WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Stillaguamish River Watershed Temperature Total Maximum Daily Load

Water Quality Improvement Report Vol. 2: Implementation Strategy

July 2006
Publication No. 06-10-057

Printed on Recycled Paper

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July 2006
Publication No. 06-10-057

Publication Information

Cover photo: Steve Hirschey, Ecology Water Resources Program

This Water Quality Improvement report is published in two parts:
Volume 1 – Study Findings (Publication No. 04-03-010)
Volume 2 – Implementation Strategy (Publication No. 06-10-057)

On the web
Volume 1 - www.ecy.wa.gov/biblio/0403010.html March 2004
Volume 2 – www.ecy.wa.gov/biblio/0610057.html July 2006

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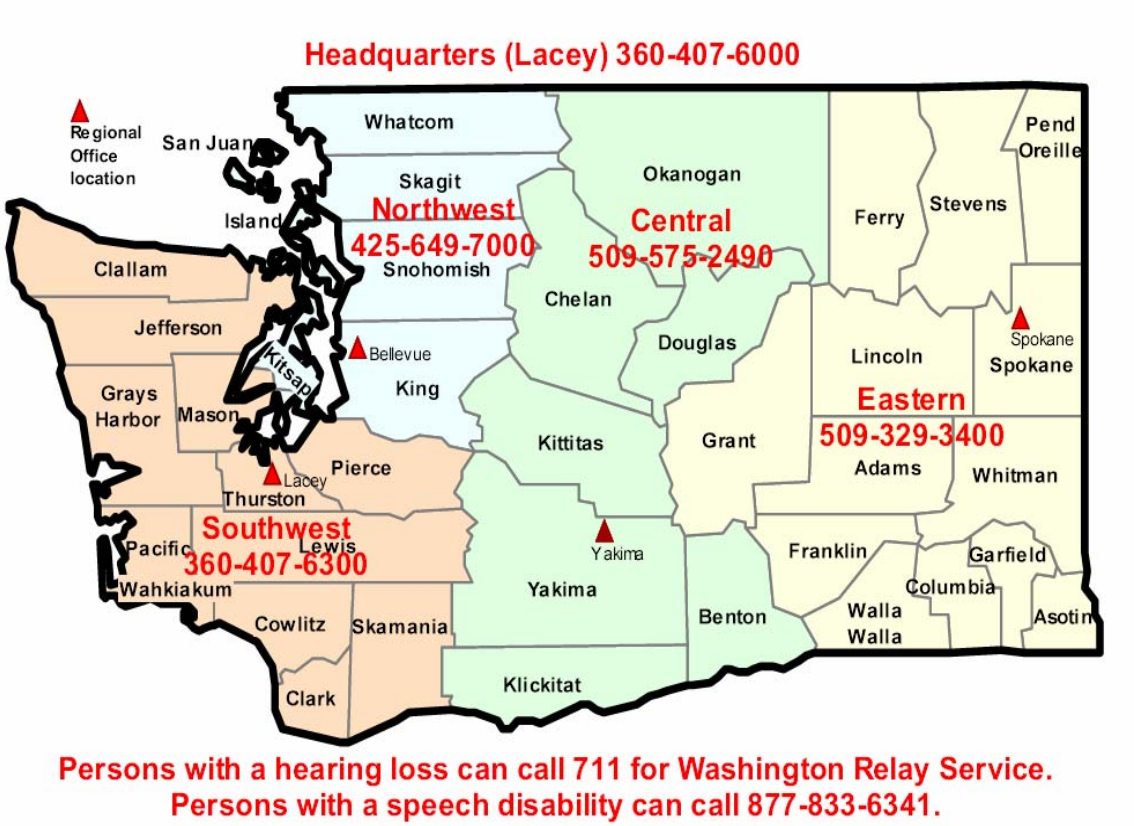

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Executive Summary

The Stillaguamish River basin in Snohomish and Skagit Counties, Washington, contains 870 miles of anadromous salmon habitat. The uses of the river by several species of salmon and other forms of cold-water aquatic life are at risk due to excessive warming during late summer, low-flow conditions.

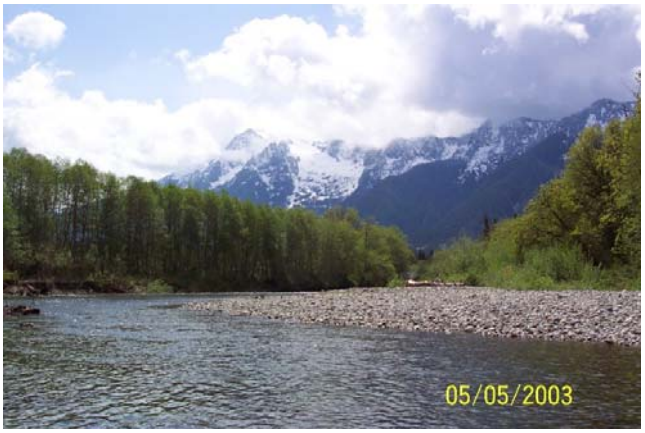

Figure 1. North Fork Stillaguamish (Steve Hirschey)

As required under the Clean Water Act, the Washington Department of Ecology (Ecology) conducted a Total Maximum Daily Load (TMDL) study (Ecology 2004) to address temperature impairments in the basin. If actions are implemented that would reduce incoming solar radiation using full riparian vegetation, and that would protect and improve groundwater inflow and reduce sedimentation, then beneficial reductions in water temperature will result, eventually improving conditions for cold-water aquatic life.

The Stillaguamish Temperature TMDL applies to 10 reaches of the river system. The 1998 303(d) list included seven stream reaches impaired for temperature: Deer, Higgins, Little Deer, and Pilchuck creeks, and the mainstem, North Fork, and South Fork Stillaguamish River. The revised 303(d) list (the 2004 Water Quality Assessment) added Canyon, Jim and Glade Bekken creeks. (Old Stillaguamish River temperature impairments will be studied in a future report.)

Summertime maximum temperatures are higher than the water quality criteria in many years, at many locations in the Stillaguamish. The river often carries a heavy sediment load; the stream channel has been made wider and shallower due to sediment carried downstream from both natural and human-caused landslides. Some of the landslides were caused by poor logging practices in the early part of the twentieth century.

The Stillaguamish Temperature TMDL establishes the loading capacity of this river system for incoming solar radiation. The loading capacity is represented by the "system potential temperature" – an approximation of the summertime maximum temperatures that would occur under optimized conditions of mature riparian vegetation, channel width, groundwater inflows, and riparian microclimate. The system potential temperature is estimated through computer modeling, using models that are effective in predicting stream temperatures in Washington.

Point sources of thermal loading are also addressed by the Stillaguamish Temperature TMDL. This report establishes wasteload allocations for two wastewater treatment facilities with National Pollutant Discharge Elimination System (NPDES) permits: the City of Arlington's facility on the mainstem Stillaguamish River and the Indian Ridge Corrections Facility on Jim Creek, a tributary to the South Fork. Both facilities may continue discharging treated effluent to the river system, but, as allowed under state water quality standards, when background

temperature is warmer than the state standard, they may not cause an increase greater than 0.3^{o} C above the water quality criterion at the edge of the chronic mixing zone. Nonpoint heat loading is addressed by load allocations. This TMDL establishes load allocations for each water body as maximum potential effective shade that would occur with mature riparian vegetation. Effective shade is the fraction of incoming solar radiation that is blocked from reaching the stream surface.

In addition to load allocations for effective shade, the TMDL study recommends other management activities that could benefit stream temperature including measures to prevent channel widening; voluntary actions to protect or increase stream flow such as voluntary retirement of water rights; and channel modifications that would maintain or increase hyporheic exchange and groundwater inflows. The natural and human-caused landslides that contribute sediment under both dry and wet conditions are one cause of poor water quality; deposition of the sediments in many locations has led to shallowing and widening of the river, resulting in greater solar exposure. Management activities to reduce slides, reduce upland and channel erosion, and help minimize deposition of fine materials in the streambed are encouraged.

Ecology's implementation strategy for nonpoint sources is to encourage and support voluntary installation of riparian vegetation that will provide effective shade when mature, and to support other riparian and channel improvements that will create deeper, cool pools, reconnect to groundwater, and reduce sedimentation. Ecology also supports programs that will encourage water conservation and protection of instream flow.

The lower watershed, largely privately owned, has mixed land uses including agricultural, rural residential and urban-commercial areas in the rapidly-growing cities of Stanwood and Arlington. Local organizations including the Stillaguamish Tribe, the Tulalip Tribes, City of Arlington, Snohomish County, Stillaguamish-Snohomish Fisheries Enhancement Task Force, and Snohomish Conservation District have active programs with landowner incentives to plant and restore riparian areas in the lower watershed (Figure 2).

Figure 2. Volunteers planting native trees at Portage Creek Wildlife Sanctuary (Dave Steiner, Stillaguamish-Snohomish Fisheries Enhancement Task Force)

Both Arlington and Snohomish County have critical area ordinances requiring protection of streamside riparian habitat for parcels under development. Also, Snohomish County's Shoreline Management Plan includes protections for the shorelines of estuarine and marine areas and rivers with average daily flow greater than 20 cfs.

To help fund implementation, Ecology awards Centennial Clean Water Funds (CCWF) for competitive restoration and water quality-related projects. For example, the Stillaguamish Tribe is using CCWF and other funds to reduce sediment from the Steelhead Haven landslide (Fig. 3).

In forested areas of the watershed (82 percent of land area), forest practices regulations require riparian protection that is expected to lead to improved stream temperatures. For National Forest System lands, the Northwest Forest Plan requires riparian reserves, where special standards and guidelines apply. As funding allows, the Forest Service implements restoration projects to address road-related sedimentation. For state Department of Natural Resources and private forests, the Forests and Fish Agreement (DNR 1999) includes strict riparian protections.

Instream flows and water withdrawals are managed through regulatory avenues separate from TMDLs. However, stream temperature is related to flow; increases in flow generally result in decreases in maximum temperature. Thus, this report makes reference to the Stillaguamish Instream Flow Rule [Chapter 173-505 Washington Administrative Code (WAC)] adopted in 2005 because of its potential to protect against future additional water allocations that could lower river flow and exacerbate existing temperature problems.

After implementation actions are under way, adaptive management will be led by Ecology with participation of local agencies and interested organizations. These agencies and organizations will work with Ecology to review annually new water quality data and achievement of implementation milestones and to consider new prospective watershed projects. Meeting the system potential temperature will take time for full maturation of newly planted riparian buffers. Implementing planting programs will take five years or more, and native trees can mature in 50 years, so the target date for reducing stream temperatures is approximately 2065.

Figure 3. Steelhead Haven landslide on North Fork prior to massive failure in January 2006 (Steve Hirschey, Ecology Water Resources Program)

Introduction

The Washington Department of Ecology (Ecology) is concerned about protecting and restoring water quality in creeks and rivers of the Stillaguamish River watershed. This watershed, whose waters rise on the western slopes of the Cascade Mountains and drain westward to Port Susan, an inlet of Puget Sound, was famed in the early 1900s for its steelhead fishery. In the second half of the century, all runs of salmon and steelhead declined. The causes are several and complex, but among the factors identified by fisheries scientists as limiting salmon and steelhead populations in this watershed is high stream temperature during the late summer, low-flow season (Washington Conservation Commission, 1999).

This document, a Water Quality Improvement Report, Volume 2: Implementation Strategy, is the second report of three that are needed to address Stillaguamish River watershed streams and rivers impaired for temperature under the federal requirements for developing a Total Maximum Daily Load. The purpose of this volume is to describe how the streams and rivers of this watershed can begin to improve to meet Water Quality Standards. It includes (1) a list of actions needed to improve water quality; (2) inclusion of the public in the decision making process; (3) a monitoring program to measure performance; and (4) the periodic readjustment of needed corrective actions if progress is not occurring rapidly enough (adaptive management).

State authority to set water quality standards and conduct TMDLs

Section 303(d) of the 1972 Clean Water Act (CWA) requires the U.S. Environmental Protection Agency, or a designated authority, to identify the polluted water bodies of the United States and to develop plans to clean them up. In Washington State, Ecology has this responsibility. Water bodies that do not meet federal or EPA-approved state water quality standards are initially put on the "303(d) list" of impaired waters. (In Washington State, these waters are listed as Category 5 of the Washington State Water Quality Assessment.) After being put on the 303(d) list, a plan must be prepared that will guide efforts to return local waters to good health. These plans are called Total Maximum Daily Loads (TMDLs).

Under a 1997 agreement with EPA, Ecology must follow a two-step process to complete a TMDL. First, Ecology prepares a TMDL submittal report for approval by EPA. The submittal report, also called a Water Quality Improvement Report, includes a technical study (Volume 1) that defines the amount of pollutant a water body can receive without exceeding water quality standards and assigns load allocations or amounts of pollutants as well as a margin of safety. The submittal report to EPA also includes an implementation strategy (Volume 2), which outlines the activities required to implement the TMDL. After EPA approves the submittal report, Ecology must prepare an implementation plan (Volume 3, the Water Quality Implementation Plan) describing the specific activities that individual parties must perform to achieve the TMDL load and wasteload allocations.

Washington's Water Quality Standards for temperature

Current standards

Numeric water quality criteria for freshwater Classes AA, A, and B state that temperature shall not exceed the following due to human activities:

	Temperature Standard not to Exceed
Class AA (extraordinary)	16.0° C
Class A (excellent)	18.0° C
Class B (good)	21.0° C

These numeric criteria are designed to ensure specific communities of aquatic life will be fully protected whenever and wherever the numeric criteria are met. The state standards recognize, however, that some water bodies may not be able to meet the numeric criteria at all places and all times.

WAC 172-201A states that: *"Temperature shall not exceed [the numeric criteria] due to human activities. When natural conditions exceed [the numeric criteria], no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°." (WAC 173-201A-030(1)(c)(iv), (2)(c)(iv), (3)(c)(iv), (4)(c)(iii))* Thus at times and locations where the assigned numeric criteria cannot be attained even under estimated natural conditions, the state standards hold human warming to a cumulative allowance for additional warming of 0.3°C above the natural conditions estimated for those locations and times.

The warm temperature conditions in the Stillaguamish are considered to result partly from excessive sedimentation and other channel alterations that reflect both natural processes and improper land use practices, including forestry practices from the late 1800s to mid-twentieth century. The Stillaguamish Temperature TMDL makes an estimate of the system potential temperature—an approximation of the maximum stream temperature that would occur under optimized conditions of mature riparian vegetation, natural channel shape, and riparian microclimate.

The system potential temperature represents the loading capacity of the stream and is estimated for both an average year and a critical condition year using analytical methods and computer simulations proven effective in modeling and predicting stream temperatures in Washington. TMDL load allocations are established so that the stream temperature meets the numeric criteria up to the critical condition. The system potential temperature does not, however, replace the numeric criteria, nor invalidate the need to meet the numeric criteria at other times of year and at other less extreme low flows and warm climatic conditions.

At locations and times where the system potential temperature is greater than the numeric criterion assigned to the water body, the loading capacity and load allocations in this TMDL are based on not allowing human sources to warm the water by more than an additional 0.3^{o}C above the criterion. In all waters where the system potential temperature is higher than the assigned

criterion, maximum riparian shade and best channel and flow conditions possible are needed; this condition is the load allocation for nonpoint sources throughout the Stillaguamish watershed.

If natural conditions are below the temperature standard, the incremental temperature increase resulting from nonpoint source activities shall not exceed 2.8°C or bring the stream temperature above the specified standard of the class at any time (Chapter 173-201A-030 WAC). Where natural conditions are below the standard, incremental temperature increases from point sources are limited using the equation, $t_{increase} = 28/(T+7)$ for Class A waters (T =upstream temperature).

Thus, if the upstream temperature was 15°C, a facility would be permitted to increase the downstream temperature no more than 1.3°C. Washington's Water Quality Standards allow mixing zones (WAC 173-201A-100). The permitted temperature increase is applied at the edge of the chronic mixing zone, determined through a modeling analysis of the facility's rated discharge capacity in relation to flow of the receiving water at a specified low-flow condition. The low flow condition used in mixing zone analyses is the 7Q10, or the lowest 7-day average stream discharge that occurs at a frequency of once in 10 years.

Proposed standards

In 2003, Ecology adopted new water quality standards for temperature, including numeric criteria based on seven-day average maxima and a system that assigns criteria to state waters based on their beneficial uses rather than on a classification system. Reaches of the river identified as supporting summer spawning of salmon have been changed to a 16°C maximum 7-day average, and reaches identified as supporting bull trout spawning and early juvenile rearing have been changed to a 12°C maximum 7-day average. In March 2006, EPA disapproved parts of these new water quality standards based on differences in the designation of certain reaches of some rivers and streams for spawning, juvenile rearing and migration of salmonid fishes. Ecology is currently proposing to adopt into rule EPA's use designations, which will result in more stringent temperature criteria in parts of some watersheds, including the Stillaguamish (Table 1). Ecology will hold public hearings on the proposed rule in summer 2006.

Table 1. Current and proposed temperature criteria for parts of the Stillaguamish river system

Stream Reach	Current Criteria °C (a)	Proposed Criteria °C (b)
Mainstem Stillaguamish	18	17.5
Jim Creek	18	16, 12
Pilchuck Creek	18	17.5, 16, 12
Deer Creek (c)	18, 16	16, 12
North Fork (d)	18, 16	16, 12
South Fork (e)	18, 16	16, 12
Canyon Creek	18	16, 12

(a) Current criteria are single-day maximum temperatures
(b) Proposed criteria are maximum 7-day averages of daily maximum temperatures
(c) Class A from mouth to National Forest boundary, Class AA above
(d) Class A from mouth to Squire Creek, Class AA above
(e) Class A from mouth to Canyon Creek, Class AA above

Temperature problems in the watershed

Ecology initiated the temperature TMDL study in 2000 to evaluate temperature conditions in the watershed. Seven stream reaches were on the 303(d) list because of exceedances of the temperature standard: Deer, Higgins, Little Deer, and Pilchuck creeks, and the mainstem, North Fork, and South Fork Stillaguamish River. In 2005, EPA approved a revised and updated version of the 303(d) list, the 2004 Water Quality Assessment, which added Canyon, Jim and Glade Bekken creeks to the list, for a total of 32 temperature impaired reaches (Table 2). (Two temperature listings in Old Stillaguamish Channel will be addressed in a future TMDL.) All Stillaguamish reaches on the 2004 Water Quality Assessment are shown in Figure 4.

