
Kennedy Creek Fecal Coliform Bacteria Water Quality Monitoring Study



September 2008
Publication No. 08-10-085



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303(d) Listings Addressed in this Study

Water Body ID AO33HF, Fecal Coliform Bacteria

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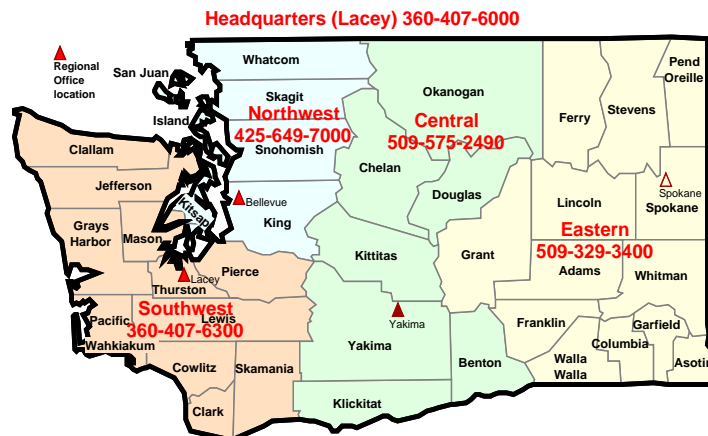
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Abstract

Water quality monitoring for fecal coliform (FC) bacteria) was conducted weekly in the Kennedy Creek watershed between August 2007 and November 2007. The objectives of the study were to assess compliance with Washington State's Extraordinary Primary Contact water quality criteria for FC bacteria and to identify potential sources of FC bacteria.

In general, water quality in Kennedy Creek did not meet the state designated water quality standard for Extraordinary Primary Contact Recreation in freshwater. The mouth site (MTH) and the site in the upper watershed (BBQ) exceeded both parts of the FC bacteria criteria. Site KCS at river mile 8.25 was the only mainstem site that met the FC bacteria criteria. The three remaining mainstem sites met the geometric mean value criteria, but exceeded the 90th percentile criteria. Five tributaries were sampled in the watershed. Three out of the five tributary sites met the FC bacteria criteria. The remaining two tributary sites met the geometric mean value criteria, but exceeded the 90th percentile criteria. FC bacteria concentrations increased in response to increased precipitation, but the pattern was not consistent.

Possible sources of FC bacteria in the watershed include waste from failing septic systems, inadequate waste management in recreational and high use areas, wildlife, domestic animals, and re-suspension of bacteria from in-stream sediments.

Acknowledgements

The author is grateful to **everyone** who assisted in this water quality study. My apologies if I've accidentally omitted anyone from this list.

- Carol Serdar, Taylor Shellfish Company, and Green Diamond Resource Company allowed access through their property.
- Kim McKee, Bill Ward, Chuck Hoffman, Lydia Wagner, Sue Davis, Cathy Hansen, Kathy Whalen, Linda Hofstad, Emily Sanford, and all members of the Totten-Eld Technical Advisory Group provided valuable comment and report review.
- Mike Woodall created the GIS site maps and provided technical assistance.
- Jason Shira, Tammy Riddell, Cindy James, Chris Hempleman, and Charles Toal provided field assistance.
- Darrell Cochran provided field support toward source identification.
- Pam Covey and Nancy Rosenbower provided sample tracking and logistics.
- Nancy Jensen conducted the microbiology analyses and technical support.
- Leon Weiks supplied bottles and ensured chain of custody during sample transport.
- Kelsey Highfill and Roberta Woods provided editorial, formatting, and publication assistance.
- Mark Golliet, David Batts, Keith Seiders, Anne Mills, Sue Davis, Carol Serdar, Cathy Hansen, Russ Walker, and Jim Goode assisted with watershed and site information.

Introduction

Kennedy Creek discharges into the head of Totten Inlet in southern Puget Sound. This area is in Washington State Department of Ecology's (Ecology's) Water Resource Inventory Area 14 (Kennedy-Goldsborough Watershed). Most of the watershed is in Thurston County, with the mouth and lower reach in Mason County (Figure 1).

Ecology monitored one site near the mouth of the creek (above marine influence) over a ten year period (1992 through 2002) as part of the comprehensive National Monitoring Program (NMP) in Totten and Eld Inlets (Batts and Seiders, 2003a and 2003b). Kennedy Creek violated water quality standards for fecal coliform (FC) bacteria, temperature, and dissolved oxygen. As a result of water quality violations, this freshwater reach of Kennedy Creek was placed on Ecology's 2004 list of impaired water bodies for all three parameters.

Ecology developed a Total Maximum Daily Load (TMDL) study for tributaries to Totten Inlet (Ahmed and Hempleman, 2006) using historic data collected by staff from Ecology, Thurston County, Squaxin Island Tribe, and Mason County. Historic FC bacteria data from the mouth of Kennedy Creek were analyzed in that TMDL study. The TMDL study identified August and September as the critical period when FC bacteria concentrations increase and do not meet criteria (Ahmed and Hempleman, 2006).

A Water Quality Implementation Plan was prepared in response to the TMDL (Hempleman, 2007). Ecology was identified as the lead for conducting segmented water quality sampling to identify bacteria sources in Kennedy Creek. The 2007 water quality study for FC bacteria, summarized in this report, is a result of that action item from the Implementation Plan.

The draft 2008 Water Quality Assessment places FC bacteria in the lower reach of Kennedy Creek in Category 4a. This category implies that the water is still polluted by bacteria, but a TMDL has been conducted and solutions are underway. See Appendix A for additional information on federal Clean Water Act requirements such as the 303 (d) list and Water Quality Assessment.

FC bacteria are found in the intestinal tract of warm-blooded animals and are transmitted to water and soil by human and animal feces. Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. Fecal coliform in water "indicates" the presence of waste from humans and other warm-blooded animals and may result in unhealthy conditions for primary contact. Elevated concentrations may result from rain washing waste material from surfaces into water bodies or can result from direct inputs to the water. Efforts to identify bacteria sources, followed by the cleanup of bacterial pollution, help protect beneficial uses such as recreational activities and shellfish harvesting.

The current water quality standards have Kennedy Creek in the category for Extraordinary Primary Contact Recreation (Appendix B). The *Extraordinary Primary Contact* use is intended for waters capable of "providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas." To protect this use

category: Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL (cfu/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 100 colonies/100 mL (Ecology, 2006a, WAC 173-201A-200(2)(b)). Both parts of the numeric criteria must be attained to meet the water quality standard.

