Quality Assurance Project Plan

Sequim-Dungeness Clean Water District Pollution Identification & Correction, Trends, and Project Monitoring

February 2015

Prepared for:
Washington State Department of Health

Prepared by:
Clallam County Department of Public Works-Roads
Clallam County Department of Health and Human Services
Clallam Conservation District

Publication Information

The Clallam Conservation District is cooperating with the Clallam County Departments of Public Works-Roads and Health and Human Services (Environmental Health Section), as well as the Sequim-Dungeness Clean Water Work Group (CWWG), to develop this Pollution Identification and Correction (PIC) Program QAPP for the Sequim-Dungeness Clean Water District. The work described herein is supported by a grant from the Washington State Department of Health (WDOH, contract N20002) which administers U.S. Environmental Protection Agency National Estuary Program (EPA NEP) funding (federal grant PC-00J32601) for the State's Puget Sound Pathogen Prevention, Reduction and Control program. The contents of the QAPP do not necessarily reflect the views and policies of the EPA or WDOH, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

This QAPP is available on Clallam Conservation District's website at www.clallamcd.org. It is also available on request from WDOH. PIC and other water quality monitoring data from this project will be available from Clallam County Health and Human Services, Environmental Health Section. Appropriate data will also be uploaded to the Washington State Department of Ecology (Ecology) Environmental Information Management (EIM) database: www.ecy.wa.gov/eim/index.htm

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1.0 Title Page/Table of Contents/Distribution List

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February 2015

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2.0 Abstract

This monitoring project has three objectives:

1. **Trends Monitoring:** Identify trends in water quality by collecting ambient water quality data on fecal coliform and nutrients in streams within the Sequim-Dungeness Clean Water District.
2. **Pollution Identification and Correction (PIC) Project Monitoring:** Identify sources of fecal coliform pollution through segmented sampling in order to target remediation efforts.
3. **Implement PIC Pilot Project:** Identify sources of fecal coliform pollution in three sub-watersheds in the PIC pilot project area.

The study area comprises the boundaries of the Sequim Bay-Dungeness Watershed Clean Water District, a shellfish protection district created by Clallam County in 2000 (see Figure 1). Clallam County Environmental Health will be the lead agency, to be assisted by staff and volunteers from Streamkeepers of Clallam County and the Jamestown S'Klallam Tribe.

3.0 Background

This section was adapted from the *Quality Assurance Project Plan for the Clallam Marine Recovery Area (MRA) Septic Solutions Project* (Soule, 2013).

Numerous studies on surface and ground water quality have been conducted over the past several decades within the Sequim Bay-Dungeness Watershed Clean Water District (CWD), particularly the Dungeness Bay drainage. Background information presented in this QAPP is based on the following documents:

1. Dungeness River and Matriotti Creek fecal coliform Total Maximum Daily Load (TMDL) (Sargeant 2002) and post-TMDL data review (Sargeant 2004b).
2. Dungeness Bay fecal coliform TMDL (Sargeant 2004a).
3. An initial shellfish closure response plan, a.k.a, Detailed Implementation Plan, was integrated with Water Cleanup Plans associated with both TMDLs into a "Clean Water Strategy" (Streeter and Hempleman 2004). This Strategy has guided the activities of the Dungeness Clean Water Work Group since it was prepared. Status reports on its implementation are submitted annually by Clallam County to the Washington State Department of Health.
4. Microbial source tracking found evidence that many animal groups, including humans, contribute to bacterial contamination in Dungeness watershed and Bay (Woodruff et al 2009a).
5. Effectiveness monitoring, including monthly sampling at dozens of sites over a two-year period for both fecal coliform and nutrients (Woodruff et al 2009b).
6. The Washington State Department of Ecology conducted a fecal coliform TMDL effectiveness monitoring project (Ecology 2009, 2010).

3.1 Location & Description of Study Area

The CWD is located in the eastern portion of Clallam County, Washington, on the northeast coast of the Olympic Peninsula, including the City of Sequim (see Figure 1). The western edge of the CWD is defined by land draining to Bagley Creek and the eastern edge extends to the area draining to Sequim Bay on the Miller Peninsula. The CWD drains into the marine waters of the Strait of Juan de Fuca, including Dungeness and Sequim bays.

The Bays have traditionally been rich in littleneck clams. Native people have harvested shellfish here throughout tribal memory. In the 1900s, commercially farmed oysters provided local jobs. Recreational harvest has been popular with residents and tourists, and contributes to the image of Sequim as a beautiful and pristine area (Streeter and Hempleman 2004).

The climate in this region of the Olympic Peninsula is considerably drier than elsewhere in western Washington because it lies in the rain shadow of the Olympic Mountains. Precipitation varies from 15 inches near Sequim to 80 inches in the headwaters of the Dungeness River. Due to the low rainfall, the lower Dungeness valley contains about 170 miles of irrigation water conveyance to support approximately 6,000 acres in agricultural production.

Land use within the study area is mostly rural residential and agricultural. Historically most of the study area, outside of the city of Sequim, was farmland. A population increase during the past 20 years has resulted in a significant amount of farmland being converted to residential use. Commercial uses are mostly located within the city of Sequim and the Carlsborg urban growth area. The city of Sequim is on a sewer system, while residential and commercial businesses in the rural areas use on-site septic systems (OSS). However, a sewer collection system is currently being designed for the Carlsborg urban growth area. The collected sewage will be transferred to the Sequim sewage treatment plant.

OSS failures can contribute to elevated fecal coliform levels in freshwater tributaries to the bays. Citizen education about proper OSS operation and maintenance, regular OSS inspections, and system repairs continue to reduce OSS sources of pollution. Within the past six years, the Clallam County Departments of Community Development and Health and Human Services (Environmental Health Section), and the Jamestown S'Klallam Tribe (JSKT) decommissioned eight on-site systems from the mouth to river mile 1.0 for river restoration purposes. Clallam Conservation District recently initiated a cost sharing program to assist with the repair of failing OSSs that are suspected of impacting water quality.

Projects conducted by the Clallam Conservation District and the Sequim-Dungeness Water Users Association have resulted in the piping of many miles of open irrigation ditches. These projects reduce the amount of water diverted from the Dungeness River, help prevent pollutants from entering the irrigation system, and when totally enclosed, eliminate tailwater discharges to marine and fresh waters.

Major Streams within the Clean Water District

Much of the following information was taken from the Elwha-Dungeness Watershed Plan (Elwha-Dungeness Planning Unit 2005).

<u>Tributaries to Sequim Bay:</u>

- Chicken Coop Creek enters the southeast corner of Sequim Bay to the northeast of Jimmycomelately Creek. The mainstem is 3.1 miles in length with an additional 3.1 miles in tributaries.
- No Name Creek, draining to Sequim Bay just south of Chicken Coop Creek, is a generally forested, short, steep creek, relatively undeveloped and minimally impacted by nonpoint sources of pollution.
- Dean Creek is an intermittent stream draining ~3 square miles, flowing ~4 miles from headwaters at an elevation of ~1900’ into the southwest corner of Sequim Bay.
- State Park Creek is the largest of several small drainages emptying into the western side of Sequim Bay north of Dean Creek, comprising mixed land uses, including forestry, small farms, and residences.

- Jimmycomelately Creek is the largest stream in the Sequim Bay watershed, draining an extended interior foothill watershed of ~16 square miles, with a vertical drop of 2500’ in less than 9 miles, emptying at the south end of Sequim Bay.
- Johnson Creek is the third largest stream within the Sequim Bay watershed (~6.2 square miles), flowing northeast from the foothills of the Olympic Mountains into the west side of Sequim Bay at Pitship Point (near the John Wayne Marina). The total length of Johnson Creek is ~7.4 miles. Five river miles are attributed to the mainstem, while two miles consist of tributaries. The upper creek flows through a substantial ravine, while the lower two miles are low gradient.
- Bell Creek is a relatively small drainage entering Washington Harbor on the marine shoreline just north of the mouth of Sequim Bay. It is 3.8 miles long and drains a watershed of over 8.9 square miles. Bell Creek has served historically as a conveyance for irrigation water, and much of the creek has been heavily altered by rural and urban development.

<u>Tributaries to Dungeness Bay:</u>

- The Dungeness River flows north into the outer Dungeness Bay just east of the opening between Graveyard and Cline Spits. The river is 32 miles long and drains 172,517 acres. The upper two-thirds of the watershed are within national forest and national park areas. The river contributes the vast majority of freshwater to the Bay (Soule 2013).
- Matriotti Creek is 9.3 miles long and is the largest low-elevation tributary to the Dungeness River, flowing into it on the left bank at RM 1.9.
- Lotzgesell Creek is a tributary to Matriotti Creek that encompasses similar land uses.
- Hurd Creek is a small, low-elevation tributary approximately one mile long that flows into the Dungeness River on the right bank at RM 2.7.
- Meadowbrook Creek flows north into the Bay 0.4 miles east of the Dungeness River mouth. Meadowbrook Slough is approximately 0.5 miles long and flows into Meadowbrook Creek just before the creek enters the bay. In recent history, Meadowbrook Creek and Slough merged with the lowest reach of the Dungeness River flowing north; however, for several years the River has been discharging on the west side of its delta and Meadowbrook has discharged directly to the Bay.
- Golden Sands Slough discharges into outer Dungeness Bay southeast of Meadowbrook Creek. The slough is a series of constructed channels in an estuarine wetland area. Water in the slough tends to be saline and stagnate (Sargeant 2002).
- Cooper Creek discharges into Dungeness Bay just southeast of Golden Sands Slough. The creek is fed by wetlands, and the upland area is undeveloped. The lower portion of the stream channel has been straightened, and the mouth is controlled by a tide gate.
- Cassalery Creek is approximately 4.2 miles long and discharges to Dungeness Bay just southeast of Cooper Creek.
- Gierin Creek discharges into Dungeness Bay just southeast of Cassalery Creek. It is fed by steep-gradient groundwater discharge from the north slopes of the Olympic Mountains. There are 8.3 miles of streams and tributaries in the 3.1 square-mile watershed.

