Town of Eatonville
Shoreline Master Program Update
Draft Shoreline Inventory and Characterization Report

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Chapter 1 Introduction

1.1 Purpose

The Town of Eatonville (Town) is conducting a comprehensive Shoreline Master Program (SMP) update with the assistance of a grant administered by the Washington State Department of Ecology (Ecology) (SMA Grant No. G1000029). According to Substitute Senate Bill (SSB) 6012, passed by the 2003 Washington State Legislature, cities and counties are required to update their SMPs consistent with the state Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58 and its implementing guidelines, Washington Administrative Code (WAC) 173-26.

An early step in the comprehensive update process is an inventory and characterization of shoreline conditions. The inventory and characterization provide a basis for updating shoreline management goals, policies, and regulations and for identifying public access and shoreline restoration opportunities. The term 'shorelines' in this report refers to areas that meet the criteria for 'shorelines of the state' as shown in Map 1 (Appendix A). In Eatonville, these shorelines are: The Mashel River, The Little Mashel River, Ohop Creek, and Lynch Creek.

This report describes the initial results of the shoreline inventory and analysis, which was completed in accordance with Tasks 2.1 and 2.2 of the Town's grant agreement with Ecology. It includes a discussion of the ecosystem processes that influence the Town's shorelines and provides more detailed descriptions of the ecological functions and land use patterns along each shoreline. Accompanying this report, in Appendix A, is a series of maps depicting shoreline features and conditions (see Table 2-1 for a list of maps in Appendix A).

Based on the findings of this report, the Town will begin the next steps in the SMP update process, which include developing shoreline environment designations and preparing draft SMP goals, policies, and regulations. The Town will also prepare a separate restoration plan to more fully describe restoration goals and opportunities.

1.2 Regulatory Overview

Washington's Shoreline Management Act was passed by the State Legislature in 1971 and adopted by the public in a referendum. The SMA was created in response to growing concerns about the effects of unplanned and unregulated development on the state's shoreline resources. A central goal of the SMA is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines[1]."

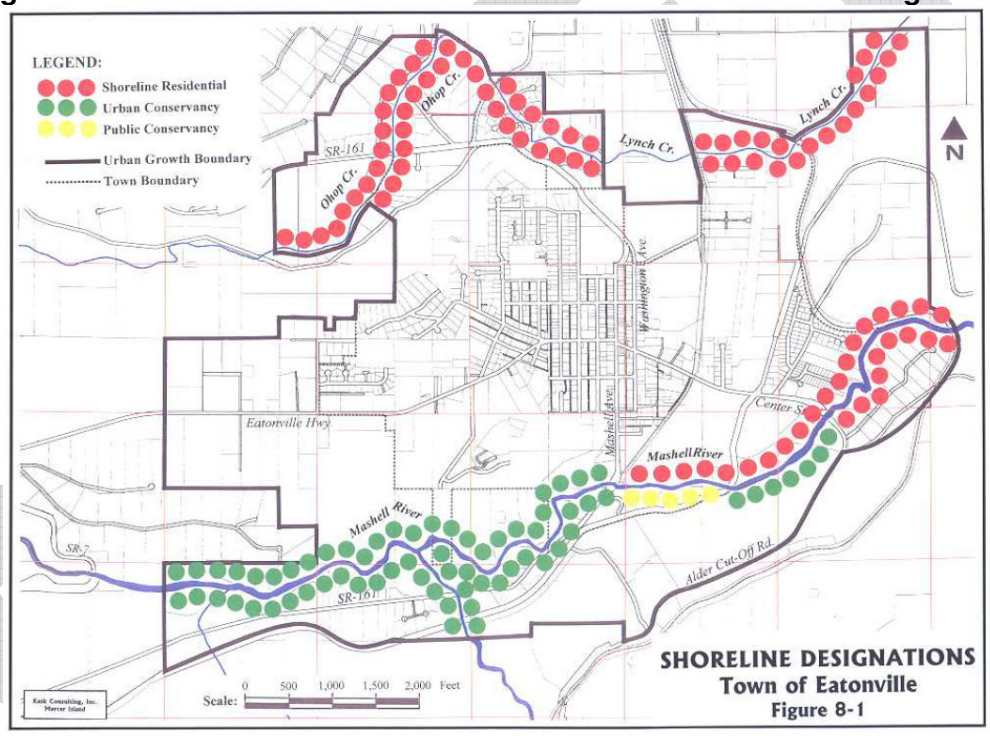
Ecology administers the Act, but gives primary permitting authority for shoreline development to local governments. Local governments are also charged with developing SMPs in accordance with the state Guidelines developed by Ecology. The Guidelines give local governments some discretion to adopt SMPs that reflect local circumstances and to develop other local regulatory and non-regulatory programs related to the goals of shoreline management as provided in the policy statements of RCW 90.58.020, WAC 173-26-176, and WAC 173-26-181.

[1] RCW 90.58.020

The Town of Eatonville has been using the Pierce County SMP to plan for and regulate uses along its shorelines. That document was adopted in 1975 and revised in 1981; it has not been revised since. Pierce County is in the process of updating its SMP and expects to complete their process in 2010. The Town began to develop an SMP in 2000, but suspended the effort when the Washington State Department of Ecology (Ecology) began the process of updating the Shoreline Guidelines (WAC 173-26).

SMPs are required to have a system for classifying shoreline areas based on their biological and physical characteristics, their existing and planned land use patterns, and the goals of the community. This system of shoreline environment designations (SED) groups areas that share similar characteristics so they can be managed in a uniform and consistent manner. In a regulatory context, shoreline environment designations function similarly to zoning overlays. 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 can be tailored to the designation. Under the current SMP, the Town's shorelines are designated as one of three environments: Shoreline Residential, Urban Conservancy, or Public Conservancy.

Figure 1-1 Current Town of Eatonville Shoreline Environment Designations



Source: Town of Eatonville Comprehensive Plan

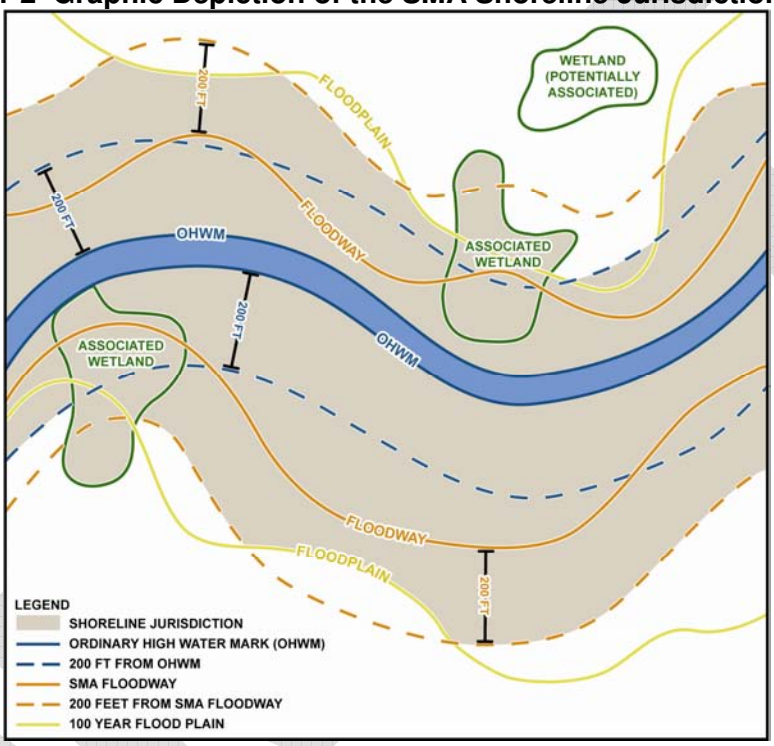
1.3 Shoreline Jurisdiction and Definitions

According to the SMA, the Town's SMP regulations apply to all 'shorelines of statewide significance', 'shorelines', and their adjacent 'shorelands'[2]. 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

[2] RCW 90.58.030

more. 'Shorelines' are defined as streams or rivers having a mean annual flow of 20 cfs or greater and lakes with a surface area of 20 acres or greater. 'Shorelands' are defined as the upland area within 200 feet of the ordinary high water mark (OHWM) of any shoreline or shoreline of statewide significance; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all associated wetlands and river deltas. 'Associated wetlands' means those wetlands that are in proximity to and either influence or are influenced by waters subject to the SMA (Figure 1-2)[3]. These are typically 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.

Figure 1-2 Graphic Depiction of the SMA Shoreline Jurisdiction Limits



This shoreline update will include qualifying waterbodoes within the Town of Eatonville as well as its Urban Growth Area (UGA). The UGA is currently in Pierce County's jurisdiction. However, by planning for the UGA as part of this SMP update, policies and regulations can be developed that address the UGA in the event that annexation occurs before the Town's next comprehensive SMP update. If annexation occurs, the annexed areas would become part of the incorporated area under the Town's jurisdiction and would be subject to the shoreline policies and regulations in this Program, without modification.

1.4 Relationship to Other Plans and Programs

Town Plans and Programs

The Town's SMP works in concert with the Comprehensive Plan and a variety of other regulatory plans and programs to manage shoreline resources and regulate development near the shoreline. The Comprehensive Plan establishes the general land use pattern and provides an overall vision for growth

[3] WAC 173-22-030(1)

and development for areas inside and outside shoreline jurisdiction. Various sections of the Eatonville Municipal Code (EMC) also play a major role in how shorelines are managed. These include:

- **EMC Title 18 – Zoning**. Establishes zoning districts and regulates land use in the Town including the shorelines.
- **EMC 15.04 - SEPA**. Establishes procedures and policies to implement the state environmental policy act (SEPA). All non-exempt Town actions require environmental review under SEPA.
- **EMC 15.16 –Critical Areas Code**. Establishes policies, regulations and land use controls to protect critical areas, including streams, wetlands, critical aquifer recharge areas, floodplains, geologic hazrds, and habitat conservation areas consistent with the State's Growth Management Act (GMA). Additional information on critical areas regulations is provided in chapter 4.
- **EMC 16.54 - Stormwater Management and Erosion Control**. Establishes policies and regulations for the comprehensive management of surface and stormwater, erosion control, flooding, clearing and grading activities. The Town has adopted the 2005 Pierce County Stormwater Management and Site Development Manual. The Town has developed a new stormwater control plan, which is currently in draft form.

The SMA requires local governments and state agencies to review their plans, regulations, and ordinances that apply to areas adjacent to shoreline jurisdiction and modify those plans, regulations, and ordinances so they "achieve a consistent use policy" in conformance with the Act and the SMP[4]. This means that the Town's comprehensive plan and development regulations must be consistent with the SMP overall.

One of the most important areas for consistency is between the SMP and the Town's development standards and use regulations for environmentally critical areas[5]. Environmentally critical areas including streams, wetlands, aquifer recharge areas, floodplains, geologic hazard areas, and habitat conservation areas are found in the Town's shoreline jurisdiction. Although critical areas in shoreline jurisdiction are to be identified and designated under the GMA[6], they must also be protected under SMA. The Washington State Legislature and the Growth Management Hearings Board have determined that local governments must adopt SMPs that protect critical areas within shoreline jurisdiction at a level that is "at least equal" to the level of protection provided by the local critical areas ordinance for critical areas outside shoreline jurisdiction[7].

State and Federal Programs

As stated in WAC 173-27, it is the intent of the SMA to provide for integration of the shoreline permit into a consolidated environmental review and permit process. In achieving this goal, the shoreline policies and regulations contained in the updated SMP will also have to work in concert with several State and Federal permitting programs that relate to shorelines. These include:

[4] RCW 90.58.340
[5] EMC 15.16
[6] RCW 36.70A
[7] ESHB 1933

- **Hydraulic Project Approval (HPA).** The HPA program applies to any construction activity in or near the waters of the state. The program is administered by the Washington State Department of Fish and Wildlife (WDFW). All applicable projects are required to submit permit applications to show that construction is done in a manner to prevent damage to the state's fish, and shellfish, and their habitats.

- **Clean Water Act Section 404 Dredge and Fill Requirements.** Section 404 of the Federal Clean Water Act (USC 1394) regulates the discharge of dredged or fill material into waters of the United States. Any project that proposes discharging dredged or fill material into the waters of the United States, including special aquatic sites such as wetlands (non-isolated), must get a Section 404 permit. The U.S. Army Corps of Engineers (Corps) can authorize activities by a standard individual permit, letter-of-permission, nationwide permit, or regional permit. The Corps makes the determination on what type of permit is needed.

- **Clean Water Act Section 401 Water Quality Certification.** Applicants receiving a section 404 permit from the U.S. Army Corp of Engineers, a Coast Guard permit or license from the Federal Energy Regulatory Commission (FERC), are required to obtain a section 401 water quality certification from the Department of Ecology (Ecology). Issuance of a certification means that Ecology anticipates that the applicant's project will comply with state water quality standards and other aquatic resource protection requirements under Ecology's authority.

- **Washington State Water Pollution Control Act.** All projects effecting surface waters in the state, including those that are not subject to the Federal Clean Water Act sections 404/401 must still comply with the provisions of the State's Water Pollution Control Act (RCW 90.48).

- **Federal Endangered Species Act (ESA).** All projects that have the potential to directly or indirectly impact wildlife species listed as endangered or threatened under ESA are subject to environmental review by the U.S. Fish and Wildlife Service (USFWS) or the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries). Chinook are listed as threatened.

- **Army Corps of Engineers Section 10 (Permit for Work in Navigable Waters).** The Corps has jurisdiction in all navigable waters of the State. Any work in, over, or under navigable waters of the U.S must apply for a Section 10 permit. The purpose of Section 10 permitting is to prohibit the obstruction or alteration of navigable waters of the U.S.

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Chapter 2 Methods

2.1 Determining Shoreline Planning Area Boundaries

The approximate extent of shoreline jurisdiction within the municipal limits of the Town of Eatonville and its UGA is shown in Map 1 (Appendix A) and referred to as the shoreline planning area (SPA). In general this extent represents:

- Lands within 200 feet of the Ordinary High Water Mark (OHWM) on either banks of the Mashel River, Little Mashel river, Ohop Creek and Lynch Creek within the Town's municipal limits;
- Lands within 200 feet of the Ordinary High Water Mark (OHWM) on either bank of the Mashel River, Little Mashel River, Ohop Creek and Lynch Creek within the designated UGA of the Town;
- All floodways associated with the areas above;
- Those portions of the 100-year floodplains currently mapped by the Federal Emergency Management Agency (FEMA) that are within 200 feet of the mapped floodway; and
- All mapped wetlands that lie adjacent and contiguous to the areas above.

This area covers a total of approximately 3 linear miles within the Town limits and 2.6 miles within the UGA. The shoreline planning area encompasses approximately 317 acres, of which approximately 190 acres (60 percent) is located within the UGA.

Planning area boundaries were derived using existing GIS information[8]. For purposes of this report, the mapped edges of the Mashel River shorelines are assumed to correspond to the approximate location of the OHWM. The Little Mashel River, Ohop Creek, and Lynch Creek SPAs are based on mapped stream centerlines. In both cases, field inspection is required to identify the actual OHWM location on a specific property and determine jurisdiction limits, regulatory setbacks and/or buffers. Likewise, the mapped wetlands may or may not be 'associated' wetlands; generally a wetland's relationship to the shoreline must be determined in the field by on-site inspection[9].

The shoreline planning area is intended for planning purposes only. As a result, the actual regulated boundaries of shoreline jurisdiction may differ from the area shown on Map 1 depending on information gathered on the ground at any specific location.

For purposes of the shoreline inventory and characterization, the shoreline planning area was divided into segments, called reaches. Each waterbody in the Town and UGA represent one reach.

[8] Pierce County reviewed the latest USGS data regarding upstream boundaries for SMA streams and rivers (USGS, Water-Resources Investigations Report 96-4208) as well as summary data provided by Ecology (available at http://www.ecy.wa.gov/programs/sea/sma/st_guide/jurisdiction/SMA%20Suggested%20Coordinates.xls) to confirm SMP jurisdictional boundaries.

[9] Additional associated wetlands may be present that are not depicted on the available maps.

2.2 Inventory Data Sources

A number of local, regional, state and federal agency data sources, maps, and technical reports were reviewed to compile this inventory and characterization report. This includes information pertaining to watershed conditions and ecosystem-wide processes as well as data on the land use patterns and ecological conditions of Eatonville's shorelines. Assessing conditions at these two distinct geographic scales (the watershed scale and the shoreline reach scale) is a key requirement of the SMP update process[10].

One of the primary information and data sources used to prepare this report was the Pierce County Inventory and Characterization Report (ICR) (ESA Adolfson, 2009), hereafter referred to as the Pierce County ICR. The Pierce County ICR describes the ecological conditions associated with the all of the SMA waterbodies in the County as well as watershed scale analysis for the Nisqually Watershed (WRIA 11).

A series of maps depicting shoreline attributes accompanies this report as Appendix A. A list of the Appendix A map themes is shown in Table 2-4. A complete list of data sources used to compile the report is included in Chapter 8.

Table 2-1 Shoreline Map List (Appendix A)

Map Title	Map No.
Shoreline Planning Area	1
Regional Context	2
Vicinity Map	3
Topography and Hydrology	4
Fish and Wildlife Habitat	5
Geology	6
Soils	7
Geologic Hazards	8
Comprehensive Plan Land Use Designations	9
Zoning	10
Parks, Open Space, and Public Access	11

[10] WAC 173-26-201

2.3 Characterizing Ecosystem-wide Processes and Shoreline Functions

The SMA Guidelines require local jurisdictions to evaluate ecosystem-wide processes and their relationship to shoreline ecological functions. Ecosystem processes generally refer to the dynamic physical and chemical interactions that form and maintain aquatic resources at the watershed scale. These processes include the movement of water, sediment, nutrients, pathogens, toxins, and wood as they enter into, pass through, and eventually leave the watershed.

