Whatcom Creek Fecal Coliform Total Maximum Daily Load Report

Water Quality Improvement Plan

DRAFT

September 2006
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Water Quality Program

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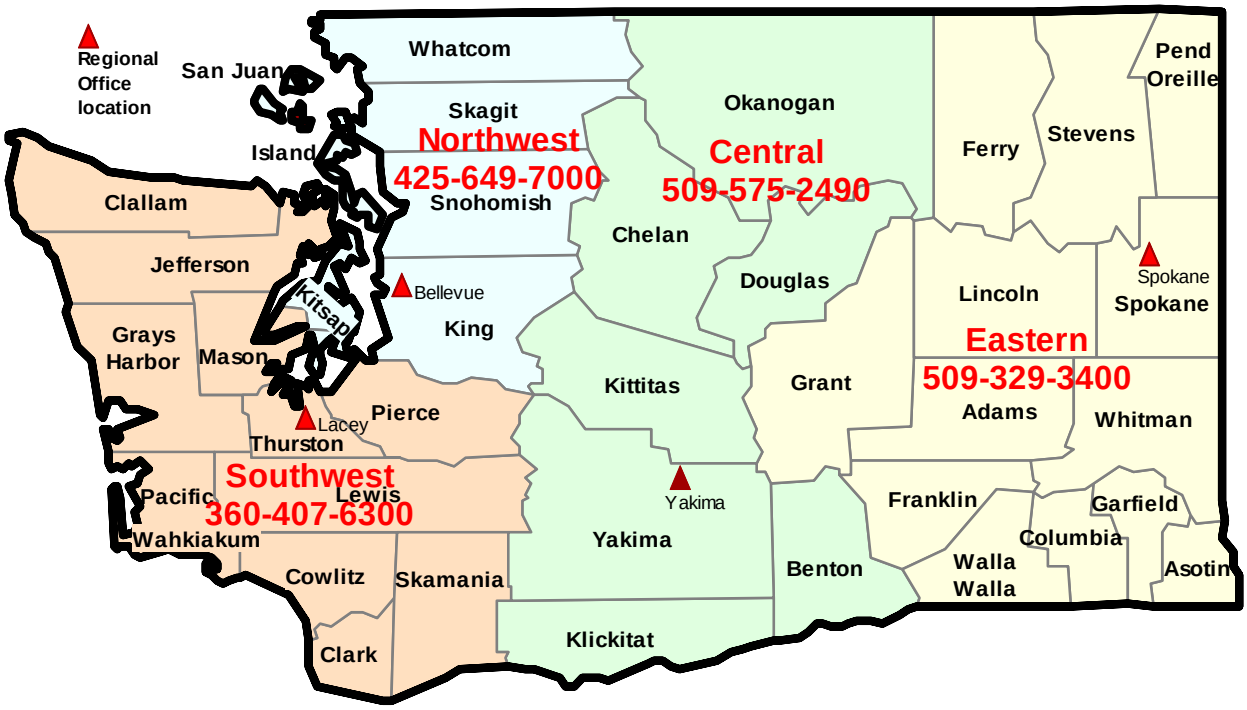

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Glossary

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

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

Fecal Coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within twenty-four hours at 44.5 plus or minus 0.2 degrees Celsius. FC are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100mL).

Geometric Mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either 1) taking the nth root of a product of n factors, or 2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Load Allocation (LA): The portion of a receiving waters' loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources. Traditionally allocations are expressed as a mass allowed per day. In this TMDL allocations are a distribution of concentrations of bacteria.

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

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

Municipal Separate Storm Sewer Systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (i) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, storm water, or other wastes and (ii) designed or used for collecting or conveying storm water; (iii) which is not a combined sewer; and (iv) which is not part of a publicly owned treatment works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

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

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

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

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

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

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

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

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitute one type of water quality-based effluent limitation. Traditionally allocations are expressed as a mass allowed per day. In this TMDL allocations are a distribution of concentrations of bacteria.

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

This report depended heavily on the Whatcom Creek Fecal Coliform TMDL Study (August 2004; 04-03-015), published by the Washington State Department of Ecology with significant contribution from the city of Bellingham. The people who worked on that report have helped with preparation of this report and readers are encouraged to re-read the acknowledgments when referring to that document and to thank the participants when the opportunity presents.

Executive Summary

What is a Water Quality Plan or Total Maximum Daily Load (TMDL)?

The terms Water Quality Plan, Water Cleanup Plan, and Total Maximum Daily Load (TMDL) are all used to describe the same thing - a process to reduce water pollution.

This report describes the type, amount, and sources of water pollution in a water body, how much pollution needs to be reduced or cut out to meet water quality standards, target pollution reduction levels, and recommendations to control the pollution. Also included are suggested actions, developed by local organizations, citizens, and the Washington State Department of Ecology (Ecology) to ensure clean water and the success of this TMDL.

After the reductions are achieved, the sum of the wasteload allocations, load allocations, and the margin of safety (if it is necessary) must not exceed the loading capacity as defined in the TMDL.

Why is a TMDL project being done in this watershed?

Whatcom Creek has been identified by Ecology as having too many fecal coliform bacteria in the water. The presence of fecal coliform bacteria indicates fecal matter from warm blooded animals has entered the water, increasing the risk that human contact with the water may result in illness. The city of Bellingham did a study of the sources of bacteria entering Whatcom Creek and found that all of the major tributaries entering the creek also had too many fecal coliform bacteria. For the water to be safe for the citizens of Bellingham, the number of bacteria entering the water must be reduced to meet a two part criterion. The geometric mean or "typical" concentration of bacteria in the water will not exceed 100 colony forming units (cfu) per 100 ml *and* no more than 10 percent of the samples will exceed 200 cfu /100 ml. For each tributary and for Whatcom Creek, the reductions needed to meet both parts of the criterion are calculated and the larger of the two reductions is used to estimate the distribution of bacterial concentrations. The distribution is described both as a percentage reduction from the existing distribution of bacterial concentrations and as a target geometric mean. This is a typical approach for bacteria TMDLs and is documented in the *Whatcom Creek Fecal Coliform Total Maximum Daily Load Study* in Appendix A-1.

Watershed description

Whatcom Creek has Lake Whatcom at its head and Bellingham Bay at its mouth. The creek and its tributaries carry stormwater runoff from central Bellingham. Figure 1 shows the relationship of the Whatcom Creek Watershed to Lake Whatcom and Bellingham Bay. The land cover in the watershed spans all of the typical urban land covers including parks and open space, residential, commercial and light industrial.