- An un-named intermittent stream periodically discharges to inner Dungeness Bay at the base of Dungeness Spit. Road-side ditches act as stormwater conveyance and may also be used for occasional flushing of irrigation pipelines under the control of the Cline Irrigation District. These conveyances are not included in this study but may be studied at some point under PIC monitoring if the area becomes a priority for remediation.

<u>Tributaries to the Strait of Juan de Fuca west of Dungeness Bay:</u>

- McDonald Creek is a significant independent drainage, entering the Strait of Juan de Fuca between the western end of Dungeness Spit and Green Point. Its 13.6 miles drain ~23.0 square miles of the northeast flank of Blue Mountain, with headwaters originating at ~4,700', flowing through a deeply incised coastal upland and marine bluff.
- Agnew Ditch is part of Sequim's irrigation ditch system, originating from the Dungeness River, then being conveyed for several miles via McDonald Creek before irrigating the Agnew area, where it is sometimes known as Agnew Creek, and emptying to the Strait.
- Siebert Creek, 12.4 miles long, drains 19.5 square miles of the northwest flank of Blue Mountain and is a significant independent drainage, entering the Strait at Green Point. The watershed includes 31.2 miles of mainstem stream and tributaries, much of which is well incised, with its upper watershed reaching an elevation of 3,800'. It is the westernmost stream influenced directly by Dungeness area irrigation flows.
- Bagley Creek is a medium-sized independent drainage, entering the Strait ~2 miles west of Green Point. It is the westernmost watershed of the Clean Water District. The drainage has approximately 9.5 miles of streams and tributaries.

Impairment determinations – Fecal coliform bacteria

Fecal coliform (FC) concentrations in Matriotti Creek were found to exceed water quality standards in 1991. Matriotti Creek was placed on Washington's 303(d) list of impaired waters in 1996. Dungeness Bay continued to meet water quality standards through 1996.

Like small streams, the network of irrigation ditches was found to be an additional conduit for fecal coliform to enter Dungeness Bay and its tributaries. Agricultural best management practice implementation and the piping of open ditches have reduced fecal coliform inputs to the irrigation system.

In 1997, the Washington State Department of Health (DOH) reported increasing levels of FC bacteria in Dungeness Bay near the mouth of the Dungeness River. Bacteria levels continued to increase in later monitoring activities, with higher levels of bacteria occurring in inner Dungeness Bay. As a result, in 2000 DOH closed 300 acres near the mouth of the Dungeness River to shellfish harvest. In 2001, 100 more acres were added to the closure area. Then, in 2003, based on a continuing decline in water quality, 1150 acres from the inner portion of Dungeness Bay was reclassified from Approved to Conditionally Approved and an additional 250 acres from the outer bay were reclassified from Approved to Prohibited. Shellfish harvest is allowed in the Conditionally Approved area from February to October.

Since 2003, DOH has gradually upgraded the classification of several stations in Dungeness Bay from “Prohibited” to "Conditionally Approved," meaning that shellfish harvest is open from February through October but closed in the rainy season—from November through January. In 2011, 500 acres in the bay were upgraded from “Prohibited” to “Conditionally Approved.” Four sites that are near or relatively close to the mouth of the River remain closed year round (DOH 2012). Please refer to Figure 2 for a map of DOH sampling locations and classifications.

3.2 Total Maximum Daily Load (TMDL) studies

TMDL studies were conducted for both the lower Dungeness River watershed (Sargeant 2002) and Dungeness Bay (Sargeant 2004a). The main objective for both studies was to determine load reductions for FC bacteria. This was done by estimating pollutant loads and concentrations for tributaries to the bay, modeling an acceptable loading capacity, and recommending load allocations.

The *Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study* (Sargeant 2002) measured FC concentrations in several freshwater tributaries to Dungeness Bay in 1999 and 2000. The purpose of the study was to determine the freshwater sources of FC that discharge to the bay. The study area included the lower Dungeness River, Hurd Creek, Matriotti Creek, Meadowbrook Creek, and Meadowbrook Slough. The results of the study set target reductions for FC concentrations in these and other tributaries to the Bay.

Rensel Associates conducted bacteria sampling in Dungeness Bay and ditches discharging into the Bay from October 2001 to 2002. A circulation and bathymetry study was also conducted and documented in an April 2003 final technical report (Rensel 2003). The Rensel study was summarized and used as the basis for the *Dungeness Bay Fecal Coliform Bacteria Total Maximum Daily Load Study* (Sargeant 2004a). The TMDL addressed FC bacteria in inner and outer Dungeness Bay, irrigation ditches to the inner Dungeness Bay, and the Dungeness River. Target reductions for FC concentrations were set for the Dungeness River and irrigation ditches discharging to inner Dungeness Bay.

TMDL study findings included:

- *Elevated FC levels are found in several freshwater tributaries flowing into the bay. More stringent load reductions are needed in several upstream tributaries to meet the marine FC criterion in Dungeness Bay, including the Dungeness River (mouth to RM 0.3), Matriotti Creek, Hurd Creek, Meadowbrook Creek, Meadowbrook Slough, Golden Sands Slough, and Cooper Creek.*
- *There are no permitted point source discharges in the study area.*
- *FC pollution is attributed to nonpoint sources, including on-site septic systems, pet and livestock waste, stormwater runoff, and wildlife.*
- *The critical period for inner Dungeness Bay is November through February, and the critical period for the outer Dungeness Bay near the mouth of the Dungeness River is March through July.*

Post-TMDL data collection and analysis

Clallam County and the Jamestown S'Klallam Tribe conducted FC sampling at many of the freshwater TMDL sites from 2001 to 2004. These data, and data collected by Ecology's ambient monitoring program, were compared to the initial TMDL FC data collected in 1999 and 2000. The results of this analysis were presented in the *Dungeness River and Matriotti Creek Post-Total Maximum Daily Load Data Review* (Sargeant 2004b).

The purpose of the 2004 post-TMDL analysis was to determine whether FC bacteria levels were improving in the tributaries to the bay and if the cleanup actions implemented had been effective. The analysis found significant improvement in some areas and seasons. The 2001-2004 data showed that further reductions are necessary even though the trend during certain critical seasons was showing a decrease in FC concentrations. The Matriotti Creek sites showed the greatest decline and may have contributed to a slight decline in FC concentrations in the Dungeness River. Meadowbrook Creek showed a slight increase in FC concentrations (Sargeant 2004a).

More recent FC data collection

In 2005, Clallam County received a Centennial Clean Water Fund grant from Ecology and the Jamestown S'Klallam Tribe received an EPA Targeted Watershed Grant. Portions of both grant funds were for FC monitoring in the Dungeness watershed (Streeter 2005).The County and Tribe combined efforts to monitor 58 sites monthly in the Dungeness watershed for FC from September 2005 to August 2008. Some of these sites were selected to fill gaps in ambient water quality information. Twenty-two of the TMDL study sites were included to continue evaluating the effectiveness of TMDL implementation. Irrigation ditches included in the *Dungeness Bay TMDL* study were also sampled when water was flowing at those sites. Seven of the 12 TMDL sites targeted for remediation of FC counts were monitored consistently between 1999 and 2009.

Extensive FC data sets resulting from this monitoring have been analyzed and reported in publications by Battelle (Woodruff et al 2009b) and Ecology (2010). Both reports present multiple diagrams and illustrations of trends by parameter and sub-area; the reader is referred to the online reports to view specific figures of interest:

- Battelle: "Effectiveness Monitoring of Fecal Coliform Bacteria and Nutrients in the Dungeness Watershed, Washington"
- Ecology: "Dungeness Bay and Dungeness River Watershed Fecal Coliform Bacteria Total Maximum Daily Load Water Quality Effectiveness Monitoring Report" http://www.ecy.wa.gov/pubs/1003032.pdf

The DOH continues to conduct monthly sampling in Dungeness Bay to monitor FC pollution in shellfish growing areas as part of the National Shellfish Sanitation Program (DOH 2009).

Analyses of DOH data found evidence of a reduction in FC pollution from 2003-2011 (DOH 2012). Some areas are "Conditionally Approved" (closed Nov–Feb) rather than "Approved" because water quality in general is consistently poor in winter months.

