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South Prairie Creek Tributaries Fecal Coliform Bacteria: Data Summary

Inglin Creek and Spiketon Ditch

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South Prairie Creek Tributaries Fecal Coliform Bacteria: Data Summary

Inglin Creek and Spiketon Ditch

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Waterbody Number:

WA-10-1085 (South Prairie Creek)

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Abstract

One component of the *South Prairie Creek Bacteria and Temperature Total Maximum Daily Load Water Cleanup Plan* is to reduce bacteria loading to surface water. The cleanup process began in 2006. The South Prairie Creek watershed could meet Washington State water quality standards with additional fecal coliform bacteria (FC) data collection on two of its tributaries. Additional FC data help further identify potential sources of bacteria pollution.

The tributaries of concern are Spiketon Ditch and Inglin Creek located in north-central Pierce County, Water Resource Inventory Area 10. Spiketon Ditch and Inglin Creek watersheds flow through rural areas near the towns of Buckley and South Prairie respectively.

The objective of this study is to provide data that lend guidance to the associated water quality improvement projects. This report summarizes FC data and other water quality parameters measured from May 2005 through December 2009 in the Inglin Creek and Spiketon Ditch watersheds. The bulk of data analysis includes data collected from November 2008 through December 2009.

The results suggest that reductions in FC are necessary in order for Inglin Creek and Spiketon Ditch to meet water quality criteria for FC. From 2008 through 2009, the mouth of Inglin Creek had four times more FC loading than the mouth of Spiketon Ditch annually. Wet-season (November-April) FC loading on Inglin Creek was higher than the dry-season (May-October) loading. FC loading was variable between the wet and dry seasons along Spiketon Ditch. Reductions in FC levels are recommended in both watersheds.

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  - Cindy James provided guidance, prepared the water cleanup plan and reviewed this report.
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  - Mindy Roberts provided guidance and authored the associated Total Maximum Daily Load Study.
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  - George Onwumere provided supervision and reviewed this report.
  - Scott Tarbutton reviewed this report.
  - Nuri Mathieu and Chris Moore assisted in data collection and provided technical guidance.
  - Joan LeTourneau and Cindy Cook formatted and edited the final report.

Introduction

The *South Prairie Creek Bacteria and Temperature Total Maximum Daily Load Water Cleanup Plan* (Seabrook et al, 2006) addresses temperature and fecal coliform bacteria (FC) impairments in the South Prairie Creek watershed, a tributary of the Carbon River. As a result of the study, an advisory committee was formed to execute the water cleanup plan. Part of the cleanup process involves FC source verification and assessment at locations along Inglin Creek and Spiketon Ditch to determine bacterial contributions (Seabrook et al, 2006).

Inglin Creek and Spiketon Ditch are tributaries to South Prairie Creek located within Water Resource Inventory Area 10 (WRIA 10, Puyallup-White) (Figure 1). Spiketon Ditch and Inglin Creek watersheds flow through rural areas near the towns of Buckley and South Prairie respectively.

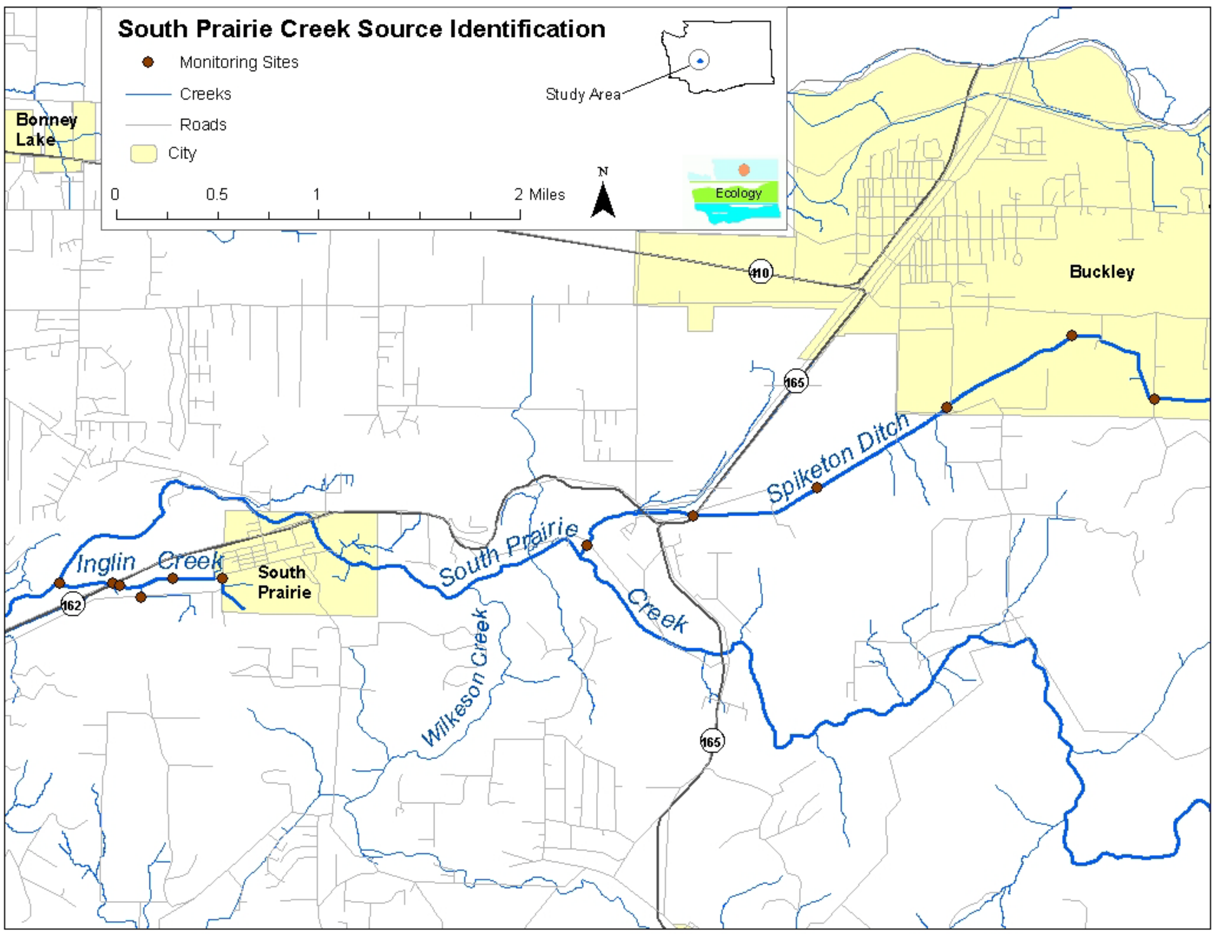

Figure 1. Map of monitoring stations along Inglin Creek and Spiketon Ditch.

The Pierce Conservation District (CD) is conducting a monitoring program that will localize contamination sources and guide remedial work or point to further FC source identification. Data collected by the Pierce CD from 2005 through 2009 are also included in this report. The Washington State Department of Ecology (Ecology) monitored FC, streamflow, and general water quality on Inglin Creek and Spiketon Ditch from November 2008 through December 2009. The data are included in this report.

Data sets from both Pierce CD and Ecology are combined with the bulk of analysis done on 2008-2009 data. The results show that Inglin Creek, Tributary 4, and Spiketon Ditch continue to not meet (exceed) Washington State water quality standards for FC (Chapter 173-201A WAC).

Purpose and Objective

The purpose of this report is to follow up on the original South Prairie Creek FC Bacteria Total Maximum Daily Load (TMDL) study by addressing the tributaries of concern.

The objective of this report is to provide data that lend guidance to the associated TMDL water quality improvement projects.

The data presentation, conclusions, and recommendations promote a better understanding of the watersheds both spatially and seasonally. The distance between sites is short enough to provide reach-specific information that may further reveal potential bacteria sources.

This report contains data collected from May 2005 through December 2009, including the following information:

- Description of applicable Washington State water quality criteria.
- Monitoring locations.
- FC data table and statistical summary.
- FC concentrations and loading assessment.
- Data table of streamflow.
- Data table of water quality parameters.

Applicable Water Quality Criteria and Beneficial Uses

The FC criteria have two statistical components: a geometric mean and an upper limit value that 10% of the samples cannot exceed. Fecal coliform samples follow a lognormal distribution. In Washington State FC TMDL studies, the upper limit statistic (i.e., not more than 10% of the samples shall exceed) has been interpreted as a 90th percentile value of the log-normalized values (Cusimano, 1997; Joy, 2000; Sargeant, 2002).

Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. In Washington State water quality standards, FC are used as an “indicator bacteria” for the state’s freshwaters (e.g., lakes and streams). FC in water “indicate” 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 FC criteria are set at levels that have been shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

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 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% 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 10% of samples (or single sample if less than ten total samples) limit. These two measures used in combination ensure that bacterial pollution in a waterbody will be maintained at levels that will not cause a greater risk to human health than intended.

The criteria for FC are based on allowing no more than the pre-determined risk of illness to humans that work or recreate in a waterbody. The criteria used in Washington State standards are designed to allow seven or fewer illnesses out of every 1,000 people engaged in Primary Contact activities. Once the concentration of FC in the water reaches the numeric criterion, human activities that would increase the concentration above the criteria are not allowed. If the criterion is exceeded, the state will require that human activities be conducted in a manner that will bring FC concentrations back into compliance with the standard.

If natural levels of FC (from wildlife) cause criteria to be exceeded, no allowance exists for additional human sources to measurably increase bacterial pollution. While the specific level of illness rates caused by animal versus human sources has not been quantitatively determined, warm-blooded animals (particularly those that are managed by humans and thus exposed to human-derived pathogens as well as those of animal origin) are a common source of serious waterborne illness for humans.

Inglin Creek Watershed

Inglin Creek (also known as Tributary 1) originates near the town of South Prairie flowing west through rural residential land and a former dairy before it enters South Prairie Creek (Figure 2). Inglin Creek has a shallow stream gradient and open grass lands along its corridors. The flat lands may act similar to a wetland that retains water thus providing a slow and steady hyporheic groundwater input to Inglin Creek. Tributary 4 originates south of the town from a nearby hillside, and enters Inglin Creek at South Prairie – Carbon River Road (Figure 2). The watershed of Inglin Creek is 1.8 km^2 (Seabrook et al, 2006).

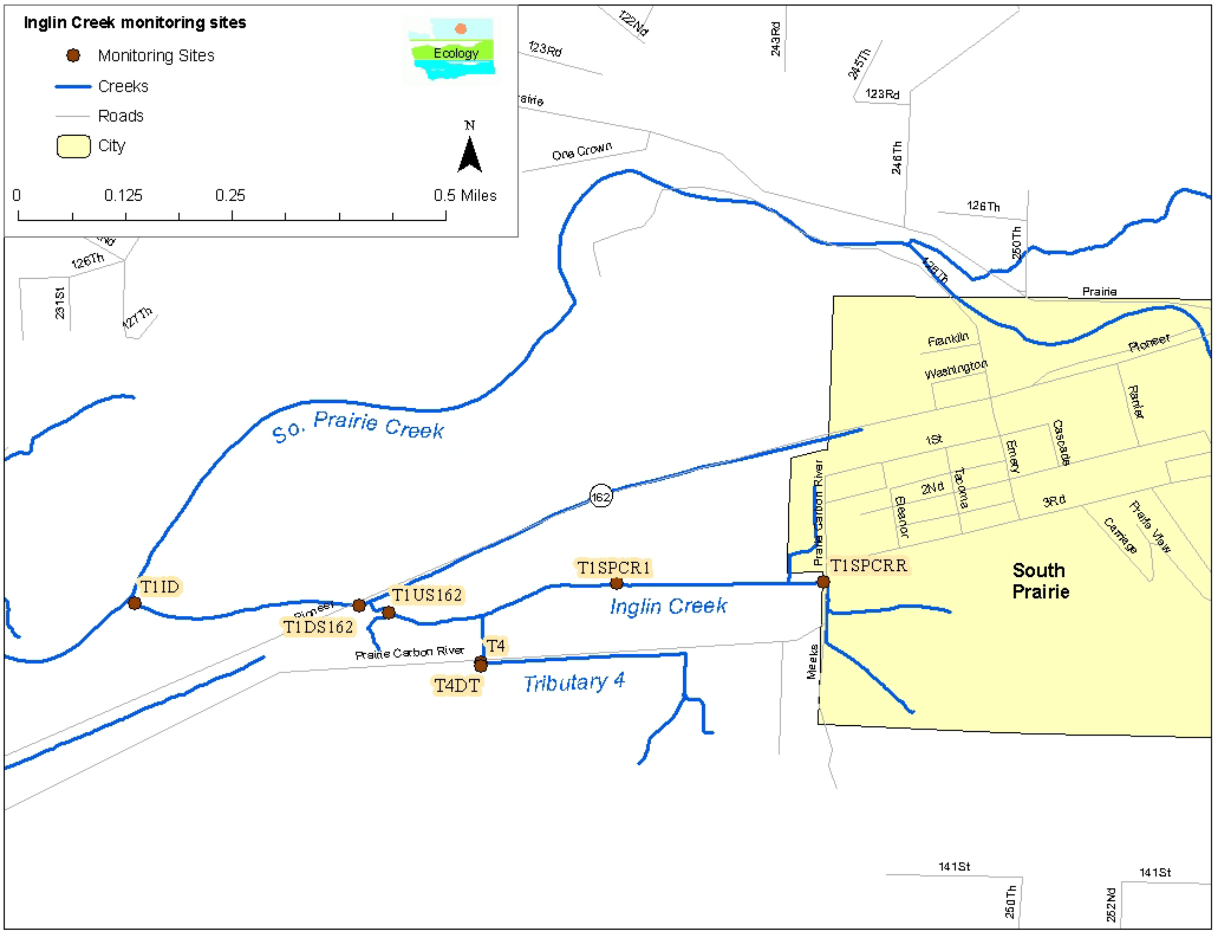

Figure 2. Inglin Creek and Tributary four monitoring locations.

Spiketon Ditch

Spiketon Ditch originates southeast of Buckley and flows southwest through rural residential land (Figure 3). Its confluence with South Prairie Creek is near Lower Burnett Road. The Spiketon Ditch watershed is 8.2 km² (Seabrook et al, 2006).

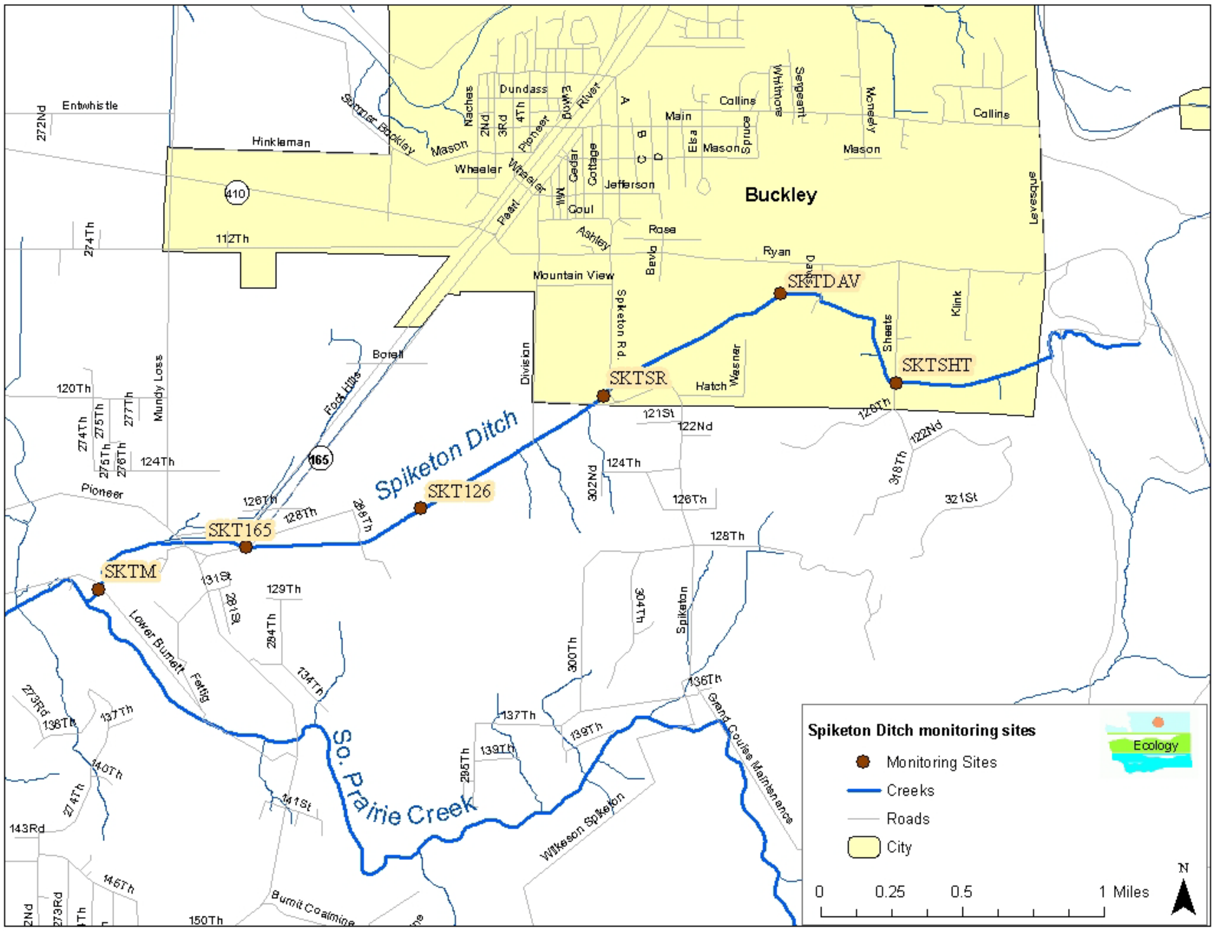

Figure 3. Spiketon Ditch monitoring locations.