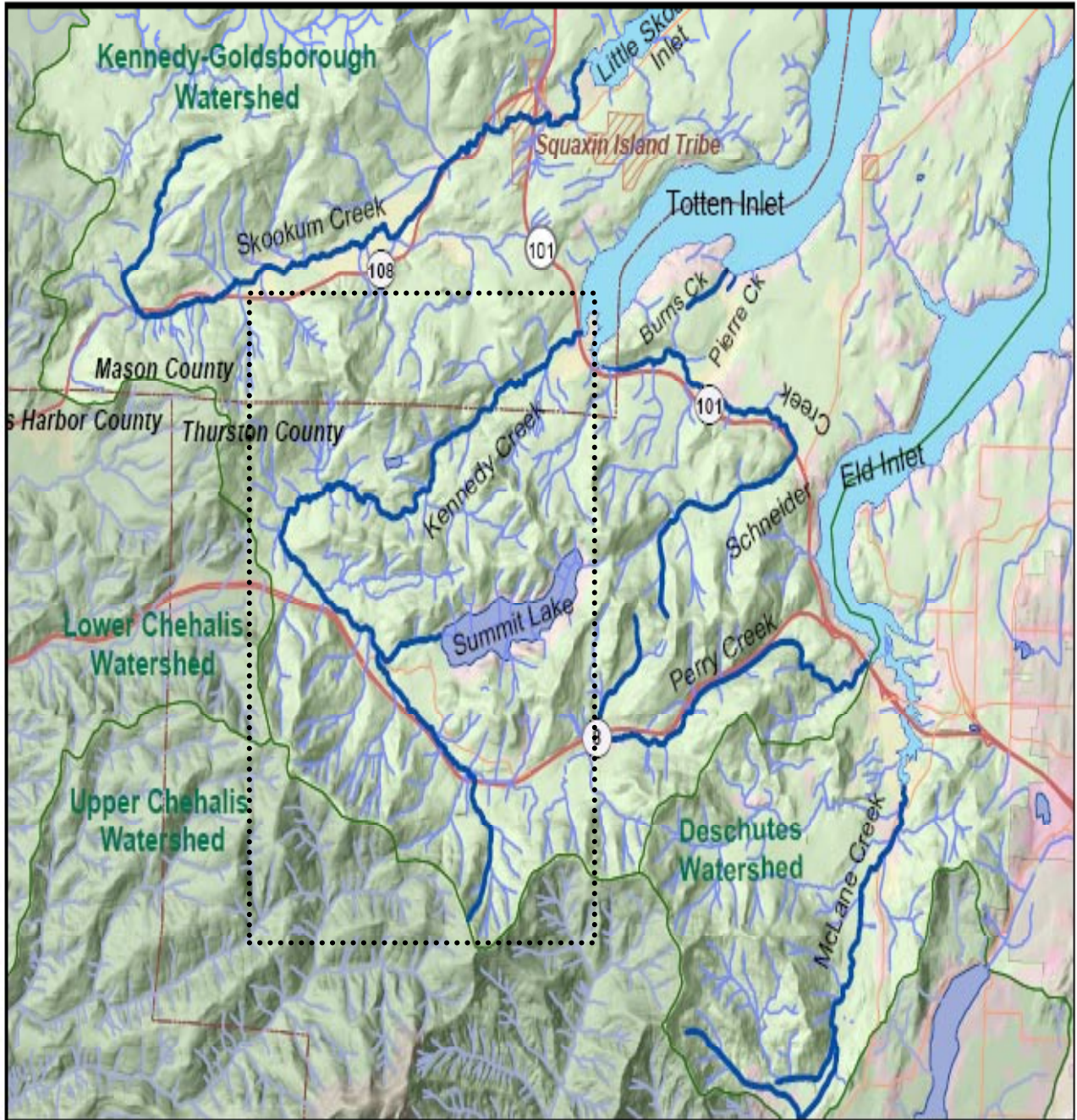


Figure 1. Study area with the Kennedy Creek sampling area outlined in a dashed line.

Totten Inlet is categorized as *Approved* for shellfish harvesting and is not on Ecology's 303(d) list for FC bacteria. However, recently the Washington State Department of Health has determined that concentrations of bacteria in the Inlet increase to unhealthy levels after heavy rain events. Therefore, the shellfish beds in Totten Inlet will enter an emergency closure whenever three inches or more of rain falls in 24 hours as measured at the Olympia Airport (Cleland, 2008, personal communication, and Appendix C).

Study Area

Kennedy Creek is approximately 12 miles long and drains about 15 square miles. The creek originates in the Black Hills and discharges to the head of Totten Inlet. The land use is primarily forestry and rural residential. There is an area of concentrated residential development around the shores of Summit Lake. Kennedy Creek provides important habitat for a variety of fish and wildlife. It is one of the most productive chum salmon (*Oncorhynchus keta*) streams in Washington State. There is varied recreational use throughout the watershed. Totten Inlet also provides important habitat for fish and wildlife and includes high quality commercial and non-commercial shellfish growing areas.

Possible sources of FC bacteria in the watershed could result from failing septic systems, wildlife, domestic animals, inadequate waste management in recreational and high use areas, and re-suspension of bacteria from in-stream sediments.

Methods

Objectives and study design

Project objectives for Kennedy Creek water quality monitoring were:

- Assess compliance with State Extraordinary Primary Contact water quality criteria for FC bacteria.
- Identify FC bacteria source areas by sampling accessible segments of the creek that bracket land use.

Samples were collected weekly from August 7, 2007 through November 13, 2007. The goal was to collect at least ten samples during the study period. Sampling sites were chosen based on accessibility and to bracket land use. See Table 1 for a map showing sampling locations and Figure 2 for location descriptions.

Map source data was obtained using Washington Hydrography Framework 1:24,000 scale stream layer, USGS 7.5 minute, and 1:24,000 scale quad map image. The accuracy of that system is within 40 feet. The stream sampling locations were mapped using GPS readings from the field. The GPS readings were usually accurate within 20 feet. Therefore, the stream mile designations should be used as relative positioning guides rather than exact locations.

Table 1. Kennedy Creek and tributary sampling site descriptions.

SITE NAME	RIVER MILE		SITE DESCRIPTION	LATITUDE	LONGITUDE
	Mainstem (MS)	Tributary Intersects MS			
MTH	0.34		Kennedy Creek freshwater mouth area approximately 60 feet upstream of the Old Olympic Highway Bridge.	N47° 05" 42.3'	W123° 05" 27.3
TINT		0.69	Right-bank (RB) tributary to Kennedy Creek; Fiscus Creek. Sample was taken about 10 feet upstream of the Jeff Cedarholm Memorial bridge.	N47° 05" 27.0'	W123° 05" 45.9
INT	0.9		Kennedy Creek accessed through the salmon interpretive trail area. The site is upstream of the confluence with Fiscus Creek.	N47° 05" 27.2'	W123° 05" 55.7
FLS	2.9		Kennedy Creek Falls area, about 75 feet above the upper falls.	N47° 04" 39.1'	W123° 07" 35.9
KCS	8.25		Kennedy Creek behind the residence at 12248 Summit Lake Road NW.	N47° 03" 11.82'	W123° 08" 46.24
TLK		8.69	Summit Lake outflow at Summit Lake Shore Road NW and Summit Lake Rd NW. Right-bank tributary.	N47° 02" 57.8'	W123° 08" 21.1
KCN	8.78		Kennedy Creek at 12239 Summit Lake Road NW above the confluence with the left-bank (LB) tributary site TCN.	N47° 02" 57.3'	W123° 08" 29.4
TCN		8.77	Downstream of 12239 Summit Lake Road NW about 6 feet upstream of confluence with Kennedy Creek. Left-bank tributary.	N47° 02" 57.7'	W123° 08" 29.6
TPK			Upstream of bridge adjacent to the WSDOT park and ride area. 0.3 miles upstream on the same tributary as site TCN.	N47° 02" 53.7'	W123° 08" 38.3
BWW		10.79	Second tributary west of the previous Ranch House BBQ restaurant on Kennedy Creek Road SW. Left-bank tributary.	N47° 01" 58.0'	W123° 06" 58'
BQW		10.82	Culvert on Kennedy Creek Road just west from previous Ranch House BBQ restaurant on Kennedy Creek Road SW. Left-bank tributary.	N47° 01" 57.2'	W123° 06" 53.0
BBQ	11		Immediately downstream of the bridge on Kennedy Creek Road SW. Downstream of previous Ranch House BBQ restaurant.	N47° 01" 56.6'	W123° 06" 45.8

*River mile is not accurate to the hundredth mile, but extra decimal places are provided to provide reference of position.

