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DEPARTMENT OF
ECOLOGY

Issaquah Creek Basin
Water Cleanup Plan
for
Fecal Coliform Bacteria

Total Maximum Daily Load

Submittal Report

June 2004

Publication No. 04-10-055

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by

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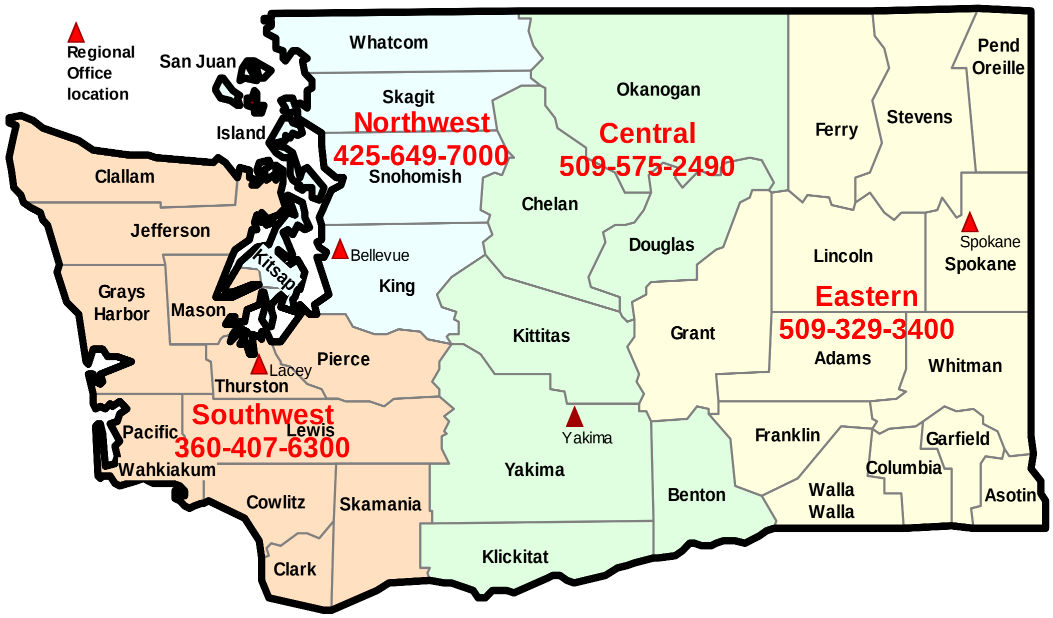

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Definitions

This report uses the following terms and definitions:

Clean Water Act (CWA): Formerly known as the Federal Water Pollution Control Act, the Clean Water Act contains a number of provisions to restore and maintain the quality of the nation's waters. Section 303(d), one of the provisions of the CWA, establishes the TMDL program.

Concentration: The amount or mass of a substance or material in a given volume or mass of sample. Concentrations of fecal coliform bacteria are usually measured in colony forming units per 100 milliliters of water (cfu/100mL).

Fecal Coliform (FC): Fecal coliform is bacteria present in the intestinal tracts and feces of warm-blooded animals. FC is used as an indicator organism to indicate the possible presence of disease-carrying (pathogenic) organisms. Fecal coliform lives in the same environment as pathogen, and increases in FC concentrations in water indicates increased likelihood of pathogen presence.

Geometric Mean: Either the 'n'th root of a product of 'n' factors, or the antilogarithm of the arithmetic mean of the logarithms of the individual sample values. It is common to report the geometric mean for fecal coliform data.

Load Allocation (LA): The portion of a receiving waters loading capacity attributed to one of its existing or future nonpoint sources of pollution or to natural background sources.

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

Municipal Separate Storm Sewer Systems (MS4): A system of pipes, ditches, or other stormwater conveyances under the jurisdiction of a municipality (such as, Issaquah, King County, and Washington State Department of Transportation MS4s).

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

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act.

Nonpoint Source: Generally, any unconfined and diffuse source of contamination, such as unpermitted stormwater or snowmelt runoff, or atmospheric pollution. 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.

90th percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90th percentile value is a statistically derived estimate of the division between 90 percent of samples, which should be less than the value, and 10 percent of samples, which are expected to exceed the value.

Pathogen: Disease causing agents, especially microorganisms such as bacteria, protozoa, and viruses are called pathogens.

Phase I Stormwater Permit: The first phase of stormwater regulation required under the federal Clean Water Act covering medium and large municipal separate storm sewer systems 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 covering smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point Source: Point sources of pollution are sources that discharge at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants, municipal stormwater facilities, or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river.

Pollution: Contamination, or other alteration of the physical, chemical, or biological properties of any waters of the state; or discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state that is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, and welfare; or to livestock, wild animals, birds, fish, or other aquatic life.

Statistical Rollback Method: The statistical rollback method is an approach to working up environmental data that predicts pollutant concentrations after pollutant controls have been implemented.

Stormwater: The water that runs off roads, pavement, and roofs during rainfall or snow melt. Storm water can also come from hard or saturated grass surfaces like lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): The amount of a particular pollutant that a stream, lake, estuary, or other waterbody can handle without violating state water quality standards. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to one of its existing or future point sources of pollution. WLAs constitute a 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 central collector such as a stream, river, or lake at a lower elevation.

Acknowledgements

The authors need to thank the many people who assisted in developing this Issaquah Creek Basin Bacteria Water Cleanup Plan and who continue to contribute to our understanding of the Issaquah Creek Basin. Thanks to Mary Maier, King County's Issaquah Creek Basin Steward, for her knowledge of the entire Issaquah and Tibbetts watersheds, for effectively pursuing acquisition and restoration projects in the basin that help protect water quality, and for her comments on the draft Water Cleanup Plan. Thanks also to Luanne Coachman and Kate Rhoads of King County's Department of Natural Resources and Parks Stormwater Services Section for helping make the report more clear and accurate in terms of stormwater and nonpoint sources.

Thanks also go to the city of Issaquah for its assistance and commitment to water cleanup. We especially appreciate Mayor Ava Frisinger's commitment to helping determine whether sanitary sewers or other point sources contribute bacteria to Issaquah streams. Thanks to Kerry Ritland of Issaquah's Public Works Engineering Department for the excellent water quality monitoring program in the city of Issaquah on which this water quality analysis relies. Peter Rosen, of Issaquah's Planning Department, provided comments and arranged to put the Water Cleanup plan on the agenda of the Rivers and Streams Board. Chrys Bertolotto, Stewardship Coordinator and an outstanding environmental steward in Issaquah's Resources Conservation Office, provided useful comments and does an excellent job of coordinating Issaquah's stream restoration efforts and volunteer stream teams.

Thanks go to Connie Marsh for helping to organize and edit the Water Cleanup Plan report. Thanks also to Barbara Shelton for her work on the Issaquah Basin Action team and for helping edit the report.

Special thanks go to several staff in Ecology's Environmental Assessment Program for their significant help in the development of this Water Cleanup Plan. Steve Butkus created the original Issaquah TMDL Draft (Butkus, 1999). Bob Cusimano reviewed the loading capacity analysis and checked the methods used to calculate load and wasteload allocations. Joe Joy's Stillaguamish River TMDL report provided the 'Simple Method' used to calculate loading estimates, some of the formatting for the Loading Capacity section, and statistical explanations in Appendix A (Joy, 2004).

The watershed community and local government involvement and commitment to water quality and natural resources in the Issaquah Basin provide considerable assurance for successful Issaquah Creek Basin water cleanup.

Executive Summary

Issaquah Creek Basin Water Cleanup Plan is one of many water quality plans Ecology must develop under the Clean Water Act and under an Agreement between Ecology and the Environmental Protection Agency by the year 2013. The Issaquah Creek Basin is located on the state's I-90 corridor at the south end of Lake Sammamish in western King County, and consists of the stream networks and watersheds of Issaquah Creek and Tibbetts Creek and contains most of the city of Issaquah. Streams in the Issaquah Creek Basin provide important resources for fish, primary contact recreation, education, and aesthetic enjoyment.

Issaquah Creek Basin streams are impaired with too much bacteria as measured by fecal coliform bacteria counts in the water. Fecal coliform bacteria live in the intestinal tracts of warm-blooded animals and are used as indicators of pathogenic, disease-causing bacteria. This Water Cleanup Plan addresses five stream segments in the basin that were listed as impaired for fecal coliform bacteria on the state's 1998-303(d) list, but also applies to all stream segments and tributaries in the Issaquah Creek Basin. Two of the listed stream segments are located on Issaquah Creek, one on the North Fork (NF) of Issaquah Creek, and two on Tibbetts Creek. Water quality monitoring conducted by Issaquah and King County since 1999 verifies that the 1998 listed stream segments are still impaired with bacteria during most of the year.

This Water Cleanup Plan differentiates between sources of bacteria, and contaminant transport mechanisms such as stormwater and roadway runoff. Sources of bacteria contamination in the Issaquah Creek Basin include on-site septic systems, possible sanitary sewer line leaks, agriculture (commercial and small farms), landfills, and wildlife; and are often conveyed to streams by urban stormwater and stormwater runoff from roads and highways.

Ecology considered seasonal variation in the Issaquah Creek Basin Water Cleanup Plan through analysis of wet and dry season water quality characteristics at six water quality monitoring stations. Ecology established wet and dry season target geometric means and target percent reductions for fecal coliform for each stream sampling station using the statistical rollback method, and set load allocation targets in cfu/100mL and percent fecal coliform density reductions needed to meet bacteria standards in Issaquah, NF Issaquah, and Tibbetts creeks (Ott, 1995).

EPA requires numeric wasteload allocations (WLAs) for permitted point sources regardless of the relative significance of the source. WLAs for fecal coliform were derived for Phase I NPDES stormwater permit holders, King County and Washington State Department of Transportation (WSDOT); and Phase II applicant, city of Issaquah. Recommended stormwater wasteload allocations are based on flow estimates, water quality monitoring data, King County and city of Issaquah land use data, and literature-derived bacteria loading estimates for various land uses.

Initial water cleanup implementation efforts will focus on five areas of known contamination problems or suspected source areas. The five initial focus areas are Tibbetts tributary 0170, McDonald Creek valley, the Four Creeks area, Lewis Lane Creek, and North Fork Issaquah Creek. Implementation focus areas will be adaptively managed pending monitoring results and success of source identification and correction efforts.

Implementation of the Issaquah Creek Basin Water Cleanup Plan relies on support for continuation of existing water quality sampling programs to assist source identification and trend monitoring, expansion of existing monitoring programs, special sampling surveys to help identify and correct local bacteria sources, and government as well as individual support for correction of known poor management practices that contribute bacteria to Issaquah Basin streams.

Recommendations

The 61 square mile Issaquah Creek Basin, at the south end of Lake Sammamish and includes the watersheds for both Issaquah and Tibbetts creeks. Stream water samples collected by King County and the city of Issaquah in Issaquah and Tibbetts creeks since prior to 1998 show that fecal coliform bacteria in the streams exceed state water quality standards. Washington State's 1998 Section 303(d) list of impaired water bodies included five stream segments in Issaquah Creek Basin, and the new draft Washington State Water Quality Assessment proposes these same five stream segments for listing (Ecology, 2004).

This report constitutes an analysis of bacterial pollution in Issaquah Creek Basin and proposes a water cleanup plan for bacteria in the basin streams. The Water Cleanup Plan, also known as a Total Maximum Daily Load (TMDL), assesses and proposes to limit pollution sources as required by the federal Clean Water Act for Section 303(d) listed waters in each state. The Issaquah Creek Basin Water Cleanup Plan covers all tributaries in the Issaquah Creek Basin, but focuses on the listed stream segments on Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creek.

This Water Cleanup Plan recommends the following activities and projects for effective implementation of the Issaquah Creek Basin Bacteria TMDL:

- Acquisition and protection of riparian areas to enhance water quality and habitat using stream buffers. Restoration of native riparian vegetation for its water quality and habitat benefits.

- Projects that monitor water quality help identify and eliminate bacteria sources such as on-site system failures, sewer leaks, and animal access to streams. This plan recommends six new stream monitoring stations on Carey, Holder, Issaquah, McDonald, and Fifteenmile creeks.

- Activity and/or educational projects that promote best management practices in agricultural areas such as fencing, management of roof runoff, and manure management to minimize bacterial pollution to streams.

- Projects or ongoing programs that address urban bacteria source control and stormwater treatment. These include low impact development to help limit bacteria-transporting sediment loads, runoff infiltration, street and parking lot sweeping to remove wildlife-attracting litter, and dumpster area maintenance.

- Initial pollution source identification focus on Tibbetts tributary 0170, McDonald Creek valley, the Four Creeks area, Lewis Lane Creek, and North Fork Issaquah Creek.

- Long-term streamflow monitoring and tracking of impacts of surface water diversions and groundwater withdrawals.

Purpose of the Plan

Water cleanup plans or TMDLs help ensure that impaired water bodies will attain water quality standards. The state Department of Ecology (Ecology) facilitates this process by encouraging and (in some cases) funding local governments, agencies, districts, and communities to participate in actions that will help identify and correct pollution sources and protect stream quality. In the case of impairment with excess bacteria, source control and treatment of bacterial contamination such as pet waste management, on-site system maintenance, and litter prevention are important solutions to the problem. Several agencies and groups are already active in the Issaquah-Tibbetts watersheds conducting educational and stream restoration projects that help remediate the problem of excess bacteria in these creeks.

The purpose of the Issaquah Creek Basin Water Cleanup Plan is to identify and control sources of bacteria in Issaquah area streams. The ultimate goal of the TMDL is for Issaquah Basin streams to meet water quality standards for fecal coliform bacteria. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the water quality problem. The assessment determines the amount of a given pollutant that can be discharged to a water body and still meet standards. The TMDL also stipulates the loading capacity and allocates that load among the various sources. If the pollutant comes from a discrete source (referred to as a point source) such as an industrial facility's discharge pipe or a permitted stormwater jurisdiction, that facility's share of the loading capacity is called a wasteload allocation. If the load comes from a diffuse source (referred to as a nonpoint source) such as a farm or unpermitted stormwater source, that source is given a load allocation.

Ecology developed the Issaquah Creek Basin Water Cleanup Plan for Fecal Coliform Bacteria, with input from local agencies and community members, to address impairments to the use of contact recreation due to high fecal coliform levels. Since both Issaquah and Tibbetts creeks discharge near the boat launch and swimming beaches of Lake Sammamish State Park, water contact recreational uses such as fishing, swimming, water skiing, and wakeboarding are considered impaired by the problem of excess bacteria in these streams. Aquatic life, which may not be affected by excess bacteria, could be adversely affected by other constituents in domestic wastewater where leaking sewers or failing on-site systems are the source of the bacteria. Figure 1 shows Issaquah Creek Basin with Issaquah and Tibbetts creek watersheds and water quality sampling stations.