Monitoring Locations

Routine monitoring locations are shown in Table 1, Figure 2, and Figure 3. The locations are consistent with the Pierce CD FC monitoring program, which began in 2005 within the South Prairie Creek watershed. Additional monitoring sites have been established to enhance sampling resolution, further leading to bacteria source identification. Flows permitting, stormwater was also sampled for FC at ditches that drain into Inglin Creek and Spiketon Ditch (Table 2 and Figures 4, 5, 6, 7, and 8).

Sites not listed in Tables 1 and 2 include T4W and T4US. Pierce CD sampled these sites four and five times respectively during the fall of 2008. Sampling results for T4W and T4US are located in the Results section and Appendices of this report.

Table 1. Monitoring locations on Inglin Creek, Tributary 4, and Spiketon Ditch.

Site ID	Monitoring Location Description	Latitude	Longitude
T1ID	Inglin Ck at mouth (former Inglin Dairy)	47.13552	-122.11898
T1DS162	Inglin Ck downstream of Hwy 162	47.13556	-122.11307
T1US162	Inglin Ck upstream of Hwy 162	47.13547	-122.11272
T1SPCR1	Inglin Ck off S. Prairie Carbon R. Rd (13428)	47.13604	-122.10701
T1SPCRR	Inglin Ck at S. Prairie Carbon R. Rd culvert	47.13612	-122.10187
T4	Tributary 4 at S. Prairie Carbon R. Rd	47.13464	-122.11034
T4DT	Drain tile ~ 3 ft. upstream of T4	47.13459	-122.11034
SKTM	Spiketon Ditch near mouth at Lower Burnett Rd	47.13898	-122.06362
SKT165	Spiketon Ditch at Hwy 165	47.14124	-122.05255
SKT126	Spiketon Ditch at 126th beyond the gate	47.14340	-122.03950
SKTSR	Spiketon Ditch at Spiketon Rd	47.14934	-122.02615
SKTDAV	Spiketon Ditch at Davis Rd	47.15455	-122.01002
SKTSHT	Spiketon Ditch at Sheets Rd	47.15033	-122.00435

Note: Inglin Ck is Tributary 1.
Latitude and longitude are in Washington State plane coordinates.

Table 2. Stormwater/other sampling locations along Inglin Creek and Spiketon Ditch.

Site ID	Stormwater Location Description	Latitude	Longitude
162DSD	Ditch along the downstream side of Hwy 162 near and west of T1US162, enters on left bank	47.13553	-122.11342
165D	Ditch along the upstream side of Hwy 165 near and east of SKT165, enters on right bank	47.14125	-122.05242
128D	Ditch along 128th near and east of SKT165, enters on left bank	47.14120	-122.05242
126D	Ditch ~ 10 ft. upstream of SKT126, enters on right bank draining a large wooded/grassy area	47.14343	-122.03959
SRUSD	Ditch along upstream side of Spiketon Rd ~ 20 ft. upstream of SKTSR, enters on right bank	47.14949	-122.02607
SRDSD	Ditch along downstream side of Spiketon Rd ~ 10 ft. upstream of SKTSR, enters on right bank	47.14937	-122.02616
SRDSD1	Ditch ~ 10 ft. downstream of SKTSR, enters on left bank	47.14926	-122.02621
SHTSD	Southern ditch along Sheets Rd adjacent to SKTSHT, enters on left bank	47.15025	-122.00435

Latitude and longitude are in Washington State plane coordinates.

Figure 4. Stormwater monitoring location on Inglin Creek at Highway 162.

Figure 5. Stormwater monitoring locations along Spiketon Ditch at Highway 165.

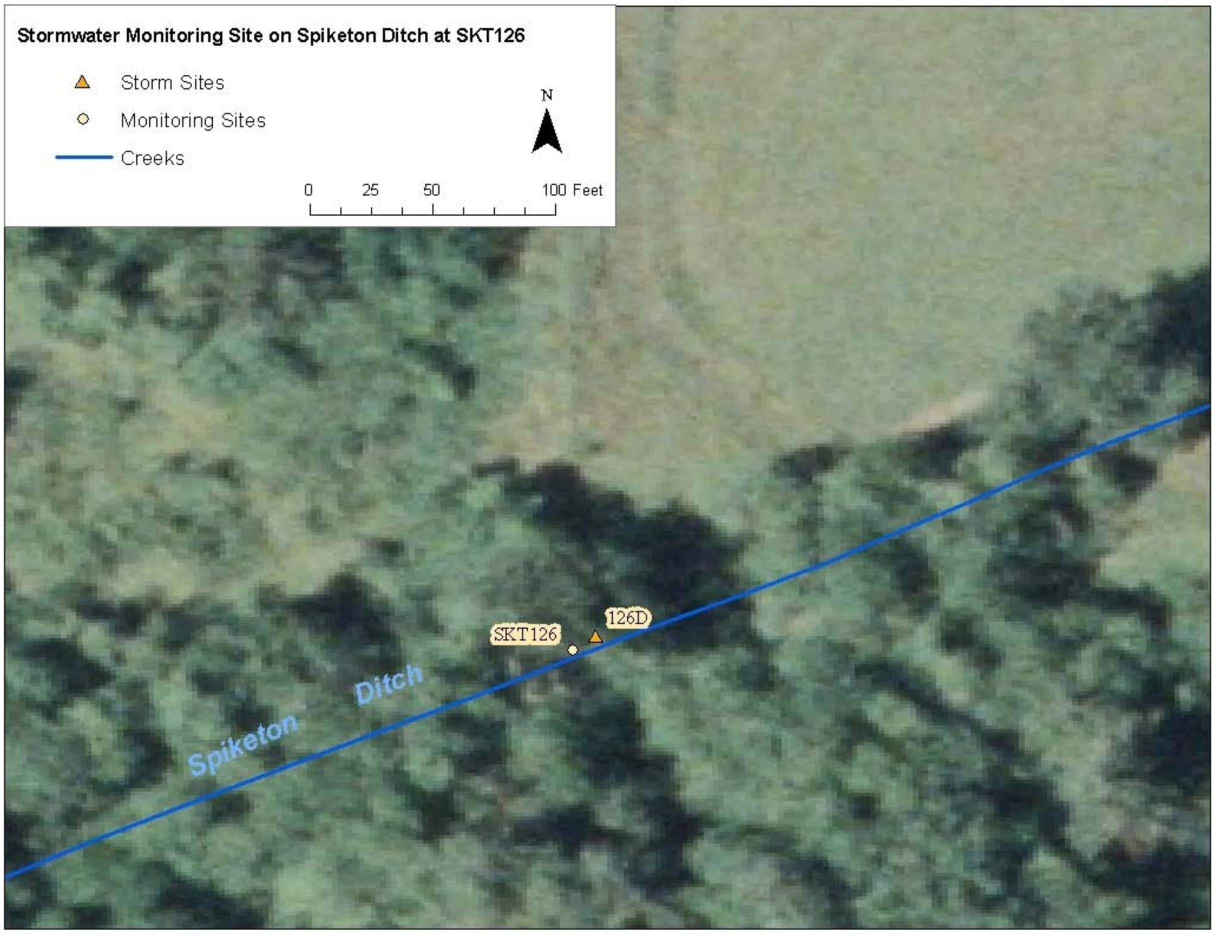

Figure 6. Stormwater monitoring location on Spiketon Ditch near 126th.

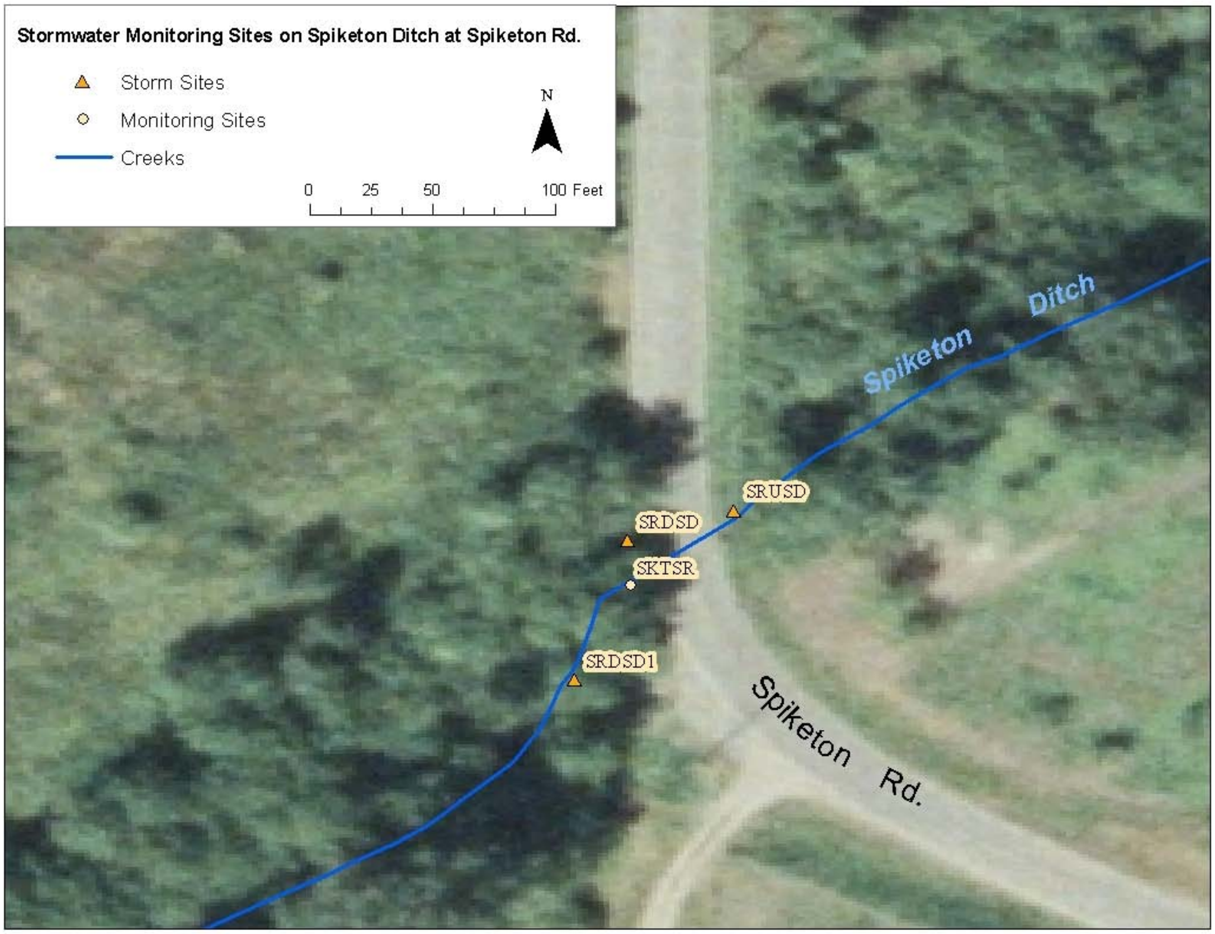

Figure 7. Stormwater monitoring locations on Spiketon Ditch at Spiketon Rd.

Figure 8. Stormwater monitoring location on Spiketon Ditch at Sheets Rd.

Methods

Field Methods

Quality assurance (QA) and field standard operating procedures (SOPs) are consistent with those of the *South Prairie Creek Total Maximum Daily Load Phase II Evaluation Quality Assurance Project Plan* (Roberts, 2001). For example, FC samples are to be less than 30% relative standard deviation (RSD) for all field replicates.

FC samples were collected following the most up-to-date SOP (Mathieu, 2006). The samples were transported to Manchester Environmental Laboratory (MEL) for analysis.

Additional water quality parameters were measured using a multi-probe/data-Sonde following the *Standard Operating Procedure (SOP) for Hydrolab® DataSonde® and MiniSonde® Multiprobes* (Swanson, 2007). Table 3 shows the instruments used to collect field data and their associated specifications.

Table 3. Methods used for field measurements.

Analysis	Method	Range	Reporting Limits
Stream Velocity	Marsh McBirney Flowmate	0.01 – 5.00 feet/second	0.01 ft/s
Water Temperature	Hydrolab Sonde®	-5° – 30° C	0.01° C
Specific Conductivity	Hydrolab Sonde®	1 – 100,000 µmhos/cm	0.1 µmhos/cm
Dissolved Oxygen	Hydrolab Sonde®	1-20 mg/L	0.01 mg/L
pH	Hydrolab Sonde®	0 to 14 pH units	± 0.2 units

Laboratory Methods

MEL followed the measurement quality objective (MQO) described in the MEL Users Manual (MEL, 2008). These protocols are consistent with the original South Prairie Creek TMDL QA Project Plan. Fecal coliform analysis was conducted according to the following specifications.

- Method: membrane filter (MF), standard method 9222D.
- Detection limit: one colony forming unit (cfu)/100 mL.
- Laboratory duplicates relative percent difference (RPD) is 40% or less.
- Sample holding time: 24 hours.

Sampling Design

Ecology collected a total of 317 FC samples from the designated monitoring locations in the Inglin Creek and Spiketon Ditch watersheds from November 2008 through December 2009. Of the 317 samples, 41 were field replicates. Each site was sampled once every two weeks. Beginning in June 2009, sampling frequency increased to three times per month. Pierce CD and Ecology shared sampling duties by alternating field days each time. From May 2005 through October 2008, the Pierce CD sampled once per month.

Table 4 is a summary of parameters collected at each site. Not all parameters were monitored at each site. In some instances streamflow or water quality measurements are so infrequent and therefore not marked on Table 4.

Table 4. Parameters monitored at all sites from November 2008 through December 2009.

Site ID	FC Bacteria	Stream-flow	Water Quality[1]	Storm-water[2]
T1ID	X	X	X	X
T1DS162	X	X	X	X
T1US162	X	X	X	X
T1SPCR1	X	X	X	X
T1SPCRR	X	X	X	X
T4	X	X	X	X
T4DT	X	--	--	X
SKTM	X	X	X	X
SKT165	X	--	--	X
SKT126	X	X	X	X
SKTSR	X	X	X	X
SKTDAV	X	X	X	X
SKTSHT	X	--	X	X
162DSD	X	--	--	X
165D	X	--	--	X
128D	X	--	--	X
126D	X	--	--	X
SRUSD	X	--	--	X
SRDSD	X	--	--	X
SRDSD1	X	--	--	X
SHTSD	X	--	--	X

[1]Water quality parameters include temperature, specific conductance, dissolved oxygen, and pH.
[2]Stormwater sampling includes all parameters where indicated during significant storm events.

Study Quality Assurance Evaluation

Data Qualifiers

Data qualifiers place specific conditions on data when necessary. Tables 5 and 6 show data qualifier codes used when analyzing FC samples and general water quality parameters respectively. Data reported with qualifiers should be used with caution, and data variability must be taken into consideration when interpreting results and applying data to other analyses. All other data reported in the appendices may be used without qualification. Unless otherwise stated, data that did not pass QA (rejected data) are not included.

Table 5. Data qualifier codes for fecal coliform bacteria laboratory analysis.

Qualifier	Definition
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. This qualifier often denotes bacteria samples analyzed beyond holding times.
U	The analyte was not detected at or above the reported sample quantitation limit.
G	Value is likely greater than result reported; result is an estimated minimum value.

Table 6. Data qualifier codes for general water quality parameters and Hydrolab Sonde® post-deployment calibration check based on the accuracy rating by USGS (Wagner et al., 2006).

Measured Field Parameter	Data Qualifier and Definition		
	Accept	Estimate (e)	Reject
Specific Conductivity (SpCond)	$\leq \pm 5\%$	$> \pm 5\%$ and $\leq \pm 10\%$	$> \pm 10\%$
Dissolved Oxygen (% saturation)	$\leq \pm 5\%$	$> \pm 5\%$ and $\leq \pm 15\%$	$> \pm 15\%$
pH	$\leq \pm 0.25$	$> \pm 0.25$ and $\leq \pm 0.5$	$> \pm 0.5$

Data Evaluation

One laboratory duplicate pair did not meet the 40% RPD criterion. Sample number 0906015-05 collected at site T1SPCR1 on 6/30/2009 with a value of 250 cfu/100 mL was “J” qualified as an estimate (RPD=63%). All other laboratory duplicates were within the 40% RPD criterion.

Sample number 0910005-06 collected at site T4 on 10/20/2009 with a value of 5600 cfu/100 mL was “J” qualified for two reasons: (1) it contained sediment and is noted on the field sheet, and (2) there were 150 or more colonies on the plate, therefore the “true” value may be greater than or equal to the result. Furthermore, the field QA did not contain sediment resulting in a RSD of 98.6% between the replicate pairs. This result was not used to assess the overall measurement quality objectives (MQOs) as described in the following paragraph.