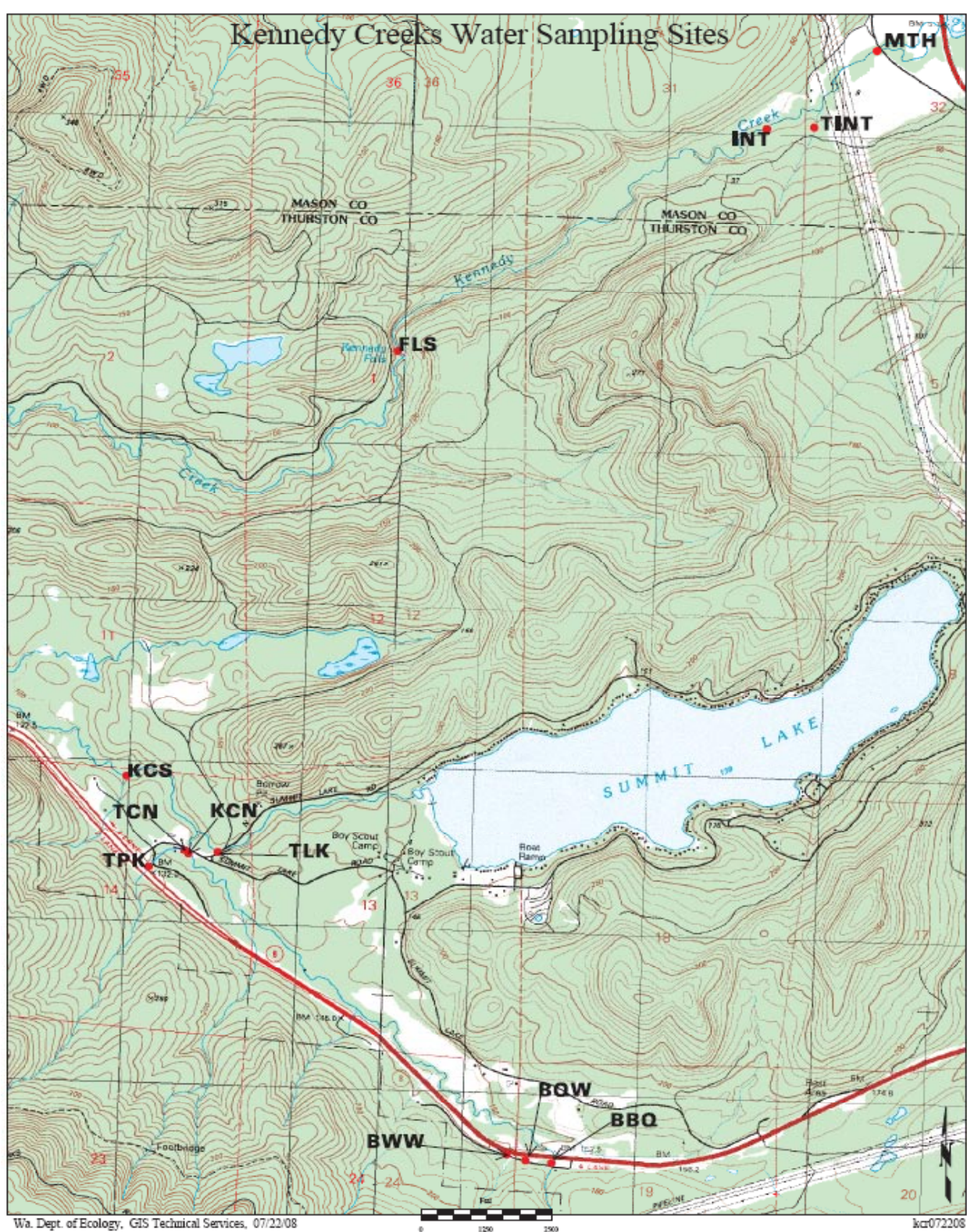


Figure 2. Location of sample sites on Kennedy Creek and tributaries.

Variations from the original sampling design (Dickes, 2007) are listed below.

- The mouth site (MTH) used for this study was relocated downstream from the sampling location used for the NMP study and TMDL analyses. Mid-stream gravel bars had developed at the previous site resulting in very low flow in the individual channels. It would have been difficult to collect representative samples. The location was moved downstream at the outset of the study approximately 60 feet upstream from the old highway bridge. The land use was similar to those encountered at the upstream location, so resulting data would be comparable. During low flow conditions this downstream location had safe access onto a gravel bar adjacent to a well mixed area. Discharge was measured at this site (Appendix D), but, bacterial loading analysis (incorporates the influence of volume of water on concentrations) was not part of the project objectives.
- The site located on Kennedy Creek adjacent to the salmon interpretive trail area (site INT) was not sampled on the first day of the study due to access issues.
- The site on Fiscus Creek (TINT) was added mid- September 2007. This location was sampled 6 times over the study period.
- Sampling started 3 weeks late at Kennedy Creek Falls (FLS) and ended in mid-October. This was due to access and safety issues. This location was sampled 7 times over the study period.
- The upper left-bank tributary (BQW) went dry before sampling was initiated. November 13, 2007, was the only day water was flowing and a sample collected. The FC bacteria concentration resulting from that sample was below detection. The result is provided in Appendix D, but it is not discussed further in the report.
- The site BBQ, located downstream of the former Ranch House BBQ restaurant, was identified in the project QAPP as a tributary to Kennedy Creek. However, both Ecology and the Washington State Department of Natural Resources (DNR) have identified that section of stream as the mainstem of Kennedy Creek. As a result, BBQ is described as a mainstem site in this report.
- In December 2007 there was a severe rain event in the area; approximately 5 inches of rain fell in 48 hours. Effects were specifically seen in the upper Kennedy Creek watershed at site BBQ. The site BBQ was located downstream of the former Ranch House BBQ restaurant and the Kennedy Creek Road NW bridge. Unfortunately the heavy rains resulted in a slope failure severely damaging the restaurant and burying the septic tank. The pre-storm data collected during this monitoring project are discussed in this report.

Field and laboratory methods

Field protocols followed those described in Cusimano, 1993, MEL 2005, and Dickes 2007. Laboratory methods followed those documented in MEL 2006. Site locations are described in Table 1 and mapped in Figure 2.

Data analysis methods

Field and laboratory data were compiled and managed using Microsoft Excel® software. The average of the field replicate pair value was used in data analyses. Laboratory duplicate values were used to provide with-in laboratory quality assurance information, but were not averaged into the reported value. The 90th percentile represents the level over which 10 percent of the samples lie, therefore the percentile is used to determine if the second part of the criteria was met.

Quality assurance data

Field and laboratory quality assurance results are available for review in Appendices D and E.

Results of laboratory duplicate pairs reflect quality laboratory analyses and were accepted.

The quality assurance objective for bacteria set by Ecology's Environmental Assessment Program (Ecology, 2006b) was used to analyze field replicate samples. The objective for field replicate samples (with a mean >20) is to have 50 percent of the replicates below a 20 percent relative standard deviation (RSD) and 90 percent of the samples below a RSD of 50 percent (Ecology, 2006). The replicate pairs met both quality assurance criteria. Fifty percent of the 24 replicate pairs had a RSD of 9 or below and 90 percent of the pairs had a RSD below 25. Therefore, all data were used for analyses.

Results & Discussion

The data can be reviewed in Table 2, Figures 3 and 4, and Appendix D. Precipitation data used for the study is from the Olympia Airport records and can be reviewed in Appendix F.

When sampling for bacteria, the number of sampling events (sample size) conducted at a site influences whether that site will meet the state's water quality standard. It is a two-part standard as mentioned in the Introduction. If the number of samples is less than 10 it will only take one sample over 100 cfu/100 mL (10 percent not to exceed 100 cfu/100 mL) for the site not to meet the criteria for FC bacteria.

In general, water quality in Kennedy Creek did not meet the state designated water quality standard for Extraordinary Primary Contact Recreation. The mouth site (MTH) and the site in the upper watershed (BBQ) exceeded both parts of the FC bacteria criteria. Site KCS at river mile 8.25 was the site on the mainstem that met both parts of the FC bacteria criteria. The three remaining mainstem sites met the geometric mean criteria, but exceeded the 90th percentile criteria. Three out of the five tributary sites met both parts of the FC bacteria criteria. The remaining two tributary sites met the geometric mean value criteria, but exceeded the 90th percentile criteria. Site specific information is provided in the following sections.

Table 2. Kennedy Creek site data in comparison with the state water quality criteria for FC bacteria

Site Name	River Mile (RM)*	Number (#) of samples	# of samples greater than 100 cfu/100 mL	Comparison with the geometric mean criterion (cfu/100 mL)		Comparison with the 90th percentile criterion (cfu/100 mL)		Does the sampling location meet the FC bacteria WQ Criteria?
				Geometric Mean (GM)	GM less than 50	90th percentile (%)	% less than or equal to <100	
Mainstem sites								
MTH	0.34	12	3	76	No	328	No	No
INT	0.9	11	2	41	Yes	110	No	No
FLS	2.9	7	2	38	Yes	177	No	No
KCS	8.25	12	0	12	Yes	72	Yes	Yes
KCN	8.78	12	2	32	Yes	123	No	No
BBQ	11	12	7	130	No	1893	No	No
Tributary sites								
TINT	0.69	6	2	48	Yes	670	No	No
TLK	8.69	12	2	20	Yes	98	Yes	Yes
TCN	8.77	11	1	15	Yes	88	Yes	Yes
TPK	**	12	3	30	Yes	175	No	No
BWW	10.79	12	0	13	Yes	55	Yes	Yes

* RM are provided in exaggerated accuracy to describe relative position.