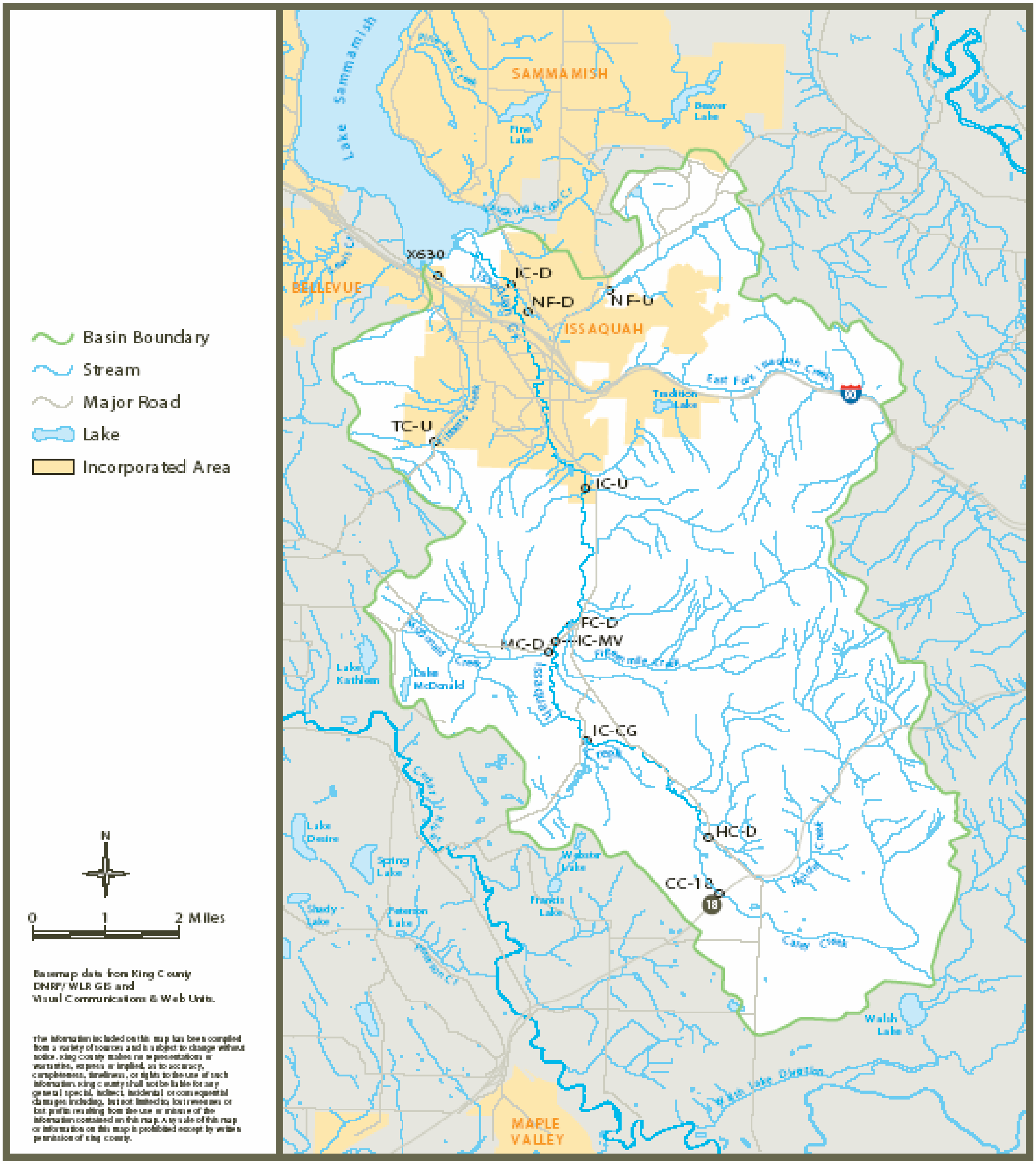

Figure 1

Issaquah Creek Basin showing sampling stations on Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creek.

Background

The Issaquah Creek Basin consists of about 61 square miles in King County and the city of Issaquah and contains the watersheds for both Issaquah and Tibbetts Creeks. These streams flow from steep forested headwaters in the southern basin, through Issaquah, and into Lake Sammamish at the northern edge of the basin. Although Tibbetts Creek is not a tributary to Issaquah Creek, it shares a common floodplain with mainstem Issaquah Creek during significant flood events (Issaquah, 2003a). The largest tributaries to Issaquah Creek are Carey Creek, Holder Creek, McDonald Creek, Fifteenmile Creek, East Fork Issaquah Creek, and North Fork Issaquah Creek (Figure 1).

Figure 2. Issaquah Creek below the confluence with McDonald Creek at May Valley Road.

Diverse land uses and natural resources characterize the Issaquah Creek Basin. Watershed elevations range from more than 3,000 feet at the Tiger Mountain summit to near sea level at the mouth of Issaquah Creek as it enters Lake Sammamish. The city of Issaquah, located in the basin's northwestern end, overlaps both the Tibbetts and Issaquah Creek watersheds. Forests cover more than 68 percent of the basin, and commercial forestry continues within the Tiger Mountain State Forest, which covers much of the eastern flanks of the basin. Land uses in the watershed include parks, forestry, mining, livestock farming, residential, commercial, and light industrial development. Much of the historical forestry and agricultural land uses have been replaced by dispersed residential development with several large subdivisions and urban development in the city of Issaquah.

Stream systems in the basin are a significant regional resource for salmonid fish production with at least seven different salmon species spawning naturally in Issaquah Creek. Both Issaquah and Tibbetts creeks are capable of supporting major fisheries, due in part to the presence of relatively stable and diverse habitat conditions. In addition the Issaquah Salmon

Hatchery nurtures five to six million salmon eggs each winter, approximately half of which are released directly into Issaquah Creek. In 1999, the hatchery released approximately 500,000 Coho and 2 million Chinook to Issaquah Creek (Issaquah, 2003a).

Issaquah Creek

Issaquah Creek tributaries Carey and Holder creeks dominate the upper Issaquah Creek watershed, with steep upper reaches, largely undeveloped forests, and scattered livestock farming in the lower gradient downstream reaches near their confluence. The mid-Issaquah Creek basin is a moderate-gradient stream system that supports a regionally significant salmonid fishery in spite of land-use impacts from livestock farming, road building activities, and floodplain encroachment. Middle Issaquah Creek basin contains a major zone of channel migration, a natural process whose impacts are problematic if development encroaches into the area of migration. Floodplain encroachment is most damaging in the Four Creeks Ranch area, which is a mid-basin residential area.

Lower Issaquah Creek is a large and varied stream system with a mean annual flow of 133 cubic feet per second (cfs). The stream channel has been significantly constrained in its floodplain by the rapid growth of the city of Issaquah. As a result of building activity in the immediate floodway, and the natural tendency of the channel to migrate in its lower reaches, major flooding of downtown Issaquah occurs at relatively regular intervals. The city of Issaquah has experimented with side-channels and low impact streambank armoring on Issaquah Creek to allow more natural stream function to occur in the urban setting. Lower Issaquah Creek provides important open space and scenic amenities to city residents, and provides important spawning areas and migratory pathways for salmon.

McDonald Creek

McDonald Creek is a tributary to middle Issaquah Creek with a relatively low gradient and a drainage system characterized by abundant wetland areas that have experienced some filling and draining for residential development in recent years. McDonald Creek parallels May Valley Road and the stream historically has received significant sediment from the steep mountain tributaries that drain to it. Upstream development, forestry, and construction in the floodplain, have all exacerbated downstream valley flooding below McDonald Creek.

Fifteenmile Creek

Fifteenmile Creek, the smallest and steepest of Issaquah Creek sub-basins, joins Issaquah Creek from the east about one-half mile downstream of McDonald Creek. The sub-basin contains several nearly pristine stream reaches and several reaches that have been destabilized by recent residential development and forestry activities. Boulder and cobble cascades dominate most of the steep stream channel of Fifteenmile Creek.

East Fork Issaquah Creek

East Fork Issaquah Creek flows through a steep mountainous watershed that has been heavily impacted by construction and runoff from a major interstate freeway (I-90). I-90 follows the East Fork stream corridor for over four miles until the East Fork joins mainstem Issaquah Creek in downtown Issaquah. Salmon still utilize the East Fork stream system all the way to Preston. Residential, commercial, and industrial structures in the East Fork floodplain significantly constrain the lower mile of the East Fork.

North Fork Issaquah Creek

The headwaters of North Fork Issaquah Creek are located in the dense residential areas of Klahanie and Issaquah Highlands. The largest and most diverse wetland systems in the Issaquah Creek Basin occur in the North Fork drainage. Residential, commercial, and mining development have partially degraded these wetlands and associated streams. Recent water quality sampling results have shown significant bacterial contamination of unknown origin in the North Fork.

Figure 3. Tibbetts Creek at Squak Mountain Nursery.

Tibbetts Creek

Tibbetts Creek is a steep gradient stream that has been impacted by historical and current mining activities, livestock keeping, and, more recently, by suburban development. Sediment sources in the Tibbetts Creek basin include abandoned mines and coal mine tailings deposits, a clay pit on Cougar Mountain, and two quarries on Squak Mountain (Issaquah, 2003). As a result, Tibbetts Creek has significant turbidity, sedimentation, and flooding problems typically associated with stormwater runoff, particularly in its lower reaches prior to entering Lake Sammamish. Tibbetts Creek also receives significant stormwater drainage from developed areas within Issaquah that may be contributing to high bacteria levels.

The possible contribution of bacteria sources to Tibbetts and Issaquah creeks as they flow through Lake Sammamish State Park will be investigated during the course of implementation and monitoring for this Water Cleanup Plan.

Land Use

The Issaquah Creek Basin, still largely rural in character, has many pristine areas in the upper watershed relatively untouched by human activity. To some extent, this character is protected for the future, with the majority of the Issaquah Creek planning area designated for rural, open space, or forest production uses in the 1985 King County Comprehensive Plan. Nevertheless, Issaquah was the state's fastest growing city in 2003 while the overall growth rate in Washington State during 2002-2003 was the weakest in 20 years (Seattle Times, 2003). This growth rate partly reflects large annexations of existing developed areas in Issaquah during the last several years. The conversion of forestland to residential developments and the conversion of non-forested lowland into commercial land use are the most common land use changes presently occurring in the basin.

Urban development in western Washington has altered runoff processes in many stream basins resulting in modified streamflow patterns (Konrad and Booth, 2002). Urban development in the Issaquah Basin, if it continues at current rates, could threaten the ability of the stream system to provide its current beneficial uses to area residents and fish. For example, under modeled future unmitigated land use conditions, runoff is predicted to increase by 14 to 78 percent in different sub-basins, with the largest flow increases occurring in the rapidly developing North Fork and McDonald Creek sub-basins (King County, 1996). These two sub-basins have most of the undeveloped urban zoning outside of Issaquah. Hydrologic impacts of growth are a concern because higher storm flows have been associated with increased levels of fecal coliform bacteria.

Water Quality Standards

The state of Washington's Water Quality Standards for Surface Waters are published pursuant to Chapter 90.48 of the Revised Code of Washington (RCW) (Ecology, 1997). The Washington State Department of Ecology (Ecology) has the authority to adopt rules, regulations, and standards as necessary to protect the environment. Under the federal Clean Water Act, the EPA regional administrator must approve the water quality standards adopted by the state (Section 303(c) (3)). State water quality standards designate certain characteristic uses for protection and specify the criteria necessary to protect those uses [Washington Administrative Code (WAC), Chapter 173-201A].

The most recent version of Washington's water quality standards was adopted in November 1997 and the standards are currently in the process of being updated. According to the state water quality standards, Tibbetts Creek (Extraordinary) is held to a higher standard than Issaquah Creek (Excellent). Issaquah Creek and all its tributaries were given a specific classification under the state water quality standards as a Class A (Excellent) stream [WAC 173-201A-130 (55)]. The water quality standards describe criteria for fecal coliform for the protection of Class A characteristic uses as:

> *"Fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 ml."*
>
> [WAC 173-201A-030(2) (c) (i) (A)]

Tibbetts Creek is designated as Extraordinary (Class AA). One of the reasons Tibbetts Creek has a more stringent standard than Issaquah Creek was the limited amount of data available for Tibbetts at the time standards were developed, and the default policy of designating streams of unknown quality draining to lakes as Class AA. The water quality criteria for fecal coliform for the protection of Class AA characteristic uses are:

> *"Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 ml."*
>
> [WAC 173-201A-030(1) (c) (i) (A)]

Both Class A and Class AA waters support comparable uses. This TMDL addresses impairments of these characteristic uses caused by high fecal coliform levels in Issaquah and Tibbetts creeks. The characteristic uses designated for protection in Issaquah Basin streams are:

"Characteristic uses shall include, but not be limited to, the following:

- *(i) Water supply (domestic, industrial, agricultural).*
- *(ii) Stock watering.*
- *(iii) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting. Other fish migration, rearing, spawning, and harvesting. Clam and mussel rearing, spawning, and harvesting, and Crayfish rearing, spawning, and harvesting.*
- *(iv) Wildlife habitat.*

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation." [WAC 173-201A-030(1) & (2)]

Ecology believes that primary contact recreation is the beneficial use most sensitive to the impairment of excess fecal coliform bacteria. The public has an increased health risk from contact with waters that are impaired by excessive bacteria concentrations. However, some forms of aquatic life may be more sensitive to unknown contaminants that may be associated with bacteria sources such as on-site sewer leaks. Bacteria water cleanup is expected to protect several beneficial uses including primary contact recreation and aquatic life. Table 1 shows the differences in fecal coliform criteria for Issaquah Creek (Class A) and Tibbetts Creek (Class AA).

Table 1. Water quality standards classifications and fecal coliform criteria for Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creeks.

Stream Standard	Geometric Mean (cfu/100mL)	90^{th} Percentile (cfu/100mL)
Issaquah Creek Class A	100	200
North Fork Issaquah Creek Class A	100	200
Tibbetts Creek Class AA	50	100

The Water Quality Standards limit the averaging periods used in the calculation of the geometric mean for comparison with the fecal coliform criteria:

"In determining compliance with the fecal coliform criteria in WAC 173-201A-030, averaging of data collected beyond a thirty-day period… shall not be permitted when such averaging would skew the data set so as to mask noncompliance periods."
[WAC 173-201A-060(3)]

Table 3 shows sample results for bacteria in Issaquah Creek at station IC-D during the period 1985-99, and shows the standard geometric mean for fecal coliform bacteria is exceeded for months at a time. Calculation of water quality criteria in Issaquah Creek Basin streams may use data collected over periods longer than 30 days because water quality in both Issaquah and Tibbetts Creeks has shown bacteria impairment for longer periods.

Water Quality and Resource Impairments

As a result of high fecal coliform in stream samples collected in Issaquah and Tibbetts creeks prior to 1998; five stream segments were included on the Washington State 1998 Section 303(d) list of impaired water bodies (Table 2). The same five stream segments are also proposed for Category 5 [Section 303(d)] listing on the new draft Washington State Water Quality Assessment (Ecology, 2004).

Table 2. Issaquah Creek Basin 1998 Section 303(d)-listed stream segments

Stream Name	Segment Location (River Mile and Township-Range Section)	Old ID #	New ID #
Issaquah Creek	River Mile 1.1 at 24N-06E-21 River Mile 3.0 at 24N-06E-28	WA-08-1110	TF31OB TF31OB
N. Fork Issaquah Cr.	River Mile 0.8 at 24N-06E-27	WA-08-1110	CZ80NC
Tibbetts Creek	River Mile 0.4 at 24N-06E-20 River Mile 1.0 at 24N-06E-29	WA-08-1115	MB51QQ EA48LQ

The original draft Issaquah Creek Basin TMDL report evaluated water quality data that had been collected by King County up to June 1999. Data collected for Issaquah Creek at River Mile 1.1 (sampling station IC-D) between January 1985 and June 1999 were compiled and descriptive statistics generated which show that on average water quality standards were not met during most of the year during that period (Table 3) (Butkus, 1999). The number of samples used to calculate monthly statistics at IC-D over the 1985-99 15-year period ranged from 14 to 24 samples.

As mentioned in the preceding standards section, the two statistics used to compare stream water quality with the bacteria standard are the geometric mean and the 90th percentile. For Class A water, the geometric mean of fecal coliform samples shall not exceed 100 colony forming units/100 mL (cfu/100 mL), and 90th percentile (10 percent of all samples used to calculate the geometric mean) shall not exceed 200 cfu/100 mL. For Class AA water, the geometric mean of samples shall not exceed 50 cfu/100 mL, and 10 percent of all samples shall not exceed 100 cfu/100 mL.

The geometric mean of data equates to the arithmetic mean of the log-transformed data (Gilbert, 1987). Water quality standards confine the period for calculating the geometric mean to 30 days, unless longer averaging periods also show noncompliance. Sample results for bacteria in Issaquah Creek at station IC-D verify that the standard geometric mean was not met for periods of longer than 30 days during 1985-99 (Table 3). Tibbetts Creek sample results demonstrate similar periods of noncompliance exceeding 30 days. Use of periods longer than 30 days to calculate the geometric mean is appropriate for stream in the Issaquah Creek Basin since the results do not mask over periods of noncompliance.