DOH shoreline surveys conducted in 2007 and 2008 traced elevated FC levels to both Golden Sands Slough and Cassalery Creek. Further evaluation in Golden Sands Slough found problems with on-site septic systems and direct sewage discharge to the slough. As a result, DOH prohibited commercial shellfish harvest within 140-meter and 121-meter radii around the mouths of Golden Sands Slough and Cassalery Creek.

From April 2013 to March 2014, Clallam County Environmental Health, in partnership with Clallam County Streamkeepers and the Jamestown S'Klallam Tribe, conducted a water quality monitoring project under an Ecology grant. This project had two objectives (Soule 2013):

1. Assess the current status of fecal coliform bacteria and nutrient concentration in the lower Dungeness River and several area streams through ambient monitoring. Fourteen stations were monitored for the ambient study.
2. Study the potential effectiveness of septic system repair in improving surface water quality in adjacent waterways. Unfortunately no opportunities for septic system repair occurred during the project period, thus system repair effectiveness could not be evaluated.

Data from this project has been recently analyzed and is expected to help with initial prioritization for targeted PIC monitoring (Clallam County Health & Human Services, Environmental Health Section (CCEH) and Clallam County Public Works-Roads, Streamkeepers 2014).

Nutrient data collection and analysis

There are no water quality criteria for nutrients in streams; however, when nutrients are found at high levels, they can have a negative impact on aquatic systems. Anthropogenic alterations within a watershed generally lead to higher nutrient concentrations.

The chemical speciation of nutrients becomes an important factor both for evaluation of ecological impacts and as a tracer of source contaminants. For example, ammonia is generally found in areas with low oxygen availability (i.e. groundwater) and is rapidly oxidized to nitrate in contact with surface waters. Its presence in surface waters, even at low levels, could indicate close proximity to potential sources such as septic systems or agricultural runoff.

Targeted Watershed Initiative funding from EPA obtained by the Jamestown S'Klallam Tribe for 2005-08 sampling included collection of nutrient (nitrogen and phosphorus) data from all sites. These data (over 830 nutrient observations), Battelle (Woodruff 2009b) provided a characterization of nutrients in the watershed, including descriptive statistics and general trends. For a general reference, nutrient data were compared to historic data (nitrate and phosphate) collected at another location in the upper Dungeness River between 1959 and 1970. Study findings include:

- For the most part, recent nutrient levels in the lower Dungeness watershed were not very different than historic values, although a direct site comparison could not be made. There were, however, several trends in the data that warrant further investigation.

- Ammonia (NH4) concentrations were slightly higher in all Dungeness River tributaries and Bell Creek compared to those detected in the River or Johnson Creek.
    - In addition, ammonia levels were an order of magnitude higher at Golden Sands Slough, another freshwater station close to the Bay.
    - There were minimal seasonal changes noted in ammonia concentrations, another possible indication of septic system influence since septic system input generally varies less by season than other anthropogenic nutrient sources that get incorporated into seasonal runoff.
- Total inorganic nitrogen (TIN) was higher in Matriotti Creek, Bell Creek, Golden Sands Slough and the irrigation ditches compared to other water bodies and stations.
    - TIN is an indicator of a number of possible anthropogenic inputs.
    - Overall, the TIN data was higher during the wet season compared to the dry season.
- Phosphate (PO4) and total phosphorus (TP) concentrations showed a similar trend of elevated concentrations in Bell Creek, Golden Sands Slough and the irrigation ditches, with higher concentrations during the wet seasons compared to the dry season.
- There was no significant correlation between nutrients (those mentioned above, plus nitrate [NO3] and nitrite [NO2]), freshwater FC concentrations, and daily rainfall determined for the days of sample collection. The lack of a statistically significant correlation may be indicative of varying sources of FC and nutrients; however, analysis of rainfall patterns over a longer duration might demonstrate a correlation.

4.0 Project Description

General Description

While water quality improvements have been made within the CWD, areas of Dungeness Bay remain closed to shellfish harvesting, because of high fecal coliform bacteria levels. The majority of water quality monitoring that has occurred to date has been project specific and grant funded. This has made the collection and analysis of long-term water quality data extremely difficult. The planned Trends Monitoring Program (Figure 3) will provide additional data that will be used to prioritize waterways for targeted water quality improvement projects (Pollution Identification & Correction Projects). Through the planned PIC Project Monitoring Program, segmented sampling will be conducted to identify pollution “hot spots” and sources that can be corrected. The PIC Pilot Project will test the newly developed PIC plan in a priority sub-watershed within the Clean Water District. The priority sub-watershed project area includes the Meadowbrook creek drainage, Golden Sands and the Cooper Creek drainage (see Figure 2).

4.1 Project goals

There are three project goals. The goal of the Trends Monitoring Program is to collect bacteria and nutrient data for the purpose of assessing water quality trends at the mouths of all significant waterways throughout the Clean Water District, thus determine which waterways to focus targeted remediation efforts. The goal of the PIC Project Monitoring Program is to identify the sources of water pollution in PIC project areas so that they may be corrected. The goal of the PIC Pilot project is to identify and correct pollution sources, in sub-watersheds located within the PIC pilot project work area.

4.2 Project Objectives

Trends Monitoring Program

A. Identify water quality trends for fecal coliform and nutrient pollution within the CWD.
B. Identify waterways that are being impacted by fecal coliform and nutrient pollution.
C. Prioritize waterways for PIC project implementation.

PIC Project Monitoring Program

A. Identify sources of fecal coliform pollution through segmented sampling.
B. Evaluate effectiveness of pollution correction efforts.

PIC Pilot Project

A. Pilot the newly developed PIC plan in a priority sub-watershed with the CWD.
B. Identify sources of fecal coliform pollution through segmented sampling in a priority sub-watershed within the CWD: Meadowbrook Creek, Golden Sands and Cooper Creek.

4.3 Information needed and sources

In addition to the studies reviewed in prior sections, this monitoring plan depends on collaboration between the members of the Sequim Bay-Dungeness Watershed Clean Water Work Group (CWWG). A subcommittee of CWWG members (consisting of both the signatories and recipients of this plan) has consulted extensively in devising this plan.

4.4 Target populations

This project's target "population" is the freshwater tributaries to marine waters in the Sequim Bay-Dungeness Watershed Clean Water District (CWD). Within that target population, assessed by the Trends Monitoring Program, focus will bear upon pollution sources via the PIC Project Monitoring Program.

4.5 Study boundaries

The study area is the Sequim Bay-Dungeness Watershed Clean Water District, which is bounded on the west by the Bagley Creek drainage area and on the east by the Sequim Bay drainage.

4.6 Tasks Required

Trends Monitoring Program Tasks

- Categorize streams in tiers according to priority (Section 7 below).
- Determine sampling sites on these streams based on a set of criteria (Section 7.3).
- Tier 1 waterways will be sampled monthly for fecal coliform and nutrients, as funding allows.
- Lower priority Tier 2 waterways will be sampled quarterly for fecal coliform, as funding allows.
- Tiers and sampling parameters/periodicity may change in response to data (and available funding). For example, a Tier 1 waterway may drop to Tier 2 if state water quality standards are consistently met, and vice versa, per decision of the CWWG
- Select polluted waterways for PIC implementation projects.
- Submit FC data to Ecology's EIM database.

PIC Project Monitoring Program Tasks

- Conduct segmented fecal coliform sampling on selected waterways to identify sources of pollution.
- Compile results, assess data and involve CWWG in preliminary analysis.
- Submit FC data to EPA's STORET or Ecology's EIM databases.
- Conduct post-remediation activity sampling to evaluate effectiveness.

PIC Pilot Project Tasks

- Conduct segmented fecal coliform sampling on Meadowbrook Creek and Cooper Creek sub-basins identify sources of pollution.
- Compile results, assess data.
- Submit FC data to Ecology's EIM system or EPA's STORET database.
- Conduct post-remediation activity sampling to evaluate effectiveness.

4.7 Practical constraints

Through the Trends Monitoring Program, the mouths of 21 waterways are proposed for regular sampling. Potential funding constraints, access difficulties, and dependence on volunteers for the bulk of the field work may limit the extent of the sampling, thus require a review of sample site priorities.

4.8 Systematic planning process used

The CWWG is tasked with ongoing water quality monitoring and clean-up activities. This group has been meeting regularly to develop the PIC plan, as described above. The PIC plan builds local capacity to adaptively and comprehensively manage pollution by better coordinating water quality monitoring, outreach and clean-up efforts.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Streamkeepers of Clallam County is the lead agency responsible for QAPP preparation and supervision of all monitoring activities, including quality assurance/quality control (QA/QC) and submittal of FC data to EIM. The Streamkeepers program coordinator is the lead staff person, assisted as needed by staff of Clallam County Environmental Health (CCEH), the Jamestown S'Klallam Tribe, and the Clallam Conservation District.