Recent MQOs have been developed by Ecology for analyzing precision in replicated FC samples (Mathieu, 2006). The MQO for FC replicate samples require that at least 50% of the samples be below a 20% RSD and that at least 90% of the samples be below a RSD of 50%. RSD is defined as the percent standard deviation divided by the mean or percent coefficient of variation for the replicated QA samples. None of the samples used to assess the MQO should have a mean concentration of 20 cfu/100 mL or less. For this study, all FC samples meet the MQO analysis criteria. Fifty percent of the samples are below 20% RSD at 15.7% RSD and 90% of the samples are below a RSD, of 50% at 42.4% RSD.

Results and Discussion

Fecal Coliform Bacteria Water Quality Statistics

Table 7 shows the geometric mean and 90th percentile for FC data collected from 2005 through 2009 at each site. The 90th percentiles for stations with less than five samples were not estimated.

Table 7. Summary statistics for fecal coliform bacteria (cfu/100 mL) at regularly sampled sites along Inglin Creek and Spiketon Ditch from 2005 through 2009.

Site ID	Site Location	n	Min.	Max.	Geometric Mean	90th Percentile
T1ID	Inglin Ck at mouth (former Inglin Dairy)	77	5	2360	90	512
T1DS162	Inglin Ck downstream of Hwy 162	76	1	10800	210	1467
T1US162	Inglin Ck upstream of Hwy 162	77	13	9700	249	1589
T1SPCR1	Inglin Ck off S. Prairie Carbon R. Rd (13428)	33	6	5200	147	1738
T1SPCRR	Inglin Ck at S. Prairie Carbon R. Rd culvert	73	1	4400	55	554
T4	Tributary 4 at S. Prairie Carbon R. Rd	73	1	17500	115	2218
T4DT	Drain tile ~ 3 ft. upstream of T4	27	4	390000	6788	185165
SKTM	Spiketon Ditch near mouth at Lower Burnett Rd	76	1	1000	43	290
SKT165	Spiketon Ditch at Hwy 165	75	2	3400	104	734
SKT126	Spiketon Ditch at 126th beyond the gate	29	6	4800	157	1692
SKTSR	Spiketon Ditch at Spiketon Rd	75	1	3200	72	641
SKTDAV	Spiketon Ditch at Davis Rd	54	3	8500	61	572
SKTSHT	Spiketon Ditch at Sheets Rd	19	1	6300	91	1295
SHTSD	Southern Ditch along Sheets Rd adjacent to SKTSHT	6	3	75	26	126
SRUSD	Ditch along upstream side of Spiketon Rd	3	140	1400	479	
SRDSD1	Ditch approximately 10 ft. downstream of SKTSR	3	6	29	15	
SRDSD	Ditch along downstream side of Spiketon Rd	5	8	480	147	1263
126D	Ditch approximately 10 ft. upstream of SKT126	2	380	1500	755	
165D	Ditch along the upstream side of Hwy 165	2	8	4700	194	
128D	Ditch along 128th near and east of SKT165	3	1	150	13	
T4US	Pierce County CD site along T4	5	1	620	23	551
T4W	Pierce County CD site along T4	4	8	264	44	

Shaded cells indicate sites where water quality criteria were not met.
“n” indicates the number of samples.

All data collected from 2005 through 2009 by Pierce CD and Ecology are presented in Appendix C (Table C-1). Data in Appendix C are arranged by 'Site ID' and subsequent 'Date' of collection.

Data collected from November 2008 through December 2009 by Pierce CD and Ecology are incorporated into most of the discussion. This allows for equal (normalized) comparison between sites and accounts for annual variability. Table 8 presents a summary of data statistics for FC collected from November 2008 through December 2009.

Table 8. Summary statistics for fecal coliform bacteria (cfu/100 mL) at regularly sampled sites along Inglin Creek and Spiketon Ditch from November 2008 through December 2009.

Site ID	Site Location	n	Min.	Max.	Geometric Mean	90th Percentile
T1ID	Inglin Ck at mouth (former Inglin Dairy)	35	5	1400	116	780
T1DS162	Inglin Ck downstream of Hwy 162	35	50	10800	331	1433
T1US162	Inglin Ck upstream of Hwy 162	35	43	9700	362	1777
T1SPCR1	Inglin Ck off S. Prairie Carbon R. Rd (13428)	33	6	5200	147	1738
T1SPCRR	Inglin Ck at S. Prairie Carbon R. Rd culvert	35	1	4400	53	666
T4	Tributary 4 at S. Prairie Carbon R. Rd	34	1	17500	152	3042
T4DT	Drain tile ~ 3 ft. upstream of T4	27	4	390000	6788	185165
SKTM	Spiketon Ditch near mouth at Lower Burnett Rd	35	1	1000	41	328
SKT165	Spiketon Ditch at Hwy 165	35	7	3400	130	1008
SKT126	Spiketon Ditch at 126th beyond the gate	29	6	4800	157	1692
SKTSR	Spiketon Ditch at Spiketon Rd	34	1	3200	75	825
SKTDAV	Spiketon Ditch at Davis Rd	35	3	2700	60	619
SKTSHT	Spiketon Ditch at Sheets Rd	19	1	6300	91	1295
SHTSD	Southern Ditch along Sheets Rd adjacent to SKTSHT	6	3	75	26	126
SRUSD	Ditch along upstream side of Spiketon Rd	3	140	1400	479	
SRDSD1	Ditch approximately 10 ft. downstream of SKTSR	3	6	29	15	
SRDSD	Ditch along downstream side of Spiketon Rd	5	8	480	147	1263
126D	Ditch approximately 10 ft. upstream of SKT126	2	380	1500	755	
165D	Ditch along the upstream side of Hwy 165	2	8	4700	194	
128D	Ditch along 128th near and east of SKT165	3	1	150	13	

Shaded cells indicate sites where water quality criteria were not met.
"n" indicates the number of samples.

Inglin Creek Fecal Coliform Bacteria Assessment

Table 9 shows a statistical summary for FC under wet/dry season conditions from 2008 through 2009. FC concentrations are expressed in the number of colony forming units (cfu)/100 mL. Inglin Creek shows variable seasonal FC concentration that is site dependent. The "dry season" is equivalent to the "growing season" from May-October, and the "wet season" is equivalent to the "non-growing season" from November-April. Seasons were previously established by the original South Prairie Creek TMDL (Roberts, 2003).

Table 9. Dry-season and wet-season summary statistics for fecal coliform bacteria (cfu/100 mL) at regularly sampled sites along Inglin Creek from November 2008 through December 2009.

Site ID	Dry Season (May – October)					Wet Season (November – April)				
	n	Min	Max	Geometric Mean	90th Percentile	n	Min	Max	Geometric Mean	90th Percentile
T1ID	17	5	1200	65	550	18	17	1400	202	793
T1DS162	17	50	2400	322	1397	18	74	10800	340	1531
T1US162	17	43	9700	430	2211	18	53	8700	308	1469
T1SPCR1	17	6	2100	58	579	16	23	5200	395	2960
T1SPCRR	17	1	4400	133	1157	18	1	520	22	242
T4	17	1	5600	98	1533	17	3	10300	233	5837
T4DT	15	1600	390000	28645	262021	12	4	18000	1122	23119

Shaded cells indicate sites where water quality criteria were not met.
"n" indicates the number of samples.

The South Prairie Creek TMDL set seasonal target FC geometric means at the mouth of Inglin Creek (T1ID). The target geometric means are based on percent FC reduction needed to meet water quality criteria. According to the 2008-2009 results (Table 9), the dry-season target at T1ID of 61 cfu/100 mL was nearly met with results of 65 cfu/100 mL. However, the wet-season target at T1ID of 48 cfu/100 mL was not met with results of 202 cfu/100 mL.

On a logarithmic scale, Figure 9 shows a 2008-2009 wet/dry season comparison for FC geometric mean concentrations. The sites are arranged on the chart showing the longitudinal profile of Inglin Creek from left to right (downstream to upstream).

Streamflow is greater during the wet season than dry season, as later presented in the 'Loading Assessment' section of this report. Greater streamflow typically dilutes FC concentrations. However, in a few places along Inglin Creek, the opposite happened where increased concentrations were exhibited during the wet season instead of the dry season. Therefore much greater FC conveyance occurs during the wet season.

Three of the five sites along Inglin Creek show higher wet-season FC geometric mean concentrations than dry season (Table 9 and Figure 9). Similarly, T4 has a higher wet-season FC concentration than dry season. T1SPCR1 had the greatest difference between seasons with wet- season concentrations higher than dry-season concentrations.

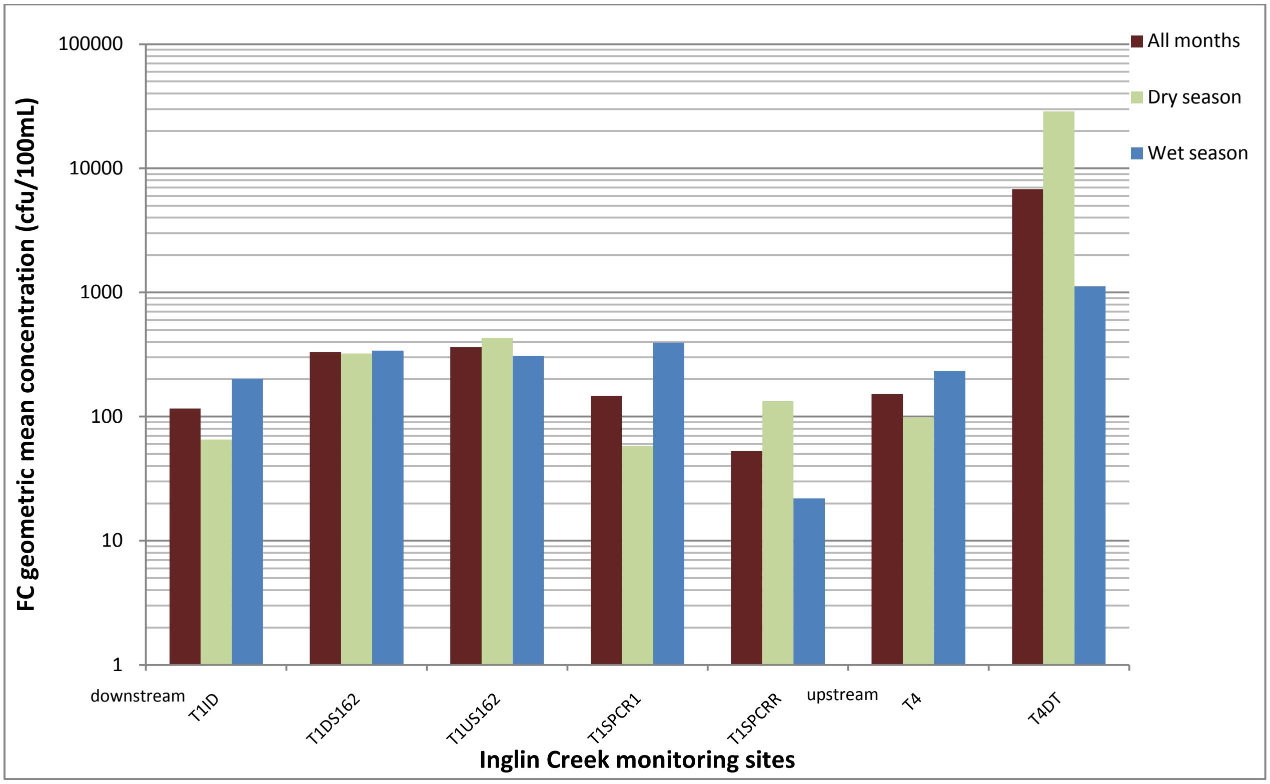

Figure 9. Inglin Creek geometric mean fecal coliform (FC) concentrations (cfu/100 mL) at routine monitoring sites from 2008 through 2009.

Two sites on Inglin Creek (T1US162 and T1SPCRR) have higher dry-season FC concentrations than wet season (Table 9 and Figure 9). T1SPCRR is the uppermost monitoring site and directly receives stormwater runoff from the town of South Prairie. Similarly, T4DT has higher dry-season FC concentration than during the wet season. The higher dry-season concentrations at these sites may indicate a year-round steady FC pollution source.

The mouth of Inglin Creek (T1ID) shows an annual FC geometric mean concentration of 116 cfu/100 mL (Table 8). The lowest annual geometric mean concentration along Inglin Creek was at the uppermost site of T1SPCRR (53 FC cfu/100 mL) (Figure 9 and Table 8). The highest FC geometric mean concentration was at T4DT with a value of 6,788 cfu/100 mL, for all months (Figure 9 and Table 8). T4DT is a drain tile from a hillside field that flows into Tributary 4 approximately 3 feet upstream of site T4. Action has been taken by the Pierce County Department of Health, Pierce CD, and Ecology to achieve water quality compliance at this site.

Figure 10 presents data from Table 8 as a longitudinal profile for Inglin Creek. The profile includes FC data statistics and water quality criteria.

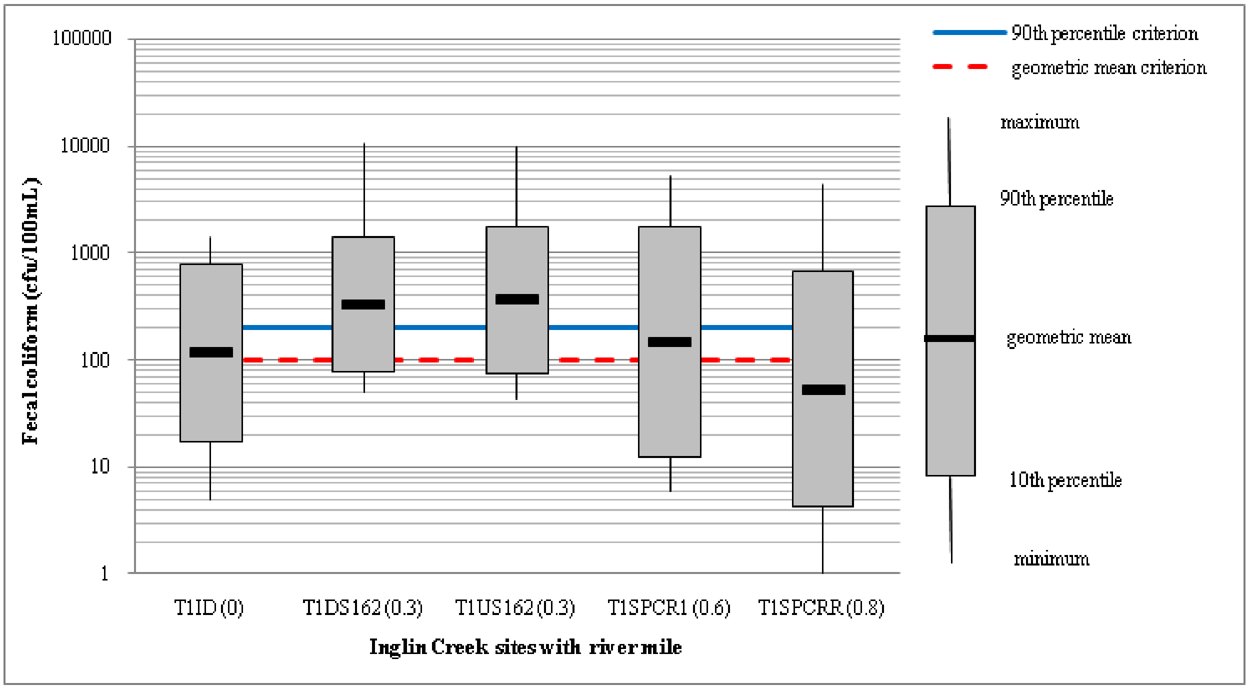

Figure 10. Longitudinal profile along Inglin Creek with 2008-09 fecal coliform data statistics and water quality criteria.

The 90th percentile water quality criterion was not met at all sites (Figure 10). The 90th percentile is a more stringent water quality criterion than the geometric mean. The highest 90th percentile along Inglin Creek was at T1US162 (1777 FC cfu/100 mL) and the lowest was at T1SPCRR (666 FC cfu/100 mL). The geometric mean water quality criterion was met at one out of five sites along Inglin Creek (T1SPCRR). From upstream to downstream, the longitudinal profile on Inglin Creek shows a gradual increase in FC concentration that peaks in the middle then decreases towards the mouth.

Figure 11 shows the RPD of geometric mean FC concentration (cfu/100 mL) between sites along Inglin Creek (including Tributary 4). FC die off, between sample sites, was not considered in this evaluation due to the short reaches between sites. The greatest FC concentration increase along Inglin Creek was between T1SPCRR and T1SPCR1. The greatest concentration decrease was between T1DS162 and T1ID. The overall greatest concentration decrease was between T4DT and T4 possibly due to dillution or incomplete mixing when the drain tile empties into the relatively larger waterbody of Tributary 4. Furthermore, the drain tile exhibits extremely high FC concentrations relative to Tributary 4.