The analysis of ecosystem processes for this report was drawn largely from the Pierce County Ecosystem analysis. That report performed the characterization using a modified version of the methods described in *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley et al., 2005). The approach develops general predictions of how water moves within a watershed based on topography, soils, geology, climate and other hydrogeologic factors. Across a watershed, these factors govern the patterns of surface water and groundwater flow between upland and aquatic areas. The approach focuses on water flow patterns because water movement underlies most of the other physical and chemical interactions that occur in a watershed (Stanley et al., 2005).

The purposes of the ecosystem-scale analysis are to highlight the relationship between key processes and aquatic resource functions, and to describe the effects of land use on those key processes. The goals are to:

- Identify and map areas in the watershed that are most important to processes that sustain shoreline resources;
- Determine the extent to which those important areas and their processes have been altered; and
- Identify management strategies and potential opportunities for protecting or restoring these areas.

The results of the analysis are provided in Chapters 3.

2.4 Inventory and Characterization Approach for Shoreline Reaches

The inventory and characterization of Eatonville's SMA water bodies at the shoreline reach scale is intended to describe conditions at a finer scale. The stream inventory was based on available documents, data and plans. It represents the best available information concerning the physical habitat of the Town's shoreline streams. It includes information on land use, zoning, public access, water quality, priority habitats and species, and shoreline modifications. Preparation of the inventory and characterization did not include site visits or field measurement. It was based solely on existing information.

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Chapter 3 Ecosystem-wide Characterization

3.1 Introduction

This section describes general ecological conditions and key ecosystem processes that occur within the Nisqually River Watershed. Although the focus of this report and of the SMP update, in general, is on conditions within the shoreline planning area of the Town, the State Shoreline Guidelines (WAC 173-26-201) require local jurisdictions to look beyond the SMA jurisdictional boundaries to "assess the ecosystem-wide processes to determine their relationship to ecological functions present within the jurisdiction." This section of the Inventory and Characterization Report describes conditions and processes that occur throughout the watershed. Subsequent sections will describe how the ecosystem-wide processes interact with and affect shoreline functions at the Town scale.

The information presented in this chapter is largely drawn from the ecosystem characterization prepared for Pierce County's SMP update (ESA Adolfson, 2009). That document considered ecosystem-wide processes throughout the Nisqually River Watershed which contains all of the Eatonville's shorelines. The analysis approach to analyzing watershed processes developed by Stanley et al. (2005) was used and adapted to complete the Pierce County Assessment of freshwater resources. The results of that analysis are summarized in this chapter as they pertain to Eatonville's shorelines.

3.2 Watershed Overview (WRIA 11)

The Town of Eatonville and all of its shorelines are located within the Nisqually River Watershed, referred to as water resource inventory area (WRIA) 11 by the state. The watershed encompasses approximately 491,300 acres within Pierce, Thurston and Lewis Counties, (Ecology, 2006). The basin's headwaters originate at Mt. Rainier's Nisqually Glacier (although none of the streams that flow through the Town are glacier-fed), and eventually empty into Puget Sound at the Nisqually National Wildlife Refuge. Medium gradient rivers in the upper watershed give way to very low-gradient systems in the lowlands. Elevations range from over 14,000 feet above sea level at the summit of Mount Rainier to sea level at the Nisqually River's mouth. Population is relatively sparse in WRIA 11, with the highest densities occurring around the Towns of Eatonville and Roy. The predominant land uses within WRIA 11 are forest resource and timber harvest.

The upper portion of WRIA 11 includes the Upper Nisqually River, Mashel River, and Ohop Creek sub-basins (Map 2). These are medium gradient river systems in "U"-shaped, glacier-carved valleys. Sub-basins within the lowland portion of WRIA 11 include the Mid and Lower Nisqually Rivers and Muck Creek. Major tributaries to the Nisqually River include: Muck Creek, Ohop Creek, Mashel River, and Tanwax Creek. SMA-regulated lakes in WRIA 11 include: Harts, Tule, Kreger, Silver, RapJohn, Ohop, Clear and Tanwax Lakes.

Climate and Geology

Climate

Climate in WRIA 11, like that of most of Western Washington, is influenced by maritime patterns and is generally characterized by mild, wet fall to spring months, and cool dry summer months. Precipitation typically occurs as low-intensity, long-duration storms. WRIA 11 spans at least two of Washington's climatic regions identified by the National Climatic Data Center branch of NOAA, the Puget Sound Lowlands, and the western Cascades.

The Town of Eatonville lies at the transition between the Puget Sound Lowlands and the Western Cascades, which occurs around 1,000 feet in elevation. Precipitation levels are higher, and temperatures are lower in the Western Cascades. Annual precipitation ranges from 60 to more than 100 inches, with maximum precipitation exceeding 140 inches once in 10 years.

Hydrologic systems in the Pacific Northwest are especially sensitive to warm rain-on-snow events, when significant volumes of surface water can be released into the system at one time. The Nisqually River is a snow-fed system, which responds to the late spring snowmelt period.

The potential effects of climate change within the Upper Nisqually River were reviewed as part of the Pierce County ICR. In general, warmer temperatures will influence the nature and geographic extent of the snowpack that feeds the higher elevation streams. Warmer temperatures could also result in higher summer water temperatures, having the potential to negatively impact several water quality parameters. Additional precipitation, and a broadened rain-on-snow area, has the potential to influence flow regimes (ESA Adolfson, 2009).

Geology

The geology of the eastern half of the watershed is dominantly underlain by volcanic rock with some sedimentary rock and deposits of alpine glaciers in the lower elevation foothills.

The topography and near surface geology of the western half of the County is largely the product of the last glaciation, the Vashon glaciation, to occupy the Puget Lowland. The Vashon and older deposits comprise several aquifers and aquitards within the subsurface, which control subsurface water movement from the upland to the lowland as well as to the locations of streams and creeks that occupy former glacial outwash channels (Jones et al. 1999). Refer to Map 6 for a description of geologic conditions within the Town of Eatonville and to the Pierce County ICR (ESA Adolfson, 2009) for a complete description of WRIA 11 geology.

Fish and Wildlife Habitats and Species

The physiographic regions in WRIA 11 provide many terrestrial and aquatic habitats. This section describes some of the key habitats and the ecological functions they provide.

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Freshwater Wetlands

The state of Washington (WAC 173-22-030) defines wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands are known to play a vital role in the landscape by performing:

- Biogeochemical functions related to trapping and transforming chemicals and improving water quality in the watershed;
- Hydrologic functions related to maintaining the water regime in a watershed and reducing flooding; and
- Food web and habitat functions (Granger et al., 2005).

Freshwater Riparian Areas

Freshwater riparian areas contribute to healthy streams by dissipating energy and inhibiting sediment input, suppressing the erosional processes that move sediment, and by mechanically filtering and/or storing upland sediments before they can enter stream channels (Knutson and Naef, 1997). Riparian areas also perform water quality functions related to pollutant removal. This occurs primarily through denitrification and trapping/storing phosphates and heavy metals that are adsorbed to fine sediments. Riparian vegetation provides shading and nutrient input to adjacent water bodies.

One of the most crucial roles that riparian areas play in the ecosystem is creating habitat. Riparian zones are a major source of LWD input to streams. Approximately 70 % of the structural complexity within streams is derived from root wads, trees, and limbs that fall into the stream as a result of bank undercutting, mass slope movement, normal tree mortality, or windthrow. LWD creates complex hydraulic patterns that allow pools and side channels to form. It also creates waterfalls, enhances channel sinuosity, and instigates other physical and biochemical channel changes. The in-channel structural diversity created by LWD is essential to aquatic species in deep, low velocity areas for hiding, overwintering habitat, and juvenile rearing, in all sizes of streams and rivers (Knutson and Naef, 1997).

Terrestrial Habitats

Other habitat resources within WRIA 11 include terrestrial forests, river-cut canyons, glacially eroded canyons, active glaciers, and riparian areas. A majority of the WRIA falls within the Cascades ecoregion, dominated by coniferous forests. Lowland forests are dominated by western hemlock, Douglas-fir, and western red cedar. Forests in the mountains are dominated by Pacific silver fir, and mountain or western hemlock. These habitats provide breeding, feeding, and migration areas for vertebrate and invertebrate grazers and seed eaters, omnivores, carnivores, and scavengers (Kruckeberg, 1991). Notable species include: black-tailed deer, elk, black bear, cougars, beavers, raccoons, and many rodents. Many of these terrestrial species rely on shoreline habitats (lakes, rivers and marine shores) for some of their life stage requirements.

Land Use and Land Cover

Land use and land cover in Pierce County follow the patterns of geology and topography discussed above. Forest land dominates the majority of the eastern portion of the County that lies within the Cascades and foothills. Much of the forest land is in active harvest rotation, but there are significant protected areas, including within Mount Rainier National Park. The eastern portion of the County also includes active glaciers and snowfields on Mount Rainier.

The western portion of the planning area (west of Eatonville) has experienced increasing development pressure and is a mixture of rural residential, open space, and agricultural land uses. The relative distribution of land use is approximately 50% rural residential, between 15% and 30% open space, and between 5% and 10% agricultural. The area generally to the east of Eatonville is more mountainous and less developed. This area is approximately 75% forested and 25% rural residential (ESA Adolfson, 2008).

The presence of a deepwater embayment (Commencement Bay) and vast forest resources within the upper portion of the County resulted in the early establishment of a major port (at what is now Tacoma) and other significant changes in land use and land cover over the past 150 years. These changes are primarily the result of the conversion of forest and prairie to either agricultural or urban lands. This shift in land use and cover includes the development of a transportation infrastructure that extends throughout the County.

To provide an overall summary of land cover in the Nisqually Watershed, data presented in the Pierce County ICR (ESA Adolfson, 2009) is presented in Table 3-1 for the Eatonville relevant sub-basins. These data were derived from the National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (CCAP) project (2001). The density of urban development generally decreases with distance away from the Sound, and cities and towns are scattered along the main river valleys.

Table 3-1. Sub-basin-scale Summary of Land Cover Data

Sub-basin Name	WRIA	Developed (%)	Agriculture (%)	Forest, Grassland, Bare Land (%)	Wetland (%)	Open Water (%)	Snow or Ice (%)
Lower Nisqually	11	11	0	81	7	0	0
Mashel River	11	2	1	97	1	0	0
Mid Nisqually River	11	5	13	74	7	2	0
Muck Creek	11	15	19	60	6	0	0
Ohop Creek	11	4	6	88	2	1	0
Upper Nisqually River	11	1	0	83	3	3	9

3.3 Ecosystem Processes

The following section describes the landscape-scale processes that shape and influence the freshwater shoreline environments of Pierce County and the Nisqually Watershed. Alterations to processes that have occurred as a result of human activity and development are also discussed. These provide a basis for understanding ecosystem-wide management issues and priorities.

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Freshwater ecosystem processes focus on the movement, partitioning, and storage of water, sediment, nutrients, bacteria, pathogens, and plants within an ecosystem at multiple spatial and temporal scales. For the purposes of this discussion, processes have been grouped under four broad headings: (1) hydrology, (2) sediment generation and transport, (3) water quality, and (4) organic materials.

For each of these broad processes, the Pierce County ICR identified the areas on the landscape that are most important (on a relative scale) for performing these key processes. These "important areas" (also known as process-intensive areas) are the intrinsic building blocks for ecosystem functioning. Alterations to these important areas were then identified. Based on the identification of important areas and alterations, ecosystem shoreline conditions were assessed for every sub-basin in the County (ESA Adolfson, 2009)

The following discussion summarizes the descriptions of ecosystem processes, important areas, and alterations within the Nisqually Watershed. It is focused specifically on elements that relate to conditions in Eatonville. The assessment of conditions within Nisqually sub-basins will also be presented. The complete Pierce County analysis including methods can be found in the Pierce County ICR (ESA Adolfson, 2009).

Hydrology

Water naturally enters the Nisqually Watershed through rain, snow, or movement of groundwater. Water moves within the watershed as surface water in rivers and streams, infiltrates and becomes groundwater, or is stored in wetlands, lakes, and floodplains. Hyporheic flow occurs as surface flow becomes shallow subsurface flow, moving down valley through alluvial sediments. Water can also flow in the subsurface as groundwater. Ground and surface waters can interact as surface water infiltrates (recharge), or as groundwater reaches the surface (discharge).

Hydrology - Important Areas

Important areas for hydrology focus on how water that enters the watershed via precipitation moves into, through, and out of the system. These areas are broadly grouped into: (1) source areas, (2) storage areas, and (3) infiltration areas.

Key source areas are focused in the snow- and rain-on-snow dominated zones, where there is the potential to release significant volumes of water that support seasonal hydrologic patterns (e.g., snow melt-driven high flows). As water moves downstream from source areas to generally broader and lower slope alluvial valleys, the potential for storage of water increases. Water storage (in natural systems) is often focused within low-slope floodplains and wetlands that provide the interface between upland and aquatic ecosystems.

Stream channel to floodplain connections provide areas where specific ecological functions (e.g., flood flow retention, peak flow reductions, etc.) can occur. Areas identified as important storage areas are focused on the broader alluvial valleys generally west of the Cascade foothills.

Once water enters a storage area, there is potential for recharge to an aquifer. Groundwater recharge is a key ecosystem function that: (1) reduces the amount of surface water flowing in channels, (2) supports

groundwater resources, and (3) supports baseflow in streams lower in the system. Groundwater recharge areas are focused within floodplain deposits.

Alterations to Hydrologic Processes in Pierce County

Alterations to hydrologic processes are generally associated with changes in land use and land cover, but also include direct structural changes to streams and wetlands. Consistent with land use patterns, the scale of hydrologic alteration in WRIA 11 increases along stream channels with proximity to the Puget Sound shoreline.

The partitioning of precipitation into evapotranspiration, infiltration, surface storage, soil storage, and surface runoff is a key hydrologic process. Removal of forest cover significantly reduces evapotranspiration rates, and installation of impervious surface significantly reduces groundwater recharge. The conversion from forest to pasture or urban uses directs more water into stream channels. Stream channels are then forced to adjust their geometry, compromising instream and riparian habitat functions.

To assess potential changes in hydrologic processes, impervious surface and forest cover data were summarized for hydrologic sub-basins for Pierce County. These parameters are thought to generally scale to the level of hydrologic alteration. As levels of impervious surface increase, and forest cover decreases, the amount of rainfall that reaches stream channels also increases, altering in-stream and riparian conditions. Streams are forced to expand to match higher peak flows, resulting in channel erosion and instability. Less water infiltrates into the soil, reducing the amount of water that is available to support baseflows in the summer months. These altered channels typically perform habitat ecosystem functions at a lower level compared to the pre-disturbance condition.

Sediment Generation and Transport

The processes that govern the production, storage, and transport of sediment play a significant role in shaping the morphology and functioning of freshwater ecosystems. Sediment is delivered to channels via overland flow, mass wasting (e.g., landslides, lahars), and channel migration (e.g., eroding the outside of a meander bend) (Stanley et al., 2005). The relative importance of sediment generation and transport pathways is typically a result of the interaction between climate and physical features of the landscape.

The movement of sediment into, through, and out of the freshwater shoreline ecosystem influences the form and functions of shorelines in the Watershed, including: (1) shoreline morphology, (2) hydrologic and hydraulic characteristics, (3) ability of surface and groundwater to interact, and (4) type and extent of aquatic habitat. These processes are described for Eatonville's shorelines in Chapter 4.

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Sediment - Important Areas

Important areas for sediment delivery and transport processes include: (1) glacier-fed streams, (2) landslide-prone areas, (3) steep slopes with erodible soils, (4) areas directly influenced by volcanic processes, and (5) alluvial river valleys. Sediment important areas were relatively limited in scope and were focused in the upper portions of the watershed, and along major river channels.

Alterations to Sediment Processes in Pierce County

Alterations to sediment generation and transport processes have occurred throughout the Watershed, resulting in additional sediment loading from areas that had historically produced much smaller quantities of sediment. Land uses, including timber harvesting and associated road construction, have generally accelerated production of coarse and fine sediment throughout the watershed. The removal of forest cover increases production of fine sediment as runoff volumes and peak flows are increased. Increased flows increase in-channel erosion and channel destabilization. Further, removal of fine-root biomass increases the potential for mass-wasting, which can deliver coarse and fine sediments to stream channels (Kerwin, 1999). Increases in fine sediment loading can adversely impact aquatic habitat by filling in the interstitial spaces of channel bed gravels and reducing the exchange of water and oxygen between stream flow and the channel bed. Fine sediment can also act as a transport vector for nutrients, metals, and other pollutants.

Alterations to sediment generation and transport processes were spatially estimated using roads intersecting streams, and road density at sub-basin scale. Sediment loading processes from forest roads in the upper watershed are going to be different from processes in urban areas. Past work indicates that localized conditions at the road-to-stream interface can be the controlling factor in sediment production (Luce and Black, 1999).

Water Quality

The quality of the water flowing through the Nisqually aquatic systems is the end result of the interaction of water with biota, soils, urban and rural land uses, and infrastructure. Ecosystem processes that impact the source, concentration, and transport of mineral and organic constituents are: biotic uptake (e.g., plant growth), decomposition (e.g., plant death), adsorption (e.g., chemical binding), and dissolution (e.g., chemical unbinding). In general, elements cycle between dissolved and particulate forms in water to plants, animals, and soils; and back to the water column via decomposition.

Processes that influence water quality occur over a variety of scales. As water moves through an ecosystem, it has the opportunity to cycle (deposit, uptake, entrain, and/or transport) mineral and organic constituents that can affect water quality. The longer water is able to contact soil and vegetation, the more cycling can occur. Longer water contact times typically occur in low gradient areas in the landscape such as riverine and depressional wetland systems. Water contact time is shorter in areas where rivers have been channelized, and the floodplain filled and paved.

Water Quality - Important Areas

Water quality important areas include streams, floodplains, lakes, wetlands, and riparian areas. These areas provide the longest water contact time and are therefore considered important areas for water quality in WRIA 11.

Alterations to Water Quality Processes in Pierce County

Alterations to water quality processes have occurred throughout the watershed. These alterations span a range of activities, and include point sources (e.g., focused discharge from a wastewater treatment plant), and non-point sources (e.g., stromwater discharge).