Table 3. Fecal coliform statistics for Issaquah Creek from data collected at River Mile1.1 (IC-D) from January 1985 to June 1999.

Month	No. of Samples	Geometric Mean (cfu/100mL)	Median (cfu/100mL)	Maximum (cfu/100mL)	Class A Standard Geometric Mean (cfu/100mL)	Meets Geometric Mean Standard
January	24	73	60	1,100	100	Yes
February	20	55	39	3,000	100	Yes
March	19	54	50	320	100	Yes
April	19	128	120	1,000	100	No
May	17	178	150	2,400	100	No
June	16	263	202	5,300	100	No
July	14	228	190	1,800	100	No
August	16	188	175	1,400	100	No
September	15	313	240	2,400	100	No
October	22	395	440	3,100	100	No
November	19	204	290	1,200	100	No
December	18	77	60	600	100	Yes

Since 1999 stream samples collected by the city of Issaquah and King County show that Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creek still exceed water quality standards during much of the year. This TMDL analysis uses data collected at six stream sampling stations in the basin. Two stations on Issaquah Creek are Issaquah Creek upstream (IC-U) at the upstream edge of the Sycamore neighborhood, and Issaquah Creek downstream (IC-D) located at NW Sammamish Road. North Fork upstream (NF-U) and North Fork downstream (NF-D) serve as the two stations on North Fork Issaquah Creek. The two Tibbetts Creek stations are Tibbetts Creek upstream (TC-U) near the old Bianco mine site and Tibbetts Creek downstream (X630). The Tibbetts Creek downstream site, located at the footbridge in Lake Sammamish State Park, also serves as King County's Tibbetts Creek monitoring station X630.

Current Water Quality

Current sampling results from Tibbetts and Issaquah creeks show that the monitored stream segments used in this TMDL analysis violate water quality standards at some time during the year. In order to better show spatial and temporal differences, and to define seasonal allocation targets, the fecal coliform data at each existing stream sampling site were divided into wet season (November through April) and dry season (May through October). Grouping the highest and lowest six contiguous months average flows during the period from 1964 to 2002 resulted in establishing the wet and dry season periods. Figure 4 shows average monthly streamflow data and fecal coliform levels for Issaquah Creek downstream station IC-D. The city of Issaquah collected the fecal coliform data in Figure 4 from 1985 to 1999 (Table 3).

Figure 4 compares average monthly streamflow and monthly fecal coliform levels in Issaquah Creek at IC-D and shows that the highest bacteria levels generally occur during low flows in dry season months. September and October were the months with highest average fecal coliform levels during 1985-99. Because storm flows wash off an accumulation of contaminants that can build up over long periods, stormwater quality is erratic and may not exhibit distinct seasonal trends. The graph in Figure 4 depicts monthly average fecal coliform levels, and does not reflect high bacteria levels that can occur at any time of year during storms.

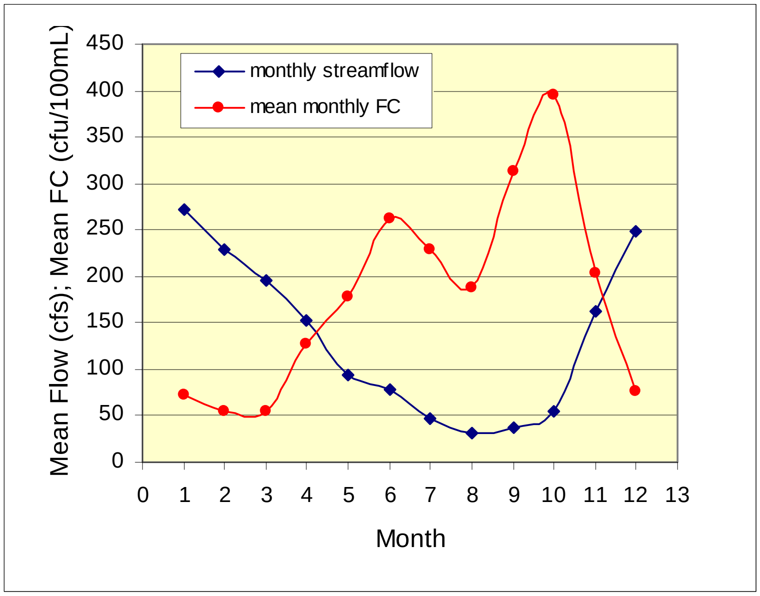

Figure 4. Comparison of monthly streamflow and average fecal coliform (FC) concentration at Issaquah Creek station IC-D.

Table 4 shows current fecal coliform results for both wet and dry seasons at Issaquah Creek stations IC-U (upstream) and IC-D (downstream), North Fork Issaquah Creek stations NF-U (upstream) and NF-D (downstream), and Tibbetts Creek stations TC-U (upstream) and X630 (downstream). Only the wet season geometric means at Issaquah Creek, North Fork Issaquah Creek, and upstream Tibbetts Creek met water quality standards. While five of the six sampling sites in Table 4 met the geometric mean fecal coliform standard during the wet season, all six sites exceeded the 90th percentile during the wet season. All six sites severely exceed the 90th percentile during the dry season. All six stations have high dry season 90th percentiles ranging from 1,600 to 2,300-cfu/100 mL.

In addition to the statistical evaluation of monitoring results from the six sampling sites shown in Table 4, review of city of Issaquah sampling data indicate several problem sampling stations and stream reaches that also warrant further investigation for bacteria pollution sources. Tibbetts Creek downstream station X630 had the highest wet and dry season geometric means for fecal coliform results. The nearby Tibbetts tributary 0170 is suspected to be contributing to this high bacteria problem and this report recommends extra attention and source identification monitoring at this site.

Table 4. Current water quality standards and fecal coliform results at Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creek (cfu/100 mL).

		Water Quality Standard	Current Water Quality	
			Wet Season	Dry Season
Issaquah Creek upstream IC-U	Geometric Mean	100	24	159
	90th Percentile	200	300	1,798
Issaquah Creek downstream IC-D	Geometric Mean	100	72	237
	90th Percentile	200	478	1,958
North Fork Issaquah Creek upstream NF-U	Geometric Mean	100	32	171
	90th Percentile	200	452	2,299
North Fork Issaquah Creek downstream NF-D	Geometric Mean	100	49	251
	90th Percentile	200	363	1,882
Tibbetts Creek upstream TC-U	Geometric Mean	50	19	201
	90th Percentile	100	198	1,631
Tibbetts Creek downstream X630	Geometric Mean	50	110	338
	90th Percentile	100	782	2,214

Lewis Lane Creek is a small tributary to Issaquah Creek located downstream of sampling station IC-U. Baseflow samples from the city's station LL-D on Lewis Lane Creek have been as high as 5,700-cfu/100 mL (6-27-2000). Maintenance of existing on-site systems in the Lewis Lane neighborhood is thought to be a water quality issue, though Issaquah plans to provide sewer service to the neighborhood in the near term (Earth Tech, 2003). Other potential sources on Lewis Lane Creek should be investigated.

McDonald Creek valley, along May Valley Road, has numerous small farms with animal access to streams. Additional source identification monitoring will be recommended on McDonald Creek and in the Four Creeks area, which is an unsewered concentrated residential area located near the confluence of McDonald Creek, Fifteenmile Creek, and Issaquah Creek. Finally, focus on contamination sources in North Fork Issaquah Creek should help identify and correct pollution sources there. A sample of the North Fork taken by Ecology on April 13, 2004 near site NF-D contained 2,100-cfu/100 mL, indicating a significant source of contamination existed at the time of the sample.

Flows

Streamflows can have important effects on stream water quality conditions. In some areas of Issaquah Basin, such as on the lower North Fork of Issaquah Creek, ground water withdrawals reduce streamflow and can exacerbate contaminant concentrations in the stream. Although TMDLs do not normally focus on streamflows, this Water Cleanup Plan recommends streamflow monitoring and tracking of impacts of surface water diversions and groundwater withdrawals for streams in the Issaquah Creek Basin.

The city of Issaquah currently maintains three stream gaging stations on Issaquah Creek and one on Tibbetts Creek. In addition, King County maintains stream gages on North Fork Issaquah Creek and East Fork Issaquah Creek, and the U.S. Geological Survey (USGS) maintains stream gages on Issaquah Creek near Hobart, and near the mouth of Issaquah Creek at S.E. 56th Street (Issaquah, 2003). The USGS has maintained the streamflow gage near the mouth of Issaquah Creek (station 12121600) since 1964, and the gage near Hobart (station 12120600) since 1986 (USGS, 2003).

Table 5. Flow statistics for Issaquah Creek near mouth (IC-D) comparing period of record data to water years 2001 and 2002.

Period of Record	Annual Average	7-day average low-flow	90th-percentile low-flow*
	(cfs)	(cfs)	(cfs)
1964 – 2002	133	14	27
Water Year 2001	116	20	22
Water Year 2002	156	19	22

* Streamflows exceed the 90th-percentile low-flow 90 percent of the time

The longest period of record of streamflow data available in the Issaquah Creek Basin is from the USGS stream gaging station at Issaquah Creek near the mouth at S.E.56th Street. Average annual discharge of Issaquah Creek at S.E.56th Street determined from the 39-year period of record (1964-2002) is 133 cubic feet per second (cfs). Average discharge at S.E. 56th Street during the wet season from November through April is 210 cfs based on average monthly flows for those months during 1964-2002 (USGS, 2003). The stream site at Issaquah Creek near the mouth is the site (IC-D) where the city of Issaquah and King County collect downstream Issaquah Creek water quality samples. Table 5 shows summary flow statistics for Issaquah Creek near the mouth.

Washington State Water Code requires water rights for any surface water diversions and for groundwater withdrawals in excess of 5,000 gallons per day. The Issaquah Salmon Hatchery holds some of the largest and oldest water rights on Issaquah Creek. Washington State Department of Fisheries constructed the Issaquah Salmon Hatchery on Issaquah Creek in 1936 about three miles above the mouth of Issaquah Creek. The hatchery water-supply intake dam is located one-half mile above the hatchery. Today the Washington Department of Fish and Wildlife operates the hatchery and has water rights for diversion of 14 cubic feet of water per second (cfs) from the dam for fish propagation. After flowing through the hatchery ponds, the water is then returned to the creek at the hatchery.

The Issaquah Salmon Hatchery maintains sufficient flows in Issaquah Creek between their diversion at the dam and return discharge at the hatchery. The hatchery also holds rights to pump 18 cfs from Issaquah Creek at the hatchery, which they return to the creek near the pumps.

Figure 5. Issaquah Salmon Hatchery water-supply intake dam and fish ladder on Issaquah Creek near Wildwood Apartments.

The Issaquah Salmon Hatchery currently produces Chinook, Coho, and Lake Washington Steelhead and nurtures five to six million eggs each winter. In recent years changes in hatchery operation have allowed more Chinook salmon to spawn in Issaquah Creek above the hatchery. Because they are not warm-blooded animals, salmon and other fish do not contribute fecal coliform to streams. The Corps of Engineers may construct improvements to the hatchery dam fish ladder to improve fish passage sometime in 2005-2006 (Issaquah, 2003a).

Pollution Sources

Potential bacteria contaminant sources in the Issaquah and Tibbetts Creek basins include urban storm water (*e.g*., construction and commercial/residential stormwater runoff), on-site septic systems, stormwater runoff from roads and highways, agriculture (commercial and small farms), possible sanitary sewer line leaks, landfills, and wildlife. Table 6 summarizes sources of bacterial pollution to streams in the Issaquah Creek Basin and their estimated significance.

Table 6. Potential sources of bacteria pollution in the Issaquah Creek Basin.

Source	Explanation	Estimated Significance
On-Site Septic Systems	Failing or improperly designed/installed on-site septic tanks and/or drainfields that allow discharge of untreated effluent to groundwater or surface water.	High
Small Farms Agriculture	Runoff and drainage from hobby farms, fields, intensive animal use areas, and pastures. Improper manure application and/or storage practices.	Medium
Stormwater	Contaminated runoff from wildlife and litter on urban and industrial parking lots, roofs, and residential pet waste runoff.	High
Road and Highway Runoff	Contaminated runoff from unsecured loads, wildlife and litter on streets, roads, highways, roadside ditches, and roadway shoulder areas.	Medium
Sewer Leaks	Potential leakage and/or overflows from municipal sanitary sewer lines.	Unknown
Cedar Hills Landfill	Landfill leachate-contaminated runoff or groundwater from Cedar Hills Landfill.	Low
Wildlife	Contamination from wildlife in the watershed such as deer, elk, cougar, bear, beaver, and birds.	Unknown

On-Site Septic Systems

Septic systems can contribute significant amounts of bacteria to streams due to system failures and surface or subsurface malfunctions (EPA, 2001). Failing septic systems may contribute significant bacteria loads directly to a water body, or via groundwater seepage, especially in shoreline areas or in areas of coarse-textured soils. Poorly installed, faulty, or improperly located on-site systems (septic tanks, drainfields) are potential sources of human pathogens to surface and ground waters.

Two sewer and water districts currently serve the Issaquah Creek and Tibbetts Creek basins. Sammamish Plateau Sewer and Water District serves the North Fork sub-basin, and the Issaquah Sewer District serves the East Fork, Issaquah Creek, and Tibbetts Creek sub-basins. The remainder of the basin has approximately 2,000 households using on-site sewage disposal systems (King County, 1996). While most of the basin on-site systems are located within King County, some on-site systems still exist within the city of Issaquah.

Public Health-Seattle and King County (PHSKC) reviewed and analyzed the status of on-site systems in the basin during 1990-91. The on-site review involved an examination of past surveys, a review of 1,432 on-site system records, and a field survey of 192 septic systems. PHSKC found a 5.7 percent combined failure rate for file records and field inspected on-site systems. Based on these failure rate assumptions, the PHSKC surveys indicate that on-site system failures may contribute significant pollution to Issaquah basin streams.

Agriculture

Issaquah Creek Basin has much less agricultural land uses today than it did historically. Animal keeping practices on small farms and activities associated with larger cattle and horse keeping operations can contribute to water quality degradation. Problems in the basin include overgrazing of pastures, inadequate manure storage and disposal, and unlimited animal access to streams and wetlands. These activities can cause increase in transport of sediment, nutrients, and bacteria to wetlands and streams. These problems are particularly pronounced along the mainstem of Issaquah Creek above the McDonald Creek confluence where the largest concentrations of small farms are located.

Stormwater

Stormwater is the portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into constructed infiltration facilities or defined surface water channels (EPA, 2001). Ecology does not consider stormwater a pollution source in itself, but an efficient conveyor of pollutants from drainage surfaces. Land uses and activities in urban areas, coupled with an increase in impervious surfaces and accumulation of contaminants, typically results in polluted stormwater. In Issaquah Creek Basin, stormwater pollutants include bacteria from sources such as pet waste, rural livestock, on-site system failures, and urban wildlife.

Urban pollutants reach Issaquah and Tibbetts creeks and their tributaries primarily by stormwater runoff. Contaminants collect on impervious areas of the basin, including rooftops, driveways, sidewalks, parking lots, and roads, and heavy rainfall and runoff wash them off into storm drains, or directly into streams. Consequently, pollutants reach stream systems quickly and in high concentrations during typical storms.

Figure 6. East Fork Issaquah Creek beneath I-90 at Sunset Interchange near Issaquah.

Road and Highway Runoff

Pollution from road runoff is generally considered part of combined stormwater sources, but is worth noting separately here in that King County and Washington State Department of Transportation (WSDOT) will be given separate bacteria wasteload allocations in this TMDL. In addition there may be best management practices (BMPs) that are specific to roadway stormwater runoff. An interstate freeway (I-90), two state roads (SR 900 and SR 18), and a major county road (Issaquah-Hobart Road), all cross over streams in the Issaquah Creek Basin. In many locations where roads pass along or over the stream system, the road discharges untreated road runoff directly to the water.