- 5.1.1 Trends Monitoring: Streamkeepers will lead, with the field work to be performed primarily by Streamkeepers volunteers. Streamkeepers staff or volunteers will be responsible for shipment of nutrient samples to UW and delivery of FC samples to the CCEH lab. Streamkeepers staff and volunteers will report on Trends Monitoring data on a quarterly basis, and, in conjunction with CCEH, will compose an annual report analyzing the data.
- 5.1.2 PIC Project Monitoring: The Jamestown S'Klallam Tribe will lead, with Streamkeepers serving in a QA/QC role, and store data in a database maintained by the Tribe.
- 5.1.3 PIC Pilot Project: CCEH will serves as project lead and segmented sampling field work to be performed primarily by Jamestown S'Klallam Tribe staff members.

Laboratories accredited by Ecology will be used to analyze water samples for all parameters that require bench testing. Currently, we intend to use:

- UW Marine Chemistry Lab for nutrient samples (Katherine Krogslund, manager)
- CCEH Water Laboratory for fecal coliform (FC) samples (Belinda Pero/Sue Waldrip, manager)

If the accreditation status of these labs changes for the methods described in Section 8.0, an addendum to this QAPP may need to be prepared.

Streamkeepers staff or volunteers will be responsible for shipment of nutrient samples to UW and delivery of FC samples to the CCEH lab.

Streamkeepers staff and volunteers will report on Trends monitoring results on an annual basis.

5.2 Special Training

Ed Chadd has been the Streamkeepers coordinator, QAPP author, QA officer, and data manager since 1999.

Streamkeepers volunteers will be are thoroughly trained per Streamkeepers' QAPP (Chadd 2014).

5.3 Organization chart

Not applicable (N/A)

5.4 Project schedule

We expect to establish a regular monthly and quarterly day of sampling (e.g., third Tuesday of the month), with a backup day (e.g., fourth Tuesday of the month) in case the regular day is not possible. But any date within the target month will suffice.

5.5 Limitations on schedule

Limitations include the availability of staff coordination, field samplers, calibrated equipment, supplies, laboratories; weather; tides; and most particularly, funding. Also, field days are limited by the need to submit FC samples to the CCEH Lab by 3:00 pm Thursdays.

5.6 Budget and funding

Stable funding for this sampling plan is not yet secured, but pilot sampling is planned to take place under a pilot implementation grant provided by the Washington Department of Health.

6.0 Quality Objectives

6.1 Decision Quality Objectives

N/A

6.2 Measurement Quality Objectives

Field sampling procedures and laboratory analyses inherently have associated error. Measurement quality objectives (MQOs) establish the allowable error for a project. Precision and bias provide measures of data quality and are used to assess agreement with MQOs.

Equipment calibration/checks will occur before and after each sampling date to confirm proper performance of the instrumentation, per procedures mentioned in section 10 below.

Table 1 outlines field and analytical parameters, expected precision for duplicates (a.k.a. replicates), method detection limits and/or resolution, and the expected range of results. The targets for precision of duplicates are based on historical performance by each laboratory.

Table 1. Measurement Quality Objectives (MQOs).

Parameter	Bias	Field Precision	Lab Precision	Sensitivity	Expected Range of Results
	Deviation from NIST standard	Field measures = Per-pair variation Lab analyses = Annual median RSD	Relative Standard Deviation (RSD)	Field Measures = Range, Lab Analyses = Method Detection Limit (MDL) [4]	
FIELD MEASUREMENTS					
Temperature (thermistor)	0.2 °C (two-point)	0.2 °C	n/a	-5 - 50 °C	0 - 30 °C
Temperature (liquid thermometer)	1 °C (two-point)	0.5 °C			
Salinity	5% RPD	0.02 PSS or 5% RSD		0 - 70 PSS	0 - 35 PSS
LABORATORY ANALYSES					
Fecal coliform	n/a	See footnotes [1,2]	40%	1 cfu/ 100 mL	<MDL - 2000 cfu/ 100 mL
NO_3 - N	15%	10% RSD [2]	20% [3]	2.1 µg/L	<MDL - 10,000 µg/L
NO_2 - N	20%			0.3 µg/L	<MDL - 100 µg/L
NH_4 - N		15% RSD [2]		1.7 µg/L	<MDL - 2000 µg/L
PO_4 - P		10% RSD [2]		0.9 µg/L	<MDL - 1000 µg/L
SiO_4 - Si	15%			16.6 µg/L	<MDL - 50,000 µg/L
Total Persulfate N	10%			6.2 µg/L	5 – 15,000 µg/L
Total Persulfate P				1.1 µg/L	5 – 1,500 µg/L

1. 50% of duplicate pairs <20% RSD; 90% of duplicate pairs <50% RSD; all duplicate pairs <85% RSD.
2. For bacteria, duplicate pairs less than 20 cfu/100mL are excluded from median calculation. For nutrients, duplicate pairs less than the reporting limit are excluded. (Mathieu 2006). Nutrient reporting limits are not reported by the lab but are calculated synthetically—see text.
3. Lab duplicates are not required, but they may be requested if field replicates exceed QC limits.
4. Detection limits for nutrients parameters are determined annually by the UW Lab per EPA methods described in 40 CFR 136, Appendix B. Those given here are for 2014.

For nutrients, field replicates and blanks will be shipped and analyzed in the same batch as regular samples. Lab duplicates (if done) will be charged the same as samples. Bias checks are run with every run /data set. For further discussion on bias checks, see Table 1 concerning SRMs and Section 6.2.1.2.

The UW lab does not report reporting limits (RLs), but we have determined the following procedure to devise synthesized RLs, in consultation with EPA: A synthetic RL will be calculated each year as the larger of 3.18 * MDL (a rule of thumb used by EPA) or the mean +1 standard deviation of the field blanks (Matheny 2014).

6.2.1 Targets for Precision, Bias, and Sensitivity

6.2.1.1 Precision

Precision measures the reproducibility of repetitive measurements and is defined as the agreement among independent measurements produced by applying the same process under similar conditions. Precision assessment measures the variability in the results of replicated measurements due to procedural inconsistency, variable environmental conditions, or unknown error. Precision for replicates will be expressed as percent relative standard deviation (%RSD, which for a pair of values equals SQRT(2) * difference/sum * 100%) and assessed following the MQOs outlined in Table 6.1. Replicate samples will be collected at a minimum 5% of sampling sites, and at least one set of replicate samples will be taken by each field team each day.

6.2.1.2 Bias

Bias is a measure of the systematic error (difference) between the population mean (or an estimated value) and true value of the parameter being measured. Field and laboratory QC procedures, such as blanks, check standards, and spiked samples, provide a measure of any bias affecting measurement procedures. Bias from the true value is very difficult to determine for the set of parameters measured in this project; however, staff will minimize bias in field measurements and samples by strictly following measurement, sampling, and handling protocols.

Project staff will assess bias in field samples by submitting field blanks. Field staff will prepare blanks in the field by filling the bottles directly with deionized water, and handling and transporting the samples to the labs in the same manner that the rest of the samples are processed.

For field measurements, project staff will minimize bias by calibrating and/or checking equipment using NIST-traceable standards before and after each run. More detailed information is found in Section 10 on Quality Control Procedures. Staff will assess any potential bias from instrument drift in probe measurements using criteria expressed in Table 7.

6.2.1.3 Sensitivity and Range

Sensitivity is defined as the smallest quantity of an analyte that can be detected by a given method, and an instrument's range represents the span of values that it can measure. Both are presented in Table 1.

6.2.2 Targets for Comparability, Representativeness, and Completeness

6.2.2.1 Comparability

Comparability. It is important for results from this project to be comparable to results generated by previous projects in the Dungeness watershed. To help ensure comparability, standardized sampling techniques and methods, and analysis and data reduction, are being used. In addition, laboratories for analysis were chosen to be consistent with those used for the EPA Targeted Watershed Grant (Streeter 2005; Woodruff et al 2009b) and Clallam Marine Recovery Area Septic Solutions (Soule 2013) monitoring plans. The same analytical methods are available and will also be used.

It should be noted that the methods that have previously been used to measure nutrient concentrations in Trends Monitoring samples have not been approved by EPA and published in 40 CFR 136. This means these results cannot be used for regulatory purposes. If this becomes an important use for future nutrient data, these analytical methods will likely need to change to ones approved by the EPA. We also recognize that our results for nutrients may not be comparable to those of other jurisdictions that use approved methods more commonly-used for measuring nutrients in freshwater. However, in choosing these methods, we assume that the same laboratory and methods as have been used previously for the last 12-15 years for the Clean Water District will provide comparable results helpful in identifying water quality trends and pollution sources.

6.2.2.2 Representativeness

Representativeness. This will be addressed by choice of sampling sites and frequency and timing of sampling. Sites will be as close as possible to discharge points of freshwater bodies into marine waters, in order to reflect as accurately as possible the pollutant concentrations upon entry into marine waters. Sampling will be collected periodically throughout the year, and in general, stream flow status and weather will not deter going into the field. Samples will be collected during low tide periods whenever possible, and samples having appreciable salinity (e.g., > 1 ppt) will be highlighted in field logs.

6.2.2.3 Completeness

Completeness. The goal set for this project is 90% of samples collected and analyzed. There are many reasons for missing sampling activities in a monitoring program. These include: (1) inclement weather or flooding, (2) hazardous driving or monitoring conditions, and (3) unavailability of monitoring staff, laboratories, equipment, or supplies.