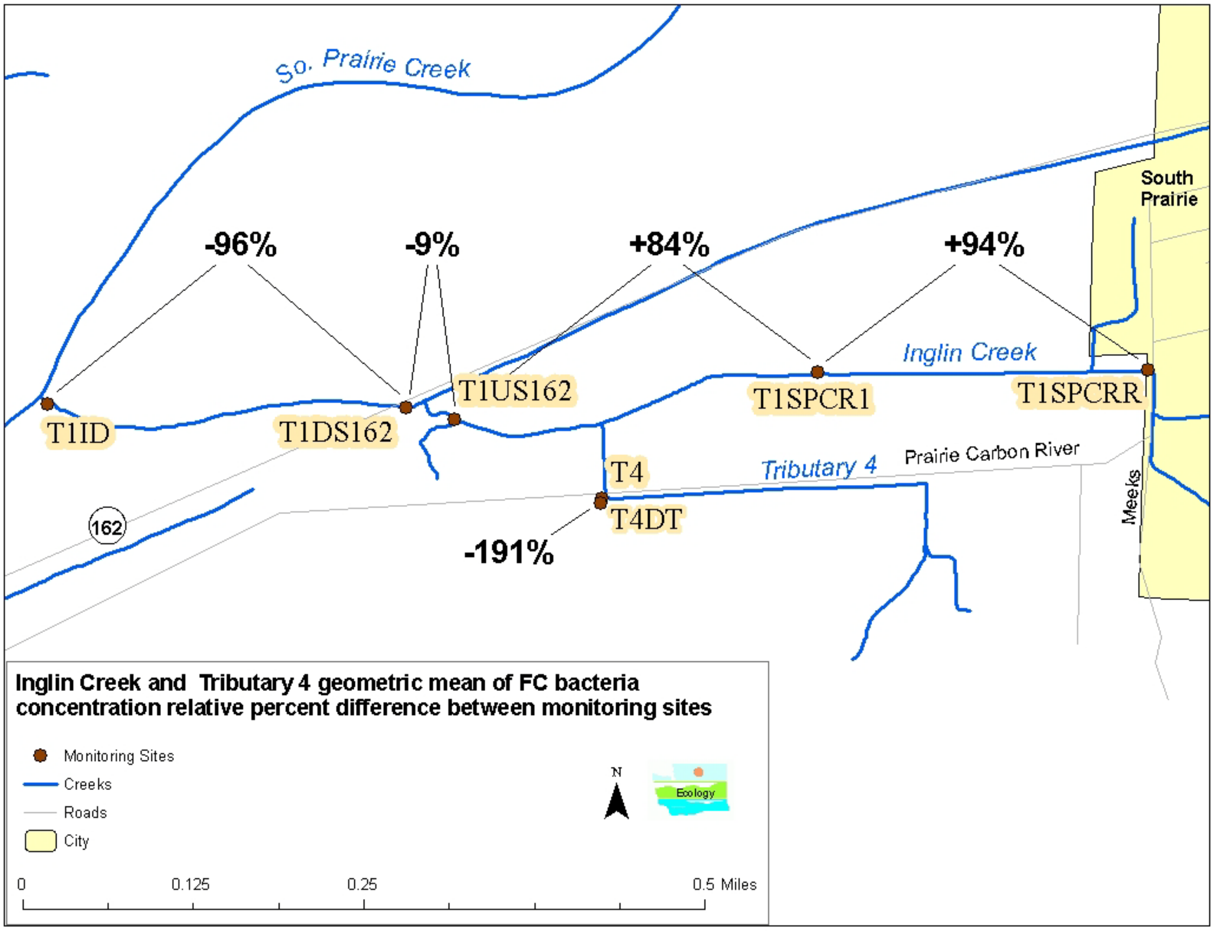

Figure 11. Relative percent difference (RPD) of geometric mean fecal coliform bacteria concentration (cfu/100 mL) between each site along Inglin Creek and Tributary 4 from 2008-2009.

Inglin Creek Loading Assessment

Increases and decreases in FC concentration can be dependent on streamflow. The same amount of pollutant, in this case FC bacteria, will have half the concentration in a creek with two times more flow than another. FC concentrations have been presented to compare against water quality criteria. Showing where water quality criteria have not been met can lend guidence during the watershed cleanup process. However, FC loading, described here, can be a more meaningful method for identifying relationships between sites and determining priorities for implemention/cleanup efforts. Loading on Spiketon Ditch is discussed in the 'Spiketon Ditch Loading Assessment' section of this report.

FC loads were calculated by multiplying the FC concentration by the streamflow. While the loading concentrations are helpful, it is important to remember that they do not indicate a violation in the water quality standard's numeric criteria. High loading may at times reflect mostly high streamflows.

Streamflow

Table 10 shows the streamflow summary for the Inglin Creek watershed from 2005 through 2009. However, most sites became active in 2008. Streamflow increases along Inglin Creek from upstream to downstream. Sites with a sample number less than five (n<5) were omitted from Table 10. Inglin Creek at the mouth had approximately seven times more streamflow during the wet season than the dry season (wet season average = 3.6 (ft^3/s), dry season average = 0.5 (ft^3/s)).

Table 10. Streamflow summary for Inglin Creek and Tributary 4 from 2005 through 2009.

Site ID	Site Location	n	Streamflow (ft^3/s)		
			Mean	Min.	Max.
T1ID	Inglin Ck at mouth (former Inglin Dairy)	20	1.9	0.2	11.9
T1DS162	Inglin Ck downstream of Hwy 162	20	1.9	0.2	11.7
T1US162	Inglin Ck upstream of Hwy 162	48	1.4	0.2	8.1
T1SPCR1	Inglin Ck off S. Prairie Carbon R. Rd (13428)	17	0.7	0.0	4.3
T1SPCRR	Inglin Ck at S. Prairie Carbon R. Rd culvert	14	0.7	0.0	3.0
T4	Tributary 4 at S. Prairie Carbon R. Rd	20	0.3	0.0	1.6

During the late summer and early fall, T1SPCR1 and T1SPCRR often had little or no detectable velocity; therefore, the streamflow was recorded as 0.0 ft^3/s. Similarly, a zero streamflow was often recorded at T4 due to water depths too shallow to measure and a volume too small. Flow was not assessed at the drain tile (T4DT) due to difficulty capturing the entire volume of water with a bucket or bottle.

Figure 12 shows FC loading and average streamflows from 2008 through 2009. The sites are arranged showing the longitudinal profile of Inglin Creek (Figure 12). T4 was also included because streamflow could be measured at that site. No loading was calculated at sites where zero streamflow (0.0 ft^3/s) is recorded, or where no measurements were taken such as at T4DT.

Fecal Coliform Loading

The mouth of Inglin Creek had four times more FC load than the mouth of Spiketon Ditch annually (Figures 12 and 16). This is interesting considering Inglin Creek has half the amount of mean annual streamflow than Spiketon Ditch. Further upstream, the FC load from T1SPCRR to T1SPCR1 practically quadruples despite nearly equal streamflow at each site. FC loading on T4 was second lowest and contributed approximately one quarter of the streamflow where it enters Inglin Creek.

All sites in the Inglin Creek watershed exhibit a higher wet-season loading than during the dry season (Figure 12). The seasonal difference was statistically significant (P=0.006) comparing all sites. The comparative seasonal difference could be attributed to greater amounts of surface water runoff and groundwater saturation during the wet season that could carry additional FC into the creek. Furthermore, the increased FC concentration combined with the increased streamflow compound the increase in loading during the wet season. The highest seasonal RPD was seen at T1SPCR1.

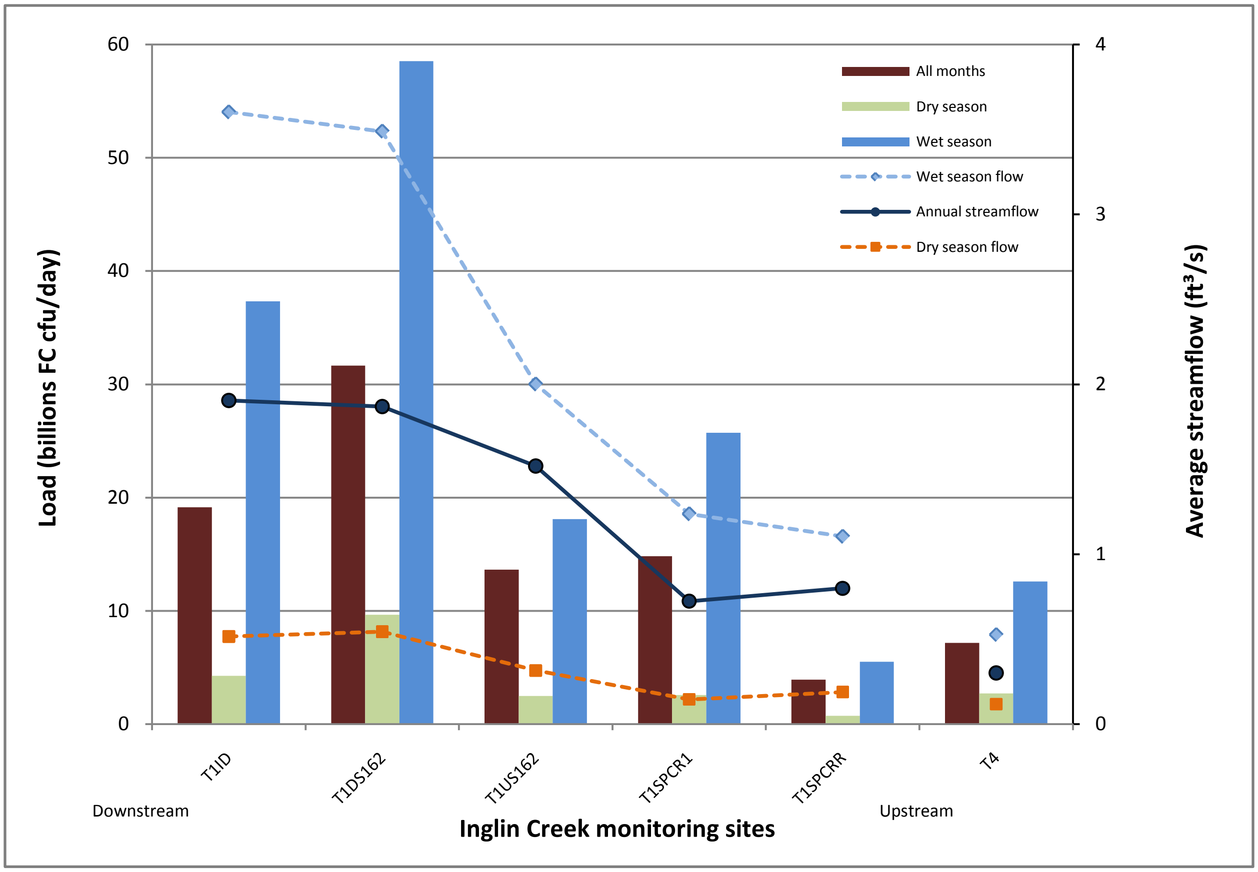

Figure 12. Fecal coliform (FC) loading (billions of cfu/day) and average streamflow in the Inglin Creek watershed from 2008-2009.

Spiketon Ditch Fecal Coliform Bacteria Assessment

Table 11 shows a statistical summary for FC under wet/dry season conditions from 2008 through 2009. FC concentrations are expressed in the number of cfu/100 mL. During the wet season, Spiketon Ditch did not exceed the water quality standard for geometric mean FC concentrations. Furthermore, the 90th percentile was lower during the wet season than the dry season.

Table 11. Dry season and wet season summary statistics for fecal coliform bacteria (cfu/100 mL) at regularly sampled sites along Spiketon Ditch from November 2008 through December 2009.

Site ID	Dry Season (May-October)					Wet Season (November-April)				
	n	Min	Max	Geometric Mean	90th Percentile	n	Min	Max	Geometric Mean	90th Percentile
SKTM	17	7	1000	70	348	18	1	880	25	248
SKT165	17	35	3400	324	1984	17	7	720	55	251
SKT126	17	17	4800	379	2437	12	6	510	45	381
SKTSR	16	12	3200	255	1622	18	1	610	25	175
SKTDAV	17	9	2700	166	1085	18	3	870	23	180
SKTSHT	11	15	6300	190	1816	8	1	780	33	518

Shaded cells indicate sites where water quality criteria were not met.
"n" indicates the number of samples.

The South Prairie Creek TMDL set seasonal target FC geometric means on Spiketon Ditch at Highway 165 (SKT165). The target geometric means are based on percent FC reduction to meet water quality criteria. According to the 2008-2009 results (Table 11), the dry-season target at SKT165 of 32 cfu/100 mL was not met with results of 324 cfu/100 mL. The wet-season target at SKT165 of 33 cfu/100 mL was not met with results of 55 cfu/100 mL.

On a logarithmic scale, Figure 13 shows a 2008-2009 wet/dry season comparison for FC geometric mean concentrations. The sites are arranged on the chart showing the longitudinal profile of Spiketon Ditch from left to right (downstream to upstream).

The data for Spiketon Ditch show a pattern where the geometric mean wet season FC concentrations are lower than the dry season (Table 11 and Figure 13). However, near the mouth (SKTM) the seasonal difference was very subtle. The greatest seasonal difference along Spiketon Ditch was seen at Sheets Rd. (SKTSHT). Spiketon Ditch experiences greater streamflow during the wet season than dry season as discussed in the 'Loading Assessment' of this report. Greater streamflow typically dilutes FC concentrations.

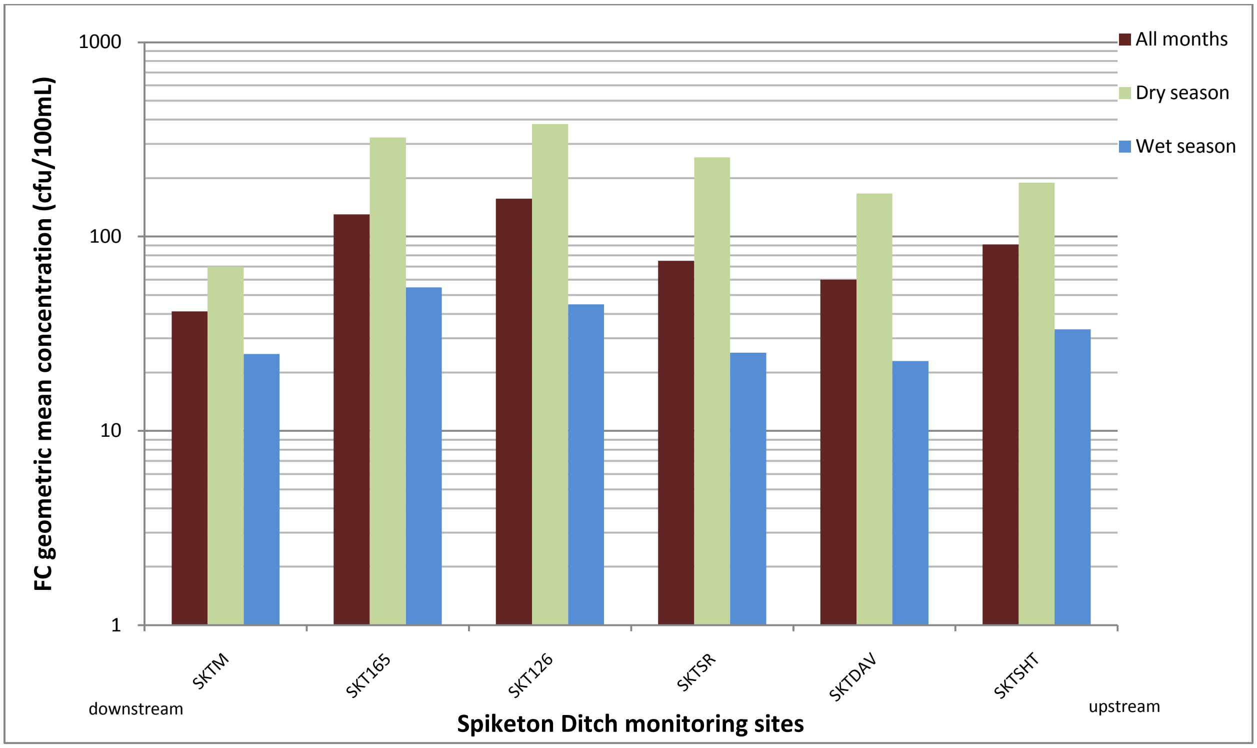

Figure 13. Spiketon Ditch geometric mean fecal coliform (FC) concentrations (cfu/100 mL) at routine monitoring sites from 2008 to 2009.

The lowest annual geometric mean FC concentration for all sites was at SKTM (Spiketon Ditch near mouth) with a value of 41 cfu/100 mL (Table 8). The highest 90th percentile along Spiketon Ditch was at SKT126 (1692 FC cfu/100 mL), and the lowest was at SKTM (328 FC cfu/100 mL) (Table 8).

The longitudinal profile of FC concentration in Spiketon Ditch, from Table 8, shows a sine wave-like pattern (Figure 14). The geometric mean water quality criterion was met at four out of six sites along Spiketon Ditch. Starting at the upstream site, the FC concentrations drop slightly. Further downstream, the concentrations rise again before dropping once more to the lowest values at the mouth. The highest FC counts were at SKT126. The higher concentrations may be attributed partially to wildlife, such as elk, because scat was seen often along the riparian corridor. However the assumption of the amount of wildlife contribution at this time cannot be confirmed and is not a definitive conclusion.