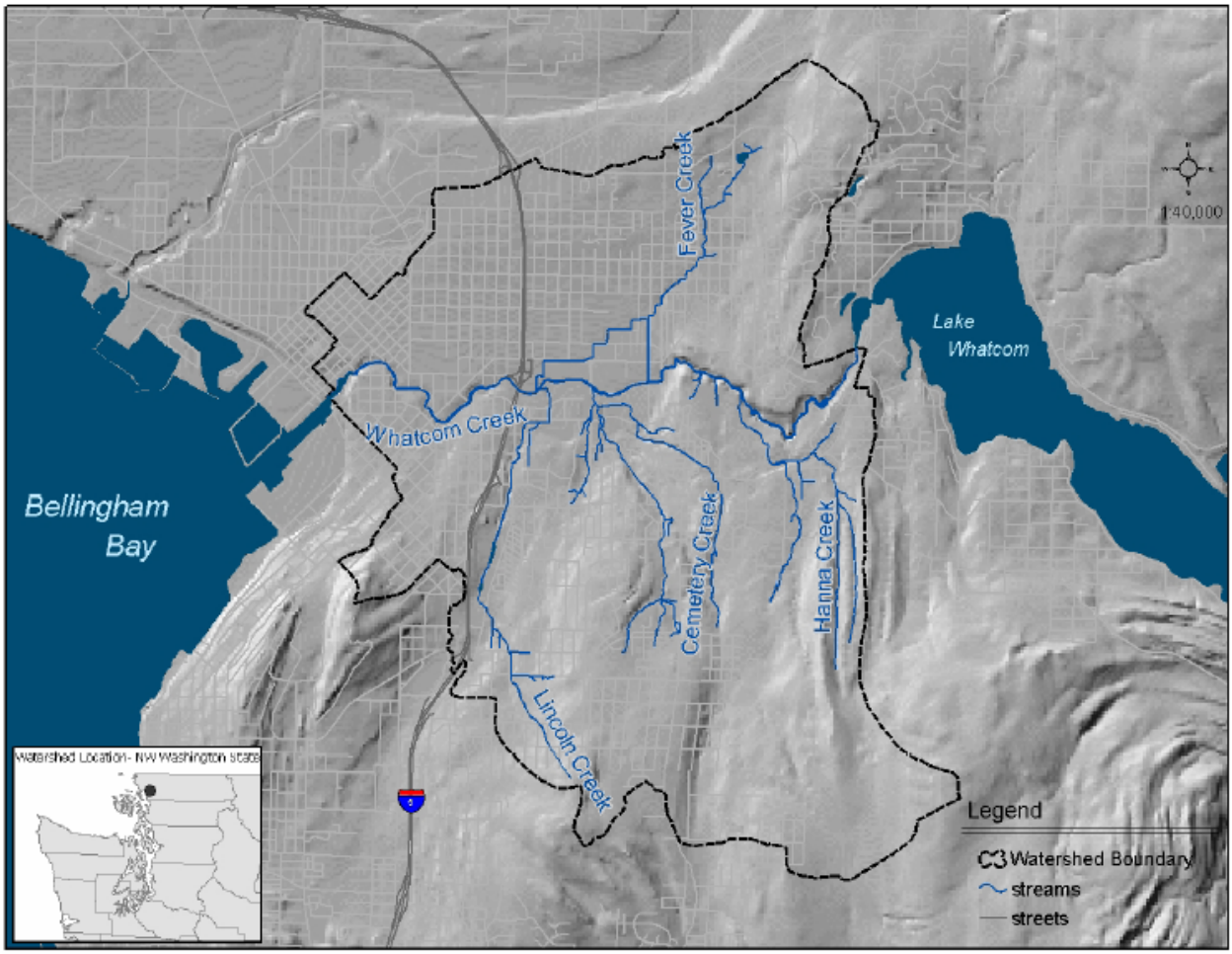

Figure 1 - Whatcom Creek Watershed

Allocations summary

Allocations will be a distribution of bacterial concentrations, expressed as a percent reduction from the existing distribution at one of the stations where sampling for this study was conducted. The resulting distribution is also characterized as a target geometric mean. The geometric mean of the concentration of bacteria will be used to measure progress toward meeting the reductions. The target geometric mean represents the expected geometric mean after reductions have been achieved. It is not appropriate to define the critical flow condition and calculate the mass or number of bacteria because many sources of pollution are stormwater driven.

The wasteload allocations are equal to the load allocations. That is, the same distribution of bacterial concentrations apply to discharges from sources covered by an NPDES permit as apply to sources not covered by an NPDES permit.

Sites with construction or industrial NPDES stormwater permits are potential sources of bacteria in the Whatcom Creek watershed. The Washington State Department of Fish and Wildlife Whatcom Falls Fish Hatchery is the only non-stormwater discharge authorized to Whatcom Creek. The discharge from the hatchery may contain bacteria from wildlife such as bird fecal mater or bacteria withdrawn from Lake Whatcom.

The city of Bellingham and Whatcom County will be covered by a municipal stormwater NPDES permit, currently under development, and due to be issued after the submittal of this TMDL . At this time, the actual area that contributes storm water to the municipal stormwater system is not known with great precision. The city has completed mapping of their drainage system in the water shed, but the actual divides between what enters a storm system and what drains directly to ground or the receiving water may never be known with great precision. As land is developed, the area generating storm water that is covered by the permit may expand. This is especially true in the urban growth area in Whatcom County.

The Washington Department of Transportation (DOT) is also covered by an NPDES Municipal Stormwater permit, which will be re-issued after this TMDL has been submitted. Drainage patterns have not been identified at this time to confirm that DOT has discharges covered by a permit into Whatcom Creek, but it is very likely that DOT has discharges covered in this TMDL.

All dischargers, both those covered by permits and those not covered, are expected to meet the target distribution of bacterial concentrations established for the relevant watershed in their discharge at the end of five years. The target distribution expressed as percent reduction and as a target geometric means for each of the tributary watersheds and for the area that directly discharges to Whatcom Creek are summarized below in Table 1 and shown in Figure 2. In a classical mass based allocation, this would mean an allocation prorated on the storm water generated. In that case, if an area was converted from generating storm water that could be discharged without a permit to an area requiring a permit for stormwater discharges, it would require altering the load and wasteload allocations. However, in this case both wasteload allocations and load allocations are expressed as a distribution of bacterial concentrations. Plus the wasteload allocation and the load allocation are equal. Therefore, the TMDL will not need to be altered. If, in the future an area requires coverage under an NPDES permit that does not now require an NPDES permit, the load allocation associated with the area will be retired and an equal wasteload allocation will be available to the permit holder for their discharge. Because the resulting sum of all allocations will still be less than the loading capacity, the TMDL will not be modified.

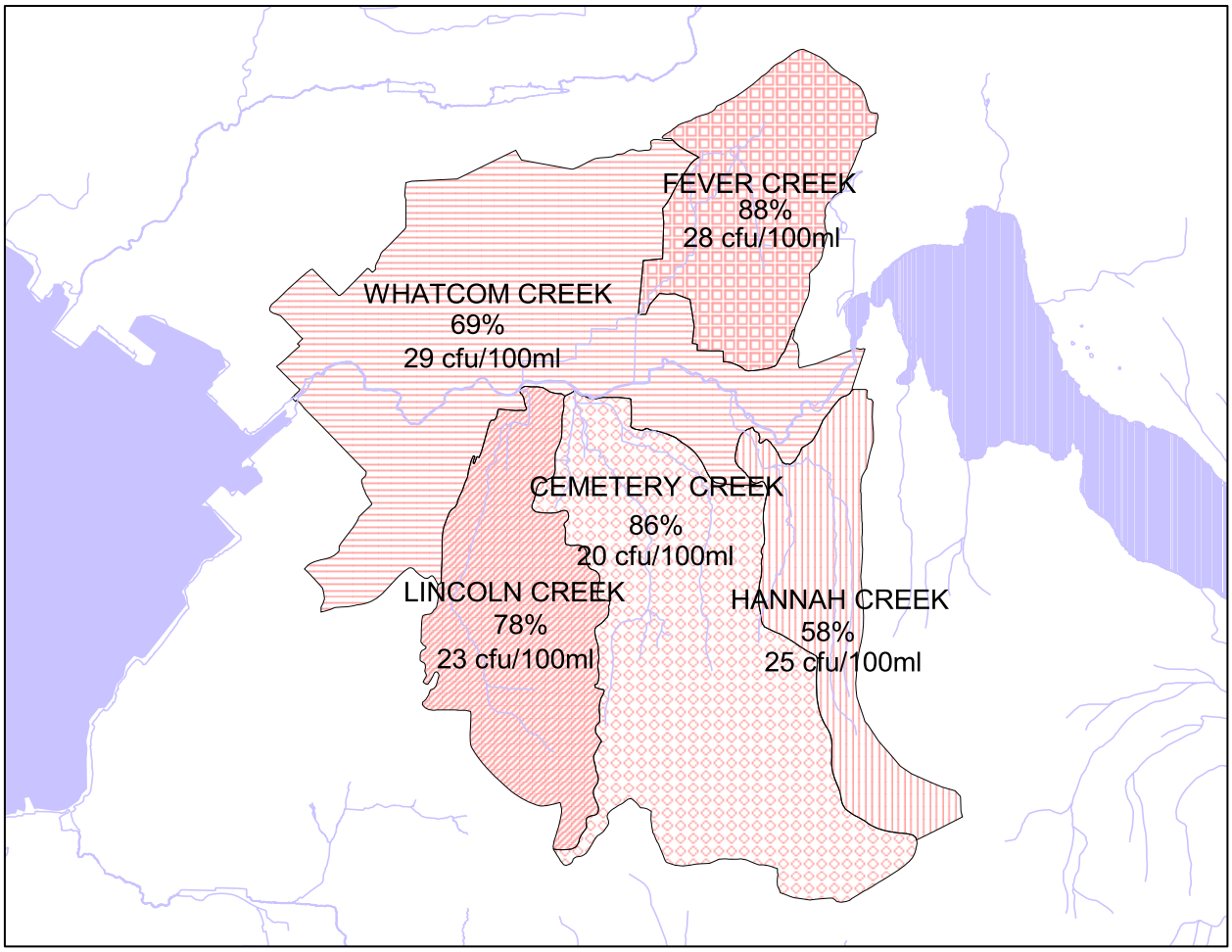

Figure 2 - Whatcom Creek TMDL sub-basins, wasteload allocations, load allocations and target geometric means

