City of Woodinville

Shoreline Inventory and Characterization

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Prepared For:

City of Woodinville

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1.0 INTRODUCTION

1.1 Background and Purpose

The purpose of this study is to conduct a baseline inventory and characterization of conditions relevant to the shoreline resources of the City of Woodinville, Washington. According to Substitute Senate Bill (SSB) 6012, passed by the 2003 Washington State Legislature, cities and counties are required to amend their local shoreline master programs (SMPs) consistent with the Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58 and its implementing guidelines, Washington Administrative Code (WAC) 173-26. The City is conducting a comprehensive Shoreline Management Plan (SMP) update with the assistance of a grant administered by Washington State Department of Ecology (G0600224). A first step in the comprehensive update process is development of a shoreline inventory and characterization. The inventory and characterization documents current shoreline conditions and provides a basis for updating the City’s SMP goals, policies, and regulations. This characterization will help the City identify existing conditions, evaluate existing functions and values of its shoreline resources, and explore opportunities for conservation and restoration of ecological functions.

Ecosystem processes and functions are evaluated at two different scales: a watershed or landscape scale, and a shoreline reach scale. The purpose of the watershed or landscape scale characterization is to identify ecosystem processes that shape shoreline conditions and to determine which processes have been altered or impaired. The intent of the shoreline reach scale inventory and characterization is to: 1) identify how existing conditions in or near the shoreline have responded to process alterations; and 2) determine the effects of the alteration on shoreline ecological functions. These findings will help provide a framework for the update of the City’s shoreline management policies and regulations.

1.2 Report Organization

The information in this report is divided into the eight following main sections.

- Section 1.0, Introduction discusses the purpose of this report and describes the regulatory context for shoreline planning.
- Section 2.0 describes the methods, approach, and primary data sources used for this inventory and characterization.
- Section 3.0 describes the regional context, general landscape setting (climate, topography, etc.), and watershed conditions.
- Section 4.0 provides an overview of ecosystem-wide processes and how they affect shoreline ecological functions in the City of Woodinville.
- Section 5.0 addresses land use patterns and the physical and biological characterization of conditions in the vicinity of the shoreline regulatory zone (referred to as the shoreline planning area).
- Sections 6.0 and 7.0 summarize conditions for the portions of the Sammamish River and Little Bear Creek in the City’s planning area, provides an assessment of shoreline...
functions, and identifies and discusses potential opportunity areas for protection, enhancement, restoration, and enhanced public access.

- Section 8.0 identifies data gaps and provides recommendations for addressing those gaps.

Appendix A of this report is a map folio that includes several figures that identify the City’s approximate shoreline planning area and document various biological, land use, and physical elements at a variety of scales.

1.3 Regulatory Overview

1.3.1 Shoreline Management Act and Shoreline Guidelines

Washington’s Shoreline Management Act (SMA) was passed by the State Legislature in 1971 and adopted by the public in a referendum. The SMA was created in response to a growing concern among residents of the state that serious and permanent damage was being done to shorelines by unplanned and uncoordinated development. The goal of the SMA was “to prevent the inherent harm in an uncoordinated and piecemeal development of the state’s shorelines.” While protecting shoreline resources by regulating development, the SMA is also intended to provide for appropriate shoreline use by encouraging land uses that enhance and conserve shoreline functions and values. The SMA gives priority to siting land use that are water-dependent in the shoreline zone and encourages the provision of public access to shorelines.

The primary responsibility for administering the SMA is assigned to local governments through the mechanism of local shoreline master programs, adopted under guidelines established by Ecology. The guidelines (WAC 173-26) establish goals and policies that are implemented through “use” regulations such as local Comprehensive Plans and SMPs. The SMP is based on state guidelines but tailored to the specific conditions and needs of individual communities. The SMP is also meant to be a comprehensive vision of how the shoreline area will be managed over time.

1.3.2 Shoreline Jurisdiction

Under the SMA, the shoreline jurisdiction includes areas that are 200 feet landward of the ordinary high water mark (OHWM) of waters that have been designated as “shorelines of statewide significance” or “shorelines of the state.” These designations were established in 1972 and are described in WAC 173-18. Generally, “shorelines of statewide significance” include portions of Puget Sound and other marine water bodies, rivers west of the Cascade Range that have a mean annual flow of 1,000 cubic feet per second (cfs) or greater, rivers east of the Cascade Range that have a mean annual flow of 200 cfs or greater, and freshwater lakes with a surface area of 1,000 acres or more. “Shorelines of the state” are generally described as all marine shorelines and shorelines of all other streams or rivers having a mean annual flow of 20 cfs or greater and lakes with a surface area of 20 acres or greater.

Under the SMA, the shoreline area to be regulated under the City’s SMP must include all shorelines of statewide significance, shorelines of the state, and their adjacent shorelands, defined as the upland area within 200 feet of the OHWM, as well as any associated wetlands (RCW 90.58.030). “Associated wetlands” means those wetlands that are in proximity to and
either influence or are influenced by tidal waters or a lake or stream subject to the SMA (WAC 173-22-030 (1)). These are typically identified as wetlands that physically extend into the shoreline jurisdiction, or wetlands that are functionally related to the shoreline jurisdiction through surface water connection and/or other factors. The specific language from the RCW describes the limits of shoreline jurisdiction as follows:

*Those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all associated wetlands and river deltas (RCW 90.58.030(2)(f)).*

Local jurisdictions can choose to regulate development under their SMPs for all areas within the 100-year floodplain or a smaller area as defined above (RCW 90.58.030(2)(f)(i)).

### 1.3.3 City of Woodinville Shoreline Master Program

Two water bodies in Woodinville, the Sammamish River and the lower portion of Little Bear Creek, are currently regulated under the SMA and the City’s SMP. The Sammamish River is designated as a “shoreline of statewide significance.” The City currently regulates the lower portion of Little Bear Creek (from the mouth at the Sammamish River north to 132nd Avenue) as a “shoreline of the state” based on hydrologic information at the time the SMP was developed. The City of Woodinville adopted the King County SMP when the City incorporated in 1993. In 1997, the City revised its SMP to more accurately reflect conditions in Woodinville.

Development regulations contained in the SMP are adopted by reference as part of the City of Woodinville Municipal Code (Woodinville Municipal Code (WMC) 24.10).

Local SMPs establish a system to classify shoreline areas into specific “environment designations.” The purpose of shoreline environment designations is to provide a uniform basis for applying policies and use regulations within distinctly different shoreline areas. In a regulatory context, shoreline environment designations function similarly to zoning overlay districts. That is, they do not change the underlying zoning or other applicable land use regulations, but provide an additional layer of policy and regulations that apply to land within the SMP jurisdiction. Generally, environment designations should be based on existing and planned development patterns, biological and physical capabilities and limitations of the shoreline, and a community’s vision or objectives for its future development.

During development of its current SMP in 1997, the City evaluated the natural and built characteristics of its shoreline jurisdiction and developed two shoreline environment designations: Conservancy and Urban. Both designations are applied to the Sammamish River and the lower portion of Little Bear Creek within the City’s municipal boundaries (Figure 1).

A variety of other regulatory programs, plans, and policies work in concert with the City’s SMP to manage shoreline resources and regulate development near the shoreline. The City’s Comprehensive Plan establishes the general land use pattern and vision of growth the City has adopted for areas both inside and outside the shoreline jurisdiction. Various sections of the City’s municipal code are relevant to shoreline management, such as zoning, flood damage prevention, and stormwater management. The City’s development standards and use regulations for environmentally critical areas are particularly relevant to the City’s SMP. Designated environmentally critical areas are found throughout the City’s shoreline jurisdiction, including streams, wetlands, aquifer recharge areas, and geologic hazard areas.
2.0 METHODS

2.1 Data Sources

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

- City of Woodinville Comprehensive Plan (Adopted 1995, updated 2002);
- City of Woodinville Shoreline Master Program (1997);
- City of Woodinville Parks, Recreation & Open Space Plan (2005);
- Sammamish River Action Plan (U.S. Army Corps of Engineers and King County Department of Natural Resources and Parks, 2002);
- Habitat Inventory and Assessment of Three Sammamish River Tributaries: North, Swamp and Little Bear Creeks (King County Water and Land Resources Division, 2002);
- Little Bear Creek Corridor Habitat Assessment (David Evans and Associates, 2002)
- The Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region (Williams et al., 1975);
- Washington State Department of Fish and Wildlife Priority Habitats and Species database (2006);

A number of sources were also reviewed to characterize overall watershed conditions and to assess the ecological function of Woodinville’s shorelines in an ecosystem-wide context. Watershed-level condition sources reviewed for this report include:

- Redmond-Bear Creek Valley Ground Water Management Plan (Redmond-Bear Creek Ground Water Advisory Committee, 1999)
- WRIA 8 Near Term Action Agenda for Salmon Habitat Conservation (WRIA 8 Steering Committee, 2002)
- Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan (WRIA 8 Steering Committee, 2005)
- Groundwater/Surface Water Interactions in the Upper Sammamish River Watershed: A Preliminary Analysis (Ecology, 2003);
- Salmon and Steelhead Limiting Factors Report for the Cedar-Sammamish Basin (Kerwin, 2001).

Mapping and aerial photographs of the study area were also consulted. Mapping and aerial photography integrated with GIS data included:

- Vertical aerial photography by U.S. Army Map Service, 1938 (through University of Washington River History Project);
• City of Woodinville GIS database, 2006
• King County GIS database, 2005

A complete list of data sources used is included in the reference list (Section 9) of this report.

2.2 **Determining Shoreline Jurisdiction and Planning Area Boundary**

This characterization is focused on those shorelines of the state within the city limits and designated Urban Growth Area (UGA) of the City of Woodinville. This includes approximately 2.5 miles along the Sammamish River and Little Bear Creek from the northern City limits to its confluence with the Sammamish River (Figure 1). It is important to note that the area depicted on Figure 1 as the shoreline planning area roughly approximates the potential shoreline jurisdiction as described in the previous section above. Boundaries were derived using existing available map information in GIS format. The area depicted is intended for planning purposes only as part of the City’s SMP update process. The actual regulated shoreline jurisdiction may differ from the area shown on Figure 1 depending on information gathered on the ground at any specific location. For example, the ordinary high water mark for the Sammamish River and Little Bear Creek has not been delineated and mapped. Therefore, the mapped edges of the river and creek were used to approximate this boundary. Similarly, mapped wetlands in proximity to the Sammamish River and Little Bear Creek were considered “associated wetlands.” The actual location of these wetlands and hydraulic connectivity would need to be determined site-by-site in the field. Furthermore, all areas mapped as 100-year floodplains for Little Bear Creek and the Sammamish River were included in the shoreline planning area boundary, although local jurisdictions can regulate a smaller area under their SMP as described above.

The shoreline planning area shown on Figure 1 is limited to the city’s municipal boundaries and designated UGA, and represents:

• 200 feet from the mapped edges of the Sammamish River and Little Bear Creek;
• All floodways and 100-year floodplains currently mapped by the Federal Emergency Management Agency (FEMA) that are associated with the Sammamish River and Little Bear Creek; and
• All mapped wetlands that lie adjacent and contiguous to the areas above.

The shoreline planning area is approximately 414 acres and represents approximately 12 percent of the City’s total UGA. The extent of the Sammamish River and Little Bear Creek in the City’s shoreline planning area is summarized in Table 1. The Department of Ecology is in the process of revising the Shoreline Management Act administrative rules to acknowledge local SMPs as the regulatory documents defining SMP jurisdiction. Preliminary information indicates that the shoreline jurisdiction of Little Bear Creek extends further upstream than the stretch that is currently regulated by the City. Based on that information, the inventory and characterization for this report includes Little Bear Creek from its mouth to the City’s northern boundary and in that portion of Snohomish County’s UGA contiguous to the City, in the area known as the Grace Neighborhood.
Table 1. Shoreline Planning Area, City of Woodinville

<table>
<thead>
<tr>
<th>Shoreline</th>
<th>General Boundaries</th>
<th>Approximate Length (miles)</th>
<th>Approximate Percentage of City’s Shoreline Planning Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sammamish River</td>
<td>From the City’s southern city limits at NE 145th Street to the City’s western city limits approximately .4 miles downstream of the confluence with Little Bear Creek.</td>
<td>2.5</td>
<td>58 %</td>
</tr>
<tr>
<td>Little Bear Creek</td>
<td>From 132nd Avenue NE to the mouth at the confluence with the Sammamish River in the City’s UGA.</td>
<td>0.3</td>
<td>7 %</td>
</tr>
<tr>
<td>Little Bear Creek</td>
<td>From 132nd Avenue NE to the northern City limits</td>
<td>1.5</td>
<td>34 %</td>
</tr>
</tbody>
</table>

2.3 Approach to Characterizing Ecosystem-wide Processes and Shoreline Functions

The SMA guidelines require a local jurisdiction to evaluate ecosystem wide processes while updating its SMP. Ecosystem-wide processes that create, maintain, or affect the City’s shoreline resources were characterized using an adapted version of the five-step approach to understanding and analyzing watershed processes described in *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley, et al., 2005). This approach defines watershed processes as the delivery, movement, and loss of water, sediment, nutrients, toxins, pathogens, and large woody debris. These processes are qualitatively described using available reports and maps related to topography, geology, soils, land cover, and other themes. This approach is most appropriate at a county or watershed scale. However, it can be used in a simplified form to support local planning processes by providing a broader understanding of the processes at work that maintain the aquatic resources being regulated by a local jurisdiction.

Natural processes, and alterations to those processes, are described at a variety of geographic scales based on existing reports and readily available mapping information. For example, conditions, processes, and functions may be described at the following scales: 1) the entire Sammamish River watershed; 2) the Lower or Upper Sammamish River watershed; 3) the Woodinville vicinity or the extent of the City’s UGA; and 4) the shoreline planning area or reach scale (Figure 2). Additionally, alterations to processes are described in terms of historical development, past land use, and existing development.