** TPK is upstream of the tributary mouth site TCN

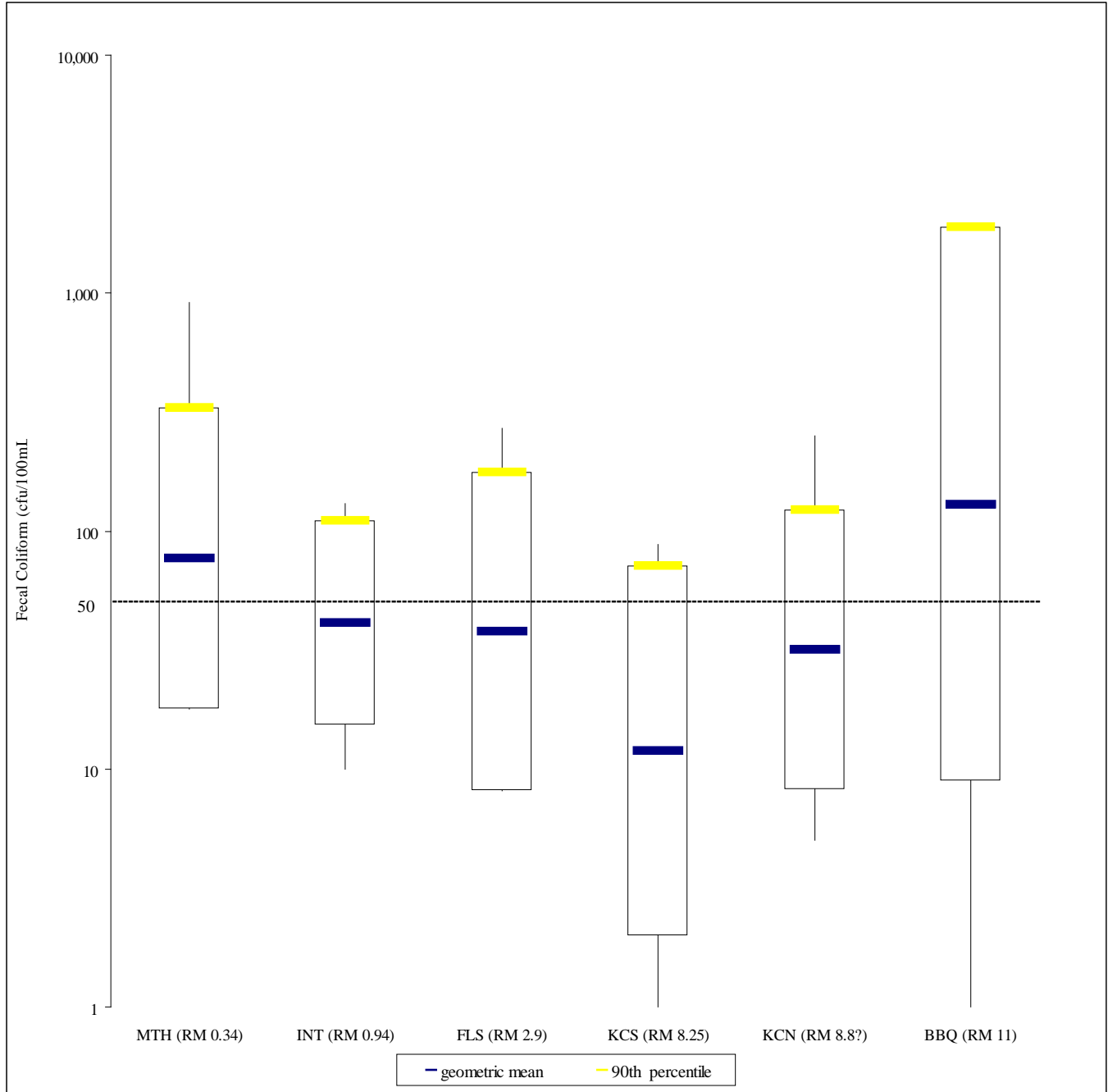


Figure 3. Kennedy Creek mainstem data summarized and described using box plots. The blue line in the middle of the box plot is the geometric mean value of the site data. The yellow top line on the box plot is the 90th percentile of the site data.

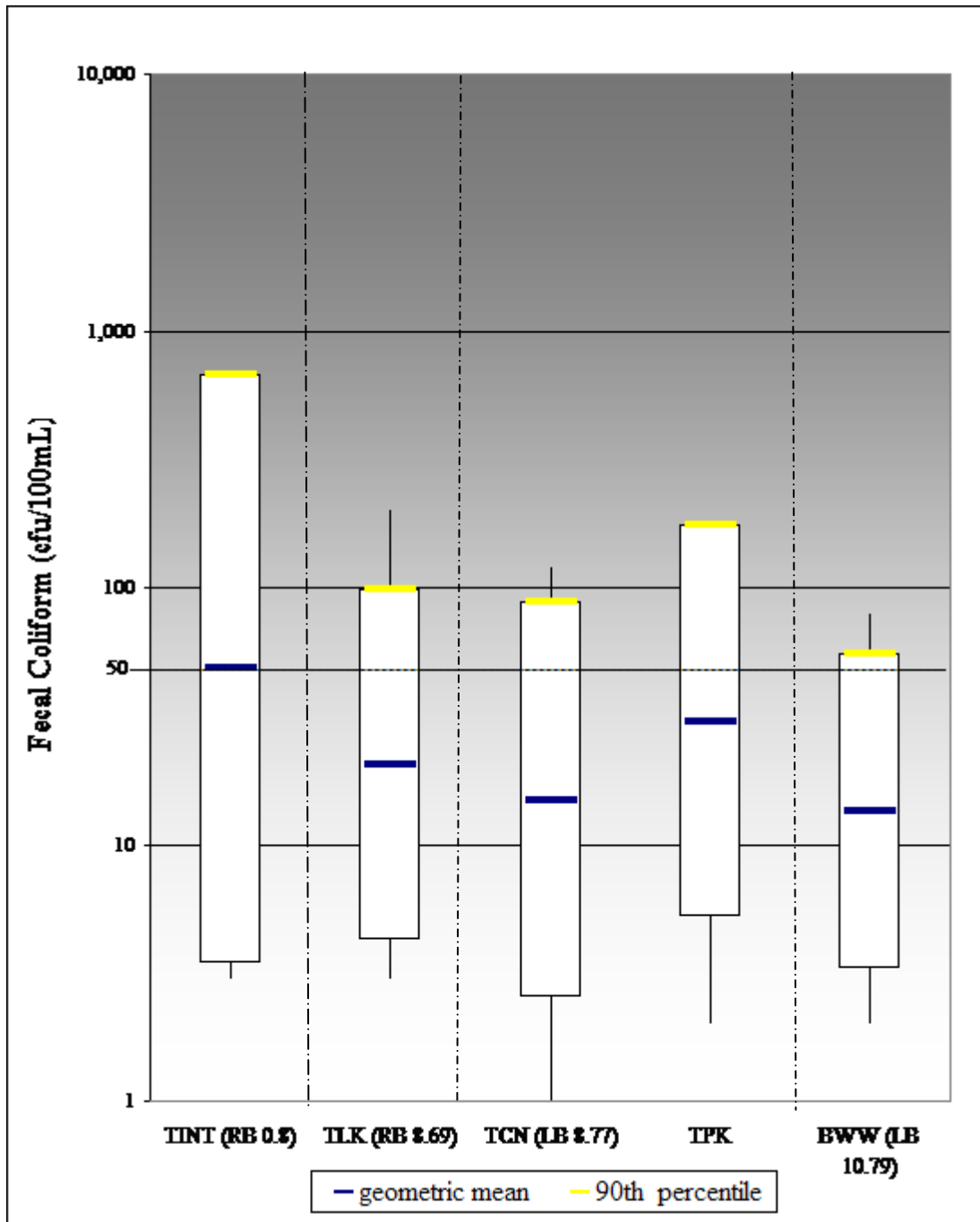


Figure 4. Kennedy Creek tributary data summarized and described using box plots. The blue line in the middle of the box plot is the geometric mean value of the site data. The yellow top line on the box plot is the 90th percentile of the site data.

Mainstem sampling sites

MTH, RM 0.34

The sampling location representing the mouth area of Kennedy Creek (MTH) is located just above the bridge on the Old Olympic Highway. This site did not meet FC bacteria criteria. Data from 12 sampling events resulted in a geometric mean of 76 cfu/100 mL and 90th percentile of 328 cfu/100 mL. The highest bacteria concentrations occurred during the rain events on September 4, 2007, (average concentration of 910 cfu/100 mL) and October 2, 2007, (average concentration of 365 cfu/100 mL). Field notes also document that it was raining while collecting these samples. See Appendix F for precipitation data. FC bacteria concentrations were also elevated (average concentration 210 cfu/100 mL) on September 11, 2007, when there hadn't been any rainfall for nearly a week. Sources of bacteria appear to be both from run-off as well as other unidentified sources. The remaining results from this site ranged from 11 cfu/100mL to 88 cfu/100mL.