Within urban areas, water quality processes have been altered by the installation of impervious surfaces and stormwater conveyance infrastructure, which can bypass natural hydrologic pathways that include infiltration and percolation through soils. Constituents that can negatively impact water quality (e.g., metals, oils and grease, nutrients, bacteria) can build up on impervious surfaces, to be washed off during storm events. Water quality can also be significantly modified by agricultural land uses. The use of fertilizers and pasturing of animals can both result in excess nutrient and pathogen loading to water bodies. The removal of streamside vegetation and installation of above-ground stormwater ponds can increase water temperatures. Water temperature is a key parameter in the level of dissolved oxygen in flowing water, and in bacteria populations and loading.

Land uses (e.g., urban and agriculture) and Category 5 listings on Ecology's 303(d) list were mapped in the Pierce County ICR to broadly assess alterations to water quality ecosystem processes (ESA Adolfson, 2009).

Organic Materials

Large woody debris or LWD significantly influences the geomorphic form and ecological functioning of riverine ecosystems in the Pacific Northwest (Maser et al., 1988; Nakamura and Swanson, 1993; Collins and Montgomery, 2002; Abbe and Montgomery, 1996; Collins et al., 2002; Montgomery and Bolton et al., 2003; Montgomery and Masson et al., 2003). 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. LWD 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).

The presence, movement, and storage of LWD influence shoreline functions as follows:

- Delivery of wood and organics affects vegetation and habitat functions such as instream habitat structure (pools and riffles) and species diversity; and
- Riparian vegetation and LWD provide 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 fish and wildlife species.

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Investigations into historical conditions in the Nisqually basin areas indicate that LWD, including riparian forests and in-channel wood, was present as a significant structural element of the floodplain and delta ecosystem, prior to the major land use changes of the late 19th and 20th centuries (Collins and Sheikh, 2005, Collins et al., 2002). Urbanization has reduced the density of LWD in river channels within WRIA 11.

Organic Materials - Important Areas

Important areas for organic debris inputs to the shoreline (including LWD) generally include riparian areas within 150 to 200 feet of stream channels. Channel migration zones (CMZs) and areas of mass wasting also deliver LWD to streams.

Alterations to Organic Materials Processes in Pierce County

Significant land use changes throughout WRIA 11 have reduced the source and potential contribution of LWD from the riparian area to the channel. Installation of dams in the upper watersheds has broken the patterns of wood transport from the upper to lower reaches. Timber harvesting, agriculture, and development of the alluvial valley have all significantly reduced the abundance and source of LWD as compared to historic conditions.

To assess the degree of alteration for organic materials ecosystem processes, NOAA CCAP data were used to calculate the percentage of each sub-basin that is currently in any sort of forest land (e.g., deciduous, evergreen, wetland forest, scrub-shrub).

Summary of Ecosystem Processes by Sub-basin

Table 3-2 provides the tabular data for the parameters discussed above, for each sub-basin in the Nisqually Watershed. This information will be used to provide an overall assessment of the level of alteration in the Watershed, which will inform the assessment of reach-scale shoreline functions in Chapter 4.

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Table 3-2. Summary of Parameters by Sub-basin

	WRIA	Total Area (acres)	Total length of stream (miles)	% Forest	Percent Impervious Surface	Road density (Road Length/Basin Size)	Number Road crossings	Number Road crossings / mile of stream	303(d) List?	% with assumed on-site septic
Alder Reservoir-Nisqually River	11	7,104	64	89.93	1.89	5.13	130	2		10
Beaver Creek	11	6,958	62	99.42	0.41	3.83	77	1		0
Berg Creek	11	5,747	54	92.99	2.29	4.87	84	2		2
Busy Wild Creek	11	10,204	131	99.13	0.62	5.58	397	3		0
Clear Creek	11	12,886	16	98.19	0.44	6.43	23	1	yes	0
Copper Creek-Nisqually River	11	9,370	109	98.77	0.71	3.04	136	1		3
Headwaters Nisqually River	11	10,093	83	99.38	0.28	1.23	12	0		0
Horn Creek-Nisqually River	11	9,434	46	87.63	1.78	5.62	60	1	yes	18
Kautz Creek	11	8,598	54	99.97	0.02	0.07	5	0		0
Lacamas Creek	11	10,741	44	63.06	1.53	4.03	73	2		22
Little Mashel River	11	15,426	122	97.41	0.48	4.04	167	1		6
Lynch Creek	11	4,848	61	99.01	0.86	4.89	126	2		0
Mashel River - Lower	11	9,836	80	93.39	2.65	6.54	186	2		4
Mashel River - Upper	11	11,985	185	98.73	1.01	5.31	501	3	yes	0
Murray Creek-Nisqually River	11	15,555	82	65.45	2.43	3.98	77	1		22
Nisqually River-Frontal Puget Sound - upper	11	11,443	27	80.12	7.57	6.20	3	0		1
Nisqually River-Frontal Puget Sound lower	11	7,562	23	76.92	8.61	9.14	27	1	yes	0
Ohop Creek	11	10,530	60	77.58	2.03	5.55	78	1	yes	14
Powell Creek-Nisqually River	11	9,107	54	80.86	1.65	5.24	60	1		11
Reese Creek-Nisqually River	11	12,767	121	98.06	0.79	4.63	153	1		9
Tahoma Creek	11	9,951	109	99.83	0.10	0.49	41	0		0
Tanwax Creek - lower	11	7,039	22	95.96	0.88	6.29	37	2		1
Tanwax Creek - upper	11	10,979	65	76.95	2.31	5.43	113	2		24
Twentyfive Mile Creek	11	6,214	56	98.11	0.77	4.20	91	2		0

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Assessment of Freshwater Ecosystem Shoreline Conditions

The ecosystem processes that occur within the freshwater shorelines of the Nisqually Watershed are all sensitive to alteration. Variation in process controls (e.g., climate fluctuations), the interdependency between each process, and the limited resolution of county-wide data sets make it challenging to assess overall levels of alteration. However, it is important to understand, at least in a relative sense, the level of alteration to the system. It is this understanding that allows for the formulation of management techniques that will preserve, protect, and restore freshwater ecosystem processes.

To provide a first-order assessment of the level of alteration to the freshwater ecosystems, the information in the previous sections on the processes within each basin (hydrology, sediment, etc.) was used to provide a high, medium, or low ranking for the level of alteration within each sub-basin (Table 3-3) in WRIA 11. In this section, a "high" ranking indicates that ecological functions are highly altered (i.e., a high level of alteration to processes). A "low" ranking indicates less altered processes and a high level of ecosystem function.

Using these relationships to develop relative rankings is a coarse method for assessing ecosystem function at the sub-basin scale. The quality of the analysis is limited by the type and quality of the spatial data, and is complicated by the interdependencies between each process group. Best professional judgment is used for the water quality and organics processes because limited data are available for this assessment.

Table 3-3. WRIA 11 Summary of Overall Assessment of Alterations for Each Group of Ecosystem Processes

Sub-basin	Hydrology	Sediment Generation and Transport	Water Quality	Organic Materials
Alder Reservoir-Nisqually River	medium	medium	medium	medium
Beaver Creek	medium	medium	low	low
Berg Creek	medium	medium	low	low
Busy Wild Creek	medium	medium	low	low
Clear Creek	medium	medium	medium	low
Copper Creek-Nisqually River	medium	medium	low	low
Headwaters Nisqually River	low	low	low	low
Horn Creek-Nisqually River	medium	medium	high	medium
Kautz Creek	low	low	low	low
Lacamas Creek	medium	medium	medium	medium
Little Mashel River	medium	medium	low	low
Lynch Creek	medium	medium	low	low
Mashel River - Lower	medium	medium	low	low
Mashel River - Upper	medium	medium	medium	low
Murray Creek-Nisqually River	low	low	medium	medium
Nisqually River-Frontal Puget Sound - upper	medium	low	low	medium
Nisqually River-Frontal Puget Sound lower	medium	high	medium	medium

Sub-basin	Hydrology	Sediment Generation and Transport	Water Quality	Organic Materials
Ohop Creek	medium	medium	high	medium
Powell Creek-Nisqually River	medium	medium	medium	medium
Reese Creek-Nisqually River	medium	medium	low	low
Tahoma Creek	low	low	low	low
Tanwax Creek - lower	medium	medium	low	low
Tanwax Creek - upper	medium	medium	medium	medium
Twentyfive Mile Creek	medium	medium	low	low

Denotes Eatonville Sub-basins/Waterbodies

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Chapter 4 Reach Inventory and Analysis

This chapter provides shoreline inventory information and analysis of shoreline functions at the reach scale for all of the SMA waterbodies in the Town of Eatonville. As noted above, portions of Ohop Creek, Lynch Creek, the Mashel River and the Little Mashel River flow through the Town and are affected by land uses and regulatory regimes in the Town.

Reach-scale inventory information, as defined in WAC 173-26-201, is presented in this chapter for each waterbody. Each waterbody in the Town's SMA jurisdiction is treated as a single reach. The inventory refers largely to data presented in Maps included as Appendix A. For each reach, inventory information is grouped in to three broad categories: 1) Physical Resources; 2) Biological Resources; and 3) Plans and the Built Environment.

Following the inventory information, this chapter presents an assessment of shoreline functions for each waterbody, as required by WAC 173-26-201(3)(d)(i). The assessment of shoreline functions takes into account both the reach-scale inventory information and their connections to ecosystem-wide processes in the broader watershed.

The assessment of functions is followed by a discussion of management issues; reasonably foreseeable land use demand and potential conflicts; and possible programmatic preservation and restoration measures. All of these items establish a baseline of conditions in the Town's shorelines and begin to plot a course forward to developing shoreline designations as well as policies and regulations aimed at achieving no net loss of shoreline functions.

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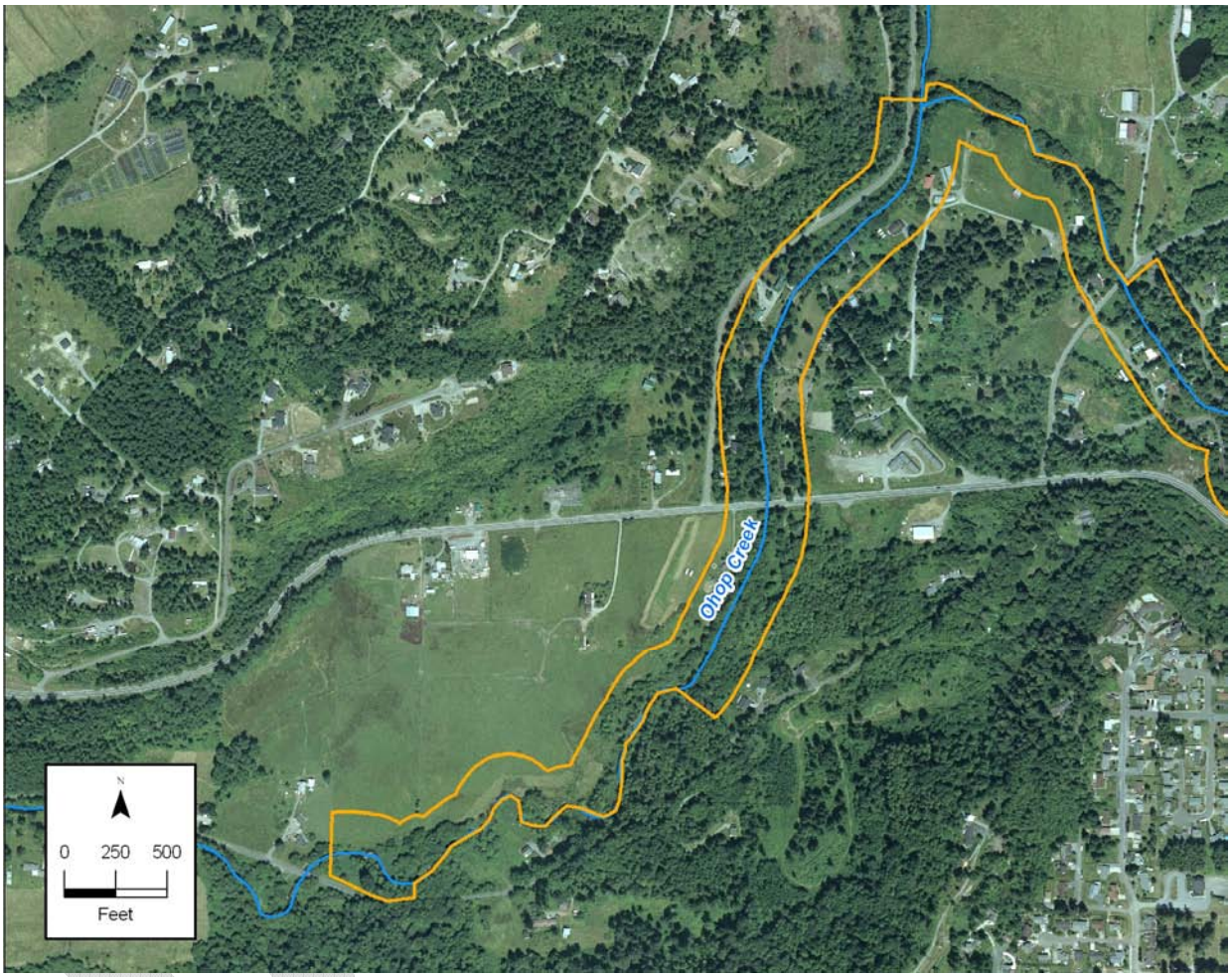
4.1 Ohop Creek

General Information

Ohop Creek Shoreline Planning Area



WRIA (MAP 2)	Watershed (Map 2)	Basin (Map 2)	Length
WRIA 11	Nisqually	Ohop Creek Basin	Town: 0.63 miles UGA: 0.48 miles Total: 1.1 miles

Physical Resources

Topography (Map 4)	Soils (Map 7)	Floodplain/Floodway (Map 4)
Elevations in the watershed range from approximately 450 feet (at the mouth of the watershed) to 3,700 feet. The Ohop Creek within the Town's SPA is relatively flat. Elevations along the creek in the SPA range from approximately 490 to 525 feet.	1. Chehalis silt loam 2. McKenna gravelly loam 3. Riverwash 4. Scamman silt loam, 15 to 30 percent slopes (mostly along the valley slopes)	Floodplains and floodways are associated with the Ohop Creek. Both are relatively narrow and are mapped within 200 feet of the OHWM on either bank of the Creek.

Channel Migration

The potential for channel migration occurs along Ohop Creek throughout the Town's SPA The potential for migration generally increases with distance downstream, substantially increasing downstream of SR 161. This portion of the creek flows through alluvial sediments over a wide floodplain. This reach of Ohop Creek is thought to be 'underfit' to the valley, meaning that the current hydrologic regime and sediment dynamics of the creek is insufficient to form the valley. The portion of Ohop Creek that flows through the Town's SPA is upstream of the direct channel modifications that likely occurred during the 1930s, but these impacts have the potential to influence channel form and processes in this area as the channel continues to adjust (WPN, 2006).

Channel Migration mapping is not available for the Ohop Creek reach within the Town's SPA.

Surface Hydrology (MAP 4)

Ohop Creek flows from its headwaters south of Lake Kapowsin south and west to its confluence with the Nisqually River. Slightly more than a mile of the Creek flows through the Town of Eatonville and its UGA. Within the Town of Eatonville, Ohop Creek flows from Ohop Lake immediately north of the Town to the eastern Town UGA boundary through the Ohop Valley. Four unnamed tributary creeks enter the mainstem of the Creek within this area.

Other Hydrologic Features

- Ohop Creek drains an area of approximately 44 square miles. It has two primary tributary streams: Lynch Creek and Twenty-five Mile Creek, which join the river at RM 6.2 and 9.9 respectively.
- During the 19th and early 20th centuries farmers turned the creek into a straight-flowing ditch in an attempt to dry out the Ohop Valley and create better pasture for their dairy cattle. Channelization occurred from the mouth of the Creek to approximately RM 4.2, which is downstream of the Town's SPA. Upstream of RM 4.7 (including the Town's SPA), the stream does not appear to be entrenched (Homza, 2002).

- Historic hydrologic conditions reflect an area saturated to the surface for most of the growing season. Water sources include overbank flooding from the creek more frequently than the annual event, high groundwater levels and numerous hillslope seeps and small tributaries which disperse as sheetflow once they reach the valley floor. No open water areas are present, but historic beaver ponds were likely present.

- Ohop Creek has a low sediment load because Ohop Lake traps all bedload sediment and most of the suspended load from approximately the upper half of the watershed. Diversion of the upper quarter of the watershed in the late 1800's to Lake Kapowsin and the Puyallup River Basin has made the stream even more under fit, with less stream power to transport sediment and carve meander bends (WPN, 2006).

- The Nisqually Land Trust is currently performing a restoration project to restore Ohop Creek's meander and rehabilitate its streamside habitat. The restoration project is ongoing and includes the entire creek from SR 7 to the Nisqually River.

Water Quality

According to the 2008 Washington State Water Quality Assessment (Ecology, 2009), The only (303(d)) listing for the Ohop Creek within the Town's SPA is a category 5 (303(d)) listing for dissolved oxygen. There is low dissolved oxygen present throughout the stream, due in part to the lack of riparian corridor. Outside of the Town's SPA, there is a category 4 listing for fecal coliform and a category 1 listing for pH.

Fecal coliform was listed as category 5 in the 2004 Water Quality Assessment, indicating that that parameter has improved. The Department of Ecology completed a TMDL study for fecal coliform bacteria during 2002-2003 for several waterbodies, including Ohop Creek. The results of this study indicate that bacteria levels in Ohop Creek have greatly improved since the early 1990's; however, load allocations for fecal coliform were deemed necessary for several sites in the creek downstream of Ohop Lake during the dry season, and for Lynch Creek (Ecology, 2005).