Routinely missed samples could impart bias in expressions generated from final data. Every effort will be made to sample within each target month. Field monitoring data loss due to equipment failure will be minimized by having backup equipment available. Apart from weather, unforeseen occurrences are random relative to water quality conditions. These occurrences will not affect long-term data analyses, except for effects from potential reduction in sample size.

7.0 Sampling Process Experimental Design

7.1 Study Design

As mentioned previously, there are three separate elements to monitoring for this project:

A. Trends Monitoring: Monthly sampling on major tributaries within the CWD to identify water quality trends.
B. PIC Project Monitoring: Targeted monitoring efforts to identify sources of pollution.
C. PIC Pilot Project Monitoring: Conduct segmented fecal coliform sampling on Meadowbrook Creek, Golden Sands Slough, and Cooper Creek sub-basins to identify sources of pollution.

7.1.1 Field Measurements

A. All water quality monitoring for trends will include field measurements of water temperature (°C) and salinity (ppt or PSS).
B. Field measurements will not typically be collected for PIC monitoring though sites that are tidally influenced may have salinity and water temperatures collected in conjunction with grab samples.

7.1.2 Sampling location and frequency

A. Trends Monitoring

Trends monitoring will begin after the PIC plan is approved. Sampling will initially occur once a month on Tier I waterways and quarterly on Tier II waterways (Tables 2 and 3), as funding allows. Tier assignments are subject to change as situations change and data informs adaptation. General criteria for choosing sites and parameters are discussed below in 7.3. Sampling sites will be located at or near the mouths of waterways, as feasible.

When possible, all monthly or quarterly samples will be collected on the same date. When not practical to do so, sites will be split such that all drainages to a specific receiving water will be sampled on the same day.

Windows for quarterly sampling will be the months of January, April, August and November. These months correspond to seasonal spikes observed in past sampling.

Table 2. Tier I Trends sampling sites (monthly, including nutrients).

Stream Name	Receiving Waters	Projected Monitoring Station (CCWR/EIM)	Description
Dungeness River	Dungeness Bay	Dungeness 0.7	0.3 miles downstream of Schoolhouse Bridge, access from Rivers End Rd.
Meadowbrook Creek		Meadowbrook 0.1	Near mouth, upstream of Sequim-Dungeness Way, near Three Crabs Rd.
Meadowbrook Slough		Meadowbrook Slough 0.23	Upstream of the Dungeness Farm Bridge at the end of Abernathy St.
Golden Sands Slough		Golden Sands Slough 0.0	At outlet of south side of Three Crabs Rd.
Cooper Creek		To be determined.	No access yet
Cassalery Creek		Cassalery 0.0 (or 0.6)	At mouth; private but can be accessed via neighbor & beach
Matriotti Creek	Dungeness River	Matriotti 0.3a	Downstream of Ward Rd.
Lotzgesell Creek		Lotzgesell 0.1	Upstream of confluence with Matriotti Cr., on Game Farm property
Sequim Bay State Park Creek	Sequim Bay	Sequim Bay State Park Creek 0.0	Sequim Bay State Park, near mouth of creek
Bell Creek		Bell 0.2	About 30' above Schmuck Rd.
Johnson Creek		Johnson Creek 0.0a	Downstream of culvert, SE end of Marina parking lot.
Jimmycomelately Cr.		Jimmycomelately 0.15	Upstream of Hwy 101, Ecology gage

CCWR = Clallam County Water Resources database
EIM = Ecology's Environmental Information Management database

Table 3. Tier II Trends sampling sites (quarterly, no nutrients).

Stream Name	Receiving Waters	Projected Monitoring Station (CCWR/EIM)	Description
Bagley Creek	Strait of Juan de Fuca	Bagley Creek 0.7a	Downstream of Olympic Discovery Trail bridge
Siebert Creek		Siebert Creek 1.0	At Olympic Discovery Trail parking area
Agnew Creek		Agnew Ditch	At 1137 Finn Hall Road
McDonald Creek		McDonald Creek 1.6	Downstream of Old Olympic Hwy bridge
Hurd Creek	Dungeness River	Hurd Creek 0.2	At Moore property
Gierin Creek	Dungeness Bay	Gierin 1.4	At upper end of Graysmarsh property, below tributary
Dean Creek	Sequim Bay	Dean Creek 0.17	At Olympic Discovery Bridge
No Name Creek		No Name Creek 0.03	Next to JST Admin Bridge
Chicken Coop Creek		Chicken Coop SF 0.2a	About 50 feet upstream of culvert at Old Blyn Hwy.

B. PIC Project Monitoring

PIC project areas will be selected from a Priority Work Area List developed biennially by the CWWG after reviewing data and reports produced by the Trends Monitoring Program. The number and location of PIC project sampling sites cannot be predicted, but the process of choosing sampling stations will be systematic, as described below.

PIC project monitoring will involve segmented sampling of targeted sub-basins that have been prioritized for cleanup. The goal of segmented sampling is to locate contamination "hot spots" within a priority sub-basin. "Hot spots" will be defined as locations where the geometric mean of preferably three water quality samples exceeds the "Extraordinary" water quality standards set by Washington State (i.e., 50 fecal coliform colony-forming units per 100 mL for freshwater). Selection of the actual hot-spot sampling sites will be based on a review of available records (e.g., OSSs of concern, poorly drained soils) and visual assessments of potential pollution sources (e.g., poorly managed farms or homes with questionable septic systems).

All samples with FC results exceeding 50 FC/100mL will be re-sampled to confirm that they are indeed hot spots. Re-sampling will occur as soon as possible, ideally within a few days of the initial collection date. When the geometric mean from samples taken exceeds 50 FC/100mL, the hot spot will be identified and further investigation is warranted. All hot spots should be investigated. However, when multiple hot spots are identified, additional investigations will be prioritized using the criteria shown in Table 4:

Table 4. Scheme for prioritizing hot spots to sample

Indicator Organism	High Priority	Medium Priority	Low Priority
Fecal Coliform (FC)	> 400 FC / 100mL	100 to 399 FC / 100mL	50 to 99 FC/100mL

Once a hot spot has been identified, additional sampling may occur if needed to further identify the source or sources of the hot spot. As needed, discharges such as ditches, drainage pipes, irrigation ditches and other drains will be sampled to aid in locating possible pollution sources.

7.1.3 Parameters to be determined

A. Trends Monitoring: Both Tier I & Tier II sampling will include the following parameters:

- Fecal coliform (CFU/100 mL)
- Salinity (ppt or PSS)
- Water temperature (°C)

Tier I sampling will also include the following parameters:

- Dissolved nutrients: NO3, NO2, NH4, PO4, Si(OH)4. If funding becomes a problem, we may choose to forego analyses for NO2, PO4, and Si(OH)4 to decrease our costs.
- Total nutrients: N and P. Note, however, that sampling conducted within the Clean Water District in 2013-14 indicated a high correlation between the dissolved and totals nutrients parameters, indicating that it might be possible to forego the Total N and P analyses in consultation with the CWWG.

B. PIC monitoring – Only samples for analysis of fecal coliform will be collected.

C. PIC Pilot Project monitoring – Only samples for analysis of fecal coliform will be collected.

7.2 Map of Tier I & II sampling locations

Please refer Figure 3.

7.3 Assumptions underlying design

The study area has been the target of several water quality investigations in the past two decades, both of surface and ground water. These prior investigations inform the selection of Tier I & II sites and the parameters to be measured, based on existing data and potential impact to public health and shellfishing. Tier II sites are assumed to contribute a smaller load of pollutants to receiving waters based on historic data, land use, or size of discharge. Sampling site selections include the following considerations:

- Attempt to sample all freshwater discharges to marine waters in the study area, plus major tributaries to those discharges.

- Sample each discharge downstream of as many possible point or non-point inputs as possible.
- If possible:
  - Avoid tidal influence so samples will represent freshwater concentrations and sources.
  - Sample at sites with the greatest ease of access, such as public access.
  - Sample at sites where there is no need to walk into the water body, to avoid invasive species contamination—see section 8.4 below.
  - Sample at sites with a rich historic data set.
  - Sites for field replicate collection should have well-mixed water and typically strong fecal coliform and nutrients signals.

This QAPP identifies analytical methods that will be used to measure nutrients in Trends Monitoring program samples (see Section 8.0). In choosing these methods, we assume that the same laboratory and methods as have been used previously will provide comparable results helpful in identifying water quality trends and pollution sources. However, the nutrients results cannot be used for regulatory purposes because the methods have not been approved by EPA (i.e., published in 40 CFR 136) for analysis of fresh non-potable water. The nutrients data may also not be comparable to analogous monitoring results reported by other local jurisdictions that are based on different methods (see Section 6.2.2.1 on Comparability).

7.4 Relation to objectives and site characteristics

Trends Monitoring Program – The study design supports project objectives to identify trends for fecal coliform and nutrients in the Clean Water District.

PIC Project Monitoring Program – The selection of PIC Project sampling sites is based on Kitsap County's Pollution Identification & Correction (PIC) Manual (Kitsap Public Health District, 2014). The primary objective of this monitoring program is to identify sources of pollution. This will occur by strategically selecting sampling stations that lead to pollution source identification. Follow-up sampling will sometimes be necessary to evaluate the effectiveness of corrective actions.