This site had notable recreational activity on the adjacent trail and gravel bars. Diapers and trash were observed on the gravel banks. Horse manure was seen occasionally on the trail above the creek. Recent beaver activity was observed immediately upstream from this sampling location. There were freshly chewed and downed trees as well as active dam building. Dogs were often heard from the adjacent residential area located back in the forested area on the left bank.

In November, 2007, the large run of chum salmon moved into Kennedy Creek to spawn. With the fish followed an increase in gulls searching for food, and most likely an increase in other wildlife predators. There was also an increase in human visitation for general salmon viewing as well as environmental education programs. Concentrations decreased in November; this could result from the effects of increased volume and dilution.

INT, RM 0.9

Site INT was accessed through the salmon viewing interpretive area and was above the influence of Fiscus Creek (site TINT). This site was out of compliance with FC bacteria criteria. Data from 11 sampling events resulted in a geometric mean value of 41 cfu/100 mL and 90th percentile of 110 cfu/100 mL. There were two events that resulted in concentrations over 100 cfu/100 mL. On September 11, 2007, after a period of dry weather, a concentration of 130 cfu/100mL resulted. The other elevated concentration, 120 cfu/100mL, resulted from a sample taken during the October 2, 2007 rain event. The remaining results ranged from 10 cfu/100mL to 84 cfu/100mL. Concentrations decreased in November. Potential sources in this area are waste from humans, pets, or wildlife, including beaver.

FLS, RM 2.9

Site FLS is located about 75 feet upstream of the waterfalls on Kennedy Creek. This site was out of compliance with FC bacteria criteria. Data from 7 sampling events resulted in a geometric mean value of 38 cfu/100 mL and 90th percentile of 177 cfu/100 mL. Two sampling events

resulted in bacteria concentrations over 100 cfu/100 mL. The highest concentration of 270 cfu/100 mL occurred on September 25, 2007. It is unclear why the concentration was elevated on this day; no rain was reported. The other elevated concentration, 110 cfu/100 mL, occurred after the rain event on September 4, 2007. The remaining results ranged from 9 cfu/100 mL to 44 cfu/100 mL. Recreational campsites located near this sampling site are known to receive use, though there were no obvious signs of heavy use during this project. There are no formal sanitary facilities in this area. Humans and wildlife are considered to be a possible source of bacteria for this reach of the creek.

KCS, RM 8.25

Site KCS was accessed through private residential property. It was the only sampling site on the Kennedy Creek mainstem to meet the state designated water quality standard for extraordinary primary contact. Twelve sampling events had a geometric mean of 12 cfu/100 mL and 90th percentile of 72 cfu/100 mL. It represents an area that flows through rural residential and forested lands. Bacteria concentration were elevated during the September 4, 2007 (88 cfu/100 mL), and October 2, 2007 (80 cfu/100 mL), rain events. Otherwise, results from this site were below 50 cfu/100 mL, ranging from a reported 1 cfu/100 mL (below laboratory instrument detection) to 39 cfu/100 mL.

KCN, RM 8.78

This site is located on Kennedy Creek immediately above the bridge on Summit Lake Road. It was above the confluence with the tributary exiting Summit Lake (TLK) and just above the influence of another tributary (characterized by TCN). This site was out of compliance with FC bacteria criteria. Data from twelve sampling events had a geometric mean of 32 cfu/100 mL and 90th percentile of 123 cfu/100 mL. Data suggest that this site responds to rain events with the highest concentrations occurring on August 21 (88 cfu/100 mL), September 4, 2007 (250 cfu/100 mL), and October 2, 2007 (110 cfu/100 mL). This site is downstream of concentrated rural residential properties. Additionally, a hose was found in the creek. It entered the creek from the left bank. It could not be determined if the hose was being used in ways that would influence water quality or quantity.

BBQ, RM 11

This upper watershed site was located south of Highway 8 and downstream of the bridge on Kennedy Creek Road NW and the previous Ranch House BBQ restaurant. Sampling results for bacteria are being reported even though the creek at this location experienced a major landslide in December 2007 altering conditions existing during the project period (see the Methods section, page 9, for more detail).

FC bacteria criteria were not met at this site. Twelve sampling events resulted in a geometric mean of 130 cfu/100 mL and 90th percentile of 1893 cfu/100 mL. In early August water quality results (190 cfu/100 mL) at this site pointed to potential upstream sources when compared with data from the rest of the watershed. The influence of upstream bacteria was seen again when FC bacteria concentrations of 1800 cfu/100 mL resulted from samples collected on August 21, 2007.

This sample was collected during the rain event. On this sampling day a temporary sanitary facility (sanican) was observed near the restaurant. The sanican had not been observed on other sampling events. Darrell Cochran, the Senior Environmental Health Specialist with Thurston County Environmental Health, later identified a party had been held at the restaurant a few days previous to the sampling event. This was confirmed with an email from Thurston Environmental Health confirming there had been a Chili Cook-off at the restaurant on 8/19/07 (Hansen, 2008).

On August 27, 2007, bacterial concentrations remained high (average concentration of 1150 cfu/100 mL) even though there had been little to no rain in the intervening week. On October 16, 2007, the bacteria concentration was 820 cfu/100 mL. Field notes recorded a large number of cars at the restaurant, on this day, as well as rain falling during sampling. In November the FC bacteria concentrations dropped to concentrations similar to other samples from the upper watershed.

The land use above the BBQ sample site included the commercial restaurant property as well as a few buildings (including a sewer hook up to the restaurant septic tank), and forested land managed by DNR. The source for elevated bacteria at this site could include unknown sources from the properties sanitary system, wildlife, pet waste or illicit dumping from recreational vehicles.

Tributary sampling sites

TINT, tributary enters Kennedy Creek at RM 0.69

Site TINT is on Fiscus Creek, a tributary at the lower end of Kennedy Creek. It is accessed through the salmon interpretive trail and is sampled just upstream of the large wooden bridge (*Jeff Cedarholm Memorial Bridge*). This site was out of compliance with FC bacteria criteria. Six sampling events resulted in a geometric mean value of 48 cfu/100 mL and 90th percentile of 670 cfu/100 mL. This site wasn't sampled until September 25, 2007, but elevated concentrations were found during the first two sampling events. On September 25, 2007, the FC bacteria concentration was 450 cfu/100 mL. There was little precipitation thus the elevated concentration does not appear to result from runoff. On October 2, 2007, the average FC bacteria concentration was 436 cfu/100 mL; this sample was taken during a rain event. These were the highest concentrations found in the tributaries during this time. Bacteria concentrations reduced over the rest of the sampling project.

Possible sources for the FC bacteria could be wildlife, and humans recreating and working in the watershed. In general, high recreational use of the interpretive trail doesn't begin until November; sanicans have been installed during the weeks of intense visitation.

TLK, tributary enters Kennedy Creek at RM 8.69

Site TLK is on the tributary that drains Summit Lake. It was sampled downstream of the bridge on Summit Lake Road. This site met FC bacteria criteria. There were 12 sampling events resulting in a geometric mean value of 20 cfu/100mL and 90th percentile of 98 cfu/100mL.

Water quality did respond to the September 4 and October 2, 2007, rain events with concentrations of 200 cfu/100 mL and 120 cfu/100 mL (replicate 130 cfu/100mL), respectively. The remaining data were at concentrations below 50 cfu/100 mL. Potential sources could be residential and recreational use near and around the lake as well as wildlife.

TCN and TPK, tributary enters Kennedy Creek at RM 8.77

Both sampling sites are on a tributary in the upper watershed. The tributary enters Kennedy Creek on the left bank just above bridge on Summit Lake Road NW. Site TCN is at the mouth of the tributary before it flows into Kennedy Creek. Site TPK is located upstream of TCN. It is located upstream of the small bridge and adjacent to the Washington State Department of Transportation (WSDOT) Park and Ride parking lot.