The Nisqually Chinook Recovery Team (NCRT) made the assumption that historic temperatures in Ohop Creek were warm between the lake outlet and Lynch Creek (greater than 20°C for more than 4 days during the warmest month). They hypothesized that, downstream of Lynch Creek, temperatures were cooled to the 16 - 20°C range (for 7-14 days during the warmest month). This assumption appears reasonable, and highlights the importance of establishing canopy closure to contribute to lowering of temperatures.

Turbid water was noted in Ohop Creek at the Lynch Creek confluence by WPN (2006). Upstream sources were not identified with the exception of the Town of Eatonville's stormwater discharge to Lynch Creek, which was identified as a source of turbidity (WPN, 2006).

Biological Resources

Critical Areas
The Town's critical areas code (EMC 15.16) regulates five types of critical areas, which are described below:
Wetlands (Map 4) Two wetlands are mapped within the Town's SPA. The first (~ 7 acres) is located near the northern town boundary at the confluence of Lynch Creek. The other (~15 acres) is located along the left bank of Ohop Creek south of the town boundary across from the UGA. Most of this wetland is located outside of the Town's UGA. The Ohop Creek restoration project currently underway includes restoration of riparian wetlands downstream of the Town's SPA. Wetland buffers range from 35 feet to 300 feet depending on wetland typing and intensity of proposed use (EMC 15.16.124).
Critical Aquifer Recharge Areas (Map 4) Two critical aquifer recharge areas are mapped in the Town of Eatonville. One of them is located along the valley floor of the Ohop valley and contains most of the Ohop SPA.
Floodplains (Map 4) Floodplains are mapped along Ohop Creek through the Town and its UGA. The mapped floodplain is relatively narrow in the Town's SPA. It does not exceed 200 feet from the stream centerline on either bank of the creek within the Town or its UGA.
Geological Hazardous Areas (Map 8) Geological Hazardous Areas are defined by EMC 15.16.161 and mapped in the Town's Ohop Creek SPA. Ohop Creek is developed on a continental glacial soil terrace. Peat and alluvial soils may be found in the valley floor. Mapped hazards include seismic hazard along the entire valley floor from peat and alluvial soils. Erodible soils and landslide areas are mapped along the valley walls. The Pierce County Inventory also identified volcanic hazards from mudflow deposits in the Ohop valley.
Habitat Conservation Area All waters of the state including rivers, streams, and watercourses within jurisdiction of the state of Washington are considered habitat conservation areas in the Town of Eatonville. Ohop Creek is classified as a Type F (fish-bearing) stream and has a 150 foot standard buffer width (EMC 15.15174).

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Shoreline Vegetation/Riparian Vegetation
The Ohop Creek Restoration Project (ongoing) is currently restoring riparian vegetation to a significant portion of Ohop Creek shorelines. Pre-restoration project riparian conditions were assessed for Ohop Creek as part of the Ohop/Tanwax/Powell Watershed Analysis (Nisqually Indian Tribes 1998, Homza et al. 2002). The assessment included the following descriptions of riparian vegetation within the Town's SPA: ▪ From Lynch Creek confluence to SR 161, riparian stands included medium sized stands of hardwoods, and mixed hardwood/conifer that were sparse in areas. Stands were not of an adequate size and density to provide functional wood development. ▪ From SR161 to roughly the town boundary, stand development was limited by wet soil conditions. Stands were primarily small sized hardwoods and had a moderate recruitment potential, but were expected to have high long-term recruitment potential. ▪ From the town boundary to the UGA boundary, stand development was limited by wet soil conditions. Stands were primarily medium sized hardwoods and had a moderate recruitment potential, but were expected to have high long-term recruitment potential.
Historic riparian conditions along Ohop Creek were also assessed in the Ohop/Tanwax/Powell Watershed Analysis (Nisqually Indian Tribes,1998): ▪ Historically, riparian vegetation along Ohop Creek was a densely vegetated mix of palustrine forest, scrub shrub, and emergent wetland. Vegetation includes Pacific willow, Douglas spiraea, vine maple, bigleaf maple, western red cedar, cottonwood, red alder, Oregon ash, red-osier dogwood, snowberry, nettles, Indian plum, and salmonberry. ▪ Stream bank vegetation is constrained in areas where reed-canary grasses are well established. The plant is difficult to remove and contribute less to stream shading than a tree canopy layer (WNP, 2006). Removal of reed-canary grass and other invasives is one of the goals of the Ohop Valley Restoration Project. Removal of invasives within the Town's SPA should be considered as well.

Wildlife Habitats (Map 5)	Fisheries (Map 5)
According to WDFW PHS data (WDFW 2009a) Ohop Creek has multiple priority habitats associated with it, including:	According to WDFW streamnet data (WDFW 2009b) Ohop Creek supports the following fish species:
1. Urban Natural open space	1. Winter Chum
2. Riparian zones	2. Pink Salmon
3. Bald Eagle use areas	3. Sockeye Salmon
4. Waterfowl concentrations	4. Winter Steelhead
5. Ohop Creek Wetlands	5. Resident Cutthroat Trout

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Spawning and Rearing Habitat:

- Natural levels of fine sediments are fairly high in Ohop Creek. Gravel is present in the channel banks in limited areas of Ohop Creek. Gravel is present in the banks of the Creek between Lynch Creek and SR 161. Through this reach, the channel is stable with minimal bed erosion or vertical adjustment of the channel (WPN, 2006).
- Downstream of SR 161 bank soils contain no significant amount of gravel. The channel in an area on the left bank, immediately upstream of the Ohop Valley Extension Road Bridge, was observed to be eroding the toe of a hillslope and recruiting gravel (WPN, 2006).
- One of only a few gravel beds is present in Ohop Creek. One was observed in the Town's SPA. Elsewhere in the Creek, the bed is sand or silt (WPN, 2006).
- Spawning habitats for anadromous fish in the Ohop Creek system are limited to two areas, one of which is the 1.5 miles of Ohop Creek downstream of the Ohop Lake (within the Town's SPA). The majority of the Ohop Creek is rearing habitat (WPN, 2006).
- The restoration project currently underway will be designed to protect existing spawning areas and enhance rearing habitat with meanders and LWD in the Creek up to SR 7 (WPN, 2006).

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Plans and Built Environment

Current Land Use Pattern	Current Shoreline Designations	Comprehensive Plan Land Use Designations (Map 9)
The general land use pattern in the Town's Ohop Creek SPA is a mix of rural density residential development, agricultural areas, small scale commercial uses and open space. Commercial uses are concentrated around SR 161. Structures include mostly one story commercial buildings, homes and agricultural structures.	**Town:** Shoreline Residential **UGA:** Rural (Pierce County)	According to the Town's Comprehensive Plan, most of the Ohop Creek SPA is designated for single-family use. The exceptions are areas on either side of the Creek along SR 161. On the right bank, the SPA south of 161 is designated for "Ohop Valley Commercial" on the left bank, the areas north and south of 161 are designated for commercial uses (Town of Eatonville, 2005).

Current Zoning (Map 10)

Zone	Town		UGA		Total (Town and UGA)	
	Acres in SPA	% of SPA	Acres in SPA	% of SPA	Acres in SPA	% of SPA
Airport						
C-2	5.8	23%	2.0	12%	7.8	18%
Ind						
MU						
ROW	1.0	4%	2.1	12%	3.2	7%
SF-1	18.3	73%	13.5	76%	31.8	74%
SF-2						
SF-3						
Totals	**25.1**		**17.7**		**42.8**	

Water-Oriented Uses

Water-dependent:	Water-related:	Water-enjoyment:
▪ None Identified	▪ None Identified	▪ None Identified

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Transportation/Roads/Bridges/Railroads (Map3)	Utilities
SR 161 (in Town) and Ohop Valley – Extension Road East (immediately south of UGA boundary) cross Ohop Creek. After crossing, Ohop Valley – Extension Road East parallels the left bank of the creek for approximately a third of a mile before veering to the east. Orville Road E runs parallel to the creek on the right bank for approximately a half mile north of 161.	The Town's Comprehensive Plan identifies a sewer trunk in SR 161 as a future capital project. The project has not been completed (Town of Eatonville, 2005).

Historic and Cultural Resources
No cultural resources are inventories within the Ohop Creek area. However, seasonal hunting by the Nisqually tribe could have occurred in the area, and there is some potential for the presence of cultural resources. There are historical structures within the Ohop valley that are registered on the State and National registries of historic Places. However, there are none within the Town's SPA.

Public Access/Parks/Trails/Open Space (Map 11)
There are no Town, County or State parks within the Town's Ohop SPA. The proposed Ohop Valley trail (Map 11), which follows the alignment of Ohop Valley – Extension Road east would offer access to the creek south of the Town and UGA boundary. As part of the Nisqually Land Trust's Ohop Creek restoration project, the Land Trust acquired approximately 241 acres. Through this acquisition, public access to the creek may be increased downstream of the Town's SPA.

Known Sites with Toxic or Hazardous Materials
None identified by DOE Confirmed and Suspected Contaminated Sites List (DOE, 2009).

Shoreline Modification
The Creek through the Town's SPA is largely unmodified. See the discussion of Ohop Creek Restoration for information related to modifications downstream of the Town's SPA.

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Degraded Areas
During the 19th and the early 20th centuries, Ohop Creek was ditched and straightened for agricultural uses. Wetlands were drained and the creek was hydrologically disconnected from much of its floodplain. Loss of the streams meander and loss of riparian forest have compromised the creek's ability to produce salmon.

Restoration Opportunities and Sites
In an effort to develop an appropriate multiple fish species management plan for the Nisqually River basin, the Nisqually Tribe analyzed fall Chinook salmon using the Ecosystem Diagnosis and Treatment (EDT) model (Nisqually Chinook Recovery Team, 2001). The EDT model ranked the lower 6.3 miles of Ohop Creek which includes the Town of Eatonville SPA, as among the highest priority tributary reaches in need of restoration for salmonid habitat. In 2002, the Nisqually Tribe led efforts in preparation of the Lower Ohop Creek Enhancement Plan (Homza et.al, 2002). The Pierce County Conservation District, South Puget Sound Salmon Enhancement Group (SPSSEG), and the Nisqually Tribe have evaluated restoration opportunities for the Ohop valley (WPN and Geoengineers, 2006). Placement of engineered logjams is slated by SPSSEG for summer of 2008 and 2009 (SPSSEG, 2008). The Nisqually Land Trust owns approximately 240 acres in the Ohop Creek valley. The Land Trust and partner organizations have begun a large-scale restoration project in the valley to restore meanders to the stream, which was historically channelized for agriculture. The project also includes restoration of floodplain wetlands (Nisqually Indian Tribe, 2008; Nisqually Land Trust, 2006). Restoration opportunities within the Town's SPA include restoring forested riparian areas, using best management practices to reduce sediment loss during agricultural lands uses, and replacing existing culverts where appropriate to improve fish passage. Removal and control of invasive plant species such as reed-canary grass is also an opportunity for shoreline restoration.

Areas of Special Interest
None Identified.

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Assessment of Ecological Functions

Ecosystem Process / Shoreline Function	Level of Alteration	Conservation / Restoration Potential
Hydrology	Moderate. Contributing area has been directly modified, as a significant portion (15 mi^2) of the upper watershed was diverted to flow to Kapowsin Lake and the Puyallup River to prevent flooding.	Low. This portion of Ohop Creek is designated a reference reach, and appears to be upstream of the channelized section.
Hyporheic Functions	Moderate. Land use conversion in the floodplain has likely disconnected and/or modified connections between the channel and wetlands in the floodplain.	High. There is high potential for restoration of these channel-floodplain connections by planting a wider riparian forest and restoring and/or enhancing connections between the channel and floodplain. This work is partially described as part of the ongoing Lower Ohop Creek restoration project.
Shoreline Vegetation	Moderate to low. A narrow, forested, riparian zone exists for the majority of the length of Ohop Creek through the Town's SPA.	High. There is high potential to preserve and restore riparian forest along Ohop Creek in the Town's SPA.
Habitat	Moderate to low. Significant habitat degradation has occurred downstream. Lowered LWD loading and increased fine sediment loading has degraded habitat in this reach.	Moderate. There is a moderate restoration potential, focused on enhancing the riparian corridor, LWD loading and improving water quality from the contributing basin (see Lynch Creek).

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Management Issues and Opportunities

Summary of Ecological Functions and Management Issues

The following summarizes the key factors effecting ecological functions in the Ohop Creek SPA:

- Historically, riparian vegetation in the Ohop SPA was a densely vegetated mix of palustrine forest, scrub shrub, and emergent wetland. During the 19th and the early 20th centuries, lower Ohop Creek (below Eatonville) was ditched and straightened for agricultural uses. Wetlands were drained and the creek was hydrologically disconnected from much of its floodplain.
- The Ohop Creek SPA includes salmon spawning and rearing habitat. However, stream channelization below Eatonville, and loss of riparian vegetation both within and outside of the Ohop Creek SPA, have compromised the creek's ability to produce salmon.
- There is low dissolved oxygen present throughout Ohop Creek, due in part to the lack of riparian vegetation. Infestation of riparian areas by reed-canary grass (invasive species) has prevented the reestablishment of a native riparian canopy.
- The Town of Eatonville's stormwater discharge to Lynch Creek has been identified as a source of turbidity in Ohop Creek.
- The Ohop Creek Restoration Project (ongoing) is currently restoring riparian vegetation and in-channel large wood to a significant portion of the Ohop Creek SPA. This project is being undertaken by the Nisqually Land Trust, Pierce Conservation District, South Puget Sound Salmon Enhancement Group (SPSSEG), and the Nisqually Tribe.

Based on these existing conditions, important management issues for Ohop Creek include the following:

- Preservation and enhancement of riparian vegetation. The Town currently has 150-foot buffers on Ohop Creek. The SMP update should evaluate these buffers and buffer standards for their adequacy to maintain riparian habitat functions
- Coordination with Nisqually Land Trust related to land restoration activities in the Valley
- Review and evaluate the Town's stormwater system and plans to assess whether prioritization of capital projects should be reconsidered to focus on the Lynch Creek outfall.

Future Use Patterns and Potential Use Conflicts

As noted above, current land use in the Ohop Creek SPA includes rural density residential development, small scale agricultural areas, limited commercial uses and open space. Commercial uses are concentrated around SR 161. The creek was ditched and straightened for agricultural uses in the 19th and early 20th centuries. The result of these modifications was a loss of salmon through habitat loss and a loss or diminishment of the riparian corridor. Most of the creek modifications occurred in the lower creek

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reaches, functions in the upper sections of the Creek, within the Town's SPA, are in better condition.

Currently, land use in the SPA is fairly low density. A review of Pierce County assessor's data and Town zoning indicates that there is the potential for development and increased land use intensity along the creek. There are approximately seven vacant parcels adjacent to the creek, which could be developed. Five of these are zoned for single-family residential (SF-1) and two are zoned for commercial uses (C-2). All of the single-family parcels adjacent to the creek are at least twice the minimum lot size (9,600), meaning that the potential for subdivision exists. There are four parcels zoned Commercial adjacent to the Creek. Two are developed for single-family use, one is vacant and one is unknown. Because a variety of commercial uses are allowed on these parcels, the potential for development and greater land use intensity exists.

Development or subdivision of these properties and their potential to alter shoreline vegetation or limit the growth of riparian areas, increase impervious surface, or modify stream banks will be key issues for the SMP update. The SMP update should consider how to minimize the potential adverse effects that potential development may have on shoreline functions. The Ohop Valley is also within a Critical Aquifer Recharge Area. The development of commercial uses could increase the potential risk to this resource. The SMP should consider how to address the potential impacts on CARAs by commercial uses.

Opportunities for Ecological Protection and Restoration

The ongoing Ohop Restoration project is likely to significantly alter current conditions and improve ecological functions along the Creek downstream of the Town's SPA. Within the SPA, the Town should consider the following restoration measures:

- Promote vegetation enhancement along the creek and protection of existing riparian corridors
- Provide public education to help reduce turbidity in Lynch and Ohop Creeks. For example, involve residents in stenciling storm drains with "drains to stream" symbols to remind people not to dispose of toxic materials in the storm system.
- The Town's 2003 Draft Stormwater Management Program includes several recommendations that would also improve shoreline functions in the Ohop Creek SPA:

    1. Retrofitting existing stormwater systems, perhaps as part of improvements required for new development;
    2. Implementing a public education program about ways that residents can reduce non-point source pollution;
    3. Regularly maintaining stormwater facilities such as catch basins; and
    4. Exploring new approaches such as semi-pervious parking surfaces.

