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CITY OF SUMNER

SHORELINE INVENTORY

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1.0 INTRODUCTION

The purpose of this study is to conduct a baseline inventory of natural and built conditions in the City of Sumner's shoreline jurisdiction to provide a basis for the update of the City's Shoreline Master Program. This characterization will help the City identify existing conditions, evaluate functions and values of resources in its shoreline jurisdiction, and explore opportunities for conservation and restoration of ecological functions. These findings will also help provide a framework for future updates to the City's shoreline environment designations and shoreline management policies and regulations.

1.1 Study Area Boundary

This inventory report includes those shorelines along the Puyallup and White Rivers[1] that fall within the Sumner city limits and urban growth area (Map 1 in Appendix A). Both rivers are shorelines of statewide significance according to the state's Shoreline Management Act, and they are the City's only two water bodies regulated under the Act. Under the Shoreline Management Act, the shoreline area to be regulated under the City's shoreline master program must include all areas 200 feet landward of the ordinary high water mark, as well as floodways and any associated wetlands. Because the shoreline within Sumner's city limits and urban growth area is largely constrained by a system of dikes, for the purposes of this programmatic inventory, the shoreline jurisdiction is assumed to extend to 200 feet landward from the top of each river's bank. The shoreline jurisdiction is shown on Map 1 in Appendix A. Unless otherwise stated, generalized references to the City or the City shoreline jurisdiction include the City's urban growth area.

The Puyallup River is located within Sumner's city limits and urban growth area from its southernmost point at approximately River Mile (RM) 12.25 downstream to its confluence with the White River at approximately RM 10.0 west of downtown Sumner. Downstream of Sumner's shoreline jurisdiction, the Puyallup River drains into Commencement Bay in Puget Sound. The White River is located within Sumner's city limits and urban growth area from approximately RM 4.5 at the northern border of the City's urban growth area downstream to its confluence with the Puyallup River at RM 0.0. The White and Puyallup Rivers are located within the boundaries of Sections 1, 12, 13, 14, 23, 24, 25, and 26 of Township 20 North, Range 4 East.

1.2 Methodology

A number of state and federal agency data sources, City of Sumner records, and technical reports were reviewed to compile this inventory, including but not limited to the following:

- The state's Salmon and Steelhead Stock Inventory (WDF, 1994);
- The Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region (Williams et al., 1975);

[1] Throughout this inventory, the terms "White River" and "Stuck River" are used interchangeably to refer to that portion of this river system located in Sumner. In 1914, the White River was permanently diverted into the former channel of the Stuck River.

- The Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP);
- Washington Department of Fish and Wildlife's Priority Habitats and Species and "StreamNet" databases;
- A Habitat Limiting Factors Report for the Puyallup River basin (Kerwin, 1999);
- An Ecosystems Diagnostics and Treatment assessment for the Puyallup River basin (Mobrand Biometrics, 2001);
- The Lower Puyallup River Watershed Action Plan (Lower Puyallup River Watershed Management Committee, 1999);
- The Pierce Conservation District Water Resource Inventory Area 10 Fish Passage Inventory (2000);
- The Puyallup River Basin Comprehensive Flood Control Management Plan (Pierce County, 1991),
- A Soil Survey of Pierce County Area (Zulauf et al., 1979), and
- Wetland studies conducted by both Pierce County (Buildable Lands Inventory, 2000) and the City of Sumner (Parametrix, 1990).

Several sources were also used to create the GIS maps for this study; these sources are outlined in Appendix A. An extensive literature review of recent scientific documents was also conducted pertaining to baseline conditions within the City's shoreline jurisdiction. A list of references is included at the end of each section of this report. Aerial photographs of the study area were consulted, and several reconnaissance field surveys of the study area were made. Finally, comments received from local tribes, Ecology, and other agencies have been incorporated into this document where appropriate.

Throughout the field surveys and in this report the terms "left bank" and "right bank" are used. Right bank refers to the river bank which, when one is facing upstream, is to one's right. Similarly, left bank refers to that bank to the left when one is facing upstream[2].

1.3 Report Organization

This report is divided in to five main sections. After Section 1.0, which provides background and introductory information, Section 2.0 discusses existing land use and zoning along the City's regulated shorelines. Section 3.0 discusses biological resources within the shoreline jurisdiction with the exception of fish habitat. Section 4.0 focuses specifically on instream fish habitat and fish use in the City. Section 5.0 provides a segment-by-segment analysis of shoreline conditions.

Also accompanying this report are several maps that identify the City's shoreline jurisdiction; identify shoreline planning segments; and document various biological, land use, and physical elements. Maps are referred to throughout the document and are contained in Appendix A.

[2] "Upstream" of the White River extends generally to the north from where it joins the Puyallup River. "Upstream" on the Puyallup River generally extends to the south and east.

1.4 Study Segments

For the purposes of categorizing distinct segments of the City's shorelines for planning purposes, the City's shoreline jurisdiction was classified into seven relatively homogeneous segments. Information from Section 2 (Land Use and Altered Conditions) of this report, in particular, information regarding current land use (Table 4) and future zoning designations (Table 6) was used to divide the shoreline into the seven segments. Aside from the potential occurrence of bald eagles, listed species occurring within the City shoreline jurisdiction are all salmonid fish species. For this reason, segments were grouped to correspond with the level of ecological function provided by each segment for salmonids (including but not limited to streambank vegetation, potential spawning areas, and off-channel habitat). Table 1 identifies the location of shoreline segments. Segments are also shown on Map 1 in Appendix A.

Table 1. Shoreline Study Segments

Location	Segment	Description	Approximate Length (feet)	River Mile
Puyallup River	**A**	Linden Ave. Bridge to City Limits	7,561	10.7 - 12.2
Confluence – Puyallup and White Rivers	**B**	Sewage works, Confluence of White and Puyallup Rivers	3,920	10.2 – 10.7 (Puyallup) 0.0 – 0.2 (White)
White River	**C**	SR 410 Bridge to Milwaukee Canal	4,560	0.2 – 1.05
White River	**D**	Milwaukee Canal to Tacoma Road Bridge	3,828	1.05 – 1.8
White River	**E**	Tacoma Road Bridge to Public Land	3,169	1.8 – 2.5
White River	**F**	Right Bank Public Land	9,160	2.5 – 4.15
White River	**G**	Sumner Urban Growth Area	4,000	4.15 – 4.9
		TOTAL	**36,198**	**6.8**

2.0 LAND USE AND "ALTERED" CONDITIONS

The City of Sumner, located approximately 16 miles east of Tacoma and 33 miles south of Seattle, encompasses an area of approximately 16 square miles. The City is predominantly located on the valley floor of the Puyallup and White River valleys. As of 2000, the City's population was approximately 8,500. Over the recent past, the city has experienced a rapid growth rate, and a portion of this development has occurred in the shoreline areas of the White and Puyallup Rivers.

2.1 Historic Land Use and Watershed Conditions

Historically, the surface geology of the valley floor in Sumner has been determined by frequent flooding of the White and Puyallup Rivers. Periodic mudflows from Mount Rainier have covered the valley with layers of mud, silt, ash, and glacial debris. The most recent mudflow (named the Osceola mudflow) occurred in the valley about 5,600 years ago.

The White River subbasin originates at the terminus of the Winthrop, Fryingpan and Emmons glaciers on the slopes of Mt. Rainier and drains an area of approximately 494 square miles (Williams, 1975). Flowing from its origin to the confluence with the Puyallup River, the White River is approximately 68 miles in length.

The Puyallup River Basin was one of the earliest areas settled in the Puget Sound basin. Historically, the study area was characterized by large tracts of old-growth forests, fertile river valley soils, and abundant runs of salmon (Kerwin, 1999). Homesteads and settlements began appearing as early as 1850.

Early in the 1900's, the majority of the White River flow was naturally directed north into the Green and Duwamish Rivers. A small overflow channel, called the Stuck River, flowed south from the vicinity of Auburn into the Puyallup River at Sumner. A rain-on-snow event triggered a flood on November 14, 1906, creating a debris dam in the White River and directing the entire flow into the Stuck River. The former White River channel into the Green River went dry as a part of this event (Chittenden, 1907). A permanent diversion wall was constructed at Auburn in 1915; as a result, the White River remains a tributary of the Puyallup today.

The headwaters of both the upper Puyallup and White Rivers are predominantly located within the Mount Baker-Snoqualmie National Forest and private commercial timberlands. Urbanization and development have been limited in these areas compared to urban areas in the Puget Sound lowlands. However, both the upper Puyallup and upper White River watersheds have been affected by timber harvest and road building practices that have reduced the ability of riparian areas to provide wood and shade to the rivers and stream channels. These areas also continue to contribute to each river system fine sediments from road construction and landslides. These activities continue to adversely impact natural salmonid production (Kerwin, 1999).

The chronology of events presented in Table 2 details landscape modifications resulting from settlement between 1792 and 1999.

Table 2. Puyallup River Basin Chronology of Events

Date	Event	Impact(s)
1792	First European description of the Puyallup River mouth	Initial description of attributes of Commencement Bay as a possible port
1850	Donation Land Claim Law	Encouraged settlement of Oregon and Wash.
1851	Initial European settlers arrive in vicinity of Tacoma	Land clearing and farming begins

Date	Event	Impact(s)
1852	Pierce County organized	First citizen based government formed
1852	First commercial lumber mill constructed	Timber harvest begins
1853	First railroad surveys conducted	First mapping attempts of historical habitat
1854	Medicine Creek Treaty signed	Large tracts of land are given up by the Puyallup and Muckleshoot Tribes
1858	Laws permitting draining passed Coal discovered in upper Carbon River subbasin	Wetlands drainage begins. Mining was initiated in 1873.
1870	Irrigation of agricultural lands begins	Water withdrawals from surface waters
1873	First railroad into Puyallup R. valley and Puyallup River valley	Allows easy access into and out of Tacoma
1874	Initial railroad construction across Commencement Bay tidal marshes	First filling of tidal marshes and tideflats in Commencement Bay
1883	First report of RR bridge across White River	Railroad is constructed east/west in the then White/Green river valley
1890s	Tacoma Land Co. began dredging of western channel of Puyallup River	Significant loss of estuarine environment and function in Commencement Bay
1899	Mt. Rainier National Park established	Headwaters of Puyallup and White rivers preserved
1903	Electron Power Project construction started.	26 miles of spawning and rearing habitat lost and 10 miles of mainstem river habitat impacted due to reduced flows
1906	Flood event (probably a 10-year flood event)	Log jam on White River diverts White into Stuck River and Puyallup River basin
1907	Washington State Legislature grants county governments authority to do flood protection work	Pierce County River Improvement District (PCRI) formed and channelization efforts begin between White River and Puyallup River mouth
1908	Channel realignment, bank stabilization and diking projects started in Puyallup, Carbon and White Rivers	Instream habitat losses associated with each project.
1911	Debris barrier constructed in White R. upstream of the 1906 diversion	Removed large woody debris from portions of the White and lower Puyallup Rivers
1913	State Legislation passed permitting Inter-County River Improvement District to be formed (1914)	Pierce and King counties work together to perform flood control projects
1914	Concrete Diversion constructed at Auburn permanently diverting White River into Stuck River	Increased Puyallup River flows by approximately 50 percent at confluence with White River
1917	Puyallup River Relocation Project complete	Channel relocation, diking alterations to salt/freshwater mixing, erosion and changes to the estuarine environment -- 1,800 acres of tidal marsh lost

Date	Event	Impact(s)
1930s	Work on St. Paul, Wapato (Blair) and Hylebos waterways	Estimated 570 acres of mudflats and 121 acres of salt marsh filled
1939	Mud Mountain Dam construction begins	Barrier to anadromous fish migration
1946	Army Corps of Engineers' channelization and diking projects	Lower three (3) river miles of Puyallup River diked
1940s – 1970s	Major logging activities in the upper watershed	Logging road construction and impacts watersheds to riparian buffers and habitat
By 1970s	Major channelization projects completed	45 miles of three rivers in basin had been channelized (14.7 miles of dikes with concrete armoring, 57.3 miles of dikes and river banks with rock riprap)
1974	County gravel removal projects started	Rivers maintained by lowering of riverbed instead of raising heights of dikes
1988	Puyallup Land Claims Settlement	Major property ownership issues settled
1999	Puget Sound Chinook Listed as Threatened under the federal Endangered Species Act	Chinook present in White and Puyallup Rivers

(Source: Kerwin, 1999)

2.2 Existing Shoreline Designations

Sumner's shoreline jurisdiction is currently divided into three shoreline environment designations- urban, suburban, and conservancy, generally representing a range of development, from high to low intensity. These shoreline environment designation locations are shown in Table 3 and are excerpted from the City's 1991 Shoreline Master Program.

