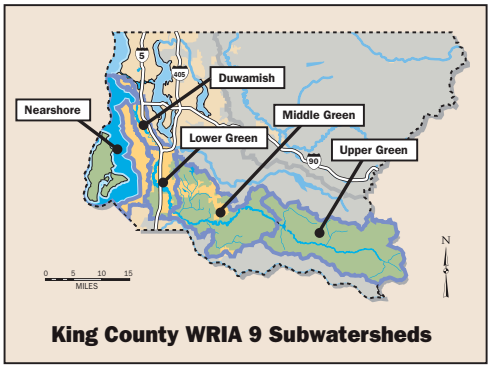
3.1 INTRODUCTION

Water Resource Inventory Area 9 (WRIA 9) consists of the Green/Duwamish Watershed and Central Puget Sound Watershed (Figure 1-1). The Green/Duwamish River flows over 93 miles from the Cascade Mountains to Elliott Bay, and the Green/Duwamish River watershed covers 482 square miles. The Central Puget Sound Watershed, the smaller portion of WRIA 9, consists of the short independent stream basins that drain to Puget Sound from West Point south to the Pierce County line and the associated shorelines of Puget Sound. Also included in WRIA 9 for salmon habitat planning purposes is Vashon/Maury Island.[1] The land area of the Central Puget Sound watershed totals 93 square miles and the marine waters make up an additional 89 square miles. Overall, the planning area of WRIA 9 encompasses 664 square miles of land and water.

For ease of reference in this Habitat Plan, this entire area is referred to as the Green/Duwamish and Central Puget Sound Watershed or simply WRIA 9.



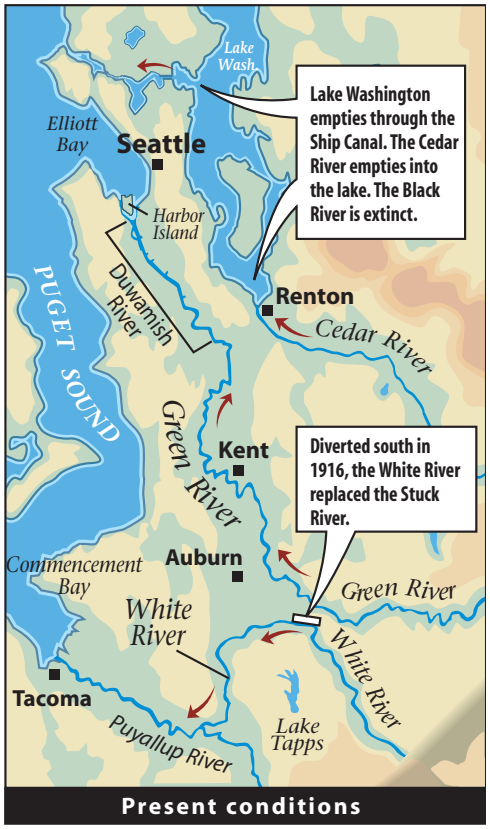
King County WRIA 9 Subwatersheds

WRIA 9 is divided into five subwatersheds for planning purposes (Figure 1-1):

- Upper Green River (Green/Duwamish river miles 93+ to 64.5);
- Middle Green River (Green/Duwamish river miles 64.5 to 32);
- Lower Green River (Green/Duwamish river miles 32 to 11);
- Duwamish Estuary (Green/Duwamish river miles 11 to 0); and
- Marine Nearshore.

These subwatersheds are described in Section 3.4.

WRIA 9 is bordered on the north by the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) and to the south by the Puyallup/White River Watershed (WRIA 10). Historically, the Green River joined the White River in Auburn. Farther downstream, in Tukwila, the Cedar/Black Rivers joined the Green/White Rivers to form the Duwamish River, which meandered 15 miles farther to empty into Elliott Bay (Figure 3-1). The three major rivers drained a watershed of



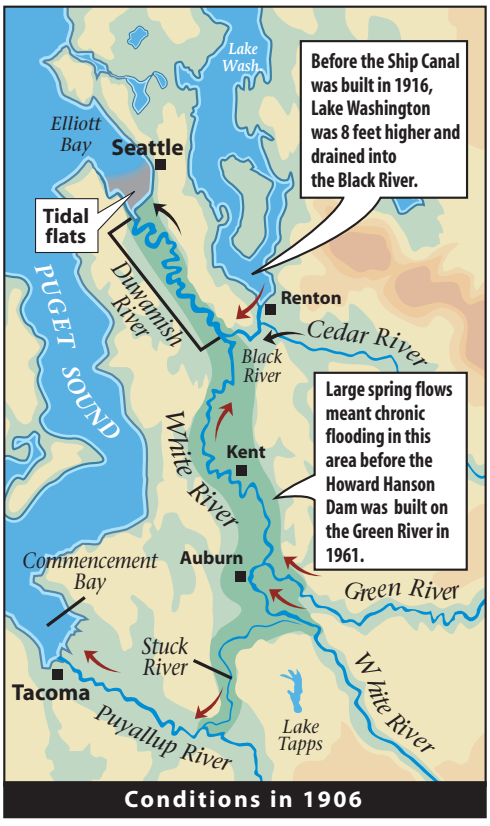


FIGURE 3-1: Duwamish Drainage Prior to 1900 and After 1916

1. Vashon/Maury Island is in two different WRIAs for planning purposes: 1) WRIA 9 for salmon habitat; and 2) WRIA 15 (Kitsap) for water supply.

about 1,600 square miles. The area draining into Elliott Bay today is about 30% of the size it was a century ago.

The physical characteristics of WRIA 9 have been affected by a legacy of development and human activities in the watershed. These alterations have affected important habitat forming processes and shaped existing salmonid[2] habitat throughout the watershed.

> ***"As habitats shrink, they are no longer capable of supporting populations large enough to maintain themselves; many are locally extirpated even though some attributes of the habitat remain."***
>
> *King County Department of Natural Resources and Parks, 2004*

The habitat changes in WRIA 9 are well documented. The area and continuity of native vegetation has been transformed from the original composition and arrangement to alternative structures and functions. This transformation and its effects are described in the Best Available Science Report (King County Department of Natural Resources and Parks 2004a). Some of the transformation processes that have occurred over the past century are continuing today as the human population growth of WRIA 9 increases.

This chapter includes the following elements:

- Section 3.2 provides a brief description of the history of human development in the watershed;
- Section 3.3 highlights impacts on salmonids and their habitat at the watershed level;
- Section 3.4 describes factors of decline specific to each subwatershed;
- Section 3.5 characterizes the factors of decline beyond the scope of this Plan; and
- Section 3.6 outlines policies that serve as guidance for protecting salmonid habitat and/or minimizing further degradation.

3.2 HUMAN DEVELOPMENT HISTORY

Between the retreat of the ice 12,000 years ago to 1850, human history and land use in the watershed was the story of the Indian tribes. Duwamish, Suquamish, and other Salish peoples developed a lifestyle centered on the annual runs of the salmon and steelhead. The fish occupied a central role in their economic, cultural, and spiritual lives.

European settlement began in 1851 in the Duwamish estuary area (Kerwin and Nelson [Eds.] 2000). WRIA 9 was one of the first areas of Puget Sound extensively settled by immigrants in the late 18th century. Beginning in the 1880s, extensive logging occurred across much of the watershed and agricultural land use expanded south to fill much of the Kent Valley from Tukwila to Auburn. Small towns such as Kent and Auburn were established to serve the farmers.

The 19th century and the early 20th century brought river channelization for navigational purposes, diversion of major Green/Duwamish tributaries for flood abatement and water supply, construction of diversion dams for municipal water needs, and filling of tidelands for development. The Duwamish estuary was

FIGURE 3-2:
Photograph of Fish Trap on a Green River Tributary Taken In 1923 Near Auburn. *(Property of White River Valley Museum, Auburn.)*

2. Salmonids include salmon, trout, and chars (including bull trout) from the Family Salmonidae.

intensively dredged and filled between 1900 and 1940, continuing to a lesser degree until the 1970s.

