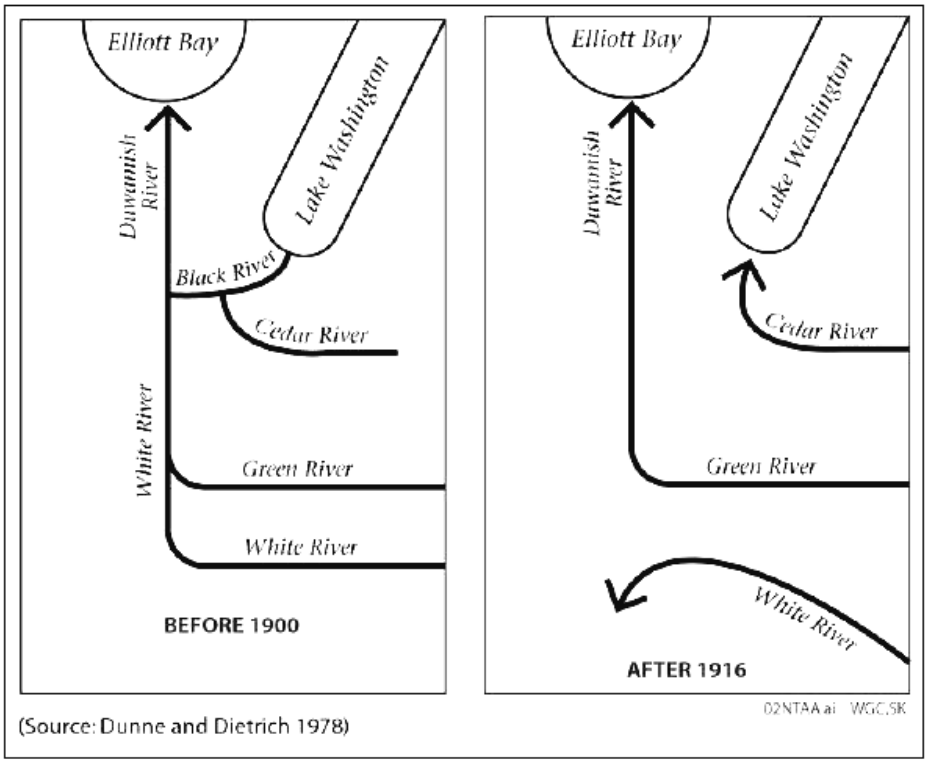


Exhibit 2. Duwamish drainage, before 1900 and after 1916.

In addition to these major events, construction of flood control levees, agricultural development, and urbanization in Kent as well as other Subwatersheds within the watershed has also had a cumulative effect on the flow regime in the Duwamish/Green River watershed. As a result of these alterations, approximately 70 percent of the historic watershed has been diverted out of the Duwamish/Green River basin, and over 90 percent of the historic floodplain has been isolated from the river ecosystem by flood control structures (Kerwin and Nelson 2000).

The clearing of mature forest vegetation over large areas of the watershed, and increasing amounts of impervious and compacted or hardened surfaces has reduced the infiltration capacity of the landscape, thereby increasing runoff rates and the magnitude and frequency of peak flows in the tributary streams. Such peak flow increases have not generally occurred along the Green River mainstem, however, due to the construction and operation of HHD and the diversion of the entire White River out of the watershed. Overall, the Green River has undergone extensive development and numerous hydromodifications.

1.4.4 ESA Listings

The Green River basin is inhabited by three federally listed species of salmonids: 1) chinook salmon of the Puget Sound Evolutionary Significant Unit (ESU), (Reaffirmed as Threatened, U.S. Federal Register, 28 June 2005), 2) bull trout of the Coastal-Puget Sound Distinct Population Segment (DPS), (threatened, U.S. Federal Register, 1 November 1999), and 3) steelhead of the Puget Sound DPS (U.S. Federal Register, 11 May 2007). Puget Sound-Strait of Georgia coho salmon also occur in the basin and are listed as a Species of Concern (U.S. Federal Register, 15 April 2004), indicating that they are under less active consideration for formal listing. An ESU of Pacific salmon is considered to be a distinct population segment (DPS) and thus a "species" under the Endangered Species Act.

The Green River basin also contains formally designated critical habitat for Puget Sound chinook salmon and Coastal-Puget Sound bull trout. Critical habitat for chinook salmon includes the Upper, Middle, and Lower Green River Subwatersheds (Watershed Codes 17110013, i-iii) of the Puget Sound ESU (U.S. Federal Register, 2 September 2005), and critical habitat for bull trout of the Coastal-Puget Sound DPS is mapped as the portions of the Green River generally downstream from Auburn, which is in Critical Habitat Unit 28 – Puget Sound (U.S. Federal Register, 26 September 2005). Critical habitat has not yet been proposed or designated for Puget Sound steelhead. No other federally listed fish species are designated for the Green River basin, including the City of Kent or its PAA.

2.0 CURRENT REGULATORY FRAMEWORK SUMMARY

2.1 CITY OF KENT

The Shoreline Management Act of 1971 brought about many changes for local jurisdictions, including the City of Kent. With the goal "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines," the City's Shoreline Master Program was developed to help regulate shoreline development in an ecologically sensitive manner with special attention given to public access. A major update of the SMP was completed in 1999 (Ordinance 3458), with a minor amendment in 2004 (Ordinance 3751). The Goals and Policies of the SMP are incorporated into the Comprehensive Plan as Appendix C.

Most of the uses, developments, and activities regulated in the City's SMP (Kent City Code 11.04, Ordinance 3458) are also subject to the City's Comprehensive Plan, the Kent City Code, the International Building Code and various other provisions of city, state and federal laws. The applicant must comply with all applicable laws prior to commencing any use, development, or activity. Kent ensures consistency between the SMP and other City codes, plans and programs

by reviewing each for consistency during periodic updates of the City's Comprehensive Plan as required by State statute.

Title 15, Zoning, of the Kent City Code (KCC), Ordinance 2404, as amended, establishes specific and detailed regulations for most of the uses, development, and activities regulated in the SMP. Title 15 and the SMP are intended to operate together to produce coherent and thorough shoreline regulations. In all cases, uses, developments, and activities must comply with both the KCC and the SMP. If there is a conflict between the two, the more restrictive applies.

The City adopted a revised Critical Areas Ordinance (CAO) in August 2006 consistent with best available science and all other requirements of the GMA. All activities which currently require a Substantial Development Permit (SDP), Conditional Use Permit (CUP) or Variance under the SMP are reviewed under the City's CAO for consistency. As stated above, if there is a conflict between the CAO and SMP, the regulations that offer the greatest environmental protection apply. The City will either adopt the existing CAO by reference into its updated SMP, excluding non-applicable provisions, or it will include relevant sections of the existing CAO, perhaps with minor modifications, as a full appendix to the SMP.

In 1995, the City adopted its first Comprehensive Plan pursuant to Growth Management Act requirements and completed a major update of the Kent Comprehensive Plan in 2004 (City of Kent 2004a). The most recent amendments went into effect in 2006. The KCC is consistent with and implements the Comprehensive Plan.

The following table (Table 1) summarizes nine years of shoreline permit applications submitted to the City of Kent. This summary likely underestimates shoreline activity, as some shoreline exemptions may not have been entered into the City's permit tracking system.

Table 1. Shoreline Permit History in the City of Kent Since 1999.

Year	# of Cases	Pier		Bulkhead Mod.	New Bulkhead	Upland Structure	Other Upland Dev. / Parks	Roads, Utilities & Levee Repair	Permit Type			
		Extension/ Mod.	New/ Replace						SDP	SCUP	Variance	Exemption
Green River												
1999	2						1	1	2			
2000	3					1		2			1	2
2001	5					1		4	4			1
2002	5						2	3	1		1	3
2003	2							2		1		1
2004	2						2		2			
2005	7					2		2	3			2
2006	6					2		4	3		1	2
2007	5		1				3	1	3	1		1

Year	# of Cases	Pier		Bulkhead Mod.	New Bulkhead	Upland Structure	Other Upland Dev. / Parks	Roads, Utilities & Levee Repair	Permit Type			
		Extension/ Mod.	New/ Replace						SDP	SCUP	Variance	Exemption
Lake Meridian												
1999	1	1										1
2001	7	2	4	1								7
2006	3		2				1					3
2007	1		1						1			
Big Soos Creek												
2007	1							1				1
TOTAL	**50**	**3**	**8**	**1**	**0**	**6**	**9**	**20**	**19**	**2**	**3**	**24**

SDP = Shoreline Substantial Development, SCUP = Shoreline Conditional Use Permit

2.2 STATE AND FEDERAL REGULATIONS

State and federal regulations most pertinent to development in the City's shorelines include the federal Endangered Species Act, the federal Clean Water Act, the state Shoreline Management Act, and the State Hydraulic Code. Other relevant federal laws include the National Environmental Policy Act, Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. Other relevant state laws include the Growth Management Act, State Environmental Policy Act, tribal agreements and case law, Watershed Planning Act, Water Resources Act, Salmon Recovery Act, and the Water Quality Protection Act. A variety of agencies (e.g., U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Ecology, Washington Department of Fish and Wildlife) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing. Depending on the nature of the proposed development, state and federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. With the comprehensive SMP update, the City will strive to ensure that Kent's SMP regulations are consistent with other agencies' requirements and explore ways to streamline the shoreline permitting process. A summary of some of the key regulations and agency responsibilities follows.

Shoreline Management Act: The Shoreline Management Act (SMA) was adopted in 1972 with the "overarching goal… 'to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines.' The SMA emphasizes accommodation of reasonable and appropriate uses, protection of shoreline environmental resources and protection of the public's right to access and use the shorelines" (http://www.ecy.wa.gov/programs/sea/sma/st_guide/intro.html). Ecology is responsible for developing and overseeing implementation of Shoreline Master Program Guidelines, which provide direction to local governments regarding development and implementation of local Shoreline Master Programs. While cities and counties

are the primary regulators under the Shoreline Management Act, Ecology has final approval authority over the local government's SMP. As mentioned above, Ecology also reviews and has final approval over Shoreline Conditional Use and Shoreline Variance permits processed under the local jurisdiction's SMP.

Clean Water Act: The federal Clean Water Act has a number of programs and regulatory components, but of particular relevance to Mercer Island is the National Pollutant Discharge Elimination System (NPDES) program. In Washington State, the Department of Ecology has been delegated the responsibility by the U.S. Environmental Protection Agency for managing implementation of this program. The City is actively engaged in compliance with the NPDES Phase II Municipal Stormwater General Permit requirements, which addresses stormwater system discharges to surface waters (see Section 3.3.3 below).

Section 404: Section 404 of the federal Clean Water Act provides the Corps, under the oversight of the U.S. Environmental Protection Agency, with authority to regulate "discharge of dredged or fill material into waters of the United States, including wetlands" (http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf). The extent of the Corps' authority and the definition of fill have been the subject of considerable legal activity. As applicable to the City of Kent's shoreline jurisdiction, however, it generally means that the Corps must review and approve most activities in streams and wetlands. These activities may include wetland fills, stream and wetland restoration, and culvert installation or replacement, among others. Similar to SEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts.

Federal Endangered Species Act (ESA): Section 9 of the ESA prohibits "take" of listed species. Take has been defined in Section 3 as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The take prohibitions of the ESA apply to everyone, so any action of the City that results in a take of listed fish or wildlife would be a violation of the ESA and exposes the City to risk of lawsuit. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and Wildlife Service (USFWS) via a process called "consultation." As previously mentioned, a Corps permit under Section 10 of the Rivers and Harbors Appropriation Act is required for projects in the Green River.

Section 401 Water Quality Certification: Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges to state waters, including wetlands. In Washington, the Department of Ecology is the state agency responsible for conducting that review, with their primary review criterion of ensuring that state water quality standards are met. Actions within streams, lakes or wetlands within the shoreline zone that require a Section 10 or Section 404 permit (see above), will also need to be reviewed by Ecology.

Hydraulic Code: Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny "any construction activity that will use, divert, obstruct, or change the bed or flow of state waters." As

applicable to the City of Kent's shoreline jurisdiction, however, it generally means that WDFW must review and approve most activities in streams and lakes. These activities may include stream alteration, culvert installation or replacement, pier and bulkhead repair or construction, among others. WDFW can condition projects to avoid, minimize, restore, and compensate adverse impacts.

3.0 ELEMENTS OF THE SHORELINE INVENTORY

The following discussion identifies each of the required inventory elements, sources of information for each element, and provides a City-wide or shoreline-wide narrative for each element, as well as segment-specific discussions, as needed.

Green River: The basic character of the river (morphology, levees) does not change as it passes through Kent City limits. However, just outside City limits at the south end, the PAA contains only one short section of levee. The land use distribution along the Green River shoreline is very patchy. Based on land use, the right bank (facing downstream) can be divided into twelve segments and the left bank can be divided into ten segments. For purposes of discussion, these are grouped by land use. For example, the open space/urban separator lands are discussed together although they may be distributed among several non-contiguous segments; in this way, many separate segments can be discussed at once. This system leads to the following four discussion units for some elements of the Green River (illustrated on Figures 3a-3c):

Unit A – Open Space: contains land areas in shoreline jurisdiction generally dominated by Parks and Open Space (OS) and Urban Separator (US) designated lands.

Unit B – High Intensity: contains land areas in shoreline jurisdiction generally dominated by Commercial (C) and Industrial (I) designated lands.

Unit C – Residential: contains land areas in shoreline jurisdiction generally dominated by Single Family (SF), Medium Density Multifamily (MDMF), Mobile Home Park (MHP), and Low Density Multifamily (LDMF) designated lands.

Unit D – Agricultural: contains land areas in shoreline jurisdiction generally dominated by Agricultural Resource (AG-R) and Agricultural Support (AG-S) designated lands.

Small amounts of other land uses may be present in each unit. Portions of the Green River are also in the City's PAA, and have been assessed by King County as part of its SMP update.

Big Soos Creek: Soos Creek's biological and land use character are generally consistent in the City. The entire shoreline area is zoned Urban Separator, and contains primarily critical areas and other vegetated areas. No segments or discussion units are established.

Lake Meridian: Lake Meridian has two distinct land use patterns and is therefore divided into two segments (A – Open Space and C – Residential) (see Figure 3e).

Lake Fenwick: Within the City, Lake Fenwick is divided into two segments based on land use (A – Open Space and C – Residential) (see Figure 3f). A portion of Lake Fenwick is also in the

City's PAA. The PAA has been assessed by King County as part of its SMP update, and was divided into two units (Fen1 and Fen2) based on existing function and level of alteration. Fen1 covers the southeast shore and Fen2 encompasses the residential area on the south and southwest shores. These areas are grouped as PAA-C (they are developed as or planned for residential use) on Figure 3f.

Green River Natural Resources Area Pond: The biological and land use character of the Green River Natural Resources Area Pond (GRNRA Pond) is generally consistent in the City.. Virtually the entire area is ponds or wetlands managed as a combination natural park and stormwater facility. No segments or discussion units are established.

Springbrook Creek: Springbrook Creek's surrounding land use is dominated by industrial use, with two narrow City-owned open space parcels between each bank of the stream and the industrial uses. Given the small area of total Springbrook Creek shoreline and its simplicity, the shorelands were not split into segment units.

Jenkins Creek: Jenkins Creek's biological and land use character are dominated by one use in the City (protected municipal watershed area), so no segments or discussion units are established.

Panther Lake: All of Panther Lake is in the City's PAA and has been assessed by King County as part of its SMP update. The lake has two distinct land use patterns and is therefore divided into two segments (A – Open Space and C – Residential) (see Figure 3g).

Table 2. Shoreline Planning Segments.

Segment	Approximate Length (feet / miles)	Approximate Area (acres / sq. miles)
City of Kent		
Green River (City)	87,242/16.5	526.5/0.82[1]
Green River (PAA)	22,018/4.2	107.4/0.17
Big Soos Creek	2,417/0.5	10.4/0.02
Lake Meridian	15,660/3.0	76.0/0.12
Lake Fenwick (City)	3,989/0.8	22.07/0.03
Lake Fenwick (PAA)	3,081/0.6	15.5/0.02
GRNRA Pond	11,931/2.3	185.2/0.29
Springbrook Creek	813/0.2	4.0/.01
Jenkins Creek	2,285/0.4	12.4/.02
Panther Lake PAA	6,368/1.2	63.5/0.10
TOTAL	**155,803/29.5**	**1,023.0/1.60**

[1] This number does not include the large area of shoreline jurisdictional floodway located near the confluence of Mill Creek Auburn and the Green River.

3.1 LAND USE PATTERNS

Understanding the land use conditions in shoreline areas is an important component of master programs for two key reasons.

First, the Shoreline Management Act (SMA), Chapter 90.58 RCW, establishes policy, giving preference to uses that are unique to or dependent upon a shoreline location. Consequently, WAC 173-26-201(2)(d) calls for master program provisions to give higher priority to the following types of uses, in the order presented below:

1. Areas for protecting and restoring ecological functions.
2. Water-dependent and associated water-related uses.
3. Other water-related and water-enjoyment uses.
4. Single-family residential uses where they are appropriate and can be developed without significant impact to ecological functions and displacement of water-dependent uses.
5. Non-water-oriented uses where the uses described in 1-4 above are inappropriate or where non-water-oriented uses demonstrably contribute to the objectives of the SMA.

Therefore, WAC 173-26-201(3)(c) directs local governments to inventory:

> "[s]horeline and adjacent land use patterns and transportation and utility facilities, including the extent of existing structures, impervious surfaces, vegetation and shoreline modifications in shoreline jurisdiction. Special attention should be paid to identification of water-oriented uses and related navigation, transportation and utility facilities."

Using this regulatory direction, the City looked for shoreline areas with development and redevelopment potential because such sites have the most potential for introducing water-oriented uses, shoreline restoration, and public access.

A second important reason for inventorying shoreline and adjacent land uses is that this information is critical for assigning environment designations as called for in WAC 173-26-211. As noted in WAC 173-26-211(3) the SMP and the comprehensive plan must be mutually consistent and shoreline and adjacent land use is very relevant to the criteria for individual environments in the WAC section.

Land use patterns were derived from GIS mapping from the City's most recent Comprehensive Plan (Figures 3a-h), from review of aerial photography from 2005, and from field inventory work. Rather than providing a quantified tabulation of adjacent land uses, the land use inventory focuses on the shoreline conditions relative to SMA objectives, most specifically, the Preferred Use Doctrine of RCW 90.58.020. To better describe existing land uses along the various shorelines within the City of Kent, the shorelines are divided into the following land use categories: open space, high intensity, residential, and agricultural.

The variety of land uses and conditions identified on Kent's shorelands will be discussed in Chapter 4. This information will be a strong determining factor in assigning environment designations to various shoreline segments.

3.2 TRANSPORTATION

Specific transportation facilities are described in greater detail for each shoreline in Chapter 4.0. In general, information about transportation facilities was derived from the City's map of *Proposed Functional Classifications of Public Roads* (City of Kent 2006), the City's *Six Year Transportation Improvement Program 2008-2013* (City of Kent 2007), aerial photographs, and other map resources.

3.3 UTILITIES

There are two primary utilities with the ability to directly and indirectly impact State shorelines: wastewater and stormwater. Drinking water and irrigation are additional water-consumption uses that are minimally discussed below. Additional wastewater and stormwater utility information is described in greater detail for each shoreline in Chapter 4.0 and illustrated on Figures 4a-4h and 5a-5h.

3.3.1 Drinking/Irrigation Water

Most of the City's drinking water is from groundwater resources located east of the City limits in the Covington and Maple Valley areas. Several wells are also located inside City limits. The City is also a partner in the Tacoma Second Supply Pipeline, operated and maintained by the City of Tacoma's water utility, which captures water from the headwater areas of the Green River between Chinook and Snoqualmie Passes. The City of Tacoma prepared and is implementing a Habitat Conservation Plan to minimize and mitigate impacts to listed fish and wildlife species that result directly and indirectly from the water supply activities (http://www.ci.tacoma.wa.us/water/WaterSystem/habitat.htm). The City also provides drinking water through municipal wells within and outside of City limits, only one of which is located in shoreline jurisdiction, Armstrong Springs located adjacent to Jenkins Creek near Covington (Mactutis, pers. comm., 6 June 2008).

The City's Riverbend Golf Course has a water right to pump water directly from the Green River for irrigation, and the privately owned Teufel Nursery just to the north and across the river also has water rights to pump water directly from the Green River for irrigation.

Water quantity issues and water rights will not be addressed in detail in this report. Because water is considered a public resource, water withdrawals are regulated by the Washington Department of Ecology and typically require a water right. Water withdrawals can have adverse affects on shoreline functions and values. For example, some withdrawals can alter flow patterns in a manner that reduces the availability and quality of in-stream habitat or reduces the availability of water for riparian vegetation. The City of Kent and the City of Tacoma have a number of programs to encourage conservation of water by users, including rebates for installation of water-saving toilets and washing machines, free water conservation devices, and educational opportunities such as the annual water festival.

3.3.2 Wastewater Utilities

The City provides sewer services to most of the incorporated City of Kent, some unincorporated areas of southern King County, and a small portion of the City of SeaTac. The City of Kent provides mostly gravity sewage collection and interceptor systems, and includes nine sewage lift

stations. The King County Department of Natural Resources and Parks Wastewater Treatment Division has responsibility for major interceptors and sewage treatment/disposal facilities for the City of Kent. King County Department of Natural Resources and Parks Wastewater Treatment Division (formerly known as Metro) treats wastewater from the City of Kent's sewer utility at the South Treatment Plant. The treatment plant, located in Renton, discharges into Puget Sound after providing primary, secondary, and disinfection treatments.

The portions of the City not served by Kent are in the Soos Creek Water & Sewer District's (eastern parts of City) or the Midway Sewer District's (west of I-5) service areas. Although the Big Soos Creek shoreline in the City of Kent is within the Soos Creek Water & Sewer District, most of the properties are still on septic. The Midway Sewer District collects wastewater from much of its Kent service area, treats it at its Des Moines Creek Wastewater Treatment Plant, and then discharges treated (primary, secondary and disinfection) wastewater into Puget Sound (PACE and URS Corporation 2000). The Midway Sewer District boundaries do not include any areas within shoreline jurisdiction.

Discharges from the treatment plants are regulated by the Washington Department of Ecology under National Pollutant Discharge Elimination System (NPDES) permits, which include performance standards and monitoring requirements.

3.3.3 Stormwater Utilities

The City of Kent's Storm and Surface Water Utility (KCC 7.05) was established for constructing, operating, maintaining, repairing, improving, and replacing drainage facilities. There are several drainage basins comprised within the Utility, some of which drain into Lake Fenwick, Clark Lake, Lake Meridian, and Big Soos Creek, and then ultimately discharge into the Green River and thus affect shoreline conditions. Other parts of the storm drainage system in the western part of the City discharge into stream systems that drain west into Puget Sound. There are several outfalls directly into the shoreline area, and many more that discharge just outside of shoreline jurisdiction, but subsequently flow into the shoreline area (see Figures 5a-5h). The City of Kent's *Drainage Master Plan* is currently undergoing an update. Some of the goals included in the Plan are outlined below:

> Flood Reduction – minimize existing flooding and prevent increase in future flooding through construction of projects that address existing problems, increased inspection and rehabilitation of the existing system, and increased public education.
>
> Water Quality Improvement - increase efforts to maintain and improve water quality by increasing public education (source control), identifying pollution "hot spots" for possible water quality treatment and by examining City practices and facilities to identify where water quality improvements could be achieved.
>
> Aquatic Habitat – increase efforts to slow the decline of aquatic habitat and create improved conditions that will sustain existing fish populations. Combine hydrological controls, such as regional detention, with in-stream habitat improvement projects within watersheds that currently support fish populations.

NPDES Phase II Permit – evaluate the city's stormwater programs with the Department of Ecology's NPDES Phase II permit requirements.

The City received its final National Pollutant Discharge Elimination System (NPDES) Phase II permit in January 2007 from Ecology. The NPDES Phase II permit is required to cover the City's stormwater discharges into regulated lakes and streams. Under the conditions of the permit, the City must protect and improve water quality through public education and outreach, detection and elimination of illicit non-stormwater discharges (e.g., spills, illegal dumping, wastewater), management and regulation of construction site runoff, management and regulation of runoff from new development and redevelopment, and pollution prevention and maintenance for municipal operations.

The City conducts all of the above at some level already, but additional effort may be needed to document activities and to alter or upgrade programs to meet permit requirements. The City has various programs to control stormwater pollution through maintenance of public facilities, inspection of private facilities, water quality treatment requirements for new development, source control work with businesses and residents, and spill control and response. Monitoring may be required as part of an illicit discharge detection and elimination program, for certain construction sites, or in waterbodies with a Total Maximum Daily Load (TMDL) Plan for particular pollutants. General water quality monitoring was not required in the first five-year term of the Phase II permit. General water quality monitoring concerns include a) stormwater quality, b) effectiveness of best management practices, and c) effectiveness of the stormwater management program.

For surface water control, treatment, and regulation, the City currently follows its 2002 *Kent Surface Water Design Manual*, which is an addendum to the *1998 King County Surface Water Design Manual*. In the future, the City will update its *Surface Water Design Manual* as part of the NPDES Phase II permit requirement. Both Ecology's 2005 *Stormwater Management Manual for Western Washington* and *King County's 2005 Surface Water Design Manual* will be evaluated as the NPDES Phase II permit requires that the City use minimum requirements that are equivalent to Ecology's manual.

Discharges into the tributary streams can have a significant impact on in-stream habitat complexity, peak flow magnitude and duration, bank stability, substrate composition, and a number of other parameters. The water quality impact of stormwater inputs is also significant. Stormwater runoff carries pesticides, herbicides and fertilizers applied to lawns and sports fields; hydrocarbons and metals from vehicles; and sediments from construction sites, among other things. All of these things can harm fish and wildlife, their habitats, and humans.

3.4 IMPERVIOUS SURFACES

Impervious surface is relevant to shoreline functions because of the relationship between impervious surfaces and stormwater runoff. In a number of ways, vegetated areas slow the movement and reduce the quantity of runoff that makes its way into streams and other waterbodies. Increases in impervious surface coverage, and the consequent reduction in soil infiltration, have been correlated with increased velocity, volume and frequency of surface water flows. This hydrologic shift alters sediment and pollutant delivery to streams and other receiving

bodies (Booth 1998; Arnold and Gibbons 1996). Increased surface water flows associated with impervious surface coverage of suburban areas (20-30%) has been linked to decreased bank stability and increased erosion (May et al. 1997). Rainwater can evaporate off of vegetation without ever reaching the ground, infiltrate into the soils where it is taken up by vegetation and evapotranspirated, infiltrate into the soils to recharge groundwater, or move slowly over the surface or subsurface into a waterbody. Impervious surfaces replace vegetation and speed the movement of runoff into waterbodies while increasing the volume of the runoff, and may pick up pollutants in the process.

Table 3 lists separate calculations for impervious surfaces with buildings (single-family building roof lines) and other impervious surfaces. Commercial and multi-family buildings (included as "other impervious area") were updated recently; single-family sites have not been updated since 1999.

Table 3. Known Impervious Surface in Shorelands Associated with each Shoreline.

Shoreline	Single-Family Impervious Area (Acres)	Other Impervious Area (Acres)	Total Impervious Area (Acres)	Total % Impervious Area
Green River (City)	2.18	77.02	79.19	15
Green River (PAA)	0.65	0	0.65	0.6
Soos Creek	0.12	0.22	0.33	3.2
Lake Meridian	7.15	7.48	14.63	19.2
Lake Fenwick (City)	0.01	0.59	0.60	2.7
Lake Fenwick (PAA)	0.44	0	0.44	2.8
GRNRA	0	1.66	1.66	0.9
Panther Lake (PAA)	1.02	0	1.02	1.6
Springbrook Creek	0	1.87	1.87	46.6
Jenkins Creek	0	0	0	0

3.5 SHORELINE MODIFICATIONS

Shoreline modifications are anthropogenic alterations to natural lakeshores, stream and river banks, and nearshore environments, and may include such features as levees, bridges, road embankments, utility crossings, bulkheads, docks or piers, a variety of armoring types (some associated with fill), and other in-water structures such as boatlifts, boathouses, and moorage covers. These sorts of modifications alter the functions of lake and stream channel edges; change erosion, sediment movement, and channel migration patterns; affect the distribution of aquatic vegetation; alter flow dynamics; impact floodplain processes; and are often accompanied by upland vegetation loss. Information about shoreline modifications was derived from several WRIA 9 products (maps and habitat studies), aerial photographs, and brief site visits. Known shoreline modifications are described in greater detail for each shoreline in Chapter 4.0 and illustrated on Figures 7a-7e.

3.6 EXISTING AND POTENTIAL PUBLIC ACCESS SITES

Public access includes the ability of the general public to reach, touch, and enjoy the water's edge, to travel on the waters of the state, and to view the water and the shoreline from adjacent locations.

WAC 173-26-221(4)(c) states that:

> "Local governments should plan for an integrated shoreline area public access system that identifies specific public needs and opportunities to provide public access... This planning should be integrated with other relevant comprehensive plan elements, especially transportation and recreation."

To support this planning, WAC 173-26-201(3)(c) calls for local governments to inventory existing and potential shoreline public access sites, including public rights-of-way and utility corridors. Because shoreline access includes visual access, important views of the water from shoreline areas were also identified.

Information about public access sites in the City was drawn from site visits, aerial photographs, the City's Parks, Recreation and Community Services Department staff and websites, and the City's land use and parks maps. The Green River, Lake Meridian and Lake Fenwick shorelines each have at least one major park that provides physical access to the water for boating or other water enjoyment activities, such as swimming and fishing. Trail systems along the Green River, Green River Natural Resources Area pond, and Lake Fenwick also provide for more passive enjoyment of the shoreline. The Springbrook Creek shoreline area lacks developed public access, other than passive views from a road crossing. However, a park is located upstream of the 20 cfs cutoff point, which contains a user-made trail connecting to two narrow parcels within jurisdiction that are owned by the City. These parcels contain the remaining Springbrook Creek buffer between the stream and the industrial development, and are undeveloped. In order to protect the City's public water supply, Jenkins Creek also has no public access. Existing and potential public access opportunities are described in greater detail for each shoreline in sections of Chapter 4.0 and illustrated in Figures 8a-8h.

3.7 CRITICAL AREAS

The inventory of critical areas was based on a wide range of information sources. A complete listing of citations used to compile information on critical areas is included in Section 8.0, References, at the end of this study. The City's critical areas mapping includes geologically hazardous areas (erosion, steep slope and seismic hazards), wetlands, streams, and critical aquifer recharge areas. This information was supplemented with maps or reports obtained from the Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources (DNR), Ecology, National Marine Fisheries Service, and U.S. Fish and Wildlife Service. Soils mapped by the Natural Resource Conservation Service (NRCS) are shown on Figure 9. Soil types classified as "hydric," or saturated, are indicative of wetland soils. The City's aquifer recharge areas (Figure 12) were identified by the City based largely on NRCS soil information.

Critical areas are described in greater detail for each shoreline in Chapter 4.0 and illustrated on Figures 10 through 14.

3.7.1 Geologically Hazardous Areas

The City's geologic hazard areas are by definition:

> lands or areas characterized by geologic, hydrologic, and topographic conditions that render them susceptible to varying degrees of potential risk of landslides, erosion, or seismic or volcanic activity; and areas characterized by geologic and hydrologic conditions that make them vulnerable to contamination of groundwater supplies through infiltration of contaminants to aquifers (KCC 11.06.320).

The regulations address four types of hazards: erosion, landslide, seismic, and volcanic (Figures 13.1-13.3). Erosion hazard areas are designated based on the soils classification in the *Soil Survey, King County Area, Washington* (USDA 1973) as having a moderate to severe, severe, or very severe erosion hazard potential. Landslide hazards are defined based on the presence of one of nine listed conditions, including slopes steeper than 40 percent with a vertical relief of at least 10 feet and soils listed by *Soil Survey, King County Area, Washington* (USDA 1973) as having a "severe" limitation for building site development. The City has mapped steep slopes and soils, but many of the other criteria are investigated on a site-specific basis so a comprehensive map of landslide hazard areas does not exist. King County has mapped landslide hazards as part of its *2003 King County Regional Hazard Mitigation Plan* (http://www.ci.kent.wa.us/emergency/KentHazards/map_landslide_14.pdf). The determination of seismic hazard areas is based on mapping by others of soils and slopes that have a strong liquefaction potential during an earthquake. Although the City has not created its own map of the volcanic hazard areas, the City has adopted a map prepared by the U.S. Geological Survey (Exhibit 3) and also references King County's map prepared as part of its *2003 King County Regional Hazard Mitigation Plan.*

The following summaries of basic geologic hazard history and risk in the City are excerpted from the *City of Kent Comprehensive Emergency Management Plan – Hazard Identification and Emergency Analysis* (2004b).

> *Landslides.* The topography of the Kent area has historically made the area prone to minor landslides. For the most part these incidents have been in remote locations causing little to no damage. In recent years, however, there has been an increase in the number of residential structures located in areas susceptible to this condition. Heavy snowstorms in December 1996 and January 1997 were followed by a warming trend that caused quick melting, runoff, and flooding. This period was then followed by rain. This led to over 100 slides in King County over the subsequent two-month period. Fissures and sand volcanoes were discovered on sand bars along the Green River following the Nisqually Earthquake on February 28, 2001. Most recently, sliding of both the East and West hills has produced incidents that range from the complete destruction of structures, to the loss of hillside view property.

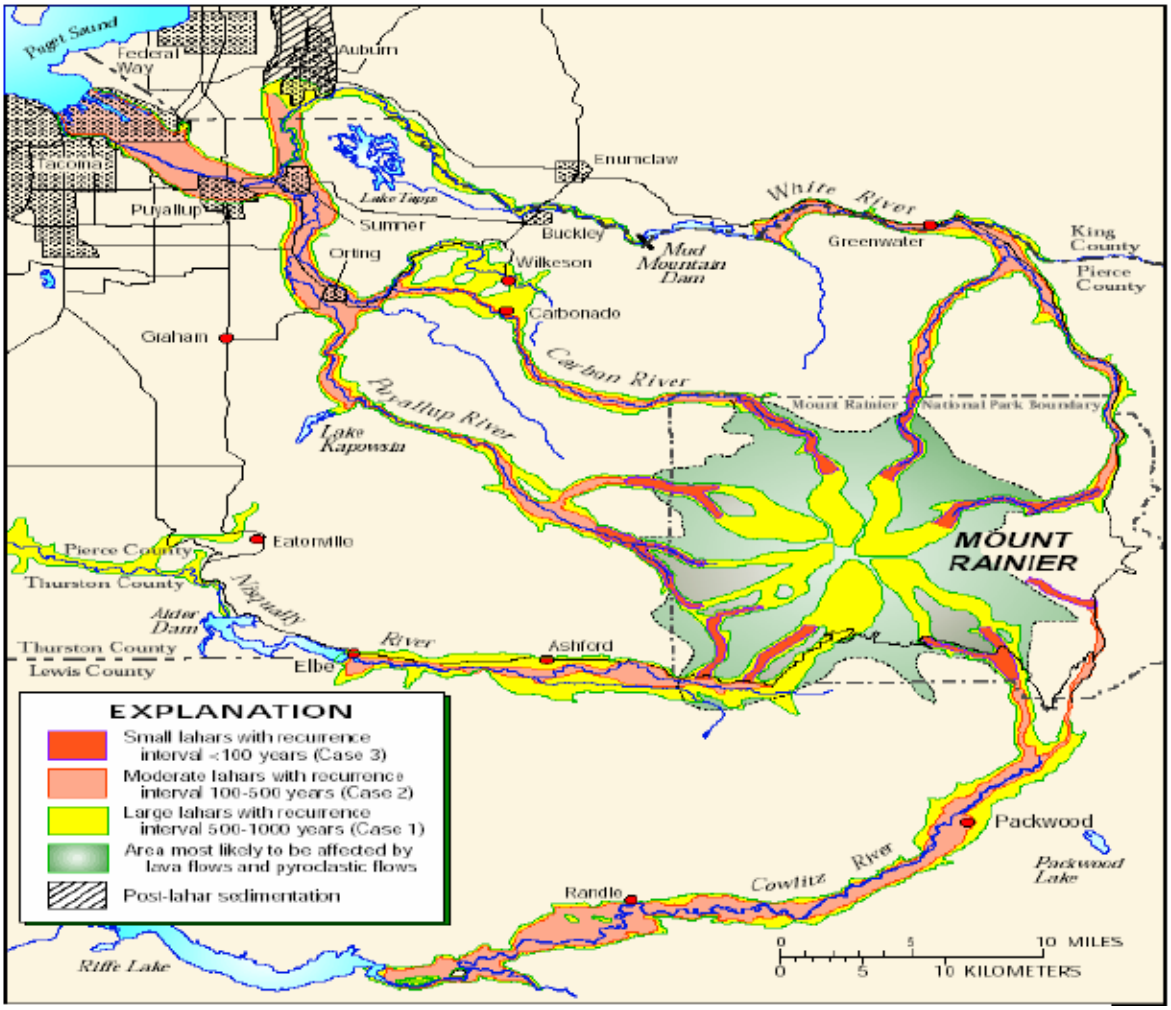


Exhibit 3. Volcano hazards from Mount Rainier, Washington: Pyroclastic-flow hazard zone and inundation zone for Case I, II and III lahars.

Liquefaction. Western Washington and the Kent area have a long history of documented earthquake activity, being located in an area known as the Pacific Ring of Fire. Various local soils and geologic factors affect how the Kent area will fare during an earthquake. The Kent valley is composed of soft materials such as mud, artificial fill and layers of sand and clay that can amplify ground shaking and make overall damage more intense. Soft soils tend to liquefy during an earthquake creating a condition known as "liquefaction." This condition can result in local areas experiencing severe damage, especially where the ground fails (or liquefies) under buildings, pipelines or bridges. Landslides and rock falls may be triggered on steep slopes.

Because the Kent valley contains the largest concentration of older buildings and lies on soil prone to liquefaction, it is likely that this area would be the most heavily damaged in the event of an earthquake. An earthquake of significant magnitude could also cause enough damage to Howard [A.] Hanson Dam and Mud Mountain Dam to create a serious flood hazard in City of Kent Shoreline areas.

Volcanic Eruption. A volcanic event in the Cascade Mountains may occur on[c]e or twice in a lifetime. The Kent area is close enough to be directly affected by eruptions from any one of five volcanoes. We are susceptible to a variety of hazardous situations during a volcanic eruption; perhaps of greatest concern is the threat of large mud flows causing damage to either the Mud Mountain or the Howard A. Hanson Dam[1]. Seismic intensities great enough to damage these dams would be of equal concern.

Geologic evidence shows major lahar and debris flows have filled the Green River valley in the past, although recent models put the Kent area at a minor risk. The overall effects of a major eruption could possibly produce an incident of disaster that could only be compared to the devastation of a major earthquake.

Tephra and ash fall from a volcanic eruption could pose health concerns for residents as well as damage property, interrupt transportation, and disrupt industry and the local commerce.

Earthquake. Western Washington and the Kent area have a long history of documented earthquake activity. Kent is geographically located in an area known as the Pacific Ring of Fire. The same geologic events that result in the creation of volcanoes and volcanic events may also generate notable earthquakes. Western Washington is framed by the Pacific, North American, and Juan de Fuca plates… [G]eologic factors affect how the Kent area will fare during an earthquake. The Kent valley is composed of soft materials such as mud, artificial fill and layers of sand and clay that can amplify ground shaking and make overall damage more intense. Soft soils tend to liquefy during an earthquake creating a condition known as "liquefaction." This condition can result in local areas experiencing severe damage, especially where the ground fails (or liquefies) under buildings, pipelines or bridges. Landslides and rock falls may be triggered on steep slopes.

3.7.2 Flood Hazard Areas

For all practical purposes, "frequently flooded areas" or "areas of special flood hazard" are those areas within the 100-year floodplain and any other areas subject to flooding (WAC 365-195-090(4)) (Figures 10.1 and 10.2). The City of Kent regulates these areas via its Flood Hazard Regulations (KCC 14.09), which are part of Title 14, Buildings and Construction Code.

The following summary of basic flood hazard history and risk in the City is excerpted from the *City of Kent Comprehensive Emergency Management Plan – Hazard Identification and Vulnerability Analysis* (2004b).

Of all possible natural hazards, Kent is most prone to flooding. There are two types of flooding which could conceivably occur in this area:

1) Riverine flooding: Floods which occur because of prolonged rain, melting snow or both. The first element leading to a potential Riverine flood is a heavy, fresh snow in the mountains. If a weather front with warm winds,

[1] It should be noted that the Howard A. Hanson Dam is on the Green River, which does not drain any volcanic peak and is therefore not subject to mudflows from a volcanic eruption.

usually from the southeast, and heavy rainfall follow the snow before it has a chance to settle and solidify, a flood potential exists.

2) Flash flooding and surface flooding: Several factors contribute to flash flooding. The two key elements are rainfall intensity and duration. Topography, soil conditions, urbanization and ground cover also play important roles. Flash flooding occurs within a few minutes to a few hours of excessive rainfall, a dam or levee failure, or a sudden release of water held by an ice or log jam. In addition, localized surface or "urban" flooding occurs as the result of drainage systems that are incapable of carrying exceptional volumes of snowmelt and heavy rain runoff.

The first flooding type is the most likely to occur, with the second being possible as the result of dam or other flood control system failure, such as the Green River levee system.

The Kent Valley was historically inundated by large floods until the construction of the Howard A. Hanson Dam. Since operation commenced in 1962, the dam, in combination with the levee systems also constructed along the Green River, have prevented that degree of flooding and limited flood damages.

Historical flooding from the White River would merge with the Stuck River and spill water to the north and south. The original path of the White River flowed north to the Duwamish valley through Kent, but nature transferred the course to the Puget Sound into Commencement Bay. Mud Mountain Dam was erected in 1948 to prevent massive flooding in South King County and North Pierce County.

The City of Kent experiences flooding to some degree nearly every year, most likely occurring during "flood season" between the months of October and March when rains are the heaviest. The major problems have been lowland flooding and road closures as a result of standing water… The City of Kent has adopted King County's Flood Management Plan, participates in the [King County Flood Control Zone District], and has adopted Flood Hazard Regulations (KCC 14.09) to address impacts of potential development in flood areas. The pending update to the City's Critical Areas Ordinance will address recent state and federal legislation.[1]

The City of Kent and King County Flood Insurance Studies provide additional information about winter flooding events. According to these studies, most floods occur primarily during the winter as a result of heavy rainfall, with snowmelt only contributing secondarily. Urbanization has cumulatively accelerated the amount of runoff reaching the valley floor. During periods of excessive precipitation, surface and subsurface runoff from the steep valley walls cause groundwater elevations in the valley floor to rise significantly. This creates open ponding in topographically depressed areas throughout Kent. This condition is further aggravated by floodflows and corresponding high-water elevations on the Green River, which prevent natural drainage of subsurface and surface water. In other areas, the overlying soils are generally less pervious than the deeper sands, and runoff collects in ponds perched above the water table.

[1] This update was completed in 2005. The City of Kent's *Surface Water Design Manual* also addresses stormwater runoff impacts from new development and redevelopment.

Although not specifically listed as shoreline waterbodies in either jurisdiction, Mill Creek Kent and Mill Creek Auburn pose significant flooding problems in the City of Kent. Intermittent flood hazard areas follow the Creek downstream through the City until the confluence with Springbrook Creek, which is the upstream limit of Springbrook Creek shoreline jurisdiction. These Mill Creek Kent-associated flood hazard areas are upstream of Springbrook Creek, but are not otherwise related to Springbrook Creek and are therefore not part of shoreline jurisdiction.