Table 3. Existing Sumner Shoreline Environment Designations

Inventory Segment	Shoreline Environment Designation
A	• Suburban, Left Bank • Conservancy, USFWS Property
B	• Conservancy From railroad crossing to SR 410 crossing, including point at confluence • Urban, Left bank
C	• Urban, Right bank • Urban/Conservancy, Left bank
D	• Urban/Suburban, Right bank • Conservancy, Left bank
E	• Conservancy/Small portion suburban, Right bank • Conservancy, Left bank
F	• Conservancy, Both banks
G	• Conservancy, Both banks

2.3 Existing Land Use

Current land use in Sumner is a mix of residential, commercial, agricultural, and light industrial uses. Agriculture is currently the dominant land use, covering a large portion of northern portions the City's shoreline jurisdiction along the White River. Industrial and commercial land uses also dominate along the City shorelines. Public land, including a wastewater treatment plant and a golf course, occupy portions of the shoreline at the north end of the shoreline jurisdiction and at the confluence of the White and Puyallup Rivers, respectively. Compared to the other land uses, low- and high-density residential uses currently occupy a relatively small portion of Sumner's shoreline area. Table 4 below presents existing land use percent coverage by shoreline planning segment. Current land uses, including the locations of structures and agricultural practices, are visible from air photos shown on Map 1 in Appendix A.

Table 4. Current Sumner Shoreline Environment Land Use

Shoreline Segment	Bank	Existing Land Use	Approximate Percent Coverage
A Puyallup River	Right Bank	Forested	40
		High Density Residential	60
B Confluence of Puyallup River and White River	Right Bank	Wastewater Treatment Plant	40
		Cleared/Vacant/Other	20
		Forested	40
	Left Bank	Forested	50
		Vacant/Cleared/Road	50
C White River	Right Bank	Commercial	35
		Residential/Road	35
		Vacant/Forested	30
	Left Bank	Commercial	45
		Vacant/Cleared/Forested	55
D White River	Left Bank	Industrial/Agriculture	80
		Roads/Cleared Areas	20
	Right Bank	Agriculture/Undeveloped	70
		Industrial	30
E White River	Right Bank	Agriculture	95
		Other (Parking Lot)	5
	Left Bank	Agriculture	100
F	Right Bank	Golf Course	40

Shoreline Segment	Bank	Existing Land Use	Approximate Percent Coverage
White River		Agriculture	60
	Left Bank	Agriculture/Forested	95
		Low Density Residential	5
G White River	Right Bank	Industrial	65
		Forested	35
	Left Bank	Industrial	80
		Other	20

2.4 Comprehensive Plan

According to the Sumner Comprehensive Plan (City of Sumner, 2000), the City contains a variety of designated land uses, ranging from heavy industrial to residential. In Sumner's shoreline jurisdiction, the predominant comprehensive land use designation is light manufacturing. Public land is the next largest designated land use within the regulated shoreline. Remaining land use designations are evenly divided among high-density residential, public/private utilities and facilities, low-density residential, general commercial, and heavy manufacturing. Table 5 identifies comprehensive plan designations by percent coverage for each shoreline segment.

Table 5. Sumner Shoreline Study Segments by Comprehensive Plan Designation

Segment	Bank	Comprehensive Plan Designation	Approximate Percent Coverage[1]
A (White River)	Right Bank	Public Land	22
		High Density Residential	35
		Low Density Residential	20
	Left Bank	Public Land	100
B (White River)	Right Bank	Low Density Residential	50
		Public Land	31
	Left Bank	General Commercial	11
		Public Land	22
C (White River)	Right Bank	Low Density Residential	31
		General Commercial	30
		Public Land	6
		Light Manufacturing	9
	Left Bank	General Commercial	73
		Low Density Residential	4
D (White River)	Right Bank	Light Manufacturing	25
		Heavy Industrial	57

Segment	Bank	Comprehensive Plan Designation	Approximate Percent Coverage[1]
	Left Bank	Light Manufacturing	77
		Heavy Industrial	2
E (White River)	Right Bank	Light Manufacturing	95
	Left Bank	Light Manufacturing	84
F (White River)	Right Bank	Public Land	100
	Left Bank	Public Land	25
		Light Manufacturing	47
		Low Density Residential	17
G (White River)	Right Bank	Light Manufacturing	100
	Left Bank	Light Manufacturing	100

[1] Coverages are approximate may not total 100 percent due to the presence of other structures and land uses, such as roads and bridges, and because portions of some segments are not within Sumner's city limits.

2.5 Zoning Designations

The City's zoning designations generally follow land use designations from the city's comprehensive plan, discussed above. According to the City's zoning map, land in Sumner is zoned into six residential categories ranging from low to high-density residential. Commercial zones include neighborhood, central business district, and general commercial areas, while industrial zones include heavy and light industrial designations. Overall, light industrial land occupies the largest area in the City, followed by low-density residential designations.

Within the shoreline jurisdiction, light industrial zoning occupies the largest portion of the total shoreline area. Remaining zoning designations in the shoreline are divided between heavy industrial, agriculture, high-density residential, low-density residential. Additional shoreline includes public/private utilities and facilities, as identified under Section 2.3, above. Table 6 documents zoning coverage by shoreline segment as well as by total regulated shoreline area.

Table 6. Sumner Shoreline Study Segments by Zoning Designation

Segment	Bank	Zoning	Percent Coverage[1]
A (Puyallup River)	Right Bank	Low Density Residential	50
	Right Bank	High Density Residential	50
B (Confluence)	Right Bank	Low Density Residential	100
C (White River)	Right Bank	Light Industrial	9
	Right Bank	General Commercial	36
	Left Bank	General Commercial	65
D (White River)	Left Bank	Light Industrial	100
	Right Bank	Light Industrial	25
	Right Bank	Heavy Industrial	75

Segment	Bank	Zoning	Percent Coverage[1]
E (White River)	Right Bank	Light Industrial	100
	Left Bank	Light Industrial	100
F (White River)	Right Bank	Light Industrial	51
	Right Bank	Agriculture	49
	Left Bank	Light Industrial	75
	Left Bank	Low Density Residential	25
G (White River)	Right Bank	N/A (outside city limits)	N/A
	Left Bank	N/A (outside city limits)	N/A

[1]Coverages are approximate may not total 100 percent due to the presence of other structures and land uses, such as roads and bridges, and because portions of some segments are not within Sumner's city limits.

2.6 Parks and Open Space

Existing open space within City shorelines includes both public and private utilities and facilities, along with wetlands, undeveloped agricultural lands, vacant land, and the river corridors themselves. As discussed under Section 2.4, above, substantial portions of Sumner's shoreline are occupied by public/private utilities and facilities. Major parks and facilities in the various shoreline study segments include the following:

- **Sumner Meadows Golf Links**: The golf course occupies 165 acres of a 280-acre site along the east bank of the White River in Segment F.
- **Confluence Park**: This park is an approximately 1.5-acre area at the confluence of the White and Puyallup Rivers near the City's wastewater treatment plant in Segment B. Access to the area is available at several points and the area is frequently used for fishing.
- **Library Park**: This small park encompasses 0.8 acre and offers access to the White River in Segment C.

In addition, the City is currently working toward the development of a riverside trail along all seven segments. This trail would provide riverside pedestrian and biking access along the River**.**

2.7 Impervious Surface

A preliminary calculation of percent impervious area within the shoreline environment area has been approximated by mapping at a 1:5,000 scale from orthophotography provided by City of Sumner. For the purposes of this inventory, areas of concentrated buildings, parking lots, and major roads were calculated together as impervious area. It should be noted that the City is currently conducting a more detailed analysis of impervious surface coverage in association with their surface water management program. Table 7 provides approximately impervious surface coverage by shoreline planning segment.

Table 7. Approximate Impervious Surface Coverage by Shoreline Study Segment

Segment	Bank	Acreage of Impervious Area	Approximate Percent Impervious Coverage
A (Puyallup River)	Right Bank	11.6	35
B (Confluence)	Right Bank	3.2	24
	Left Bank	1.5	19
C (White River)	Right Bank	7.0	32
	Left Bank	8.4	41
D (White River)	Right Bank	1.7	11
	Left Bank	0.7	4
E (White River)	Right Bank	0.5	3
	Left Bank	0	0
F (White River)	Right Bank	0	0
	Left Bank	0	0
G (White River)	Right Bank	6.1	37
	Left Bank	6.4	33

2.8 Filled Areas

As a result of channel realignment, bank stabilization and diking projects that started along Puyallup and White Rivers in the early 1900s and subsequent active agricultural use of adjacent areas, it is likely that several areas in the shoreline jurisdiction have previously been filled. Many areas containing buildings, roads, parking lots, and other developed structures have also been filled for development.

2.9 Roads and Bridges

2.9.1 Roads

Sumner's shoreline jurisdiction contains several roads, from two-lane neighborhood collectors to arterials. In the regulated shoreline, the highest road density is located in the vicinity of downtown Sumner, in Segment C. State Route 410 crosses the White River upstream of the confluence with the Puyallup River, forming the boundary between Segments B and C. Refer to Maps 4-A through 4-G in Appendix A for the location of roads in each shoreline segment.

2.9.2 Bridges

In addition to the State Route 410 crossing, bridges located in the shoreline area include: the Linden Avenue Bridge at the western end of Segment A, Bridge Street Bridge at the Bridge Street crossing in Segment B, the Union Pacific Railroad Spur Bridge in Segment C, the pedestrian bridge at 24th Street in Segment D, Pioneer Bridge at the north end of Segment D, and the 8th Avenue Bridge at the north end of Segment G in Sumner's urban growth area. Refer to

Maps 4-A through 4-G in Appendix A for the location of bridges in each shoreline segment. A railroad crossing of the Puyallup River also parallels the Linden Avenue Bridge.