Between 1906 and 1916, the White and Cedar/Black Rivers were diverted from the Green/Duwamish River. The White River was diverted in 1906 for flood control, and the Cedar River was diverted between 1912 and 1916 when the Hiram M. Chittenden Locks were constructed and the level of Lake Washington was lowered (Figure 3-1). The re-routed Cedar River provides water to operate the locks. Tacoma Public Utilities completed its headworks (diversion dam) in 1913 to draw 65 cubic feet per second worth of water from the Green River for its water supply, and the total diversion capacity was subsequently increased to 113 cubic feet per second (Culhane et al. 1995). The White and Cedar/Black River basins combined previously comprised approximately 70% of the watershed in total acreage and contributed a commensurate amount of flow to the lower Green/Duwamish River. Because of these two diversions, the area presently draining into Elliott Bay is approximately 482 square miles, which is about 30% of the size it was a century ago. The reduction in drainage area has increased salinity levels in and decreased the size of the Duwamish estuary.

During the middle of the 20th century, economic development fostered further construction of levees and dams to reduce flooding, construction of roads and other transportation infrastructure, and industrial, commercial, and residential development. Howard Hanson Dam and its storage facility were constructed in 1962. Tacoma Public Utilities acquired a well field along the North Fork tributary of the Green River in 1975 to provide an alternate source of drinking water during times of high turbidity in the Green River. Bulkheads, seawalls, and piers were added to the nearshore environment. An estimated 64% of the nearshore has some form of armoring to accommodate residential and commercial development. Although armoring has occurred on Vashon/Maury Island, it has occurred to a lesser extent than on the mainland.

In the early 20th century, the region experienced a dramatic increase in human population, predominantly in urban areas in the western one-third of the watershed. As the Puget Sound population centers continued to expand through the 1970s, 1980s, and 1990s, WRIA 9 experienced increasing urbanization throughout what would become the Urban Growth Area under the King County Comprehensive Plan (King County 2004). Smaller cities in the Middle Green River Subwatershed such as Black Diamond and Enumclaw were joined by Covington and Maple Valley in the 1990s as rapid population growth and development shifted eastward. In 2004, the population in WRIA 9 was estimated at 630,000 (adapted from Puget Sound Regional Council data). About 89% of the population lives within the Urban Growth Area and 11% live in the Rural Area. Land development estimates indicate the biggest areas of future development will be in the Middle Green River Subwatershed and along the nearshore. Black Diamond is the city projected to have the greatest increase in housing development in the Middle Green River Subwatershed over the next 20 years (Kerwin and Nelson [Eds.] 2000).

Time line

12,000 BC
Ice age ends and the Puget Sound glacier retreats.

Thousands of years before present
Indian peoples thrive on the salmon and other resources of the watershed.

1851
First settlers arrive in Duwamish estuary area.

1866
Population of valley starts to grow in earnest.

1870s
Major railroads build lines.

1880-1910
Major logging occurs.

1888
Northern Pacific Railroad constructs east-west line through the watershed.

1889
Washington granted statehood.

1895
Duwamish East Waterway construction begins.

1900
Extensive logging on Vashon Is.

1902
Green River Hatchery completed.

1906
Major flooding in rivers during fall and winter; log jam forces White River south.

1909
Harbor Island, at the time the world's largest artificial island, is completed in 1909.

1911
The White River is completely diverted to Puyallup River to reduce flooding problems

1913
City of Tacoma completes its Headworks water diversion dam on the upper Green River.

1916
Lake Washington Ship Canal completed. Cedar River diverted to Lake Washington. Most of Black River dries up.

1917
Dredging fills more Duwamish intertidal areas and the East/West Waterways are finished.

1919
Private levee construction begins all along the Green/Duwamish rivers to prevent flooding.

1954
Seattle and King Co. development plan recommends the Howard Hanson Dam, converting 2,500 acres of farmland to industrial area, river dredging and estuary filling.

1963
Howard Hanson Dam is completed. Major floods are eliminated.

1977
Federal Clean Water act generally halts filling of freshwater or marine wetlands

1990
Washington State Growth Management Act promotes denser, smarter growth.

1999
Federal listing of chinook salmon and bull trout as threatened species; protection is required.

2015
Significant habitat improvements accomplished in first 10 years of Habitat Plan.

2055
Watershed is healthy for people and fish.

During the last 30 years of the 20th century, government agencies and the public began to support environmental protection measures and growth management. The federal government passed environmental legislation to protect undeveloped land, wetlands, shorelines, and endangered species habitat. State and local government began to embrace policies to manage development growth an protect shorelines, undeveloped land, wetlands, and farmlands. For a more extensive history of human development, land uses, and environmental protection measures in WRIA 9, see Part II of the Habitat Limiting Factors and Reconnaissance Assessment Report (Kerwin and Nelson [Eds.] 2000). For a synopsis of some of the significant current efforts to recover salmon and their habitat, see Chapter 2, Introduction.

Table 3-2 in Section 3.6 of this chapter summarizes the percentages of designated land uses in WRIA 9 by subwatershed. For a spatial representation, refer to the Land Use Designation Map (Figure 3-3) in Section 3.6.

"By intentionally and unintentionally altering how landscapes work, modern human societies transformed whole regions into new worlds to which salmon are not well adapted."

Montgomery 2003

3.3 WRIA-WIDE FACTORS OF DECLINE

Factors of decline are the natural and human caused factors that contribute to the decline of salmonids (Kerwin and Nelson [Eds.] 2000). Several factors of decline have been identified throughout the five subwatersheds of WRIA 9. Two of these factors of decline are considered WRIA-wide in effect: land use alterations and water quality changes. These widespread factors of decline in the WRIA are described in this section. Section 3.4 contains information on conditions and factors of decline specific to each subwatershed.

Some of the causes attributable to human activities include:

- Hydropower operations and other impacts from dams;
- Over-exploitation from fishing (harvest);
- Poor hatchery practices; and
- Degradation of habitat through land use and water-use practices.

In addition, climatic and ocean changes are responsible for natural variability that provides a background of change. Predation of salmonids by mammals, birds, and other fish during different life history stages also has an impact on salmon populations.

Although the relative impact of these different factors varies among basins and river systems, habitat loss and degradation are considered contributing factors in the decline of *most* salmonid populations (Spence et al.1996).

The potential impacts of harvest and hatcheries are described in Section 3.5.

This Habitat Plan addresses, to the extent practicable, human impacts on salmonids with regards to the habitat within the watershed planning area.

General Factors of Decline

Human development and activities over the last 150 years have resulted in significant physical changes to WRIA 9. These changes have resulted in many direct and indirect impacts to salmonid habitat structure and function, as well as to habitat forming processes.

Watersheds with a high degree of urbanization are less likely to have good stream health, whereas watersheds with a low degree of urbanization are more likely to good stream health (Booth et al. 2002). Impacts on salmonid habitat in WRIA 9 linked to human interactions include:

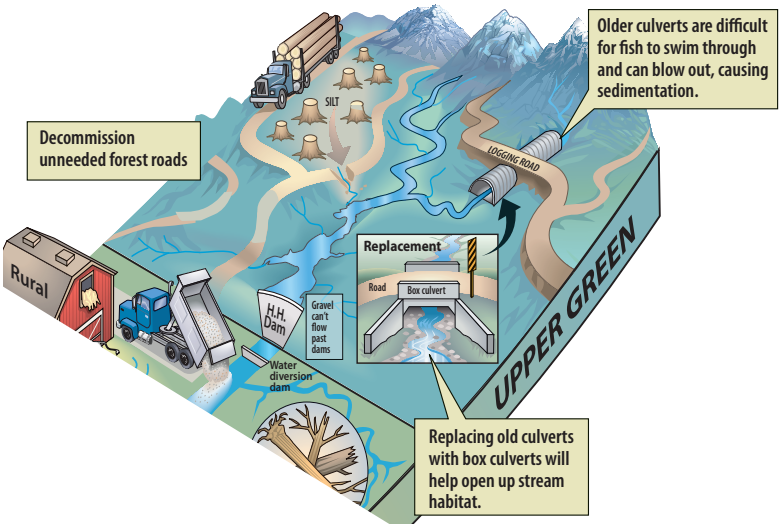
- Extensive urbanization coupled with industrial, agricultural, and residential development has reduced channel and shoreline complexity, added impervious surfaces, filled wetlands, and altered stormwater runoff patterns throughout the watershed;
- Loss of riparian vegetation has affected habitat suitability and formation as well as the base of the salmonid food chain by decreasing the recruitment potential for large woody debris, increasing temperature, and reducing leaf and insect inputs to the river;
- Levees and revetments sever the connections between the mainstem river and off-channel habitats such as side channels, off-channel sloughs, and tributary mouths;
- Bulkheading in the marine nearshore has effects similar to levees/revetments, but also has cut off much of the sediment supply to marine habitats;
- Water withdrawals lower the quantity of water in the river and its tributaries; and
- Many of the connections between the river and its floodplain and other riparian areas have been eliminated through development infrastructure (e.g., dams, roads, railroads, sewers, etc.). This isolation of the mainstem channel from adjacent floodplains and habitats has altered the natural functions provided by these areas. Functions that have been altered include perennial and seasonal off-channel habitat and refuge, groundwater recharge, flood infiltration, and supply of gravel and large woody debris.

Table 3-1 provides greater detail on the relationship between activities and factors of decline. These factors generally apply to all freshwater, estuarine, and nearshore environments. Those that are unique to the estuarine and/or nearshore environments are noted.

3.4 FACTORS OF DECLINE SPECIFIC TO SUBWATERSHEDS

Some factors of decline relate specifically to different subwatersheds within WRIA 9. Conditions and factors of decline specific to each subwatershed are summarized in this section (see Figure 1-1 for a map showing the subwatersheds).

Upper Green River Subwatershed



The Upper Green River Subwatershed contains the headwaters of the Green River and represents approximately 45% of the area and stream mileage of the Green/Duwamish Watershed. The river flows generally west and northwest from the Cascades through 30 miles of steep, densely forested valleys (Figure 7-1).

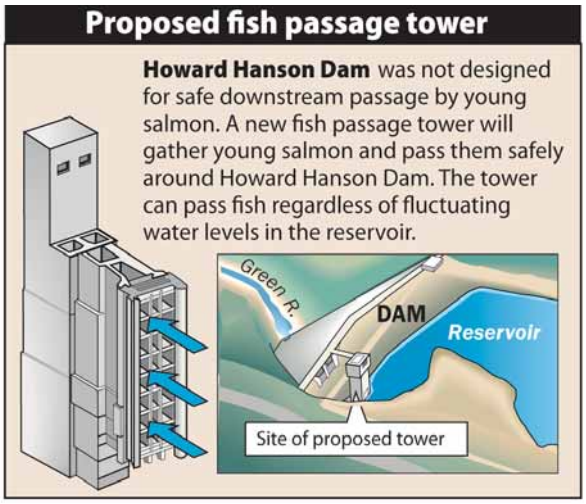
Howard Hanson Dam is located immediately below the confluence of the North Fork Green River with the Green River at river mile 64.5. When filled, the Howard Hanson reservoir inundates 4.5 miles of mainstem and 3.0 miles of tributary habitat.

The primary purpose of the Howard Hanson project, operated by the U.S. Army Corps of Engineers, is flood control. The Corps operates the project to prevent flood flows over 12,000 cubic feet per second at Auburn and to provide a minimum flow of 223 cubic feet per second from the dam. This lower flow ensures that 110 cubic feet per second passes through the Palmer stream gage, located downstream of the Tacoma Headworks. (Culhane et al. 1995). The reservoir is kept

TABLE 3-1: Factors of Decline

Factor of Decline	Description	Examples of Activities or Impacts Related to Factor of Decline
Reduced Water Quality	Changes to temperature, dissolved oxygen, chemical and microbiological contaminants and nutrients, suspended sediment/turbidity	Stormwater runoff, lack of shade due to loss of riparian vegetation, increases in impervious surfaces, use of synthetic pesticides/fertilizers in agricultural and residential/commercial settings, aquaculture, waste water and historic industrial effluent
Modified Hydrology (does not apply to marine nearshore)	Alterations in water storage and flow via surface water (e.g., lakes, streams, and wetlands) or ground water	Stormwater runoff, water withdrawals, diversions, dams, reservoir inundation, increases in impervious surfaces, altered timing and magnitude of flows, frequency of side-channel connectivity, accessibility of habitat to fish, channel stability, constrained salmonid migration due to low flows, reduced or degraded wetland functions
Alteration of Sediment Transport Processes	Changing the movement of sand, gravel, and other sediment downstream or along marine shorelines	Clearing and grading practices, forestry activities, and construction practices contributing increased levels of fine sediments; dams, roads and vegetation removal activities affecting the frequency and magnitude of landslides or rate of erosion; sediment starvation and scouring; bulkheads and armoring of marine shorelines
Hydromodification	Changes to the channel or banks of the river; includes changes in the amount of in-channel large woody debris Estuarine: Changes to estuarine tributary and distributary channels Nearshore: Changes to independent channels or banks	Bank hardening, levees, loss of large woody debris, dams, channel straightening, dredging, filling, habitat fragmentation, loss of side channel and other off channel habitats, loss of channel and habitat complexity, loss of connection to floodplain, loss of channel migration, accessibility of habitat to fish, reduced or degraded wetland functions
Loss of Habitat in Migratory Corridor (Nearshore)	Degradation or elimination of shallow-water habitats, such as mud flats, eelgrass, and kelp beds	Shoreline armoring, dredging, filling, and overwater structures
Degraded Riparian Condition	Absence of or altering the presence of native vegetation along the shorelines	Bank hardening, shoreline armoring, overwater structures, increase in impervious surfaces, vegetation removal, competition from invasive/noxious weeds, agricultural and forestry practices, reduced riparian habitat functions (shading, bank stability, nutrients, etc.)
Reduced Sediment Quality (Estuarine)	Increased presence of metals, organics, and other substances in sediments at levels that exceed standards or affect food chains	Stormwater runoff, malfunctioning septic systems, point source discharges, agricultural practices, oil spills, historic and ongoing industrial/commercial discharges
Alteration of Habitat-Forming Processes (Nearshore)	Interruption or other modification of processes that form nearshore habitat, such as sediment transport and freshwater input	Shoreline armoring; development on top of and below banks, bluffs, and beaches; changes in flow due to diversion of rivers or streams
Fish Passage Barriers	Limiting the accessibility of a stream or river reach to fish	Culverts, dams, drops in water levels, dikes, levees, flapgates
Non-Native Species	Introduction of plant and animal species whose natural distribution did not include Puget Sound	Fishery management stocking, intentional introduction of gamefish by anglers, and liberation of baitfish by anglers; introducing non-native vegetation Nearshore: Ballast water discharge, packing materials from foreign seafood, intentional or unintentional establishment by the aquaculture industry

Source: Kerwin and Nelson (Eds.) 2000



low during most of the winter to capture and delay runoff. In the spring, the reservoir is allowed to fill. Reservoir water is released during the summer to provide water for Tacoma's municipal water supply, which is withdrawn three miles downstream, and augment summer low flows to benefit salmonids.

Since 1962, Tacoma Public Utilities has diverted between 75 and 113 cubic feet per second of water from the mainstem Green River at river mile 61 to meet the needs of the rapidly expanding population in Puget Sound (Washington State Department of Ecology 1980). In 1985, the Washington State Department of Ecology granted a water right permit to Tacoma for an additional 100 cubic feet per second diversion (priority date 1933), subject to the minimum instream flows for the Green River. Water withdrawals by Tacoma now also are governed by the terms of its 50-year Habitat Conservation Plan.