Table 1 – Reductions and Ultimate Target Geometric Means

Watershed	% reduction	Target GM(cfu/100ml)
Hanna Creek	58	25
Fever Creek	88	28
Cemetery Creek	86	20
Lincoln Creek	78	23
Whatcom Creek	69	29

The wasteload allocations will be implemented in permits with a suite of actions that will result in meeting the target geometric means within five years of the submittal of the detailed implementation plan to EPA. Interim targets will be established in a detailed implementation plan to guide adaptive management plans insuring that progress is made toward meeting the target geometric means. The detailed implementation plan will be developed in the year that follows approval of the TMDL. The target geometric means will continue to function as a guide to adaptive management in order to maintain the water quality.

Permit writers for the facilities that have a very low likelihood of approaching their waste load allocation may document the in the permit fact sheet that no monitoring is necessary to ensure compliance with the wasteload allocation.

Decisions

Permitted and non permitted sources will have the same target distribution of bacterial concentrations for a wasteload allocation or a load allocation respectively. The target distribution is based on the percentage reduction necessary for compliance with water quality standards at the representative station in the drainage where they discharge. The metric used to measure progress toward meeting the distribution will be the target geometric mean of the target distribution.

The city of Bellingham and Whatcom County will take the lead in achieving non point source reductions. The primary means of doing so will be to apply the same source control methods to sources not covered by their stormwater permit within the area drained by Whatcom Creek and its tributaries, as they apply to sources that are covered by their permit. This will provide reasonable assurance that the load allocations will be reduced so that wasteload allocations do not have to be further reduced.

Next steps

Within the next year, a detailed implementation plan will be developed. The plan will establish the interim targets and monitoring responsibilities of each permitted discharger. The plan will also document the actions that are to be taken that are expected to meet the targets and the actions that will be taken if interim and or ultimate targets are not met. The monitoring responsibilities and the actions believed necessary to meet the interim and ultimate targets, and the actions to take when targets are not met will become part of the various permits when they are re-issued.

Whatcom Creek Fecal Coliform TMDL

Purpose

Section 303(d) of the federal Clean Water Act mandates that states establish Total Maximum Daily Loads (TMDLs), or water clean up plans for surface waters that do not meet standards after application of technology-based pollution controls. The U.S. Environmental Protection Agency (EPA) has established regulations (40 CFR 130) and developed guidance (EPA, 1991) for establishing TMDLs.

Under the Clean Water Act, every state has its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses, such as cold water biota and drinking water supply, and criteria (usually numeric) to achieve those uses. When a lake, river or stream fails to meet water quality standards after application of required technology-based controls, the Clean Water Act requires that the state place the water body on a list of "impaired" water bodies and to prepare an analysis called a **Total Maximum Daily Load (TMDL)**.

The goal of a TMDL is to ensure impaired waters will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of a given pollutant, which can be discharged to the water body and still meet standards, called the **loading capacity,** and allocates that load among the various sources. If the pollutant comes from a source that has an NPDES permit, typically a discrete source (referred to as a **point source**) such as an industrial facility's discharge pipe, that facility's share of the loading capacity is called a **wasteload allocation**. If it comes from a diffuse source (referred to as a **nonpoint source**) such as a farm, that facility's share is called a **load allocation**.

The TMDL must also consider seasonal variations and include a **margin of safety** that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. The sum of the individual allocations and the margin of safety must be equal to or less than the loading capacity.

The Washington State Department of Ecology (Ecology) is establishing a TMDL for Whatcom Creek and its tributaries Hanna, Fever, Cemetery, and Lincoln creeks, to address impairments due to bacteria. The 1998 303(d) list identifies Fecal Coliform impairments on Whatcom Creek. The *Whatcom Creek Fecal Coliform Total Maximum Daily Load Study* (Shannahan et al 2004) identified impairments on the tributaries. The impairments are now documented on the 2004 Section 303(d) list of impaired water bodies. The "Listing ID #" used as a unique identifier for the 2004 list is used in to identify the segments.

Table 2 - List of impaired water bodies addressed by this TMDL

Water Name	Tier	Range	Section	Listing ID #
Whatcom Creek	38N	03E	30	16408
Cemetery Creek	38N	03E	29	38957
Fever Creel	38N	03E	21	39089
Fever Creel	38N	03E	29	39090
Lincoln Creek	38N	03E	29	39112
Whatcom Creek	38N	03E	28	39033
Whatcom Creek	38N	03E	29	39162

The five elements of Whatcom Creek Fecal Coliform TMDL as required by the Clean Water Act are:

Loading capacity

The loading capacity for this TMDL is based on a two part criterion in the Water Quality Standards. The standards recognize that bacteria concentrations vary over time. Neither part of the criteria describes a maximum concentration for a single sample, but together, the two parts describe a maximum allowable distribution of concentrations of bacteria. The implementation strategy will be designed to control sources to reduce bacteria concentrations to meet the most stringent part of the bacteria criterion. All concentrations are expected to be reduced by the same percentage. The sources that will remain after the reductions are primarily stormwater runoff derived. Therefore, the loading capacity is a distribution that meets both parts of the water quality criterion that is a distribution that has a geometric mean that does not exceed 100 cfu/100 ml and a 90^{th} percentile that does not exceed 200 cfu/100 ml.

Wasteload allocation

Several sources of storm water discharged to Whatcom Creek and its tributaries are covered by NPDES discharge permits. One source has non stormwater discharge. That source of non-stormwater discharge should not contain bacteria unless contaminated by wildlife or background bacteria that is passed through. The same concentration based allocation will therefore be made to all NPDES permitted dischargers.

Load allocations

Load allocations will be met by applying the same controls used by the city of Bellingham to meet the wasteload allocations. The allocation will be in the form of a distribution that is based on reductions from the existing distribution of bacteria at the monitoring station downstream of the site. The amount of reduction from the existing distribution is that which is required to meet both parts of the water quality criterion.

Margin of safety

The margin of safety is not strictly calculated or allocated in this TMDL. Rather, conservative assumptions have been used throughout the analyses to achieve an implicit margin of safety..

Seasonal variation

There is not a relationship between concentration and flow in Whatcom Creek and its tributaries. Violations can occur under any flow and in any season. Therefore no critical season can be identified.

Watershed description

Whatcom Creek flows from Lake Whatcom in the east to Bellingham Bay on the west. It runs through the city center and receives stormwater runoff from park, residential, commercial, and light industrial lands. It is popular for fishing and swimming in season and supports a fish hatchery at the mouth. See Figure 1.

There are shellfish beds on the west side of Bellingham Bay. Those shellfish beds are both sensitive to bacteria contamination and important to the Lummi Nation. However the bacteria source that most heavily impacts the shellfish bed is the Nooksack River. The Nooksack River TMDL established a target geometric mean for fecal coliform bacteria of 39 cfu/100 ml. The impact of the Nooksack River on the shellfish beds after TMDL goals are met was analyzed and predicted to be supportive of shellfish harvest. Whatcom Creek is much more remote from the shellfish beds so a separate analysis of Whatcom Creek's effect on the shellfish beds has not been pursued.