2.10 Flood Control Structures

Both the Puyallup and White Rivers are lined through their entire length in Sumner with a system of levees and concrete revetments that began as early as the late 1800s. These structures are under the jurisdiction of the Pierce County River Improvement Division (PCRI). According to the *Puyallup River Basin Comprehensive Flood Control Management Plan* (PCRI, 1991), levees are defined as “structures designed, constructed, and maintained as flood proof structures with three feet of freeboard (as required by FEMA) above a design flood elevation.” Revetments are “flood control structures not necessarily engineered or designed to be flood proof and do not have three feet of freeboard above the 100-year flood elevation.” The Puyallup River within Segments A and B is lined with a levee, while most of the White River within Segments B through G is armored with revetments (R. Brake, personal communication, 2002). Over time, vegetation has grown and obscured the revetment system and levees (Fantello, personal communication, 2002). An agreement with the Puyallup Tribe in 1995 calls for retention and encouragement of plant growth near the ordinary high water mark and/or toe of the levees and revetments. Only woody plants with a trunk diameter exceeding six inches may be removed from that zone (PCRI, 1991). Maintenance of these flood control structures by the County is currently minimal and limited to vegetation removal to maintain access, and occasionally removal of larger diseased or damaged trees.

2.11 Docks, Piers, and Over-Water Structures

With the exception of the bridges previously described, and the Puget Sound Energy power lines crossing the White River north of 24th Street, there are no major docks, piers, or over water structures located on the Puyallup or White Rivers in Sumner.

2.12 Storm Water and Sewer Outfalls

The Sumner Sewage Treatment Plant is located at the confluence of the Puyallup and White Rivers in shoreline Segment B. Sewage is conveyed to the treatment plant by a series of collectors, as well as the 36-inch Sewage Treatment Plant interceptor. There are two pump stations located in the shoreline jurisdiction – these are the North Pump Station on the White River on the right bank of Segment D, and the Cherry Avenue Pump Station on the Puyallup River on the left bank of Segment A. The City’s sewer system also contains two overflow outfalls, one in the White River on the right bank of Segment C, and the other on the left bank of the Puyallup River near the Cherry Avenue Pump Station in Segment A (City of Sumner, 1993).

Within the core downtown area of Sumner, generally south of Puyallup Street and west of Valley Avenue, the City’s storm drainage system consists of collection by a network of pipes and direct discharge to the White and Puyallup Rivers (City of Sumner, 1992). North of the downtown core, a series of ditches convey drainage to the White River; these ditches are maintained to a specified design flow. Salmon Creek has been used in the past for stormwater conveyance and contains several stormwater discharge outfalls (City of Sumner, 1993).

2.13 Other Utilities

Commercial, residential, and industrial buildings located in the shoreline jurisdiction are served by municipal water, as well as gas and electricity (Puget Sound Energy) and telephone (Qwest). There are no major utility structures in the shoreline jurisdiction.

Other utilities include the Dieringer Powerhouse and its associated “tailrace” or discharge canal, located on the right bank of Segment F in the White River. Water from the White River is diverted through Lake Tapps and discharged back into the White River at the Dieringer Powerhouse. The tailrace consists of a constructed canal approximately 30 feet wide that discharges water to the White River at high velocities. As discharges from the powerhouse are regulated to meet power needs, changes occur in river elevations. High flows create a false attraction for salmonid species, while low flows occur in river reaches below the diversion (Kerwin, 1999). These “ramping” rates may strand juvenile and adult fish (Kerwin, 1999). Flows are discussed in further detail in Section 4.3 of this report.

2.14 Culverts

The Pierce County Conservation District, in cooperation with the Puyallup Tribe, has documented the location and condition of culverts throughout the Puyallup River watershed. Specifically, there are no culverts on the main channels of the White or Puyallup Rivers in Sumner. However, culverts that are barriers to fish passage have been identified on several tributaries to the White and Puyallup Rivers. Tributaries with culvert barriers within 200 feet of the mainstem reaches are identified in Segment G, south of Segment A, north of Segment F, and on the Milwaukee Canal in the vicinity of Segment D. These fish passage barriers are represented on Maps 4-A through 4-G in Appendix A.

3.0 BIOLOGICAL RESOURCES AND CRITICAL AREAS

This section identifies critical areas as defined by the State's Growth Management Act (RCW 30.70.170) and other biological resource elements. Fish species and habitat are discussed in Section 4.0. Identified critical areas located in Sumner's shoreline jurisdiction are shown on Map 3 in Appendix A. Wetlands, aquifer recharge areas, priority habitats, geologically hazardous areas (steep slopes), channel migration zones, and frequently flooded areas that occur within the 200-foot shoreline jurisdiction boundaries along the White and Puyallup Rivers were identified for each segment and mapped where applicable.

3.1 Wetlands

Information on wetlands was obtained from data provided by Pierce County as part of the County's Buildable Lands Inventory, from a wetland study prepared for the City by Parametrix, Inc. (1990), and from National Wetland Inventory data. For the purposes of mapping, only the Buildable Land Inventory and National Wetland Inventory information were available in GIS format; these two information sources have been aggregated and shown on Map 3 in Appendix A. Soil types located in the City limits, including hydric soils, are mapped on Figure 1.

Because the entire shoreline for both the White and Puyallup Rivers within the City limits and the urban growth area is diked, the shoreline jurisdiction is assumed to extend 200 feet landward from the top of the bank. For the purposes of this inventory, wetlands within the floodplain beyond the dike system are assumed to be associated with the shoreline only if they fall within 200 feet of the top of bank or if a surface water connection exists between the wetland and the shoreline. Additional site-specific review will be required by future project proponents to determine the presence of any additional associated wetlands, as well as wetland categories. Table 8 identifies wetlands currently identified within the shoreline jurisdiction for each shoreline planning segment.

Table 8. Wetlands Within the Shoreline Study Segments

Shoreline Segment	Inventory Reference*	Number of Wetlands	Wetland Type	Total acreage	Approximate Percent Coverage
A	N/A	0	N/A	.5[1]	1.5
B	N/A	2	2 emergent	1.4	6.6
C	43	3	2 emergent 1 scrub-shrub	1.7	4.1
D	N/A	2	1 emergent 1 forested/scrub-shrub	2.1	6.0
E	22	2	1 emergent 1 forested	4	11.6
F	50, 20, 9, 53, 5, 10	7	2 emergent 5 forested/scrub-shrub	11	12.5
G	4, 8, 9	0	N/A	1.3[1]	3.7
			TOTAL	**19.9**	**36.0**

*: Numbers refer to the Sumner Wetland Inventory (Parametrix, 1990).
N/A: No information available.
[1]: Identified only from Buildable Lands Inventory.

According to the City of Sumner Municipal Code (Chapter 16), Category I wetlands presently require a 150-foot buffer, Category II wetlands require a 100-foot buffer, Category III wetlands require a 50-foot buffer, and Category IV wetlands require a 25-foot buffer.

3.2 Aquifer Recharge Areas

According to the National Water Well Association (1985), due to its predominant valley location, the entire Sumner city limits is included as a groundwater resource area. As a result, all of Sumner's shoreline jurisdiction is likely a high aquifer recharge area (SMC 16.48). The National Water Well Association and United States Environmental Protection Agency provide indices of the groundwater potential and susceptibility to contamination. Within the City limits (and shoreline jurisdiction limits), the valley floor is rated at 180 or greater, one of the highest indices for Pierce County (Parametrix, 1993). This index corresponds to areas of high groundwater recharge potential. A layer of coarse gravel and sand lies approximately 80 to 150 feet below the land surface in the valley and another layer occurs approximately 400 feet below the surface (Washington Department of Water Resources, 1968).

3.3 Priority Habitats and Species

The Washington State Department of Fish and Wildlife (WDFW) maintains a Priority Habitats and Species (PHS) program to inventory potential state or federal proposed, threatened, or endangered species as well as other "priority" species of state concern. Digital PHS data were obtained and mapped as part of the inventory process. No upland priority habitat in the Sumner shoreline was identified by the PHS data.

Correspondence received from the United States Fish and Wildlife Service (USFWS, 2001) indicates wintering bald eagles *(Haliaeetus leucocephalus)* may occur within the shoreline jurisdiction during October 31 through March 31, and bull trout *(Salvelinus confluetus)* are likely present in the White and Puyallup Rivers. Although there has been no documentation of presence, the USFWS lists the following species of concern as potentially occurring within the City limits: long-eared myotis *(Myotis evotis)*, long-legged myotis *(Myotis volans)*, olive-sided flycatcher *(Contopus cooperi)*, Pacific lamprey *(Lampetria tridentata)*, peregrine falcon *(Falco peregrinus)*, river lamprey *(Lampetria ayresi)*, and western toad *(Bufo boreas)*.

Black cottonwood-dominated forest is the most common vegetation assemblage found throughout the segments. Riparian forested areas are typically productive wildlife habitats, however those within the study area are generally limited in structural diversity due the relatively even-aged trees which have little stratification. Very few snags were identified, as well as very few coniferous trees.

Table 9 lists those fish species found within the City limits. According to WDFW's StreamNet 2001 data (derived from the National Marine Fisheries Service (NMFS)), all river segments within the City shoreline jurisdiction are used by anadromous salmonids for transportation. The data indicates the potential use of all of the shoreline river segments by spring and fall chinook salmon, as well as pink and coho salmon. Pink salmon potentially use segments A and B for spawning, and segment G is potentially used by winter steelhead trout and by coho salmon for spawning. Resident cutthroat are noted to be present in segments C through G. Fish species and habitat are discussed in greater detail in Section 4.0.

Table 9. Documented Priority Salmonid Species within the Shoreline Planning Segments

STREAM SEGMENT	TYPE OF USE	SPECIES NAME
A-B	Anadromous - Presence	Fall Chinook Spring Chinook Pink Salmon Coho Salmon Chum Salmon Summer Steelhead Sockeye Salmon Winter Steelhead Bull Trout
	Anadromous - Rearing	Spring Chinook Fall Chinook Pink Salmon Coho Salmon Winter Steelhead Bull Trout
A	Anadromous - Spawning	Winter Steelhead
C-G	Anadromous - Presence	Spring Chinook Winter Steelhead Pink Salmon Chum Salmon Coho Salmon Summer Steelhead Bull Trout
	Anadromous - Rearing	Spring Chinook Coho Salmon Pink Salmon Bull Trout Winter Steelhead
	Resident	Cutthroat
F-G	Anadromous - Spawning	Winter Steelhead Coho Salmon Chum Salmon

Source: StreamNet, 2001/Nauer.D, 2001

3.4 Geologically Hazardous Areas

According to the City's current critical areas regulations (Title 16), geologically hazardous areas include elements such as landslide hazard areas, erosion hazard areas, and seismic hazard areas. For this inventory, only steep slope and erosion-prone soils information was available on a citywide basis. The City of Sumner's Municipal Code defines landslide hazard areas as the following:

- Slopes steeper than 15 percent which occur on relatively permeable sediment overlying relative impermeable sediment in the vicinity of documented springs or groundwater seepage;

- Slopes of 15 percent or greater with a vertical relief of 10 feet or more (Type 2 landslide hazard areas); and

- Slopes of 25 percent or greater (Type 1 landslide hazard areas).