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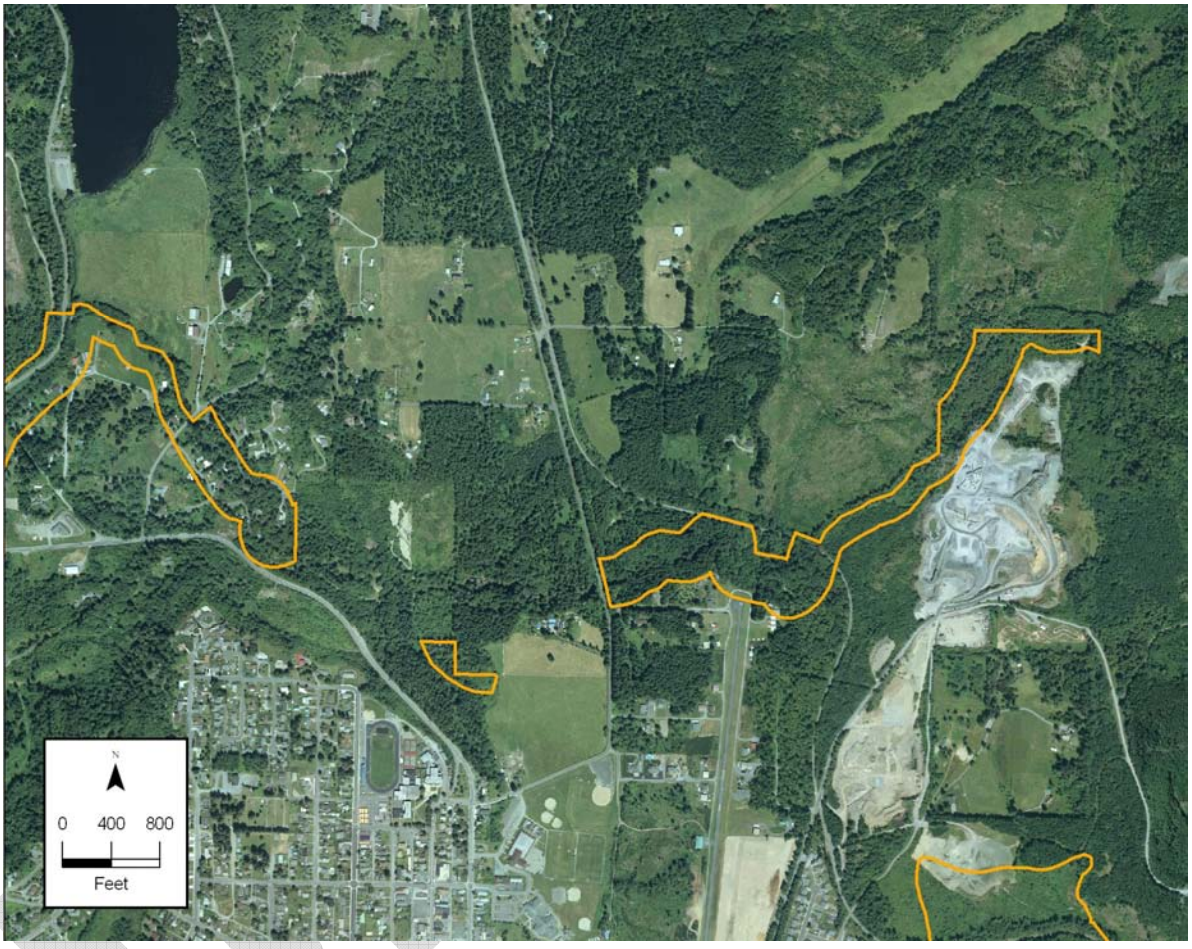
4.2 Lynch Creek

General Information

Lynch Creek Shoreline Planning Area



WRIA (MAP 2)	Watershed (Map 2)	Basin (Map 2)	Length
WRIA 11	Nisqually	Ohop Creek Basin	Town: 0.68 miles UGA: 0.79 miles Total: 1.77 miles

PHYSICAL RESOURCES

Topography (Map 4)	Soils (Map 7)	Floodplain/Floodway (Map 4)
Mean elevation within the basin is 1,060 feet, with a maximum of 3,720 and a minimum of 360 at the mouth of the basin (WPN, 2002). Lynch Creek with the Town's SPA ranges in elevation from approximately 850 feet at the eastern boundary of the Town UGA to approximately 525 at the confluence with Ohop Creek.	1. Barneston gravelly coarse sandy loam, 0-6% slopes 2. Barneston gravelly coarse sandy loam, 6-15% slopes 3. Barneston gravelly coarse sandy loam, 30-45% slopes 4. Chehalis silt loam 5. Rock outcrop	Floodplains and floodways are associated with Lynch Creek. Both are relatively narrow and are mapped within 200 feet of the Creek's centerline.

Channel Migration
The channel migration zone has not been mapped, but the potential for migration exists along the portion of Lynch Creek within the Town's SPA.

Surface Hydrology (Map 4)
Lynch Creek is one of two primary tributaries of Ohop Creek. The headwaters of the stream originate on a ridge at approximately 3,000 feet in elevation. Lynch Creek has one named tributary stream: Burg Creek, which joins Lynch Creek east of the Town's UGS boundary. Lynch Creek flows into Ohop Creek within the Town's boundary. Approximately 1.9 discontinuous miles of Lynch Creek flow through the Town and the Town's UGA; weaving in and out. There roughly 1.7 miles of the Creek with the Town and UGA. Two unnamed tributary creeks enter the mainstem of the Creek within this area.
Other Hydrologic Features
▪ Lower Lynch Creek receives stormwater runoff from a large portion of Eatonville via a large ditch. Ohop Lake acts as a sediment trap. Therefore, Lynch Creek is an important sediment source for the lower Ohop Creek. ▪ Stormwater from Eatonville's stormwater collection system is released into Lynch Creek. This addition of stormwater may increase the 'flashiness' of the creek, with higher peak flows that occur sooner after the rain event. It may also convey suspended solids, bacteria, nutrients, and other common urban runoff constituents to Lynch Creek (ESA Adolfson, 2008). ▪ Lower Lynch Creek (river mile 0.2 – 0.9) has a higher gradient than any other stream in the anadromous portion of the Ohop subbasin, and therefore the substrate is composed of mostly cobbles, with some pockets of gravel and boulders (ESA Adolfson, 2008).

Water Quality
According to the 2008 Washington State Water Quality Assessment (Ecology, 2009), there are no 303(d) listings for Lynch Creek within the Town's SPA. According to the 2004 Washington State Water Quality Assessment (Ecology, 2004), Lynch Creek was not listed for any water quality impairments. Lack of inclusion in the assessment does not indicate that the waterbody is not impaired; smaller streams are often not sampled and may not reflect degraded water quality standards. Lynch Creek receives discharge from the Town of Eatonville's stormwater collection, which contributes to a sediment load that is 17% above background values in the stream (WPN, 2002). Forestry has been listed as a probably cause of the elevated levels of total suspended solids (TSS) within the stream.

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Biological Resources

Critical Areas
The Town's critical areas code (EMC 15.16) regulates five types of critical areas, which are described below:
Wetlands (Map 4) Four wetlands are mapped along Lynch Creek. All four straddle the Town and/or UGA boundary. A series of three wetlands (4.7, 6.4, and 14.7 respectively from east to west) are located between the Town's eastern boundary and an area approximately a quarter mile past Lynch Creek Rd E. There is also a wetland mapped near the northern town boundary (~ 7) at the confluence of Ohop Creek. Wetland buffers range from 35 feet to 300 feet depending on wetland typing and intensity of proposed use (EMC 15.16.124).
Critical Aquifer Recharge Areas (Map 4) Two critical aquifer recharge areas are mapped in the Town of Eatonville. One of them is located along the valley floor of the Ohop Valley. Approximately 0.3 miles of Lynch Creek are located with this CARA.
Floodplains (Map 4) Floodplains are mapped along Lynch Creek through the Town and its UGA. The mapped floodplain is relatively narrow in the Town's SPA. It does not exceed 200 feet from the stream centerline on either bank of the creek within the Town or it UGA.
Geological Hazardous Areas (Map 8) Geological Hazardous Areas are defined by EMC 15.16.161 and are mapped in the Town's Lynch Creek SPA. The creek passes through a small area of landslide hazard in the northeast corner of the UGA boundary. There are also landslide hazard areas on either side of the creek in the west end of the Town's SPA. This area is within the Town's UGA. The creek also flows through seismic hazard areas near the confluence with Ohop Creek. Much of the Ohop valley is mapped as a seismic hazard.
Habitat Conservation Area All waters of the state including rivers, streams, and watercourses within jurisdiction of the state of Washington are considered habitat conservation areas in the Town of Eatonville. Lynch Creek is classified as a Type F (fish-bearing) stream and has a 150 foot standard buffer width (EMC 15.15174).

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Shoreline Vegetation/Riparian Vegetation
The Ohop Creek Restoration Project (ongoing) is currently restoring riparian vegetation to a significant portion of the Ohop Creek SPA. Pre-restoration project riparian conditions were assessed for Ohop Creek and a small portion of Lynch Creek; roughly a half mile upstream of the confluence, as part of the Ohop/Tanwax/Powell Watershed Analysis (Nisqually Indian Tribes,1998). The assessment included the following descriptions of riparian vegetation of Lynch Creek: ▪ Riparian stands included medium sized stands of hardwoods, and mixed hardwood/conifer that were sparse in areas. Stands were not of an adequate size and density to provide functional wood development. Other data sources indicate that Lynch Creek flows through commercially-owned timberlands, to rural residential areas and hobby farms throughout the lower mile of the stream (WPN, 2002). There are localized areas of residential encroachment into the riparian zone along the lower reaches of Lynch Creek; however, the remainder of the riparian area is comprised of second growth hardwoods. LWD is sparse in the lower reaches of the stream (Kerwin, 1999).

Wildlife Habitats (Map 5)	Fisheries (Map 5)
According to WDFW PHS data (WDFW 2009a), the only mapped priority habitat associated with Lynch Creek is Riparian zones	According to WDFW streamnet data (WDFW 2009b) Lynch Creek supports the following fish species:
	1. Channel Catfish (documented presence)
	2. Winter Chum (presence/migration)
	3. Sockeye Salmon (documented presence)
	4. Resident Cutthroat Trout (documented presence)
	5. Coho Salmon (presence/migration)
	6. Fall Chinook (documented presence)
▪ There is a natural falls located at RM 1.0 of the stream that blocks upstream fish access. In addition, the steep gradient in the lower reach of the stream serves as a limiting factor for spawning (WPN, 2002). ▪ Beyond the Town and UGA limits, there are several other priority habitat areas associated with Lynch Creek including the White River elk range; Ohop Creek riparian corridor areas which are comprised of an assortment of conifer, mixed trees, and broadleaf shrub riparian habitat; a small waterfowl concentration area; and Upper Nisqually River bald eagle use area; and Ohop Creek wetland areas, comprised of forested, riparian, shrub, and agricultural wetlands (WDFW, 2007a). ▪ In Lynch Creek, major problems affecting salmon survival include the high sediment load, reduced channel stability and habitat diversity (due to some reduction in the amount of instream wood and simplification of the channel and its disconnection from the floodplain in some areas) and a loss of pool habitat compared to presumed historic conditions (ESA Adolfson, 2008).	

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- Accentuated high flows and increased 'flashiness' of flow (i.e., quicker in-stream flow responses to rainfall events and higher peak flows) compared to presumed historic conditions in Lynch Creek reduce survival of salmon and trout in the creek (ESA Adolfson, 2008).
- Lynch Creek is an important source of coarse gravels to the Ohop Creek system. (Homza et al. 2002).

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Plans and Built Environment

Current Land Use Pattern	Current Shoreline Designations	Comprehensive Plan Land Use Designations (Map 9)
The general land use pattern in with the western portion of the Town's Lynch Creek SPA is a mix of rural density residential development, agricultural areas and undeveloped areas. Land use in the eastern portion of the SPA (east of Lynch Creek Rd E) includes undeveloped lands, Eatonville airport, and the Lynch Creek Quarry. A narrow forested riparian corridor is maintained surrounding Lynch Creek.	**Town:** Shoreline Residential **UGA:** Conservancy (Pierce County)	According to the Town's Comprehensive Plan, all of the lands in the western portion of the SPA are designated for single-family uses. Lands in the eastern portion (east of Lynch Creek Rd E) are designated for Aerospace uses and industrial uses. The aerospace and industrial designations are divided by the Tacoma Railroad tracks (Town of Eatonville, 2005).

Current Zoning (Map 10)						
	Town		UGA		Total (Town and UGA)	
Zone	Acres in SPA	% of SPA	Acres in SPA	% of SPA	Acres in SPA	% of SPA
Airport	19.8	70%			19.8	33%
C-2						
Ind			18.9	58%	18.9	31%
MU						
ROW			2.8	9%	2.8	5%
SF-1	0.6	2%	11.1	34%	11.7	19%
SF-2	6.7	24%			6.7	11%
SF-3	1.0	4%			1.0	2%
Totals	28.1		32.8		60.9	

Water-Oriented Uses		
Water-dependant: ▪ None Identified	Water-related: ▪ None Identified	Water-enjoyment: ▪ None Identified

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Transportation/Roads/Bridges/Railroads (Map3)	Utilities
There are two bridges that cross Lynch Creek within the Town's SPA. The first is at Ski Park Rd E and the second is Lynch Creek Rd E. The Tacoma Railroad also crosses the creek. The only other transportation infrastructure in the SPA are portions of residential streets that intersect the SPA.	Most of the Town's stormwater drains to an open ditch which drains to Lynch Creek. The ditch begins just east of the intersection of Washington Ave S and Lynch Creek Rd NE and flows northwest to an outfall located outside the Town and UGA boundary north of SR 161 (R.W. Beck, 2003).

Historic and Cultural Resources
Cultural resources were reviewed as part of the Pierce County Inventory and Characterization Report (ESA Adolfson, 2009). Cultural resources within the Lynch Creek SPA included cultural resources within the Lynch Creek shoreline planning area include recorded pre-contact materials and campsites. Native American use of the Nisqually basin area, by the Nisqually Tribe and neighboring tribes, included seasonal hunting and gathering campsites near Lynch Creek. Recorded artifacts include lithic scatters, charcoal deposits, and calcined bones. Subsistence harvest of anadromous fish (salmon and trout) and supplemental hunting of upland mammals occurred along Lynch Creek and throughout the watershed (ESA Adolfson, 2009). There are no historical structures within the Lynch Creek SPA that are identified on the State or National Register of Historic Places.

Public Access/Parks/Trails/Open Space (Map 11)
There are no Town, County or State parks within the Town's Lynch Creek SPA. Visual access is available at road crossings that include SR 161, Ohop Ski Park Rd, Lynch Creek Rd E. The proposed Rim Rocks Nisqually-Mashel Trail, and the Tacoma Railroad right-of-way could also provide access.

Known Sites with Toxic or Hazardous Materials
None identified by DOE Confirmed and Suspected Contaminated Sites List (DOE, 2009).

Shoreline Modification
No levees or other significant shoreline modifications are mapped along Lynch Creek, however, as reported in the Nisqually River Basin plan (ESA Adolfson, 2008), artificial confinement of the stream channel due to residential development restricts movement of the channel to some degree, but the channel is fairly stably situated in this canyon reach.

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Degraded Areas

Most of the Town's stormwater drains north to an outfall in Lynch Creek. Pierce County Basin plan (2008) has identified this outfall as a potential source of bacteria, phosphorus and suspended solids that enter Lynch and Ohop Creeks.

Pierce County's Nisqually River Basin Plan identified stream habitat and riparian area conditions based on Nisqually Tribes' Ecosystem Diagnosis and Treatment (EDT) model results (ESA Adolfson, 2008). According to the EDT method, the major problems affecting salmon survival include the high sediment load, reduced channel stability and habitat diversity (due to reduction in the amount of instream wood and simplification of the channel and its disconnection from the floodplain in some areas), and a loss of pool habitat compared to presumed historic conditions. In addition, accentuated high flows and increased 'flashiness' of flow (i.e., quicker in-stream flow responses to rainfall events and higher peak flows) compared to presumed historic conditions in Lynch Creek reduce survival of salmon and trout in the creek. The EDT analysis ranked Lynch Creek as a high priority for both restoration and preservation.

These results are generally similar to watershed scale analysis performed for the Pierce County Shoreline Master Program – Restoration Plan (ESA Adolfson, 2008). This analysis suggested that protection and restoration were the highest priority for the Lynch Creek and Ohop Creek subbasins.

Restoration Opportunities and Sites

Restoration opportunities for Lynch Creek shorelines include: restoring forested riparian areas where they are degraded due to agricultural practices and gravel mining; decommissioning forest roads; stabilizing slopes, implementing flow control measures to restore a more natural runoff hydrograph. Aerial photographs indicate that riparian cover is lacking within 200 feet of the stream in some locations.

Areas of Special Interest

The Town is currently developing a sub-area plan for the area currently occupied by the Lynch Creek Quarry in the Town's UGA. Under the Plan, 86 acres of the quarry would be annexed to the Town and zoned for industrial uses. The subarea is located between Lynch Creek and the Mashel River. The concept of the plan is to create industrial development clusters, separated by roads and green space corridors. The owners of the quarry have submitted a conditional use permit to Pierce County for continued mining for the next 5-10 years. Implementation of the sub-area plan and development would occur after cessation of mining activities.

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Assessment of Ecological Functions

Ecosystem Process / Shoreline Function	Level of Alteration	Conservation / Restoration Potential
Hydrology	Moderate to low. Runoff generated in the Town of Eatonville flows to Lynch Creek with minimal flow control measures. Much of Lynch Creek is low elevation, and therefore rain dominated, but the watershed does extend to the rain-on-snow dominated elevations.	Moderate. There is moderate potential to restore a more natural rainfall to runoff relationship within the Town of Eatonville. Retrofitting stormwater management measures could reduce flashiness of storm flows and reduce pollutant loading. Conservation potential exists to preserve existing functioning riparian forest and forest lands in the contributing basin. Conservation potential is high for the Lynch Creek riparian corridor, which is an important source of coarse gravels to the Ohop Creek system.
Hyporheic functions	Moderate. Residential development and road crossings have modified channel plan form and limited migration, especially in the lower portion near the confluence with Ohop Creek.	Moderate. Restoring hyporheic functions would typically involve large-scale restoration of channel-floodplain relationships and channel plan form with appropriate frequency and type of LWD. From a feasibility perspective, this type of project has higher potential in more altered areas with low levels of infrastructure, such as the lowest reach below Ski Park Road. This type of project is more challenging, and less feasible in areas with greater density of infrastructure.
Shoreline Vegetation	Moderate. Riparian forest exists along the majority of Lynch Creek, gaps occur and width is very narrow in places.	High. Conservation potential is high for existing significant riparian forest. Restoration potential is moderate

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		to close gaps and expand the width of riparian forest in places.
Habitat	Moderate. Reduced habitat diversity due to reduction in LWD, simplification of channel, disconnection of channel and floodplain, and loss of pool habitat (ESA Adolfson, 2008).	High. High potential to improve habitat diversity and key habitat quality (in ESA Adolfson, 2008). High Potential for Conservation of existing instream habitat (in ESA Adolfson, 2008).