The water withdrawals and flow control affect the timing and magnitude of instream flows, reduce the base flows, and can lead to changed channel morphology as well as a loss of connectivity with the floodplain (Spence et al. 1996). These factors lead to an overall reduction of quality and quantity of salmon habitat (Kerwin and Nelson [Eds.] 2000).

Sediment (gravel) and large woody debris transport from the Upper Green to the Middle Green is curtailed by the Howard Hanson project (the effects of this are discussed further in the Middle Green River Subwatershed subsection below).

At present, Howard Hanson Dam and the Tacoma Headworks block upstream fish passage to and downstream passage from the Upper Green Subwatershed. This is expected to change with the completion of downstream fish passage facilities at Howard Hanson Dam as part of the Additional Water Storage Project. The upstream fish passage facility was completed in 2004 by Tacoma. Test passages of fish are expected in 2006 with regular operation beginning in 2007.

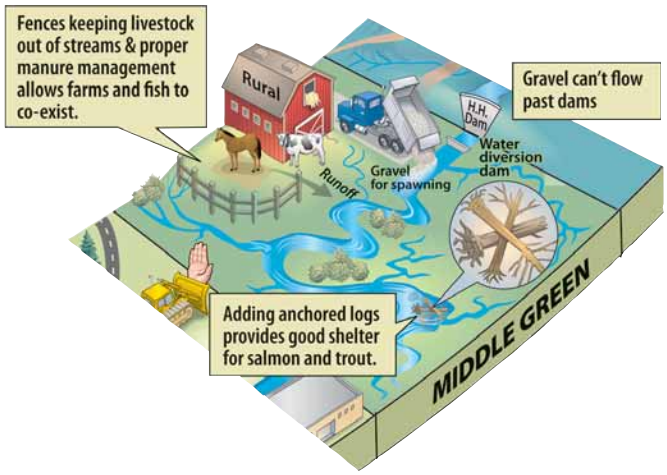
The primary land use in the Upper Green is forestry (99%). The upland vegetation is a patchwork of old growth, second growth, and recently logged areas.

The placement of forest dirt roads and railroads immediately adjacent to the mainstem and streams in the subwatershed has reduced or degraded riparian habitat functions such as providing shade and input of large woody debris. Streamside roads also have reduced the creation of new habitat by limiting lateral channel migration. Increased rates of erosion and alteration of sediment transport processes due to logging and road building have also resulted in aggradation (sediment build up) in reaches in the Upper Green River Subwatershed that has, in some instances, resulted in flows going subsurface during the late summer (U.S. Forest Service 1996).

The Upper Green River, shown here at river mile 81, contained some pool-riffle habitat. August 2001 photo.

Logging practices near Green River tributaries have reduced riparian habitat functions (such as shade and instream large woody debris), increased sedimentation (in particular the introduction of fine sediments into the systems via on-going erosion), decreased water quality, and altered stream hydrology. A railroad and extensive logging road network has also resulted in numerous fish passage barriers.

Middle Green River Subwatershed



The Middle Green River Subwatershed extends from Howard Hanson Dam at river mile 64.5 to river mile 32, just downstream of the confluence of Soos Creek with the Green River. Tacoma Public Utilities operates its drinking water diversion dam ("Headworks") at river mile 61. Below the diversion dam, the Green River flows between steep forested valley walls before emerging from the mouth of the Green River Gorge at the upstream end of Flaming Geyser State Park (river mile 45.6). Newaukum Creek flows in from the south at river mile 40.7. The river flows through a broad valley about a mile wide on average to its confluence with Soos Creek at river mile 33.9. Levees and revetments constrain channel migration in significant portions of the reach below Flaming Geyser State Park (Figure 7-2).

The major land uses in the Middle Green River are residential (50%), forestry (27%), and agriculture (12%). The Middle Green River Subwatershed includes the cities of Covington, Maple Valley, Black Diamond, Enumclaw, and a portion of Kent, and is bisected by the Urban Growth Area Line.[3]

Lake Meridian in Kent, looking east. This area of the Middle Green River Subwatershed is undergoing extensive urbanization. July 2004 photo.

Dams, levees, revetments, and residential and agricultural land use along the mainstem in this subwatershed have changed the natural flow regime, caused sediment starvation and scouring, reduced the amount and size of large woody debris, reduced channel complexity, reduced side channel and other off-channel habitats, and reduced or degraded riparian habitat functions.

Howard Hanson Dam completely blocks large woody debris and sediment (gravel) from the Upper Green from reaching the Middle Green and beyond. As a result, there is a gravel deficit because winter flows flush sediments downstream of Howard Hanson Dam with no replenishment from the Upper Green. This has resulted in channel incision (downcutting) and subsequent armoring (removal of smaller sediments leaving bare rock or large boulders). Lack of sediment has a significant effect on spawning in the river downstream. Armoring is believed to have altered the reach between river mile 61 and river mile 57 and may be affecting the river downstream of the Green River gorge (Perkins 1993; Perkins 2000). Significant channel incision may reduce the amount of available rearing habitat by increasing the amount of time that side channels are disconnected from the mainstem during low flows. Because of this, coupled with a reduction in coarse sediment inputs from upstream, sand-sized material (which is not suitable for spawning) now comprises a much larger proportion of the total bedload.

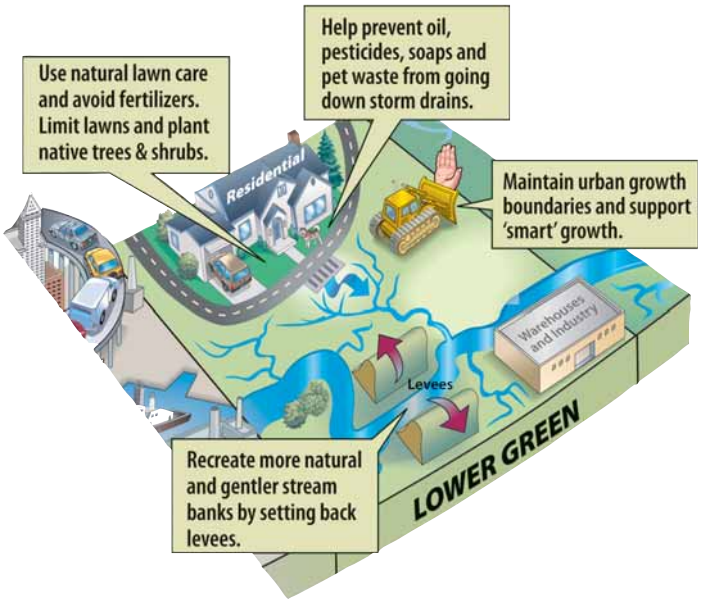
3. Note that municipal boundaries do not follow watershed and/or subwatershed boundaries. Refer to Figure 1-1 for boundaries of cities in relation to the subwatershed and watershed boundaries.

Despite the many problems described above, the Middle Green River mainstem retains some of the best spawning and rearing habitat left in the watershed.

Residential, agricultural, and some urban developments along Soos Creek, Newaukum Creek, and other tributaries to the mainstem have reduced and degraded wetland and riparian functions. Similarly, these activities have reduced forest cover and increased impervious surfaces leading to hydrologic disruption to stream flow, channel degradation, increased sedimentation, and decreased water quality. Road construction and protection measures for private property have rechanneled streams, limited their lateral migration, and created barriers to fish passage. The amount and size of large woody debris have also been limited. Non-native plant species encroach on riparian habitat in some areas, degrading the quality of habitat.

The Middle Green River, shown here near river mile 39, contains the best remaining spawning and rearing habitat. Note recently recruited large woody debris (trees that fall in the river). May 2005 photo.

Lower Green River Subwatershed



The Lower Green River Subwatershed begins at river mile 32 and extends downstream to river mile 11, the confluence with the old Black River. The subwatershed is characterized by a broad, flat floodplain across which the river meanders. Historically, the White River, the Cedar/Black River, and the Green River all joined in this reach to form a single large river. The White River was diverted by a log jam in 1906 to flow south through the Stuck River to join the Puyallup. This diversion was made permanent in 1911 with the construction of a retaining wall in Auburn. Approximately 80% of the Lower Green River Subwatershed has a levee or revetment on at least one bank in response to periodic flooding. Springbrook Creek, Mill Creek, and Mullen Slough are the major tributaries of the Lower Green River (Figure 7-3).