7.5 Characteristics of existing data

Existing data is fairly recent and plentiful for core study sites as well as optional sites. This is thanks to Ecology TMDL studies and efforts of Clean Water District members, especially the Jamestown S'Klallam Tribe, Streamkeepers, and Clallam County Environmental Health. This project addresses a need to update water quality conditions in the lower Dungeness.

8.0 Sampling Procedures

8.1 Field measurement and field sampling SOPs

The field measurement methods and laboratory analytical methods that will be used for trends and PIC monitoring are summarized in Table 5. Sample container, preparation, and holding times are included. The detailed SOPs that will be used are also cited below.

Table 5. Field and laboratory methods; sample container, preparation, and holding times

Parameter	Field Method	Field Method Citation	Instrument/ Container type [1]	Sample Preparation	Min. Quantity, Holding time (per lab)
FIELD MEASUREMENTS					
Water Temperature	Electronic meter or thermometer	Chadd 2014	Thermistor or thermometer	In situ	n/a
Salinity	Electronic meter or refractometer	Chadd 2014	Electrode or refractometer	In situ	
LABORATORY ANALYSES					
Fecal coliform [CCEH Lab]	Manual grab	Chadd 2014	Sterilized poly ≥125 mL	4°C, dark	100 mL, 24 hr
Nutrients (dissolved) [UW]	Manual grab	Joy 2006	60 mL HDPE narrow mouth acid washed	Field filter with surfactant-free cellulose acetate filter; 4°C, dark	40 mL, 48 hr (unfrozen samples)
Nutrients (total) [UW]	Manual grab	Joy 2006	60 mL PP wide-mouth, acid washed	4°C, dark	40 mL, 7 days

1. Containers will be supplied by the accredited laboratory

8.2 Measurement and sample collection

<u>In-Situ Sampling Procedures</u>: A basic schema of sampling and measurement procedures is presented in Section 8.1 above. The cited method sources, hereby incorporated by reference into this document, give full explanations relating to:

- collection of samples and associated field QC samples
- analytical methods for measurements/analyses done in the field as well as the laboratory

- required equipment and in-situ calibration and maintenance procedures
- required content and format of field log entries
- sampling equipment and methods for its preparation and decontamination

8.3 Containers, preservation methods, holding times

See Table 5.

8.4 Invasive species evaluation

To avoid cross-contamination of invasive species between sites, samplers will follow the Streamkeepers of Clallam County Anti-Contamination Protocol (Chadd 2014), which is compliant with WA Dept. of Ecology SOPs EAP070 and EAP071.

8.5 Equipment decontamination

This project does not expect to be sampling substances with high levels of contaminants. For the routine sampling being performed here, it is sufficient to rinse sampling equipment (but not sample bottles) with sample water between locations (EPA 2011). Samplers will follow the Streamkeepers of Clallam County Safety SOP (Chadd 2013).

8.6 Sample ID

Bottles will be labeled either with numbers, referenced on the field data sheet, or with the name of the site, date, and QC type (primary sample, field replicate, blank). Bottles intended for different analyses can be distinguished by size and shape, so no further labeling is necessary. Each bottle sent to a lab will be entered into the Clallam County Water Resources database with a unique ID, and each result from each Batch will also have a unique ID.

8.7 Chain-of-custody

Samples will be sent to the appropriate lab accompanied by a copy of the relevant field sampling log and a chain of custody form that has been signed and dated. Chain of custody forms will likely be obtained from the labs.

8.8 Field log requirements

The field log for this project will consist of the field sampling log sheet containing the primary data, plus the additional log sheets listed below, describing the overall sampling event and calibration/drift check results. Any corrections will use strikeouts and be initialed and dated.

- Episode cover sheet—one per sampling day
  http://www.clallam.net/streamkeepers/assets/applets/EpisodeCover.pdf
- Tour cover sheet—one per sampling team per sampling day
  http://www.clallam.net/streamkeepers/assets/applets/TourCoverGeneric.pdf
- Instrument calibration activity & pre/post checks:
  http://clallam.net/streamkeepers/assets/applets/Hydrolab_Cal_data_sheet.pdf

8.9 Other sampling-related activities

At sites with stream gages, samplers will be asked to record stage height. Discharge will not be measured simultaneously with sampling, but stage measurements will give a relative idea of stream stage on the day of sampling.

9.0 Measurement Methods

9.1 Lab Measurement Methods

The matrix for all analyses will be non-potable water. Analytical methods are listed in Table 6. All FC samples will be delivered the same day to the Clallam County Environmental Health Laboratory (CCEH Lab) in Port Angeles, WA (accreditation # M421-12) to be analyzed.

Nutrient analyses of water samples will be performed by UW School of Oceanography Marine Chemistry Laboratory (UW Lab) in Seattle, WA (accreditation # A521-12). All nutrient samples will be shipped to UW Lab on the day of sampling. UW Lab will batch the dissolved nutrients Nitrate (NO3), Nitrite (NO2), Ammonia (NH4), Phosphate (PO4), and Silicate (SiOH4) for analysis, and will batch Total N and P for separate analysis.

The methods for analyzing nutrients in samples of non-potable water listed in Table 6 have not been published in 40 CFR 136 and so have not been approved by the EPA. They may yield results useful for analyzing trends or as an additional line of evidence for identifying pollution sources but they cannot be used to support regulatory decisions.

Table 6. Laboratory Analytical Procedures

Analysis	Method Reference	EPA or Standard Method #	NELAC Code	Detection Limits [1] (MDL)
Fecal coliform	APHA 1998	SM 9222 D (m-FC)-97	20210008	1 cfu/100 mL
UW Marine Chemistry Laboratory				
NO_3 - N	UNESCO 1994	EPA 353.4_2_1997	10068209	2.1 µg/L
NO_2 - N				0.3 µg/L
NH_4 - N		EPA 349	WM920220	1.7 µg/L
PO_4 - P		EPA 365.5_1.4_1997	WM920270	0.9 µg/L
SiO_4 - Si		EPA 366	WM920240	16.6 µg/L
Total Persulfate N	Valderrama 1981	SM 4500-P J	WM920270	6.2 µg/L
Total Persulfate P				1.1 µg/L

[1] Detection limits for nutrients parameters are determined annually by the UW Lab per EPA methods described in 40 CFR 136, Appendix B. Those given here are for 2014.

[2] Reporting limits for nutrients parameters were determined in consultation with the UW Lab and other scientists.

[3] Dilution Factor is the result reported as corrected to fecal coliform colonies counted per 100 ml sample filtered.

9.2 Sample preparation methods

See Table 6.

9.3 Field Measurement Methods

Instruments and methods to be used for field work are described in Section 8.1 above. Instruments will be calibrated in accordance with Streamkeepers' protocols and manufacturers' instructions.

9.4 Special method requirements

Dissolved nutrient samples will be filtered in situ (see Table 5).

10.0 Quality Control (QC) Procedures

10.1 Lab and field QC required

QC procedures for the field and laboratory are summarized in Table 7. A "tour" is a round of sampling conducted on a given day by a given field team. A "run" is a batch of samples processed by the lab. Laboratory QC samples will be obtained by Streamkeepers for documentation purposes.

Table 7. QC Samples, Types, and Frequency

<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">FIELD</th><th colspan="4">LABORATORY</th></tr>
<tr><th>Blanks</th><th>Replicates</th><th>Check Standards</th><th>Method Blanks</th><th>Analytical Duplicates</th><th>Matrix Spikes</th></tr>
<tr><td>Fecal coliform</td><td colspan="2" rowspan="3">≥ 1 per tour and 5% of sites</td><td>None</td><td>2 per ≤ 10 samples (See Table 8)</td><td>1 per ≤ 10 samples</td><td>n/a</td></tr>
<tr><td>Nutrients</td><td>2 per run</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">None</td></tr>
<tr><td>Total N & P</td><td>1 per run</td></tr>
<tr><td>Water temperature</td><td rowspan="2">n/a</td><td rowspan="2">≥ 1 per tour & 5% of sites</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td></tr>
<tr><td>Salinity</td></tr>
</table>

NOTE: NIST SRMs for nutrients will also be run as QC samples to help assess bias. See Section 6.0 and Table 1.

10.2 Corrective action processes

For CCEH Lab fecal coliform analyses, QC will be performed using "Standard Methods 9020B Intra-laboratory Quality Control Guidelines" (Pero, 2013).

UW Lab indicated that analytical QC criteria listed for nutrients and Total N and P in Tables 1 and 6 will always be met. Standards checks are performed at the beginning of each run; if they are not within the QC range, they are discarded and begun again (Krogslund, 2013).

If data are qualified by the laboratory or adjusted due to blanks, replicates, spikes, or blind standards, these adjustments will be documented along with the data and flagged appropriately.

Field blank results for each parameter for each day will be processed using the following steps, developed in consultation with state and federal scientists (Mathieu 2014; Matheny 2014):

- If Field Blank (FB) ≤ Reporting Limit (RL), no qualifier.
- If FB > RL, designate (FB – RL) as the absolute bias for that day, in which case the relative bias for a given measurement would be (absolute bias) / (sample value). Then apply qualifiers per the MQO's for bias in Table 1:
    - If (relative bias) ≤ (target bias) for that parameter, no qualifier.
    - If (relative bias) > (target bias) but <= 2x (target bias), qualify as EST.
    - If (relative bias) > 2x (target bias), qualify as REJ.