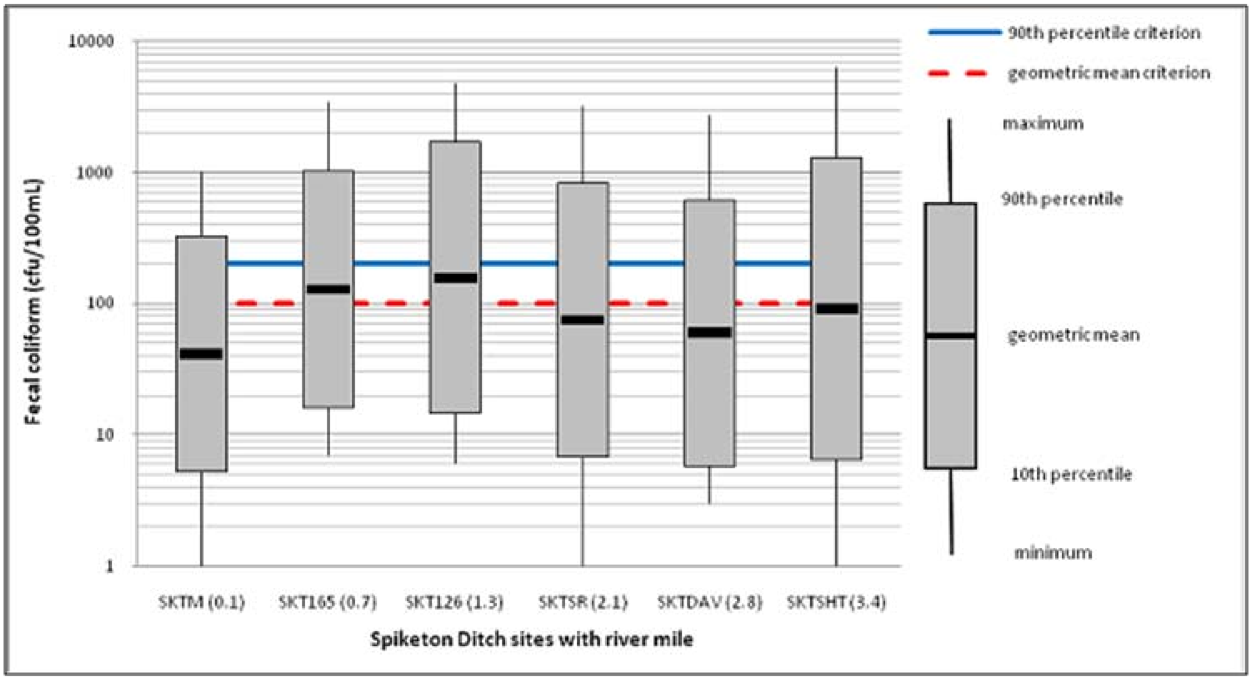

Figure 14. Longitudinal profile along Spiketon Ditch with 2008-2009 fecal coliform data statistics and water quality criteria.

Figure 15 shows the RPD of geometric mean FC concentration (cfu/100 mL) between sites along Spiketon Ditch. FC die off, between sample sites, was not considered in this evaluation due to the short reaches between sites. Along Spiketon Ditch the highest FC concentration increase was between SKTSR and SKT126. The greatest concentration decrease along Spiketon Ditch was between SKT165 and SKTM.

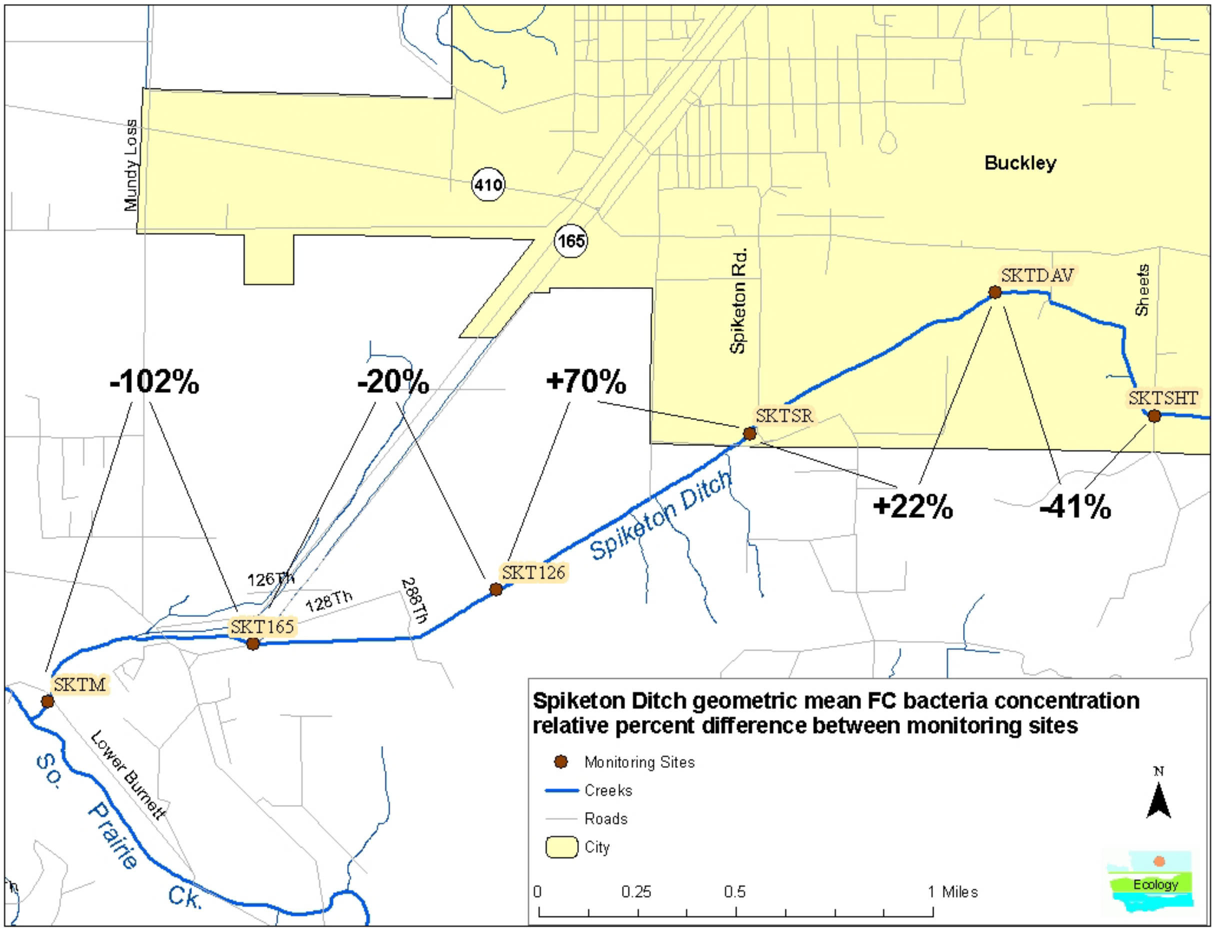

Figure 15. Relative percent difference of geometric mean fecal coliform concentration (cfu/100 mL) between each site along Spiketon Ditch from 2008-2009.

Spiketon Ditch Loading Assessment

Fecal Coliform Loading

The sites along Spiketon Ditch had variable seasonal loading (Figure 16). The seasonal difference was not statistically significant (P=0.397) comparing all sites, possibly due to seasonal variability along Spiketon Ditch. SKT126 was the only site to experience a higher wet-season loading compared to the dry season for reasons unclear. However one assumption at SKT126 is that wetlands are present around SKT126 that could increase surface water and hyporheic flow. Also, increased surface water runoff during the wet season may introduce more FC bacteria at this site than during the dry season.

Near the Spiketon Ditch mouth (SKTM), similar loading year-round occurs comparing both seasons (Figure 16). Excluding SKT126, the remaining three upstream sites show higher dry-season loading compared to the wet season. This may indicate a steady FC source year-round and dilution from increased streamflow during the wet season. The highest seasonal RPD was seen at Sheets Road (SKTSHT).

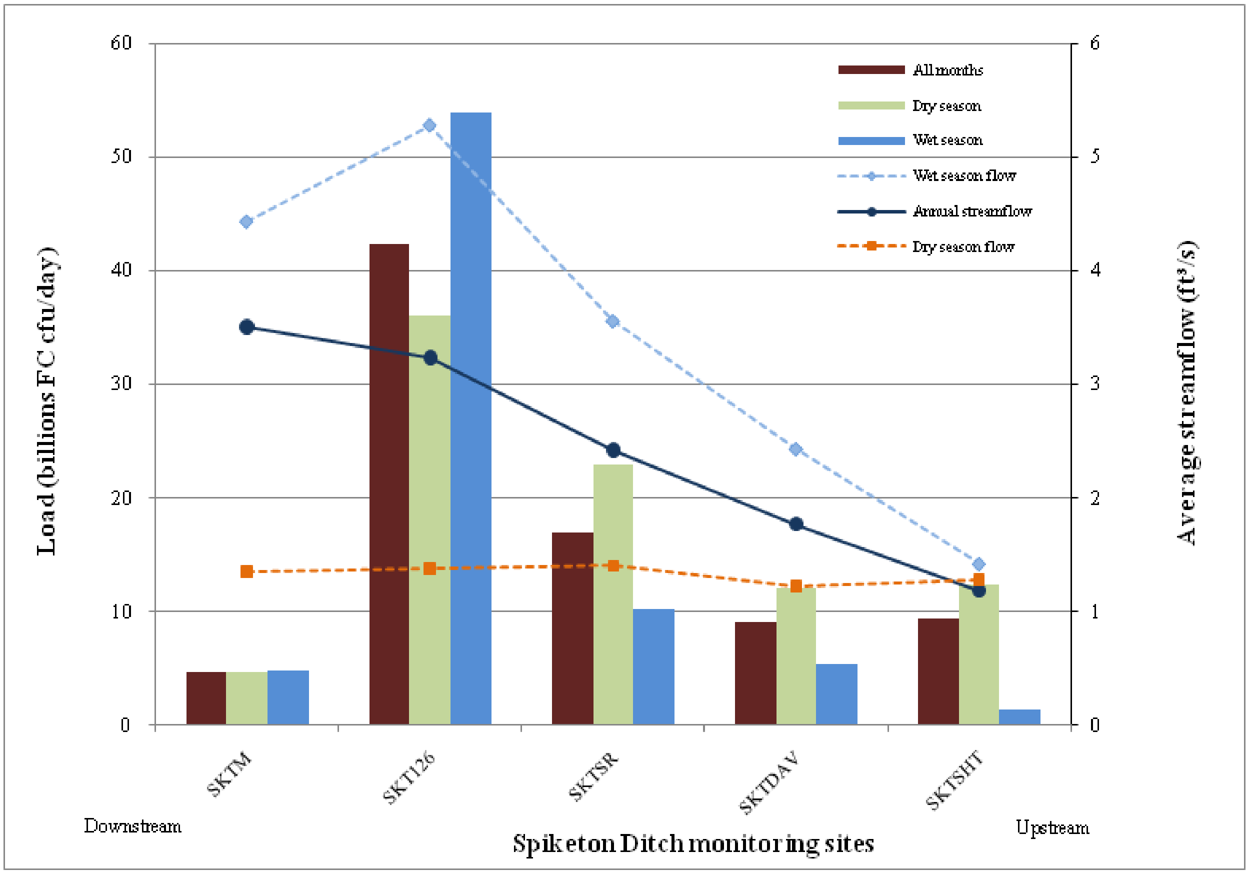

Figure 16. Fecal coliform (FC) loading (billions of cfu/day) and average streamflow along Spiketon Ditch from 2008-2009.

Streamflow

Table 12 shows the streamflow summary for Spiketon Ditch from 2005 through 2009. However, most sites became active in 2008. Spiketon Ditch contributes approximately twice as much volume to South Prairie Creek than Inglin Creek (Tables 10 and 12). Streamflow increases along Spiketon Ditch from upstream to downstream. Sites with a sample number less than five ($n<5$) were omitted from Table 12, such as SKT165. Spiketon Ditch at the mouth had approximately four times more streamflow during the wet season than the dry season (wet-season average = 6.3 (ft^3/s), dry-season average = 1.7 (ft^3/s)).

Table 12. Streamflow summary for Spiketon Ditch from 2005 through 2009.

Site ID	Site Location	n	Streamflow (ft^3/s)		
			Mean	Min.	Max.
SKTM	Spiketon Ditch near mouth at Lower Burnett Rd	43	3.8	0.1	23.0
SKT126	Spiketon Ditch at 126th beyond the gate	17	3.6	0.3	23.7
SKTSR	Spiketon Ditch at Spiketon Rd	19	2.4	0.4	11.1
SKTDAV	Spiketon Ditch at Davis Rd	20	1.8	0.3	7.4
SKTSHT	Spiketon Ditch at Sheets Rd	11	1.2	0.2	2.4

Annual Comparisons of Loading and Streamflow

Figure 17 shows the annual mean FC loading and streamflow based on instantaneous measurements. The two sites depicted are Inglin Creek upstream of Highway 162 (T1US162) and Spiketon Ditch near the mouth (SKTM). Both sites have the most streamflow and FC data collected compared to all others, and were therefore selected for annual comparisons. The data from 2005 have been omitted from the annual comparison because not enough samples were taken to constitute a full year. The FC loads seem to exhibit a direct relationship to streamflow. A paired t-test shows no statistically significant difference in FC loading from year to year, possibly due to limited data. Additional streamflow and FC data could be useful in determining annual trends.

Since 2007, the FC loads at T1US162 have gradually decreased; however, 2006 shows the lowest loading over all (Figure 17). At SKTM, the highest FC loads were observed during 2006. Since then, the loads were variable from year to year. Changes in streamflow and land use can play a role in FC loading when comparing annual trends.

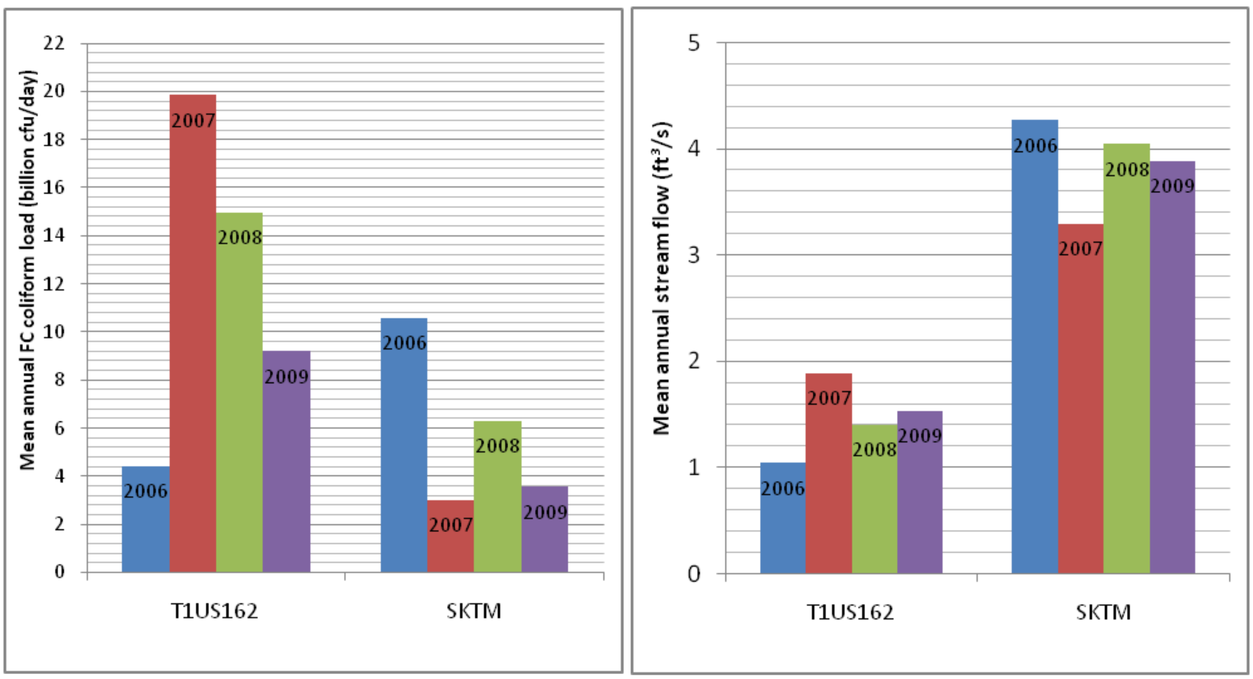

Figure 17. Mean annual fecal coliform (FC) loading and mean annual streamflow at long-term monitoring sites on Inglin Creek (T1US162) and Spiketon Ditch (SKTM). These data are based on instantaneous measurements.

Stormwater

Stormwater ditches were sampled when adequate precipitation caused flow (Table 8). Inglin Creek has a ditch along the downstream side of Highway 162 that was sampled once (250 cfu/100 mL). Spiketon Ditch was sampled more frequently at seven sites.

The highest FC results were at a ditch (126D) that drains a field/wooded area upstream of SKT126. The two ditches upstream (SRUSD) and downstream (SRDSD) of Spiketon Road show high FC results as well. The lowest results were at a ditch along Sheets Road (SHTSD) and Spiketon Road (SRDSD1). More stormwater samples are necessary to further develop results. However, these data do suggest stormwater conveyance of FC bacteria along Spiketon Road and at SKT126.

Environmental Information Management Database

All data presented in Appendix C (Table C-1) of this report can also be found on the internet though Ecology's Environmental Information Management (EIM) database at: www.ecy.wa.gov/eim/ . The database may be searched using a number of methods. Site-specific results may be found using the 'User Location ID' listed in Appendix B (Table B-1). Results may also be accessed through the 'User Study ID' including *G0500118* and *JKAR0001*.