Mill Creek Auburn has a very significant floodway and floodplain in its lower reach (see Figure 10.1). After it crosses SR 167, it, together with Mullen Slough, becomes a significant storage area floodplain involving backwater from the Green River. Not only a floodplain, it is also designated as a storage floodway, which carries significant restriction on building. Because the Mill Creek Auburn flooding is so tightly related to Green River flows, the floodway and contiguous floodplain areas are considered to be in shoreline jurisdiction.

Implementation of the City's Flood Hazard Regulations will likely be affected by the recent proposal of the Federal Emergency Management Agency (FEMA) to expand its map of the 100-year floodplain to include the entire Kent valley due to FEMA's assumption that the Green River levees would fail in a 100-year flood event. The City believes FEMA's draft map makes incorrect assumptions, and thus has appealed the draft. Where appropriate, river and stream shoreline-specific flood hazard discussions are included below in the Floodplain discussions in Chapter 4.0.

3.7.3 Wetlands

The City's wetland inventory map was updated in 2001 based on field assessments, and was modified in 2004 to incorporate additional wetland delineations that had been submitted to the City. Wetland mapping within portions of the PAA outside of the City's study area is derived from King County GIS as well as consultant investigations. Both mapping efforts used a combination of soils mapping, aerial photographs, National Wetland Inventory maps, submitted reports, and some field inventory (Figure 11). Soils mapped by the NRCS are shown on Figure 9. Soil types classified as "hydric" are indicative of wetland soils. Nine hydric soil types were mapped in portions of shoreline jurisdiction in the City limits and the PAA: Briscot silt loam, Norma silt loam, Oridia silt loam, Puget silty clay loam, Renton silt loam, Seattle muck, Snohomish silt loam, Tukwila muck, and Woodinville silt loam. Mapped wetlands and mapped hydric soils have a high level of overlap.

3.7.4 Streams

Information regarding streams tributary to or originating in the shoreline waterbodies was gathered from WDFW's Priority Habitats and Species (PHS) maps and reports (WDFW 2007), WRIA 9 map products (King County DNR 2001), and other agency resources.

3.7.5 Other Fish and Wildlife Habitat Conservation Areas

Fish and Wildlife Habitat

In addition to the shoreline waterbodies themselves, significant fish and wildlife habitats in the City's shorelines include wetlands and the upland forest areas surrounding Lake Fenwick, Jenkins Creek, and partially Big Soos Creek. Otherwise, most of the shoreline areas are altered

by residential, agricultural, commercial or industrial development. These land uses do provide differing levels of habitat for different species, but those habitat types are not limiting in the watershed and the species served are highly adaptable to urban environments and may be introduced. Some agricultural areas and arguably golf courses do provide valuable habitat for migrating birds, but only because they replicate to some extent floodplain marshes.

Special Status Species

Special status species are species that are listed or proposed for listing under the State or Federal Endangered Species Act or that are identified by WDFW as State Priority Species. All game and food fishes, including salmon, trout, and char, are considered to be Priority Species by the WDFW. In addition, Coastal-Puget Sound bull trout and Puget Sound steelhead trout are listed as threatened by the USFWS and Puget Sound chinook salmon are listed as threatened by NOAA Fisheries. Specific information on fish occurrence and habitat use within the City was provided by the PHS data (WDFW 2007); *Washington State Salmon and Steelhead Stock Inventory* (SASSI) (WDFW 2002); the *SASSI Bull Trout/Dolly Varden Appendix* (WDFW 1998); the *Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region* (Williams et al. 1975); the *Habitat Limiting Factors and Reconnaissance Assessment Report* (Kerwin and Nelson 2000); *Salmon Habitat Plan: Making Our Watershed Fit for a King* (Green/Duwamish and Central Puget Sound Watershed Water Resource Inventory Area (WRIA 9) Steering Committee [Steering Committee] 2005); the *WRIA 9 Strategic Assessment Report – Scientific Foundation for Salmonid Habitat Conservation* (King County 2005); and additional sources as cited in the text.

Although other sensitive species are likely to occur in the City's shoreline areas, according to WDFW, the following special status species are known to occur in one or more of the City of Kent's shorelines:

- Bald Eagles (*Haliaeetus leucocephalus*) (nesting and/or foraging in Green River, Lake Fenwick, Panther Lake, Lake Meridian, Big Soos Creek)
- Pileated Woodpecker (*Dryocopus pileatus*) (Lake Fenwick)
- Bull Trout (*Salvelinus confluentus*) (Green River)
- Chinook Salmon (*Oncorhynchus tshawytscha*) (Green River, Big Soos Creek)
- Chum Salmon (*O. keta*) (Green River)
- Coho Salmon (*O. kisutch*) (Green River, Big Soos Creek)
- Pink Salmon (*O. gorbuscha*) (Green River)
- Sockeye Salmon (*O. nerka*) (Green River)
- Steelhead (*O. mykiss*) (Green River, Big Soos Creek)
- Cutthroat Trout (*O. clarki*) (Green River, Big Soos Creek)

Relevant species are described in greater detail for each shoreline in Chapter 4.0. Special status species locations, except for fish distribution, are not mapped in order to protect nesting sites and other sensitive use areas.

3.7.6 Critical Aquifer Recharge Areas

The City of Kent has mapped critical aquifer recharge areas. As noted in its critical areas regulations, "critical aquifer recharge areas (CARAs) are those areas with a critical recharging

effect on aquifers used for potable water as defined by WAC 365-190-030(2). CARAs have prevailing geologic conditions associated with infiltration rates that create a high potential for contamination of groundwater resources or contribute significantly to the replenishment of groundwater." There are only five CARA polygons mapped in the City of Kent. The only two shoreline management areas overlapped by CARAs are the full Big Soos Creek shoreline in the City and the northern and southern quarters of Lake Meridian (Figure 12).

There are five uses specifically prohibited in CARAs: 1) landfills, 2) underground injection wells, 3) mining, 4) wood treatment facilities, 5) Storage, processing, or disposal of radioactive substances, 6) private wells, and 7) other uses ("Activities that would significantly reduce the recharge to aquifers currently or potentially used as a potable water source or activities that would significantly reduce the recharge to aquifers that are a source of significant base flow to a regulated stream") (KCC 11.06.800). Certain other uses with aquifer contaminant potential (e.g., storage tanks, vehicle repair facilities) must comply with specific regulations contained in KCC 11.06.790.

3.8 FLOODPLAIN AND CHANNEL MIGRATION ZONE

3.8.1 Floodplain

Floodplain boundaries for the Green River, Big Soos Creek, Springbrook Creek and Jenkins Creek were developed from the published and adopted FEMA FIRM maps, and further revised using data developed by King County in early 2008 in response to preliminary maps developed by FEMA in 2007 (Figures 10.1 and 10.2). Lake Meridian, Lake Fenwick, and the Green River Natural Resources Area pond do not have floodplains, although the GRNRA pond is in the Green River floodplain per FEMA's draft map.

3.8.2 Channel Migration Zone

According to definitions in Ecology's Shoreline Master Program Guidelines (WAC 173-26-020), "'Channel migration zone (CMZ)' means the area along a river within which the channel(s) can be reasonably predicted to migrate over time as a result of natural and normally occurring hydrological and related processes when considered with the characteristics of the river and its surroundings." In other words, river and stream channels can move, or migrate, laterally across their floodplains. Channel migration can occur gradually, as a river erodes one bank and deposits sediment along a point bar on the other, or can occur as an abrupt shift of the channel to a new location. Such abrupt shifts are called avulsions, which may happen during a single flood event. The highest rates of channel migration typically occur in zones of rapid sediment deposition, such as where steep rivers flow out of foothills onto flatter floodplains to form an alluvial fan.

Channel migration poses a potential and sometimes underestimated risk to public health and safety. It represents a different type of flood hazard than getting inundated by overbank flow, and can endanger properties and structures located outside of the regulatory floodplain and thus thought to be safe. It may be the least recognized and yet most destructive type of damage that results from flooding. Erosion caused by channel migration can undermine houses, roads, and infrastructure, wash away property, and even threaten lives (http://www.kingcounty.gov/environment/waterandland/flooding/maps/migration.aspx).

In Kent, channel migration zone discussions are relevant for the Shoreline streams and rivers, which include the Green River, Big Soos Creek, Springbrook Creek and Jenkins Creek. Channel migration zones do not typically apply to lakes. No formal channel migration zone study has been done on any of the creeks in the City of Kent, but King County completed a partial study of the Green River in 1993 and updated the associated map in 1999. See Chapter 4.0 for a discussion of the channel migration zones of the Green River and the City's Shoreline streams.

3.9 HISTORICAL OR ARCHAEOLOGICAL SITES

The Washington State Office of Archaeology and Historic Preservation (OAHP) WISAARD website was searched to identify known historical or archaeological features (http://www.oahp.wa.gov/gis/INDEX.CFM). Four sites were identified, all in the Green River shoreline. Site description and general information about Native American use of the Green River is provided in Section 4.1.8.

3.10 OTHER AREAS OF SPECIAL INTEREST

Areas of special interest not included in the other elements of the inventory, such as rapidly developing waterfronts, eroding shorelines, or other degraded sites with potential for ecological restoration were identified based on the references described above and during the field reconnaissance of the study area.

3.10.1 Lake Aquatic Invasive Species

Noxious weeds of Washington State are non-native, invasive plants defined by law as a plant that when established is highly destructive, competitive, or difficult to control by cultural or chemical practices (RCW 17.10). These plants have been introduced intentionally and unintentionally by human actions. Most of these species were brought in without any natural enemies, such as insects or diseases, to help keep their populations in check. As a result, these plants can often multiply rapidly (Ecology and Washington State Department of Agriculture 2004). Species of aquatic noxious weeds found in Lake Fenwick and/or Lake Meridian are listed in Table 4. The two most common invasive species that are impacting the lakes are Brazilian elodea and Eurasian watermilfoil. Information about presence in each lake can be found in Chapter 4.0.

Table 4. Aquatic noxious weeds found in Lakes Meridian and Fenwick.

Common Name	Scientific Name	Growth Habitat	Documented Presence	King County Noxious Weed Classification[1]
Eurasian watermilfoil	*Myriophyllum spicatum*	Submergent	Lake Meridian	Non-designated
White water lily	*Nymphaea odorata*	Submergent	Lake Meridian	Non-designated
Brazilian elodea	*Egeria densa*	Submergent	Lake Fenwick	Class B
Purple loosestrife	*Lythrum salicari*	Emergent	Lake Meridian	Blass B

[1] Class B – control required in King County
Non-designated – control recommended but not required in King County

Impacts

The introduction of any non-native species has an effect on native species and habitats, although it is often difficult to predict those effects. However, there is a growing number of non-native aquatic plant and animal species whose current or potential impacts on native species and habitats are known to be significant. Potential threats may be evidenced by the degree of negative impact these species have upon the environment, human health, industry and the economy (WDFW 2001). Potential negative impacts include:

- loss of biodiversity;
- alterations in nutrient cycling pathways;
- decreased habitat value of infested waters;
- decreased water quality;
- decreased recreational opportunities;
- increased safety concerns for swimmers; and
- decreased property values.

Control

The Washington Department of Fish and Wildlife has set guidelines for aquatic plant control and removal in the pamphlet *Aquatic Plants and Fish*.[1] This serves as the Hydraulic Project Approval (HPA) for any project that is conducted solely for the removal or control of such aquatic noxious weeds, provided that the project is carried out as described in the pamphlet. Mechanical and physical means of removal and control of aquatic noxious weeds are discussed in the pamphlet (more information can be found on WDFW's website). Mechanical and physical methods of removal discussed in the *Aquatic Plants and Fish* pamphlet include hand pulling, hand tools, bottom barrier, weed roller, mechanical cutters, and harvesters. Some mechanical methods may require an individual HPA. If the project calls for any use of herbicides, additional permits are required through Ecology.

Ecology currently issues coverage for aquatic herbicide use under the National Pollutant Discharge Elimination System (NPDES) permit to qualified applicants. The applicant must be a licensed pesticide applicator (WAC 16-228-1545) in the state of Washington and have an aquatic endorsement (WAC 16-228-1545 3[t]). The applicant must agree to comply with all requirements of the permit, including posting public notices, adhering to timing restrictions, complying with the specific application restrictions for each herbicide product, conducting monitoring, performing sampling and analytical procedures, and reporting and recordkeeping (Ecology 2006).

As of 2006, there are seven aquatic herbicides approved for the management of noxious aquatic plants in lakes, rivers, and streams. The characteristics and recommended usage of these herbicides are summarized in Table 5.

[1] [1] The online version of the Aquatic Plants and Fish pamphlet is for informational purposes only and copies of it do not satisfy the requirement to have a copy of the Aquatic Plants and Fish pamphlet on the job site when conducting aquatic plant control operations. An official copy must be obtained from WDFW.

Table 5. Aquatic herbicides approved for use in Washington State waters to control nuisance weeds.

Aquatic Herbicide Name	Type of Herbicide	Targeted Species and Recommended Usage
Glyphosate	Systemic broad spectrum, non-selective herbicide	Floating plants, not submerged plants
Fluridone	Broad spectrum, slow-acting systemic herbicide	Eurasian watermilfoil and Brazilian elodea
2,4-Dichlorophenoxyacetic acid, dimethyl-amine salt	Liquid formulation; fast-acting, systemic, selective herbicide	Selective to Eurasian watermilfoil and Brazilian elodea
Endothall - Dipotassium Salt	Fast-acting, non-selective contact herbicide	Short term (one season) control of a variety of aquatic plants
Diquat bromide	Fast-acting, non-selective contact herbicide	Short term (one season) control of a variety of submersed aquatic plants
Triclopyr	Fast-acting, systemic, selective herbicide	Selective to Eurasian watermilfoil
Imazapyr	Systemic broad spectrum, slow-acting herbicide	Floating plants, not submerged plants
All aquatic herbicides may only be used by an approved licensed herbicide applicator (Ecology; http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html)		

Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants. Rapid-acting herbicides like endothall and diquat may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills. Additional information about invasive aquatic plants and methods of control can be found in the Water Quality section of Ecology's website.

There is often a fine line between whether or not control is biologically necessary or justifiable. Depending on the method of control chosen, there could be disturbance of the substrate, reduction in benthic invertebrates (which are an important food source), and increased risk of spread of the invasive species to other areas. Depending on the condition of the sediments, substrate disturbance can result in acute, although temporary, increases in turbidity and may re-introduce pollutants bound to the sediments back into the water column. In addition, reductions in aquatic vegetation, whether native or non-native, reduce primary productivity, which is the foundation of the lake food chain. This could result in reduced fish production at the top of the food chain (Kahler et al. 2000). However, control of invasive aquatic vegetation may be biologically justifiable where the plants are so dense that dissolved oxygen (DO) levels fall to suboptimal or even lethal levels (2-4 mg/L). DO levels drop below dense surface mats because light is blocked to the submerged aquatic vegetation which produces the majority of the oxygen to the water column. Much of the oxygen produced by the surface mats of vegetation is lost to the atmosphere. Decomposition of submerged dead material also depletes the water column of oxygen. In addition, dense vegetation can reduce wave action at the surface, which would

otherwise help oxygenate the water. Reduced wave action can also contribute to increased water temperature, as the cooler water from deep areas does not flush the warmer, vegetated shallow areas. Warmer water holds less oxygen than cold water.

3.10.2 Water-Oriented Uses

According to Ecology's SMP Guidelines (173-26-020 WAC), "water-oriented use means a use that is water-dependent, water-related, or water-enjoyment, or a combination of such uses." Aside from City parks in shoreline jurisdiction and private and public piers/boat launches on Lake Meridian, no other water-oriented uses have been identified in shoreline jurisdiction. Park-related water-oriented uses are discussed in Chapter 4.0 under the *Existing and Potential Public Access* headings and piers are discussed in Chapter 4.0 under the *Shoreline Modifications* headings.

3.10.3 Toxic or Hazardous Waste Sites

The Department of Ecology regulates certain activities and sites that have potential for adverse environmental impacts, such as sites that use or store hazardous wastes or toxics. Listing as a regulated site does not necessarily mean that the activity occurring on the site is polluting, but that at the very least it has potential for damages and requires some level of monitoring or reporting.

The following sites in or close to the Green River shoreline were mapped on Ecology's Facility/Site Atlas (http://apps.ecy.wa.gov/Website/facsite/viewer.htm) as being active sites regulated by Ecology.

- Julius Rosso Wholesale Nursery Co: This site reportedly contained a leaking underground storage tank, presumably cleaned up prior to Ecology listing the site as inactive in 1998. This site is located on the west side of the Green River, east and west of Frager Road. [This site is inactive, but the City has conducted its own studies of the eastern site when investigating potential for a City purchase of the property. That study "revealed some areas that potentially could have some contamination from vehicle maintenance and repair." In addition, a City consultant indicated that fill material used on the western site could have been contaminated with vehicle fluids (Mactutis, pers. comm., 22 May 2008).

- B&B Partnership Area BB5: This property has been an active voluntary "State Cleanup Site" since 1997. The property is located in a portion of the PAA off of 88th Avenue South, south and west of the Green River.

- Truesoups: This site, located off of 79th Avenue South on the north side of the Green River, has been active since 2005. Because the site stores 10,000 pounds or more of a hazardous chemical or 500 pounds or less, depending on the chemical, of an extremely hazardous chemical on site at any one time, it is required to report annually.

- Kent City Public Works City Shops: The site, located on South 240th Street east of the Green River, has three regulated activities: underground storage tanks (contain regulated substances and has a tank volume of ten percent or more beneath the surface of the ground), leaking underground storage tanks (undergoing clean-up), and general hazardous waste management.

- La Croix Industry Inc.: This fabrication site, located on the east side of the Green River on South 226th Street, is a hazardous waste generator.

- Toys R Us Inc.: This warehouse facility located on the east side of the Green River on Russell Road South is regulated for underground storage tanks and hazardous chemical storage (similar to Truesoups, above).

- Sunset Press Inc: This commercial printing facility, located on the east side of the Green River on 58th Place SE, is a hazardous waste generator.

- Ralcorp Frozen Bakery Products: This business, located on the east side of the Green River on South 190th Street, is a regulated hazardous chemical storage facility.

- West Valley Business Park: This development, located on 72nd Avenue South on the east side of the Green River, is undergoing toxics clean-up.

- Coatings Unlimited Inc. Kent: This facility, located on the east side of the Green River on 68th Avenue South, is regulated in three categories related to hazardous waste generation or use.

The following sites in or close to the Springbrook shoreline were mapped on Ecology's Facility/Site Atlas as being active sites regulated by Ecology.

- Royal Reprographics Inc.: This facility, located on the east side of Springbrook Creek, stores 10,000 pounds or more of a hazardous chemical or 500 pounds or less, depending on the chemical, of an extremely hazardous chemical on site at any one time.

- King Command Foods Inc.: This meat packing facility, located on the west side of Springbrook Creek, stores 10,000 pounds or more of a hazardous chemical or 500 pounds or less, depending on the chemical, of an extremely hazardous chemical on site at any one time. The facility was also issued a water-quality-related enforcement action in 2003.

The following site in or close to the Lake Meridian shoreline was mapped on Ecology's Facility/Site Atlas as being an active site regulated by Ecology.

- Covington Chevron and Car Wash: This facility, located on SE 272nd Street, has underground storage tanks that contain regulated substances.

3.11 OPPORTUNITY AREAS

Ecology's *Shoreline Master Program Guidelines* (173-26 WAC) includes the following definition:

> "Restore," "Restoration" or "ecological restoration" means the reestablishment or upgrading of impaired ecological shoreline processes or functions. This may be accomplished through measures including but not limited to re-vegetation, removal of intrusive shoreline structures and removal or treatment of toxic

> materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions.

Consistent with Ecology's definition, use of the word "restore," or any variations, in this document is not intended to encompass actions that re-establish historic conditions. Instead, it encompasses a suite of strategies that can be approximately delineated into four categories: creation (of a new resource), restoration (of a converted or substantially degraded resource), enhancement (of an existing degraded resource), and protection (of an existing high-quality resource).

There is a critical distinction between restoration and mitigation. Mitigation will require applicants whose shoreline proposals will have adverse impacts to complete actions to mitigate those impacts or provide compensation in other ways for losses of ecological function. Degraded wetland buffers are required to be restored under the City's CAO. The City can encourage applicants to implement restoration actions that will improve ecological functions relative to the applicant's pre-project condition. As stated in WAC 173-26-201(2)(c):

> 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 Opportunity Areas discussions in Chapter 4 present options for "restoration" that would improve ecological functions (Figure 16). For example, enhancement of riparian vegetation, reductions or modifications to shoreline hardening, minimization of in- and over-water structures, and improvements to fish passage would each increase one or more ecological parameters of the City's shoreline. The City or City residents could implement these options voluntarily or, depending on specific project details, they could be required measures to mitigate adverse impacts of new shoreline projects.

Opportunity areas were initially identified during the compilation of the reference materials described above, review of recent aerial photographs, and several brief site visits in Fall 2007. More detailed descriptions of each segment can be found in Section 4.0. Generally, restoration opportunities which have been identified are focused on City property, including parks and open spaces. Many other restoration opportunities exist throughout the City on private property. These opportunities would include many of the same issues as listed above, but would likely occur only through voluntary means or through re-development proposals.

A Restoration Plan document will be prepared in 2008 as a later phase of the Shoreline Master Program update process, consistent with WAC 173-26-201(2)(f). The Restoration Plan will "include goals, policies and actions for restoration of impaired shoreline ecological functions.

These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program." The Restoration Plan will mesh the specific potential projects identified in this report, with regional or City-wide efforts and programs of the City, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline. The City's *2008-2013 Capital Improvement Program* report also includes some projects that will be discussed in greater detail in the Shoreline Restoration Plan.

The *Salmon Habitat Plan: Making Our Watershed Fit for a King* (Steering Committee 2005), which was adopted by the City, lists a number of programs that can and do occur in Kent, but also across the entire watershed, that would contribute to the recovery of habitat basin-wide. The 16 WRIA-wide (WW) actions listed in the Plan are programmatic in nature and range from public education and stewardship to incentives to regulations and regulatory enforcement (Table 6).

Table 6. WRIA-wide Programs Recommended to Support Habitat

Program WW-#	Program
1	Conduct Shoreline Stewardship Workshops and Outreach
2	Increase/Expand Water Conservation Incentive Programs
3	Increase/Expand Natural Yard Care Programs for Landscapers
4	Increase/Expand the Natural Yard Care Program for Single Family Homeowners
5	Promote the Planting of Native Trees
6	Promote Better Volunteer Carwash Practices
7	Increase Public Awareness about What Healthy Streams and Rivers Look Like and How to Enjoy Recreating on Them
8	Increase Involvement of Volunteers in Habitat Stewardship
9	Green/Duwamish Volunteer Revegetation Program
10	Support/Expand the Natural Resource/Basin Steward Programs
11	Expand existing incentives and develop new incentives for property owners to protect salmon habitat.
12	Improve Enforcement of Existing Land Use and Other Regulations
13	Increase Use of Low Impact Development and Porous Concrete
14	Provide Incentives for Developers to Follow Built Green™ Checklist Sections Benefiting Salmon
15	Develop a Coordinated Acquisition Program for Natural Areas
16	Develop Salmon Restoration Tools Consistent with Agricultural Land Uses

The following recommended policy for the lower Green River subwatershed, including Kent, is also taken from the *Salmon Habitat Plan: Making our Watershed Fit for a King* (Steering Committee 2005).

- In the Lower Green River, every opportunity should be taken to set back levees and revetments to the maximum extent practicable. Habitat rehabilitation within the Lower Green River corridor should be included in all new developments and re-developments that occur within 200 feet of the river.

4.0 SHORELINE-SPECIFIC CONDITIONS

4.1 GREEN RIVER

4.1.1 Land Use Patterns

The shoreline of the Green River is split into four key land use categories: Open Space, High Intensity, Residential, and Agricultural. Figures 3a-3c shows the location of these land use categories along the Green River, and Tables 7, 8, 9 and 10 describe them in greater detail.

Unit A – Open Space

This category contains land areas in shoreline jurisdiction generally dominated by Parks and Open Space (OS) and Urban Separator (US) land use designations as set forth in the Comprehensive Plan. The Green River Trail follows along the Green River throughout the City of Kent. In areas where the trail is the only use within Shoreline Jurisdiction, the area was designated in Unit A for open space. In areas where the trail is only a portion of the land use, the area was designated for the other dominant use in the area.

The land uses in this unit are natural areas, trails, open spaces, and parks. A complete list of parks and open spaces is provided in Section 4.1.5.

Riverbend Golf Complex

Green River Trail

Table 7. Existing land uses by sub-unit in Green River Unit A – Open Space.

Sub-Unit	Existing Use
A-1. Open space area on the east side of the river to the north and south of South 277th Street bounded by the City limits	This area is currently designated as US (Urban Separator) in the comprehensive plan and consists of a combination of open land and forested land.
A-2. Foster Park is on the north side of the river generally west of the railroad line and east of the Valley Freeway (SR 167)	Foster Park is a 4-acre greenbelt with walking trails and picnic areas providing visual access to the Green River.
A-3. Riverview Park is on the north and east side of the river just west of the Valley Freeway (SR 167)	Riverview Park is a 14-acre undeveloped park that is located on the Green River.
A-4. Undeveloped area on south river bank with tributary west of	This segment consists of a vegetated open area with a small tributary entering the Green River. This segment is approximately

Sub-Unit	Existing Use
Valley Fwy (SR 167)	500' in length. This area is currently designated AG-S and agricultural activities lie along the outermost margin of the jurisdictional boundaries. The City of Kent purchased this property in 2007 for salmon habitat and floodplain restoration.
A-5. The Riverbend Golf Complex	This segment includes Riverbend Golf Complex separated from the shoreline by approximately 30-80 feet of Green River Trail corridor.
A-6. Golf course and open space on the south and west side of the river from the city limits south of W. Meeker St. to the industrial area north of the golf complex	Riverbend Golf Complex is designated OS (Open Space) and Old Fishing Hole Park is designated US (urban separator).
A-7. Open space on the west side of the river from Cottonwood Grove Park to the residential area approximately 2,400' north of S 228th Street	This area consists of heavily vegetated open space and a frontage road along the shoreline.
A-8. Green River Natural Resource Area	This segment includes approximately 3,500 linear feet of Green River Natural Resources Area (GRNRA) frontage, which includes public water quality facilities, wildlife habitat, and passive recreation trails and views to the west. The GRNRA is largely surrounded by large-scale industrial uses. The Green River Trail occupies the first 75-150' of shorelands adjacent to the shoreline.
A-9. Valley Floor Community Park	This park is primarily undeveloped. There is an old agricultural building and a frontage road within shorelands.
A-10. Green River Trail north of S 212th St and south of Russel Road	The 200-ft shoreline jurisdiction is within the Green River Trail corridor in this area and is designated OS (Open Space). Adjacent to this corridor (outside jurisdiction) is underdeveloped industrial land.
A-11. Future North Green River Park on the east shoreline just south of the City limits.	Primarily passive park with tree cover. The Green River Trail runs along the shoreline.
PAA-A-1. Area within the PAA and City Limits north and east of the river at the easternmost segment of the Green River shorelands within the City and PAA	This segment consists of primarily undeveloped open space and the North Green River Park (currently in King County jurisdiction). There are a few residential lots separated from the shoreline by 94th Pl. S. There is also a large wetland.

Unit B - High Intensity

This category contains land areas in shoreline jurisdiction generally dominated by Commercial (C) and Industrial (I) designated lands. Some Mixed Use (MU) areas are also included.

The commercial uses in the Green River jurisdiction are generally one-story commercial buildings surrounded by surface parking lots. The industrial uses in this area are characterized by self-contained light industry such as warehousing.

Typical industrial development along the Green River

Table 8. Existing land uses by sub-unit in Green River Unit B – High Intensity.

Sub-Unit	Existing Use
B-1. Industrial area north of the river from commercial lot east of Central Ave, generally west and north to Foster Park	This area consists of large-scale industrial uses separated from the shoreline by the Green River Trail corridor. There are some scattered residential lots and underutilized parcels.
B-2. Industrial area south of the river just east of the Valley Freeway (SR 167)	This area consists of large-scale industrial uses and has a land use designation of I (Industrial).
B-3. Industrial area north of the river just east of the Valley Freeway (SR 167) located between Foster Park and Riverview Park	This segment includes large-scale industrial uses with I (Industrial) land use designations.
B-4. Small industrial area north of the river between the Valley Freeway (SR 167) and SR 181.	Industrial activities are separated from the shoreline by the Green River Trail corridor.
B-5. Industrial area located along Russell R. north of S. 228th St and south of the GRNRA	Approximately 2,600 linear feet of this segment has a majority of the shoreline jurisdiction within the Green River Trail corridor, which is designated OS (Open Space). In this area, there is only a small portion of the shoreline jurisdiction within industrial use, which is designated I (Industrial). For approximately 1,100 linear feet of the shoreline, industrial use dominates. This area is also surrounded by the GRNRA to the east.
B-6. Industrial area along east side of the river north of S 200th St.	This area consists of industrial buildings, warehouses and office buildings typical of lands designated industrial. The industrial uses are separated from the shoreline by the Green River Trail corridor.
B-7. Industrial and commercial area east of SR 181 and south of SW 43rd Street	A small buffer and SR 181 are adjacent to the river in this area. The east side of SR 181 is designated as Commercial and Industrial. The northern corner of this area has a land use classification of Commercial (C). The parcel looks like it had a commercial building on it at one point, but it is currently vacant. The rest of the area has a land use classification of Industrial (I). A hotel and a single-family residence are the existing uses in this area.
PAA-B-1. Shorelands in the potential annexation area (PAA) generally south of the river and west of the Valley Freeway (SR 167)	This segment consists primarily of a wrecking yard and other open industrial uses.

Unit C – Residential

This category contains land areas in shoreline jurisdiction generally dominated by Single Family (SF 4.5, SF 8), Low Density Multifamily (LDMF), Medium Density Multifamily (MDMF), and Mobile Home Park (MHP) designated lands.

The single-family area on the west side of the river south of South 212th Street is characteristic of single-family development in the Green River shoreline jurisdiction, with fairly small-lot single-family homes.

The multifamily development south of South 228th Street on the east side of the Green River and the multifamily development south of SR 516 and west of SR 181 that follows the loop of Frager Road are both characteristic of townhouse-style multifamily development within the Green River shoreline jurisdiction.

A few mobile home parks also exist within shoreline jurisdiction.

Example of residential development along the Green River with the Green River Trail.

Table 9. Existing land uses by sub-unit in Green River Unit C – Residential.

Sub-Unit	Existing Use
C-1. Residential area north and west side of the Green River east of Central Ave	This segment includes multifamily residential development separated by the greenbelt and trail for the first 800 feet. The segment then includes multifamily residential and mobile home courts, separated by the roughly 40- to 60-foot-wide Green River Trail corridor.
C-2. Residential area on north side of the river from one property west of SR 181 to the golf course at Russell Rd	This segment consists of approximately 6,500 linear feet of multi-family residences separated from the shoreline by 150' wide Green River Trail and open space corridor. The houses are relatively new town house and low-rise multi-family type residences.
C-3. Residential area on east side of River from James Street north to S 228th Street	This segment consists of approximately 4,000 linear feet of multifamily residential residences separated from the shoreline by 100' wide Green River Trail and open space corridor. The residences are relatively new town house and low-rise multi-family type residences.
C-4. Residential area on west side of River south of S 216 Street	This segment consists of approximately 1,200 linear feet of single-family residences separated from the shoreline by a frontage road. The residences are relatively new. North of the existing residences is a stretch approximately 5,000' long of generally vacant land that is zoned and platted for new single-family residences. North of that is

Sub-Unit	Existing Use
	approximately another 1,000' of large lot single-family residences.
C-5. Recreational Vehicle (RV) Campground (KOA) on east side of the river south of S. 212th St. and north of the GRNRA	This segment consists of a small KOA campground that allows recreational vehicles designated MHP (mobile home park) in the Comprehensive Plan. The development is not fully used and it is separated from the shoreline by the Green River Trail corridor and Russell Road.

Unit D – Agricultural.

This category contains land areas in shoreline jurisdiction generally dominated by Agricultural Resource (AG-R) and Agricultural Support (AG-S) designated lands. The agricultural areas that exist within the Green River's shoreline jurisdiction are primarily pasture land

Table 10. Existing land uses by sub-unit in Green River Unit D – Agricultural.

Sub-Unit	Existing Use
D-1. South of the river just west of Valley Freeway (SR 167)	This segment consists of agriculture uses for about 2,400 linear feet within the shoreline jurisdiction. The majority of this area is designated as AG-S (Agricultural Support), with a small area designated AG-R (Agricultural Resource) in the northwest corner of the segment. This segment continues a considerable distance to the south because of the inclusion of joint Mill Creek Auburn/Green River floodway/floodplain in shoreline jurisdiction.
D-2. Agricultural activities on the west side of the river from Riverbend Golf Course to Cottonwood Grove Park	This segment includes agricultural activities including green houses. This area is designated US (urban separator) in the comprehensive plan.
D-3. Agricultural area on west side of river south of S. 212th Street	This area consists of agricultural uses separated from the shoreline by a frontage road. It is undergoing single-family residential development.
C-4. Residential area on west side of River south of S 216 Street	This segment consists of approximately 1,200 linear feet of single-family residences separated from the shoreline by a frontage road. The residences are relatively new. North of the existing residences is a stretch approximately 5,000' long of generally vacant land that is zoned and platted for new single-family residences. North of that is approximately another 1,000' of large lot single-family residences.
D-4. Agricultural lands north of Valley Floor Community Park	This segment consists primarily of agricultural activities.

4.1.2 Transportation

There are 13 major crossings of the Green River within City limits and the PAA:

- Freeways: SR 167, SR 18, and SR 516
- Principal arterials: South 212th Street, SR 181, East Valley Road
- Minor arterials: South 200th Street/Russell Road South, South 228th Street, West Meeker Street, South 277th Street (PAA)
- Industrial collector arterial: 78th Avenue South (PAA)

- Railroads: Union Pacific Railroad, Burlington Northern Santa Fe Railroad

In addition, there are four small bridge crossings: one connecting the two sides of the Riverbend Golf Complex near West Meeker Street, a pedestrian bridge connecting east and west river trails near the Green River Natural Resources Area, a pedestrian bridge below SR 516, and a small bridge in the PAA just south of South 277th Street. Several roads parallel the river for relatively long distances, including Frager road on the west/south sides of the river, Russell Road on the east/north sides of the river, and Green River Road in the PAA. Otherwise, numerous smaller roads approach the shoreline or parallel it for short distances, and the Green River Trail parallels the river, often on both sides.

The City's *Six Year Transportation Improvement Program 2008-2013* describes four project segments in the Green River shoreline:

1. West Meeker Street Widening Phase I (Project 30): Project 30 will widen and improve West Meeker Street from 64th Avenue South to the Green River Bridge.

2. West Meeker Street Widening Phase II (Project 31): Project 31 will widen West Meeker Street between Lake Fenwick Road and the east side of the existing bridge. A major project element will be the construction of a new bridge.

3. SR 167 Corridor Plan (Project 38): The City of Kent will be supporting the planning and design of the SR 167 improvement project, which will address capacity problems that adversely affect the City's roadways. Ultimately, SR 167 will have an additional lane in each direction, likely resulting in bridge expansion over the Green River.

4. Central Avenue South Pavement Rehabilitation (Project 20): Project 20 will rehabilitate the road surface from the Green River bridge north to East Willis Street and make "minor storm drainage improvements" (undefined).

4.1.3 Wastewater and Stormwater Utilities

Wastewater Utilities

All Green River shoreline areas within the City are provided with sewer service by the City. There are numerous sewer lines near the outer edge of shoreline jurisdiction and just outside of shoreline jurisdiction (Figures 4a-4c). There are three City force main crossings of the Green River: one west of the Green River Natural Resources Areas, one at South 212th Street, and one at South 231st Way. In addition, a 24-inch King County Metro force main crosses the Green River at West Meeker Street, a 72-inch force main crosses just east of SR 167, and a 54-inch force main crosses at South 277th Street. Additional sewer line connections are proposed that would cross the river or otherwise cross or parallel shoreline jurisdiction.

Stormwater Utilities

According to the City's map of surface drainage facilities, approximately 26 stormwater outfalls are located within Green River shoreline jurisdiction (Figures 5a-5c). It appears that much of the stormwater flow in the area is initially routed away from the Green River, and funneled into

ditches and streams that ultimately lead to the Green River, often, but not always, via detention and treatment facilities.

4.1.4 Shoreline Modifications

The mainstem Green/Duwamish River, including the portion of the Lower Green River flowing through Kent, is among the most hydrologically and habitat-altered of the large river systems flowing into Puget Sound. Changes in the landscape began when early Euro-American settlers began changing the landscape when they settled the lower basin beginning sometime around 1850. These early settlers began altering the habitats of the lower river valley in the vicinity of what is now Kent and Tukwila, and bank hardening projects probably started with the first railroad bridges in 1867. Levee construction was initiated before 1875, the White River was diverted into the Puyallup River basin in 1906, the Cedar/Black River[1] was diverted into Lake Washington in 1916, the City of Tacoma water diversion dam was finished in 1913, and Howard A. Hanson Dam was completed in 1962. Most of the Duwamish estuary had been filled by 1940. Currently, runoff from 70 percent of the historic watershed area has been diverted out of the basin, and over 90 percent of the historic floodplain is no longer connected due to these diversions and the construction of flood protection structures, including Howard A. Hanson Dam (Kerwin and Nelson 2000).

A systematic, programmatic approach for the hydromodification of the Green River was put forth by Colonel Howard A. Hanson of the U.S. Army Corps of Engineers in his landmark publication, “More Land for Industry” (Hanson 1957). This document promoted an incremental, systematic scheme for the channelization and dredging of the Duwamish estuary and for permanent flood containment throughout the Lower Green River valley by means of a massive levee construction program and the construction of the Howard A. Hanson Dam. Prior to 1961, the historic agricultural levee system along the Green River was constructed and maintained by King County through acquisition of easements and construction of a vast, unwieldy array of levees and revetments financed by municipal bonds. These levees were constructed by King County crews employing draglines to clear and shape the bank, place riprap, and remove logs and stumps from the river channel. The program was active from the early 1960s through the mid- to late 1970s.

Systematic suppression of riparian plant growth was also undertaken in order to comply with eligibility guidelines for local levee systems to be included in the federal levee flood damage rehabilitation program administered by the U.S. Army Corps of Engineers under Public Law (PL) 84-99. County compliance with this federal de-vegetation requirement was informally suspended in 1989, and formally addressed in the 1993 King County Council-adopted King County Flood Hazard Reduction Plan (FHRP), Policies FHR-10 and G-7 (King County 1993). Project-by-project consideration of these policies with respect to Green River levee maintenance has resulted in incremental establishment of riparian shrub communities on several levee segments along the lower river, and to the formal disqualification of these same segments from eligibility for federal rehabilitation assistance to repair flood damages (Kerwin and Nelson 2000).

[1] The Black River, which formerly drained south Lake Washington to the Green River, now only exists in a remnant channel section.

In 1960, the Green River Flood Control Zone District was created with the concurrence of the Cities of Auburn, Kent, Renton and Tukwila. This district is a quasi-municipal corporation and independent taking authority of the state, with the goal of operating, maintaining and repairing river flood protection facilities and pump stations within the lower Green River watershed. The King County Department of Natural Resources serves as the lead agency of the District.

In 2006, the County Council adopted the King County Flood Hazard Management Plan, which identifies a number of steps to be taken to address flooding issues in King County. Following the adoption of that plan, in 2007, the King County Flood Control Zone District was established. According to the District's web site, this agency "will be instrumental in addressing the backlog of maintenance and repairs to levees and revetments, acquiring repetitive loss properties and other at-risk floodplain properties, and improving countywide flood warning and flood prediction capacity". It is chartered as an independent special purpose district of the State, as authorized by RCW 86.15.

The Lower Green River borders or flows through the City of Kent roughly between RM 14.5 and RM 28. In the Lower Green River sub-watershed, over 80 percent of the riverbanks are lined with levees or revetments, and these levees typically line both banks of the river at any given location (see Figures 7a-7c). The primary function of revetment construction is the mechanical armoring of natural riverbank soils against slumping, sloughing, scour and downstream transport of eroded materials, all to protect the stability of the adjoining lands. Though these structures (artificially) maintain bank stability and prevent erosion, they also prevent many natural geomorphic processes from occurring, including channel migration, avulsion, braiding, large woody debris (LWD) recruitment, and the formation of undercut banks. The continuance of these processes is needed to provide and maintain important habitat for salmonids. The channel migration zone along the Lower Green River has effectively been eliminated, in large part due to the construction of the levee system (Kerwin and Nelson 2000).

4.1.5 Existing and Potential Public Access Sites

The City of Kent provides fairly continuous public access to the Green River through public parks, greenbelts, and trails. The existing public access sites provide for a number of water-oriented uses including water-dependent uses such as fishing, swimming, and boat launching. They also provide for water-related and water-enjoyment uses such as trails, picnic areas, and playfields that benefit from the visual connection to the water. A majority of the open spaces along the river are connected by trails or greenbelts, providing an interconnected system of open space and access to the Green River. There are a few gaps in the open space connections where potential trail continuations could be pursued. Undeveloped public spaces also have the potential to improve public access to the Green River.

Beginning at the northern City limits, the following public properties provide public access to the Green River:

- Green River Trail: The Green River Trail is a 10-mile walking/biking trail that runs south from Briscoe Park and connects numerous parks and greenbelts along the Green River. The trail provides public access for fishing, as well as picnic areas and benches. There are numerous points of access along the trail throughout the City limits. A number of the parks located along the Green River provide parking areas and access for trail users.

Also of note is that the Green River Trail is part of a regional trail system with connections to the Interurban Trail and northward to the Mountains to Sound Greenway, the Elliott Bay Trail, and the Burke-Gilman Trail. While portions of the northern trail links are not yet constructed, the system will ultimately make the Green River shoreline accessible to cyclists from vast portions of the County.

- Briscoe Park: Briscoe Park is a 7-acre park that has trails, fishing areas, a hand carried boat launch, as well as picnic areas and a playfield.
- Three Friends Fishing Hole (Gateway Park): This 3-acre park provides access to the Green River Trail, a fishing area, and a picnic area.
- Valley Floor Community Park: This park is a 50-acre undeveloped open space. It has great potential to provide both physical and visual access to the Green River.
- Anderson Park: Anderson Park is a very small park that provides visual access to the Green River. The park includes picnic tables and a drinking fountain.
- Green River Natural Resources Area: This 304-acre site is a combined stormwater detention and enhanced wetland facility that provides a rich diversity of wildlife habitat. In addition, it provides both visual and physical public access to the Green River through bike and walking trails.
- Van Doren's Landing Park: This 10-acre park includes trails, fishing areas, a hand-carried boat launch in addition to playfields and picnic areas.
- BMX Park: This half-acre bike park provides visual access to the Green River.
- Russell Woods Park: Russell Woods Park is a 3.38-acre park that provides entry onto the Green River Trail and includes fishing areas.
- Cottonwood Grove: Cottonwood Grove is a small park that provides visual access to the Green River.
- Riverbend Golf Complex: The Green River runs through the 167-acre Riverbend Golf Complex. The golf complex provides visual access to the river.
- Old Fishing Hole: The Old Fishing Hole is a 5.7-acre park that provides fishing areas and public docks.
- Riverview Park: Riverview Park is a 14 acre undeveloped park that is located on the Green River.
- Foster Park: This 4-acre greenbelt has walking trails and picnic areas and provides visual access to the Green River.