2.4 Approach to Inventory and Characterization of Regulated Shorelines

The inventory of the Sammamish River and Little Bear Creek at the shoreline reach scale, or within the limits of the mapped shoreline planning area as described above, is intended to characterize conditions adjacent to the regulated water body. The shoreline planning area roughly approximates the regulatory limits of the City’s SMP as described above. GIS data and analysis were used to quantify certain conditions in this area (e.g., acres per zoning or land use...
Aerial photography and review of existing reports and planning documents were used to qualitatively describe conditions in this area.

The portion of the Sammamish River shoreline running through the City is generally homogenous and was characterized as one reach. The Little Bear Creek shoreline is less homogenous, but was also characterized as one reach. The analysis of shorter reaches did not appear warranted for either water body. This approach should not suggest that only one regulatory shoreline environment designation in the City for either Little Bear Creek or the Sammamish River would be appropriate.
3.0 REGIONAL CONTEXT

The City of Woodinville is located within the greater Lake Washington Watershed (WRIA 8), which includes two major river systems, the Cedar and Sammamish Rivers, as well as Lakes Sammamish, Washington, and Union and numerous tributaries to each (Figure 3). The Sammamish River flows approximately 13.8 miles from its origin at the north end of Lake Sammamish to its mouth at the northern tip of Lake Washington. The entire Sammamish River drains a watershed of approximately 240 square miles that consists of many rivers and streams, with the largest tributaries being Bear, Little Bear, North, and Swamp Creeks (Kerwin, 2001). The Sammamish River is fed primarily by Lake Sammamish and its tributary streams, which drain the Cascade foothills between the WRIA 7 and WRIA 9 drainages and also includes lowland streams originating in King and Snohomish County (Figure 3).

The City of Woodinville lies between River Miles (RM) 5.0 and 8.0 on the Sammamish River in the middle of the Sammamish River basin (Figure 3). WRIA 8 covers a land area of approximately 692 square miles. The City and its UGA occupy approximately 7 square miles, or 1 percent of the land area included in WRIA 8. The portion of the Sammamish River within the City and its UGA is approximately 21.7 percent of the total length of the river.

The Sammamish River has been dramatically changed in the past 100 years (U.S. Army Corps of Engineers and King County, 2002). The river corridor historically consisted of vast wetlands, with numerous braided channels. The floodplain was heavily forested. The first significant change resulted from the construction of the Hiram Chittenden Locks in 1917 built to connect the Lake Washington system with Puget Sound. The navigational project resulted in lowering of Lake Washington by 9 feet and Lake Sammamish by 6 feet. This reduced the river gradient and altered flow patterns. Drainage districts formed during the 1910s drained wetlands and diked and straightened the river for flood control to allow agriculture in the floodplain. In the 1960s, the U.S. Army Corps of Engineers took over flood control on the Sammamish River. The river was dredged and deepened. Although there is no formal levee system along the river, the excavated material from dredging was deposited along the channel creating de facto levees. All riparian vegetation was removed along the river and the Corps continues to maintain a grass-lined channel. As a result of these actions, the Sammamish River was channelized and straightened and the length was reduced by approximately half to 14 miles. The changes are illustrated in Figure 4.

3.1 Climate

Woodinville is located in the greater Puget Lowlands of western Washington. This area surrounding Puget Sound has a maritime climate with cool winters, dry summers, and a distinct rainy season through fall and spring. Precipitation in the Puget Lowlands varies considerably because of the effects of mountains. The Woodinville area receives on average between 35 and 55 inches of rain per year (NRCS, 2002). The majority of the precipitation falls between October and March. Winds are generally from the southwest during the rainy season and from the northwest during the dry summer months. These conditions generally result in greater volumes of flow and seasonal flooding in the Woodinville area during the rainy season associated with peak flow events driven by storms.
3.2  **Topography**

The Sammamish River flows north through a broad, flat floodplain from its source at Lake Sammamish to the mouth of Little Bear Creek. At Little Bear Creek, the river turns west and flows through a narrower floodplain to its mouth at Lake Washington. The broad floodplain is bordered on the east and west by steeply sloped hills that rise to elevations of 500 to 600 feet. The Sammamish River channel elevation decreases from approximately 28 feet near the outlet of Lake Sammamish to 20 feet in Woodinville.

Within the City of Woodinville the maximum topographic relief is about 510 feet from the Sammamish River valley at an approximate elevation of 40 feet to the topographic high located near the intersection of NE 175th Street and 159th Avenue at about 550 feet. There are several ravines and valleys within the City that range from approximately 80 to 300 feet deep. The slopes west of the Sammamish River and the Woodinville-Redmond Road are dissected by steep ravines that contain intermittent drainages. The valley floor is approximately 0.5 miles wide through Woodinville south of the mouth of Little Bear Creek.

The headwaters of Little Bear Creek are located in Snohomish County at an elevation of approximately 250 feet and gradually decreases to an elevation of 20 feet near the confluence with the Sammamish River (David Evans and Associates, 2002). The overall grade varies between 0.6 and 0.8 percent (David Evans and Associates, 2002, 2002; Kerwin, 2001).

3.3  **Geology and Soils**

General geology in the vicinity of the City of Woodinville is illustrated by the geologic maps of the Kirkland, Bothell, and Maltby quadrangles (Minard, 1983; 1985a; and 1985b). Soil units mapped by the Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service) is shown in Figure 5. The geology of Woodinville is shown in Figure 6.

The Sammamish River watershed is located in the east central portion of the Puget Lowland, an elongated topographic and structural depression bordered by the Cascade Mountains on the east and the Olympic Mountains on the west. The lowland is characterized by glacial drift plains of low rolling relief separated by deeply cut ravine valleys.

Geology of the Sammamish River watershed is the result of mountain building, glaciation, and post-glacial alluvial deposits. The Sammamish River Valley is a glacially carved trough that has filled with sediment since the melting of glacial ice approximately 13,500 years ago. The valley contains three basic rock types: tertiary or older sedimentary and crystalline bedrock, semi-consolidated to unconsolidated fluvial, glacial, and marine Pleistocene sediments, and recent alluvium (Redmond-Bear Creek Ground Water Advisory Committee, 1999). Depth to bedrock generally ranges from 400 to 1,200 feet with few surface outcrops.

The Woodinville area is underlain by a thick sequence of unconsolidated glacial and nonglacial deposits of the Pleistocene age. Geologic maps for the area indicate that the Pleistocene deposits exposed at the ground surface within the City of Woodinville are from oldest to youngest: undivided glacial till (Qtu), Olympia gravel (Qob), Transitional beds (Qtb), Vashon advance outwash (Qva), Vashon recessional outwash (Qvr), older Holocene alluvium (Qoal), and younger Holocene alluvium (Qyal). These units are shown on Figure 6.
The surficial geology of the Sammamish River area is primarily the result of advances and retreats of glaciers during the Fraser Glaciation. Most of the Woodinville area is covered by glacial till from glacial recessions (Qvt). Vashon advance outwash (Qva) also covers large areas of the City. Glacial ice melted from the Woodinville area about 13,500 years ago. Since then stream erosion and deposition and mass wasting have modified the landscape. In the Sammamish River Valley, the primary deposits are Pleistocene and Holocene alluvium (Qyal and Qoal, respectively). The older alluvium (Qoal) forms terraces along the margins of the river valley. The younger alluvium (Qyal) is located within the Sammamish River floodplain.

Soils in the Sammamish River area are typical of areas influenced by glaciers. The major soil type in the valley is the Alderwood gravelly loam (Figure 5). Other soil types include the Indianola loamy fine sand, Tukwila muck, Snohomish silt loam, Everett gravelly sandy loam, Norma sandy loam, and Earlmont silt loam. The Indianola and Alderwood soils are somewhat excessively drained to moderately well drained. The other soil types are somewhat to very poorly drained. In Woodinville, the Indianola and Alderwood soils are located on the upland areas. Soils in the river valley and within the shoreline jurisdiction are poorly drained with many hydric soils.

### 3.4 Aquatic Resources

#### 3.4.1 Rivers and Streams

The Lake Washington/Cedar River watershed (WRIA 8) is subdivided into 12 drainage basins (Figure 3). Major tributary systems include Issaquah, Bear, Little Bear, North and Swamp Creeks and the Cedar River. The Sammamish River watershed makes up one-third of the entire watershed and is located predominantly within the UGAs of several jurisdictions. It extends generally from the outlet at Lake Sammamish to the confluence with Lake Washington. Major contributing subbasins include the Bear, Little Bear, North, and Swamp Creeks. The majority of the Sammamish River watershed is located in the Puget Lowlands and is significantly urbanized (Kerwin, 2001 and King County, 2001). The upper Sammamish River watershed includes the City of Redmond, while the middle Sammamish River watershed includes the City of Woodinville and portions of the City of Bothell. The lower portion of the Sammamish River includes the City of Kenmore and portions of the City of Bothell.

The City of Woodinville is located within three of the drainage basins in the middle Sammamish River watershed. The western portion of the City and its UGA are situated within the Little Bear Creek basin (Figure 3). The eastern portion is situated in the Bear Creek basin and the remaining portion of the City is located within the greater Sammamish River basin.

In the City, the flow of the Sammamish River is generally to the northwest and most tributaries drain to the Sammamish River in a north or south direction. Little Bear Creek is a 7.7-mile stream that drains a 9,600-acre watershed in King and Snohomish Counties, Washington (David Evans And Associates, 2002). Little Bear Creek flows from its source in a peat bog in Snohomish County through the City of Woodinville for approximately 2.2 miles from NE 205th Street to its mouth on the Sammamish River at RM 5.4 and has several unnamed tributaries (David Evans And Associates, 2002). The City contains many small watercourses that are remnant portions of previously existing natural drainage systems that originate from the slopes.
located east and west of the Sammamish River. Tributary streams other than Little Bear Creek include Derby Creek; Gold Creek; Woodin Creek; and smaller unnamed sidewall tributaries (Figure 3).

3.4.2 Wetlands

At a watershed scale, most wetlands in the City of Woodinville are positioned in the Sammamish River watershed where the topography is relatively flat and the gradient is low. Mapped soil units classified as poorly drained or hydric indicate the extent of potential or historic wetlands. In the Sammamish River floodplain, areas of Tukwila muck, Snohomish silt loam, Earlmont silt loam, and Briscot silt loam represent the largest areas of poorly drained, hydric soils (Figure 5). Another poorly drained, hydric soil, Norma loam is mapped along Little Bear Creek.

The City of Woodinville’s wetland inventory is based on the King County Wetland Inventory, the National Wetland Inventory (NWI), the Snohomish County Wetland Inventory (in the potential annexation area), and on site-specific studies from development projects. Most of the wetlands identified in the inventory are classified as “palustrine” or freshwater wetlands according to the Cowardin wetland typing system (Cowardin et al., 1979). Most are also considered to be “depressional” using the hydrogeomorphic (HGM) classification system. The HGM approach is based on the position of the wetland in the landscape (geomorphic setting), the hydrologic source of water, and the flow and fluctuation of the water once in the wetland (hydrodynamics). While the majority of the wetlands in the watershed are depressional wetlands, a number of riverine wetlands and slope wetlands are also present (Figure 7).

Depressional wetlands are those that form in topographically low-lying areas without natural outlets or with constrained outlets. Depressional wetlands in the City tend to be larger and more diverse in terms of habitat types than other wetland types such as riverine and slope. Common habitat types in depressional wetlands include palustrine open water, emergent, scrub-shrub, and forest. Most of these wetlands are positioned in the Sammamish River floodplain or are associated with Little Bear Creek, Woodin Creek, and other tributary streams (Figure 7).

Riverine wetlands are associated with a stream or river that frequently experiences overbank flooding. Riverine wetlands are found along the steep-sided banks of the Sammamish River and along Little Bear Creek and other tributary streams. Most of the wetlands above the banks of the Sammamish River are functionally depressional due to the Sammamish River flood control project that has separated floodplain wetlands from the river system (Figure 7).

Slope wetlands are also present in the watershed. Slope wetlands, which typically occur on hills or valley slopes, result from side slope seepage or groundwater expression. Within the City of Woodinville, slope wetlands likely occur on steep slopes in association with the numerous tributary streams southwest of the Sammamish River and near the headwaters of Woodin Creek and other tributary streams northeast of the Sammamish River (Figure 7).
3.5 Land Cover and Land Use

3.5.1 Land Cover

Historically, vegetation within the Puget Lowlands was coniferous forest, marsh, wetland, and other native habitat types. Native vegetation is currently dominated by Douglas-fir forests with western hemlock and red cedar as the primary late-successional species. Oregon white oak, Pacific madrone, big-leaf maple, and red alder forests are other frequent components of the landscape (WDNR, 2003). Other special habitats within the region include wetlands, riparian areas, bogs, and estuaries.

Within the Sammamish watershed, vegetation existing today is largely a function of the type and degree of agricultural, residential, and commercial development. Little natural vegetation remains in the lowland as the floodplain has been extensively farmed or developed in light industrial or business, and residential development.

Most of the Sammamish River drainage lies within the incorporated cities of Redmond, Woodinville, Bothell, and Kenmore. Land use in the reach upstream of Woodinville includes open space and recreational areas at Marymoor Park, urban commercial and residential development in the City of Redmond, the Willows Run Golf Course, and the Sammamish Valley Agricultural Production District (Kerwin, 2002). The reach downstream of Woodinville includes the downtown cores of Bothell and Kenmore and some open space areas, including the Wayne and Inglemoor Country club golf courses, Bothell parkland along the Sammamish River Trail, and King County-owned parcels at the mouth of Swamp Creek and the mouth of the river.