On the 4.5-mile East Fork segment of Interstate 90, approximately 50 drainage outfalls discharge either directly to the stream or into swales that ultimately drain to the stream (Figure 5). Insufficient monitoring data exist to determine the severity of bacteria loading from roads. However, literature sources indicate that highway runoff is a significant source of bacteria to streams. The exact sources of bacteria from road runoff are unknown but may be generally due to wildlife, roadside litter, and unsecured loads. Some road right-of-ways, such as I-90 on the East Fork may be close to 80 percent impervious surface. Others, such as Highway 18 or State Road 900 are closer to 50 percent. For the purposes of this report, average road right-of-way was considered to be 65 percent impervious.

Landfills

The Cedar Hills landfill operated by the King County Solid Waste Division is located partially in the McDonald Creek sub-basin. The water quality treatment facilities on the site are the best available technology for the industry, and monitoring data from sites surrounding the landfill indicate there are few water quality problems. Years ago, stormwater runoff from non-active areas of the landfill was a source of turbidity problems and fine sediment transport into

McDonald Creek (King County, 1996). Monitoring results from the proposed sampling site on McDonald Creek will help identify whether bacteria normally associated with landfill leachate is getting into McDonald Creek from Cedar Hills landfill.

Wildlife

Wildlife contributes bacteria to surface waters. Bear, elk, deer, cougar, beaver, otter, ducks, geese, heron, and other wildlife are observed in the Issaquah Creek Basin. These and other warm-blooded animals contribute fecal coliform bacteria loading directly and indirectly to streams. Wildlife can contribute significant bacteria loading in the fall when birds and other animals feed on spawned-out salmon in the Issaquah Creek system. Loading from wildlife is considered natural background except where land use practices inordinately attract the wildlife. Some practices such as unkempt dumpster areas or littered parking lots can attract birds and other wildlife, and cause excess bacteria loading.

Loading Capacity Analysis

Identification of the contaminant loading capacity for a water body is an important step in developing TMDLs. EPA defines the loading capacity as "the greatest amount of loading that a water body can receive without violating water quality standards." (EPA, 2001) The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring a water body into compliance with standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity.

Bacteria TMDLs often express overall loading capacity and wasteloads as quantitative mass loading terms such as colony forming units per day (cfu/day) or cfu/year. For nonpoint sources, federal regulations allow expression of TMDL loads using "other appropriate measures" (40 CFR 122.45(f)). These alternative expressions for load are especially appropriate for nonpoint pollution, which is often non-continuous, highly variable, and usually comes from diffuse sources. Loads and load allocations for fecal indicators from nonpoint sources are more usefully represented as concentration or percent reduction in concentration (EPA, 2001). Defining allocations in these terms will allow monitoring data to be used to verify effectiveness of meeting the TMDL goals.

Water quality data collected by King County and city of Issaquah were relied upon for the TMDL analysis. Bacteria sampling data at six stream stations in the Issaquah Creek Basin were compiled and compared with standard normal distributions using normal probability plots and correlation coefficients (Gilbert, 1987). Logged values of the sampling data from all six stations were found to have a high degree of normality with linear correlation coefficient ‘R^2’ values ranging from 0.944 to 0.984. The highest correlation with a standard normal distribution would be indicated by a correlation coefficient (R^2) value equal to 1.0. Figure 7 shows a normal probability plot and ‘R^2’ value for fecal coliform sampling data from Tibbetts Creek upstream station TC-U.

The analysis in this plan applied the statistical rollback method to the wet (November–April) and dry (May–October) season data (Ott, 1995). The rollback method involves determining the (log) distribution statistics and calculating the 90th percentile based on the mean, standard deviation, and Z-score (Appendix A). The rollback method adjusted the statistical distribution of each sample population so as not to exceed the geometric mean and 90th percentile values of the standard. The more restrictive of the resulting criteria became the controlling statistic for the distribution ‘shift.’ Finally, the rollback method compared the resulting target statistics to water quality standards to show the amount of bacteria load reduction needed to meet standards year round at each site.

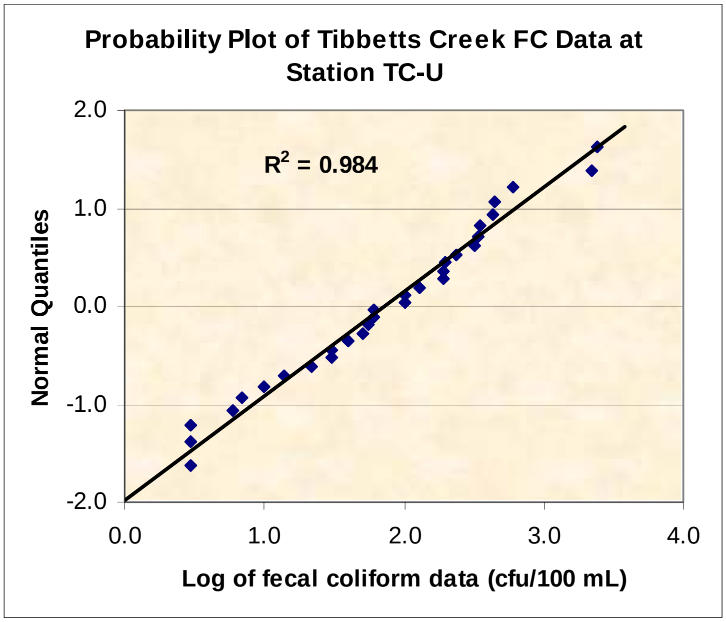

Figure 7. Probability plot of Tibbetts Creek fecal coliform data collected at upstream station TC-U between December 1998 and October 2003.

All six sampling sites require different percent reductions to meet the standard. The first part criterion (geometric mean) will need reduction below the standard geometric mean in order for target criteria to meet both parts of the standards. These reductions are based on the assumptions that the largest of the two criteria reductions will be needed to meet the standards overall, and that the statistical distribution of the sample population will be comparable following implementation of source controls. Tables 7, 8, and 9 show the target water quality statistics and fecal coliform density reductions for Issaquah Creek, North Fork Issaquah Creek, and Tibbetts Creek stations, respectively.

The results in Table 7 for Issaquah Creek indicate generally higher dry season bacteria concentrations and therefore suggest larger reductions needed in fecal coliform densities during May through October. Downstream monitoring site IC-D during May through October requires the largest fecal coliform reduction in Issaquah Creek. The results shown in Tables 8 and 9 for North Fork Issaquah and Tibbetts creeks also indicate that dry season bacteria concentrations are higher and therefore require larger reductions. The target geometric means for all basin sampling stations range from 10 to 30-cfu/100 mL.

Table 7. Allocation targets (cfu/100mL) and FC density reductions (%) needed to meet fecal coliform standards in Issaquah Creek.

Issaquah Creek	Geometric Means				Percent	
	Current Water Quality		Water Quality Targets		Target Reductions (%)	
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
IC-U Upstream	24	159	16	18	33.4%	88.9%
IC-D Downstream	72	237	30	24	58.1%	89.8%

Table 8. Allocation targets (cfu/100mL) and FC density reductions (%) needed to meet bacteria standards in North Fork Issaquah Creek.

North Fork Issaquah Creek	Geometric Means				Percent	
	Current Water Quality		Water Quality Targets		Target Reductions (%)	
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
NF-U Upstream	32	171	14	15	55.7%	91.3%
NF-D Downstream	49	251	27	27	44.8%	89.3%

Table 9. Allocation targets (cfu/100mL) and FC density reductions (%) needed to meet fecal coliform standards in Tibbetts Creek.

Tibbetts Creek	Geometric Means				Percent	
	Current Water Quality		Water Quality Targets		Target Reductions (%)	
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
TC-U Upstream	19	201	10	12	49.6%	93.9%
X630 Downstream	110	338	14	15	87.2%	95.5%

In addition to determining target stream statistics and percent reductions, the modeling approach for establishing loading and wasteload allocation estimates involved land-use data and impervious cover within each sub-basin as well as literature-derived runoff characteristics (Schueler, 1987). Ecology sorted areas within the basin by land-use into forest, agriculture, residential, commercial/urban, and roadway categories. Table 10 shows percentage land-use areas for individual sub-basins. Table 11 shows estimates of runoff concentrations and impervious cover for each land-use category.

Table 10. Percentage estimates for land-use areas in individual sub-basins in the Issaquah Creek Basin.

Sub-basin	Forest	Agriculture	Residential	Commercial / Urban	Roadway
Issaquah Creek	69.3%	15.9%	8.3%	4.6%	1.9%
North Fork Issaquah Creek	70.1%	2.0%	21.0%	5.2%	1.7%
Tibbetts Creek	63.2%	9.0%	10.6%	11.5%	5.7%

Table 11. Stormwater runoff bacteria concentration and impervious cover estimates for various land use categories.

Land-use type	Fecal coliform (cfu/100 mL)	Total phosphorus (mg/L)	Impervious cover (%)
Forest	100	0.10	20
Agriculture	3,000	0.35	30
Residential	2,000	0.26	40
Commercial/Urban	980	0.21	87
Roadway	890	0.26	65

Ecology estimated the relative proportion of stormwater fecal coliform loads for the three National Pollutant Discharge Elimination System (NPDES) jurisdictions using the "Simple Method Model" (Schueler, 1987). The model requires sub-basin drainage areas and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. Ecology divided the sub-basin areas for each listed water body into respective jurisdictions of the relevant stormwater permit holders and categorized land uses in each sub-area as residential, commercial/industrial, agricultural, forest, and roadway. Finally, Ecology estimated the portion of fecal coliform stormwater load for each permit holder, using watershed areas and land use percentages for each jurisdiction, and typical stormwater runoff pollutant concentrations for each land use category taken from the literature (Joy, 2004).

Once established, the relative proportions of bacteria loading from the NPDES stormwater permit jurisdictions were applied to the loading capacities to obtain proposed wasteload allocations. The following section of the report includes estimates of the fecal coliform loading capacities at each stream station.

Loading Capacity

Table 12 shows statistical summaries for fecal coliform sampling at water quality monitoring sites on Issaquah, North Fork Issaquah, and Tibbetts creeks.

Table 12. Fecal coliform statistical summaries for water quality monitoring sites on Issaquah, North Fork Issaquah, and Tibbetts creeks.

Site	Period of record	Season	No. of samples	Geomean	90th percentile	Target capacity geometric mean
Issaquah Creek IC-U	1998 - 2004	Wet	19	24	300	16
Issaquah Creek IC-U	1999 - 2004	Dry	19	159	1,798	18
Issaquah Creek IC-D	1998 - 2004	Wet	44	72	478	30
Issaquah Creek IC-D	1999 - 2004	Dry	38	237	1,958	24
NF Issaquah Cr. NF-U	2000 - 2004	Wet	11	32	452	14
NF Issaquah Cr. NF-U	2001 - 2004	Dry	12	171	2,299	15
NF Issaquah Cr. NF-D	1998 - 2004	Wet	37	49	363	27
NF Issaquah Cr. NF-D	1999 - 2004	Dry	33	251	1,882	27
Tibbetts Creek TC-U	1998 - 2004	Wet	19	19	198	10
Tibbetts Creek TC-U	1999 - 2004	Dry	18	201	1,631	12
Tibbetts Creek X630	2000 - 2004	Wet	27	110	782	14
Tibbetts Creek X630	2000 - 2004	Dry	19	338	2,214	15

Since pollution loading associated with permitted municipal storm water requires quantification in the TMDL, Table 13 shows estimated wet season loading capacities at monitored stream segments in the basin.

Table 13. Estimated wet season loading capacities at monitored stream segments in Issaquah Creek Basin.

Water Body Segment	Drainage area (acres)	Mean wet season flow (cfs)	Target geomean (cfu/100 mL)	Estimated wet season loading capacity (cfu/day)
Issaquah Creek @ IC-U	21,600	126	16	4.93×10^{10}
Issaquah Creek @ IC-D	36,224	210	30	1.54×10^{11}
NF Issaquah Creek @ NF-U	2,000	7.92	14	2.71×10^{9}
NF Issaquah Creek @ NF-D	2,855	11.3	27	7.46×10^{9}
Tibbetts Creek @ TC-U	700	2.44	10	5.97×10^{8}
Tibbetts Creek @ TC-D	3,446	12.1	14	4.14×10^{9}

Loading capacities were estimated using target capacity geometric means and average monthly wet season streamflows. Wet season flows for stations without flow gages were estimated based on relative drainage areas compared with stations having streamflow measurements. Loading capacities listed in Table 13 pertain to total wet season loading throughout the entire basin above the station.

Load and Wasteload Allocations

The Issaquah Creek Basin total maximum daily load evaluation recommends general load allocations (LAs) for nonpoint sources and specific wasteload allocations (WLAs) for municipal stormwater permit holders. The LAs are derived for the cumulative loading from all nonpoint sources, and WLAs are derived for point sources with NPDES or state waste discharge permits. Taken together, the allocations must not exceed the loading capacity for each water body.

Load Allocations

Available information on the relative contributions from the various nonpoint sources contributing to exceedance of the fecal coliform standards in the Issaquah Creek Basin did not allow development of specific load allocations by source type. Source identification monitoring during early implementation of the TMDL in 2005-06 will help determine relative contribution of the various pollution sources in Issaquah Basin. Load allocations pertain to nonpoint sources discharging directly to state waters, and not to municipal stormwater conveyance systems such as roadside ditches or urban storm sewers.

The most significant nonpoint sources of bacterial contamination are probably on-site sewage system failures, inadequate agricultural and livestock practices, pet wastes, and runoff from homes, local roads and commercial businesses. Loading from wildlife is considered natural background except where certain land uses attract wildlife. Load allocations for the Issaquah Creek Basin were developed as target percent reductions within each listed stream segment and are shown in Table 14.

Table 14. Load allocation targets (cfu/100mL) and load reductions needed to meet fecal coliform standards in Issaquah, North Fork Issaquah, and Tibbetts creeks.

Stream Station	Water Quality Targets (geometric mean)		Target Reductions (percent - %)	
	Wet Season	Dry Season	Wet Season	Dry Season
Issaquah Creek IC-U	16	18	33.4%	88.9%
Issaquah Creek IC-D	30	24	58.1%	89.8%
North Fork Issaquah Creek NF-U	14	15	55.7%	91.3%
North Fork Issaquah Creek NF-D	27	27	44.8%	89.3%
Tibbetts Creek TC-U	10	12	49.6%	93.9%
Tibbetts Creek X630	14	15	87.2%	95.5%

Table 14 lists the geometric means and target reductions required to meet the standard at each of the six main monitoring sites in the Issaquah Basin. The analysis compared the percent reductions required by each part of the criteria for each season at each station, and selected the most restrictive criterion to establish the allocation target (Tables 7, 8, & 9). The Statistical

Rollback Method was used to set the targets and is discussed in Ott (1995). These site-specific allocations and targets will be used to monitor and gauge the success of source control management measures taken in each subbasin.

Wasteload Allocations

As part of 1987 amendments to the Clean Water Act, Congress added Section 402(p) to the Act to cover discharges composed entirely of stormwater. Section 402(p) requires permit coverage for discharges associated with industrial activity and discharges from large and medium municipal separate storm sewer systems (MS4), *i.e*., systems serving populations over 250,000 or systems serving populations between 100,000 and 250,000, respectively. These discharges are referred to as Phase I MS4 discharges.

EPA was also directed to study and issue regulations that designate additional stormwater discharges (other than those regulated under Phase I) to be regulated in order to protect water quality. In December 1999, EPA issued regulations expanding the NPDES stormwater program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations from 10,000 to 100,000). This expansion of the NPDES stormwater regulatory program is referred to as Phase II. The city of Issaquah is a Phase II stormwater community by virtue of being an urbanized area having a population of over 10,000 (13,169 in 2002).