For the purpose of this inventory, slopes in the shoreline jurisdiction steeper than 15 percent are identified on Map 3 in Appendix A. Information on the presence of steep slopes was obtained from topographic data provided by Pierce County as part of the Buildable Lands Inventory project.

Erosion hazard areas are those areas classified as having moderate to severe, severe, or very severe erosion potential according to the United States Department of Agriculture Natural Resources Conservation Service (formerly Soil Conservation Service) classification system. Erosion prone soils identified by the Natural Resources Conservation Service include Alderwood gravelly sandy loam (15 to 30 percent slopes), Xerochrept soils, and Kapowsin gravelly loam. None of these soil types occur within Sumner’s shoreline jurisdiction. Generally, the greatest erosion and landslide potential areas in Sumner are located along the valley sides outside of the shoreline jurisdiction limits. Soils mapped by the Soil Conservation Service as occurring within the shoreline jurisdiction include Pilchuck fine sand, Puyallup fine sandy loam, and Riverwash.

3.5 Channel Migration Zone

The channel migration zone is typically defined as the lateral extent of likely movement along a stream reach with evidence of active stream channel movement over the past 100 years (Perkins, 1996). Land within the City limits broadens into a wide, relatively flat floodplain and would historically have supported movement of the river channel across the valley floor. Evidence of remnant oxbows exist upstream of the city limits on both rivers to verify this. However, since the late 1800s, both rivers have been incrementally confined within flood control structures, effectively removing the ability of both river channels to migrate across their floodplains. . A channel migration study of the Puyallup River watershed is currently being conducted by the PCRI (R. Brake, personal communication, 2002).

3.6 Frequently Flooded Areas

Both the Puyallup River and the White River have overtopped the existing dike system within the City limits, resulting in flooding. Major flood events recorded by the United States Geological Survey (USGS) in the Puyallup River at the Puyallup gage include events in December 1917; two events in December 1933; and an event in January 1965, December 1977, November 1986, January 1990, November 1990, and February 1996. The 1996 flood is the current peak flood of record for the Sumner region.

Often called the base flood, the primary measure of flood potential is the 100-year flood. Mapped by the Federal Emergency Management Agency (FEMA), the 100-year floodplain in

Sumner fills a large portion of the valley within City limits. The floodplain is shown on Map 2 in Appendix A.

Throughout the basin, some former floodplain areas on the landward side of the dikes have been converted into residential and industrial development. The loss of natural vegetation and wetlands in the Puyallup basin has reduced the watershed's ability to store and process water in a manner that will minimize flood event duration and peaks. Because of increases in impervious surface and reduced floodplain storage, this process results in increased peak flows, quicker peak flows and reduced base flows (Booth 1991; Booth and Jackson 1997). Contributing to the increase in flood potential is the aggradation, or filling in of the river channel with sediment from upstream areas, which increases the potential for flooding. White River flows are regulated by Mud Mountain Dam upstream of the City limits, at RM 29.6. The dam's primary function is to protect property along the lower three miles of the Puyallup River. Along the White River, downstream of the dam and downstream of the King County–Pierce County line, the channel has the capacity to convey a 2.5-year flood flow, approximately 11,000 cubic feet per second (cfs), without overtopping the existing banks. A flow of this volume would leave no freeboard above the flood elevation (PCRI, 1991). Puyallup River flows are presently uncontrolled.

Several flooding "hot spots" within Sumner's City limits were identified in the *Puyallup River Basin Comprehensive Flood Control Management Plan* (PCRI, 1991). One area, a mobile home park and adjacent apartments, was identified along the Puyallup River within Segment A. Three areas were identified along the White River, including an area at the mouth of Jovita Creek in Segment G, the Dieringer Powerhouse area in lower Segment F, and the golf course area in upper Segment F.

4.0 FISH USE AND HABITAT

4.1 Focus on Salmonid Fishes

As discussed earlier in Section 3.3, aside from the potential occurrence of bald eagles, listed species occurring within the City shoreline jurisdiction are all salmonid fish species. For this reason, a significant portion of this shoreline inventory document focuses on environmental conditions within the shoreline jurisdiction in light of their impact on listed salmonid species.

Three salmonid stocks in the Puyallup River basin have been listed as threatened under the federal Endangered Species Act (ESA) or are currently proposed for listing as threatened species (Table 10). In particular, the White River spring chinook and Puyallup River coho salmon are noted by Washington State's Salmon and Steelhead Stock Inventory (SASSI) as having depressed populations. The bull trout is the third listed species present.

Table 10. Status of Salmonid species in the White and Puyallup Rivers

Species	Federal Status[1]
Chinook	Threatened
Chum	Not Listed
Coho	Candidate
Pink	Not Listed
Steelhead	Not Listed
Coastal Bull Trout	Threatened

[1]Threatened: Species are likely to become endangered within the foreseeable future.
Candidate: Species is on waiting list for federal listing consideration.

4.2 Properly Functioning Conditions

Research conducted by fisheries scientists over the years has identified a number of environmental conditions that directly or indirectly affect anadromous salmonids. The new shoreline management guidelines define properly functioning conditions as "conditions that create and sustain natural habitat-affecting processes over the full range of environmental variation and that support productivity at a viable population level [of listed species]" (NMFS,0 1996).

The NMFS (1996) has identified six significant environmental "pathways," or factors that are in some are important for the survival of anadromous salmonids. These pathways include water quality, habitat access, habitat elements, channel conditions, flow/hydrology, and watershed conditions. These pathways are further broken down into "indicators." Indicators are generally of two types; (1) standards of measurement that have associated numeric values (e.g., six pools per mile); and (2) descriptive indicators (e.g., adequate habitat). The purpose of having both types of indicators is that numeric data are not always readily available; in those cases, a description of overall condition may be the only method available to evaluate salmonid habitat. For the purposes of this study, three level of function are described: "properly functioning," "at risk," and "not properly functioning." A discussion of the major indicators of properly functioning conditions is provided in Section 4.4.

River ecosystems are formed and maintained by natural disturbances (such as landslides, debris torrents, and flooding) that contribute resources (such as woody debris, spawning gravel, and nutrients) to riparian and instream habitat. Therefore, processes that affect the habitat available to listed species within the Sumner shoreline jurisdiction operate at a watershed scale. As described in Section 2.0, human activities have caused changes to these key processes as development has increased in the watershed. Thus, the local habitat conditions that are the focus of this section of the study are a product of (and are continually being impacted by) natural processes and human-induced forces that are often beyond the influence of the City.

4.3 General Baseline Conditions

Water Quality

Water quality indicators for properly functioning conditions as described by the NMFS (1996) and USFWS (1998) include temperature, sediment/turbidity, and chemical contamination/nutrients.

For salmonids, water temperatures within the range of 62 degrees Fahrenheit are at the upper limits of an “at risk condition” (NMFS, 1996). Temperatures below 57 degrees are required for “properly functioning” systems and temperatures in excess of 64 degrees are “not properly functioning.” A search of the Department of Ecology water quality monitoring station records reveals one violation, in 1986, of the criterion for temperature on the Puyallup River downstream of the City limits at RM 8.3 (Station 10A070). Records from two stations on the White River at RM 0.7 (Station 10C070) and RM 4.9 (Station 10C085) reveal several excursions in excess of 64 degrees. The White River in the vicinity of RM 6.3 (upstream of City limits) is a Washington Clean Water Act 1998 303(d) designated reach for temperature. The stations show temperature data to the year 2000 for the Puyallup River and to the year 1996 for the White River. However, it is assumed that further evaluation may determine that the river segments in Sumner would be, at a minimum, “at risk” for temperature, due to changes in land use and development patterns that have occurred in the basin since the 1990s.

Both the White and the Puyallup originate from glaciers on the slopes of Mt. Rainier Rivers and cut through a relatively steep gradient and gravelly soils in their upper reaches. Turbidity and sediment load is therefore a significant factor in these rivers, with mostly fine sediments being transported out of the upper reaches of the rivers and deposited into lower gradient reaches (Kerwin, 1999). Sediment transport has been estimated to range from 440,000 to 1,400,000 tons annually in the White River (Kerwin, 1999). Mud Mountain Dam, operated by the U.S. Army Corps of Engineers upstream of the City limits at RM 29.6, disrupts the natural delivery of sediments by impounding fine sediments during high flow and/or high load periods and discharging those same sediments for persistent and prolonged periods during lower river flows (Kerwin, 1999). A sediment load of 12 to 17 percent fines and moderate turbidity would qualify for an “at risk” condition. Greater than 17 percent fines and high turbidity would qualify for “not properly functioning” (NMFS, 1996). Sediment and turbidity are anticipated to be at least at an “at risk” condition for both the Puyallup and White Rivers. These conditions are beyond the scope of Sumner’s jurisdiction.

Moderate levels of chemical contamination from agriculture, industry, and other sources, excess nutrients, and one Clean Water Act 303(d) designated reach qualifies for an “at risk” condition. High levels of chemical contamination from agriculture, industry, and other sources, excess nutrients, and more than one Clean Water Act 303(d) designated reach qualifies for an “not properly functioning” condition (NMFS, 1996). The Puyallup River is not listed within Sumner jurisdiction on the 1998 303(d) list, but is listed several times for fecal coliform and pH at RM 8.3 (Station 10A070) which is downstream of Sumner. The White River within Sumner jurisdiction appears several times on the 1998 303(d) list, at RM 0.7 for fecal coliform and at RM 4.9 for pH. Therefore, it is likely that the river reaches in Sumner would be, at a minimum, “at risk” for high nutrient/contamination levels in 2001.

Habitat Access

For all the segments, with the exception of Segment F, no barriers to adult and juvenile salmonid migration on the mainstem Puyallup or White Rivers have been identified. As a result, this indicator appears to be "properly functioning" for this criteria. However, at the point where water from the Dierenger Powerhouse flows into the White River in Segment F, high velocity flows attract migrating adult salmonids into the discharge channel. These flows may cause a delay in the salmonid's natural upstream migration (Muckleshoot Indian Tribe, 1996).

Habitat Elements

Habitat elements include substrate, large woody debris (LWD), pool frequency, pool quality, off channel habitat and refugia (NMFS, 1996; USFWS, 1998). NMFS (1996) and USFWS (1998) define properly functioning conditions for these indicators, respectively, as:

- Gravel and cobble dominated substrate with less than 20 percent embeddedness;
- LWD (greater than 24 inches diameter and 50 feet long) at greater than 80 pieces per mile;
- Approximately 70 pools per mile; a prevalence of high quality pools over 3 feet deep;
- A prevalence of backwaters and off-channel areas; and
- A prevalence of high quality refugia including adequate buffers and riparian reserves.

Sumner's shorelines are dominated by concrete revetments and dikes along both banks, which have straightened, confined, and simplified the river channel (Kerwin, 1999). Channelization and dikes have eliminated connections with side- and off-channel aquatic habitats, decreased the contribution of prey organisms to the rivers by precluding functioning riparian vegetation habitats, and precluded the recruitment of small and large wood from areas most likely to contribute this material (Kerwin, 1999). Channelization and dikes have also reduced river processes that form pools, side channels and other habitat features used by salmonids (Kerwin, 1999).