Project Objective Assessment

The data provided for this 2008-09 study should promote a better understanding of the watersheds and FC characteristics both seasonally and spatially. The distance between sites should be short enough to provide reach-specific information that may further reveal potential FC sources. However direct source identification becomes difficult when considering the broad nature of nonpoint source pollution. One way to address nonpoint source pollution is to understand land use practices and consider potential pollution sources. Sampling upstream and downstream of an area brackets the stream reach and potentially assesses how land use influences water quality. The stormwater assessment provides limited data but delivers some guidance to potential problematic areas.

Conclusions

The following is a summary of conclusions based on this 2008-09 data summary evaluation:

- All routinely monitored sites did not meet the 90th percentile water quality criterion for fecal coliform bacteria (FC) from 2005-2009.
- Eight of the 13 routinely monitored sites met the geometric mean FC water quality criterion from 2005-2009.
- Spiketon Ditch and Inglin Creek have no capacity for additional FC contributions.
- Inglin Creek at the mouth had four times more FC loading than the mouth of Spiketon Ditch annually.
- The highest FC concentrations were at a drain tile (T4DT) to Tributary 4, and corrective action is underway to fix the problem.
- Wet-season (November-April) and dry-season (May-October) comparisons of FC bacteria geometric mean concentrations were variable along Inglin Creek.
- Wet-season FC loading was higher than dry-season FC loading along Inglin Creek.
- Dry-season geometric mean FC concentrations were higher than wet-season concentrations along Spiketon Ditch.
- Dry-season FC loading tends to be higher than wet-season FC loading at most sites along Spiketon Ditch.
- No definite conclusions can be drawn based on the number of samples taken in stormwater ditches. However, the data show high FC concentrations for the upstream and downstream ditches along Spiketon Road and for the field/wooded area of SKT126.

Recommendations

The following is a summary of recommendations based on this 2008-09 data summary evaluation:

- Reduce fecal coliform bacteria (FC) levels along Inglin Creek, Spiketon Ditch, and associated inputs.

- Give priority to cleanup areas that have the highest FC loads or subsequent concentrations.
  - On Inglin Creek, this includes the reach upstream of Highway 162 (T1DS162) and the reach upstream of T1SPCR1 off South Prairie Carbon River Road.
  - On Spiketon Ditch, this includes the reach upstream of 126^{th} (SKT126), the reach upstream of Sheets Road (SKTSHT), and the reach upstream of Spiketon Road (SKTSR).
  - Continue cleanup efforts and monitoring on the drain tile (T4DT).

- Along Inglin Creek, FC loading is higher during the wet season than dry season, possibly caused by increased surface water runoff during the wet season. The transport and fate of surface water combined with land uses should be considered in order to reduce FC loading.
- At one site (SKT126) on Spiketon Ditch, FC loading is higher during the wet season than dry season, possibly caused by increased surface water runoff during the wet season.
- Most sites along Spiketon Ditch have higher FC loading during the dry season than wet season. This may indicate a year-round FC source to Spiketon Ditch not impacted by surface water runoff. Possible sources include but are not limited to; failing septic systems, animals that have access to the ditch, or land use practices.

- Observe land-use practices and explore possible sources of FC pollution in areas of high FC loads or concentrations.

- Implement riparian vegetation buffer zones along the waterbodies to help reduce FC pollution from nearby livestock.

- Continue to complete septic inspections and repairs for reaches that experienced high FC concentrations in the dry season.

- Continue to educate residents and recreational users about FC pollution and ways to promote a cleaner watershed.

- Continue to use best management practices in the South Prairie Creek watershed, including stormwater runoff mitigation and land-use assessment.

- Monitor cleanup effectiveness on an as-needed basis.

References

Cusimano, R., 1997. Water Quality Assessment of Tributaries to the Snohomish River and Nonpoint Source Pollution TMDL Study. Washington State Department of Ecology, Olympia, WA. 52 pgs. Publication No. 97-334. www.ecy.wa.gov/biblio/97334.html.

Joy, J., 2000. Lower Nooksack River Basin Bacteria Total Maximum Daily Load Evaluation. Washington State Department of Ecology, Olympia, WA. 60 pgs. Publication No. 00-03-006. www.ecy.wa.gov/biblio/0003006.html.

Mathieu, N., 2006. Replicate Precision for 12 TMDL Studies and Recommendations for Precision Measurement Quality Objectives for Waster Quality Parameters. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-044. www.ecy.wa.gov/biblio/0603044.html.

Mathieu, N., 2006. Standard Operating Procedure for Sampling Bacteria in Water, Version 1. Washington State Department of Ecology, Olympia, WA. SOP No. EAP012. www.ecy.wa.gov/programs/eap/quality.html.

MEL, 2008. Manchester Environmental Laboratory Lab Users Manual, Ninth Edition. Manchester Environmental Laboratory, Washington State Department of Ecology, Manchester, WA.

Roberts, M.L., 2003. South Prairie Creek Bacteria and Temperature Total Maximum Daily Load Study. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-021. www.ecy.wa.gov/biblio/0303021.html.

Roberts, M.L., 2001. South Prairie Creek Total Maximum Daily Load Phase II Evaluation: Quality Assurance Project Plan. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-064. www.ecy.wa.gov/biblio/0103064.html.

Sargeant, D., 2002. Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study. Washington State Department of Ecology, Olympia, WA. 46 pgs. Publication No. 02-03-014. www.ecy.wa.gov/biblio/0203014.html.

Seabrook, D., K. McKee, and C. James, 2006. South Prairie Creek Bacteria and Temperature Total Maximum Daily Load (Water Cleanup Plan), Detailed Implementation Plan. Washington State Department of Ecology, Olympia, WA. Publication No. 06-10-018. www.ecy.wa.gov/biblio/0610018.html.

Swanson, T., 2007. Standard Operating Procedure (SOP) for Hydrolab® DataSonde® and MiniSonde® Multiprobes, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP033. www.ecy.wa.gov/programs/eap/quality.html.

WAC 173-201A: Water Quality Standards for Surface Waters in the State of Washington. Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/laws-rules/ecywac.html.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting: U. S. Geological Survey Techniques and Methods 1-D3. 51 p. + 8 attachments. Accessed April, 10, 2006. http://pubs.water.usgs.gov/tm1d3 (see pg. 38, Table 18).

Appendices

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Appendix A. Glossary, Acronyms, and Abbreviations

Glossary

Anthropogenic: Human-caused.

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

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Dry season: In this study, the dry season is the non-growing season, November through April.

Fecal coliform bacteria (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 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria 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/100 mL).

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 10 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.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

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 NPDES 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.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

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

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Reach: A specific portion or segment of a stream.

Riparian: Relating to the banks along a natural course of water.

Specific conductance: A measure of water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

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

Streamflow: Discharge of water in a surface stream (river or creek).

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and watercourses within the jurisdiction of Washington State.

Total Maximum Daily Load (TMDL): Water cleanup plan. A distribution of a substance in a waterbody 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 for point sources, (2) the load allocations 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 is also generally provided.

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.

Wet season: In this study, the wet season is the growing season, May through October.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically 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.

90th percentile: A statistical number obtained from a distribution of a data set, above which 10% of the data exists and below which 90% of the data exists.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMP	Best management practices
CD	Conservation district
DO	(See Glossary above)
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
FC	(See Glossary above)
MEL	Manchester Environmental Laboratory
QA	Quality assurance
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
TMDL	(See Glossary above)
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WRIA	Water Resources Inventory Area

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cfu	colony forming units
ft	feet
ft^3/s	cubic feet per second
l/s	liters per second (0.03531 cubic foot per second)
m	meter
mL	milliliters
µS/cm	microsiemens per centimeter, a unit of conductivity

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Appendix B. Environmental Information Management Study Locations

Table B-1. Site identification in relation to Environmental Information Management (EIM) user location identification on the internet.

Site ID	EIM	
	User Location ID	Location Name
T1ID	SPC_T1ID	Mouth of Tributary 1 at SPC
T1DS162	SPC_T1DS162	T1 DS of Hwy 162 culvert&drainage ditch
T1US162	SPC_T1US162	T1 US of Hwy 162 culvert&drainage ditch
T1SPCR1	SPC_T1SPCR1	T1 off Carbon R Rd
T1SPCRR	SPC_T1SPCRR	T1 US of SP-Carbon River Road culvert
T4	SPC_T4	T4 @ Pioneer Way crossing
T4DT	SPC_TDT4	Tile Drain upstream of T4
SKTM	SPC_SKTM	SKT near mouth from Lower Burnett Rd
SKT165	SPC_SKT165	SKT @ Highway 165 culvert
SKT126	SPC_SKT126	SKT @ 126th beyond gate
SKTSR	SPC_SKTSR	SKT @ Spiketon Rd in Buckley
SKTDAV	SPC_SKTD	SKT @ Davis St.
SKTSHT	SPC_SKTSHT	SKT @ Sheets Rd in Buckley
162DSD	SPC_SKT162DSD	Ditch to T1 dwnstm of Hwy 162
165D	SPC_SKT165D	Ditch to Spktn upstrm of Hwy 165
128D	SPC_SKT128D	Ditch to Spktn on 128th and SKT165
126D	SPC_SKT126D	Ditch to Spktn 10 ft upstm of SKT126
SRUSD	SPC_SKTSRUSD	Ditch to Spktn ditch upstrm of Spktn Rd
SRDSD	SPC_SKTSRDSD	Ditch to Spktn D dwnstrm of Spktn Rd
SRDSD1	SPC_SKTSRDSD1	Ditch to Spktn D 10 ft DS of Spiktn Rd
SHTSD	SPC_SKTSHTSD	Ditch to Spktn D on Sheets Rd

SPC – South Prairie Creek.
TI – Inglin Creek.
DS – Downstream.
UP – Upstream.
T4 – Tributary 4.
SKT – Spiketon Ditch.
Spktn – Spiketon Ditch.

Appendix C. Fecal Coliform and Water Quality Data Results

Table C-1. Data collected by Pierce Conservation District and Ecology. (See end of table for acronyms.)

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
T1ID	5/16/05		1000					
T1ID	6/13/05		220					
T1ID	7/18/05		320					
T1ID	8/29/05		96					
T1ID	9/19/05		135					
T1ID	10/17/05		120					
T1ID	11/14/05		29					
T1ID	12/12/05		119					
T1ID	1/17/06		46					
T1ID	2/13/06		189					
T1ID	3/13/06		95					
T1ID	4/17/06		24					
T1ID	5/15/06		23					
T1ID	6/12/06		46					
T1ID	7/17/06		26					
T1ID	8/14/06		36					
T1ID	9/18/06		18					
T1ID	10/16/06		276					
T1ID	11/13/06		26					
T1ID	12/11/06		47					
T1ID	1/17/07		38					
T1ID	2/12/07		29					
T1ID	3/12/07		248					
T1ID	4/16/07		52					
T1ID	5/16/07		61					
T1ID	6/11/07		80					
T1ID	7/16/07		2360					
T1ID	8/13/07		74					
T1ID	9/17/07		2020					
T1ID	10/15/07		109					
T1ID	11/12/07		25					
T1ID	12/10/07		28					
T1ID	1/14/08		27					
T1ID	2/11/08		18					
T1ID	3/10/08		62					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
T1ID	4/14/08		184					
T1ID	5/12/08		43					
T1ID	6/9/08		51					
T1ID	7/7/08		23					
T1ID	8/18/08		112					
T1ID	9/8/08		66					
T1ID	10/13/08		11					
T1ID	11/10/08		1400					
T1ID	11/19/08	11:28	270					1.05
T1ID	12/3/08	11:16	390	9.15	187.9	10.34	7.50	0.88
T1ID	12/8/08		560					
T1ID	1/13/09		136					
T1ID	1/28/09	10:09	230	4.78	142.5	11.37	7.33	1.71
T1ID	2/10/09		208					
T1ID	2/25/09	10:40	520	6.73		10.15	7.45	1.83
T1ID	3/10/09		82					
T1ID	3/25/09	11:20	390	5.64		13.29	6.92	11.77
T1ID	4/7/09		103					
T1ID	4/22/09	10:57	170	10.41	139.3 e	12.17	7.64	1.07
T1ID	5/5/09		240					
T1ID	5/20/09	10:32	390	11.03	159.8	10.28	7.25	1.44
T1ID	6/2/09		52					
T1ID	6/17/09	11:05	1200	13.06	172.6	9.41	7.76 e	0.41
T1ID	6/30/09	11:00	400	11.61	173.5	9.54	7.55	0.45
T1ID	7/14/09		65					
T1ID	7/15/09	8:40	31 J	10.63	170.8	9.50	7.64	0.27
T1ID	7/29/09	11:15	79	14.86	181.0	8.96	7.83	0.23
T1ID	8/12/09	12:08	580	14.79	184.4 e	8.57	7.38	1.09
T1ID	8/19/09		236					
T1ID	8/26/09	10:38	23	10.69	184.1	9.93		0.25
T1ID	9/9/09	10:55	45	12.48	180.0	8.38 e	7.08	0.27
T1ID	9/15/09		39					
T1ID	9/22/09	11:44	6	10.54	181 e	10.20	7.20	0.31
T1ID	10/5/09	12:02	5	7.92	181.0	10.69	8.25	0.36
T1ID	10/13/09		14					
T1ID	10/20/09	10:28	8	9.93	202.4 e	10.49 e	6.71	0.60
T1ID	11/3/09	11:23	260 J	8.33	214.1	9.67 e	6.73	0.60
T1ID	11/10/09		59					
T1ID	11/17/09	10:19	570 J	8.21	123.4 e	9.36	6.09	11.86

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1ID	12/1/09	11:59	43	8.11		9.82	7.04	1.65
T1ID	12/8/09		17					
T1ID	12/15/09	10:38	300	2.17	142.4	11.20	7.27	
T1DS162	5/16/05		1440					
T1DS162	6/13/05		184					
T1DS162	7/18/05		149					
T1DS162	8/29/05		344					
T1DS162	10/17/05		1120					
T1DS162	11/14/05		72					
T1DS162	12/12/05		102					
T1DS162	1/17/06		45					
T1DS162	2/13/06		50					
T1DS162	3/13/06		624					
T1DS162	4/17/06		23					
T1DS162	5/15/06		43					
T1DS162	6/12/06		39					
T1DS162	7/17/06		85					
T1DS162	8/14/06		58					
T1DS162	9/18/06		80					
T1DS162	10/16/06		488					
T1DS162	11/13/06		48					
T1DS162	12/11/06		155					
T1DS162	1/17/07		20					
T1DS162	2/12/07		48					
T1DS162	3/12/07		176					
T1DS162	4/16/07		70					
T1DS162	5/16/07		81					
T1DS162	6/11/07		212					
T1DS162	7/16/07		1860					
T1DS162	8/13/07		260					
T1DS162	9/17/07		3800					
T1DS162	10/15/07		2520					
T1DS162	11/12/07		73					
T1DS162	12/10/07		12					
T1DS162	1/14/08		30					
T1DS162	2/11/08		1 U					
T1DS162	3/10/08		83					
T1DS162	4/14/08		152					
T1DS162	5/12/08		78					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1DS162	6/9/08		91					
T1DS162	7/7/08		316					
T1DS162	8/18/08		1940					
T1DS162	9/8/08		5800					
T1DS162	10/13/08		308					
T1DS162	11/10/08		10800					
T1DS162	11/19/08	11:54	1000 J					1.09
T1DS162	12/3/08	11:37	340	8.87	184.9	8.22	7.26	0.61
T1DS162	12/8/08		640					
T1DS162	1/13/09		184					
T1DS162	1/28/09	10:41	130	4.86	139.8	10.15	7.08	1.10
T1DS162	2/10/09		300					
T1DS162	2/25/09	11:02	680	6.81		9.14	7.17	1.67
T1DS162	3/10/09		144					
T1DS162	3/25/09	11:34	450	5.76		11.49	6.85	10.95
T1DS162	4/7/09		130					
T1DS162	4/22/09	11:26	210	10.46	136.1 e	9.94	7.25	1.29
T1DS162	5/5/09		150					
T1DS162	5/20/09	10:59	550	11.31	157.2	8.95	6.98	1.37
T1DS162	6/2/09		184					
T1DS162	6/17/09	11:30	2400	12.78	170.2	8.77	7.7 e	0.45
T1DS162	6/30/09	11:55	900	11.85	173.9	8.15	7.41	0.38
T1DS162	7/14/09		208					
T1DS162	7/15/09	9:15	200	10.82	172.0	9.01	7.52	0.32
T1DS162	7/29/09	11:41	1900 J	14.05	180.1	8.60	7.62	0.25
T1DS162	8/12/09	12:37	700	14.89	180 e	7.47	7.17	1.09
T1DS162	8/19/09		504					
T1DS162	8/26/09	11:05	970	11.08	185.7	9.17		0.43
T1DS162	9/9/09	11:15	350	12.40	183.6	7.47 e	6.83	0.65
T1DS162	9/15/09		184					
T1DS162	9/22/09	12:11	62	10.90	184.8 e	9.17	7.06	0.33
T1DS162	10/5/09	12:29	65	8.75	184.0	9.09	7.91	0.24
T1DS162	10/13/09		50					
T1DS162	10/20/09	10:52	380 J	10.01	203.3 e	8.05 e	6.59	0.48
T1DS162	11/3/09	11:47	570	8.48	214.0	8.02 e	6.42	1.10
T1DS162	11/10/09		114					
T1DS162	11/17/09	11:07	1100 J	8.21	124.5 e	8.42	6.09	11.71
T1DS162	12/1/09	12:27	130	8.21		8.49	6.93	1.88
T1DS162	12/8/09		74					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1DS162	12/15/09	11:00	260	2.50	139.8	10.47	7.18	
T1US162	5/16/05		2020					
T1US162	6/13/05		180					
T1US162	7/18/05		660					
T1US162	8/29/05		388					
T1US162	9/19/05		428					0.35
T1US162	10/17/05		1300					0.16
T1US162	11/14/05		61					0.84
T1US162	12/12/05		344					1.61
T1US162	1/17/06		34					
T1US162	2/13/06		47					
T1US162	3/13/06		356					1.62
T1US162	4/17/06		13					1.80
T1US162	5/15/06		36					0.72
T1US162	6/12/06		46					1.18
T1US162	7/17/06		67					0.40
T1US162	8/14/06		40					0.33
T1US162	9/18/06		60					0.54
T1US162	10/16/06		648					0.58
T1US162	11/13/06		52					
T1US162	12/11/06		228					2.19
T1US162	1/17/07		34					3.36
T1US162	2/12/07		78					1.55
T1US162	3/12/07		180					8.05
T1US162	4/16/07		93					1.89
T1US162	5/16/07		101					0.90
T1US162	6/11/07		488					0.64
T1US162	7/16/07		1340					0.35
T1US162	8/13/07		236					0.42
T1US162	9/17/07		3820					1.12
T1US162	10/15/07		2580					0.69
T1US162	11/12/07		79					
T1US162	12/10/07		20					1.79
T1US162	1/14/08		38					2.42
T1US162	2/11/08		76					4.83
T1US162	3/10/08		40					1.28
T1US162	4/14/08		276					1.50
T1US162	5/12/08		80					1.11
T1US162	6/9/08		108					1.00