A November 22, 2002 EPA memorandum written to clarify EPA's stormwater regulatory requirements requires all regulated stormwater discharges be addressed by the wasteload allocation (WLA) component of TMDLs. The EPA directive states that WLAs for NPDES-regulated discharges need not be determined on an outfall-specific basis, but recommends expressing stormwater WLAs in the TMDL as aggregate allocations for identifiable categories. These categories should be defined as narrowly as available information allows (e.g., for municipalities, separate WLAs for each municipality) (Wayland and Hanlon, 2002).

King County and the Washington State Department of Transportation (WSDOT) have NPDES permit coverage for their municipal stormwater discharges under a Phase I stormwater permit for the Cedar/Green Water Quality Management Area (Ecology, 1995). The city of Issaquah made application for their Phase II stormwater permit coverage in March 2003 (Issaquah, 2003a). In accordance with the 2002 EPA directive, Table 15 proposes fecal coliform WLAs for the city of Issaquah, King County, and WSDOT.

The point source stormwater component of Issaquah Creek Basin bacteria loads was estimated based on percentage of sub basin drainage areas contributing to municipal controlled stormwater systems. Thus, permitted storm water is responsible for varying percentages of the wet season targets reductions listed in Table 14. Table 15 shows the aggregate NPDES stormwater reduction targets for each station, and individual reduction targets for each permit holder are listed in the far right column. Table 15 may be use in future general municipal stormwater permits pertaining to Issaquah Creek Basin.

EPA and Ecology recognize the difficulty of characterizing the highly variable frequency and duration in bacteria loads in storm water. Numeric limits for municipal stormwater discharges are not often feasible or appropriate when determining stormwater discharge effluent limits in NPDES permits that are consistent with TMDL-established WLAs. Therefore, best management practices (BMPs) are considered an appropriate form of permit effluent limit to control pollutants in storm water (Wayland and Hanlon, 2002). Stormwater permit-required BMPs should be designed to achieve bacteria loading reductions listed in Table 15.

Table 15. Fecal coliform (FC) wasteload allocations (WLAs) for city of Issaquah, King County, and Washington State Department of Transportation (WSDOT).

Water Body	NPDES stormwater target reduction (%)	Permittee	Estimated stormwater portion of FC load (%)	Permittee target reductions (WLAs)
Issaquah Creek @ IC-U	6.6 %	Issaquah	0.6 %	0.1 %
		King County	98.3 %	6.4 %
		WSDOT	1.1 %	0.1 %
Issaquah Creek @ IC-D	14.4 %	Issaquah	41.8 %	6.0 %
		King County	55.4 %	8.0 %
		WSDOT	2.8 %	0.4 %
North Fork Issaquah Creek @ NF-U	15.2 %	Issaquah	25.8 %	3.9 %
		King County	74.2 %	11.3 %
North Fork Issaquah Creek @ NF-D	15.5 %	Issaquah	75.6 %	11.7 %
		King County	23.6 %	3.7 %
		WSDOT	0.8 %	0.1 %
Tibbetts Creek @ TC-U	5.2 %	Issaquah	14.6 %	0.8 %
		King County	83.2 %	4.3 %
		WSDOT	2.2 %	0.1 %
Tibbetts Creek @ X630	34.9 %	Issaquah	66.5 %	23.2 %
		King County	27.1 %	9.5 %
		WSDOT	6.4 %	2.2 %

When states use a BMP approach to meet the stormwater component of the TMDL, EPA recommends that permits provide a mechanism to require use of expanded or more effective BMPs when monitoring demonstrates they are necessary to implement the WLA and protect water quality. Since NPDES permits require monitoring necessary to assure compliance with permit limitations, monitoring should measure at least cumulative BMP performance, which may lead to recognition of the need for revised management measures. Ecology will implement these recommendations in the issuance of subsequent general stormwater permits for jurisdictions in the Issaquah Creek Basin.

Other than municipal stormwater discharges, there are no other point sources in the Issaquah Creek Basin where bacteria is a concern in the discharge.

Margin of Safety

Uncertainty is accounted for in TMDLs using a margin of safety to ensure that load and wasteload allocations remain protective of water quality. The margins of safety are explicit in the form of an allocation, or implicit, such as in the use of conservative assumptions in the analysis. Basing allocations on conditions during the most critical period constitutes one approach to setting the margin of safety. Analysis of Issaquah Creek Basin bacteria data determined that the summer months are the most critical period when fecal coliform standards are furthest from being met. Many of the management measures used for controlling fecal coliform pollution sources during the dry season will help reduce bacterial loading throughout the year. Setting the loading capacity based on the critical dry season will help protect water quality during the other months of the year and serves as an implicit margin of safety for this TMDL.

The conservative assumption used in calculating the water quality target statistics in the TMDL provides an additional safety factor for the Issaquah Creek Basin Fecal Coliform TMDL. The statistical rollback method assumes equivalent variances of the pre-management data set and the post-management data. The frequency of high sample values should decrease as implementation controls pollution sources, which should reduce the variance and 90th percentile of the post-management condition (Ott, 1995).

Summary Implementation Strategy

This Summary Implementation Strategy (SIS) for the Issaquah Creek Basin Fecal Coliform TMDL presents a feasible and effective strategy to get the Issaquah/Tibbetts stream system to achieve its respective water quality standards for bacteria. The 1997 Memorandum of Agreement between the U.S. Environmental Protection Agency and Ecology requires a SIS for all TMDL submittals (EPA, 1997). The Issaquah Creek Basin SIS describes implementation activities that are planned or already underway by Issaquah, King County, Ecology, and other parties. The SIS also includes a strategy for developing follow-up monitoring plans, a summary of public involvement, and potential funding sources to help implement the plan.

The Detailed Implementation Plan (DIP) for the Issaquah Creek Basin will be developed following the Summary Implementation Strategy (SIS) by about one year. The DIP is a required element of TMDLs and provides specific detail on how implementation will occur, a specific framework for implementing the TMDL bacteria load reductions, and documents ongoing and planned actions designed to bring Issaquah Basin streams into compliance with state water quality standards.

Several local agencies have plans or existing programs to address the bacteria problem in Issaquah and Tibbetts creeks. For example, educational programs conducted by Issaquah and Issaquah Salmon Hatchery increase awareness of water quality issues including bacteria source control. The Issaquah Parks Department has installed pet waste stations and educational signage in city parks and the Issaquah Resource Conservation Office coordinates volunteer stream teams, helps sponsor workshops, and promotes low impact gardening and low impact development methods. This plan inventories existing activities in the Issaquah Creek Basin that will help remediate the bacteria impairment in basin streams and recommends focused source identification and source correction actions in known problem areas based on existing monitoring programs.

Outside of local government, several citizen groups, such as Issaquah Environmental Council, Mountains to Sound Greenway, and Friends of Issaquah Salmon Hatchery (FISH), actively plan and develop stream restoration and other watershed activities that will help reduce fecal coliform contamination in the Issaquah Creek Basin. Ecology anticipates that if these water quality programs and projects proceed as expected, concurrent with additional source identification and correction work in focus areas, all water bodies within the Issaquah Creek Basin will meet their respective water quality standards for bacteria by December 2010. Table 16 shows a summary of implementation actions and responsible parties to correct sources of bacteria in Issaquah Creek Basin.

Table 16. Summary of actions and responsible parties to correct sources of bacteria in Issaquah Creek Basin**.**

Corrective Action	Responsible Parties	Schedule
Watershed stewardship education	City of Issaquah, King County, Ecology, Lake Sammamish State Park	2004-10
Bacteria source identification monitoring	City of Issaquah $\geq$6 sites~6 times @ year King County $\geq$6 sites~6 times @ year Ecology miscellaneous surveys	2004-07
Stormwater source control Best Management Practices (BMPs)	Property owners, City of Issaquah, King County, WSDOT, Lake Sammamish State Park, Ecology	2004-10
Stormwater treatment BMPs	City of Issaquah, King County, WSDOT, Lake Sammamish State Park	2004-10
On-site septic system inspection, repair, and maintenance	On-site owners, Ecology, City of Issaquah, WSDOH, Public Health-Seattle and King County	2004-10
Stormwater treatment of road and highway runoff	City of Issaquah, King County, WSDOT, Ecology	2004-10
Small Farms-Agriculture inspection and assistance	King County, King Conservation District, Ecology	2004-10
Investigation and repair of sewer leaks	Sammamish Plateau Sewer and Water District, City of Issaquah, Issaquah Sewer District	2004-07
Cedar Hills Landfill monitoring	King County Dept. of Natural Resources and Parks – Solid Waste Division	2004-10
BMP and water cleanup effectiveness monitoring	City of Issaquah $\geq$6 sites~6 times @ year King County $\geq$6 sites~6 times @ year Ecology miscellaneous surveys	2007-10

Implementation Plan Development and Activities

Ecology developed this Summary Implementation Strategy (SIS) with assistance from basin stakeholders including city of Issaquah, King County, King Conservation District, Issaquah Basin Action Team, and others. A description of government agencies, citizen groups, and tribes that have regulatory authority, influence, information, resources or other involvement in the coordinated effort to implement the TMDL follows. The SIS also includes a description of implementation authorities and activities for each group pertaining to on-going and planned actions to reduce fecal coliform. Ecology will lead the coordination effort for development and implementation of the Detailed Implementation Plan (required under the Memorandum of Agreement between Ecology and EPA) with consultation from the following groups.

City of Issaquah

The city of Issaquah has been very active in watershed protection, stream restoration, and water quality improvement. Issaquah's Public Works Engineering (PWE) Department reviews current stormwater facilities within the city. Two major developments; Issaquah Highlands and Talus, require extensive water quality monitoring programs with reporting to the department. PWE conducts investigations and code enforcement of illicit sewer connections to storm drainage systems. PWE also regularly monitors storm flow and baseflow water quality in city streams and stormwater outfalls including periodic sampling for fecal coliform bacteria at eleven sites in the city. Issaquah recently expanded its monitoring program to include seven additional monitoring sites located outside the city in King County. Water quality data collected by Issaquah were used in this TMDL analysis, and future Issaquah data will help evaluate pollution sources and BMP effectiveness.

The city of Issaquah implements, primarily through its Resource Conservation Office (RCO), many public education and outreach projects aimed at increasing public awareness of water quality and water resource issues, providing educational materials to residents and businesses, and recruiting volunteers to participate in water quality monitoring and habitat restoration efforts (Issaquah, 2003a). Issaquah has pursued habitat preservation and acquisition of riparian property to restore and preserve streamside parcels. Many of Issaquah's habitat restoration projects also improve water quality functions along streams.

The Issaquah Stream Team, a voluntary group managed by the RCO, helps monitor stream conditions through monthly water quality monitoring and annual habitat surveys and bug sampling. The RCO also assists businesses to reduce potential stormwater pollution by providing free on-site consultations on storm drain maintenance and pollution prevention through their Businesses for Clean Water program. Participating businesses receive local recognition for their efforts.

Issaquah Rivers and Streams Board

The Issaquah Rivers and Streams Board is an appointed city advisory board that serves to protect, preserve, and enhance the water quality of the waterways of Issaquah, and to protect the fish, birds, and mammals that depend upon such aquatic environments by advising the Mayor and City Council of actions necessary to achieve this end. The Rivers and Streams Board could evaluate and prioritize proposals related to water quality and can advocate for certain future actions that will result in reducing bacteria levels in basin streams. Ecology will work with the Issaquah Rivers and Streams Board to propose water cleanup implementation actions in Issaquah Creek Basin.

Issaquah Salmon Hatchery

Washington Department of Fisheries constructed the Issaquah Salmon Hatchery during the Depression and has operated the hatchery since 1936. Washington Department of Fish and Wildlife currently operates the hatchery that is the focus of Issaquah's annual Salmon Days Festival celebrating the return of the salmon to the hatchery and area streams. The state's most visited hatchery with over 350,000 visitors a year, Issaquah Salmon Hatchery has an important public education function being in close proximity to the Seattle urban area.

It is important to note that salmon are not affected by fecal coliform bacteria, but can be adversely affected by contaminants typically associated with some bacteria sources. Salmon are also not a source of fecal coliform bacteria because they are not warm-blooded animals.

Friends of Issaquah Salmon Hatchery (F.I.S.H.)

The Friends of the Issaquah Salmon Hatchery (FISH) is a private, non-profit group that provides educational services such as volunteer guides and school presentations at the Issaquah Salmon Hatchery. FISH has helped the Issaquah Salmon Hatchery stay open during times of hatchery cuts and uses salmon and the hatchery setting to teach watershed stewardship. Since salmon need cold, clean, well-oxygenated water, educational efforts help bring about public water quality awareness and assist in water cleanup implementation by increasing appreciation of fisheries resources and stream functions and values.

Issaquah Basin Action Team - IBAT

The Issaquah Basin Action team consists of representatives of city of Issaquah, Issaquah Environmental Council, Issaquah School District, King County, Mountains to Sound Greenway, citizens, businesses, and Ecology. Meetings are held on a monthly basis to discuss watershed issues and plan restoration, education, and outreach projects. IBAT coordinated the preparation and publication of the brochure "Issaquah Basin Best Places", which describes Issaquah watershed highlights and explains watershed and water quality values.

King County Department of Natural Resources and Parks

The Water and Land Resources Division (WLR) of King County's Department of Natural Resources and Parks is involved in watershed stewardship, stormwater compliance, and water quality monitoring throughout King County. At the recommendation of the County's Issaquah Creek Basin Nonpoint Action Plan (King County, 1996), WLR employs a Basin Steward for the basin. The Steward serves as a liaison between residents and City, County, state, federal, and Tribes on topics related to the basin and provides technical assistance to basin residents on preventing nonpoint pollution, revegetating disturbed areas, and pursuing other aspects of basin plan implementation.

Other WLR programs that contribute to preventing or reducing bacterial pollution to the Basin include the Agriculture Program, which provides education about livestock management practices that can reduce bacterial pollution of streams and also provides grants to agricultural landowners for the implementation of these and other BMPs. The Agricultural Program also supports implementation of the County's Livestock Management Ordinance, which requires manure management to reduce the potential for bacterial pollution of streams.

The Stormwater Services Section provides source control inspections and technical assistance to businesses in the Basin. This service helps to curb such bacterial sources as littered parking areas and poorly managed dumpsters. The Section also responds to drainage and water quality complaints that frequently include poor pet waste management and other bacterial pollution. Additionally, the Section identifies and facilitates the removal of any illicit sewage or other bacterial-type discharges to the storm drainage system.

The Natural Lands Program manages over 2,000 acres of headwaters forestland on Taylor Mountain, helping preserve the hydrologic integrity of the Issaquah Creek Basin, and thus preventing the bacteria-carrying peak flows that would have resulted from development of this land. King County's Small Habitat Restoration Program helps keep bacteria out of streams by providing fencing to keep livestock from streams while enhancing the buffers, which help filter out pollutants.

Figure 8. McDonald Creek valley and McDonald Creek at 217th Avenue SE.

King Conservation District

King Conservation District (King CD) is a separate municipal corporation of the state created under Chapter 89 RCW to administer programs to conserve the natural resources of King County. The goal of the district is to promote practices that maximize productive land use, while conserving natural resources and protecting water quality through education, funding assistance, and cooperation. King CD develops farm plans to protect water quality and provides animal waste management information, education and technical assistance to residents of King County.

The King Conservation District has developed approximately 40 small farm plans within the Issaquah Creek Basin. The CD helps advise and implement BMPs to protect water quality and fish and wildlife habitat, and designs and installs stream enhancement projects. King CD also holds classes, conducts farm tours, and provides grants and cost share funding for water quality related farm improvements. King CD is currently working on a Centennial Clean Water Fund grant application to provide small farm BMP education in Issaquah Creek Basin through workshops, farm tours, technical assistance, and farm plans.