Pollutant sources are typical of urban sources. Human waste from leaking sewers and or any residences that have not been connected to the sewer system can contribute sources of bacteria. Each sewer connection will typically contribute bacteria at high concentration but low volumes. Domestic animal waste from pet waste that is not collected or is disposed of improperly can contaminate surface water. Wild life sources can also be significant. Typical urban wildlife sources would be from birds that have deposited waste that enters the storm drainage system through roof drainage.

There is only one source of non stormwater discharge into Whatcom Creek or its tributaries authorized by an NPDES permit. A fish hatchery in the park near the head of the creek discharges water after it has been cycled through rearing ponds and raceways. As fish are not warm blooded, the greatest potential for bacteria contamination would be through birds over the rearing ponds and pre-existing bacteria found in the water when it is withdrawn from Lake Whatcom.

Applicable Water Quality Standards

Within the state of Washington, water quality standards are published pursuant to Chapter 90.48 of the Revised Code of Washington (RCW). Authority to adopt rules, regulations, and standards as are necessary to protect the environment is vested with the Department of Ecology (Ecology). Under the federal Clean Water Act, the EPA Regional Administrator must approve the water quality standards adopted by the state (Section 303(c)(3)). Through adoption of these water quality standards, Washington has designated certain characteristic uses to be protected and the criteria necessary to protect these uses [Washington Administrative Code (WAC), Chapter 173-201A]. These standards were last adopted in July 2003.

This TMDL is designed to address impairments of primary contact recreation uses by excessive fecal coliform bacteria concentrations.

Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses, based on the expected use of the water. In the state water quality standards, fecal coliform is used as an "indicator bacteria" for the state's freshwaters (e.g., lakes and streams). Fecal coliform in water "indicates" the presence of waste from humans and other warm-blooded animals. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold blooded animals. The fecal coliform criteria are set at levels that have been shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

The "Primary Contact" use is intended for waters "where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and waterskiing." More to the point, however, the use is to be designated to any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat. Since children are also the most sensitive group for many of the waterborne pathogens of concern, even shallow waters may warrant primary contact protection. To protect this use category: "Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

Compliance is based on meeting both the geometric mean criterion and the ten percent of samples (or single sample if less than ten total samples) limit. These two measures, used in combination, ensure that bacterial pollution in a water body will be maintained at levels that will not cause an excessive risk to human health. Attainment of TMDL goals will be measured based on seasonal (wet and dry) data sets.

The fecal coliform criterion used in the state standards for excellent waters (the relevant criterion for Whatcom Creek) are designed to allow seven or fewer illnesses out of every 1,000 people engaged in primary contact activities. Once the concentration of fecal coliform in the water reaches the numeric criterion, human activities are not allowed that would increase the concentration above the criterion. If the criterion is exceeded, the state will require that human activities be conducted in a manner that will bring fecal coliform concentrations back into compliance with the standard. If natural levels of fecal coliform (from wildlife) cause criterion to be exceeded, no allowance exists for human sources to measurably increase bacterial pollution further.

Study findings and load analyses

The technical study upon which this TMDL is based has been separately published as Ecology Publication No. 04-03-015 and titled *Whatcom Creek Fecal Coliform Total Maximum Daily Load Study*. The description of the methods, results, and conclusions contained in that study will not be repeated except as necessary to describe the loading capacity, load allocation, wasteload allocations, and the margin of safety.

In the study, all of the tributaries (Hanna, Fever, Cemetery and Lincoln) exceeded one or both of the parts of the bacteria criterion. Whatcom Creek was shown to be meeting the criterion at Valencia Street and above but failing to meet the criterion at James Street and below. The streams that are known to violate the criterion are shown with thick lines in Figure 3. The dark thin line is the reach of Whatcom Creek shown by sampling to meet criterion. The upper reaches of the tributaries are shown in thin light lines to represent that there is no data to asses the upper reaches.

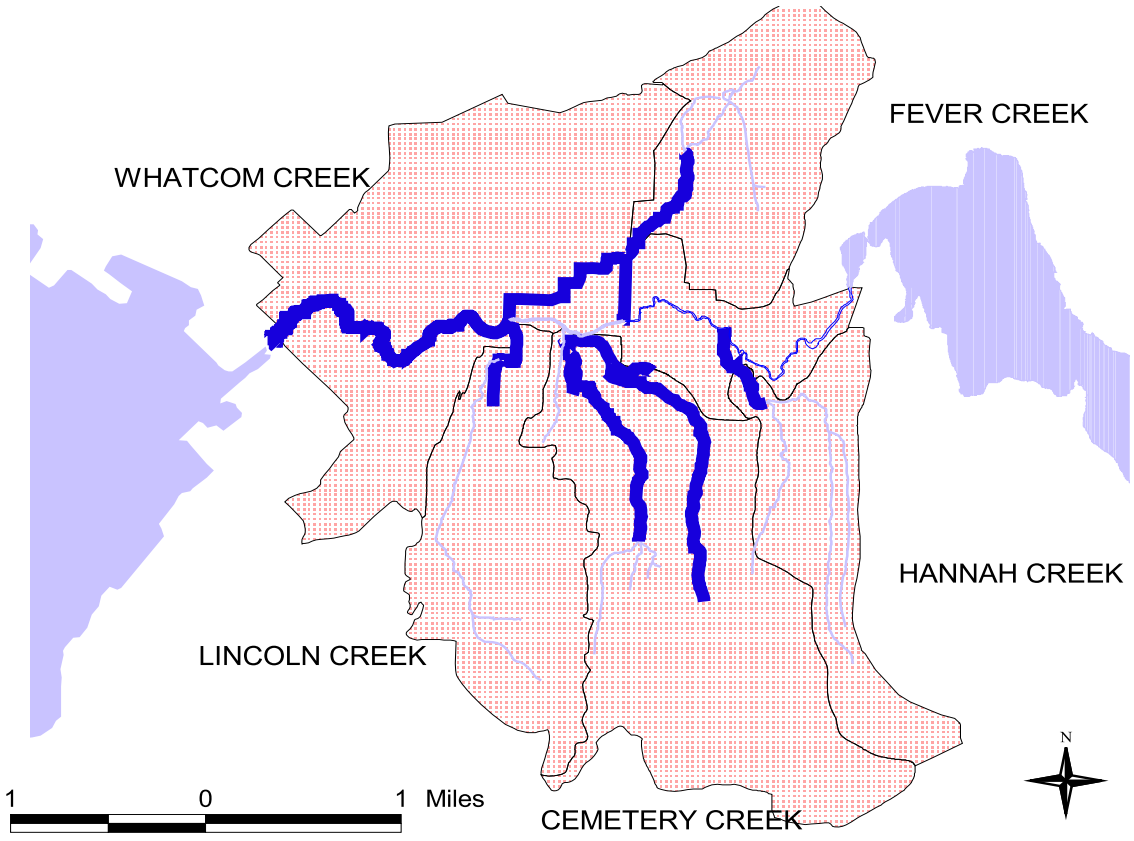

Figure 3 - Impaired Streams

For each station, a percent reduction was calculated that would result in meeting the two part fecal coliform criterion. The calculation is based on the assumption that the coefficient of variation will be constant as bacterial concentrations decline. The rational for this assumption is given in *Environmental Statistics and Data Analysis (Ott, 1995).* As the majority of the known sources in this TMDL are storm water derived, the fact that they are now covered by a permit should not change the underlying assumption that the coefficient of variation will be stable as the reductions take place.

Figure 4 depicts the cumulative distribution of bacterial concentrations for Fever Creek as an example. The circles represent the measurements that were taken for the study. The blue solid line is a lognormal fit to the points. That is, it is a lognormal distribution with the shape and location parameters estimated from the observations. This is similar to the procedure adopted by the National Shellfish Sanitation Program. The gray shaded area represents the loading capacity, that is, the lognormal distribution with a geometric mean of 100 cfu/100ml and a 90th percentile of 200 cfu/100ml. The red dashed line represents the target distribution. The red dashed line

and the blue solid line appear as a translation along the x-axis (or separated by a constant distance measured parallel to the x-axis), as the x-axis uses a log scale.