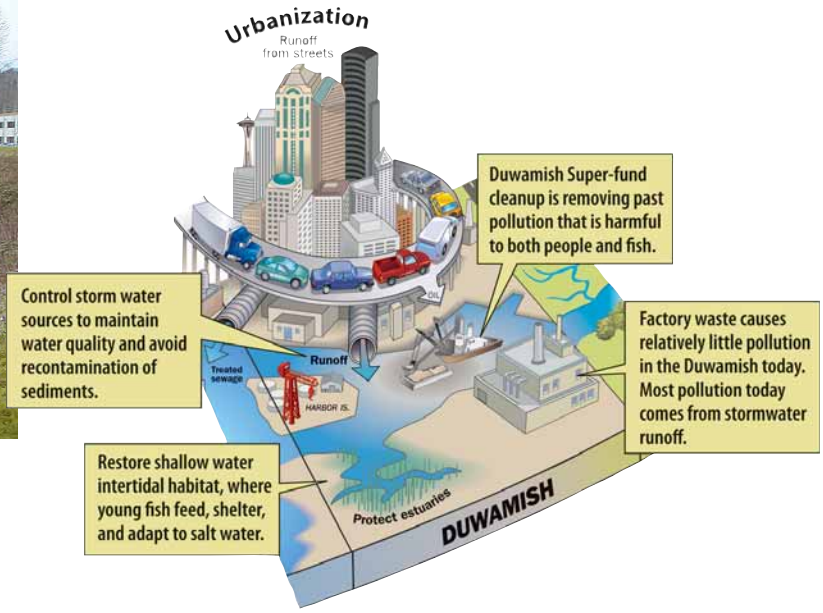
Residential land uses constitute about half of the subwatershed area with industrial and commercial uses comprising about 27%. Mixed uses, parks, and agriculture comprise the remaining land uses. A portion of the cities of Algona, Auburn, Federal Way, Kent, Renton, SeaTac, and Tukwila are located within the Lower Green River Subwatershed.[4]

Urbanization, water diversions, levees, and revetments on the mainstem have gradually lowered the floodplain and resulted in disconnection of off-channel habitats such as sloughs and adjacent wetlands from

4. Note that municipal boundaries do not follow watershed and/or subwatershed boundaries. Refer to Figure 1-1 for boundaries of cities in relation to the subwatershed and watershed boundaries.

The Lower Green River, shown here at river mile 16 in Kent, is mostly leveed and its banks host more invasive weeds than native plants. February 2005 photo.

Duwamish Estuary Subwatershed



the mainstem. Juvenile fish migrating downstream have few places to take refuge from high flows.

The river is starved of large woody debris and consequently lacks associated instream habitat complexity, such as pools and riffles. Low flows, associated with water withdrawals and the diversion of the White River, have exacerbated low flow conditions and contributed to adult salmon migration problems. The loss of mature native riparian vegetation has been accompanied by extensive amounts of non-native plants. These same human activities and developments have caused chronic water quality problems, particularly in the tributary streams.

The Duwamish Estuary Subwatershed begins at river mile 11, which is the historical confluence of the Black River and the Green/White River, and ends at the mouth of the river where it empties into Elliott Bay. The Duwamish Estuary historically contained over 4,000 acres of tidal marshes and intertidal mudflats. Major tributaries to the Duwamish include Hamm Creek and Riverton Creek. The upper portion of the Duwamish (above river mile 5.5) has levees and revetments (originally to protect agricultural lands but which now protect residential/commercial areas), whereas the lower Duwamish industrial area has been dredged and filled to support navigation and water-dependent businesses. Approximately 42% of the Duwamish is comprised of industrial land uses and 29% is comprised of residential land uses. Parts of the cities of Tukwila and Seattle are located within this subwatershed (Figure 7-4).

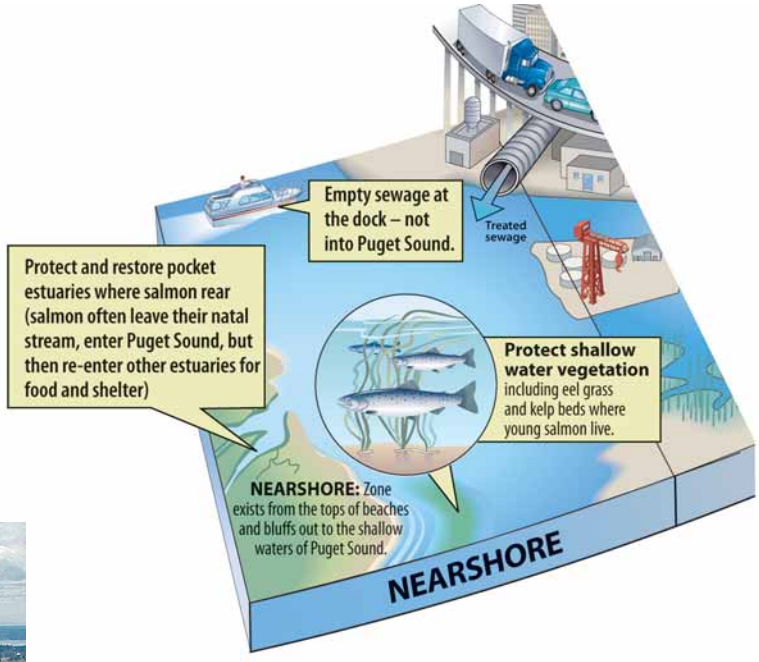
The Duwamish Estuary has been dredged and channelized, and 97% of the estuarine mudflats, marshes, and forested riparian swamps have been filled. The Duwamish Estuary was filled between 1900 and 1940 to create Harbor Island and the East and West Waterways, largely to support industrial and shipping activities. Most of the lower five miles of the Duwamish has little or no native riparian vegetation remaining. Development patterns and land uses have also significantly polluted water and sediments in the remaining channel via stormwater and wastewater effluents and historic industrial contaminants.

Development and shoreline modifications in the Duwamish, combined with river diversions upstream, have resulted in a reduction of transition zone habita the location where juvenile salmonids make the transition from fresh water to salt water. The almost complete loss of marshes and swamps has significan reduced the ability of this part of the watershed to support juvenile rearing. Lack of riparian vegeta-tion, extensive infestations of non-native plants, armoring, and piers mean that the shoreline habitat remaining is of poor quality.

Taken together, these changes dramatically reduced the quality and quantity of estuarine habitat, which is particularly important to juvenile Chinook salmon.

Looking southwest over the Lower Duwamish, showing its straightened alignment. Kellogg Island is at center. July 2004 photo.

Marine Nearshore Subwatershed



The Marine Nearshore Subwatershed encompasses the Puget Sound shorelines of mainland WRIA 9 including Elliott Bay, Vashon/Maury Island, and the small streams that drain directly into Puget Sound. The northern boundary of the Marine Nearshore Subwatershed is West Point in the city of Seattle, and the southern boundary is the King-Pierce County line just west of Dumas Bay in the city of Federal Way. The seaward boundary of the marine nearshore is the outer limit of the photic zone (approximately 100 feet below mean lower low water), or the depth beyond which there is insufficient sunlight for active photosynthesis. However, the subwatershed itself includes the deeper waters of Puget Sound as well. The major streams in this subwatershed include Longfellow, Fauntleroy, Salmon, Miller/Walker, Des Moines, Massey, McSorley, Lakota, and Joe's Creeks (Figure 7-5).

Along the mainland, residential development com-prises 68% of the subwatershed and industrial land uses comprise 10%. Residential land uses and zoning accounts for 92% of the lands on Vashon/Maury Island. Most of the mainland portion of the subwatershed is incorporated into the cities of Seattle, Burien, SeaTac, Normandy Park, Des Moines, and Federal Way.[5]

5. Note that municipal boundaries do not follow watershed and/or subwatershed boundaries. Refer to Figure 1-1 for boundaries of cities in relation to the subwatershed and watershed boundaries.