- North Green River Park: This 169.1-acre King County Park provides visual access to the Green River in addition to numerous recreational opportunities including soccer fields, garden plots, and trail access.

4.1.6 Critical Areas

Geologically Hazardous Areas

Except for seismic hazard areas, geologically hazardous areas in the Green River shoreline are limited to very small areas at the intersection of the valley floor with the toe of the East Hill and West Hill areas (Figures 13.1-13.3). These junctures contain steep slopes (>40%) and landslide-type soils. Virtually the entire valley floor is a seismic hazard area.

Wetlands

The City's wetland map shows a number of very large wetland areas and numerous smaller wetlands that still remain along the Green River and scattered throughout the Green River floodplain (as preliminarily mapped by FEMA) (Figure 11). The City has not classified these wetlands, but aerial photograph examination shows that they are of a wide variety of types, ranging from high-quality forested wetlands along the West Hill foothills and in other scattered patches to actively farmed wetlands. Many of the wetlands appear to have little to no buffer and are completely surrounded by development and roads. A large proportion of the wetlands appear to be hydrologically connected to other wetlands by a network of ditches, many of them likely meeting wetland criteria as well. Although the City does not regulate wetlands in man-made ditches, the U.S. Army Corps of Engineers may regulate them in some circumstances. The higher-quality wetlands are generally located in lands designated by the Comprehensive Plan as either Urban Separator (US) or Parks and Open Space (OS). The most impacted wetlands are in areas planned and developed for industrial and manufacturing uses.

Streams

Several streams pass through the City of Kent's Green River shoreline management area and discharge into the Green River within the City (Figure 14). These include left (west) bank tributaries of Mill Creek Auburn (Auburn, WRIA 09-0051), Mullen Slough (WRIA 09-0045), an unnamed creek (WRIA 09-0041), and Johnson Creek (WRIA 09-0038). Springbrook Creek (WRIA 09-0005) and its tributary, Mill Creek Kent, flow through the City on the east side of the Green River, but do not pass through any Green River shoreline areas. However, the section of Springbrook Creek extending for approximately 450 feet downstream of the Mill Creek Kent confluence to the City limits at S. 180th Street is designated as a shoreline water in its own right. Springbrook Creek joins the Green/Duwamish River to the north of the City via the Black River pump station. Information regarding each of these streams was gathered from WDFW's Priority Habitats and Species (PHS) maps and reports (WDFW 2007) and WRIA 9 map products (King County DNR 2000). Of these streams, Mill Creek Auburn, Mullen Slough, and streams in the Springbrook Creek basin are known to support fish use, including chinook (juvenile use at the mouths) and coho salmon and cutthroat trout.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitat: The Green River shoreline contains several priority habitat types as identified by WDFW (2007): urban natural open space, wetlands, and riparian zones. These habitat areas

are shown on Figure 14 and in general are the only areas of Green River shoreline that have diverse, native vegetation communities with multi-story structure. Several of the palustrine wetlands mapped by WDFW have been replaced with residential or industrial developments. The majority of other undeveloped areas in the Green River shoreline are either agricultural land or narrow corridors along the river that contain the levee and trail. Upland habitat conditions in these corridors are largely Himalayan blackberry, non-native landscaping, other weeds, or mowed grass. Patches of trees, primarily red alder and black cottonwood, can be found in some areas along the river.

The highest-quality riparian habitat associated with the City along the Green River is found in the PAA at the south end of the City upstream of Horsehead Bend. The levee protection is intermittent, allowing a slightly more meandering natural channel compared to downstream areas already within City limits. Wider, wooded buffers are accommodated between the river and the adjacent agricultural lands and open space.

Special Status Species: The *Washington State Salmon and Steelhead Stock Inventory* (SASSI) (WDFW 2002) distinctly identifies one chinook, two chum, one coho, and two steelhead stocks as spawning in the Green River basin. One bull trout stock has also been identified as inhabiting the basin (WDFW 1998), and the basin is used by sea-run coastal cutthroat trout as well. Given that the sections of the Green River within City of Kent Shoreline jurisdiction are fairly low in the basin, most of the fish comprising these anadromous stocks must pass through the City's jurisdiction at least twice to successfully complete their life cycles.

Chinook salmon are relatively abundant in the Green River basin, in large part due to the presence of the state salmon hatchery on Green River tributary Soos Creek. Chinook escapement from 1986 to 2003 ranged between approximately 2,500 and 21,400 fish (WDFW 2002).

Although no bald eagle nests are mapped or known in the Green River shoreline area, they are likely to forage in the river. Bald eagles would prey on adult salmonids, as well as concentrations of waterfowl.

4.1.7 Floodplain and Channel Migration Zone

Floodplain

The combined effects of the levees along the river through the City and the construction of the Howard A. Hanson Dam, which was completed in 1962, have prevented flooding from the Green River in most areas. The last high-flow event on the Green River that exceeded the USGS flood elevation of 64 feet (at gage 12113000, near Auburn) was in November 1959. Approximately $1.5 million in damages was reported in that event, and agricultural lands were either buried under sand deposits left behind by flood waters or had their topsoils removed by the flood (Stein 2001a). Prior to that, historic photographs show flooding in Kent for nine out of 40 years, between 1906 and 1946 (Collins and Sheikh 2005).

FEMA's draft map of the revised Green River floodplain (dated 28 September 2007) includes the entire Kent valley due to FEMA's assumption that the Green River levees would fail in a 100-year flood event. The City believes FEMA's draft map makes incorrect assumptions, and thus

appealed the draft in early 2008, in cooperation with King County and other Green River valley cities. The appeal was based on the March 2008 King County "Lower Green River Mapping Study," which revised FEMA's draft 2007 map. The 2008 King County appeal map was accepted by FEMA and is anticipated to be incorporated into the new preliminary Flood Insurance Rate Maps. The resulting floodway and floodplain boundaries in the City of Kent are shown on Figures 10.1 and 10.2. Adoption of a final Green River floodplain map would likely not occur until after SMP adoption. As previously mentioned, not all of the King County-mapped floodways are considered shoreline jurisdiction under the SMA definition of floodway. The only jurisdictional floodway/floodplain area is that associated with the Mill Creek Auburn/Green River interaction.

Channel Migration Zone

As mentioned in Section 3.8.2, King County completed the *Green River Channel Migration Study* in 1993 and updated the associated map in 1999 (Figure 10.2[1]). Of note, the mapped channel migration zone (CMZ) extends upstream from approximately RM 25.4 in Kent, near the Central Avenue South crossing just downstream of Horsehead Bend. As such, no channel migration zone is mapped for most of the Green River length through the City (extending downstream from approximately RM 25.4 to the City limits near RM 15.8) because it is assumed that the existing flood control levees closely lining the banks will be maintained to prevent such migration. Small areas of the City adjoining the river upstream of RM 25.4 are, however, within the mapped CMZ. These include areas along the right bank of the river (facing downstream) near Horsehead Bend and the South 277th Street crossing. In addition, potentially annexed areas (PAAs) extending roughly between 86th Avenue South and South 277th Street along both sides of the river include mapped CMZ areas. Channel migration zones associated with the City are mapped as either moderate hazard or severe hazard areas.

Levees had already been constructed along the mainstem Green River in the lower Green River sub-watershed by the time the earliest maps of the river channel were produced in 1907, so it is difficult to determine the historic extent of the CMZ along the river through most of the City (Kerwin and Nelson 2000). Old meander scars suggest the channel would have had access to the entire valley bottom at some time in the past and the CMZ, depending on time scale, may have encompassed the entire width of the valley. Over 90 percent of the channel in the lower Green River sub-watershed is now confined between levees, however, and the channel alignment has changed little since 1907 (Kerwin and Nelson 2000). Hence there is now effectively no channel migration zone associated with the river in the lower Green River sub-watershed, which encompasses nearly all of the City of Kent.

4.1.8 Historical or Archaeological Sites

According to the Office of Archeology and Historic Preservation's (OAHP) WISAARD (Washington Information System for Architectural and Archaeological Records Data) website, there are four sites of historical interest located in the City of Kent's Green River shoreline area.

[1] Note: The CMZ area shown on King County iMap on the north side of Horseshoe Bend is incorrect and does not match the 1993 King County Channel Migration Study. Per page 41 of the study, the Green River levee is considered a fixed boundary beyond which channel migration will be prevented (pers. comm. Terry Butler, King County, May 19, 2009).

Maddocksville Landing: Maddocksville Landing, named after Moses Maddocks who staked his claim to the site in 1861, was the site of one of the first settlements in the White River Valley (http://www.dahp.wa.gov/gis/pdfs/284.pdf). It is located just downstream of Van Doren's Landing Park on the east bank of the river. Mr. Van Doren operated a ferry landing at this site, which received goods, people and mail. The "landing" consisted only of a sandy river bank, now vegetated by Himalayan blackberry; no structures could be constructed because of flood events. The site is listed on the Washington Heritage Register.

Alvord's Landing: Thomas and Julia Alvord established Alvord's Landing in 1860, the farthest upstream accessible landing to steamers (http://www.dahp.wa.gov/gis/pdfs/285.pdf). It is located in south Kent, east of SR 167 and just north of South 262nd Street. Similar to Maddocksville Landing, the "landing" consisted only of a sandy river bank, now vegetated by Himalayan blackberry. According to the registration documents, this landing was "very significant in the development of that agricultural area." The site is listed on the Washington Heritage Register.

Langston's Landing: Langston's Landing was established in 1867 on the riverbank at the west end of what is now Willis Street, just west of SR 167 (http://www.dahp.wa.gov/gis/pdfs/286.pdf). Langston's Landing currently has no structures or other indicators of its historical use as a regionally important ferry site between the east and west banks and as a landing for stern wheel river boats that dropped off goods and supplies. The "landing" consisted only of a sandy river bank, now vegetated by Himalayan blackberry; no structures could be constructed because of flood events. The site is listed on the Washington Heritage Register.

The Green River and the landings provided an important connection between the Green River valley settlers and the City of Seattle. Produce from the farms was delivered to Seattle for sale, at first by canoe and later by steamers, and important goods not produced on the farms could be purchased.

Neely House: Original construction on the home of David F. Neely occurred in 1885, with subsequent additions in 1900 and 1954 (http://www.dahp.wa.gov/gis/pdfs/422.pdf). It is one of the oldest houses in Kent, constructed during a time when settlers were first arriving in the valley from the East. The City of Kent Parks and Community Services Department owns and manages the house, and completed major renovations in 1999 and 2000 (http://www.ci.kent.wa.us/kentcommons/rooms/neelysoameshouse.asp). The house and grounds are open to the public and can be rented for special events.

Although the entire Green (White) River valley was likely inhabited or utilized by Native Americans at least 7,000 years ago, and even earlier, the subsequent modification of the Green River channel and the deposition of sediment by the river during flood events has limited the number of discovered sites in the Kent area (Forsman and Lewarch 2001). The Green River valley was used for fishing, hunting, and root- and berry-gathering. In what is now Renton, archeologists have identified former hunting, fishing, and wapato-harvest camps (Forsman and Lewarch 2001). Similar camps are expected to have been present in Kent "on old river levees adjacent to abandoned river channels." However, no camps have yet been found in Kent. The native peoples were named based on their village, but are now known collectively as the

Muckleshoot tribe. One of the Kent-area communities was named Steq, and was the birthplace of Chief Seattle's mother (Forsman and Lewarch 2001).

The first European settlers came to the valley in the mid-1800s to farm the rich floodplain soils. At first, relations were cordial as the Native Americans were eager to trade. However, as the settlers took up more land and tightened river access, tensions built. Other Puget Sound tribes were signing treaties and being relocated to reduce conflict. The Green River valley populations resisted, and the Seattle Indian Wars began in 1855 after the Native Americans killed nine people. Troops quelled the fighting and the Green River tribes relocated to a King County reservation (Stein 2001b).

4.1.9 Opportunity Areas

WRIA 9 Projects

The following policy statement and recommended project actions (see Figure 16) are taken directly from the 2005 *Salmon Habitat Plan: Making Our Watershed Fit for a King* for the lower Green River subwatershed, including Kent. The lower Green River subwatershed extends from River Mile 11 to River Mile 32, including those reaches adjoining Kent roughly between River Miles 14 and 26. Only those projects in or bordering the City of Kent are described below. As stated in the *Salmon Habitat Plan*, this policy and these project actions are intended to:

- Protect and restore habitat that provides refugia (particularly side channels, off channels, and tributary access) and habitat complexity (particularly pools) for juvenile salmon over a range of flow conditions and at a variety of locations (e.g., mainstem channel edge, river bends, and tributary mouths);

- Enhance natural sediment recruitment (particularly spawning gravels) by reconnecting sediment sources to the river.

Policy LG-1: In the Lower Green River, every opportunity should be taken to set back levees and revetments to the maximum extent practicable. Habitat rehabilitation within the Lower Green River corridor should be included in all new developments and re-developments that occur within 200 feet of the river.

Project LG-3 - Horsehead Bend Off-Channel Habitat Restoration at RM 26 (Left Bank): This project would excavate an off-channel habitat through a terrace in a manner that would avoid potential fish stranding. The channel would be approximately 950 linear feet in length and would follow the old river channel, terminating at a depression located on the east side of the terrace. The project also would rehabilitate floodplain wetland habitat, plant native riparian vegetation, and add large woody debris. [Note: this project is also identified as #19 by the Duwamish/Green River Ecosystem Restoration Project]

Project LG-4 - Horseneck Off-Channel Habitat Restoration at RM 25.9 (Left Bank): This project would excavate backwater off-channel flood refugium to create juvenile salmonid rearing habitat, restore floodplain wetland habitat, add large woody debris, and plant native wetland and riparian vegetation at the Horsehead/Horseneck site.

Project(s) LG-7 - Lower Mill Creek, Riverview (Formerly Green River) Park, Hawley Road Levee, Lower Mullen Slough, and Lower Mill Creek Restoration Between RM 21.3 and 24 (Both Banks): This suite of projects would be coordinated on lands that are adjacent to and/or share a floodplain. Overall goals are to restore habitat along the mainstem and lower sections of Mill Creek [Auburn] and Mullen Slough by:

- Creating off-channel habitat for rearing and flood refugia and over-wintering habitat;
- Reconnecting mainstem and tributaries with portions of the floodplain;
- Setting back levees to improve bank conditions and create shallow water vegetated benches;
- Installing anchored large woody debris; and
- Controlling invasive plant species and planting with native plants.

These projects are being coordinated by the City of Kent, King County, and the U.S. Army Corps of Engineers. Sub-projects include:

Lower Mill Creek Floodplain Wetland and Off-Channel Habitat Rehabilitation	This project includes restoration of the lower 0.3 miles of Mill Creek [Auburn] and adjacent segments of the currently armored riverbank. The project would include excavation of off-channel habitat on the right bank of Mill Creek [Auburn] and reshaping the stream banks and the mainstem left bank of the Green River. This would create a more complex channel and aquatic edge habitat that includes off-channel habitat and large woody debris. Nine acres of off-channel and riparian habitat would be created adjacent to lower Mill Creek [Auburn] and approximately 1,600 lineal feet of lower Mill Creek [Auburn] would be restored.
Riverview (Formerly Green River) Park	This project is located opposite from the mouth of Mill Creek [Auburn], on the right bank of the Green River. The project would provide summer rearing habitat and high flow winter refuge through excavation of an off channel area combined with placement of large woody debris and revegetation. Land is in public ownership and belongs to the City of Kent. [Note: this project is also identified as #12 by the Duwamish/Green River Ecosystem Restoration Project]
Hawley Revetment	This project would set back the over-steepened Hawley Revetment between river miles 23.5 and 23.3, in order to achieve a more stable slope angle, create a low, vegetated bench, and allow the placement of large woody debris. Land is in public ownership and is immediately downstream of Riverview Park.
Lower Mullen Slough (Prentice Nursery Reach) at RM 21.4 (Left Bank)	This project would improve fish passage and create a natural habitat for rearing and refuge from high flows in the Green River mainstem by restoring the mouth of Mullen Slough and connecting it with a nearby pond to create a new flatter-gradient meandering outlet. Actions include improving the channel to eliminate a summer low flow fish passage blockage, clearing the site of unnatural debris and

	Himalayan blackberry, planting riparian vegetation, placing large woody debris, and constructing dendritic, branched channels for improved water circulation and habitat diversity.
Mullen Slough (Slough Mile 1.8-0.3)	Habitat for rearing and providing refuge from high flows in the Green River mainstem would be created by this project. Restoration along the slough would include channel meandering, large woody debris placement, and riparian plantings. This project site is upstream from the Prentice Nursery Reach project (previous sub-project) and includes about 90 acres from Highway 516 to the head of the slough.
Lower Mill Creek Future Project	The City of Kent has also proposed an additional setback of the levee near the mouth of Mill Creek [Auburn] and four acres of riparian planting.

Project LG-9 - Rosso Nursery Off-Channel Rehabilitation and Riparian Restoration Between RM 20.8 and 20 (Left Bank): This project would rehabilitate habitat at the Rosso Nursery site between river miles 20.8 and 20.0 by constructing an outlet at RM 20.1. Actions would include removing fill, excavating off-channel flood refugium for juvenile rearing habitat, and planting native wetland and riparian vegetation. The City of Kent received a Salmon Recovery Funding Board grant to acquire the site, but [has since transferred those allocated funds to purchase of three different parcels located north of SR 516 on the south side of the Green River. This effort is titled "The Lower Green River Property Acquisition"].

Project LG-10 - Mainstem Maintenance (including the Boeing Levee Setback and Habitat Rehabilitation) Between RM 20.5 and 16.3: Fish habitat along the Lower Green River would be improved by these projects while providing stable bank and levee conditions to protect significant human infrastructure and development. They are being coordinated by local jurisdictions, the Green River Flood Control Zone District, and the U.S. Army Corps of Engineers. The majority of the banks in this portion of the river have been hardened and trees and other fish-friendly features have been removed to make the river flow without impediment. Riprap or rock bank protections have reduced fish habitat along this stretch of the river. Sub-projects include:

Boeing Setback and Restoration Between RM 18 and 17.1 (Right Bank)	Actions include reshaping the bankline between the upstream end of the Christian Brothers Revetment and South 212th Street, widening the channel cross-section, restoring channel complexity and meanders, creating a two stage channel, excavating low benches and alcoves, installing large woody debris, and planting native riparian vegetation. The proposed project is within City of Kent open space, which has a 200-foot buffer with restricted development.
Carrot Patch Setback and Russell Road Restorations	Implement fish friendly, bio-engineered solutions to levee maintenance problems. Set the levee back to enable habitat rehabilitation, including reshaping the bankline, widening the channel cross section, restoring channel complexity and meanders,

excavating low benches, installing large woody debris, and planting native riparian vegetation.

Project LG-12 - Briscoe Off-Channel Habitat Rehabilitation Between RM 16.1 and 15.8 (Right Bank): With cooperation from the City of Kent, this project would involve removing the armoring on the Briscoe meander shoreline, excavating a flood refugium for juvenile salmonid rearing habitat, installing large woody debris, and planting native riparian vegetation. An existing (landlocked) levee on the eastern boundary of the park would provide continued flood protection.

Project LG-13: - Acquisition, Levee Setback, and Habitat Rehabilitation Between RM 15.3 and 14.7 (Right Bank): Acquire additional right of way along the river-ward edge of the business park parking lot between River Miles 15.3 and14.7 (right bank), set back the oversteepened levee, create bench habitat, install large woody debris, and plant native riparian vegetation. This project would extend downstream from a levee setback project completed in the [early 2000s].

4.2 BIG SOOS CREEK

The Big Soos Creek basin is approximately 70 square miles and contains three major hydrogeomorphic settings (Kerwin and Nelson 2000). As delineated by Kerwin and Nelson (2000), the City's shoreline segment of Big Soos Creek is in the headwaters "on a rolling glacial outwash plain" and has a "very low gradient (>1%) unconfined channel with low velocity flows." Based on a site visit to this segment of Big Soos Creek, the mapping and characterization seem accurate. Big Soos Creek only meets shoreline jurisdictional criteria (minimum 20 cfs mean annual flow) for a short distance into the City limits, all occurring between the SR 18 and SR 516 (SE Kent Kangley Road) crossings.

View of Big Soos Creek facing downstream from the SR 516 crossing.

4.2.1 Land Use Patterns

The Big Soos Creek shoreline affects only five parcels within the City. Three of the parcels each contain a single-family residence, the fourth is part of King County's Soos Creek Park, and the fifth is owned by WSDOT (Figure 3d). The site contains a three-celled stormwater detention pond and wetland mitigation, which drain to Big Soos Creek. Lands surrounding Big Soos Creek tributaries are undeveloped, except for a portion of shorelands that lie in platted residential lots and extend into large backyards of nearby residences.

4.2.2 Transportation

There are no stream crossings of the Big Soos Creek shoreline within City limits. State Route 18 crosses Big Soos Creek just downstream of the City limits and Kent Kangley Road/SR 516 (a principal arterial) appears to mark the upstream limit of the Big Soos Creek shoreline in the City. The City's *Six Year Transportation Improvement Program 2008-2013* does not identify any transportation projects in the Big Soos Creek shoreline area.

4.2.3 Wastewater and Stormwater Utilities

Wastewater Utilities

The Big Soos Creek shoreline area is part of the Soos Creek Water & Sewer District's service area. According to King County iMAP, only one of the shoreline parcels is served by public sewer service; the remaining properties in shoreline jurisdiction have private septic systems.

Stormwater Utilities

The City's map of surface drainage facilities does not show any storm sewers or detention facilities in the City's Big Soos Creek shoreline jurisdiction. However, a multi-celled facility on WSDOT property is located outside of Big Soos Creek shoreline jurisdiction just north of SR 18, with one cell extending into shoreline jurisdiction and draining ultimately into Big Soos Creek.

4.2.4 Shoreline Modifications

There are no known shoreline modifications within the Big Soos Creek shoreline area within City limits, though modifications have occurred at both the SR 516 and SR 18 highway crossings, each immediately bordering the City. As previously mentioned, the upstream (north) shoreline limit is SR 516, which bridges the stream. Though the SR 516 span is fairly long, estimated at around 80 feet, it nonetheless imposes a significant constriction on the floodplain at that location. A gravelly bar is present on the east side of the stream under the bridge, and the bridge footings are likely armored to prevent erosion and undermining, although this was not specifically observed.

Two SR 18 bridge spans modify Soos Creek shoreline areas immediately downstream (south) of areas under Kent shoreline jurisdiction. These modifications include floodplain clearing and the placement of road embankment fill, armoring, footings, pilings, and the bridge spans themselves. The south span has no pilings, and the stream banks at that location are armored with quarry spalls. In contrast, the north span includes some concrete piling supports outside of the active channel and the banks are lined only with gravelly soils. The floodplain of Soos Creek has also been constricted considerably at the SR 18 crossing location.

4.2.5 Existing and Potential Public Access Sites

There is no public access to the Big Soos Creek shoreline area. However, upstream of the 20 cfs cutoff point, the vast majority of Big Soos Creek is surrounded by Gary Grant Soos Creek Park, a King County-owned park. This park is over 500 acres and provides access to the Soos Creek Trail. While the park does not provide public access for water-dependent activities, it does provide opportunities for water-related and water-enjoyment activities such as picnic areas and access to the 7-mile long Soos Creek Trail.

4.2.6 Critical Areas

Geologically Hazardous Areas

City maps do not show any geologically hazardous areas in the Big Soos Creek shoreline. However, landslide-type soils, steep slopes, and seismic hazards flank the creek farther upstream where the channel is more confined (Figures 12-13.3).

Wetlands

City, King County, and WDFW PHS (2007) wetland mapping all show that much of the Big Soos Creek shoreline area within the City limits is wetland (Figure 11). Based on aerial photos and a brief site visit, the wetland is forested with young willows, red alder, and black cottonwood and contains large emergent patches of reed canarygrass.

Streams

No mapped or known streams discharge into the Big Soos Creek shoreline within City limits. Little Soos Creek joins Big Soos Creek in Covington from the east, between discontinuous sections of the City through which Big Soos Creek runs.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: WDFW mapping of Priority Habitat and Species classifies the riparian wetland as a Priority Habitat and maps it as palustrine (WDFW 2007). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration."

Vegetation mapping by King County Department of Natural Resources shows the west side of the stream to be primarily "shrub" (likely Himalayan blackberry and Scotch broom based on aerial photos and a brief site visit) and "young deciduous" on the east side of the stream (Kerwin and Nelson 2000). The vegetation maps do not distinguish between upland and wetland vegetation types. Some of the "young deciduous" areas, however, are identified on other maps as wetland, and contain willows, red alder, dogwood and rose.

Priority Species: The only Priority species identified in this section of Big Soos Creek are fish species, including: chinook and coho salmon, steelhead, and resident cutthroat trout (WDFW 2007). Coho salmon were observed on redds just downstream of SR 516 on 10 December 2007. A great blue heron colony is mapped farther upstream outside of shoreline jurisdiction.

4.2.7 Floodplain and Channel Migration Zone

The Big Soos Creek 100-year floodplain and floodway are encompassed by shoreline jurisdiction (see Figure 10). Based on the maps, no upland structures are found within the floodplain in City limits. The north edge of shoreline jurisdiction is the crossing of the stream by SE 272nd Street (SR 516/Kent Kangley Road); the floodplain narrows at that crossing. Outside of City limits downstream, the floodplain narrows down under SR 18 and then expands again to the south. At present, the channel is free to migrate within the valley bottom, except as pinched downstream by the SR 18 crossing.

4.2.8 Opportunity Areas

There are no known shoreline modifications within the Big Soos Creek shoreline area within the City limits. As previously described, the footings of the SR 516 span just upstream of shoreline jurisdiction are likely armored. However, vegetation on properties west of the stream, including private properties and what appears to be a WSDOT-owned area on the north side of SR 18, could be enhanced in order to develop a functioning buffer of native trees and shrubs, particularly conifer species such as Douglas-fir and western red cedar.

Placement of additional in-stream large woody debris would also serve to enhance in-stream fish habitat. Some in-stream woody debris is present, but is primarily derived from the smaller willow and other deciduous trees which presently predominate within the floodplain. Beavers are active throughout the area and have utilized much of this material to construct a number of dams of various sizes and in various states of repair. Fish habitat along Big Soos Creek in the area would benefit from the placement of various configurations of larger, longer-lasting conifer logs to scour substantive pools and provide complex cover habitat for fish within those pools.

4.3 LAKE MERIDIAN

The Lake Meridian watershed area is 742 acres, and includes a tributary stream at the north end that originates approximately one-half mile to the northwest. The lake itself is approximately 150 acres, and drains at the southeast corner to the east and then south, joining Big Soos Creek outside of City limits. According to King County's basin condition evaluation model, it ranks "medium." "Medium" condition basins are designated because they are "Areas with either high or moderate development intensity and moderate or low in significant biological value."

As part of the U.S. Army Corps of Engineers *Duwamish/Green River Ecosystem Restoration Project* (identified as project #23), the outlet of Lake Meridian has been modified to reduce lake flooding and provide better flow control out of the lake into the outlet stream, locally known as Cow Creek. Lake Meridian was once known as Cow Lake. A second phase of the project may be constructed in Summer 2008, and will consist of approximately 2,500 feet of new channel construction from the improved outlet northeast through Soos Creek Park to Big Soos Creek. A flow-splitter will ensure that sufficient flow is maintained through the old Cow Creek channel to maintain hydrology in existing wetlands.

Typical residential development on Lake Meridian

View of Lake Meridian Park pier

4.3.1 Land Use Patterns

Lake Meridian is split into two land use categories: Unit A - Open Space and Unit C - Residential (Figure 3e). The Unit A area consists of Lake Meridian Park, which occupies a roughly 1,400-foot stretch of shoreline at the southeast corner of the lake. Unit C consists of residential development, which occupies the rest of the lake. Single-family homes (designated SF-3 and SF-6 in the Comprehensive Plan) are the dominant residential type, except for an approximately 300-foot segment at the extreme northwest end of the lake occupied by a mobile home park. Additionally, associated wetlands surrounded by single-family residences extend south of Kent-Kangley Road.

4.3.2 Transportation

The primary roadway passing through the Lake Meridian shoreline is SR 516 (Kent-Kangley Road), located at the south end of the lake. A small portion of 148th Avenue SE is in shoreline jurisdiction, as well as a few minor residential access roads. The City's *Six Year Transportation Improvement Program 2008-2013* does not identify any transportation projects in the Lake Meridian shoreline area.

4.3.3 Wastewater and Stormwater Utilities

Wastewater Utilities

The Lake Meridian shoreline area is part of the Soos Creek Water & Sewer District's service area (Figure 4e). All of the developed residential properties with Lake Meridian frontage were connected to the sewer system in 1974 (Metro 1977 cited in Verhey and Mueller 2000). However, an analysis of the Lake Meridian drainage basin completed by the City in 2007 found that 72 improved parcels were not yet connected to the public sewer system, and are managing their wastewater with on-site septic systems (Knox, pers. comm., 21 May 2008).

Stormwater Utilities

At least 11 stormwater outfalls into Lake Meridian or into minor tributaries just upstream of the lake were noted on the City's map of surface drainage features (Figure 5e). Two detention facilities at the edge of the associated wetland at the south end of the lake appear to collect stormwater from surrounding residential areas, and these ponds likely drain into the associated

wetland after detention and treatment. A third pond appears to collect runoff from the park next to the outlet stream (Cow Creek).

4.3.4 Shoreline Modifications

The most common shoreline modifications on Lake Meridian are anthropogenic alterations to the natural lake edge and nearshore environments, and primarily include a variety of armoring types (some associated with fill), piers, and other in-water structures such as boatlifts, boathouses, and moorage covers. These sorts of modifications alter the function of the lake edge, change erosion and sediment movement patterns, affect the distribution of aquatic vegetation, and are often accompanied by upland vegetation loss.

Mapping of shoreline armoring and piers was not conducted as part of this study. However, studies conducted by King County (Verhey and Mueller 2001) and Peratrovich, Nottingham & Drage, Inc. (PN&D 2001) for the City of Kent contain discussions of piers and shoreline armoring in Lake Meridian.

Shoreline Armoring

Shoreline armoring can have many justifications, but often the intent of bulkheads is to:

- protect shoreline property by reducing wave impacts and decreasing erosion,
- increase or maintain lawn areas, and/or
- coordinate style of neighboring shoreline properties.

Possible erosion forces on the lake edge include wind-driven waves during storms and boat-driven waves. Lake Meridian is one of a few King County lakes that allows motorized boat use. Boating regulations on the lake prohibit waterskiing within 300 feet of shore, except for shore-starts from private property and starts 200 feet from the park shore. In addition, all other boating activities exceeding 8 miles per hour must be at least 200 feet from shore. Many of the bulkheads on the lake may also have been constructed to facilitate placement of fill upland of the bulkhead, raising the elevation of the land to minimize flooding during winter months.

Aerial photos, field observation, and the PN&D (2001) and Verhey and Mueller (2001) studies indicate several shoreline condition types: vegetated, grass to water's edge, sand, gravel, and bulkheads (either boulder, wood or concrete). Shoreline condition as reported by the property owners is outlined in Table 11.

Table 11. Lake Meridian Shoreline Condition as Reported by Property Owners (PN&D 2001).

	Grass	Sand	Gravel	Rock/Other (Armored)
% of Respondents	22	3	40	30

Verhey and Mueller (2001) estimated a shoreline armoring of 50 percent on Lake Meridian. They additionally noted that shoreline armoring is concentrated on the southwest shore, corresponding with steeper upland slopes descending to the water's edge. Although PN&D (2001) did not observe substantial erosion at the toe of or behind bulkheads during its field work,

60 percent of questionnaire respondents indicated that they had experienced shoreline erosion at their properties. Nearly half of the respondents felt erosion was due to high lake levels in winter and nearly half also believed erosion was occurring as a result of boat activity. PN&D (2001) noted that some bulkheads may not be counter-sunk deep enough to prevent scour at the bulkhead toe. Specific shoreline functions and the related effects of shoreline modifications are discussed in greater detail in Chapter 5.0.

Piers

The two Lake Meridian studies (Verhey and Mueller 2001; PN&D 2001) report total pier numbers of 154 and 137, respectively. Ninety percent of questionnaire respondents stated they have a dock, 7 percent indicated they do not have a dock, and 18 percent have a boatlift (PN&D 2001). Although specific information on dock material could not be located, it is probable that many of the piers were constructed using components treated with chemicals that are no longer approved for in-water use because of their potential to have adverse affects on water and sediment quality.

The most substantial pier on the lake is the City's pier at Lake Meridian Park. Relatively wide concrete floats surround the beach, forming a safe swimming area. Most of the private residential piers are likely a mix of fixed-pile piers and floating docks, typically constructed of wood. The docks are aging; 68 percent of respondents reported that their docks were constructed prior to 1990 (PN&D 2001). Pier repair and replacement proposals are likely to increase in the future, providing opportunity to minimize pier-related impacts and eliminate some sources of chemicals.

For additional discussion of the potential biological impacts of cover and structure, see Chapter 5.

4.3.5 Existing and Potential Public Access Sites

Lake Meridian is a primarily residential lake with a small park located on the southeast tip of the lake. Lake Meridian Park is a 16-acre park that provides public access to Lake Meridian in the form of a boat launch, designated swimming areas, and designated fishing areas (Figure 8e). The park also includes picnic areas, trails, and play equipment. The boat launch at Lake Meridian Park was recently replaced and widened with pre-cast concrete planks. Three floats were added to improve ease of access. A second, WDFW-owned boat launch is located adjacent to the east edge of the park. Because the shoreline of the lake is primarily built-out with residential development, there is little potential for future public access sites.

4.3.6 Critical Areas

Geologically Hazardous Areas

Potential erosion hazard areas are mapped around virtually the entire lake (see Figures 13.1-13.3). Seismic hazard areas are also identified at the north and south ends of the lake, generally corresponding to wetland areas. Finally, a landslide hazard area is identified at the northwest end of the lake in an area with particularly steep slopes.

Flood Hazard Areas

Lake Meridian does not have a mapped flood hazard area. However, Lake Meridian has had a history of reported congestion at the outlet and winter flooding problems. Still, lake water level fluctuations are normally fairly modest ranging from typical low summer levels of around 374.5 feet to high typical winter levels of 375.5 feet or only about one foot of fluctuation during the normal annual cycle. A 10-year high lake level is estimated at 376.2 feet and the 100-year at 376.4, or still less than 2 feet of fluctuation for even the most extreme of circumstances (MGS Engineering Consultants, Inc. 2004). Reported damage to structures appears to be limited primarily to docks and some shoreline erosion. However, as noted by PN&D (2001), many docks are improperly constructed such that even average summer lake levels damage them. No studies were found that indicated that flooding damages residences or upland park facilities. Re-configuration of the outlet completed in Summer 2007 may reduce some of the Lake Meridian winter flooding.

Wetlands

Three known wetland systems are found along Lake Meridian (Figure 11), as well as a sporadic fringe of emergent and aquatic bed wetland in and along the nearshore. The two larger wetlands at the south end of the lake are mixed scrub-shrub and forested wetlands, dominated by willows, hardhack, rose, dogwood, red alder and cottonwood.

Streams

Springs at the north end of the lake coalesce into a small stream that enters the lake along the west edge of the mobile home park.

The alignment of "Cow" Creek, the outlet stream from Lake Meridian (formerly Cow Lake), has been severely altered and its condition has been degraded with respect to its usefulness as fish and wildlife habitat. Emanating from the lake, the outlet stream currently flows across City of Kent Park property, crosses under 152nd Way SE, flows through undeveloped King County park property for approximately 600 feet, and then runs south through the Cascade Villa Mobile Home Park wetland. The present alignment of the "creek" continues within roadside ditches for nearly a mile along 152nd Way SE. More than 30 culvert crossings are present along this existing alignment, between the outlet of the lake and its confluence with Big Soos Creek. A feasibility study's conclusion of the existing creek was that "the habitat potential of the existing stream is so limited that there is little to be gained in any restoration effort" (HARZA Northwest 2000).

In an effort to more fully realize the stream's potential as fish and wildlife habitat and also as an aesthetic and passive recreational resource, the City of Kent is endeavoring to realign the creek along an almost entirely new pathway to join Big Soos Creek through intervening, mostly wooded land owned by King County. The proposed project will create a new stream channel for Cow Creek, which will continue on for a total of 3,350 feet to Big Soos Creek after passing through Lake Meridian Park and crossing under 152nd Way SE. A number of formidable constraints have been overcome in the process. The combined slopes and elevations of the existing land surface along the possible realignment pathway alternatives presented a fundamental challenge: the slope variability and maximum slope of the new stream channel need to be kept within limits to provide fish passage and productive habitat. However, the existing ground is fairly flat in some places and quite steep in others.

Phase 1 of the project was completed in 2007 and involved construction, on City of Kent park property, from the outlet of Lake Meridian to the east side of 152nd Way SE. Fish-passable box culverts and a labyrinth weir were installed to alleviate the flooding problems that occur for lake residents and increase the duration of flow from the lake to the proposed stream and wetlands.

Future Phase 2 will involve excavating a new channel that will meander through forested areas and existing wetlands before entering Big Soos Creek. A flow splitter will divert a portion of the higher flows back along the existing alignment to maintain the hydrology of existing wetlands, three acres of which will be enhanced to improve wildlife habitat. This new channel will incorporate large woody debris, riparian plantings, spawning gravel and scour pools to be used as resting areas for the resident and anadromous fish. The channel and backwater areas will also provide additional habitat to amphibians and other wildlife in the Big Soos Creek Watershed. New box culverts will cross the channel at three points within the new stream channel: two for utility access and one for the Soos Creek Park trail.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: WDFW mapping of Priority Habitat and Species classifies the two southern wetlands areas as Priority Habitat and maps it as palustrine (WDFW 2007) (Figure 14). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration."

Special Status Species: The only priority species noted by WDFW (2007) in the area is resident cutthroat trout in the outlet stream from Lake Meridian. The lake itself contains 10 fish species, more than half of which are yellow perch, followed in number by largemouth and smallmouth bass (Verhey and Mueller 2001). In addition, kokanee salmon are present in the lake (Seiders et al. 2008), and Lake Meridian property owners have reported seeing kokanee spawn in the shallow beach areas. A bald eagle nest is mapped outside of shoreline jurisdiction, approximately 0.4 mile from the lake (WDFW 2007). The eagle likely forages in the lake and perches on trees within shoreline jurisdiction.

4.3.7 Lake Aquatic Invasive Species

Numerous studies have been conducted in Lake Meridian that include an aquatic vegetation component. King County identified 19 plant species in the lake, including seven emergent species, two floating species, and ten submergent species (KCSWM 1996). In 1994, surface coverage by floating aquatic vegetation totaled 5.3 acres, while the submergent aquatic vegetation comprised 25.4 acres. A more recent study commissioned by the City found eight submergent species, and calculated that milfoil alone affected 35 acres (Tetra Tech, Inc. 2002) (Exhibit 4). The typical lakeshore emergent vegetation community coverage was limited by shoreline alterations conducted by residential property owners: bulkheads, lawns, and other modifications. No more than 5 percent of the shoreline in most of the examined survey sections contained emergent vegetation (Verhey and Mueller 2001).

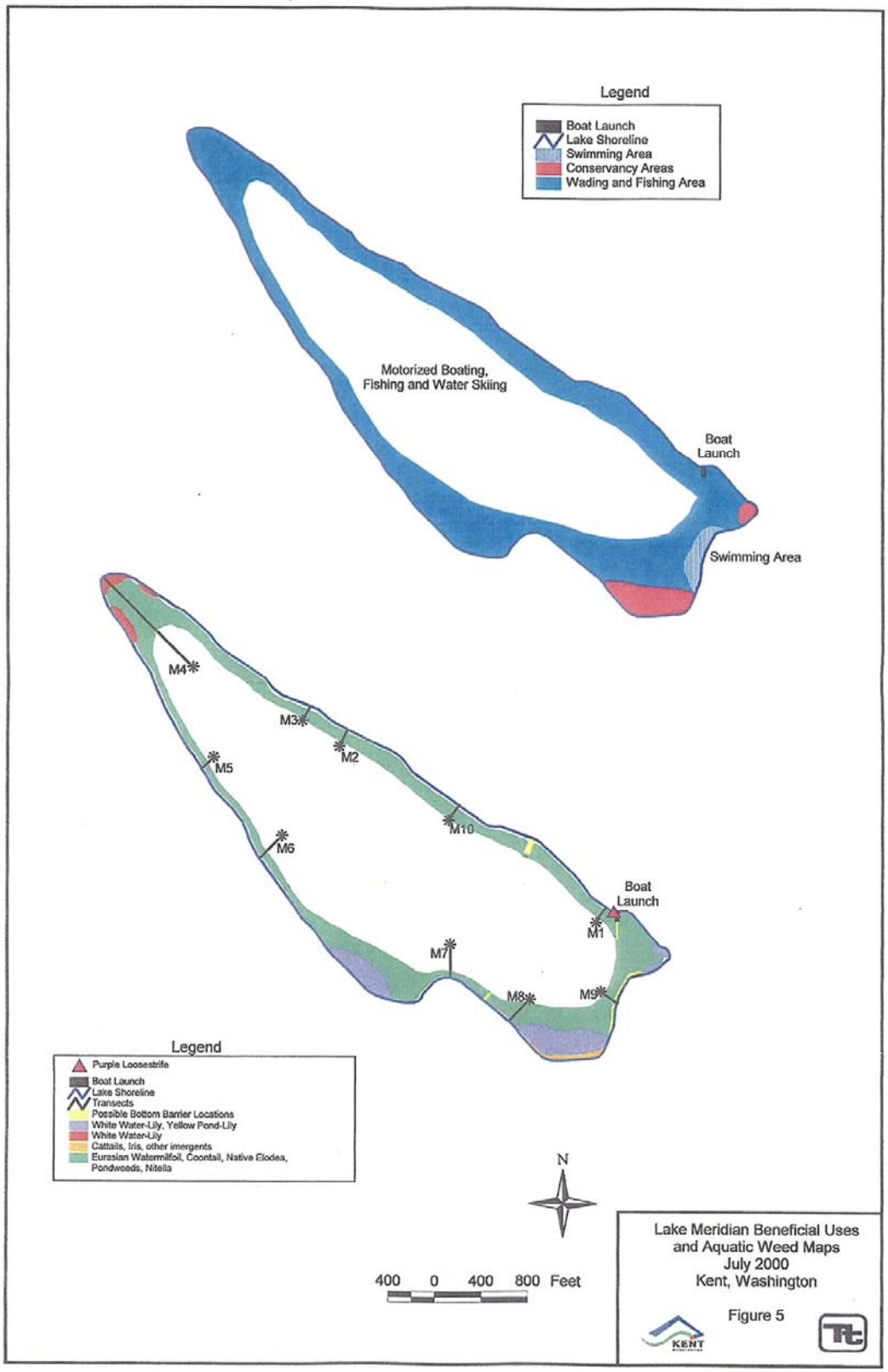


Exhibit 4. Lake Meridian Beneficial Uses and Aquatic Weed Map. Excerpted from Tetra Tech, Inc. 2002.

The dominant aquatic plant is Eurasian watermilfoil, a Class B noxious weed. At the time of WDFW's 2000 survey, milfoil formed a continuous band around the lake at depths between approximately 3 and 9 feet, covering the gravel substrate and occupying that portion of the lake which is most productive (Verhey and Mueller 2001). Tetra Tech's 2000 survey found milfoil between depths of 2 and 15 feet, with the highest densities between 6 and 14 feet (Tetra Tech 2002). The greatest concentrations were found near the WDFW boat launch and at the northwest end of the lake (Tetra Tech 2002). King County surveys conducted between 1976 and 1980 also found milfoil to be the dominant species (KCSWM 1996 cited in Verhey and Mueller 2001). According to the Department of Ecology, Lake Meridian became the first known Washington site to contain Eurasian watermilfoil in 1965 (http://www.ecy.wa.gov/Programs/wq/plants/weeds/milfoil.html).