The allocation of a distribution of bacterial concentrations represented by a target geometric mean of 28 cfu/100ml and as an 88 percent reduction at Fever creek is a result of the calculation that an 88 percent reduction in the 90th percentile at Fever Creek from 1918 cfu/100ml to 200 cfu/100ml will be accompanied by an 88 percent reduction in the Geometric Mean from 268 cfu/100ml to 28 cfu/100ml. Therefore, upstream of the Fever Creek station, the load allocation and the wasteload allocation will be a distribution of bacterial concentrations represented by a reduction of 88 percent. Reducing the geometric mean to the target geometric mean of 28 cfu/100ml will be used to monitor progress toward achieving the allocated distribution.

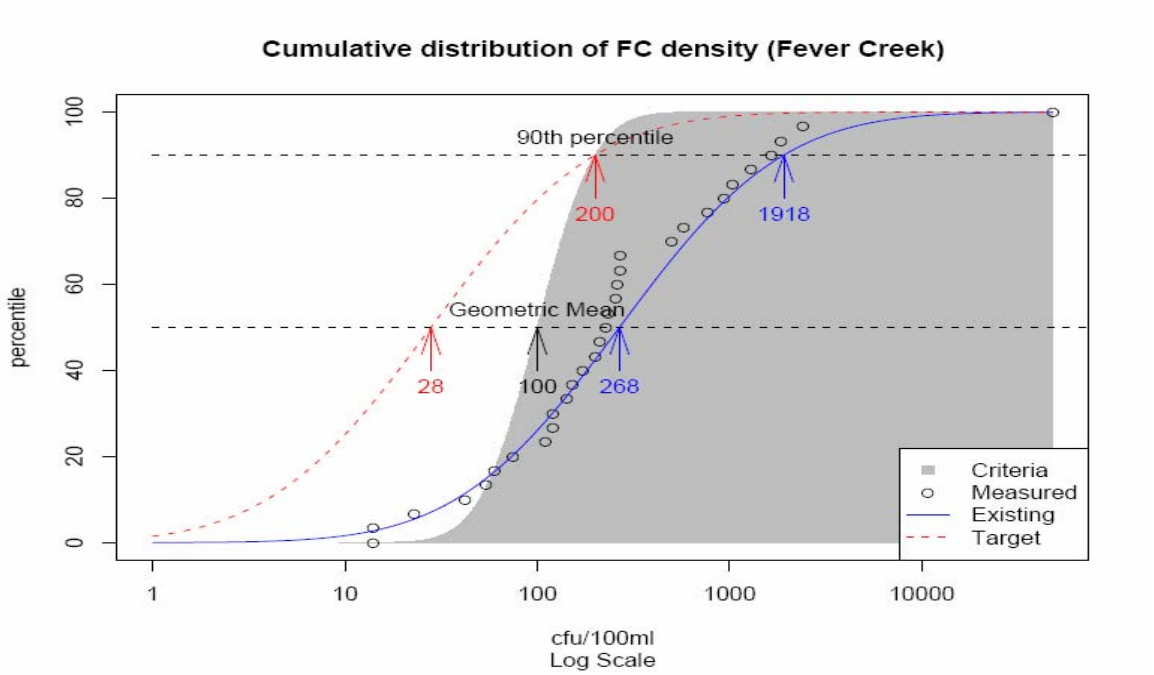

Figure 4 - Fever Creek Cumulative Distribution of Fecal Coliform Concentrations

In the study, stations were located along Whatcom Creek and at the most downstream location feasible for each of the tributaries. The original concept was to apply separate targets along Whatcom Creek. However, bacterial concentrations increase as one moves downstream and the result would have reserved all of the assimilative capacity for the most downstream dischargers. Consider the fish hatchery near the head of the creek. It discharges into a part of the stream with very low levels of bacteria because the assimilative capacity of the stream has not been used. The fairest allocation would be to base the allocation on the need to meet the discharge at the mouth of the creek.

Allocations are based on the station that characterizes the discharge at the critical point. That is water which will flow past the Fever Creek Station receives allocations based on the distribution of bacteria concentrations measured at the Fever Creek Station. Water that flows past the Hanna Creek Station receives allocations based on the Hanna Creek Station. Water that flows past the Cemetery Creek station receives allocations based on the Cemetery Creek Station. Water that flows past the Lincoln Creek Station receives allocations based on the Lincoln Creek Station.

Whenever a discrepancy may be discovered between the above description and the map, the description shall govern the basis of the allocation.

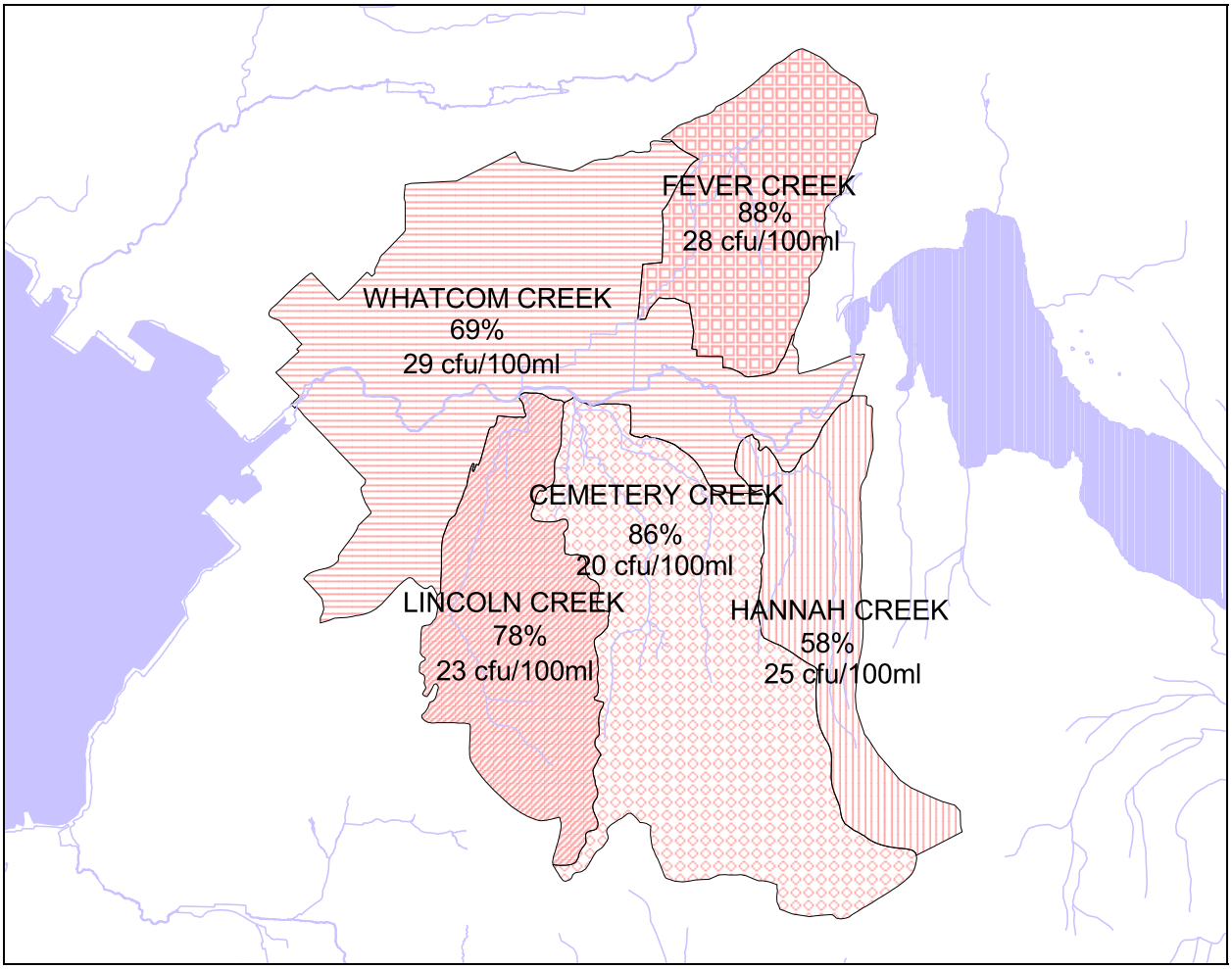

Figure 5 - Whatcom Creek TMDL sub-basins, wasteload allocations, load allocations, and target geometric means

Loading capacity

Identification of the loading capacity is an important step in developing TMDLs. The loading capacity is the amount of pollutant a water body can receive and still meet water quality standards. By definition, a TMDL is the sum of the allocations. An allocation is defined as the portion of a receiving water's loading capacity that is assigned to a particular source. EPA defines the loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards."