The headwaters of both the upper Puyallup and White Rivers are predominantly located within the Mount Baker-Snoqualmie National Forest and private commercial timberlands. As a result, urbanization and development have been limited in these areas compared to urban areas in the Puget Sound lowlands. However, both the upper Puyallup and upper White River watersheds have been affected by timber harvest and road building practices that have reduced the ability of riparian areas to provide wood and shade to the rivers and stream channels, and continue to contribute fine sediments from road construction and landslides. These activities continue to adversely impact natural salmonid production (Kerwin, 1999).

Upstream of the city limits, timber harvest reduces potential sources of LWD to the stream channel. The Mud Mountain Dam operators also actively remove LWD, depriving downstream reaches of this material. The removal of this wood reduces the quantity and quality of salmonid habitat downstream of the dam on the White River. While not all of this removed wood can be characterized as LWD, small wood also creates highly functional habitats and provides necessary nutrients to the river system.

Debris removal by private parties and municipalities in the White River is regulated by the Hydraulic Project Approval (HPA) permit process administered by WDFW. While these permits typically prohibit the removal of LWD from the "wetted" river channel, it is still often removed from the channel outside the wetted area, thereby reducing the amount of LWD debris available for redistribution during future flow events.

Water velocity refugia in the White and Puyallup Rivers have been reduced by alteration of the shoreline, thereby decreasing the suitability of this area for all salmonids, including juvenile chinook. The alteration in flow reduces habitat quality and quantity by increasing water velocities, and degrades habitat quality by increasing metabolic energy demands of juveniles attempting to maintain position and defend territories.

Salmonid spawning ground surveys conducted by staff from Puyallup Tribe of Indians indicate that there is only limited spawning activity throughout the diked and diked mainstem reaches (Kerwin, 1999). Bedload transport tends to be high because of dike-induced increases in water velocities. Survival from any spawning that does occur is believed to be low due to the bedload and increased velocity scouring of egg pockets, also known as "redds" (Kerwin, 1999).

A lack of quantitative, site-specific data for Sumner's shoreline jurisdiction limits the accuracy of determinations for substrate, LWD, pool quality, and pool frequency. However, even without quantitative data, it is evident that the shoreline areas of the Puyallup and White Rivers do not meet the thresholds established for "properly functioning conditions" for these habitat elements.

Channel Condition and Dynamics

While higher quality habitats are still found in some areas, in general, the channel condition and dynamic nature of the White and Puyallup Rivers in Sumner are degraded. NMFS (1996) and USFWS (1998) define properly functioning channel conditions and stream dynamics as a width/depth ratio of less than 10:1, naturally stable stream banks, and a prevalence of riparian and streamside wetlands hydrologically linked to the river system.

A lack of quantitative data limits the accuracy determinations for width/depth ratios and stream bank stability. However, based on habitat conditions observed in the field, it is evident that shorelines within Sumner do not meet the thresholds for "properly functioning" and appear to be at least "at risk" (i.e., width depth ratio less than 12:1 and less than 80 percent of naturally stable banks). These areas may be marginally "not properly functioning."

Floodplain connectivity is determined more qualitatively. Although wetlands do occur within the adjacent floodplain in several segments, they are disconnected from the river by the existing system of dikes. All segments therefore appear to be "not properly functioning" due to the lack of any surface water connection between the river and adjacent wetlands or mapped 100-year floodplain.

Flow/Hydrology

NMFS (1996) and USFWS (1998) state that flow/hydrology is not properly functioning when there are pronounced changes in peak flows and base flows, and when there has been a significant increase in impervious surface coverage within a basin (most often attributed to roads).

Although there is still a significant amount of agricultural land within the City of Sumner, there is also an extensive network of paved roadways, parking areas, roofs, and other impervious areas. As noted in Table 7, impervious surface covers over 40 percent of some of the City's shoreline segments. Other factors outside of Sumner's jurisdiction also influence the hydrology of the rivers. A permanent diversion wall was constructed on the White River at Auburn in 1915, redirecting flows into the present-day channel. The White River added 50 percent to the annual flow in the lower Puyallup River (Williams et al., 1975). Also, flow from the White River is diverted at a diversion dam located near Buckley at RM 23.4 through Lake Tapps and discharged back into the White River at the Dieringer Powerhouse. This has resulted in low flows in the river reaches below the diversion. The Dieringer Powerhouse, located at RM 3.5, changes river elevations as discharges are regulated to meet power needs. These "ramping" rates may strand juvenile and adult fish (Kerwin, 1999).

A hydrologic evaluation of City shorelines was not conducted for this assessment. However, for the 14-year time period from 1980 to 1993, instream flows were not met at the lower Puyallup River gauge, downstream of the City, an average of 35 days annually (Kerwin, 1999). In addition to the factors discussed above, low flows may be attributed to increased groundwater withdrawal through unregulated wells (5,000 gallons or less per day) and increases in impervious surfaces that lead to a decline in groundwater and base surface water flows (Kerwin, 1999).

The shorelines within the City of Sumner appear to fall within the Services' thresholds of "at risk" for flow/hydrology conditions as there is evidence of altered peak flow, base flow and timing relative to an undisturbed watershed of similar size, geology, and geography.

Watershed Conditions

NMFS (1996) and USFWS (1998) define "not properly functioning" watershed conditions by the presence of many valley bottom roads, the disturbance of greater than 15 percent of a watershed, and fragmented riparian conditions. Beyond this threshold, watershed conditions can be expected to continue to degrade. In the Puyallup watershed, future land development is expected to continue, increasing peak flows within the White and Puyallup Rivers and exacerbating existing erosion, sedimentation, and water quality problems. In addition, due to past and onging urbanization, Sumner and its surroundings contain many valley bottom roads. These factors have resulted in a "not properly functioning" watershed condition.

4.4 Opportunity Areas

As part of the inventory process, this report identified several "opportunity" areas, or areas that offer the potential to protect or contribute to the long-term improvement in the conditions described above. This inventory report incorporates a study prepared for Pierce County using the Ecosystem Diagnostics Method, a method whereby reaches throughout the Puyallup River watershed were identified and prioritized with respect to the conservation and recovery of salmonid species (Mobrand Biometrics, Inc., 2001). In that study, individual segments in the White and Puyallup Rivers were rated according to the benefit that full restoration to historic conditions would provide to salmonid diversity, productivity, and abundance.

According to the study, the Puyallup River within Sumner's jurisdiction ranked highest in the watershed for restoration potential. This section of the river had high combined scores for capacity (equilibrium spawning population size), productivity (number of spawners produced per parent spawner), and diversity (percentage of life history trajectories that are sustainable). The White River in Sumner below the Dieringer Powerhouse ranked fourth for restoration potential, while the segment above the powerhouse ranked eighth. The section of the river below the powerhouse had moderate combined scores for capacity, productivity, and diversity. These findings are discussed in greater detail for each planning segment in Section 5.0.

As mentioned above, many of the factors that limit salmonid production within Sumner's shoreline jurisdiction are caused by factors outside of the City's jurisdiction, such as upstream dam operations, flood control, or timber harvest in the upper portions of the watershed. As a result, this report identifies opportunity areas that are both effective and achievable within the scope of Sumner's jurisdiction. The preliminary selection of opportunity areas was based on field observations, zoning and comprehensive plan information, and aerial photograph analysis. Recommendations from the *Puyallup River Basin Comprehensive Flood Control Management Plan* (PCRI, 1991), were also incorporated where applicable.

5.0 CONDITIONS BY INVENTORY SEGMENT

An overview of baseline inventory conditions for each of the seven inventory segments is provided below. Each segment discussion identifies where baseline conditions are meeting species requirements (PF - properly functioning), or where they have been altered to the point that they are limiting (AR - at risk), or threatening (NPF - not properly functioning) species survival and recovery. These conditions are summarized in Table 17 at the end of this section. Current land use, critical resources, and "opportunity areas" are also identified for each segment. Individual segment conditions are shown in Maps 4-A through 4-G in Appendix A.

SEGMENT A. LINDEN AVENUE BRIDGE TO CITY LIMITS

Summary: Segment A extends from approximately RM 10.8 to RM 12.25. Only the left bank of the Puyallup River is within City limits for this segment. This segment is constrained by dikes and offers limited instream habitat. Land use in Segment A is predominantly high-density residential, and little riparian vegetation exists. No wetlands have been identified within the shoreline jurisdiction.

Current Land Use

Land use in Segment A is currently approximately 50 percent vacant land and 50 percent high-density residential land. Impervious surface covers approximately 35 percent of the segment. The comprehensive plan and zoning map indicate that future land use for this segment will remain relatively similar to current conditions.

Critical Resource Areas

No wetlands have been identified within the shoreline environment.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by fall and spring chinook, pink, coho, chum, summer and winter steelhead trout. Sockeye salmon may also use this segment for transportation. Fall and spring chinook, pink, and coho salmon, and winter steelhead use this segment for rearing and winter steelhead use this segment for spawning (Nauer, 2001). Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

The most significant factor in this segment is the conversion of riparian habitat to residential land use and the corresponding increase in impervious surface. Riparian vegetation in this segment is limited for 50 percent of the shoreline, with a very narrow strip of vegetation paralleling the existing residential development. An approximately100-foot wide early successional/mixed age stand dominated by cottonwood occurs in the narrow band of land between the river and SR 410.

A-1 Opportunity Areas

<u>Restoration</u>

There is limited opportunity to provide areas of overbank flooding and side channel habitat in this segment, given the levee and existing development. Many of the existing structures in this segment have been subject to flood-proofing measures. However, several vegetation management opportunities include:

- Blackberry could be removed from the understory and the shoreline planted with willow species including Sitka (*Salix sitchensis)*, Piper's (*Salix piperi)*, and Pacific willow (*Salix lasiandra)* on the lower portion of the bank, and intermix other riparian species including ninebark (*Physocarpus capitatus)*, twinberry *(Lonicera involucrata)*, and red-osier dogwood (*Cornus sericea).* These lower bank plantings would provide additional "over water" vegetation, providing increased protection from predation for fish species, increased habitat for birds, and input of organic material to the river.

- Snowberry *(Symphoricarpus albus)*, Scouler's willow *(Salix scouleriana)*, and beaked hazelnut *(Corylus cornuta)* could be planted on the higher bank elevations in addition to forested species (western redcedar, hemlock, and Douglas fir) within existing shaded areas.

Table 11. Status of Conditions, Segment A

Indicators	Pathways	Conditions
Water Quality		
	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity
	Chemical	**Appears at risk**
Habitat Access		
	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements		
	Substrate	**Appears at risk**
	LWD	**Not properly functioning:** Limited riparian fringe, and logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning:** Dike has resulted in few or no backwaters, no off-channel ponds
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Conditions	**Appears at risk**
	Floodplan connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

SEGMENT B. CONFLUENCE OF WHITE AND PUYALLUP RIVERS

Summary: Segment B extends from approximately RM 10.2 to RM 10.7 on the Puyallup River, and RM 0.0 to RM 0.2 on the White River. This segment is constrained by dikes and revetments and offers limited instream habitat. Land use in Segment B is predominantly public utilities. SR410 and SR167 meet in the vicinity of this segment. Riparian vegetation occurs predominantly as a narrow band, but widens to approximately 250 feet beyond the shoreline in the adjacent WDFW-managed land to the east. Two wetlands were identified within the shoreline jurisdiction in this segment. "Confluence Park", a 1.5-acre park, offers public access and fishing.

