KITSAP PUBLIC HEALTH DISTRICT
ENVIRONMENTAL HEALTH DIVISION
POLLUTION IDENTIFICATION & CORRECTION PROGRAM

JUMP OFF JOE RESTORATION PROJECT

FINAL REPORT

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Funded by:

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JUMP OFF JOE RESTORATION PROJECT
FINAL REPORT

EXECUTIVE SUMMARY

The Jump off Joe Restoration Project was awarded to the Kitsap Public Health District (Health District) on November 15, 2007 to address serious fecal coliform (FC) pollution problems in Jump off Joe Creek. Funding was provided with a Washington State Department of Ecology (Ecology) Centennial Clean Water Fund grant.

Hood Canal, the receiving waters, is a class AA water body, meaning that it is suitable for all types of water recreation, fishing and shellfish harvesting. Consequently, Hood Canal must receive the highest degree of protection possible by applying stringent water quality standards to surface waters discharging into the marine environment.

All of the Kitsap portion of Hood Canal was open to shellfish harvest prior to the "2002 Shoreline Survey of the Hood Canal 1 Shellfish Growing Area," published by Washington State Department of Health (DOH) in July 2003. As a result of the shoreline survey, DOH established a large shellfish closure zone of 515 feet on either side of Jump off Joe Creek due to FC contamination.

The Health District conducted an intensive surface water monitoring and property survey campaign in the Jump off Joe Watershed in 2008. By October of 2008, 75% of the 304 properties in the project area had been visited by Health District staff. Staff met with property owners and discussed the recommended procedures to prolong the life of their onsite sewage systems (OSS), protect their investment and protect water quality.

In October 2008 Ecology authorized expansion of the project area to include nearby Vinland, Kinman and Lofall Creek watersheds to address FC pollution hot spots in these areas. Surface water monitoring, dye testing and property surveys were conducted to identify and correct FC pollution sources.

Pollution identification and correction (PIC) work by the Health District in 2008 and 2009 resulted in decreasing FC concentrations in Jump off Joe Creek. FC concentrations at the mouth of Jump off Joe Creek met Part 1 and Part 2 of the Washington State Surface Water Quality Standards for fecal coliform (FC) June 15, 2009. Consequently, DOH removed the shellfish closure zone at the mouth of Jump off Joe Creek in October 2009.

A second amendment to the project area was authorized by Ecology in June 2010 to include the Hood Canal #1 shellfish growing area. The growing area's southern border is Naval Base Kitsap–Bangor (NBK-Bangor). Its northern boundary is the Driftwood Key Marina south of Foulweather Bluff. The Health District conducted marine shoreline surveys to locate sources of fecal pollution and correct them to prevent future downgrades in classification.

PIC surveys were performed at 430 properties in the Vinland, Jump off Joe, Lofall and Kinman Creek watersheds and the shoreline was surveyed from NBK-Bangor to Driftwood Keys. Twenty-eight onsite sewage system OSS failures were discovered and repaired during the project.

Factors that contributed to the failures found during the project were similar to those found in other pollution identification projects undertaken by the Health District. OSS age, soil type, water table elevation, proximity to surface waters, physical damage to drainfields and hydraulic overloading of the system by residents contributed to many of the failures found during the project. Repairs of the failures have ranged from minor repairs to complete replacement of the onsite sewage system.

During the course of the project FC bacteria concentrations initially decreased in Jump off Joe, Vinland and Kinman Creeks. By the end of the project, the trend was stationary in Jump off Joe and Vinland Creeks. Water quality in Lofall Creek initially worsened and then improved dramatically in 2011.

Shoreline sampling was a useful tool for locating FC sources along the Hood Canal Shoreline. Seven failing OSS discharging to the beach were discovered and repaired/replaced during the project.

As a result of samples collected, residents surveyed and observations made during the Jump off Joe Restoration project, the Health District's Pollution Identification and Correction Program recommends the following:

- Conduct periodic shoreline surveys along Hood Canal to maintain the progress made by the Jump off Joe Restoration Project. Older gravity OSS along the shoreline will likely continue to fail as they age.

- The Health District will continue to be involved in the Upper Hood Canal watershed through public complaint response, water quality trend monitoring, and follow-up of reports submitted by certified monitoring and maintenance specialists and pumpers. In addition, properties with ongoing concerns will be flagged in Health District records to assist future inspections.

- The Vinland, Jump Off Joe, Lofall and Kinman watersheds will need ongoing work to prevent water quality degradation due to elevated FC levels. Many of the OSS in the area have no installation records, are old and designed for disposal only, and are challenged by surface water and seasonal groundwater.

- Continue to be proactive in OSS maintenance. Alternative OSS are inspected annually by their maintenance provider. Standard gravity OSS and drainfields should be inspected every three years (at minimum).

1.0 BACKGROUND AND PROBLEM STATEMENT

The “Water Quality Standards for Surface Waters of the State of Washington” are codified in Chapter 173-201A of the Washington Administrative Code (WAC). As defined in Chapter 173-201A of the WAC, the Jump off Joe, Vinland, Kinman and Lofall Creeks have been designated as “extraordinary primary contact waters.”

The extraordinary primary contact fresh water standard for FC bacteria is:

“Fecal coliform organism levels shall not exceed a geometric mean value of 50 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.”

The marine water FC standard is:

“Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.”

In 2004, Washington DOH created small shellfish closure zones around the mouths of several creeks in the Hood Canal 1 shellfish growing area due to bacterial pollution:

- Jump off Joe Creek (515 feet on either side of the mouth)
- Kinman Creek (50 feet on either side of the mouth)
- Lofall Creek (360 feet on either side of the mouth)

The Jump off Joe Restoration project was funded by a grant from the Washington State Department of Ecology (Ecology) Centennial Clean Water Fund (CCWF), with matching funds provided by the Kitsap County Surface and Stormwater Management Program.

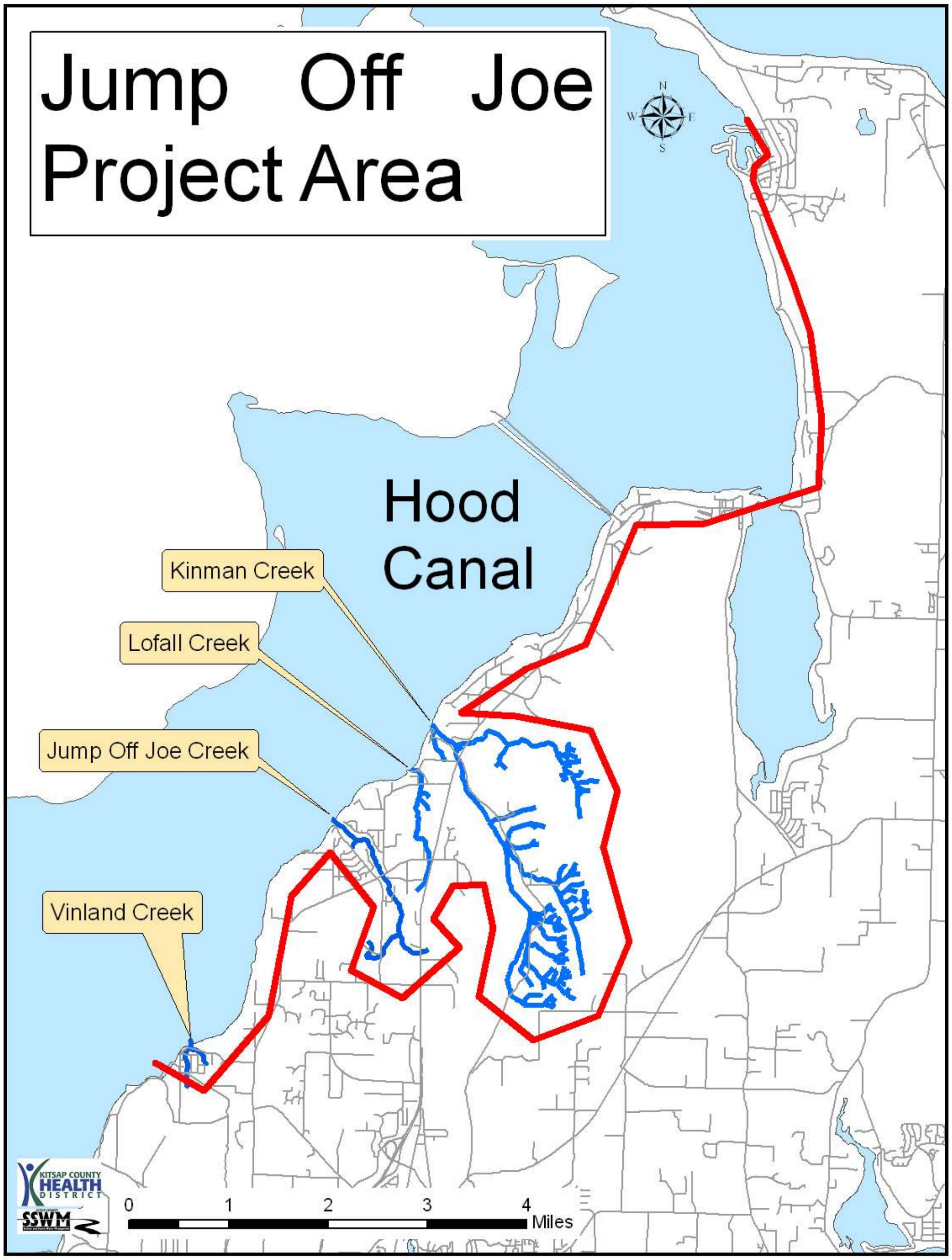
This project addressed an FC bacterial contamination problem in the Jump off Joe Creek, Vinland Creek, Lofall Creek, Kinman Creek and Upper Hood Canal watersheds in Kitsap County as evidenced by ongoing violations of the extraordinary primary fresh water FC standard since 2003.

The project goal was to restore beneficial uses in Hood Canal and streams flowing into it. To accomplish this goal, the Health District applied its FC bacteria pollution identification and correction process as outlined in its “Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction” (November 2003).

2.0 PROJECT AREA DESCRIPTION

There are four major watersheds in the project area: Vinland Creek, Jump Off Joe Creek, Lofall Creek, and Kinman Creek. These largest fresh water drainages to this portion of the Hood Canal shoreline have the greatest potential impact on water quality. The project area also included some shoreline and upland properties outside of those four major drainages. The Jump off Joe Restoration Project area is mapped in **Figure 1** below:

Figure 1. Upper Hood Canal Watersheds for the Jump off Joe Grant



Vinland Creek

Vinland Creek is a small stream located just north of the Bangor submarine base on Hood Canal. It has two tributaries, which combine for a total of 0.75 miles of stream corridor. Land use in the area is primarily residential, with some forest land to the south. Vinland Creek watershed residences are approximately 30 years old, and the lots are small. Eighty-two of the eighty-five residences were surveyed for this project.

The Health District began monitoring Vinland Creek in the spring of 2008, after initial sampling showed elevated levels of bacteria. The short term water quality trend in the stream is stationary. **Figure 2** provides a map of the area.

Vinland Creek mouth station

Jump off Joe Creek

Jump off Joe Creek is located five miles south of the Hood Canal Bridge on the eastern shoreline of Hood Canal in Kitsap County (**Figure 6**). The headwaters of Jump off Joe Creek are located near the Pioneer Hill Industrial Park and south of Pioneer Hill Way. From there, it flows north approximately 1.8 miles to Hood Canal, near the Edgewater Community Club Beach.

Land use in the watershed is primarily residential west of Pioneer Hill Way and light industrial, hobby farm and forest east of Pioneer Hill Way. Two hundred seventy-three of the two hundred eighty-seven properties in the watershed were surveyed.

Jump off Joe Creek as it flows into Hood Canal downstream of monitoring station JJ01

The State Department of Health lifted a shellfish closure zone around the mouth of Jump off Joe Creek in 2009. Statistical analysis for the creek now shows a stationary trend.

Lofall Creek

Lofall Creek is a small stream that starts near the intersection of Highway 3 and flows in a northerly direction for about a mile. The stream discharges through a long culvert into Hood Canal near the Lofall Community Club dock. Land use in the creek drainage is primarily rural residential with some agricultural.

Lofall Creek monitoring station LF01 at the creek's discharge into Hood Canal

Water quality is poor and a public health advisory remains in place, recommending that people avoid contact with water from this stream. The State Department of Health has designated a shellfish closure area within 360 feet of Lofall Creek. Although water quality in Lofall Creek has improved in the last year, it is still one of the most polluted streams in Kitsap County.

Kinman Creek

From its headwaters on Big Valley Road, Kinman Creek flows approximately three miles in a northerly direction to its discharge into Hood Canal north of Kitsap Memorial State Park. Land use in the Kinman Creek drainage is primarily rural residential west of Highway 3 and agricultural east of Highway 3. At least one of the houses dates from the 1890's when Washington was a territory.

Kinman Creek monitoring station KN01

Fecal coliform bacteria concentrations in the creek exceed state water quality standards. Statistical analysis for the creek shows a worsening trend. Because of the elevated bacteria levels in Kinman Creek, the DOH has established a shellfish closure area within 50 feet of the stream.

Hood Canal

Hood Canal is a pristine fjord-like marine waterbody extending 66 miles from Foulweather bluff to Belfair. It was created about 15,000 years ago during the Vashon Stade of the Pleistocene glaciation of Western Washington. The 16 mile northern section from NBK-Bangor to Driftwood Key was evaluated during the project. Land use along this section is mostly residential with some forested areas. Numerous footing drains, downspouts, curtain drains, stormdrains and small streams discharge to the shoreline. Most discharges met Health District established water quality screening criteria. However, eight failing OSS were identified and corrected.

Figure 2. Jump off Joe Grant Streams

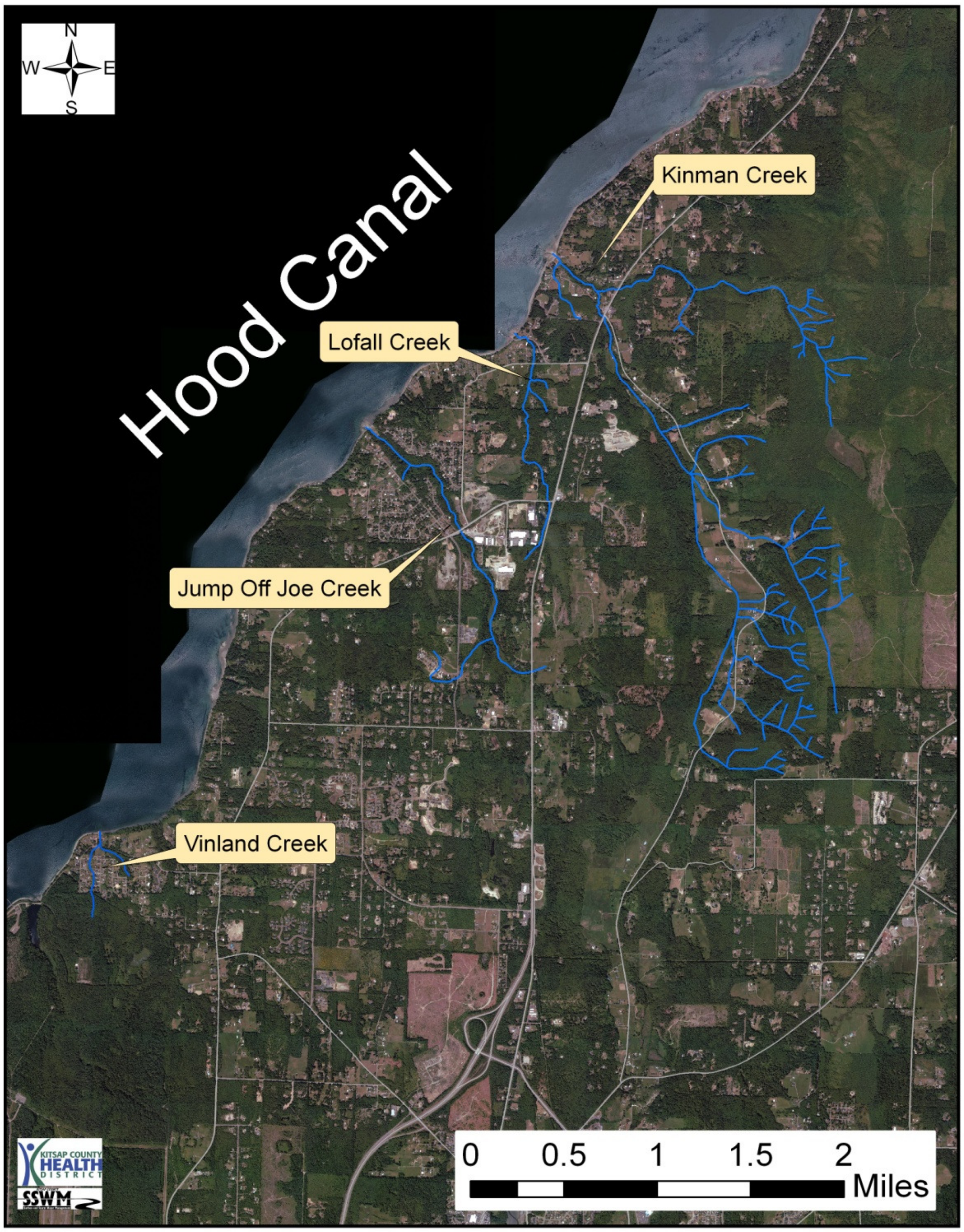


Figure 3. Upper Hood Canal Shellfish Growing Area North

Figure 4. Upper Hood Canal Shellfish Growing Area South

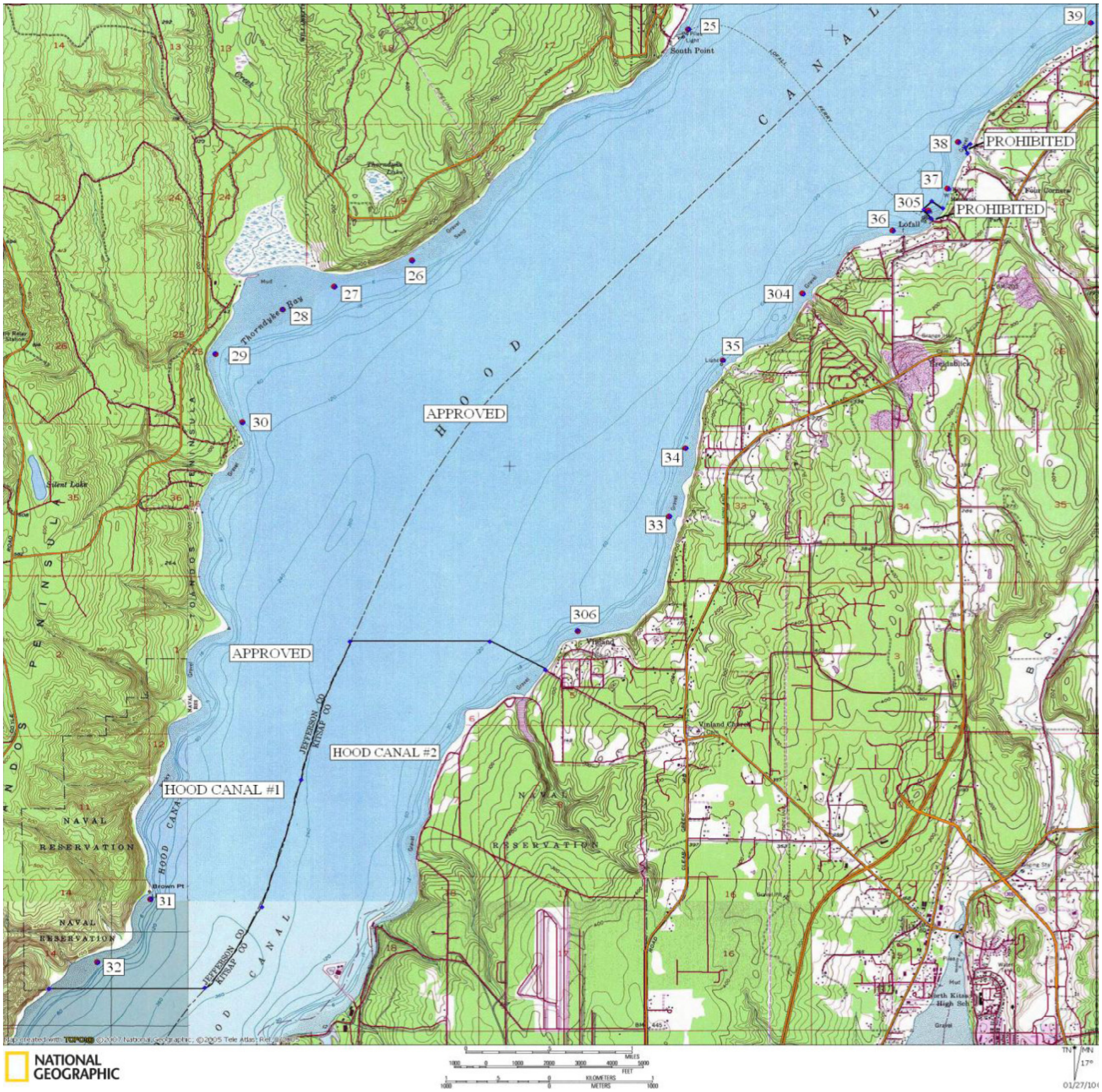


Figure 5. Vinland Creek Watershed

Figure 6. Jump off Joe Creek Watershed

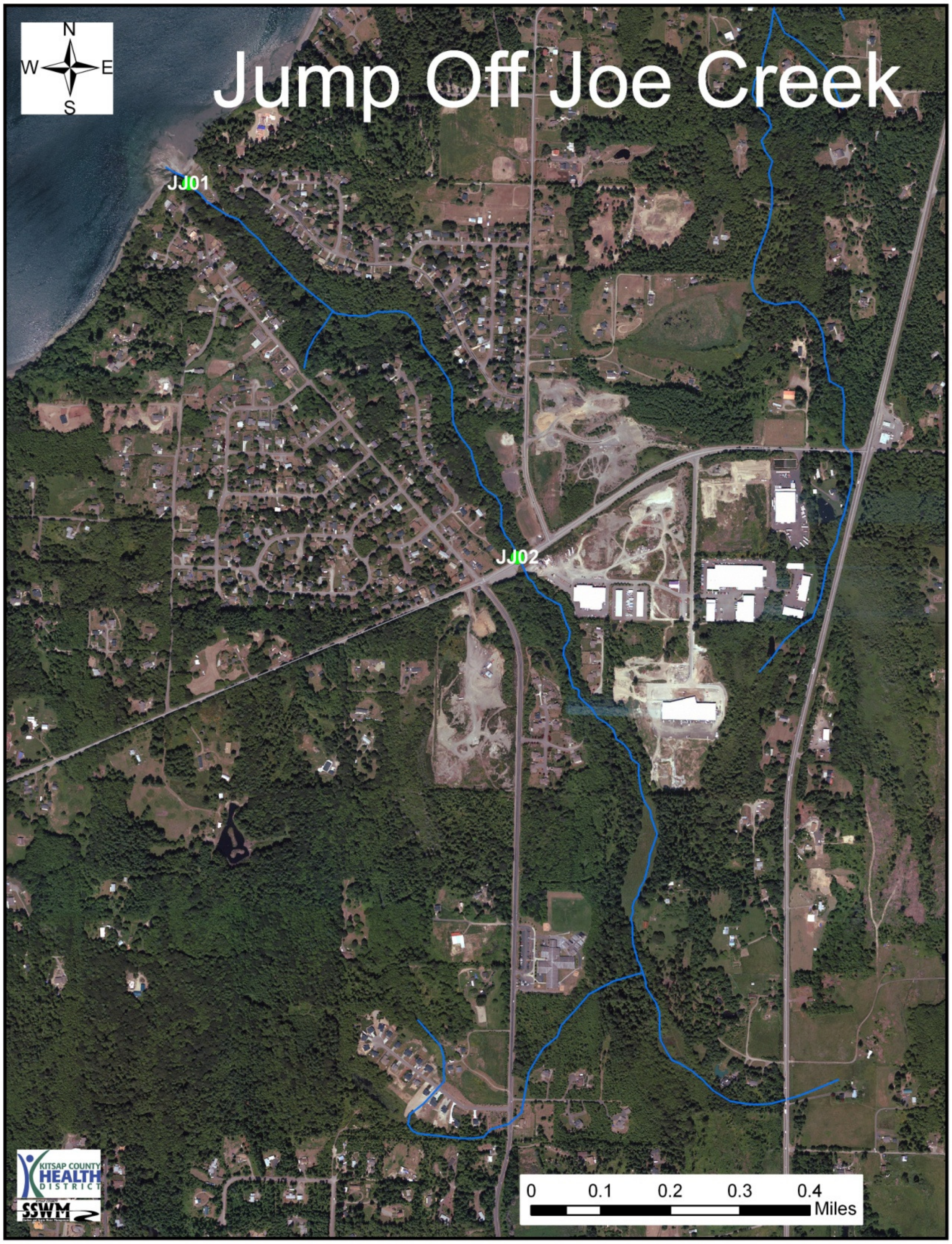


Figure 7. Lofall Creek Watershed

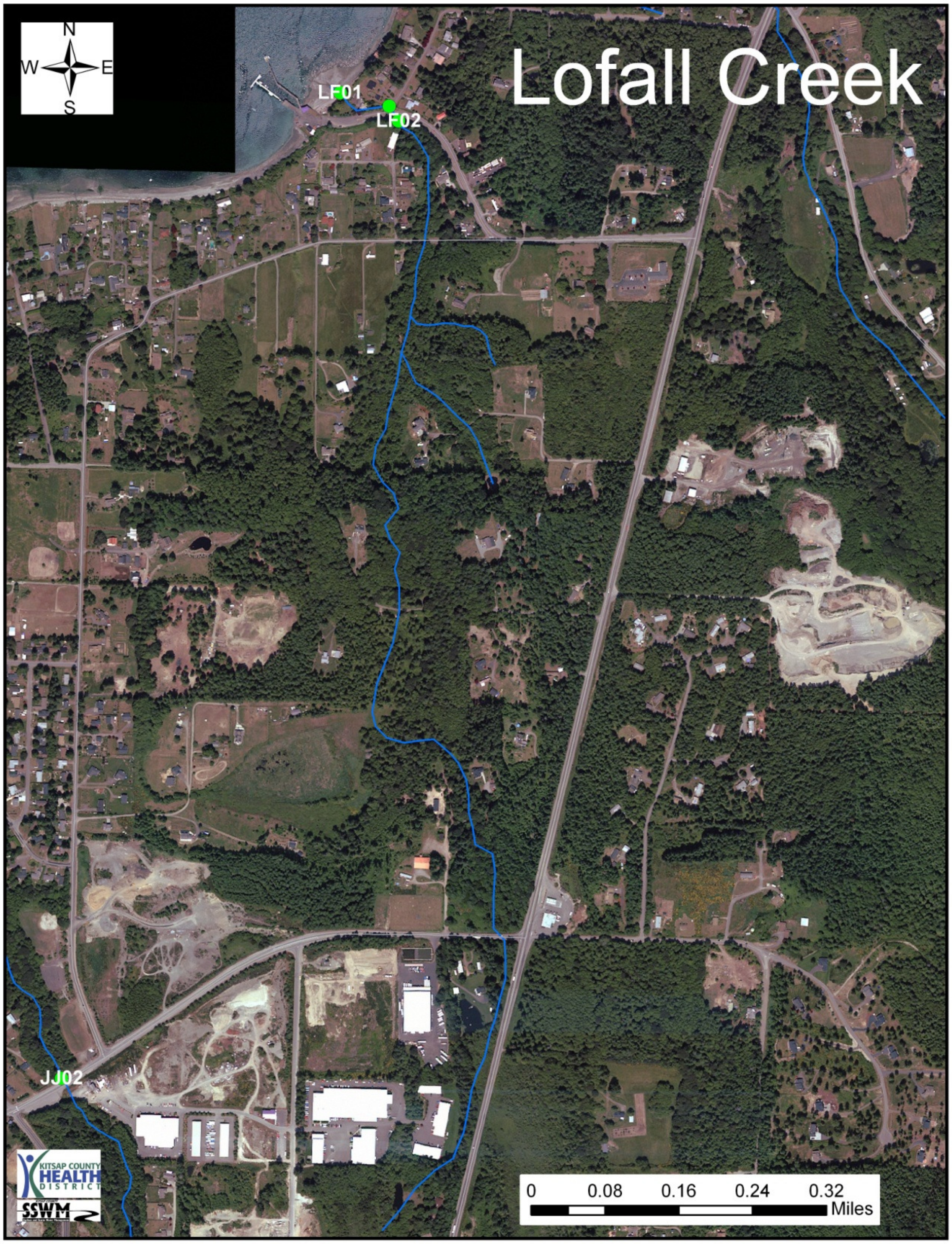
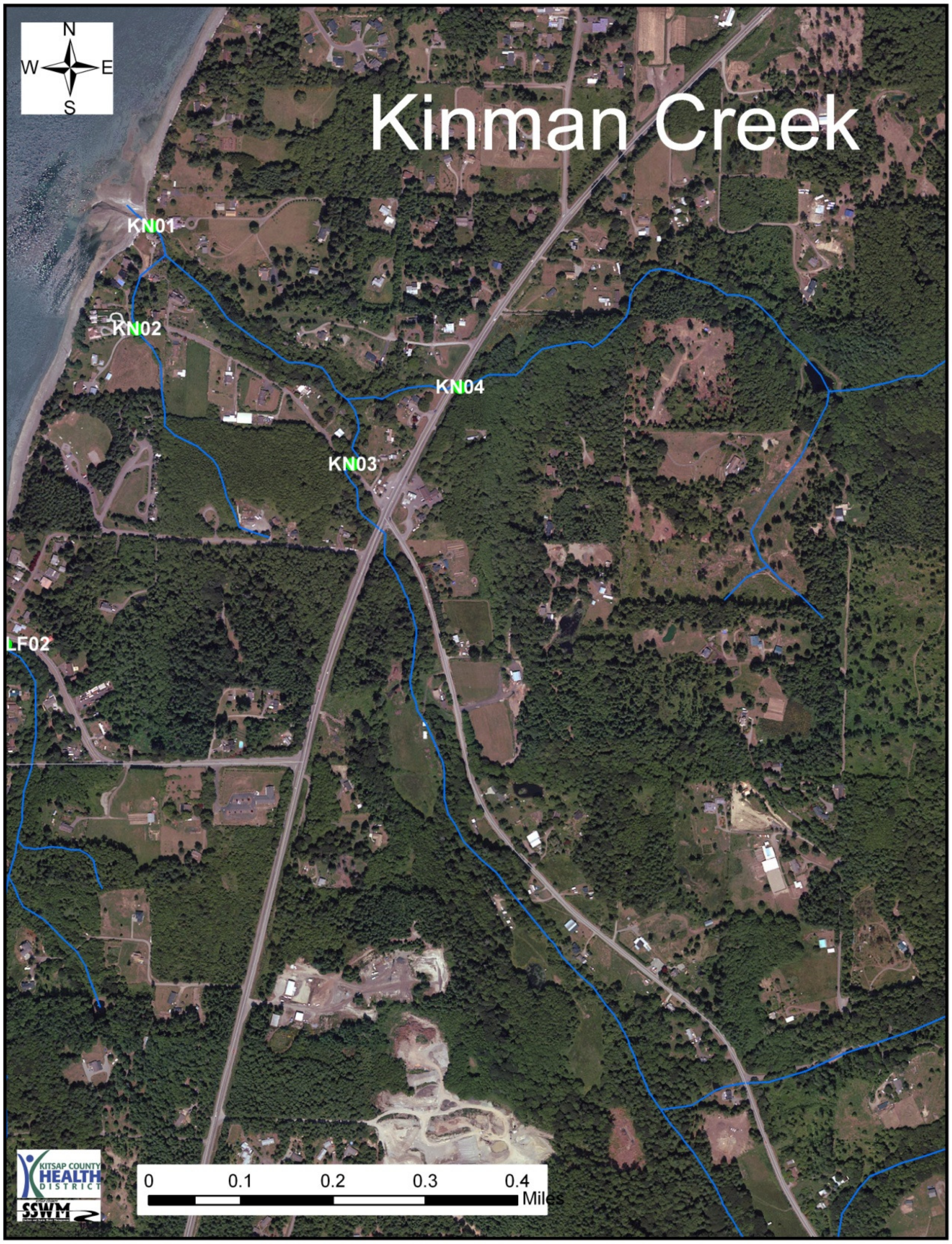