The Little Bear Creek watershed is approximately 40 percent forested with 37 percent impervious surface (Kerwin, 2000). Within the City of Woodinville, approximately 46 percent of the Little Bear Creek 200-foot shoreline jurisdiction is impervious surface. The Sammamish River 200-foot shoreline jurisdiction is approximately 80 percent impervious surface within the City.

In Woodinville, developed land is generally concentrated near the major transportation corridors of Interstate-405 and State Route 522 (Figure 8). Developed areas are also more prevalent in the western portion of the Woodinville Planning Area and closer to the cities of Bothell and Kirkland.

Within the City of Woodinville, developed areas are concentrated in the Town Center, North Industrial, and Valley Industrial neighborhoods, as well as the western portion of the West Ridge Neighborhood. Developed lands are also located along both sides of State Route 522. Agricultural land cover is primarily located in the Sammamish River Valley where a number of large farms (particularly turf farms) exist. Much of this agricultural land is located within the 100-year floodplain of the river.

Natural Open Lands and Forest Lands are generally located east of the city limits, with the exception of the eastern half of the Leota Neighborhood, and generally contain single-family houses located on large lots. Water within the Woodinville Planning Area includes the Sammamish River, Little Bear Creek and Leota, Crystal, and Cottage Lakes (City of Woodinville, 2002).
3.5.2 Land Use

The Sammamish watershed is part of the greater Lake Washington - Cedar River drainage, encompassing the land area in which rainwater drains to Lake Sammamish, the Sammamish River and out into Lake Washington. The Sammamish watershed includes Swamp Creek, North Creek, Bear Creek and Little Bear Creek, Cottage Lake Creek, Evans Creek, Issaquah Creek, Tibbetts Creek and a number of smaller creeks draining to the east and west shores of Lake Sammamish. Land use in the Sammamish watershed consists primarily of forestry uses in the eastern portions of the watershed and residential and commercial uses further west. Agricultural uses are common along the Sammamish River from the outlet of Lake Sammamish in Redmond to Woodinville (Ecology, 2006).

The predominant land use in and around the City of Woodinville is residential. Generalized existing land use is shown on Figure 9. Residential uses constitute 55 percent of the City’s area, although significant areas of the City are used as retail services (8 percent) and industrial uses (16 percent). Most of the residential area in the Urban Growth Area (UGA) is dedicated to low-density single-family uses. Table 3-1 provides a summary of current land use in the City of Woodinville, based on the City of Woodinville Comprehensive Plan (City of Woodinville, 2002).

<table>
<thead>
<tr>
<th>Category</th>
<th>Acres</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family</td>
<td>1,985</td>
<td>55</td>
</tr>
<tr>
<td>Multi-Family</td>
<td>99</td>
<td>3</td>
</tr>
<tr>
<td>Parks/Open Space</td>
<td>46</td>
<td>1</td>
</tr>
<tr>
<td>Retail Services</td>
<td>288</td>
<td>8</td>
</tr>
<tr>
<td>Office</td>
<td>19</td>
<td>0.5</td>
</tr>
<tr>
<td>Industrial</td>
<td>562</td>
<td>16</td>
</tr>
<tr>
<td>Public/Institution</td>
<td>128</td>
<td>4</td>
</tr>
<tr>
<td>Tourist Business</td>
<td>33</td>
<td>1</td>
</tr>
<tr>
<td>Vacant</td>
<td>427</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,587</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: City of Woodinville Comprehensive Plan, 2002
4.0 RELATIONSHIP OF ECOSYSTEM-WIDE PROCESSES TO SHORELINE FUNCTIONS

A number of key ecosystem processes work in concert to maintain aquatic ecosystems. Alterations or land use activities that occur across the landscape can affect ecosystem-wide processes and shoreline functions. Much watershed planning and assessment work has been conducted in the Sammamish River basin. A review of this work is useful in understanding the condition of the City’s shoreline resources and identifying activities that influence those conditions but which may be beyond the City’s jurisdiction and regulatory authority.

4.1 Overview of Key Processes

The processes that form and maintain the Sammamish River and its tributary systems are focused on hydrology (i.e., the quantity and timing of surface flow and groundwater flow characteristics). The movement of water and the hydrogeologic characteristics that control flow drive the input and distribution of sediment, water quality processes (influence of nutrients, toxins, and pathogens), and the input of large woody debris (Stanley et al., 2005). These processes and the factors and mechanisms that control them are discussed below. Geographic areas that are important in maintaining these processes are discussed at the watershed scale generally, and more specifically in the vicinity of Woodinville or throughout the City’s UGA.

Processes occurring at a landscape or watershed scale form, maintain, or influence shoreline ecological functions. Examples of shoreline functions include habitat structure, nutrient filtering, and vegetation (which provides temperature control and organic inputs). Changes in land use patterns and development across the landscape, not solely at the river’s edge, may change these processes and alter shoreline functions. Alterations in the Sammamish River watershed and in the City’s UGA and their effects on shoreline functions are included in the following discussion.

4.2 Hydrology – Surface and Groundwater Flow

Water naturally enters a watershed through rain, snow, or movement of groundwater. Water moves within a watershed by surface water flow in rivers and streams, infiltrates and becomes groundwater, or is stored in wetlands, lakes, and floodplains. In a natural system, the movement and storage of water is generally controlled by physical conditions such as climate (precipitation patterns and volumes), topography (gradient), land cover (vegetation) and the permeability or infiltration capacity of soils and the underlying surficial geology (Stanley, et al., 2005).

Important areas for hydrologic processes include:

- Recharge areas with high amounts of precipitation and rain-on-snow zones provide delivery of water;
- Saturated areas or areas with low permeability provide overland or shallow subsurface flow;
- Areas with high permeability provide groundwater recharge;
City of Woodinville Shoreline Inventory and Characterization

- Lakes, low-gradient floodplains, and depressional wetlands provide surface water storage; and
- Topographic slope breaks or contact areas between geologic deposits of differing permeability provide groundwater discharge (i.e., return to surface flow) (Stanley, et al., 2005).

Hydrologic processes influence the following shoreline functions:

- Quantity and timing of flow affects hydrologic functions such as channel incision and flood storage;
- Quantity and timing of flow affects instream habitat functions such as channel complexity and habitat availability; and
- Groundwater flow affects hydrologic and hyporheic functions such as baseflow and temperature, as well as habitat and vegetation functions related to species diversity. Groundwater flow affects these functions in both riverine and wetland ecosystems.

General groundwater and hydrology in the Sammamish River basin are described in the Redmond-Bear Creek Valley Ground Water Management Plan (1999) and in Kerwin (2001). Soil units classified by infiltration rates (hydrologic rating) and permeability in the vicinity of Woodinville are shown on Figure 5.

Surface water in the Sammamish River flows generally northwest to Lake Washington. Precipitation falling within the watershed is conveyed directly to small lakes, ponds, streams, and rivers by surface runoff, or travels subsurface as groundwater flow. Water that is unable to infiltrate travels downslope across the ground surface as sheetflow. Small amounts of rainfall soak into the ground, but during heavy rainfall, the ground quickly becomes saturated thus inhibiting further infiltration. The weir on Lake Sammamish at the head of the Sammamish River affects surface water flow volumes. However, periodic flooding occurs in the Sammamish River watershed due to rainy wet season cycles, as in much of the Puget Lowlands, when large storm events pass through the area.

As described earlier, the glacial and sedimentary deposits in the Sammamish River valley form a sequence of sand and gravel layers separated by finer grained layers of clay and silt or tight, well-graded soils, which are exposed in places along the steep slopes that lie between the upland plateau and the lowland floodplain. The deposits comprise several aquifers and aquitards within the subsurface. These interspersed permeable and impermeable layers control subsurface water movement from the upland to the lowland (Redmond-Bear Creek Ground Water Advisory Committee, 1999). Water that infiltrates into the ground generally flows downward until impeded by less permeable soils and then flows laterally to a body of water or to a slope face where it may emerge as springs or seeps on the hillside. A portion of the groundwater, however, will percolate downward through lower-permeability soils, recharging underlying aquifers.

Natural surface and groundwater flow paths from the slopes and river floodplain have been altered or disrupted by constructed levees along the Sammamish River, by culverts, and by drainage ditches. Such constructed features disrupt hyporheic flow, which is surface water that travels in more permeable soils below or adjacent to river or stream channels. Former channels of the Sammamish River or its tributaries may influence hyporheic flow because more permeable soils commonly lie within the former channels. These former channels were abandoned as the
river or stream suddenly changed locations. Sudden channel shifts (avulsions) are a natural stream process. Former channels were also created during the straightening of the Sammamish River channel in the early 1900s (U.S. Army Corps of Engineers and King County Natural Resources and Parks, 2002).

Under natural conditions, important areas for water storage in the Sammamish River valley include the floodplain and wetlands. Poorly drained soils generally correspond to hydric soil units. These areas approximate the extent of potential wetlands under natural conditions. Areas of Bristcot silt loam, Snohomish silt loam, Earlmont silt loam, and Tukwila muck in the river valley may have provided important storage for surface water (Figures 5). Historic river channel mapping of the Sammamish River indicates that the river was much more sinuous prior to channelization ((U.S. Army Corps of Engineers and King County Natural Resources and Parks, 2002). At that time, the natural floodplain would have been much broader than it is today, and would have been important for surface water storage during peak flow events.

### 4.3 Sediment Delivery

Sediment is naturally delivered to river systems through three primary processes: surface erosion (from overland sheet flow in upland areas), mass wasting (landslides), and in-channel erosion (eroding banks or streambeds). The delivery, movement, and storage of sediment is largely driven by hydrology and generally controlled by physical conditions such as topography (gradient), land cover (vegetation), soil characteristics (erodibility), and the transport capacity or velocity of moving water (Stanley, et al., 2005).

Important areas for sediment delivery and movement include:

- Steep slopes with erodible soils provide sediment input through surface erosion or landslide (mass wasting) events;
- Natural or unconfined channels provide sediment input through in-channel erosion; and
- Lakes, depressional wetlands, floodplains, and depositional channels provide sediment storage (Stanley, et al., 2005).

Sediment processes influence the following shoreline functions:

- Sediment delivery affects hydrologic and hyporheic functions such as channel morphology and hyporheic exchange; and
- Sediment delivery affects instream habitat functions by maintenance, loss, or homogenization of habitat availability. That is, sediment delivery is a natural process but too much sediment input can adversely affect habitat.

At a landscape or watershed scale, most sediment processes that influence conditions in the Sammamish River are driven by conditions in the upper watershed. The Sammamish River is different from most systems in that its origins are from a lake, which essentially acts as a sediment trap. The low gradient of the Sammamish River also results in fine sediments dropping out of the water column to the channel bottom. Natural sources of sediment delivery may include landslides, and avulsions, which provide large amounts of sediment rapidly. Soil mapping by the Natural Resource Conservation Service (NRCS) and the Washington
Department of Natural Resources Forest Practices Division indicates important areas for sediment inputs in the Sammamish River watershed. These include areas with high mass wasting potential, unstable slopes, and areas with high erosion potential. These areas are most extensive and most concentrated in the upper portions of the watershed including several of the Sammamish River tributary streams.

Across the City’s UGA, important areas for sediment input include steep slopes with erodible soils and/or identified erosion or landslide hazard areas to the west of the Sammamish River. Critical erosion hazard areas are lands underlain by soils identified by the NRCS as having “severe” or “very severe” erosion hazards. These include Alderwood gravelly sandy loams; Kitsap silt loam, and Everett gravelly sandy loam. Landslide hazard areas occur when the combination of slope inclination and relative soil permeability create susceptibility to landsliding. Erosion and landslide hazard areas are generally concentrated along the transition between the upland plateaus on either side of the Sammamish River and the Sammamish River valley floor. Several streams that drain across this boundary, including the upper reaches of some Little Bear Creek tributaries, the upper reaches of Derby Creek and sidewall tributaries to the Sammamish River that originate from hillsides at the southwest corner of the City have the potential to erode streambanks where these conditions exist. These areas would represent important areas for sediment input to the Sammamish River and Little Bear Creek.

The majority of the Sammamish River shoreline is not mapped as having steep or slopes steeper than 15 percent. While the banks of these levees and dikes are typically steep enough to create landslide hazards, the underlying soil conditions would indicate these areas are of only moderate landslide risk.

Land use development and other uses can also result in sediment input to water bodies. Surface runoff from agricultural land can erode soils and deliver sediment to receiving water bodies. Vegetation clearing associated with urban development can result in erosion temporarily during construction activity if not properly managed or more long-term if exposed soils are not replanted. The agricultural activities and associated ditches adjacent to the City’s shoreline jurisdiction are also likely contributors of fine sediments to the Sammamish River.

**4.4 Water Quality**

There are many processes at work that maintain or affect water quality in a watershed. This report focuses on the movement of phosphorus, toxins, nitrogen, and pathogens. Key processes include biotic uptake and decomposition, adsorption, and denitrification. The movement of water and sediment largely drives these processes, and they are generally controlled by physical characteristics such as biotic cover and composition, soil characteristics, and bacterial activity (Stanley, et al., 2005).

Important areas for water quality related processes include:

- Depressional wetlands with organic, mineral, or clay soils provide adsorption of phosphorus, toxins, and pathogens (fecal matter);
• High and low permeability geologic deposits provide a longer flow path relative to areas of overland and surface water flow and therefore have a greater capacity to remove pathogens;
• Depressional wetlands transform nitrogen through nitrification movement) and denitrification (loss of nitrogen from the system);
• Riparian areas with a consistent supply of shallow groundwater provide denitrification; and
• Headwater streams can provide biotic uptake and decomposition, and/or adsorption of nitrogen (Stanley, et al., 2005).