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Management Issues and Opportunities

Summary of Ecological Function and Management Issues

The following summarizes the key factors affecting ecological functions in the Lynch Creek SPA:

- The lack of riparian vegetation along portions of Lynch Creek reduces shading along the stream, potentially resulting in increased stream temperatures and lowered dissolved oxygen. A lack of larger trees along the stream means less wood in the stream channel. In-channel wood is key to creating habitat, and supporting channel morphology similar to natural conditions.
- Removal of native riparian vegetation also increases the opportunity for non-native invasive plants such as reed canary grass to become established. Reed canary grass does not provide shade or woody material to the stream, and its aggressive growth prevents native trees and shrubs from becoming re-established in infested areas.
- Most of the Town's stormwater runoff is conveyed to an outfall in Lynch Creek. Stormwater runoff increases turbidity and other pollutants in the stream, as well as increasing peak flows. These impacts degrade water quality and habitat for aquatic life including salmon.
- Eventual redevelopment of the Lynch Creek Quarry site from a mining area to industrial uses presents an opportunity to restore shoreline functions in a significant portion of the watershed. The sub-area plan for the site should include policies to restore riparian vegetation and minimize stormwater impacts during redevelopment.
- Potential future redevelopment of the Lynch Creek Quarry site from a mining area to industrial uses presents an opportunity to restore shoreline functions in a significant portion of the watershed. The Town should ensure that the SMP does not preclude development within the Sub-area plan and should also ensure that development does not adversely affect shoreline functions.

Based on these existing conditions, the important management issues for the Lynch Creek are:

- Lack of riparian vegetation
- stormwater impacts on the stream
- potential new industrial development in the Lynch Creek Quarry sub-area

Future Use Patterns and Potential Use Conflicts

Current land use in the Lynch Creek River SPA consists of single-family developments within the western portion of the SPA and the airport and quarry in the eastern portion of the SPA. The Quarry is likely to operate for another 5-10 years after which the land is planned to be redeveloped into an industrial area. Lack of riparian cover, leading to a paucity of wood in the creek and stormwater impacts are the primary factors limiting shoreline functions.

A review of Pierce County assessor's data and town zoning indicates that there is the potential for

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increased residential developed in the western portion of the SPA and the likelihood of increased development in the longer-term through the Lynch Creek Quarry Sub-area plan. Based on a review of Pierce County assessor's land use data and Town zoning review, there are approximately 15 vacant parcels adjacent to the creek. Of these 14 are located in the western portion of the SPA, which is zoned for single family development. Some of these vacant parcels are subdivided lots that are part of an established housing development. Six parcels located west of Ski Park Road E are all at least twice the minimum lot size (9,600), meaning that the potential for subdivision and development exists.

There are two principal land uses in the east portion of the SPA. One is the airport and the other is the Lynch Creek Quarry. Some of the airports infrastructure may be located within the SPA and new development related to the airport is possible. The Aerospace zoning district also allows commercial, industrial, and residential uses. (EMC 18.04.185). Impacts to the creek from new development should be limited by the 150 foot Lynch Creek buffer.

The Quarry, located in the Town's UGA, will likely operate for the next 5 – 10 years. In general quarry operations are located outside the 200-foot SPA and 150 Lynch Creek buffer. As described above, a sub-area plan for the quarry could introduce new industrial uses to the area, but would also represent an opportunity for the Town to reclaim some of the Quarry area and implement creek enhancement or restoration as part of any proposed development.

Opportunities for Ecological Protection and Restoration

In general, enhancement and restoration efforts should focus on the processes and functions identified in this report. Specific opportunities will be described in more detail in the restoration plan. The Town should consider the following programmatic restoration measures:

- Restoration of native vegetation along Lynch Creek is important to improving shoreline conditions and functions. Several organizations are undertaking large-scale restoration along portions of Ohop Creek, including revegetation and control of invasive species. The Town and private landowners could use this project as a model for restoration within the Lynch Creek SPA.
- The Town should consider reviewing its River buffer standards to ensure protection and/or improvement of riparian corridors. This could take the form of modified vegetation conservation standards.
- The Town's 2003 Draft Stormwater Management Program includes several recommendations that would also improve shoreline functions in the Lynch Creek SPA:
    - Retrofitting existing stormwater systems, perhaps as part of improvements required for new development;
    - Implementing a public education program about ways that residents can reduce non-point source pollution;
    - Regularly maintaining stormwater facilities such as catch basins; and
    - Exploring new approaches such as semi-pervious parking surfaces.
- Development under the Lynch Creek Quarry Sub-area plan also gives the Town the opportunity to improve riparian conditions along Lynch Creek and improve shoreline functions.

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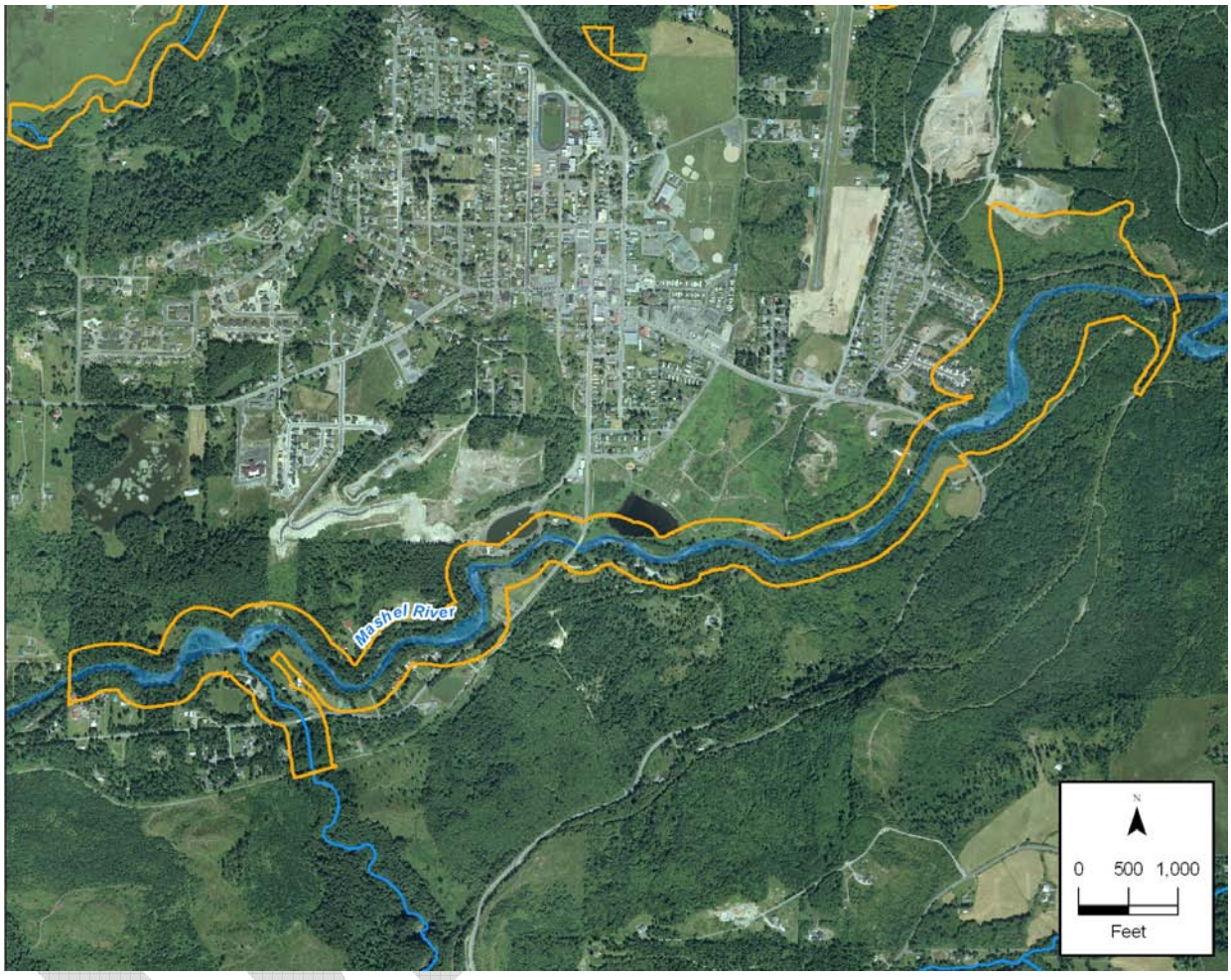
4.3 Mashel River

General Information

Mashel River Shoreline Planning Area (SPA)



WRIA (MAP 2)	Watershed (Map 2)	Basin (Map 2)	Length
WRIA 11	Nisqually	Mashel River Basin	Town: 1.6 miles UGA: 1.2 miles Total: 2.8 miles

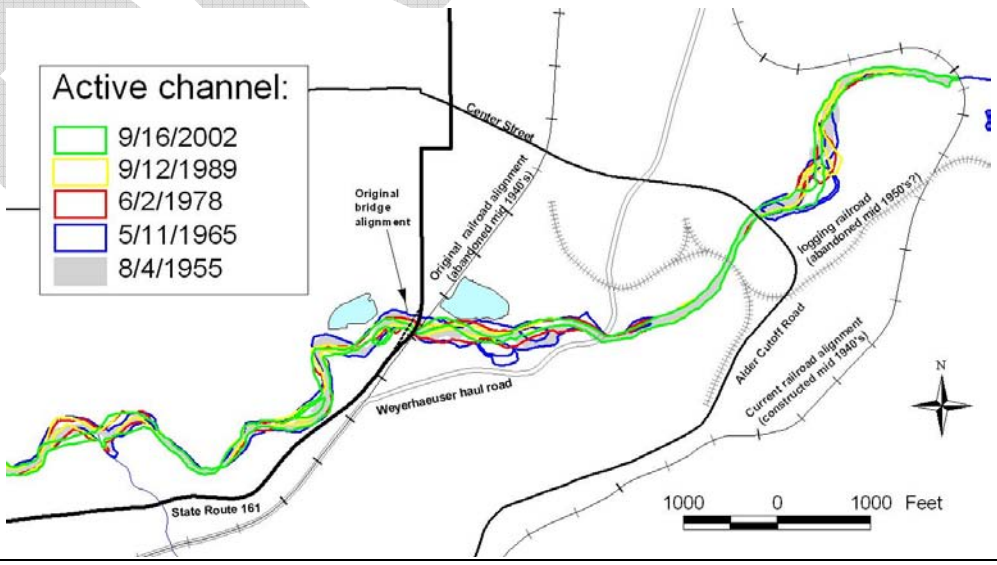
Physical Resources

Topography (Map 4)	Soils (Map 7)	Floodplain/Floodway (Map 4)
Topography of the Mashel River SPA is relatively flat through the Town. The Mashel River within the Town's SPA ranges in elevation from approximately 900 to 700 feet.	1. Rock outcrop 2. Aquic Xerofluvents, level 3. Barneston gravelly coarse sandy loam, 6 – 15 % slope 4. Briscot loam, variant 5. Riverwash 6. Barneston gravelly coarse sandy loam, 30 – 45 % slope	Floodplains and floodways associated with the Mashel River are relatively narrow and are mapped within 200 feet of the OHWM on either bank of the River. The floodway and floodplain widen in two places in the SPA: 1) an area at the eastern UGA boundary where the river bottom flattens and broadens within a mapped wetland complex; and 2) downstream of the confluence with the little Mashel River.

Channel Migration

As part of the Mashel River Restoration Design Technical Memo (WPN, 2004), channel changes over the past 50 years were assessed using aerial photographs from 1955, 1965, 1978, 1989, and 2002. As shown in Figure X, The most dynamic portions of the stream included the area immediately upstream of the Alder Cutoff Road, the area downstream of the old Weyerhaeuser haul road bridge to downstream of the present-day sewage treatment plant, and the area near the confluence of the Little Mashel River. The remaining areas have remained stable over the 50-year period analyzed.

Summary of all channel changes within the project reach: 1955 to 2002



Surface Hydrology (MAP 4)

The Mashel River flows from its headwaters west of Big Deer Creek and Neisson Creek, and merges with the Nisqually River northwest of La Grande, Washington. Approximately 2.8 mile of the River flow through the Town of Eatonville and its UGA, primarily along the Town's southern boundary. Several unnamed tributary creeks enter the mainstem of the River within this area. The largest tributary within the Town's SPA is the Little Mashel River, which joins the mainstem at RM 4.4.

Other Hydrologic Features

- The Mashel River has 20 miles of mainstem and drains an area of 83 square miles (WPN, 2004). The Mashel River originates on the mountain slopes associated with Mount Rainier. It is a tributary to the Nisqually River which it joins at RM 39.6. The Mashel River has three major tributaries: Busy Wild Creek, Beaver Creek, and the Little Mashel River.
- Flow of the River through Eatonville is unregulated except for a diversion for municipal located upstream of Weyerhaeuser Road S.
- There are three bridges that influence hydraulic conditions in the River: A private driveway bridge located approximately a quarter mile upstream of the Little Mashel Confluence; The SR 161 bridge; and the Alder Cutoff Road bridge (WPN, 2004).
- The Mashel River has the highest overall flows of any of the Nisqually tributaries below the LaGrande Dam. However, it also has very low flows in the summer that are lower than historic summer flows. The river's flow is also 'flashy,' responding rapidly to precipitation (ESA Adolfson, 2009).
- Low flow conditions within the Town are to a large extent due to the inherent hydrology of the Mashel watershed, impacted to some extent by land management activities (primarily in the upper watershed). Water withdrawal for the Town further exacerbates the low flow problem in the Town's SPA (WPN, 2004).

Water Quality

According to the 2008 Washington State Water Quality Assessment (Ecology, 2009), The only (303(d)) listing for the Mashel River within the Town's SPA is a category 5 (303(d)) listing for temperature. There are no other listings for the Mashel in the Town's SPA.

According to the 2004 Washington State Water Quality Assessment (Ecology, 2004b), The Mashel River also had a category 2 listing for temperature and four Category 1 listings for dissolved oxygen, fecal coliform, pH, and temperature outside of the Town's SPA.

According Mashel River Restoration Design (WPN, 2004) Current riparian shade conditions were not adequate to maintain water quality standards for stream temperature along the portion of the Mashel River immediately upstream of the Town.

Data from the Nisqually Indian Tribe's water quality database from the 1990s indicates that minimum dissolved oxygen concentrations in the stream were above the State standards. In addition, temperature

standards were exceeded at monitoring stations along the stream (WPN, 2002). Forestry and other natural causes have been listed as probable sources for the temperature departures from the State standard. Forestry has also been listed as a probably source for elevated TSS concentrations in the stream during the wet season (WPN, 2002).

In addition, the Town of Eatonville operates a secondary treatment sewage plant that discharges into the Mashel River at RM 5.4. This facility is thought to be a source of elevated total phosphorus within the river (ESA Adolfson, 2009).

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Biological Resources

Critical Areas
The Town's critical areas code (EMC 15.16) regulates five types of critical areas, which are described below:
Wetlands (Map 4) A large riparian wetland system, containing forested habitat, is mapped along the Mashel River at the eastern Town boundary and UGA. The mapped wetlands system extends east beyond the Town's SPA and is approximately 142 acres in size. There are very limited scattered wetlands mapped along the Mashel River through the remainder of the Town's SPA. Wetland buffers range from 35 feet to 300 feet depending on wetland typing and intensity of proposed use (EMC 15.16.124).
Critical Aquifer Recharge Areas (Map 4) Two critical aquifer recharge areas are mapped in the Town of Eatonville. One of them includes roughly half of the Town's Mashel River SPA. Approximately 1.4 miles of the Mashel River are mapped with the CARA.
Floodplains (Map 4) Floodplains are mapped along the Mashel River through the Town and its UGA. The mapped floodplain is relatively narrow in the Town's SPA. It does not exceed 200 feet from the mapped OHWM. There are two locations within the Town's SPA where the floodplain is mapped beyond 200 feet from OHWM. The first is in the vicinity of 436th St SE, where the floodplain extends approximately 230 feet from the OHWM of the left bank. The second in immediately downstream of the confluence with the Little Mashel River, where the floodplain extends approximately 280 feet from the OHWM.
Geological Hazardous Areas (Map 8) Geological Hazardous Areas are defined by EMC 15.16.161 and mapped in the Town's Mashel River SPA. Mapped hazards include seismic hazard along most of the river shoreline in the SPA. Landslide areas are mapped along the left bank of the upper portion of the Town's SPA. Areas of erosion potential are also mapped around the old sewage lagoon, Mill Pond, and several areas upstream along the River. The Pierce County Shoreline Inventory also identified volcanic hazards from mudflow deposits, seismic hazards from alluvial deposits, flooding, and erosion potential. The Town also has mapped flood hazard areas which coincide with the 100-year floodplain (ESA Adolfson, 2009).
Habitat Conservation Area All waters of the state including rivers, streams, and watercourses within jurisdiction of the state of

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Washington are considered habitat conservation areas in the Town of Eatonville.

The Mashel River is classified as a Type S (Subject to Shoreline Management Act) stream and has a 200 foot standard buffer width (EMC 15.15174).

Shoreline Vegetation/Riparian Vegetation

Upstream of Little Mashel

Riparian conditions along the Town's shorelines upstream of the confluence with the Little Mashel were interpreted from orthophotos and field verified in 2002, as part of the Mashel River Restoration Design (WPN, 2004). That study found the following:

- Approximately 60 percent of the riparian area within 200 of the active channel is currently in a forested conditions; consisting primarily of small and medium sized hardwood or mixed hardwood-conifer stands.
- 8 percent of the riparian area is currently occupied by conifer-dominated forest, sparse forested stands, or regenerating clearcuts.
- The primary non-forest riparian types within 200 feet of the active channel include pasture (8%), brush-dominated areas (6%), Road/railroad right-of-way and driveways (5%), and lawns, gardens, and other residential clearing (5%).
- Other minor components of current riparian conditions include areas of active landslides, ponds, and buildings, the Town of Eatonville Sewage treatment lagoon, un-vegetated rip-rap, and rock outcrops.
- As of 2004, LWD loading within the Town's SPA was virtually nonexistent. The only significant LWD jam was located below the sewage treatment plant. Riparian stands along the channel were assessed to be too small to prove an adequate supply of LWD (WPN, 2004).

Riparian conditions as mapped in 2004 are shown in the figure below.