Figure 8. Kinman Creek Watershed



3. GOALS AND OBJECTIVES

The goals of the Jump off Joe Restoration Project were to:

- Protect designated beneficial uses in Jump off Joe, Vinland, Kinman and Lofall Creeks and Hood Canal receiving waters.
- Locate approximately 310 OSS within the project area, identify their component parts and characterize performance.
- Reduce FC pollution into Jump off Joe, Vinland, Kinman and Lofall Creeks from a variety of sources, including failing OSS and inadequate animal waste management.
- Conduct a before and after FC source correction nutrient (BACI) study at OSS failure sites, where applicable.
- Provide water quality data to determine if correction of FC sources also nets reductions in nutrients.
- Educate watershed residents about actions they can take to prevent bacterial and nutrient impacts to Jump off Joe, Vinland, Kinman and Lofall Creeks and Hood Canal.

The objectives of the Jump off Joe Project were met:

- A total of 430 onsite sewage systems were inspected and characterized; 273 in the Jump off Joe project area and an additional 157 systems in the expanded project area.
- Fecal coliform pollution inputs to surface waters in the project area were reduced by the identification and repair of 28 failing OSS, homeowner education, and a pet waste management effort.
- Strategic stormwater discharge locations were located and sampled during five qualifying storm events. Agricultural properties evaluated were in compliance.
- Health district staff discussed the recommended practices to prolong the life of their OSS with the residents of the 430 properties visited during door to door sanitary surveys in the project area.
- Nutrient levels were evaluated monthly at trend stations located at discharge points to marine waters.
- Educational brochures, fact sheets and display boards were presented at outreach events. Three public meetings were held to report on the progress and findings of the project: one pre-project, one mid-project and one at the end of the project.

4.0 PROJECT DESIGN AND METHODS

4.1 Property Surveys

Individual property surveys were conducted according to the "Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction" (Health District, 2011). A property survey consisted of an OSS record search, homeowner/resident interview, field inspection, and water sampling and dye test when necessary. The purpose of the survey was to identify all potential sources of FC contamination (including failing OSS and inadequate animal waste management). Surveys included an educational component to provide information to property owners about how to operate and maintain their OSS and to identify any non-conforming conditions that could cause premature OSS failure. Property owners were given copies of their OSS records, a fact sheet about the project, and information about septic loan programs when appropriate. Homeowners were encouraged to inspect their drainfield and tank areas with Health District staff to learn the symptoms of a failing OSS. Often these inspections revealed non-conforming conditions and potential problems, such as improper placement of roof drains, damage to a drainfield by parking vehicles over the laterals, or unwanted growth of blackberry bushes and tree roots that could obstruct the disposal lines. Most properties were selected based on the watershed boundaries but others were added based on DOH recommendations, public sewage complaints and "deficient" OSS monitoring and maintenance or pumper reports.

Some of the surveys required additional inspections due to conditions that suggested a failing OSS. These "suspect" systems required laboratory samples of surface water and dye testing. A system with suspect conditions, such as a saturated drainfield area, or a negative dye test with high FC counts, received a rating of "suspect," and the homeowner was encouraged to take the necessary steps to improve the operation of the OSS. When an OSS received a rating of "non-conforming," such as non-permitted repairs or alterations or additional bedrooms added to the home, the homeowner was informed of the issues, their impact on the OSS, and the necessary steps to resolve the issues. Suspect and non-conforming systems found during this project were recorded in Health District records without corrective enforcement. Inspectors also identified potential non-OSS FC sources like pet waste, livestock waste, as well as nutrient sources during the survey. Property survey results are located in Section 5.1.

4.2 Shoreline Surveys

A dry season shoreline survey was performed in July and August 2010 and a wet season survey was completed in February and March 2011, along the 16-mile shoreline between NBK-Bangor and Driftwood Key. Please refer back to **Figure 1** for a map of the shoreline survey area. Wet season shoreline surveys screen for OSS that fail due to surface or groundwater intrusion. Dry season surveys can identify failures masked by dilution during the wet season. Discharges exceeding screening criteria of 200 FC/100ml were resampled twice to confirm contamination. If the geometric mean of the samples exceeded screening criteria, then the location was designated a hot spot and the source identification process was initiated.

Sampling stations were given an identification number in sequence from the starting point to the endpoint of the survey. They were also photographed, noted, and global position system (GPS) coordinates were recorded. Location descriptions were recorded at each sample station in the field notebook.

All significant discharges to the marine environment were sampled for FC bacteria. Typical discharges included: curtain drains, bulkhead drains, roof drains, culverts, small streams and bank seeps. Samples were collected at low tide to target the discharge of fresh water versus the drainage of residual marine water.

4.3 Water Quality Monitoring

Water quality monitoring was conducted pursuant to the approved "Jump off Joe Creek 2007 Restoration Project Quality Assurance Project Plan" (February 2008).

4.3.1 Trend Monitoring

The Health District has conducted trend monitoring of Kitsap County streams and marine waters since January 1996, through funding from KCSSWM. This trend monitoring revealed poor water quality in Jump off Joe, Kinman and Lofall Creeks. Vinland Creek was added to the Jump off Joe project when preliminary sampling determined that water quality was a concern. Trend monitoring is conducted pursuant to the Health District's Trend Monitoring Plan, see **Appendix A** for Trend Plan.

The Health District conducted monthly trend monitoring of twelve stream stations in the project area (three on Vinland Creek, two on Jump off Joe, three on Lofall and four on Kinman Creeks). Please see **Appendix B** for a list of monitoring stations, and **Figures 5 - 8** for their locations.

4.3.2 Special Investigation Sampling

The purpose of special investigation sampling was to characterize FC water quality of watershed stream segments. Stream monitoring began with monthly sampling of twelve trend stations in the project area. Additional stations were added during the project to facilitate source identification. Numerous investigative samples were collected to further segment streams and parcels to identify FC sources. This investigative impact monitoring was conducted using the same field procedures as set forth in the Trend Monitoring Plan.

4.3.3 Stormwater Monitoring

The purpose of stormwater impact monitoring was to identify specific sources of bacterial pollution contaminating stormwater in the project area. For this project, stormwater discharges to Jump off Joe Creek were monitored for FC and total suspended solids (TSS). Five (5) rainfall events were selected to characterize stormwater outfalls in the project area. Field observations during rain events in the Jump off Joe watershed showed that stormwater conveyances have a very short response time to precipitations events. Furthermore, temporal proximity to the onset of the rain event and precipitation intensity appear to have a more significant effect on discharge to Jump off Joe creek than precipitation quantity in a 24 hour period. The results of stormwater monitoring are in Section 5.3.5 of this report.

The results show very high fecal concentrations at JJ01A, which is located immediately downstream of two OSS failures and another two OSS failures were nearby. JJ01 showed less influence likely due to dilution.

The Health District expanded the PIC process into urban areas with the Dyes Inlet Restoration Project (2005 – 2009). This project was a cooperative effort of the Health District, Kitsap County Surface Stormwater Management (KCSSWM), and the local community to conduct commercial property stormwater inspections. Funding was provided with a Washington State Department of Ecology (DOE) Centennial Clean Water grant.

The project analyzed stream sample data downstream of stormwater runoff before and after the initiation of the inspection program and corrections. Statistically significant water quality improvements were found at several fresh and marine water monitoring stations. These data indicate that the correction of stormwater deficiencies and other sources in the Clear Creek watershed led to significant water quality improvements.

The Health District then conducted the Kitsap Regional Illicit Discharge Detection and Elimination Clean Runoff project from 2008 – 2011. To achieve stormwater quality improvements, the Health District coordinated the development of a county wide Illicit Discharge Detection and Elimination (IDDE) approach. Interlocal agreements (ILAs) were developed with partnering agencies to update and complete stormwater system mapping; produce or refine written IDDE procedures; develop regulatory mechanisms to prevent illicit discharges into stormwater; and perform outfall screening of high priority areas. All permitees satisfied the National Pollutant Discharge and Elimination System (NPDES) Phase II requirements during the project.

Joint commercial property inspections were also conducted between May of 2009 and November of 2011. Commercial property inspections were successful in identifying neglected stormwater systems and illicit discharges. This included properties located in the Edgewater Industrial Park located in the Jump Off Joe watershed.

This IDDE work has shown that regular catch basin and stormwater conveyance system maintenance reduces FC and turbidity in surface waters. Analysis of sediment sampling results from the IDDE project, which were collected before and after catch basin maintenance, showed no water quality improvements, indicating that there is a consistent source of pollutants to catch basins and that they need ongoing inspection and regular maintenance.

Kitsap County has incorporated low impact development techniques such as rain gardens, pervious pavement and vegetative swales into development regulations. Kitsap Conservation District is currently administering low impact development grants to private property owners.

4.3.4 Nutrient Monitoring

The Health District planned to conduct a before and after FC source correction nutrient (BACI) study at ten (10) OSS failure sites and at the mouth of Jump Off Joe Creek as part of this project. This task was based on a preliminary pilot nutrient study conducted in 2005-2008 as part of Upper Hood Canal Pollution Identification and Correction projects. The goal was to provide water quality data to determine if correction of FC sources also nets reductions in nutrients.

The plan was to collect FC, nitrate+nitrite nitrogen, ammonia nitrogen, and ortho-phosphate samples from FC contaminated drainages with OSS failures and similar control drainages before and after FC source correction. Salinity would be measured and flows measured or estimated.

The Upper Hood Canal project could only find seven sites suitable for the study. Shoreline access posed some challenges. Discharges were often intermittent, leaky, pulsing, or buried in the beach. Discharges were often immediately mitigated through water conservation or tank pumping, removing them from the list of potential study sites.

The OSS failures found during the Jump off Joe Restoration project were not suitable for before and after correction study because they were not shoreline discharges but were surfacing on the ground in the upland areas. The exception was three shoreline failures in the northern portion of the project area where no nearby control sites could be found due to drainage interconnections.

Nutrient monitoring was conducted at the mouth stations of Jump Off Joe, Kinman, Lofall, and Vinland Creeks for this project.

4.4 Education and Outreach

Educating homeowners on potential FC and nutrient sources and how to prevent them was an important part of the Jump off Joe Creek Restoration Project. During property surveys, Kitsap Health staff provided homeowners with educational brochures, a copy of the sewage disposal permit, as-built, and OSS plans for their home. Health District staff also emphasized that operation and maintenance is crucial to prevent premature septic system failures and for protecting water quality in Hood Canal. During the OSS inspection, the Health District staff shared site-specific recommendations on how to get the most life out of their septic system. Any practice that might stress the system or reduce performance was identified and possible solutions were provided. Informational brochures and water-conserving fixtures were made available to all residents.

Three public meetings were held in the project area to provide project updates and more detailed education for property owners and their tenants. The Health District also attended and provided educational displays at local events like the Kingston Open House, Kitsap County Fair and North County Futures Festival.

5.0 RESULTS AND DISCUSSION

5.1 OSS Property Survey Results

Pollution Identification and Correction (PIC) OSS surveys were conducted from November 2007 to August 2011. The project area consisted of 453 parcels in the residential and commercial areas of Vinland Creek, Jump off Joe Creek, Lofall Creek, and Kinman Creek.

Residents of 430 of the 453 properties (95%) participated in the PIC survey:

- A project total of 28 OSS failures (7%) were found.
- A project total of 6 suspect OSS (1%) were found.
- A project total of 25 non conforming (6%) were found.
- A project total of 30 "no records" OSS (7%) were found.
- A project total of 341 "no apparent problems" OSS (79%) were found.

Based upon the results of each survey, OSS were categorized as "Failing," "Suspect," "Non-Conforming," "No Records," or "No Apparent Problems." **Table 1** summarizes the project OSS survey results. OSS were rated according to "Criteria for Rating OSS" in **Appendix C.**

Table 1. Summary of Pollution Identification and Correction Results 2005 – 2009

Project Areas	Participating Properties	Failing		Suspect		Non Conforming		No Records		No Problems	
		#	%	#	%	#	%	#	%	#	%
Vinland Creek	82	2	2	0	0	2	2	8	10	70	85
Jump off Joe Creek	273	12	4	3	1	14	5	7	3	237	87
Lofall Creek	42	3	7	3	7	6	14	9	21	21	50
Kinman Creek	7	0	0	0	0	0	0	2	29	5	71
Shoreline	18	8	44	0	0	1	5	3	17	6	33
Upland	8	3	37	0	0	2	25	1	13	2	25
Total Project Area	430	28	7	6	1	25	6	30	7	341	79

The four watersheds listed in Table 1 above are the largest fresh water drainages to the Hood Canal shoreline in the project area (between NBK-Bangor and the Hood Canal bridge) and have the greatest potential impact on the water quality of Hood Canal. The shoreline and upland categories summarize properties outside of those four major drainages.

5.1.1 Analysis of Failures

Historically, the average life expectancy for onsite sewage systems in Kitsap County is thirty years. Misuse and environmental factors can shorten their life and regular maintenance and good home practices can lengthen it. The most common factors observed in the project area that contributed to OSS failure were:

- Age of the OSS
- Poor soil types
- Shallow depth to water table or an impervious layer
- Hydraulic overload by the residents
- Inadequate or lack of maintenance of the OSS
- Root intrusion into OSS components

Figure 9 shows the locations of failures in the project area. The **7%** failure rate found in the project area is within the expected range for properties in Kitsap County. Historically, similar projects conducted by the Health District since 1995 have found a failure rate between two and fifteen percent (2% - 15%).

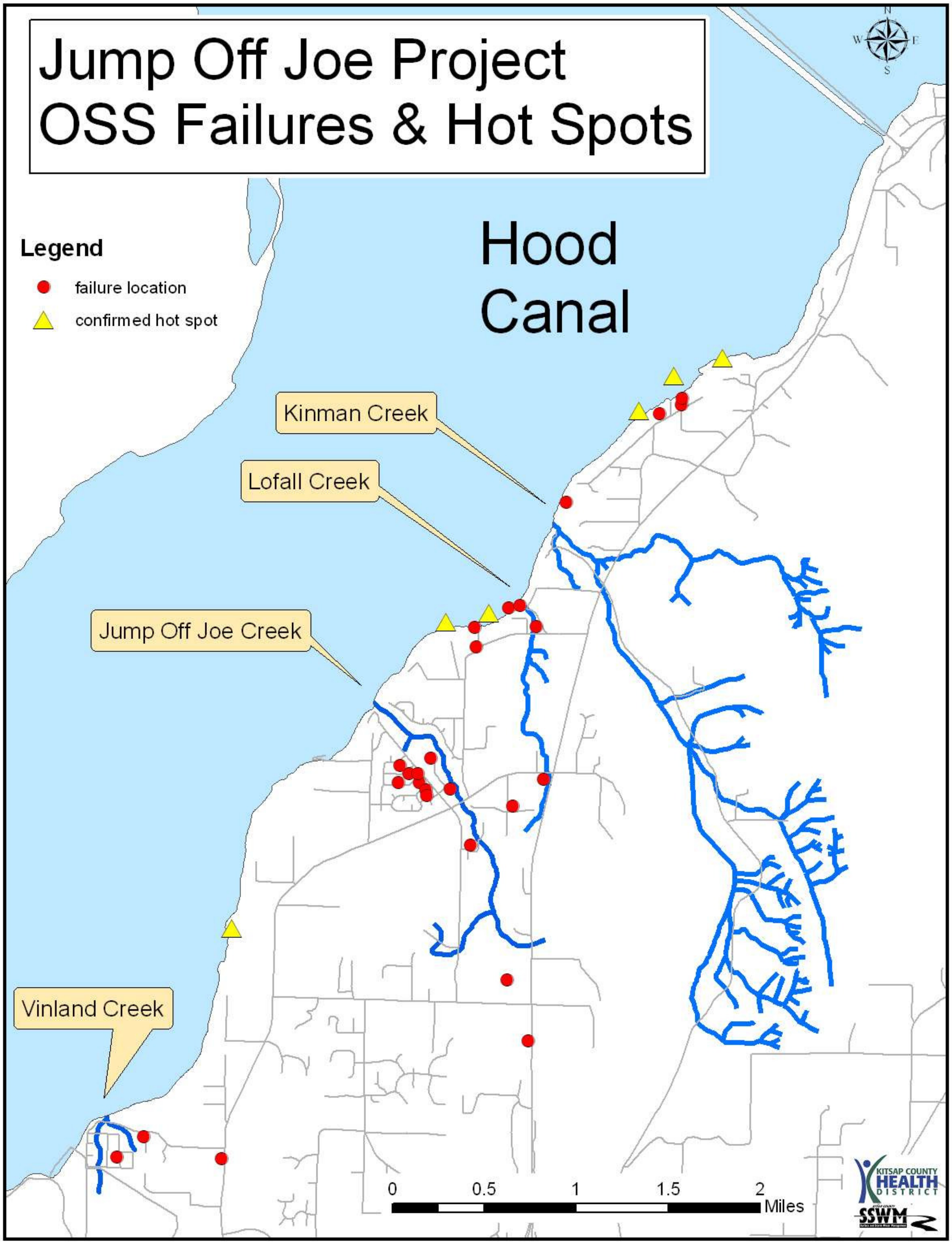
Of the 28 failures identified during the project the most common identifying characteristic was sewage coming to the surface of the ground from the OSS. **Table 3** displays the types of failures observed during the project.

Table 2. Onsite Sewage System Failure Type

Number	Percent of total	Description
13	46	Surfacing on ground
5	18	Discharge to surface water
6	18	Cross connection to drain system
3	11	Discharge to ground surface
1	4	Backing into structure

Twenty six (26) of twenty eight (96%) failing OSS have been repaired: thirteen (48%) were repaired with alternative on-site systems, two (7%) were repaired with standard gravity systems, eight (29%) were repaired with minor repairs, one (4%) was addressed by vacating the structure and two (7%) had a phased repair. Two (7%) of the twenty eight failing OSS are pending repair.

Figure 9. Project Area Failures & Hot Spots



5.1.2 Non-OSS FC Sources

PIC surveys include a non-OSS FC source component for animal, pet and livestock waste. Property owners and residents are asked if they have any animals, how many, and what type. They are asked to see how they manage the animal waste and are advised that state and local regulations require that pet waste not be stored in areas where it may pollute surface or ground water. Drainage patterns and animal wastes are documented and water quality across the property is investigated.

Kitsap County's solid waste regulations require that pet owners pick up pet waste at least weekly, or more often as necessary, double bag, and dispose in a sealed trash container. The Kitsap Peninsula Clean Runoff Collaborative has provided new outreach materials to address the estimated eleven plus tons of dog waste dropped on the Kitsap Peninsula daily. This daily load is consistent with other Puget Sound communities.

The Health District investigates high priority agricultural properties in project areas and works cooperatively with the Kitsap Conservation District (KCD). Landowners are referred to KCD to address water quality violations due to animal waste management.

Water quality monitoring results below agricultural properties in the Jump off Joe watershed have not demonstrated a detrimental effect from farms with horses and cows. While agricultural use exists in the project area, the primary land use is residential. Wildlife can adversely affect water quality by digging latrines, obstructing stormwater conveyances and burrowing into drainfields. Raccoons, mountain beavers and otters exist in the Lofall Creek watershed. Black bears have been sighted along Jump off Joe Creek and deer are present throughout the project area.

5.1.3 OSS Maintenance Requirements

New state and local regulations require that all OSS be properly maintained and monitored. Bremerton-Kitsap County Board of Health Ordinance 1995-14, "Regulations for Operation and Maintenance of On-Site Sewage Treatment Systems" and 2008A – 01, "Onsite Sewage System and General Sanitation Regulations" were applied to OSS problems during this project. All alternative septic systems are required to have ongoing operation and maintenance, and all standard gravity septic systems require tank inspection every three years.

5.1.4 Results of Public Participation in PIC Property Surveys

Table 3 summarizes public participation in the PIC property survey. Ninety four percent (94%) of the homes in the project area were surveyed, 12 (**3%**) were vacant, 4 (1**%**) did not participate, and 7 (**2%**) denied access for inspection. "Did not participate" means that the property owner and/or occupant never responded to Health District attempts to contact them through repeated attempts with door hangers and letters.

Table 3. Summary of Public Participation 2007 – 2011

	Total Properties	Participating Properties	Did Not Participate	Denied Access	Vacant
Project Watershed	427	404	4	7	12
Shoreline	18	18	0	0	0
Upland*	8	8	0	0	0
	453	430	4	7	12

*Upland properties were located in the project watersheds but were not near Vinland, Jump Off Joe, Lofall or Kinman Creeks.

5.2 SHORELINE SURVEYS RESULTS

Shoreline sampling is an effective approach to restore and prevent further downgrades in shellfish growing areas along the Hood Canal Shoreline. Shoreline surveys consist of walking the shoreline at low tide and sampling all discharges to the beach. Sixteen (16) miles of Hood Canal shoreline were surveyed from NBK-Bangor to Driftwood Key, during wet weather and dry weather. A total of 158 initial FC samples and 40 confirmation samples were collected from the Upper Hood Canal Shoreline during the course of the project. Twenty one (21) FC hotspots were identified during the initial survey. Subsequent confirmation sampling confirmed ten of these and identified ten OSS failures. Eight of those failures are corrected, two are in the repair process and one hot spot will require further investigation. Confirmed hot spots with geometric mean values greater than 200 FC/100ml are presented in **Figure 9**.

A dry season shoreline survey along Hood Canal was completed in July and August of 2010 and the wet season survey was completed in February and March of 2011.See **Appendix D** for shoreline survey area results.

Currently, the majority of the Hood Canal shoreline between NBK-Bangor and Driftwood Key is open to shellfish harvest. However, two sections are currently closed to harvest by Washington State DOH due to bacterial pollution: fifty feet north and south of the mouth of Kinman Creek and 300 feet north and south of the mouth of Lofall Creek.

<u>South Shoreline-Naval Base Kitsap-Bangor to Hood Canal Bridge</u>

The eight-mile south section of the project shoreline is predominantly medium bank waterfront with some low and high bank properties. Part of the shoreline is protected by bulkheads or riprap and the remainder is unimproved. Significant sections of the shoreline in this area are stabilized by native vegetation and most of the developed low bank parcels contain grass. Approximately 80% of the shoreline parcels contain structures near the beach.

Eighty initial samples and twenty confirmation samples were collected in this section during the project. Sample results exceeded the FC screening criteria of ≥200/100ml at 10 locations, which is 12.5% of the discharges. Failing OSS were found at three of the hot spots and all three have been repaired.

Central Shoreline-Hood Canal Bridge to Port Gamble

The shoreline from the Hood Canal Bridge to Port Gamble is predominately low bank residential along the western half and undeveloped high bank on the eastern half. Four samples were collected in this area and no hot spots were found.

North Shoreline-Port Gamble to Driftwood Key

The shoreline from Port Gamble to Driftwood Key contains long sections of native vegetation and the residences are set back from the immediate shoreline due to the high bank nature of the coastline. Fifteen discharges were found during shoreline surveys and none of these exceeded the FC screening criteria.

Driftwood Key Shoreline

Driftwood Key is a developed community situated along the northwest shoreline of the Kitsap Peninsula, approximately four miles north of Port Gamble. Marine access has been enhanced for the residents by dredging a harbor. Gradient within the harbor is low, with subsequent accumulation of fine grained sediment. Most of the parcels are developed and the shoreline vegetation is native and planted grasses. Seven discharges to tidewater were found and one of those was > 200FC/100ml. No OSS failures were found at the time of the surveys.

5.3 WATER QUALITY MONITORING

5.3.1 Trend Monitoring Results

Trend monitoring was conducted at four mouth stations and eight upstream stations during the project to evaluate FC contamination in the streams. A summary of the sample results is presented in **Table 4** below.