Processes influencing water quality include the following shoreline functions:

• Delivery and storage of nitrogen, phosphorus and toxins, and pathogens affect hyporheic and vegetation functions such as denitrification and nutrient cycling. Habitat functions such as invertebrate abundance and diversity, and food sources for fish, are also affected; and
• Delivery of nitrogen, phosphorus, and pathogens affects these functions in both riverine and wetland aquatic ecosystems.

At the watershed scale, important areas for processes influencing water quality are concentrated in the lower portions of the watershed. Under natural conditions, these lower gradient areas would provide surface water storage and nutrient cycling and filtering. In the vicinity of the Woodinville UGA, these areas would generally correspond to those areas important for surface water storage and hyporheic exchange. As described above, the extent of historic wetlands can be approximated by the mapped extent of poorly drained or hydric soil units. Within the City’s UGA, these are mostly concentrated on the valley floor (Figure 5). The extent of the hyporheic zone generally corresponds to areas of alluvium or advance glacial outwash in the historic floodplain, which are also concentrated on the valley floor (Figure 6). Finally, areas that provide groundwater recharge are located in the upland areas east of the river.

Impairments to water quality within the waters of the City of Woodinville have a variety of point and non-point sources. Many of these sources may also result from land uses and activities upstream of the City’s jurisdictional boundaries. Agriculture, gardening practices, and property development can result in excessive nutrients (nitrogen and phosphorous) entering surface and groundwater, which promote algae growth and too much organic waste in the water. This reduces dissolved oxygen needed by fish. Failing septic systems and livestock are the typical sources of fecal coliform bacteria, which can indicate a risk to human health. Land development, roads, logging, and agriculture increase sediment in streams, cloud the water, and cover aquatic habitat. These activities may occur both upstream of the City and within the City’s UGA and affect water quality in the City’s water bodies.

At the north end of Little Bear Creek, east of SR 9, the Brightwater Wastewater Treatment facility is currently under construction. This site has been used for commercial and industrial purposes for many years and surface water and groundwater contamination from these uses has been documented. Site cleanup during construction, the low impact development (LID) measures being used, and restoration of three tributary streams and wetlands should result in
improved surface and ground water quality overall in this area (King County Department of Natural Resources and Parks, 2003).

The Washington Department of Ecology (Ecology) maintains a 303(d) list of water bodies where tested pollutants exceed thresholds established by the state surface water quality standards (WAC 173-201A). Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water, such as drinking, recreation, aquatic habitat, and industrial use, are impaired by pollutants. Streams that do not appear on the 303(d) list may fall short of that pollutant threshold, but may not be free of pollutants. In addition, not all streams or all stream reaches are tested as part of this process. Therefore, absence from the 303(d) list does not necessarily indicate that the water body is not impaired.

Ecology’s 2002/2004 Water Quality Assessment identifies and reports on tested water body segments as they relate to state water quality standards for a variety of parameters, including temperature, pH, dissolved oxygen, metals, etc. Water body segments are classified as Category 1, 2, 4, or 5. Category 5 waters are polluted waters that require a Total Maximum Daily Load (TMDL). A TMDL or the Water Quality Improvement Project process was established by Section 303(d) of the Clean Water Act (CWA). Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards, and to develop Water Quality Improvement Reports to address those pollutants. The Water Quality Improvement Project (TMDL) establishes limits on pollutants that can be discharged to the water body and still allow state standards to be met (Ecology, 2006b). In November 2005 the U.S. Environmental Protection Agency approved the list of Category 5 waters, which represents the state’s 303(d) list of impaired waters. Category 4 waters are polluted but do not require a TMDL because a TMDL or pollution control plan is already in place or the water body is impaired by a non-pollutant such as low streamflow or dams. Category 2 waters are considered “waters of concern”, where pollution is present but may not violate state water quality standards. Category 1 waters meet tested standards for clean waters, but may not be free of all pollutants.

Table 4-1 shows the water bodies within the City UGA that were evaluated for the 2002/2004 Water Quality Assessment and appear on the approved 303(d) list. The Sammamish River, Little Bear Creek, and Derby Creek (not a shoreline of the state) are included on the list.
Table 4-1. 2002/2004 Water Quality Assessment in Woodinville, WA

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Category Listing</th>
<th>Water Quality Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sammamish River</td>
<td>5</td>
<td>Fecal coliform; dissolved oxygen; temperature</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Dissolved oxygen; temperature; pH</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Alpha-endosulfan; ammonia-N; arsenic; beta-endosulfan; cadmium; chlorpyrifos; chromium; copper; endosulfan; lead; mercury; nickel; pentachlorophenol; pH; selenium; silver; zinc</td>
</tr>
<tr>
<td>Little Bear Creek</td>
<td>5</td>
<td>Dissolved oxygen (lower reach)</td>
</tr>
<tr>
<td></td>
<td>4A</td>
<td>Fecal coliform</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Dissolved oxygen (lower reaches); temperature; pH; bioassessment</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Alpha-endosulfan; ammonia-N; arsenic; beta-endosulfan; cadmium; chlorpyrifos; chromium; copper; endosulfan; lead; mercury; nickel; pentachlorophenol; pH; selenium; silver; temperature; zinc</td>
</tr>
<tr>
<td>Derby Creek</td>
<td>5</td>
<td>Fecal coliform</td>
</tr>
</tbody>
</table>

Source: Washington State Department of Ecology, 2006a

In 2005, the Department of Ecology developed the Little Bear Creek Water Cleanup Plan (a TMDL) to address the fecal coliform issue within the basin (Dettelbach and Garland, 2005). Major contributors of fecal coliform may include small farms, businesses that handle pet waste, failing septic systems, wildlife, and possible leaks in sanitary sewer lines. It was identified that the transport of fecal coliform is likely resulting from urban and stormwater runoff from roads and highways (Dettelbach and Garland, 2005). Ecology is currently working with the Washington State Department of Transportation (WSDOT), Snohomish County, and the City of Woodinville through the TMDL by assigning specific allowable discharges by each entity through their applicable stormwater permits, and to eliminate or reduce non-point sources of pollution generally.

A TMDL has yet to be prepared addressing fecal coliform, dissolved oxygen, and temperature issues within the Sammamish River.

King County and the U.S. Army Corps of Engineers have undertaken a number of studies of water temperature in the Sammamish River (U.S. Army Corps of Engineers and King County Department of Natural Resources and Parks, 2002; King County Department of Natural Resources, 2001; Jain et al., 2000; and Martz, et. al., 1999). Water temperatures as high as 80º F (27º C) have been measured in late July (Martz et al., 1999). This temperature is well above the lethal limit for salmon. Water temperatures in the river frequently exceed the temperatures recommended as properly functioning habitat for salmonids (50 to 70º F or 10-14º C). The main causes of elevated water temperatures occur in the upper watershed. Elevated river temperatures are caused by high temperatures from Lake Sammamish. Downstream tributaries, especially Bear Creek, moderate the high temperatures somewhat. Increased development on those tributaries and increased withdrawals from them have reduced the moderating effect.

4.5 Large Woody Debris and Organics

Large woody debris (LWD) consists of logs or trees that have fallen into a river or stream. In a natural system, LWD provides organic material to aquatic ecosystems and is considered a
principal factor in forming stream structure and associated habitat characteristics (e.g., pools and riffles). Riparian vegetation is the key source of LWD. Large woody debris is primarily delivered to rivers, streams, or wetlands by mass wasting (landslide events that carry trees and vegetation as well as sediment), windthrow (trees, branches, or vegetation blown into a stream or river), or bank erosion (Stanley, et al., 2005).

Important areas for LWD delivery and movement include:

- Channel migration zones where unconfined channels allow streambank erosion and associated delivery of LWD;
- Forested mass wasting or landslide hazard areas deliver LWD during slide events;
- Forested areas adjacent to aquatic resources can provide LWD via windthrow; and
- Low-gradient channels (less than 4 percent slope) provide storage of LWD and organic material, subject to the transport capacity of water (flow velocity) (Stanley, et al., 2005).

The presence, movement, storage, and decomposition of LWD influence the following shoreline functions:

- Delivery of wood and organics affects vegetation and habitat functions such as instream habitat structure (pools and riffles) and species diversity; and
- Riparian vegetation, especially LWD, provides habitat in the form of nesting, perching, and roosting as well as thermal protection, nutrients, and sources of food (terrestrial insects) to a variety of wildlife species.

Historically, the upper portions of the Sammamish River watershed were important for LWD recruitment and movement. The lower portions of the watershed, characterized by lower gradients and broader floodplains, and coniferous riparian habitat, would have been important for LWD recruitment, as well as storage and accumulation. Within the City’s UGA, important areas for LWD historically included forested riparian corridors along the Sammamish River and tributary streams. Additionally, landslide-prone areas adjacent to the river or tributary streams would have been important for delivery of LWD. Currently, LWD is lacking throughout the majority of the Sammamish River shoreline. Forests that once contributed LWD to the Sammamish River have been dramatically reduced to allow for urban development, agriculture, trails, and other transportation infrastructure. In addition, the deepening and straightening of the Sammamish River channel resulted in removal of LWD from the channel. A 2002 assessment of riparian vegetation cover estimated that the extent of blackberry and reed canarygrass in the City’s shoreline jurisdiction was 50 to 90 percent (King County and U.S. Army Corps of Engineers, 2002). Since then the City has actively restored extensive sections of the river to native vegetation and the current estimate is 50 to 60 percent cover by blackberry and reed canarygrass (Crawford, personal communication, 2006). The presence of levees along the Sammamish River in the City’s shoreline jurisdiction eliminates the potential for channel migration and introduction of new sources of LWD. In addition, vegetation is maintained along the levee in such a manner that mature trees are not allowed to establish along the shoreline, especially those with deep taproots, that could potentially destabilize the levee. Roads, development, and trails occur within the functioning riparian buffer, which has eliminated LWD sources and reduced recruitment potential.
The Little Bear Creek basin is also highly urbanized resulting in the lower portion of the reach being devoid of LWD within the City’s shoreline jurisdiction. Riparian vegetation is primarily limited to a narrow band (25 feet on either side of the stream) consisting primarily of shrubs and grasses (David Evans And Associates, 2002). Riparian width and quality improve north toward the current city boundary at NE 205th Street. However, the trees, where present, are dominated by deciduous species that do not provide the high quality LWD that coniferous species provide. No pieces of LWD meeting the NOAA Fisheries standards for properly functioning conditions were documented within the lower reach of Little Bear Creek within the City’s shoreline jurisdiction (David Evans And Associates, 2002). The remainder of the stream above this reach contained some pieces of LWD; however, they were all well below the properly functioning conditions standard. The lack of LWD within Little Bear Creek reduces potential salmonid habitat by reducing channel complexity and the quality and quantity of pools.
5.0  SHORELINE PLANNING AREA INVENTORY

The purpose of this section is to inventory and characterize conditions within the approximate boundaries of the City’s shoreline jurisdiction in greater detail and in the context of the larger watershed or landscape scale characterization of ecosystem-wide processes. The intent is to inventory elements of the natural and built environment as described in WAC 173-26-201(3)(c). Additionally, this section identifies how existing conditions in the shoreline jurisdiction influence or contribute to alterations of processes that maintain aquatic ecosystems or alter shoreline functions. The study area is shown on Figure 1 and subsequent figures as the City’s “shoreline planning area.”

5.1  Physical Features

Physical features in the shoreline planning area include natural landforms (steep slopes, floodplains, etc.) and structural alterations to the shoreline (bulkheads, levees, etc.). Landform features are shaped by natural processes and may influence or maintain shoreline functions. Alterations or shoreline modifications may affect natural processes and shoreline functions. Both natural features and modifications are related to biological resources (such as wetlands and streams) and land use patterns, which are described in subsequent sections.

Many physical and biological features of the shoreline (e.g., steep slopes, floodplains, wetlands) are subject to development standards or regulations by the City of Woodinville Municipal Code and/or other regulatory requirements. The following discussion focuses on how these features are defined, their location relative to regulated shorelines, and their relationship to shoreline ecological functions.

5.1.1  Geologically Hazardous Areas

Geologically hazardous areas are regulated under the City of Woodinville’s Critical Areas Regulations (WMC 21.24). Geologically hazardous areas include areas susceptible to erosion, sliding, earthquake, or other geological events.

Erosion hazard areas are defined by the Woodinville Municipal Code (21.24.290) as areas defined by the NRCS or a critical area special study as having a severe to very severe erosion potential. No erosion hazard areas are shown on the City’s map of geologically hazardous areas. Landslide hazard areas are defined as those areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors (WMC 21.24.290). Landslide hazard areas in the City of Woodinville are located on the steep slopes to the west of the Sammamish River. No landslide hazard areas are located in the shoreline jurisdiction. Seismic hazard areas are areas subject to severe risk as a result of earthquake induced ground shaking, slope failure, settlement, surface rupture, or soil liquefaction (WMC 21.24.290).

Sammamish River

There are no erosion or landslide hazard areas within the shoreline jurisdiction of the Sammamish River. The entire Sammamish River valley floor in Woodinville is mapped as seismic (liquefaction) hazard area.
Little Bear Creek

The shoreline jurisdiction of Little Bear Creek contains no erosion or landslide hazard areas. The entire length of Little Bear Creek in the City is mapped as seismic (liquefaction) hazard area.

5.1.2 Aquifer Recharge Areas

The primary source of information on aquifers in the Sammamish River Valley is the Redmond-Bear Creek Valley Ground Water Management Plan (Redmond-Bear Creek Ground Water Advisory Committee, 1999). According to this Plan, there are four aquifer zones underlying the Sammamish River Valley—Alluvial, Local Upland, Sea Level, and Regional. The Alluvial Aquifers are apparently restricted to alluvial deposits along Cottage Lake Creek, Evans Creek, and Bear Creek in the Redmond area. The local Upland Aquifers occur beneath the ridge of the Redmond-Bear Creek Ground Water Management Area. The Sea Level Aquifers underlie the entire Redmond-Bear Creek Ground Water Management area and are apparently independent of topography. The Regional Aquifers also underlie the entire Redmond-Bear Creek Ground Water Management Area and are also independent of topography. There is a high degree of connectivity between the surface water of the Sammamish River and its tributaries and the Alluvial Aquifer. The direction of flow between the river and the aquifers is the subject of ongoing research (Carey, 2003).