Lake residents and the City of Kent have also noticed an increase in white water lily (also known as fragrant water lily) (*Nymphaea odorata*), which is on King County's list as a "non-designated noxious weed." Control of species in this weed category is recommended, but not required, by King County. According to the City (Knox, pers. comm., 5 June 2008), this non-native water lily may be displacing the native yellow pond lily (*Nuphar luteum* ssp. *polysepalum*) and lake residents at the northeast corner of the lake have reported dramatic increases in coverage, which has prevented use of the swimming beach. Functionally, the two species are very similar.

4.3.8 Water Quality/Toxics

There are several sources of information regarding water quality in Lake Meridian, including various King County studies, the Department of Ecology, Washington State Department of Health, and more recently the City of Kent.

Water Quality

Lake Meridian is on Ecology's 303(d) list for two Category 5[1] parameters in the water medium: total phosphorus and fecal coliform. The "Listing Basis" notes for total phosphorus also indicate that the listing is based on 1978 data, and acknowledges that studies conducted in the 80s, 90s, and 2000s do not indicate that total phosphorus exceeds water quality standards (http://apps.ecy.wa.gov/wats/QBEListingReport Data.asp?resp=6356). However, King County's data might not be of sufficient rigorousness to meet Ecology's specific criteria for delisting (Koch, pers. comm., 7 May 2008). Further, meeting the water quality standard for phosphorus may not be sufficient to delist the lake as the listing is based additionally on impairment of "beneficial uses" tied to algal blooms.

The "Listing Basis" notes for fecal coliform state: "Recent verification monitoring since 1998 indicates that this water segment is meeting fecal coliform standards. Previous listing was based on data from 1978" (http://apps.ecy.wa.gov/wats/QBEListingReportData.asp?resp=6316). The listing is based on samples taken from the swimming beach area at Lake Meridian Park in 2003. Again, Ecology does not have verification that the King County data were collected in a manner

[1] "Placement in this category means that Ecology has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan. TMDLs are required for the water bodies in this category." http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/2004_wq_assessment_cats.html

consistent with the criteria for delisting. Ecology is searching for the data to determine if delisting could be warranted (Koch, pers. comm., 7 May 2008).

Studies have not been conducted to determine the origin of the fecal coliform bacteria. As mentioned above, there are 72 parcels in the Lake Meridian drainage basin that are using septic systems to manage wastewater, in addition to a public park with a beach and swimming area. Properly functioning septic systems and drainfields may be a source of nitrates to groundwater, but bacteria, viruses and other chemicals such as phosphates are effectively neutralized or captured by soil filtration and the activity of soil microorganisms (http://www.metrokc.gov/health/wastewater/owners/questions.htm).

Lake Meridian has generally been classified as an oligotrophic (low productivity or low biological activity) lake in one of the headwater areas of the Big Soos Creek basin due to its low surface-water phosphorus levels and good clarity (Verhey and Mueller 2001; King County 2006). Tetra Tech, however, in its recent (2007) monitoring report for the City, reevaluated the historic data and determined that the lake bottom phosphorus and dissolved oxygen levels indicate that the lake is more mesotrophic (moderate productivity and biological activity).

Since early 2007, the City has been conducting bi-weekly water quality sampling of various stormwater outfalls on Lake Meridian. According to the City (Knox, pers. comm., 5 June 2008), the results generally indicate acceptable water quality. The exception would be a few occurrences of high phosphorus levels, possibly from residential fertilizer usage and/or car-washing soap in the Lake Meridian drainage area.

Toxics in Fish

The Washington State Toxics Monitoring Program (WSTMP), which characterizes toxic contaminants in freshwater fish, sampled fish tissue from 14 lakes in 2006, including Lake Meridian (Seiders et al. 2008). This was the first test of its kind in Lake Meridian, and indicates the presence of historical contaminants rather than the development of a new water quality problem. The assessed persistent bioaccumulative toxins (PBTs) include mercury, PCBs, dioxins and furans, chlorinated pesticides, and PBDE flame-retardants. Lake Meridian fish contained PBT concentrations that exceeded National Toxics Rule (NTR) criteria for total PCBs, 2,3,7,8-TCDD (the most toxic dioxin congener), 2,3,7,8-TCDD TEQ, and the chlorinated pesticides dieldrin, total chlordane, hexachlorobenzene, and toxaphene (Table 12). As indicated in Table 12, many of the sampled fish did not have detectable levels of the PBTs.

Table 12. Lake Meridian Fish Tissue Not Meeting Water Quality Standards (2006 WSTMP data in context of other Washington State data).

Analyte	**Total PCB Aroclors (ug/Kg)**		**2,3,7,8-TCDD (ng/Kg)**	**Dieldrin (ug/Kg)**		**Total Chlordane (ug/Kg)**		**Hexachloro - benzene (ug/Kg)**		**Toxaphene (ug/Kg)**		**2,3,7,8-TCDD TEQ (ng/Kg)**
Species[1]	KOK	LMB	KOK	KOK	LMB	KOK	LMB	KOK	LMB	KOK	LMB	KOK
Water Quality Standard (NTR)[2]	5.3		0.07	0.65		8.3		6.7		9.8		formerly 0.07
Median value in statewide data set	19		0.082	0.52		1.1		1.4		17		0.202
Result from Lake Meridian 2006 sample	32.5[3]	24.7[3]	0.017[3]	6.8[3]	2.3	13[3]	5.6[3]	15[3]	9.5[3]	15[3]	11[3]	0.659[3]
Percentile rank in data set of detected values[4]	70	59	69	100	93	93	86	98	96	44	23	88
Historical data set reviewed[5]	A		B	C		A		C		C		A
% fish sampled with detectable levels of analyte	65		37	41		40		44		8		100

Source: Keith Seiders, Washington Department of Ecology.
[1] KOK – Kokanee, LMB - Largemouth bass
[2] NTR - National Toxics Rule
[3] Result is qualified as an estimated value
[4] Indicates the percent of samples in the data set that have lower concentrations than Lake Meridian
[5] A - WSTMP 2001-2006, statewide freshwater fillet
B - Statewide freshwater fillet 1994+ from Ecology's Environmental Information Management (EIM) database
C - Statewide freshwater fillet 1992+ from EIM

The NTR criteria established by the federal government under the Clean Water Act were adopted by Ecology in lieu of setting state-specific standards based on local studies of natural background levels of these pollutants. The NTR criterion for PCBs is 5.3 parts per billion (ppb), a standard that is not met by 90 to 95 percent of fish in Washington's lakes (McBride, pers comm., 24 June 2008). The Department of Health has different criteria used in establishing its Fish Consumption Advisories. According to David McBride, human health issues are not a concern until PCB and mercury levels in fish exceed approximately 100 ppb (pers. comm., 24 June 2008). Based on available data from the early 1980s to 2003, the statewide average for PCBs in fish was around 65 ppb; the average PCB value of 19 included in Table 12 above is based only on data collected between 2001 and 2006 (Seiders, pers. comm., 25 June 2008). A median PCB value calculated from multiple studies spanning from 1990 to the present is expected to lay between 19 and 65 ppb (Seiders, pers. comm., 25 June 2008). Fish in Lake Meridian had total PCB concentrations under 35 ppb.

Exceedances of the federal NTR criteria require placement of Lake Meridian on Ecology's proposed 2008 303(d) list for the exceeded parameters. Ecology recommendations for 303(d) list inclusions were sent to the EPA on 23 June 2008. All of the exceeded parameters were placed in Category 5, except for 2,3,7,8-TCDD TEQ, which was placed in Category 2. Although tissue samples from Lake Meridian fish exceeded NTR criteria thresholds for PBTs, the PBT concentrations were not considered high in comparison to a list of 60 other Washington State lakes (including Lake Washington) that have been sampled since 2004 (Seiders et al. 2008). The lakes with the highest contaminant levels received scores between 50 and 250; Lake Meridian's score was 19.7 (Seiders et al. 2008).

The PBTs found in Lake Meridian's fish can come from the following sources:

- Mercury: Mercury occurs in the earth's crust and is released to the environment from natural events (e.g. volcanoes, weathering, and forest fires) and human activities (e.g. coal-fired power plant, disposal of fluorescent lamps, thermometers, thermostats, monometers and switches, medical-waste incinerators, and other industrial processes).

- PCBs: Polychlorinated biphenyls (PCBs), banned in the U.S. in 1979, are synthetic organic compounds historically used as cooling fluids in electrical equipment, and in inks, paints, and plastics. PCBs are stable, have low solubility in water, and have a high affinity for sediments and animal fats. PCBs can be released to the environments through the disposal of fluorescent lamp ballasts, older televisions, appliances, transformers, and capacitors.

- Dioxins and furans (PCDD/Fs): Dioxins and furans, or polychlorinated dibenzo-p-dioxins and –furans (PCDD/Fs), are unintentional byproducts of combustion processes. Sources can include municipal- and medical waste incinerators, forest fires, cement kilns, coal combustion, residential and industrial wood combustion, residential waste combustion, diesel and gasoline fuel combustion, bleached-chemical wood pulp and paper mills, pentachlorophenol-treated wood, and chemical and pesticide manufacturing.

- Chlorinated pesticides: Pesticides historically received widespread use, and include insecticides, herbicides, fungicides, and related chemicals used to control pests. Many (including DDT, chlordane, and dieldrin) were banned from use in the U.S. during the 1970s and 80s. However, residual levels of these toxins persist in soils, sediments, water, fish tissue, and in wood products treated to resist termites.

Much of the PBTs in Lake Meridian's fish are a legacy of anthropogenic activities that occurred in the past. These toxins have largely been regulated or otherwise controlled at the source, however, and it is unlikely that additional PBTs are being delivered to Lake Meridian or other parts of the watershed (Gallagher, pers. comm., 21 March 2008). The PCBs and pesticides (dieldrin, total chlordane, hexachloro-benzene, and toxaphene) that typically entered the lake through surface-water runoff have been outlawed and are no longer in use. Airborne dioxins, mercury, and PCBs were largely produced and distributed at single sources like power plants and factories, and these have largely been controlled at the source (Gallagher, pers. comm., 21 March 2008).

The PBTs generally enter Lake Meridian from either the atmosphere (as airborne particulate matter) or in surface water/stormwater runoff. These chemical toxins do not break down, and persist in lakebed substrates where the macroinvertebrate community ingests them. Once they enter the biological food chain, these toxins bioaccumulate in fish, and the older, larger fish end up carrying the highest relative concentrations. Rapid urbanization, such as that in the Lake Meridian watershed, can increase the volume of other chemical pollutants (not measured or reported in the Toxics Monitoring Study) delivered to the lake, but increasing upland development is unlikely to significantly affect the levels of PBTs currently found in Lake Meridian fish (Gallagher, pers. comm., 21 March 2008; Seiders, pers. comm., 24 June 2008). Existing City and State requirements for short- and long-term stormwater management, and erosion and sedimentation prevention during construction are likely preventing or minimizing introduction of new PBTs into the Lake Meridian system (Seiders and McBride, pers. comm., 24 June 2008).

According to the Environmental Protection Agency (EPA), PBTs "are associated with a range of adverse human health effects, including effects on the nervous system, reproductive and developmental problems, cancer, and genetic impacts" (EPA 2008). The Department of Health (2008) has not specifically placed Lake Meridian on its Washington State Fish Consumption Advisories list, although in all lakes and rivers of Washington State there is a mercury advisory recommending that the general public limit consumption of largemouth and smallmouth bass to two meals per month. Although mercury was found in Lake Meridian largemouth bass at a level of 512 ppb, this did not exceed the NTR standard of 825 ppb (Seiders et al. 2008). The mercury level in kokanee salmon (115 ppb) and the levels of other tested analytes in largemouth bass and kokanee salmon fell below the typical fish consumption advisory thresholds (McBride, pers comm., 26 June 2008).

Wisconsin Department of Natural Resources (2008) reports that "[b]ehavioral changes, mortality, reproductive failure, eggshell thinning, developmental abnormalities, impaired growth and development, altered blood chemistry, increased rate of disease outbreaks, organ and central-nervous-system damage, and impaired immune-system response are just some of the reported effects of PBTs in wildlife." Animals, such as bald eagles, osprey or great blue heron, that prey on fish in the lake would be vulnerable to accumulation of PBTs in their tissues. Amphibians that have close contact with contaminated sediments may also absorb PBTs through their skin (Wisconsin Department of Natural Resources 2008). The Washington Department of Health (McBride, pers. comm., 24 June 2008) stated that PBT levels in Lake Meridian fish pose "little to no risk" to humans swimming or otherwise recreating in the lake.

4.3.9 Opportunity Areas

General: Investigate potential for control of Eurasian watermilfoil through chemical, mechanical or biological control methods. The City's IAPMP (Tetra Tech 2002) recommended placement of bottom barriers (burlap sheets) in localized areas (see Exhibit 3 above). This work has not yet been conducted.

Residential: Many residential shoreline properties on Lake Meridian have the potential for improvement of ecological functions through: 1) reduction or modification of shoreline armoring, 2) reduction of overwater cover and in-water structures (grated pier decking, pier size reduction, pile size and quantity reduction, moorage cover removal), 3) improvements to

nearshore native vegetative cover, and/or 4) reductions in impervious surface coverage. Shoreline properties outside of shoreline jurisdiction but within the Lake Meridian basin that manage wastewater through on-site septic systems could also connect to the public sewer system.

Lake Meridian Park: Several opportunities exist to improve habitat conditions along the shoreline. These include: reduction of overwater cover by the existing pier through the installation of deck grating, removing or minimizing the impacts of shoreline armoring; and supplementation of nearshore native vegetation to improve habitat conditions.

4.4 LAKE FENWICK

4.4.1 Land Use Patterns

The north side of Lake Fenwick lies within the City of Kent and has two land use categories: Unit A - Open Space and Unit C – Residential (Figure 3f). Shoreline jurisdiction lies predominantly within Unit A - Open Space on the City Parks property, Lake Fenwick Park. A small Unit C segment (approximately 700' of shoreline) is in single-family ownership at the lake's northern tip. Residential buildings in this area appear to be located outside of shoreline jurisdiction.

The south end of the lake is in King County jurisdiction and is in Kent's PAA. Approximately 2,100 feet of shoreline is designated PW (King Co. Other Parks/Wilderness) and the remaining 900 feet are designated UR 4-12 (allowing residential development). The topography rises steeply from the lake in this area and the residential areas are located up from the lake.

South end of Lake Fenwick Park

Image of Lake Fenwick

4.4.2 Transportation

The primary roadway passing through the Lake Fenwick shoreline is Lake Fenwick Road, located at the west end of the lake. Lake Fenwick road is classified as a residential collector arterial on the City's road classification map. No other roads are located within shoreline jurisdiction. The City's *Six Year Transportation Improvement Program 2008-2013* does not identify any transportation projects in the Lake Fenwick shoreline area.

4.4.3 Wastewater and Stormwater Utilities

Wastewater Utilities

The only mapped sewer line in Lake Fenwick shoreline jurisdiction is a 6-inch "siphon line" crossing of the associated wetland located west of Lake Fenwick Road (Figure 4f).

Stormwater Utilities

Only a few stormwater conveyances exist in shoreline jurisdiction, and those are primarily identified culverts passing runoff beneath Lake Fenwick Road (Figure 4g). A detention facility is shown at the upstream end of the associated wetland on the west side of Lake Fenwick Road, capturing stormwater runoff from the adjacent residential community.

4.4.4 Shoreline Modifications

Lake Fenwick has a low level of shoreline modification in the City portions. Approximately 350 linear feet of shoreline is armored, mostly in scattered short sections associated with a small fishing pier, the boardwalk trail crossing, and a boat launch. In the primary active use area near the parking lot, the shoreline is armored with vertical timbers with inset steps for lake access. Other access points with no vegetation are also armored with either timbers or boulders. The boat launch access is lined with small gravel up to the water's edge, with pre-cast concrete slabs in the water.

In the PAA portion of the lake, some single-family housing is closer to the water's edge where slopes allow, and several of the homes have a small floating dock and/or minor shoreline armoring.

4.4.5 Existing and Potential Public Access Sites

The primary public access for Lake Fenwick is Lake Fenwick Park, a 140-acre park that provides public access in the form of a boat launch, and swimming and fishing areas (Figure 8f). The park also includes water-enjoyment activities such as a trail, picnic areas, and a disc golf course.

4.4.6 Critical Areas

Geologically Hazardous Areas

The lake sits within a ravine between two steep hillsides. Therefore, the lake is encumbered by a number of geologic hazard areas. Landslide hazard areas are mapped around the entire lake (see Figure 13.1-13.3). Seismic hazard areas are identified along the western edge of the lake. Finally, steep slopes exist along the entire eastern edge of the lake, as well as the southwestern shoreline located just south of the city limits.

Flood Hazard Areas

Lake Fenwick does not have a mapped flood hazard area.

Wetlands

There is one known wetland system found within Lake Fenwick jurisdiction (Figure 11). The wetland is both mixed scrub-shrub and forested wetlands, transitioning to emergent and aquatic

bed at the lake edge. The lake-edge community includes a diverse mix of willow, alder, native yellow pond lily, floating-leaved pondweed, and cattail, among others.

Streams

Lake Fenwick is drained by a seasonal stream outlet at the southern tip of the lake in King County. An additional seasonal stream enters the lake through the associated wetlands at the northwest corner.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: WDFW mapping of Priority Habitat and Species classifies the wetland area as Priority Habitat and maps it as palustrine (WDFW 2007) (Figure 14). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration." Lake Fenwick and the surrounding area are also classified as Urban Natural Open Space. Designation criteria for Urban Natural Open Space are the same as for priority wetlands.

Special Status Species: The only priority species noted by WDFW (2007) in the area is a bald eagle pair, which nests in the shoreline area to the northeast. Watershed Company staff observed a bald eagle pair perched in a Douglas-fir snag on the east shore during a site visit on December 10, 2007. Wood ducks were also observed earlier in the year, and a number of what appear to be wood duck nest boxes were mounted on trees at the lake edge. The lake itself is stocked with rainbow trout; yellow perch, largemouth bass and brown bullhead catfish are also found in the lake (http://wdfw.wa.gov/fish/prospects/county_k-l.htm).

4.4.7 Lake Aquatic Invasive Species

The City commissioned an integrated aquatic plant management plan, which was completed for Lake Fenwick in 2002 (Tetra Tech). This study found five submergent and one emergent aquatic vegetation species in Lake Fenwick, dominated by the invasive species Brazilian elodea (Exhibit 5). The survey noted presence of elodea at depths between 0 and 18 feet, with the highest densities in areas shallower than 8 feet. In all, approximately 77 percent of the surveyed shallow areas were affected. Brazilian elodea can be so dense that fish movement is limited; forage areas are reduced; and predators and prey have reduced visibility, hampering foraging and escape from predators. Dense stands of elodea can also uptake dissolved oxygen, reducing dissolved oxygen to lethal levels for fish (Tetra Tech 2002).

Although Brazilian elodea is listed by King County as a Class B noxious weed, control is not required in Lake Fenwick, presumably because the infestation is too far advanced. However, Tetra Tech recommended that triploid grass carp be introduced into the lake to control the Brazilian elodea. Stocking of the lake with grass carp is scheduled to occur in June 2009. The City's planned use of grass carp to eliminate Brazilian elodea will be monitored for effectiveness. A weed rake will be used to sample along predetermined aquatic transects with the results compared to 2001 diver surveys along these same transects.

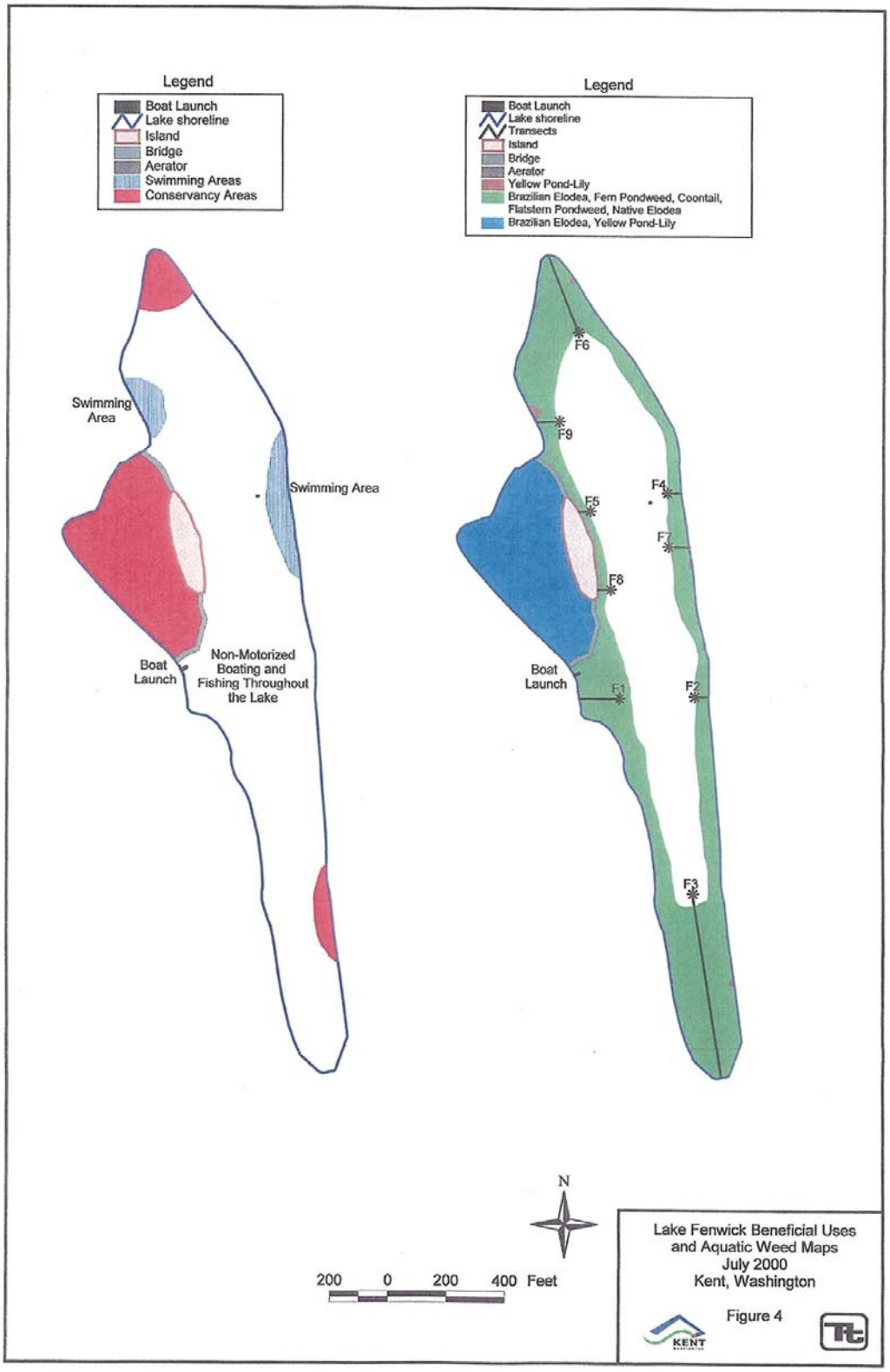


Exhibit 5. Lake Fenwick Beneficial Uses and Aquatic Weed Map. Excerpted from Tetra Tech, Inc. 2002.

4.4.8 Water Quality

There are several sources of information regarding water quality in Lake Fenwick, including King County and the Department of Ecology. Lake Fenwick is on Ecology's 303(d) list for two Category 5 parameters: total phosphorus and invasive exotic species (Brazilian elodea, see discussion in Section 4.4.7 above). A Total Maximum Daily Load (TMDL) Plan for phosphorus was prepared in 1992, establishing a target total phosphorus concentration of 19 µg per liter (Onwumere 2002). Implementation of the TMDL was assessed by the Department of Ecology in 2002 (Onwumere 2002). The assessment found that while "progress in water quality recovery" has been made, Lake Fenwick is still not meeting the quantitative standard necessary to meet Ecology's narrative water quality standard for aesthetics (unsightly algal blooms) (Onwumere 2002). Data was collected by King County in four years between 1993 and 2001, with an average total phosphorus of 36 µg per liter. The sources of phosphorus and their relative contributions to the lake have been determined (Table 13).

Table 13. Sources of Total Phosphorus Loads to Fenwick and Sawyer lakes (Data from Entranco, 1991 and King County, 2000).

Sources	Percent Contribution of Total Phosphorus
Net sediment release	23.6
Aquatic Plants	5.4
Birds	6.2
Atmosphere	2.6
Groundwater	8.5
Stormwater	46.5
Septic tanks	7.7

Partial table excerpted from Onwumere 2002.

Actions that the City has taken to implement the TMDL include: "phosphorus precipitation/inactivation, hypolimnetic aeration, watershed nutrient management (ordinances, sediment reductions, [and] passive nutrient attenuation" (http://apps.ecy.wa.gov/wats/QBEListingReportData.asp?resp=6336). The relatively high contribution level of "net sediment release" (24%) suggests that even though the lake may be experiencing reduced levels of external phosphorus inputs as a result of TMDL-related activities, it may still exceed the target limit for total phosphorus and continue to be subject to algal blooms. "Net sediment release" occurs when phosphorus that entered the lake is "absorbed or adsorbed to lake sediments and recycled among the sediment, water, and biotic compartments" (Onwumere 2002). The TMDL effectiveness report concludes with the following recommendations:

1) reducing cumulative loadings from internal phosphorus sources following turnover of the lakes,
2) reducing the increased fall and winter stormwater runoff activities,
3) continuing aeration at Lake Fenwick…, and
4) considering alum addition to take phosphorus out of the water column, which may improve adsorption to the sediments (Onwumere 2002).

Lake Fenwick is considered by King County to be a mesotropic to eutrophic (moderate to high productivity) (King County 2006). Based on data collected from the early 80s to 2004, King County characterizes lake water quality as "good to fair" (King County 2006).

4.4.9 Opportunity Areas

Lake Fenwick is an unusual urban lake because of its low level of modification, and its generally wide buffer of mixed forest. However, as noted above, there are some areas of shoreline armoring that could be modified to support public access while stabilizing the banks using bioengineering techniques.

Further, Brazilian elodea is currently a problem that the City will address through introduction of approximately 600 grass carp in 2008, consistent with a permit obtained from the Washington Department of Fish and Wildlife. The carp will be sterile and blocked from leaving the lake by a fish barrier at the outlet. Grass carp prefer to graze on Brazilian elodea and are expected to drastically reduce or eliminate the noxious weed.

4.5 GREEN RIVER NATURAL RESOURCES AREA POND

4.5.1 Site History

The Green River Natural Resources Area pond complex is a multi-celled facility with two inlets and one outlet funded and managed by the City's Public Works Department. The first cells (Cells 1-3 on Exhibit 2 included in Appendix B) at the northeast corner of the complex were constructed between 1964 and 1973 for sewage treatment. The northern-most cell (Cell 1) has overgrown with vegetation, and is now a forested wetland. Cells 2 and 3 are normally filled with water, but become partially dry in the late summer, creating mudflat habitat. Cell 5 was originally two separate primary treatment sewage lagoons divided down the center, each 16.5 acres in size. Each of the 16.5-acre lagoons contained up to 3 feet of water.

View of weir in the GRNRA

View of natural area in the GRNRA.

In the mid-1980s, the City began planning the conversion of the sewage treatment system into a larger stormwater storage and treament and flood control facility to improve water quality and reduce flood flows in Mill Creek Kent. Cells 1, 2 and 3 are not part of this stormwater and flood control system because of low-level contaminants (PCBs, heavy metals) that were found during site investigations prior to the GRNRA's construction. Storm and floodwater is therefore routed

away from those cells and the original clay linings of those cells were left intact to minimize groundwater infiltration. Cell 5 was reconfigured into its current arrangement and Cells 4, 6, 7 and 8 were constructed in 1996. The divider between the two 16.5-acre cells was removed and one new, larger cell (Cell 5) was graded to construct a central upland peninsula with a total finished pond area of 18.7 acres at the average water depth. The northeast corner of the eastern 16.5-acre cell was separated to form what is now a stormwater settling pond (Cell 4). A new 35.2-acre lagoon (Cell 6) was constructed west of Cell 5 for flood detention, and two additional cells (Cells 7 and 8) were constructed to the south as stormwater presettling ponds.

When flood conditions are not occurring, stormwater from an 832-acre sub-basin typically flows into the presettling ponds (Cells 4, 7 and 8), then into the treatment wetland (Cell 5), and then into the detention lagoon (Cell 6) before being routed back to Mill Creek Kent through the outflow channel. The detention lagoon (Cell 6) normally has a water level two feet lower than the constructed wetland (Cell 5), but water continuously drains from Cell 5 to Cell 6 over a sharp-crested weir set at an elevation of 23.0 feet above mean sea level (MSL).

A new diversion channel from Mill Creek Kent was also constructed in 1996 to route flood flows into the GRNRA storage ponds. This diversion channel directs floodwaters to the northeast corner of the GRNRA where water flows first into Cell 4 during minor events, or directly into Cell 6 via the flood overflow channel whenever the flood size exceeds the six-month event.

The ordinary high water marks of the individual cells have not been delineated. However, during a site investigation attended by Ecology, the City, The Watershed Company, and Makers on December 20, 2007, Richard Robohm (Ecology) placed the ordinary high water mark at approximately the 22.5-foot elevation in the detention lagoon (Cell 6). This estimation was based on Matt Knox (City) reporting the weir height between Cells 5 and 6 at 23.0 feet, and an examination of indicators in Cell 6 relative to the weir. After some field discussion, it was preliminarily determined that Cells 5 and 6 are effectively one body of water frequently enough during the year (Ecology suggested at least six times per year) to consider combining Cells 5 and 6 as a single shoreline lake.

From a review of GRNRA water level data (based on six years of continuous water level monitoring from 2000 to 2005), Cell 6 exceeds 23.0 feet MSL (and therefore overtops the weir from the downstream end leaving one continuous body of water) on average just over five times per year. Additional discussion ensued regarding the status of the perimeter cells (Cells 4, 7 and 8). Cell 7 is separated from Cell 6 by a weir with a top elevation of 26.0 feet (set at the calculated 25-year flood recurrence level), approximately 3.5 feet above the Cell 6 OHWM. Cells 7 and 8 are separated by a large concrete culvert; Cells 8 and 5 are separated by additional concrete culverts with a gate; and Cells 4 and 5 are also separated by a culvert with a gate. While these cells are hydraulically connected to Cells 5 and 6 via culverts and/or the 26.0-foot weir, that hydraulic connection is not a part of the ordinary high water mark definition or the criteria for establishing jurisdiction. Rather, hydraulic connectivity is a factor in determining associated wetlands.

By definition, the lake edge is determined by a “continuous ordinary high water mark” and the ordinary high water mark “is a biological vegetation mark…found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so

long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland…" Although the cells are connected, the culverts/weirs interrupt the ordinary high water marks between cells, do not have beds or banks, and do not contain vegetation. Further, the ordinary high water mark elevations of Cells 4, 7 and 8 appear to differ from that of Cells 5 and 6. The above factors constitute a break in the OHWM, and thus render Cells 5 and 6 the only shoreline waterbodies within the Green River Natural Resources Area. The other cells are considered associated wetlands, but the 200-foot shoreland area does not extend upland of the associated wetland edges.

Additional background information about the Green River Natural Resources Areas can be found at http://www.ci.kent.wa.us/publicworks/index.aspx?id=6120&terms=grnra.

4.5.2 Land Use Patterns

The Green River Natural Resources Area (GRNRA) is a City-owned and managed water quality management facility that includes extensive habitat enhancement and wildlife viewing activities. The facility includes two human-constructed ponds connected by a weir that constitute an approximately 55-acre lake. Additionally, there are four other human-constructed pond/wetland cells that are part of the water management system. The GRNRA site is surrounded on the north, east and south sides by industrial uses and the Green River Regional Trail lies to the west. Shoreline jurisdiction is located entirely within the GRNRA, so is therefore in the Unit A - Open Space category (Figure 3h). An associated wetland to the south of the GRNRA lies within an area designated as Industrial in the Comprehensive Plan.

4.5.3 Transportation

There are no roadways passing directly through the GRNRA. There are two roads which run adjacent to the GRNRA pond: South 212th Street and 64th Avenue South. South 212th Street is classified as a principal arterial and 64th Avenue South is classified as a minor arterial on the City's road classification map. The City's *Six Year Transportation Improvement Program 2008-2013* does not identify any transportation projects in the GRNRA shoreline area.

4.5.4 Wastewater and Stormwater Utilities

Wastewater Utilities

As previously mentioned, portions of the GRNRA pond complex were once wastewater treatment lagoons. A 12-inch sewer main originates at the southwest corner of the constructed wetland, joining with a 27-inch line that heads east and crosses the long inlet cell just west of 64th Avenue South (Figure 4h). According to City staff (Knox, pers. comm., 21 May 2008), this line is probably abandoned, although it does contain some flow that is assumed to be either groundwater leakage lagoon surface water seepage into the line. Most of the City's sewer mains in the area connect to the King County-Metro interceptor along 64th Avenue South.

Stormwater Utilities

As described above under Section 4.5.1, the GRNRA ponds are a stormwater and flood control facility. During Mill Creek Kent flood events, the ponds receive peak flows from Mill Creek Kent. The remainder of the year, the ponds receive stormwater runoff from an 832-acre sub-basin (Figure 5h).

4.5.5 Shoreline Modifications

Consistent with the GRNRA pond complex's nature as a constructed flood and stormwater facility, derived from a smaller sewage treatment facility (no longer active), the pond system is highly modified and controlled by weirs and culverts (see exhibit in Appendix B).

4.5.6 Existing and Potential Public Access Sites

The GRNRA is a 304-acre wildlife refuge that includes a combined stormwater detention and enhanced wetland facility, a public park, and a trail system (Figure 8h). This site provides public access to the ponds and wetlands that are part of the stormwater facility. With its nature walks, wildlife viewing towers, and bike path along the west and south sides of the site, the GRNRA pond and associated wetlands provides extensive water-enjoyment opportunities.

4.5.7 Critical Areas

Geologically Hazardous Areas

The GRNRA is located entirely within a seismic hazard area (see Figures 13.2). There are no other geologic hazard areas located around the GRNRA ponds.

Flood Hazard Areas

The wetland portions of GRNRA shoreline jurisdiction outside of the formal stormwater facility complex are within the current mapped 100-year floodplain (Figure 10.1). Other non-wetland areas north, south, and partially to the east are also in the floodplain. Flooding in the GRNRA shoreline jurisdiction likely does not threaten the perpetuation of trails, culverts, weirs and some access roads that are part of the park and stormwater facility.

Wetlands

Much of the GRNRA, including the individual cells that make up the GRNRA pond complex, consists of forested, scrub-shrub, emergent, and aquatic bed wetland (Figure 11). This large wetland area, with its diversity of vegetation types, provides habitat for a large number of birds, mammals, reptiles and amphibians. The complex also performs other wetland functions at a high level, including water storage and water quality treatment.

Streams

A system of constructed ditches and channels directs peak Mill Creek Kent flows into the GRNRA pond complex at the southeast and northeast corners. The system outlets at the northwest corner of the westernmost pond into a ditch system that leads back to Mill Creek Kent.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: WDFW mapping of Priority Habitat and Species classifies several areas of the GRNRA as Priority palustrine wetland habitat (WDFW 2007) (Figure 14). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration."

Special Status Species: PHS data do not show any priority species in the GRNRA pond complex itself. However, the outlet stream reportedly contains resident cutthroat trout (WDFW 2007), and other fish species may enter the system during Mill Creek Kent flooding events. During bird surveys conducted at the GRNRA, bald eagles, peregrine falcons, pheasant, and a variety of other waterfowl species have been observed. During one trip in April 2005, bird counters identified 62 species (http://www.ci.kent.wa.us/publicworks/index.aspx?id=6120&terms=grnra).

4.5.8 Opportunity Areas

The Public Works Department and the Parks, Recreation and Community Services Department should continue to work together managing the GRNRA and implementing the Landscape Master Plan for the site.

4.6 SPRINGBROOK CREEK

The Springbrook Creek (09.0005) Subbasin is located east of the mainstem Green River, in and around the cities of Kent and Renton. The creek enters the mainstem Green River via the Black River downstream of Kent at RM 11.0. With an estimated mainstem stream length of 12.0 miles, and approximately 19.1 miles of tributary streams and 3.8 miles of drainage ditches (Williams 1975), it is the largest subbasin in the lower Green River Basin, draining an area of about 15,763 acres. In the eastern part of the subbasin, rolling hills rise to elevations of about 525 feet above the valley floor. One significant lake is present (Panther Lake) along with several smaller ponds and wetlands. Creeks originating in these upland areas drop abruptly through sharply defined, steep canyons to the valley floor where stream gradients flatten quickly. Typically, these canyons are short, with high gradients, and the streams they carry are generally not accessible to anadromous salmonids. The western half of the subbasin lies on the valley floor and stream gradients are virtually flat. A unique feature to this subbasin is the Black River Pump Station, where the entire flow of Springbrook Creek is *pumped* into the Green River (Kerwin and Nelson 2000). A Denil fish ladder allows salmon migration upstream past the pump station, and an airlift system enables downstream salmon migration. Springbrook Creek only meets shoreline jurisdictional criteria (minimum 20 cfs mean annual flow) for a short distance (approximately 450 feet) into the City limits.

4.6.1 Land Use Patterns

The entire Springbrook Creek shoreline jurisdiction is zoned and planned for Industrial Park and Industrial use, respectively (Figure 3c). The two industrial parcels to either side of the stream are developed, with buildings between 100 and 200 feet from the ordinary high water mark, and parking areas 50 or more feet from the ordinary high water mark. However, there are two undeveloped narrow parcels comprising the riparian corridor of Springbrook Creek that are noted as “dedicated open space” in the parcel data, even though they still remain in the Industrial/Industrial Park zones.

4.6.2 Transportation

South 180th Street (Southwest 43rd Street) is the only stream crossing of the Springbrook Creek shoreline within City limits. Parking areas associated with light industrial uses are the only other vehicular access areas located within Springbrook Creek shoreline jurisdiction. The City’s *Six*

Year Transportation Improvement Program 2008-2013 does not identify any transportation projects in the Springbrook Creek shoreline area.

4.6.3 Wastewater and Stormwater Utilities

Wastewater Utilities

A sewer main crosses Springbrook Creek at SW 43rd Street (Figure 4c).

Stormwater Utilities

Just outside of shoreline jurisdiction to the west is a stormwater pond for the industrial building. That pond discharges into Mill Creek Kent just upstream of the upper limit of shoreline jurisdiction (Figure 5c). There do not appear to be any direct discharges to the system within Springbrook Creek shoreline jurisdiction.

4.6.4 Shoreline Modifications

The stream passes underneath SW 43rd Street in a large corrugated metal culvert. The banks for a short distance on either side of the culvert inlet are armored with angular boulders. The channel itself is a deep, excavated, canal-like feature.

4.6.5 Existing and Potential Public Access Sites

There is no developed public access to the Springbrook Creek shoreline area, other than a viewing opportunity from SW 43rd Street. However, just upstream of the 20 cfs cutoff point is the 5-acre Springbrook Greenbelt, which contains a user-made trail connecting to the Springbrook Creek shoreline area (Figure 8c). The shoreline-designated portion of Springbrook Creek could potentially accommodate a trail within the two narrow City-owned parcels located between the stream and industrial developments, if able to comply with Kent Critical Area regulations.

4.6.6 Critical Areas

Geologically Hazardous Areas

City maps show seismic hazard areas flanking the creek within the shoreline jurisdiction area (Figure 13.1-13.3). No other geologic hazards are mapped along this corridor.

Flood Hazard Areas

The Springbrook Creek 100-year floodplain is encompassed by shoreline jurisdiction (see Figure 10). The floodplain does not appear to extend beyond the top of bank, and does not appear to impact any of the developments on either side of the stream.

Wetlands

The Springbrook Greenbelt open space just upstream of shoreline jurisdiction is inventoried by the City as wetland (Figure 11). Based on aerial photo analysis, it appears to be primarily scrub-shrub wetland with a narrow, intermittent forested fringe along the stream corridor and scattered trees.

Streams

The upstream limit of shoreline jurisdiction is the confluence with Mill Creek Kent.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: A small, forested portion of the Springbrook Creek Greenbelt open space is mapped as Priority palustrine wetland habitat (WDFW 2007) (Figure 14). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration."

Special Status Species: According to WDFW (2007), Springbrook Creek contains coho salmon and cutthroat trout. Mill Creek Kent, at the upstream extent of Springbrook Creek shoreline jurisdiction, contains chinook and coho salmon, as well as resident cutthroat trout and steelhead. Kerwin and Nelson (2000) also report steelhead use of Springbrook Creek. No other priority species are mapped in the City of Kent's Springbrook Creek shoreline jurisdiction.

4.6.7 Floodplain and Channel Migration Zone

The Springbrook Creek shoreline area is within the draft 100-year floodplain for the Green River, but also has its own narrow floodway and floodplain (Figure 10.1). The current Springbrook Creek FEMA floodplain and floodway are encompassed by shoreline jurisdiction. Based on the maps, no upland structures are found within the 1995 Springbrook Creek-specific floodplain or floodway in shoreline jurisdiction. However, there are multiple structures located within the Springbrook Creek floodplain or floodway in City limits upstream of shoreline jurisdiction, almost all of which are classified as Limited Industrial uses such as warehouses and office complexes. At present, the channel within shoreline jurisdiction is confined between relatively high banks and is unlikely to migrate significantly.

4.6.8 Opportunity Areas

The City of Kent has provided some enhancement of the buffer on both banks of Springbrook Creek within the shoreline area, as well as upstream; several small conifer plantings were noted during December 2007 and February 2008 site visits. The enhancement included plantings and the installation of large woody debris structures adjacent to the stream channel. Additional plantings of native trees and shrubs would improve the wildlife corridor, and provide additional shade and organic debris to the stream. Landscape debris was noted in the buffer as well; adjacent businesses could be educated regarding appropriate disposal of lawn clippings and other landscape items. Finally, the culvert underneath SW 43rd Street could be replaced with a bridge.

4.7 JENKINS CREEK

4.7.1 Land Use Patterns

The Jenkins Creek shoreline affects only one parcel, which is the City of Kent's Armstrong Springs municipal watershed area (Figure 3d). There are no structures located on the property within shoreline jurisdiction. However, there is one well located on the property farther upstream.

4.7.2 Transportation

There are no roads that bisect shoreline jurisdiction of Jenkins Creek. The nearest roadway is Wax Road, located to the north within the City of Covington.

4.7.3 Wastewater and Stormwater Utilities

There are no stormwater or wastewater services or facilities in the Jenkins Creek shoreline jurisdiction.

4.7.4 Shoreline Modifications

There does not appear to be any shoreline modifications within the City of Kent's Jenkins Creek shoreline jurisdiction. However, there are extensive channel modifications less than one-half mile downstream adjacent to the Bonneville Power Administration property (City of Covington), and culverts and other modifications farther upstream.

4.7.5 Existing and Potential Public Access Sites

Public access to the Jenkins Creek shoreline area within the City is strictly prohibited to the public as part of the City's watershed protection policies. As previously mentioned, Armstrong Springs is a source of City drinking water.