Table 4. Freshwater Trend Monitoring (FC) Results 11/15/2007 to 9/30/20011

Station	Number of samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >100FC/100ml	% Samples > 100 FC/100ml	Meets FC Standard?
VC01	41	4 – 1601	**99**	20	**49**	NO
VC02	67	2 - 1601	**124**	40	**60**	NO
VC03	36	4 - 1601	**138**	21	**58**	NO
JJ01	46	< 2 – 950	31	12	**26**	NO
JJ02	83	< 2 - 1600	20	13	**16**	NO
LF01	45	50 – 1780	**337**	38	**84**	NO
LF01B	29	2 - >=2000	60	10	**34**	NO
LF02	33	30 - >=2000	**382**	30	**91**	NO
KN01	45	2 – 900	**61**	20	**44**	NO
KN02	34	< 2 - 900	55	13	**38**	NO
KN03	34	< 2 - 310	36	10	**29**	NO
KN04	34	< 2 - 1600	16	4	**12**	NO

VC01 – Vinland Creek mouth station

J01 –Jump off Joe Creek mouth station

LF01 – Lofall Creek mouth station

KN01 – Kinman Creek mouth station

[1] Extraordinary Primary Use Category. FC levels shall not exceed a GMV of 50 FC/100 ml and not have more than 10% of all samples exceed 100 FC/100 ml.
Bold entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)

Table 5. GMV by Water Year Summary Table*

	Geomean			
Water Year	**Vinland**	**JOJ**	**Lofall**	**Kinman**
2005	----	46	65	119
2006	----	50	132	42
2007	----	43	523	41
2008	118	17	360	28
2009	89	29	414	53
2010	90	32	469	72
2011	89	41	243	119

*Results are for stream mouth stations

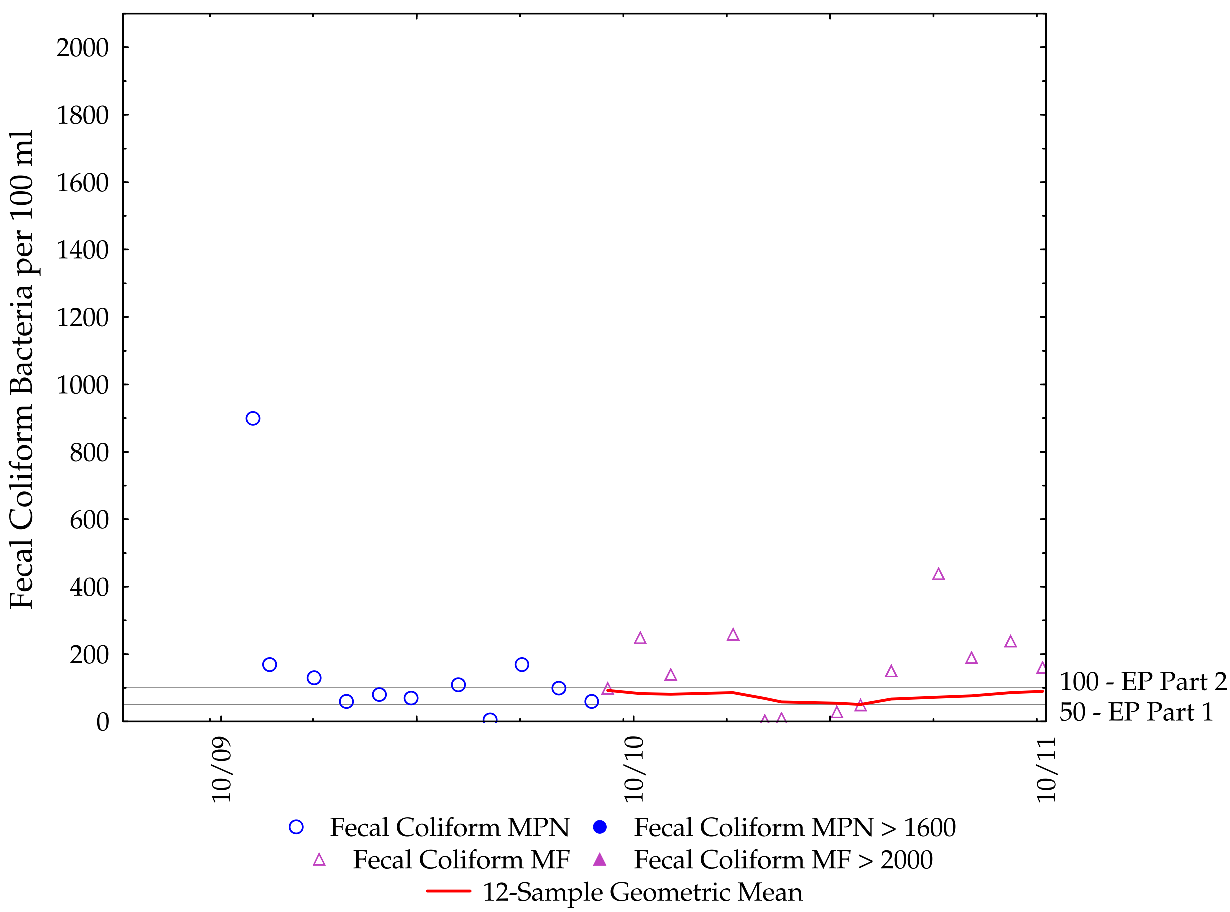
Additional stream mouth station water quality information is presented in **Appendix E**.

5.3.2 Trend Analysis

Statistical analysis of FC data was performed at the mouth stations of Vinland, Jump off Joe, Lofall and Kinman Creeks. **Figures 10, 11, 12 and 13**, present summaries of the trend results. Kendall seasonal statistical data is available in **Appendix F**.

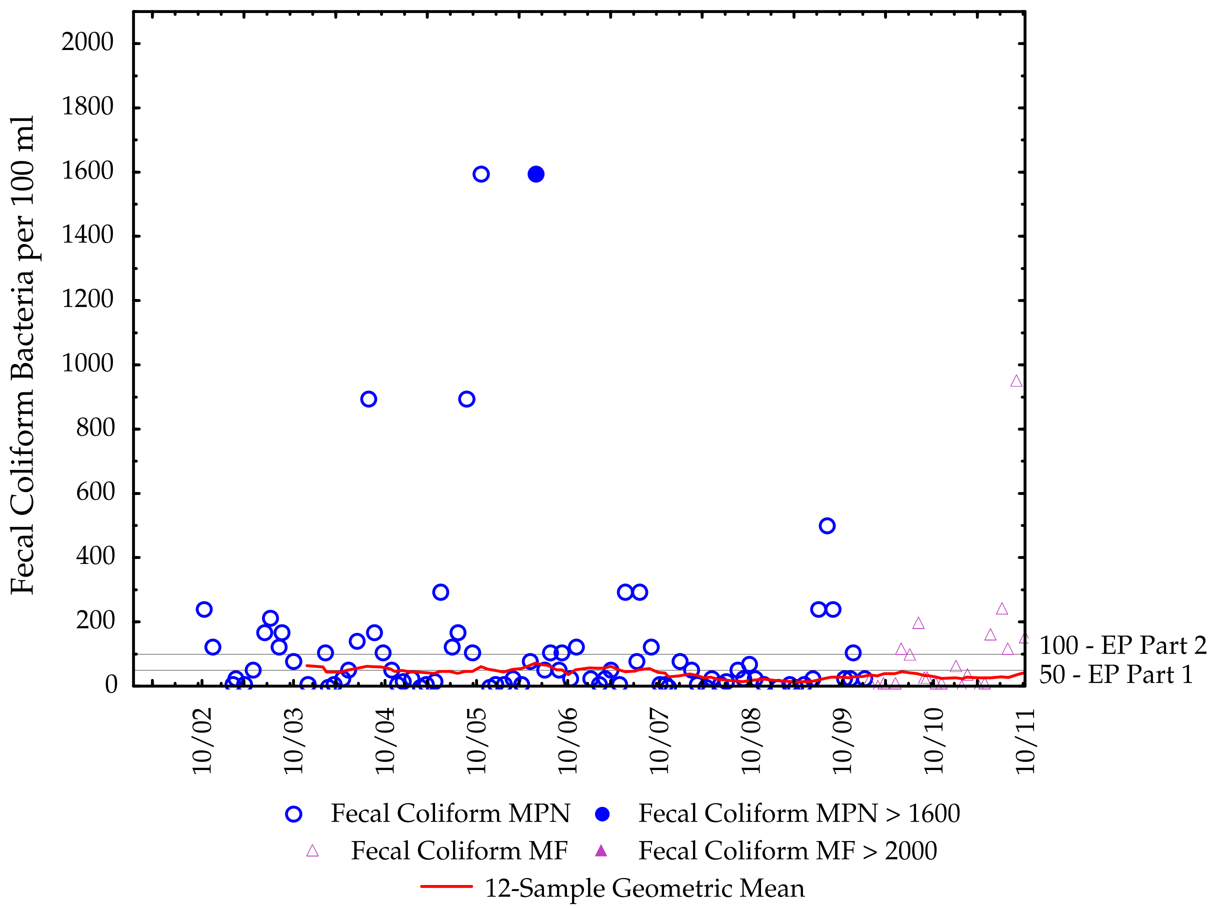
Intensive monthly sampling of Vinland Creek started in October 2009, when it was included in the expanded project area. Currently, with a geometric mean value (GMV) of 89 FC/100ml, FC levels in the stream do not meet the water quality standard of 50FC/100ml. This is despite the fact that two failing OSS have been identified and repaired and all of the residents in the watershed have been educated about maintaining their OSS. The east fork of Vinland Creek has a healthy riparian corridor and FC levels are generally lower than the west fork, which is bordered by residential properties. Pets have access to the stream at several properties near the mouth and this could be adversely affecting water quality. Outdoor feeding of pets and wildlife attracts animals and may be a factor as well. The average age of the homes in the neighborhood is 29 years, and the average OSS lifespan is 30 years. Consequently, some OSS may be in a state of failure but are not being detected by currently available methods.

Figure 10. Fecal Coliform Bacteria Trend Analysis Vinland Creek (Station VC01), 2009 – 2011



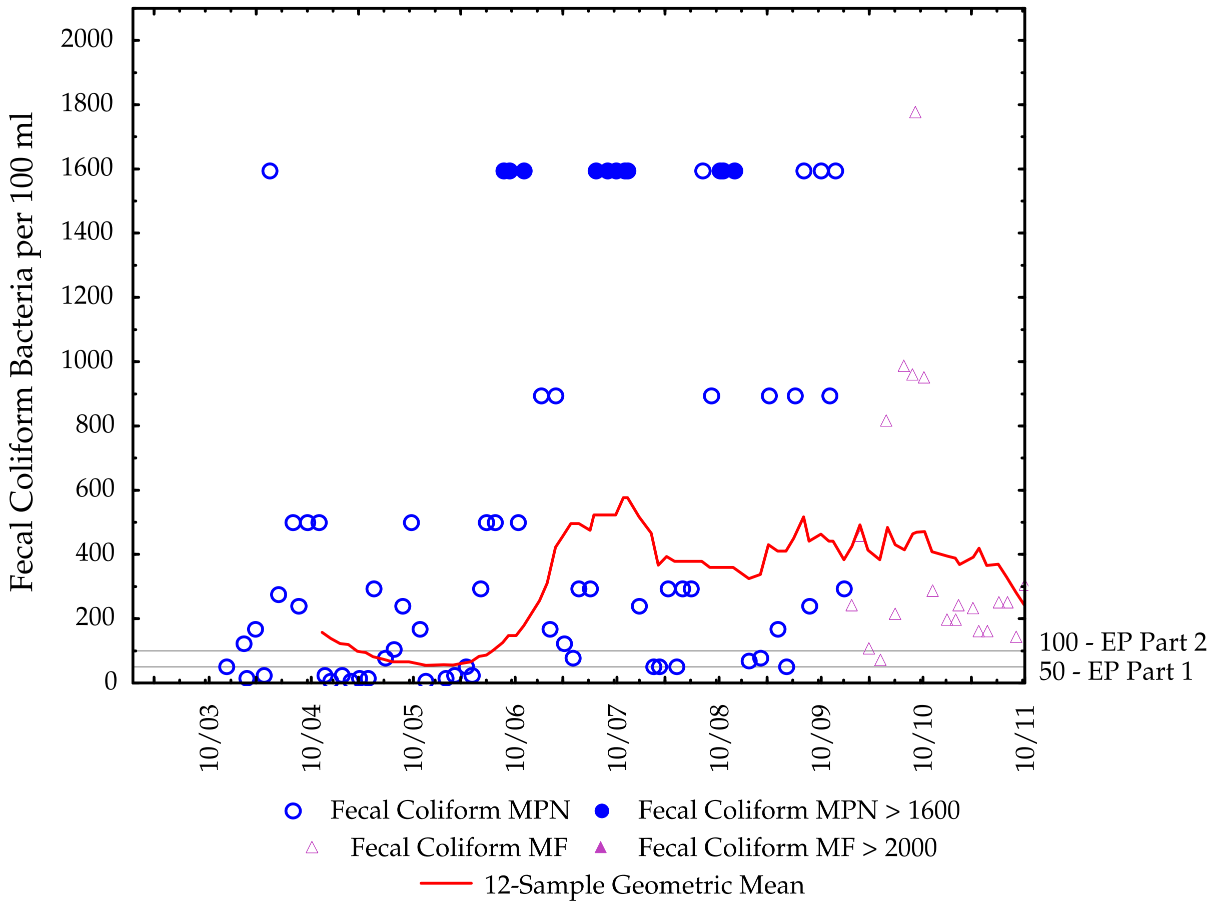
The short term trend FC concentration in Vinland Creek is stationary. The GMV concentration for the 2007 water year was 118 FC/100ml and 89 FC/100ml in 2011.

Figure 11. Fecal Coliform Bacteria Trend Analysis
Jump off Joe Creek (Station JJ01), 2002 - 2011



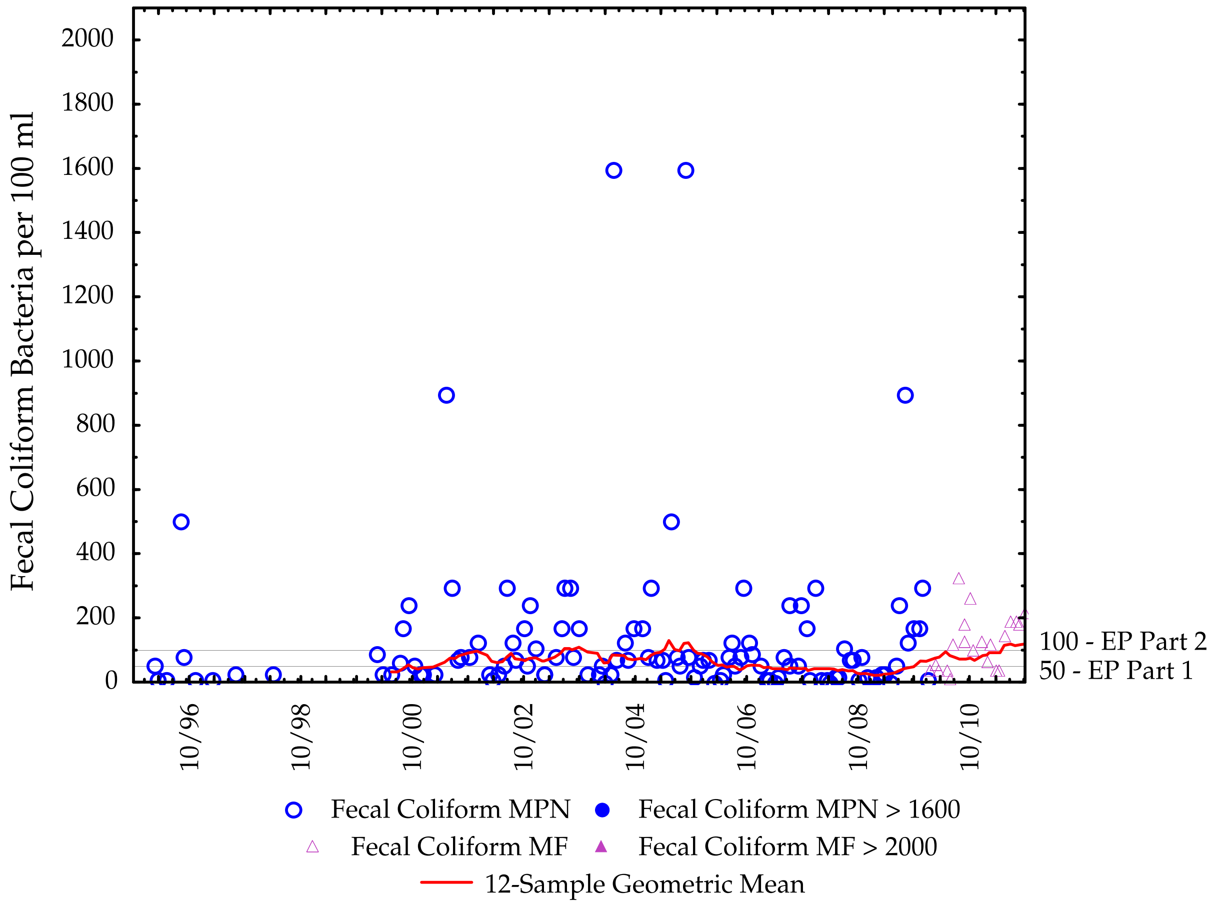
Water quality in Jump off Joe Creek is good, with both short (3 year) and long (5+years) term trends stationary. The stream met Part 1 of the state FC standard in 2011.

Figure 12. Fecal Coliform Bacteria Trend Analysis
Lofall Creek (Station LF01), 2002 - 2011



Water quality in Lofall Creek is poor and the stream is posted with a no-contact public health advisory. The long term statistical trend is increasing and the three year average is stationary. However, water quality substantially improved from 2010 to 2011 with the GMV dropping from 469 to 243 respectively. Land use in the creek drainage is rural residential and agricultural. Vegetative cover includes residential grass, pasture and forest. Deer, bears, raccoons, rodents and pets are present and may impact FC levels in the stream. The Lofall community has been in existence since the early 20th century and development over the years has created an interwoven stormwater and OSS network underground. The potential for cross-connection, crushing, slumping, sagging, settling and breakage of these conveyance systems is high. Three failing OSS have been found and repaired and the Health District has dye tested all 33 of the residences near Lofall Creek.

**Figure 13. Fecal Coliform Bacteria Trend Analysis
Kinman Creek (Station KN01), 1996 - 2011**



The long term FC trend in Kinman Creek has been stationary but the three year trend suggests worsening water quality. Land use in the Kinman Creek drainage is a combination of rural residential and agricultural. Wildlife and pets are present and home ages range from five to 127 years. The Health District has interviewed all residents near the stream in the lower part of the drainage but no failing OSS have been found.

A comparison of wet season and dry season GMVs showed that FC concentrations are significantly higher during the dry season than during the wet season. Possible explanations are that higher flows dilute the FC levels in the winter and some residents spend their winters out of state.

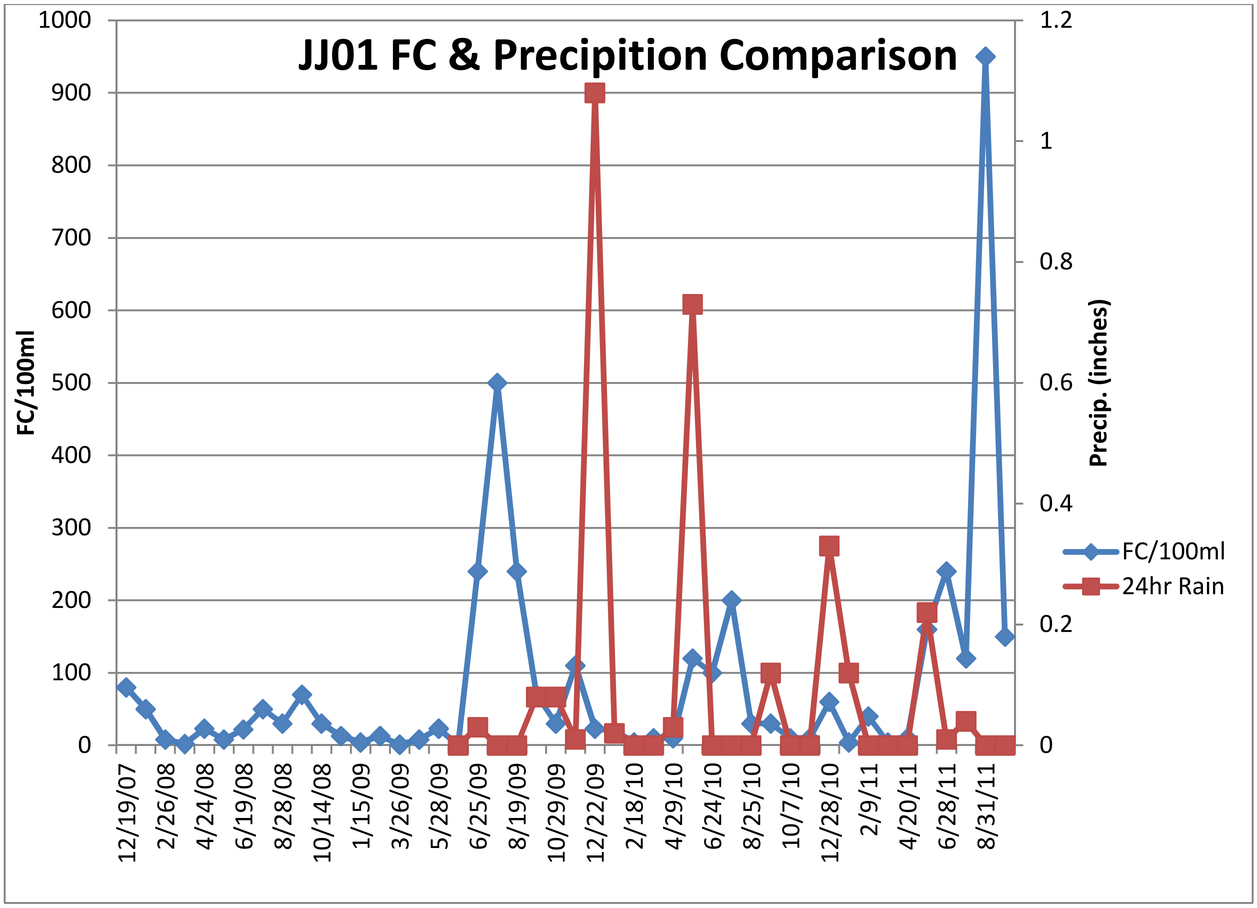
5.3.3 Trend FC and Rainfall Correlations

Trend monitoring data was analyzed for correlation of FC and previous 24-hour rainfall depths using the Pearson correlation coefficient value. Precipitation and FC data at stream mouth trend stations was available for the period June 25, 2009 to September 28, 2011. Precipitation was measured by Kitsap County Public Utility District (KPUD) #1 at the Edgewater Industrial Park, which is within one half mile of Jump off Joe Creek. Due to the rain shadowing effect of the Olympic Mountain range, the project area receives less rainfall than Silverdale, Bremerton and the western part of Kitsap County.

It is widely accepted that there is a direct relationship between an increase rainfall and an increase in stream discharge, but the relationship between increased rainfall and FC concentration in streams is not as straightforward. An analysis of the data collected by KPUD and the Health District during the project suggests that an increase in precipitation often resulted in a decrease in FC concentration. Although not always the case, this trend was verified most of the time. With a fixed FC pollution source and an increase in stream volume from precipitation, then a decrease in FC concentration in the streams is expected through dilution. Another trend noted was that FC concentrations can increase in streams after a rain event if the rain event follows a significant period of dry weather. One explanation for this observation is that contaminants which have been sitting on the ground are not being gradually transported to the streams over a period of time but are flushed into the streams with a significant rain event, or onset of the rainy season. **Figure 14** presents the relationship between precipitation and FC concentrations in Jump off Joe Creek at trend mouth station JJ01. Charts of the results for Vinland, Kinman and Lofall Creeks can be viewed in **Appendix G.**

Correlation coefficients were calculated for each stream to see if there is a mathematical relationship between FC concentration (the dependent variable Y) and rainfall (the independent variable X). There was a negative correlation between X and Y, meaning that as X (rainfall) increases, Y (FC concentration) decreases, for Jump off Joe and Kinman Creeks. The correlation was inconsistent for Lofall and Vinland Creeks. The correlation coefficients are listed in **Appendix G**.

Figure 14. JJ01 FC & Precipitation Comparison



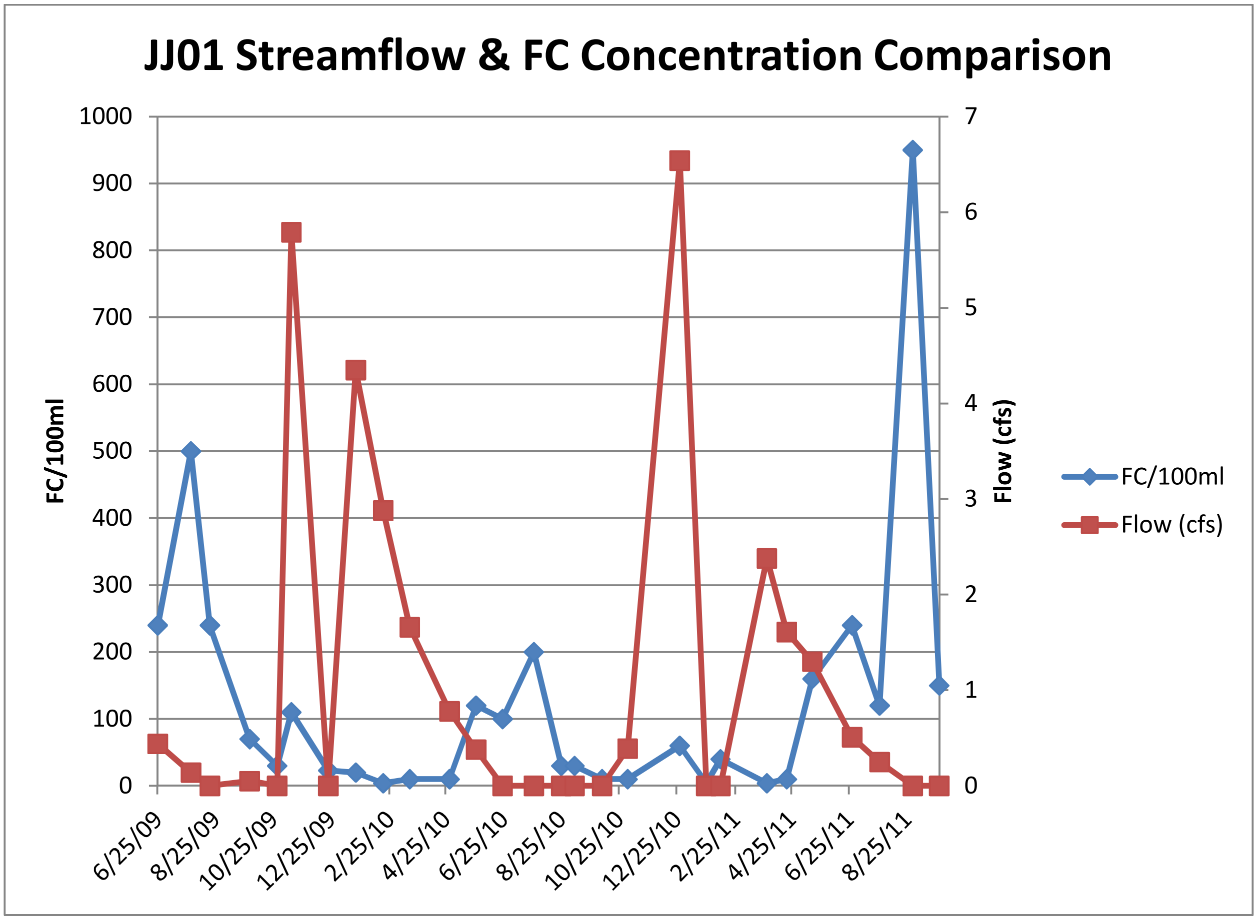
5.3.4 Stream Discharge and FC Concentration Analysis

Stream discharge at the mouth stations of Jump off Joe, Lofall and Kinman Creeks was measured by hydrologist Jim LeCuyer at KPUD from June 2009 to August 2011. Flow measurements were made with a Swoffer Velocity Meter and/or using the Bucket and Stop Watch method. Reported flows of <1cfs should be considered 'best available estimates' due to insufficient depth and velocity of water in measured cross section. Width of measured cross sections was in many cases insufficient to make enough subsections to make flow from each subsection 10% or less of total flow. Flows made with the Bucket and Stop Watch method are considered reasonably accurate.

Stream discharge and precipitation depth are closely related, with an increase in precipitation causing an increase in streamflow (discharge). The relationship is not absolutely linear however, because precipitation can be attenuated by interception, infiltration and vegetative cover. Impervious surfaces and development can act as a collection and conveyance system and increase streamflow.

Data collected during the project supports the theory that increased stream discharge has an inverse relationship to FC concentration. Stream flow and FC concentration recorded during the project are presented below for Jump off Joe Creek and in **Appendix I** for Lofall and Kinman Creeks. Insufficient flow data was available to compare discharge and FC concentrations in Vinland Creek.

Figure 15. JJ01 Streamflow & FC Concentration



5.3.5 Stormwater Monitoring Results

FC and total suspended solid (TSS) samples were collected during five storm events between November 2008 and May 2009 in the Jump off Joe watershed. Previous PIC projects in Kitsap County have found that storm events often cause an increase in FC concentrations in streams. This pattern was observed during the wet season storm events sampled for the project but not during the dry season. Stream response to FC concentrations during storm events is complex. Heavy rain events can transport contaminants that have accumulated on the ground during days and weeks of light precipitation and can mobilize pollution sources such as failing OSS by saturating the ground. Conversely, increased precipitation results in increased streamflow which causes dilution. Forest, natural vegetation and bioretention structures tend to attenuate flows and reduce peaks in FC levels observed in streams during storm events, while impervious surfaces collect and increase streamflows. A rapid response to rain events was observed at sampling stations near impervious surfaces during the project.