There is limited information on groundwater within the City of Woodinville. The easternmost portion of the City is located in the Redmond-Bear-Creek Valley Groundwater Area. A 2004 King County study of groundwater in the Sammamish River Valley included monitoring at four locations in Woodinville (King County DNRP, 2005). This study indicated that groundwater flows in the Woodinville area, like other areas in the Sammamish valley, flow toward the river.

King County GIS indicates several aquifer recharge areas in the Woodinville area (Figure 10). Critical aquifer recharge areas are protected by Woodinville’s Critical Areas Regulations (WMC 21.24)

A shallow, unconfined aquifer is located along the City’s northern border (King County Department of Natural Resources and Parks, 2003). The aquifer is fed by infiltration of precipitation from the surface and from upslope areas. The aquifer discharges to Little Bear Creek or flows in the same direction as Little Bear Creek.

The Cross Valley Aquifer is located north of the Woodinville city limits, but areas of the UGA are located within the aquifer. The aquifer was designated as a sole source aquifer by the Environmental Protection Agency (EPA) in 1987. A sole source aquifer is one that supplies 50 percent of more of the drinking water for an area. Contamination of a sole source aquifer could pose a threat to public health.

Sammamish River

Aquifer recharge areas are located to the east of the Sammamish River primarily in the upland areas (Figure 10). As indicated above, groundwater flow is toward the river with the aquifers recharging the river.
Little Bear Creek

Detailed information on aquifers is limited along Little Bear Creek. It is likely, however, that aquifer recharge areas are located adjacent to the creek. As in the Sammamish River Valley, these aquifers likely recharge Little Bear Creek. Studies of the Cross Valley Aquifer indicate that the City of Woodinville lies outside the 10-year time of travel zone of the aquifer and that the flow of groundwater is away from the Cross Valley Aquifer water supply wells and toward the City.

5.1.3 Flood Hazard Areas

Flood hazard areas are defined in the Woodinville Municipal Code as “those areas in the City of Woodinville subject to inundation by the base flood” (WMC 21.06.245). The base flood is defined as “a flood having a one percent chance of being equaled or exceeded in any given year, often referred to as the 100-year flood” (WMC 21.06.043). These areas are typically identified on the Federal Emergency Management Agency (FEMA) flood insurance rate maps as the 100-year floodplain. Because of its hydrologic association, jurisdictions may regulate all areas within the 100-year floodplain for shoreline management under the SMA. Flood hazard areas in the City are regulated by the Critical Areas Ordinance (WMC 21.24). The 100-year and 500-year flood zones for the Sammamish River and Little Bear Creek are shown on Figure 7.

Sammamish River

FEMA is in the process of updating flood hazard mapping on the Sammamish River. The updated maps are expected to be complete in September 2006, but are unlikely to be official until sometime in 2007. As described above, the Sammamish River is part of a U.S. Army Corps of Engineers flood control project and has been channelized, dredged and straightened. The flood control project is designed to accommodate approximately the 40-year springtime flood (equivalent to the 10-year winter storm) (King County, 2006). The project has reduced the frequency and severity of flooding problems. Flooding that does occur is typically an overflowing of the river channel and generally not destructive. Flooding has primarily affected agricultural and recreational lands in the floodplain, but as development increases, residential and industrial lands may be affected in the future. No known threats to public safety are likely to result from flooding of the Sammamish River (King County, 2006).

Figure 7 shows that the 100-year floodplain for the Sammamish River is primarily confined to the river channel. In the area from Tributary 0090 to just north of Woodin Creek, the 100-year floodplain extends beyond the river channel. The area on the east bank of the river is agricultural land, while the land on the west side is primarily industrial.

Little Bear Creek

The mapped floodplain for Little Bear Creek is relatively narrow in the lower reaches in the City (Figure 7). The floodplain widens north to the City limits. There is extensive commercial and industrial development adjacent to the floodplain, especially on the south side of the creek. Some older structures are constructed within the floodplain. Flooding of Little Bear Creek has posed little threat to public safety and there is no history of flood insurance payments along the creek.
5.1.4 Channel Migration Zones

The channel migration zone refers to the area along a river or stream within which the channel can be expected to migrate over time and which can generally correspond to the 100-year floodplain. Local geology, soils, and hydrologic conditions are principle forces driving channel migration. For example, a stream channel that occurs in areas underlain by bedrock or some other erosion-resistant soil would be relatively stable and not subject to channel migration. A stream channel that is underlain by highly erodible soils is more likely to migrate. Channel migration zones are generally greatest where stream channels exit steep terrain onto a broad valley floor. In a natural setting, channel migration zones provide important shoreline ecological functions, most notably aquatic habitat formation. These areas can provide the linkage between terrestrial (riparian) zones and aquatic systems, and regulate the entry of water, sediment, nutrients, and organic material into aquatic habitats (Gorsline, 2001).

Sammamish River

The Sammamish River shoreline planning area is not within an active channel migration zone. Due to the underlying geology, the Sammamish River in its natural state would be expected to have a fairly wide channel migration zone. However, historic and existing flood control projects (dikes and levees) have confined the channel to its present location. This channelization has eliminated shoreline functions that channel migration may have provided in an unaltered state, such as formation of off-channel habitat, LWD recruitment and storage, flood storage, and sediment delivery and storage.

Little Bear Creek

Little Bear Creek is essentially a low-gradient stream with a wide floodplain valley deriving most of its hydrology from groundwater seepage. The main channel of Little Bear Creek essentially from the current city boundary to the confluence with the Sammamish River is composed of somewhat poorly drained soils and therefore channel migration, when it occurred, was a gradual process. Contributions of LWD would have contributed much to channel migration through this area. Upstream of the current city boundary and including the UGA and several tributary streams on the western side of Little Bear Creek, soils are somewhat excessively drained. It would be expected that these areas were more susceptible to channel migration. However, bank armoring has reduced the migratory capacity of the stream channel. The channel in the lower portions has also become more entrenched, which also limits channel migration. The only portion of Little Bear Creek that maintains limited channel migration capacity is upstream of the King/Snohomish County line. However, continued development in this area ultimately results in the channel being confined. Shoreline functions provided by channel migration are generally absent in Little Bear Creek.

5.1.5 Shoreline Modifications

Shoreline modification refers to structural changes to the shorelines’ natural bank. Examples include shoreline armoring (bulkheads, riprap, etc.), overwater structures (dock and piers), or dredging and filling. The following assessment of the extent of shoreline modification is primarily based on the information presented in the Habitat Inventory and Assessment of Three
Shoreline armoring within the City’s shoreline jurisdiction is primarily in the form of levees. These structures are typically used to protect upland property from flooding and to retain or stabilize unstable banks. However, shoreline armoring also has adverse effects on the physical processes necessary to maintain native species habitats and shoreline functions. Dikes and levees do not allow stream access to floodplains and thus cut off side channel areas and wetlands that support natural processes and are vital to a number of species. Maintenance of dikes and levees often includes vegetation removal, which can reduce the recruitment of LWD that would facilitate the formation and maintenance of habitat. In addition to the loss of shoreline functions that channel migration would provide (as described above), constrictions to a channel can alter rates of sediment transport, change sediment composition, and increase flow velocities.

The Sammamish River and Little Bear Creek contain man-made channel crossings via roads/bridges and footbridges. Support structures for bridges and other stream crossings, and bridge abutments that are placed within the active stream channel can cause a decrease in stream velocity, thereby increasing sediment deposition upstream of the structure. This can potentially constrict flow in the channel, resulting in localized scouring and erosion of the streambed. If improperly constructed, some instream support structures can cause water to back up upstream of the bridge or crossing and result in localized flooding.

**Sammamish River**

The entire reach of the Sammamish River within the City’s shoreline jurisdiction has been confined by levees. The U.S. Army Corps of Engineers (Corps) is responsible for the bank armoring activities and their maintenance. Levee maintenance by the Corps is limited to the removal of wood debris if it is detrimental to the flood control structure. There are five bridges crossing the Sammamish River in the City’s shoreline planning area. Two vehicular bridges cross the Sammamish River in the City—NE 145th Street in the Tourist District and NE 175 Street in the Town Center. A bicycle/pedestrian bridge crosses the Sammamish River immediately north of NE 145th. There are also two railroad crossings, one immediately north of NE 175th and one immediately south. Most bridges have footings constructed in or on the levees, rather than in the river channel.

**Little Bear Creek**

Industrial and commercial areas surround the lower reach of Little Bear Creek within the City’s shoreline jurisdiction. This reach has been substantially armored with approximately 98 percent of the streambank being modified to protect properties from channel migration and the subsequent potential for erosion and loss of property. Armoring is primarily riprap along this reach. In addition, a culvert is located beneath State Route (SR) 202. The amount of armoring in the form of riprap generally decreases north toward the city limits and the UGA. Armoring here ranges from 10 to 17 percent and includes modifications such as riprap, culverts, gabion weirs, and bridges. There are approximately six stream crossings of Little Bear Creek within the City and the UGA.
5.2 Biological Resources

5.2.1 Wetlands

The City of Woodinville has GIS information on critical areas located in the City, including wetlands. The City’s wetland inventory is based primarily on the King County Wetland Inventory, which used the National Wetlands Inventory (NWI). The City has since added further wetland information to its GIS database based on input from the City’s Community Development Department and permitted development projects.

Sammamish River

The Sammamish River Valley was historically a wide area filled with wetlands and meandering and braided channels (U.S. Army Corps of Engineers and King County Department of Natural Resources and Parks, 2002). The river channel and valley have been significantly altered by development, forests have been cleared, wetlands have been drained, the river has been confined to one channel, the level of Lake Washington has been lowered altering the flow pattern of the river, and the river has been constrained for flood control.

Most floodplain wetlands no longer occur within the shoreline planning area of the Sammamish River due to the flood control project and other development projects. The remaining wetlands have high potential to provide hydrologic, water quality, and habitat functions, especially if more of them can be protected and enhanced. Restoring wetlands that are currently drained by agricultural activities can also create additional floodplain wetlands with relatively high functions. Most of the Sammamish River floodplain is mapped as having hydric soils.

A narrow swath of riverine wetland borders the Sammamish River for its length through the City of Woodinville. In most places this riverine wetland is dominated by reed canarygrass, but at a growing number of sites enhancement projects have been installed and are becoming established, increasing the diversity of shrub and forest vegetation along the banks of the Sammamish River. Common species that have been planted in this zone include black cottonwood, red-osier dogwood, Pacific ninebark, and western red cedar.

Little Bear Creek

Wetlands are found along Little Bear Creek and are generally associated with Norma loam, a hydric soil, which is mapped along most of the length of Little Bear Creek through the City of Woodinville and its UGA. Wetlands in the Little Bear Creek shoreline planning area are riverine and depressional. The habitat types include palustrine emergent, scrub-shrub, and forest. The habitat quality of wetlands along Little Bear Creek varies between disturbed wetlands dominated by reed canarygrass and bordered by major highways to relatively pristine mature forest with native herb and shrub layers. Dominant plants in the mature forest wetlands include western red cedar, salmonberry, and skunk cabbage. Willow species, red alder, black cottonwood, and reed canarygrass dominate wetland areas more disturbed by development.

Wetlands in the Little Bear Creek shoreline planning area provide a relatively high level of hydrologic, water quality, and habitat functions due to their diversity, ability to store floodwater flows, dense vegetation, and association with the stream. Though development continues to
encroach upon the Little Bear Creek shoreline planning area, wetland functions are generally improving in many areas along Little Bear Creek due to a number of wetland mitigation projects that have been installed or are in the planning stages. Fill has been removed and wetlands have been restored along Little Bear Creek as part of a WSDOT mitigation project near the intersection of State Route (SR) 9 and SR 522. This newly created dense shrub-scrub wetland is quickly becoming a forested wetland, providing habitat protection and shade to Little Bear Creek. The City of Woodinville has recently acquired an 18-acre parcel as Little Bear Creek Rotary Park. The park is being developed to provide recreation, non-motorized transportation, and habitat restoration along the banks of Little Bear Creek as it passes through the City. In addition, the City has acquired land for Little Bear Creek Linear Park along the west bank of the creek. The park is not yet developed, but some restoration work has been done by volunteers.

5.2.2 Critical Wildlife Habitat and Species

Critical fish and wildlife habitat areas are those areas identified as being of critical importance in the maintenance and preservation of fish, wildlife, and natural vegetation. Critical habitat, or fish and wildlife habitat conservation areas, means habitat areas with which endangered, and threatened species of plants or wildlife have a primary association (e.g., feeding, breeding, rearing of young, migrating), heron rookeries and nesting trees, Type 1 Streams and their buffers, Class 1 wetlands and their buffers, native growth protection areas and bald eagle territories (Chapter 21.24.410 WMC). Fish and wildlife habitat areas mapped by WDFW and the City of Woodinville are shown on Figure 11.