4.7.6 Critical Areas

Geologically Hazardous Areas

City maps do not show any geologically hazardous areas in the Jenkins Creek shoreline jurisdiction. However, landslide-type soils and steep slopes are located to the southeast, outside of shoreline jurisdiction (Figures 13.1-13.3).

Flood Hazard Areas

The Jenkins Creek 100-year floodplain is encompassed by shoreline jurisdiction (see Figure 10.1). Based on aerial photos, there is one structure, a City well, located within the floodplain in City limits. The well is located farther upstream outside of shoreline jurisdiction.

Wetlands

City, King County, and WDFW PHS (2007) wetland mapping all show that much of the City-owned watershed parcel in the Jenkins Creek shoreline jurisdiction is wetland (Figure 11). Based on aerial photos, the wetland is forested.

Streams

Cranmar Creek discharges into Jenkins Creek from the south at the 20 cfs point. There are also other small tributaries that feed into Jenkins Creek further upstream outside of shoreline jurisdiction.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: Priority habitats are not mapped by WDFW (2007) in Jenkins Creek shoreline jurisdiction (Figure 14).

Special Status Species: According to WDFW (2007), Jenkins Creek contains coho salmon and steelhead trout, as well as resident cutthroat trout. Cranmar Creek reportedly only contains coho and cutthroat trout (WDFW 2007). A bald eagle nest has also been mapped on the north side of Jenkins Creek, upstream of the confluence with Cranmar Creek. No other priority species are mapped in the City of Kent's Jenkins Creek shoreline jurisdiction.

4.7.7 Floodplain and Channel Migration Zone

As previously mentioned, the Jenkins Creek 100-year floodplain and floodway are encompassed by shoreline jurisdiction because of the presence of associated wetlands. Based on the maps, no upland structures are found within the floodplain or floodway in the City's shoreline jurisdiction. There are no engineered restraints on channel migration of the stream.

4.7.8 Opportunity Areas

The Jenkins Creek shoreline area will benefit most from continued preservation and protection.

4.8 PANTHER LAKE

Panther Lake is located in the 15,763-acre Springbrook Creek basin, which ultimately drains to the Black River and finally the Lower Green River. It is entirely within King County, but is also part of the City's Potential Annexation Area. King County has assessed and characterized Panther Lake as part of its SMP Update, including inventory, characterization, restoration plan, and cumulative impacts analysis. Panther Lake is approximately 34.3 acres. King County's Department of Natural Resources reports a maximum lake depth of 7 feet and a mean depth of 3 feet. Panther Lake has a public access boat launch, but much of the lake surface is covered by water lilies, which hampers some beneficial uses.

4.8.1 Land Use Patterns

The lake is entirely with the City's PAA. The north, northeast, and southern tip of the lake are within the Urban Separator land use classification, and are therefore categorized as Unit A - Open Space (Figure 3g). The rest of the lake is surrounded by residential land uses and is categorized as Unit C - Residential.

4.8.2 Transportation

The primary roadway passing through the Panther Lake shoreline is SE 208th Street, located south of the lake and classified by Kent as a minor arterial. SE 196th Street, classified as a residential collector arterial, also passes through shoreline jurisdiction at the north end of Panther Lake shoreline jurisdiction. The City's *Six Year Transportation Improvement Program 2008-2013* does not identify any transportation projects in the Panther Lake shoreline area, as the area is not yet located within the City limits. However, King County's *Six Year Capital Improvement Program 2007-2012* identifies one study project along SE 208th Street to optimize signal timings and match signal lengths by the City of Kent and WSDOT. No other projects were identified within shoreline jurisdiction.

4.8.3 Wastewater and Stormwater Utilities

The City's wastewater and stormwater utility maps do not include this area of the PAA.

4.8.4 Shoreline Modifications

Aside from the public boat launch, the lake edge does not appear to be modified and no over-water structures are present.

4.8.5 Existing and Potential Public Access Sites

There is one public access boat launch located along the southwestern shoreline (Figure 8g). However, as mentioned previously, the lake is almost completely covered by water lilies, which severely limit recreational potential.

4.8.6 Critical Areas

Geologically Hazardous Areas

According to King County's iMAP, potential erosion hazard areas are mapped adjacent to the southeastern portion of Panther Lake (Figures 13.1-13.3). There are no other hazard areas identified within the immediate vicinity of the lake.

Flood Hazard Areas

Panther Lake does not have a mapped flood hazard area.

Wetlands

Panther Lake itself, lake fringe areas, and substantial areas extending north and south of the lake comprise a single wetland (Figure 11). The wetland is primarily mixed scrub-shrub with some small forested areas, with aquatic bed in the body of the lake and emergent communities at the lake edge.

Streams

According to King County iMAP, Panther Lake is fed upstream by Panther Creek, the headwaters of which begin about 600 feet south of SE 208th Street. Panther Creek continues past Panther Lake and eventually feeds into Springbrook Creek in the City of Renton.

Other Fish and Wildlife Habitat Conservation Areas

Priority Habitats: Panther Lake and its associated wetland are considered a Priority wetland habitat as both palustrine and lacustrine types (WDFW 2007) (Figure 14). To be considered a "Priority" wetland, it must have met the following criteria in WDFW's estimation: "Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration."

Special Status Species: WDFW (2007) maps coho salmon in Panther Creek and into Panther Lake itself. These fish are planted. Two bald eagle nests have been mapped northeast of the lake, outside of shoreline jurisdiction.

4.4.9 Lake Aquatic Invasive Species

According to King County and local residents (Johnson 2007), the lake is overgrown with exotic water lilies. This species has crowded out native plants and has made it very difficult to navigate the lake, even with small watercraft.

4.4.8 Opportunity Areas

Panther Lake was assigned a Category H restoration designation based on King County's shoreline inventory and characterization model. Category H applies to those shorelines with a "Low" basin function and a "Medium" reach function. The appropriate restoration strategy according to this methodology is to focus on enhancement and creation.

The non-native lily infestation in Panther Lake is adversely affecting lake habitat by creating a monoculture and excluding native plants, and is limiting lake access even by canoes. One shoreline property owner also noticed a "rotten" smell (Johnson 2007), which is likely caused by decomposition of large volumes of organic material, reduced circulation in the lake resulting from the dense lily cover, and breakdown of muck soils. Some mechanical or chemical control of the lily problem may be necessary.

Residential shoreline properties on Panther Lake have the potential to provide improvement of ecological functions through improvements to nearshore native vegetative cover.

5.0 ANALYSIS of ECOLOGICAL FUNCTIONS and ECOSYSTEM WIDE PROCESSES

Ecological processes and functions of the City of Kent's shorelines are summarized in Tables 14 through 21, below, and illustrated on Figures 17a through 17h. For areas of the PAA characterized by King County as part of its Shoreline Master Program update, the level of ecological function was assigned per that effort. In the City, a number of variables were qualitatively factored together to assign a level of function to shoreline areas using the same labels as King County: Low, Low Medium, Medium, Medium High, and High.[1] Variables considered in the assignment of function included: condition of riparian vegetation, presence of impervious surfaces, bank condition (armored or levee), and general land use.

5.1 LOWER GREEN RIVER

Approximately 90 percent of the Lower Green River watershed is developed, with 65 percent of that being urban commercial land use. Urbanization increases the frequency, magnitude and

[1] To avoid confusion by the public and simplify mapping, the same naming scheme was used for assigning function labels per Kent's analysis of shorelines in City limits as King County used in their analysis of shorelines in unincorporated areas. The methodologies are quite different, however. King County developed a GIS-based "spatially explicit raster model." Each process that operates in lacustrine or riverine environments was modeled and scored, with scoring assigned as a particular process in the "pixel" (smallest evaluation unit, 25 ft^2) rated relative to all other King County lake or river shoreline pixels. Potential scores ranged from 0 to 4, with 0 representing "highly altered conditions" and 4 representing little or no alteration. Pixel scores were then combined at the reach scale (delineated by King County using geomorphic data only). The process scores were averaged for each pixel and divided into five generalized categories of low, medium/low, medium, medium/high or high function.

duration of stormwater runoff, which adversely impacts salmonid rearing habitat. It also results in lower summer flows which adversely impact the amount of rearing habitat and increase summer water temperatures (Kerwin and Nelson 2000). As a result of the various flood protection plans, most of the commercial and rural developments rely on the built-up levee/revetment system. Two significant tributaries to the Lower Green River Watershed, Mill Creek Kent (Mullen Slough) and the Black River (Springbrook Creek), both experience backwater effects during high flow events, resulting in localized flooding within their respective Subwatersheds.

Table 14a. Process and Function Summary for the Green River in the City of Kent.

Process	Function Performance
Hydrologic	
Storage of water and sediment	LOW: Isolation of the river channel from its formerly wide floodplain and constriction of the channel by an extensive diking system has greatly reduced its ability to store flood waters across the floodplain and thereby attenuate flows. Similarly, fine sediments are prevented from reaching the floodplain for deposition and storage, and, within the leveed channel, fewer gravel bar areas are available for the deposition of coarser sediments. Though the river section south of Horsehead Bend in the City's PAA (Potential Annexation Area)[1] has not been as extensively leveed, still, out-of-bank flows are uncommon, likely due to the combined effects of the White River diversion and flood control provided by the Howard A. Hanson Dam. Furthermore, the armored embankment of Green River Road SE along much of the right (east) bank of that section functions in a somewhat levee-like fashion and serves to truncate the channel migration zone in that area. Much of the former floodplain area now functions more like upland, and uplands have low water and sediment storage functions. Impervious surfaces and compact, managed lawns and other landscaped areas, which are only semi-permeable, interfere with the infiltration of precipitation and rapidly send water downstream rather than storing it. Wetlands and other natural water and sediment storage features are greatly reduced compared to their historic prevalence.
Transport of water and sediment	MODERATE: The constricted river channel is somewhat efficient at transporting water and fine to medium sediment based on its relatively narrow width, increased flood-flow depth, and decrease in channel roughness. Basically, the engineering of the channel over time has been done with an increase in flow conveyance efficiency in mind. The Howard A. Hanson Dam upstream represents a significant sediment sink, presumably reducing the quantity of sediments reaching the river channel in the vicinity of the City and needing to be passed through.
Attenuating flow energy	LOW: Particularly where both banks are leveed, the decrease in river channel roughness brought on by a decrease in the width/depth ratio, reduction in accumulated woody debris, and reduction in riverbank vegetation has greatly reduced the river channel's ability to absorb and dissipate stream flow energy.
Developing pools, riffles, and gravel bars	LOW: Along the leveed channel sections through most of the City, a lack of roughness elements such as primary log jams and a narrowing of the channel and floodplain to eliminate and prevent the re-formation of backwaters and side channels has resulted in a uniform, monotypic channel form which is not conducive to the formation and maintenance of

Process	Function Performance
	the basic habitat elements, including pools, riffles, and gravel point bars. However, a few moderate backwater areas, pools and bars are present along the upstream section adjoining the City's PAA.
Removing excess nutrients and toxic compounds	LOW: Former floodplain areas provided a vast biofiltration function. Now that these areas are needed more than ever to provide this function, to remove an increased loading of toxics and nutrients, they have been virtually eliminated. The upland shoreline areas and the former floodplain areas now functioning essentially as upland are more often a source of nutrients and toxic compounds than a sink, due to lawn and landscaping runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals). Segments of the Lower Green River mainstem within the Kent City limits are currently listed on the State's 303(d) list as Category 5 waters (failing to meet surface water quality standards) for fecal coliform, and as Category 2 waters (waters of concern) for PCBs, mercury, and Bis (2-ethylhexyl phthal) (see report text).
Recruitment and transport of large woody debris (LWD) and other organic material	LOW: Riverbank forest vegetation has been greatly reduced, reducing the recruitment of logs and other vegetative material as well. Furthermore, the channel migration zone has been eliminated and the river channel "frozen" in place. Laterally migrating river channels recruit the forest materials in their paths and also recruit and recycle riverbank gravels laid down along previous channel alignments. Levees and the land use modifications behind them restrict the ability of the river to recruit LWD and organic material.
Vegetation	
Temperature regulation	LOW: Low density of shoreline vegetation greatly reduces the level of shading afforded the river. Segments of the Lower Green River mainstem within the Kent City limits are currently listed on the State's 303(d) list as Category 5 waters (failing to meet surface water quality standards) for temperature.
Water quality improvement	LOW: Well-vegetated banks and buffers improve shading conditions, in turn benefiting both temperature and dissolved oxygen, and help to biofilter out toxic substances. However, the City's urban areas are dominated by roads and other impervious surfaces, lawns, and landscaping, and lack dense buffers of riverbank vegetation. These urban areas are sources, rather than sinks, of water quality contaminants such as fertilizers, herbicides, pesticides, hydrocarbons, metals, and eroded soils. Segments of the Lower Green River mainstem within the Kent City limits are currently listed on the State's 303(d) list as Category 5 waters (failing to meet surface water quality standards) for fecal coliform, and as Category 2 waters (waters of concern) for PCBs, temperature, mercury, and Bis (2-ethylhexyl phthal). Low dissolved oxygen levels have also been recorded (Kerwin and Nelson 2000) (see report text).
Slowing riverbank erosion; bank stabilization	LOW: The function of slowing the rate of riverbank erosion formerly provided by riverbank vegetation has now been taken over by artificial riverbank armoring, associated with the diking system, including areas of rip-rap and other artificial armoring materials. Prior to construction of the levees and artificially protected banks, the river was lined with mature, mixed-forest communities. Those communities are now almost entirely absent in these segments, so vegetation does not provide any significant riverbank stabilization function.

Process	Function Performance
Attenuation of flow energy	LOW: (As stated above), the decrease in river channel roughness due to a reduction in accumulated woody debris, and reduction in riverbank vegetation has greatly reduced the river channel's ability to absorb and dissipate stream flow energy.
Sediment removal	LOW: As stated above, isolation of the river channel from its formerly wide floodplain has greatly reduced its ability to biofilter flood waters across the floodplain and thereby has prevented fine sediments from reaching the floodplain for deposition and storage.
Provision of LWD and organic matter	LOW: Riverbank forest vegetation has been greatly reduced, contributing to a reduction, along with the prevention of channel migration, in the recruitment of logs and other vegetative material. The reduction in shoreline vegetation has curtailed large woody debris and organic matter recruitment potential.
Hyporheic	
Removing excess nutrients and toxic compounds	LOW-MODERATE: The water table in the hyporheic zone has likely been reduced due to a lowering of the river channel relative to its floodplain, thereby reducing the proportion of river flow which routinely flows in and out of the zone to be filtered in the process. However, the hyporheic zone likely does provide some nutrient and toxic compound removal when water from the developed floodplain and uplands infiltrates into the hyporheic zone instead of running off of the surface. Though overall river water quality parameters show mixed results and include specific problem areas (see previous discussions), water quality is still likely improved due to some of its flow entering the channel as groundwater via the hyporheic zone rather than as surface flow.
Water storage and maintenance of base flows	LOW: Hyporheic zone functioning with respect to water storage is likely restricted, again, due to the relative depth of the river channel and its separation from its historic floodplain by the existing diking system. Such water stored in the hyporheic zone would be available to supplement dry season low river flows. Quantitative data are not available.
Support of vegetation	LOW: Much of the vegetation within the range of the hyporheic zone and also within the shoreline zone is landscaping vegetation supported by irrigation water and precipitation rather than by hyporheic water storage. In addition, the river channel is typically deeper now relative to its floodplain than it was historically, thereby reducing the ability of the hyporheic zone to supply water to floodplain vegetation.
Sediment storage	LOW: The hyporheic zone is restricted by a lowering of the river channel relative to its floodplain, as mentioned above, and extensive shoreline armoring, which limits movement of fines from the river into the hyporheic zone. Levees prevent silt-laden flood flows from spreading across the floodplain to infiltrate, recharge the hyporheic zone from above, and store sediments.
Habitat	
Physical space and conditions for life history	LOW: Habitat in and along the river has been much reduced in quality, quantity, and complexity compared to its original condition. The vegetative community is now much sparser, with a much lower level of accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The remaining vegetation also consists of a higher proportion of non-native, invasive species. The absence of dense shoreline vegetation is a limiting factor in terrestrial species (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are

Process	Function Performance
	absent. Within the channel itself, fewer major log jams and less wood overall similarly results in less available protective cover, and diminishes the creation of pool/riffle sequences as well. The reduction in side channels and backwaters greatly reduces the amount of valuable edge habitat available, and further reduces overall complexity. These sheltered, low-energy environments would be more hospitable to emergent vegetation, providing a refuge for small fish and amphibians. Shallow aquatic areas provide critical rearing, foraging, and refuge habitat for fish, particularly salmonids. Riverbank armoring, however, generally eliminates the low-energy shallow-water environment, creating deeper, higher-velocity water that is inhospitable to small fish and amphibians, as well as to emergent vegetation.
Food production and delivery	LOW: Food production from developed floodplain and upland areas is limited by a reduction in native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food for fish and other aquatic life. The historic, but now absent, emergent wetland areas that were associated with side channels, backwaters, and extensive floodplain wetlands also provided productive foraging areas for juvenile fish, small mammals, wading birds, and waterfowl.

[1] King County's function assessment of the Horsehead Bend PAA is provided in Table 12b.

Table 14b. Ecological Function Summary for the Green River (Horsehead Bend area) in Kent's PAA.

River Reach Quality Element	Quality Rating
Light energy	Medium High on most of the right bank, some Medium Medium on the "head" portion of Horsehead Bend on the left bank, remainder is mostly Medium
Large woody debris	Medium on the "head" portion of the right bank, Low Medium on the remainder of the right bank Low Medium on the "head" portion of the left bank, Medium on the remainder of the left bank
Nitrogen	High on most of the right bank Medium on the "head" portion of the left bank, Medium High on the remainder of the left bank
Pathogens	Medium High on the right bank Low Medium on the "head" portion of Horsehead Bend on the left bank, remainder is Medium High
Phosphorus	Medium High on the right bank Low Medium on the "head" portion of Horsehead Bend on the left bank, remainder is Medium
Sediment	Medium on the right bank Low Medium on the "head" portion of Horsehead Bend on the left bank, remainder is Medium
Toxins	Medium on most of the right bank Medium on the "head" portion of Horsehead Bend on the left bank, remainder is

River Reach Quality Element	Quality Rating
	mostly Medium High
Hydrologic cycle	Low Medium
Overall	**Medium High on the "head" portion of the right bank, Medium on the remainder of the right bank** **Low Medium on the "head" portion of the left bank, Medium on the remainder of the left bank** Note: See illustration in Exhibit 6 below

Source: King County iMAP, results of King County's shoreline functions modeling

Table 14c. Ecological Function Summary for the Green River (industrial area east of U.P. railroad) in Kent's PAA.

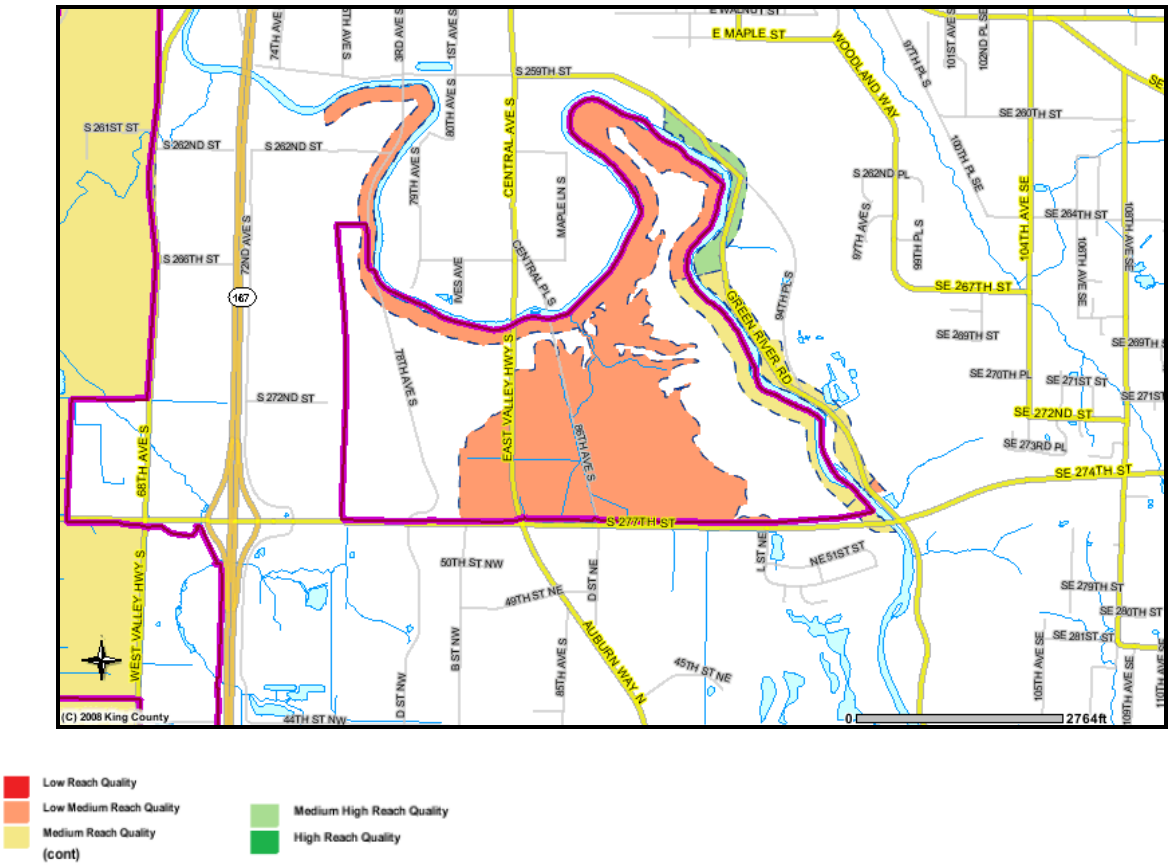
River Reach Quality Element	Quality Rating
Light energy	Medium
Large woody debris	Low Medium
Nitrogen	Medium
Pathogens	Low Medium
Phosphorus	Low Medium
Sediment	Low Medium
Toxins	Medium
Hydrologic cycle	Low Medium
Overall	**Low Medium** Note: See illustration in Exhibit 6 below.

Source: King County iMAP, results of King County's shoreline functions modeling

5.1.1 Hydrologic

Both the White and Cedar/Black Rivers were diverted out of the Lower Green River subwatershed in the early 1900s, resulting in significant changes to hydrology and allowing salt water from the estuary to move farther upstream than before. The combined diversion of these two rivers reduced the drainage area of the Green River basin by almost 60 percent, with the diversion of the White having a much greater impact on the sections of the river in and near Kent.

The White River is a glacially fed stream supplying large quantities of sediment and summer flows. It previously joined the Green River near RM 31, several miles upstream of Kent. Historically, the White River functioned primarily as a Green River tributary, but was also connected to the Puyallup River via an overflow channel known as the Stuck River. However, the entire flow of the White River was diverted to the Puyallup River in 1906 by a log jam that formed during a flood. Subsequently, because of flood control concerns, a permanent diversion structure was constructed and completed in 1911, forcing the flow of the White River to continue discharging into the lower Puyallup River. Because it is glacially fed, the White River tends to have higher summertime flows than other, non-glacial systems in Puget Sound, and its diversion reduced summer flows in the Lower Green River sub-watershed by roughly 50 percent.



Low Reach Quality
Low Medium Reach Quality
Medium Reach Quality
(cont)
Medium High Reach Quality
High Reach Quality

Exhibit 6. King County's overall shoreline function rating of the Green River PAA in Horseshead Bend area and in the industrial areas east of the railroad (from King County iMap).

Sediment transport from source areas to the downstream reaches of the river is an important process that produces and maintains salmonid habitat. In a properly functioning system, sediment provides a quality (medium-coarse) substrate for salmon egg incubation, food source (aquatic insect) production and cover from predators. However, the presence of Howard A. Hanson Dam effectively prevents delivery of these medium and coarse sediments from the upper basin to downstream reaches, though fine, suspended sediment continues to be carried past the dam (USACE and King County 2000). For salmonid fish and aquatic insect habitat, this is the worst of both worlds. In particular, the elimination of the supply of coarse sediment from the upper basin is believed to have had a profound effect on habitat conditions in the Middle Green River sub-watershed extending roughly upstream from Kent.

Diversion of the sediment-rich White River in 1906 also substantially reduced the supply of sediment to Green River reaches downstream of RM 31 (Kerwin and Nelson, 2000). According to Mullineaux (1970), the White River formerly supplied approximately 75 percent of the sediment reaching the lower Green. Of particular importance, the diversion of the White River substantially reduced the delivery of *coarse* sediment to the lower Green River, which may have reduced the availability of suitable anadromous salmonid spawning habitat there.

With the diversion of the White River and the construction of the Howard A. Hanson Dam, much of the total water volume and natural variability in streamflow has been lost, replaced by a smaller, highly regulated flow regime (see Exhibit 7). Now, flows that occur once every 100 to 200 years will be almost identical to those that flow every 5 or 10 years, except in duration, because outflow from the dam will not exceed 12,000 cfs. Fundamental to the form of a river is its hydrologic regime, which produces seasonal and decadal patterns of floods and drought. The historic patterns of channel migration, braiding, erosion, and deposition were for the most part controlled by moderate, relatively frequent floods. Typically, floods remove trees along the river's edge, deposit sediment in the floodplain, and do the work that forms the channel and its floodplain.

The Green River's ability to transport sediment, migrate across the valley floor, or inundate a significant portion of the floodplain has been significantly reduced since the placement of the dam as well as numerous levees. Given the dam operation, flows sufficient to cause large-scale channel avulsions are unlikely to occur more frequently than once in 100 or 200 years (Fuerstenberg et al. 1996). The historical floodplain, which developed in response to higher peak flows, has become largely isolated from flooding. In one unleveed location north of 277th Street, near the upstream extent of the PAA along the east bank, sediment deposition within the historical banks of the Green River indicates that a new, lower elevation floodplain is beginning to form (Andy Levesque, pers. comm., 19 October 2007). Construction of levees and revetments has further isolated the river from its historic floodplain, reducing the river's ability to inundate historic side channels or create new ones.

The conversion of shoreline areas from their pristine, pre-development condition to urban and agricultural development, flood control activities, and channelization all contribute to a loss of floodplain function. The presence of roads, pavement, and developed areas severely restricts the effectiveness of sediment filtration in riparian zones along the Lower Green River. Only 1.8 miles of habitat presently provide good sediment filtration with an additional 5.9 miles providing fair filtration. However, in general, the presence of non-vegetated, impervious areas near the river will likely prevent future improvements in sediment filtration by riparian zones. Properly functioning forested floodplains reduce the energy of flood flows, protect banks from excessive erosion and capture and store sediment, organic matter, and nutrients carried by floodwaters (Benner and Sedell 1997).

Levees and revetments have locked the channel into place and have effectively prevented bank erosion, even where gradual channel migration would have occurred naturally, effectively halting an important mechanism of large woody debris recruitment to the lower mainstem Green River. As described previously, these large-scale levees were built beginning in the early 1900's to help prevent the floodplains of the lower Green River from flooding. Levees are virtually continuous along both banks downstream of RM 25 (Fuerstenberg 1996), including most of the City of Kent. Levees and stream bank revetments also affect over 80 percent of the length of channel between RM 25 and RM 31 in and just upstream of the City (Perkins 1993).

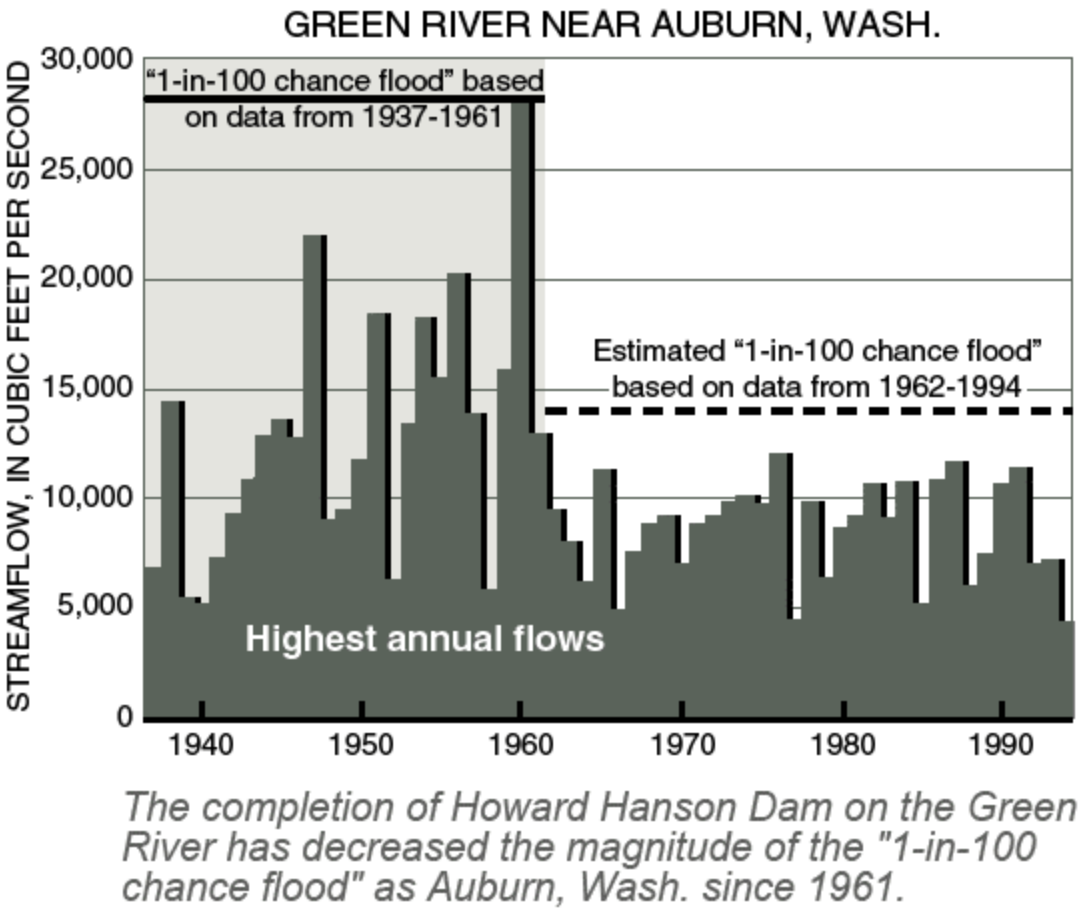


Exhibit 7. Pre- and post-Howard A. Hanson Dam flows and floods (http://pubs.usgs.gov/fs/FS-229-96/images/fig4_full.gif).

Confinement of the channel between levees prevents high flows from accessing the floodplains, thereby reducing groundwater and hyporheic recharge, the filtering out and deposition of fine sediments, and biofiltration in general. The narrower, deeper channels resulting from construction of the levees also have higher water velocity and bed shear stress. Thus even small flood events may scour bed materials. At the same time, simplification of the channel, including elimination of access to off-channel areas, reduces the availability of high flow refugia used by salmonids to escape the high velocity flows. Such channel simplification can also reduce the accumulation and stability of spawning gravels.

Increased winter peak flows from tributary streams, including Soos and Newaukum Creeks upstream of Kent, may exacerbate flooding in the lower Green River. Conversely, decreased tributary inflows during the summer tend to exacerbate low summer flows and high water temperatures in the lower Green River (Kerwin and Nelson 2000).

5.1.2 Hyporheic Functions

As a result of the diversion of the White River and Cedar/Black River, the lower Green River bed and floodplain in and near Kent have been lowered. This lowering has disconnected off-

channel juvenile salmonid rearing habitat and has been further compounded and masked by the construction of levees. Since the diversions, the channel downstream of RM 32 has narrowed by forming a new floodplain within the old channel (Perkins 1993). The new floodplain surface is at least 7 feet lower than the former floodplain (Dunne and Dietrich 1978), presumably lowering the water table of the hyporheic zone as well. During the periodic episodes of inundation of the floodplain which occur naturally, water slowly seeps into the soil, recharging shallow alluvial aquifers (Bayley 1995; Junk et al. 1989). Water stored in alluvial aquifers, including the hyporheic zone, and wetlands slowly drains toward the river, sustaining baseflows in off-channel habitats and the mainstem river during periods with little precipitation (Naiman et al. 1992 in Kerwin and Nelson 2000). With this disconnection of the river from its floodplain and lowering of the floodplain (hyporheic) water table, storage of water in the hyporheic zone for low flow supplementation has been significantly reduced.

Construction of the Howard A. Hanson Dam has further reduced high-end flood flows, in turn urther reducing the amount of flow provided to side channels. During overbank flows, when adjacent floodplains are inundated, floodwaters seep into the floodplain, recharging the water table (USACE and King County 2000). This supply slowly drains toward the river throughout the year, supplying small floodplain streams, side channels, and even the river itself with cool flows late in the season. Without such inundation, the process cannot occur and floodplain streams and side channels dry up earlier in the season and river temperatures may be affected. Reduced flows also reduce water supply to the banks and areas within the active channel, thereby reducing bank storage and affecting riparian growth. The temperature of effluent groundwater is also a possible factor of temperature elevation in streams due to the effect of elevated soil temperatures outside the buffer (Fuerstenberg et al. 1996).

Groundwater levels in the current White River valley are higher than in the Green River Valley in the vicinity of Auburn and Kent, resulting in a flow of groundwater from the White River system to the Green River system. This flow was estimated to be approximately 34 million gallons per day (53 cfs) in September 1998 (Pacific Groundwater Group 1999). Thus, taking hyporheic flows into account, the diversion of the White River out of the Green appears to have been incomplete (Kerwin and Nelson 2000).

Water withdrawals and diversion of springs or other surface water sources also serve numerous cities and water districts in the Lower and Middle Green River Subwatersheds. These withdrawals, together with smaller wells exempt from water rights requirements, further reduce the water available to streams and the mainstem. An analysis of present flow conditions, conducted as part of the Reconnaissance Assessment (Kerwin and Nelson 2000), revealed that flows less than 302 cubic feet per second occurred 49 percent more often and summertime means and annual minimum extremes were consistently longer than under natural, pre-developed conditions. The annual minimum flow occurs two weeks earlier, in late August rather than mid-September, than it did in the natural condition (Green/Duwamish Steering Committee 2005).

5.1.3 Shoreline Vegetation

The wide, low-gradient valley bottom of the Lower Green River near Kent was historically a mosaic of floodplain forest with numerous large “swampy” wetlands scattered throughout. During flood events, the river overflowed its banks creating a network of ephemeral streams that fed the wetlands and tributaries within the valley (Green/Duwamish Steering Committee 2005).

Since a low, natural levee had formed along the riverbanks, water that left the main channel during such events would typically flow down-valley paralleling the river in tributary channels for miles before eventually rejoining the main channel once again. The riparian zone vegetation and structure of the river have since been radically altered, resulting in the decline of the functions connected to riparian zone vegetation for nearly the past 100 years (Fuerstenberg et al. 1996). The Howard A. Hanson Dam reduces flow rates and sediment passage, and the levees and revetments reduce river migration rates. This reduces the amount, frequency, and extent of sediment deposition, slowing the natural progression of plant succession that normally occurs in the riparian zone (USACE and King County 2000).

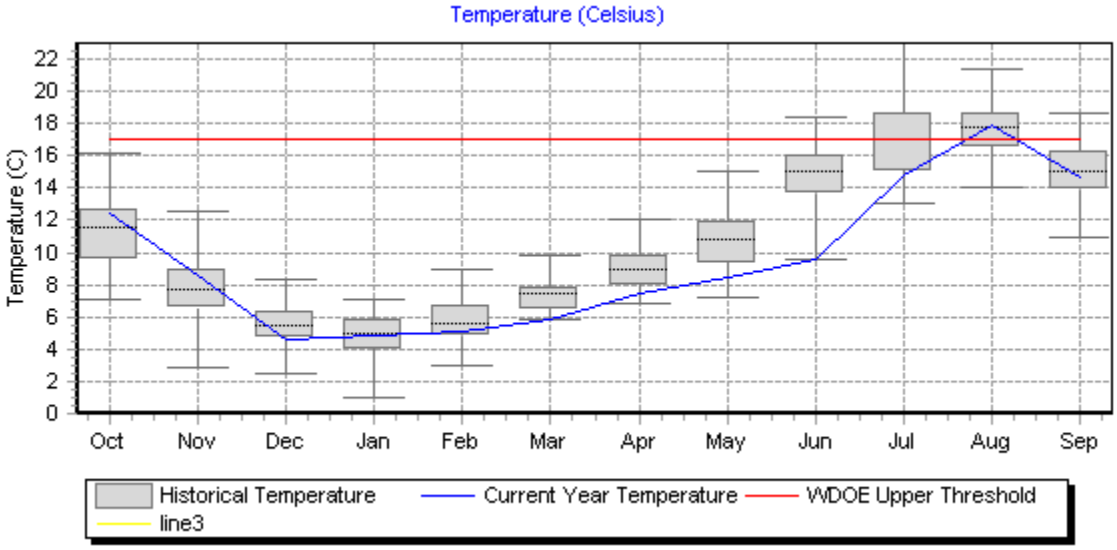
Soils data and anecdotal accounts suggest that the historic riparian vegetation community along the lower Green River was comprised of a mix of coniferous-dominated riparian stands, forested wetlands, and swampy meadows (Wharton 1990; Dunne and Dietrich 1978; Mullineaux 1970; Pence 1946). Young, early-successional deciduous trees such as willow, red alder, and black cottonwood probably occupied recently exposed bar surfaces, with older stands of coniferous or mixed coniferous and deciduous trees growing on terraces or stable floodplain surfaces. Western red cedar and Sitka spruce may have dominated forested wetlands. Other riparian tree species that were found in the lower Green River valley probably included black cottonwood, bigleaf maple, and western hemlock. Trees that were both abundant and routinely grew to a large diameter, and so would have most commonly contributed large wood to channels, included black cottonwood and bigleaf maple and, to a lesser extent, some large conifers including western red cedar and Douglas-fir. These trees would have contributed wood to the river channel large enough to function as persistent snags or the key pieces in jams (Collins and Sheikh 2005).

The Lower Green River valley bottom has since been dramatically altered. The most obvious and significant land cover change has been urban development. It is estimated that about 60 percent of the valley bottom is either high density (100% impervious) or low-density (50% impervious) development (Green/Duwamish Steering Committee 2005). Only 3 percent of the riparian stands along the lower mainstem Green River now consist of vegetation communities that are considered to provide good riparian shade. The majority of the channel between RM 11 and RM 32, including the sections in and along Kent, is exposed to direct solar radiation and has poor shade. The presence of roads and development within the floodplain will likely prevent the reestablishment of riparian vegetation that could provide adequate shade in the future.

White River diversion, levee construction, and flow controls due to Howard A. Hanson dam have all contributed to a decrease in the amount of riverbank and floodplain moisture available to vegetation (USACE and King County 2000). Growth rates and survival of typical riparian species decrease with reduced soil moisture conditions, leading to a reduction in riparian corridor width, and replacement of historic riparian species with species more tolerant of dryer conditions (Smith 1991). Cumulatively, there is less than one mile of intact riparian zone comprised of medium to large mixed deciduous and coniferous trees along the lower mainstem Green River. Approximately 18 percent (12.4 miles) of the riparian zone in the Lower Green River sub-watershed supports native deciduous trees. However, in most cases, deciduous stands are narrow (<100 feet) or comprised of small, sparse trees mixed with patches of grass, pavement, or bare ground. Almost 50 percent of the riparian zone is comprised of forbs and grass, or shrubs, many of which are non-native. Pavement and bare ground account for approximately 33 percent of the total area within 300 feet of the river in this sub-watershed.

None of the mainstem riparian habitat in the Lower Green River sub-watershed is in good enough condition to be considered as functioning properly based on the NOAA Fisheries criteria. Over 80 percent of the riparian zone is currently considered to provide poor shade, organic matter recruitment, and sediment filtration because native vegetation communities have largely been converted to grass or shrubs and because development often extends to within 75 feet of the channel (Kerwin and Nelson 2000).

Studies by the Muckleshoot Indian Tribe and King County suggest that elevated temperatures may also be a significant problem in the lower Green River, with lack of large vegetation along the riverbanks cited as a primary cause (Fuerstenberg et al. 1996). The loss of streamside vegetation along tributaries and watershed forest cover has also resulted in an increase in the temperature of runoff entering the river and its tributaries. This could lead to water temperatures in the river that are harmful and, in extreme cases, fatal to fish and other aquatic species, particularly in the late summer when flows are low. The following graph shows stream temperatures during 2008 measured at Site 0311 (few hundred yards upstream from the former outfall at the Renton Junction Bridge on West Valley Road at Highway 1) relative to Ecology's threshold and the historic data. In 2008, temperatures were generally in line with historic values. King County's 25-year trend analysis, however, shows that "temperatures increased significantly at station 0311" (http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/trends.pdf).



Source: http://green.kingcounty.gov/WLR/Waterres/StreamsData/Conventional.aspx?Locator=0311

The height and density of the canopy is a factor in the production of shade, so trees up to 200 feet in height (approaching the site potential tree height) provide incremental shading of the river. The maximum tree height today is 60 to 80 feet and shrub vegetation is a maximum of 20 feet high. Approximately 37 percent of the Green/Duwamish Basin consists of pavement which provides no shade. Thicker canopies of conifers are more efficient traps of radiation than the thin canopies of hardwoods even though the densities may be the same (Fuerstenberg et al. 1996). Along the river's edge, the low percentage of conifers contributes less thermal protection of the river.

5.1.4 Habitat

The full extent of off-channel habitat originally available in the Lower Green River sub-watershed (RM 11 to RM 25) pre-dating European settlement is unknown, since channelization and flow diversions had already begun to influence these channel segments at the time of the earliest maps (Kerwin and Nelson 2000). However, it is evident that the availability of these habitat types was once vastly higher. The Lower Green River historically migrated across a broad floodplain, but has since been channelized, and is now largely constrained by a system of levees and revetments that armor most of its banks and extend throughout the City of Kent and the lower Subwatershed (Perkins 1993; Kerwin and Nelson 2000). Virtually the entire length of the river in this area has been so affected. Channelization and an associated increase in sediment transport capacity have resulted in a loss of the active sand and gravel bars that historically typified the Lower Green River. The extensive network of valley-bottom wetlands previously maintained by frequent flooding along the Lower Green River was also lost as a result of flood control projects and urbanization. Although extensive wetlands, sloughs, and beaver ponds were once present throughout this area, the Lower Green River currently has little floodplain connectivity and supports little or no off-channel habitat (Kerwin and Nelson 2000).

The Lower Green River mainstem near where it enters the Kent City limits was historically characterized by a "Floodplain" channel type where sand and gravel bars were common, but the river quickly transitioned to a lower gradient "Palustrine" channel type through most of its length now adjoining the City that was gently sinuous, slowly migrating across the floodplain (Kerwin and Nelson 2000). Six miles of Floodplain channel type and fourteen miles of Palustrine channel type in the Lower Green River have since been channelized, each of which typically expressed complex planforms and dissipated flood energy via overbank flows. These changes appear to have resulted in the loss of nearly all the mainstem winter rearing habitats and a reduction in the quality of summer rearing and adult holding habitats in this portion of the watershed (Kerwin and Nelson 2000). The Floodplain areas that were channelized eliminated significant areas of gravel bars, which formerly provided important shallow marginal habitat, increased channel complexity, and sites suitable for colonization by riparian hardwood forests.