Field observations and TSS results showed that turbidity and sediment transport increase during storm events. Increased flow allows more particle suspension, catchbasin scour and erosion. Mobilization of catchbasin sediment during storm events contributes to decreased water quality during storm events by resuspension of FC bacteria bound to sediment particles (May and Cullinan, 2005). The highest turbidity was recorded at station JJ02S2 which drains a road shoulder. This station also had high FC concentrations during storm events. Very high FC levels were recorded at station JJ01A which originates in a roadside ditch in a residential area. The PIC process was applied by Health District staff and several failing OSS upstream of this station were found and repaired. FC levels at JJ01A subsequently dropped to the levels similar to other monitoring stations on Jump off Joe Creek. **Table 6** presents the results of FC and TSS sampling during storm events.

Table 6. FC & TSS Results During Storm Events

Jump off Joe Creek Stormwater Monitoring Results

Date	Station	Precipitation* (inches)	FC/100ml	TSS (mg/L)
11/6/2008	JJ01	0.71	900	23
	JJ01A		1600	25
	JJ02S2		140	69
	JJ03S4		<2	15
	JJ03S5		170	52
12/12/2008	JJ01	0.37	50	7
	JJ01A		1600	37
	JJ02S2		240	130
	JJ03S4		2	35
	JJ03S5		8	22
2/24/2009	JJ01	0.26	80	17
	JJ01A		170	<4
	JJ02S2		----	----
	JJ03S4		110	56
	JJ03S5		23	23
5/6/2009	JJ01	0.81	30	<4
	JJ01A		50	<4
	JJ02S2		170	30
	JJ03S4		2	7
	JJ03S5		<2	11
5/14/2009	JJ01	0.34	30	5
	JJ01A		80	<4
	JJ02S2		240	5
	JJ03S4		<2	<4
	JJ03S5		<2	<4

Station	Description
JJ01	Jump off Joe Creek
JJ01A	24" corrugated metal pipe draining roadside ditch
JJ02S2	Sluiceway draining road shoulder
JJ03S4	Type 1 stormdrain in parking lot
JJ03S5	Parking lot discharge to conveyance system

*Precipitation recorded during the storm event at KPUD rain gage #1

5.3.6 Nutrient Evaluation

Nitrate + Nitrite-nitrogen, ammonia and orthophosphate were measured monthly at stream mouth stations from November 8, 2008 to September 28, 2011 to determine if FC source corrections resulted in nutrient reduction in the project streams. Previous Health District studies evaluating FC hot spots and nutrient reduction were targeted for OSS shoreline failure sites where a nearby similar clean drainage system could be compared to the contaminated drainage. This method was not applicable to the OSS failures identified in the Jump off Joe drainage because the failures were primarily found in residential upland neighborhoods that did not have a direct connection to surface water.

In previous before and after correction nutrient studies, drainages with failing OSS showed elevated nitrate+nitrite nitrogen, ammonia nitrogen or ortho-phosphate concentrations compared to control discharges before OSS correction. Failing OSS may contribute nitrogen in the form of nitrate+nitrite or ammonia nitrogen, and ortho-phosphate depending upon the mechanism of the failing OSS.

High ammonia nitrogen levels indicate incomplete nitrification of septic tank effluent. In the Upper Hood Canal project this was caused by sewage surfacing at the tank due to hydraulic overloading, plugged drainfields, and/or groundwater intrusion into the tank. At sites where high FC and nitrate+nitrite nitrogen levels were measured, OSS direct discharges were found due to limited vertical separation and horizontal setback to the shoreline. A broken well overflow at one site carried incompletely treated drainfield effluent to the shoreline.

The nutrient and FC data from mouth stations were analyzed over the course of the project to determine if corrective measures in the watershed improved water quality at the marine/fresh water interface. Salinity was measured concurrently with nutrients and did not influence nutrient results. The seasonal Kendall statistical method was used to plot nutrient data trends over time and determine if there was a statistically significant change. Although graphical representation of the results shows a decrease in FC at Lofall Creek and a decrease in ammonia at Jump off Joe Creek, the only statistically significant result noted was the decrease in ammonia concentrations at the mouth station of Kinman Creek, with a p-value of 0.0389 at the 95% confidence level. Data and graphs of the Kendall method are available in **Appendix J**.

The Center for Watershed Protection's Illicit Discharge Detection and Elimination guidance manual notes that ammonia is a parameter that has been used by some communities with sewage contamination issues. An ammonia concentration greater than 1 mg/L is generally considered to be a positive indicator of sewage contamination. Ammonia concentrations at the stream months were very low, ranging from <.01 to .12 mg/L. Average values are .027 for Jump Off Joe Creek , .022 for Kinman Creek, .030 for Lofall Creek, and .034 for Vinland Creek.

Nitrate+nitrite concentrations were also low, ranging from <.01 to 3.25 mg/L. Average values are 1.721 for Jump Off Joe Creek, 1.227 for Kinman Creek, 1.928 for Lofall Creek, and 2.215 for Vinland Creek.

6.0 CONCLUSIONS

The goals of the Jump off Joe Creek Restoration Project have been achieved:

- FC concentrations in Jump off Joe and Vinland Creeks have been reduced. The shellfish closure zone around the mouth of Jump off Joe Creek was removed in 2009 as a result of water quality improvements. The Health District expects to see more improvements after follow-up work is completed. Unfortunately, those improvements may be masked by new FC sources.

- Completed 430 property surveys, nearly forty percent more than the 270 committed to in the grant agreement.

- 94% of the OSS in the project area were inspected which exceeds the project requirement of 65%. The uninspected parcels were not streamside or within shoreline "hotspot" drainages and were not inspected because the occupants did not respond to repeated contact attempts.

- 100% of the failing OSS were corrected or are in the correction process and are scheduled for repair in summer 2012.

- Shoreline surveys were an effective method of finding OSS failures. OSS inspections and water quality monitoring activities are effective in the wet season to find OSS failures caused by surface or ground water intrusion. Dry season inspections and monitoring are effective to find OSS failures that are masked by storm water or are only occupied in the summer.

- Non-point pollution is best addressed by visiting as many watershed residents as possible. Door-to-door surveys are an excellent way to get site-specific information on local water quality problems and how to reduce bacterial and nutrient pollution sources.

- Analysis of wet and dry season monitoring indicates that FC levels are significantly higher during the dry season then during the wet season in various drainages. Decreased stream flow and external sources such as runoff from impervious surfaces may contribute to higher bacteria levels during dry weather.

- It is difficult to meet the extraordinary primary FC standard that applies in this watershed. This is particularly difficult in this large watershed with dense housing pockets, old storm water drains, and discharges buried in the beach.

- This watershed will need an ongoing effort to protect water quality because many of the OSS are well past the average functional lifespan of approximately 30 years. Older OSS were designed through percolation tests and are designed for disposal rather than effluent treatment.

7.0 RECOMMENDATIONS

The following recommendations are presented as a result of interaction with homeowners, experience gained, and evaluation of sample results from the Jump off Joe Restoration Project:

- Complete correction of the remaining OSS failures and investigate remaining FC hotspots found through the Upper Hood Canal shoreline survey.
- Continue to track water quality trend data at mouth stations for post-corrective analysis and long-term correction. The Health District's annual project area ranking process automatically assesses water quality for FC problem areas. These are ranked by KCSSWM partners and guide program activities.
- Share project results with DOH's shoreline survey program to remove closure zones from areas established around OSS failure zones.
- Pursue funding to conduct future shoreline surveys to protect shellfish growing areas and continue to maintain other improvements gained by the project. Proactively promote water quality in the community at outreach events.
- Continue the strong partnership with DOH, Ecology and other water quality agencies to coordinate, assess and implement ongoing water quality restoration and protection tasks. Communicate significant water quality issues with DOH, Ecology and other appropriate agencies.
- Continue to seek technology and methods to better identify and correct FC pollution sources.
- Research potential methods to better build public trust, by actively working to provide accurate and representative data upon which to base regulation and legislation.
- Recommended follow-up work will be conducted through ongoing KCSSWM funding. The trend monitoring program, public water quality complaint process, and tank inspection deficiency reporting process, will provide continued follow-up for problems in the area.

8.0 REFERENCES

Kitsap County Board of Health Ordinance No. 2008A-01, "Rules and Regulations Governing On-Site Sewage Systems." 2008.

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APPENDIX A

TREND PLAN

WATER QUALITY TREND MONITORING PLAN, STREAMS AND MARINE WATERS

Kitsap County Health District
Water Quality Program

Revised March, 2010

KITSAP COUNTY HEALTH DISTRICT

SSWM KITSAP COUNTY Surface and Storm Water Management

TABLE OF CONTENTS

(The Appendices listed above are not included with this document, but are available upon request.)

1. Introduction

The purpose of the Water Quality Trend Monitoring Plan, Streams and Marine Waters (plan) is to determine ongoing, long-term water quality trends for marine waters and streams in Kitsap County. This plan details the goals, objectives, and methodologies of the trend monitoring program and serves as a guide to Health District monitoring staff. As needed, this plan will be reviewed and amended in response to changes in monitoring goals, objectives, and practices.

Consistent with the Health District's mission, the primary focus of this monitoring program is assessing long-term trends in parameters associated with human sewage and animal waste from nonpoint pollution sources. The Health District assesses water quality trends by analyzing bacteria data from streams, lakes, and marine waters throughout Kitsap County. Fecal coliform bacteria are used as an indicator organism in streams and marine water, and levels of E. coli are used for lakes.

In addition to the bacterial data, basic water chemistry parameters (temperature, dissolved oxygen, pH) have been measured at some stations over time. This monitoring data is available to the Kitsap County Surface and Storm Water Management Program (SSWM), residents of Kitsap County, and staff from other local, state, and tribal water quality programs.

Because Kitsap County municipalities do not participate in the SSWM Program, no data is collected on Bainbridge Island or from surface waters exclusively within the jurisdiction of a municipality. Additionally, stormwater monitoring is the responsibility of the Kitsap County Department of Public Works and is *not* addressed in this plan. Coordination with these agencies occurs to the extent necessary to meet the goals and objectives stated in this plan and in the SSWM Program scope of work. Groundwater monitoring is also *not* included in this plan. The Health District's lake monitoring activities are discussed in a separate plan.

In Kitsap County, as elsewhere, surface water quality provides an early warning in determining whether development, land uses, and other human activities are being managed to effectively protect public health and the environment. Because County streams are relatively small, pollution impacts manifest themselves more readily, and damage occurs more quickly. Because all County streams discharge to the marine waters of either Puget Sound or Hood Canal, polluted streams have the potential to impact nearshore marine areas as well.

The major types, and sources, of pollution affecting Kitsap County's surface waters and their resources are:

- Human Sewage and Animal Waste from failing on-site sewage systems, inadequate livestock keeping practices, pet and wildlife waste, combined sewer overflows, inadequate community wastewater treatment systems, sewage spills from municipal wastewater treatment plants and sewage collection systems, and sewage discharges from boats. Assessing trends associated with this pollution source is the primary focus of the program.

- Sedimentation and soil erosion from improper land clearing and logging activities, poor construction practices, inadequate livestock keeping practices, insufficient stream buffers and storm water control/treatment, wetlands elimination, and the re-channeling and culverting of natural streams. Assessing trends associated with this pollution source is *not* the primary focus of the program.

- Toxic chemicals and metals from industrial and military wastewater and storm water discharges, urban storm water runoff, closed or abandoned landfill sites, and the illegal dumping or mismanagement of solid and hazardous wastes. Due to funding constraints and the overlap with other local, state, and federal monitoring efforts in this area, these pollution sources are not typically monitored or assessed under this program.

This plan does not address monitoring conducted by the Health District for the following programs:

- Pollution Identification and Correction Program.
- Recreational Shellfish Program.
- Swimming Beach (Lake) Monitoring Program.
- All Other Water Quality Monitoring Projects.

Monitoring plans for these programs are discussed in separate Health District documents.

2. Monitoring Goals and Objectives

The goals and objectives of the monitoring program are provided below.

2.A. Monitoring Goals

The goal of this program is to develop and implement a comprehensive, County-wide, water quality monitoring plan that will:

- Protect and preserve public health and the environment;
- Identify and correct sources of water pollution caused by human sewage and animal waste;
- Inform and educate the public, private industry, and governmental agencies on specific Kitsap County surface water quality issues;

- Provide the public, private industry, and governmental agencies with current surface water quality information in a timely and effective manner; and
- Promote stewardship of the County's waterways and their respective resources.

2.B. Monitoring Objectives

The objectives of the monitoring program are:

- Implement a long-term monitoring program to measure, assess, and characterize surface water quality trends in Kitsap County with the primary focus on the impacts caused by human sewage and animal waste pollution;
- Compare and assess surface water quality results to applicable surface quality standards, criteria, and guidelines with the primary focus on the impacts caused by human sewage and animal waste pollution;
- Provide monitoring data to prioritize nonpoint pollution problem areas in Kitsap County for Health District pollution source investigation and correction efforts;
- Identify specific surface water public health concerns based on the assessment of monitoring results and trends;
- Provide the public with specific health advisory information related to surface water and shellfish tissue quality through the local press, signage, Internet home page, public presentations, and the Health District's 1-800-2BE-WELL hotline number;
- Provide data and comment to SSWM and the State Department of Ecology to evaluate waterbodies included on the state's Clean Water Act Section 303(d) List for bacterial contamination, i.e., specifically compare fecal coliform bacteria results against the state standard for this parameter;
- Provide data and comment to the State Department of Health and SSWM to justify the upgrade, or prevent the downgrade, of commercial or recreational shellfish areas as applicable; and
- Provide surface water information to SSWM, the public, or other private or governmental entities by responding to data requests and by preparing summary reports.

3. Water Quality Standards and Criteria

The Washington State Department of Ecology (Ecology) establishes surface water quality standards in Chapter 173-201A Washington Administrative Code (WAC). The Health District continues to compare monitoring results against the current Washington State water quality standards, as amended.

Surface waters in Kitsap County are designated in the WAC as either Primary or Extraordinary Primary waters. Both earn this designation by markedly and uniformly exceeding established criteria related to watershed use and water quality. Applicable surface water quality standards are summarized in **Table 1**.

TABLE 1
Surface Water Quality Standards and Related Criteria

Parameter	**Freshwater Standard**		**Marine Water Standard**	
	Extraordinary Primary	**Primary**	**Extraordinary Primary**	**Primary**
Fecal Coliform Bacteria (FC)	Part 1: ≤50 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >100 FC/100 mL.	Part 1: ≤100 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >200 FC/100 mL.	Part 1: ≤14 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >43 FC/100 mL.	Part 1: ≤14 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >43 FC/100 mL.
E. Coli Bacteria	≤126 organisms/100 mL (geomean)[1]		None	None
Dissolved Oxygen	> 9.5 mg/L	> 8.0 mg/L	> 7.0 mg/L	> 6.0 mg/L
pH	6.5 – 8.5 units	6.5 – 8.5 units	7.0 – 8.5 units	7.0 – 8.5 units
Temperature	16.0° C[2]	18.0° C[2]	13.0° C[2]	16.0° C[2]
Turbidity	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU

1 U.S. EPA criterion (U.S. EPA 1986A).

2 Shall not exceed standard due to *human activities*. When natural conditions exceed these standards, no human caused temperature increases are allowed which will raise the receiving water temperature by greater than 0.3° C.

The temperature standard in WAC 173-201A can only be *violated* as a result of human activities. However, the highest temperature in the temperature standard "range" is often *exceeded* as a result of natural conditions. Likewise, dissolved oxygen and pH levels may also exceed the range established in the standards as a result of natural conditions.

The turbidity standard in Chapter 173-201A WAC for freshwater and marine water states that turbidity shall not exceed five (5) nephelometric turbidity units (NTU) over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU. Since no background samples are collected as part of this monitoring program, Health District turbidity data cannot be compared to this standard. Starting in the 2006 water year, the Health District no longer routinely collected turbidity data for Kitsap County streams and marine waters.

4. Monitoring Strategy

A ***stratified random sampling*** strategy is used to determine current conditions and track long-term water quality trends.

Stratified random sampling involves some limited grouping of the population of interest, and then randomly sampling each group or stratum. This type of approach is often used in water quality sampling because certain parameters are known to vary by the time of day, season, precipitation levels and duration, or some other factor(s). The advantages of a stratified random sampling strategy include (MacDonald, 1991; Journel, 1989):

- Improves the efficiency of sampling;
- Provides separate data (i.e., data collected during different times, seasons, and weather conditions) on each stratum (or matrix); and
- Enhances the sensitivity of future statistical tests by separating the variability among the strata (e.g., station locations, surrounding land uses, etc.) from variability within the strata (e.g., season, time of day, tide cycle, precipitation conditions, etc).

A stratified random sampling approach is employed by both the Washington State Department of Health (DOH) Shellfish Program in their classification of commercial and recreational shellfish areas, and Ecology's Environmental Investigations and Laboratory Services Program for their ambient marine water monitoring for the Puget Sound Ambient Monitoring Program (PSAMP).

Both stream and marine water stations are typically monitored monthly to provide a base of continuous, widespread, long-term water quality monitoring results for Kitsap County. Monitoring results provide a basis for determining the following:

- Compliance with the state surface water quality standards (Chapter 173-201A WAC), National Shellfish Sanitation Program surface water criteria, and other applicable standards, criteria, or guidelines where applicable;
- Classification on the State's 305(b) and 303(d) Lists;
- Temporal changes and spatial differences in water quality between offshore and nearshore sampling locations, and between urbanized and rural based watersheds or waterbodies;
- Annual, seasonal, and rainfall related variability of marine water and stream quality;
- Changing water quality conditions and emerging problems or improvements; and
- Relationships with spatial patterns and temporal trends from other monitoring programs (i.e., DOH Shellfish Program, PSAMP, etc.).

Fecal coliform samples are analyzed at the Health District contracted laboratory, which is accredited by the Department of Ecology. Data on basic water chemistry parameters (temperature, dissolved oxygen, pH) may be collected in the field through the use of electronic monitoring equipment (Hydrolab® or YSI units). Weather and tidal information are collected through the use of published information and access to Internet sites. Rainfall data for Kitsap County is provided by the Kitsap Public Utility District #1. If necessary, targeted parameters that cannot be analyzed by the Health District contract laboratory are sent to other Department of Ecology accredited laboratories. All applicable Puget Sound Estuary Program protocols and methods are followed.

5. Monitoring Parameters

The parameters monitored and analyzed under the marine and stream monitoring component include the following:

- Biological: Fecal coliform and E.Coli bacteria (E.Coli - lakes only).
- Conventional: Temperature, pH, conductivity, and dissolved oxygen (stream). Temperature and salinity (marine).
- Environmental: Rainfall amounts and tidal conditions.

5.A. Biological

The analysis for fecal coliform bacteria is the Health District's primary indicator of nonpoint pollution when evaluating surface water quality. The sample is collected in a 100 mL sterile water bottle, stored at 4^0C, and transported to the Health District laboratory for analysis.

The Health District laboratory has used the multiple-tube fermentation technique, also called the Most Probable Number (MPN) method, of fecal coliform analysis for surface water samples for samples collected prior to January, 2010. This analysis followed Fecal Coliform Procedure 9221-E, "Fecal Coliform Direct Test (A-1 Medium)", described in Standard Methods for the Examination of Water and Wastewater (APHA, 1998). This method of fecal coliform analysis uses dilutions of the water sample to obtain statistically valid MPN estimates of fecal coliform densities through gas production in the incubated samples.

As of January 4, 2010, the District switched to using the membrane filter (MF) method to analyze for fecal coliform. (Method 9222D) This change was made for the following reasons:

- Increases capacity of our contract laboratory to analyze fecal bacteria samples.
- This method gives a more accurate count of fecal colonies in the sample than MPN.
- The MF method costs less per sample which will save the District around $4600/year.
- The MF method is more environmentally friendly, producing less laboratory waste.

5.B. Conventional

Conventional parameters may be measured in the field using an electronic multi-probe sensor, such as Hydrolab® or YSI. Conventional data consist of temperature, pH, conductivity, salinity, and dissolved oxygen. This type of data was collected at stream stations during trend monitoring events through September 2008. Temperature and salinity continue to be collected for marine stations.

5.C. Environmental

Environmental parameters are collected from outside data sources to assess weather and tidal characteristics that can influence water quality. These conditions are reviewed when conducting water quality data analyses.

In summary, the parameters, analytical procedures, method detection limits, and method accuracies are summarized in **Table 2** below.

TABLE 2
Analysis Methods, Detection Limits, and Accuracy

Parameter	Method of Analysis	Method Detection Limits	Accuracy
Fecal Coliform Bacteria (prior to 1/4/2010)	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	2 to 1,600 col/100 mL (without dilution)	1 col/100 mL
Fecal Coliform Bacteria (after 1/4/2010)	APHA Procedure 9222-D, Fecal Coliform Membrane Filter	1 to 200 col/100ml (without dilution)	1 coliform/100 mL
Temperature	Field Meter: Hydrolab Model MS5, EPA Method 170.1	-5 to 50^{o} C	$\pm$ 0.1^{o} C
pH	Field Meter: Hydrolab Model MS5, EPA method 150.1	0 to 14 units	$\pm$ 0.2 units
Dissolved oxygen (luminescent)	Field Meter: Hydrolab Model MS5 , Hach Method 10360	0 to 20 mg/L	$\pm$ 0.1 mg/L (<8.0) $\pm$ 0.2 mg/L (<8.0)
Specific Conductance	Field Meter: Hydrolab Model MS5, EPA Method 120.1	0 to 100 mS/cm	$\pm$ .001 mS/cm
Salinity	Field Meter: Hydrolab Model MS5, SM2520B	0 to 70 ppt	$\pm$ 0.2 ppt

6. Monitoring Station Locations

The number of stations actively monitored by the Health District varies from year to year. Currently the Health District has 198 active trend monitoring station locations (77 marine water and 121 stream). Detailed descriptions of each station are listed in Appendix A. Maps showing the location of trend analysis stations are provided in each annual water quality monitoring report prepared by the Health District. Station locations are determined through review and consideration of the following:

- Geographical and hydrological characteristics of each watershed;
- Kitsap County waterbodies on the state 303(d) List;
- Water quality results and findings from earlier watershed assessment projects;
- Types, locations, and densities of land uses within each watershed;
- Locations of public parks and recreational shellfish beaches;
- Monitoring station locations from other monitoring efforts (PSAMP, Public Utility District No. 1 of Kitsap County, etc.);
- "Positioning Protocols for Sampling in Puget Sound" (EPA, 1986A); and
- "Technical Guidance for Assessing the Quality of Aquatic Environments" (Ecology, 1992).

Precision, comparability, and reproducibility of station locations are achieved through the identification and documentation of major landmarks and road crossings (visual and descriptive), on-water triangulation, and identification of Geographic Positioning System (GPS) coordinates of latitude and longitude. The Health District boat is equipped with a Garmin GPSMAP unit to locate marine water stations in a consistent manner. Detailed sampling station lists, maps and descriptions ensure consistency in locating the stream stations.

6.A. Marine Water Stations

The majority of marine water stations are located in nearshore areas adjacent to potential sources of pollution such as:

- Stream mouths;
- Major stormwater outflows;
- Wastewater treatment plant outfalls or combined sewer overflows; and
- Marinas.

The purpose of siting the majority of marine water stations in these nearshore areas is to assess water quality and public health impacts to the areas most accessible to, or accessed by, Kitsap County residents and visitors.

Because tide changes mix marine waters, and water quality problems from one watershed may affect the water quality of another, several offshore marine water stations have also been established to provide background data for each major water body. This data compliments the ambient monitoring information currently collected through PSAMP.

6.B. Stream Stations

Most of the stream stations are located at, or near, the mouths of streams prior to their discharge to the marine environment. The purpose of siting stream stations at the mouths is to assess the cumulative impacts of the stream basin on overall stream water quality.

The remaining stream stations are sited at either strategic segment locations upstream of the mouth station and/or near the headwaters of the stream. Segment stations help to assess an individual segment’s contribution to overall stream water quality and help to separate and identify pollution problem areas.

Nearly all of the stream stations are located in public access areas, such as road right-of-ways, to ensure unlimited and continued access to these sites over the long term.

7. Monitoring Schedule

Monitoring is conducted in ten (10) of the eleven (11) Kitsap County watersheds (the Health District does not conduct routine water quality monitoring on Bainbridge Island). All stream stations are monitored monthly, and the marine stations have been monitored monthly and semi-monthly at times.

This schedule enables Health District staff to capture major seasonal hydrographic conditions and makes our data more comparable to similar monitoring programs such as PSAMP and DOH Shellfish.

8. Monitoring Procedures

The monitoring procedures provided herein were developed from Health District and other established monitoring protocols identified in this document. These procedures do not address every possible monitoring situation. As such, guidance from the program manager should be sought in determining the best course of action during unusual circumstances.

8.A. Monitoring Event Preparation

Prior to conducting a complete and successful monitoring event, certain preparations must be made. Monitoring event preparations are coordinated by program staff and shall include the following:

- Checking and following the applicable monitoring schedule.
- Identifying the number and location of monitoring stations for that event.
- Identifying and scheduling field staff.
- Ensuring that the necessary field equipment will be available, calibrated, and ready for monitoring.
- Obtaining the correct type and number of sampling containers.
- Coordinating sample delivery and analysis/holding times with the receiving laboratory.
- Reviewing tide charts before planned monitoring events.
- Developing a monitoring route.

8.B. Equipment and Supplies Checklist

The Equipment and Supplies Checklist provided in **Table 3** below should be referenced by field staff prior to performing fresh and marine water monitoring events.

TABLE 3
Equipment and Supplies Checklist

General Monitoring Checklist	Additional Fresh Water Monitoring Checklist	Additional Marine Water Monitoring Checklist
Cooler with Ice Packs	Health District/Personal Vehicle	Tool Box
Sample Bottles	Waders	Boat Safety Box (Green)[1]
Sampling Wand	Hydrolab field storage tube	Health District Truck
Marking Pen		Health District Boat

Hydrolab MS5 and Surveyor		Boat Motor Oil (Truck)
Field book / pencil		Life Jackets (Truck)
Station List/Map		Cleaning Supplies[2]
Cellular Phone		
Digital Camera		

[1] The Health District's Boat Safety Box includes the following equipment and supplies: Radio, Garmin GPS Unit, Flares, Fire Extinguisher, Air Signal Horn, Flashlight, First Aid Kit, Boat Binder, Manuals/Instruction Books, and Marine Charts.
[2] Cleaning supplies are used to clean the boat and truck after a marine event and include the following: wash bucket, soap, sponge, and scrub brush.

8.C. Pre-Monitoring Activities

All field monitoring activities will be conducted in the same manner for all monitoring stations. The standard sequence of events for each monitoring site, where applicable, is as follows:

- Put on field gear and protective clothing appropriate for the sampling event and weather conditions.
- Park vehicle in a safe and clearly visible location that provides staff a safe exit from the vehicle.
- Enter monitoring event information in field notebook (see Section 8.E).
- Gather all applicable field equipment and approach the specific monitoring station

8.D. Monitoring Activities

The following text summarizes the applicable monitoring protocols used for fresh water streams and marine waters. Variations from approved monitoring protocols, when necessary, are noted. For specific information related to a monitoring protocol, please refer to the published document.

<u>Fresh Water Streams</u>

Fresh water stream samples are collected and analyzed according to the following monitoring protocols (as cited or as amended):

- "Recommended Protocols for Measuring Conventional Water Quality Variables and Metals in Fresh Water of the Puget Sound Region" (EPA, 1990); and
- "Guidance for Conducting Water Quality Assessments and Watershed Characterizations Under the Nonpoint Rule (Chapter 400-12 WAC)" (Ecology, 1995).

Fresh water stream stations will be monitored and sampled as follows:

- Stations shall be approached from a down-stream direction. Care shall be taken to avoid disturbing bottom sediments.
- The Hydrolab multisonde shall be deployed up-stream of the path of approach. As the Hydrolab is a sensitive piece of electronic equipment, care must be taken

when deploying unit. In shallow water conditions, ensure the probes on the unit are submersed in the water.

- Once at the station location, sample containers to be used at that site shall be labeled per Section 8.F.
- Samples shall be collected while facing upstream (against the flow) at approximately 12 inches below the water surface, or at half the depth of the water column (when the depth of the stream is 23 inches or less). To address the fact that bacteria concentrate in the surface micro layer, sample bottles will be filled using the "U" scoop motion. The "U" scoop motion ensures that the sample will not be biased with micro layer bacteria. The sample will then be sealed, placed in a cooler and held at four degrees Celsius. Sample analysis will begin no later than 24 hours from collection.
- Data from the Hydrolab, along with any notes of interest, shall be recorded in the field notebook and/or the Hydrolab Surveyor.
- After the data is recorded, the Hydrolab shall be pulled from the water and placed in its field travel container until deployment at the next station.