Site TCN met the FC bacteria criteria. Data from eleven samples resulted in a geometric mean value of 15 cfu/100mL and 90th percentile of 88 cfu/100 mL. Water quality did respond to the September 4 and October 2, 2007, rain events with concentrations of 71 cfu/100 mL and 120 cfu/100 mL respectively. This site represents a stretch of the tributary that flows as a roadside ditch in front of several houses. There are hoses/pipes entering the ditch in this area (near the private residence at 12235 Summit Lake Road NW). It was not clear if the conveyances were being used. On September 11, 2007, the lower reach of the tributary went dry. Though the water could have gone subsurface, the presence of conveyances in the creek needs further investigation. The data don't reflect septic leakage, but most likely is being influenced by bacteria from the upstream site (described below).

Site TPK did not meet FC bacteria criteria. Data from twelve sample events resulted in a geometric mean value of 30 cfu/100 mL and 90th percentile of 175 cfu/100 mL. Bacteria concentrations responded to rain events on August 21 (92 cfu/100 mL), September 4 (130 cfu/100 mL), and October 2, 2007, (110 cfu/100 mL). But, data show that it often stays relatively high even when there is no precipitation. The creek in this area appears to get used for recreational activity. This activity is assumed by the amount of toilet paper and trash often found on the gravel bar of the creek. Pet waste and wildlife may also be a contributing source of bacteria in the creek.

BWW, tributary enters Kennedy Creek at RM 10.79

This site is located south of Highway 8 and is in an adjacent drainage west of site BBQ in Kennedy Creek. This site was in compliance with the FC bacteria criteria. There were 12 sampling events which resulted in a geometric mean of 13 cfu/100 mL and 90th percentile of 55 cfu/100 mL. There was no clear response to rain events. This is an area of sparse rural residential and forested areas. Wildlife would be a likely source of bacteria.

Conclusions

In general, the Kennedy Creek watershed does not meet water quality criteria for Extraordinary Primary Contact for FC bacteria. One mainstem site at river mile 8.25 met FC bacteria criteria. Two sites upstream and three sites downstream of this location did not meet criteria. Three of the five tributary sites met the FC bacteria criteria.

Elevated concentrations of bacteria were seen in the mainstem as in many of the tributaries. Increased concentrations often occurred in August through October during rain events or after previous day's rain. However, elevated FC bacteria concentrations also resulted during dry weather. Concentrations tended to decrease in November as water volume in the creeks increased.

A notable source of FC bacteria was in the upper watershed immediately below the Ranch House BBQ Restaurant (closed after December 2007 landslide) at site BBQ. In August, just downstream of the restaurant, this site had concentrations notably higher than anywhere else sampled in the watershed. Elevated bacteria concentrations were seen after increased rain as well as with increased patronage at the restaurant and use of parking facilities. Specific sources were not verified through this study.

The mouth of Kennedy Creek does not meet FC bacteria criteria for Extraordinary Primary Contact. Elevated concentrations were seen during wet and dry weather. However, it does not appear that FC bacteria sources in the upper watershed are the primary cause. Waste from human and animal sources are likely sources influencing elevated bacteria concentrations in the lower reach of the creek between RM 1 and RM 0.34.

Sampling sites near areas of high recreation, on both the mainstem (MTH, FLS) and tributaries (TINT, TPK), had occasional elevated FC bacteria concentrations. Except for sanicans at Fiscus Creek (TINT) during November, these recreational areas had no facilities to manage human waste.

Site BWW was located in an area of little human influence. Results during this study show relatively low FC bacteria levels even after rain events.

Possible sources of FC bacteria in the watershed include recreational use, failing septic systems, wildlife, domestic animals (including dogs and horses), and re-suspension of in-stream sediments harboring FC bacteria.

Recommendations

1. Focus investigations on potential nonpoint sources coming into the lower reach of Kennedy Creek from just above the salmon interpretive area (approximately RM 1.0) downstream to the freshwater mouth site (approximately RM 0.34). This would include, but should not be limited to:
 - a) Investigate possible sources of FC bacteria entering the mainstem from Fiscus Creek.
 - b) Ensure that the sanicans placed near Fiscus Creek in November (for salmon environmental education activities) are located far enough away so that the creek would be protected in the event there was a spill from the sanicans.
 - c) Investigate land use at the residential areas immediately upstream of RM 0.34 to determine potential sources of bacteria to Kennedy Creek. This would include dye testing septic systems.
 - d) Investigate options for improving waste management in areas near the Old Olympia Highway bridge where recreational use is particularly heavy.
2. If the septic system located on the property at the previous Ranch House BBQ restaurant is put back into use, by a new commercial or residential facility, the following evaluations should be conducted:
 - a) Conduct a dye test on the septic system to evaluate its functioning status before it is put into use.
 - b) Diagnose and verify the integrity of existing system components, including collection lines, septic tank, and drainfield.
 - c) Conduct water quality monitoring above and below the property to ensure the septic system is adequate to protect human health and water quality. Weekly sampling during August and September would be a priority, but characterizing the conditions during the wet season is also recommended.
3. Investigate the source and purpose for the pipes entering Kennedy Creek immediately upstream of the Summit Lake Road NW bridge near the residence at 12239 Summit Lake Road NW.
4. Investigate the source and purpose for the hoses entering the tributary near 12235 Summit Lake Road NW. The hoses are located upstream of sampling location TCN near a private wooden bridge.
5. Continue to investigate the WSDOT Park and Ride lot. Identify sources of FC bacteria and determine ways to protect water quality in that area.
6. Continue to investigate activities at the Kennedy Creek falls camping area. Identify sources of FC bacteria and determine ways to protect water quality in the area.
7. Focus on-going education and outreach, for watershed residents and recreational users, on effective waste management options for human and pet waste (including horses) while hunting, boating, trail riding, etc. The connection between waste management, human health, and water quality should be addressed; impacts to the Totten-Eld Inlet marine environments and shellfish consumption should be highlighted. Education and outreach should be sustained throughout the year using a variety of communication methods.
8. Consider Microbial Source Tracking at key locations in the watershed to better determine sources of bacteria in the Kennedy Creek watershed and ultimately Totten Inlet. The finding could assist in prioritizing future actions to reduce FC bacteria pollution and improve water quality.

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Appendix A

Federal Clean Water Act requirements Water Quality Assessment

The Clean Water Act established a process to identify and clean up polluted waters. Under the Clean Water Act, each state is required to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses for protection, such as cold water biota and drinking water supply, as well as criteria, usually numeric criteria, to achieve those uses.

Every two years, states are required to prepare a list of water bodies—lakes, rivers, streams, or marine waters—that do not meet water quality standards. This list is called the 303(d) list. To develop the list, Ecology compiles its own water quality data along with data submitted by local, state, and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed to ensure that they were collected using appropriate scientific methods before the data are used to develop the 303(d) list. The 303(d) list is part of the larger Water Quality Assessment.

The Water Quality Assessment is a list that tells a more complete story about the condition of Washington's water. This list divides water bodies into one of five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested.

Category 2 – Waters of concern.

Category 3 – Waters with no data available.

Category 4 – Polluted waters that do not require a TMDL because:

4a. – Has a TMDL approved and it's being implemented

4b. – Has a pollution control plan in place that should solve the problem

4c. – Is impaired by a non-pollutant such as low water flow, dams, culverts

Category 5 – Polluted waters that make up the **303(d)** list and require a TMDL.

TMDL process overview

The Clean Water Act requires that a Total Maximum Daily Load be developed for each of the water bodies on the 303(d) list. A TMDL identifies how much pollution needs to be reduced or eliminated and still meet Washington State's Water Quality Standards, Chapter 173-201A of the Washington Administrative Code. Then Ecology works with the local community to develop (1) a strategy to control the pollution and (2) a monitoring plan to assess effectiveness of the water quality improvement activities.

Elements required in a TMDL

The goal of a TMDL is to ensure the impaired water 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 that can be discharged to the water body and still meet standards (the loading capacity) and allocates that load among the various sources.

If the pollutant comes from a discrete (point) source such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a *wasteload allocation*. If the pollutant comes from a set of diffuse (nonpoint) source such as general urban, residential, or farm run-off, the cumulative 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. A reserve capacity for future loads from growth pressures is sometimes included as well. The sum of the wasteload and load allocations, the margin of safety, and any reserve capacity must be equal to or less than the loading capacity.

TMDL = Loading Capacity = sum of all wasteload allocations + sum of all load allocations + margin of safety

Total Maximum Daily Load Analyses: Loading capacity

Identification of the contaminant loading capacity for a water body is an important step in developing a TMDL. The Environmental Protection Agency (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 pollution 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.