The marine nearshore on the mainland shown here in West Seattle, is characterized by intense urban development. July 2004 photo.

Development and shoreline modifications in nearshore areas has resulted in the loss of nearshore habitat and marine riparian vegetation and disconnected nearshore habitats from habitat-forming processes (sediment sources, hydrology, riparian vegetation, etc.), similar to the impacts described previously in the Middle and Lower Green River Subwatersheds subsections. The nearshore on the mainland also has been affected by urbanization in the small drainages that empty directly into Puget Sound. These streams suffer from lack of riparian vegetation, extensive infestations of non-native plants, excessive sedimentation, high storm flows, and serious water quality problems.

Bulkheads and seawalls have filled shallow water habitats, and these changes have resulted in reduced juvenile rearing area, loss of marine riparian vegetation and associated invertebrate food sources, and isolation of the nearshore aquatic environment from sediment sources. In Elliott Bay, piers shade shallow water habitat, which reduces the productivity of that habitat and may alter salmonid migration patterns.

The effect of these changes has been to reduce the quality and quantity of nearshore habitat available to salmonids.

3.5 OTHER FACTORS OF DECLINE

This Habitat Plan provides strategies and actions for protecting and restoring salmonid habitat as one piece of the overall effort to recover threatened salmonids in Puget Sound. Yet there are other factors of decline at play in the watershed as a result of hatchery operations, harvest, predation, and climatic/oceanic changes. Human-controlled factors of decline within this list are hatchery and harvest operations, which are described in this section.

Local governments do not have the authority to effect direct change for hatchery operations and harvest practices. However, discussions between local governments and those with decision-making authority about the implications of these activities on habitat will benefit overall Plan implementation. This discussion is expected to occur in the first years of implementation of the Plan.

Hatchery Operations

The earliest purpose for hatcheries was to produce large numbers of fish for harvest to compensate for declines in wild salmon populations. As salmon habitat was altered or destroyed by dams, forestry, and urbanization, hatchery production was viewed as a way to mitigate for lost natural production.

Impacts of artificial production on wild salmon populations likely include, but are not limited to:

- Genetic impacts, which affect the loss of diversity within and among populations and reproductive success in the wild;
- Ecological impacts, such as competition with wild populations, predation, and disease; and
- Demographic impacts that directly affect the physical condition, abundance, distribution, and survival of wild fish.

The Washington State Department of Fish and Wildlife and the Treaty Tribes ("co-managers"[6]), along with federal fisheries officials play a major role in the Puget Sound and Coastal Washington Hatchery Reform Project launched by Congress in 2000 (Hatchery

6. The Boldt Decision (United States v. Washington) established the co-manager (Tribal and State) construct for managing fishery resources within Washington.

Scientific Review Group 2005). The federally-appointed Hatchery Scientific Review Group was tasked with the review and oversight of hatchery reforms for state, tribal, and federal hatcheries throughout the state. The Washington State Department of Fish and Wildlife also completed, in conjunction with the other co-managers, a Hatchery Resource Management Plan in 2004 that developed specific, scientific criteria for Chinook hatchery operations on a regional basis.

Harvest Practices

The management of salmon harvest is a complex undertaking that occurs at multiple scales. Intercepting fisheries in Alaska and British Columbia are managed cooperatively by Canada and the United States in compliance with the Pacific Salmon Treaty (Pacific Salmon Commission 1999), a process that is overseen by the Pacific Salmon Commission. Outside (ocean) and inside (Puget Sound and state rivers) fisheries in Washington, Oregon and California, are managed by the Secretary of Commerce via the North of Falcon Process, which is overseen by Pacific Fisheries Management Council.

The Pacific Fisheries Management Council (2000) acknowledges the following effects of harvest practices on salmonids and their habitat:

- Reduction of the number of fish returning to the river to spawn (escapement) and the amount of carcasses that enhance smolt growth and survival through the contribution of significant amounts of nutrients to streams;
- Commercial or recreational fisheries of important prey for salmon (e.g., herring, sardine, anchovy, squid, smelt, groundfish and crab) may lead to a reduction in salmon populations. In addition, fisheries of important prey for pinnipeds[7] could increase pinniped predation on salmon; and
- Vessel operations and the use of fishing gear can reduce the quality of habitat through increasing sedimentation, damaging redds (spawning egg nests in stream gravel), causing bank erosion, and increasing turbidity.

The peak recorded harvest landed in Puget Sound occurred in 1908, when 95,210 cases of canned Chinook salmon were packed. This corresponds to a run size of approximately 690,000 Chinook salmon at a time when both ocean harvest and hatchery production were negligible. Recent mean spawning escapements totaling 71,000 correspond to a run size entering Puget Sound of approximately 160,000 fish. Based on an exploitation rate of one-third in intercepting ocean fisheries, the recent average potential run-size would be 240,000 Chinook salmon (Pacific Salmon Commission 1994). Harvest impacts to Puget Sound Chinook were historically very high. In its 1992 annual report, the Pacific Salmon Commission estimated that for the 1982-89 brood years, the ocean exploitation rates on natural stocks averaged 56-59% and total exploitation rates averaged 68-82%. On some stocks, exploitation rates exceeded 90%.

Escapement (the number of adults reaching the spawning grounds) to rivers in Puget Sound is monitored by the co-managers. The escapement goal being used for naturally spawning Green River Chinook is 5,800 fish. This goal, derived by averaging the estimated numbers of spawners over a 12-year period from 1965 to 1976, was established in 1977. Annual management recommendations for fisheries in this area are developed according to the Pacific Coast Salmon Plan of the Pacific Fisheries Management Council. The recommendations are provided to the Secretary of Commerce, who implements these measures within U.S. waters (the Exclusive Economic Zone) if they are found to be consistent with the Magnuson–Stevens Act (1996) and other applicable laws. It is important to note that the Pacific Coast Salmon Plan provides for the modification or annual management objectives for those stocks, including the Puget Sound Chinook, that are managed under federal court order.

7. Pinnipeds are marine mammals with flippers, such as seals, walruses and sea lions.

3.6 RECOMMENDED POLICIES TO MINIMIZE IMPACTS ON SALMON HABITAT

In a significantly altered system such as WRIA 9, capital improvements to restore, rehabilitate, and substitute habitat cannot protect and increase biodiversity alone. These actions must be complemented by and supported with a sound approach to land use and land use related activities. The policies in this section provide guidance for protecting, minimizing and preventing further degradation of salmonid habitat in WRIA 9.

The policies have been organized under the following categories:

1) Using Innovations to Promote Habitat Protection/Restoration;
2) Protecting and Improving Hydrology and Water Quality/Quantity;
3) Removing Barriers to Fish Passage;
4) Reducing Impacts of Human Population Growth and Development; and
5) Promoting Citizen Education and Stewardship

Using Innovations to Promote Habitat Protection/Restoration

The policies in this category are designed to promote habitat protection/restoration within the current regulatory framework, recognizing that relevant regulations and policies are not designed exclusively for the protection of salmonid habitat. Local governments have the authority to interpret and apply land use regulations/policies and provide incentives. They can also encourage state and federal agencies to apply their regulations/policies in ways that would provide greater benefit to salmonids and their habitat in WRIA 9.

The following table (3-2) and figure (3-3) are references for the following policy (IN1).