For in-situ measurements, see Additional QC notes below.

10.3 Additional QC notes

Streamkeepers of Clallam County maintains rigorous protocols for all steps in the process of monitoring area streams, from documentation to calibration to SOPs to training. Some details from their Quality Assurance Project Plan may be useful here (Chadd, 2011).

Training:

Streamkeepers offers training to volunteers, based on the procedures in the Volunteer Handbook (Chadd, 2014). Volunteers see the procedures demonstrated and have the opportunity to practice them, under supervision of staff or experienced volunteers. Training participation is recorded in Streamkeepers' database. New volunteers are then assigned to teams with experienced volunteers guiding them through procedures. Usually several outings are required before new volunteers feel comfortable performing procedures on their own. Only volunteers trained in a given procedure will be allowed to attach their initials to data gathered under that procedure. The Streamkeepers database connects all data with a sampler, whose training history is recorded in a separate table in that database.

Data Qualifiers:

To be unqualified (i.e., acceptable without qualification for submission for the State Water Quality Report), data must be gathered in accordance with established monitoring procedures, be fully documented, and pass all QC screens. Data qualified with a flag will use codes established by the WA Dept. of Ecology; the most common flags are:

- **J-variants** (laboratory-data estimate): Apply if laboratory identifies sample as an estimate, or if established QC procedures have not been followed or documented (for example, lab duplicates were not run), or one or more QC screens have not passed (for example, lab duplicates were outside precision targets), but project managers believe the data to be reasonably trustworthy for general water-quality assessments.

- **EST** (field-data and blank estimate): For measurement data; apply if established procedures have not been followed or documented, or one or more QC screens have not passed, but project managers believe the data to be reasonably trustworthy for general water-quality assessments.
- **REJ** (reject): Apply if established procedures have not been followed and/or documented, or one or more QC screens have not passed, and program managers believe the data to be untrustworthy for any purposes.

Qualifiers Based on QC Controls:

For each QC control performed, qualifiers indicated by a QC test will be applied to all data governed by that test. In general, instruments will be calibrated (or checked if not able to be calibrated) prior to the sampling session and then checked subsequent to the sampling session. Both pre- and post-sampling checks must meet QC criteria in order for data gathered in between to be considered acceptable.

Post-Period Drift Check Is Sufficient:

Instrument drift away from accuracy is presumed to progress in a single direction, either above or below the accuracy margins. Therefore, in a case where an instrument was checked for accuracy only subsequent to a sampling episode, if the instrument passes its QC post-check, it is presumed that the instrument performed to specifications prior to that check (Katznelson, 2011), so long as no substantive maintenance or replacement of instrument parts was performed in between. This situation is to be avoided, because samplers run the risk of downgrading an entire set of data due to not having checked instrument accuracy at the outset.

Accuracy Tests:

Accuracy of water quality measurements is estimated by performance evaluation measurements of the equipment; see Tables 1 and 8 for criteria.

Precision Tests:

Precision of water quality measurements is estimated by analysis of replicate samples taken in the field at one site per team per sampling period. The variation between these sample and replicate values is a measure of variability due to short-term environmental factors, instrument operation, and sampling procedure. See Tables 1 and 8 for acceptance criteria and control limits based on comparing replicates with their paired samples.

QC qualifiers are then applied to all samples in the grouping covered by that replicate/sample pair—for example, the entire group of samples taken by that team during that sampling period. These qualifiers are only applied if they downgrade already-applied QC qualifiers; for example, if program managers have already applied a "REJ" qualifier to a result, a downgrade value of "J" based on replicate/sample comparison will not change the "REJ" designation for that result.

Special note for QC of nutrients blanks:

We validated this evaluative procedure in consultation with federal and state QAPP reviewers (Matheny 2014; Mathieu 2014):

- If Field Blank (FB) ≤ Reporting Limit (RL), no qualifier.
- If FB > RL, designate (FB – RL) as the absolute bias for that day, in which case the relative bias for a given measurement would be (absolute bias) / (sample value). We then apply qualifiers per the MQO's for bias in Table 6.1 of the QAPP.
    - If (relative bias) ≤ (target bias) for that parameter, no qualifier.
    - If (relative bias) > (target bias) but <= 2x (target bias), qualify as EST.
    - If (relative bias) > 2x (target bias), qualify as REJ.

Table 8. Field and Lab Equipment QA/QC Measures

RSD in the table below refers to the relative standard deviation or RSD (also known as the coefficient of variation), which, when n = 2 (as when comparing a sample with a replicate), is defined as:

RSD = abs(difference/sum) x sqrt(2), where abs = absolute value and sqrt = square root

Parameter	Office prep (start of each sampling period)	Mainten-ance measures (office & field)	Field prep/ checks	Bias checks	Accuracy qualification per bias checks	Replicates for precision control	Precision qualification (per rep/ sample difference)
Temperature	2-pt. (~0° & 20°C) check vs. NIST-traceable thermo-meter	Keep sensor clean		2-pt. calibration check vs. NIST-traceable thermo-meter	"EST" if >±0.2°C "REJ" if >± 0.5°C	1 per tour	"EST" if > ±0.2°C; "REJ" if > ± 0.5°C
Salinity	Calibration with NIST-traceable standard	Electrode cleaning solution	Check / rinse electrodes	Post-season check against NIST-traceable standard	"EST" if > ± 10% of standard value; "REJ" if > ± 15% of standard value		"EST" if RSD > 5%; "REJ" if RSD >10%
Fecal Coliform	Verification of colonies once a month; annual proficiency testing with state	Checks of medium, filters, funnels, thermo-meter, rinse & dilution water	Sterilized bottles, 4 oz. (125 mL) minimum; observe holding specs	Pre- and post-sample blanks; control blanks for 1/10 of samples	Adjust/flag data as needed per blank results	Field / lab replicates: ≥ 1 / tour & ≥ 5% of sites	"REJ" if > ± 10 and log-transformed values > ± 0.6 (RSD > 85%) (see text below)

Special note for QC of fecal coliform samples:

Both field and lab replicates are taken with ≥ 5% of samples. Rather than randomly choosing samples for field and laboratory duplicates, we intend to choose samples likely to have high counts, on the notion that replicated samples with no counts provide little information (Lombard 2007). The acceptance criteria and control limits in Table 9 are based on comparing field and laboratory replicates with their paired samples.

Table 9. QC Measures for Bacterial Samples

Control measure used: variance between sample and field or lab replicate
If absolute difference ≤ 10 or difference between base-10 logs ≤ 0.6 (RSD ≤ 85%): No qualifier
Otherwise, qualify per the following, using best professional judgment of program manager and laboratory analyst: • Flag sample as "REJ" (unacceptable); • If other rep/sample pairs from that day's analysis were within tolerance, do not flag the other data, unless there is reason to question the entire batch; • If no other rep/sample pairs in that batch, use best professional judgment of laboratory and monitoring program managers to decide whether to flag other data; • If other rep/sample pairs from that day's analysis exceeded tolerance, consider flagging all the data from that day, or possibly from the team(s) which collected those samples.

Side-by-Side Sampling—External:

As possible, Streamkeepers volunteers or staff will participate in Ecology's Side-by-Side Sampling program (http://www.ecy.wa.gov/programs/eap/fw_riv/SxSIndex.html), whereby water-quality monitors test water bodies at the same time Ecology tests them as part of their monthly Ambient Monitoring Program. This program affords both parties the opportunity for additional validation of their data.

Other General QC Measures:

- Clear, user-friendly, and detailed instructions for all procedures, minimizing judgment calls
- Equipment checked for damage prior to sampling
- Multiple observers when possible
- Each sampling team has an experienced leader
- Staff review of data, including comparing values year-to-year
- Values compared to external data from other agencies, such as stream gage data

11.0 Data Management Procedures

11.1 Data recording/reporting requirements

Data collection, quality control, management, and reporting will be coordinated by the Clallam County Streamkeepers program. See Section 5.0 for more details.

Recording Field Data

Field data will be collected on custom-designed data sheets. The primary field data sheet, as well as ancillary data sheets (Episode and Tour cover sheets, calibration/check sheets), are on Streamkeepers' website at http://www.clallam.net/SK/monitoringusables.html. Field samplers will record data and enter their and initials on these sheets. When all data have been collected at a site, the team leader looks over the sheets for completeness, legibility, and obvious errors, and gets further information from team members as appropriate. Any problems with data collection are noted in a "Comments" section of the data sheet. The team leader initials and dates this review, then initials and dates again when turning the sheets in to the office. Then staff initials and dates receipt and QC review of the data. This latter review is a thorough process that includes troubleshooting for decimal and rounding errors, data entered into the wrong field, incomplete data, etc.