In a conventional mass based TMDL, the loading capacity is calculated based on critical flow conditions by calculating the mass that can be assimilated into the critical flow. In this storm water driven TMDL, it is not possible to separate the mass entering the water from the flow as separate entities.

Also complicating the calculation of a conventional loading capacity under critical conditions, is the two part criterion for fecal coliform bacteria. Fecal coliform are limited by both a geometric mean and a limit on the 90th percentile of the samples. The limits are not a measure of a maximum instantaneous concentration of bacteria but a limit on the distribution of bacteria over time.

Increasing quantities of water bring increasing loads of the pollutant. The study did not identify any significant die off, growth, or re-suspension of bacteria from the sediments. Therefore the fecal coliform bacteria will be considered as a conservative pollutant and the loading capacity is the two part criterion. That is, the loading capacity is a distribution of bacterial concentrations over time that has a geometric mean of 100 cfu/100ml and no more than 10 percent of the samples exceed 200 cfu/100ml.

Reasonable assurance

The study did not separate point sources and non point sources of bacteria. Stormwater runoff and non stormwater discharges into the storm drainage system are the primary sources of known contamination, and fall into both point source and non point source categories separated only by whether or not NPDES permit coverage is required for the discharge. Leaking sewer lines and failing septic systems are also assumed to be present. Detection and elimination of these non stormwater sources is required under the municipal stormwater permit. It is assumed that all sources will control stormwater runoff contamination to meet either wasteload allocation or load allocations.

The wasteload allocations are therefore dependant upon achieving equivalent reductions in the load allocations to those necessary to meet the wasteload allocations. Reasonable assurance that reductions necessary to meet load allocations will be achieved, is provided because the same tools used to achieve the reductions for wasteload allocations will be applied to the load allocations. The inability to distinguish a non point source from a point source results in the efforts to achieve a reduction in point sources will result in equivalent reductions in load allocations.

Load and wasteload allocations

Allocations will be given as a distribution of bacterial concentrations that is necessary to achieve a distribution that meets both parts of the criterion in the water quality standards. The distribution is described in terms of a percent reduction from the existing distribution and as a target geometric mean.

The largest point source will be the city of Bellingham as part of their Phase II Municipal Stormwater Permit. The primary means of controlling pollution discharged under the permit is the development of a stormwater management plan. The municipal stormwater permit only regulates discharges from a municipality's stormwater system. Storm water that does not enter the municipality's stormwater system continues to be a non point source. Many of the provisions of the stormwater management plan are equally applicable to reducing pollution discharges from non point sources. Program elements such as public education and outreach have essentially the same impact on all stormwater discharges regardless of whether they enter a municipal

stormwater system or are discharged directly to a receiving water. Other elements, such as responding to complaints of illicit discharges are relatively simple to extend from discharges to a municipal stormwater system to all illicit discharges. The city of Bellingham, by voluntarily extending their program to cover all areas in their jurisdiction within the watersheds of Whatcom Creek and its tributaries, will provide reasonable assurance that load allocations are met allowing wasteload allocation to have the same targets as load allocations.

Similarly, there is a small part of Lincoln Creek, Cemetery Creek, and Hanna Creek that will be covered by Whatcom County Phase II Municipal Stormwater Permit. This is shown in Figure 6. The yellow area is the city of Bellingham area subject to the permit. The brown is the area of Whatcom County subject to the Phase II Municipal Stormwater Permit. The small unshaded portion of the Whatcom Creek Watershed is also in Whatcom County jurisdiction. It is largely forest land and unlikely to be developed, and no reductions are likely to be necessary in this area to meet the load allocations.

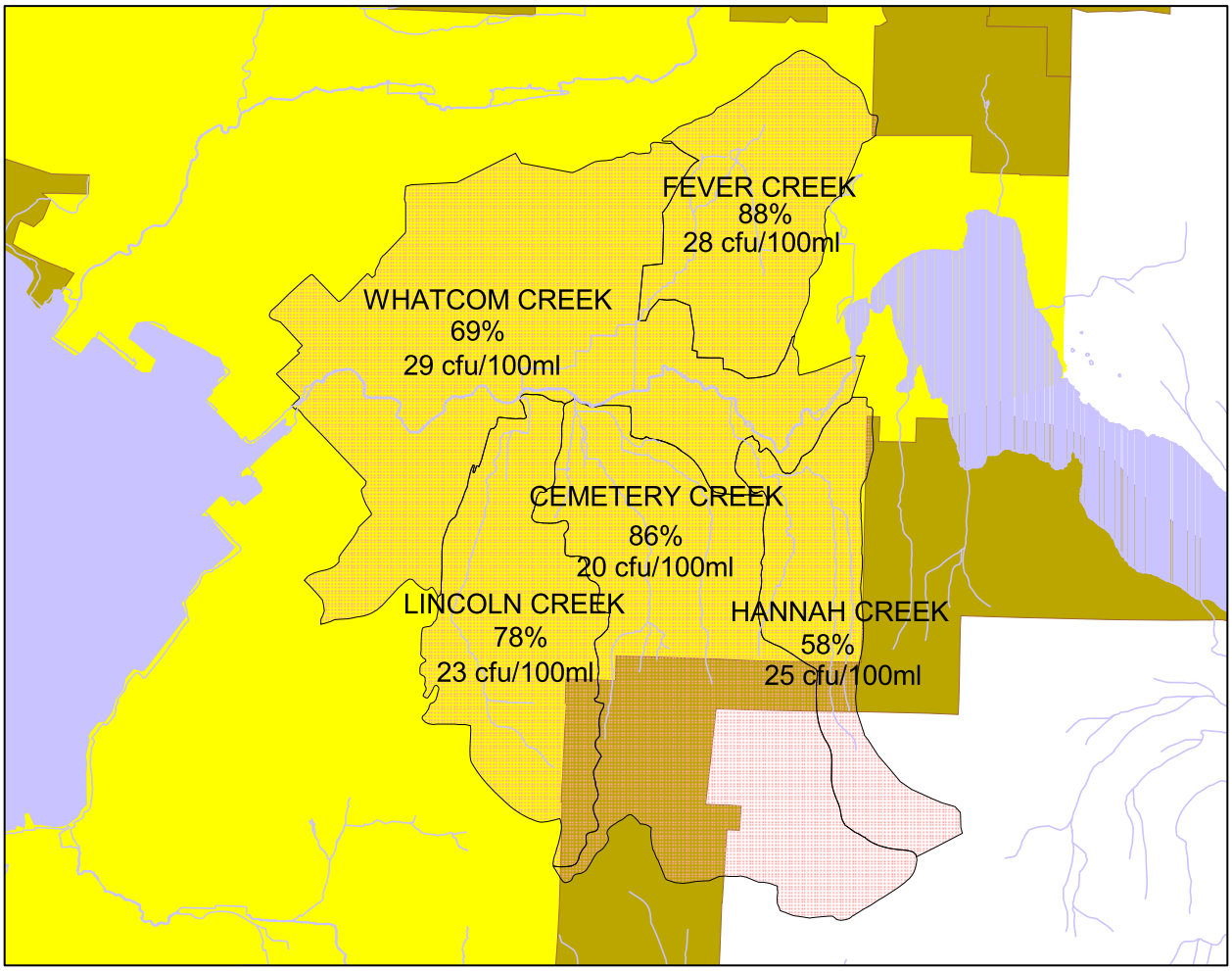

Figure 6 - Areas subject to MS4 Municipal Stormwater Coverage

There are several smaller dischargers covered by NPDES permits, shown in Figure 7. WA0031500, represented by an open circle, is the only discharger with a non stormwater component permitted in their discharge.