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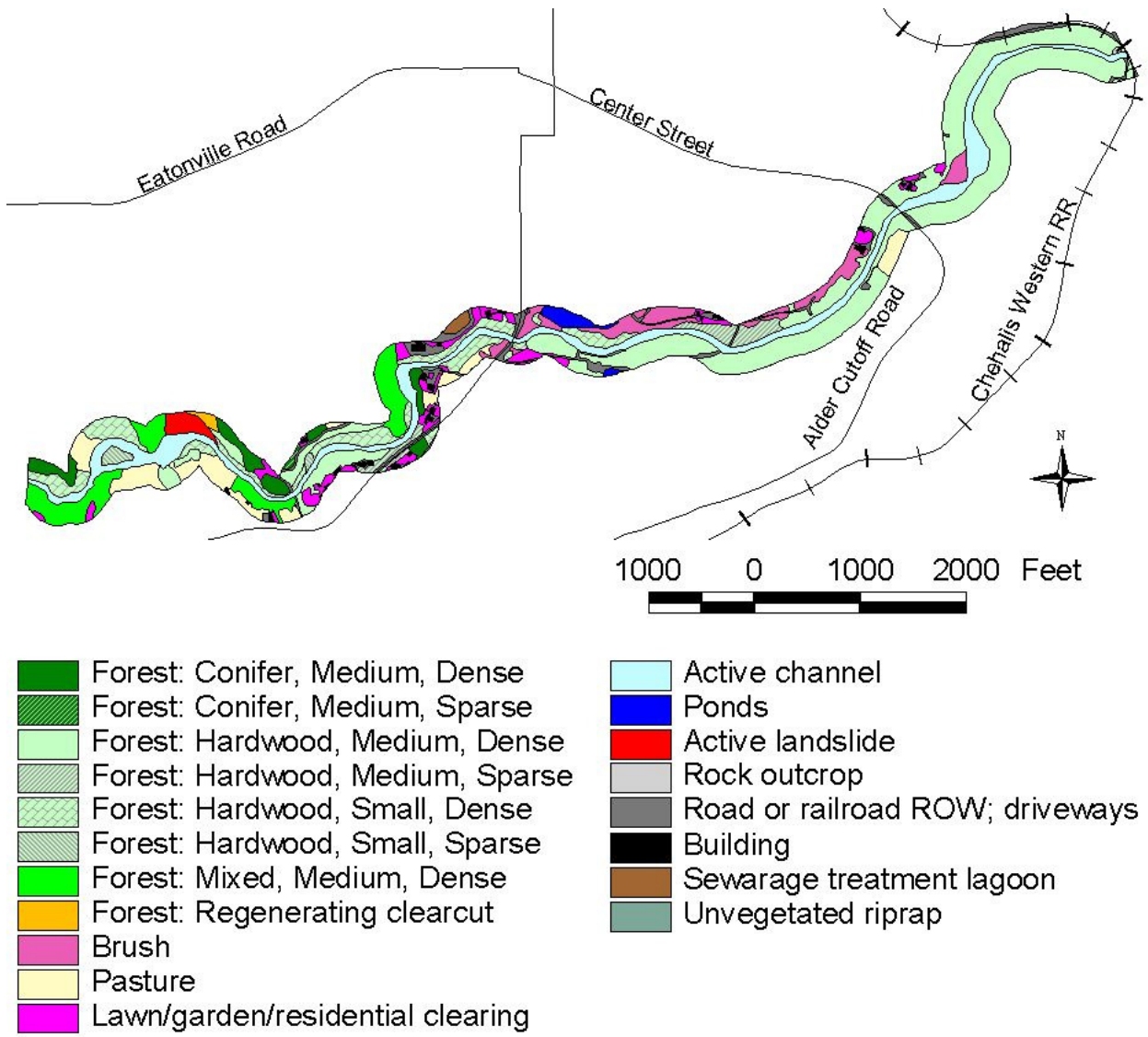

Downstream of Little Mashel River

Based interpretation of recent orthophotos, riparian vegetation downstream of the Little Mashel confluence to the UGA boundary, appears to consist primarily of conifer and mixed hardwood forest stands. Pasture and lawns are present, but in less abundance than forest. All of the right bank is owned by the Nisqually Land Trust and is undeveloped. There are some structures within 200 feet of the channel.

Wildlife Habitats (Map 5)	Fisheries (Map 5)
According to WDFW PHS data (WDFW 2009) the Mashel River has multiple priority habitats	According to WDFW streamnet data (WDFW 2009) the Mashel River supports the following fish

associated with it, including:	species:
1. Bald Eagle use areas	1. Fall Chinook (known spawning)
2. Wetlands	2. Coho Salmon (known spawning)
3. Waterfowl concentrations	3. Winter Chum (known spawning)
4. Riparian zones	4. Resident Cutthroat (presence/migration)
5. There are elk habitat mapped south and east of the Town and UGA boundary.	5. Sockeye Salmon (presence/migration)
	6. Winter Steelhead (known juvenile rearing)

Spawning and Rearing Habitat:

- The lower four miles of the mainstem Mashel River (including the Town's SPA), is where the bulk of the fall Chinook spawning occurs within the watershed. Gravels are present and deep pools for potential holding habitat are limited (WPA, 2004).
- The falls upstream of Eatonville present a fish passage barrier to all salmonids.
- The bulk of the mainstem of Mashel Creek upstream of Eatonville and downstream of the falls as RM 15.4 provide conditions most suited for steelhead trout spawning and rearing (WPA, 2004).
- Water withdrawal and porous channel bed conditions may impede upstream movement of spawning fish in the vicinity of Eatonville (WPA, 2004).
- As of 2004, LWD loading within the Town's SPA were virtually nonexistent. The only significant LWD jam was located below the sewage treatment plant. Riparian stands along the channel were assessed to be too small to prove an adequate supply of LWD (WPN, 2004).
- The Nisqually Indian Tribe, South Puget Sound Salmon Enhancement Group, and Northwest Indian Fisheries Commission have worked together to enhance and monitor salmonid habitat in the Mashel River. Large woody debris and log jams were installed in the lower 1.6 miles of the Mashel River in 2004 to improve instream fish habitat. In 2005, the stream was monitored to determine the success of these habitat structures. Fish surveys conducted in 2005 indicated that a large number of pink salmon and Chinook redds were counted in the Lower Mashel River (ESA Adolfson, 2009).

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Plans and Built Environment

Current Shoreline Use Pattern	Current Shoreline Designations	Comprehensive Plan Land Use Designations (Map 9)
The general land use pattern in the Town's Mashel River SPA is a mix of rural density residential development, minor agricultural areas, limited small scale commercial uses and open space. A significant portion of the Mashel River shorelines in the Town's SPA are publically owned or privately owned by the Nisqually Land Trust or Nisqually Tribe and dedicated to restoration and preservation. The town also owns and operates a water and wastewater facility, both located within the SPA.	**Town:** Shoreline Residential Urban Conservancy Public Conservancy **UGA:** Rural (Pierce County)	According to the Town's Comprehensive Plan, the entire left bank of the River from the western UGA boundary to Center Street E is designated single-family. From Center Street to the eastern boundary the left bank is designated parks and open space. The right bank is designated single-family from the western boundary to Mashel Ave S. Between Mashel Ave and Center Street, shorelines are designated mixed-use, commercial, and parks and open space. East of Center Street the right bank is designated as single-family. The wetland complex, which is likely associated with the River extends into an industrial area (Town of Eatonville, 2005).

Current Zoning (Map 10)

Zone	Town		UGA		Total (Town and UGA)	
	Acres in SPA	% of SPA	Acres in SPA	% of SPA	Acres in SPA	% of SPA
Airport						
C-2	8.3	11.2			8.3	4.1
Ind			23.0	17.9	23.0	11.4
MU	11.3	15.4			11.3	5.6
ROW	7.4	10.0	4.1	3.2	11.5	5.7
SF-1	20.6	28.0	58.6	45.7	79.2	39.2
SF-2	20.6	28.0	42.6	33.2	63.2	31.3
SF-3	5.4	7.3			5.4	2.7
Totals	**73.6**		**128.2**		**201.9**	

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Water-Oriented Uses		
Water-dependent: ▪ None Identified	Water-related: ▪ None Identified	Water-enjoyment: ▪ None Identified

Transportation/Roads/Bridges/Railroads (Map3)	Utilities (Map 3)
There are three auto bridges over the Mashel River in the Town's SPA: 439th St E; Mashel Ave S; and Center St E. A railroad bridge crosses the Mashel at the eastern boundary of the UGA. SR 161 parallels the River along the left bank until it crosses and becomes Mashel Ave S.	The Town's water treatment facility and wastewater facilities are both located within the Town's SPA on the right bank of the River. The water intake is located approximately halfway between the Alder Cutoff Road bridge and the location of the former Weyerhaeuser haul road bridge. The wastewater outfall is located at approximately milepost 5.3.

Historic and Cultural Resources
Cultural resources within the Mashel River shoreline planning area include recorded pre-contact materials and campsites. Native American use of the Mashel River area, by the Nisqually Tribe and other neighboring tribes, included seasonal hunting and gathering campsites near the Mashel River. Subsistence harvest of anadromous fish (salmon and trout) and supplemental hunting of upland mammals occurred along the Mashel River and throughout the watershed (ESA Adolfson, 2009). There are no historical structures within the Mashel River SPA that are registered on the State or National registries of historic Places (DAHP, 2009).

Public Access/Parks/Trails/Open Space (Map 11)
The only public Park that offers physical access to the shoreline is George Smallwood Park. The Town's Alder Street Park offers visual access to the River. Several parcels on the left bank of the River are planned for acquisition by the Town (see map 11). Public access will be provided at these locations. Additionally, the proposed Rim Rocks Nisqually-Mashel Trail and the proposed Mashel River Greenbelt Trail would offer visual and physical access to the River.

Known Sites with Toxic or Hazardous Materials
None identified by DOE Confirmed and Suspected Contaminated Sites List (DOE, 2009).

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Shoreline Modification
Riprap is present intermittently along both banks of the River from the Alder Cutoff Road bridge to the downstream end of the wastewater treatment plant (downstream of the SR 161 bridge). Much of the riprap in these areas is old, however, more recent placements have occurred on the left bank in the vicinity of Smallwood Park, and on the left bank below the SR 161 bridge.

Degraded Areas
Hydro-modifications within the stream channel, such as bank riprap and bridges were identified as one of the factors that resulted in Rivers impacted condition (WPN, 2004). A loss of riparian function and the lack of LWD within the River are also sources of habitat loss and degradation (WPN, 2004). Channel stability and flow conditions have also been altered resulting in habitat degradation. Changes to channel stability and flow conditions have both been related to clear cutting in the upper watershed (WPN, 2004). Due to a combination of floods and timber harvest activities in the upper watershed, large amounts of sediment from landslides were moved into the channel of the Mashel River about 20 to 30 years ago. Much of that sediment still controls the form of the channel seen today. The channel has mostly shallow pools, unconsolidated substrate, and is generally fairly wide. The river is now slowly reworking those deposits, leading to narrowing of the channel and consolidation of gravel (ESA Adolfson, 2008)

Restoration Opportunities and Sites
The South Puget Sound Salmon Enhancement Group (SPSSEG) and Nisqually Tribe led restoration efforts on the Lower Mashel River near Eatonville. In 2004, seven engineered logjams were constructed. In 2006 and 2007, a total of 13 engineered logjams were installed to increase large woody debris and enhance in-channel habitat. Long term habitat monitoring of this section of the Mashel River is underway to determine the use and success of the restoration project. SPSSEG conducted habitat monitoring in 2007 and 2008. Funding for this project was provided by the Salmon Recovery Funding Board, U.S. Fish and Wildlife Service, and National Wildlife Foundation (SSPEG, 2006, 2009). Pierce County has identified acquisition of shoreline properties along the Mashel River in and near Eatonville as capital improvement projects in the Nisqually River Basin Plan (ESA Adolfson, 2008). Other restoration opportunities for the Mashel River shorelines include restoring forested riparian areas where they are degraded due to agricultural practices and timber harvest. Aerial photographs indicate that riparian cover is lacking within 200 feet of the stream in some locations. This limits the recruitment of LWD. Decommissioning timber roads or resurfacing gravel roads would reduce sedimentation inputs into streams. Culverts could be replaced where appropriate.

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Areas of Special Interest

The Town of Eatonville operates both a water facility that provides potable water to the Town and a wastewater treatment facility. The water facility processes approximately 400,000 gallons of water per day from the River. The intake is located upstream of Weyerhaeuser Road S.

The treatment facility is located on a 10 acre parcel west of State Highway 161 and north of Mashel River, in the south-central part of Eatonville. It processes an average of 275,000 gallons of sewage per day and had an outfall located at milepost 5.3 (Town of Eatonville, 2005). Prior to the construction of the wastewater treatment plant, Eatonville was treating its wastewater by aerating it in a lagoon and disinfecting the effluent by injection of chlorine before discharging it into Mashel River.

Both facilities are located within the SPA. The Town plans on continued use of the facilities. Both have capacity to accommodate planned future development in the Town.

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Assessment of Ecological Functions

Ecosystem Process / Shoreline Function	Level of Alteration	Conservation / Restoration Potential
Hydrology	Moderate to High. Past channel modifications resulted in a simplified, narrow channel between the Little Mashel River confluence and Boxcar Canyon (ESA Adolfson, 2008). Summer low flows do not meet minimum instream flows at times (Golder, 2003). Other water quality issues include low dissolved oxygen, high turbidity, and high fecal coliform bacterial levels (WPN, 2002).	High for channel structure. Channel restoration is underway in places to remove artificial bank hardening and increase the amount of LWD in the SPA. Moderate for water quality. Changes to the contributing basin have the potential for restoration, but most would need to be accomplished on a watershed-wide basis.
Hyporheic functions	Moderate to High. Channel alterations have altered the overall planform, removed riparian vegetation, and decreased channel-floodplain connections. Secondary treated wastewater is discharged to the river in this reach.	Moderate. As noted above, channel restoration is ongoing. Portions of the floodplain have been developed, limiting full hyporheic functioning in this area.
Shoreline Vegetation	Moderate. Discontinuous and developing riparian exists through much of the reach.	Moderate to High. Restoration potential exists to plant native riparian forest to close gaps and target a wider riparian area.
Habitat	Moderate to High. Direct and indirect alterations to the channel have resulted in-bed scour and high levels of fine sediment have reduced habitat quality throughout the Town's SPA.	High. Potential for restoration with a focus on overall channel stability, habitat diversity, and hydraulics (ESA Adolfson, 2008).

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Management Issues and Opportunities

Summary of Ecological Function and Management Issues

The following summarizes the key factors affecting ecological function in the Mashel River SPA:

- The lack of riparian vegetation along portions of the river reduces shading along the stream, potentially resulting in increased stream temperatures and lowered dissolved oxygen. A lack of larger trees along the stream means less wood in the stream channel. In-channel wood is key to creating habitat structures for fish such as pools. Restoration of native vegetation along the river is important to improving shoreline conditions and functions.

- Armoring of shorelines with riprap can stabilize the banks in the short term, but may result in impacts to other portions of the channel (for example, increased erosion in other areas if there are changes in flow patterns). In addition, riprap does not provide refuge or feeding habitat for salmonids. The lack of riparian vegetation in riprap areas means a loss of shading and wood input.

- Large amounts of sediment from past logging practices are present in the Mashel River. Much of that sediment still controls the form of the channel seen today. The river is now slowly reworking those deposits, leading to narrowing of the channel and consolidation of gravel (ESA Adolfson, 2009)

- Low flows in the river appear to result from both human actions (such as municipal water withdrawals) and natural conditions (e.g., a naturally porous riverbed substrate).

Based on these existing conditions, the important management issues for the Mashel river are:

- lack of riparian vegetation and in-channel wood,

- channel confinement and shoreline armoring

- low flows

Future Use Patterns and Potential Use Conflicts

Current land use in the Mashel River SPA consists of several land use types including a low density residential development, small scale agricultural areas, limited commercial uses and open space. Past logging practices continue to affect ecological functions. Excessive sediments introduced in the past has lead to a wider shallower river. Logging and removal of riparian vegetation has lead to a lack of wood in the stream. These activities largely occurred outside of the Town. Within the Town, the lack of riparian cover and the presence of shoreline armoring have contributed to a decline in the quality of salmonid habitat.

Currently, land use in the Mashel SPA consists of low density residential, small scale commercial, and government uses. However, a review of Pierce County assessor's land use data and Town zoning indicates that zoning in the SPA is varied and there is the potential for increased residential, commercial, and mixed use development along the River. Excluding properties owned by the Nisqually Land Trust,

the Town, or planned for acquisition, there are approximately three vacant parcels adjacent to the River and zoned for single-family development. These parcels are all at least twice the minimum lot size (9,600), meaning that the potential for subdivision and development exists.

There are two large parcels (41 acres combined) zoned Mixed-use adjacent to the creek. Both are currently undeveloped but could accommodate multi-family development at a density of 15 units/acre or mixed use development at 23 units/acre. These parcels represent an opportunity to accommodate water-oriented uses as part of mixed-use developments. There are two parcels (11 acres combined) zoned for commercial use adjacent to the river. One of the parcels is vacant, the other is a residence with commercial redevelopment potential. Both parcels have the potential for increased development and land use intensity. Although the likelihood for development is not know, the potential for significant development exists

Development, subdivision, or land use change of these properties and their potential to alter shoreline vegetation or limit the growth of riparian areas, increase impervious surface, or modify stream banks will be key issues for the SMP update. The SMP update should consider how to minimize the potential adverse effects that potential development may have on shoreline functions. Future development may conflict with the Town's ability to improve riparian conditions and reduce riprap.

Opportunities for Ecological Protection and Restoration

In general, enhancement and restoration efforts should focus on the processes and functions identified in this report. The ongoing Mashel river restoration project is likely to improve hydrology and salmonid habitat conditions in the Town's SPA. In addition to this undertaking, the Town should consider the following restoration measures:

- Areas of the Mashel River SPA owned by the Town, the Nisqually Land Trust, and the Nisqually Tribe provide excellent opportunities for restoration. Several organizations are already undertaking restoration, including the placement of wood in the river channel and revegetation. The Town and private landowners could use these projects as a model for restoration within the Mashel River SPA.