Current Land Use

The City of Sumner's wastewater treatment plant and associated facilities cover approximately 60 percent of this segment. The comprehensive plan and zoning map indicate that future land use is residential and/or public facilities. Current impervious surface cover is approximately 24 percent on the right bank and 19 percent of the left bank of this segment.

Critical Resource Areas

Two wetlands were identified within the shoreline environment in this segment. Both wetlands are classified as emergent wetlands, with a combined acreage of 1.4 acres, or about 6.6 percent of the total segment area.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by fall and spring chinook, pink, coho, chum, summer and winter steelhead trout. Sockeye salmon may also use this segment for transportation. Fall and spring chinook, pink, and coho salmon, winter steelhead use this segment for rearing. Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

The SR410 Bridge crosses the White River at the northern limit of this segment, and the Linden Street Bridge crosses the Puyallup River at the eastern limit. Riparian vegetation consists of an approximately 25- to100-foot wide early successional/mixed age stand dominated by cottonwood, with an understory of non-native blackberry. Pacific willow is common along the river banks. Adjacent land use includes the City Wastewater Treatment Plant. The Plant treats mainly domestic wastewater, but also receives some manufacturing, commercial, and industrial wastewater. The outfall for the plant is on the

White River approximately 400 feet upstream of the confluence with the Puyallup River. Also of significance in this segment is the adjacent 300-foot wide corridor of riparian forest located on WDFW-managed land.

Table 12. Status of Conditions, Segment B

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk:** Wastewater treatment plant discharge
Habitat Access	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements	Substrate	**Appears at risk**
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning:** Dike has resulted in few or no backwaters, no off-channel ponds
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**
	Floodplain Connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met, unregulated groundwater withdrawals
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves

B-1 Opportunity Areas

Protection

Black cottonwood-dominated forest is the most common vegetation assemblage found throughout all of the segments and is represented in this segment. Riparian forested areas are typically productive wildlife habitats. Protection of this forested area could increase potential habitat for many sensitive species.

<u>*Restoration*</u>
City property adjacent to the City's Wastewater Treatment Facility, at the confluence of the White and Puyallup Rivers, is used informally by residents for fishing access. Current access is provided by a dirt road, which has intruded into the riparian vegetation. Denuded areas could be planted with riparian vegetation, such as Pacific and Sitka willow, Pacific ninebark, and beaked hazelnut, all species that are already present in this area. This site could be further improved by restricting access to a smaller area through use of fencing and signs and repaving an access road and parking area with a semi-pervious surface such as crushed gravel or pervious pavers.

SEGMENT C. SR410 BRIDGE TO MILWAUKEE CANAL

Summary: Segment C extends from approximately RM 0.2 to RM 1.05. This segment is constrained by revetments and offers limited instream habitat. Land use in Segment C is predominantly general commercial. No wetlands were identified within the shoreline jurisdiction. "Library Park", an approximately 0.8 acre City-owned park, provides access to the White River.

Current Land Use

Land use in this segment is 100 percent general commercial. The City's comprehensive plan and zoning maps indicate predominantly future general commercial and light industrial land uses for the area. Adjacent land use includes Pacific Avenue and Housten Street East and urban development; paving extends to the top of the river's bank in some areas. Impervious surface is approximately 32 percent on the right bank and 41 percent on the left bank of this segment.

Critical Resource Areas

This segment contains three identified wetlands totaling 1.7 acres, or about 4 percent of the total area of the segment. Two of the wetlands are classified as emergent, while the other is classified as a scrub-shrub wetland.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by spring chinook, pink, coho, and chum salmon, and winter and summer steelhead trout. Spring chinook, pink, and coho salmon, and winter steelhead trout use this segment for rearing and cutthroat trout are resident in this segment. Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

At certain points within this segment, land is cleared to the top of bank, leaving only a limited riparian fringe between the top of the bank and the ordinary high water mark. Some areas have only a narrow strip of riparian vegetation, approximately 10 to 40 feet wide including big leaf maple, cottonwood, and alder with an understory of snowberry. In other areas, the riparian zone is completely cleared to the river's edge. Streambank erosion was noted in several of these areas. In most areas within this segment, however, the riparian corridor consists of a 25- to100-foot wide early successional/mixed age stand dominated by cottonwood. The riparian fringe consists of willow, snowberry, and non-native blackberry.

Table 13. Status of Conditions, Segment C

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to revetment-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk**
Habitat Access	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements	Substrate	**Appears at risk:** Removal of gravel for flood control
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Bank hardening and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning:** Dike has resulted in few or no backwaters, no off-channel ponds
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**
	Floodplain Connectivity	**Not properly functioning:** Revetments and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

C-1 Opportunity Areas

Two areas within this segment offer potential protection or restoration opportunities.

<u>*Restoration*</u>
Area C-1, shown on Map 4-C in Appendix A, is an approximately 100-foot long section of revetment denuded of vegetation through constant public use. The area offers opportunity for

replanting with live native willow stakes and fascines. Large root wads could be buried in the bank to provide a more diverse aquatic habitat for macroinvertebrates and fish. Plantings along the upper terrace could include riparian scrub-shrub (vine maple, snowberry, beaked hazelnut) and forested species (black cottonwood, western redcedar, hemlock, Douglas fir) to improve bird habitat and reduce peak flows during flood events.

Protection and Restoration

Area C-2 is undeveloped land (private) containing two wetland areas that extend within the 200-foot shoreline jurisdiction (Map 4-C in Appendix A). The area downstream of the recently developed industrial park has a dense cover of riparian vegetation with moderate diversity. The shoreline adjacent to the industrial park has sparse plantings and turf. The grassy area within 100 feet of the shoreline could be replanted with forest and scrub-shrub species, including black cottonwood, snowberry, and beaked hazelnut.

SEGMENT D. MILWAUKEE CANAL TO TACOMA ROAD BRIDGE

Summary: Segment D extends from approximately RM 1.05 to RM 1.8. This segment is constrained by revetments and offers limited instream habitat. Land use in Segment D is predominantly agricultural. In several areas the riparian vegetation widens to approximately 200 feet. Two wetlands have been identified within the shoreline jurisdiction. Milwaukee Canal enters the White River within this segment.

Current Land Use

At least 75 percent of the left bank of this segment is being used for agriculture, the remaining 25 percent for industry. The dominant land use along the right bank is industrial park. The comprehensive plan and zoning map indicate that future land use is light and heavy industry. Impervious surface is approximately 11 percent on the right bank and 4 percent on the left bank, indicating a future significant increase in impervious surface.

Critical Resource Areas

Two wetlands were identified within the shoreline jurisdiction in this segment, covering approximately 2.1 acres, or about 6.0 of the total land area. One wetland is classified as emergent, while the other is a forested, scrub-shrub wetland.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by spring chinook, pink, coho, and chum salmon, and winter and summer steelhead trout. Spring chinook, pink, and coho salmon, and winter steelhead trout use this segment for rearing and cutthroat trout are resident in this segment. Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

Land is cleared to the top of the bank in some areas, with a limited riparian fringe between the top of bank and ordinary high water mark. The bank is armored with concrete debris in areas and lacks vegetation cover, limiting habitat quality. In most areas, however, the riparian corridor is predominantly a 25- to100-foot wide early successional/mixed age stand dominated by cottonwood, with an understory of non-native blackberry.

Table 14. Status of Conditions, Segment D

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk**
Habitat Access	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements	Substrate	**Appears at risk** Removal of gravel for flood control
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning**
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**
	Floodplain Connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

D-1 Opportunity Areas

Potential habitat enhancement opportunities include the removal of invasive plants such as Himalayan blackberry and English ivy, combined with the planting of trees and shrubs to restore riparian cover, reduce erosion along the riverbanks, and improve nesting and forage habitat.

Protection

Three areas have been identified within this segment as offering opportunities for habitat protection, within the limits of the future projected land use (light and heavy industry) (Map 4-D in Appendix A). Opportunity area D-1 is the point at which Milwaukee Canal enters the White River (Map 4-D in Appendix A). Outside the shoreline jurisdiction limits, a fish barrier has been identified on Milwaukee Canal. According to the *Puyallup River Flood Control Management Plan* (PCRI, 1991), at the 100-year flood level there is some backwater flooding west of the railroad across vacant and agricultural land, as well as some overbank flooding. Opportunity area D-2 contains a wetland and is associated with an approximately 150-foot band of riparian vegetation. Opportunity area D-3 is an area of undeveloped land.

SEGMENT E. TACOMA ROAD BRIDGE TO PUBLIC LAND

Summary: Segment E extends from approximately RM 1.8 to RM 2.5. This segment is constrained by dikes and offers limited instream habitat. Land use in Segment E is predominantly agricultural. Salmon Creek enters the White River within this segment. Two wetlands have been identified within the shoreline jurisdiction.

Current Land Use

Land use in Segment E is predominantly agriculture. The comprehensive plan and zoning map indicate future land use to be 100 percent light industrial. Current impervious surface is currently calculated at approximately 3 percent, indicating a future significant increase in impervious surface under current land use projections.

Critical Resource Areas

Two wetlands were identified within the shoreline jurisdiction in this segment, totaling approximately 4 acres. One wetland is classified as a forested wetland, the other as an emergent wetland.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by spring chinook, pink, coho, and chum salmon, and winter and summer steelhead trout. Spring chinook, pink, and coho salmon, and winter steelhead trout use this segment for rearing and cutthroat trout are resident in this segment, according to the StreamNet data. Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

Salmon habitat limiting factors in this segment are similar to those throughout the Sumner shoreline jurisdiction, however, this segment faces significant increases in impervious surface. Riparian vegetation along the river is an approximately 25- to100-foot wide early successional/mixed age stand dominated by cottonwood. Various willow species, as well as native shrubs and non-native Himalayan blackberry, line the river banks.

Salmon Creek and the associated riparian wetlands are of significance for wildlife habitat, providing water, food, and cover. Salmon Creek also serves as a wildlife corridor between the wooded east valley slopes and the White River. Salmon Creek flows year round and is a fish-bearing stream. Salmon Creek has experienced several water quality issues in the past, and a number of culvert barriers to fish passage have been identified.

Table 15. Status of Conditions, Segment E

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk**
Habitat Access		
	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements	Substrate	**Appears at risk :** Removal of gravel for flood control
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning**
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**
	Floodplain Connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

E-1 Opportunity Areas

Protection

According to the *Puyallup River Flood Control Management Plan* (PCRI, 1991), at the 10-year flood level, the river floods the immediate overbank area, and at the 100-year level most of the adjoining lands, on both sides of the river. Two areas, E-1 and E-2, have been identified as offering a habitat protection opportunity (Map 4-E in Appendix A). E-1 includes a forested riparian wetland associated with Salmon Creek. E-2 is a second wetland in what is currently farmed land.

<u>*Restoration*</u>

Recommendations in the *Puyallup River Flood Control Management Plan* (PCRI, 1991) for the entire Segment E include flood-proofing the existing structures, acquiring the land and removing any structures, upgrading the existing flood control structures, and constructing a setback revertment. At Salmon Creek (E-1), immediately north of the REI warehouse, the shoreline is a thin riparian strip bounded by agricultural fields to the north and a dirt access road and the warehouse to the south. Where the dirt road crosses the stream, a substandard culvert currently obstructs fish passage. This area offers opportunities to enhance the stream buffer by re-planting native vegetation, and to incorporate a culvert replacement or bridge with any future plans to develop the agricultural land.