Table 2. Stillaguamish River watershed (WRIA 5) segments listed for temperature on the 2004 Water Quality Assessment and addressed in this report

Waterbody Name	Township	Range	Section	List ID
Deer Creek	32N	07E	08	6454
	33N	07E	01	7188
	34N	07E	35	6455
Higgins Creek	32N	07E	20	7198
Little Deer Creek	34N	07E	35	6456
Pilchuck Creek	33N	05E	27	6450
	32N	05E	16	6448
	33N	06E	17	6447
	32N	05E	31	6449
South Slough	31N	04E	02	6452
Stillaguamish River	31N	05E	06	6565
	31N	05E	02	7244
	31N	04E	02	6453
Stillaguamish River, N.F.	32N	07E	10	15567
	32N	09E	7	6568
	32N	08E	6	15572
	31N	05E	2	6446
	32N	09E	10	6457
	32N	06E	15	6567
	32N	09E	22	7247
	33N	09E	22	6458
Stillaguamish River, S.F.	31N	05E	02	6566
	30N	08E	08	6460
	31N	06E	18	6451
	30N	08E	16	6459
	30N	07E	07	10587
Canyon Creek	30N	06E	12	15568
	30N	07E	06	6444
	30N	07E	03	15569
Jim Creek	31N	06E	08	15570
	31N	06E	16	15571
	31N	06E	07	6445

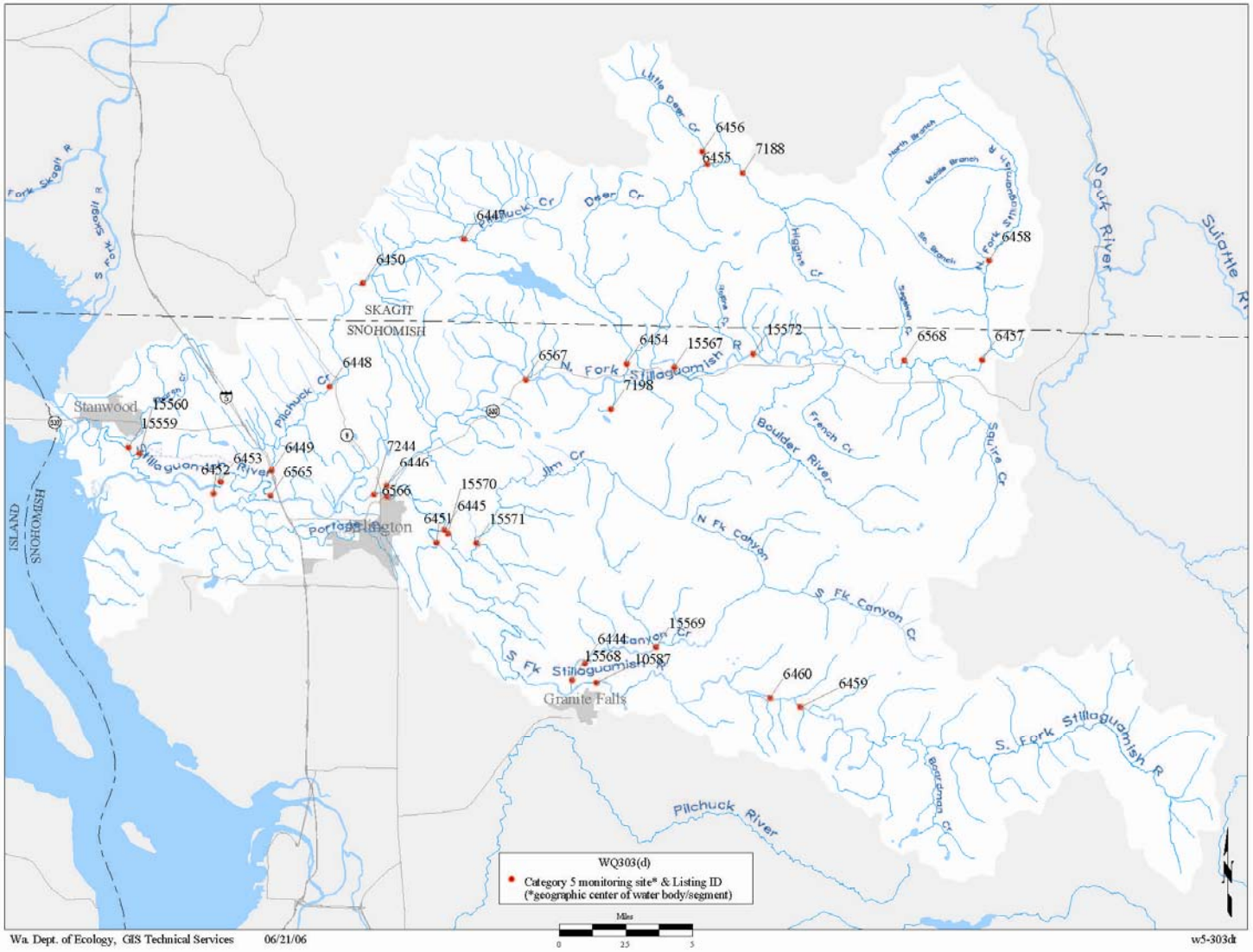

Figure 4. Stillaguamish watershed stream reaches listed for temperature on the 2004 Water Quality Assessment

Background: TMDL study (Volume 1)

Volume 1 is a report (Ecology 2004) on the TMDL study conducted in 2001, which documented exceedances of water quality criteria for temperature in most parts of the watershed. Modeling was conducted to determine whether full riparian buffers with mature native trees and other improvements could reduce stream heating sufficiently to allow the water bodies to meet standards. The study established load allocations for shade and wasteload allocations for point source discharges to creeks and rivers in the watershed (*Volume 1, Stillaguamish River Watershed Total Maximum Daily Load Study* (online at www.ecy.wa.gov/biblio/0403010.html).

Existing conditions for stream temperatures in the Stillaguamish River watershed reflect seasonal variation. Seasonal estimates appropriate for local streamflow, solar flux, and climatic variables were taken into account in selecting critical conditions for the TMDL model. The critical period for evaluation of solar flux and effective shade was assumed to be August 1 because it is the mid-point of the period of peak seasonal water temperatures.

To evaluate the influence of four factors: *riparian vegetation, microclimate, channel width, and groundwater inflows*, a water quality model was initially run with existing conditions of these factors and the model's predictions were compared with measured stream temperatures. Then the model was run with hypothetical input conditions of potential mature vegetation, improved microclimate, reduced channel width, and increased groundwater inflows to determine whether these conditions would enable the stream reach to meet the temperature criterion.

To develop the scenario for potential maximum riparian vegetation (as input to the model), the height and density of trees was estimated based on the description of the historically mixed deciduous and coniferous species in the Stillaguamish floodplain (Pess et al., 1999) and was assumed to be represented by an average tree height of 45 meters (about 150 feet) and canopy density of 85 percent. The estimated characteristics were selected to represent a mid-range for mature vegetation from the values presented by Pess et al. (1999). This hypothetical future scenario does not take into account current land uses or land ownership.

Ecology used Oregon Department of Environmental Quality's Ttools extension for Arcview (ODEQ 2001) to sample and process GIS data for input to two models. Ecology's Shade model was used to estimate effective shade along the mainstem, North and South forks, Deer Creek and Pilchuck Creek; these estimates were then used as inputs to the QUAL2Kw dynamic stream model, which was used to calculate the components of the heat budget and simulate water temperatures. It was calibrated to instream data collected in 2001 for the five modeled stream reaches.

The required Margin of Safety (Ecology 2004) is implicit and is addressed through the use of conservative assumptions in the model (7Q10 low flows and the 90^{th} percentile of the highest 7-day average of daily maximum air temperatures were used to develop a reasonable worst case stream temperature condition). The model's ability to predict stream temperature was evaluated by calculating the Root Mean Square Error which was on average, 0.7^{o}C.

The model results suggest that substantial reductions in water temperature (compared with the current regime) would occur with mature riparian vegetation, improvements in riparian microclimate, reduced channel width, and increases in groundwater inflows. Potential reduced

temperatures are predicted to be less than the threshold for lethality of 23°C but greater than 18°C in Class A and greater than 16°C in Class AA waters during critical conditions in some or most of the segments in all streams that were evaluated.

The model predicts that the mainstem Stillaguamish, under critical low flow, late summer conditions, would not meet the Class A criterion, even with maximum riparian vegetation, microclimate improvement, reduced channel width, more groundwater recharge, and with all tributary waters at the water quality standard for temperature. However, substantial temperature reductions are predicted if these factors influencing potential temperature are optimized. Mature riparian vegetation, the most important factor, would reduce temperatures by about 3^{o} C, from about 26^{o} C to about 23^{o} C under critical conditions.

The model's results are similar for the South Fork, North Fork, Deer Creek and Pilchuck Creek. Under critical conditions, mature riparian vegetation is the most important factor for protecting stream temperature; however the combined effect of all factors is predicted to be insufficient for these water bodies to meet the temperature criterion. The predicted temperature under optimum and feasible improved conditions of the four factors is called the *system potential temperature*.

Watershed description

The Stillaguamish River watershed covers 683 square miles and extends from sea level at Port Susan to an elevation of more than 6,000 feet on Whitehorse Mountain in the Squire Creek drainage. Based on Landsat imagery from the 1990s (USGS, 1999), the watershed is 82% forested and 6.5% in either developed or agricultural uses. The remaining 11.5% is comprised of barren, wetlands, herbaceous upland, shrubland, and non-natural woody areas.

Snohomish County used Landsat imagery from 2001 to assess riparian forest cover and determined that approximately 52% of the riparian area in the Stillaguamish watershed is forested (Purser et al., 2003). The riparian forest cover reported for each of the sub-basins is listed in Table 3. (These forest cover percentages are based on aerial views and do not convey information about the age, or maturity, of the cover. The report by Pess et al., 1999, was used for detailed information on current vegetation maturity and height for this TMDL.)

Landslides in the Stillaguamish Watershed

The Stillaguamish Temperature TMDL supports projects that would reduce sediment buildup in the channels of this river system, which generally carries a heavy silt load supplied by landslides and eroding banks upriver. At locations and times when river velocity is reduced, deposition of sediment occurs, leading to shallow, widened reaches with greater solar exposure. The watershed includes some very large natural landslides and landslides caused by human activity. Geological formations in the watershed include unstable deposits from lahars (volcanic debris flows) that originated from Cascade volcanoes, including Glacier Peak (Beechie, Collins and Pess, 2001). Land use practices during the period 1870 to 1900 included the clearing of forests from the floodplain of most of the mainstem as well as significant portions of the North and South forks (Collins, 1997). Such clearing removes stabilizing vegetation, eliminates a source of woody debris to the channels, increases streambank erosion, and alters the hydrology of the river system. As timber harvest and road building continued at higher elevations in the watershed

during the mid-twentieth century, the resulting physical and hydrological modification of the landscape contributed significantly to landsliding and the resulting heavy load of sediment carried by the Stillaguamish.

According to a study of landslides in the watershed by Collins (1997), "Nearly all landslides in the Stillaguamish basin (97 percent) are in the North and South fork basins. Three quarters are associated with land uses, mostly clearcuts (52 percent) or roads (22 percent). Shallow-rapid failures are the most common (59 percent), with debris torrents accounting for 18 percent and deep-seated landslides for 21 percent. Most deep-seated landslides were in glacial deposits. These are predominantly in Deer Creek (NF), Higgins Ridge, Gold Basin, Canyon Creek, and Hell-Hazel basins."

Table 3. Percent of riparian zone under forest cover in Stillaguamish sub-basins (based on Snohomish County data in Purser et al., 2003). Some of these forested riparian zones are less than 30 years of age and do not provide maximum shade.

Sub-basin	%	Sub-basin	%
Gold Basin	79	Pilchuck Creek (upper)	55
South Fork (upper)	79	French-Segelsen	50
North Fork (upper)	77	North Fork (middle)	48
Canyon Creek (upper)	77	Harvey Armstrong Creek	39
Stillaguamish Canyon	72	North Fork (lower)	38
Boulder River	70	Pilchuck Creek (lower)	36
Deer Creek	67	South Fork (lower)	34
Robe Valley	64	Port Susan drainages	34
Jim Creek	57	Church Creek	20
Canyon Creek (lower)	56	Portage Creek	19
Squire Creek	55	Stillaguamish River (lower)	16

Land ownership and forested areas

The recommendations in this Water Quality Improvement Report focus on riparian protection and restoration. Requirements for riparian buffers vary with type of land ownership. Land ownership in the watershed is a mixture of public and privately owned land (Figure 5). A large part of the headwater areas of the North and South Fork Stillaguamish River is federally managed by the U.S. Forest Service according to the Forest Plan (as amended) of the Mount Baker-Snoqualmie National Forest. Sub-basins of the North Fork include Little Deer, Deer, French, Boulder, Squire and Segelson creeks. Sub-basins of the South Fork include Boardman, Canyon, and Jim creeks.

The lower portions of the watershed are primarily privately owned. The Washington State Department of Natural Resources (DNR) owns and manages a significant portion of the middle region watershed as state trust lands. Both state and private forest lands are subject to the

management practices prescribed in the Washington State DNR Forest and Fish Report (DNR, 1999), and in addition, state trust lands have a multi-species Habitat Conservation Plan, effective since 1997, that establishes riparian buffer widths.

Lower watershed land uses

The Stillaguamish's urban centers are concentrated primarily in the lower third of the watershed, with Stanwood (population 4,190) at the river's mouth on Port Susan; Arlington (population 14,330) at river mile 17; Granite Falls (population 2,915) on the South Fork at river mile 27; and Darrington located on the divide between the North Fork drainage and the Sauk River, which drains north into the Skagit River watershed.

The primary land use along the mainstem and lower reaches of the major forks is agricultural and rural residential, but also includes rapidly growing urban centers of Arlington and Stanwood. Most land is privately owned. In 1995 there were an estimated 909 commercial and non-commercial farms in the lower basin (Stienbarger, 1995). Although agriculture is still active, conversions to rural residential or non-commercial farm uses are becoming common along the Interstate 5 corridor. The state Department of Natural Resources controls approximately 28 square miles in the Pilchuck Creek sub-basin. Privately-owned forest lands are scattered throughout the upper reaches of other tributaries as well.

The Stillaguamish Tribe and Tulalip Tribes have important cultural and economic interests in the Stillaguamish River basin. The Stillaguamish Tribal offices are in Arlington and the Tulalip Tribes' offices are on the Tulalip Indian Reservation immediately south of the watershed. The Stillaguamish Tribe is a co-lead for salmon recovery programs in the watershed, and also contributes actively through its natural resources programs to understanding fisheries and water quality conditions.

The local watershed organization, the Stillaguamish Implementation Review Committee (SIRC), is the lead entity for salmon recovery in this watershed and has a high level of participation by municipalities, Tribes, non-profit organizations, and citizens. There is excellent support for, and interest in, both water quality and salmon recovery. Several member organizations have established programs for water quality and fish habitat restoration. This voluntary support for maintaining water quality is vital to maintaining the quality and function of the river system.

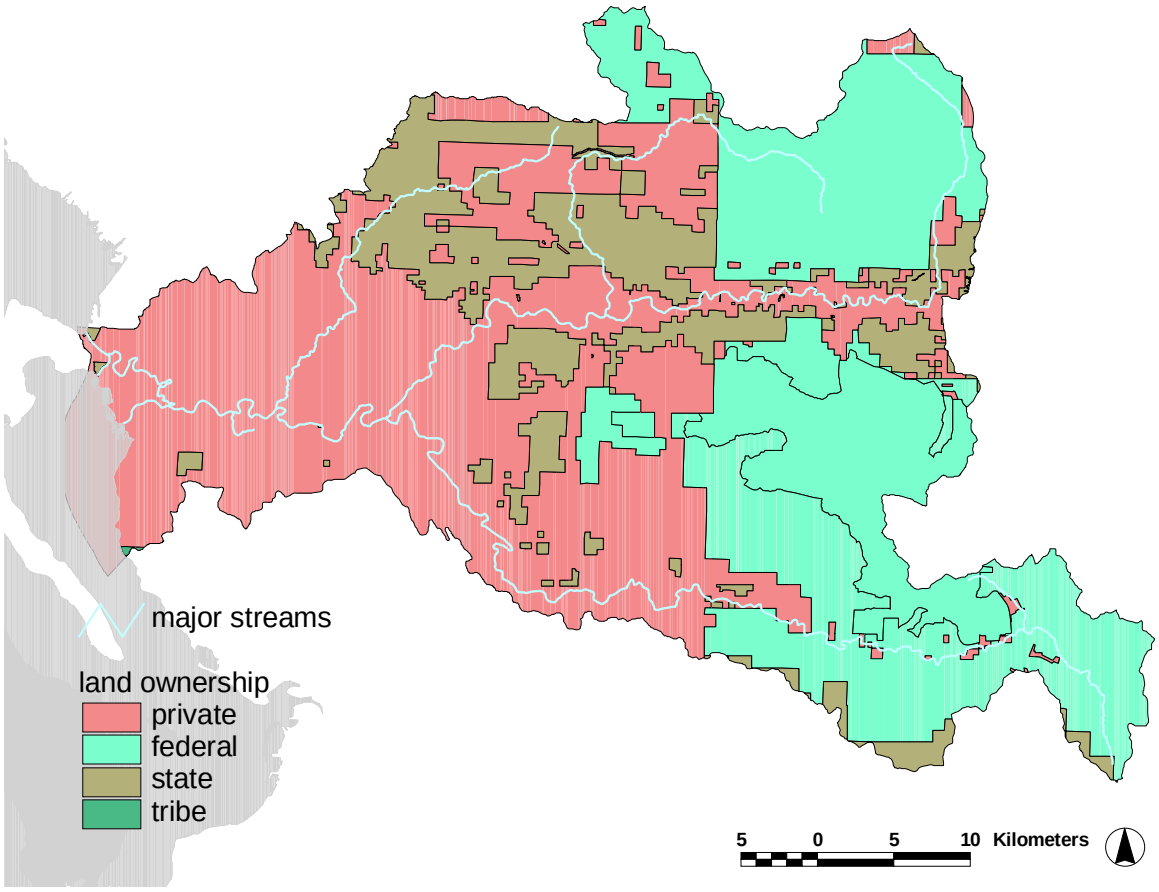

Figure 4. Land ownership in the Stillaguamish River watershed.

What Needs to be Done?