- The confluence of the Mashel and the Little Mashel Rivers is a good candidate for restoration and protection. This area is likely dynamic in terms of channel behavior, given the combination of toeslope failure on the opposite bank, the alluvial fan of the Little Mashel, and an actively migrating main channel. The Little Mashel provides a key source of gravels and LWD to the larger system which is a good opportunity for protection.

- As the Town acquires new properties along the left bank of the river, these areas can be targeted for protection and/or restoration as appropriate.

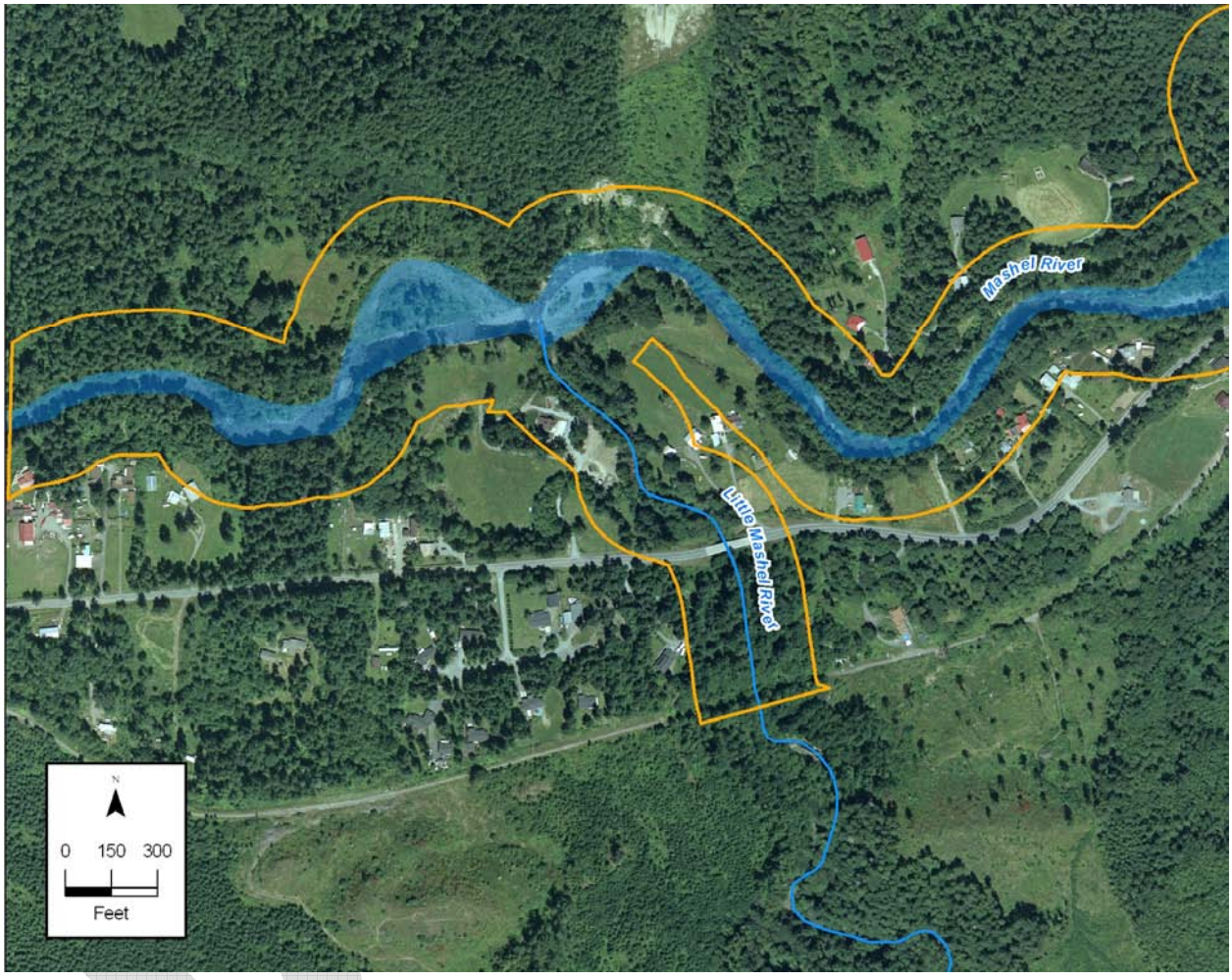
- The Town could explore alternatives to hard shoreline armoring for river bank stabilization, such as intensive vegetation plantings or other bioengineering solutions that would improve riparian functions.

- The Town could consider reviewing its river buffer standards to ensure protection and/or improvement of riparian corridors. This could take the form of modified vegetation conservation standards.

4.4 Little Mashel River

General Information

Little Mashel River Shoreline Planning Area (SPA)



WRIA (MAP 2)	Watershed (Map 2)	Basin (Map 2)	Length
WRIA 11	Nisqually	Mashel River Basin	Town: 0 miles UGA: 0.25 miles Total: 0.25 miles

Physical Resources

Topography (Map 4)	Soils (Map 7)	Floodplain/Floodway (Map 4)
Topography of the Little Mashel River SPA is mostly flat through the Town. The Mashel River within the Town's SPA ranges in elevation from approximately 735 to 705 feet.	1. Aquic Xerofluvents, level 2. Barneston gravelly coarse sandy loam, 6 – 15 % slope	Floodplains and floodways associated with the Little Mashel River are very narrow within the Town's SPA. Both are mapped within 200 feet of the OHWM on either bank of the River. The floodplain broadens along the Mashel River immediately downstream of the confluence with the Little Mashel River. Channel migration of the Little Mashel river has not been mapped. Based on review of aerial photography, there do appear to be significant historical meanders within the Town's SPA.

Channel Migration
There is a variable potential for channel migration along the Little Mashel River within the Town's SPA. In general, there is lower potential for channel migration for the upper portion of the Little Mashel River within the Town's UGA, upstream of SR 161. This portion of the channel has a relatively high gradient, and flows through continental sedimentary deposits or rocks which likely limits the potential for migration. There is high potential for channel migration in the lowest reach leading to the confluence with the Mashel River. This area transitions into the alluvial sediments of the mainstem, with a much flatter gradient. The Mashel River Restoration Design Technical memorandum (WPN, 2004), indicates that the confluence area was observed to be one of the most dynamic portions of the River. A channel migration zone has not been mapped along the Little Mashel River.

Surface Hydrology (MAP 4)
The Little Mashel River flows from its headwaters north of the Nisqually River to its confluence with the Mashel River southwest of Eatonville, Washington. The Little Mashel River sub-basin is 15 square miles in size. Identified tributaries include Midway Creek and South Fork Little Mashel River. The Little Mashel flows for approximatlely a quarter mile within the Town's UGA prior to its confluence with the Mashel River.
Other Hydrologic Features
▪ Within the Town's SPA, it appears that channelization has occurred (ESA Adolfson, 2009)

Water Quality
According to the 2008 Washington State Water Quality Assessment (Ecology, 2009), there are no 303(d) listings for the Little Mashel River within the Town's SPA. According to the 2004 Washington State Water Quality Assessment (Ecology, 2004), the Little Mashel River was not listed for any water quality impairments. Lack of inclusion in the assessment does not indicate that the waterbody is not impaired; smaller streams are often not sampled and may not reflect degraded water quality standards. Increased concentrations of total phosphorus occur in the Little Mashel River during storm events and are thought to be linked to total suspended solids present in the stream (Kerwin, 1999b).

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Biological Resources

Critical Areas
The Town's critical areas code (EMC 15.16) regulates five types of critical areas, which are described below:
Wetlands (Map 4) There are no mapped wetlands within the Town's Little Mashel River SPA. A riparian wetland system is located along the Little Mashel River immediately south of the Town's UGA boundary. Wetland habitats in this area are forested, scrub-shrub, and emergent (ESA Adolfson, 2009). Wetland buffers range from 35 feet to 300 feet depending on wetland typing and intensity of proposed use (EMC 15.16.124).
Critical Aquifer Recharge Areas (Map 4) There are no mapped Critical Aquifer Recharge Areas (CARA) within the immediate vicinity of the Little Mashel River SPA. One of two CARAs identified with the Town is located along the Mashel River approximately a quarter mile upstream of the confluence.
Floodplains (Map 4) Floodplains are mapped along the Little Mashel River. The mapped floodplain is relatively narrow in the Town's SPA. Upstream of the confluence, its width is in the range of 50 to 150 feet. The floodplain broadens at the confluence, where its width exceeds 200 feet. Immediately downstream of the confluence the floodplain broadens further to a maximum width of approximately 600 feet along the Mashel River mainstem.
Geological Hazardous Areas (Map 8) Geological Hazardous Areas as defined by EMC 15.16.161 and mapped in the Town's Little Mashel River SPA are limited. Mapped hazards include only seismic hazard areas at the confluence of the Little Mashel and Mashel Rivers. The Town also has mapped flood hazard areas which coincide with the 100-year floodplain. According to the Pierce County Shoreline Inventory (ESA Adolfson, 2009), identified hazards also include flooding and localized areas of erosion potential.
Habitat Conservation Area All waters of the state including rivers, streams, and watercourses within jurisdiction of the state of Washington are considered habitat conservation areas in the Town of Eatonville. The Little Mashel River is classified as a Type S (Subject to Shoreline Management Act) stream and has a 200 foot standard buffer width (EMC 15.15174).

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Shoreline Vegetation/Riparian Vegetation
The Pierce County Shoreline Inventory (ESA Adolfson, 2009) reported that the Little Mashel River flows through hobby farms and rural residential areas. It assesses the riparian zone in the Town's UGA as low to moderate quality with some trees in the riparian zone. Based on a review of recent aerial photos, the Little Mashel riparian corridor is very narrow north of SR 161, where it passes through two properties developed as single-family. South of SR 161, the riparian corridor appears to occupy most of the SPA in a relatively undeveloped condition.

Wildlife Habitats (Map 5)	Fisheries (Map 5)
According to WDFW PHS data (WDFW 2009) there are no priority habitats associated with the Little Mashel River within the town's SPA. Several priority habitats are mapped upstream of the Town's UGA boundary. These include: large waterfowl concentrations, numerous areas of the White River elk range, six Upper Nisqually River bald eagle use areas, an area of Mashel River wetlands, one small waterfowl concentration area, and several Mashel River riparian corridor habitat areas	According to WDFW streamnet data (WDFW 2009) Ohop Creek supports the following fish species:
	1. Resident Cutthroat (presence/migration)
	2. Fall Chinook (presence/migration)
	3. Winter Chum (presence/migration)
	4. Coho Salmon (Known Spawning)
▪ According to the Nisqually River Basin Level I assessment (2001), The Little Mashel joins the mainstem Mashel River at RM 4.4. A waterfall at RM 0.8 is impassable. The Little Mashel passes hobby farms, and rural residential areas. A cobble/boulder substrate with some gravel patches is present in some areas. Coho, steelhead and cutthroat populations are supported here. Habitat conditions are generally good but fish use is limited.	

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Plans and Built Environment

Current Shoreline Use Pattern	Current Shoreline Designations	Comprehensive Plan Land Use Designations (Map 9)
The general land use pattern in the Town's Little Mashel River SPA is rural density residential development.	**Town:** Urban Conservancy **UGA:** Rural (Pierce County)	According to the Town's Comprehensive Plan, the entire Little Mashel SPA is designated for single-family use (Town of Eatonville, 2005).

Current Zoning (Map 10)						
	Town		UGA		Total (Town and UGA)	
Zone	Acres in SPA	% of SPA	Acres in SPA	% of SPA	Acres in SPA	% of SPA
Airport						
C-2						
Ind						
MU						
ROW			2.41	21%	2.41	20%
SF-1	0.03	1%	9.24	79%	9.27	77%
SF-2	0.3	91%			0.31	0.3%
SF-3						
Totals	0.33		11.65		11.99	

Water-Oriented Uses		
Water-dependent: ▪ None Identified	Water-related: ▪ None Identified	Water-enjoyment: ▪ None Identified

Transportation/Roads/Bridges/Railroads (Map3)	Utilities (Map 3)
There is one auto bridge over the Little Mashel River in the Town's SPA at SR 161. A pedestrian bridge is proposed over the Little Mashel as part of the proposed Rim Rocks Nisqually Mashel Trail. There are also some private/residential roadways within the SPA.	There are no utilities or utility infrastructure within the Town's Little Mashel SPA.

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Historic and Cultural Resources
No cultural resources are inventoried within the Little Mashel River SPA (ESA Adolfson, 2009). There are no historical structures within the Little Mashel River SPA that are registered on the State or National Register of Historic Places (DAHP, 2009).

Public Access/Parks/Trails/Open Space (Map 11)
A parcel within the Town boundary that extends south into the Little Mashel SPA is designated as open space and provides both visual and physical access to the Mashel River immediately upstream of the confluence. That property also provides visual access to the Little Mashel. The proposed bike lane along SR 161 and the proposed Rim Rocks Nisqually-Mashel Trail would offer visual and physical access to the River.

Known Sites with Toxic or Hazardous Materials
None identified by DOE Confirmed and Suspected Contaminated Sites List (DOE, 2009).

Shoreline Modification
A railroad bridge used to cross the Little Mashel River. While the railroad is no longer operating, the bridge abutments are still present along the shoreline. The embankments in this area are relatively high and the bridge abutments have increased channel confinement. It appears that the creek has been channelized within the Town's SPA (ESA Adolfson, 2009). No other shoreline modifications are present.

Degraded Areas
Riparian areas immediately upstream of the confluence with the Mashel River are lacking which is a contributing factor in the overall lack of wood in the river. The River, in the Town's SPA, also appears to have been channelized.

Restoration Opportunities and Sites
Acquisition of riparian and floodplain habitat near the confluence of the Mashel and Little Mashel Rivers has been identified as an opportunity by the Nisqually Land Trust and Pierce County. Other restoration opportunities for the Little Mashel River shorelines include restoring forested riparian areas, protecting associated wetlands for the enhancement of waterfowl habitat, restoring wetlands to enhance water

quality improvement functions, and restoring natural channel configuration.

Areas of Special Interest
None identified

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Assessment of Ecological Functions

Ecosystem Process / Shoreline Function	Level of Alteration	Conservation / Restoration Potential
Hydrology	Minimal. Natural snowmelt and rain-on-snow hydrology currently function. Moderate. Some channelization may have occurred in the reach downstream of SR 161, and channel migration may be artificially limited to protect existing buildings and other infrastructure.	High. Good conservation potential of existing river channel, floodplain, and riparian system. Restoration potential exists upstream of the Town's SPA, where riparian conditions appear to have been degraded.
Hyporheic Functions	Minimal. Upstream of SR 161. Moderate. Downstream. Any channel modification may have resulted in scour and loss of habitat.	Minimal. Limited restoration potential exists in lower reach.
Shoreline Vegetation	Minimal. Riparian forest exists (albeit narrow in places) throughout the portion that flows through the SPA, with the exception of the two bridge crossings.	High. High conservation potential of existing riparian forest. This portion of the Little Mashel has the potential to contribute large wood to the mainstem Mashel, making it an important source of organics for the overall system. Restoration potential focuses on increased width of riparian zone.
Habitat	Minimal. Instream habitat is reported to be good, but fish use limited due to natural migration barrier at RM 0.8 (WPN et al. 2001).	High. High potential for conservation of existing good quality instream habitat. Limited restoration potential.

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Management Issues and Opportunities

Summary of Ecological Function and Management Issues
The following summarizes the key factors affecting ecological function in the Little Mashel River SPA: ▪ The lack of riparian vegetation reduces shading along the stream, potentially resulting in increased stream temperatures and lowered dissolved oxygen. A lack of larger trees along the stream means less wood in the stream channel. In-channel wood is key to creating habitat structures for fish such as pools. ▪ Channelization and armoring in the lower reaches have increased channelization and removed the river's natural meander. As a result, hydrology has been altered resulting in channel scour, increased sedimentation, and ultimately decreased fish habitat quality. Based on these existing conditions, the important management issues for the Little Mashel River are: ▪ lack of riparian vegetation and in-channel wood, ▪ channel confinement and shoreline armoring
Future Use Patterns and Potential Use Conflicts
Current land use in the Little Mashel River SPA consists of low density residential development. SR 161 also crosses the river via abridge and former railroad also crosses the river. The Little Mashel River is wholly in the Town's UGA. The lack of riparian cover and modified hydrology through channel confinement are the major land use issues for the Little Mashel. A review of Pierce County assessor's land use data indicates that there are four private properties in the Little Mashel SPA, all of which are zoned for single-family development. The parcels range in size from four to nine acres, meaning that the potential for subdivision and development exists. Subdivision and/or additional development on these properties would have the potential to alter shoreline vegetation or limit the growth of riparian areas, increase impervious surface, or modify stream banks. Future development may conflict with the Town's ability to improve riparian conditions and reduce riprap. The SMP update should consider how to minimize the potential adverse effects that potential development may have on shoreline functions.
Opportunities for Ecological Protection and Restoration
In general, enhancement and restoration efforts should focus on the processes and functions identified in this report. The Town could consider the following restoration measures: ▪ Restoration of native vegetation along the Little Mashel is important to improving shoreline

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conditions and functions. Educating private landowners about the importance of riparian vegetation for salmon, wildlife, and water quality could encourage restoration on private shoreline properties.

- Restoring meanders where the river has been channelized would increase fish habitat and return surface flows to a more natural condition. Large-scale channel restoration may be more feasible on public lands than on private property.
- There are also restoration opportunities on public properties, for example along proposed pedestrian trails/bridges and in designated open space areas. The Town could work with the Nisqually Land Trust and Pierce County to protect riparian and floodplain habitat near the confluence of the Mashel and Little Mashel Rivers.
- Several organizations are undertaking large-scale restoration along portions of Ohop Creek and the Mashel River. The Town and private landowners could use these projects as a model for restoration within the Little Mashel River SPA.

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Appendix A: Shoreline Inventory Mapping

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