SEGMENT F. RIGHT BANK PUBLIC LAND

Summary: Segment F extends from approximately RM 2.5 to RM 4.15. This segment is constrained by dikes and offers limited instream habitat. Land use in Segment F is predominantly golf course and agriculture. In several areas the riparian vegetation widens to approximately 200 feet. Seven wetlands have been identified within the shoreline jurisdiction. The tailrace from the Dieringer Powerhouse enters the White River within this segment. "Sumner Meadows Golf Course" is a significant feature of this segment.

Current Land Use

Farm vegetation is the most common and widespread type of vegetation in Segment F. At least 70 percent of the segment is being used for some agricultural purpose. The most common agricultural use in this reach is crops (primarily rhubarb).

Currently the right bank is 40 percent golf course, 60 percent agriculture, and the left bank 95 percent agriculture, 5 percent low density residential. The comprehensive plan indicates 100 percent of the right bank to be public land, with light manufacturing and residential along the left bank. The zoning map indicates future land use to be agriculture, light industry and residential. Current impervious surface is calculated at 0 percent.

Critical Resource Areas

Segment F contains the largest number of wetlands, with 7 wetlands inventoried within the shoreline jurisdiction limits. In total, wetlands within this segment cover 11 acres, or approximately 12.5 percent of the total area. Wetlands occurring within Segment F are classified as farmed emergent, forested, and scrub-shrub wetlands. This area is characterized by numerous drainage ditches that drain water from the agricultural land to the White River.

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by spring chinook, pink, coho, and chum salmon, and winter and summer steelhead trout. Spring chinook, pink, and coho salmon, and winter steelhead use this segment for rearing and cutthroat trout are resident in this segment. Winter steelhead trout, coho and chum salmon use Segment F, upstream of the tailrace, for spawning (Nauer, 2001). Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

The outfall from the Dieringer Powerhouse/Lake Tapps enters the right bank of the White River at RM 3.5 within this segment. High velocity flows attract migrating adult salmonids into this discharge channel causing delays in their upstream migration.

The riparian corridor consists of a 25-to100-foot wide early successional/mixed age stand dominated by cottonwood. A large gravel bar was noted in this segment (F-3 on Map 4-F in Appendix A). A riparian island vegetated with early successional cottonwood and willow also occurs in this segment, forming a backwater side channel along the right bank. This feature has a significant amount of woody debris and offers good edge habitat. The primary channel along the left bank of the river also contains an accumulation of large woody debris. Juvenile salmonids were noted utilizing edge water habitat in this area during the field visit (F-5 on Map 4-F in Appendix A).

Table 16. Status of Conditions, Segment F

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk**
Habitat Access	Physical barriers	**Appears at risk:** False attraction to tailrace flume
Habitat Elements	Substrate	**Appears at risk:** Removal of gravel for flood control
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning**
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**

Indicators	Pathways	Conditions
	Floodplain Connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

F-1 Opportunity Areas

Protection and Restoration

City-owned land along the length of the right bank offers opportunity for habitat preservation and restoration (F-2). This segment appears to function as significant rearing habitat for salmonids and therefore is a candidate for preservation. Riparian vegetation can be enhanced throughout this segment. The tailrace and drainage ditch offer potential surface water connections to wetland areas. Flow from the tailrace could be diverted through a separate channel through City-owned farmland, allowing the development of relatively natural meanders, and pool and riffle sequences. Diversion of water from these sources into created or enhanced wetland and stream channel areas could provide off-channel and rearing fish habitat in areas where there is adequate fish passage to the site. According to the *Puyallup River Flood Control Management Plan* (PCRI, 1991), at the 10-year flood level the river floods the immediate overbank area, and at the 100-year level across most of the valley.

Restoration

Similarly, the two other areas, F-1 and F-3, contain wetlands as well as remnant riparian forested areas, and offer potential to reconnect the river channel to its floodplain by breaching and setting back the revetments. This could allow for the re-creation of side channel habitat where fish could take refuge from high velocity flows in the main river channel. This would also help to alleviate overbank flooding.

SEGMENT G. SERVICE AREA

Summary: Segment G extends from approximately RM 4.15 to RM 4.9. This segment is constrained by dikes and offers limited instream habitat. Land use in Segment G is predominantly industrial. The riparian vegetation is narrow within this segment. No wetlands have been identified within the shoreline jurisdiction. Jovita Creek enters the White River within this segment.

Current Land Use

Current land use is 100 percent industrial, which corresponds with the comprehensive plan. This area is in the Urban Growth Boundary, and as yet has no City of Sumner zoning designation. Impervious surface is approximately 35 percent on each bank of the river.

Critical Resource Areas

No wetlands were identified within the shoreline jurisdiction in this segment. Jovita Creek flows south into the right bank of this segment (G-1 on Map 4-G in Appendix A).

Priority Species Use

According to StreamNet data (2001), this segment is used for transportation by spring chinook, pink, coho, and chum salmon, and winter and summer steelhead trout. Spring chinook, pink, and coho salmon, and winter steelhead use this segment for rearing, cutthroat trout are resident in this segment. Winter steelhead trout, coho and chum salmon use Segment G for spawning (Nauer, 2001).Dolly Varden/bull trout utilize this segment for rearing and transportation (Puyallup River Technical Advisory Group, 1999).

Salmon Habitat Limiting Factors

The riparian corridor in Segment G is a 25- to100-foot wide early successional/mixed age stand dominated by cottonwood. Significant salmon habitat limiting factors in this segment may be gravel removal operations and low instream flows resulting from the diversion dam located upstream at RM 23.4. Jovita Creek enters this segment; it flows year round and is a fish-bearing stream. A number of culvert barriers to fish passage have been identified on the creek.

Table 17. Status of Conditions, Segment G

Indicators	Pathways	Conditions
Water Quality	Temperature	**Appears at risk**
	Sediment	**Appears at risk:** Glacial origins, high bedload transport due to dike-induced increases in water velocity, sediment trapped behind Mud Mountain Dam at high flows/released at low flows
	Chemical	**Appears at risk**
Habitat Access	Physical barriers	**Properly functioning:** No barriers to fish passage
Habitat Elements	Substrate	**Appears at risk:** Removal of gravel for flood control
	LWD	**Not properly functioning:** Limited riparian fringe, logging upstream have degraded LWD frequency
	Pool frequency	**Not properly functioning:** Diking and channelization have degraded pool frequency
	Pool quality	**Not properly functioning**
	Refugia	**Appears at risk:** Refugia exist where overhanging vegetation occurs but are limited due to limited buffering and channelization
	Off-channel habitat	**Not properly functioning**
Channel Condition and Dynamics	Width/Depth Ratio	**Appears at risk**
	Streambank Condition	**Appears at risk**
	Floodplain Connectivity	**Not properly functioning:** Diking and wetland conversion have limited floodplain connectivity
Flow/Hydrology	Peak/ Base Flows	**At risk:** Instream flows frequently not met
	Drainage Network Increase	**Appears at risk**
Watershed Conditions	Road density and location	**Not properly functioning:** Many valley bottom roads
	Disturbance History	**Not properly functioning:** Conversion of land to residential use, channelization, and loss of riparian vegetation
	Riparian reserves	**Not properly functioning:** Conversion of riparian reserves to residential land use

G-1 Opportunity Areas

Protection and Restoration

A culvert barrier has been identified in area G-1 along Jovita Creek (Map 4-G Appendix A). Jovita Creek and the associated riparian forest within shoreline jurisdiction is of significance for wildlife habitat, providing water, food, and cover. Improvements to the culvert barrier in Segment G have a high potential to improve salmonid habitat, as this portion of stream is used as rearing habitat by juvenile salmonids that enter from the White River during periods of high water. A hanging culvert at the mouth of the stream precludes the upstream migration of juvenile fish during low water. This substandard culvert hangs approximately two feet above the stream bed and discharges to a boulder splash pad. High velocities in the undersized 16-inch diameter culvert are likely a migration barrier to adult and juvenile fish during high-flow periods.

This area also offers significant forested cover and has been identified for potential preservation. The PHS data indicates the potential for this area to be used for spawning by winter steelhead and coho salmon in the area identified as G-2. Protection and restoration of this area would offer significant benefits to salmonid species by protecting a potential spawning area from future development or buffer encroachment.

According to the *Puyallup River Flood Control Management Plan* (PCRI, 1991), at the 10-year flood level the river floods the immediate overbank area, and at the 100-year level across most of the valley on both sides of the river. Recommendations in the *Puyallup River Flood Control Management Plan* (PCRI, 1991) for the Segment G include flood-proofing the existing structures, constructing a ring levee around existing development, upgrading the existing flood control structures, or constructing a setback levee.

5.1 Summary of Conditions for Segments A through G

Table 17 provides a summary of conditions for the seven segments discussed above. Each segment identifies where baseline conditions are meeting species requirements (PF - properly functioning), or where they have been altered to the point that they are limiting (AR - at risk), or threatening (NPF - not properly functioning) species survival and recovery.

Table 18. Condition Summary for Segments A though G

	A	B	C	D	E	F	G
Water Quality							
Temperature	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Sediment	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Chemical	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Habitat Access							
Physical barriers	**PF**	**PF**	**PF**	**PF**	**PF**	**AR**	**PF**
Habitat Elements							
Substrate	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
LWD	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Pool frequency	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Pool quality	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Refugia	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Off-channel habitat	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Channel Condition and Dynamics							
Width/Depth Ratio	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Streambank Condition	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Floodplain Connectivity	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Flow/Hydrology							
Peak/ Base Flows	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Drainage Network Increase	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**	**AR**
Watershed Conditions							

	A	B	C	D	E	F	G
Road density and location	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Disturbance History	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**
Riparian reserves	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**	**NPF**

The following items are key findings on the condition of the Puyallup and White Rivers in Sumner and on the availability of baseline information:

Summary of Key Findings - Puyallup River

- The Puyallup River through Sumner has been extensively altered through channelization and the loss of riparian and off-channel habitats.
- Opportunities to reestablish at least portions of off-channel habitats still exist.
- Large woody debris is limited throughout the system.
- Summer low flows have declined continuously since at least 1980, in spite of the closure on new surface water withdrawals and the establishment of minimum flow requirements (Kerwin, 1999).
- The Puyallup River in Sumner serves as a salmonid transportation corridor and rearing area.

Summary of Key Findings - White River

- Mud Mountain Dam interrupts the recruitment of large woody debris to downstream sections in Sumner and the natural sediment flow regime, and adversely impacts salmonid migration and production.
- Water quality may be impaired due to high sediment and turbidity.
- The Lake Tapps Hydroelectric Project significantly adversely impacts salmonid production through adverse attraction at the Dieringer Powerhouse tailrace and lack of suitable low flow regimes in the bypass reach of the White River.
- Flood control practices have adversely impacted fish production throughout the basin. The removal of riparian vegetation, construction dikes and revetments and removal of large woody debris adversely impact the natural production of salmonids.
- Water quality parameters are exceeded in the vicinity of the White River because of sanitary sewage effluent from the cities of Buckley and Enumclaw, upstream of Sumner.
- Data on temperature, spawning gravels, large woody debris and holding pools from tributaries to the White River indicates the chinook beneficial uses are currently poorly supported.
- Barriers to adult and juvenile salmonids in the form of culverts exist on tributary streams.
- The White River in Sumner serves as a salmonid transportation corridor and rearing area, with limited spawning habitat available to salmonids in Segment G.