Under the Clean Water Act, for a water quality-limited water that requires a TMDL, the state must establish a TMDL that quantifies pollutant sources and allocates allowable loads to the contributing point and nonpoint sources so that the water quality standards are attained for that water body. The Stillaguamish watershed includes both point sources (two municipal wastewater treatment plants) and nonpoint sources. The nonpoint sources are assigned Load Allocations (LAs) which will be addressed using a variety of approaches to reduce direct solar radiation and warming by ambient air and streambed. Examples of approaches that could be employed to address nonpoint source heat loading include: Riparian plantings that reduce solar exposure; improved stream channel shape and connections to groundwater; and policies and regulations that protect or increase existing streamflow. Point sources are addressed through the NPDES permitting process. These facilities are assigned Wasteload Allocations (WLAs), which provide the basis for permit limits when NPDES permits are reissued.

Approaches for point sources

The point sources associated with locations of impaired water quality in the TMDL study (Ecology 2004) are Wastewater Treatment Plants (WWTPs) with NPDES discharge permits. In the Stillaguamish watershed, two WWTPs discharge to reaches with temperature impairments: the City of Arlington's facility and the Indian Ridge Corrections Facility (formerly managed by Snohomish County and currently closed) on Jim Creek which drains to the South Fork.

The applicable Water Quality Standards (WAC 173-201A-030 (2) (iv)) are:

> *Temperature shall not exceed 18^{o}C (freshwater) and 16^{o}C (marine water) due to human activities. When natural conditions exceed 18.0^{o}C (freshwater) and 16^{o}C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3^{o}C.*
> and
> *Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T +7) (freshwater)….For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.*

In other words, the permit for a wastewater treatment plant must require the discharge to meet the following elements of the state's temperature standards:

- A summer maximum criterion (e.g., the Class A 18^{o}C criterion).
- An incremental warming criterion. At times and locations when a summer maximum criterion would be exceeded under natural conditions, human sources both alone and in combination may warm the water an additional 0.3°C above that condition.
- Cool background water temperatures also need to be protected and warming of cooler background waters not permitted such as to cause downstream waters to rise above the threshold criterion (18^{o}C).

- Discharges are not allowed to cause lethality. To prevent acute exposures, discharges may not exceed 33°C.

Washington state allows mixing zones (WAC 173-201A-100). A mixing zone is that portion of a water body adjacent to an effluent outfall where mixing results in dilution of the effluent with the receiving water. The standards specify a number of criteria that must be met, including considering critical discharge conditions, sizes of mixing zones in relation to the river width, and other considerations. The chronic mixing zone, by regulation, is limited to utilizing no more than 25 percent of either the flow or the width of the river. The standards also state, in WAC 173-201A-100 (4): *No mixing zone shall be granted unless the supporting information clearly indicates the mixing zone would not have a reasonable potential to cause a loss of sensitive or important habitat, substantially interfere with the existing or characteristic uses of the water body, result in damage to the ecosystem, or adversely affect public health as determined by the department*

Municipal permits are written to comply with the water quality standards following guidance in *Water Quality Program Permit Writers Manual* (Ecology, 2005), available on the web at: http://www.ecy.wa.gov/biblio/92109.html.

City of Arlington Wastewater Treatment Facility

Arlington's wastewater treatment facility discharges to the mainstem Stillaguamish River just below the confluence of the North and South forks. This reach of the river has a summertime maximum temperature criterion of 18°C (Class A) and in some years exceeds the criterion during the warmest period of the year. Based on the modeling analysis in the TMDL study, it is unlikely, even with maximum riparian shaded condition throughout the watershed, that this reach under critical conditions will be able to meet the summer maximum criterion. In this case the final effluent limits should be set so as to not cause more than a 0.3°C increase above the temperature criterion at the edge of a standard mixing zone allowance:

$$T_{WLA} = (\text{summer maximum criterion} - 0.3) + (\text{chronic dilution factor}) \times (0.3).$$

The chronic dilution factor for the City of Arlington's existing 2 mgd facility is 30. In the late 1990s, a future Phase II 3 mgd facility was planned; the dilution factor for this facility was calculated to be 20.4 (Arlington, 1997). However, in February 2006, the City of Arlington met with Ecology to discuss a potentially larger (4 mgd) Phase II facility. Ecology recently reviewed the assumptions and modeling used to develop the chronic dilution factors in the 1997 report and concluded that they should be revised using updated data for river flow upstream of the facility and that use of the RIVPLUME model should also be reevaluated (Ahmed, 2006). Pending these revisions, the WLA temperature calculations for an expanded facility (Table 4) should be considered estimates:

The Wasteload Allocation Temperatures are calculated using this formula where 18°C is the current temperature criterion (Class A waters):

$$T_{WLA} = (18 - 0.3) + (\text{chronic dilution factor} \times 0.3)$$

For the two most recent summers, Arlington's maximum daily effluent discharge temperatures, measured in the late afternoon, were 24.0° C (August 14, 2004) and 23.8° C (August 12, 2005) (D. Randolph, City of Arlington 2005) (Figure 6). These temperatures are in compliance with

the WLA Temperature of 26.7°C for the current facility, but are very close to or slightly above the approximate WLA for a 3 mgd facility and above that for a 4 mgd facility.

Table 4. Estimates of Wasteload Allocation Temperatures for Arlington WWTP

Arlington Facility	Chronic Dilution Factor (cdf)	WLA Temperature (°C) under Current Standards	WLA Temperature (°C) under Proposed Standards
2 mgd (existing)	30	26.7	26.2**
3 mgd (Phase II proposed)	20.4*	23.8*	23.3**
4 mgd (Phase II proposed)	15*	22.2*	21.7**

* To be reevaluated

** Recalculated using 17.5°C (maximum 7-day average of daily maximum temperatures) as the summer maximum criterion for this reach of the Stillaguamish River. This value is expected to be adopted in future when Ecology's Water Quality Standards for Temperature are approved by EPA. These values also need to be recalculated using any revised chronic dilution factor.

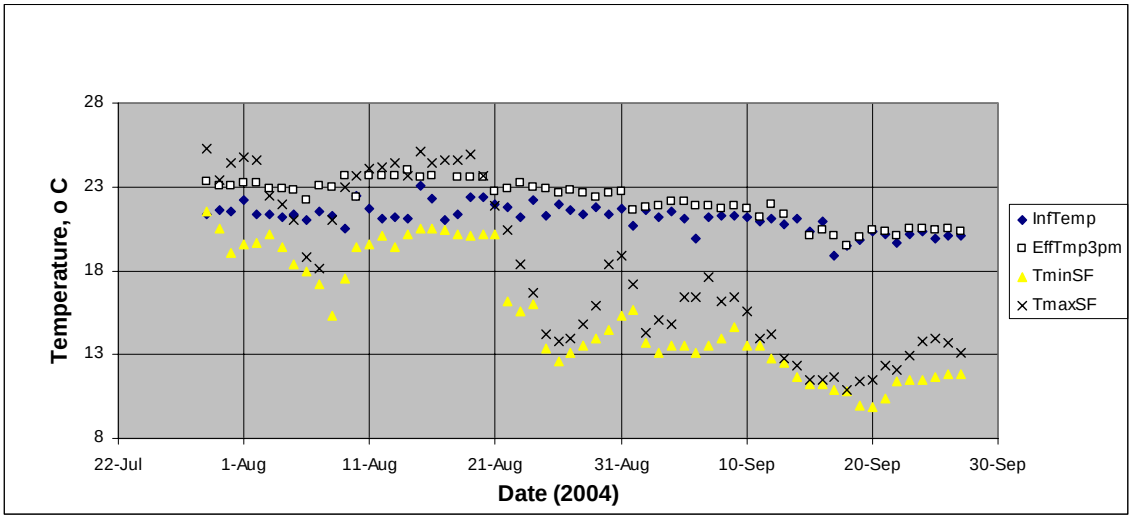

Figure 6: Summer 2004: Arlington WWTP influent and effluent temperatures, and daily temperature minima and maxima for South Fork Stillaguamish River, about a half mile upstream of the WWTP

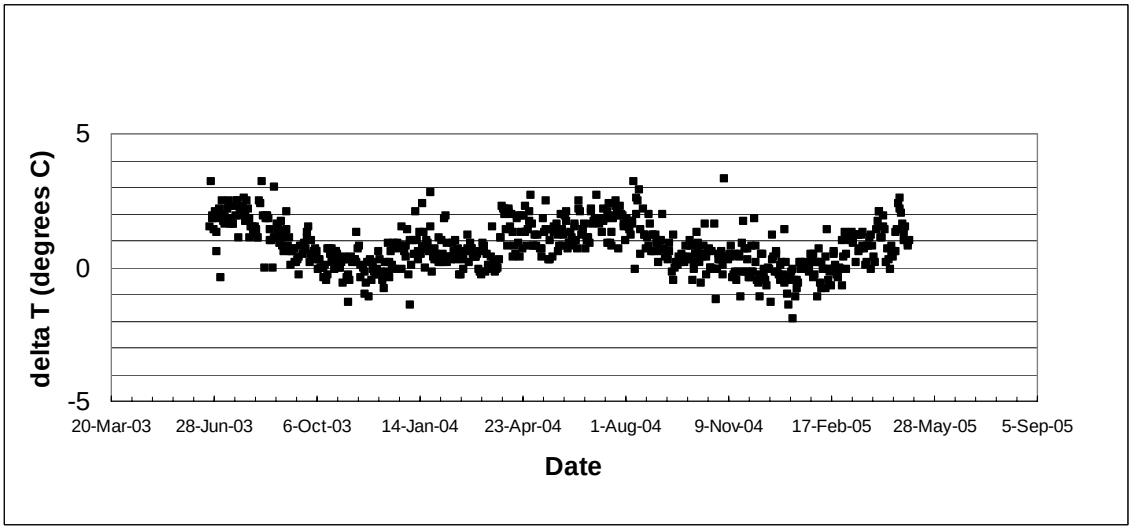

Figure 7: Daily differences between influent and effluent temperatures at Arlington WWTP

Examination of the temperature records for the existing facility suggests that the water temperature change during treatment is generally 2.5° C or less and varies with season, from a low of about a 1.5°C decrease in January-February period to a high of about 3°C in July-August period (Figure 7). Opportunities for controlling this temperature change are currently being examined by the City of Arlington. The current treatment train is exposed to daily solar radiation, and the months in which the difference between influent and effluent temperature (delta-T, or $T_{effluent} - T_{influent}$) is largest are April through August, which is also the season with longer days and warmer air and ground temperatures.

Possibility for Seasonal Effluent Limits

Seasonal effluent limits could be appropriate for some facilities. For example, in western Washington, seasonal 7Q10 low river flows generally occur in late summer-early fall, while a plant's discharge capacity is designed for the maximum flows that occur during the winter wet season. A single chronic dilution factor developed from flow statistics for such seasons that do not co-occur could be unnecessarily conservative. Wet season and dry season dilution factors could be developed that reflect this reality. According to TMDL Development Guidelines (November 1996), if semiannual limits are imposed in a permit, the 7Q20 for each season should be used (Ahmed, 2006).

If a permit were issued with seasonal effluent limits, these limits would still need to meet the summer maximum criterion and incremental warming criterion of 0.3°C, applied at the edge of the mixing zone.

Where meeting final effluent limits would require substantial cost, interim limits may be applied until a TMDL implementation plan is developed. This approach is reasonable where cost-effective alternatives could be developed through pollution trading, regionalized treatment, or some other approach using this watershed-wide TMDL for implementation. If such opportunities are not reasonably foreseeable, final limits should be established with a compliance schedule set to attain compliance at the shortest practical time.

Indian Ridge Corrections Facility Wastewater Treatment Plant

The Indian Ridge Corrections facility is currently closed, and the WWTP, which discharges to Jim Creek, is not operating. Should Snohomish County reopen Indian Ridge, Ecology will request that the operators maintain daily effluent temperature records to ascertain compliance with temperature requirements of this TMDL. Like the Arlington WWTP, Indian Ridge will be prohibited from discharging treated effluent at a temperature greater than that equivalent to the water quality criterion for the reach plus 0.3° C times the chronic dilution factor for the facility. Note that the lower portion of Jim Creek where the facility discharges is a reach proposed for a change in criterion from 18°C (summertime maximum) to 16°C (maximum 7-day average).

Approaches for nonpoint sources

The TMDL study (Ecology 2004) identified several approaches for reducing overall heat inputs to the river system: Installation and maturation of full riparian vegetation; projects with potential to increase groundwater inflows to streams; voluntary retirement of water rights; and management activities that could reduce sediment inputs and narrow channel widths. Also, because groundwater and hyporheic exchange flow are important for maintaining cooler stream temperature, the study also recommended avoidance or prevention of actions that could reduce hyporheic exchange flow or inflow of groundwater. Protection of the existing flow regime is provided by the Stillaguamish River Instream Flow Rule [Chapter 173-505 Washington Administrative Code (WAC)].

Additional mature riparian vegetation

For nonpoint sources of heat, the primary tool for addressing stream temperature impairments in the Stillaguamish watershed is protecting the existing riparian vegetation and increasing the overall quantity of mature native riparian vegetation that can shade the river and its tributaries. In addition to its direct role in blocking incoming solar radiation, riparian vegetation creates an area of moderating microclimate, prevents erosion, and can filter out unwanted substances before they are carried by surface runoff into streams. Studies have shown that wooded areas have slightly narrower channels than average, which allows riparian shading to cover a greater percentage of stream surface (Dunne and Leopold, 1978). Bank vegetation exerts a stabilizing effect on the channel, maintaining narrower bankfull dimensions wherever a deep root structure is intact (Booth, 1997).

The highest-priority areas of river and stream reaches in the watershed that should be addressed through riparian planting and restoration projects are identified in Figure 8. The priorities assigned in this figure are based on the findings of the TMDL temperature study (Ecology, 2004) and reflect both the effectiveness of the shade that could be achieved (i.e., shade is generally more effective in cooling smaller streams than it is in cooling larger streams) and the current vegetation status of the streams that are prioritized (i.e., currently unvegetated riparian areas are given higher priority than those with existing, albeit not mature, vegetation).

Note that Figure 8 is inclusive of riparian shade needs throughout the watershed, whereas the Stillaguamish TMDL focuses on the programs and activities needed for riparian restoration and protection in those areas that are not private commercial forest, National Forest, or state DNR lands, because these areas have their own prescriptions for buffer protection of streams.

For National Forest System land, the Northwest Forest Plan (USDA and USDI, 1994) designates riparian reserves with special restrictions to encourage the establishment of mature riparian vegetation. The Forest Service has not removed timber from the Deer Creek sub-basin since 1986. Private forest land in the watershed is subject to practices outlined in the Washington State DNR Forests and Fish Report (DNR 1999), and state land is subject to these practices as well as requirements of a state-wide multispecies Habitat Conservation Plan, effective in 1997. Consistent with the Forests and Fish agreement, implementation of the load allocations established in this TMDL for private and state forestlands will be accomplished via implementation of the revised forest practice regulations.

The effectiveness of the Forests and Fish rules will be measured through adaptive management and monitoring of streams in the watershed. If shade is not moving on a path toward the TMDL load allocation by 2009, Ecology will suggest changes to the Forest Practices Board.

The remaining areas of the watershed are those primarily addressed by this TMDL: riparian borders of agricultural lands; rural and suburban areas; and urban centers, most privately owned. Local and Tribal governments and non-governmental organizations can encourage riparian protection and habitat enhancement through education of citizens; local governments can adopt and enforce riparian and shoreline protections and buffers prescribed under critical areas ordinances and shoreline management plans. These land uses (shown in white in Figure 8) are concentrated along the mainstem Stillaguamish and tributaries and include many miles along the North Fork (all the way to Darrington), and all of the South Fork as far as Granite Falls.

Protection of cool groundwater and tributary inflows

Existing inflows of cool groundwater and tributaries benefit the Stillaguamish and should be protected from potential negative impacts of development. Under the County Comprehensive Plan, lands located within 300 feet of streams designated as Chinook Salmon or Bull Trout corridors and lands within the 100-year floodplain are currently exempted from future development. County and City planning departments should also consider protecting streamside lands with springs and side channels that provide cooler water to the Stillaguamish and its major tributaries.

In September 2001, Ecology conducted an aerial Thermal Infrared (TIR) photographic study of the Stillaguamish. The data (for example, see Figure 9) include aerial photographs paired with corresponding infrared images showing surface temperatures indicated by a color key (on Ecology's web site at: http://www.ecy.wa.gov/apps/watersheds/temperature/).