Washington State Department of Ecology

Ecology has been delegated authority under the federal Clean Water Act by the U.S. Environmental Protection Agency to establish water quality standards, administer the National Pollution Discharge Elimination System (NPDES) wastewater-permitting program, and enforce water quality regulations under Chapter 90.48 RCW. Ecology responds to complaints, conducts inspections, and issues NPDES permits as part of its responsibilities under state and federal laws and regulations. In cooperation with conservation districts, Ecology supports implementation of farm plans and "Best Management Practices" (BMPs) for small farms and may use formal enforcement, including fines, if voluntary compliance is unsuccessful.

Ecology’s role in water cleanup implementation is through coordination of water cleanup plans (TMDLs), administration of the Water Pollution Control Act, and support of other programs such as Watershed Planning and the state’s Nonpoint Plan. Ecology has authority to protect water quality under the Water Pollution Control Act (RCW 90.48), and will implement many of the nonpoint source control activities through administration of state statutes and regulations, and through local jurisdictions, resource agencies, and landowners. Ecology will also coordinate with and, when possible, facilitate joint projects and efforts with local watershed planning groups initiated by the watershed planning process under the Watershed Planning Act (RCW 90.82) and the Washington State Salmon Recovery effort.

Ecology encouraged development of “400-12” plans by local government and watershed groups in accordance with Chapter 400-12 WAC: Local Planning and Management of Nonpoint Source Pollution. Chapter 400-12 WAC purposed to reduce pollutant loading from nonpoint sources, prevent new sources from being created, enhance water quality and protect beneficial uses, all of which closely coincide with the purposes of this TMDL. In 1996, King County and the Issaquah/East Lake Sammamish Watershed Management Committee developed the Issaquah Creek Basin and Nonpoint Action Plan, which served as a combination basin plan and nonpoint action plan (King County, 1996).

Washington's Water Quality Management Plan to Control Nonpoint Source Pollution helps guide implementation for the Issaquah Creek Basin TMDL and some of the stream restoration and pollution correction actions that are already underway in the Issaquah/Tibbetts watersheds (Ecology, 2000). Ecology developed Washington’s nonpoint plan to include all nonpoint source pollution control efforts by federal, state, tribal, and local governments as well as citizen groups. The state nonpoint plan describes existing programs, identifies gaps, sets a strategy for improving those programs, provides tools, recommends timelines, and outlines methods for determining success.

Implementation of Ecology’s water quality standards for nonpoint sources has four elements (Ecology, 1997);

1. Activities that generate nonpoint source pollution shall be conducted so as to comply with the water quality standards. The primary means to be used for requiring

compliance with the standards shall be through BMPs required in waste discharge permits, rules, orders, and directives issued by Ecology for activities that generate nonpoint pollution.

2. BMPs shall be applied so that when all appropriate combinations of individual BMPs are utilized, violations of water quality criteria shall be prevented. If a discharger is applying all BMPs appropriate or required by the department and a violation of water quality criteria occurs, the discharger shall modify existing practices or apply further water pollution control measures, to achieve compliance. BMPs established in permits, orders, rules, or directives shall be reviewed and modified, as appropriate, so as to achieve compliance with water quality criteria.

3. Activities that contribute to nonpoint source pollution shall be conducted utilizing best management practices (BMPs) to prevent violation of water quality criteria. When applicable BMPs are not being implemented, Ecology may conclude individual activities are causing pollution in violation of RCW 90.48.080. In these situations, Ecology may pursue orders, directives, permits, or civil or criminal sanctions to gain compliance with standards.

4. Activities that cause pollution of storm water shall be conducted to comply with the water quality standards. The primary means to be used for requiring compliance with the standards shall be through BMPs required in waste discharge permits, rules, orders, and directives issued by Ecology for activities that generate stormwater pollution. The consideration and control procedures in (2) and (3) of this subsection apply to control of pollutants in storm water. [WAC 173-201A-160(3)]

Ecology provides financial assistance to local governments, tribes, universities, watershed groups, and conservation districts for stream restoration and water quality improvement projects through its Centennial Clean Water Grant Program. Ecology gives high priority to TMDL-related grant project proposals in funding decisions for state Centennial Clean Water Funds.

Public Health-Seattle and King County

Public Health-Seattle and King County (PHSKC) has the authority to enforce rules adopted by the state Board of Health that include rules necessary to assure safe and reliable public drinking water and to protect the public health. The Wastewater Program regulates on-site sewage systems, in accordance with Chapter 246-272 WAC, which requires county certification of on-site sewage system pumpers and installers.

The Public Health Wastewater Program also provides educational, advisory and permitting services for owners of septic systems. Wastewater Program activities include issuance of installation and repair permits for septic systems, sewage complaint investigations for septic systems, homeowner education, and enforcement.

Washington State Department of Transportation

The Washington State Department of Transportation (WSDOT) water quality program provides guidance and technical support to road planning, design, construction, and maintenance to help WSDOT enhance transportation project delivery and achieve compliance with the federal Clean Water Act and state water quality laws. WSDOT prepares stormwater pollution prevention plans for major road projects, prepares annual NPDES compliance reports, and conducts water quality monitoring.

Muckleshoot Indian Tribe

The ancestors of the present day Muckleshoot Indian Tribe had usual and accustomed fishing places primarily at locations on the upper Puyallup, Carbon, Stuck, White, Green, Cedar, and Black Rivers, including tributaries. Issaquah Creek Basin is part of the Cedar-Sammamish system, and thus the Muckleshoot Tribe has an interest, including fishing rights, in the basin. The Muckleshoot Indian Tribe consists of the descendants of the area's original Coast Salish peoples. The Tribe has always regarded salmon, which were more abundant in area streams, with great reverence. Today the Muckleshoot Indian Tribe has an active resource protection staff and may assist in stream restoration and water quality improvement efforts.

Enumeration of Agencies

The implementation of the Issaquah Creek Basin TMDL relies on the coordination and collaboration of numerous local jurisdictions and landowners. Ecology commits to managing the TMDL through water quality tracking and periodic reporting to watershed stakeholders on the water quality status. More than 20 agencies and organizations have a role in implementing the plan. Key tasks for which these agencies will be responsible include development of programs, projects, budgets, and regulations consistent with water cleanup goals. Implementing agencies include:

<u>King County Agencies:</u>
Department of Natural Resources and Parks
- Water and Land Resources Division
- Wastewater Treatment Division
- Parks Division
- Solid Waste Division

Department of Transportation
- Road Construction Services
- Road Maintenance Services

Development and Environmental Services (DDES)
- Land Use Services
- Building Services Division
- Environmental Division

<u>City Agencies:</u>
City of Issaquah
- Public Works Engineering
    - Resource Conservation Office (RCO)
- Planning Department

<u>Regional Agencies and Special Purpose Districts:</u>
King Conservation District (KCD)
Public Health – Seattle and King County (PHSKC)

Indian Tribes:
Muckleshoot Indian Tribe (MIT)

State Agencies:
Washington State Department of Agriculture (WSDA)
Washington State Department of Ecology (Ecology)
Washington State Department of Fish and Wildlife (WDFW)
- Issaquah Salmon Hatchery
Washington State Department of Health (DOH)
Washington State Department of Natural Resources (DNR)
Washington State Department of Transportation (WSDOT)
Washington State Parks and Recreation Commission (WSPRC)
- Lake Sammamish State Park

Federal Agencies
Environmental Protection Agency (EPA)
National Marine Fisheries Service (NMFS)
United States Fish and Wildlife Service (USFWS)
Army Corps of Engineers

Others:
Issaquah Basin Action Team (IBAT)
Issaquah Environmental Council
Issaquah Trails Association
Mountains to Sound Greenway
Friends of Issaquah Salmon Hatchery (FISH)
Save Lake Sammamish (SLS)

Summary of Public Involvement

The Issaquah Creek Basin Water Cleanup Plan for Fecal Coliform Bacteria; TMDL Assessment public comment period was open from May 12 through June 14, 2004 (34 days) and commenced with a public informational meeting that was held at the Issaquah Parks Department Pickering Barn in Issaquah on May 18, 2004, from 6:30-8:30 p.m. The public comment period allows time to solicit public input and feedback on the proposed final draft TMDL assessment and its associated Summary Implementation Strategy (SIS). Public notice for the commencement of the public comment period and public meeting consisted of a mailed Focus Sheet and legal ad in the Issaquah Press published on May 12, 2004. Appendix B includes copies and affidavits for the above newspaper legal and display ads.

Ecology published a "Focus Sheet" summary on the Issaquah Basin Cleanup Plan on May 6, 2004, distributed it to the above-listed agencies and groups and interested persons, and made it available at the public meeting held at the Issaquah Pickering Barn on May 18, 2004. Ecology responded to all written comments received during the public comment period. All comment responses are collectively provided in the Responsiveness Summary, included as Appendix C of this report.

Reasonable Assurance

The goal of the Issaquah Creek Basin Water Cleanup Plan for Fecal Coliform Bacteria is for the waters of the basin to meet the state's Class A and AA fecal coliform water quality standards. There is considerable interest and local involvement toward resolving the bacteria and other water quality problems in the Issaquah Basin. Numerous organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the bacteria problem. The following rationale help provide reasonable assurance that the Issaquah Creek Basin TMDL goals will be met by 2010.

- The city of Issaquah and King County have ongoing monitoring programs which will assist in identification of pollution sources and enable the ongoing evaluation of Issaquah Creek Basin water quality. These monitoring programs are being expanded to a total of 18 sampling sites in Issaquah and King County that will help define source areas. Ecology will periodically conduct special sampling surveys to help further define pollution sources and promote source correction. Ecology has priority grant rating for water cleanup-related projects applying for Centennial Clean Water Funds.

- 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.

- King Conservation District will continue providing and tracking technical assistance and best management practices implementation for landowners in the Issaquah Creek Basin for small farms and agricultural activities. King CD is currently developing a grant project to provide small farm BMP education in Issaquah Creek Basin through workshops, farm tours, technical assistance, and farm plans. Ongoing sampling and special sampling surveys conducted by Issaquah, King County, and Ecology will help reveal whether agricultural sources are causing significant bacteria loading to basin streams.
- King County Public Health regulates on-site sewage systems in accordance with Ch. 246-272 WAC and County Board of Health regulations.

Potential Funding Sources

The Department of Ecology administers the Centennial Clean Water Fund, Section 319, and State Revolving Fund grants and makes them available to fund activities to help implement water cleanup Plans (TMDLs). Non-governmental organizations can apply for 319 Grants to provide additional assistance. The Puget Sound Water Quality Action Team has Public Involvement and Education grants available for additional assistance. King Conservation District makes a limited amount of federal money available via the Conservation Reserve Enhancement Program for conservation easements and as cost-share for implementing agricultural best management practices (BMPs). The federal Natural Resources Conservation Service also administers federal money, the Environmental Quality Incentive Program, which provides cost share funds for farm BMPs.

Stream restoration activities are eligible for salmon restoration grants through various sources. Ecology will work with stakeholders to prepare appropriate scopes of work, to assist with applying for grant opportunities as they arise, and to help in other ways to implement the Issaquah Creek Basin TMDL.

Monitoring Strategy

EPA (1991) guidance calls for a monitoring plan for TMDLs where implementation will be phased in over time. The monitoring is conducted to provide assurance that pollution control measures achieve the expected load reductions. Over the next two years, the city of Issaquah and King County will periodically monitor water quality in Issaquah Basin. Ecology will conduct sampling surveys approximately quarterly to help further define pollution sources and promote source correction. Additional monitoring will be considered, if necessary, for source identification or for determining whether TMDL allocation targets are being met. All monitoring results will be utilized in the evaluation of whether or not the goals of the Issaquah Creek Basin Water Cleanup Plan for Fecal Coliform Bacteria are being met.

Initial pollution source identification monitoring in Issaquah Creek Basin will focus on the sources of high bacteria in Tibbetts Creek tributary 0170, McDonald Creek valley, the Four Creeks area of Issaquah Creek, Lewis Lane Creek, and North Fork Issaquah Creek. Investigations of sources in all five areas will include potential for on-site septic system failures.

Ecology will initiate compliance water quality monitoring where ambient monitoring shows that adequate progress toward fecal coliform targets is not occurring. Ecology will coordinate compliance water quality monitoring to identify the specific source(s) of fecal coliform pollution, and will refer identified sources to the appropriate agency with technical assistance resources or enforcement authority. Sampling over time will be adjusted to locate the source by narrowing the geographic area where contamination is occurring and, thereby, focus in on the specific source of fecal coliform pollution. This strategy allows implementation of appropriate BMPs in the specific areas of concern, thus maximizing the available resources.

This Water Cleanup Plan requires some monitoring in the Issaquah Creek Basin beyond current ongoing monitoring programs. This plan recommends additional monitoring on Carey Creek, Holder Creek, McDonald Creek, Fifteenmile Creek, and two additional stations on Issaquah Creek mainstem (Figure 1). The monitoring network recommended by this plan includes sampling sites on Issaquah Creek located at May Valley Road and at the crossing of Cedar Grove Road, generally between the middle and upper Issaquah Creek basin. The proposed sampling station IC-CG is located at the downstream edge of the bridge at S.E. 156th Street. This station will assist in isolating fecal coliform pollution sources that originate in the upper Issaquah Creek watershed. Preliminary sampling results for April 13, 2004 (9 cfu/100 mL) indicated no significant contribution of bacteria pollution from upper Issaquah Creek at that time.

Adaptive Management

Implementation of the Issaquah Creek Basin Fecal Coliform TMDL will be adaptively managed such that Issaquah and Tibbetts creeks will meet Washington State's Water Quality Standards by 2010. Opportunities for adaptive management of the Issaquah Creek Basin TMDL implementation include adjusting best management practices, modifying stream sampling frequency and/or locations, conducting special inspections in identified source areas, helping develop and fund water quality projects that address fecal coliform pollution, local educational initiatives, and other means of conforming management measures to current information on the impairment. If water quality standards are met without attaining the load allocation reductions specified in Table 14, then the objectives of this TMDL are met and no further reductions are needed.

Ecology will evaluate sampling results collected by city of Issaquah and King County Department of Natural Resources and will adaptively manage TMDL implementation measures accordingly. The on-going ambient monitoring being conducted by Issaquah and King County will assist in enabling the implementing groups and jurisdictions to revise and shift implementation efforts, as necessary, in order to bring all tributaries into compliance with water quality standards. Ecology will continue to offer grant funding for water quality studies, stream restoration projects, BMP effectiveness evaluations, and for development and implementation of monitoring programs through its annual Centennial Clean Water Fund.

Conclusions

The following conclusions derive from the Issaquah Creek Basin Water Cleanup Plan:

- Water quality monitoring conducted by Issaquah and King County since 1999 verifies that the 1998 listed stream segments are still impaired with bacteria during most of the year.

- Potential bacteria pollution sources include failing on-site systems, possible sewer leaks, agriculture (commercial and small farms), landfills, and wildlife. Stormwater and road runoff often convey contamination accumulated from wildlife, litter, and other sources.

- Streams in Issaquah Creek Basin will meet water quality standards with reductions in target fecal coliform geometric means of from 39 to 96 percent. Progress toward attaining water quality standards will be tracked by comparing current water quality results with targets listed in Tables 7, 8, and 9 of this report.

- The Summary Implementation Strategy for the Issaquah Creek Basin Water Cleanup Plan involves support of existing pollution control programs being conducted by King County, Issaquah, State Parks, Washington Department of Fish and Wildlife (WDFW), a Washington state Department of Transportation (WSDOT), Ecology, and others. In addition, the SIS includes initiation of new projects and approaches that are deemed necessary for water quality improvement in Tibbetts and Issaquah creeks.

- Based on current and planned implementation measures and commitments by King County, city of Issaquah, Ecology, WDFW, and WDOT, all the streams in Issaquah Creek Basin are scheduled to meet water quality standards for fecal coliform by the year 2010.

- Progress toward meeting water quality targets and attaining water quality standards will be tracked and adaptively managed using the proposed monitoring strategy consisting of continuation of Issaquah and King County monitoring programs plus supplemental monitoring by Issaquah, King County, and Ecology. Ecology sampling surveys will initially occur in five focus areas consisting of Tibbetts Creek tributary 0170, McDonald Creek valley, the Four Creeks area, Lewis Lane Creek, and North Fork Issaquah Creek.