Appendix B

Water quality criteria for fecal coliform bacteria.

Table B1. Water Contact Recreation Bacteria Criteria in Freshwater

Water Contact Recreation Bacteria Criteria in Freshwater	
Category	Bacteria Indicator
Extraordinary Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.
Primary Contact Recreation	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 10 sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.
Secondary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

Bacteria, fresh waters

Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. In the Washington 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.

Use categories

There are three use categories related to the freshwater bacteria criteria in Washington:

(1) The *Extraordinary Primary Contact* use is intended for waters capable of “providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.” To protect this use category: Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100/colonies mL” [WAC 173-201A-200(2)(b), 2003 edition].

(2) 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 10 sample points exist) obtained for calculating the geometric mean value exceeding 200/colonies mL” [WAC 173-201A-200(2)(b), 2003 edition].

(3) The *Secondary Contact* use is intended for waters “where a person’s water contact would be limited (e.g., wading or fishing) to the extent that bacterial infections of the eyes, ears, respiratory or digestive systems, or urogenital areas would be normally avoided.” To protect this use category: “Fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 400/colonies mL” [WAC 173-201A-200(2)(b), 2003 edition].

Compliance is based on meeting both the geometric mean criterion and the 10 percent of samples (or single sample if less than 10 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 a greater risk to human health than intended. While some discretion exists for selecting sample averaging periods, compliance will be evaluated for both monthly (if five or more samples exist) and seasonal (summer versus winter) data sets.

Appendix C

Emergency closure letter for Totten Inlet

October 4, 2007

«FirstName» «LastName»
«Organization»
«Address1»
«Address2»
«City», «State» «Zip»

Dear «Salute» «LastName»:

During the heavy rain storms we experienced in November of 2006, we collected water samples in Totten Inlet. The fecal coliform results from November 6, 2006 were very poor from Oyster Bay to Arcadia.

Although Totten Inlet is classified as Approved, it's obvious that heavy rains can rapidly transport pollution into the inlet, creating a health risk to shellfish consumers. As a result, we want to alert you that we plan to close all of Totten Inlet as shown on the enclosed maps whenever three inches or more of rain falls in 24 hours as measured at the Olympia Airport. National Weather Service records indicate such heavy rains happen in Totten Inlet about once every two years. Our experience indicates that we would need to close the area for a period of one week; however, a longer closure may be required depending on the circumstances.

These closures comply with the National Shellfish Sanitation Program requirements that shellfish growing areas must be closed when:

- An emergency condition or situation exists; or
- Pollution conditions exist that were not included in the data set used to classify the area.

In addition to protecting shellfish consumers, closing the area after extreme rain events may also help protect the Approved classification of Totten Inlet. Water samples collected after heavy rains often show very high fecal coliform bacteria results. When we close an area, water samples collected during the closure are not included in the data used to classify the area. However, if the area is left open, the water sampling results must be included.

We recognize the hardship that closures place on shellfish operations. However, we believe that such closures are needed to assure the safety of the shellfish and to maintain the Approved classification status of Totten Inlet.

We welcome any questions or suggestions you may have about this safety measure. Please contact Bill Cleland at (360) 236-3306 or by e-mail at bill.cleland@doh.wa.gov by October 19, 2007.

Sincerely,



Bob Woolrich, Manager
Growing Area Section

Enclosures

Appendix D

Laboratory and field data

Table D-1: Laboratory and field data for FC bacteria samples collected in Kennedy Creek watershed.

Site Name	Date	Time	FC Bacteria Result* (cfu/100 mL)		Field Replicate (cfu/100 mL)		Laboratory Duplicate (cfu/100 mL)		Discharge (cfs)** .	Discharge Replicate (cfs)
MTH	8/7/07	14:30	87		88				nd	nd
	8/14/07	13:06	29		28				5.2	nd
	8/21/07	12:40	51		48				5.7	5.6
	8/27/07	14:20	39		68				4.2	4.2
	9/4/07	12:47	980	J	840	J	800	J	5.8	5.4
	9/11/07	13:33	190		230				4.0	3.5
	9/25/07	13:18	84		40				4.0	3.9
	10/2/07	15:36	320		410				11.0	11.2
	10/9/07	13:20	11		26				10.2	9.7
	10/16/07	9:43	57		40	J			7.0	7.1
	11/5/07	13:50	28		32				too many salmon	
11/13/07	10:40	53		51				water too high and fast		
TINT	9/25/07	14:05	450							
	10/2/07	15:19	500		380					
	10/9/07	13:05	120		54					
	10/16/07	10:12	23	J	31					
	11/5/07	13:40	3							
	11/13/07	11:15	9							
INT	8/14/07	12:29	32							
	8/21/07	12:09	61		41					
	8/27/07	14:00	33							
	9/4/07	12:32	84							
	9/11/07	13:16	130							
	9/25/07	14:10	46							
	10/2/07	15:12	120							
	10/9/07	12:57	23		17					
	10/16/07	10:05	26							
	11/5/07	13:36	10							
	11/13/07	11:11	34							
FLS	8/27/07	10:40	44		37					
	9/4/07	11:14	110							
	9/11/07	11:47	17							
	9/25/07	12:17	270	J						
	10/2/07	13:50	43							
	10/9/07	11:37	14							
	10/16/07	11:04	9							

Site Name	Date	Time	FC Bacteria Result (cfu/100 mL)		Field Replicate (cfu/100 mL)		Laboratory Duplicate (cfu/100 mL)		Discharge (cfs)	Discharge Replicate (cfs)
KCS	8/7/07	13:57	9							
	8/14/07	11:28	4							
	8/21/07	11:03	20				29			
	8/27/07	13:20	18				20			
	9/4/07	10:22	88							
	9/11/07	11:02	2							
	9/25/07	11:45	39				33			
	10/2/07	13:09	80							
	10/9/07	11:02	19							
	10/16/07	13:50	4							
	11/5/07	12:55	1	U						
	11/13/07	11:53	15							
	KCN	8/7/07	13:26	23		24		27		
8/14/07		10:56	7		15					
8/21/07		10:39	88							
8/27/07		13:05	36							
9/4/07		10:05	250	J						
9/11/07		10:43	14							
9/25/07		11:12	25							
10/2/07		12:44	110							
10/9/07		10:44	31							
10/16/07		13:33	26							
11/5/07		12:36	5							
11/13/07		12:04	33							
TCN		8/7/07	13:10	55						
	8/14/07	10:54	20							
	8/21/07	10:37	22							
	8/27/07	13:03	6	J						
	9/4/07	10:04	71	J						
	9/25/07	11:10	11							
	10/2/07	12:43	120							
	10/9/07	10:43	6							
	10/16/07	13:32	20							
	11/5/07	12:35	5							
	11/13/07	12:05	1	U						

Site Name	Date	Time	FC Bacteria Result (cfu/100 mL)		Field Replicate (cfu/100 mL)		Laboratory Duplicate (cfu/100 mL)		Discharge (cfs)	Discharge Replicate (cfs)
TLK	8/7/07	13:42	15							
	8/14/07	11:09	13	J			21	J		
	8/21/07	10:48	47							
	8/27/07	13:12	21							
	9/4/07	10:11	200							
	9/11/07	10:50	17							
	9/25/07	11:30	3							
	10/2/07	12:54	120				130			
	10/9/07	10:53	28							
	10/16/07	13:40	22							
	11/5/07	12:43	9							
	11/13/07	12:10	4							
	TPK	8/7/07	12:45	29						
8/14/07		10:36	29							
8/21/07		10:30	92							
8/27/07		12:50	84							
9/4/07		9:58	130	J						
9/11/07		10:35	160							
9/25/07		11:04	26							
10/2/07		12:33	110							
10/9/07		10:35	9							
10/16/07		13:30	10							
11/5/07		12:33	8				1	U		
11/13/07		12:15	2							
BBQ		8/7/07	11:47	190						
	8/14/07	10:00	80		55					
	8/21/07	10:07	1800	J						
	8/27/07	11:30	1100		1200	J				
	9/4/07	9:42	200	J	220	J				
	9/11/07	10:22	66		68					
	9/25/07	10:51	200		240					
	10/2/07	11:59	380		380					
	10/9/07	10:25	88							
	10/16/07	13:15	820							
	11/5/07	12:22	1	U						
	11/13/07	12:20	10							

Site Name	Date	Time	FC Bacteria Result (cfu/100 mL)		Field Replicate (cfu/100 mL)		Laboratory Duplicate (cfu/100 mL)		Discharge (cfs)	Discharge Replicate (cfs)
BWW	8/7/07	12:19	14							
	8/14/07	10:06	29							
	8/21/07	10:18	35							
	8/27/07	11:35	18							
	9/4/07	9:46	17	J						
	9/11/07	10:28	2				4			
	9/25/07	10:54	7							
	10/2/07	12:06	24							
	10/9/07	10:28	21				28			
	10/16/07	13:20	79				58			
	11/5/07	12:25	2							
	11/13/07	12:23	7							
BQW	11/13/07	12:30	1	U			1	U		

* U - The analyte was not detected at or above the reported sample quantitation limit.