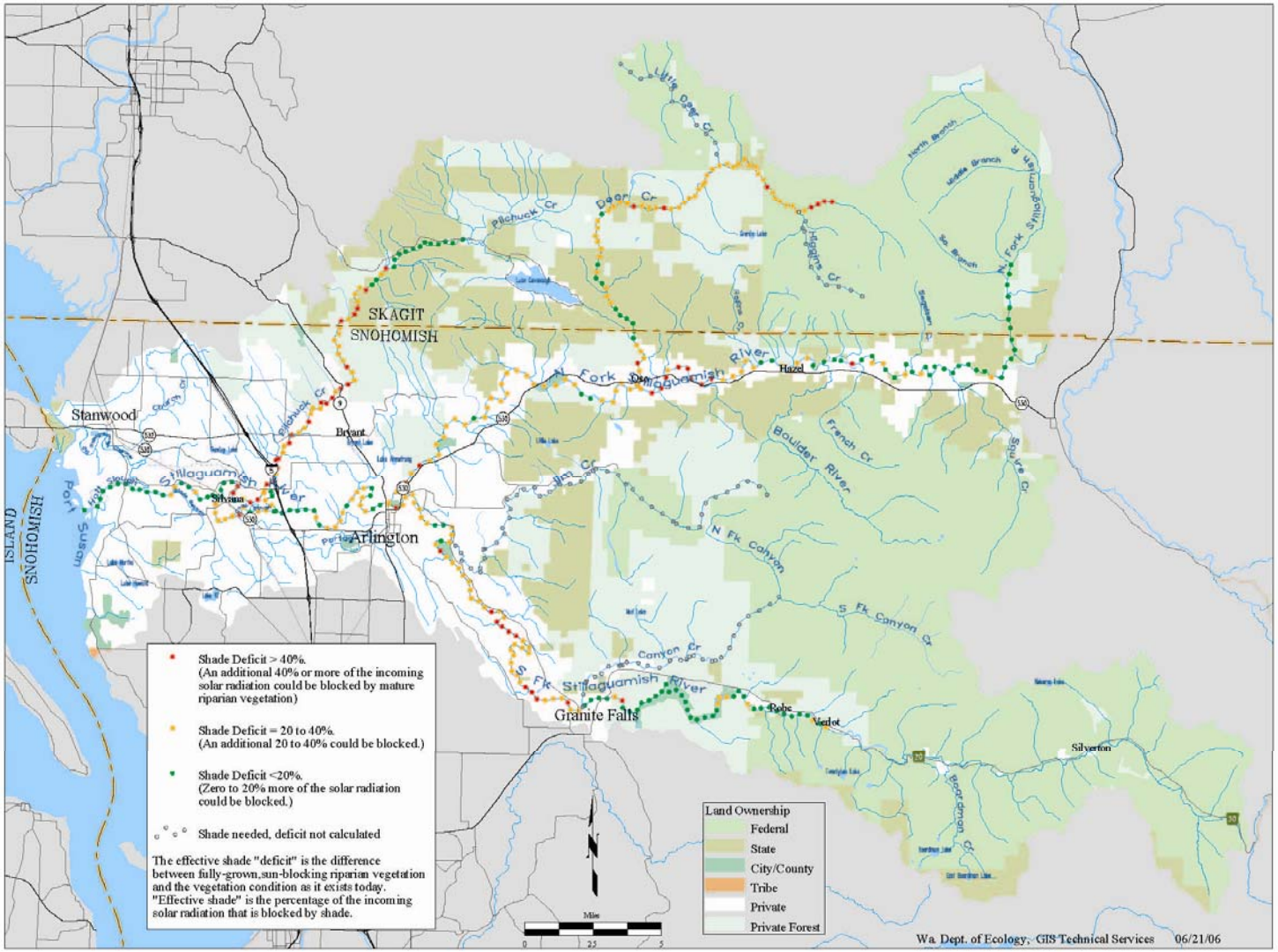

Figure 8. Stillaguamish Watershed: Where Shade is Most Needed

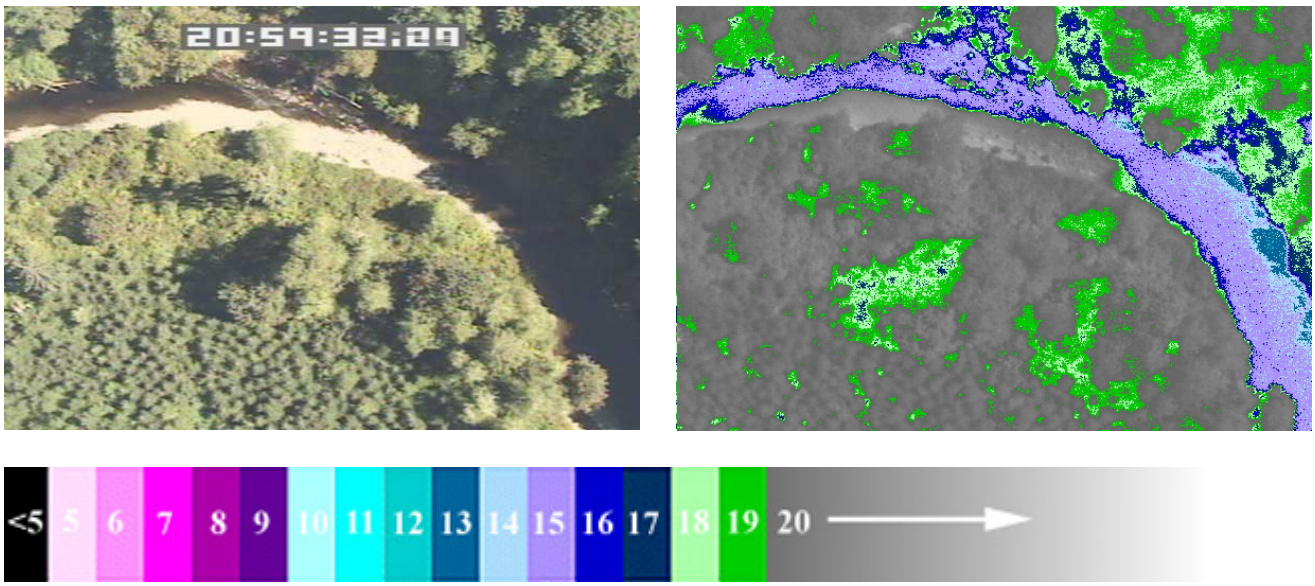

Figure 9. Ecology Stillaguamish TIR study shows a cool pocket in Pilchuck Creek at mile 4.8, left bank

The Stillaguamish TIR data may be useful not only for identifying cool-water-contributing reaches that should be protected but also for finding locations for future riparian and streambed restoration projects. The Stillaguamish Tribe, for example, has consulted these data as it researches good locations for engineered logjams and wood structures.

Projects to improve channel structure

Stream channels are altered by changes in flow frequency and by changes in sediment yield; both can be caused by land-use alterations such as urbanization, grazing, agriculture, forest clearcutting, and others (Dunne and Leopold, 1978). Wider stream channels such as braided streams are more vulnerable to solar warming. Braided stream channels separate and rejoin around gravel bars in a rapidly changing distribution of channels and bars. Braided channel patterns usually develop where flood discharges are high and fluctuate rapidly; where sediment transport rates along the stream bed are high; and where the channel gradient is steep and the stream banks are formed in weak, non-cohesive sand and gravel (Dunne and Leopold, 1978).

Projects which restore natural stream channel meander patterns can enhance hyporheic flow and thus help lower stream temperature regimes. In addition, engineered placement of large woody debris in stream channels creates channel complexity and forms scour pools; improving fish habitat as well as enhancing streambed groundwater inflow to the stream (Booth, 1997; Drury, 1999). For these reasons, projects involving improved channel structure; such as placement of large woody debris and restored meanders, are supported by this TMDL.

Projects involving low impact development

Low impact development (LID) is a stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic pre-development hydrologic functions (PSAT, 2005). Ideally, as a basin is developed, site planning and stormwater management are integrated at the initial design phases of a project to maintain a more hydrologically functional landscape. The goal of LID is to prevent measurable harm to streams, lakes, wetlands, and other natural aquatic systems from residential, commercial, or industrial development sites.

If low impact development approaches are incorporated into developments at inception, stormwater infiltration can be increased, peak flow can be reduced, and excess erosion and sedimentation can be avoided, compared with conventional development design (PSAT, 2005). Because infiltration can in some cases provide cooler groundwater inflow to streams, and because excess riverine erosion and sedimentation contributes to channel widening and warmer stream temperatures, low impact development projects are encouraged for this TMDL.

Stillaguamish River instream flow rule

Ecology is required by law to protect instream flows by adopting regulations and to manage water uses that affect streamflow. To develop an "instream flow rule," which sets for a particular stream the minimum flows needed, Ecology considers existing flow data, stream hydrology and natural seasonal variation in flow, water quality, fish habitat needs, and other factors. An adopted instream flow rule acquires a priority date and water right seniority the same as that associated with a water right. Water rights existing at the time an instream flow rule is adopted are unaffected by the rule and those issued after rule adoption are subject to its requirements.

Instream flows and water withdrawals are managed through regulatory avenues separate from TMDLs. However, stream temperature is related to the amount of instream flow. In a stream, the more flow there is, the less sensitive the water temperature is to the influences of streambed and groundwater temperature, air temperature, and solar radiation. The smaller the flow, the more these external influences determine stream temperature. Because of this relationship, considering stream temperature issues when setting a minimum flow needed during critical times of year is a way to help protect the stream's temperature regime. Having an instream flow rule for a particular stream doesn't mean that it will never exceed the water quality standard for temperature, but it provides some protection against future water rights removing water and changing the stream's natural flow and ability to regulate temperature.

On August 29, 2005, Ecology adopted the Instream Flow Rule for the Stillaguamish River, Chapter 173-505 Washington Administrative Code (WAC). This rule became effective on

September 26, 2005 and established minimum instream flows for 32 rivers and streams in the basin. The rule reserved a limited amount of groundwater for future domestic use, reserved a limited amount of water for stockwatering; established maximum limits for withdrawals from nine water sources; closed certain lakes and ponds to new diversions, except for domestic use; and administratively closed numerous rivers and streams to new uses unless the use qualifies under identified exemptions.

The administrative closures to new water rights were established for Armstrong, Deer, Fortson, Segelsen, Jim, Moose, Squire, Grant, and French creeks from June to November. In addition, the rule reaffirms prior closures for Canyon, Pilchuck, Portage, and Church creeks. The rule does not affect existing water rights, including those who have small wells already in place that are exempt from state permitting requirements and people who receive their supplies from municipal or community water systems. General information about the state's process for establishing instream flows can be found on the web at www.ecy.wa.gov/programs/wr/instream-flows/isfhm.html**.**

Who Needs to Participate?

Tribes, local agencies and Stillaguamish watershed organizations have ongoing programs (see Appendix B for many examples of completed projects) that will assist in making improvements to water quality in the Stillaguamish basin. This section describes the capabilities of each organization to complete on-the-ground water quality projects that will lead to reduced stream temperatures. Each organization has a unique approach to restoration based on its funding sources and its responsibilities for reaching its own goals. And, although there are some opportunities for restoration on public lands, such as at Snohomish County's Portage Creek Wildlife Sanctuary, a great deal of work needs to be done on private property. As a result, organizations with capabilities for conveying a message about the importance of riparian restoration are vital to this effort to recruit more "willing landowners." This section also describes the role of Ecology and EPA in overseeing TMDL development.

Stillaguamish Implementation Review Committee (SIRC)

The Stillaguamish Implementation Review Committee (SIRC) is a watershed-based local stakeholder group established in the early 1990s. The SIRC's mission is to restore and maintain a healthy, functioning Stillaguamish River watershed by providing a local forum in which agencies, organizations, communities and the public can engage in a collaborative watershed-based process of decision-making and coordination. Its initial focus was to oversee implementation of the 1990 Stillaguamish Watershed Action Plan, which included 71 recommendations for controlling non-point pollution in the watershed.

In the mid-1990s, the SIRC added salmon habitat restoration issues to its scope. Since 1999, with leadership from the Stillaguamish Tribe and Snohomish County, the SIRC has served as the local citizens' committee for recommending prioritized lists of salmon habitat restoration projects to the Washington State Salmon Recovery Funding Board. SIRC has final oversight authority for lead entity projects, including salmon habitat project lists and the habitat restoration work schedule.

Currently, the following are member organizations of SIRC:

- City of Arlington
- City of Stanwood
- Clean Water District Advisory Board
- Federation of Fly Fishers
- Mainstem Stillaguamish community
- The Nature Conservancy
- North Fork Stillaguamish community
- South Fork Stillaguamish community
- Pilchuck Audubon Society
- Snohomish Conservation District
- Snohomish County Council
- Snohomish County Surface Water Management

- Stillaguamish Flood Control District
- Stillaguamish Grange
- Stillaguamish Tribe
- Stillaguamish-Snohomish Fisheries Enhancement Task Force
- Twin City Foods
- Tulalip Tribes
- U.S. Forest Service
- Washington Dairy Federation
- Washington Dept of Ecology
- Washington Dept of Fish & Wildlife
- Washington Dept of Natural Resources
- Washington Farm Forestry Association
- WSU Cooperative Extension

In May 2005, SIRC issued the Stillaguamish (WRIA 5) Chinook Salmon Recovery Plan (SIRC, 2005) which recommends an integrated strategy for protecting and restoring Chinook salmon populations. The strategy includes recommendations for habitat restoration projects; compliance and enforcement of existing regulations; policy and regulatory coordination; preliminary commitments and conditions to achieve recovery objectives; monitoring and adaptive management; and public outreach and coordination.

The Chinook Salmon Recovery Plan and Ecology's Stillaguamish Temperature TMDL share a common goal of reducing stream temperatures in many parts of the watershed, because of the critical role cold water temperature plays in the lives of salmonid fishes. Temperature is considered one of several habitat limiting factors contributing to the Chinook salmon population decline. As a result, riparian restoration projects that include planting to block solar radiation, erosion control projects to reduce the river's sediment load, and projects that restore connections with temperature-moderating groundwater, will serve the objectives of both programs.

Clean Water District

The Stillaguamish Clean Water District was established in 1993 by Snohomish County Ordinance 96-080, Title 25 A, to improve drainage, water quality and fish habitat/shellfish beds. This establishment occurred after the state Department of Health indicated, in response to a request, that water quality would not be good enough to open shellfish beds in Port Susan to commercial harvest. Parcels in the district are assessed an annual fee to support the goals of the Clean Water District. Originally called the Lower Stillaguamish Clean Water District, its geographic coverage and fee assessment area were expanded to comprise the full Stillaguamish watershed by action of County Council in January 2005. Currently, 33% of fees are allocated to the Snohomish Conservation District to reduce pollution; 59.1% is allocated to water quality restoration activities administered by Snohomish County Surface Water Management in the Public Works Department, including funding of the Stillaguamish Steward position; and the remaining 7.9% is allocated to County Surface Water Management for local water quality restoration projects that are recommended by the Clean Water District Advisory Board.

Each year, several of the projects undertaken by the Stillaguamish Steward and the Conservation District with funding provided by the Clean Water District are riparian restoration projects on private land and include installation of native vegetation that will provide riparian shade when mature. In addition, the Board of the Clean Water District writes an annual letter of work priorities and recommended actions to the director of Snohomish County Surface Water Management. The annual letter to the director is another opportunity for this temperature TMDL's recommendations for riparian planting and restoration throughout the watershed to be made more visible to County Surface Water Management.

City of Arlington

The city of Arlington borders the South Fork Stillaguamish River and a short extent of the mainstem, totalling about one mile of shoreline. Just below the confluence of the two forks, the city operates a 2-mgd wastewater treatment facility (WWTP) that discharges treated effluent to the river and a drinking water treatment facility serving more than 4,000 connections. Through city efforts, riparian plantings have been installed at 26 sites along a total of about five miles of streambank within the city limits (see completed projects summary, Appendix B).

Arlington has a Critical Areas Ordinance for properties on streams that prescribe a buffer width ranging from 25 to 150 feet depending on land type, land use and whether land use conversion is involved.

Snohomish County Surface Water Management

Snohomish County Surface Water Management (SWM) administers a water quality monitoring program in the Stillaguamish basin and also manages a number of programs that improve water quality. The County has monitored eight sites monthly in this watershed since 1994, and targeted monitoring has been conducted to assess the effect of small farm BMPs and riparian restoration projects. SWM programs that directly benefit water quality in the Stillaguamish watershed include:

- Strong public outreach through educational programs for students, teachers, and the general public. The County has a native plant salvage program that generates hundreds of hours of volunteer time each year in watershed restoration projects. A full-time watershed steward is assigned to work with citizens on riparian restoration, small farm BMPs, and other water quality projects throughout the Watershed (Appendix B).
- A Water Pollution Control Ordinance (Chapter 7.53 Snohomish County Code) in March 1998. The ordinance prohibits the discharge of pollutants to County Streams.
- Water quality monitoring data are available on the internet at http://www.data.surfacewater.info. The County has provided support to the Washington State Department of Health in monitoring South Skagit Bay for bacteria.
- As part of Phase I NPDES Municipal Stormwater Permit requirements, the County identifies and inspects selected storm sewer outfalls in the Stillaguamish watershed, inspects residential stormwater detention facilities, has an illicit discharge detection and

elimination program, maintains its storm sewer system, and identifies and implements drainage infrastructure improvements.

- Co-leadership and support, with the Stillaguamish Tribe, for the Stillaguamish Implementation Review Committee and its goals of increasing salmonid populations and improving water quality throughout the basin.

Under requirements of the Growth Management Act, Snohomish County is updating its Critical Areas Ordinances. The ordinances will include protections for riparian buffers and wildlife habitat along streams and areas of groundwater recharge, such as wetlands, that can influence stream flow and temperature.

Stillaguamish Tribe

The Stillaguamish Tribe Natural Resources Department administers a number of programs that contribute to understanding of, and making improvements to, the watershed conditions that affect salmonid and other fish and shellfish resources of the Stillaguamish watershed and Port Susan. Programs include:

- Leadership and support for the Stillaguamish Implementation Review Committee and its goals of increasing salmonid populations and improving water quality throughout the basin. Writing grant proposals for, and managing, projects involving salmon habitat assessment and riparian restoration.
- Water quality monitoring of Port Susan under a cooperative agreement with the Department of Health to assess conditions for commercial and recreational shellfish harvest.
- Water quality monitoring at a number of locations throughout the watershed, including a study of the effects of a flow enhancing structure on the upstream end of the Old Stillaguamish Channel.
- Certification to negotiate CREP (Conservation Reserve Enhancement Program) contracts with landowners to plant riparian buffers and fence livestock away from streams to prevent or reduce fecal coliform pollution.
- Banksavers Program, a for-profit native plant nursery that maintains native plant nursery stock and manages riparian planting and maintenance projects (Appendix B).
- Operating a smolt trap on the Stillaguamish River to help determine numbers of coho and chinook smolts.
- Operating a hatchery on Harvey Creek.

Snohomish Conservation District

The Snohomish Conservation District (SCD) works throughout Snohomish County and on Camano Island with landowners and livestock owners in developing resource management plans. A principle focus of their work is surface water quality protection. The SCD provides information and services related to riparian and instream restoration, soils, and nutrient management. In addition they may be assisted in providing technical assistance on soil science,

hydrology, forestry, wetlands and engineering by the Natural Resource Conservation Service (NRCS).

The SCD provides technical assistance, farm plans and cost-share funds for the implementation of BMPs using state and federal funding sources. TMDL-related BMPs that are recommended and implemented include: fencing livestock out of streams, improving pasture and nutrient management, installing gutters to keep water away from barnyard areas, composting and storage of manure, and planting riparian buffers. These BMPs help prevent the transport of mud, nutrients and manure to surface waters and improve watershed health overall. The SCD implements riparian restoration through the Conservation Reserve and Enhancement Program (CREP) and conducts water quality monitoring (recent projects – Appendix B).

The SCD has a strong program of education and outreach including well-attended workshops and evening programs on Small Farms Management, Horses for Clean Water, and other topics.