Marine Water Monitoring Procedures

Marine water samples will be collected and analyzed according to the following monitoring protocols (as cited or as amended):

- "Recommended Protocols for Microbiological Studies in Puget Sound" (EPA, 1986B); and
- "Recommended Guidelines for Measuring Conventional Marine Water Column Variables in Puget Sound" (EPA, 1991).

In summary, marine water stations are monitored and sampled as follows:

- Each station is located through the use of the Garmin GPSMAP unit and the station description as described in Section 6.
- Stations shall be approached from a "down-current" direction. Care shall be taken to avoid stirring up bottom sediments by remaining in at least six feet of water.
- Once at the sample station, deploy the Hydrolab meter outside of the influence of the motor prop.
- Sample containers are labeled and filled using the "U" scoop motion. Samples shall be collected at approximately 15 - 18 inches below the water surface.
- Sample bottles are then sealed, immediately put into a cooler, and held at four degrees Celsius.
- Data from the Hydrolab, along with any notes of interest, shall then be recorded in the field notebook and/or the Hydrolab Surveyor.
- After the data is recorded, the Hydrolab shall be pulled from the water and placed in its travel container until deployment at the next station.

8.E. Field Data Documentation Procedures

Water resistant field books will be used during every monitoring event. Entries shall be made in pencil. Field books will be used to record, at minimum, the following:

- Sampling date and time;
- Field personnel present;
- Type of matrix (e.g., marine water, fresh water streams, etc.);
- Watershed or area being monitored;
- Hydrolab and Surveyor ID numbers for the units being used for the event;
- General weather conditions (e.g., dry or rainy, windy or calm, cloudy or sunny, air temperature);
- Sampling location identification number;
- Parameters monitored (e.g., water temperature, salinity or conductivity, dissolved oxygen concentration, etc.); and
- Related field observations (e.g., color and/or smell of water, potential sources of pollution observed, notes on sampling collection, etc.).

Area-specific precipitation amounts are retrieved from local rainfall stations established by the Kitsap County PUD No. 1. Tidal stage readings are retrieved from localized tide charts.

8.F. Sample Container Identification and Labeling Procedures

All sample containers must be marked with the pre-assigned monitoring site identification code. A complete list of all monitoring locations and their assigned sample identifications can be found in Appendix A of this document.

Field duplicate samples always end with the letter "R" (e.g., field samples DF01 & DF01R). Refer to Section 9., "Quality Assurance/Quality Control", for additional information regarding trip blank and field duplicate samples.

9. Quality Assurance and Quality Control

Quality assurance (QA) provides a process for ensuring the reliability and value of measured data (Lombard, 2001). Sound QA practices are essential to acquire data of the necessary type and quality for their intended use. To be scientifically and legally defensible, data must be of documented quality.

9.A. Data Quality Objective

The primary data quality objective of this monitoring program is to measure the concentration of fecal coliform bacteria and specified field parameters at the stream and marine water monitoring sites described in this plan, and to compare these results with state water quality standards. These results will be used to report compliance with the state standards and to report water quality trends over the long term.

9.A.1 Bias

Bias is considered the consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Bias within the monitoring program will be reduced to the extent practicable by the following:

- Strict adherence to the sampling procedures of this plan;
- Complete data collection and organization;
- Regular and documented calibration and maintenance of field equipment.
- Periodic reviews and evaluations of field sampling procedures; and
- Analyzing data in an appropriate manner based upon essential considerations, such as temporal variations.

9.A.2 Precision

Precision is a measure of the variability in the results of replicate measurements due to random error (Lombard, 2001). Random errors are always present due to normal variability in the many factors affecting the measurement results. Precision will be determined by the following:

- Collection and analysis of field duplicates (not splits) for fecal coliform will be conducted for a minimum of 10%of the samples collected each monitoring day or event. When possible, duplicates will be collected from sites with expected higher concentrations of fecal coliform in order to determine variability of bacterial concentration.
- Calculation of the percent relative standard deviations (%RSD) of the pooled log transformed fecal coliform measurement results. Results pooled by magnitude will be evaluated allowing the higher percentage %RSDs of low values to be taken into account.
- Documentation of ongoing field equipment maintenance, calibration, and operation.

The total precision for field duplicate measurements should not exceed 10% RSD for results at or above 10 times the reporting limit. Precision up to 50% of the RSD for any lower field replicate results, and for the fecal coliform duplicates, is acceptable. At levels close to the method detection limit (marine water FC data typically is close to detection limit), %RSDs greater than 50% are to be expected and are acceptable. Duplicate samples that are "non-detects" shall not be used to measure precision.

Using this methodology, the overall variability will be calculated. Overall variability includes the natural environmental variability of the measured parameter, sampling variability, and lab variability (lab method and lab analyst). The overall variability of the parameter will be taken into consideration in the interpretation of the results.

9.B. Data Representativeness, Completeness, and Comparability

Representativeness of the analytical data is simply described as an adequate number of samples and monitoring events to determine water quality trends. Representativeness will be primarily achieved through the following:

- Strict adherence to the specific procedures of this plan including the selection of correct monitoring stations and methods;
- Thorough documentation of applicable environmental factors (e.g., weather and tidal conditions, observable changes, fish present, etc.); and
- Entering all applicable environmental information for each monitoring station into the water quality database for use in reporting data collected under this plan.

Completeness is considered and will be expressed as the percent of valid data obtained as compared to the amount of data planned for each particular reporting period.

Comparability of the data will be attained through strict adherence to the plan and thorough documentation of that adherence. The plan has been based on accepted protocols and procedures, and has been made consistent with other applicable monitoring efforts.

9.C. Field Quality Assurance

Quality assurance for the field monitoring activities covered under this plan will be achieved through documentation of the following:

- Consistent adherence to monitoring protocols identified within this plan; and
- A determination of whether the project objectives and data quality objectives have been met for specific set of data and information at the time of reporting.

With the beginning of the 2005 water year (October 1, 2004), "blue ice" packs and water have been used to cool and hold fecal coliform samples at 4°C. Previously only "blue-ice" packs were used. "Blue ice" is placed in the bottom of the cooler, samples are placed in a wire rack on top of the “blue ice”, and then cold water is added until approximately 1” of the bottle is submerged.

9.C.1. Personnel Training

All field personnel will be trained in, and be required to demonstrate competency of, the monitoring components contained herein. The Program Manager will ensure that personnel are given first-hand field and data management training. The Program Manager will ensure that only trained personnel having demonstrated competency are allowed to perform the work contained in this plan.

The Program Manager will conduct periodic performance checks to ensure that staff adhere to the procedures described herein. The performance checks will be performed, at minimum, concurrent with the standard employee performance evaluation process.

9.C.2. Maintaining and Calibrating Field Equipment

Having well maintained and properly calibrated monitoring equipment is an essential element to collecting scientifically valid and defensible data of known precision and accuracy. Staff will reference the binder entitled "Hydrolab Probe Calibration & Maintenance Records” located in the Health District water quality laboratory, for detailed instructions regarding equipment calibration and maintenance activities.

9.C.3. Monitoring Procedures

Consistent and properly implemented monitoring procedures are an essential element to collecting scientifically valid and defensible data of known precision and accuracy. Staff will reference Section 8.0 for detailed instructions regarding monitoring activities.

9.D. Laboratory Quality Assurance

Laboratory QA/QC for the work covered under this plan will be assured through the lab’s participation in the Washington State Department of Ecology accreditation program. The laboratory will follow the QA/QC requirements specified in standard analytical methods. See **Appendix C** for a description of the Health District’s Standard Operating Procedures including QA procedures.

9.E. Data Management Quality Assurance

As discussed in Section 10 below, only acceptable high quality data will be entered into the water quality database and used for reporting purposes. Data will be reviewed by field staff for acceptance prior to being entered into the database. Health District staff should reference **Appendix B**, "Water Quality Database Data Entry and QA/QC Procedures," for a detailed explanation of the QA process for data entry.

10. Data Management, Assessment, and Reporting

Proper data management is essential to water quality assessment activities necessary for the completion of written reports. In-house data management activities include the following:

10.A. Data Review, Reduction, Database Entry, and Storage

All water quality data will be reviewed by staff prior to being accepted and entered into the Health District's water quality Access™ database. Data review requires that staff review all field notes and laboratory results prior to entering the data electronically. Staff will review this information to ensure the following:

- All required data sets have been included;
- Parameters monitored are characteristic of expected results; and
- Laboratory analytical results are characteristic of expected results.

Should Health District staff determine the dataset is either incomplete or includes uncharacteristic results, the Program Lead or Program Manager will be consulted for a decision regarding the validity of the data. Data may only be excluded with the approval of the Program Lead or Program Manager. Once it is determined that the data is acceptable, staff may begin performing data entry procedures. Health District staff should reference **Appendix B** of this document for specific data entry procedures.

All acceptable data collected through this program will be stored in two ways:

- The Water Quality Program central files, filed by watershed.
- Electronically in the Water Quality Microsoft Access™ database.

For each monitoring event the following documentation will be entered into the files:

- The printed database record entry sheet;
- Original copy of the "Chain Of Custody/Laboratory Analytical Results" form; and
- Original field notes from the field book.

The water quality database serves as the repository for acceptable data. Only data that meets the data quality objectives and quality assurance and control requirements (see Section 9.0) will be entered into the database. In this way, only valid data will be retrievable from the database. All data input to the database will have a 100% review after input is complete to assure no transcription errors have occurred. The water quality database is automatically backed-up on a daily basis to minimize the loss of data caused by electrical or computer malfunctions.

10.B. Data Assessment and Reporting

Once data is entered into the database, it will be assessed by running standardized queries with the Microsoft Access™ database, and exporting the desired information from the water quality database to an Excel™ spreadsheet.

Annual Water Quality Monitoring Reports are prepared by Health District staff and distributed to SSWM, the local press, and other interested parties. More specific data summaries are available upon request. Water quality information is available through the Water Quality Program Homepage located at www.kitsapcountyhealth.com/environmenta_health/water_quality/wq_index.htm, and the Health District's public health advisory hotline number (800-2BE-WELL).

The Annual Water Quality Monitoring Report provides information to meet the monitoring objectives listed in Section 2.B. These reports typically include discussions of the following for ten of the eleven watersheds in Kitsap County:

- Watershed Background Information
- Watershed Focus Areas (State 303(d) listed waterbodies, shellfish classifications, and specific watershed water quality improvement projects)
- Annual Stream Monitoring Data and Long-Term FC Trends
- Annual Marine Monitoring Data and Long-Term FC Trends
- Annual Lake Monitoring Data and Long-Term Trends
- Monitoring Station Maps

Long-term FC trends are determined according to procedures described in **Appendix D**. To better define the precision of the fecal coliform sample results, the Annual Water Quality Monitoring Report will also include a discussion of the variability of the fecal coliform data collected. See Section 9.A.2 for a discussion of the procedure used to estimate variability.

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Swwqbdc1/user/os_wq/common/water quality/trend plan/wq trend monitoring plan/Oct 2006

Appendix B

TREND MONITORING STATION LIST

Jump off Joe Creek Trend Monitoring Stations[1]

Station ID	Station Description	GPS Coordinates LAT/LONG
JJ01	Mouth of Jump Off Joe Creek	47.80744/122.67063
JJ02	Off Pioneer Way in ravine	47.80003/122.66035

1 - Trend stations are monitored monthly and are used to establish improving or worsening water quality

Vinland Creek Trend Monitoring Stations

Station ID	Station Description	GPS Coordinates LAT/LONG
VC01	Mouth of Vinland Creek, 24" corrugated metal pipe	47.77484/122.70063
VC02	East fork of Vinland Creek, stream in gully south of guardrail on Lakeness Road	47.778333/122.701389
VC03	West fork Vinland Creek, upstream end of 16" concrete pipe, south side of Lakeness Road	47.778611/122.701667

Kinman Creek Monitoring Stations

Station ID	Station Description	GPS Coordinates LAT/LONG
KN01	Near Mouth at end of Shorebrook Drive	47.82159/122.64967
KN02	Downstream end of culvert under NW Kinman Rd., North of 165 NW Kinman Rd.	47.82001/122.65001
KN03	Downstream end of culvert crossing to north side of Kinman Road by stream name sign	47.81781/122.64478
KN04	North Fork of Kinman creek crossing Hwy 3, east end of culvert	47.81899/122.64247

Lofall Creek Monitoring Stations

Station ID	Station Description	GPS Coordinates LAT/LONG
LF01	Mouth station, end of Wesley Way, north of Ferry Dock	47.815280/122.65424
LF01B	Located on north side of Wesley Way, at intersection of Ferry St, N of LF02	47.815107/122.653010
LF02	Located behind chain link fence on S side of Wesley Way, at intersection of Wesley Way and Ferry Street	47.814878/122.652814

Appendix C

CRITERIA FOR RATING OSS

CRITERIA FOR RATING OSS INSPECTION RESULTS

Rating Classification	Criteria for Meeting Classification[1]
No Apparent Problems[1]	• **Completed/signed** Sewage Disposal Permit on file at Health District, or available from owner. • No illegal repairs or alterations have been performed on OSS. • All applicable setbacks and conditions in effect at the time of permitting are in place.
No Records[1]	• No **completed/signed** Sewage Disposal Permit on file at the Health District, or in possession of the owner/occupant . • No Non-Conforming, Suspect or Failure criteria were observed .
Non-Conforming[2]	• Repairs or alterations have been performed on OSS without a permit • Additional bedrooms have been added to the home (or business) without a permit. • Non-conforming conditions exist (such as insufficient setbacks from surface waters or wells, no reserve area, vehicular traffic on drainfield).
Suspect[2]	• Drainfield area is saturated. • Collected water sample results from bulkhead drains, curtain drains, or other pipes or seeps, at or above 500 FC/100 ml. **and** negative dye-test. • Collected water sample results from bulkhead drains, curtain drains, or other pipes or seeps, less than 500 FC/100 ml. **and** positive dye-test.
Failure [2, 3]	• Sewage backing up into, or not draining out of a structure caused by slow soil absorption of septic tank effluent. • Sewage leaking from a septic tank, pump tank, holding tank, or collection system. • Surfacing sewage in a documented drainfield area. • Collected water sample result from bulkhead drains, curtain drains, or other pipes or seeps, at or above 500 FC/100 ml. **and** positive dye-test results. • Straight discharge (gray or blackwater) from any indoor plumbing is observed and documented.

[1] All of the criteria in each rating classification must be met.

[2]One of the criteria must be met.

[3] As defined in the Kitsap County Board of Health Rules and Regulations Governing On-Site Sewage, 1996-8.

Appendix D

SHORELINE SURVEY RESULTS

Jump Off Joe Upper Hood Canal 1 Shoreline Survey

Dry Weather - July 2010

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-2*	167	7/12/2010			
JHC1-3	<1	7/12/2010			
JHC1-4	33	7/12/2010			
JHC1-5	153	7/12/2010			
JHC1-6	312	7/12/2010	1660	2001	1012
JHC1-7	281	7/12/2010	450	50	185
JHC1-8	<1	7/12/2010			
JHC1-9	177	7/12/2010			
JHC1-10	125	7/12/2010			
JHC1-11	16	7/12/2010			
JHC1-12	94	7/12/2010			
JHC1-13	19	7/12/2010			
JHC1-14	78	7/12/2010			
JHC1-15	44	7/12/2010			
JHC1-16	<1	7/12/2010			
JHC1-17	2	7/12/2010			
JHC1-18	115	7/12/2010			
JHC1-19	374	7/12/2010	620	540	500
JHC1-20	302	7/12/2010	1870	3300	1231
JHC1-21	32	7/12/2010			
JHC1-23	<1	7/12/2010			
JHC1-24	165	7/12/2010			
JHC1-25	<1	7/12/2010			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-26	<1	7/12/2010			
JHC1-27	170	7/12/2010			
JHC1-28	39	7/12/2010			
JHC1-29	156	7/12/2010			
JHC1-30	<1	7/12/2010			
JHC1-31	66	7/12/2010			
JHC1-32	200	7/12/2010	730	2820	744
JHC1-33	125	7/12/2010			
JHC1-34	104	7/12/2010			
JHC1-35	44	7/12/2010			
JHC1-36	25	7/12/2010			
JHC1-37	29	7/12/2010			
JHC1-38	120	7/12/2010			
JHC1-39	69	7/12/2010			
JHC1-40	4	7/12/2010			
JHC1-41	<10	7/14/2010			
JHC1-42	<10	7/14/2010			
JHC1-43	650	7/14/2010	170	40	164
JHC1-80	20	7/13/2010			
JHC1-81	<10	7/13/2010			
JHC1-82	<10	7/13/2010			
JHC1-83	170	7/13/2010			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-84	290	7/13/2010	10	dry	54
JHC1-85	200	7/13/2010	160	dry	179
JHC1-86	110	7/13/2010			
JHC1-87	250	7/13/2010	240	120	193
JHC1-100	230	7/14/2010	30	<10	83
JHC1-101	100	7/14/2010			
JHC1-102	40	7/14/2010			
JHC1-103	<10	7/14/2010			
JHC1-104	<10	7/14/2010			

Confirmation samples were collected when sample results were >200FC/100ml
Sample JHC1-1 is a monthly trend station (VC01).
Results are available in Appendix F, Trend Results.

Jump Off Joe Upper Hoood Canal 1 Shoreline Survey

Wet Weather - February-March 2011

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-2*	10	2/7/2011			
JHC1-3	20	2/7/2011			
JHC1-3a	5	2/7/2011			
JHC1-4	70	2/7/2011			
JHC1-4a	5	2/7/2011			
JHC1-4b	5	2/7/2011			
JHC1-6a	5	2/7/2011			
JHC1-6b	5	2/7/2011			
JHC1-6c	30	2/7/2011			
JHC1-6d	5	2/7/2011			
JHC1-6e	40	2/7/2011			
JHC1-6f	5	2/7/2011			
JHC1-6g	5	2/7/2011			
JHC1-6h	5	2/7/2011			
JHC1-6i	5	2/7/2011			
JHC1-6j	10	2/7/2011			
JHC1-6k	520	2/7/2011	220	10	105
JHC1-7	5	2/7/2011			
JHC1-7a	10	2/7/2011			
JHC1-8	5	2/7/2011			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-8a	10	2/7/2011			
JHC1-9	10	2/7/2011			
JHC1-9a	5	2/7/2011			
JHC1-9b	5	2/7/2011			
JHC1-10	5	2/7/2011			
JHC1-10a	10	2/7/2011			
JHC1-10b	5	2/7/2011			
JHC1-11	60	2/7/2011			
JHC1-13	120	2/23/2011			
JHC1-14	10	2/23/2011			
JHC1-15	40	2/23/2011			
JHC1-15a	120	2/23/2011			
JHC1-15b	40	2/23/2011			
JHC1-16	<10	2/23/2011			
JHC1-16a	<10	2/23/2011			
JHC1-17	70	2/23/2011			
JHC1-18	50	2/23/2011			
JHC1-19	260	2/23/2011	70	20	71
JHC1-20	320	2/23/2011	20	10	40
JHC1-22a	<10	2/23/2011			
JHC1-23	<10	2/23/2011			
JHC1-24a	<10	2/23/2011			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-25	<10	2/23/2011			
JHC1-26	<10	2/23/2011			
JHC1-27	20	2/23/2011			
JHC1-27a	<10	2/23/2011			
JHC1-27b	2001	2/23/2011	70	210	309
JHC1-28	<10	2/23/2011			
JHC1-28a	10	2/23/2011			
JHC1-29	80	2/23/2011			
JHC1-30	<10	2/23/2011			
JHC1-32	120	2/23/2011			
JHC1-32aa	<10	2/23/2011			
JHC1-32bb	<10	2/23/2011			
JHC1-33a	<10	2/23/2011			
JHC1-34	10	2/23/2011			
JHC1-35	70	2/23/2011			
JHC1-35a	30	2/23/2011			
JHC1-36	<10	2/23/2011			
JHC1-36a	20	2/23/2011			
JHC1-36b	1000	2/23/2011	4	4	25
JHC1-36c	420	2/23/2011	10	100	75
JHC1-36d	<10	2/23/2011			
JHC1-38	<10	2/23/2011			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-38a	40	2/23/2011			
JHC1-39	350	2/23/2011	4	4	18
JHC1-39a	<10	2/23/2011			
JHC1-40	<10	2/23/2011			
JHC1-40a	2001	2/23/2011	4	4	32
JHC1-20	320	2/23/2011	20	10	40
JHC1-20b	20	2/23/2011			
JHC1-20c	10	2/23/2011			
JHC1-31	910	2/23/2011	50	1190	378
JHC1-80	60	2/24/2011			
JHC1-81	<10	2/24/2011			
JHC1-81a	200	2/24/2011			
JHC1-82	30	2/24/2011			
JHC1-82b	100	2/24/2011			
JHC1-82c	<10	2/24/2011			
JHC1-84	120	2/24/2011			
JHC1-84a	100	2/24/2011			
JHC1-85	<10	2/24/2011			
JHC1-86	50	2/24/2011			
JHC1-86a	30	2/24/2011			
JHC1-86b	60	2/24/2011			
JHC1-87	30	2/24/2011			

Station	FC RESULT	Date	Confirmation	Confirmation	Geomean
JHC1-82a	10	2/24/2011			
JHC1-41	<10	2/24/2011			
JHC1-41a	200	2/24/2011			
JHC1-41b	10	2/25/2011			
JHC1-42	40	2/25/2011			
JHC1-42a	<10	2/25/2011			
JHC1-43	10	2/25/2011			
JHC1-99a	7	3/7/2011			
JHC1-101	200	3/7/2011	160	2001	400
JHC1-101a	1	3/7/2011			
JHC1-101b	62	3/7/2011			
JHC1-102	5	3/7/2011			
JHC1-103	1	3/7/2011			
JHC1-104	9	3/7/2011			
JHC1-100	145	3/7/2011			

Confirmation samples were collected when sample results were >200FC/100ml
Sample JHC1-1 is a monthly trend station (VC01).
Results are available in Appendix F, Trend results.

Appendix E

TREND STATION SAMPLE RESULTS

Appendix E.

TREND MONITORING RESULTS FOR JUMP OFF JOE CREEK, KINMAN CREEK, LOFALL CREEK AND VINLAND CREEK[1] MOUTH STATIONS, WATER YEARS 2005-2011

Extraordinary Primary Use Category Fresh Water Stream Fecal Coliform (FC) Results[2]

October 01, 2004 - September 30, 2005						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [3] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	4 – 900	**46**	5	**42** %	**NO**
KN01	11	13 – 1600	**119**	4	**36** %	**NO**
LF01	12	11 – 500	**65**	5	**42** %	**NO**

October 01, 2005 - September 30, 2006						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	2 – ≥ 1600	**50**	4	**33** %	**NO**
KN01	12	4 – 300	**42**	2	**17** %	**NO**
LF01	11	11 – ≥ 1600	**132**	6	**55** %	**NO**

October 01, 2006 - September 30, 2007						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	7 – 300	43	4	**33** %	**NO**
KN01	12	2 – 240	41	3	**25** %	**NO**
LF01	12	80 – ≥ 1600	**523**	11	**92** %	**NO**

October 01, 2007 - September 30, 2008						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	2 – 80	17	0	**0** %	**YES**
KN01	12	2 – 300	28	3	**25** %	**NO**
LF01	12	50 – ≥ 1600	**360**	9	**75** %	**NO**
VC01	6	21 – 900	**118**	2	**33** %	**NO**

October 01, 2008 - September 30, 2009						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	<2-500	29	4	**33%**	No
KN01	11	4-900	**53**	4	**36%**	No
LF01	11	8-1601	**414**	8	**73%**	No
VC01	10	13-1601	**89**	4	**40%**	No

October 01, 2009 - September 30, 2010						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	4-200	32	3	**25%**	No
KN01	12	10-320	**72**	6	**50%**	No
LF01	12	70-1780	**469**	11	**92%**	No
VC01	12	4-900	**90**	5	**42%**	No

October 01, 2010 - September 30, 2011						
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV [2] (FC/100ml)**	**# Samples > FC/100ml**	**% Samples > 100**	**Meets WQ FC/100ml**
JJ01	12	4-950	41	5	**42%**	No
KN01	12	40-260	**119**	8	**67%**	No
LF01	12	140-950	**243**	12	**100%**	No
VC01	12	4-440	**89**	8	**67%**	No

J01 –Jump off Joe Creek mouth station

KN01 – Kinman Creek mouth station

LF01 – Lofall Creek mouth station

VC01 – Vinland Creek mouth station

[1] Vinland Creek Trend not available until 2008 water year

[2] Extraordinary Primary Use Category. FC levels shall not exceed a GMV of 50 FC/100 ml and not have more than 10% of all samples exceed 100 FC/100 ml.

[3] Geometric Mean Value

Bold entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)

Appendix F

TREND STATION STATISITCAL ANALYSIS

APPENDIX F. NUTRIENT STATISTICAL ANALYSIS

For a trend to be significant the two-sided p-value for the Seasonal Kendall Test statistic must be less than 0.05 and the 12 monthly Kendall Tests must be homogeneous with a common trend. If the Seasonal Kendall Test statistic is significant, the magnitude of the trend is given by the Kendall Slope. A negative slope corresponds to an improving condition, a positive slope corresponds to a worsening condition. The Kendall Slope is only provided if there is a significant trend. Kendall Seasonal z-value is provided only if the monthly tests show a homogeneous and common trend.

χ^2_{Homo} Bold Print indicates homogeneous trends across seasons (p>0.05)

χ^2_{Trend} Bold Print indicates a common trend (p<0.05) and is only valid if seasonal trends are homogeneous

Kendall Seasonal Bold Print indicates a significant trend and is only valid if seasonal trends are homogeneous and common

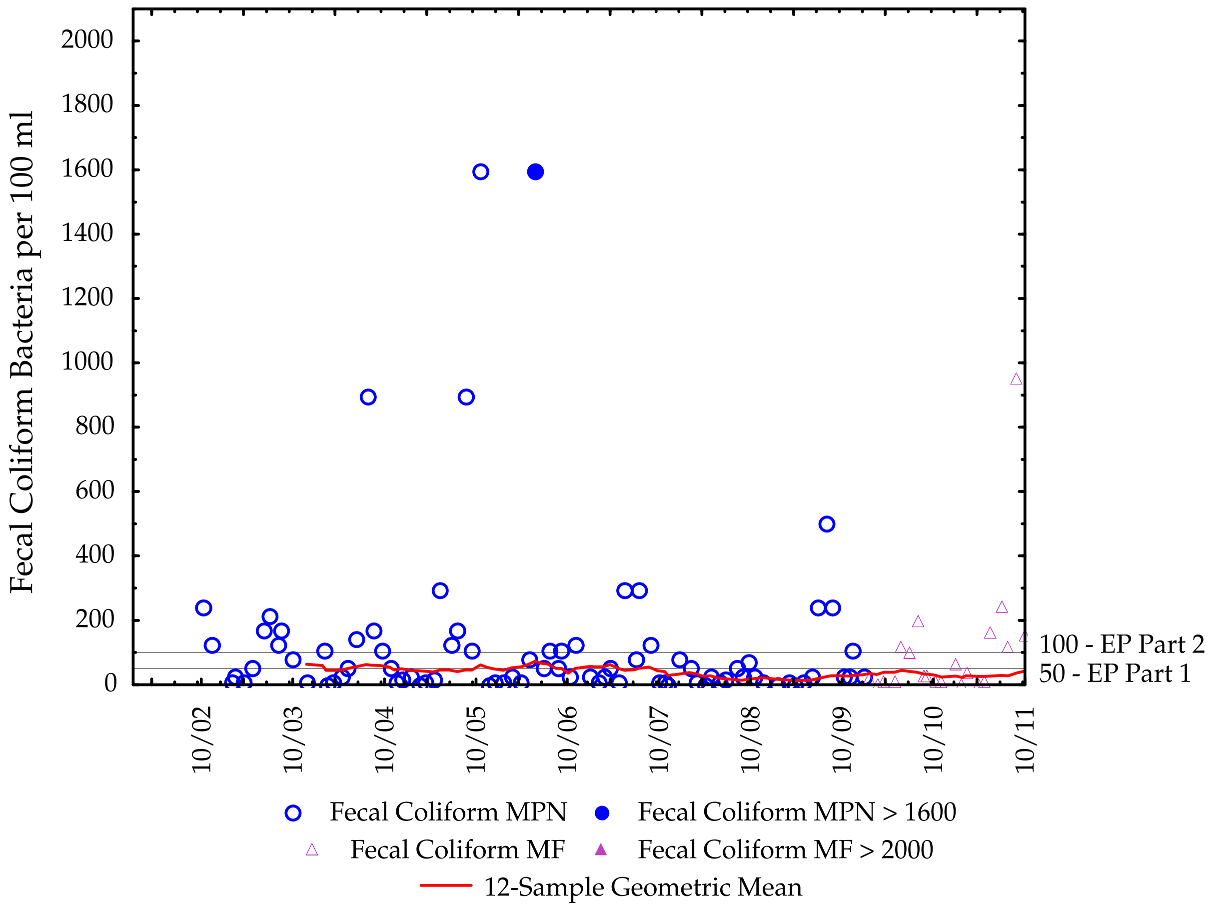
Kendall Slope only has meaning if the seasonal trends are homogeneous and significant.