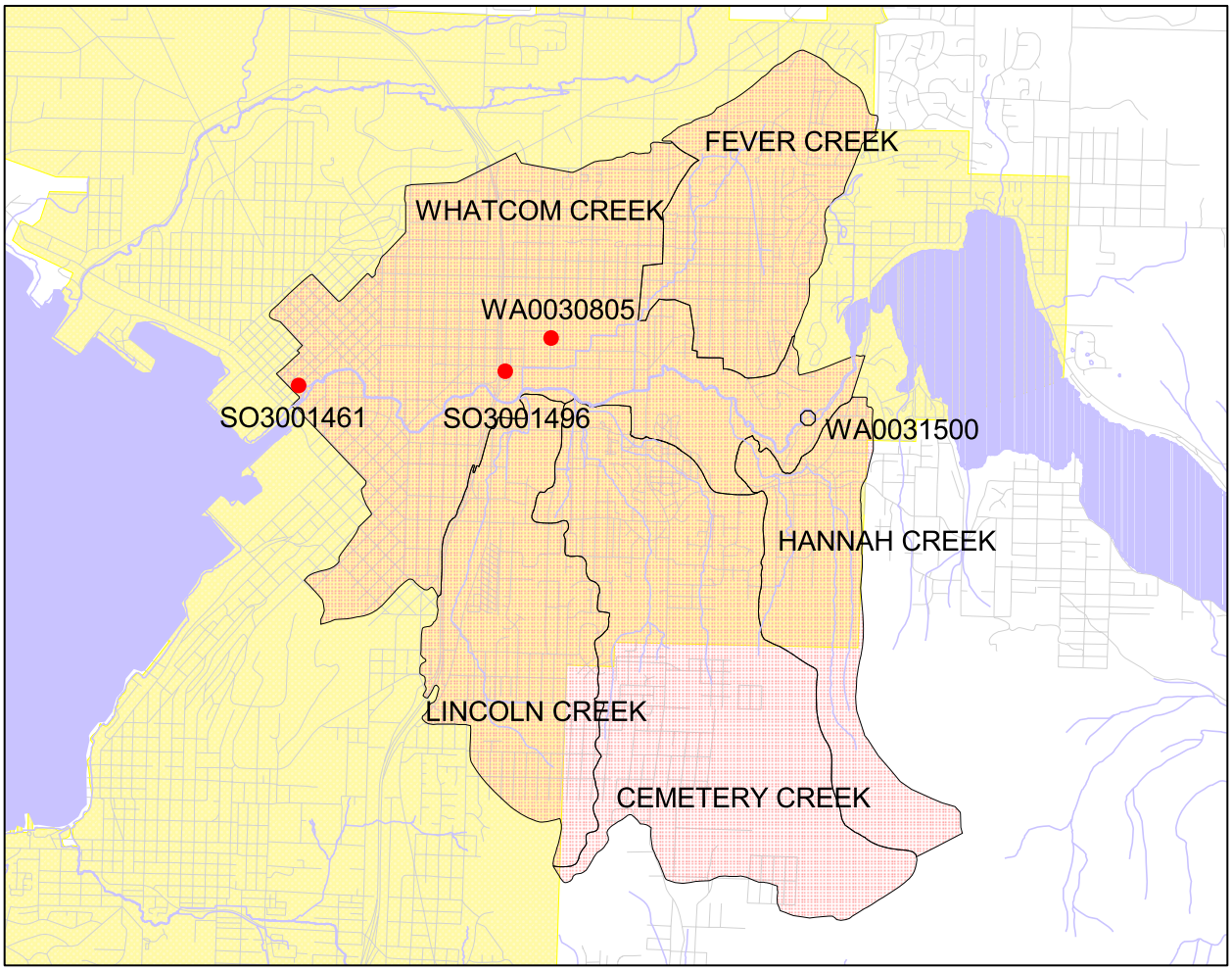

Figure 7 - Dischargers covered by NPDES Permit

All of the dischargers shown will receive a wasteload allocation (WLA) to meet the 69 percent reduction necessary at the mouth of Whatcom Creek. The municipal stormwater dischargers will have WLAs based on the stormwater discharge point. This is summarized below in Table 3. Wasteload allocations that are not assigned but are later necessary for NPDES permits will be consistent with these established wasteload allocations and the load allocation that will be retired when the facility comes under permit coverage.

Table 3 - Facilities with WLA established

Permit Number	Facility Name	Permit Type	Wasteload Allocation
SO3001461	NW Recycling	General Permit Storm Water Ind	69% reduction Target GM = 29
SO3001496	Wholesale Auto	General Permit Storm Water Ind	69% reduction Target GM = 29
WA0030805	Brooks Manufacturing Co	Minor Industrial	69% reduction Target GM = 29
WA0031500	WA DFW Bellingham Hatchery	Minor Industrial	69% reduction Target GM = 29

Permit Number	Facility Name	Permit Type	Wasteload Allocation
Unassigned	Department of Transportation	General Permit Storm Water Municipal	69% reduction Target GM = 29
Unassigned	City of Bellingham	General Permit Storm Water Municipal	Based on point of stormwater discharge
Unassigned	Whatcom County	General Permit Storm Water Municipal	Based on point of stormwater discharge

Both the distribution based wasteload allocations and the load allocation will be equal. The allocations are based on the distribution of the concentration of bacteria in the stormwater runoff. If an area of land is converted to a use that requires coverage under an NPDES discharge permit, the associated load allocation is retired and an equal wasteload allocation is available to the discharger. The allocations are expressed as a percent reduction. This is a description of an entire distribution of bacterial concentrations compared to the existing distribution of bacterial concentrations. The geometric mean will be compared to a target geometric mean to measure the reduction. The target geometric mean is a description of the "typical" concentration when the target distribution has been achieved.

Table 4 – Ultimate Target Geometric Means

Watershed	% reduction	Target GM (cfu/100ml)
Hanna Creek	58	25
Fever Creek	88	28
Cemetery Creek	86	20
Lincoln Creek	78	23
Whatcom Creek	69	29

Margin of Safety

An implicit margin of safety was established through the use of conservative assumptions.

There is a margin of safety provided by the assumption that the coefficient of variation will remain stable. As the upper end of the bacterial concentration distribution typically is the most difficult to meet, the geometric mean is well below the criterion. Fever Creek, where an 88 percent reduction is necessary, provides a good example. In Figure 4, the grey shading depicts the loading capacity. It represents the maximum distribution of bacterial concentrations. The red dashed line represents the target distribution after the allocated reductions have been achieved. For percentiles less than the 90th percentile, the target concentration is expected to be less than the same percentile of the loading capacity. It is only when observing the top 10 percent, when concentrations are expected to exceed 200 cfu/100ml, that the target concentration could be expected to exceed the loading capacity concentration. These exceedances would be consistent with the Water Quality Criterion. The margin of safety is represented by the area between the dashed line and the shaded area.

Another view of the shift in the distribution is given in Figure 8. In this depiction, the distributions have been normalized and probability densities are plotted. The logarithm of the probability density distribution is plotted so that a normal distribution with the familiar bell shaped curve is displayed. To facilitate understanding, the x-axis however is labeled with the actual fecal coliform concentration instead of the logarithm of the fecal coliform density. The grey shaded area represents the loading capacity. The solid blue line represents the existing distribution and the dashed red line represents the target distribution. The loading capacity (the distribution that just meets both parts of the criterion) is much taller than the existing and target distributions because it has a smaller standard deviation. The vertical lines show the cut off of 90 percent of the distribution of the loading capacity and target distributions respectively. The line for the cut off of the lower 90th percentile of the existing distribution is off the graph on the right side. Because of the larger standard deviation of the existing and target distributions, the target distribution has to be shifted far to the left in order to assure that 90 percent of the distribution is below 200 cfu/100ml. The larger variation in the target distribution requires on average lower concentrations. The grey shaded area above the target distribution represents an implicit margin of safety.