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
T1US162	7/7/08		356					0.61
T1US162	8/18/08		2660					0.26
T1US162	9/8/08		6800					0.31
T1US162	10/13/08		304					0.45
T1US162	11/10/08		8700					
T1US162	11/19/08	12:08	600					0.9 e
T1US162	12/3/08	11:49	200	8.84	187.6	8.17	7.16	0.9 e
T1US162	12/8/08		1120					2.64
T1US162	1/13/09		248					4.10
T1US162	1/28/09	10:58	110	5.00	139.4	10.87	7.06	1.60
T1US162	2/10/09		368					1.57
T1US162	2/25/09	11:19	680	6.90		9.35	7.10	1.40
T1US162	3/10/09		124					1.96
T1US162	3/25/09	11:56	410	5.91		13.36	6.89	
T1US162	4/7/09		114					2.58
T1US162	4/22/09	11:45	220	10.49	135.8 e	10.15	7.29	
T1US162	5/5/09		360					
T1US162	5/20/09	11:16	760 J	11.49	158.3	9.25	6.89	
T1US162	6/2/09		224					
T1US162	6/17/09	11:50	730	12.83	173.5	8.60	7.73 e	
T1US162	6/30/09	12:03	9700 J	11.91	175.7	8.30	7.28	
T1US162	7/14/09		372					0.24
T1US162	7/15/09	9:25	380	10.90	172.0	9.20	7.42	
T1US162	7/29/09	11:52	2300 J	14.11	181.1	8.80	7.44	
T1US162	8/12/09	12:45	1200	14.92	178.5 e	7.46	7.25	
T1US162	8/19/09		628					0.37
T1US162	8/26/09	11:14	730	11.14	185.6	9.67		
T1US162	9/9/09	11:25	280	12.40	183.8	7.32 e	6.93	
T1US162	9/15/09		276					0.27
T1US162	9/22/09	12:22	120	11.07	183.6 e	9.41	7.10	
T1US162	10/5/09	12:40	65	8.81	185.0	9.55	8.04	
T1US162	10/13/09		43					0.39
T1US162	10/20/09	11:00	290	10.10	206.0 e	8.63 e	6.75	
T1US162	11/3/09	11:55	480	8.60	217.3	8.33 e	6.49	
T1US162	11/10/09		196					2.36
T1US162	11/17/09	11:18	1000	8.27	131 e	8.40	6.12	
T1US162	12/1/09	12:36	54	8.13		8.77	6.90	
T1US162	12/8/09		53					
T1US162	12/15/09	11:10	230	2.67	140.6	10.13	7.09	

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1SPCRR	9/19/05		436					
T1SPCRR	10/17/05		108					
T1SPCRR	11/14/05		21					
T1SPCRR	12/12/05		23					
T1SPCRR	1/17/06		22					
T1SPCRR	2/13/06		3					
T1SPCRR	3/13/06		9					
T1SPCRR	4/17/06		18					
T1SPCRR	5/15/06		66					
T1SPCRR	6/12/06		260					
T1SPCRR	7/17/06		228					
T1SPCRR	8/14/06		408					
T1SPCRR	9/18/06		85					
T1SPCRR	10/16/06		412					
T1SPCRR	11/13/06		96					
T1SPCRR	12/11/06		200					
T1SPCRR	1/17/07		6					
T1SPCRR	2/12/07		28					
T1SPCRR	3/12/07		144					
T1SPCRR	4/16/07		83					
T1SPCRR	5/16/07		15					
T1SPCRR	6/11/07		102					
T1SPCRR	7/16/07		200					
T1SPCRR	8/13/07		106					
T1SPCRR	9/17/07		3820					
T1SPCRR	10/15/07		63					
T1SPCRR	11/12/07		200					
T1SPCRR	12/10/07		23					
T1SPCRR	1/14/08		1 U					
T1SPCRR	2/11/08		1 U					
T1SPCRR	3/10/08		17					
T1SPCRR	4/14/08		49					
T1SPCRR	5/12/08		48					
T1SPCRR	6/9/08		204					
T1SPCRR	7/7/08		61					
T1SPCRR	8/18/08		124					
T1SPCRR	9/8/08		104					
T1SPCRR	10/13/08		22					
T1SPCRR	11/10/08		2					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1SPCRR	11/19/08	13:41	28					
T1SPCRR	12/3/08	12:05	46	8.80	216.2	6.61	6.95	0.05
T1SPCRR	12/8/08		520					
T1SPCRR	1/13/09		16					
T1SPCRR	1/28/09	13:07	8	5.16	144.9	9.59	7.01	0.77
T1SPCRR	2/10/09		6					
T1SPCRR	2/25/09	12:11	17 J	6.35	133.9	8.43	6.99	0.85
T1SPCRR	3/10/09		1					
T1SPCRR	3/25/09	12:38	120	6.17	83.6	11.62	6.96	2.61
T1SPCRR	4/7/09		1					
T1SPCRR	4/22/09	12:31	100	10.68	142.2 e	10.28	7.10	0.54
T1SPCRR	5/5/09		1 U					
T1SPCRR	5/20/09	11:54	120	12.43	164.8	8.64	6.85	0.54
T1SPCRR	6/2/09		160					
T1SPCRR	6/17/09	12:06	280	16.94	189.4	7.72	7.59 e	0.05
T1SPCRR	6/30/09	12:18	140	17.69	190.7	7.28	7.37	0.04
T1SPCRR	7/14/09		61					
T1SPCRR	7/15/09	9:33	170	16.59	194.2	4.80	7.24	0.00
T1SPCRR	7/29/09	12:01	340	26.85	202.5	3.83	7.22	
T1SPCRR	8/12/09	12:54	4400	17.23	152 e	6.72	6.97	0.00
T1SPCRR	8/19/09		444					
T1SPCRR	8/26/09	11:23	400	18.57	210.0	5.88	7.09	
T1SPCRR	9/9/09	11:40	290	15.18	196.9	4.46 e	6.66	0.13
T1SPCRR	9/15/09		164					
T1SPCRR	9/22/09	12:30	140	15.89	215.7 e	5.07	6.81	
T1SPCRR	10/5/09	12:47	36					
T1SPCRR	10/13/09		34					
T1SPCRR	10/20/09	11:07	80	10.92	246.4 e	6.02 e	6.38	
T1SPCRR	11/3/09	12:05	28	8.79	262.4	7.40 e	6.29	0.18
T1SPCRR	11/10/09		36					
T1SPCRR	11/17/09	11:54	460	8.72	162.9 e	8.60	6.02	3.00
T1SPCRR	12/1/09	12:43	38	8.25	217.0	8.56	6.77	0.84
T1SPCRR	12/8/09		4					
T1SPCRR	12/15/09	11:18	100	1.58	148.2	10.21	6.93	
T1SPCR1	11/19/08	13:12	120					0.43
T1SPCR1	12/3/08	12:16	200	8.98	220.7	6.70	7.09	0.03
T1SPCR1	1/13/09		90					
T1SPCR1	1/28/09	12:31	740	5.55	147.6	9.55	7.04	0.88
T1SPCR1	2/10/09		3100					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T1SPCR1	2/25/09	11:42	5200 J	6.45	135.8	7.65	6.97	0.73
T1SPCR1	3/10/09		1640					
T1SPCR1	3/25/09	12:10	460	6.11	76.8	11.84	6.86	4.32
T1SPCR1	4/7/09		2000					
T1SPCR1	4/22/09	12:00	1200	10.72	147.4 e	9.62	7.09	0.57
T1SPCR1	5/5/09		941					
T1SPCR1	5/20/09	11:38	970	12.16	170.7	7.78	6.83	0.54
T1SPCR1	6/2/09		116					
T1SPCR1	6/17/09	12:27	31	16.62	188.2	3.83	7.5 e	0.28
T1SPCR1	6/30/09	12:52	250 J	15.75	191.0	2.69	7.06	0.03
T1SPCR1	7/14/09		55					
T1SPCR1	7/15/09	9:51	9	13.53	181.5	2.60	7.11	0.01
T1SPCR1	7/29/09	12:15	36 J	19.87	193.8	1.51	7.22	
T1SPCR1	8/12/09	13:17	2100	17.39	163.8 e	3.69	6.85	0.14
T1SPCR1	8/19/09		116					
T1SPCR1	8/26/09	11:35	25 U	12.99	218.0	2.25	6.78	
T1SPCR1	9/9/09	11:55	55	14.52	196.2	2.02 e	6.55	0.04
T1SPCR1	9/15/09		13					
T1SPCR1	9/22/09	12:39	6 J	12.28	193.1 e	2.04	6.61	
T1SPCR1	10/5/09	12:56	14	8.39	190.0	4.38	7.60	0.01
T1SPCR1	10/13/09		6					
T1SPCR1	10/20/09	11:25	31	10.51	259.8 e	4.14 e	6.38	0.12
T1SPCR1	11/3/09	12:18	73 J	8.52	268.9	5.29 e	6.28	0.23
T1SPCR1	11/10/09		47					
T1SPCR1	11/17/09	12:07	680	8.66	150 e	8.21	6.07	3.32
T1SPCR1	12/1/09	13:07	23	8.30	217.6	7.11	6.76	0.63
T1SPCR1	12/8/09		360					
T1SPCR1	12/15/09	11:35	390	1.15	154.2	9.79	6.99	
T4	5/16/05		560					
T4	6/13/05		180					
T4	7/18/05		121					
T4	9/19/05		1840					
T4	10/17/05		1 U					
T4	11/14/05		3					
T4	12/12/05		4					
T4	1/17/06		26					
T4	2/13/06		22					
T4	3/13/06		4					
T4	4/17/06		15					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
T4	5/15/06		62					
T4	6/12/06		82					
T4	7/17/06		1040					
T4	8/14/06		111					
T4	9/18/06		35					
T4	10/16/06		64					
T4	11/13/06		242					
T4	12/11/06		232					
T4	1/17/07		12					
T4	2/12/07		12					
T4	3/12/07		70					
T4	4/16/07		20					
T4	5/16/07		112					
T4	6/11/07		392					
T4	7/16/07		3320					
T4	8/13/07		292					
T4	9/17/07		5940					
T4	10/15/07		7920					
T4	11/12/07		288					
T4	12/10/07		11					
T4	1/14/08		8					
T4	2/11/08		7					
T4	3/10/08		40					
T4	4/14/08		35					
T4	5/12/08		99					
T4	6/9/08		113					
T4	7/7/08		17500					
T4	8/18/08		1200					
T4	11/10/08		10300					
T4	11/19/08	14:07	2600 J					0.20
T4	12/3/08	12:26	830	8.79	139.6	8.70	7.17	0.14
T4	12/8/08		5540					
T4	1/13/09		9					
T4	1/28/09	12:47	340	5.46	121.1	8.11	6.60	0.55
T4	2/10/09		59					
T4	2/25/09	11:58	2500	7.32	103.5	9.36	7.34	0.33
T4	3/25/09	12:24	460	6.41	75.4	11.46	6.96	1.58
T4	4/7/09		3					
T4	4/22/09	12:14	31	10.25	115.1 e	9.84	7.00	0.35

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
T4	5/5/09		92					
T4	5/20/09	11:43	680 J	11.48	135.1	9.61	6.75	0.34
T4	6/2/09		148					
T4	6/17/09	12:40	31	13.23	149.6	9.13	7.69 e	0.14
T4	6/30/09	13:09	220	13.72	151.4	8.72	7.29	0.10
T4	7/14/09		79					
T4	7/15/09	10:14	200	11.54	150.0	8.23	7.25	0.07
T4	7/29/09	12:27	270	16.63	154.0	7.38	7.18	0.04
T4	8/12/09	13:32	360	14.54	161.1 e	7.58	7.18	0.20
T4	8/19/09		66					
T4	8/26/09	11:48	62	11.76	160.2	8.01	7.02	0.05
T4	9/9/09	12:40	2300	12.49	160.6	6.07 e	6.75	0.11
T4	9/15/09		20					
T4	9/22/09	12:56	25	11.28	162.7 e	7.72	6.85	0.07
T4	10/5/09	13:10	3	8.50	160.0	8.40	7.69	0.07
T4	10/13/09		1					
T4	10/20/09	11:37	5600 J	9.68	170.7 e	8.63 e	6.46	0.11
T4	11/3/09	12:32	320	8.43	165.0	8.08 e	6.39	0.09
T4	11/10/09		8					
T4	11/17/09	12:18	1800	8.35	120.8 e	9.20	6.27	1.07
T4	12/1/09	13:12	680	8.05	152.9	9.03	6.81	0.43
T4	12/8/09		9					
T4	12/15/09	11:37	270	3.37	117.4	9.71	6.89	
T4DT	12/8/08		14000					
T4DT	1/28/09	12:55	1300 J					
T4DT	2/25/09	12:00	16000					
T4DT	3/10/09		4 U					
T4DT	3/25/09	12:25	1400					
T4DT	4/22/09	12:15	150					
T4DT	5/20/09	11:43	1600 J					
T4DT	6/17/09	12:40	10000 J					
T4DT	6/30/09	13:10	110000 G					
T4DT	7/14/09		37200					
T4DT	7/15/09	10:15	310000 J					
T4DT	7/29/09	12:28	46000					
T4DT	8/12/09	13:33	11000					
T4DT	8/19/09		20000 G					
T4DT	8/26/09	11:50	390000 J					
T4DT	9/9/09	12:45	92000	15.33	155.0	5.81 e	6.10	

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
T4DT	9/15/09		20000 G					
T4DT	9/22/09	12:57	2400					
T4DT	10/5/09	13:11	13000					
T4DT	10/13/09		5200					
T4DT	10/20/09	11:38	300000 J					
T4DT	11/3/09	12:33	2500 U					
T4DT	11/10/09		1260					
T4DT	11/17/09	12:19	18000					
T4DT	12/1/09	13:12	750					
T4DT	12/8/09		192					
T4DT	12/15/09	11:37	2000					
T4US	8/18/08		620					
T4US	9/8/08		36					
T4US	10/13/08		1 U					
T4US	11/10/08		5					
T4US	12/8/08		64					
T4W	8/18/08		264					
T4W	9/8/08		8					
T4W	10/13/08		68					
T4W	11/10/08		26					
SKTM	5/16/05		180					
SKTM	6/13/05		61					
SKTM	7/18/05		52					
SKTM	9/19/05		12					1.95
SKTM	10/17/05		26					2.32
SKTM	11/14/05		18					3.46
SKTM	12/12/05		4					4.84
SKTM	1/17/06		52					
SKTM	2/13/06		45					8.28
SKTM	3/13/06		2					5.09
SKTM	4/17/06		15					9.25
SKTM	5/15/06		1 U					1.51
SKTM	6/12/06		596					4.47
SKTM	7/17/06		74					0.69
SKTM	8/14/06		980					0.35
SKTM	9/18/06		59					1.83
SKTM	10/16/06		152					2.61
SKTM	11/13/06		83					
SKTM	12/11/06		28					8.59