Trends are shown as S for stationary, D for decreasing (improving) and I for increasing (worsening).

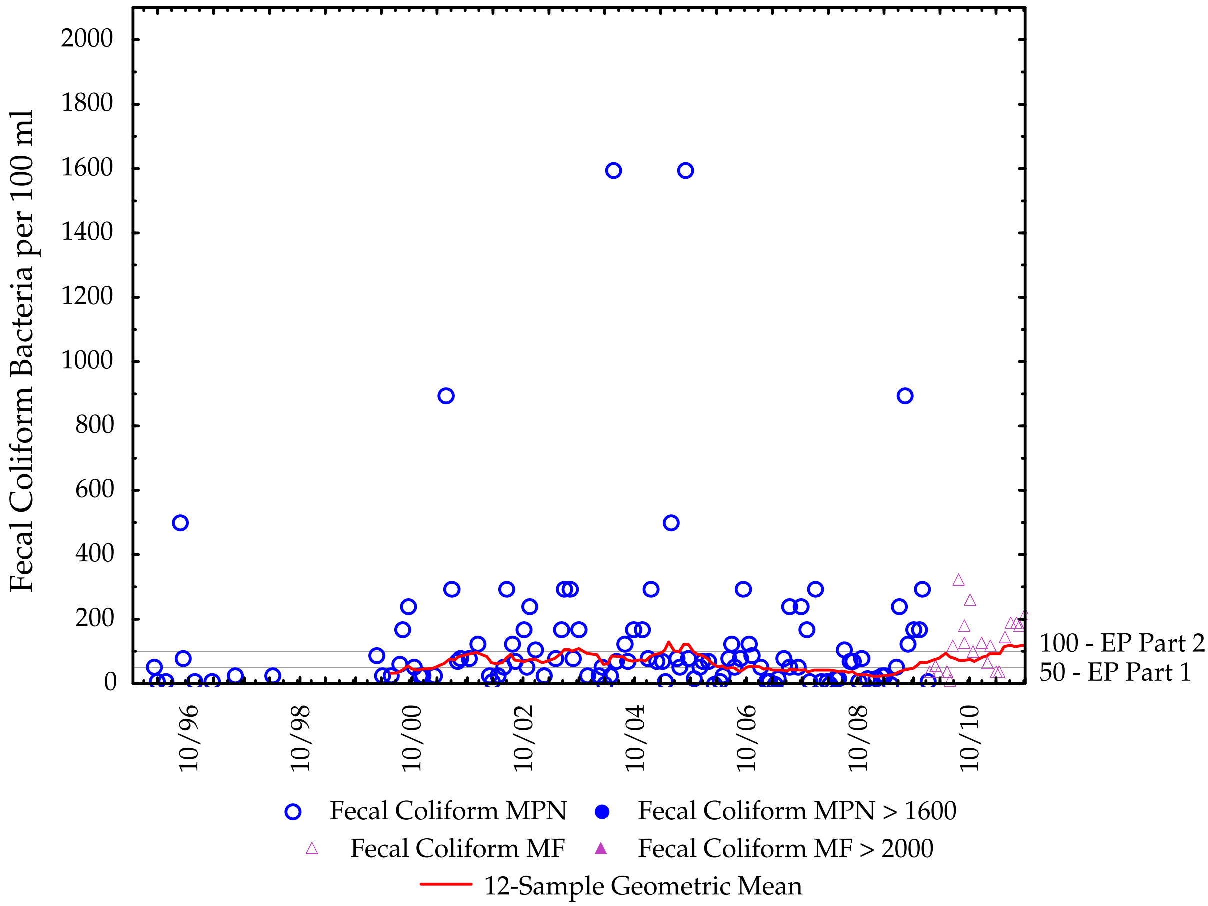
Upper Hood Canal Watershed Fresh Water Seasonal Kendall Trend Results through Water Year 2010-2011 Long Term Trend Transition from MPN method to MF method occurred January 2010															P-Value		Z-Value (P-Value)	Trend	Kendall Slope
Station	Earliest Date	n	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	χ^2_{Homo}	χ^2_{Trend}	Kendall Seasonal		FC / Month
JJ01	10/9/02	104	-15	4	-13	-16	-5	-1	-4	-2	-4	-15	-2	8	0.483	0.063		S	
KN01	2/7/96	136	2	14	0	2	-16	-1	15	8	0	30	0	2	0.641	0.217		S	
LF01	**11/24/03**	**92**	**12**	**16**	**10**	**17**	**-10**	**1**	**2**	**-4**	**4**	**9**	**5**	**0**	**0.391**	**0.023**	**2.33 (0.020)**	**I**	**13**

Upper Hood Canal Watershed Fresh Water Seasonal Kendall Trend Results through Water Year 2010-2011 3-Year Trend Transition from MPN method to MF method occurred January 2010															P-Value		Z-Value (P-Value)	Trend	Kendall Slope
Station	Earliest Date	n	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	χ^2_{Homo}	χ^2_{Trend}	Kendall Seasonal		FC / Month
JJ01	10/14/08	35	0	1	1	2	3	0	-3	1	2	-2	-1	1	0.477	0.345		S	
KN01	**10/14/08**	**35**	**3**	**3**	**2**	**2**	**1**	**-1**	**-3**	**2**	**3**	**3**	**1**	**1**	**0.492**	**0.004**	**2.58 (0.010)**	**I**	**24**
LF01	10/14/08	35	1	1	-1	-1	1	-1	-3	-1	-1	-1	-3	-1	0.895	0.100		S	
VC01	10/29/09	24	-1	-1	-1	-1	1	1	1	1	1	-1	-1	1	0.364	1.000		S	

Fecal Coliform Bacteria Trend Analysis
Jump off Joe Creek (Station JJ01), 2002 - 2011

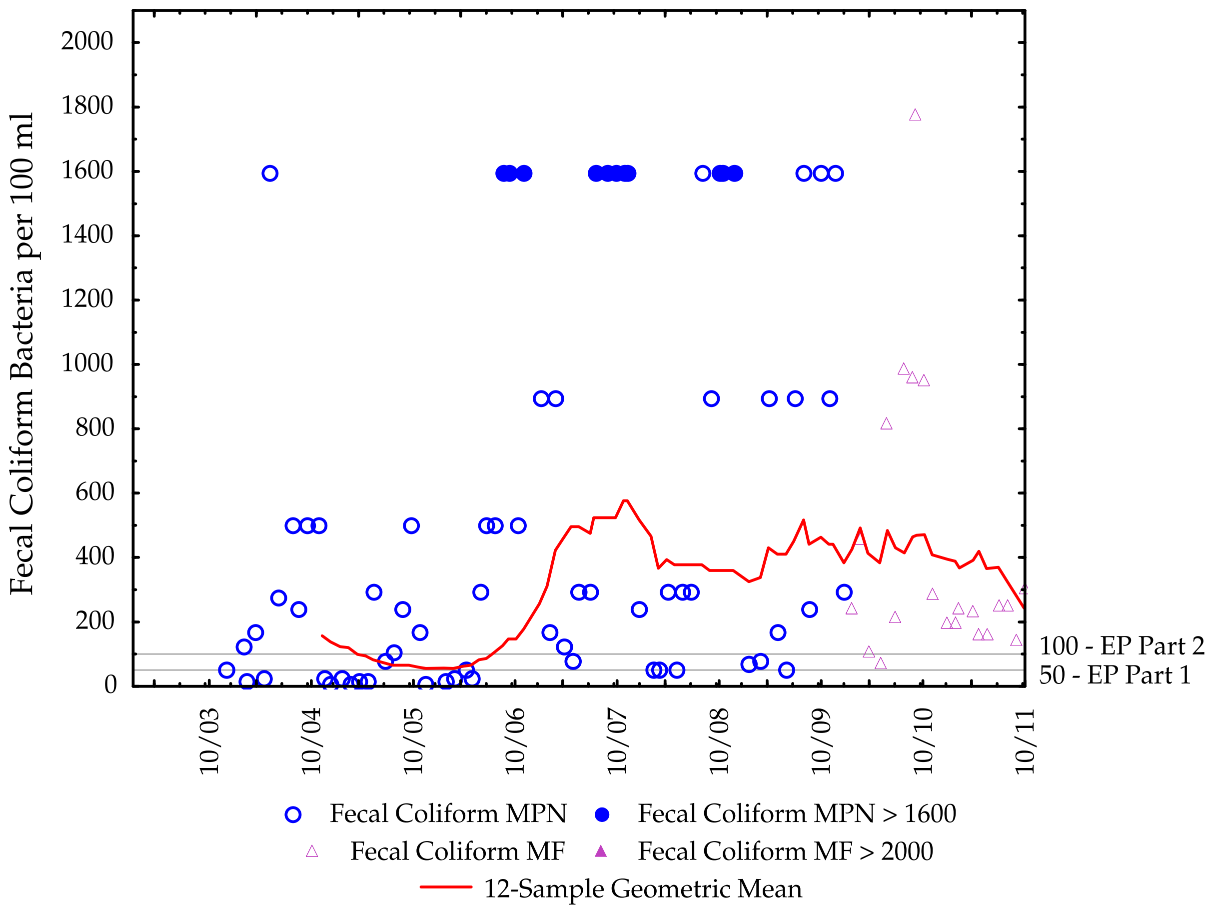


Fecal Coliform Bacteria Trend Analysis
Kinman Creek (Station KN01), 1996 - 2011

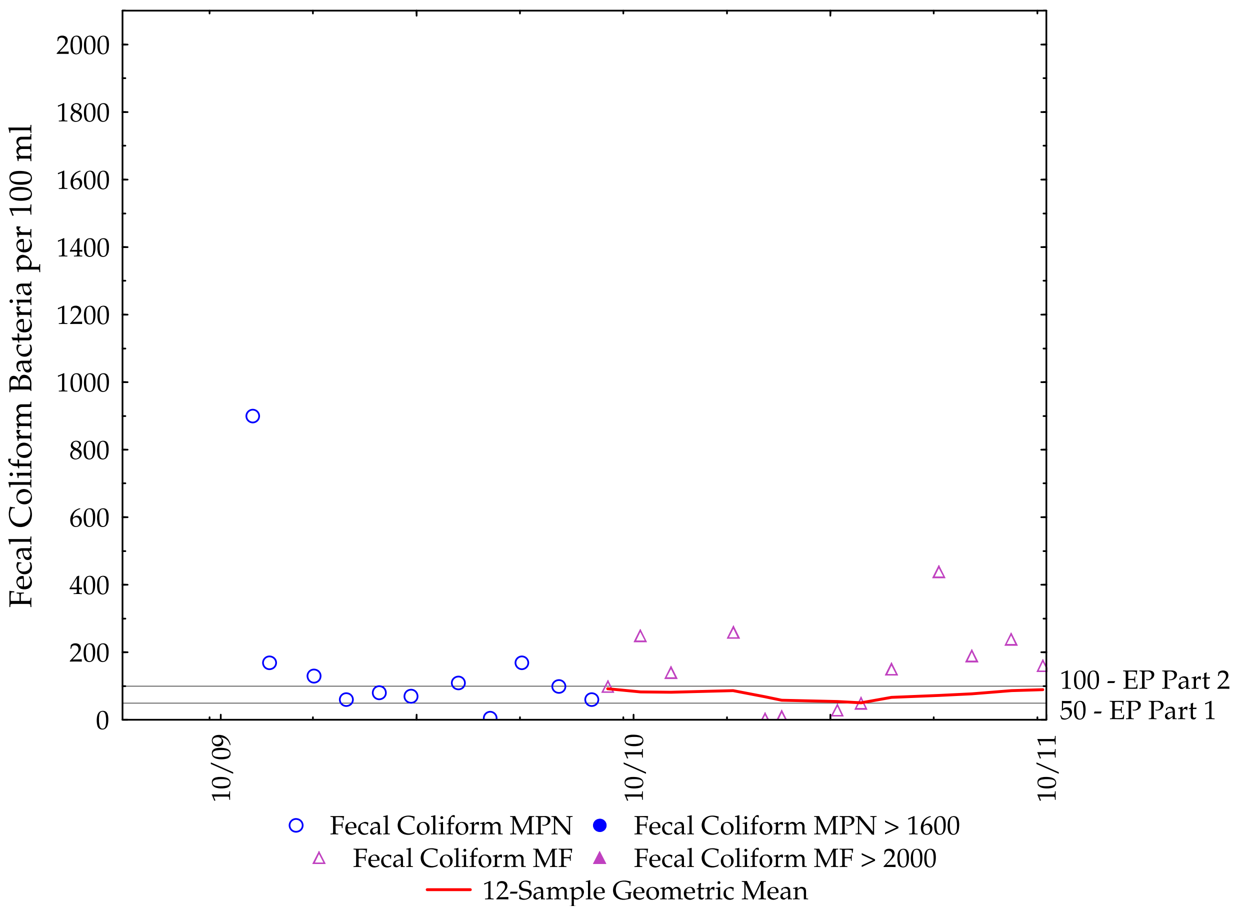


Fecal Coliform Bacteria per 100 ml
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10/96
10/98
10/00
10/02
10/04
10/06
10/08
10/10
100 - EP Part 2
50 - EP Part 1
Fecal Coliform MPN
Fecal Coliform MPN > 1600
Fecal Coliform MF
Fecal Coliform MF > 2000
12-Sample Geometric Mean

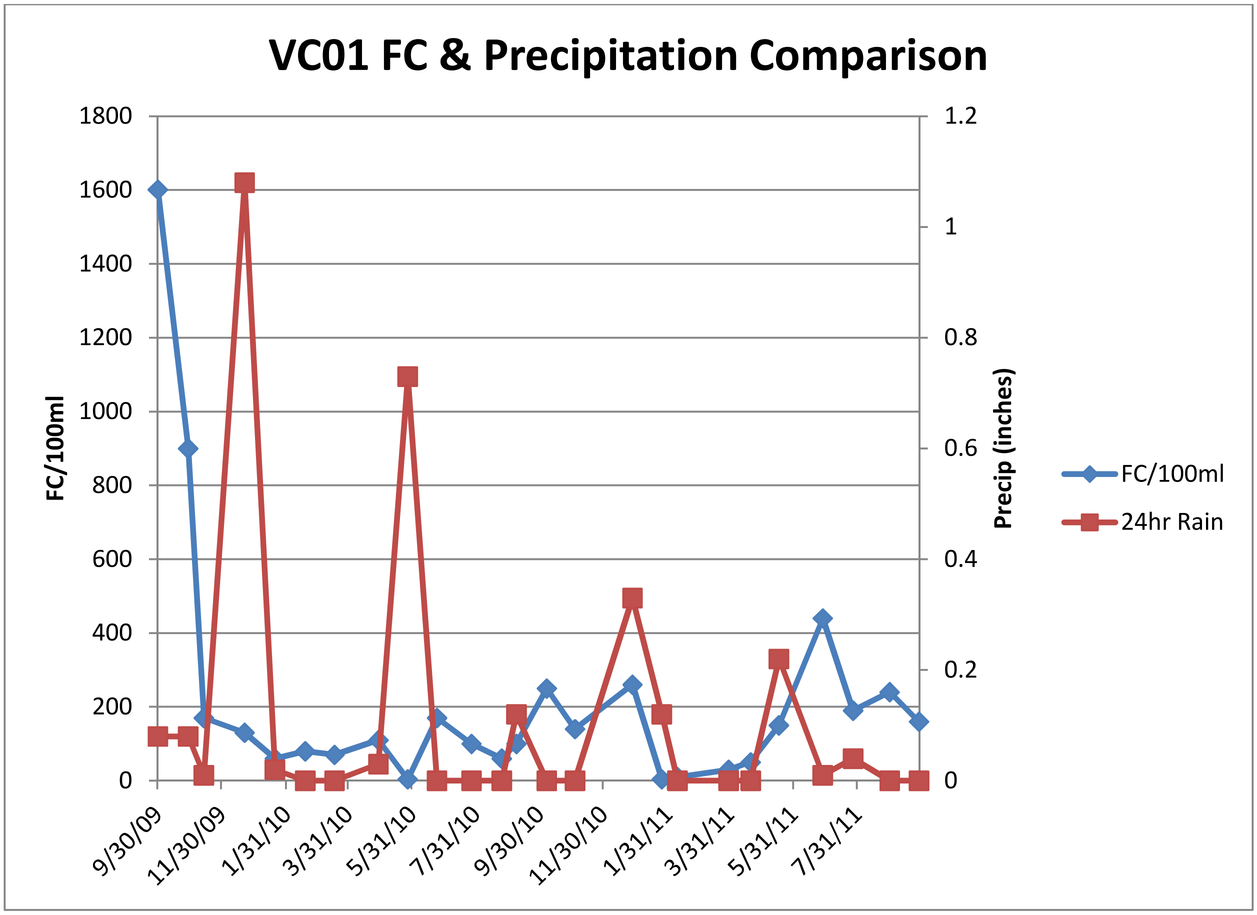
Fecal Coliform Bacteria Trend Analysis
Lofall Creek (Station LF01), 2003 - 2011



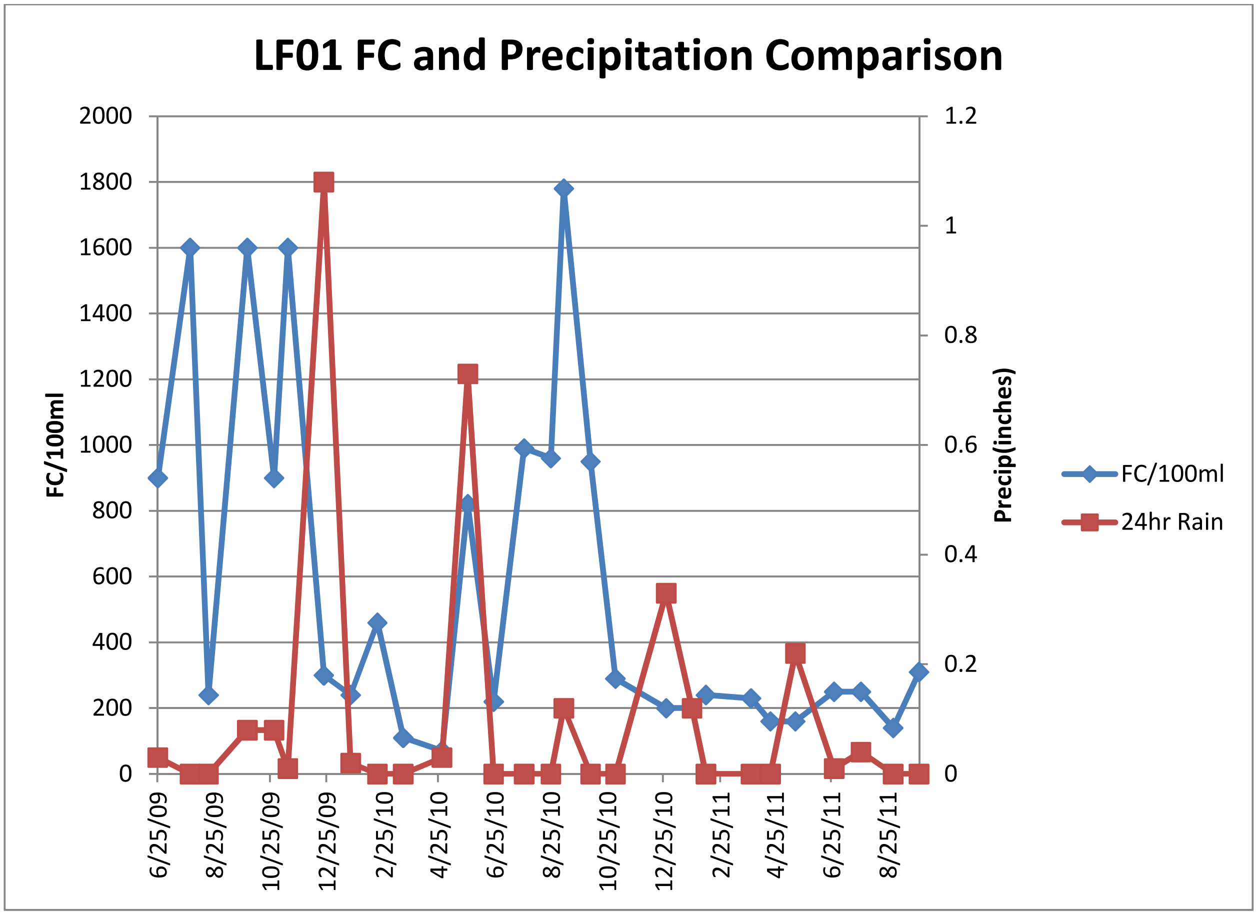
Fecal Coliform Bacteria Trend Analysis
Vinland Creek (Station VC01), 2009 - 2011


Fecal Coliform Bacteria per 100 ml
2000
1800
1600
1400
1200
1000
800
600
400
200
0
100 - EP Part 2
50 - EP Part 1
10/09
10/10
10/11
Fecal Coliform MPN
Fecal Coliform MPN > 1600
Fecal Coliform MF
Fecal Coliform MF > 2000
12-Sample Geometric Mean

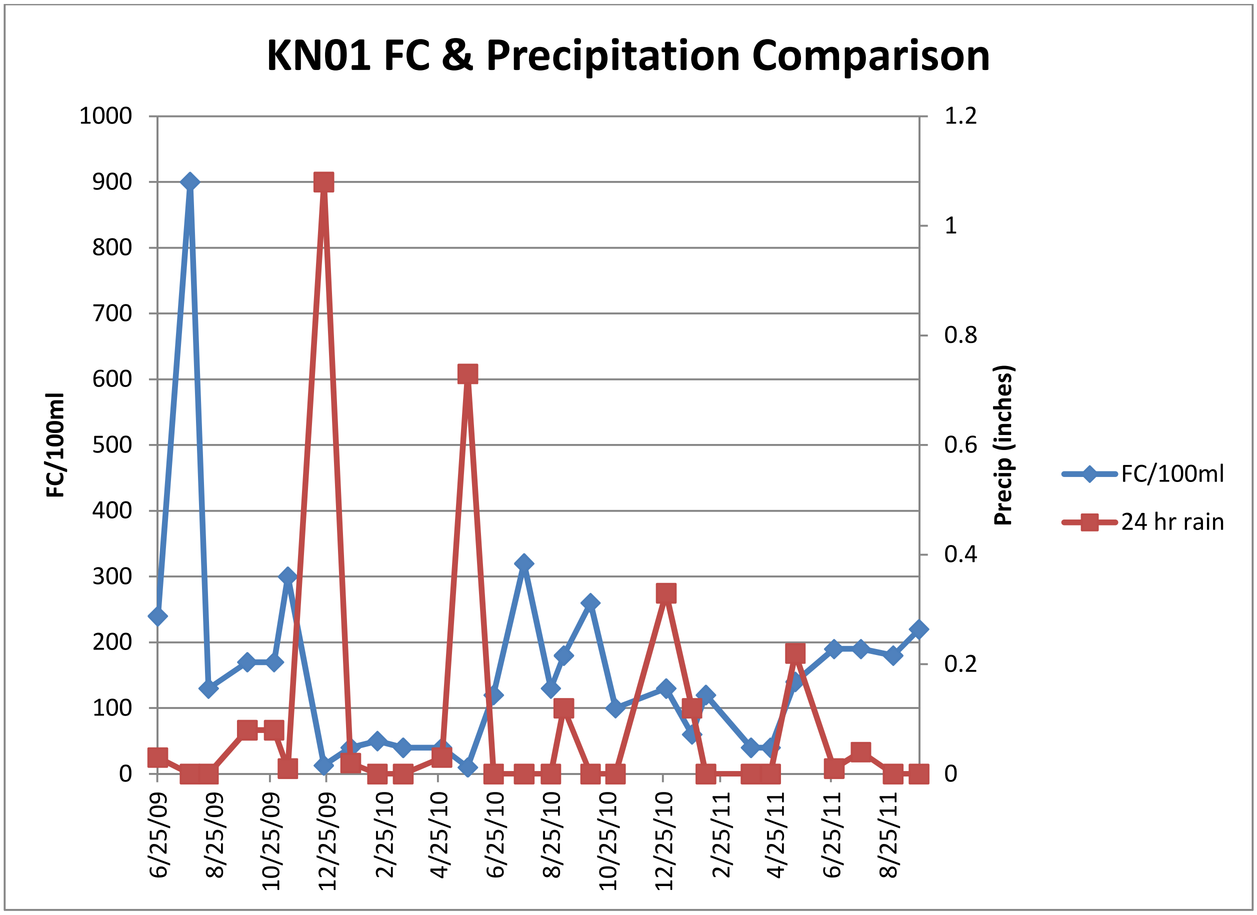
Appendix G. Precipitation and FC Concentration Comparison



VC01 FC & Precipitation Comparison
FC/100ml
Precip (inches)
1800
1600
1400
1200
1000
800
600
400
200
0
1.2
1
0.8
0.6
0.4
0.2
0
9/30/09
11/30/09
1/31/10
3/31/10
5/31/10
7/31/10
9/30/10
11/30/10
1/31/11
3/31/11
5/31/11
7/31/11
FC/100ml
24hr Rain



LF01 FC and Precipitation Comparison
FC/100ml
Precip(inches)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1.2
1
0.8
0.6
0.4
0.2
0
6/25/09
8/25/09
10/25/09
12/25/09
2/25/10
4/25/10
6/25/10
8/25/10
10/25/10
12/25/10
2/25/11
4/25/11
6/25/11
8/25/11
FC/100ml
24hr Rain


KN01 FC & Precipitation Comparison
FC/100ml
Precip (inches)
1000
900
800
700
600
500
400
300
200
100
0
1.2
1
0.8
0.6
0.4
0.2
0
6/25/09
8/25/09
10/25/09
12/25/09
2/25/10
4/25/10
6/25/10
8/25/10
10/25/10
12/25/10
2/25/11
4/25/11
6/25/11
8/25/11
FC/100ml
24 hr rain

Appendix H. Precipitation and FC Concentration Coefficients

Jump off Joe, Vinland, Kinman, Lofall FC & Precipitation Correlation Coefficients

Station	Visit Date	FC/100ml	24hr Rain *	FC & Prcp Correl.	Event
JJ01	6/25/09	240	0.03	-0.13	Trend
JJ01	7/30/09	500	0	-0.12	Trend
JJ01	8/19/09	240	0	-0.10	Trend
JJ01	9/30/09	70	0.08	-0.09	Trend
JJ01	10/29/09	30	0.08	-0.09	Trend
JJ01	11/13/09	110	0.01	-0.09	Trend
JJ01	12/22/09	23	1.08	-0.09	Trend
JJ01	1/20/10	20	0.02	-0.03	Trend
JJ01	2/18/10	4	0	-0.04	Trend
JJ01	3/18/10	10	0	-0.05	Trend
JJ01	4/29/10	10	0.03	-0.07	Trend
JJ01	5/27/10	120	0.73	-0.08	Trend
JJ01	6/24/10	100	0	-0.13	Trend
JJ01	7/27/10	200	0	-0.14	Trend
JJ01	8/25/10	30	0	-0.13	Trend
JJ01	9/8/10	30	0.12	-0.15	Trend
JJ01	10/7/10	10	0	-0.11	Trend
JJ01	11/3/10	10	0	-0.11	Trend
JJ01	12/28/10	60	0.33	-0.14	Trend
JJ01	1/25/11	4	0.12	-0.09	Trend
JJ01	2/9/11	40	0	-0.02	Trend
JJ01	3/30/11	4	0	-0.12	Trend
JJ01	4/20/11	10	0	-0.14	Trend
JJ01	5/17/11	160	0.22	-0.21	Trend
JJ01	6/28/11	240	0.01	-0.26	Trend
JJ01	7/27/11	120	0.04	-0.26	Trend
JJ01	8/31/11	950	0	-0.29	Trend
JJ01	9/28/11	150	0	-0.25	Trend
Station	Visit Date	FC/100ml	24 hr rain		Event
KN01	6/25/09	240	0.03	-0.27	Trend
KN01	7/30/09	900	0	-0.26	Trend
KN01	8/19/09	130	0	-0.38	Trend
KN01	9/30/09	170	0.08	-0.38	Trend
KN01	10/29/09	170	0.08	-0.38	Trend
KN01	11/13/09	300	0.01	-0.38	Trend
KN01	12/22/09	13	1.08	-0.38	Trend
KN01	1/20/10	40	0.02	-0.27	Trend
KN01	2/18/10	50	0	-0.30	Trend