Additional services the SCD is interested in providing, should resources be available, would assist in achieving the goals of this TMDL. These include:

- Sub-basin water quality monitoring coordinated with education and outreach to landowners in the sub-basin
- Focused BMP effectiveness monitoring
- Inventory of farms, including "animal census" information
- New and expanded financial assistance programs for farm planning and BMP implementation

Stillaguamish-Snohomish Fisheries Enhancement Task Force

The Stillaguamish-Snohomish Fisheries Enhancement Task Force is a 501(c) (3) nonprofit corporation based in Everett. The Task Force's mission is to ensure the future of salmon in the Stillaguamish and Snohomish watersheds. Since 1990 it has developed community partnerships and strategies for restoring salmon habitat, and has conducted a number of volunteer planting events and stream restoration projects in the Stillaguamish watershed, including tree planting projects on Portage Creek and Glade Bekken Creek near Silvana and programs to educate landowners about, and control, invasive knotweed. The Task Force brings programs to high school and elementary classrooms, providing hands-on opportunities for youth to learn about salmon and water quality and the importance of good stewardship of both land and water. This outreach helps to educate watershed residents about the importance of good habitat for salmon, and the value of mature native riparian vegetation in improving water quality and salmon habitat.

Tulalip Tribes

The Tulalip Tribes are a sovereign nation with land use authority within their reservation in Marysville. Usual and Accustomed fishing areas include Port Susan and the Stillaguamish River. The Tribes' Water Quality and Fisheries Department has conducted water quality monitoring programs in the watershed and has an interest in targeting priority areas of the

watershed and assessing success of implementation activities. The Tribes have supported a number of water quality, aquatic habitat and fisheries-related studies of the Stillaguamish River watershed.

Department of Natural Resources

The Washington State Department of Natural Resources manages activities on private and State Trust forestlands in the Stillaguamish Watershed. This comprises roughly 40% of the forestland in the watershed. An estimated 25% of this forestland is private, with the remaining 15% under State management. Regulations are in place to protect existing mature riparian vegetation and allow for creation of intact riparian forests where they do not currently exist.

Private forests are subject to regulations outlined in the Forest Practices Rules (Chapter 76.09 RCW) and the Final Forest Practices Habitat Conservation Plan (FPHCP). The Forest Practices Rules are regulations that are adopted by the Forest Practices Board and establish minimum guidelines for timber harvesting activities, including management of riparian forests. Riparian vegetation must remain intact along all perennial streams, and certain silvicultural activities are allowed to accelerate the development of healthy, functioning riparian forests in areas that do not meet minimum standards. The FPHCP is designed to obtain assurances from the National Marine Fisheries Service and U.S. Fish and Wildlife Service that all forest practice activities, when in compliance with the Forest Practices Rules, will fully satisfy federal requirements for protection of aquatic species.

State Trust Lands are subject to the Forest Practices Rules as well as the State Lands Habitat Conservation Plan (HCP). The HCP is a multi-species agreement that ensures management activities on State Trust lands will not result in degradation of habitats that are important for federally listed species. Under these regulations, riparian vegetation is to remain intact on all streams that are an average of 2 feet wide or wider, with minimum buffer widths of 100 feet. All streams except seasonal streams, referred to as Ns, have a minimum 50-foot core zone riparian buffer, and width of the remaining buffer depends on the stream type. Thinning and other activities are allowed outside of the core zone as long as they are consistent with creating a forest stand that will meet desired future condition more rapidly, i.e., grow large wood for potential recruitment into the stream and provide adequate shading and other benefits.

Detailed descriptions of different riparian scenarios are available in the forest practice rules (Timber Harvesting section, 222-30); stream type descriptions are also in the forest practice rules (Definitions section, 222-16) available online at http://www.dnr.wa.gov/forestpractices/rules/. At this time, the buffers are considered no-cut areas; however, in the near future DNR will implement a riparian restoration procedure that will allow selective thinning in the buffer, to create a desired future condition more rapidly. Buffers designated for stream types 1-3 are consistent with the soil productivity of the site and are termed “site index buffers.” These buffers range in size from a minimum of about 150 feet to over 200 feet width. If the buffer is on the windward side of the prevailing winds and wind throw is a concern after field inspection of the stand, an additional 50-foot wind buffer is applied, resulting in a net buffer of 200 or more feet. Type 4 streams (those on average 2 feet wide or wider at ordinary high water mark,

whether or not the stream is perennial) have buffers of 100 feet. Type 5 streams—those less than 2 feet wide--get no buffer.

Ecology

Washington State Department of Ecology has been delegated authority under the federal Clean Water Act by the U.S. EPA to establish water quality standards and enforce water quality regulations under Water Pollution Control Act, Chapter 90.48 RCW. Ecology staff from the Environmental Assessment and Water Quality programs conduct monitoring, analyze data and conduct modeling, and coordinate with local organizations as part of Total Maximum Daily Load projects. Ecology has enforcement authority for NPDES permits and for nonpoint pollution for pasture-based livestock operations. Also Ecology provides financial assistance to local governments, Tribes, and conservation districts for water quality projects. Projects that implement Water Quality Improvement Plans (TMDLs) are a high priority for funding.

U.S. Environmental Protection Agency

The EPA is responsible for reviewing and approving Ecology's TMDLs and enforcement of the Clean Water Act. EPA provides funding for states and tribes to implement the Clean Water Act.

U.S. Forest Service

The upper watershed of the Stillaguamish is part of the Mount Baker-Snoqualmie National Forest, managed under the Northwest Forest Plan, which requires the establishment of Riparian Reserves. Riparian Reserves have special standards and guidelines that restrict activities. The forest is largely managed for recreation and environmental protection. Funds have been limited for addressing road treatments to reduce impacts to streams; as a result, Forest Service staff actively seek grant funds for such projects as inventorying roads that should have access blocked and to obtain additional enforcement support in areas of dispersed camping and recreation. In recent years, through partnerships with Snohomish Conservation District, the Forest Service has treated more than 24 miles of forest roads in the Deer Creek sub-basin. The Forest Service has placed large woody debris jams in Deer Creek, Higgins Creek, and also Little Deer Creek in part to address temperature concerns.

The Forest Service also works to reduce impacts of recreation to riparian areas and is working to prevent invasive knotweed from infesting the upper watershed. One area of infestation in the lower watershed, on the South Fork, has been successfully treated by the Forest Service and Snohomish County Noxious Weed Control.

The Stillaguamish temperature TMDL supports the Forest Service's continued efforts to seek funding for stream-protecting projects and encourages the agency to work creatively on projects to reduce the river's sediment load. If some parts of the popular Gold Basin campground on the South Fork could be relocated, for example, this could open opportunities to reducing some of the sediment input to the river from the Gold Basin landslide as well as potentially increasing public safety.

What is the Schedule for Achieving Water Quality Standards?

The following table is a program of milestones and target dates for developing and implementing the recommendations of this TMDL. This table will be further developed in Volume 3: Water Quality Implementation Plan.

Table 5. Schedule for TMDL milestones and achieving water quality goals

Task	Responsible Organization	Target Date
Pre-DIP review of water quality data/Prioritize actions	Ecology with local organizations	December 2006 (complete)
Preliminary list of riparian improvement projects and activities	Ecology with local organizations	March 2007
Implementation/Restoration and planting	Local organizations	Ongoing
First annual review of water quality data/Review & discuss actions	Ecology with local organizations	April 2007
Water Quality Implementation Plan	Ecology with local organizations	September 2007
Second, 3rd, 4th and 5th annual reviews of water quality data/Review & discuss actions	Ecology with local organizations	April 2008, 2009, 2010, 2011
Effectiveness monitoring	Ecology	To be determined
Measurable reductions in temperature	Ecology	2040 or later
Achieve system potential temperature	Ecology with local organizations	2065

Because it will take many years for a number of planting and riparian restoration projects to be completed, the date for effectiveness monitoring will be determined at an appropriate time in the future.

Reasonable Assurances

Ecology believes that the activities and programs in the Stillaguamish watershed (examples, Appendix B) are already supporting this TMDL and add to the assurance that stream temperatures in the Stillaguamish River watershed will be reduced over time as riparian protection, restoration and planting continue to be implemented.

The following information provides reasonable assurance that the Stillaguamish Watershed water quality goals will be met by 2065. Considerable interest and local commitment to improve and protect water quality and restore salmon habitat in the watershed are evident in these examples:

- The Stillaguamish Tribe has two grants (one a Centennial Fund grant) to address excessive sediment inputs to the North Fork from the Steelhead Haven landslide. A new massive failure occurred in January 2006, pushing material 700 feet south, blocking the river and threatening homes. Emergency work by Snohomish County and the Corps of Engineers made a new channel to save the homes. The Tribe will use the funding for design and construction to provide stabilization, add wood to the river, and reduce sediment input from the slide, which increases the river's shallowing and widening, and exposes it to greater solar heating.

- The Stillaguamish Tribe was awarded grants from the state Salmon Recovery Fund and the National Fish and Wildlife Foundation to support its Bank Savers Project through 2009. This program is one of the principal vehicles for on-the-ground riparian planting and restoration in the watershed (see Appendix B, completed projects).

- Snohomish County is updating the County Shoreline Management Plan for adoption by end of 2006. Planning staff have received a copy of the "Shade Most Needed" map and GIS data documenting the high priority riparian shade locations summarized in Figure 7. The County has also included these priority shade locations as a data layer in the Shoreline Management Plan (K. Stewart, personal communication, 2005) for reference as the County reviews development proposals in the future.
- The SIRC has identified water quality as one of its highest priorities as it seeks to protect and restore salmonid habitat throughout the watershed. Local government agencies and individual citizens are well represented and involved at SIRC meetings and at Clean Water District meetings.
- The Stillaguamish-Snohomish Fisheries Enhancement Task Force is successful in attracting a substantial number of volunteers to planting and other restoration activities and in providing educational programs for schools.
- Snohomish County's Stillaguamish Steward is experienced and successful in outreach to private landowners and increasing participation in riparian restoration projects.
- Snohomish Conservation District (SCD) will continue to provide technical assistance and best management practices implementation for Stillaguamish watershed small farms and agricultural activities. In July 2005 the SCD was awarded Centennial Grant funds to provide

small farm BMP education, including riparian vegetation improvements, in the Harvey-Kackman-Armstrong and March and Fish Creek subwatersheds. Included in the project are funds for water quality monitoring, which will provide an additional informal means of education and outreach to local residents during sampling events. The SCD also has received state Salmon Recovery Funds to control erosion from forest roads in the Segelsen Creek area.

Whenever applicable BMPs are not being implemented and Ecology has reason to believe that individual sites or facilities are causing pollution in violation of RCW 90.48.080, Ecology may pursue orders, directives, permits, or enforcement actions to gain compliance with the state's water quality standards. Ecology will enforce water quality regulations under Chapter 90.48 RCW in pursuit of the objectives of this TMDL. While Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards, it is the goal of all participants in the Stillaguamish watershed TMDL process to achieve clean water through voluntary pollution control actions.

Adaptive Management

Implementation of the Stillaguamish River Watershed TMDL will be adaptively managed such that the listed reaches of the river system will meet the system potential temperature by 2065. Adaptive management could include adjusting best management practices, helping develop and fund water quality projects that address the required temperature reductions, local education initiatives, and other means of conforming management measures to current information on the impairment. If water quality standards are met without attaining the load reductions specified in this document, then the objectives of this TMDL are met and no further reductions are needed. Adaptive management will follow this process:

(1) The Water Quality Implementation Plan will be developed by Ecology with review and participation of local agencies and organizations. It will prioritize locations for addressing water quality problems, assign local responsibility, list activities needed to address the problem, and develop a schedule for the activities.

(2) The Water Quality Implementation Plan will also identify locations within the Stillaguamish watershed where additional monitoring is needed.

(3) Ecology will facilitate an annual review of water quality data and implementation activities with participation by local organizations and agencies, including Snohomish County Surface Water Management, the Stillaguamish and Tulalip Tribes, the City of Arlington, Snohomish Conservation District and other partner organizations. A summary spreadsheet will be developed to assist in implementation tracking. It is expected that some activities, such as education and outreach programs, will be County-wide or watershed-wide.

(4) Adjustments will be made to the Water Quality Implementation Plan, based on annual review of water quality data and activities, to ensure that sampling locations and activity priorities continue to be effective. The updated Water Quality Implementation Plan will be made available to local organizations so that programs and grant applications can be adjusted to reflect changes in priority locations and actions and identified education and outreach needs.

(5) Priority locations for riparian restoration and assessing project effectiveness, and milestones for accomplishing planting will be developed in the Water Quality Implementation Plan. It will take years to develop evidence that additional shade is contributing to a cooler temperature regime, and thus assessment in the initial years will focus on appropriate measures such as miles of stream planted, percent survival of plants after five years, or average stand height.

(6) Effectiveness monitoring of water quality (stream temperature) by Ecology will be scheduled for an appropriate future year when temperature reductions are expected to be measurable. The long term monitoring stations maintained by Ecology (see Monitoring Strategy section below) may prove to be sufficient to document changes and adaptively manage implementation. The decision to schedule effectiveness monitoring will depend on best professional judgment that measurable improvement in water quality has occurred, based on the annual review of water quality and implementation activities.

Summary of Public Involvement Methods

In 2000 through 2006, Ecology held a number of meetings for local stakeholder organizations and citizen representatives to involve them in developing the Stillaguamish Temperature TMDL. A news release in August 2004 about publication of the TMDL study resulted in a visit to the watershed to view restoration projects by Seattle Times reporter Christopher Schwarzen, whose article, "Bacteria, other pollutants in Stillaguamish targeted," was published September 9th, 2004.

The draft TMDL Implementation Strategy was circulated for local organization review in November 2004 and a revised draft circulated in May and June 2006. A public meeting was held on November 9, 2004, at Pioneer Museum in Arlington, to present the Implementation Strategy for the Temperature TMDL. Public notice for the commencement of the public comment period and public meeting consisted of a mailed Focus Sheet and legal advertisement in the Arlington and Everett newspapers on November 3, 2004.

In addition to TMDL-specific public meetings, Ecology's TMDL regional lead participates in regular meetings of the SIRC, the Stillaguamish Clean Water District Advisory Board, and the Stillaguamish lead entity Technical Advisory Group. Ecology participation in Stillaguamish Tribe's Festival of the River (annually in August) and Snohomish County Park Department's Discovery Day at Portage Creek (annually in July) have provided opportunities to acquaint the public with Ecology TMDL goals for this watershed and the need for riparian restoration to reduce stream temperature and improve salmon habitat.

Ecology's Response to public comments on draft Volume 2 is provided in Appendix A.

Potential Funding Sources

The Centennial Clean Water Fund, Section 319 grants under the federal Clean Water Act, and State Revolving Fund loans are available to fund activities by jurisdictions to help implementation of the TMDL. For example, both CCWF and funds from the Salmon Recovery Funding Board in 2004 were awarded to the Stillaguamish Tribe for the Steelhead Haven Landslide Project which will reduce sediment loading and protect the river from the shallowing and widening (causing increased exposure to solar radiation) effects of this landslide. Non-governmental organizations can apply for 319 grant funding. Should additional funding be necessary to reach standards, Ecology will work with the local organizations to prepare appropriate scopes of work, to implement this TMDL, and to assist with applying for grant opportunities as they arise.

The Puget Sound Water Quality Action Team administers Public Involvement and Education grants. The Conservation District provides technical assistance and BMP cost-share funding using local (Clean Water District), state and federal funds, as available. The Stillaguamish Tribe and the Conservation District write CREP plans and work with landowners to get riparian buffers installed with funds from the Farm Service Agency and the Washington Conservation Commission. The federal Natural Resources Conservation Service provides some technical assistance and also administers the Environmental Quality Incentive Program (EQIP), which provides cost share funds for BMPs on agricultural sites. Stream restoration activities are eligible for salmon restoration grants through various sources, including the Salmon Recovery Funding Board.

The Stillaguamish Clean Water District is supported through a fee assessment on watershed property owners for projects related to drainage and improved water quality in Port Susan. Besides the portion administered by Snohomish County Surface Water Management for drainage and other improvement projects, some Clean Water District fees go to Snohomish Conservation District (above paragraph); also a Discretionary Fund of approximately $45,000 is available annually for on-the-ground projects to improve water quality and aquatic habitat. The Clean Water District Citizens Advisory Board is charged with reviewing grant applications for these funds.

Monitoring Plan

EPA (1991) guidance calls for a monitoring program for evaluating progress on TMDLs. Monitoring is important for assessing the progress or success of implementation measures based on the total maximum daily load (TMDL) recommendations. Post-implementation monitoring is required in the TMDL process to ensure that water quality standards are being attained and that implementation measures are effective. If water quality standards are not met after the TMDL has been established, then adjustments to the load and wasteload allocations may be required, or implementation activities may require modification.

Successful TMDL evaluations require several types of monitoring data. Water quality, aquatic resources, land use, and implementation activity data are needed to evaluate the progress and effectiveness of the TMDL. The details of the location, type, and timing of data collection and TMDL compliance schedule will be provided in the Water Quality Implementation Plan (Volume 3).

Recommendations for Monitoring

To determine the effects of management strategies within the Stillaguamish River watershed, regular monitoring is recommended. Continuously-recording water temperature monitors should be deployed from July through September to capture the critical conditions. The following locations are suggested for a minimal sampling program:

- Stillaguamish River at Norman Road
- South Fork Stillaguamish River near mouth
- North Fork Stillaguamish River near mouth
- Deer Creek near mouth
- Pilchuck Creek near mouth

Shade management practices involve the development of mature riparian vegetation, which requires many years to become established. Interim monitoring of water temperatures during summer is recommended, and could be as infrequent as five-year intervals because of the long time needed to establish riparian vegetation. Interim monitoring of the composition and extent of riparian vegetation is also recommended (for example, by using photogrammetry or remote sensing methods).

Methods to measure effective shade at the stream center in various segments for comparison with the load allocations could employ hemispherical photography, angular canopy densiometers, or solar pathfinder instruments.

Initial Monitoring Needs

The detailed Water Quality Implementation Plan, to be developed by Ecology with review and participation of local agencies and organizations, will prioritize locations for addressing water

quality problems, assign local responsibility, list cleanup activities needed to address the problem, and develop a schedule for activities.

Ecology will facilitate an annual review of water quality data and cleanup activities with participation by local organizations and agencies, including Snohomish County Surface Water Management, the Stillaguamish and Tulalip Tribes, the city of Arlington, Snohomish Conservation District and other partner watershed organizations. The changes in land use and the measures used to reduce the impact of land uses on water quality should be inventoried, evaluated, and tracked. This will require assistance from partner organizations such as Snohomish County because the County GIS database includes such information.