Data Gaps

The following elements are data gaps that have been identified as part of basin-wide analyses (Kerwin, 1999). While many of these elements would assist the City of Sumner in compiling shoreline inventory information, several are more appropriately addressed on a coordinated, watershed scale:

- Additional data on presence and distribution anadromous salmonids and native char should be collected.
- Freshwater life history data is lacking, including spawning run timing of all species of naturally produced salmonids.
- A sediment budget for the White River should be prepared.
- Existing flood control facilities and opportunities to restore floodplain and off-channel salmonid habitat restoration opportunities should be identified and mapped.
- Development of baseline data on habitat utilization by salmonid species should be addressed for effective management of the watershed.

5.2 Cumulative Impacts

On a basinwide scale, activities in Sumner's shoreline jurisdiction contribute to past, present, and future opportunities and constraints for the maintenance and long-term recovery of PFC for salmonids and other species. As discussed in Section 2.0, the Puyallup River basin has been subject to a series of activities and actions over time, including river channelization and impoundment, timber harvest, agricultural activities, and urban development. Collectively, these activities have altered basin conditions that contribute to PFC. Upon development of updated shoreline policies and regulations, the City will conduct an evaluation of cumulative impacts to examine the implications to basinwide conditions of full buildout of the City's shoreline jurisdiction.

6.0 RECOMMENDATIONS

The inventory of existing conditions provides the basis for making preliminary recommendations for updates to the City's shoreline master program. Recommendations address both steps to protect and contribute to long-term recovery of properly functioning conditions, and efforts to address data gaps through monitoring and adaptive management.

6.1 Recommendations to Protect and/or Contribute to Restoration of Properly Functioning Conditions

- Conserve remaining forested riparian areas within the shoreline management zone.

- Enhance and restore the ability of forested areas to contribute large woody debris and nutrients to the river channel through vegetation management practices (i.e., removing invasive non-native plant materials such as Himalayan blackberry and reed canarygrass) and enhancing undeveloped shoreline areas with under-plantings of coniferous vegetation.

- On publicly-owned land and undeveloped land along the White River, explore opportunities to re-create off-channel habitat

- Conserve wetlands in the shoreline area though conservation and maintenance of adequate buffers. Explore opportunities to re-establish connections between floodplain wetlands and the river channel to re-create off-channel habitat.

- Encourage access to the river using alternative measures. Limit the use of over-water or in-channel structures such as docks and piers to provide access to the river.

- Reduce the quantity of hardened riverbank. Explore the use of alternate bank treatments or eliminate the need for bank hardening through appropriate site planning or facilities design. Reduce the reliance on of the construction of bulkheads and physical hardening of shorelines. Focus shoreline stabilization, when necessary, on bio-stabilization techniques. Explore opportunities to replace existing concrete revetments with bio-stabilized banks or a more natural shoreline profile.

- Stormwater facilities and stormwater outfalls should be designed to provide adequate water quality treatment appropriate for the use of the site. Opportunities to provide regional or retroactive treatment should be explored and incorporated into new construction where possible.

- Work with Puget Sound Energy when future work is planned on the tailrace or powerhouse to assure constancy with conservation and restoration goals in other areas of Sumner.

- Incorporate general recommendations from the *Puyallup River Flood Control Management Plan* (PCRI, 1991), including coordinating with Pierce County ordinance requirements to ensure the floodplain is regulated similarly throughout the watershed, implementing a public education program, and acquiring floodplain property. Explore opportunities to coordinate shoreline restoration and enhancement with floodplain management activities.

- Because many of the factors affecting the function and condition of Sumner's shorelines are caused by activities out of Sumner's jurisdiction, the City should seek ways to coordinate and partner with other local, state, and federal agencies with jurisdiction over the river.

6.2 Recommendations to Address Data Gaps

- Map the locations of stormwater outfalls in the City's jurisdiction and incorporate a water quality monitoring program into future stormwater capital improvement programs (CIPs).

- Participate in basin-wide efforts to document the life histories of salmonids inhabiting the White and Puyallup Rivers. This information will be useful in support of private development projects and local CIPs, and for planning future restoration.

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APPENDIX A – TABLES AND MAPS

GIS DATA SOURCES

WETLANDS

Existing information reviewed to identify wetlands for the City of Sumner Draft Shoreline Inventory GIS maps included:

- Parametrix, Inc. 1990. *Sumner Comprehensive Planning Area Wetland Inventory*. Sumner, Washington.
- LeRoy Surveyors & Engineers, Inc. 2001. *Pierce County Buildable Lands Inventory.* Pierce County, Washington.
- Pierce County. 2001. *GIS Wetland Inventory data.*

For the purposes of mapping, only the Buildable Land Inventory and Pierce County Wetland Inventory information were available in GIS format; these two information sources were aggregated and shown on Map 2 in Appendix A of the Draft Shoreline Inventory.

1.1 Sumner Wetland Inventory, Parametrix, Inc. (1990)

A wetland inventory was completed for the City of Sumner during the spring of 1990. The purpose of the inventory was to map the general location of the wetlands and document the character of each wetland.

Information reviewed for the 1990 wetland inventory:
- Aerial photographs (1:1,200) taken in the early growing season (March 1985)
- Soil Conservation Service soil survey maps (Pierce County, 1973)
- US Fish and Wildlife Service National Wetlands Inventory data
- Blue line aerial photographs (1:425)

Field methods for the 1990 wetland inventory:
- Potential wetlands were examined according to *Federal Manual*..... criteria and findings were recorded on data sheets
- Observations of hydrology conducted during the early growing season of 1990
- Soils were examined to a depth of 6 to 18 inches where standing water or surface saturation occurred, or where hydrophytic plants were found
- Many wetland areas were farmed, thus wetlands were identified wherever hydric soils characteristics and hydrology occurred together. Where undisturbed native vegetation occurred, it was used to assist in the determinations.

Deliverables are stated in the 1990 report to include a hard copy report, GIS overlay maps, data sheets documenting wetland conditions, and photographs of each of the 58 identified wetlands.

1.2 Pierce County GIS data (2001)

Information incorporated in the Pierce County Wetland Inventory:

- delineated and surveyed wetlands
- field-verified wetlands
- unverified, potential wetlands (see source maps below)

Source maps include: Assessor-Treasurer 1:100, 1:200, and 1:400 scale quarter section tax maps; DNR National Wetlands Inventory, and Pierce County wetland biologist maps.

1.3 Pierce County Buildable Lands Inventory, LeRoy Surveyors & Engineers, Inc (2001)

Information incorporated in the Buildable Lands Inventory data:

- aerial photo interpretation of 6" pixel color orthophotos
- depression analysis from Digital Terrain Model surfaces
- hydrology analysis from Digital Terrain Model surfaces

LeRoy Surveyors & Engineers, Inc state that wetlands were “spot-verified” in the field to determine the accuracy of their modeling efforts. They found a high rate of success in areas not covered with heavy vegetation, but less success in forested areas. The Buildable Lands Inventory records a greater total area of wetlands than the Pierce County Wetland Inventory does.

1.4 Comparison of data sources

The Buildable Lands Inventory records a greater total area of wetlands than the Pierce County Wetland Inventory does, while the Parametrix/Sumner Wetland Inventory records the greatest total area. While both the Buildable Lands Inventory and the Pierce County Wetland Inventory have been partly “ground-truthed”, the ground-truthed wetlands are not distinguishable from unverified wetlands in the GIS data used for the City of Sumner Draft Shoreline Inventory. In the Parametrix/Sumner Wetland Inventory, however, all wetlands were field-visited, photographs were taken, and soil and hydrology data was recorded. Although the inventory was conducted in 1990 and it would be prudent to revisit the areas and update the inventory, it would seem that the Parametrix/Sumner Wetland Inventory is the most comprehensive of the three data sources. It would be desirable if the GIS maps, which were a stated product of this inventory, could be located and used as the baseline reference.

STREAMS

Existing information reviewed to identify streams for the City of Sumner Draft Shoreline Inventory GIS maps included:

- LeRoy Surveyors & Engineers, Inc. 2001. *Pierce County Buildable Lands Inventory.* Pierce County, Washington.
- Pierce County. 2001. *GIS Stream data.*

- The Pierce Conservation District Water Resource Inventory Area 10 Fish Passage Inventory. 2000.

SLOPES

Existing information reviewed to identify 40 percent or greater slopes for the City of Sumner Draft Shoreline Inventory GIS maps included:

- Pierce County GIS data. 2001.

FLOOD PLAINS

Existing information reviewed to identify the 100-year floodplain for the City of Sumner Draft Shoreline Inventory GIS maps included:

- City of Sumner GIS data *from* FEMA 1987 maps
- Pierce County GIS data *from* FEMA 1995 maps

Table A-2.
Baseline conditions for Threatened and Endangered Species
(TO BE PROVIDED)

Element	Source*	Report Section	Notes
PHYSICAL			
Location and extent of populations of PTE species	LR	5	
Drift cells	LR	-	
Direction of littoral drift (primary)	LR	-	
Sediment accretion areas	LR, F		
Sediment transport zones	LR, F		
Erosion zones and ‘feeder’ bluffs	A, F	-	
Geological hazard areas	GIS, F	4	
Wave energy or fetch	A, F	-	
Substrate Description	LR, F	-	
Channel migration zones	A, F	5	
Pool/riffle ratios	LR, F	5	
Flood plains	GIS	4	
Groundwater upwellings or springs	LR	5	
Hydric soils	GIS	4	
BIOLOGICAL			
Forage fish spawning and holding areas	LR, F	5	
Spit berm vegetation (gravelly and sandy soils)	A, F	5	
Condition of riverine vegetation (native, non-native) age and width	A, F	3	
Submerged and emergent vegetation	A, F	-	
Wetlands (associated and isolated)	GIS, A	4	
Salmon and bull trout spawning, rearing, feeding, and migration areas	LR	5	
Altered Conditions			
LAND USE			
Zoning density	GIS	2	
Single-family residences and appurtenant structures	A, F	2	
Agricultural structures and practices	A, F	2	
Aquacultural practices	LR	-	
Industrial complexes and appurtenant structures	A, F	2	
Commercial buildings and appurtenant structures	A, F	2	
Bulkheads and shore hardening, including dikes and dikes	A, F	5	

Element	Source*	Report Section	Notes
Filled areas	A, F	2	
Docks, piers, and other over-water structures	A, F	5	
Storm water outfalls	GIS		
Sewer outfalls	GIS		
Roads within shoreline jurisdiction	GIS	6	
Extent of impermeable surfaces	GIS	2	
Identified contaminated sediments	LR		
Tide gates, ditches, diversions, culverts, and barriers to wildlife migration	LR, A, F	5	
Utilities	GIS		
Shoreline designations	LR		
Land use overlays	GIS	2	
Development within channel migration zones	LR, A, F	5	

LR = Literature review
A = aerial photo
F = Field Truthing
GIS = GIS data