KN01	3/18/10	40	0	-0.33	Trend
KN01	4/29/10	40	0.03	-0.38	Trend
KN01	5/27/10	10	0.73	-0.42	Trend
KN01	6/24/10	120	0	-0.13	Trend
KN01	7/27/10	320	0	-0.15	Trend
KN01	8/25/10	130	0	-0.08	Trend
KN01	9/8/10	180	0.12	-0.09	Trend
KN01	10/7/10	260	0	-0.11	Trend
KN01	11/3/10	100	0	-0.03	Trend
KN01	12/28/10	130	0.33	-0.06	Trend
KN01	1/25/11	60	0.12	-0.08	Trend
KN01	2/9/11	120	0	-0.13	Trend
KN01	3/30/11	40	0	-0.15	Trend
KN01	4/20/11	40	0	-0.02	Trend
KN01	5/17/11	140	0.22	-0.04	Trend
KN01	6/28/11	190	0.01	0.33	Trend
KN01	7/27/11	190	0.04	-0.23	Trend
KN01	8/31/11	180	0	-0.23	Trend
KN01	9/28/11	220	0	-0.26	Trend
Station	Visit Date	FC/100ml	24hr Rain		Event
LF01	6/25/09	900	0.03	-0.04	Trend
LF01	7/30/09	1600	0	-0.04	Trend
LF01	8/19/09	240	0	0.00	Trend
LF01	9/30/09	1600	0.08	-0.01	Trend
LF01	10/29/09	900	0.08	0.00	Trend
LF01	11/13/09	1600	0.01	0.00	Trend
LF01	12/22/09	300	1.08	0.06	Trend
LF01	1/20/10	240	0.02	0.18	Trend
LF01	2/18/10	460	0	0.17	Trend
LF01	3/18/10	110	0	0.17	Trend
LF01	4/29/10	70	0.03	0.16	Trend
LF01	5/27/10	820	0.73	0.14	Trend
LF01	6/24/10	220	0	-0.05	Trend
LF01	7/27/10	990	0	-0.07	Trend
LF01	8/25/10	960	0	-0.03	Trend
LF01	9/8/10	1780	0.12	0.03	Trend
LF01	10/7/10	950	0	-0.25	Trend
LF01	11/3/10	290	0	-0.35	Trend
LF01	12/28/10	200	0.33	-0.30	Trend
LF01	1/25/11	200	0.12	0.11	Trend

LF01	2/9/11	240	0	0.22	Trend
LF01	3/30/11	230	0	0.22	Trend
LF01	4/20/11	160	0	-0.16	Trend
LF01	5/17/11	160	0.22	-0.15	Trend
LF01	6/28/11	250	0.01	-0.11	Trend
LF01	7/27/11	250	0.04	-0.09	Trend
LF01	8/31/11	140	0	-0.08	Trend
LF01	9/28/11	310	0	-0.20	Trend
Station	Visit Date	FC/100ml	24hr Rain		Event
VC01	9/30/09	1601	0.08	-0.07	Trend
VC01	10/29/09	900	0.08	-0.08	Trend
VC01	11/13/09	170	0.01	-0.10	Trend
VC01	12/22/09	130	1.08	-0.09	Trend
VC01	1/20/10	60	0.02	-0.15	Trend
VC01	2/18/10	80	0	-0.17	Trend
VC01	3/18/10	70	0	-0.18	Trend
VC01	4/29/10	110	0.03	-0.20	Trend
VC01	5/27/10	4	0.73	-0.20	Trend
VC01	6/24/10	170	0	0.12	Trend
VC01	7/27/10	100	0	0.13	Trend
VC01	8/25/10	60	0	0.11	Trend
VC01	9/8/10	100	0.12	0.08	Trend
VC01	10/7/10	250	0	0.10	Trend
VC01	11/3/10	140	0	0.15	Trend
VC01	12/28/10	260	0.33	0.14	Trend
VC01	1/25/11	4	0.12	-0.11	Trend
VC01	2/9/11	10	0	0.03	Trend
VC01	3/30/11	30	0	-0.05	Trend
VC01	4/20/11	50	0	-0.18	Trend
VC01	5/17/11	150	0.22	-0.42	Trend
VC01	6/28/11	440	0.01	-0.12	Trend
VC01	7/27/11	190	0.04	-0.14	Trend
VC01	8/31/11	240	0	NA	Trend
VC01	9/28/11	160	0	NA	Trend

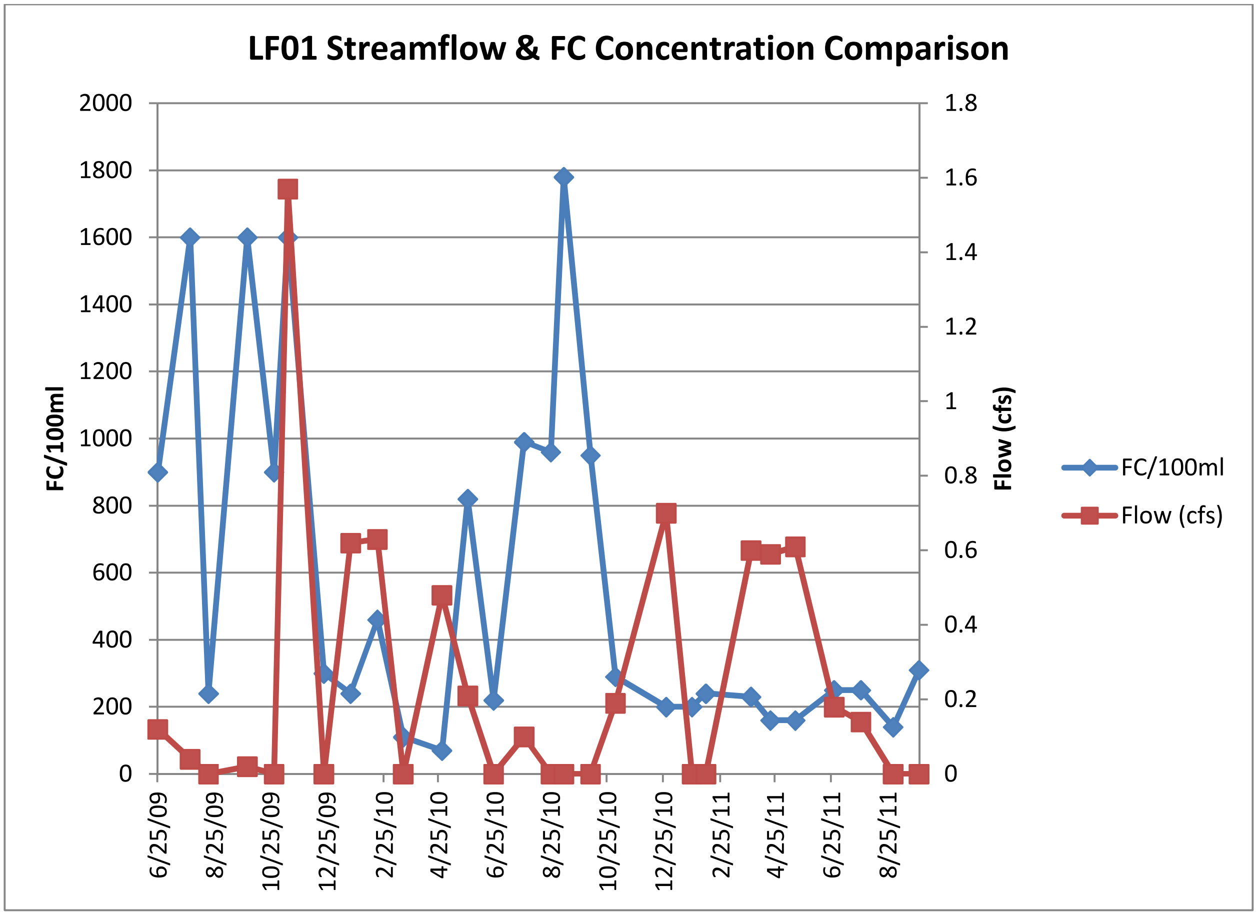
* 24 hour rainfall was measured from midnight to midnight on the previous day

APPENDIX I

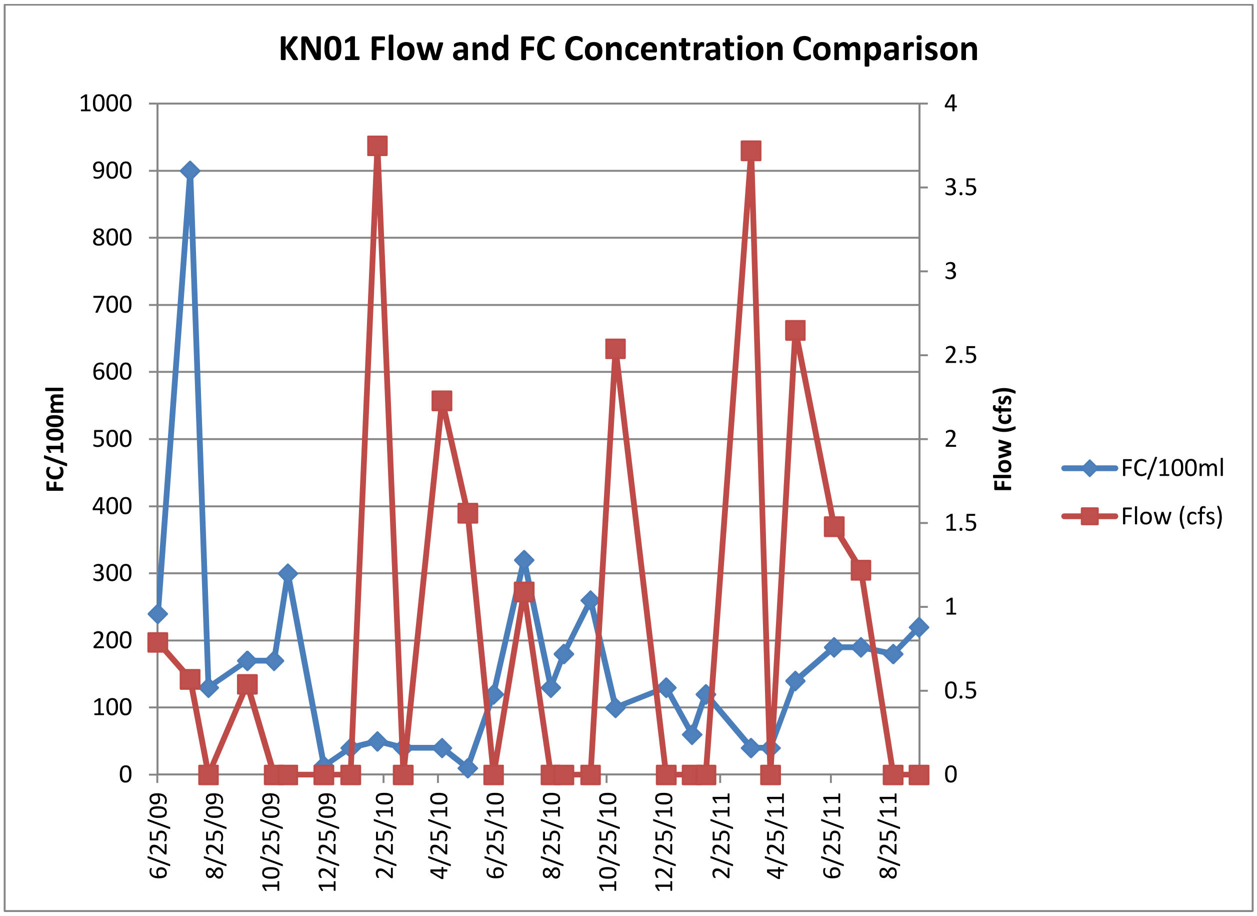
Streamflow & FC Concentration Comparison

Appendix I. Streamflow & FC Concentration Comparison

LOFALL CREEK

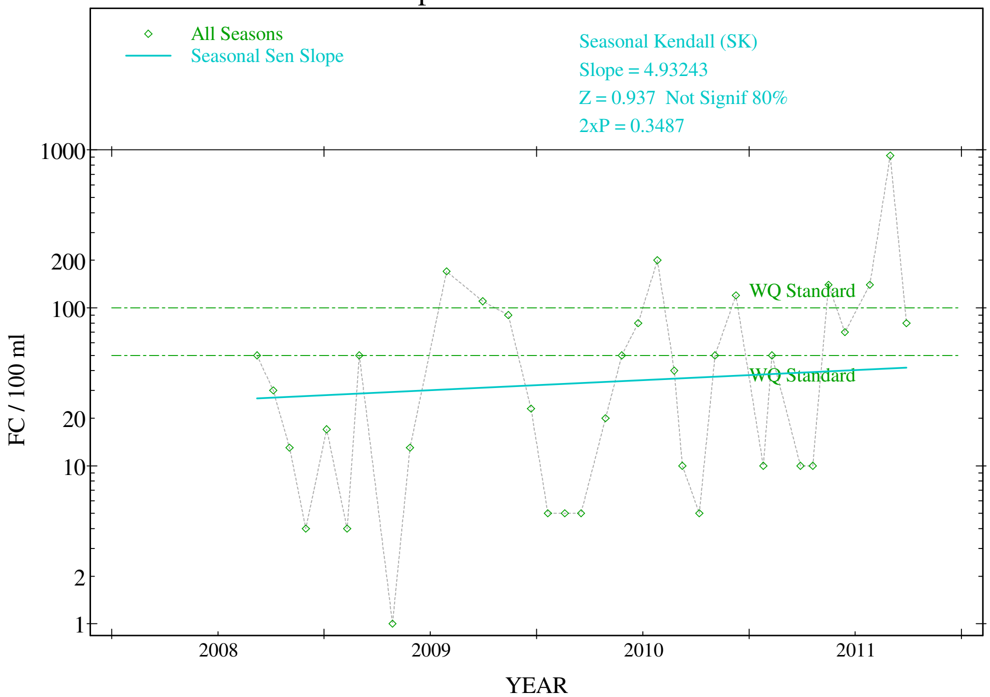


KINMAN CREEK

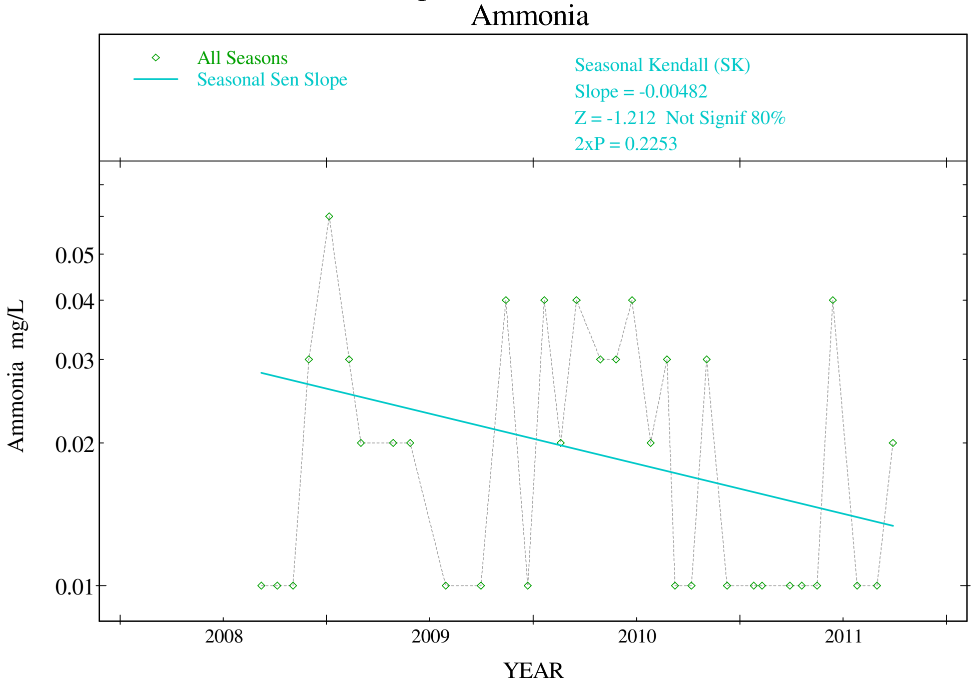


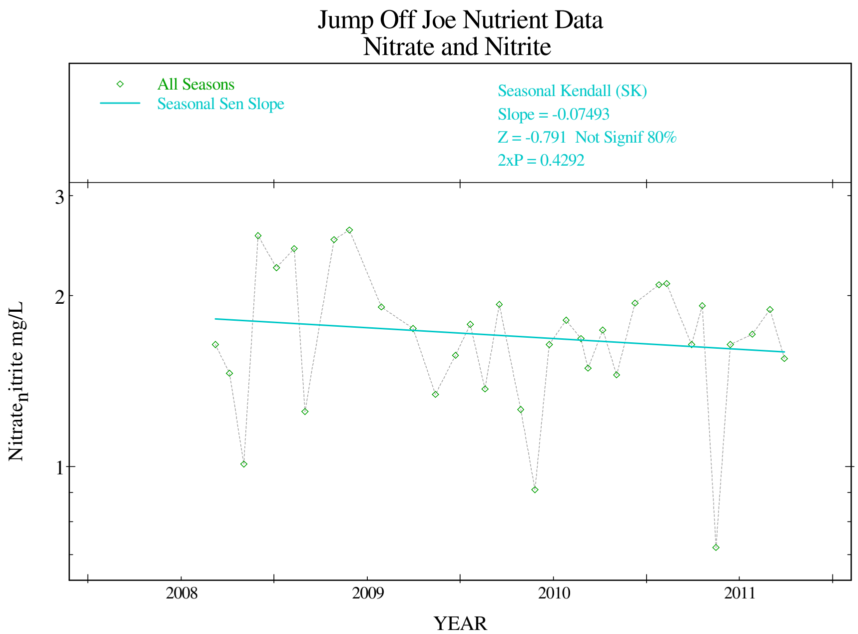
Appendix J. Nutrient Graphs & Tables

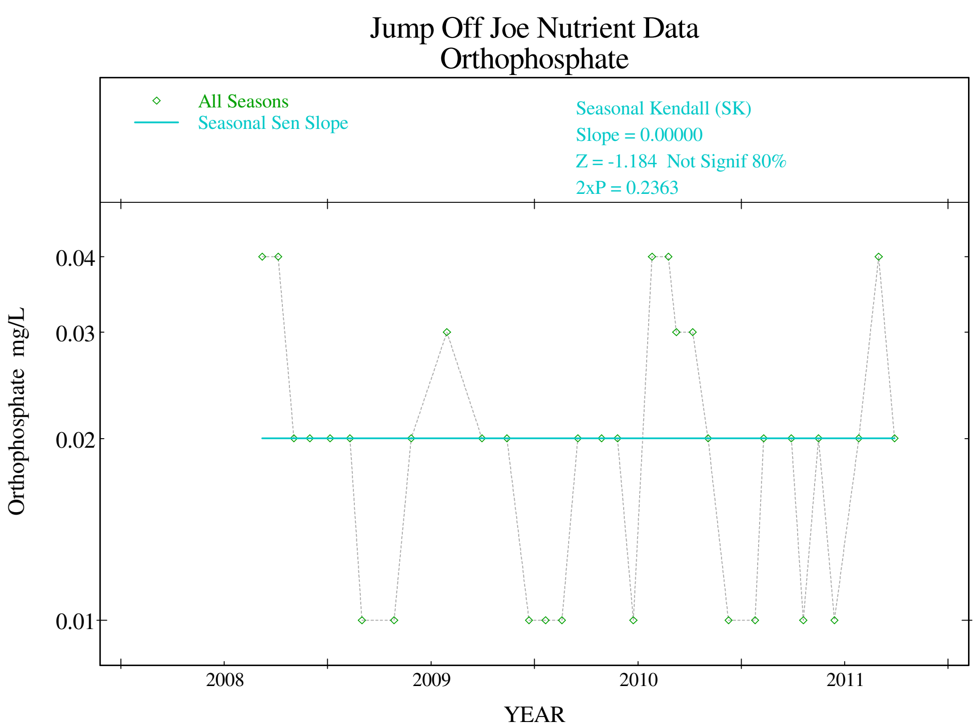
Jump Off Joe 2008 to 2011

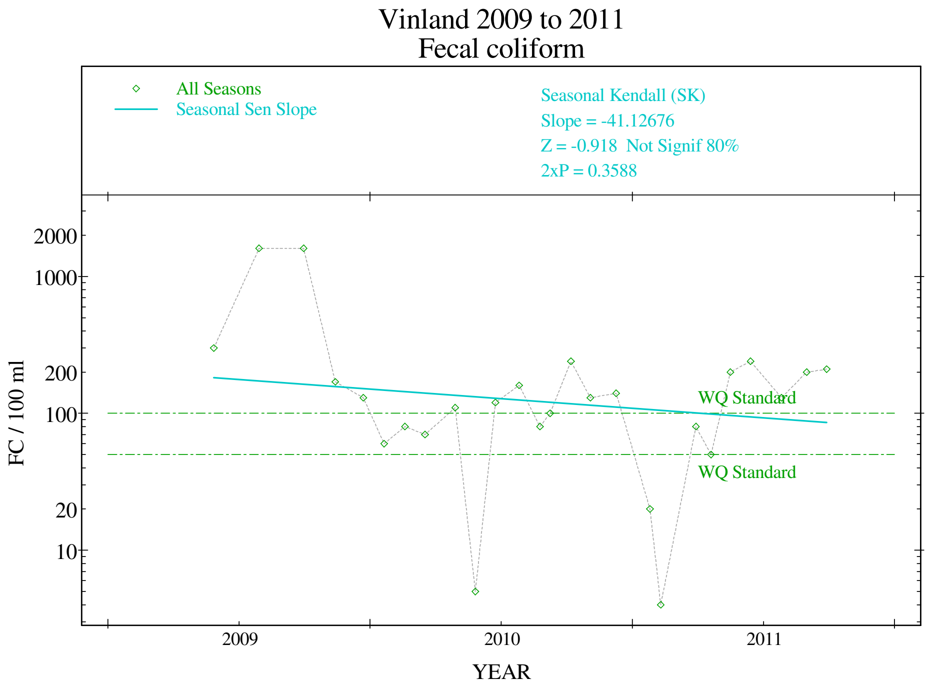


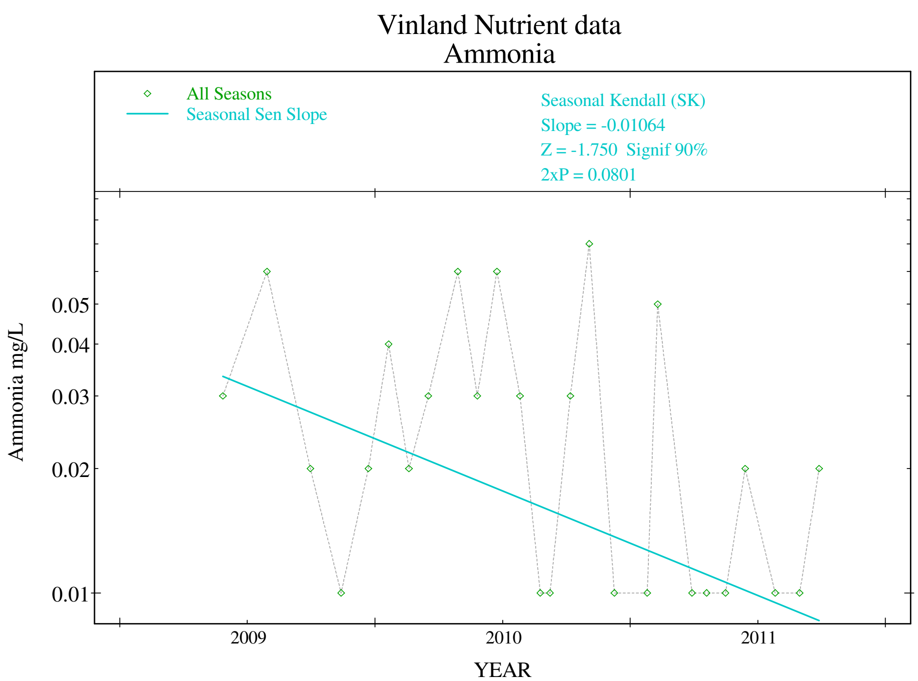
Jump Off Joe Nutrient Data
Ammonia

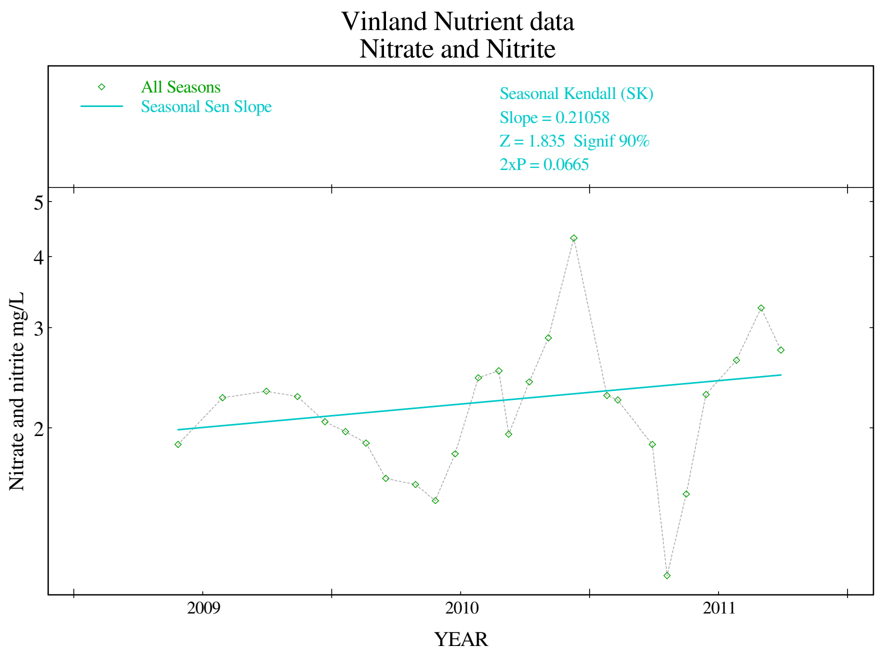



Jump Off Joe Nutrient Data
Nitrate and Nitrite
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = -0.07493
Z = -0.791 Not Signif 80%
2xP = 0.4292
Nitrate_nitrite mg/L
3
2
1
2008
2009
2010
2011
YEAR

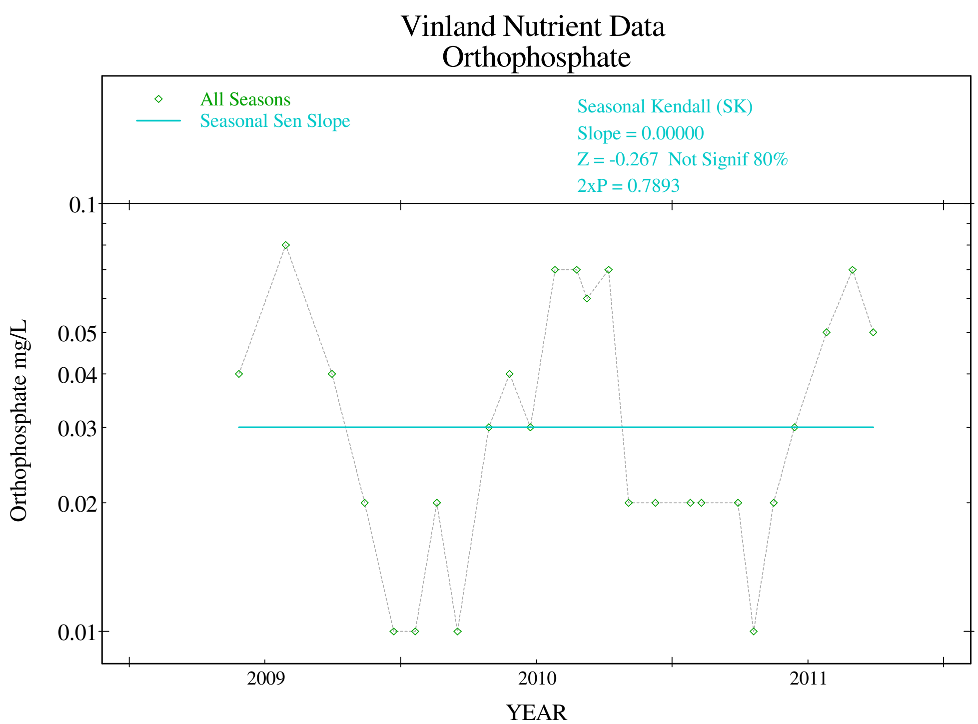

Jump Off Joe Nutrient Data
Orthophosphate
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = 0.00000
Z = -1.184 Not Signif 80%
2xP = 0.2363
Orthophosphate mg/L
0.04
0.03
0.02
0.01
2008
2009
2010
2011
YEAR