The construction of Howard A. Hanson Dam as well as diversion of the White River out of the basin have resulted in a reduction of the high flooding flows that are essential for reshaping the floodplain to form, maintain, and modify channel bars, braids, and side channels. In particular, the absence of large floods has had a profound influence on habitat conditions in the unconfined portion of the mainstem in the middle Green River, upstream of Kent. Coupled with this reduction in flood flows delivered to the lower reaches, the development of extensive levee systems along the lower Green River in and around Kent has greatly reduced channel diversity. The constructed levee system disconnects the mainstem Green River from its floodplain and reduces the river to a single, non-migratory channel. Where confined by levees, the cross section of the river may efficiently transport water but not sediment, and may result in the storage of sediment that has moved from eroded areas upstream (Fuerstenberg et al. 1996). River channelization and construction of levees reduce habitat complexity by creating and maintaining a single, deep, uniform channel which results in an overall decrease in channel length and less channel and estuary shoreline (ratio of 2.2 to 1, former to existing) (USACE and King County 2000).

Without periodic inundation, floodplain streams and off-channel habitats dry up earlier in the season and water temperatures may increase (Gore 1995). The diversion of the White and Cedar/Black Rivers and construction of revetments also reduced the channel width and caused the Green River to form a new, lower floodplain, cutting off access to former off-channel rearing habitats (Kerwin and Nelson 2000). Anchor Environmental (2004b) summarized conditions by noting that gradual channelization of the river in the last century has resulted in substantial losses in the quality and quantity of mainstem spawning, winter and summer rearing, and adult holding habitat (i.e. large, channel-wide pools) (Green/Duwamish Steering Committee 2005).

Because of the fluvial, glacial, and other geologic processes that formed the Lower Green River valley, tributaries historically provided the most abundant and dominant type of channel edge within it. Flooding was formerly common, creating a network of flood channels that fed the tributaries and wetlands. These tributaries provided important habitat and accounted for approximately one-third of total channel area and two thirds of channel edge (Collins and Sheikh 2004). Today, the tributaries are heavily altered due to development of the floodplain and are rarely fed by floodwater. Riparian habitats have been lost to roads, levees, and various encroaching land uses (Green/Duwamish Steering Committee 2005).

The resulting loss of these tributary, side channel, and riparian features has resulted in a significant decline in the diversity of habitat for salmon, which use off-channel habitats for spawning and rearing (USACE and King County 2000). Encroachment of land use, roads, trails, and levees to the river margins has greatly reduced the extent of existing or potential riparian habitat (Green/Duwamish Steering Committee 2005).

Many fish and wildlife species are dependent on the natural seasonal variations in streamflow that occur in free-flowing rivers to time their migrations, reproduction, and other behaviors. For example, the reduced flows and absence of spring freshets may prolong downstream migration of juvenile salmonids, thereby making juvenile salmonids more susceptible to predators and adverse water quality conditions (Fuerstenberg et al. 1996 in USACE and King County 2000). Juvenile salmonids including chinook, coho, steelhead, chum and cutthroat have been observed utilizing side channel habitats in the mainstem Green River during the spring (Jeanes and Hilgert 2000). Refill operations at Howard A. Hanson Dam during the spring have reduced the frequency of side-channel connectivity, which would increase the probability that juvenile salmonids may become stranded in side channels that become disconnected from the mainstem. Alterations in the natural flow regime during refill operations at the dam may also adversely impact spring spawning and incubation success by disconnecting off-channel habitats.

The floodplain in the Lower Green River Subwatershed is typically composed of gravelly and sandy alluvium, much of which was originally deposited during Pleistocene glaciation and has subsequently been reworked by the river (Perkins 1993). Southwest of Renton, valley floor deposits are composed of silt, clay and fine sand interbedded with peat (Mullineaux 1970). With the exception of coarse materials associated with a smaller alluvial fan that formed near the mouth of the Cedar/Black Rivers, these deposits of fine material form the substrate of the lower Green/Duwamish River (Mullineaux 1970). Therefore, it is unlikely that this sub-watershed ever provided important spawning habitat for anadromous salmonids downstream of RM 27, including the sections through and adjoining Kent. Just upstream of Kent, “spawning surveys

conducted between RM 27 and RM 30 indicated that use by spawning chinook is currently low compared to upstream reaches" (Cropp 1999 as cited in Kerwin and Nelson 2000).

With less than one mile of intact riparian zone vegetation (medium to large deciduous and coniferous trees located on the right bank near RM 32), the Lower Green River mainstem riparian habitat is not properly functioning and in poor condition. In most cases, deciduous stands are narrow and patchy, and much of the riparian vegetation consists of non-native forbs, grass, or shrubs. Pavement and bare ground account for approximately 33 percent of the total area within 300 feet of the river in the Lower Green River sub-watershed. Levees and revetments have confined the river channel, preventing erosion, channel migration, and recruitment of large woody debris. Overhead shading is largely non-existent throughout the Lower Green River, and the dense road network and development within the watershed will likely prevent establishment of riparian vegetation that could provide shade and large woody debris in the future.

This reduced recruitment and deposition of LWD has contributed to an overall decline in the channel complexity of the mainstem Lower Green River. Reduction in the supply of naturally recruited large wood through historical and ongoing timber harvest throughout the Green River Watershed contributes to the absence of in-stream wood (USACE and King County 2000). Ninety seven percent of the riparian zone along the lower Green River is considered to have poor LWD recruitment potential and microclimate conditions because native vegetation communities have largely been converted to grass or shrubs, and because development often extends to within 75 feet of the channel. None of the riparian zone along the lower Green River is considered to have good LWD recruitment potential. In unconfined streams where the channel migrates back and forth across the floodplain over time, wood may be recruited to the channel from throughout the channel migration zone (CMZ). The channel migration zone is defined as the lateral extent of likely movement along a stream reach with evidence of active channel migration or avulsions over the past 100 years (WFPB 2000).

5.1.5 Water Quality

Water quality in the Green River and its tributaries is affected by seasonal runoff patterns, and also varies widely depending on location in the watershed, intensity of land use (level of urbanization), and human activities. Most of Kent occupies the Lower Green River Subwatershed, which is a heavily developed area with extensive tracts of office/commercial and multi-family residential complexes. Land uses in this basin include residential, commercial, industrial, and agricultural, as well as some major highways, including Interstate 5. The City is also located in the Middle Green River Subwatershed, which has a lower level of development.

Section 303(d) of the Clean Water Act requires the State to identify waterbodies failing to meet water quality standards and develop Total Maximum Daily Loads (TMDLs) or Water Cleanup Plans for each waterbody on the 303(d) list. To comply with the Clean Water Act, waterbodies are assessed and subsequently characterized as either: Category 1-Meets clean water standards; Category 2-Water of concern; Category 3-No data available; Category 4-Polluted but the problem is currently being addressed; or Category 5-Polluted waters that require a TMDL (or the 303d list).

Segments of the Lower Green River mainstem within the Kent City limits are currently listed on the State's 303(d) list as Category 5 waters (failing to meet surface water quality standards) for temperature and fecal coliform, and as Category 2 waters (waters of concern) for PCBs, temperature, mercury, and Bis (2-ethylhexyl phthal). Maps showing specific locations in the mainstem with TMDL listings are available on Ecology's website. Mainstem summer water temperatures have peaked between 23 and 24 degrees C at several stations throughout the Lower Green River, posing a potential threat to anadromous salmonids migrating upstream during August and early September, and a probable threat to juvenile salmonids rearing throughout this reach of the river (Taylor Assoc. and King County 2004). Low dissolved oxygen levels have also been recorded in the Lower Green River and are likely detrimental to juvenile rearing habitat for salmonids. As a result of reductions in municipal and industrial discharges, however, water quality conditions in the Lower Green River have improved over those that existed in the 1960s (Kerwin and Nelson 2000).

Segments of shoreline tributary Big Soos Creek are also currently listed on the State's 303(d) list as Category 5 waters for fecal coliform and dissolved oxygen, affecting water quality in the lower Green River. In addition to shorelines of the State, other smaller Kent area streams flowing into the Green River mainstem have TMDL listings as well. Mullen Slough, where it discharges to the west side of the Green River, is listed as a Category 5 water for fecal coliform and dissolved oxygen. Hill (Mill) Creek, also entering the Green River from the west, is a Category 5 water for dissolved oxygen, temperature, copper, and fecal coliform; and a Category 2 water for pH and mercury.

5.2 BIG SOOS CREEK

Table 15. Process and Ecological Function Summary for Big Soos Creek in Kent.

Process	Function Performance
Hydrologic	
Storage of water and sediment	MODERATE: The creek still flows through fairly wide wetland floodplain along much of its length in and near the City, typically vegetated with willows and other scrub-shrub vegetation. During high flows, the creek is still able to spread out across its floodplain, and so the floodplain is still able to store and attenuate flood flows and trap and store fine sediments. These fine sediments are incorporated into the floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat. Beaver dams at some locations aid in keeping the creek connected with its floodplain. In contrast to the Green River in and near Kent, the floodplain of Big Soos Creek has gone largely un-leveed and unconstrained. Wetland and floodplain regulations have helped to keep the floodplain relatively undeveloped, and thus able to better carry out its natural hydrologic and habitat functions.
Transport of water and sediment	MODERATE: Deforestation and urbanization throughout the basin has increased stream flows, flow volatility, erosion, and sedimentation. As for most streams in the region, the stream channel and floodplain have formed in response to a lower flow and sediment regime and are not entirely suited to carry the increased flows and sediment loadings experienced. For example, bank erosion is typically a response to higher flows as the channel enlarges and widens to accommodate higher flows.

Process	Function Performance
Attenuating flow energy	MODERATE: As mentioned above, some sections of broad floodplain remain which are characterized as scrub-shrub wetlands. These are effective at attenuating streamflow energy during flood events. However, the recruitment of woody debris, especially large woody debris, is impaired due to clearing and the small size of the streambank trees remaining. To its benefit, the basin includes a system of lakes, large wetland areas, and naturally infiltrative recessional outwash soils which all serve to dampen and moderate stream flow fluctuations. Still, the decrease in channel roughness brought on by a reduction in accumulated woody debris and bank vegetation has reduced the stream channel's ability to absorb and dissipate stream flow energy.
Developing pools, riffles, and gravel bars	MODERATE: Reduction in roughness elements, such as primary log jams and a narrowing of the floodplain in some areas, has resulted in a simpler channel form which is less conducive to the formation and maintenance of the basic habitat elements, including pools, riffles, and gravel point bars. Some pools have been formed in and near the City by beaver activity.
Removing excess nutrients and toxic compounds	MODERATE: Remaining broad floodplain areas provide a competent biofiltration function. However upland shoreline areas and developed, former floodplain areas now functioning essentially as upland are more often a source of nutrients and toxic compounds than a sink, due to lawn and landscaping runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals). Segments of Big Soos Creek upstream of the City are also currently listed on the State's 303(d) list as Category 5 waters for fecal coliform.
Recruitment and transport of LWD and other organic material	LOW: Streambank forest vegetation, particularly large trees, has been reduced, reducing the recruitment of large logs and some other vegetative material as well. Remaining trees along the creek are typically small in size, such as the stands of willow lining the banks even where the floodplain is relatively intact, so opportunities for recruiting large wood are reduced. Furthermore, channel migration has been curtailed by development in places, primarily the major road crossings of SR 18 and SR 516. Laterally migrating channels recruit the forest materials in their paths and also recruit and recycle riverbank gravels laid down along previous channel alignments.
Vegetation	
Temperature regulation	MODERATE/LOW: Well-vegetated banks and buffers improve shading conditions, in turn benefiting both temperature and dissolved oxygen. Segments of Big Soos Creek upstream of the City are currently listed on the State's 303(d) list as Category 5 waters for dissolved oxygen. Low density and small size of shoreline vegetation greatly reduces the level of shading afforded the creek. However, smaller vegetation is needed to provide shade to a narrower creek as opposed to a wider river.
Water quality improvement	MODERATE: Where wide floodplain areas remain and are densely vegetated with willows, grasses, emergent vegetation, and other riparian vegetation types, an effective level of biofiltration can still occur. However, urbanizing areas in the basin are dominated by roads and other impervious surfaces, lawns, and landscaping, and lack densely vegetated buffers of sufficient width. These urban areas are sources, rather than sinks, of water quality contaminants such as fertilizers, herbicides, pesticides, hydrocarbons, metals, and eroded soils. Segments of Big Soos Creek upstream of the City are currently listed on the State's 303(d) list as Category 5 waters for fecal coliform.

Process	Function Performance
Slowing riverbank erosion; bank stabilization	MODERATE: The dense grasses and shrubby vegetation such as willows that line much of the Soos Creek banks are fairly effective at stabilizing soils and slowing the rate of erosion. However, the function of slowing the rate of bank erosion formerly provided by bank vegetation has now been taken over by artificial armoring in some areas, such as at the road crossings. Prior to settlement and clearing, the creek was lined with mature, mixed-forest communities.
Attenuation of flow energy	MODERATE/LOW: (As stated above), the decrease in channel roughness due to a reduction in accumulated woody debris, and reduction in bank vegetation has reduced the channel's ability to absorb and dissipate stream flow energy.
Sediment removal	MODERATE: As stated above, remaining densely vegetated floodplain areas are effective filters for the filtering and retention of fine sediments.
Provision of LWD and organic matter	LOW: Streambank vegetation now includes primarily only smaller tree sizes, so there is little opportunity for the recruitment of large woody debris. There is better opportunity for the recruitment of small woody debris, leaf litter, etc. that would contribute to a decomposition-based food chain.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE/HIGH: The Soos Creek basin is dominated by highly infiltrative, glacial outwash soils which provide for a high degree of interaction between ground and surface waters. Stream flows supplement shallow groundwater or hyporheic flows and vice versa, thereby increasing the proportion of flow which routinely flows in and out of the zone to be filtered in the process. Furthermore, the hyporheic zone also provides some nutrient and toxic compound removal when water from the developed floodplain and uplands infiltrates into the permeable soils instead of running off of the surface. Though overall water quality parameters show mixed results and include specific problem areas (see previous discussions), water quality is likely improved due to its filtration as groundwater prior to entering stream flow.
Water storage and maintenance of base flows	MODERATE/HIGH: The combined presence of headwater lakes, large wetland areas, and highly infiltrative and interactive soils throughout the Soos Creek basin provides a high level of water storage which is available for the support of stream base flows. Hyporheic zone functioning with respect to water storage is enhanced due to the high degree of interactivity between the creek and its floodplain and supporting aquifers. Such water stored in the hyporheic zone is available to supplement dry season, low stream flows.
Support of vegetation	MODERATE: While the interaction between Soos Creek and its hyporheic zone is generally quite good, the gravelly outwash soils that tend to be present in the hyporheic zone and throughout the basin can be so well-draining and poor at wicking water upward that plants growing above these gravelly soils can be deprived of water even when an active water table is only a few feet below the surface. The few prairie areas present in Western Washington tend to form on such gravelly outwash soils, as occurs near Yelm, because these soils are too well-drained to support forest vegetation. However, landscaping vegetation within the shoreline zone is supported by irrigation water and precipitation rather than by hyporheic water storage.
Sediment storage	MODERATE/HIGH: Good interaction between the hyporheic zone and stream flows allows good potential for filtration of interflow and hyporheic flow, and thereby sediment storage. If sediment loading is too high, however, gravels of the hyporheic zone could become clogged, their sediment storage capacity used up, and the overall functioning of the hyporheic zone impaired.

Process	Function Performance
Habitat	
Physical space and conditions for life history	MODERATE/LOW: Habitat in and along Soos Creek has been reduced in quality, quantity, and complexity compared to its original condition. The vegetative community is now much sparser and with a much lower level of accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The diminishment of dense shoreline vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are absent. Within the channel itself, fewer log jams and less wood overall similarly results in less available protective cover, and diminishes the creation of pool/riffle sequences as well. Some beaver dams along the course of the creek have helped to maintain the abundance of in-channel wood, however. A reduction in side channels and backwaters has reduced the amount of valuable edge habitat available, and further reduced overall complexity. Shallow, low-energy aquatic areas provide critical rearing, foraging, and refuge habitat for amphibians and juvenile fish, particularly salmonids. Bank armoring has reduced the amount of low-energy shallow-water environment, creating deeper, higher-velocity water that is inhospitable to small fish and amphibians, as well as to emergent vegetation.
Food production and delivery	MODERATE: Food production from developed floodplain and upland areas is limited by a reduction in native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. The historic, but now reduced, emergent wetland areas that were associated with side channels, backwaters, and extensive floodplain wetlands also provided productive foraging areas for juvenile fish, small mammals, wading birds, and waterfowl.

5.2.1 Hydrologic

The Soos Creek subbasin is in the process of changing from being rural and forested to being heavily urbanized (particularly in the western areas). The subbasin has an extensive system of interacting lakes, wetlands and gravelly, infiltrating soils that collectively attenuate peak stream flows. In the 1980s, Soos Creek discharged about 8 to 10 cfs to the Green River during the summer (Metro 1988) and 400 cfs during one-year event high flows (King County 1990). The Soos Creek Basin Plan provides detailed subcatchment peak flow tables and maps for various future and existing conditions using HSPF modeling.

Existing flow-related problems occur in the upper reaches of the creek which are subject to low stream flows, both natural and anthropogenic (Exhibit 8). In 1990, it was predicted that stream flows would increase by an average factor of 1.8 under build-out conditions. However, some areas were expected to have stream flows increase to 3.5 times the 1985 levels (King County 1990). These higher flow increases would be in areas that have highly infiltratable soils that are converted to urban areas with impervious surfaces (Kerwin and Nelson 2000). Preliminary evidence from gaging stations seems to support the general conclusion of increased peak flows.

According to peak flow data collected since 1962 at the USGS gaging station on Soos Creek, the top five flow events on record all occurred after 1990 (Exhibit 9).

Soos Creek is one of the largest tributaries to the Green River and its hydrologic regime is dominated by winter rain events, with low flows occurring in the late summer. The topography is typified by rolling hills formed on glacial deposits. Lakes and wetlands in the headwaters of the basin help sustain stream flows by slowly releasing groundwater during the summer months. The primary impacts on the hydrology of Soos Creek include stormwater runoff, urban development and consumptive water use. The effects of urbanization and groundwater withdrawals have reduced summer low flows, which may delay the increase in streamflows in the fall to a level allowing the upstream migration of adult chinook salmon (Kerwin and Nelson 2000). The increased sediment delivery to alluvial fans and low gradient reaches of the Green River, in combination with the even lower low flows, impedes adult chinook attempting to migrate upstream into Soos Creek and other tributaries.

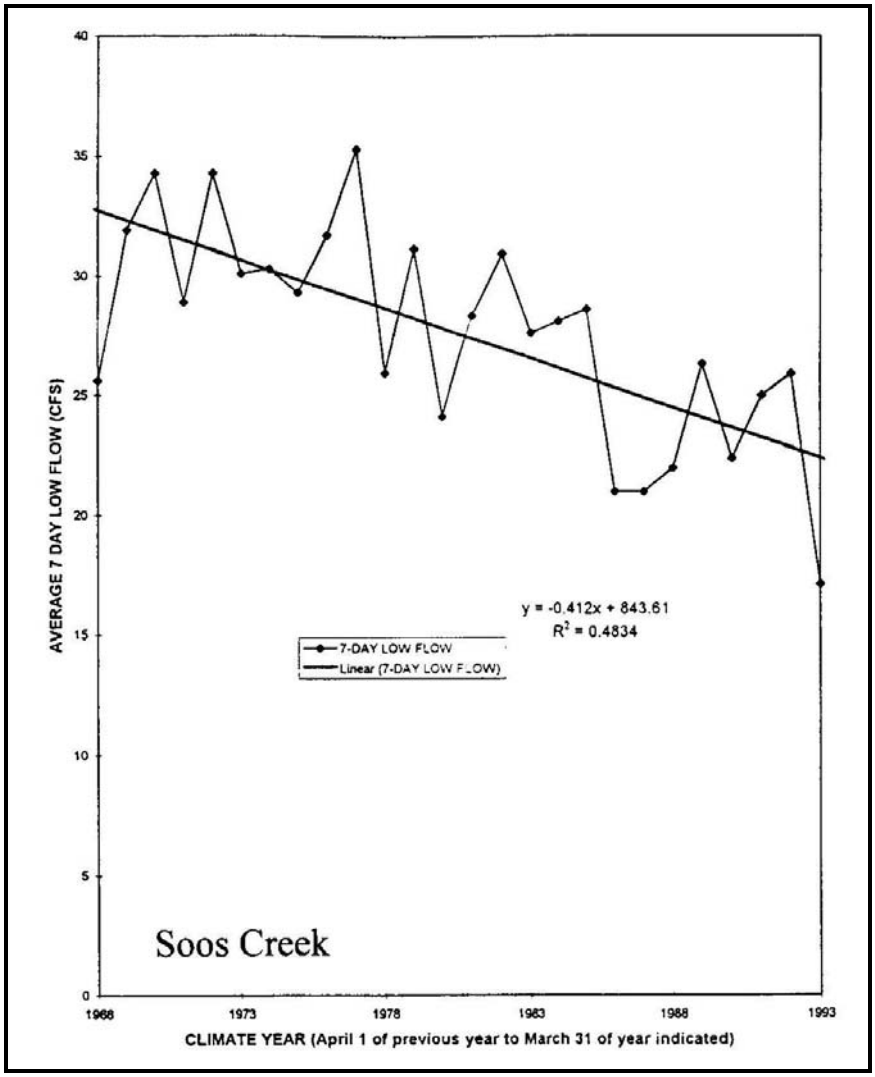


Exhibit 8. Average 7-day low flows in Soos Creek from 1953-1993 (after Kerwin and Nelson 2000).

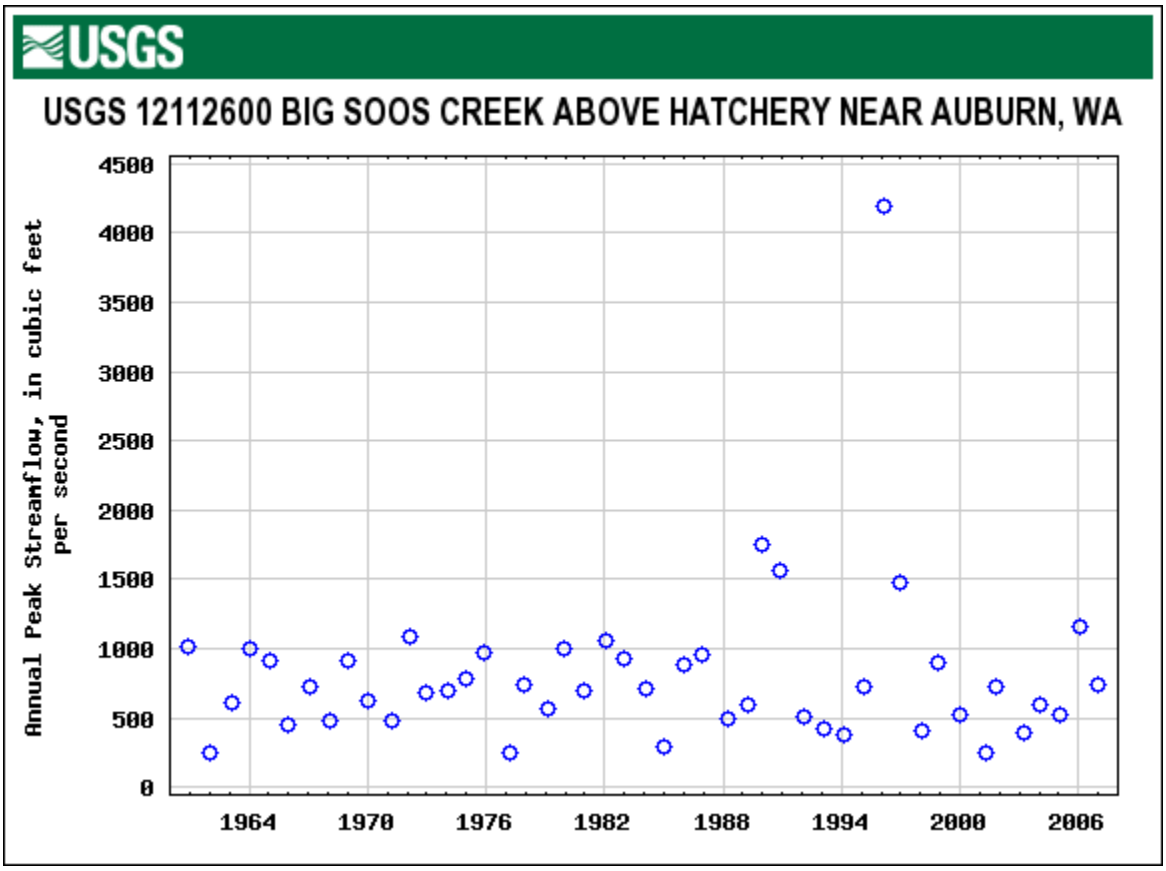


Exhibit 9. USGS peak flow data for Big Soos Creek near Auburn, Washington, from 1964 through 2006.

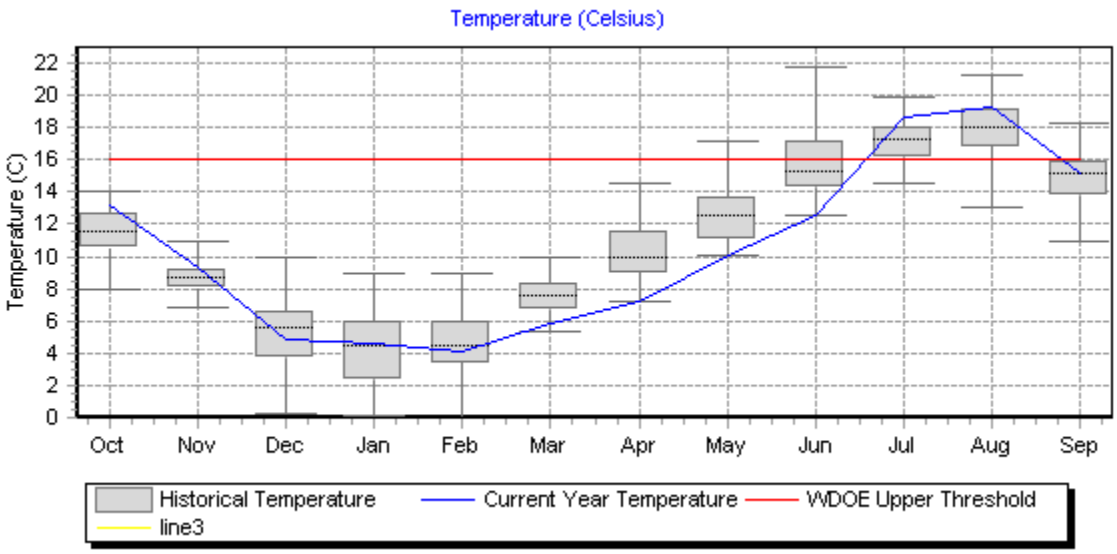
Dense stands of young trees or shrubs are sufficient to provide good sediment filtration where the riparian zone is at least 150 feet wide. Approximately 45 percent of the existing riparian zone along Soos Creek provides good sediment filtration. Elsewhere, roads, development, or other contributing activities near the stream reduce the ability of riparian area to filter fine sediment (Kerwin and Nelson 2000).

5.2.2 Shoreline Vegetation

Streambank and riparian vegetation is important for maintaining temperature, removing excessive nutrients and toxic compounds, sediment removal, bank and channel stabilization, attenuation of flow energy, and provision of large woody debris and other organic matter. The following graph shows stream temperatures during 2008 measured at Site G320 (at confluence with Little Soos Creek) relative to Ecology's threshold and the historic data. In 2008, temperatures were generally in line with historic values. King County's 25-year trend analysis, however, shows a pattern of increasing temperatures at Site D320 (confluence with Jenkins Creek) (http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/trends.pdf).

Though shrubby willow and similar types of vegetation occur along the City's shoreline reaches of Soos Creek, little mature native vegetation remains in the riparian zone along the creek.

Basin-wide, there is still an intact riparian zone supporting native tree species between RM 1.5 and 2.8, and patches of native deciduous trees also occur elsewhere along the lower six miles of the creek. However, these trees are generally small. The remainder of the riparian zone is composed primarily of shrubs or grass. Development and roads limit the riparian zone width in many cases (Kerwin and Nelson 2000).



Source: http://green.kingcounty.gov/wlr/waterres/streamsdata/Conventional.aspx?Locator=G320

5.2.3 Hyporheic Functions

Surface water rights and claims in the Soos Creek basin amount to approximately 27 cfs, and are predominantly for irrigation and small multiple domestic systems (Culhane et al. 1996). Groundwater withdrawals represent the largest water source in the major Green River tributary basins, including Soos Creek. Apparent declines in summer stream flow have been identified for the Soos Creek basin, likely in response to increased urbanization, groundwater withdrawals, and changes in precipitation (WDOE 1995). The seven-day-average low flow rates in Soos Creek have decreased significantly between 1968 and 1993 (Kerwin and Nelson), with declining trends in the seven-day-average low flow rates detected for all years between 1968 to 1993 (Culhane 1995). The likely causes for these instream flow declines include a combination of decreased precipitation 1993 (Culhane 1995), increases in the percentage of impervious surfaces associated with urbanization, and increased groundwater withdrawal.

Potable water wells that produce less than 5,000 gallons per day do not require a water right. It is not known how many of these wells are present in the subbasin and what their cumulative impacts might be. Information in the *Ground Water Management Plan* (SKCGWAC 1989) and studies conducted by the USGS indicate that groundwater withdrawals from the Covington Upland have adversely impacted streamflow in Soos Creek. The mean annual streamflow in Soos Creek decreased about 14 percent and the mean monthly low flow rate decreased by about 33 percent during the time period from 1967 to 1992. However, precipitation as measured at

Palmer decreased only 5 percent during that same period, indicating that the declines cannot be attributed to decreases in precipitation alone. More likely, the decreases are also caused by a combination of groundwater removal and increases in the percentage of impervious surfaces (Culhane 1995 in Kerwin and Nelson 2000).

5.2.4 Habitat

Because existing stands of riparian trees (where present) are small, LWD recruitment is currently considered poor all along Soos Creek. Bank stability, shade, and organic matter recruitment are also considered poor along approximately 65 percent to 80 percent of Soos Creek (overall, not just in the City) because of development that extends to within 75 feet of the channel and the small size of trees in the riparian zone. Summer low-flow discharges are also decreasing (see *hydrology* above), which limits available rearing production for species of salmonids that require over-summer residency (Kerwin and Nelson 2000).

5.3 LAKE MERIDIAN

Table 16. Ecological Function Summary for Lake Meridian.

Function	Performance
Hydrologic	
Storing water and sediment	LOW-MODERATE: The lake of course provides excellent water and sediment storage functions. However, the uplands surrounding the lake within Shoreline jurisdiction have low water and sediment storage functions. Impervious surfaces and compact managed lawns interfere with infiltration of precipitation and rapidly send water "downstream." Wetlands and other natural water and sediment storage features are generally lacking. The water storage capacity of the lake was decreased somewhat by the recent US Army Corps sponsored project, which sought to stabilize lake levels and reduce fluctuations to the benefit of lakefront homeowners.
Attenuating wave energy	MODERATE: Bulkheading and other shoreline modifications have replaced native vegetation and natural woody debris as the features in place to attenuate wave energy. Shoreline erosion is not known to be a serious problem on the lake.
Removing excess nutrients and toxic compounds	LOW: The lake is surrounded by intensively landscaped lakefront homes. The upland shoreline areas are more often a source of nutrients and toxic compounds, via lawn treatment runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals). Although the lake is on Ecology's 303d list for fecal coliform and total phosphorus, the notes indicate that recent data shows Lake Meridian is meeting water quality standards for those criteria.
Recruitment of LWD and other organic material	LOW: Dense residential development and other upland modifications restrict the ability of the lake to recruit LWD and organic material.
Vegetation	
Temperature regulation	LOW: Lack of dense shoreline vegetation nearly eliminates potential for some shading of the shallow-water nearshore area. Vegetation is less effective at shading west-facing shoreline areas due to afternoon sun from the west.
Water quality improvement	LOW: Residential areas surround the lake and are dominated by lawn and landscaping rather than dense buffers of native lakeside vegetation. These residential areas are sources of water quality contaminants such as fertilizers, herbicides and pesticides. In addition to the typical residential landscaping

Function	Performance
	pollutants, runoff from surrounding urban areas carries hydrocarbons, metals, sediments, and other pollutants to the lake from roads, parking lots, and other developed areas.
Attenuating wave energy	LOW: In its pre-development condition, the lake was ringed with emergent wetlands and mature mixed-forest communities. Those communities are now almost entirely absent around the lakeshore, so vegetation does not provide any significant wave attenuation function. As mentioned above, bulkheading and other shoreline modifications have replaced native vegetation and natural woody debris as the features in place to attenuate wave energy.
Sediment removal and bank stabilization	LOW: Under natural conditions, there would be an ongoing, underlying rate of shoreline erosion, which would contribute to maintaining substrate conditions. This rate would be partially determined and moderated by the presence of shoreline vegetation whose root systems would tend to hold bank material in place. Instead, the lake shore now has little shoreline vegetation and a large proportion of it is armored. While this “stabilizes” the banks, it limits natural recruitment of lakebed materials.
LWD and organic matter recruitment	LOW: Again, the loss of natural, forested shoreline vegetation and its replacement primarily with lawn and other types of landscaping has nearly eliminated large woody debris and organic matter recruitment potential along the lake shore. Any trees or large woody debris that do enter the lake are likely to be quickly removed out of concern for safety or to reduce the risk of property damage.
Habitat	
Physical space and conditions for life history	LOW: Under natural conditions, the lake bottom would gradually rise in a shallow wedge such that incoming waves would roll up the bottom, and onto the shore, losing energy. This reduced energy environment would be more hospitable to emergent vegetation, which further attenuates wave energy and provides a refuge for small fish and amphibians. Shallow nearshore areas in lakes typically provide rearing, foraging and migration habitat for fish. Shoreline armoring, however, generally reduces this low-energy shallow-water environment, creating a deeper, more turbulent nearshore area that is less hospitable to small fish and amphibians, as well as to emergent vegetation. The deeper water may also allow larger fish predators to prey on small fish. The absence of dense shoreline vegetation is a limiting factor in terrestrial species’ (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are limited or largely absent.
Food production and delivery	LOW: Food production from the uplands is limited by the lack of native seed- and fruit-bearing vegetation. This may be made up for, in part, by fruit trees and other non-native vegetation in yards which supplies some food for wildlife. Not only does native upland vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water to provide food for fish and other aquatic life. The historical emergent wetland areas that are now reduced or absent also provided productive foraging areas for small mammals, wading birds and waterfowl.

5.4 LAKE FENWICK

Table 17. Ecological Function Summary of Lake Fenwick in the City of Kent.

Function	Performance
Hydrologic	
Storing water and sediment	MODERATE/HIGH: The lake of course provides excellent water and sediment storage functions. Furthermore, much of the upland surrounding the lake within Kent Shoreline jurisdiction is well-vegetated and undeveloped with relatively good water and sediment storage functions. Though some of the shoreline areas surrounding the lake are steep-sloped, there is little impervious surface or landscaped areas to interfere with infiltration of precipitation. Wetlands and other natural water and sediment storage features are present on City park property in the vicinity of a small inlet stream to the lake.
Attenuating wave energy	MODERATE/HIGH: The lake is not large enough to generate very large waves. Furthermore, the lake is surrounded by forested steep slopes and higher ground which protect the lake somewhat from wind energy. Boat wakes are not believed to be a major factor, especially since gas-powered engines are prohibited. Shoreline erosion is not a serious problem on the lake.
Removing excess nutrients and toxic compounds	MODERATE/HIGH: Relatively little impervious surface area such as roads feeds into the lake. Immediately surrounding areas are not urbanized, so runoff carries less in the way of hydrocarbons, metals, sediments, and other pollutants to the lake as would be the case from roads, parking lots, and other developed areas.
Recruitment of LWD and other organic material	LOW/MODERATE: A severely eroding lakeshore could recruit the large woody debris and other organic materials present in the eroded areas. However, lakeshore erosion around Lake Fenwick is quite slow and does not appear to be a factor in the recruitment of wood or other organic materials to the lake. Some wood, however, does fall into the lake as trees die or due to wind, but these are not hydrologic factors.
Vegetation	
Temperature regulation	HIGH: The combination of a forested lake shore and steep slopes provides good shading to the lake surface. The long and narrow shape of the lake also allows a higher percentage of its area to be shaded. As the forest trees mature further, shade may increase somewhat.
Water quality improvement	MODERATE/HIGH: The lake is generally surrounded by maturing mixed forest areas, as is the inlet small stream channel, which would tend to biofilter the water entering the lake. The lake is also shallow in areas with thick beds of macrophytic vegetation which would also tend to retain and/or break down toxics and nutrients. The few lakefront homes present do not appear to be intensively landscaped. Although the lake is on Ecology's 303d list for total phosphorus and invasive exotic species (Brazilian elodea), neither of these listings is related to the condition of the well-vegetated shorelands.
Attenuating wave energy	HIGH: Native vegetation around the lake is relatively intact, and so is available to provide a significant wave attenuation function. Little bulkheading or other shoreline modifications have occurred which would remove native vegetation and natural woody debris, the natural features which attenuate wave energy.
Sediment removal and bank stabilization	HIGH: Much of the lakeshore is lined with native vegetation, so the rate of shoreline erosion is presumably an underlying, natural, ongoing rate which contributes to maintaining natural lake substrate conditions. This rate is determined and moderated by the presence of the shoreline vegetation whose root systems tend to hold bank material in place.

Function	Performance
LWD and organic matter recruitment	MODERATE/HIGH: Much of the lake shore is forested with a mixed, maturing forest, providing opportunities for smaller wood, leaves, and some larger wood to enter the lake. However, the trees along the shore are not overly large and many are deciduous such as alder which decay much faster than conifer trees such as cedar. Divers conducting an aquatic vegetation survey noted that a "significant portion of the lake bottom was covered by woody debris of all sizes and species" (Tetra Tech 2002). Several large pieces of wood, unknown species, were also noted during site visits.
Habitat	
Physical space and conditions for life history	MODERATE/HIGH: The lake is largely surrounded by native upland vegetation. This dense shoreline vegetation is beneficial for terrestrial species' (birds, mammals, amphibians) and increases their use of the shoreline since cover, food, nesting sites, travel corridors, etc. are more available. Shallow nearshore areas include both emergent and submerged vegetation, which attenuates wave energy and provides a refuge for small fish and amphibians. These shallow nearshore areas provide rearing, foraging and migration habitat for fish. Maturing shoreline vegetation provides large organic debris recruitment to the lake to a moderate degree, which should increase over time as the forest matures.
Food production and delivery	MODERATE/HIGH: Food production from the uplands is available in various forms, including native seed- and fruit-bearing vegetation. Fruit trees and other non-native vegetation in yards may also supply some food for wildlife. Not only does native upland vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water to provide food for fish and other aquatic life. The emergent wetland areas present along sections of the lakeshore, particularly in the park, provide productive foraging areas for small mammals, wading birds and waterfowl.

5.5 GREEN RIVER NATURAL RESOURCES AREA POND

Table 18. Ecological Function Summary of the Green River Natural Resources Area Ponds.

Function	Performance
Hydrologic	
Storing water and sediment	MODERATE/HIGH: The ponds and associated wetlands of course provide excellent water and sediment storage functions. Furthermore, much of the shoreline area surrounding the ponds within shoreline jurisdiction is well-vegetated and undeveloped with relatively good water and sediment storage functions. There is little impervious surface or landscaped areas to interfere with infiltration of precipitation.
Attenuating wave energy	MODERATE/HIGH: The ponds are not large enough to generate very large wind-driven waves, and are also shallow with abundant emergent and aquatic vegetation to attenuate any wave energy. Furthermore, the ponds are surrounded by shrubby slopes which protect the ponds somewhat from wind energy. Shoreline erosion is not a problem on the ponds.
Removing excess nutrients and toxic compounds	MODERATE/HIGH: Flows entering the ponds contain typical urban runoff pollutants, including hydrocarbons, metals, sediments, and other pollutants. However, many of these settle out in the ponds before re-entering Mill Creek Kent, providing an important water quality function.

Function	Performance
Recruitment of LWD and other organic material	LOW/MODERATE: Only low quantities of small woody debris would be found in the ponds, and pond hydrology would not facilitate additional recruitment. The ponds' hydrologic regime does facilitate growth of emergent and aquatic vegetation that contributes ample organic material.
Vegetation	
Temperature regulation	LOW: The shallow pond depths and the high ratio of area to perimeter limit the vegetation's ability to regulate water temperature of the ponds. Further, aquatic and emergent vegetation in the ponds may hinder water circulation in the ponds themselves.
Water quality improvement	MODERATE/HIGH: Water moving through the upland shoreline area is provided a high level of treatment by vegetation prior to reaching the ponds (particularly any water traveling through the emergent wetland meadow to the west), and the emergent/aquatic vegetation in the ponds also provides valuable water quality improvement function to storm waters and diverted Mill Creek Kent waters.
Attenuating wave energy	MODERATE/HIGH: Although the need for wave attenuation on the ponds is quite low, the abundant emergent and aquatic vegetation would perform that function well.
Sediment removal and bank stabilization	MODERATE/HIGH: Much of the pond-shore is lined with at least a narrow band of native shrubs and emergent vegetation, there is no boat activity, and wind-driven wave energy is low. The need for bank stabilization is therefore quite low and the existing vegetation adequately performs that function. The shorelands surrounding the ponds would remove sediments from any sediment-laden water that passes through.
LWD and organic matter recruitment	LOW: The existing riparian vegetation is a source of only small woody debris (small branches). Organic matter contribution could be moderately high, although the shrub/tree riparian area is narrow.
Habitat	
Physical space and conditions for life history	MODERATE/HIGH: The ponds are set on the east side of the Green River Natural Resource area, which includes large areas of emergent, scrub-shrub and forested wetlands and some upland areas. Habitat diversity in the complex is high, and the area provides abundant space for a large variety of birds, mammals, reptiles and amphibians to carry out most or all life history stages. The abundance of shallow pond areas include both emergent and aquatic vegetation, which attenuates wave energy and provides a refuge and breeding/rearing areas for small fish and amphibians.
Food production and delivery	MODERATE/HIGH: Food production for a variety of wildlife is high in the ponds and the associated wetlands. For example, swallows and other insect-eating birds, reptiles and raptors that prey on small mammals, and waterfowl and larval amphibians that feed on aquatic vegetation or aquatic invertebrates have ample food supplies.

5.6 SPRINGBROOK CREEK

Table 19. Ecological Function Summary for Springbrook Creek near Kent.