State and Federally Listed Species

Several state and federally listed species are known to occur or could potentially occur within the City’s shoreline jurisdiction. Federally listed species that have been documented within the City’s shoreline jurisdiction include bald eagle and Puget Sound Evolutionarily Significant Unit (ESU) Chinook salmon. Puget Sound/Strait of Georgia coho salmon, a federal species of concern, also occurs in the area. The Bull Trout and Dolly Varden Appendix to the 1998 Salmonid Stock Inventory (WDFW, 1998) does not identify any reproducing bull trout (or Dolly Varden, a similar native char) populations within the Sammamish River or its tributaries, which includes Little Bear Creek. One bull trout was identified during a two-year creel survey in Lake Washington (Pfeiffer and Bradbury, 1992) and two bull trout were reported within Issaquah Creek in 1993. The Coastal-Puget Sound Distinct Population Segment (DPS) bull trout is currently listed as threatened; however, the species has not been documented in the Sammamish River or its tributary streams. The Puget Sound ESU steelhead was recently proposed for listing as threatened and is anticipated to be listed in Fall 2006. Steelhead may use the Sammamish River and any accessible tributary streams, although anecdotal evidence suggests that Steelhead numbers may be very limited.

The Sammamish River, including tributaries and upland areas adjacent to these streams within the City’s shoreline jurisdiction do not contain critical habitat for any listed species.

Priority Habitats and Species

The Washington Department of Fish and Wildlife (WDFW) publishes the Priority Habitats and Species (PHS) list for Washington State, which includes a catalog of habitats and species.
considered to be priorities for both conservation and management. Priority species include those species that, due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance, require specific protective measures to perpetuate their existence. This includes State Endangered, Threatened, Sensitive, and Candidate species; species congregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable. Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species, which may consist of unique vegetation types or dominant plant species, a described successional stage, or a specific structural element (WDFW, 2005).

The only priority species documented in the City are anadromous and resident fish species, including resident cutthroat trout (Oncorhynchus clarki), rainbow trout (O. mykiss), Chinook salmon (O. tshawytscha), coho salmon (Oncorhynchus kisutch), largemouth bass (Micropterus salmoides), sockeye salmon (O. nerka) and winter steelhead (O. mykiss). The City’s shoreline planning area contains the following priority habitats: urban natural open spaces and wetlands (Figure 7). The area contains no nests or nesting territories for the bald eagle (Haliaeetus leucocephalus), and no great blue heron (Ardea herodias) rookeries or nests have been documented within the City or the City’s shoreline jurisdiction. However, foraging for both bald eagle and great blue heron is likely to occur within this area.

**Sammamish River**

Chinook salmon are documented as occurring throughout the entire reach of the Sammamish River within the City’s shoreline jurisdiction (Williams et al., 1975; WDFW, 2006; Kerwin, 2001; and David Evans And Associates, 2002). These are two separate stocks including the North Lake Washington tributary stock and the Issaquah Creek stock (Kerwin, 2001). Both of these stocks are summer/fall runs that generally enter the system from June through November with spawning occurring from late September through October. The predominant use of the Sammamish River within the City’s shoreline jurisdiction is limited primarily to rearing and migration. Spawning does not occur within the City’s shoreline planning area primarily due to the historical straightening and channelization that has occurred. The presence of the system of levees has also cumulatively resulted in the creation of a uniform channel that is devoid of habitat conducive to spawning (such as spawning gravels and side channel habitat). The levees have essentially removed much of the riparian vegetation, and LWD presence and recruitment are limited. Channel migration and contributions of new sediment, especially gravels, have been eliminated by the levee system. Typical reaches of the Sammamish River are comprised of 70 to 90 percent silt and clay substrates (King County, 2002). Water quality, especially temperature has been identified as the primary limiting factor for salmonids within the Sammamish River and its tributaries (Kerwin, 2001 and King County, 2002).

Coho salmon are also known to occur within the City’s shoreline jurisdiction (Williams et al., 1975; WDFW, 2006; Kerwin, 2001; and David Evans And Associates, 2002). The coho stock in Lake Washington and the Sammamish River are all of one stock, which is a mixture of native and hatchery origin fish (Kerwin, 2001). Adults typically enter the system from August through December with spawning occurring in tributaries from November through December. Coho generally rear in freshwater for up to eighteen months and likely utilize the Sammamish River for rearing in addition to migration. Spawning is not known to occur in the mainstem Sammamish River (King County, 2002).
Winter steelhead are also considered as one stock throughout WRIA 8, and the stock is considered native (King County, 2002). Adults typically enter the system from December through March and spawn in all accessible tributaries from March through June. Spawning does not occur in the mainstem Sammamish River; however, juveniles may rear in freshwater for up to three years before they outmigrate to the ocean, so the Sammamish River likely provides some rearing opportunities for juvenile winter steelhead.

Bull trout status within WRIA 8 is largely unknown and information on their abundance is limited (U.S. Army Corps of Engineers and King County Department of Natural Resources, 2002 and Kerwin, 2001). A self-sustaining population does exist above Chester Morse Dam on the Cedar River; however no spawning redds have been documented in the Sammamish River system. This is likely due to their preference for cold headwater streams, which are absent from the Sammamish River.

No bald eagle nests or breeding territories are located within the City’s Sammamish River shoreline jurisdiction. It is likely, however, that bald eagles use the area for forraging.

In addition to the state and federally listed species discussed above, the Sammamish River within the City’s shoreline planning area contains several salmonid species that are not considered endangered or threatened, but are listed as priorities for conservation and management including: sockeye salmon, rainbow trout, and cutthroat trout. Existing instream conditions limit the use of the Sammamish River within the City’s shoreline planning area to rearing and migrational corridors (U.S. Army Corps of Engineers and King County Department of Natural Resources, 2002 and Kerwin, 2001). Coho salmon and cutthroat trout have been documented within Woodin Creek, Gold Creek, and Derby Creek (stream # 0090), tributaries to the Sammamish River within the City’s shoreline jurisdiction. Kokanee (O. nerka) are also known to occur and spawn in the mainstem Sammamish River. Kokanee have been observed spawning downstream of the mouth of Little Bear Creek (R2 Consultants, 1999).

Riparian habitat is limited along the Sammamish River within the City’s shoreline jurisdiction. This is primarily due to development, the presence of levees/dikes, and agricultural areas. No priority riparian habitat is mapped along the Sammamish River in this area. The City has recently restored several sections of riparian vegetation as part of its Sammamish Re-Leaf Program. These restored areas have improved riparian vegetation along the river.

**Little Bear Creek**

Chinook salmon are known to occur within Little Bear Creek; however, the system is not highly utilized based on historical data and observations. Salmon spawning ground surveys performed by WDFW from 1952 through 2000 indicated that utilization over that time period was generally limited to less than 8 individuals with no adults documented from 1997 through 2000 (David Evans And Associates, 2002). Most Chinook are thought to be strays from the Issaquah Creek Hatchery or from Bear Creek. Little Bear Creek provides limited spawning, rearing, and migration habitat for Chinook salmon.

Coho salmon are also documented as occurring within Little Bear Creek. WDFW also performed salmon spawning ground surveys for coho during the same time frame identified above for Chinook and found that coho numbers vary year to year but indicated that “fair” numbers spawn.
in Little Bear Creek. Yearly observations ranged from 4,852 in the late 1970’s to 68 in 1991. The Washington Department of Fish and Wildlife counted 21 coho in 2004. Little Bear Creek provides spawning, rearing, and migration areas for coho salmon.

Winter steelhead have not been observed in Little Bear Creek; however, the potential exists for them to occur in the system. Bull trout are not expected to occur in Little Bear Creek due to life history requirements and preference for higher elevation streams with very cold water. These conditions do not exist within Little Bear Creek.

In addition to the state and federally listed species discussed above, Little Bear Creek within the City’s shoreline planning area contains several salmonid species that are not considered endangered or threatened, but are listed as priorities for conservation and management including: sockeye salmon, chum salmon, pink salmon, rainbow trout, and cutthroat trout (David Evans And Associates, 2002). Chum and pink salmon have only been observed once in the system and are thought to be strays from another Puget Sound watershed. Kokanee (O. nerka) are also known to occur and spawn in Little Bear Creek.

5.2.3 Instream and Riparian Habitats

Rivers and streams provide valuable wildlife corridors, a source of fluvial sediments to the marine shoreline, recreational opportunities, and support for a range of fish species. Information on stream conditions was drawn in particular from the following documents: Lake Washington/Cedar/Sammamish watershed (WR 8) Near Term Action Agenda (WR 8 Steering Committee, 2002), Sammamish River Corridor Action Plan (King County and U.S. Army Corps of Engineers, 2002), Final Lake Washington/Cedar/Sammamish Watershed (WR 8) Chinook Salmon Conservation Plan (WR 8 Steering Committee, 2005), Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8) (Kerwin, 2001), A Catalog of Washington Streams and Salmon Utilization - Volume I, Puget Sound Region (Williams et al., 1975), Little Bear Creek Corridor Habitat Assessment (David Evans And Associates, 2002) and the Habitat Inventory and Assessment of Three Sammamish River Tributaries: North, Swamp, and Little Bear Creeks (King County, 2001). The following characterization of the Sammamish River and Little Bear Creek is focused on conditions relative to fish and wildlife habitat.

Sammamish River

The Sammamish River Corridor Action Plan (King County, 2002) and the Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8) (Kerwin, 2001) both discuss habitat conditions within the mainstem Sammamish River. The two main factors influencing the Sammamish River within the City’s shoreline planning area are the channelization of the main channel and the rapid rate of urbanization. The impacts of agricultural development, urbanization, and channel modifications have impaired and effectively limit the ecological functions that the Sammamish River provides. Overall, habitat conditions are highly degraded compared to historical conditions. This in large part is due to increased urbanization within the entire watershed, and historical and current flood control practices. The habitat assessment indicated the following disturbances as having the most impact on the riverine aquatic system:
• Riverbanks have been hardened along the entire length through the City’s shoreline jurisdiction;

• Water quality, especially temperature and dissolved oxygen, have been impaired as a result of development, dependence upon aquifers for water supply, agriculture, and loss of riparian habitat. The loss of connections to wetlands has also reduced the overall water quality within the basin;

• Shoreline areas are highly developed with little riparian vegetation present and vegetated areas that are present are primarily composed of invasive species;

• LWD recruitment is limited due to historical river widening practices and currently by development and its associated infrastructure (roads/trails) and agricultural activities;

• Channel straightening has resulted in lack of habitat complexity (e.g., proper pool to riffle ratios, LWD, substrate composition); and

• Bank stability is good and erosion is minimal; however, this is due primarily to the levees and other modifications. These modifications do not allow the stream to form natural meanders and limit floodplain connections to adjacent wetlands and off-channel habitats.

**Little Bear Creek**

Little Bear Creek drains an area of approximately 15 square miles and includes a large portion of the City of Woodinville and portions of Snohomish County with approximately 80 percent of the drainage basin occurring in Snohomish County. Little Bear Creek experiences many of the problems associated with streams found in urban areas including water quality degradation, altered hydrology, increased sedimentation and altered sediment transport, lack of habitat complexity and connectivity, and inadequate riparian buffers.

Habitat in Little Bear Creek is affected by urban development within and outside of the City’s UGA. Increased development of the basin has resulted in an overall increase in impervious surface, with increased peak flows and decreased base flows in Little Bear Creek. Issues include:

• Increased peak flows cause erosion, excessive turbidity, scouring or downcutting of the channel bed, loss of pool habitat, and reduction in habitat complexity;

• Decreased base flows cause low flow during the dry summer months. The presence of impervious surfaces does not allow the water to infiltrate, but rather the water is collected in man-made collection systems that direct the water to the streams at a much faster rate than would occur naturally;

• Removal of riparian vegetation has occurred throughout much of the stream length, which reduces the recruitment of habitat forming LWD, removes potential sources of food and nutrients to the system, increases overall stream temperatures, and increases risk of predation to salmonids and other aquatic biota;

• Streambanks have been armored to confine the channel, thus the stream has lost much of its access to its former floodplain and off-channel habitat including wetlands; and

• Improperly constructed road crossings present barriers to salmonid migration; and
• Channel complexity has been reduced by road crossings, armoring, abrupt land use changes, channel incision and instability, and clearing and development of the riparian areas.

Little Bear Creek within the City’s shoreline jurisdiction is predominantly surrounded by industrial and commercial activities as well as transportation infrastructure. Historical and current development practices as well as associated armoring have resulted in degraded conditions throughout this reach. Approximately 98 percent of the reach is armored and therefore there is reduced connections to riparian wetlands and subsequently little off-channel habitat is provided for salmonids (David Evans and Associates, 2002). The riparian buffer along this reach averages approximately 25 feet with development along both banks and is typically of low quality consisting of red alder (Alnus rubra), Himalayan blackberry (Rubus discolor), bittersweet nightshade (Solanum dulcamara), and reed canarygrass (Phalaris arundinacea) (David Evans and Associates, 2002). The lowest reach contains only 5.1 percent forest habitat within a 400-foot wide riparian corridor (David Evans and Associates, 2002). The lack of LWD and potential for recruitment reduces pool quantity and quality and reduces quality of overall habitat. Impervious surface area throughout the basin has altered peak and base flows within the entire system. Substrates in this reach were found to consist primarily of coarse gravels that are approximately 29 percent embedded with fines, which would not provide adequate spawning conditions for salmonids. Few off-channel, ox-bows, or other potential refugia exist within the Little Bear Creek system. Water quality within the Little Bear Creek basin is also degraded. Temperature data collected indicate that temperatures within Little Bear Creek are not conducive to rearing and migration; however, temperatures are adequate during the timeframe when most adults are in the system spawning (David Evans and Associates, 2002). Little Bear Creek is also listed on the Washington State Department of Ecology 303(d) list of impaired water bodies for the dissolved oxygen parameter (Ecology, 2005). Little Bear Creek is no longer on the 303(d) list for fecal coliform bacteria. The Little Bear Creek Water Cleanup Plan (a TMDL) was prepared to address the fecal coliform issue within the basin (Dettelbach and Garland, 2005). Pesticides have also been indicated as occurring in concentrations high enough to be toxic to test species (Kerwin, 2001). Overall, habitat within this reach is highly degraded.