Ecology will track implementation through the annual review or through individual consultation with the responsible organization. A summary spreadsheet will be developed to assist in tracking. Provided resources are available, the summary spreadsheet will be linked to a GIS map tool to locate cleanup activities as appropriate. Activities such as education and outreach programs that would apply County-wide or watershed-wide will be tracked only on the spreadsheet.

Organizations with Water Quality Monitoring Programs

Organizations with capability and experience in monitoring water quality in the Stillaguamish watershed include:

- Snohomish County Surface Water Management
- Stillaguamish Tribe Natural Resources Department
- City of Arlington
- Tulalip Tribes
- Stillaguamish-Snohomish Fisheries Enhancement Task Force
- Snohomish Conservation District

Ongoing water quality monitoring in the basin is conducted by Snohomish County Surface Water Management and the Stillaguamish Tribe. Ecology long-term river monitoring stations are located at the following sites:

- Stillaguamish River near Silvana (05A070)
- South Fork Stillaguamish River at Arlington (05A090)
- South Fork Stillaguamish River near Granite Falls (05A110)
- North Fork Stillaguamish River at Cicero (05B070)
- North Fork Stillaguamish River near Darrington (05B110)

Next Steps

Once the TMDL has been approved by EPA, a more detailed *Water Quality Implementation Plan* for Stillaguamish Temperature will be developed over the next two years. Ecology works with local organizations, Tribes, and agencies to create this plan, choosing the combination of possible solutions thought to be most effective in the watershed. Elements of this plan will include: the parties responsible for programs, projects and activities, the plan for evaluating effectiveness, targets that will be used to assess progress, and potential funding sources.

This Temperature TMDL shares a goal with the Stillaguamish Chinook Salmon Recovery Plan: to reduce critical season stream temperatures to provide better habitat for cold water aquatic species. Besides Ecology's commitment to this plan, the commitment of Stillaguamish Implementation Review Committee member organizations to salmon recovery and to address the limiting factor of warm stream temperature to salmon recovery will help ensure success.

References

Ahmed, A. 2006. *Mixing zone study: City of Arlington STP*. June 14, 2006 memorandum from Anise Ahmed, P.E., Ecology Environmental Assessment Program, to Sally Lawrence and Mike Dawda, Ecology Water Quality Program. Lacey, Washington.

Arlington. 1997. Appendix D: Effluent Dilution and Discharge Requirements Study. Appendix D of Wastewater Treatment Plant Engineering Report. City of Arlington, Washington. March 1997.

Beechie, T. B. Collins, and G. Pess 2001. *Holocene and Recent Geomorphic Processes and Salmonid Habitat in Two North Puget Sound River Basins*, pp.37-54, in: Geomorphic Processes and Riverine Habitat, Water Sciences and Applications Vol.4.

Booth, D. B., 1997. *Geology and Geomorphology of Stream Channels*, Course Manual by D.B.Booth with B.Collins, D.Montgomery, and S.Perkins, University of Washington Center for Urban Water Resources Management, January 1997, 282 pp.

Collins, B., 1997. *Effects of Land Use on the Stillaguamish River, Washington, 1870 to 1990: Implications for Salmonid Habitat and Water Quality and their Restoration*. December 1997. Report to Stillaguamish Tribe of Indians Department of Natural Resources, Arlington WA. 76 pp plus appendices.

DNR. 2005. Final Forest Practices Habitat Conservation Plan. December 2005. Washington Department of Natural Resources, Olympia.. 274 pp.

DNR. 1999. Forests and Fish Report.Forest Practices Board. April 29, 1999. Washington Department of Natural Resources, Olympia.
http://www.dnr.wa.gov/forestpractices/rules/forestsandfish.pdf.

DNR. 1997. Final Habitat Conservation Plan. September 1997. Washington Department of Natural Resources, Olympia. 212 pp.

Drury, T.A., 1999. *Stability and Pool Scour of Engineered Log Jams in the North Fork Stillaguamish River, Washington.* Civil Engineering Master of Science thesis, University of Washington Dept.of Civil and Environmental Engineering, 62 pp.

Dunne, T. and L.B. Leopold. 1978. *Water in Environmental Planning*, W.H. Freeman and Company, San Francisco. 818 pp.

Earth Tech. 1996. Engineering report: wastewater treatment plant expansion, City of Arlington, Washington. Prepared by Earth Tech, Bellevue, WA.

Ecology. 2005. Water Quality Program Permit Writers Manual. Originally published 1989, revised 2005. Washington State Department of Ecology, Olympia,WA.

http://www.ecy.wa.gov/biblio/92109.html
Ecology. 2005. *Washington's Water Quality Management Plan to Control Nonpoint Source Pollution*, Washington State Department of Ecology, Water Quality Program, Olympia, WA 98504-7710, March 2005.

Ecology. 2004. *Stillaguamish River Watershed Temperature Total Maximum Daily Load Study*. Greg Pelletier and Dustin Bilhimer. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Publication No. 04-03-010.

Ecology. 2002. *Evaluating Standards for Protecting Aquatic Life in Washington's Surface Water Quality Standards Temperature Criteria Draft Discussion Paper and Literature Summary.* Mark Hicks, Water Quality Program, Washington State Department of Ecology, Olympia, WA. Publication No. 00-10-070. Available online at: http://www.ecy.wa.gov/biblio/0010070.html

Ecology. 2001. *Stillaguamish River Temperature Total Maximum Daily Load: Quality Assurance Project Plan*. Greg Pelletier and Dustin Bilhimer, Environmental Assessment Program, July 30, 2001. Publication No. 01-03-066.
http://www.ecy.wa.gov/biblio/0103066.html.

Ecology. 1994. *Watershed Approach to Water Quality Management: Needs Assessment for Skagit/Stillaguamish Watershed.* June 1994. Prepared by S. Messman, G. Dorf, B. Duffy; Northwest Regional Office Water Quality Program.

EPA. 1998. Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program. The National Advisory Council For Environmental Policy and Technology (NACEPT). U.S. Environmental Protection Agency, Office of the Administrator.
EPA 100-R-98-006.

EPA. 1997. *Memorandum of Agreement Between the USEPA and Washington State Department of Ecology Regarding the Implementation of Section 303(d) of the Federal Clean Water Act*, U.S. Environmental Protection Agency, 1997, 22 pp.

EPA. 1991. Guidance for Water Quality-based Decisions: The TMDL Process.
U.S. Environmental Protection Agency. EPA 440/4-91-001.

Knight, K. 2004. Personal communication (email) to S. Lawrence, Washington Dept. of Ecology, Oct. 22, 2004. Kris Knight, Restoration Site Supervisor, The BankSavers Project, Stillaguamish Tribe of Indians, Arlington, WA.

ODEQ. 2001. Tools 3.0 User Manual. Oregon Department of Environmental Quality, Portland, OR. http://www.deq.state.or.us/wq/TMDLs/WQAnalTools.htm.

Pess, G.R., B.D. Collins, M. Pollock, T. J. Beechie, A. Haas, and S. Grigsby. 1999. Historic and current factors that limit Coho salmon *(Oncorhynchus kisutch*) production in the Stillaguamish River basin, Washington state: Implications for salmonid habitat protection and restoration. Prepared for Snohomish County Department of Public Works, Everett, WA, and the Stillaguamish Tribe of Indians, Arlington, WA.

PSAT. 2005. *Low Impact Development Technical Guidance Manual for Puget Sound*, Puget Sound Action Team and Washington State University-Pierce County Cooperative Extension, January, 2005, 247 pp

Purser, M.D., R. Simmonds, S. Brunzell, and D.D. Wilcox. 2003. Classification and analysis of 2001 land cover: Snohomish County, WA. Snohomish County, Department of Public Works, Surface Water Management, Everett, WA. www.co.snohomish.wa.us/publicwk/swm/publications/2003-02LandCoverAsOfAug2001/+Index.html.

Randolph, D. 2005. Personal communication, June 25, 2003 and December 16, 2005 from David Randolph, City of Arlington Wastewater Treatment Plant Operations Manager. Excel files with effluent temperature data for WWTP treated effluent discharge.

SIRC. 2005. *Stillaguamish Watershed Chinook Salmon Recovery Plan.* Final Plan. June 2005. Prepared by Jones & Stokes, Bellevue, WA for Stillaguamish Implementation Review Committee (SIRC) and Shared Strategy for Puget Sound.

Stewart, K., 2005. Personal communication, March 18, 2005. Phone conversation regarding Snohomish County Shoreline Management Planning process use of "Shade Most Needed" map figure for the Stillaguamish Watershed.

Stienbarger, D., 1995. Inventory and evaluation of livestock operations and the potential for non-point pollution in the Stillaguamish Clean Water District. Snohomish Conservation District, Everett, WA. 26 pp.

Thornburgh, K., 1996. Snohomish County: Ambient water quality monitoring: Summary report for 1992-1995. Snohomish County, Department of Public Works, SurfaceWater Management, Everett, WA.

Thornburgh, K., 1995. Water quality monitoring in the Stillaguamish clean water district: Results of surface water management monitoring: 1994-1995. Snohomish County, Department of Public Works, Surface Water Management, Everett, WA.

USDA Forest Service and USDI Bureau of Land Management. 1994. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl*. Portland, Oregon. 73p.

USGS. 1999. Washington Land Cover Data Set. U.S. Geological Survey. http://edcwww.cr.usgs.gov/programs/lccp/nationallandcover.html

Washington Conservation Commission. 1999. Salmon and Steelhead Habitat Limiting Factors Analysis for the Stillaguamish Watershed (WRIA 5).

Glossary and Acronyms

303(d) List: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

7Q10: The lowest 7-day average flow that occurs on a frequency of once in 10 years.

Best Management Practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

cfs: cubic feet per second.

Chronic Dilution Factor: An estimate of the amount of dilution for a facility's effluent, calculated using approved models for specific conditions of discharge and receiving water flow. The chronic dilution factor is calculated for situations in which exposure to an effluent constituent over an extended period of time (chronic exposure) would result in injury or death to an organism.

Clean Water Act (CWA): Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the CWA establishes the TMDL program.

Critical Conditions: The physical, chemical and biological characteristics of the receiving water environment that produce the greatest potential adverse impact of the listed parameter on aquatic biota and existing or characteristic uses. For steady-state discharges to riverine systems, the critical conditions may be assumed to be equal to the 7Q10 flow event unless otherwise determined by Ecology.

Designated Uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Effective Shade: The fraction of incoming solar shortwave radiation that is blocked from reaching the surface of a stream or other defined area.

Existing Uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of nonself-replicating introduced native species, do not need to receive full support as an existing use.

Hyporheic Zone: The volume of saturated sediment beneath and beside streams and rivers where ground water and surface water mix.

Load Allocation (LA): The portion of a receiving waters' loading capacity designated by the TMDL for one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading Capacity: The greatest amount of a pollutant loading that a water body can receive and still meet water quality standards.

Margin of Safety (MOS): Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

mgd: million gallons per day

Mixing Zone: That portion of a water body adjacent to an effluent outfall where mixing results in the dilution of the effluent with the receiving water. Water quality criteria may be exceeded in a mixing zone as conditioned and provided for in WAC 173-201A-100.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, the municipal separate storm sewer systems of medium and large cities and counties, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Natural Conditions: Surface water quality that was present before any human-caused pollution.

Nonpoint Source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Phase I Stormwater Permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres.

Phase II Stormwater Permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point Source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or

odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface Waters of the State: Lakes, rivers, ponds, streams, inland waters, saltwaters, wetlands and all other surface waters and water courses within the jurisdiction of the state of Washington.

System Potential Temperature: An approximation, estimated by stream temperature modeling, of the summertime maximum temperatures that would occur under a specific set of natural conditions.

Total Maximum Daily Load (TMDL): An estimated quantity of a substance in a water body that permit it to meet water quality standards. A TMDL is equal to the sum of: 1) individual wasteload allocations (WLAs) for point sources, 2) the load allocations (LAs) for nonpoint sources, 3) the contribution of natural sources, and 4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth may also be provided.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitutes one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a lower elevation central collector such as a stream, river, or lake.

Appendices

Appendix A. Record of Public Participation

Introduction

Development of the Stillaguamish TMDL for temperature has its origin in the Stillaguamish Watershed Action Plan (January 1990). This "Non-Point Action Plan" was developed under WAC 400-12 under a Centennial Fund grant to Snohomish County. To provide for strong public involvement in development of the watershed plan, a Citizens Advisory Committee was formed. Now, renamed the Stillaguamish Implementation Review Committee (SIRC), the committee is the lead entity for salmon restoration planning in the watershed and has continued to provide strong support for and coordination of water quality improvements.

Ecology's TMDL process in the Stillaguamish includes the milestones listed below, followed by approximate dates for completing the TMDL in 2007:

June 1994—Ecology Water Quality Needs Assessment for Skagit/Samish/Stillaguamish Watersheds identified a "Lower Stillaguamish & Portage Creek TMDL for DO, turbidity and FC" as a medium priority future project (Ecology 1994)

March 2000—Pre-TMDL Assessment completed

2001—Quality Assurance Project Plans completed for Temperature TMDL study (July) and for Fecal Coliform, Dissolved Oxygen, pH, Arsenic and Mercury TMDL study (December).

June 2000 – June 2002—Data for TMDLs based on water quality sampling by Ecology with additional data provided by the Stillaguamish Tribe and Snohomish County Surface Water Management. Aerial surveys of Stillaguamish Watershed for infrared sensing of water temperature on Sept. 7 and 8, 2001.

2003 and 2004—Analysis of TMDL data. Computer models used to model effects of changes in riparian vegetation, water withdrawals, channel width changes and riparian microclimate changes on stream temperature under critical low flow conditions.

2003 and 2004—Watershed meetings on progress of the TMDL study

November 4, 2004—Draft Summary Implementation Strategy distributed by email to watershed advisory group, local agencies, Tribes and made available online at Ecology's WRIA 5 TMDL website.

November 9, 2004—Public meeting on Draft TMDL Summary Implementation Strategy (Water Quality Improvement Report).

December 17, 2004—Public comment period closed.

May - June 2006 - Revised Draft Stillaguamish River Watershed Temperature Total Maximum Daily Load – Water Quality Improvement Report distributed by email to watershed advisory group, local agencies, Tribes, and made available online at Ecology's TMDL website.

June 2006—TMDL Water Quality Improvement Report to be submitted to EPA for approval.

2007—TMDL Water Quality Implementation Plan to be developed by Ecology with watershed organizations

Summary of comments and responses

Comments on Temperature TMDL received during the public review period November 9 – December 17, 2004, are paraphrased below, followed by Ecology's responses. Many comments were addressed by adopting recommended text changes in this Submittal Report; those that were not, are included here. Responses to comments on the Instream Flow Rule Presentation for the Stillaguamish River watershed were provided by Water Resources Program, Ecology Northwest Regional Office. More recent comments on the revised draft distributed May-June 2006 are also addressed either by adopting recommended text changes or through a response in this section.

Comment: Recommendations in the plan that discuss pollutants other than bacteria, dissolved oxygen, or temperature, or any recommendations that discuss nutrients, are inappropriate.

Response: Temperature, fecal coliform, and dissolved oxygen were the major pollutants evaluated in the Stillaguamish River Watershed TMDL studies. However, nutrients, pH, arsenic, mercury, suspended sediment, channel structure, riparian conditions, and instream flows were all discussed in the temperature and conventional contaminants TMDL technical documents. Nutrients were specifically discussed in their relation to dissolved oxygen and pH conditions in the Stillaguamish River mainstem and its two major forks in the conventional contaminants report. Suspended sediment reductions were recommended to reduce mercury and arsenic concentrations in the convention contaminants report, and to reduce temperatures from channel filling and bank erosion (channel widening) effects in the temperature report**.**

Comment: References to retirement or purchases of water rights are inappropriate in a TMDL for bacteria, oxygen and temperature. In addition, the previous page notes that groundwater may deplete dissolved oxygen in surface waters.

Response: Increasing seasonal instream flows by retirement or purchase of water rights are reasonable measures to help improve stream temperature. Larger volumes of water take longer to heat and thus are less vulnerable to thermal loading as they flow downstream. In addition, groundwater inflows can provide relatively cool water during the warmer seasons. Depletion of surface water oxygen concentrations from groundwater inputs does not occur in all situations and is typically compensated for by stream movement. Not all groundwater has depressed oxygen concentrations, and some stream channel geometries allow quick re-aeration of groundwater.

Comment: References to sediment as a pollutant in the TMDL are not appropriate.

Response: Sediment control measures are mentioned in the context of improving instream temperatures. The temperature TMDL technical report demonstrated that channel geometry is an important factor for instream temperatures in the Stillaguamish River watershed. Bank erosion widens channels, reduces the effectiveness of riparian shading, and adds excessive sediment to the stream channel. Excessive sedimentation of channels reduces hyporheic exchange (i.e., introduction of subsurface groundwater) by impeding vertical hydraulic gradients.

The Fecal Coliform and Dissolved Oxygen TMDL (Ecology April 2005) addresses arsenic and mercury in the watershed as well as fecal coliform bacteria, pH and dissolved oxygen. The analysis demonstrated that arsenic and mercury tend to be associated with sediment particles; measures that reduce the overall sediment load in the river are recommended for their effect in reducing arsenic and mercury as well.

Comment: Under section titled "Identified Needs and Early Action Proposals," remove reference to County involvement with the in-stream flow rule. It is not clear that Snohomish County has any obligations under the Instream Flow rule that would tie County actions to reductions in stream temperature. Similarly, it is inappropriate to include County Planning Department under "Agency Policy or Program Changes that Could Help Achieve TMDL Goals."

Response: Reference to the Stillaguamish Instream Flow rule, which has its own regulatory process, has been modified in this Temperature TMDL Water Quality Improvement Report (Submittal Report). We have changed this to a general recommendation for approaches such as flow augmentation and voluntary retirement or purchase of water rights that could increase available flow during low flow season.

Comment: Under section titled "Identified Needs and Early Action Proposals", under highest priorities for reducing stream temperatures, the third bullet states that the connection between excessive sediment load and warming stream temperatures is not direct. References to sediment should be deleted from this cleanup plan. Degradations that are vital to fish habitat can be included in other planning efforts. This bullet should be deleted.

Response: Refer to the response above regarding sediment. Sediment control is necessary to improve instream temperature regime by controlling channel widening and bed sedimentation.

Comment: The TMDL addresses only problems associated with low flows and salmon, and ignores problems associated with high flows.

Response: The TMDL study includes an analysis of the seasonal variation and critical conditions associated with periods of more frequent or higher exceedances of water quality standards. Efforts that address excess sedimentation and erosion, and projects that add channel complexity, will also help with temperature problems associated with high flow conditions.