Function	Performance
Hydrologic	
Storage of water and sediment	LOW: The Green River Valley diking network as a whole and the dam at the Black River Pump Station in particular prevent the storage of Green River

Function	Performance
	flood waters on the valley floor portion of Springbrook Creek. Isolation of the Springbrook Creek channel from the formerly wide Green River floodplain has greatly reduced its ability to help store Green River flood waters. Prior to diking throughout the valley, the Springbrook channel was commonly fed by overbank flows from Green River flooding. Since a low, natural berm had been formed by deposition along the river banks, overbank river flow typically did not readily re-enter the river, but, rather, paralleled the river in floodplain tributary channels including Mill Creek Kent and Springbrook Creek. The extensive diking system has also now prevented fine sediments of Green River origin from reaching the Springbrook Creek floodplain for deposition and storage. Uplands have low water and sediment storage functions, and, as elsewhere in the Green River Valley, much of the former floodplain area in the Springbrook Creek basin now functions more like upland. Impervious surfaces such as roofs and pavement associated with industrial and light industrial land uses and compacted, managed lawns and other landscaped areas, which are only semi-permeable, interfere with the infiltration of precipitation and rapidly send water downstream rather than storing it. Wetlands and other natural water and sediment storage features within the basin are greatly reduced compared to their historic prevalence.
Transport of water and sediment	MODERATE: The transport of water has been highly managed in the lower basin through an extensive system of pipes, channelized conveyances and, of course, the Black River Pump Station and dam. This system appears to be efficient with respect to flood prevention. Low streamflow gradients and energy in the lower basin limit sediment transport potential. Due to the diking system, sediments from the Green River are no longer supplied to the area. Sediments carried off of the Covington uplands to the east by various tributary streams tend to be deposited in alluvial fans upon reaching the valley floor, and the substrate in lower Springbrook Creek is dominated by silts.
Attenuating flow energy	LOW: In the lower basin, the decrease in channel roughness brought on by a decrease in the width/depth ratio (a narrowing and deepening of the channel), reduction in accumulated woody debris, and reduction in bank vegetation has greatly reduced the channel's ability to absorb and dissipate stream flow energy. However, gradients are very flat in the lower basin, and so there is little energy to dissipate and erosional forces are low. Tributary channels fed by the Covington uplands, however, experience increased peak flow rates and overall flow volumes due to urbanization at the same time their channels are losing vegetation, large wood, and other roughness features which function to attenuate energy and reduce erosion.
Developing pools, riffles, and gravel bars	LOW: Lack of roughness elements such as complexes of large woody debris, straightened, artificial channel sections, and a narrowing of the channel and floodplain to eliminate and prevent the re-formation of backwaters and side channels has resulted in a uniform, monotypic channel form which is not conducive to the formation and maintenance of the basic habitat elements, including pools, riffles, and gravel point bars. Inherent low energy and gradient in the lower watershed is also not conducive to gravel transport or bar formation, the scouring of deep pools, or the formation of pool/riffle complexes.
Removing excess nutrients and toxic compounds	LOW: Most of the former Green River floodplain in the basin is now occupied by urban uses - primarily industrial, light industrial, and retail. As such, it is not available to provide its former biofiltration function as part of either the Green River or Springbrook Creek floodplain. Though these areas are needed more than ever to provide this function, to remove an increased

Function	Performance
	loading of toxics and nutrients, their prevalence and functionality have been greatly reduced. The upland shoreline areas and the former floodplain areas now functioning essentially as upland are more often a source of nutrients and toxic compounds than a sink, due to landscaping runoff (pesticides, fertilizers, herbicides) and paved area runoff (hydrocarbons, metals).
Recruitment and transport of LWD and other organic material	LOW: Relatively few trees of any size occur along lower Springbrook Creek, so the recruitment potential for Large Woody Debris is quite low. Furthermore, much of the channel was constructed and is maintained as part of an artificial conveyance system. The creek has essentially no channel migration zone and so is "frozen" in place. Channels migrating laterally through forested areas recruit the trees in their paths and also recruit and recycle riverbank gravels laid down along previous channel alignments. The land use modifications in the areas they protect from flooding restrict the ability of the river to recruit LWD and organic material.
Vegetation	
Temperature regulation	LOW: The low density and reduced height of shoreline area vegetation along the creek greatly reduces the level of shading to the water surface.
Water quality improvement	LOW: The urban areas in the basin are dominated by roads, paved parking areas, industrial yards, roofs, and other impervious surfaces, and so lack dense buffers of streambank vegetation. What vegetated areas there are tend to be landscaped rather than natural vegetation. These urban areas tend to be predominantly sources, rather than sinks, of water quality contaminants such as fertilizers, herbicides, pesticides, hydrocarbons, metals, and eroded soils.
Slowing riverbank erosion; bank stabilization	LOW: The function of slowing the rate of bank erosion formerly provided by bank vegetation has now been taken over by artificial channelization and armoring associated with the extensive managed drainage system feeding into the Black River Pump Station. The system's channels include limited areas of rip-rap and other artificial armoring materials, though stream energy and erosive forces tend to be low due to low stream gradients. Prior to urbanization and construction of the drainage system, the creek flowed in a dispersed and braided fashion across the densely vegetated Green River floodplain and was lined with mature, mixed-forest communities. Those communities are now almost entirely absent in these segments, so vegetation does not provide any significant riverbank stabilization function, though the channels are not necessarily unstable.
Attenuation of flow energy	LOW: (As stated above), the decrease in channel roughness due to a reduction in accumulated woody debris, and reduction in bank vegetation has reduced the channel's ability to absorb and dissipate stream flow energy.
Sediment removal	LOW: As stated above, isolation of the Springbrook Creek channel from its own and the Green River's formerly wide floodplain has greatly reduced its ability to biofilter flood waters across the floodplain. Coarse sediments carried off of nearby hilly areas deposit upon reaching the valley floor, and finer sediments are either deposited in the channel, rather than on the floodplain, or are carried on through to and beyond the pump station. Furthermore, levees along the Green River have prevented fine river sediments from reaching the floodplain for deposition and storage.
Provision of LWD and organic matter	LOW: Streambank and floodplain forest vegetation has been greatly reduced, and the reduction in shoreline vegetation has curtailed large woody debris and organic matter recruitment potential. Furthermore, the channel has typically been narrowed to a single thread, whereas pre-development it spread out and braided across the floodplain in much more intimate contact

Function	Performance
	with a much more intact and diverse vegetative community.
Hyporheic	
Removing excess nutrients and toxic compounds	LOW: The water table in the hyporheic zone on the valley floor portion of the basin has likely been lowered due to the development of a comprehensive drainage system in support of industrial and other urban development on the former floodplain. The Black River Pump Station is an integral part, which keeps water surface elevations in the drainage system pumped down, particularly preventing high water levels and associated floodplain recharge from occurring. Water tables in the hyporheic zone are therefore likely lowered as well. The lowering of the stream channel and the water surface elevation within it relative to the floodplain nearly eliminates hyporheic recharge due to flooding, and greatly reduces the proportion of streamflow which routinely passes in and out of the zone to be filtered in the process. The hyporheic zone may still provide some limited nutrient and toxic compound removal from the developed floodplain and uplands in those limited areas where water is still allowed to infiltrate into the hyporheic zone rather than running off of the surface.
Water storage and maintenance of base flows	LOW: Hyporheic zone functioning with respect to water storage is restricted, again, due to the relative depth of the stream channel and its separation from the historic floodplain, the development of an extensive artificial drainage system, the operation of the Black River Pump Station, and industrial and other urban development that has resulted in the placement of large areas of contiguous impervious surfaces. All of these factors combine to prevent hyporheic floodplain recharge from occurring. If more water were stored in the hyporheic zone, it would be available to supplement dry season low stream flows.
Support of vegetation	LOW: Little natural vegetation within the influence of a hyporheic zone in the lower basin remains. Much of the existing vegetation within the range of the hyporheic zone and also within the shoreline zone is landscaping vegetation, typically supported by irrigation water and precipitation rather than by hyporheic water storage. In addition, the channel is typically deeper now relative to the floodplain than it was historically, thereby reducing the ability of the hyporheic zone to supply water to floodplain vegetation.
Sediment storage	LOW: Prior to European settlement of and development in the area, the Green River and Springbrook Creek floodplains overlapped considerably, and could be considered to be one and the same at many locations. The hyporheic zone is restricted by a lowering of the stream channel relative to the floodplain, as mentioned above, and the extensive placement of levees and impervious surfaces. These factors combine to limit the movement of fine sediments from either the Green River or Springbrook Creek into the hyporheic zone.
Habitat	
Physical space and conditions for life history	LOW: Habitat in and along lower Springbrook Creek has been much reduced in quality, quantity, and complexity compared to its original condition. The vegetative community is now much sparser along a narrower band of buffer and with a much lower level of accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The absence of dense shoreline vegetation is a limiting factor in terrestrial species (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are all diminished. Within the channelized stream itself, fewer large logs and less wood overall similarly result in less available protective cover and diminish the depth and

Function	Performance
	complexity of pools. (Naturally lower gradients and stream energy make the lower basin generally less conducive to the formation of classic pool/riffle sequences). The reduction in side channels, backwaters, and braided channel areas due to development and creation of the drainage system has greatly reduced the amount of valuable edge habitat available and further reduced overall complexity. These sheltered, low-energy environments formerly provided more emergent vegetation and served as a refuge for small fish and amphibians. Shallow aquatic areas provide critical rearing, foraging, and refuge habitat for fish, particularly salmonids. Channelization and floodplain development, however, have eliminated many of these low-energy, shallow-water environments and the remaining channelized stream sections are less hospitable to small fish, amphibians, and emergent vegetation. The presence of the Black River Pump Station and dam near the mouth of Springbrook Creek has complicated and hindered the access of the basin by migratory salmonid fish, adversely affecting both upstream and downstream migrations.
Food production and delivery	LOW: Food production from developed floodplain and upland areas is limited by a reduction in native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food for fish and other aquatic life. The historic, but now much-reduced, emergent wetland areas that were associated with side channels, backwaters, and extensive floodplain wetlands also provided productive foraging areas for juvenile fish, small mammals, wading birds, and waterfowl.

5.6.1 Hydrologic

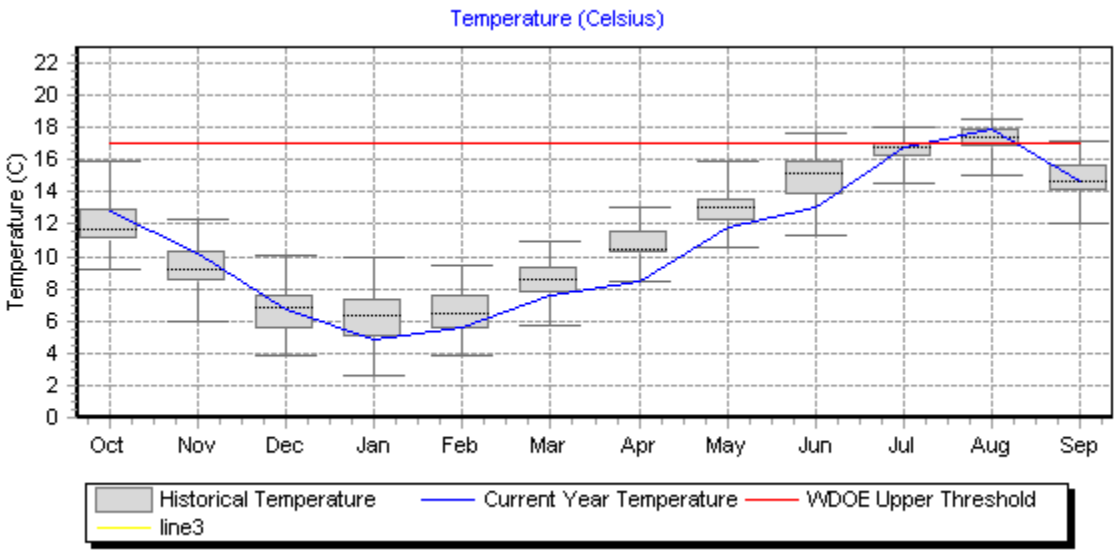
Springbrook Creek flow has an annual yield of about 40 cfs. Bortz (1981) concluded that the most serious condition existing in this subbasin was the extreme volumes of water associated with storm events, and Harza (1995) reported that water quantity responded quickly after each storm event. This is typical of streams in urban areas that have relatively high impervious surface areas. In basins with greater permeable surface areas, flow decreases more slowly following rainfall events, allowing for a more efficient utilization by fish and other aquatic organisms of the increased instream flows (Lucchetti and Furstenberg 1992). There currently are two U.S. Geological Survey (USGS) stream gages in this subbasin. USGS gage number 12113346 is located in Garrison Creek and 12113349 is in Mill Creek Kent (Kerwin and Nelson 2000).

Mill Creek Kent, Garrison Creek and other Springbrook Creek tributaries arise along the east side of the basin from wetlands, lakes and rolling hills on the Covington drift plain, about 500 feet above the valley floor. Runoff in these till-covered areas is produced primarily as shallow subsurface interflow. Seepage zones along the valley wall bluffs contribute baseflow to streams and feed wetlands that line the upslope side of SR-167 along the base of the bluffs. The lower portion of the basin occupies a low-gradient alluvial floodplain on the Green River Valley floor (Gersib et al. 2005).

Bortz (1981) also observed that the extreme volumes of water associated with storm events resulted in scouring, streambank erosion, and subsequent siltation in the basin. The upper reaches of tributary Mill Creek Kent have been extensively modified. Harza (1995) found evidence of low to moderate downcutting along the hillslope sections of Springbrook Creek.

Past observed construction practices in the basin which removed vegetation to the water's edge are thought to have been a significant contributor to sediment entering Springbrook Creek. The instream substrate of the lower reaches of Springbrook Creek upstream as far as the SR 167 crossing reflects a depositional regime and consists exclusively of silts.

The Springbrook Creek subbasin appears on the EPA Clean Water Act 1996 and 1998 303(d) lists for water quality violations for the parameters of high temperature and low dissolved oxygen levels at multiple locations low in the subbasin. However, the 2008 303(d) list only includes Springbrook Creek for fecal coliform and dissolved oxygen violations. Temperature was downgraded to Category 2 (water of concern). The following graph shows stream temperatures during 2008 measured at Site 0317 (between East Valley Road and SR 167, north of SW 34th Street) relative to Ecology's threshold and the historic data. In 2008, temperatures were generally in line with historic values. King County's 25-year trend analysis did not evaluate water temperature.



Source: http://green.kingcounty.gov/WLR/Waterres/StreamsData/Conventional.aspx?Locator=0317

Low dissolved oxygen levels have been reported by numerous sources at sampling locations throughout the subbasin and appear to be a chronic seasonal occurrence. These water quality violations are believed to be the result of low water flows, lack of adequate riparian vegetation and shade, and point and non-point pollution sources (Harza 1995). During 1994, adult chinook salmon entered the Black River Pump Station between September 17 and October 22 when water temperatures were as high as 20.2 C at the station and 19.5 C at the Mill Creek Kent USGS gage, and dissolved oxygen levels averaged 4.5 mg/l at the Mill Creek gage. In 1994, coho salmon that entered the Springbrook Creek subbasin before October 26 would have faced similar water quality issues as chinook. Parametrix (1990) also suggested that concentrations of heavy metals in Mill Creek Kent increase during the first storm event after a dry period.

5.6.2 Shoreline Vegetation

From the confluence of Mill Creek Kent, near the Kent/Renton boundary, upstream to the State Route 167 highway crossing, Springbrook Creek resembles a drainage ditch. The creek continues mostly parallel and adjacent to State Route 167 with reed canarygrass and Himalayan blackberry bushes remaining the dominant vegetation. Red alder was also found sporadically throughout this reach with very little instream structure. Several sections of Springbrook Creek are so choked with invasive reed canarygrass and other vegetation such as nightshade that they serve as partial barriers (Kerwin and Nelson 2000). Riparian habitat along Springbrook Creek is not judged to be properly functioning based on NMFS criteria and is considered a limiting factor to natural salmonid production (Kerwin and Nelson 2000).

Reed canarygrass is abundant throughout the Springbrook Creek subbasin and was historically removed by dredging. Although it can provide some streambank erosion protection functions, it generally affords minimal fish habitat and prevents native shrubs and trees from becoming established in the riparian habitat zone. Japanese knotweed, an aggressive non-native weed that spreads rapidly in moist environments, was found in a wetland associated with Springbrook Creek between Highway 167 and Talbot Road.

Numerous streambank revegetation efforts have been conducted along the banks of Springbrook Creek and Mill Creek Kent over the past 10 years by both the City of Kent and King County Drainage District #1. Large projects have recently been completed just south of South 180th Street (near Kent's northern border) and just north of South 212th Street along Mill Creek Kent. Bank plantings of deciduous and evergreen trees will eventually provide additional shade and fish habitat structure.

5.6.3 Hyporheic Functions

Mill Creek Kent and other Springbrook Creek tributaries arise from the glacial deposits known as the Covington Uplands, and cut canyons through these deposits before emerging onto the valley floor. Recessional outwash deposits cover the floors of these side canyons. Advance outwash and pre-Fraser seepage zones are exposed at the base of the bluffs, and recharge the alluvial aquifer. Small alluvial fans develop where the creeks transition onto the valley floor. The lower reaches of Mill Creek Kent and most of Springbrook Creek flow through extensive alluvial deposits on the Green River valley floor (Gersib et al. 2005).

5.6.4 Habitat

Coho salmon, cutthroat trout, and winter steelhead adults have been observed spawning in Springbrook Creek and its tributaries, and juvenile hatchery origin coho salmon have also been released routinely in upper reaches of several tributary streams (Kerwin and Nelson 2000). The most significant fish passage barrier in this system is the Black River Pump Station, which poses some unique and difficult challenges. In 1958, an earthen Black River Dam was completed approximately 1,000 feet upstream of its confluence with the Green River, primarily to prevent Green River flood flows from backing up onto the Black River/Springbrook Creek floodplain. In 1972, the U.S. Natural Resources Conservation Service (NRCS, formerly U.S. Soil Conservation Service) replaced the dam with the current Black River Pumping Station. The station provided a means of discharging flood flows from the Black River/Springbrook Creek system to the Green River when the Green River was at a *higher* stage than the Black River

(otherwise flows could be discharged by gravity and pumping would not be needed). The pumping station is currently operated and maintained by King County Surface Water Management.

During flood periods on the Green River, the pumping station acts as a dam, preventing floods from backwatering into the Black River and the wide valley floor of the lower Springbrook Creek subbasin. The Black River Pump Station thereby isolates the Springbrook Creek subbasin from the Green River floodplain. Water levels downstream of the pumping station range from –4.0 to +21.5 feet MSL, depending on tidal conditions and the water level of the Green River. Water surface elevations upstream are normally held in the range of 0.0 to 2.0 feet, though they can reach as high as 13.0 feet. This range of water surface elevations upstream and downstream of the station often results in situation where the downstream water surface is *higher* than the upstream water surface. In order to pass upstream- and downstream-migrating salmonids around the structure, a unique fish passage system has been constructed and is in operation. A combination of a fish ladder followed by a fishway chute is used for upstream passage. At times, fish swim up a relatively short ladder to then slide down a somewhat longer chute to end up at a lower elevation than they started at. Juvenile fish migrating downstream are diverted around the pumps using an air-lift pump to raise the fish to the downstream water levels.

The upstream passage facility is normally operated from mid-September through 31 January of each year. This operational window precludes the upstream migration of some adult resident and anadromous cutthroat trout and anadromous steelhead. The species composition of fish migrating upstream was assessed in 1994, when a total of 229 coho salmon and 14 chinook were trapped between 17 September and 9 December (Harza 1995). The facility is not equipped to handle downstream migrating adult fish, including spawned-out steelhead (kelts) or chinook, so those that move upstream past the station cannot change their mind and exit the Springbrook Creek subbasin to spawn elsewhere. It is thought that some of the chinook entering the system do so to explore for spawning opportunities, but would leave again to look elsewhere if they could.

The downstream passage facility is operated weekdays from early April to mid-June each year, for approximately eight hours per day. Fish attempting to move downstream outside of that operational window are either prevented from exiting the subbasin, or must pass through the pumps (if operational). Juvenile chinook emerge and begin moving downstream in the middle Green River system and Soos Creek as early as February (J. Kerwin, pers. obs., cited in Kerwin and Nelson 2000; Jeanes and Hilgert 2000 cited in Kerwin and Nelson 2000; Hilgert and Jeanes 1999 cited in Kerwin and Nelson 2000). Thus any such early downstream chinook migrants may be prevented from exiting the Springbrook Creek subbasin.

The Springbrook Creek channel section parallel and adjacent to State Route 167 contains little LWD – primarily only pieces placed and anchored during restoration projects such as those mentioned above. Instream substrates consist almost exclusively of silts.

5.7 JENKINS CREEK

As previously mentioned, Jenkins Creek's biological and land use character are dominated by one use in the City (protected municipal watershed area), so no segments or discussion units are

established. Jenkins Creek within the City of Kent has moderate to high performance of ecological functions and lack of modification.

Table 20. Ecological Function Summary for Jenkins Creek near Kent.

Function	Performance
Hydrologic	
Storage of water and sediment	HIGH: Along Kent's shoreline section of Jenkins Creek, approaching the upstream shoreline boundary, the stream flows through a densely wooded area which is managed as a City watershed with very restricted access. Some of the City's Jenkins Creek shoreline area is wooded wetlands, and the soils beneath the floodplain and wetlands are sandy, gravelly, and permeable. During high flows, the creek is still able to spread out across its floodplain. As such, there is a high degree of flow interaction between the creek, its floodplain, associated riparian wetlands, and the floodplain/wetland soils. Water spilling over the banks and/or infiltrating through the permeable bank soils during flood events can be stored on the floodplain (including the riparian wetlands) and in the permeable soils below for later release. By this process, the floodplain is able to store and attenuate flood flows and trap and store fine sediments. These fine sediments are incorporated into the floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat. The floodplain along the City's portion of Jenkins Creek is largely unconstrained.
Transport of water and sediment	MODERATE: Flows through the area of Kent's shoreline section of Jenkins Creek are somewhat dispersed as they pass through a forested wetland area. While this does not make for the most efficient transport of water and sediment, it is beneficial in terms of fish and wildlife habitat, sediment retention and biofiltration for water quality improvement. However, deforestation and urbanization throughout the basin upstream of the City's Jenkins Creek shoreline area has likely increased streamflows, flow volatility, erosion, and sedimentation to a moderate extent. As for most streams in the region, the stream channel and floodplain have formed in response to a historically lower flow and sediment regime and are not entirely suited to carry the increased flows and sediment loadings experienced. Bank erosion may occur as the channel enlarges and widens to accommodate higher flows.
Attenuating flow energy	HIGH: As mentioned above, sections of floodplain remain along Kent's shoreline section of Jenkins Creek which are characterized as forested wetlands. These are effective at attenuating streamflow energy during flood events as flow disperses and follows complex flow pathways. The recruitment of woody debris, including large woody debris, is good, increasing complexity and roughness in the channel as well as throughout the floodplain. To its benefit, the basin includes a system of lakes, large wetland areas, and naturally infiltrative recessional outwash soils which all serve to dampen and moderate stream flow fluctuations.
Developing pools, riffles, and gravel bars	MODERATE/HIGH: The naturally forested condition of the channel banks and buffers provides for adequate large woody debris recruitment and bank protection, which is, in turn, conducive to bed scour and pool formation at locations where such debris accumulates. The debris also provides protective cover in the pools for fish, and riffles formed downstream provide spawning habitat. Gravel bars may form on the inside of channel bends where pools form on the outside. Gravel substrate supply and condition are good due to the underlying gravelly soils.

Function	Performance
Removing excess nutrients and toxic compounds	MODERATE/HIGH: There is a high degree of interaction between the creek, its floodplain and included riparian wetlands, and an extensive hyporheic zone consisting of gravelly glacial outwash soils. These conditions are well-suited to provide for a high degree of biofiltration, removing pollutants entering the stream from portions of the watershed farther upstream. These pollutants may include lawn and landscaping runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals).
Recruitment and transport of LWD and other organic material	MODERATE/HIGH: As a well-forested shoreline area that is protected, the potential for large woody debris recruitment is presently good and should increase even further as the forest matures over time. Due to the relatively small size of the stream (the City's Jenkins Creek shoreline area is at the upstream limit of shoreline jurisdiction), it would not transport *large* wood well, but would supply smaller wood and leaf litter to support biological functions downstream.
Vegetation	
Temperature regulation	HIGH: The combination of a well-established and maturing forest in the shoreline/buffer areas and a relatively narrow active channel during low-flow periods results in excellent shade being provided to the stream. This is not true for all areas farther upstream, however, so water may enter the City's shoreline reach at temperatures which have already been somewhat elevated. Vegetation need not be as tall to provide shade to a narrower creek as opposed to a wider river.
Water quality improvement	HIGH: Riparian and floodplain areas are intact and well-forested, resulting in good biofiltration function. However, for fine sediments and pollutants originating from farther upstream, shoreline vegetation can only be effective at removing pollutants when stream flow is made to come in direct contact with the vegetation, which happens most effectively during flood events. Under low-flow conditions, there is less direct contact between the streamflow and the riparian vegetation, so considerably less biofiltration can occur. The segment of Jenkins Creek in the City's shoreline jurisdiction is on Ecology's 303d list for fecal coliform.
Slowing riverbank erosion; bank stabilization	HIGH: The well-forested stream banks provide good bank stabilization with erosion occurring at rates consistent with well-functioning natural processes.
Attenuation of flow energy	HIGH: (As stated above), complex flow patterns through areas of riparian wetlands and accumulated woody debris during flood events provide a rough channel, enhancing the stream's ability to absorb and dissipate flow energy.
Sediment removal	HIGH: Densely vegetated floodplain and riparian area forest vegetation, along with its associated leaf litter and forest duff, effectively filters and retains fine sediments. Also highly infiltrative soils and an active and interactive hyporheic zone (see below) also provide capacity for biofiltration function.
Provision of LWD and organic matter	HIGH: In contrast with most areas in the region, opportunity for the recruitment of large woody debris is good due to the forested condition, and should improve further as the forest continues to mature. The City's Jenkins Creek shoreline areas are within a protected watershed area. There are also good opportunities for the recruitment of small-to-medium woody debris and leaf litter that contribute to a decomposition-based food chain.
Hyporheic	
Removing excess nutrients and toxic compounds	HIGH: The overall Soos Creek basin, including the tributary Jenkins Creek basin, is dominated by highly infiltrative, glacial outwash soils which provide for a high degree of interaction between ground and surface waters. Stream flows supplement shallow groundwater or hyporheic flows and vice versa,

Function	Performance
	thereby increasing the proportion of flow which routinely flows in and out of the zone to be filtered in the process.
Water storage and maintenance of base flows	MODERATE/HIGH: The combined presence of headwater lakes (Shadow, Wilderness, Pipe, and Lucerne), large wetland areas, and highly infiltrative and interactive soils throughout the Jenkins Creek basin provides a high level of water storage which is available for the support of stream base flows. Hyporheic zone functioning with respect to water storage is enhanced due to the high degree of interactivity between the creek and its surrounding gravelly soils and supporting aquifers. Such water stored in the hyporheic zone is available to supplement dry season, low stream flows.
Support of vegetation	MODERATE: While the interaction between Jenkins Creek and its hyporheic zone is generally quite good, the gravelly outwash soils that tend to be present in the hyporheic zone and throughout the basin can be so well-draining and poor at wicking water upward that plants growing above these gravelly soils can be deprived of water even when an active water table is near the surface. Riparian wetlands would not be expected to extend far upslope under such conditions.
Sediment storage	MODERATE/HIGH: Good interaction between the hyporheic zone and stream flows allows good potential for filtration of interflow and hyporheic flow, and thereby sediment storage. If sediment loading is too high, however, gravels of the hyporheic zone could become clogged, their sediment storage capacity used up, and the overall functioning of the hyporheic zone impaired.
Habitat	
Physical space and conditions for life history	HIGH: Though second-growth, the forest in the City's Jenkins Creek shoreline area provides habitat of good quality and complexity and in good quantity for fish and wildlife. The forested vegetative community is complex and maturing, with accumulating downed wood and snags, resulting in more places for various wildlife species to find cover or suitable nesting and rearing sites. This increase in dense shoreline vegetation increases the quantity and quality of habitat available for use by terrestrial species (birds, mammals, amphibians) since cover, food, nesting sites, travel corridors, etc. are available and functioning. Within the stream channel itself, an increase in logs and overall wood similarly results in more available protective cover, the creation of pool/riffle sequences, and an increase in habitat complexity as described above. Shallow, low-energy aquatic areas provide critical rearing, foraging, and refuge habitat for amphibians and juvenile fish, particularly salmonids.
Food production and delivery	HIGH: The natural forest in the City's Jenkins Creek shoreline area should provide the food production that native wildlife are adapted to, including native seed- and fruit-bearing vegetation from wetland, floodplain, and upland areas. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. Emergent wetland areas associated with side channels, backwaters, and extensive floodplain wetlands also provide productive foraging areas for juvenile fish, small mammals, wading birds, and waterfowl.

5.8 PANTHER LAKE

As previously mentioned, Panther Lake has been inventoried and analyzed by King County as part of its SMP update. The entire lake is in unincorporated King County, and within the City's PAA. The following table shows the results of King County's function analysis of Panther Lake.

Table 21. Ecological Function Summary for Panther Lake in Kent's PAA.

Lake Reach Quality Element	Quality Rating
Light energy	Medium High on west shore High on remainder of lake
Large woody debris	Low Medium on south shore Medium on north shore Medium High on west shore High on east shore
Nitrogen	High
Pathogens	Medium High
Phosphorus	Medium on north/south shores Medium High on east/west shores [lake is on Ecology's 303(d) list for total phosphorus]
Wave energy	High
Toxins	High on east shore Medium High on north, south and west shores
Sediment	Medium on north/south shores Medium High on east/west shores
Hydrologic cycle	Medium
Overall	**High on east shore** **Medium High on remainder of lake** Note: See illustration in Exhibit 10 below

Source: King County iMAP, results of King County's shoreline functions modeling

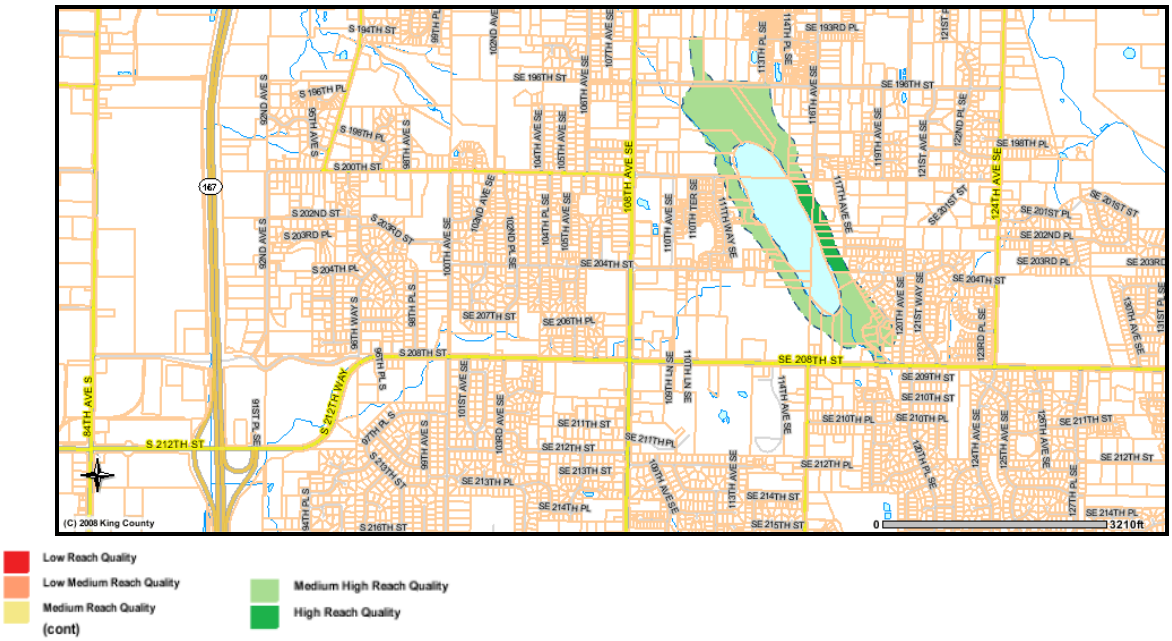


Exhibit 10. King County's overall shoreline function rating of the Panther Lake PAA (from King County iMap).

6.0 LAND USE ANALYSIS

As noted in Section 3.1, land use patterns are an important consideration in SMP analysis because such analysis can identify opportunities for "preferred uses", especially water dependent, water oriented and water enjoyment uses. Land uses adjacent to the water are also a determinant in assigning environment designations to specific sections of the shoreline. WAC 173-26-201(2)(d) requires future uses to be consistent with preferred uses. Additionally, an analysis of land use conditions is necessary to determine potential land use changes and their effect on shorelines with respect to SMA objectives. Finally, the existing land uses and proposed environment designation boundaries and provisions must be mutually consistent with Kent's comprehensive plan.

This section examines the data gathered in the inventory and describes likely land uses and comprehensive plan designations and implications for shoreline management for each segment. The analysis begins with the "Unit" classifications described in the inventory section, but describes specific segments in more detail. The unit classifications are:

- Unit A – Open Space: contains land areas in shoreline jurisdiction generally dominated by Parks and Open Space (OS) and Urban Separator (US) zoned lands.
- Unit B – High Intensity: contains land areas in shoreline jurisdiction generally dominated by Commercial (C) and Industrial (I) zoned lands.
- Unit C – Residential: contains land areas in shoreline jurisdiction generally dominated by Single Family (SF), Medium Density Multifamily (MDMF), Mobile Home Park (MHP), and Low Density Multifamily (LDMF) zoned lands.
- Unit D – Agricultural: contains land areas in shoreline jurisdiction generally dominated by Agricultural Resource (AG-R) and Agricultural Support (AG-S) zoned lands

6.1 GREEN RIVER

6.1.1 Unit A – Open Space

Table 22. Likely changes in land use and implications for shoreline management by sub-unit in Green River Unit A – Open Space.

Sub-Unit see Figures 3a-3c)	**Likely Changes in Land Use**	**Implications for Shoreline Management**
A-1. Open space area on the east side of the river to the north and south of South 277th Street bounded by the City limits	This area is designated as Urban Separator (US), so therefore may redevelop with low density residential or clustered residential with the possibility of some low intensity commercial.	Urban Conservancy – Low Intensity appears to be the most appropriate environment designation for this segment. Special attention should be paid to addressing new development in Urban Separator areas. It may be that special environmental protections should be placed on the new development.
A-2. Foster Park is on the north side of the river generally west of the railroad line and east of the Valley	There are no likely changes in land use, except for minor park improvements and potentially some environmental restoration. The City should consider changing the land	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment, although the land use designation is Industrial.

Sub-Unit see Figures 3a-3c)	**Likely Changes in Land Use**	**Implications for Shoreline Management**
Freeway (SR 167)	use designation to Open Space because it currently has an Industrial designation.	
A-3. Riverview Park is on the north and east side of the river just west of the Valley Freeway (SR 167)	There are no likely changes in land use, except for minor park improvements and potentially some environmental restoration.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment.
A-4. Undeveloped area on south river bank with tributary west of Valley Fwy (SR 167)	Land use change in this area is unlikely because most of the shoreland area is also a stream corridor. This area is designated AG-S, however, so some low intensity commercial development may occur.	Urban Conservancy – Low Intensity appears to be the most appropriate environment designations for this segment. Special attention should be paid to addressing new development in Urban Separator areas. It may be that special environmental protections should be placed on the new development. A portion of this area is a designated wetland and is therefore protected under the Critical Area Ordinance.
A-5. The Riverbend Golf Complex	This area is unlikely to change as this is designated as OS (Open Space) in the Comprehensive Plan.	Urban Conservancy – Open Space appears to be the most appropriate environment designation. It will be important to ensure that there are provisions for golf courses in the SMP.
A-6. Golf course and open space on the south and west side of the river from the city limits south of W. Meeker St. to the industrial area north of the golf complex	The area that is designated OS (Open Space) is unlikely to change, but the area designated US (Urban Separator) has the potential to be redeveloped unless the land use designation is changed.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment. The City might consider changing the land use designation for Old Fishing Hole Park from Urban Separator to Open Space. It will be important to ensure that there are provisions for golf courses in the SMP.
A-7. Open space on the west side of the river from Cottonwood Grove Park to the residential area approximately 2,400' north of S 228th Street	This area is designated as Urban Separator (US), so therefore may redevelop with low density residential or clustered residential with the possibility of some low intensity commercial.	Urban Conservancy – Low Intensity appears to be the most appropriate environment designations for this segment. Special attention should be paid to addressing new development in Urban Separator areas. It may be that special environmental protections should be placed on the new development.
A-8. Green River Natural Resource Area	This area is unlikely to change as it is in public ownership and used for water quality and natural resource purposes. The area is designated OS.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment. It will be important to ensure the SMP includes provisions for this facility.

Sub-Unit see Figures 3a-3c)	**Likely Changes in Land Use**	**Implications for Shoreline Management**
A-9. Valley Floor Community Park	The park is likely to remain a park, but will likely develop with more active uses, although perhaps not within shoreline jurisdiction. There are opportunities to increase public access and increase opportunities for water-dependent recreational uses when this park is improved. Environmental restoration should also be considered.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment. It will be important to ensure that there are provisions for park maintenance in the SMP.
A-10. Green River Trail north of S 212th St and south of Russel Road	The Green River Trail corridor is unlikely to develop as it is designated OS. The underdeveloped industrial land may develop, but it is outside shoreline jurisdiction.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment.
A-11. Future North Green River Park on the east shoreline just south of the City limits.	This area is unlikely to change land uses. The only changes might include some park improvements.	Urban Conservancy – Open Space appears to be the most appropriate environment designation for this segment. It will be important to ensure that there are provisions to accommodate new trail connections in the SMP.
PAA-A-1. Area within the PAA and City Limits north and east of the river at the easternmost segment of the Green River shorelands within the City and PAA	The area that is designated OS (Open Space) is unlikely to change, but the area designated US (Urban Separator) has the potential to be redeveloped to low density residential or clustered residential unless the land use designation is changed..	Urban Conservancy – Open Space appears to be the most appropriate environment designation for the area that is designated OS. Urban Conservancy – Low Intensity appears to be the most appropriate environment designation for the area designated US. Special attention should be paid to addressing new development in Urban Separator areas. It may be that special environmental protections should be placed on new development.

6.1.2 Unit B – High Intensity

Table 23. Likely changes in land use and implications for shoreline management by sub-unit in Green River Unit B – High Intensity.

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
B-1. Industrial area north of the river from commercial lot east of Central Ave, generally west and north to Foster Park	With the Industrial land use designation and predominance of industrial activities, it is likely that underdeveloped shoreline properties (approximately 1,000 feet of shoreline) will, over time, convert to large- to moderate-scale industrial uses.	High Intensity appears to be the most suitable environment designation, perhaps with an Urban Conservancy – Open Space parallel environment for the trail corridor. A new section of trail between S 266th St and S 259th St should also be Urban Conservancy – Open Space. The Cumulative Impact

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
		Analysis should identify the impacts of roughly 1,000 ft^2 of underutilized lots being converted to industrial uses. Regulations should ensure that adverse impacts to the shoreline are avoided.
B-2. Industrial area south of the river just east of the Valley Freeway (SR 167)	With the Industrial land use designation and predominance of industrial activities, it is unlikely that property in this area will change use.	High Intensity appears to be the most suitable environment designation, perhaps with an Urban Conservancy – Open Space parallel environment for the trail corridor.
B-3. Industrial area north of the river just east of the Valley Freeway (SR 167) located between Foster Park and Riverview Park	With the Industrial land use designation and predominance of industrial activities, it is unlikely that property in this area will change use.	High Intensity appears to be the most suitable environment designation. Development regulations should address modifications to industrial uses to ensure that environmental conditions are improved as the site is redeveloped.
B-4. Small industrial area north of the river between the Valley Freeway (SR 167) and SR 181.	With the Mixed Use (MU) land use designation and predominance of industrial activities, it is unlikely that property in this area will change use.	High Intensity appears to be the most suitable environment designation for the industrial area and Urban Conservancy – Open Space appears to be the most suitable environment designation for the trail corridor. Development regulations should address modifications to industrial uses to ensure that environmental conditions are improved as the site is redeveloped.
B-5. Industrial area located along Russell R. north of S. 228th St and south of the GRNRA	With the Industrial land use designation and predominance of industrial activities, it is unlikely that property in this area will change use. Russell Road is located in shoreline jurisdiction in this area. The comprehensive plan designation is OS (Open Space) in the Green River Trail corridor area.	High Intensity appears to be the most appropriate environment designation for the industrial areas and Urban Conservancy – Open Space appears to be the most appropriate designation for the Green River Trail corridor. Russell Road will also need to be considered.
B-6. Industrial area along east side of the river north of S 200th St.	It is unlikely that these relatively new facilities will change in the foreseeable future.	High Intensity appears to be the most appropriate environment designation. Urban Conservancy – Open Space appears to be the most appropriate designation for the Green River Trail corridor.
B-7. Industrial and commercial area east of SR 181 and south of SW 43rd St	The commercial parcel will likely develop in the near future. It is also likely that the single-family residence will redevelop into an industrial use at some point in the future. The hotel is unlikely to change because it appears to be a fairly new building.	High Intensity appears to be the most appropriate environment designation
PAA-B-1. Shorelands in the potential annexation area (PAA)	This area is designated Industrial in King County's Comprehensive Plan so it is likely to remain in industrial use.	High Intensity appears to be the most appropriate environment designation. It is important to add SMP provisions that ensure that shoreline conditions in this

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
generally south of the river and west of the Valley Freeway (SR 167)		area are upgraded if it redevelops.

6.1.3 Unit C – Residential

Table 24. Likely changes in land use and implications for shoreline management by sub-unit in Green River Unit C – Residential.

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
C-1. Residential area north and west side of the Green River east of Central Ave	The Comprehensive Plan designation is Medium Density Multifamily and Mobile Home Park. There are no likely land use changes because the current land uses fit the comprehensive plan.	Shoreline Residential for the residential area and Urban Conservancy – Open Space for the trail corridor appear to be the most appropriate environment designations, perhaps with parallel environments. There is little or no opportunity for conversion to water-oriented uses. It is not likely that redevelopment would cause impacts or contribute to cumulative impacts.
C-2. Residential area on north side of the river from one property west of SR 181 to the golf course at Russell Rd	There is little likelihood of a change in land use because the residences are relatively new and they are consistent with the MDMF (Medium Density Multifamily) land use designation.	There is little potential for negative impacts due to new development. Urban Conservancy – Open Space would be an appropriate designation for the trail portion of the segment and Shoreline Residential would be the most appropriate environment designation for the residential portion.
C-3. Residential area on east side of River from James Street north to S 228th Street	There is little likelihood of a change in land use because the residences are relatively new and they are consistent with the LDMF (Low Density Multifamily) land use designation.	There is little potential for negative impacts due to new development. Urban Conservancy – Open Space for the trail portion and Shoreline Residential for the residential portion appear to be the most appropriate environment designations.
C-4. Residential area on west side of River south of S 216 Street	There will be approximately 1,000 feet of new residential development with perhaps about 20 new homes in this segment. These new homes will all be separated from the shoreline by the existing frontage road, Frager Road.	Shoreline Residential appears to be the most appropriate environment designation for this area. Regulations for shoreline development should address impacts due to new development, although in this case, the new development will be separated from the shoreline by Frager Road.
C-5. Recreational Vehicle (RV) Campground (KOA) on east side of the river south of S. 212th St. and north of the GRNRA	This use is somewhat an anomaly in this area and so may change in spite of the current comprehensive plan designation. Because of the industrial uses around it, it may be developed as industrial although the GRNRA is a local amenity and so	This area might best be designated as Urban Conservancy – Low Intensity. The property only occupies about 300 feet of shoreline jurisdiction.

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
	multifamily housing might be a possibility.	

6.1.4 Unit D – Agricultural

Table 25. Likely changes in land use and implications for shoreline management by sub-unit in Green River Unit D – Agricultural.