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
SKTM	1/17/07		22					
SKTM	2/12/07		47					7.37
SKTM	3/12/07		332					
SKTM	4/16/07		20					4.64
SKTM	5/16/07		36					2.22
SKTM	6/11/07		36					2.06
SKTM	7/16/07		145					1.05
SKTM	8/13/07		104					1.60
SKTM	9/17/07		55					2.07
SKTM	10/15/07		12					3.92
SKTM	11/12/07		48					
SKTM	12/10/07		7					4.71
SKTM	1/14/08		45					10.08
SKTM	2/11/08		38					22.95
SKTM	3/10/08		14					1.90
SKTM	4/14/08		22					3.94
SKTM	5/12/08		252					2.61
SKTM	6/9/08		68					2.15
SKTM	7/7/08		62					0.47
SKTM	8/18/08		600					0.25
SKTM	9/8/08		34					0.06
SKTM	10/13/08		62					0.27
SKTM	11/10/08		27					
SKTM	11/19/08	10:41	11					3.16
SKTM	12/3/08	10:46	20	8.63	103.3	10.90	7.88	1.30
SKTM	12/8/08		248					3.45
SKTM	1/13/09		31					11.46
SKTM	1/28/09	13:27	19					3.30
SKTM	2/10/09		1					1.93
SKTM	2/25/09	12:30	45	6.55	73.3	10.19	7.86	
SKTM	3/10/09		9					
SKTM	3/25/09	12:58	330	5.18	41.6	13.49	7.29	
SKTM	4/7/09		4					6.42
SKTM	4/22/09	12:54	40	10.17	92.5 e	11.30	8.08	
SKTM	5/5/09		42					
SKTM	5/20/09	12:18	140	10.46	93.9	10.83	7.70	
SKTM	6/2/09		7					
SKTM	6/17/09	13:05	470	12.73	74.7	10.12	7.94 e	
SKTM	6/30/09	13:55	130	12.27	65.1	9.97	7.44	

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
SKTM	7/14/09		100					1.31
SKTM	7/15/09	10:45	130	12.57	77.1	10.22	7.58	
SKTM	7/29/09	13:00	20	16.82	99.6	9.32	7.53	
SKTM	8/12/09	14:25	1000 J	14.28	73.6 e	10.22	7.52	
SKTM	8/19/09		280					1.29
SKTM	8/26/09	12:10	69	12.62	76.5	10.00	7.48	
SKTM	9/9/09	13:00	71	12.76	72.0	9.54 e	7.14	
SKTM	9/15/09		55					1.46
SKTM	9/22/09	13:21	29	12.58	73.6 e	10.73	7.31	
SKTM	10/5/09	13:34	22	9.12	72.9	10.95	8.02	
SKTM	10/13/09		28					
SKTM	10/20/09	12:03	28	9.80	81.6 e	10.01 e	6.74	
SKTM	11/3/09	12:58	4	8.00	87.9	11.38 e	6.95	
SKTM	11/10/09		44					
SKTM	11/17/09	13:20	880 J	8.17	75.1 e	11.46	6.92	
SKTM	12/1/09	13:36	15	7.79	113.1	11.75	7.46	
SKTM	12/8/09		2					
SKTM	12/15/09	12:16	160	2.56	92.2	12.84	7.59	
SKT165	5/16/05		480					
SKT165	6/13/05		164					
SKT165	7/18/05		151					
SKT165	9/19/05		600					
SKT165	10/17/05		50					
SKT165	11/14/05		228					
SKT165	12/12/05		8					
SKT165	1/17/06		65					
SKT165	2/13/06		86					
SKT165	3/13/06		6					
SKT165	4/17/06		20					
SKT165	5/15/06		268					
SKT165	6/12/06		756					
SKT165	7/17/06		544					
SKT165	8/14/06		140					
SKT165	9/18/06		82					
SKT165	10/16/06		99					
SKT165	11/13/06		77					
SKT165	12/11/06		42					
SKT165	1/17/07		9					
SKT165	2/12/07		64					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
SKT165	3/12/07		400					
SKT165	4/16/07		2					
SKT165	5/16/07		37					
SKT165	6/11/07		168					
SKT165	7/16/07		616					
SKT165	8/13/07		544					
SKT165	9/17/07		224					
SKT165	10/15/07		86					
SKT165	11/12/07		43					
SKT165	12/10/07		23					
SKT165	1/14/08		21					
SKT165	2/11/08		32					
SKT165	3/10/08		10					
SKT165	4/14/08		36					
SKT165	6/9/08		344					
SKT165	7/7/08		340					
SKT165	8/18/08		172					
SKT165	9/8/08		296					
SKT165	10/13/08		47					
SKT165	11/10/08		59					
SKT165	11/19/08	10:00	16					2.14
SKT165	12/3/08	10:21	33	7.97	87.0	8.80	7.41	0.61
SKT165	12/8/08		280					
SKT165	1/13/09		41					
SKT165	1/28/09	14:01	34					2.11
SKT165	2/10/09		82					
SKT165	2/25/09	12:43	160	6.09	61.6	9.57	7.38	2.18
SKT165	3/10/09		17					
SKT165	3/25/09	13:10	350					
SKT165	4/7/09		55					
SKT165	4/22/09	13:05	34					
SKT165	5/5/09		404					
SKT165	5/20/09	12:30	390					
SKT165	6/2/09		45					
SKT165	6/17/09	13:15	870					
SKT165	6/30/09	14:12	1100					
SKT165	7/14/09		3400					
SKT165	7/15/09	10:55	1400					
SKT165	7/29/09	13:11	1200					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
SKT165	8/12/09	14:34	2200					
SKT165	8/19/09		464					
SKT165	8/26/09	12:19	200					
SKT165	9/9/09	13:15	100	12.84	57.2	9.34 e	6.92	
SKT165	9/15/09		316					
SKT165	9/22/09	13:33	100					
SKT165	10/5/09	13:40	65					
SKT165	10/13/09		83					
SKT165	10/20/09	12:14	35					
SKT165	11/3/09	13:08	16					
SKT165	11/10/09		41					
SKT165	11/17/09	13:29	720					
SKT165	12/1/09	13:42	15					
SKT165	12/8/09		7					
SKT165	12/15/09	12:24	230					
SKT126	2/10/09		8					
SKT126	2/25/09	13:20	170	6.19	60.2	9.76	7.26	1.92
SKT126	3/10/09		6					
SKT126	3/25/09	13:37	290	5.43	38.4	12.81	6.91	23.73
SKT126	4/7/09		38					
SKT126	4/22/09	13:28	80	10.80	73.1 e	10.90	7.35	1.62
SKT126	5/5/09		180					
SKT126	5/20/09	13:08	440	11.22	79.8	10.27	7.17	2.58
SKT126	6/2/09		380					
SKT126	6/17/09	13:45	1500 J	12.52	35.3	10.05	7.5 e	1.85
SKT126	6/30/09	15:07	240	11.95	33.8	9.79	7.22	1.76
SKT126	7/14/09		1180					
SKT126	7/15/09	11:35	2400	12.63	42.7	9.84	7.31	1.22
SKT126	7/29/09	13:56	1600	21.24	53.1	8.01	7.26	0.33
SKT126	8/12/09	15:15	4800	14.61	69.2 e	9.02	7.09	1.56
SKT126	8/19/09		424					
SKT126	8/26/09	12:55	300	12.27	56.2	10.11	7.24	0.87
SKT126	9/9/09	13:35	250	12.96	57.4	8.96 e	6.86	1.43
SKT126	9/15/09		520					
SKT126	9/22/09	14:10	210	12.57	54.5 e	10.20	7.05	1.14
SKT126	10/5/09	14:22	17	8.31	55.6	11.22	8.00	1.08
SKT126	10/13/09		184					
SKT126	10/20/09	12:56	27	9.16	65.4 e	10.90 e	6.66	1.32
SKT126	11/3/09	13:40	13					1.93

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
SKT126	11/10/09		40					
SKT126	11/17/09	14:14	440	8.00	68.2 e	9.60	6.08	13.18
SKT126	12/1/09	14:23	11	7.15	95.1	10.25	6.80	3.35
SKT126	12/8/09		7					
SKT126	12/15/09	12:50	510					
SKTSR	5/16/05		240					
SKTSR	6/13/05		188					
SKTSR	7/18/05		69					
SKTSR	9/19/05		660					
SKTSR	10/17/05		78					
SKTSR	11/14/05		30					
SKTSR	12/12/05		9					
SKTSR	1/17/06		19					
SKTSR	2/13/06		21					
SKTSR	3/13/06		4					
SKTSR	4/17/06		28					
SKTSR	5/15/06		164					
SKTSR	6/12/06		1220					
SKTSR	7/17/06		151					
SKTSR	8/14/06		134					
SKTSR	9/18/06		48					
SKTSR	10/16/06		124					
SKTSR	11/13/06		28					
SKTSR	12/11/06		15					
SKTSR	1/17/07		10					
SKTSR	2/12/07		100					
SKTSR	3/12/07		156					
SKTSR	4/16/07		7					
SKTSR	5/16/07		40					
SKTSR	6/11/07		153					
SKTSR	7/16/07		296					
SKTSR	8/13/07		125					
SKTSR	9/17/07		41					
SKTSR	10/15/07		58					
SKTSR	11/12/07		53					
SKTSR	12/10/07		17					
SKTSR	1/14/08		15					
SKTSR	2/11/08		12					
SKTSR	3/10/08		5					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
SKTSR	4/14/08		109					
SKTSR	5/12/08		440					
SKTSR	6/9/08		312					
SKTSR	7/7/08		800					
SKTSR	8/18/08		2240					
SKTSR	9/8/08		1020					
SKTSR	10/13/08		23					
SKTSR	11/10/08		32					
SKTSR	11/19/08	9:32	29					1.39
SKTSR	12/3/08	9:53	10	7.92	93.1	8.92	7.30	0.49
SKTSR	12/8/08		85					
SKTSR	1/13/09		5					
SKTSR	1/28/09	14:22	15					1.19
SKTSR	2/10/09		14					
SKTSR	2/25/09	14:00	45	6.18	64.1	9.87	7.31	1.50
SKTSR	3/10/09		1 U					
SKTSR	3/25/09	14:39	170	5.94	41.9	12.81	6.98	11.08
SKTSR	4/7/09		4					
SKTSR	4/22/09	14:22	46	11.31	76.6 e	10.13	7.26	1.23
SKTSR	5/5/09		232					
SKTSR	5/20/09	13:52	280	11.88	83.6	9.35	7.06	1.60
SKTSR	6/2/09		256					
SKTSR	6/17/09	14:30	970	12.27	31.5	9.60	7.35 e	2.18
SKTSR	6/30/09	15:45	420	12.96	33.5	9.12	7.21	2.01
SKTSR	7/14/09		640					
SKTSR	7/15/09	11:58	2800	12.86	42.3	9.40	7.25	1.40
SKTSR	7/29/09	14:23	3200	20.86	52.7	7.39	7.01	0.39
SKTSR	8/19/09		276					
SKTSR	8/26/09	13:29	310	12.43	56.7	9.75	7.08	1.08
SKTSR	9/9/09	14:10	150	12.98	56.1	8.23 e	6.87	1.56
SKTSR	9/15/09		204					
SKTSR	9/22/09	14:41	120	13.02	54.2 e	10.05	6.99	1.28
SKTSR	10/5/09	14:44	34	8.56	55.4	10.94	7.82	1.34
SKTSR	10/13/09		66					
SKTSR	10/20/09	13:25	12	9.19	64.5 e	9.78 e	6.67	1.18
SKTSR	11/3/09	14:18	8					2.14
SKTSR	11/10/09		38					
SKTSR	11/17/09	15:05	160	7.87	67.8 e	9.85	6.16	10.29
SKTSR	12/1/09	14:53	20	7.10	99.5	9.70	6.67	2.70

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
SKTSR	12/8/09		25					
SKTSR	12/15/09	13:15	610					
SKTDAV	4/16/07		21					
SKTDAV	5/16/07		15					
SKTDAV	6/11/07		72					
SKTDAV	7/16/07		308					
SKTDAV	8/13/07		72					
SKTDAV	9/17/07		22					
SKTDAV	10/15/07		50					
SKTDAV	11/12/07		64					
SKTDAV	12/10/07		10					
SKTDAV	1/14/08		21					
SKTDAV	2/11/08		8					
SKTDAV	3/10/08		6					
SKTDAV	4/14/08		104					
SKTDAV	5/12/08		320					
SKTDAV	6/9/08		135					
SKTDAV	7/7/08		84					
SKTDAV	8/18/08		8500					
SKTDAV	9/8/08		65					
SKTDAV	10/13/08		146					
SKTDAV	11/10/08		58					
SKTDAV	11/19/08	9:09	26					1.09
SKTDAV	12/3/08	9:33	27 J	7.94	84.5	8.65	7.11	0.47
SKTDAV	12/8/08		168					
SKTDAV	1/13/09		6					
SKTDAV	1/28/09	14:42	11					1.33
SKTDAV	2/10/09		4					
SKTDAV	2/25/09	14:18	32	6.50	59.7	9.85	7.25	1.24
SKTDAV	3/10/09		3					
SKTDAV	3/25/09	15:20	100	6.26	39.8	15.22	6.85	7.37
SKTDAV	4/7/09		4					
SKTDAV	4/22/09	15:33	47	12.13	74.3 e	10.42	7.22	0.85
SKTDAV	5/5/09		448					
SKTDAV	5/20/09	13:55	180	13.55	80.4	9.86	6.94	1.13
SKTDAV	6/2/09		304					
SKTDAV	6/17/09	14:55	560	11.82	30.1	10.39	7.27 e	1.64
SKTDAV	6/30/09	16:35	54	12.99	33.3	10.36	7.14	1.65
SKTDAV	7/14/09		980					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft^3/s)
SKTDAV	7/15/09	13:25	210	13.25	41.0	10.02	7.17	1.05
SKTDAV	7/29/09	14:46	830	20.79	59.6	7.81	6.76	0.29
SKTDAV	8/12/09	15:41	2700	14.24	59.2 e	9.55	6.96	1.21
SKTDAV	8/19/09		97					
SKTDAV	8/26/09	13:46	150	13.13	57.1	9.86	6.94	0.98
SKTDAV	9/9/09	14:35	130	13.20	51.8	8.92 e	6.83	1.49
SKTDAV	9/15/09		172					
SKTDAV	9/22/09	15:16	96	13.56	33.2 e	11.10	6.93	1.38
SKTDAV	10/5/09	15:21	20	9.29	69.4	10.88	7.80	1.32
SKTDAV	10/13/09		30					
SKTDAV	10/20/09	13:55	9	9.52	58.3 e	10.08 e	6.53	1.34
SKTDAV	11/3/09	14:36	4					1.99
SKTDAV	11/10/09		26					
SKTDAV	11/17/09	15:36	180	7.78	62.5 e	9.83	6.06	5.88
SKTDAV	12/1/09	15:30	14	7.35	90.6	10.21	6.66	1.68
SKTDAV	12/8/09		4					
SKTDAV	12/15/09	13:46	870	-0.07	66.7	11.73	6.74	
SKTSHT	11/19/08	8:42	6					0.22
SKTSHT	12/3/08	9:14	30 J	7.71	101.4	10.65	7.59	0.15
SKTSHT	1/28/09	14:57	8					
SKTSHT	2/25/09	14:40	200	6.40	64.5	10.15	7.41	
SKTSHT	3/25/09	15:41	96					
SKTSHT	4/22/09	15:54	1 U	12.51	76.1 e	10.95	7.88	
SKTSHT	5/20/09	14:39	130	14.64	98.6	9.97	7.38	
SKTSHT	6/17/09	15:00	320	10.50	27.3	10.78	7.37 e	
SKTSHT	6/30/09	16:45	120	11.40	30.7	10.42	7.00	1.40
SKTSHT	7/15/09	12:54	170	13.39	39.8	10.63	7.32	0.87
SKTSHT	7/29/09	15:11	6300 J					
SKTSHT	8/12/09	16:07	2700	13.12	52.9 e	10.31	7.15	1.18
SKTSHT	8/26/09	13:52	250	13.34	59.2	9.96	7.12	0.98
SKTSHT	9/9/09	14:45	85	12.47	49.4	9.32 e	7.01	1.41
SKTSHT	9/22/09	15:40	77	12.61	52.7 e	10.30	7.05	1.53
SKTSHT	10/5/09	15:44	32	8.88	82.7	11.12	7.89	1.32
SKTSHT	10/20/09	14:15	15	9.40	56.8 e	10.43 e	6.60	1.58
SKTSHT	11/17/09	15:43	70	7.05	54.4 e	10.96	6.24	2.41
SKTSHT	12/15/09	13:25	780					
162DSD	3/25/09	11:51	250					
165D	11/17/09	13:34	4700 J					
165D	12/1/09	13:44	8					

Site ID	Date	Time	FCMF (#cfu/ 100 mL)	Temp (°C)	SpCond (µS/cm)	DO (mg/L)	pH	Streamflow (ft³/s)
128D	11/17/09	13:36	15					
128D	12/1/09	13:44	1					
128D	12/15/09	12:30	150					
126D	3/25/09	13:36	1500					
126D	11/17/09	14:16	380 J					
SRUSD	3/25/09	14:50	140					
SRUSD	5/20/09	14:10	1400 J					
SRUSD	11/17/09	15:07	560 J					
SRDSD	3/25/09	14:45	200					
SRDSD	5/20/09	14:08	210 J					
SRDSD	6/30/09	16:00	430					
SRDSD	11/17/09	15:06	480 J					
SRDSD	12/1/09	14:54	8 U					
SRDSD1	5/20/09	14:09	29					
SRDSD1	11/17/09	15:04	19					
SRDSD1	12/1/09	14:55	6					
SHTSD	1/28/09	15:00	12					
SHTSD	2/25/09	14:40	60					
SHTSD	4/22/09	16:05	3					
SHTSD	5/20/09	14:40	75					
SHTSD	8/12/09	16:08	31					
SHTSD	11/17/09	15:43	57					

FCMF – Fecal coliform membrane filter analysis method.
SpCond – Specific conductance.
DO – Dissolved oxygen.