TABLE 3-2: Designated Land Uses in WRIA 9

Land Use Designations	Percentage of Upper Green River Subwatershed	Percentage of Middle Green River Subwatershed	Percentage of Lower Green River Subwatershed	Percentage of Green/ Duwamish Estuary Subwatershed	Percentage of Nearshore Subwatershed (excluding Vashon/Maury Island)	Percentage of Vashon Island
Agriculture		11	5			4
Commercial		1	10	1	6	
Forest Lands	100	26				
Industrial		1	17	44	10	
Mixed Use		1	5	2	4	
Residential		50	50	29	68	92
Mineral Resources		2				1
Other		2	7	10	4	
Parks and Open Space		5	6	4	8	2
Percent of Subwatershed in the Urban Growth Area	0	22	100	100	100	0

FIGURE 3-3: Land Use Designations Map

Policy IN1:

Discussion:

Refugia are geographic locations or a collection of habitat units that support a persistent population during normal environmental perturbations. They are important for long-term survival of fish populations.

Policy:

Local governments shall encourage activities within the designated land uses of WRIA 9 that:

- Maintain, restore, and rehabilitate natural watershed and ecological processes;
- Facilitate the expansion of refugia; and
- Enhance connectivity between refugia or from the headwaters to Puget Sound.

Policy IN2:

Support a shorelines exemption for properties affected by salmon habitat restoration projects that would relocate the location of the ordinary high water mark.

Policy IN3:

Support bioengineering alternatives for shoreline bank stabilization and flood control facilities where feasible. See King County's Best Management Practices regarding bioengineering for guidance.

Policy IN4:

Support new and existing incentives to protect salmon habitat. Such incentives for local governments to choose from include but are not limited to:

- Mitigation banking and water rights acquisition to protect habitat;
- Fee simple land acquisition and land exchange;
- Development rights purchase and transfer of development rights;
- U.S. Department of Agriculture Forest Service Legacy program, Wetland Reserve Program, Conservation Reserve Enhancement Program, Washington State Department of Fish and Wildlife Small Forest Landowner Incentive Program;
- Small Forest Landowners Riparian Easements (RCW 76.13.140);
- Public Benefit Rating System (PBRS);
- Tax credit for water conservation/wastewater reuse, sales tax exemptions, and tax reductions for riparian and forest protection and restoration;
- Conservation easements;
- Surface water fee reduction for landowners with properties that are at least 65% forested and have no more than 10% impervious surface; and
- Streamlined permitting for single-family rural residential landowners using stewardship programs.

Policy IN5:

Local governments should review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.

This Green River Flood Control Zone District levee setback project at river mile 22 in Kent used bioengineering techniques. March 2004 photo.

Policy IN6:

Local governments should evaluate shorelines and critical areas under public ownership prior to sale or exchange out of public ownership in light of WRIA 9 salmon habitat priorities.

Protecting and Improving Hydrology and Water Quality/Quantity (Water Quality/ Quantity Policies)

The loss of cool, clean water and altered hydrologic cycles are key factors of decline for salmonids. Development often leads to increases in impervious surfaces that reduce groundwater recharge and increase stream flows during storms, pollution, water withdrawals, excessive sediment input, and loss of forest cover, which all have been connected with degraded hydrology, water quality, and quantity.[8] The following policies are designed to minimize the potentially negative impacts of development.

Policy WQ1:

In the Rural Area,[9] King County should work to keep basin imperviousness below 10% or utilize best management practices to maintain an equivalent stormwater runoff potential. At least 65% of each stream basin surface area should be preserved as natural forest cover. In the Urban Growth Area, local governments should strive to reduce impervious surfaces and increase forest cover to the extent possible.

Recommended practices include:

- Managing and maintaining storm drainage systems to minimize the transport of pollutants into receiving waters;
- Using low impact development techniques to manage stormwater from new (or re-) development;
- Promoting infiltration of clean stormwater runoff where soils allow; and
- Retaining and/or planting natural vegetation to promote infiltration and reduce flooding.

8. Please refer to Chapter 4, Scientific Foundation, for an explanation of water quantity and quality impacts. Also, see Part II of the *Habitat Limiting Factors and Reconnaissance Assessment Report* (Kerwin and Nelson (Eds.) 2000) and the *Draft Assessment of Current Water Quantity Conditions in the Green River Basin* (Northwest Hydraulics 2005) for more detailed descriptions on the causal relationships.

9. The "Rural Area" and the""Urban Growth Area" are defined under the *King County Comprehensive Plan*. (King County 2004). The Urban Growth Area Line divides the two areas (See Figure 1-1 and Figure 3-3). King County is the only local government that has jurisdiction over the "Rural Area."

Policy WQ2:

Local jurisdictions and developers should reduce the volume of stormwater runoff through use of low impact development techniques. Low impact development includes the use of:

- Native vegetation and small-scale treatment systems to treat and infiltrate stormwater runoff close to where it originates;
- Clustering of buildings and narrower and shorter roads to reduce total impervious areas and leave larger areas in native vegetation;
- Infiltration in urban areas (e.g., bio-swales, natural drainage systems, and vegetated "eco" roofs); and
- Porous or permeable paving materials. Porous paving materials are suitable for use in areas with well-drained soils and significantly reduce or eliminate the need for stormwater sewer hookups. Suitable uses include sidewalks, trails, residential driveways, residential streets, and parking lots.

Bio-swales, such as these at the King County Library in Auburn, infiltrate stormwater on site and reduce stormwater flows to streams. September 2002 photo.

Policy WQ3:

Manage ground water in conjunction with surface water to provide adequate surface water flows and water temperatures for salmonids. Within the urban areas, provide access to public wastewater treatment systems to reduce use of on-site sewage (septic) systems in areas with a direct ground water connection to river and streams. In the Rural Area, promote the best affordable on-site sewage systems. Local governments should coordinate as appropriate with water and sewer districts and state agencies to:

- Study, map, and analyze key groundwater resources and recharge areas and use this information in land use planning and environmental review;
- Protect against negative impacts on designated critical recharge areas (see Habitat Plan policies and programs addressing impervious surface reduction, stormwater management, retention/addition of native vegetation, and water conservation and reuse);
- Manage the mix of ground water and surface water consumption seasonally to maximize the benefits to salmonid habitat and ground water recharge;
- Develop drought preparedness guidelines that minimize the impacts on salmonid habitat by identifying an optimal mix of ground and surface water withdrawals; and
- Limit or preclude mining and other significant excavation activities below the water table or where removal of material would deplete critical soil materials that store, filter, or convey groundwater resources.

Policy WQ4:

Local governments should assess current surface water management standards, facilities, and programs and strengthen them where necessary to reduce entry of sediment and other pollutants to salmon streams.

Policy WQ5:

Discussion:

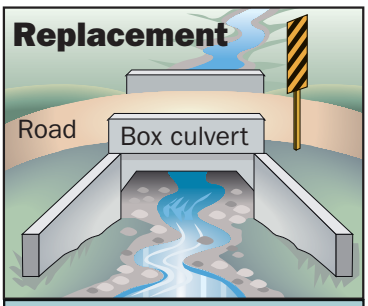
Reclaimed wastewater is water treated to such a high level that it can be used safely and effectively for non-drinking water purposes such as landscape and agricultural irrigation, heating and cooling, and industrial processing. Reclaimed water is available year-round, even during dry summer months or when drought conditions can strain other water resources. The King County Regional Wastewater Services Plan calls for expanding the production and use of reclaimed water as a valuable resource.

Reclaimed water could potentially:

- Enhance or maintain fish runs consistent with the regional Endangered Species Act response;
- Supply additional water for the non-potable and indirect potable uses; and
- Preserve environmental and aesthetic values.

Policy:

Develop uses for reclaimed and reused wastewater to reduce water demand.



Replacing old culverts with box culverts will help open up stream habitat.

Removing Barriers to Fish Passage

Policy FP1:

Local governments should evaluate fish passage barriers within their jurisdictions, assess which barriers are most important to remove based on the suitability of potential salmonid habitat that would be opened, and add the high priority barrier removals to Capital Improvement Programs (CIPs).

Policy FP2:

Local governments should replace culverts with bridges or arched-culverts that have natural streambed material in the course of planned maintenance and/or improvements.

Reducing Impacts Of Human Population Growth And Development (Land Use)

Policy LU1:

Uphold the growth management and concentration principles of the King County Countywide Planning Policies (1994). Specifically, support maintaining the current Urban Growth Area Line until 2015.