Sub-Unit see Figures 3a-3c	**Likely Changes in Land Use**	**Implications for Shoreline Management**
D-1. South of the river just west of Valley Freeway (SR 167)	This area is designated as AG-S and AG-R, so some agricultural-related low intensity commercial development may occur.	Urban Conservancy - Low Intensity, or some other designation that recognizes agricultural activities, would be an appropriate environment designation.
D-2. Agricultural activities on the west side of the river from Riverbend Golf Course to Cottonwood Grove Park	This area is designated as Urban Separator (US), so therefore may redevelop with low density residential or clustered residential with the possibility of some low intensity commercial.	Urban Conservancy – Low Intensity, or some other designation that recognizes agricultural activities, would be an appropriate environment designation.
D-3. Agricultural area on west side of river south of S. 212th Street	This area is being redeveloped into single-family houses. Since this area comprises approximately 2,000 linear feet of shoreline, it is conceivable that 20 to 40 new dwelling units might fall within shoreline jurisdiction. They would be separated from the shoreline by a frontage road.	Shoreline Residential seems to be an appropriate environment designation for this area. SMP regulations should address public access and environmental restoration opportunities when multi-lot development takes place.
D-4. Agricultural lands north of Valley Floor Community Park	This area is designated US (Urban Separator) and AG-R, so therefore may redevelop with low density residential or clustered residential with the possibility of some low intensity commercial	Urban Conservancy –Low Intensity appears to be the most appropriate environment designation for this area. Special attention should be paid to addressing new development in this area. It may be that special environmental protections should be placed on new development.

6.2 BIG SOOS CREEK

6.2.1 Likely Changes in Land Uses

This area is designated "Urban Separator" so therefore may redevelop with low density residential or clustered residential with the possibility of some low-intensity commercial.

6.2.2 Implications for Shoreline Management

The creek and adjacent shorelands lie within the Comprehensive Plan's Urban Separator designation (see Figure 3d) which "is reserved for low-density lands that define community or municipal identities and boundaries, protect adjacent resource lands, rural areas, and environmentally sensitive areas, and create open space corridors within and between urban areas which provide environmental, visual, recreational and wildlife benefits." Shoreline regulations should be prepared to ensure that the environment is not degraded with any potential new development, and consider restricting or prohibiting development in the channel migration zone or other flood hazard areas.

6.3 LAKE MERIDIAN

6.3.1 Likely Changes in Land Uses

Unit A - Open Space is unlikely to change because Lake Meridian Park is designated as OS (Open Space) in the Comprehensive Plan and the SF-planned wetland area is owned by the City of Kent and should likely be redesignated as Open Space. Unit C - Residential has a few lots that are either underdeveloped or could possibly be subdivided, although the effect on the overall land use would be minimal (See Figure 3e).

6.3.2 Implications for Shoreline Management

Urban Conservancy – Open Space appears to be the most appropriate environment designation for Unit A – Open Space (Lake Meridian Park) and Shoreline Residential appears to be the most appropriate environment designation for Unit C - Residential. Shoreline provisions should address shoreline modifications associated with single-family residences, such as decks, shoreline stabilization, and vegetation conservation. Provisions should call for public access and environmental restoration in the event that the mobile home park is redeveloped as multi-family dwellings.

6.4 LAKE FENWICK

6.4.1 Likely Changes in Land Uses

Changes in land use are unlikely within Kent jurisdiction and in the lands designated King Co. Other Parks/Wilderness. However, the residential-designated area within the PAA has the potential to redevelop and possibly increase in density (see Figure 3f).

6.4.2 Implications for Shoreline Management

The SMP provisions should address the residential properties and potential increase in residential development. Natural or Urban Conservancy – Open Space appear to be appropriate environment designations for the Unit A - Open Space areas within City limits. The residential areas within City limits and within King County jurisdiction should be designated as Shoreline Residential, but special environmental restrictions should be considered. For example, the first 100 feet closest to the shoreline might be designated Urban Conservancy – Open Space or Low Intensity.

6.5 GREEN RIVER NATURAL RESOURCES AREA POND

6.5.1 Likely Changes in Land Uses

Changes in land uses are unlikely. This site is in public ownership and used for water quality and natural resource purposes. There is a small utility property within shoreline jurisdiction (see Figure 3h).

6.5.2 Implications for Shoreline Management

This is a public facility developed and managed for priority uses, namely: water quality, flood control, wildlife enhancement, and public access. Urban Conservancy – Open Space may be an appropriate designation for areas within the GRNRA. Provisions should be made to consider maintenance and restoration activities of the GRNRA.

6.6 SPRINGBROOK CREEK

6.6.1 Likely Changes in Land Uses

No changes are likely, as this land is designated Industrial/Industrial Park. The two developable parcels are already built out. The two undeveloped, narrow parcels on either side of the stream are dedicated open space.

6.6.2 Implications for Shoreline Management

High Intensity appears to be an appropriate environment designation for the developed parcels, with an Urban Conservancy – Open Space assigned to the City-owned parcels.

6.7 JENKINS CREEK

6.7.1 Likely Changes in Land Uses

No changes are likely, as this land is protected for water supply purposes (see Figure 3d).

6.7.2 Implications for Shoreline Management

Urban Conservancy – Open Space or Natural would be an appropriate designation for this segment.

6.8 PANTHER LAKE

6.8.1 Likely Changes in Land Uses

The north, northeast, and southern tip of the lake are within the Urban Separator land use classification. This area may therefore redevelop with low density residential or clustered residential with the possibility of some low intensity commercial. On the west side of the lake, in the area with a residential land use designation, there is approximately 1,200 linear feet within shoreline jurisdiction that is currently underdeveloped and therefore has the potential to develop into residential uses. The development pattern will likely be similar to the residential development along the southwest corner of the lake (see Figure 3g).

6.8.2 Implications for Shoreline Management

Urban Conservancy – Low Intensity appears to be the most appropriate environment designation for the areas with the Urban Separator land use designation. Shoreline Residential would be the most appropriate environment designation for the areas with a residential land use classification. Regulations for shoreline development should address impacts due to new development in the residential areas. King County assigned the entire area around Panther Lake an environment designation of Residential Shoreline.

7.0 SHORELINE MANAGEMENT RECOMMENDATIONS

The following are recommended actions for translating inventory and characterization findings into proposed SMP policies, regulations, environment designation boundaries and restoration strategies.

7.1 SHORELINE MASTER PROGRAM

7.1.1 Environment Designation Provisions

- Recommendations for specific shoreline segments are discussed in Chapter 6.0 in Tables 22 through 25.
- Consider defining two different Urban Conservancy (UC) environments to address different concerns in the parks, agricultural areas and natural areas in the City. Urban Conservancy – Open Space would apply to parks and open spaces. Urban Conservancy – Low Intensity would apply to areas with land use designations of Urban Separator (US) and Agriculture (AG-S or AG-R). These areas tend to be underdeveloped but have the potential to experience low-density development. It may be that special environmental protections should be placed on new development in these areas. Also, the GRNRA area must accommodate a different variety of activities from the construction and maintenance of water quality facilities to natural habitat, so some special provisions for it may be useful. Identify a specific environment designation for wetlands not contiguous with other shorelands. There are several options for addressing this depending on the structure of SMP critical area provisions. It will be especially important to make the requirements for non-contiguous wetlands clear to permit applicants in this case.
- Incorporate parallel environments for sections along the Green River Trail.
- Pre-assign environment designations to potential annexation areas (PAAs) within the UGA. Coordinate with King County to identify the differences between County environment designations and the City's future designations.

7.1.2 General Policies and Regulations

Critical Areas Regulations

- Incorporate or reference the City's critical areas regulations in the Master Program. Address the fact that there are a number of wetlands potentially in SMA jurisdiction (depending on the FEMA floodplain determination) so these regulations could apply to wetlands located outside the primary jurisdictional areas and distant from the shoreline waterbodies.

Flood Hazard Management Regulations

- Ensure that the SMP reflects the flood hazard reduction elements in the City's current Comprehensive Emergency Management Plan and is current with the efforts to maintain a 100-year rating on the Green River levee. See also Section 7.3 Shoreline Modifications – Levees.
- Consider restricting or prohibiting development within channel migration zones and other flood hazard areas.

Parking Regulations

- Prepare provisions that accommodate parking for trail users. In many places, parking may be advantageously located outside jurisdiction, but some places, it may be necessary to develop parking in shoreline jurisdiction. The Green River Trail is a regional facility and part of a trail system of state-wide importance. It is expected that people from distant locations will want access to the trail.

Public Access

- Work with the Parks department to identify improvements to increase the quality of public access. Kent's shorelines are graced with excellent public access features. Besides the Green River Trail, there are numerous parks along the river that provide a variety of opportunities from passive enjoyment, nature study, fishing, boating and active sports. Lake Meridian Park has a boat launch that is a favored spot for water-skiers. Lake Fenwick's shorelines are currently dominated by a City park that offers fishing and other passive activities. Given this wealth of existing facilities, a public access plan was not prepared. Provisions for water-enjoyment uses and recreation uses should allow appropriate park and recreation improvements and encourage water-enjoyment uses along appropriate sections of the shoreline.

Shorelines of Statewide Significance

- Refer to or incorporate Shorelines of Statewide Significance priorities of RCW 90.58.020 in the SMP policies. The Green River is a Shoreline of Statewide Significance; provisions for shorelands of that water body must address the priorities in section 90.58.020 RCW. The Green River Trail is part of a regional trail system that is used by people from all over Puget Sound. Given this perspective, the trail is meeting the criteria of providing a resource of statewide significance. Additionally, Kent's portion of the Green River Valley is home to a wide variety of important industrial companies and activities and flood hazard reduction is a concern of relevance to the state. Finally, as a corridor for migrating listed salmon species, habitat restoration and water quality improvements are in the broader statewide interest. By giving priority to these shoreline functions, the Master Program can comply with shorelines of statewide interest policy.

Water Quality

- Include policies to address water quality issues that lie outside SMA jurisdiction.
- Identify measures that can be taken to improve water quality, especially in Lake Meridian and the Green River.

- Integrate City's NPDES stormwater activities with shoreline planning, either as part of the SMP or the Restoration Plan.

Vegetation Management

- Include provisions to retain and enhance shoreline vegetation around Lake Meridian, Lake Fenwick, and, upon annexation, Panther Lake.
- Identify measures to enhance vegetation on the Green River levees, acknowledging that levee maintenance places special constraints on the planting of vegetation.
- Include provisions for the control of noxious aquatic weeds, especially on Lake Meridian and Lake Fenwick. If necessary, include in the SMP policies calling for public actions to address noxious aquatic weeds.

7.2.7 Low Impact Development and "Green Building" Practices

- Coordinate with City staff to make sure that SMP provisions support the City's goal of encouraging environmentally responsible development.

7.1.3 Shoreline Modification Provisions

Shoreline Stabilization

- Explore a range of solutions to reduce the amount of bulkheads and shoreline armoring over time around Lake Meridian. Water depth and erosion concerns vary greatly around the lake.

Levees

- Include provisions for levee maintenance that, to the extent possible, encourages the restoration of ecological functions. See the Shoreline Restoration Plan.

Shoreline Restoration

- Include provisions encouraging applicable shoreline restoration activities.

Piers, Docks and Floats

- Include provisions related to dock expansion and replacement, especially on Lake Meridian. Explore issues related to the police boat ramp on Lake Meridian.
- Determine if further piers or docks are part of Parks Department plans.
- Pier regulations should be consistent with Washington Department of Fish and Wildlife design standards, and should recognize local issues related to fluctuating water levels and corresponding depth.
- Address piers and docks on Panther Lake through coordination with King County.

Shoreline Modifications in the GRNRA

- Ensure that SMP provisions continue to allow water quality and habitat conservation activities in the GRNRA. This area is highly managed to achieve multiple public functions and upgrade habitat in a controlled setting. Typical activities that should be accommodated include:
  1. Dewatering of lagoon and constructed wetlands
  2. Pumping water onto and from the mudflats.

3. Managing invasive vegetation through tilling and sparing use of herbicides.
4. Irrigating native plants with water from storm water pond.
5. Conserving native plant communities through a variety of activities including thinning.
6. Installing raised planting beds.
7. Trapping undesirable wildlife.
8. Conducting studies to monitor wildlife usage.

Transportation/Utilities/Levee Repair

- Include provisions for public transportation and utilities repair and maintenance in the shoreline jurisdiction. In particular, the SMP should take care to encourage and enable levee repair proposals to incorporate restoration while still accommodating the regionally valuable Green River Trail.

7.1.4 Shoreline Uses

Agriculture

- Include provisions for selected applicable agricultural activities. There are a few sections of shoreline that feature small agricultural activities such as nurseries. The Comprehensive Plan includes land use designations that allow for agricultural support activities. The SMP should address these uses within the limited context envisioned in Kent's Comprehensive Plan.

Boating Facilities

- Include provisions for boat ramps.
- Address the issue of boating impacts on Lake Meridian and see piers and docks discussion above.

Industry

- Address impacts of industrial development on the Green River. This may not be a substantial concern because most industrial uses do not front directly on the shoreline. However, development standards for industrial uses should be included for those few cases where they do front on the shoreline. Additionally, standards may be necessary to ensure that industrial uses adjacent to the Green River Trail do not impact that corridor.

Recreation

- Work with the Parks Department to identify issues related to park development. City parks provide many opportunities for shoreline restoration and can serve as demonstration projects to the greater public. Policies and regulations related to parks management should provide clear preferences for shoreline restoration consistent with public access needs and uses. Existing natural parks should be protected and enhanced.
- Include provisions for golf course to reduce impacts and encourage restoration near the shoreline.

Residential Development

- Address building setbacks, shoreline armoring, piers and docks and vegetation conservation for residential properties. Urban lakes, including Lake Meridian in Kent, have been impacted by nearshore vegetation removal, shoreline armoring, and piers. The SMP should consider

developing regulations that encourage or require shoreline restoration when specific new development or redevelopment activities are proposed. A standard buffer and/or setback should be developed, with an aggressive but practical list of buffer/setback reduction options that would result in a net improvement in shoreline functions. These might include removal of bulkheads, shoreline plantings, landscape chemical reduction or elimination, and removal of other near shore impervious surfaces, among others.
- Explore a range of options to address differing conditions, especially on Lake Meridian.

Water Enjoyment Commercial Uses

- Address opportunities for including more uses that increase opportunities for public enjoyment of the shoreline. For example, restaurants and cafes and other retail activities that orient toward the water should be addressed. Identify opportunity sites and include SMP provisions specifically allowing such uses. Discuss with Parks Department the possibility of concessions for small eating and drinking establishments as part of park development.
- Include provisions for public transportation and utilities development in the shoreline jurisdiction.

7.2 RESTORATION PLAN

The Restoration Plan should be prepared consistent with 173-26-201(2)(f)(i-vi) by addressing the following six subjects:

(i) Identify degraded areas, impaired ecological functions, and sites with potential for ecological restoration;

The discussions of degraded areas, impaired functions, and opportunity areas included in this report should be carried forward to the Restoration Plan.

(ii) Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;

A recommended starting point for development of restoration goals and priorities is the WRIA 9 products. Although the WRIA 9 work is largely salmon-focused, many of the salmon-related goals, policies, and other actions benefit other fish and wildlife as well. The WRIA 9 goals and policies should be examined and supplemented as needed to ensure that these goals are appropriate and comprehensive, not just for application to the Green River and Big Soos Creek, but also to the lakes and other streams that receive less attention in those documents.

(iii) Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;

There are numerous City programs and numerous outside organizations that are actively engaged in planning and implementing projects that could directly or indirectly contribute to achievement of restoration goals. Some of these are identified briefly in this report and should be expanded upon in the Restoration Plan (e.g., CIP projects planned by the City's Public Works Department). A special effort should be made to ensure that all City departments are contacted to identify

additional projects or programs. Further, other organizations should be contacted to determine what projects or programs may be implemented in the future that would have a positive affect on shoreline ecological functions.

(iv) Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs;

The degraded areas, impaired ecological functions, and sites with potential for ecological restoration identified under (i) above, and not addressed by any of the programs and projects identified in (iii) above, could be translated into additional projects and programs that the City should evaluate for implementation potential. Often, implementation of projects and programs is dependent on annual budgets, grant funding, partnerships with other entities, and unexpected "windfalls." The City should clearly identify and then pursue potential partners for implementation of certain projects or programs.

(v) Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and

(vi) Provide for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

The City should identify timelines and benchmarks for each project and program. For some planned actions, such as implementation of CIP projects, this may be easy. For other projects and programs that are the responsibility of outside organizations or that do not have a clear City authority, timelines and benchmarks may of necessity be vague and speculative. Despite the uncertainty inherent in timelines, identifying the timelines and benchmarks shows a commitment to long-term restoration goals.

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9.0 LIST OF ACRONYMS and ABBREVIATIONS

CAC .....City of Kent Critical Areas Code

Corps.....U.S. Army Corps of Engineers

Ecology .....Washington Department of Ecology

GMA .....Growth Management Act

HPA.....Hydraulic Project Approval

KCC .....Kent City Code

LWD .....Large Woody Debris

NOAA Fisheries.....National Marine Fisheries Service

NRCS .....Natural Resources Conservation Service

PAA.....Potential Annexation Area

PAHs.....polycyclic aromatic hydrocarbons

PCBs .....polychlorinated biphenyls

PHS .....Priority Habitats and Species

SMA.....Shoreline Management Act

SMP.....Shoreline Master Program

USFWS .....U.S. Fish and Wildlife Service

WDFW.....Washington Department of Fish and Wildlife

APPENDIX A

INFORMATION REQUEST LETTER AND DISTRIBUTION LIST

KENT
WASHINGTON

COMMUNITY DEVELOPMENT
Fred N. Satterstrom, AICP
Director

PLANNING SERVICES
Charlene Anderson, AICP
Manager

Mailing Address:
220 Fourth Ave. S.
Kent, WA 98032-5895

Location Address:
400 West Gowe
Kent, WA 98032

Phone: 253-856-5454
Fax: 253-856-6454

July 20, 2007

RE: City of Kent Shoreline Inventory and Assessment, request for existing information
Green River, Lake Meridian and Big Soos Creek

Dear Stakeholders:

The City of Kent is in the early stages of examining its Green River, Lake Meridian and Big Soos Creek Shorelines for the purposes of updating its Shoreline Master Program per requirements of the Washington State Department of Ecology. We have recently hired MAKERS and The Watershed Company to assist with Shoreline characterization, analysis, and regulatory review. A Shoreline inventory, conducted by biologists from The Watershed Company, will be the first step. The products of the inventory include a map portfolio and a report characterizing ecological functions and ecosystem-wide processes, among other things.

The City is requesting your help in obtaining all existing physical and biological information regarding Green River, Lake Meridian and Big Soos Creek; their associated riparian and wetland areas; and other water relevant watershed or basin information. We are interested in any and all inventories, assessments, water quality analyses, and/or fish and wildlife distribution and habitat information. A map identifying the City's Shorelines is attached.

We are hoping to assemble our inventory by October 31, 2007 in order to complete the necessary characterization and analysis, and resultant recommendations, in a timely manner. Because we are hoping to reduce redundant data collection at the field level, a response would be appreciated by August 15, 2007. If possible, please provide hard copies or electronic files of any studies instead of a list of citations; contact the City if a copy fee is required. If you believe that another individual within your organization would be a more appropriate contact for this solicitation, please forward this letter to that individual, and notify us of the change in contact.

If you have any questions or need additional information, please feel free to contact me at (253) 856-5431 or canderson@ci.kent.wa.us.

Sincerely,

Charlene Anderson, AICP
Planning Manager

CA:S:\Permit\Plan\COMP_PLAN_AMENDMENTS\2007\CPA-2007-1_SMP\Kent Info Request Letter.doc

ADOPT A STREAM
600 128 ST SE
EVERETT WA 98208

AMERICAN RIVERS
NORTHWEST REGIONAL OFFICE
150 NICKERSON ST, SUITE 311
SEATTLE WA 98109

CASCADE BICYCLE CLUB
PO BOX 15165
SEATTLE WA 98115

CASCADE LAND CONSERVANCY
615 SECOND AVE, #525
SEATTLE WA 98104

FRIENDS OF THE GREEN RIVER
10510 11 AVE NE
SEATTLE WA 98125

GREEN/DUWAMISH & CENTRAL
PUGET SOUND WATERSHED SALMON
HABITAT CONSERVATION(WRIA) 9
201 S JACKSON ST, #601
SEATTLE, WA 98104-3855

KING CONSERVATION DISTRICT
935 POWELL AVE SW
RENTON WA 98057

KING COUNTY
DEPT OF NATURAL RES & PARKS
PARKS AND RECREATION DIV
201 S JACKSON ST, #700
SEATTLE WA 98104

KING COUNTY
DEPT OF NATURAL RES & PARKS
WATER & LAND RESOURCES DIV
GREEN RIVER FLOOD CONTROL ZONE
201 S JACKSON ST, #600
SEATTLE WA 98104

KING COUNTY
DEPT OF NATURAL RES & PARKS
WATER & LAND RESOURCES DIV
DOUG OSTERMAN, WRIA 9
201 S JACKSON ST, #600
SEATTLE WA 98104

KING COUNTY
DEPT OF NATURAL RES & PARKS
WATER & LAND RESOURCES DIV
JOSH KAHAN, GREEN RIVER BASIN
201 S JACKSON ST, #600
SEATTLE WA 98104

LAKE MERIDIAN COMMUNITY ASSOC
12946 KENT KANGLEY RD, #132
KENT WA 98031

WA DEPT OF FISH & WILDLIFE
PRIORITY HABITATS AND SPECIES
LORI GUGGENMOS
600 CAPITOL WAY N
OLYMPIA WA 98501-1091

MID PUGET SOUND FISHERIES
ENHANCEMENT GROUP
TROY FIELDS, EXEC DIR
7400 SAND POINT WAY NE, #202N
SEATTLE WA 98115

MUCKLESHOOT INDIAN TRIBE
KAREN WALTERS
39015 172 AVE SE
AUBURN WA 98092

NATIONAL MARINE FISHERIES
TOM SIBLEY
7600 SAND POINT WAY NE
SEATTLE WA 98115

NATIONAL PARKS SERVICE
RIVERS, TRAILS & CONSERVATION
909 FIRST AVE, 5TH FLR
SEATTLE WA 98104

RAINIER AUDUBON SOCIETY
NANCY HERTZEL
PO BOX 778
AUBURN WA 98071

SHARED STRATEGY FOR
PUGET SOUND
1411 4TH AVE, #1015
SEATTLE WA 98101

TROUT UNLIMITED
SOUTH KING COUNTY CHAPTER 115
PO BOX 3434
FEDERAL WAY WA 98003

US ARMY CORPS OF ENGRS
SEATTLE DIST
PO BOX 3755
SEATTLE WA 98124-3755

US EPA REGION 10
1200 6TH AVE
SEATTLE WA 98101

US FISH AND WILDLIFE
ROGER TABOR
510 DESMOND DR, #102
LACEY WA 98503-1263

UW CENTER FOR
STREAMSIDE STUDIES
BOX 352100
SEATTLE WA 98195

UW CENTER FOR
URBAN WATER RESOURCES
BOX 352700
SEATTLE WA 98195

UW SCHOOL OF AQUATIC & FISHERY
SCIENCES
SI SIMENSTAD
BOX 357980
SEATTLE WA 98195

WASHINGTON DEPT OF
FISH & WILDLIFE
16018 MILL CREEK BLVD
MILL CREEK WA 98012-1296

WASHINGTON DEPT OF
NATURAL RESOURCES
REX THOMPSON
PO BOX 47001
OLYMPIA WA 98504-7001

WASHINGTON DEPT OF NATURAL
RESOURCES AQUATIC LANDS AND
RESOURCES PROGRAM
1111 WASHINGTON ST SE, MS 47027
OLYMPIA WA 98504-7027

WASHINGTON STATE DEPT OF
NATURAL RESOURCES
BOYD POWERS, EXTERNAL SEPA
PO BOX 47015
OLYMPIA WA 98504-7015

WASHINGTON TRAILS ASSOC
1305 FOURTH AVE, #512
SEATTLE WA 98101-2401

WASHINGTON TROUT
PO BOX 402
15629 MAIN ST NE
DUVALL WA 98019

WASHINGTON WATER TRAILS ASSOC
4649 SUNNYSIDE AVE N #305
SEATTLE WA 98103-6900

SIERRA CLUB NW OFFICE
180 NICKERSON ST, #202
SEATTLE WA 98109

MASTER BUILDERS ASSOC
GARRETT HUFFMAN
PO BOX 50108
BELLEVUE WA 98015

BLDG INDUSTRY ASSOC OF WA
PO BOX 1909
OLYMPIA WA 98507-1909

LIVABLE COMMUNITIES COALITION
JOHN MAURO
1617 BOYLSTON AVE, #201
SEATTLE WA 98122

SOOS CREEK WATER & SEWER
PO BOX 58039
14616 SE 192 ST
RENTON WA 98058-1039

WATER DISTRICT #111
27224 144 AVE SE
KENT WA 98042

APPENDIX B

ASSESSMENT OF SHORELINE JURISDICTION

22 January 2008

Charlene Anderson
City of Kent Planning Services
220 Fourth Avenue South, Suite 300
Kent, WA 98032-5895

Re: Proposed Kent Shoreline Jurisdiction

Dear Charlene:

The Watershed Company, in collaboration with City of Kent staff, has developed the attached proposed maps of shoreline jurisdiction. Under the City's current Shoreline Master Program, the Green River, Big Soos Creek, and Lake Meridian are regulated as shorelines. Existing shoreline jurisdiction includes the shorelands extending 200 feet from the ordinary high water mark and identified associated wetlands, and includes the floodway and 200 feet of adjacent floodplain where present.

The first step in updating the map of shoreline jurisdiction was to review the precise shoreline and associated wetlands definitions found in the WAC and in Washington Department of Ecology's (Ecology) rules and guidance documents. Portions of these definitions that apply to the City of Kent revolve around the size and flow thresholds for waterbodies meeting Shoreline criteria, the State Ordinary High Water Mark (OHWM) definition, and when to consider critical areas (wetlands) as "associated" with the shoreline.

Streams/River

Washington Department of Ecology's Digital Atlas was consulted to verify the upstream limits of stream and river shoreline jurisdiction based on USGS's recent study of the 20 cubic feet per second (cfs) cut-off. As in the original SMP work, the entire extent of the Green River within the City and a portion of Big Soos Creek are in shoreline jurisdiction. The Big Soos Creek shoreline jurisdiction area was modified slightly based on USGS point data, and the adjacent shorelands were projected 200 feet perpendicular to the direction of flow at that point.

USGS data placed an additional two City streams partially into shoreline jurisdiction: Springbrook Creek and Jenkins Creek. In the case of Springbrook Creek, Ecology's *proposed point* shapefile placed the upstream limit of 20 cfs approximately 100 feet downstream of the Mill Creek confluence. In the case of Jenkins Creek, Ecology's *proposed point* shapefile placed the upstream limit of 20 cfs a few hundred feet upstream of a major Jenkins Creek tributary (Cranmar Creek). Although Don Bales at Ecology indicated that the USGS points should not be shifted up- or downstream to tributaries without substantial flow data, a follow-up call was made directly to USGS (David Kresch) to discuss concerns. It was discovered that USGS' intent for

those points was that they fall at the Mill Creek tributary in the case of Springbrook Creek and at Cranmar Creek in the case of Jenkins Creek.

USGS seemed surprised that their points were not appearing on the shoreline waterbody in question, but, at least in our experience, up to 100 feet to the side (or even up- or downstream of USGS' intended point as discussed above). It is my understanding that USGS provided latitude-longitude data for the new points, and Ecology transcribed those into point shapefiles. That may be one source of error, or Mr. Kresch suggested that it might be a "projection error." Finally, Mr. Kresch postulated that the placement of Ecology's *proposed point* data may fall directly on the waterbody in the intended location when Ecology's 24k data layers are used, rather than the City's hydro layer. This latter possibly was investigated, and at least for Jenkins Creek and Big Soos Creek, the *proposed point* still fell in the same location regardless of whether the 24k hydro layer or the City's hydro layer was used.

Lakes

The minimum size limit for lakes to be designated as shoreline is 20 acres. Thus, as in the original SMP work, Lake Meridian is identified as a shoreline jurisdictional lake. Panther Lake, located in the City's Potential Annexation Area (PAA), also exceeds 20 acres. In addition, aerial photographs and GIS data were used to review other waterbodies within the City and its PAA to determine if they meet shoreline criteria. As a result, Lake Fenwick and the Green River Natural Resources Area were analyzed.

Lake Fenwick

According to the City's GIS layer, Lake Fenwick is just over 20 acres. However, other on-line sources and King County showed a lower area of 18 acres. The Watershed Company and two City staff adjusted the ordinary high water mark layer based on recent aerial photography, and then further adjusted the OHWM layer during a field visit by boat on 17 September 2007. The resultant acreage of Lake Fenwick is 23.6 acres.

Green River Natural Resources Area (GRNRA) Pond Complex

The Green River Natural Resources Area pond complex is a multi-celled facility with two inlets and one outlet funded and managed by the City's Public Works Department. The first cells (Cells 1-3 on the attached exhibit) at the northeast corner of the complex were constructed between 1964 and 1973 for sewage treatment. The northern-most cell (Cell 1) has overgrown with vegetation, and is now a forested wetland. Cells 2 and 3 are normally filled with water, but become partially dry in the late summer, creating mudflat habitat. Cell 5 was originally two separate primary treatment sewage lagoons divided down the center, each 16.5 acres in size. Each of the 16.5-acre lagoons contained up to 3 feet of water.

In the mid 1980s, the City began planning the conversion of the sewage treatment system into a larger stormwater storage and treament and flood control facility to improve water quality and reduce flood flows in Mill Creek. Cells 1, 2 and 3 are not part of the this stormwater and flood

control system because of low-level contaminants (PCBs, heavy metals) that were found during site investigations prior to the GRNRA's construction. Storm and floodwater is therefore routed away from those cells and the original clay linings of those cells were left intact to minimize groundwater infiltration. Cell 5 was reconfigured into its current arrangement and Cells 4, 6, 7 and 8 were constructed in 1996. The divider between the two 16.5-acre cells was removed and one new, larger cell (Cell 5) was graded to construct a central upland peninsula with a total finished pond area of 18.7 acres at the average water depth. The northeast corner of the eastern 16.5-acre cell was separated to form what is now a stormwater settling pond (Cell 4). A new 35.2-acre lagoon (Cell 6) was constructed west of Cell 5 for flood detention, and two additional cells (Cells 7 and 8) were constructed to the south as stormwater presettling ponds.

When flood conditions are not occurring, stormwater from an 832-acre sub-basin typically flows into the presettling ponds (Cells 4, 7 & 8), then into the treatment wetland (Cell 5), and then into the detention lagoon (Cell 6) before being routed back to Mill Creek through the outflow channel. The detention lagoon (Cell 6) normally has a water level two feet lower than the constructed wetland (Cell 5), but water continuously drains from Cell 5 to Cell 6 over a sharp-crested weir set at an elevation of 23.0 feet above mean seal level (MSL).

A new diversion channel from Mill Creek was also constructed in 1996 to route flood flows into the GRNRA storage ponds. This diversion channel directs floodwaters to the northeast corner of the GRNRA where water flows first into Cell 4 during minor events, or directly into Cell 6 via the flood overflow channel whenever the flood size exceeds the 6-month event.

The ordinary high water marks of the individual cells have not been delineated. However, during a site investigation attended by Ecology, the City, The Watershed Company, and Makers on December 20, 2007, Richard Robohm (Ecology) placed the ordinary high water mark at approximately the 22.5-foot elevation in the detention lagoon (Cell 6). This estimation was based on Matt Knox (City) reporting the weir height between Cells 5 and 6 at 23.0 feet, and an examination of indicators in Cell 6 relative to the weir. After some field discussion, it was preliminarily determined that Cells 5 and 6 are effectively one body of water frequently enough during the year (Ecology suggested at least six times per year) to consider combining Cells 5 and 6 as a single shoreline lake.

From a review of GRNRA water level data (based on six years of continuous water level monitoring from 2000 to 2005), Cell 6 exceeds 23.0 feet MSL (and therefore overtops the weir from the downstream end leaving one continuous body of water) on average just over five times per year. Additional discussion ensued regarding the status of the perimeter cells (Cells 4, 7 and 8). Cell 7 is separated from Cell 6 by a weir with a top elevation of 26.0 feet (set at the calculated 25-year flood recurrence level), approximately 3.5 feet above the Cell 6 OHWM. Cells 7 and 8 are separated by a large concrete culvert; Cells 8 and 5 are separated by additional concrete culverts with a gate; and Cells 4 and 5 are also separated by a culvert with a gate. While these cells are hydraulically connected to Cells 5 and 6 via culverts and/or the 26.0-foot weir, that hydraulic connection is not a part of the ordinary high water mark definition or the criteria for establishing jurisdiction. Rather, hydraulic connectivity is a factor in determining associated wetlands. By definition, the lake edge is determined by a "continuous ordinary high

water mark" and the ordinary high water mark "is a biological vegetation mark…found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland…" Although the cells are connected, the culverts/weirs interrupt the ordinary high water marks between cells, do not have beds or banks, and do not contain vegetation. Further, the ordinary high water mark elevations of Cells 4, 7 and 8 appear to differ from that of Cells 5 and 6. It is our professional opinion that the above factors constitute a break in the OHWM, and thus render Cells 5 and 6 the only shoreline waterbodies within the Green River Natural Resources Area.

Additional background information about the Green River Natural Resources Areas can be found at http://www.ci.kent.wa.us/publicworks/GRNRA/grnra.asp.

Associated Wetlands

Existing wetland inventory information was reviewed to identify associated wetlands. Ecology guidance states that the entire wetland is associated if any part of it lies within the area 200 feet from the OHWM (or floodway in riverine environments) of a state Shoreline. Further guidance states that wetlands that are hydraulically connected to a Shoreline also would be considered associated, as well as wetlands within the 100-year floodplain. Wetlands that are separated by an obvious topographic break from the shoreline are not associated, provided they are outside the shoreland zone and provided that the break is not an artificial feature such as a berm or road. As needed, a few of the wetlands were visited in the field to verify the nature of their association with the shoreline waterbody. Generally, the City's latest Wetland Inventory Map was assumed to be sufficient for the shoreline jurisdiction assessment.

FEMA's draft map of the revised Green River floodplain (dated 28 September 2007) includes the entire Kent valley due to FEMA's assumption that the Green River levees would fail in a 100-year flood event. The City believes FEMA's draft map makes incorrect assumptions, and thus intends to appeal the draft. Adoption of a final Green River floodplain map would likely not occur until after SMP adoption, and the final map is expected to be revised from the 2007 draft. Accordingly, wetlands determined to be associated based on location in the Green River floodplain are not identified on the proposed jurisdiction maps as the map would be obsolete at finalization of FEMA's map. Associated wetland determinations based on presence in the Green River floodplain would be made on a project-by-project basis at the time of application using the latest approved version of FEMA's floodplain map.

Revised Jurisdiction Summary

The following are proposed areas of shoreline jurisdiction:

- Green River
- Big Soos Creek
- Springbrook Creek
- Jenkins Creek

- Lake Meridian
- Lake Fenwick
- Green River Natural Resources Area Cells 5 and 6 (the detention lagoon and constructed wetland)
- Panther Lake (in City's PAA)
- Shorelands 200 feet from the OHWM, including floodways and contiguous floodplain areas landward 200 feet from the floodway
- Associated wetlands
- The City is not proposing to include the 100-year floodplain or critical area buffers as part of shoreline jurisdiction.

Please call if you have any questions.

Sincerely,

Amy Summe
Environmental Planner

Enclosures

Proposed Shoreline Management Area

- Shoreline Master Program - City of Kent

0 1,800 3,600 Feet

Scale: 1" = 3,600'

KENT WASHINGTON

Figure 1b

Legend

- Kent City Limits
- Kent Potential Annexation Area (PAA)
- Adjacent City Limits
- Proposed Shoreline Management Area (In City Limits)
- Proposed Shoreline Management Area (In PAA)

Exhibit 1

Flown March, 2006

Wetlands associated with the Green River based on presence in the 100-year floodplain will be determined at the project level at the time of application, and using the latest approved version of FEMA's 100-year floodplain map. Green River floodplain wetlands are not included on this map.

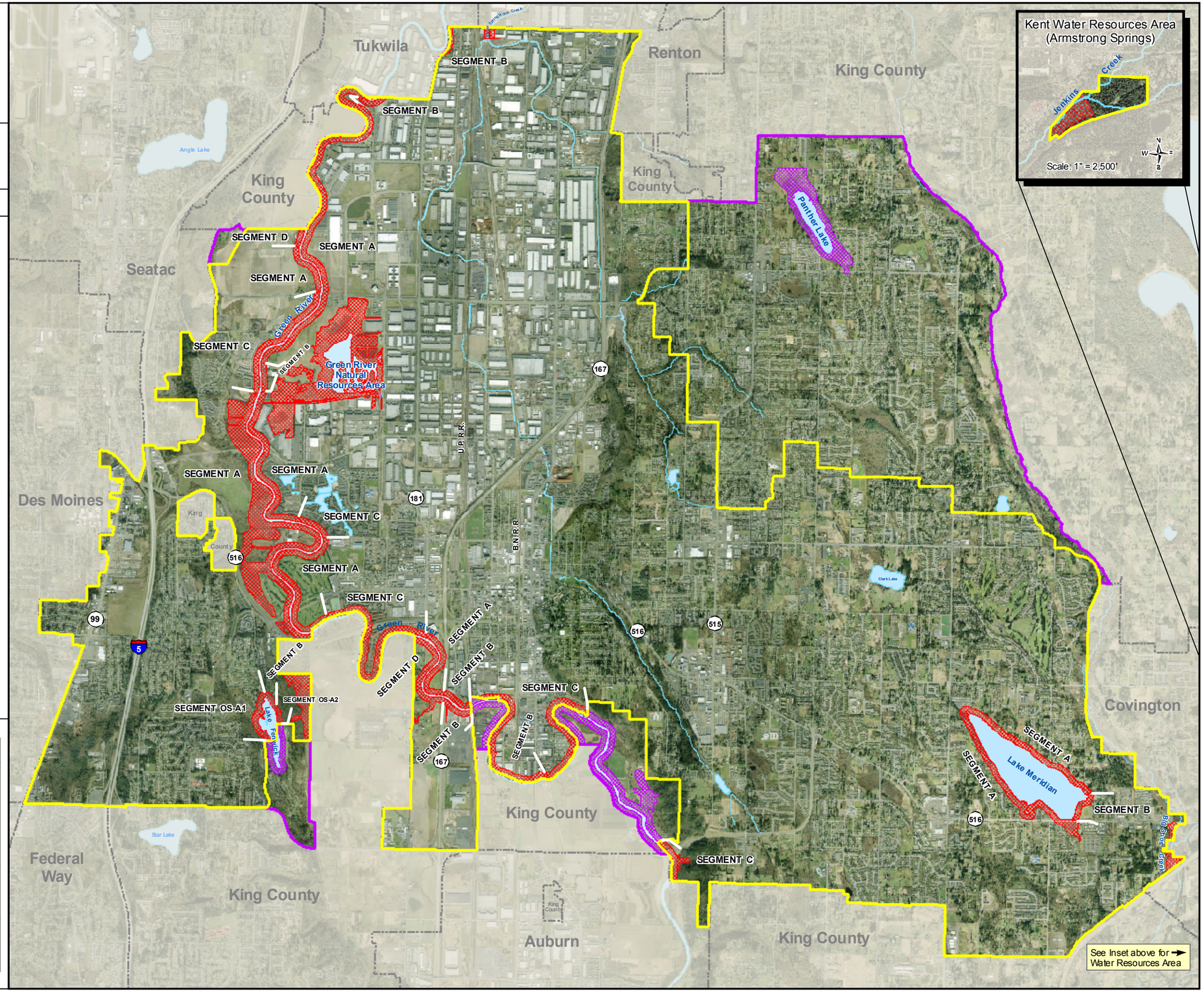
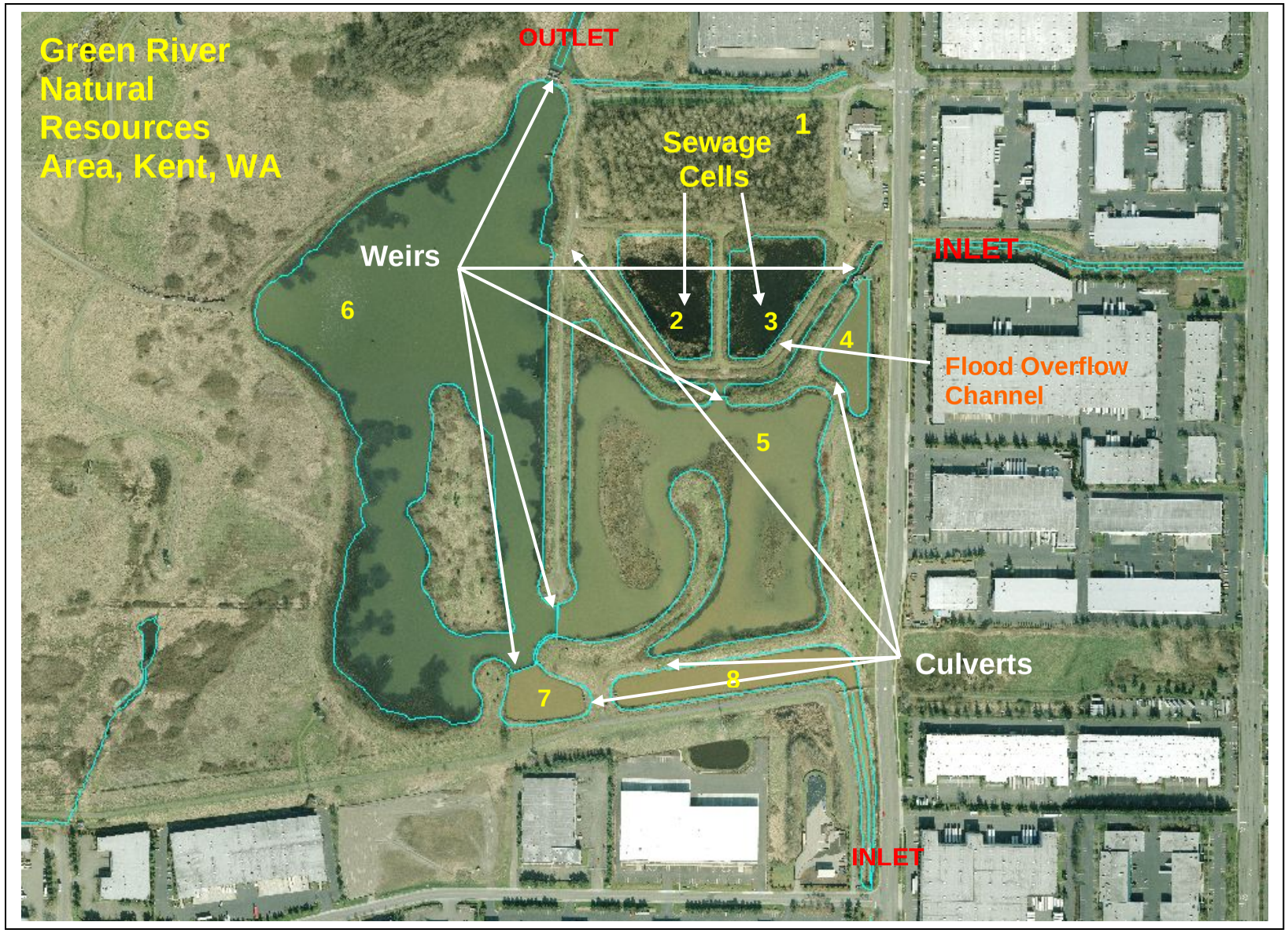


Exhibit 2


Green River
Natural
Resources
Area, Kent, WA
OUTLET
Sewage
Cells
1
Weirs
6
2
3
4
INLET
Flood Overflow
Channel
5
Culverts
8
7
INLET

APPENDIX C

MAP FOLIO