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Appendix A

Equations for Statistical Analyses

Appendix A.

Equations for Statistical Analyses

Statistical Theory of Rollback

The statistical rollback method proposed by Ott (1995) describes a way to use a numeric distribution of a water quality parameter to estimate the distribution after applying abatement processes to pollutant sources. The method relies on basic dispersion and dilution assumptions and their effect on the distribution of a chemical or a bacterial population at a monitoring site downstream from a source. It then provides a statistical estimate of the new population after application of a chosen reduction factor to the existing source. In the case of the TMDL, compliance with the most restrictive of the dual fecal coliform criteria will determine the reduction factor needed.

As with many water quality parameters, fecal coliform (FC) counts collected over time at an individual site usually follow a lognormal distribution. That is, over the course of a year's sampling period, most of the counts are low, but a few are much higher. When monthly FC data are plotted on a logarithmic-probability graph (the open diamonds in Figure A-1), they appear to form nearly a straight line.

The 50th percentile, an estimate of the geometric mean, and the 90th -percentile, a representation of the level over which 10% of the samples lie, can be located along a line plotted from an equation estimating the original monthly FC data distribution. In the graphical example, these numbers are 75 cfu/100 mL and 383 cfu/100 mL, respectively. Using the statistical rollback method, the 90th -percentile value is then reduced to 200 cfu/100 mL (Class A 90th -percentile criterion), since 75 cfu/100 mL meets the Class A geometric mean criterion. The new distribution plots parallel to the original and the estimate of the geometric mean for this new distribution, located at the 50th percentile = 39 cfu/100 mL. The resulting geometric mean target represents a sample distribution that would likely have less than 10% of its samples over 200 cfu/100 mL. A 48% FC reduction is required from combined sources to meet this target distribution from the calculation: (383 - 200) / 383 = 0.477 * 100 = 48%.

The following list summarizes the major theorems and corollaries for the Statistical Theory of Rollback (STR) from *Environmental Statistics and Data Analysis* by Ott (1995).

1. If Q = the concentration of a contaminant at a source, and D = the dilution-diffusion factor, and X = the concentration of the contaminant at the monitoring site, then X = Q*D.
2. Successive random dilution and diffusion of a contaminant Q in the environment often result in a lognormal distribution of the contaminant X at a distant monitoring site.
3. The coefficient of variation (CV) of Q remains the same before and after applying a "rollback", *i.e.*, the CV in the post-control state equates to the CV in the pre-control state.

The rollback factor = r, a reduction factor expressed as a decimal (a 70% reduction equates to a rollback factor of 0.3). The random variable Q represents a pre-control source output state and rQ represents the post-control state.

4. If D remains consistent in the pre-control and post-control states (long-term hydrological and climatic conditions remain unchanged), then CV(Q)*CV(D)=CV(X), and CV(X) will be the same before and after the rollback is applied.
5. If X is multiplied by the rollback factor r, then the variance in the post-control state will be multiplied by r^2, and the post-control standard deviation will be multiplied by r.
6. If X is multiplied by the rollback factor r the quantiles of the concentration distribution will be scaled geometrically.
7. If any random variable is multiplied by a factor r, then its expected value and standard deviation also will be multiplied by r, and its CV will be unchanged. (Ott uses "expected value" for the mean.)

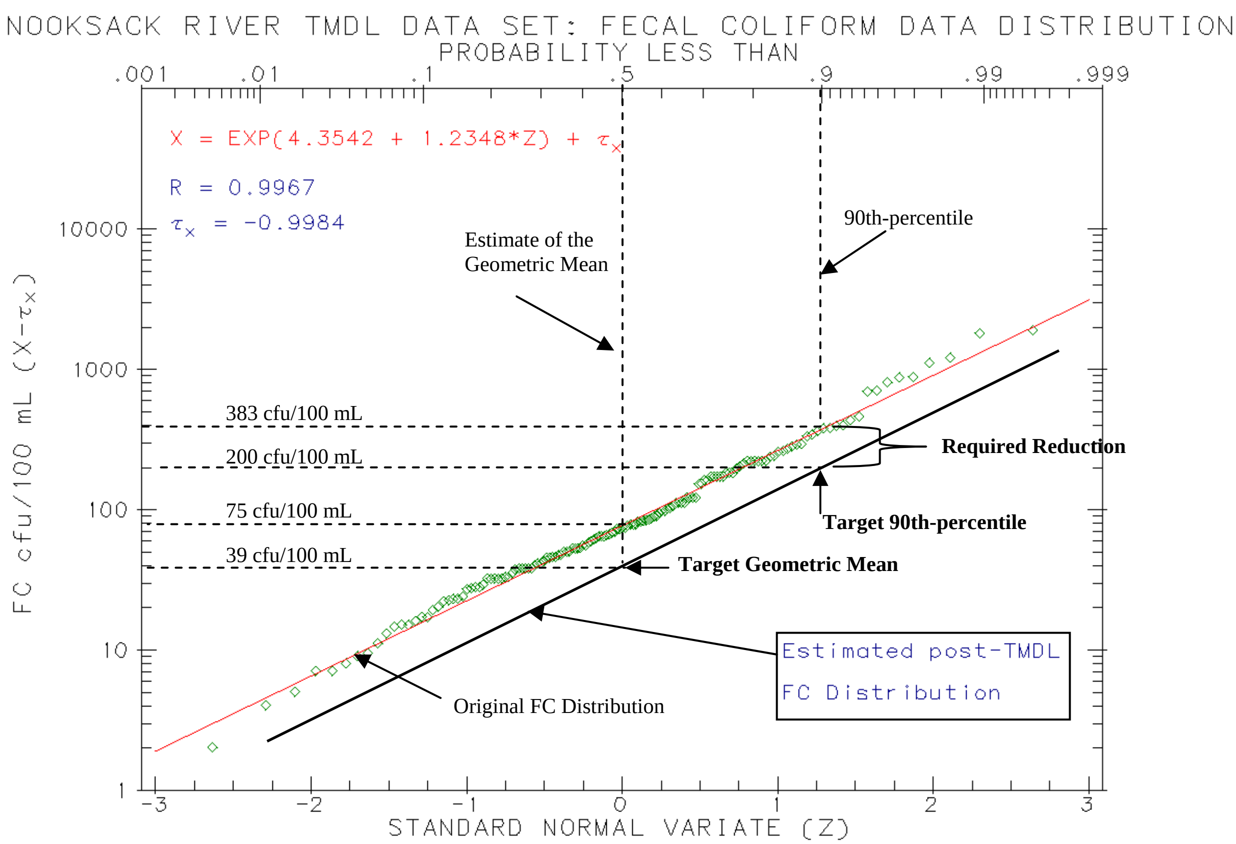

Figure A-1. Graphical demonstration of the statistical rollback method (Ott, 1995) used to calculate the fecal coliform TMDL target on the lower Nooksack River.

Statistical Method for Deriving Percentile Values

The 90^{th}-percentile value for a population can be derived in a couple of ways. The set of fecal coliform counts collected at a site were subjected to a statistically based formula used by the Federal Food and Drug Administration to evaluate growing areas for shellfish sanitation. The National Shellfish Sanitation Program Model Ordinance (USFDA, 2000) states:

The estimated 90^{th} percentile shall be calculated by:

(a) Calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10);
(b) Multiplying the standard deviation in (a) by 1.28;
(c) Adding the product from (b) to the arithmetic mean;
(d) Taking the antilog (base 10) of the results to get the estimated 90th percentile; and
(e) The most probable number (MPN) values that signify the upper or lower range of sensitivity of the MPN tests in the 90^{th} percentile calculation shall be increased or decreased by one significant number.

The 90^{th}-percentile derived using this formula assumes a lognormal distribution of the fecal coliform data. The variability in the data is expressed by the standard deviation, and with some datasets, the calculated 90^{th}-percentile may be greater than any of the measured data.

The Simple Method to Calculate Urban Bacteria Loads from Storm Water

$$L = 1.03\text{ E-3} * R * C * A$$

L = Annual load in billions of colonies
R = Annual runoff in inches
C = Bacteria concentration in #/100 mL
A = Area in acres
1.03 E-3 = unit conversion factor

$$R = P * Pj * Rv$$

P = Annual rainfall in inches

Pj = Fraction of annual rainfall events that produce runoff (assumed 90%, although not necessarily true for western Washington storm intensities)

Rv = Runoff coefficient

Rv = 0.05 + 0.9Ia

Ia = Percent impervious cover

Concentration estimates and imperviousness for various land uses:

Land use type	FC	TP	BOD_5	Impervious Cover
	(cfu/100mL)	(mg/L)	(mg/L)	(%)
Roadway	890	0.26	10	80
Residential	2000	0.26	13	40
Commercial/Urban	980	0.21	15	87
Forest	100	0.10	5	20
Agriculture	3000	0.35	15	30

The 'Simple Method' is taken from Schueler (1987); Controlling Urban Runoff: a Practical Manual for Planning and Designing Urban BMPs.

Appendix B

Public Notice Materials

Focus: Bacteria in the Issaquah Creek Basin

Fecal Coliform Bacteria Cleanup

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Public Meeting:

A community meeting will be held to provide information and receive comments on the Issaquah Creek Basin Water Cleanup Plan.

Tuesday, May 18

6:30 – 8:30 pm

Pickering Barn at 1730 10th Ave NW Issaquah (south of 56th and east of Costco)

Please join us for an Informal Open House with displays-followed by presentations starting at 7:00 pm

Public Comment:

The public comment period will run from May 12 through June 14, when comments must be received. The document is available at the downtown Issaquah Public Library or from Dave Garland (see "Contact" on next page).

Water samples collected in Issaquah and Tibbetts Creeks in recent years show that several stream segments have exceeded state water quality bacteria standards. These bacteria problems will be addressed in the proposed *Issaquah Creek Basin Water Cleanup Plan for Fecal Coliform Bacteria*.

Water Cleanup Plans

A Water Cleanup Plan, also known as a Total Maximum Daily Load (or TMDL), includes the following:

- a process of evaluating water quality problems
- an analysis of the pollutant sources that caused the problems
- a plan to correct the problems

The plan is a tool for implementing measures to bring waters into compliance with state water quality standards.

The Water Cleanup Plan for Issaquah Creek Basin

The City of Issaquah and King County have already done much to restore and clean up Issaquah and Tibbetts Creeks. The Department of Ecology (Ecology) would like to assist in identifying and correcting the remaining pollution sources in the watersheds. Ecology is compiling information on what activities are currently underway, and what additional actions need to take place for Issaquah and Tibbetts Creeks to meet water quality standards.

Potential Sources of Fecal Coliform Bacteria:

Human sources for these bacteria vary depending on whether the watershed has sewers or not. In a sewered watershed, the following sources may contribute to pollution:

- Sewer overflows
- Illegal sanitary connections to storm drains
- Illegal disposal to storm drains
- Landfills

In a non-sewered watershed, failing septic systems are often significant human sources of fecal coliform bacteria and other pollutants.

Potential Sources of Fecal Coliform Bacteria (continued):

Non-human sources for these bacteria include the following:

- Livestock (cattle, horses, poultry)
- Other domestic animals (especially dogs and cats)
- Pigeons, gulls, ducks, geese and other waterfowl
- Rats, raccoons, squirrels, beaver, muskrats, deer, and other wild mammals

Fecal Coliform Facts

Fecal coliform bacteria are used as indicators for disease-causing bacteria (pathogens) in water. Because of the small size of pathogens, they are easily carried by stormwater runoff or other discharges into natural water bodies. Once in a stream, lake, or estuary, they can infect humans through contaminated fish and shellfish, skin contact, or ingestion of water.

- **Bacteria** often settle out of water into bottom sediments, where they can persist and even multiply for weeks or months in the warm, dark, moist and organically-rich conditions. When the sediments are stirred up, the bacteria become re-suspended in the water.[1]
- **Livestock** are major sources of fecal coliform in rural and unsewered urban watersheds, particularly areas of the urban fringe that have horse pastures, small farms, and ranches.[2]
- **Cats and dogs** are primary sources of fecal coliform in urban Puget Sound watersheds, and residential lawns, driveways, and streets are major source areas for bacteria.[3]
- **Domestic sewage** typically is two to three orders of magnitude "stronger" than stormwater runoff in terms of bacteria, and four to five orders stronger than forest runoff influenced only by wildlife sources.[4] This means that the concentration of pollutants in domestic sewage can be up to 100,000 times stronger than stormwater or natural runoff.

Contact Information

This document is on the internet:
http://www.ecy.wa.gov/programs/wq/tmdl/watershed/index.html#nwro. To request copies of the Issaquah Creek Basin Water Cleanup Plan document or for questions, contact Dave Garland, Washington Dept. of Ecology, 3190 160th Ave SE, Bellevue, WA 98008-5452; phone: (425) 649-7031; email: dgar461@ecy.wa.gov.

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2. *Samadpour, M. and N. Checkowitz, 1998. Little Soos Creek microbial source tracking. Washington Water RESOURCE, Spring, 1998. University of Washington Urban Water Resources Center.*
3. *Trial, W., et al., 1993. Bacterial source tracking: studies in an urban Seattle watershed. Puget Sound Notes. 30:1-3*
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Department of Ecology seeks comments on:

Water Cleanup Plan for the Issaquah Creek Basin

WASHINGTON STATE DEPARTMENT OF ECOLOGY

The state Department of Ecology has drafted a water cleanup plan for fecal coliform bacteria in the Issaquah Creek Basin. The plan recommends actions to reduce bacteria levels to meet state water quality standards and improve stream conditions.

Public comment period May 12 through June 14
Open House and Public Meeting
May 18, 6:30-8:30 p.m. at the Pickering Barn
1730 10th Ave NW, Issaquah, WA
(south of 56th and east of Costco)

We welcome your comments and participation at our Open House and Public Meeting on May 18th, and appreciate your interest in improving water quality.

You can review, or obtain a copy of the Water Cleanup Plan at:

- The Issaquah Library, the Ecology Office below
- On the Internet under "Issaquah Creek Basin" at:

http://www.ecy.wa.gov/programs/wq/tmdl/watershed/index.html#nwro

- Or call to request a copy by phone @ 425-649-7041

Please send comments by June 14, 2004, to Dave Garland, Dept. of Ecology, 3190 160th Ave SE, Bellevue, WA 98008-5452, or email dgar461@ecy.wa.gov.
For special accommodation needs, call (425) 649-7041 or (425) 649-4259 (TDD).

Appendix C

Responses to Comments

Response to Comments on the Draft Issaquah Creek Basin Water Cleanup Plan

Ecology received comments on the Draft Issaquah Creek Basin Bacteria Water Cleanup Plan (TMDL) from city of Issaquah, Department of Transportation, King County, and several watershed citizens. Written comments are paraphrased and summarized below. Many of the comments resulted in revisions to the plan and report. The list below summarizes Ecology's responses to significant comments on the draft plan:

1. **Comment**: What is the most sensitive of the beneficial uses in the listed waters? There is very little discussion on what is known about the biological resources in the creeks or tributaries or how the listed impairment is having an impact on the system.

   Response: Primary contact recreation in the streams, and in Lake Sammamish State Park near the mouths of Issaquah and Tibbetts creeks is the most sensitive beneficial use of the bacteria-impaired waters in the basin. Where sources of bacteria are domestic on-site sewage system failures, other unknown household chemicals and contaminants may be having unknown detrimental effects on aquatic life. The relative sensitivities of human primary contact recreation versus potential associated risks to aquatic life to the impairment are unknown. Ecology added language to the Water Cleanup Plan to clarify this point according to this comment.

2. **Comment:** The Issaquah Creek Basin TMDL submittal report states "the public has an increased health risk from contact with waters that are impaired by excessive bacteria concentrations." The risk seems overstated for exceedance of Class AA, since Class A supports primary contact recreation at double the FC concentrations (geometric mean=100 cfu/100mL, 90th percentile=200 cfu/100mL). In addition, the Federal Water Pollution Control Federation's fresh water swimming beach standard is (Part 1:200, Part 2: 400); quadruple the Class AA standard.