Vinland 2009 to 2011
Fecal coliform
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = -41.12676
Z = -0.918 Not Signif 80%
2xP = 0.3588
2000
1000
200
100
20
10
FC / 100 ml
WQ Standard
WQ Standard
2009
2010
2011
YEAR

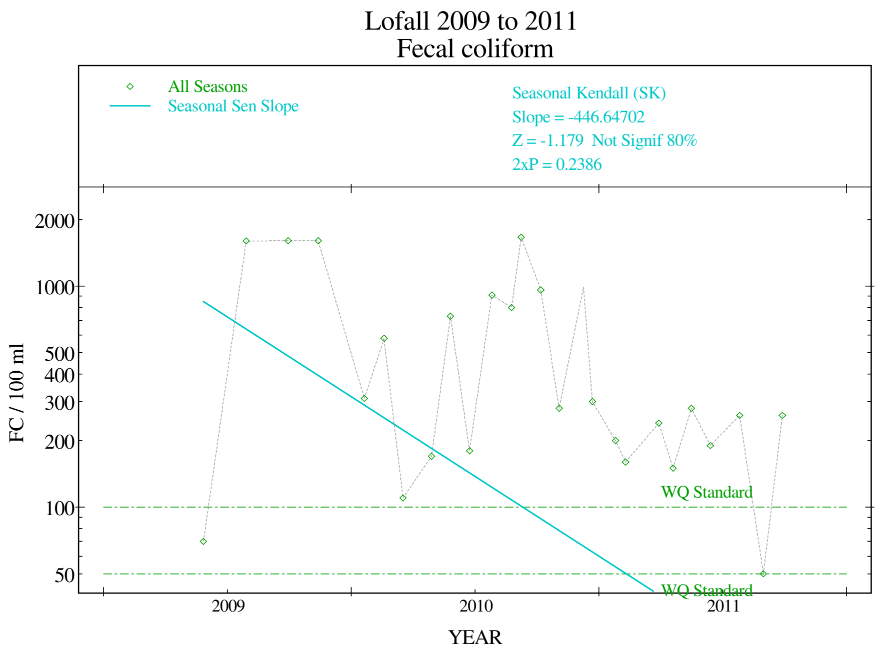

Vinland Nutrient data
Ammonia
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = -0.01064
Z = -1.750 Signif 90%
2xP = 0.0801
0.05
0.04
0.03
0.02
0.01
Ammonia mg/L
2009
2010
2011
YEAR



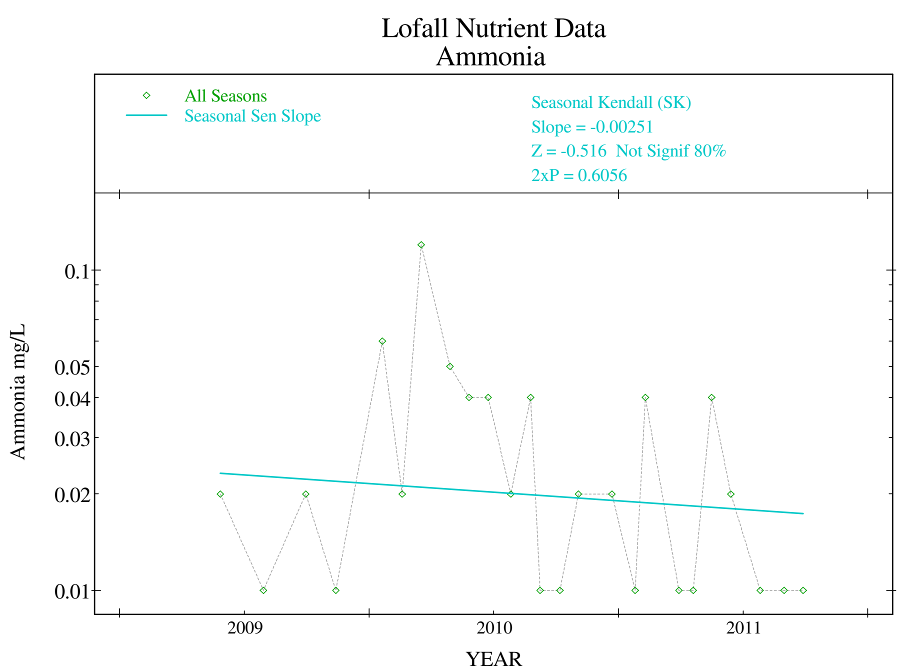
Vinland Nutrient data
Nitrate and Nitrite
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = 0.21058
Z = 1.835 Signif 90%
2xP = 0.0665
5
4
3
2
Nitrate and nitrite mg/L
2009
2010
2011
YEAR



Vinland Nutrient Data
Orthophosphate
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = 0.00000
Z = -0.267 Not Signif 80%
2xP = 0.7893
0.1
0.05
0.04
0.03
0.02
0.01
Orthophosphate mg/L
2009
2010
2011
YEAR

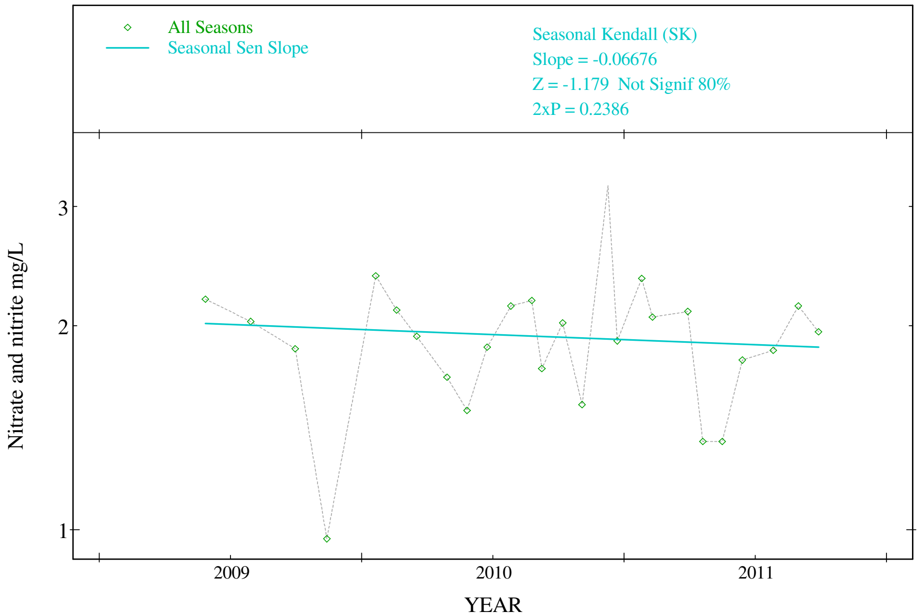


Lofall 2009 to 2011
Fecal coliform
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = -446.64702
Z = -1.179 Not Signif 80%
2xP = 0.2386
FC / 100 ml
2000
1000
500
400
300
200
100
50
WQ Standard
WQ Standard
2009
2010
2011
YEAR

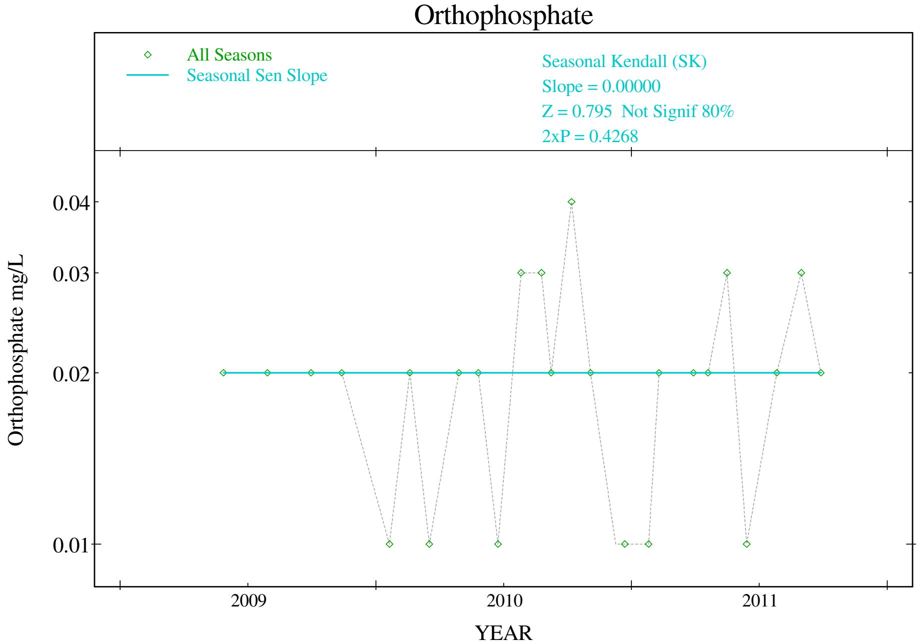


Lofall Nutrient Data
Ammonia
All Seasons
Seasonal Sen Slope
Seasonal Kendall (SK)
Slope = -0.00251
Z = -0.516 Not Signif 80%
2xP = 0.6056
Ammonia mg/L
0.1
0.05
0.04
0.03
0.02
0.01
2009
2010
2011
YEAR

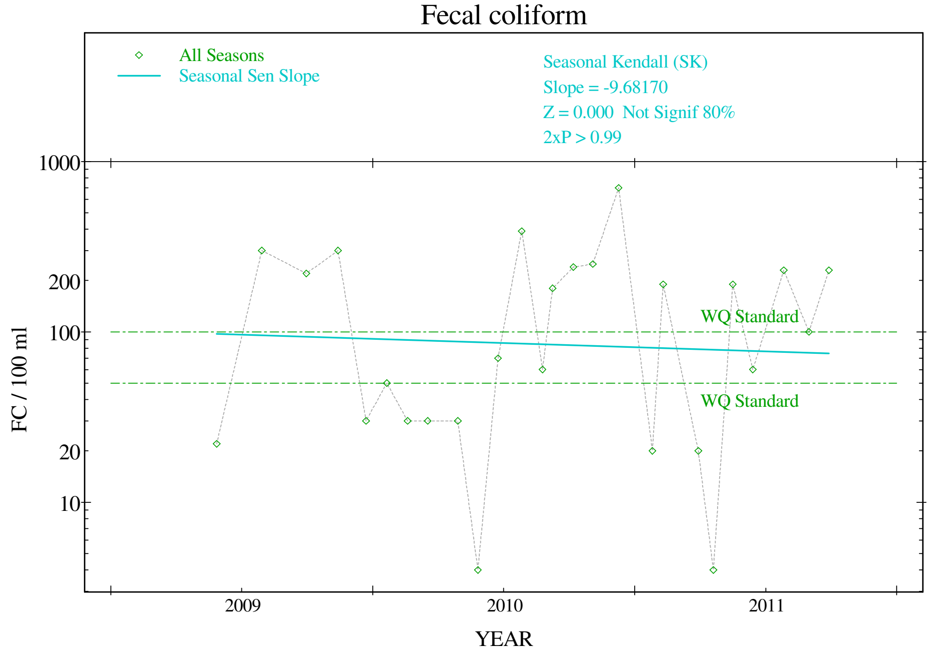
Lofall Nutrient Data
Nitrate and nitrite



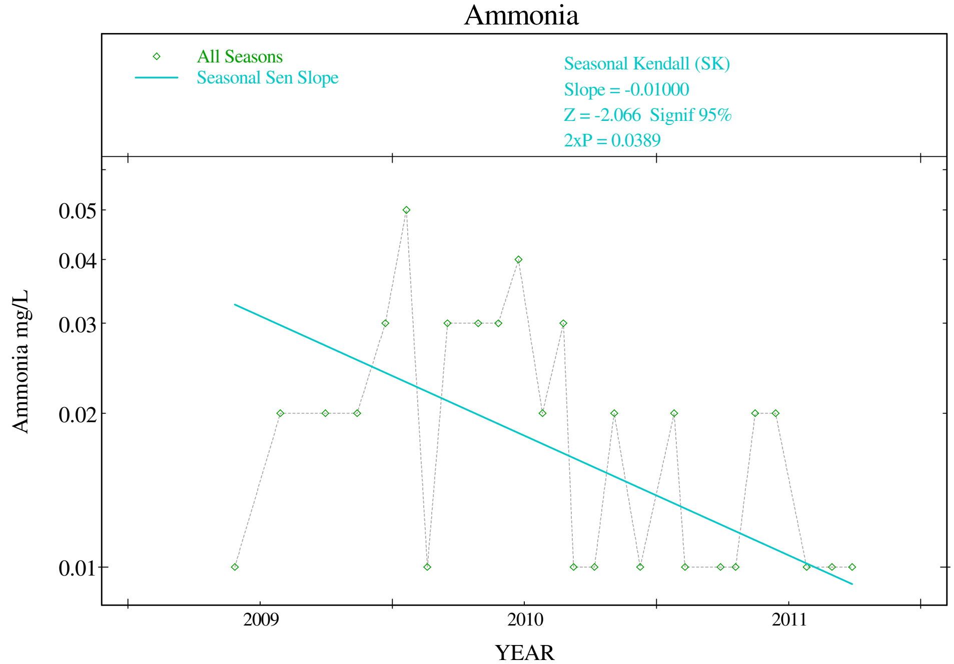
Lofall Nutrient Data
Orthophosphate



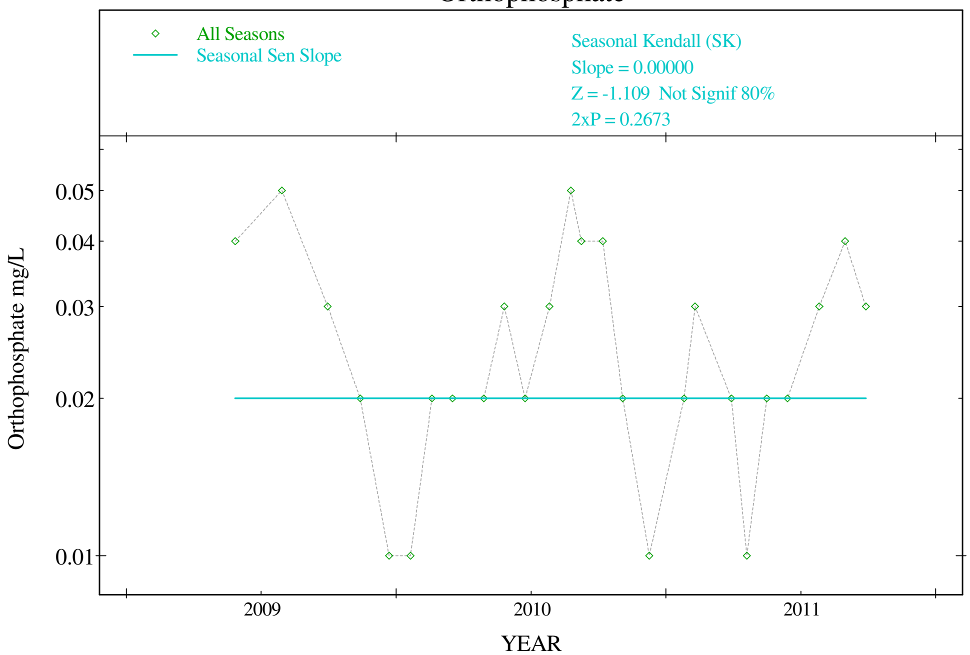
Kinman 2009 to 2011
Fecal coliform



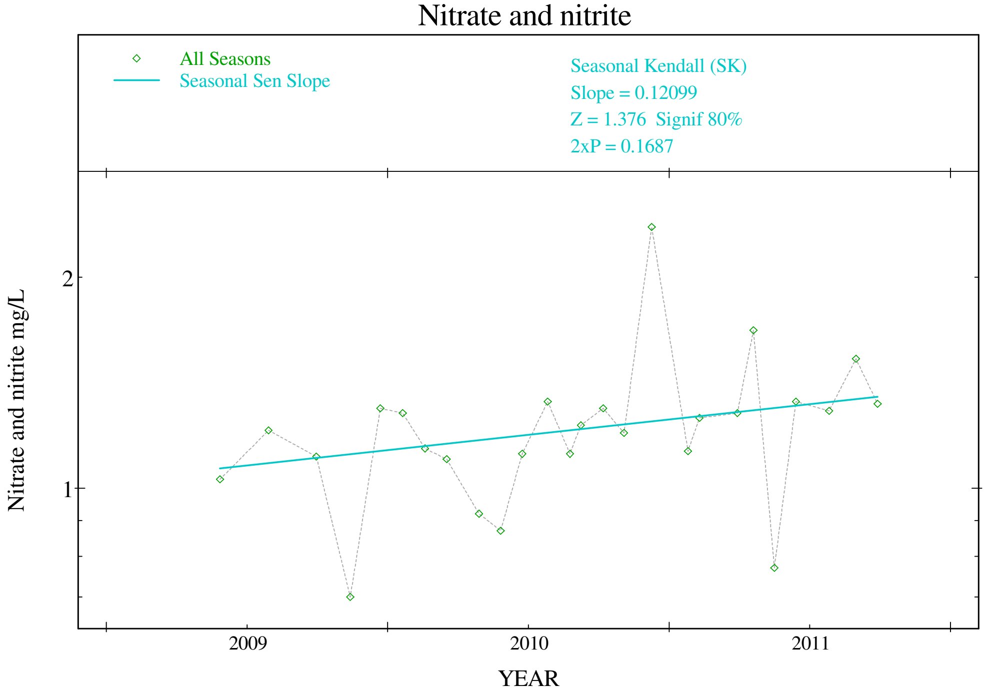
Kinman Nutrient data
Ammonia



Kinman Nutrient Data
Orthophosphate



Kinman Nutrient data
Nitrate and nitrite



Stream Mouth Trend Station Nutrient Data 11/8/2008 to 9/28/2011

	Sample Date	Time	FC/100 ml	Ammonia (mg/L)	Nitrate + Nitrite (mg/L)	O - phosphate (mg/L)	Salinity (ppt)	Flow (cfs)
Jump off Joe Creek JJ01								
JJ01	9/8/2008	945	50	0.01	1.64	0.04		
JJ01	10/6/2008	855	30	<0.01	1.46	0.04		
JJ01	11/3/2008	1315	13	<0.01	1.01	0.02		
JJ01	12/1/2008	1125	4	0.03	2.55	0.02	0.1	
JJ01	1//05/2009	1130	17	0.06	2.24	<0.02	0.1	
JJ01	2/9/2009	1345	4	0.03	2.42	<0.02	0.1	
JJ01	3/2/2009	1240	50	0.02	1.25	<0.01	0.1	
JJ01	4/28/2009	1150	<2	0.02	2.51	0.01	0.1	
JJ01	5/28/2009	1130	13	0.02	2.61	<0.02	0.1	
JJ01	7/30/2009	950	170	<0.01	1.91	0.03	0.1	0.14
JJ01	9/30/2009	1145	110	<0.01	1.75	0.02	0.1	0.05
JJ01	11/13/2009	1045	90	0.04	1.34	<0.02	0.1	5.79
JJ01	12/22/2009	1047	23	0.01	1.57	<0.01	0.1	ND
JJ01	1/20/2010	1050	5	0.04	1.78	<0.01	<0.1	4.35
JJ01	2/18/2010	1122	5	0.02	1.37	0.01	<0.1	2.88
JJ01	3/18/2010	1205	5	0.04	1.93	0.02	<0.1	1.66
JJ01	4/29/2010	1105	20	0.03	1.26	0.02	<0.1	0.78
JJ01	5/27/2010	1120	50	0.03	0.91	0.02	<0.1	0.38
JJ01	6/24/2010	1050	80	0.04	1.64	<0.01	0.1	ND*
JJ01	7/27/2010	1140	200	0.02	1.81	0.04	0.1	ND
JJ01	8/25/2010	1045	40	0.03	1.68	0.04	0.1	ND
JJ01	9/8/2010	1135	10	<0.01	1.49	0.03	0.1	ND
JJ01	10/7/2010	1345	<10	0.01	1.74	0.03	0.1	ND
JJ01	11/3/2010	1140	50	0.03	1.45	0.02	0.1	0.39
JJ01	12/9/2010	1115	120	<0.01	1.94	<0.01	<0.1	6.54
JJ01	1/25/2011	1250	10	<0.01	2.09	0.01	0.1	ND
JJ01	2/9/2011	1305	50	0.01	2.1	0.02	0.1	ND
JJ01	3/30/2011	1125	10	<0.01	1.64	0.02	<0.1	2.38
JJ01	4/20/2011	1105	10	<0.01	1.92	<0.01	<0.1	1.61
JJ01	5/17/2011	1045	140	<0.01	0.72	0.02	<0.1	1.3

JJ01	6/14/2011	1215	70	0.04	1.64	0.01	0.1	0.51
JJ01	7/27/2011	1245	140	<0.01	1.71	0.02	0.1	0.25
JJ01	8/31/2011	1035	920	<0.01	1.89	0.04	0.1	ND
JJ01	9/28/2011	1330	80	0.02	1.55	0.02	0.1	ND
Vinland Creek VC01								
VC01	5/28/2009	1035	300	0.03	1.87	0.04	0.1	ND2
VC01	7/30/2009	910	1601	0.06	2.26	0.08	0.1	ND2
VC01	9/30/2009	1110	1601	0.02	2.32	0.04	0.1	ND2
VC01	11/13/2009	945	170	<0.01	2.27	<0.02	0.1	ND2
VC01	12/22/2009	1240	130	0.02	2.05	<0.01	0.2	ND2
VC01	1/20/2010	1345	60	0.04	1.97	<0.01	0.1	ND2
VC01	2/18/2010	1100	80	0.02	1.88	0.02	0.1	ND2
VC01	3/18/2010	1105	70	0.03	1.63	0.01	<0.1	ND2
VC01	4/29/2010	1000	110	0.06	1.59	0.03	<0.1	ND2
VC01	5/27/2010	1030	5	0.03	1.49	0.04	0.1	ND2
VC01	6/24/2010	955	120	0.06	1.8	0.03	0.1	ND2
VC01	7/27/2010	1045	160	0.03	2.45	0.07	0.1	ND2
VC01	8/25/2010	1005	80	<0.01	2.52	0.07	0.1	ND2
VC01	9/8/2010	1035	100	<0.01	1.95	0.06	0.1	ND2
VC01	10/7/2010	1200	240	0.03	2.41	0.07	0.1	ND2
VC01	11/3/2010	940	130	0.07	2.88	0.02	0.1	ND2
VC01	12/9/2010	140	140	<0.01	4.31	0.02	0.1	ND2
VC01	1/25/2011	1320	20	<0.01	2.28	0.02	0.1	ND2
VC01	2/9/2011	1335	4	0.05	2.24	0.02	0.1	ND2
VC01	3/30/2011	1045	80	<0.01	1.87	0.02	0.1	ND2
VC01	4/20/2011	1000	50	<0.01	1.1	0.01	0.1	ND2
VC01	5/17/2011	1015	200	0.01	1.53	0.02	0.1	ND2
VC01	6/14/2011	1150	240	0.02	2.29	0.03	0.1	ND2
VC01	7/27/2011	1000	130	0.01	2.63	0.05	0.1	ND2
VC01	8/31/2011	1000	200	<0.01	3.25	0.07	0.1	ND2
VC01	9/28/2011	945	210	0.02	2.74	0.05	0.1	ND2
VC01								
Lofall Creek LF01								
LF01	5/28/2009	1331	70	0.02	2.19	<0.02	0.1	0.12
LF01	7/30/2009	1055	1600	0.01	2.03	0.02	0.1	0.04
LF01	9/30/2009	1317	>1600	0.02	1.85	<0.02	0.1	0.02
LF01	11/13/2009	925	>1600	0.01	0.97	<0.02	0.1	1.57
LF01	12/22/201	1345	300	0.02	1.90	<0.01	0.1	ND

	0							
LF01	1/20/2010	1255	310	0.06	2.37	0.01	0.2	0.62
LF01	2/18/2010	1315	580	0.02	2.11	0.02	0.1	0.63
LF01	3/18/2010	1355	110	0.12	1.93	0.01	<0.1	ND
LF01	4/29/2010	1255	170	0.05	1.68	0.02	<0.1	0.48
LF01	5/27/2010	1345	730	0.04	1.5	0.02	0.1	0.21
LF01	6/24/2010	1255	180	0.04	1.86	<0.01	0.1	ND
LF01	7/27/2010	1340	910	0.02	2.14	0.03	0.1	0.1
LF01	8/25/2010	1250	800	0.04	2.18	0.03	0.1	ND
LF01	9/8/2010	1345	1660	<0.01	1.73	0.02	0.1	ND
LF01	10/7/2010	1040	960	0.01	2.02	0.04	0.1	ND
LF01	11/3/2010	1055	280	0.02	1.53	0.02	0.1	0.19
LF01	12/9/2010	1405	990	0.02	3.22	0.01	0.1	0.7
LF01	1/25/2011	1235	200	0.01	2.35	0.01	0.1	ND
LF01	2/9/2011	1240	160	0.04	2.06	0.02	0.1	ND
LF01	3/30/2011	1155	240	<0.01	2.1	0.02	0.1	0.6
LF01	4/20/2011	1135	150	<0.01	1.35	0.02	0.1	0.59
LF01	5/17/2011	1130	280	0.04	1.35	0.03	0.1	0.61
LF01	6/14/2011	1315	190	0.02	1.78	0.01	0.1	0.18
LF01	7/27/2011	1155	260	<0.01	1.84	0.02	0.1	0.14
LF01	8/31/2011	1235	50	<0.01	2.14	0.03	0.1	ND
LF01	9/28/2011	1125	260	0.01	1.96	0.02	0.1	ND
LF01								
Kinman Creek KN01								
KN01	5/28/2009	1405	22	0.01	1.03	0.04	0.1	0.79
KN01	7/30/2009	1120	300	0.02	1.21	0.05	0.1	0.57
KN01	9/30/2009	1340	220	0.02	1.11	0.03	0.1	0.54
KN01	11/13/2009	905	300	0.02	0.70	<0.02	0.1	ND
KN01	12/22/2009	1415	30	0.03	1.30	0.01	0.1	ND
KN01	1/20/2010	1315	50	0.05	1.28	<0.01	0.2	ND
KN01	2/18/2010	1420	30	0.01	1.14	0.02	0.1	3.75
KN01	3/18/2010	1420	30	0.03	1.10	0.02	<0.1	ND
KN01	4/29/2010	1325	30	0.03	0.92	0.02	<0.1	2.23
KN01	5/27/2010	1440	4	0.03	0.87	0.03	0.1	1.56
KN01	6/24/2010	1325	70	0.04	1.12	0.02	0.1	ND
KN01	7/27/2010	1410	390	0.02	1.33	0.03	0.1	1.09

KN01	8/25/2010	1315	60	0.03	1.12	0.05	0.1	ND
KN01	9/8/2010	1405	180	<0.01	1.23	0.04	0.1	ND
KN01	10/7/2010	940	240	0.01	1.3	0.04	0.1	ND
KN01	11/3/2010	1015	250	0.02	1.2	0.02	0.1	2.54
KN01	12/9/2010	1355	700	0.01	2.36	<0.01	0.1	ND
KN01	1/25/2011	1220	20	0.02	1.13	0.02	0.1	ND
KN01	2/9/2011	1140	190	0.01	1.26	0.03	0.1	ND
KN01	3/30/2011	1240	20	<0.01	1.28	0.02	0.1	3.72
KN01	4/20/2011	1240	4	<0.01	1.68	0.01	0.1	ND
KN01	5/17/2011	1255	190	0.02	0.77	0.02	0.1	2.65
KN01	6/14/2011	1335	60	0.02	1.33	0.02	0.1	1.48
KN01	7/27/2011	1115	230	<0.01	1.29	0.03	0.1	1.22
	8/31/2011	1150	100	<0.01	1.53	0.04	0.1	ND
	9/28/2011	1055	230	0.01	1.32	0.03	0.1	ND

*ND - No data was available

ND2 - No data was avaialble at VC01 due to restricted access, culvert obstruction and limited flow.