Comment: Doesn't mature riparian canopy have a significant impact on cooling smaller channels such as Streams Type 3, 4 and 5 as opposed to 1 and 2? Would this effect of mature canopy make the Instream Flow Rule less important?

Response: It is true that the same width buffer consisting of mature riparian canopy would be relatively more effective in cooling smaller streams compared with larger streams. The riparian vegetation recommendations of the Stillaguamish Temperature TMDL are designed to reduce water temperatures; their ability to protect flow or increase flow was not addressed in this analysis.

Comment: Has the instream flow rule already been established?

Response: The Stillaguamish Instream Flow Rule became effective on September 26, 2005.

Comment: The Instream Flow Rule has significant implications for Arlington's current and future water rights and perhaps for its wastewater operations. Please clarify that domestic uses identified in the draft TMDL Strategy apply only to unincorporated areas and not municipalities. (Similar comment from both City of Arlington and Snohomish County Planning.)

Response: The Department of Ecology appreciates the concerns expressed by the City of Arlington and Snohomish County. We recognize and support the City's intent to make full use of existing water rights. We also note the Instream Flow Rule does not impact existing rights. The Rule will preclude future water diversion from lowering the instream flow below the established minimums, which in turn will support the TMDL objectives. Ecology agrees with the City that the Instream Flow Rule will affect how cities, special purpose districts, and private citizens obtain water rights for public water supply in the future. The Instream Flow is a water right, and like any new water right, will have implications for future use from that source.

The domestic uses identified in the draft TMDL strategy apply only to unincorporated areas. The domestic use referenced is the residential and small business reservation to meet basic human needs in the Instream Flow Rule. Use of water under the reservation will be in the rural areas and not in areas served by existing public water systems.

Comment: Ecology states that forested areas comprise 82% of the watershed. Only about two-thirds of the land use designation shown as forest has trees greater than 27 years old which are capable of providing adequate shade. If this estimate is based on the land use designation of forest, the shading potential is over-estimated.

Response: The shading potentials are not based on land use designations. The height and density of trees for potential maximum riparian vegetation was estimated based on the description of the historically mixed deciduous and coniferous species in the floodplain (Pess et al., 1999) and was assumed to be represented by an average tree height of 45 meters (about 150 feet) and canopy density of 85 percent. The estimated characteristics were selected to represent a mid-range for mature vegetation from the values presented by Pess et al. (1999).

Comment: The data used to develop the table must be referenced. The existing shade condition has been overestimated if this estimate is based on the land use designation of forest (see previous comment). From values reported, it appears that the Snohomish County data have been used and may have been misinterpreted. If hydrologically mature total forest cover values were used, the shading provided may be overestimated since vegetation in this cover class is just greater than 27 years old. The nearstream forest cover percentages in Table 2 include areas with

vegetation that is too young to be providing shade. The calculated values of nearstream total forest cover include the cover classes of Mature Evergreen Forest (< 100 years old), Medium Evergreen Forest (27-100 years old in 2001) and Deciduous Stands. Other evergreen and deciduous trees and shrubs were included in the Small Trees and Shrubs cover class (Purser, et al. 2003). Thus, a particular age could be selected as the age of a shade cover-providing stand. The Medium Evergreen Forest could then be divided into a shade cover-providing component and a component that does not provide shade cover using a linear estimation. That part that does not provide shade can be subtracted from the nearstream total forest cover values to better estimate 2001 shade cover. This would not be spatially explicit, however, it could be randomly distributed within the Medium Evergreen Forest.

Response: See response to previous comment.

Comment: The section describing the water quality criteria should be expanded to provide the supporting information such as the stream reaches under question and their classification, and the assumed or modeled natural condition. This information is needed to clarify the basis for assuming that there is assimilative capacity above the criterion or "natural" condition (pp 13, 14).

Response: New table added to the section describing the water quality criteria. In addition, Volume 1 of this TMDL (the TMDL study; Ecology 2004) provides detailed results of the modeled system potential temperature for the mainstem Stillaguamish; South Fork; North Fork; Deer Creek; and Pilchuck Creek (pp. 65-69).

Comment: The analysis of the current impact of the Arlington Wastewater Treatment Plant should be made more explicit by identifying terms of the equations, identifying data sources, and justifying the assumed "natural" condition. The data reported on page 14 show the effluent discharge temperatures to average 23.9 degrees C. The threshold of lethality for salmon given on page 9 is 23 degrees C. Ecology does not explain how Arlington's discharge of effluent that results in stream temperatures in excess of known preference ranges of Endangered Species Act-listed Chinook salmon in part or all of the mainstem Stillaguamish River during migration is consistent with the objectives of the TMDL. It would appear that the assimilative capacity of the river has been used up by human sources of thermal pollution and therefore no incremental warming criterion should apply.

The document states on p. 33 that this TMDL shares a goal with the Stillaguamish Chinook Salmon Recovery Plan to reduce critical season stream temperatures to provide better habitat for cold water aquatic species. Allowing WWTP effluent at temperatures higher than those acknowledged to be lethal to salmon is not consistent with the salmon recovery plan and does nothing to reduce critical season stream temperatures to provide better habitat for cold water aquatic species. The proposed doubling of the facility could pose a significant impact to salmon.

We propose that monitoring be conducted at the end of the mixing zone to determine if permit conditions are being met. We also propose that monitoring be conducted across the channel within the mixing zone to determine if the high temperatures extend across the river, creating a thermal barrier to salmon. The extent of the river impacted by the mixing zone needs to be discussed relative to the impacts on listed endangered species.

Response: More information and citations have been added to the section describing the derivation of Wasteload Allocation for Temperature for the Arlington WWTP.

- Ecology's development of a Wasteload Allocation for Arlington's WWTP is based on sections of the Water Quality Standard (WAC 173-201A-100) which describes the conditions under which a Mixing Zone may be allowed.
- It is not appropriate to calculate an average for the effluent discharge temperature based on the two maxima (maxima for two different years) cited in the text. The appropriate critical condition effluent temperature for comparison with potential permit limits is a 7-day average of daily maximum temperatures. For 2004, this was 23.5^{o}C.
- The threshold for lethality of 23^{o}C is based on chronic exposures. Scientific literature supporting Ecology's proposed temperature standards is summarized in Ecology (2002), *Evaluating Standards for Protecting Aquatic Life in Washington's Surface Water Quality Standards Temperature Criteria Draft Discussion Paper and Literature Summary,* available online at: http://www.ecy.wa.gov/biblio/0010070.html. The acute criterion of 33^{o}C is used for short term exposures expected for migrating salmon passing in or near a wastewater treatment plant's effluent discharge.
- Washington's Water Quality Standards allow for mixing zones. Text added.
- Monitoring. This is an appropriate element of the NPDES permit for the Arlington WWTP. Arlington has been voluntarily monitoring its effluent temperature at the point of discharge for three to four years. During the next permit cycle (2008), the temperature issue will be fully evaluated, and at that time it will be determined whether temperature monitoring in the river will be necessary. If required, this monitoring would be to assure compliance with the Water Quality Standards and to assure that the boundaries of the mixing zone are not exceeded. Also, such monitoring would likely be limited to the critical time of year.

Comment: p. 26, Reasonable Assurances. The fact that organizations are planting riparian areas does not necessarily provide assurance that the effort will be sufficient to de-list streams when many of the reaches are being planted in average widths of 30 feet or less. Landowners willing to volunteer their sites for planting are not always located in the areas where new riparian forest is needed for the temperature TMDL. Ecology should identify the specific reaches where stream cooling is needed so that agencies and organizations can better spend limited resources. Since Ecology is not identifying activities needed on forest land use areas, is assuming that sufficient volunteers will participate, and is providing no dedicated funding to support the hundreds or thousands of acres that need planting (at a cost of about $6,000 per acre according to analysis provided in Appendix C), it is difficult to provide assurances that stream cooling will occur.

Response: Ecology believes it has provided sufficient detail on the specific reaches where stream cooling is needed in Figure 8: Stillaguamish Watershed – Where Shade is Most Needed. Ecology has provided this information as GIS-based data to Snohomish County and will make this information available to anyone who requests it. Regarding the dependence of this project on voluntary cooperation by willing landowners, we agree this limits any rosy forecast of 100 percent compliance. Nevertheless, Centennial Grant funds have been provided at a fairly steady rate to local governments and organizations in this watershed for projects that will improve riparian conditions - $499,000 to the Stillaguamish Tribe for its landslide project; $171,750 to the Snohomish Conservation District for the Stillaguamish Sub-Basin Improvements project;

$332,250 to Snohomish County for the South Fork Big Trees project; and small grants to the City of Arlington for a wetland enhancement project and the Stillaguamish-Snohomish Fisheries Enhancement Task Force for a knotweed removal project. Ecology believes these initial projects will provide sufficient support to further energize the salmon habitat restoration efforts already underway by local governments and organizations.

Comment: p. 30, Potential Funding Sources. Ecology should state that while the Centennial Grant program has been widely used to help fund water cleanup activities, current policy will prevent it from being used by Phase I and Phase II permittees to address actions in the TMDL once it has been incorporated into the stormwater permit. The paragraph as written is misleading because it implies that Centennial funds will be available for programs such as those currently being funded in Snohomish County. The policy reduces a potential source of funding at the same time regulations are increasing in one of the most challenging arenas of pollution reduction (e.g., nonpoint source pollution). We strongly urge Ecology to revisit this policy and use the Centennial program as another incentive to explore programs that can enhance effectiveness of programs in areas that most need it (TMDL watersheds). No new funds are identified in this plan and no Centennial Clean Water Funds are dedicated to implement this strategy.

Response: Refer to response to previous comment for specific Centennial funds awarded to this watershed. In addition, the comment is incorrect. Current policy does not prevent Phase I and Phase II permittees from applying for and receiving Centennial funds for projects that would implement this TMDL. The only NPDES permittees that would not be eligible for Centennial grants to implement this TMDL are those assigned Wasteload Allocations for temperature in this TMDL. Only Wastewater Treatment facilities have established Wasteload Allocations for temperature in this TMDL; as permittees, they can apply for Centennial loans but not grants.

Comment: p.15, Additional mature riparian vegetation. The management plans and regulations for forest land use are incorporated by reference and reaches under administration of the USDA-Forest Service are in some of the best condition in all the watershed (Purser, et al., 21003; SWM 2001, 2002, 2003). However, it would be helpful to understand how private, state, and federal forest lands contribute to the high stream temperatures extant in the watershed and to what extent they may contribute to the relief from temperatures in excess of water quality criteria and a "natural" condition.

Federal forest lands contribute to several listed reaches including Little Deer Creek, Higgins Creek, Jim Creek, and Canyon Creek. State forest lands contribute to listed reaches such as Deer Creek, Pilchuck Creek, Jim Creek, and the North Fork Stillaguamish River. Finally, private forest lands contribute to North Fork Stillaguamish River, Deer Creek, Pilchuck Creek, Jim Creek, Canyon Creek, and the South Fork Stillaguamish River (see Fig. 6 for all). The current strategy appears to miss the opportunity to secure an explicit, multi-agency, volunteer agreement to modify activities, where needed, based on stream temperature needs of this TMDL. The fact that Ecology may suggest changes to the Forest Practices Board (p. 17) does not provide any assurance that state and private forest lands will be contributing to the cooling of listed streams. We have not seen evidence that the Northwest Forest Plan or the Forest Practice Regulations resultant from the Forest and Fish Report have led to the establishment of riparian reserves that will be sufficient to contribute to stream cooling needed for the next 65 years to de-list reaches.

Response: Volume 1 of this TMDL (Ecology, 2004) includes an analysis that can partially answer the question--how do private, state, and federal forest lands contribute to the high temperatures extant in the watershed? In Figure 28, results of modeling are shown for the mainstem Stillaguamish. If the North Fork and South Fork are assumed to meet the temperature criteria (lowest result trace on charts, "boundaries at WQS") then the mainstem is about one degree cooler (difference between fifth-lowest result trace and the lowest) throughout its length. (This is a very crude estimate of the contribution of the private, state, and federal forest lands above the mainstem part of the watershed, since there is also a significant contribution by streamside rural residential or agricultural landowners that would also have to completely revegetate their riparian zones in order for the two forks to come into compliance for temperature.)

Regarding this TMDL's deferral of load allocations for private, state and forest lands to the riparian protections and enhancements of National Forest Plan and to the riparian prescriptions of the Forests and Fish Report (DNR 1997), it would be an unnecessary duplication of planning if this TMDL were to separately make buffer prescriptions and habitat restoration prescriptions for those lands. A section of the Forests and Fish report entitled "TMDLs produced prior to 2009 in mixed use watersheds" specifically lays out this agreement.

List of public meetings and presentations

April 22, 2003 – SIRC workgroup meeting, Silvana. TMDL progress report.

September 9, 2004 – SIRC workgroup meeting, Silvana. TMDL progress report.

November 9, 2004 – Pioneer Museum. Arlington, WA. Ecology public meeting on the Stillaguamish Instream Flow Rule and on implementation strategies for the Stillaguamish Fecal Coliform, Dissolved Oxygen, pH, Arsenic and Mercury TMDL, and the Stillaguamish Temperature TMDL

May 10, 2006. SIRC monthly meeting, Silvana. Presentation on Draft TMDL Submittal Report.

Outreach and announcements

From: Altose, Larry
Sent: Thursday, December 09, 2004 6:15 PM
To: Lawrence, Sally (ECY); Hirschey, Steve
Cc: Garland, Dave; Palenshus, DouGlas; Beitel, Judy; Swenson, Dan
Subject: News; Stanwood-Camano News; 11-2-04; Stillaguamish

Stillaguamish watershed plans back for review

Department of Ecology (Ecology) will sponsor an open house and two public meetings Tues, Nov. 9 in Arlington so people can learn about the department's efforts to improve water quality and allocate future water supplies in the Stillaguamish watershed.

Two separate presentation and discussion sessions, each covering both topics, will be offered at Arlington's Stillaguamish Valley Pioneer Museum, 20722 67th Ave. N.E. The first public meeting will be held from 3 to 5 p.m., followed by an open house from 5 to 7 p.m., with the second meeting from 7 to 9 p.m.

Ecology, in conjunction with local organizations, has been identifying pollutants and developing a water cleanup plan for the Stillaguamish watershed.

According to public information officer Larry Altose, the river basin is failing to meet state water-quality standards due to the following:

- Elevated concentrations of fecal coliform pollution from farms, domestic and wild animals, failing septic systems, urban storm water runoff and leaking sewer systems.
- Decreased levels of dissolved oxygen. Fecal coliform and other nutrients such as fertilizers enter the watershed and feed algae blooms that use up available oxygen. Low dissolved oxygen levels threaten salmon and other aquatic life.
- High summer water temperatures. A lack of sufficient streamside shading, upstream landslides, bank erosion and low stream flows all contribute to warm water problems which harm fish and other wildlife.

A proposed water cleanup plan for the Stillaguamish is available at the Stanwood Library or visit www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html.

Ecology will also present features of a new draft rule the department is considering to help determine how water in the Stillaguamish basin ought to be allocated for future uses. When formally adopted, the rule is intended to:

- protect fish, wildlife, water quality, recreation and aesthetics in the watershed while also providing water for future domestic uses;
- set minimum stream flows for rivers and creeks in the Stillaguamish watershed;
- protect water levels for lakes and ponds in the watershed;
- reserve a certain amount of ground water for future domestic use that won't need a new water right; and,
- set aside sufficient water for grazing livestock without needing a new water right.

The public is invited to ask questions and provide comments about the concepts and issues Ecology is seeking to address through the stream-flow rule. According to Altose, Ecology will present a formal proposed stream-flow rule for the Stillaguamish watershed later in the winter and will conduct public hearings next year before a rule is adopted.

Comments about the Stillaguamish water cleanup plan should be addressed by Fri., Dec. 10, to Sally Lawrence, Department of Ecology, 3190 160th Ave. SE, Bellevue, WA 98008; e-mail: slaw461@ecy.wa.gov, or phone 425-649-7036.

Comments regarding the features and issues for consideration in the draft Stillaguamish stream-flow rule should be sent by Fri., Dec. 10, to Steve Hirschey at the above address or shir461@ecy.wa.gov or phone 425-649-7066.