   Response: While both Class A (excellent) and Class AA (extraordinary) water quality classifications support the recreational uses of primary contact recreation, sport fishing, boating, aesthetic enjoyment, any beneficial use can be said to be threatened when the water quality exceeds the criteria for that class. In the case of primary contact recreation, exceedance of the fecal coliform standard for Class AA water can present an increased health risk if the concentration continues higher and exceeds Class A (mean: 100 cfu, 90th percentile: 200 cfu). This is more likely to occur if there is a source that causes the mean to rise above 50 cfu, and therefore it can be said that, in this instance, "the public has an increased health risk". Ecology does not administer the Water Pollution Control Federation's (WPCF) fresh water swimming beach standard. Washington's water quality standards for fecal coliform in surface waters (Chapter 173-201A WAC) are more stringent than the WPCF fresh water swimming standard.

3. **Comment**: The "Simple Method Model" (Schueler, 1987) estimates stormwater runoff pollutant load for urban areas, and we believe this does not provide a representative characterization for a non-urban setting. The Simple Method provides a general planning estimate of likely stormwater pollutant export from development sites less then one square mile (640 acres) in size. More sophisticated methods, such as time-step or continuous simulation modeling (e.g., HSPF), may be needed to analyze large and complex watersheds. The Issaquah Creek basin is approximately 61 square miles in size, which would suggest a more complex model is required.

   Response: While the Simple Method was first developed in urban areas around Baltimore, Maryland, the method takes more rural surrounding land uses and their lesser loading characteristics into consideration. The Issaquah Creek Basin TMDL used the Simple Method to determine the relative proportion of loading from the land use categories, not for determining the wasteload allocations themselves.

   We recognize that the Simple Method model does not provide as accurate a stormwater loading characterization, as one would expect from a continuous simulation model like HSPF. The USEPA directive does 'recognize that these allocations might be fairly rudimentary because of data limitations and variability in the system' (Wayland and Hanlon, 2002). The Simple Method addresses quantification of stormwater loads at a 'screening level' scale commensurate with the data currently available in the basin. The model is recommended by the USEPA as providing a 'quick and reasonable estimate of pollutant loadings'. Since the numeric results do not go into the NPDES permit, the model 'loads' suggest relative magnitude from various land use types – not necessarily a highly accurate accounting of loads.

   'Roadway' loads assigned to WSDOT are less than 10 percent of the cumulative fecal coliform loads in all water bodies listed in the Issaquah Creek Basin. These numbers do not appear to be outside of what might be expected for Issaquah Creek. Drainages from adjacent properties into the permit holder's infrastructure are not closely managed and could be contributing loads as well.

   The NPDES permit will only list best management practices (BMPs) that will likely reduce the pollutant loads. WSDOT may already have BMPs in place on the drainage systems discharging to the listed water bodies in the Issaquah Creek Basin. These BMPs can be listed in the TMDL Detailed Implementation Plan that will be written over the coming year. By listing these treatment practices and by better characterizing the potential impact of storm water from WSDOT highways and facilities in future monitoring work, we can more accurately determine the pollutant loads.

4. **Comment**: The impervious cover estimate of 80 percent assigned to roadways appears to be significantly overestimated. A large percentage of WSDOT right-of-ways in Issaquah Creek Basin (I-90, SR 900 and SR 18) are vegetated and the actual percent impervious cover is significantly less than 80 percent. The inaccuracy of the impervious cover estimate is also likely magnified in comparing the rural nature of WSDOT highways in the Issaquah Creek basin to an urban model. The majority of the stormwater runoff in the Issaquah Creek basin is generated as sheet flow that

preferentially infiltrates to groundwater rather than is transported via overland flow to receiving water.

Response: Ecology took the estimate for road right-of-way impervious area directly from the “Simple Method Model” (Schueler, 1987), and did not attempt to estimate the actual roadway impervious area in the basin. Ecology also acknowledges that some roadway runoff in Issaquah Creek Basin infiltrates from sheet flow and does not coalesce everywhere into roadside ditches to enter nearby streams. Ecology may be able to determine where roadside runoff discharges to streams for the Detailed Implementation Plan.

In response to this comment, and still lacking hard data on Issaquah Basin right-of-way imperviousness, Ecology added language to the report to clarify this point and reduced the percent impervious assumption for road right-of-way from 80 to an estimated 65 percent impervious. Because of this adjustment, the estimated maximum loading contribution from state roadway, which is associated with the Tibbetts Creek downstream station, was reduced from 7.7 to 6.4 percent of the total load.

5. **Comment**: Conveyance of contaminants from adjacent land uses to the roadway ditches was not mentioned as part of this analysis. Ecology’s Stillaguamish River Watershed TMDL states “Conveyance of contaminants from adjacent land uses to roadway ditches was not considered for this level of analysis.” The Issaquah Creek Basin TMDL does not specify whether this issue has been considered in the analysis. It is important to consider contaminant conveyances because all land uses except Forest report higher concentration estimates for fecal coliform than Roadway. In addition, all of the sub-basins listed show significantly higher percentages of residential and agricultural land uses. Given the relatively low proportion of roadway, the conveyance of contaminants from adjacent land uses appears to be of greater significance than roadway contributions to the roadside ditches.

   Response: We agree that adjacent land uses may have more impact on water quality in roadside ditches than the roads themselves. WSDOT and other jurisdictions under the stormwater permit system are responsible for these pollutant loads because they manage the conveyance system. Where runoff from adjacent land uses affects the quality in state or county roadside ditch flow, the state or county is considered responsible for the quality of discharges from those ditches to water bodies of the state. It is up to the owner of the conveyance to ensure that pollutant loads from adjacent land uses are adequately treated. Ecology looks forward to working with state and county agencies to bring about improved road design, stormwater treatment, and best land use practices to help meet Washington’s water quality standards for fecal coliform in surface waters (Chapter 173-201A WAC).

6. **Comment**: WSDOT is concerned with the process of assigning a wasteload allocation (WLA) based solely on NPDES permits for stormwater systems, particularly when there is no data to confirm the WLA. In rural jurisdictions with few or no permit holders other than WSDOT, and an inadequate data set to characterize nonpoint sources for load allocation, a WLA does not appear justified.

   Response: The TMDL evaluation attempts to use the best available data to address the potential sources of pollutants. Bacteria loading from road runoff in Issaquah Creek Basin will be characterized more accurately in the process of implementing the TMDL. Meanwhile, the Issaquah Creek Basin TMDL assigned estimated load allocations to both point and nonpoint sources as required by law. The TMDL evaluation suggests that nonpoint sources will require more implementation work and greater pollutant reductions than the point sources to reduce pollutant loads in the basin.

   The focus in the Water Cleanup Plan on stormwater wasteload allocations is not because municipal storm water is the most significant source of bacteria to Issaquah basin streams, but because EPA requires quantified WLAs in approvable TMDLs.

7. **Comment**: With regard to setting a WLA for fecal coliform, in particular when a reduction in fecal coliform load may be required, the *Stormwater Management Manual for Western Washington* (Ecology Publications 99-11 through 99-15) does not provide any best management practices that are designed for reduction of fecal coliform, nor does the 2004 *Highway Runoff Manual*. Will Ecology be establishing reductions in the fecal coliform WLA for WSDOT? If so, in order for Ecology to set meaningful goals for reducing fecal coliform in stormwater discharges, it will first need to establish a means of meeting those goals.

   Response: The Stormwater Management Manuals are not the only reference tool available to engineers and planners for designing treatment systems to reduce fecal coliform bacteria. Agricultural engineers have evaluated the bacteria removal efficiencies of various BMP systems, *e.g.*, riparian buffers, lagoons, wetlands, and settling ponds. Most of the treatment systems we have seen in the journal literature appear to take advantage of the tendency of bacteria to adsorb to certain types of sediment particles. Treatment systems that reduce sediment or allow water to percolate through soil or media may be the most effective. The local Natural Resource Conservation Service office or county conservation district may be able to help you evaluate your treatment systems. Ecology staff looks forward to working with WSDOT staff in evaluating these processes.

   Ecology does not anticipate reducing Issaquah Basin bacteria WLAs in the near future, but may eventually do so if implementation monitoring proves the WLAs are overestimated and fecal coliform loading is found to be from other nonpoint sources.

8. **Comment**: The Detailed Implementation Plan that will follow should provide more clarification on what exactly can and should be done to effect improvements to water quality. This should alleviate the concern that we have of whether the TMDL process will be effective in the end.

Response: Ecology agrees that water cleanup implementation monitoring will help identify and correct fecal coliform point and nonpoint sources. Exact sources must be identified in order to know what should be done to correct the impairment.

9. **Comment**: **Focus on the three action streams in Issaquah**. While it is a good idea to identify specific problem areas that can be the focus of initial cleanup actions, the three locations identified in the TMDL are all in Issaquah. Given the high bacteria levels entering the city, there are other likely problem areas in the county that should be given special consideration. The Four Creeks area would be a good candidate, as well as areas with large numbers of livestock in close proximity to streams.

   Response: Ecology agrees that the draft Water Cleanup Plan inordinately focused on the city of Issaquah due to the relative higher resolution of monitoring data in the city. In accordance with this comment, Ecology added two water cleanup focus areas located in King County to the existing three water cleanup focus areas located in Issaquah. In addition to early action focus on Tibbetts tributary 0170, Lewis Lane Creek and North Fork Issaquah Creek, the cleanup plan now also recommends early focus on McDonald Creek valley and the Four Creeks area of Issaquah Creek.

   The bacteria cleanup plan also recommends additional stream monitoring in the King County portion of the basin in order to bring better resolution on source locations in the county.

10. **Comment**: **Summary Implementation Strategy.** The Water Cleanup Plan seems to rely on a 'status quo' of existing programs. The fact that fecal coliform contamination is still a big problem in Issaquah Creek Basin would indicate that, unless existing efforts are greatly expanded, conditions will not change significantly in the future. While addressing this comment may be more appropriate in the Detailed Implementation Plan, the Summary Implementation Strategy could make a better attempt at identifying shortcomings in current programs, and identifying new and more effective methods to control bacteria contamination.

    Response: Ecology agrees that additional information is needed on effectiveness of existing programs and that some existing programs will have to be expanded to reach the goals of the Water Cleanup Plan. Water quality monitoring is the first existing program in need of expansion in order to identify the nature and location of the bacteria sources and the programs needed to address them.

11. **Comment**: Substandard onsite sewer systems are a likely problem throughout the basin. Consideration should be given to bolster local health department programs that need to comply with state health regulations (passed in 1995) that require inspection and maintenance of these systems. While Issaquah currently has a limited onsite septic system inspection program (for properties along existing public sewer lines only), to our knowledge a countywide program has not been implemented by Seattle-King County Department of Health even though state law required it by 2000.

Response: We agree. Support of health department programs requiring inspection and maintenance of on-site septic systems will be a priority in the implementation of the bacteria cleanup. This is especially true for situations where there are failing systems discharging directly to streams. We are interested in and support the implementation of the countywide program, which is cited.

12. **Comment**: **Monitoring Strategy -** we recommend establishing more than one monitoring location in the Issaquah Creek basin upstream of city of Issaquah. Data presented in the TMDL identifies very high fecal coliform concentrations entering the city, but no data are available in the county to assess where that contamination is coming from. This will require an in-depth evaluation using new data collected in the county jurisdiction. The city and county are currently exploring a cooperative monitoring program that includes seven (7) new sampling locations in the County on Issaquah Creek, East Fork Issaquah Creek, and North Fork Issaquah Creek. When this data is available it should be incorporated into the TMDL to reassess bacteria contaminant sources and load allocations in the watershed.

Response: While the draft monitoring strategy envisioned miscellaneous sampling investigations in these tributary streams, Ecology agrees they will be sampled over a long enough period to justify establishing permanent sampling stations. In addition to the proposed monitoring station on Issaquah Creek at Cedar Grove Road (IC-CG), Ecology recommends five more sampling sites to the proposed Issaquah Creek Basin monitoring network.

These sampling locations are plotted in Figure 1 of the report and may be altered pending access permission and other sampling issues. The monitoring network will be verified in the Detailed Implementation Plan. Ecology is interested in coordinating sampling with the Issaquah Basin monitoring program currently being developed by Issaquah and King County. The proposed additional sampling sites include:

CC-18	*Carey Creek at Hwy 18*
HC-D	*Holder Creek downstream*
MC-D	*McDonald Creek downstream*
IC-MV	*Issaquah Creek at May Valley Road*
FC-D	*Fifteenmile Creek downstream*

At a minimum, this TMDL recommends the city of Issaquah and King County continue water quality monitoring at over 16 stations in the Issaquah Creek Basin.

13. **Comment**: Other than storm water sources are there any other point sources that need to be addressed in the watershed, *i.e*., small businesses, farms or horse ranches that may have permits?

Response: There are no other permitted point sources in the Issaquah Creek Basin that have bacteria as a concern in their discharge. If any in need of permitting are found during the course of implementing the TMDL, Ecology will initiate permitting for those sources.

14. **Comment**: It would also be helpful if the report quantified the agricultural sources in the watershed to identify for instance how many small farms there are and where. A map illustrating the various land uses would also support your discussions.

    Response: King CD is currently working on a Centennial Clean Water Fund project to provide small farm BMP education in Issaquah Creek Basin through workshops, farm tours, technical assistance, and farm plans. In the process of working with the CD on formulating the Detailed Implementation Plan (DIP), farm sources will be characterized and the DIP will include a more specific quantification of agricultural sources using a map.

15. **Comment**: Since sedimentation, nutrients and temperature increases are identified in a number of sections in the document as a problem, how will this be addressed. Is there enough data to determine if sediments and other parameters should be recommended for listing in the next 303(d) List update? Given that areas such as Tiger Mountain are slated for substantial commercial harvest, and overall urban growth continues, I anticipate some of these problems may worsen over the next decade.

    Response: This bacteria Water Cleanup Plan does not directly address sediments, nutrients, and temperature. However, in some instances, there may be reduction in other parameters as bacteria sources are controlled.

16. **Comment**: The report would be improved with a map showing the listed waterbody segments.

    Response: The Detailed Implementation Plan for Bacteria Water Cleanup in Issaquah Creek Basin will include a map showing listed waterbody segments for 1998 and 2004 303(d) lists.

17. **Comment**: Wildlife is mentioned as a contributing factor to the fecal load but it is not clear how this is accounted for in the percent load from land use types. Is this considered background?

    Response: The loading contribution from wildlife is considered natural background unless land use activities result in attracting the wildlife. The wildlife contribution to the overall loading will become better defined with further monitoring and source control. The report was modified in accordance with this comment.

18. **Comment**: Overall, given the amount of growth this area has received and the amount of reductions needed to attain the water quality goal, the section on reasonable assurance may need to be expanded.

Response: Existing monitoring networks are in the process of being expanded and additional sampling surveys are committed to by Ecology, which should help identify whether contamination is from existing or new development. Ecology will work with King County, WSDOT, and the city of Issaquah to ensure that new development minimizes additional fecal coliform to Issaquah Basin streams.

19. **Comment**: King County has reservations about the use of the Statistical Rollback Method with what appears to be relatively small sample sizes.

Response: The statistical rollback method allows establishment of best estimate water quality targets using available data. The estimates are valid even for small sample groups (i.e., 8-12) if the sample population is bias-free. Numbers of samples used to establish targets for the Issaquah Creek TMDL ranged from 11 to 44. One of the assumptions used in the rollback method assumes equivalent variances of the pre-management data set and the post-management data. The frequency of high sample values should decrease as implementation controls pollution sources, which should reduce the variance and 90th percentile of the post-management condition (Ott, 1995). Control of contamination sources may also reduce bias in sample populations for the effected monitoring stations. In other words, statistical characterization of water quality samples should become more accurate as implementation progresses.