Areas upstream extending to the current city boundary and into the UGA are not as degraded as the lower reach within the City’s jurisdiction; however, they are under the same pressures as that occurring in the lower jurisdictional reach.

5.3 Land Use Patterns

Land use patterns are described in the context of existing land use, as well as planned or future land uses that are established by Comprehensive Plan land use designations and zoning designations.

5.3.1 Existing Land Use

The City of Woodinville’s shoreline jurisdiction is located within three of the City’s neighborhoods (as defined in the City’s Comprehensive Plan, 2002). From south to north the Sammamish River flows through the Tourist District, the Valley Industrial Neighborhood and the Town Center (Figure 8). Little Bear Creek is only considered a shoreline of the state from
slightly north of NE 132nd Avenue NE to its confluence with the Sammamish River. This reach extends through the Town Center and Valley Industrial neighborhoods. North of NE 131st Street (the shoreline jurisdiction boundary), the creek flows through portions of the City’s UGA referred to as the Grace Neighborhood, the Wedge Neighborhood, and the North Industrial Neighborhood (Figure 9).

**Sammamish River**

Current land use within the City’s Sammamish River shoreline jurisdiction is predominantly industrial, particularly on the west bank of the river, which lies completely in the Valley Industrial Neighborhood. The east bank includes multi-family uses in the Tourist District and a mix of parks, open space, and multi-family in the Town Center Neighborhood (City of Woodinville, 2002). The majority of the west bank of the Sammamish River near the City is the Sammamish River Trail owned by King County. East of the trail, from approximately NE 171st Street to NE 154th Street is unincorporated King County. Generalized existing land use within the City’s shoreline area is shown on Figure 9.

**Little Bear Creek**

Current land use within the City’s Little Bear Creek shoreline jurisdiction is also predominantly industrial with some park and open space near its confluence with the Sammamish River and some retail service use further north. North of the 132nd Avenue NE (the shoreline jurisdiction boundary), land uses along Little Bear Creek are predominantly single family residential and general business services with a smaller amount of parks and open space (City of Woodinville, 2002). No current land use data was available for the City UGA (the Grace neighborhood).

### 5.3.2 Comprehensive Plan and Zoning Designations

The City’s Comprehensive Plan provides a guide for future growth. The plan contains eleven land use goals developed through an analysis of existing conditions, projected needs, and community vision. These goals are meant to achieve a balance in the City’s development patterns and are to be achieved by implementing future land use policies. The goals include accommodating growth (residential, commercial and industrial) patterns while maintaining and promoting the City’s quality of life, encouraging less reliance on automobiles, and promoting development of the City’s downtown (City of Woodinville, 2002).

To implement its planning policies, areas of the City are assigned discrete categories of land use illustrated on its Comprehensive Plan Land Use Map. In general, future land use designations along the Sammamish River and Little Bear Creek closely follow the existing land use patterns. Figure 9 illustrates the future land use designations according to the Comprehensive Plan.

Zoning designations in the City of Woodinville generally follow the future land use designations established in the City’s Comprehensive Plan (Figure 8). These include Industrial, Residential, and Business. Snohomish County zoning designations apply in the UGA (Grace) until those areas are incorporated through annexation. Snohomish County zones in the Grace Neighborhood include Industrial and Agriculture.
Sammamish River

The Comprehensive Plan land use map shows that the west bank of the Sammamish River shoreline planning area, located entirely in the Valley Industrial Neighborhood, is primarily designated as Industrial. The east bank is designated Medium Density Residential in the Tourist District, a mix of Public/Open Space and Medium Density Residential in the Town Center, and Industrial north of SR 202 (City of Woodinville, 2002).

City zoning designations in the Sammamish River shoreline jurisdiction are, in general, consistent with the Comprehensive Plan land use designations. The west bank of the Sammamish River is zoned Industrial. The east bank is zoned a mix of Residential (R-12) and Tourist Business in the Tourist District, Residential (R-18) and Public Park/Open Space in the Town Center, and Industrial and Public Park/Open Space in the Valley Industrial Neighborhood.

Little Bear Creek

Both banks of Little Bear Creek within the City’s shoreline jurisdiction are designated on the Comprehensive Plan Land Use Map primarily as Industrial, with a small amount of land on the east bank designated Central Business. North of the City’s shoreline jurisdiction boundary, Little Bear Creek flows through areas designated industrial in the Grace neighborhood, moderate density residential and Park in the Wedge Neighborhood, and Auto/General Business in the North Industrial Neighborhood (City of Woodinville, 2002).

Zoning designations in the Little Bear Creek shoreline jurisdiction (approximately south of 132nd Avenue NE include Public Park/Open Space, Industrial, Central Business District (CBD), and General Business. North of the shoreline boundary, the zoning adjacent to the creek includes General Business, Public Park/Open Space, and Residential (R-6) (City of Woodinville, 2002). The Little Bear Creek shoreline area in the UGA (Grace) is zoned by Snohomish County. Snohomish zoning designation adjacent the creeks include Heavy Industrial, Light Industrial, and Agriculture (Snohomish County GIS, 2006).

5.3.3 Roads and Bridges

Road density is often used as an indicator of watershed conditions. Roads and transportation infrastructure near or adjacent to water bodies can create adverse impacts to those natural systems by blocking flow or creating impervious surfaces. Roadways represent a significant source of impervious surface in urban areas. Auto-related pollutants including petroleum products, hydrocarbons, and heavy metals, accumulate on road surfaces and are carried to nearby water bodies during storm events through sheet runoff or stormwater collection systems.

Sammamish River

Two automobile bridges cross the Sammamish River in the City, NE 145th Street in the Tourist District and NE 175th Street in the Town Center. A bicycle/pedestrian bridge crosses the Sammamish River immediately north of NE 145th Street. There are also two railroad crossings, one immediately north of NE 175th Street and one immediately south.

The density of roads along the west side of the Sammamish River is relatively low. Although there are few City roads along the river’s west bank, there are large areas of business and parking
access associated with buildings. SR 522 is within the shoreline jurisdiction of the Sammamish River where the river exits the City. The Sammamish River Trail runs the length of the Sammamish River within the City.

**Little Bear Creek**

Little Bear Creek is crossed by NE 178th Street and NE 131st Street (SR 202) in the shoreline jurisdiction. The creek then flows under SR 522 further north. Little Bear Creek is also crossed near it confluence with the Sammamish River by a bicycle/pedestrian bridge that is part of the Sammamish River Trail.

Road density within the Little Bear Creek jurisdiction is relatively high. In addition to NE 175th Street and NE 131st Street, SR 522 runs parallel to the Creek shoreline through the City and UGA. The total impervious surface in the Little Bear Creek watershed is approximately 37 percent. Road density in the Little Bear Creek watershed was estimated to be approximately 2.28 mi/mi². Based on this estimate, the NOAA Fisheries watershed conditions indicator for road density is not properly functioning (David Evans and Associates, 2002).

5.3.4 **Utilities (Stormwater/Wastewater Outfalls; Other)**

Sewer service is provided to the City at two levels. King County Metro provides sewage treatment and disposal as well as interception/transmission of collected wastewater. The Woodinville Water District provides for sewer collection and connection to the Metro system for most of the City. The Northshore Utility District provides service for a small area located in the southwest corner of the City. Sewer service in the City’s UGA is provided by the Cross Valley Water District and the Alderwood Water District. According to the Woodinville Water District’s Comprehensive Sewer Plan (1993), approximately 80 percent of the District’s residential water consumers were using septic systems. Approximately two-thirds of the City is connected to sewer. Within the 200-foot floodplain jurisdiction for the Sammamish River and Little Bear Creek, 100 percent of the development is hooked up to sewer.

The district system includes 13 connections to Metro’s system and approximately 60 miles of sewer mains ranging in size from 8 to 18 inches. Sewer lines cross the Sammamish Rivers at three locations and Little Bear Creek at two locations. King County’s Brightwater Wastewater Treatment facility is currently under construction and is expected to begin operation in 2010. The facility is located the north end of Little Bear Creek, east of SR 9 within the City’s annexation area. The outfall for this facility would be in Puget Sound.

Runoff in the City of Woodinville drains to a network of rivers, streams, lakes, and wetlands that feed into Lake Washington. In addition to the natural water system, the area contains a complex system of built conveyance, water quality protection, and storage facilities. Increases in population and development in this area have led to degraded water quality, erosion, flooding, and loss of habitat for fish and wildlife (City of Woodinville, 2002).

Upon incorporation, the City established a stormwater utility to manage flooding, erosion, sedimentation, aquatic habitat, and water quality. Chapter 13.03 of the Woodinville Municipal Code establishes stormwater standards for new development. The Sammamish River has seven stormwater outfalls maintained by the City. There are also 13 private outfalls and two
maintained by King County. There are 13 stormwater outfalls located along Little Bear Creek. Nine of these are private and four are maintained by the City.

Undetained and untreated stormwater runoff can deliver pollutants to water bodies, including heavy metals and other pollutants associated with automobiles and roadways. Water quality impairments described in previous sections include the presence of fecal coliform, heavy metals, and chemical compounds in the Sammamish River and Little Bear Creek. Untreated stormwater discharging to water bodies are likely contributing factors.

### Other Utilities

Water in the City is provided by the Woodinville Water District. The District purchases its water from the Seattle Water Department and is supplied from the Tolt River Pipeline and the Tolt Eastside Supply Line (City of Woodinville, 2003). The District operates and maintains eight storage facilities, five pumping stations (three active and two standby), 44 pressure-reducing stations, and 253 miles of transmission and distribution lines.

A variety of gas, telephone, electric, and related utilities serve the existing residential and commercial developments within the shoreline jurisdiction.

### 5.3.5 Existing and Potential Public Access Sites

The City of Woodinville has a diversity of parks, open space, and public facilities. There are approximately 45 acres of land zoned Parks. This includes the Sammamish River Trail, which parallels the Sammamish River; Woodin Creek Park, Wilmot Park, DeYoung Park positioned in the heart of downtown along NE 175th Street, Little Bear Creek Rotary Park, Little Bear Creek Lineal Park Property and a small residential pocket park in the Wedge Neighborhood.

Several parks and open space areas provide access to the Sammamish River and Little Bear Creek. The City’s Parks Recreation and Open Space Plan (2005) describes many of them. These areas are shown on Figure 12.

#### Sammamish River

**Wilmot Gateway Park**

The Wilmot Gateway Park is a 3.7-acre Community Park located on the east bank of the Sammamish River in the Town Center Neighborhood. Park features include a playground and open play area, picnic tables and shelters, public art, restrooms, and a non-motorized boat launch to the River. The Sammamish River Trail also passes through the park (City of Woodinville, 2005).

**Woodin Creek Park**

Woodin Creek Park is located approximately 0.2 miles south of Wilmot Gateway Park. It is a 4.1-acre park that was transferred from King County in 1997. The park features picnic shelters and benches, tennis and basketball courts, public art and an open play area. The park is immediately east of the Sammamish River Trail right-of-way (City of Woodinville, 2005).
Lake Sammamish River Trail (King County)

The Burke Gilman/Sammamish River Trail is a 27-mile trail that begins at 8th Avenue NW in the Ballard Neighborhood of Seattle and follows an old railroad right-of-way along the Ship Canal and north along Lake Washington. At Blyth Park in Bothell the trail becomes the Sammamish River Trail and continues for 10 miles through Woodinville to King County's Marymoor Park in Redmond. The trail is primarily used by bicyclists and pedestrians, but equestrians are allowed on the Trail between NE 175th Street in Woodinville to Marymoor Park where a separate soft surface equestrian trail exists (King County Parks Website, Accesses May 2006). Shoreline access (both physical and visual) is available for most of the length of the trail though the City.

Little Bear Creek

Little Bear Creek Park

Little Bear Creek Park is a resource conservancy park that is planned as a future community or neighborhood park. The park is a 6.8-acre park located immediately west of SR 522 north of 134th Avenue NE. Little Bear Creek flows from north to south through the park. The park has several wetlands and is currently undeveloped (City of Woodinville, 2005). The park is not within the City’s shoreline jurisdiction.

Rotary Community Park and Trail

Rotary is an 18.3-acre park located approximately 0.5-mile north of Little Bear Creek on the west side of SR 522. Primarily a resource conservancy park, it has a high use area comprising a small portion along NE 195th Street. The high use portion of the park features a skate/BMX facility, picnic shelters/tables, restrooms, art wall, climbing rock, playground, and lookouts to Little Bear Creek. There are also trails through the resource conservancy portion of the park.

Little Bear Creek Linear Park

A master plan for the Little Bear Creek Linear Park was completed in April 2004. The City’s 1998 Park’s Recreation, and Open Space Plan recommended a variety of open spaces, trails, and recreation areas, among these was the development of a linear trail system along the length of Little Bear Creek from the Sammamish River to the city limits at NE 205th Street (City of Woodinville, 2004). Implementation of the master plan would include conservation or acquisition of additional riparian habitat, wetlands areas, and woodlands located along the Little Bear Creek corridor on the east and west sides of SR 522. The park would conserve these areas for water quality protection, wildlife habitat, and open space buffer. Viewpoints, picnic facilities, and active and passive recreation activities may be developed. The plan seeks to link the downtown area with Little Bear Creek and residential areas through trails, bridges, and landscaping (City of Woodinville, 2005).

5.3.6 Historical/Cultural Resources

The existing Woodinville Shoreline Master Program (1997) provides a general goal to protect and restore those aspects, buildings, sites, and areas of shoreline having historic, cultural,
scientific, or educational values or significance (City of Woodinville, 1997). The program establishes policies to encourage compatible surrounding environments to ensure planning for the preservation of significant archeological resources, especially Native American sites in river and stream corridors. The program’s policies also direct the City to protect shoreline resources that provide educational opportunities or access to scientifically significant areas.