Appendix B. Stillaguamish Watershed Restoration Projects

Tables B-1 through B-8 comprise recent projects by watershed partners that will benefit habitat and temperature regime of Stillaguamish watershed rivers and creeks

Table B-1. Recent City of Arlington Projects Addressing Impaired Waters in Stillaguamish Watershed

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Public Education					
Signs at arterial-stream crossings	Portage Creek	General	City of Arlington	2002	Objective: watersheds, water quality, fish
Provide contact information for enforcement at task force projects		Temperature	SSFETF, City of Arlington	2003	
"Arlington Update" newsletter articles on water quality programs and actions	All basins in city limits	General	City of Arlington	Quarterly	
"Arlington Times" newspaper articles on watershed subjects	All basins in city limits	General	City of Arlington		Regularly published, great support
Storm drain stenciling	All basins in city limits	Dissolved Oxygen	City of Arlington		"Dump No Waste, Drains To Stream"
Watershed Protection program at airport and industrial center	Portage Cr eek (also Quilceda)	Temperature, Dissolved Oxygen	City of Arlington	2003	Engage businesses in BMPs and good housekeeping practices
Research and inspection of all septic systems at the airport	Portage creek springs	Groundwater	City of Arlington	1998-2000	Good opportunity to outreach and inventory airport businesses
Participated in the Portage Creek Stewardship program	Portage Cr eek	Temperature, Dissolved Oxygen	City of Arlington	January – May 2003	Included planting, native plant salvage, speakers, bus tours
Public Participation					
Began operation of new state of the art Wastewater Treatment plant	All City, other than areas served by Marysville	Dissolved Oxygen, Fecal Coliform, BOD, COD	City of Arlington	1997	Management is researching methods to decrease impacts to fecal coliform and nutrients
Golf course ponds water quality improvements	Prairie Cr eek	Temperature, Dissolved Oxygen, Nutrients	Gleneagle golf course, High School Vo-Tech, City of Arlington		Management changes to solve waters quality problems; High School vocational program for plantings
March Creek water quality	March Cr eek	Fecal	City of		Coordinated with landowners

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Public Education					
investigation		Coliform, Dissolved Oxygen, Temperature, Nutrients	Arlington, landowners		for monitoring access, gage installation, management history, pollution sources, improvement alternatives
Citizen Advisory Committee on Stormwater	All basins in city limits	General	City of Arlington	Ongoing	Education and social needs
Planning and Development					
NPDES Phase II application	All basins in city limits	General	City of Arlington	2003	On-time submittal
SCD Annexation		General	City of Arlington	2003	Annexed in to the Snohomish Conservation District
Adopted new Critical Areas regulations	All basins in city limits	Temperature, Dissolved Oxygen	City of Arlington	2003	Buffers up to 150’ on ESA habitats
Significant tree rules	All basins in city limits	Temperature	City of Arlington		Encourage forest retention
Low Impact Development	All basins in city limits	Water Quantity	City of Arlington		Encourage LID designs where a viable option
Developed strict TESC standards	All basins in city limits	Sediment	City of Arlington		Require meeting project specific NPDES limits (see also Enforcement)
Identified Priority Protection Areas	All basins in city limits	Temperature, Dissolved Oxygen	City of Arlington		Developed capital plan using Ecology’s wetland characterization method to identify 100’s of acres of wetlands and 3,000 feet of streambanks (see separate Arlington table)
Enforcement					
Enforce TESC standards	All basins in city limits	Sediment	City of Arlington	Ongoing	Code enforcement on construction sites
Construction project turbidity	All basins in city	Sediment	City of		Mandate projects with sediment

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Public Education					
monitoring	limits		Arlington		problems sample outfall for Turbidity
Operations and Maintenance					
Gleneagle pet waste station	Prairie Cr eek	Fecal Coliform	City of Arlington		First one installed; frequently used
Prairie Creek Storm Detention System Cleaning	Prairie Cr eek	General, Water Quantity	City of Arlington	2004	Restore capacity to reduce peak flows, address urban flooding and habitat issues
Riparian Restoration					
Numerous stream and wetland restoration projects (see attached Table A-2)	All basins in city limits	Temperature, Dissolved Oxygen	City of Arlington		Total 5.5 miles and >53acres; most recently Hecla wetland restoration
Provided trees to landowners willing to plant along critical areas	City wide	Temperature, Dissolved Oxygen	City of Arlington	Ongoing	Estimated 500 trees 2003/4
Supplemental plantings and maintenance in existing riparian restoration projects	Citywide	Temperature, Dissolved Oxygen	Banksavers, City of Arlington	Ongoing	Estimated 400 trees 2003/4
Prisoner crew plantings—new plus follow-up maintenance	Citywide	Temperature, Dissolved Oxygen	Oscar Cullem, City of Arlington	Ongoing	5 acres 2003/4
Portage Creek ponds vegetation enhancement	Portage Creek	Temperature, Dissolved Oxygen	Pioneer Museum, City of Arlington	2003/4	Added vegetation around the ponds where feasible due to historical dikes
Golf course plantings near ponds		Temperature, Dissolved Oxygen	Gleneagle golf course, High School Vo-Tech, City of Arlington	2003/4	Also see Public Participation
Wetland Creation / Acquisition					
Eagle Creek elementary school wetland creation	Eagle Cr eek	Temperature, Nutrients	City of Arlington		3 acres
Pioneer elementary school wetland	Prairie Cr eek	Temperature,	City of		6 acres

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Public Education					
creation		Nutrients	Arlington		
Monitoring					
Illicit discharge detection and elimination		Fecal Coliform, Dissolved Oxygen	City of Arlington		e.g., as discovered during sewer inspections
Increase water quality staffing		General	City of Arlington		New hire in Utilities Department May 2004
Continuous water quality monitoring stations	Portage Cr eek, Prairie Cr eek	Temperature, Dissolved Oxygen	City of Arlington		Hydrolab Quanta monitors installed at 2 sites, some work yet to be done on Prairie
Stormwater outfall monitoring	Largest stormwater outfall; discharge to mainstem Stillaguamish	Fecal Coliform (FC), Dissolved Oxygen, Temperature	City of Arlington	September 2003	Main old town outfall plus background conditions in River; monthly
Source water monitoring	Mainstem Stillaguamish	Temperature, Turbidity, pH, Conductivity, Flow	City of Arlington		Daily (mostly) by Water Department
Wastewater NPDES compliance effluent monitoring	Mainstem Stillaguamish	FC, Dissolved Oxygen, Temperature	City of Arlington		
Wastewater additional effluent monitoring	Mainstem Stillaguamish	Total Phosphorus, Total Kjeldahl Nitrogen	City of Arlington		
March Creek water quality investigation	March Cr eek	FC, Dissolved Oxygen, Temperature	City of Arlington		Mapping, water quality sampling, survey cross-sections to evaluate correction alternatives and treat stormwater; see also Public Participation

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Public Education					
Construction project turbidity monitoring	All basins in city limits	Sediment	City of Arlington		Mandate projects with sediment problems sample outfall for Turbidity

Table B-2. Priority areas inside and outside of Arlington's Urban Growth Boundaries identified as critical components to restore or maintain naturally sustaining watershed process including flood storage, water quality, fish and wildlife habitat, groundwater recharge, discharge and others.

Project Name	Sub-basin	Area or lineal	Stream/Wetland	Solve identified problems
Portage Mill Reach	Portage Creek	3,000 feet left bank	Stream	Rearing Stabilization
Wetland 1051	Portage Creek	127.1	Wetland/Stream	Temperature, Nutrients Flood Storage, Base Flow, Bird Diversity
Wetland 1561	Portage Creek	56 acres	Wetland/Stream	Nutrients, Flood Storage Bird Diversity
Wetland 1247	Portage Creek	18.9 acres	Wetland/Stream	Temperature, Sediments Nutrients, Flood Storage Base Flow, Bird Diversity
Wetland 1144	Prairie Creek	8.27 acres	Wetland/Stream	Temperature, Sediments Nutrients, Flood Storage Base Flow, Bird Diversity
Wetland 0979	Prairie Creek	9 acres	Wetland/Stream	Temperature, Flood Storage, Base Flow, Bird Diversity
Wallace Ponds	Kruger Creek	40 acres	Wetland/Stream	Temperature. Nutrients Flood Storage, Base Flow, Bird Diversity
Jensen's Farm ESA	Kruger Creek	6.5 acres	Stream	Temperature, Sediments Nutrients, Flood Storage Base Flow, Bird Diversity Fish abundance
Wetland 0888	Eagle Creek	127 acres	Wetland	Temperature, Nutrients Flood Storage, Base Flow, Bird Diversity
Clay Cliff Ponds	Eagle Creek	23 acres	Wetland/Stream	Temperature, Nutrients Flood Storage, Base Flow, Bird Diversity
Graafstra Farm	Eagle Creek	41 acres	Wetland/Stream	Temperature, Nutrients, Flood Storage, Base Flow, Bird Diversity, Fish Diversity
Valley Gem	March Creek	96 acres	Wetland/Stream	Temperature, Nutrients Flood Storage, Base Flow, Bird Diversity

Table B-3. Riparian Restoration, Maintenance or Protection Activities – Estimates of projects within the City of Arlington, by sub-basin beginning upstream.

Project Name	Sub-basin	Estimated Lineal length	Avg. Total Width or landowners stream bank	Average Forest Age Class H = Healthy M = Medium S = Sparse
New High School	Portage Creek	2,000	150' Left Bank and lower Right	60 years H
Hecla Wetland	Portage Creek	900'	120'	3 years H
Jensen's farm	Portage Creek	1,400'	115'	5 years H
Mill Reach	Portage Creek	3,000	50' Right bank	13 years S
Zimmerman	Portage Creek	330'	50'	Planting 2002/3
Ronning	Portage Creek	330'	75'	Planting 2002/3
Rivercrest	Portage Creek	1,800	75' Right Bank	50 years H
Alterna-care	Kruger Creek	300'	33'	8 years M
Wallace Ponds	Kruger Creek	500'	80'	Planting 2003
Portage Estates	Kruger Creek	800'	60'	10 years M
Jensen's Farm	Kruger Creek	1,400	115'	6 years H
Casperson	Prairie Creek	700'	100'	Planting 2003
Magnolia2003	Prairie Creek	1,000	100'	50 % Planting 50% 50 yrs M
Gleneagle	Prairie Creek	4,000	50'	50 Year H
AVL	Prairie Creek	3,000	100'	20 Year M
McKinley	Prairie Creek	500'	75'	3 year H
Jensen's B. Park	Prairie Creek	1,300	100'	4 year H
Newell Machine	Prairie Creek	700'	60'	5 year S
67th and 204th	Prairie Creek	300'	20'	8 years S
Zimmerman	Prairie Creek	500'	100'	Planting 2002/3
Ronning	Prairie Creek	120'	50' Right Bank	Planting 2002/3
Post Middle	Eagle Creek	700'	160'	50% 80 years H 50% 3 years M
Total		28,080		
		5.3 miles		

Table B-4. 2002-2004 Stillaguamish Tribe BankSavers Riparian Planting in Stillaguamish Watershed

Site Identifier	Linear ft	Miles	Avg. Buffer Width	Acreage	# of Plants	Water Body	Project Partner
A	1650		30	1.1	1234	Unnamed trib to NF Stillaguamish	Snohomish Conservation District
B	1200		20	0.6	503	Glade Bekken (Trib to Lower Stillaguamish)	Snohomish Conservation District
C	15650		50	18.0	2161	Old Stillaguamish Channel	Max Albert's Old Stillaguamish Channel Project
D	600		15	0.2	500	Stillaguamish Mainstem	None
E	1500		50	1.7	2059	Stillaguamish Mainstem	None
F	1854			6.0	2500	Pilchuck Creek	CREP project
G	1300		50	1.5	2005	Church Creek	Snohomish County-SWM-Jake Jacobson
H	3320		25	1.9	326	Church Creek trib	Snohomish County-SWM-Jake Jacobson
I	300		30	0.2	505	Church Creek trib	Snohomish County-SWM-Jake Jacobson
J	1300		45	1.3	130	Old Stillaguamish Channel	Max Albert's Old Stillaguamish Channel Project
K	400		60	0.6	110	Old Stillaguamish Channel	Max Albert's Old Stillaguamish Channel Project
L	945		40	0.9	562	Stillaguamish Mainstem	None
M	2660		20	1.2	1426	Unnamed trib to NF Stillaguamish	Stillaguamish-Snohomish Task Force
N	2000		80	3.7	1332	Old Stillaguamish Channel	CREP project
O	1039			4.3	1487	Stillaguamish Mainstem	CREP project
P	1800		300	12.4	1300	NF Stillaguamish @ C-Post Bridge	Stillaguamish Tribe DNR
Q	600		20	0.3	500	Trib to NF Stillaguamish	Snohomish Conservation District
R	3500		30	2.4	1700	Harvey Creek/Kackman Creek	Snohomish Conservation District
Totals for all projects	**41618**	**7.9**		**58.3**	**20340**		

Table B-5. Portage Creek Watershed Revegetation Sites - Stillaguamish Tribe BankSavers Project

Site #	# of Plants Planted	# of Plants to be Planted	Maintenance Services	Acres Protected	Length of Project	Avg. Buffer Width/Fencing Installed	Project Partner
1	2450.0		Yes	2.2	3200 ft	30 ft/4400 ft	
2	2260.0		Yes	1.9	4150 ft	20 ft	
3		3500	Yes	2.3	2000 ft	50 ft	Snohomish County / NOAA grant
4	594.0		Yes	0.6	1300 ft	20 ft	
5	4962.0		Yes	3.3	7110 ft	20 ft	
6	1099.0		Yes	1.1	1200 ft	40 ft	Stillaguamish Tribe DNR
7	3576.0		Yes	3			Snohomish County Parks / Task Force
8	1365.0		Yes	1.5	1200 ft	60 ft	Stillaguamish-Snohomish Task Force
9	4611.0		Yes	3	2600 ft	50 ft	Stillaguamish Tribe DNR
10	889.0		Yes	1.4	3000 ft	20 ft	
11			Yes	2.1	3000 ft	30 ft	Stillaguamish Snohomish Task Force
12	200.0		Yes	1.1	2000 ft	25 ft	Stillaguamish Snohomish Task Force
13	200.0		Yes	0.6	500 ft	50 ft	Stillaguamish Snohomish Task Force
14	270.0	2300	Yes	3.5	5100 ft	30 ft	Stillaguamish Snohomish Task Force
Totals	22476.0	5800		27.5	36360 (6.9 miles)	20 to 60/4400 ft	

Table B-6. Recent Snohomish County/Partner Projects Addressing Impaired Waters in Stillaguamish Watershed

Project Title	River Segment	Parameter Addressed	Organization	Date Completed
	Pilchuck Creek Trib80a		Stillaguamish Tribe	
Streambank Revegetation (many individual projects)	Indian, Church, Deer, Deforest, French, Jim, Jorgenson Slough, Portage, Porter, Prairie, Riley, Rock, Sills, Trafton II 05-0145	Temperature	City of Arlington/Stillaguamish Tribe, Snohomish Conservation District, Stillaguamish-Snohomish Fisheries Enhancement Task Force, Stillaguamish Flood Control District, WDFW, DNR, private landowners, Snohomish County	1994 - 2004
Flow Enhancement Structure	Old Stillaguamish Channel	Temperature, Dissolved Oxygen	Stillaguamish Flood Control District, Stillaguamish Tribe	2003
Riparian Repair/ Revegetation	South Fork, Church, Portage, Kackman, North Fork, Trib to North Fork near Trafton, Trib to South Fork off Burn Rd	Temperature, some Fecal Coliform locations	Snohomish County	2001-2004
Glade Bekken restoration	Glade Bekken watershed	Temperature, Dissolved oxygen, Fecal coliform	Snohomish County	1996-2001
Ambient monitoring	8 sites on mainstem and tributaries	Temperature, Dissolved oxygen, Fecal coliform	Snohomish County	1994-ongoing
Water quality complaint investigations	Clean Water District	Temperature, Dissolved oxygen, Fecal coliform	Snohomish County	1994-ongoing
Church Creek restoration	Church Creek watershed	Temperature, Dissolved oxygen, Fecal coliform	Snohomish County	2000-ongoing
Dry Weather Outfall Monitoring	Clean Water District	Temperature, DO, Fecal Coliform	Snohomish County	1998-Ongoing
Adult Education (e.g. Watershed Keepers, tours, community events)	Clean Water District	Temperature, DO, Fecal Coliform	Snohomish County	1994 – ongoing
Streamside Landowner Workshops	Clean Water District	Temperature, DO, Fecal Coliform	Snohomish County with Ecology funding	2003 - 2004
Streamside BMP Direct Mail campaign	Stillaguamish Basin	Temperature, DO, Fecal Coliform	Snohomish County with Ecology funding	2004
Teacher and Youth Education	Most schools in CWD	Temperature, DO, Fecal Coliform	Snohomish County	1996 - ongoing

Table B-7. Snohomish Conservation District: 2004 Public Education Projects in Stillaguamish Watershed

Project Title	River Segment	Parameter Addressed	Organization	Date Started/ Completed	Comments
Spring Farm Clinic	Lower watershed	General	Snohomish CD	4/24/04	Held at Stanwood Grange
Ice Cream Social	Lower watershed	General	Snohomish CD	6/18/04	Held at private farm, Arlington
Silvana Fair (booth)	Lower watershed	General	Snohomish CD	7/31/04	At Silvana
Stanwood-Camano Fair (booth)	Lower watershed	General	Snohomish CD	8/6-8/8/04	In Stanwood
Festival of the River (booth)	Lower watershed	General	Snohomish CD	8/6/04	In Arlington
Fall Farm Workshop	Lower watershed	General	Snohomish CD	10/9/04	At Stanwood Grange

Table B-8. Snohomish Conservation District: 2004 Projects in Stillaguamish Watershed

Project Type	River Segment	Project Type	River Segment
Site visit/farm plan review	Arlington Junction South	Planting/site visit/Nutrient management	Hat Slough South
Site visit/farm plan review	Arnot Road Drainages	Data collection & Evaluation/Meetings/Site visit/farm plan review	Hell-Hazel Drainages
Site visit/farm plan review	Boulder Ridge	Data Collection & Evaluation/ Nutrient Management/Site visit/farm plan review	Higgins Ridge Area
Fencing & Structural BMPs/Site visit/farm plan review	Burn Hill Road Drainages	Firebreak/Structural BMPs/Site visit/farm plan assistance	Jackson Gulch
Site visit/farm plan review	Church Creek	Structural BMPs/Site visit/farm plan review	Jim Creek
Site visit/farm plan review	Deer Creek	Nutrient management/Fencing/ Site visit/farm plan review	Jordan Road Drainages
Brush Management/Structural BMPs/Site visit/farm plan review	Ebey Hill Drainages	Data Collection & Evaluation/Fencing/ Site visit/farm plan review	Kackman Rd Drainages
Data collection/Site visit/farm plan review	Frailey Mountain Drainages	Structural BMPs/Data Collection & Evaluation/ Site visit/farm plan review/Nutrient management/Brush management	Pilchuck Creek
Site visit/farm plan review/Data collection, Structural BMPs/Tree & shrub establishment	Glade Bekken	Fencing/ Site visit/farm plan review	Silvana Terrace
Fund raising/ Site visit/farm plan review	Grandview Area	Site visit/farm plan review	Squire Creek
Data Collection/Fencing/Site visit/farm plan review	Harvey Armstrong Creek	Structural BMPs/Data Collection & Evaluation/ Site visit/farm plan review/Nutrient management/Brush management/Pest management	Stillaguamish Floodplain

Appendix C. Cost Estimate for Highest Priority Riparian Restoration

This section provides a cost estimate for completing the water quality improvement projects of the type likely to be undertaken to implement this TMDL. The cost of riparian planting and maintenance for the 55 highest-priority half-mile stream reaches (Figure 2) in the watershed can be estimated by using these figures:

- $75,000 = approximate cost of 1 mile of installation riparian planting (assumes 100-ft buffer and $15,000 installation cost per 1,000 ft stream reach, using low-cost labor)[1]
- 55 reaches x ½ mile per reach x $75,000 per mile = $2,062,500.
- An additional annual maintenance cost of $2500 per mile of stream reach ($68,750) should be considered. Maintenance is needed in the first five years of a project to ensure plant survival.
- Total: $ 2,131,250.

These figures are provided to give a rough estimate of the financial investment that may be required to meet the goals of the TMDL. Some projects can be accomplished for less money using volunteer labor, however, complex projects could be more expensive.

[1] *Cost estimates based on information from K. Knight, The Stillaguamish Tribe Bank Savers Project, personal communication, 2004.*