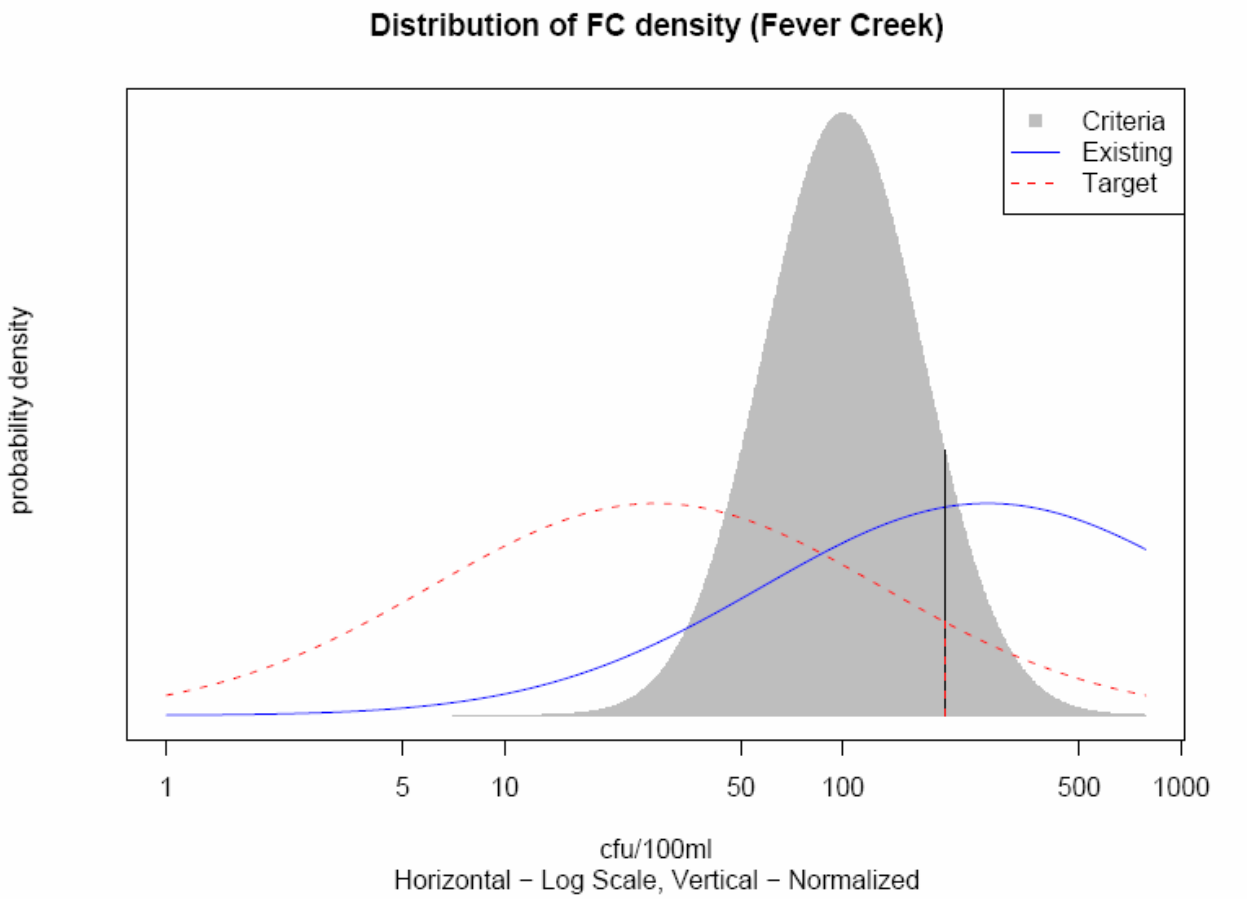

Figure 8 - Fever Creek Normalized Distribution of Fecal Coliform Concentrations

Summary Implementation Strategy

Overview

The city of Bellingham has the largest source of bacteria controlled by a permit. The city also has land use control over most of the area that can generate the non point sources of bacteria. The city will therefore take the lead in implementing the TMDL. Ecology will retain the responsibility for issuing permits that meet the established wasteload allocations, but the city of Bellingham and Whatcom County will have the lead in ensuring reductions are achieved in the area covered by their municipal stormwater discharge as well as the non point stormwater discharges in their jurisdiction. This provides reasonable assurance that reductions necessary to meet load allocation will be achieved allowing the wasteload allocations to be made for their permitted discharges.

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Implementation Plan Development

A detailed implementation plan will be developed over the next year in consultation with the city of Bellingham and Whatcom County. The city of Bellingham and Whatcom County have a long history of cooperation over stormwater issues throughout the urban growth area and in the adjacent Lake Whatcom Watershed. The plan will identify the measures that must be taken to ensure load allocations and wasteload allocation will be met within the respective jurisdictions. It will include monitoring necessary to demonstrate progress toward meeting TMDL goals. Upon completion, Ecology will submit the detailed implementation plan to Environmental Protection Agency (EPA).

Implementation Activities

Non Municipal Permits.

Most of the existing permits are not likely to have high bacteria concentrations. Access to the sites are controlled such that pet waste and failing human waste collection facilities are not likely to be contributors of bacteria. Permit writers at the time of permit renewal in the case of individual permits, and compliance inspectors at the time of site visits in the case of general permits, should address the reasonable potential that wasteload allocations will be exceeded to determine if monitoring is necessary to ensure compliance. If monitoring is deemed appropriate, it can be adopted voluntarily before the permit is re-issued, or required by administrative order if appropriate. If it is determined that monitoring is not necessary, it will be documented in the fact sheet for individual permits.

Municipal Permits

The city of Bellingham as the largest municipal storm water in the water shed and receiver of Whatcom County municipal storm water will take the lead in developing a draft detailed implementation plan over the course of the next year. The plan will be developed in consultation with Whatcom County and Washington State Departments of Ecology and Transportation. Participation in the development of the draft implementation plan is required of the municipal stormwater dischargers.

Non Point Sources

It is expected that most non point sources will be covered under the same stormwater management program established to deal with discharges associated with the municipal stormwater discharges and required by condition S6 of that permit. Any departure from that assumption, and how it does not adversely affect the reasonable assurance that load allocation reductions will be made, will be identified in the detailed implementation plan.

Monitoring Strategy

Monitoring at the stations used to establish the targets will be used to guide and prioritize the implementation activities. Rolling geometric means at those stations will be used to demonstrate progress toward meeting wasteload and load allocations. Additional monitoring will be necessary for tracking bacteria to sources. Roles and responsibilities for monitoring will be established in the detailed implementation plan.

Reasonable Assurance

The municipal stormwater permit depends on a reduction in load allocation as outlined in this TMDL in order to make their wasteload allocation. The permit holders (city of Bellingham and Whatcom County) will work together with Ecology to draft a detailed implementation plan that provides reasonable assurance that the reductions are achieved. Failure to achieve the load reductions necessary may require a modification of the TMDL to reduce wasteload allocations in the future.

Funding Sources

Ecology's financial assistance programs provide funding for point and non point activities and facilities.

Non point activities are those that address pollution sources not covered by an NPDES permit. Non point activities are eligible for grants and loans. Those grants could cover the portion of the stormwater program dedicated to the expansion beyond that required under the municipal stormwater permit.

Point source activities and facilities are those that address pollution sources covered by an NPDES permit. Point source activities are not eligible for grants. Low interest loans are available to assist with point source activities and facilities.

References Cited

Ott, W. R., 1995. *Environmental Statistics and Data Analysis.* CRC Press LLC. Boca Raton, FL. 313 pages.

Shannahan, P., LaCroix, R. , Cusimano B., Hood, S. 2004. *Whatcom Creek Fecal Coliform Total Daily Maximum Load Study*, Ecology Publication 04-03-015.

Appendix A - Technical Document

A-1: *Whatcom Creek Fecal Coliform Total Maximum Daily Load Study*. Published under separate cover

Available electronically via http://www.ecy.wa.gov/pubs/0403015.pdf

Appendix B - Public Participation Materials

(Reserved)

Appendix C - Responses to Comments Received

(Reserved)