There are no known archeological or historical resources within the area subject to shoreline jurisdiction. The Washington State Department of Archeology and Historic Preservation maintains a database of sites listed on Washington’s Historic Register and the National Register of Historic Places. A search of the database for sites within the City revealed only one site, the Hollywood School House, located on NE 145th Street. This property is listed on both the state and national registers (Department of Archaeology and Historic Places, 2006). In addition to the Hollywood School, the Hollywood Farm, located a short distance east on NE 145th Street, and the Woodinville School, located in the Town Center, are on the King County’s Local Landmarks List (King County, 2006). None of these sites are located within the City’s shoreline jurisdiction.
6.0 ASSESSMENT OF SHORELINE FUNCTIONS AND OPPORTUNITY AREAS

This section summarizes key findings concerning how shoreline functions of the Sammamish River have been impaired, both by land use activities and alterations occurring at an ecosystem-wide scale, and by activities within the City, its UGA, and its shoreline planning area. This section also identifies opportunities for the protection or enhancement of areas where shoreline ecological functions are intact, and opportunities for restoration of impaired shoreline functions, at both a programmatic (i.e., City or UGA-wide) and site-specific level. Opportunities for enhanced or expanded public access to the shoreline are also discussed. A similar discussion for Little Bear Creek is presented in Section 7.0.

6.1 Status of Shoreline Functions

Table 6.1 provides a summary of shoreline ecological functions for the Sammamish River. Causes of impairment and the relative scale at which impairments are occurring (e.g., watershed, UGA-wide, shoreline reach scale, or multiple scales) are identified. Finally, general or programmatic restoration opportunities to address impairments are described. Following Table 6.1 is a more detailed discussion of site-specific restoration opportunities.

<table>
<thead>
<tr>
<th>Condition and Causes of Impairment</th>
<th>Scale of Alterations and Impairment</th>
<th>Shoreline Ecological Functions Affected</th>
<th>Programmatic Restoration Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak and base flows may be impaired. Summer low flows in the Sammamish River have declined. Potential causes include increased impervious area and increased demand for groundwater and tributary withdrawals in the watershed.</td>
<td>Watershed scale</td>
<td>Hydrologic Hyporheic</td>
<td>Protect groundwater sources to the River, particularly in the Little Bear Creek basin.</td>
</tr>
<tr>
<td>Movement and storage of water has been highly altered. Channelization via dikes and levees has isolated the river from its former floodplain and associated wetlands, reducing flood storage capacity and increasing flow velocities. Levees constructed of or on compacted fill have likely altered groundwater movement, infiltration capacity, and capacity for groundwater exchange.</td>
<td>Watershed scale</td>
<td>Hydrologic Hyporheic</td>
<td>Support efforts to set back levees to reestablish connectivity to former floodplain and associated wetland. However, the potential for set backs is limited by Corps of Engineer policy and adjacent trails, roads, and development.</td>
</tr>
<tr>
<td>Condition and Causes of Impairment</td>
<td>Scale of Alterations and Impairment</td>
<td>Shoreline Ecological Functions Affected</td>
<td>Programmatic Restoration Opportunities</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------------------------</td>
<td>----------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Wetlands cut off from the river can no longer provide essential storage, recharge, or water quality functions.</td>
<td>Watershed, UGA-wide, and reach scale</td>
<td>Hydrologic&lt;br&gt;Hydorheic&lt;br&gt;Water quality</td>
<td>Target local wetland restoration and mitigation so they provide storage, detention, and water quality functions. Restore and reconnect wetlands adjacent to tributary streams of the Sammamish River. Continue to restore wetlands within the levees.</td>
</tr>
<tr>
<td>Channel migration has been eliminated by the levee system along the river and the ability to incorporate new sediments (gravel) has been impaired.</td>
<td>Watershed scale</td>
<td>Hydrologic&lt;br&gt;Instream habitat structure&lt;br&gt;Off-channel habitat formation</td>
<td>Opportunities are limited. Localized setback levees could reestablish some sediment delivery processes.</td>
</tr>
<tr>
<td>Sources of suspended sediment in the river are natural, but increased flow velocities from channelization has resulted in increased bedloads, habitat homogenization, and lack of refugia for rearing and migrating salmonids.</td>
<td>Watershed scale</td>
<td>Hydrologic&lt;br&gt;Instream habitat structure</td>
<td>Protect tributaries to the river which provide off-channel habitat.</td>
</tr>
<tr>
<td>Habitat is impaired. Channelization via dikes and levees has reduced riparian and off-channel habitats and reducing instream habitat types. The lack of instream structure has limited the rearing and spawning habitat in the Sammamish River.</td>
<td>Watershed scale</td>
<td>Instream and riparian habitat structure</td>
<td>Protect tributaries to the river which currently provide off-channel habitat.</td>
</tr>
<tr>
<td>No forested riparian vegetation exists along the Sammamish River. Some areas along the river have been planted with trees in the last 10 years as part of riparian and wetland restoration projects. Vegetation management practices for the levees has eliminating large woody debris recruitment potential.</td>
<td>Watershed and reach scale</td>
<td>Instream and riparian habitat structure</td>
<td>Where feasible under Corps of Engineers regulations, restore riparian habitats, particularly conifers, through shoreline plantings. Continue riparian and wetland restoration plantings. Minimize future tree removal within the levees.</td>
</tr>
<tr>
<td>The potential causes of water quality impairment (i.e., contamination by fecal coliform) include leaking septic systems and animal wastes entering the stream (in the City and upstream in the watershed). Agricultural runoff and</td>
<td>Watershed, UGA-wide, and reach scale</td>
<td>Water quality</td>
<td>Manage, detain and treat stormwater discharging to the Sammamish. Coordinate with King and Snohomish</td>
</tr>
</tbody>
</table>
6.2 **Site-Specific Restoration Opportunities**

Site-specific restoration opportunities on the Sammamish River are somewhat limited by the Corps of Engineers flood control project. The flood control project constrains levee setbacks, reestablishing meanders, adding LWD, and riparian plantings. The City of Woodinville has worked within these constraints and has conducted or sponsored several riparian restoration projects along the Sammamish River in the past 10 years.

Several site-specific opportunities along the Sammamish River have been previously identified (U.S. Army Corps of Engineers and King County Department of Natural Resources and Parks, 2002; WRIA 8 Steering Committee, 2002 and 2005). The opportunity areas are described below and shown in Figure 14.

- **S-1.** There are potential opportunities to restore the riparian area adjacent to and downstream of the Little Bear Creek confluence. Some restoration has already been done in this area. The existing vegetation should be maintained and efforts to remove invasive species and plant native vegetation should continue.

- **S-2.** The creation and enhancement of pools in the Sammamish River has been identified as a way to provide cool water refuges for migrating adult salmon in the entire Sammamish River system (WRIA 8 Steering Committee, 2002 and 2005). In the Woodinville area, the mouths of the tributary streams, Gold, Woodin, and Derby Creeks, provide opportunities for pool creation.

- **S-3.** Gold, Woodin, and Derby Creeks also provide opportunities for enhancing tributary confluences. Enhancements could include correction of fish passage barriers, riparian restoration and placement of LWD.
• **S-4.** Wetland restoration opportunities exist at Gold Creek. Restoration projects would include removal of non-native vegetation, creation of side channel and wetlands, revegetation of riparian and wetland areas with native plants, and placement of terrestrial LWD.

• **S-5.** The general lack of riparian vegetation along the Sammamish River provides the opportunity for riparian restoration along the full length of the river corridor in Woodinville. The City has been actively involved in the Sammamish River Re-Leaf Program, an annual planting event along the river. Continuation of the Re-Leaf Program will increase riparian vegetation and provide shaded refuge areas for migrating salmon.
7.0 ASSESSMENT OF SHORELINE FUNCTIONS AND OPPORTUNITY AREAS – LITTLE BEAR CREEK

This section summarizes key findings concerning how shoreline functions of Little Bear Creek have been impaired, both by land use activities and alterations occurring at an ecosystem-wide scale, and by activities within the City, its UGA, and its shoreline planning area. This section also identifies opportunities for the protection or enhancement of areas where shoreline ecological functions are intact, and opportunities for restoration of impaired shoreline functions, at both a programmatic (i.e., City or UGA-wide) and site-specific level. Opportunities for enhanced or expanded public access to the shoreline are also discussed.

7.1 Status of Shoreline Functions

Table 7.1 provides a summary assessment of shoreline ecological functions for Little Bear Creek. Causes of impairment and general or programmatic restoration opportunities are described. Following Table 7.1 is a more detailed discussion of site-specific restoration opportunities.

<table>
<thead>
<tr>
<th>Condition and Causes of Impairment</th>
<th>Scale of Alterations and Impairment</th>
<th>Shoreline Ecological Functions Affected</th>
<th>Programmatic Restoration Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of residential and industrial land uses and transportation corridors has resulted in the use of shoreline armoring to limit channel migration and protect private properties. This channelizes flow, limits sediment supply to the stream, reduces habitat complexity, and reduces off-channel habitat. Reduction in connectivity between streams and off-channel and riparian wetlands can reduce overall flood storage capacity, water quality, reduce biotic diversity, and simplify habitat types.</td>
<td>Reach scale</td>
<td>Hydrologic Instream habitat structure Off-channel habitat formation Water quality</td>
<td>Implement the City’s updated Environmentally Critical Areas Code (e.g., stream and wetland buffers on new development as well as on redevelopment). Where feasible, consider removal of bank armoring (riprap/concrete) and replacement with soft armoring and bioengineering measures (i.e., riparian plantings). More engineered types of armoring that would still maintain protection of private property, but would also allow more natural processes to occur could be employed.</td>
</tr>
<tr>
<td>Development (including bank armoring) has resulted in the removal of riparian vegetation. Riparian vegetation serves to protect water quality by providing thermal cover, serves to attenuate flooding by reducing the rate of flow</td>
<td>Reach scale</td>
<td>Hydrologic Instream and riparian habitat structure Water quality</td>
<td>On a programmatic level, potential opportunities to increase habitat complexity through the introduction of LWD should be evaluated. Given the location of Little</td>
</tr>
</tbody>
</table>
Site-specific restoration opportunities on Little Bear Creek are limited by private ownership of large portions of the shoreline area in the City. The WRIA 8 planning process identified several site-specific opportunities along the creek (WRIA 8 Steering Committee, 2002 and 2005). Most
of the opportunities are the removal of fish passage barriers. In addition, there are riparian restoration opportunities associated with the proposed Little Bear Creek Linear Park. The opportunity areas are described below and shown in Figure 14.

- **LBC-1.** Fish passage barriers are located at several points along the lower reach of Little Bear Creek in the City. Removal of these barriers will improve fish passage opportunities. The City has completed fish passage improvements at NE 205th Street. The barriers are located at the following road crossings:
  - 132nd Avenue NE;
  - 134th Avenue NE;
  - NE 195th Street
- **LBC-2.** The City has plans to develop a linear park along the west bank of Little Bear Creek. This will provide opportunities for riparian restoration and providing public access to the Creek.
8.0 DATA GAPS AND RECOMMENDATIONS

This section describes data gaps identified during development of the shoreline inventory and characterization. It also provides recommendations for addressing data gaps as the City continues the process to update its Shoreline Master Program.

- **Floodplain Mapping.** Since the location of the floodplain is integral to the definition of the City’s shoreline management jurisdiction and planning area, accurate mapping is critical to the City’s SMP. FEMA is remapping flood hazard areas in the City of Woodinville and expects to release the maps sometime in 2006. Incorporating this mapping would enhance the City’s understanding of baseline conditions as it continues to update its SMP.

- **Little Bear Creek and Sammamish River TMDLs.** The City is working with Ecology, WSDOT, and Snohomish County through the TMDL process to assign specific allowable discharges. The TMDL assignments will assist the City in eliminating and reducing non-point sources of pollution. The TMDL that will be developed for fecal coliform, dissolved oxygen and temperature issues on the Sammamish River will also help the City identify sources of water quality problems and potential restoration opportunities.
9.0 REFERENCES


King County. 2006. DRAFT 2006 King County Flood Hazard Management Plan. February 6, 2006 Public Review Draft.

King County Department of Natural Resources and Parks Water and Land Resources Division. 2001. Habitat Inventory and Assessment of Three Sammamish River Tributaries: North, Swamp and Little Bear Creeks. Seattle, Washington.


APPENDIX A – MAP FOLIO
FIGURE 10
CITY OF WOODINVILLE FISH AND WILDLIFE HABITAT AREAS
WOODINVILLE SMP UPDATE
WOODINVILLE / KING COUNTY, WASHINGTON

Species Name:
- Coho Salmon
- Fall Chinook
- Largemouth Bass
- Rainbow Trout
- Resident Cutthroat
- Sockeye Salmon
- Summer Steelhead
- Winter Steelhead
- Shad
- Red Patagon

Map data are the property of the sources listed below.
Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.
SOURCE: King County, 2005; Woodinville, 2006.
Map data are the property of the sources listed below. Inaccuracies may exist, and Adolfsen Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.

SOEURCE: KINCN G CONUTY, 2005; WOODINVILLE, 2006

Miles

Central Puget Sound Basin

Cedar River / Lake Washington

Central Puget Sound

Sammamish River

Woodinville

Duwamish / Green River Basin

Cedar River / Lake Washington Basin

WRIA -8

Cedar-Sammamish

Lak e Was hin gton

Lake Sammamish

Lake Sammamish

Cedar River / Lake Washington

Cedar River

Ced ar R iver / Lake Washington-

Lake Washington

Howard A. Hanson Dam

Tacoma Water Withdrawl Point
FIGURE 1

CITY OF WOODINVILLE SHORELINE PLANNING AREA
Woodinville Shoreline Inventory
WOODINVILLE / KING COUNTY, WASHINGTON

Woodinville City Limits and PAA
County Boundary
Parks
King County Streams
Waterbodies
smp