J- The analyte was positively identified, but the count was estimated.

** Discharge only measured at the mouth site

Table D-2. Summary data for Kennedy Creek mainstream sites.
 FC bacteria concentration and summary statistic units are in cfu/100 mL.

DATE	MTH	INT	FLS	KCS	KCN	BBQ
8/7/07	88	nd	nd	9	24	190
8/14/07	29	32	nd	4	11	68
8/21/07	50	51	nd	20	88	1800
8/27/07	54	33	41	18	36	1150
9/4/07	910	84	110	88	250	210
9/11/07	210	130	17	2	14	67
9/25/07	62	46	270	39	25	220
10/2/07	365	120	43	80	110	380
10/9/07	19	20	14	19	31	88
10/16/07	49	26	9	4	26	820
11/5/07	30	10	nd	1	5	1
11/13/07	52	34	nd	15	33	10
Summary Statistics	MTH	INT	FLS	KCS	KCN	BBQ
10th percentile	18	15	8	2	8	9
Minimum	19	10	9	1	5	1
Geometric mean	76	41	38	12	32	130
Maximum	910	130	270	88	250	1800
90th percentile	328	110	177	72	123	1893
Number of samples	12	11	7	12	12	12

Table D-3. Summary FC bacteria data for Kennedy Creek tributary sites.
 FC bacteria concentration and summary statistic units are cfu/100 mL.

DATE	TINT	TLK	TCN	TPK	BWW
8/7/07	nd	15	55	29	14
8/14/07	nd	13	20	29	29
8/21/07	nd	47	22	92	35
8/27/07	nd	21	6	84	18
9/4/07	nd	200	71	130	17
9/11/07	nd	17	nd	160	2
9/25/07	450	3	11	26	7
10/2/07	440	120	120	110	24
10/9/07	87	28	6	9	21
10/16/07	27	22	20	10	79
11/5/07	3	9	5	8	2
11/13/07	9	4	1	2	7
Summary Statistics	TINT	TLK	TCN	TPK	BWW
10th percentile	3	4	3	5	3
Minimum	3	3	1	2	2
Geometric mean	48	20	15	30	13
Maximum	450	200	120	160	79
90th percentile	670	98	88	175	55
Number of samples	6	12	11	12	12

Appendix E

Quality assurance for field and laboratory

Laboratory duplicates

The quality assurance objective used by MEL for FC bacteria samples is 40 percent relative percent difference (RPD). RPD is the percent difference between the duplicate sample concentrations. MEL takes two aliquots (duplicates) from a field replicate sample. Results from the duplicate samples provide quality assurance by measuring with-in laboratory precision. Duplicate sample concentrations 20 cfu/100 mL and less are close to the detection limit and thus RPD analyses result in artificially escalated values, and thus do not meet the MEL quality assurance objective. Microbiology samples were analyzed within 24 hours of collection. Using a 24 hour holding time versus the typical 6 hours has been field tested (Mathieu, 2005) and is standard procedure for MEL. The laboratory quality assurance checks reflect good laboratory technique and quality data. Figure E-1 summarizes the laboratory quality assurance data.

Field replicates

Field quality assurance samples (replicates) are samples taken one right after the other in the same location in the stream. Field replicates were collected at approximately 20 percent of the total number of sites. Replicate results reflect total variability associated with the laboratory, field, and transport. Relative standard deviation (RSD) is used to analyze field replicates (Ecology, 2006). RSD is calculated by dividing the standard deviation of the replicate pairs by their mean and multiplying by 100.

Two of the 26 replicate pairs were equal to or below 20 cfu/100 mL and thus were not used in determining compliance with the quality assurance objective. These concentrations are too close to the method detection limit resulting in artificially escalated RPD values.

Twenty four replicate pairs had a mean greater than 20 cfu/100 mL and were used for measuring quality assurance in the field. The quality assurance objective for field replicate samples is to have 50 percent of the replicates below a 20 percent RSD and 90 percent of the samples below a RSD of 50 percent (Ecology, 2006). Figure E-2 shows the quality assurance objective was met for this sampling project.

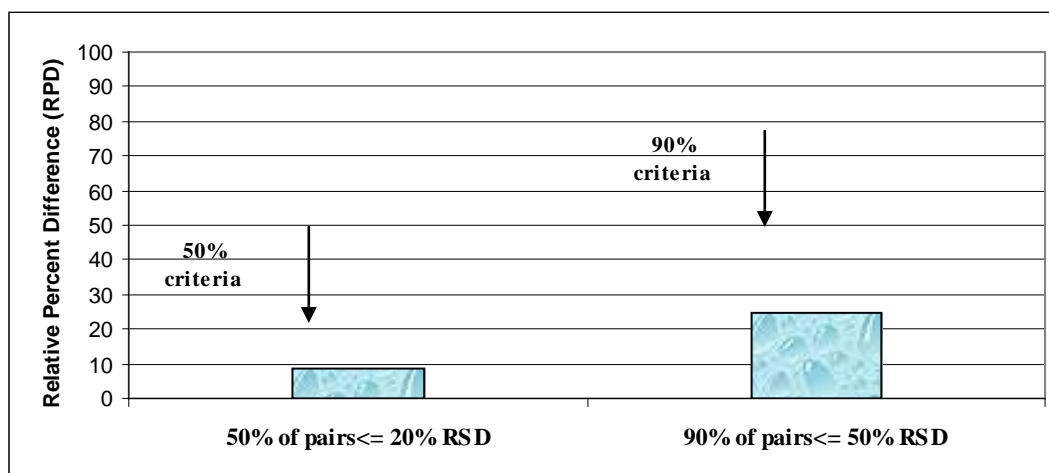


Figure E -1. RSD for field replicate samples (cfu>20cfu) in Kennedy Creek watershed July – October, 2007.

Appendix F

Precipitation

Table F-1. Precipitation (inches) as recorded at Olympia, WA. Airport.
 Bolded data represent rain on a sampling day.

Precipitation 2007 for Select Months						
Day	July	August	September	October	November	December
1	0	0	0	0.16	0	0.6
2	0	0	0	1.06	0	2.12
3	0	0	0.39	0.11	0	3.19
4	0	0	0.31	0.13	0.001	0.16
5	0	0	0.001	0.01	0	0.001
6	0	0	0	0.07	0	0.06
7	0	0.01	0	0.21	0.03	0.001
8	0	0.001	0	0	0.01	0
9	0	0	0	0.001	0.19	0.07
10	0	0.001	0	0.12	0.33	0.001
11	0	0	0	0	0.15	0.001
12	0.001	0.001	0	0.04	0.74	0
13	0	0	0	0	0.04	0.01
14	0.001	0	0	0	0.12	0.12
15	0.001	0	0	0.1	0.79	0.42
16	0	0.001	0.15	0.14	0.12	0.01
17	0.61	0.001	0.09	0.34	0.61	0.06
18	0.19	0.23	0.02	0.41	0.01	0.63
19	0.36	0.12	0.001	1.26	0.03	1.14
20	0.29	0.05	0.06	0.64	0.001	0
21	0.32	0.14	0.01	0.07	0	0
22	0.08	0.001	0.07	0	0	0.4
23	0.001	0	0	0	0	0.86
24	0.001	0	0	0.001	0	0.06
25	0	0.01	0.02	0	0	0.37
26	0	0	0	0.001	0.3	0.001
27	0	0	0.13	0	0.001	0.43
28	0	0	0.001	0	0.32	0.49
29	0	0	0.03	0.01	0.25	0.23
30	0	0	0.96	0	0.001	0.28
31		0.001		0		