Policy LU2:

Encourage use of the Built Green™ building program (or comparable programs) to provide incentives for developers (private and public). Incentives could include reductions in impact fees, reduced or waived permit costs, and/or reduced buffer widths.

Policy LU3:

New roads and infrastructure should be critically evaluated for likely salmon habitat impacts, and road building, clearing and grading within landslide hazard areas should be avoided or minimized except where necessary for public health and safety.

Policy LU4:

Local governments should adopt the Tri-County Regional Road Maintenance Endangered Species Act Program Guidelines for maintenance of existing infrastructure or an equivalent set of practices.

Promoting Citizen Education and Stewardship

The public has a vital role to play in the protection and restoration of salmon habitat in WRIA 9. Governmental and non-governmental projects to protect and restore salmon habitat will be undermined or overwhelmed unless many of the 630,000 people of the watershed help protect and restore healthy habitat.

Citizens should be enlisted to be partners in caring for the watershed and its salmon in three main ways:

- By informing and educating them about the watershed, its problems, and efforts needed to protect and restore it;
- By involving them in stewardship of habitat protection/restoration sites; and
- By taking voluntary personal action in daily life to reduce harmful practices.

In addition to the three approaches listed above, ongoing dialogue with the public is necessary so that the WRIA 9 partners hear about opportunities for new projects, new ways of protecting and restoring habitat, and public views of what is working and what should be improved. WRIA 9 watershed efforts have been characterized by a commitment to public input through mechanisms such as the WRIA 9 Steering Committee and formal public involvement efforts. This level of commitment to soliciting and using the input of people with a range of opinions should continue as part of the adaptive management/implementation phase of this Plan.

Education/Information

Watershed partners should promote greater awareness of the watershed, its resources – including salmon — and how people depend on and affect those resources. This should be done through education and information that:

- Promotes understanding of the geographical boundaries of our watershed and promotes a "sense of place;"
- Increases awareness of how a healthy watershed benefits people through improved water quality, reduced flooding, greater recreational and aesthetic benefits, and other ecosystem services;
- Informs them about the major health problems of the watershed;
- Informs them about the impacts of personal choices on watershed health (e.g., single family bulkheads on the marine nearshore, removal of trees on runoff);
- Explains what governments, businesses, non-profit organizations, and private property owners are doing to protect and restore habitat; and
- Gives a periodic status report of the health of the watershed and its salmon populations.

People who have this information will be more likely to support watershed preservation – through stewardship, personal behavior changes, or political support – than those who do not.

This information/education effort would be carried out by WRIA 9 and cross-WRIA partners (e.g., Shared Strategy for Puget Sound) using print and electronic media and personal contacts/presentations. It also includes simple techniques such as posting interpretive signs at protection/restoration projects so people are more aware of on-the-ground projects being created with their tax dollars and/or volunteer labor.

Stewardship programs, such as this forest stewardship class by King County, give private property owners the information to help make good habitat management decisions. March 2003 photo.

Stewardship

Thousands of people contribute to the health of the watershed through being good stewards of its land and water. These people include:

- Farmers who conserve soil and protect water quality;
- Forest owners who practice sustainable forest practices;
- Individual property owners who keep a portion of their property, especially streamside areas, in native vegetation;
- Schools that make stewardship projects a part of the curriculum; and
- Volunteers who plant native trees, water plants, and control invasive weeds at habitat restoration sites throughout the watershed.

Expansion of stewardship is vital to increase the amount and quality of healthy salmon habitat throughout the watershed. Increased and improved stewardship needs to occur on a voluntary basis on both private and public lands. This will require greater support and recognition of property owners who are good stewards of privately-owned land and re-doubled efforts to recruit and retain volunteer stewards for public lands.

Much private property stewardship and all stewardship on public lands is made possible by the volunteers at non-profit groups such as Horses for Clean Water, People for Puget Sound, Mid-Sound Regional Fisheries Enhancement Group, and local stream groups and professional staff at the cities and King County, the King Conservation District, Washington State University Cooperative Extension, and Puget Sound Action Team. Additional stewardship is unlikely to occur without additional people working to organize and publicize volunteer opportunities or support private property owners.

Beyond the obvious improvements on the ground from increased stewardship, the experience of wielding a shovel or controlling weeds creates a greater sense of understanding of and responsibility for the parts of the watershed in public ownership. This is expected to gradually increase the level of public support for future habitat efforts.

Volunteers affix 4-inch plastic buttons with this image next to Federal Way storm drains as "prompts" for salmon-friendly behavior.

Personal Action in Daily Life

With over 630,000 persons sharing the WRIA 9 watershed, the collective impact of daily actions is tremendous, for good or bad. Individuals make a big difference in watershed health as they conserve water, practice natural yard care, follow good car maintenance and washing practices, and make other modest changes in their daily activities.

Encouraging and sustaining voluntary changes in daily behavior will require more than just information and awareness. There is an increasing body of information (identified through "community based social marketing") that indicates that providing information alone or encouraging changes in attitudes alone (e.g., through advertising) are not sufficient to create changes in personal behavior.

Programs to encourage voluntary changes in people's habits frequently benefit when they rely on a series of steps that:

- Identify the barriers to change;
- Seek to either remove as many barriers as possible or overcome them through tools such as gaining

commitment, providing "prompts" to remind people of better practices, establishing norms, relying on periodic communication, establishing incentives, developing personal contacts, asking neighbors to talk to neighbors, and improving convenience;

- Pilot test the program to evaluate the overall approach and make changes needed before committing greater resources;
- Conduct the program; and
- Evaluate the success of the program by measuring actual changes in behavior (as opposed to what people say they do).

The Natural Neighborhoods Yard Care Program developed and carried out by local jurisdictions is a good example of a program that relies on this approach.

New or expanded programs to promote personal action should have as many of the following attributes as possible:

- The program focuses on changing specific behaviors that contribute to salmon habitat problems (rather than general environmental education);
- The program focuses on the most significant factors of salmonid decline;
- The program focuses on the behaviors easiest to change;
- The program is designed to address a large percentage of the total problem, either across the WRIA or within a given stream basin or nearshore reach; and
- The program is the most cost-effective means of changing the behavior.

The preceding lengthy description of the public role in the watershed partnership is intended to underscore the importance of citizen attitudes and actions in recovering salmon habitat. Governments alone cannot save salmon; success also depends on contributions big and small by many of the people who live, work, and play in the watershed.

Given the previous considerations, the Habitat Plan recommends the following policies related to education, stewardship, and personal action:

Policy ES1:

Support vigorous education/information efforts to promote greater awareness of the watershed, its resources – including salmon – and how people depend on and affect those resources. School districts are encouraged to include watershed concepts and salmon recovery into school curricula, where feasible, and include watershed stewardship as a community service opportunity.

Policy ES2:

Support programs that foster stewardship among private property owners, including providing information at local public events, one-on-one consultation and development of farm/forest/conservation plans, and hosting classes and workshops on practices that protect and restore the health of land and water.

Policy ES3:

Increase the number of volunteer stewardship events, better promote the events, and strive to retain volunteers over time for salmon restoration/protection projects on public lands.

Policy ES4:

Develop, continue, expand, and improve programs to encourage positive personal action in daily life including:

- Natural yard care (water conservation, reduced use of pesticides, improving soil, careful plant selection, natural lawn care);
- Good car maintenance (fixing oil/coolant leaks, recycling of used oil);
- Maintenance of septic systems;
- Minimize paving in single-family household uses such as driveways and patios and instead rely on pervious materials;
- Use of toxic-free products or methods to clean roofs, sidewalks, decks, and driveways;
- Salmon-friendly car washing by individuals and charity groups (keeping soap and oil out of storm drains);
- Pet waste cleanup;
- Beach use etiquette (not damaging marine life when tidepooling, leaving large woody debris and drift logs in place);
- Patronizing of EnviroStars businesses; and
- Other practices of people in their daily lives that are identified as having a significant impact on watershed health.