Requirements for Laboratory Data Packages

The microbiology and chemical laboratories will report sample results, on report forms provided by Streamkeepers or of their own making. They will indicate their QC review and approval of the data presented. Laboratories will not be required to submit internal QA/QC documentation, such as blanks, spikes, and blind standards, used to determine the adequacy of the analytical procedures, providing their procedures met all internal laboratory QA/QC requirements; but they will be required to keep all such internal records for a minimum of five years.

Transferring Data to Electronic Form

Once field data sheets have been received and reviewed at the Streamkeepers office, volunteers will enter the Trends Monitoring data into the Clallam County Water Resources (CCWR) database. Detailed procedures will be provided to the volunteers, both in written form and in one-on-one training, and staff will be available to volunteers as they perform data entry. Volunteers subsequently will check the database entries against the field sheets, and later perform an additional troubleshooting double-check.

Laboratory Data Upload

When laboratories report data in a standard electronic format, Streamkeepers staff and volunteers will devise database queries to upload the data.

Automated Data Checks

Our intention is to program the CCWR database to automatically perform some of the statistical checks described in the "Quality Control" section above, and in some cases to downgrade data automatically as appropriate (leaving a record of the downgrade). In other cases the database will display a message instructing program managers to examine data and apply downgrades as appropriate. These automated routines will ensure compliance with QC procedures. In the absence of automation, data qualifiers will be applied manually by the QC officer.

Final Sign-Off of Data

Once all of the above checks have been performed, the QC officer will do a final review of data, including examination of outliers, and sign off that the data are ready for publication.

Management and Storage of Database

The CCWR database is managed by the Streamkeepers program of the Clallam County Department of Public Works-Roads. It is stored on Clallam County's network drive, which is backed up daily. The database itself is actually two files: CCWR_Data consists exclusively of data tables, while CCWR_User comprises data-entry forms, database queries, reports, lookup tables, metadata, and other database objects. This structure provides stable storage for the data.

Retrieval of Data

Data can be retrieved from the CCWR database in a variety of ways. A number of custom-made reports and queries have been designed to portray the environmental data in the database. Data can also be retrieved via user queries. A variety of CCWR data is also available on the Streamkeepers website: http://www.clallam.net/SK/studies.html.

11.2 Lab data package requirements

Lab documentation should always include all QC results associated with the data, a case narrative discussing any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers.

The Clallam County Environmental Health Laboratory reports results directly on data sheets provided for the project. Outside laboratories will report results and QC information on their standard forms.

11.3 Electronic transfer requirements

Any electronic data transfer will need to be in format readable by the Streamkeepers program.

11.4 Acceptance criteria for existing data

Existing data are covered under other Quality Assurance Project Plans and will be submitted to Ecology per these Plans if they have not been already.

11.5 EIM or STORET data upload procedures

FC data from the Trends Monitoring program will be uploaded from the Clallam County Water Resources database to Ecology's EIM database after completion of monitoring and data assessment. Nutrient data will not be so formatted for transfer because they will be based on methods not approved by the EPA and listed in 40 CFR 136, so they cannot be used for regulatory purposes.

12.0 Audits and Reports

12.1 Number, frequency, type, and schedule of audits

and

12.2 Responsible personnel

Formal program audits are not planned at this time but the need for a program audit may be considered in the future. In lieu of such an audit, the QA officer will be responsible for day-to-day compliance with this document, including assuring that quality of the data is acceptable and that corrective actions are implemented in a timely manner. QC review and signoff will be conducted after each sampling period. In addition, the project manager will review the data and metadata in consultation with the QA officer at some point early in the project and at the end of the project, to assure that procedures have been followed as outlined in this document.

Laboratories participate in performance and system audits of their own procedures; these are available on request.

12.3 Frequency and distribution of report

and

12.4 Responsibility for reports

The data manager will upload Trends Monitoring FC data to either Ecology's EIM database or EPA's STORET database after completion of monitoring and data assessment, and summarize the monitoring results on a quarterly basis at the Clean Water Workgroup meetings.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Field team leaders will verify data before turning in data sheets. The QA officer will examine the data and metadata for errors or omissions as well as completeness and compliance with QC acceptance criteria, and will apply data qualifiers as needed.

13.2 Lab data verification

Laboratory results are reviewed and verified by qualified and experienced lab staff, with findings documented in a case narrative.

13.3 Validation requirements, if necessary

The complete data package, along with the laboratories' written reports, will be assessed by the QA officer and project manager for completeness and reasonableness. There will be no independent data validation.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining whether project objectives have been met

The project manager, in consultation with other staff and laboratories working on this project, will comment in the project final report on whether the data are of sufficient quality and quantity to have achieved the project goals.

14.2 Data analysis and presentation methods

Verified Trends Monitoring FC data will be uploaded to Ecology's EIM database or EPA's STORET database. PIC project segmented and hot spot sampling results will be maintained in a database by the Jamestown S'Klallam Tribe and will be uploaded to EPA's STORET or Ecology's EIM database within 6 months of project completion.

14.3 Treatment of non-detects

If the lab does not report a value for analyte concentrations less than the MDL (see Table 6 in Section 9), results will be reported at the MDL.

14.4 Sampling design evaluation

and

14.5 Documentation of assessment

An annual data report will be prepared for the Clean Water Work Group as part of the PIC plan. A draft of the report will be made available to Ecology staff and peers for review and comment.

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16.0 Figures

Figure 1. Sequim-Dungeness Clean Water District

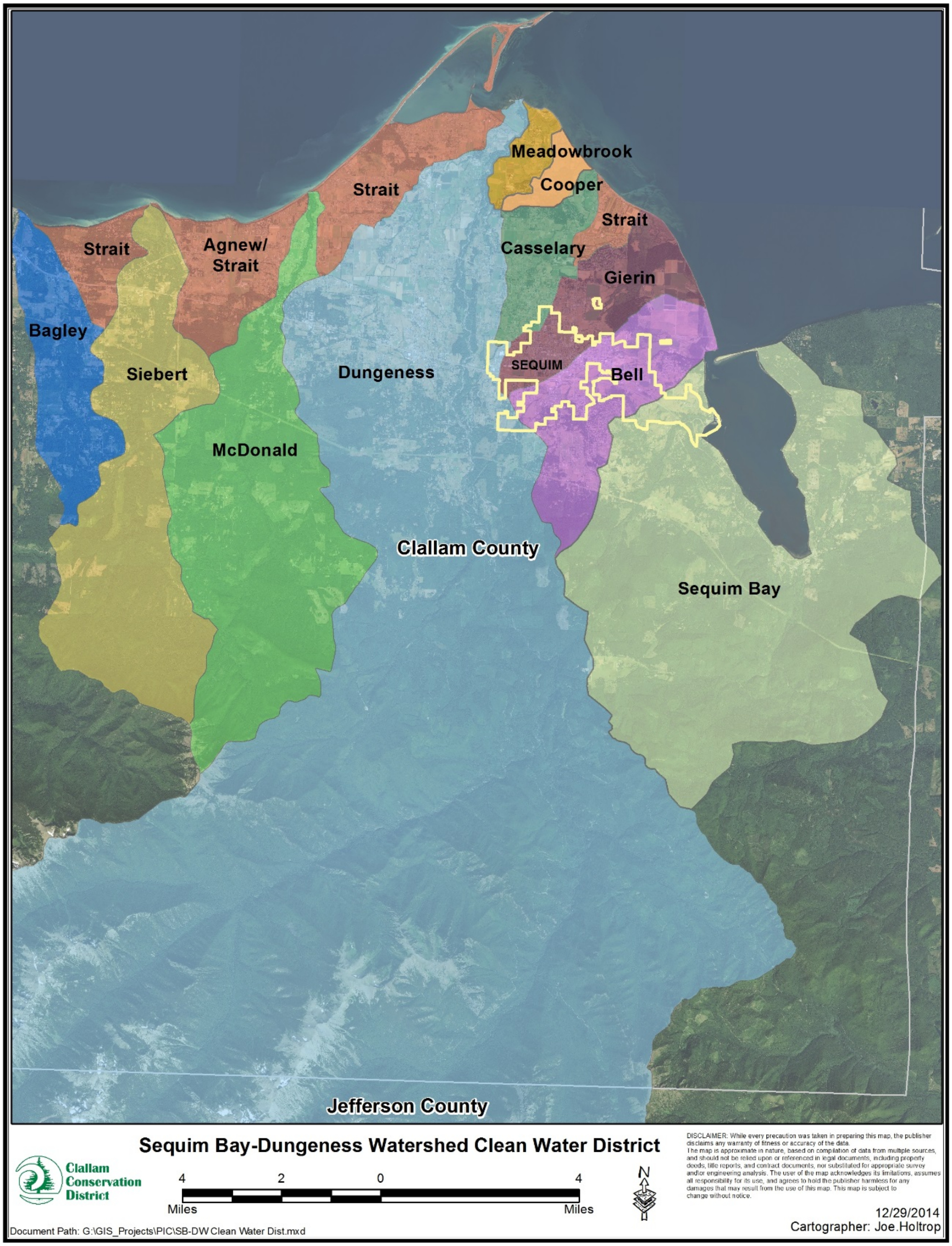


Figure 2 – Marine monitoring stations in Dungeness Bay and Jamestown growing areas (Schultz 2013).

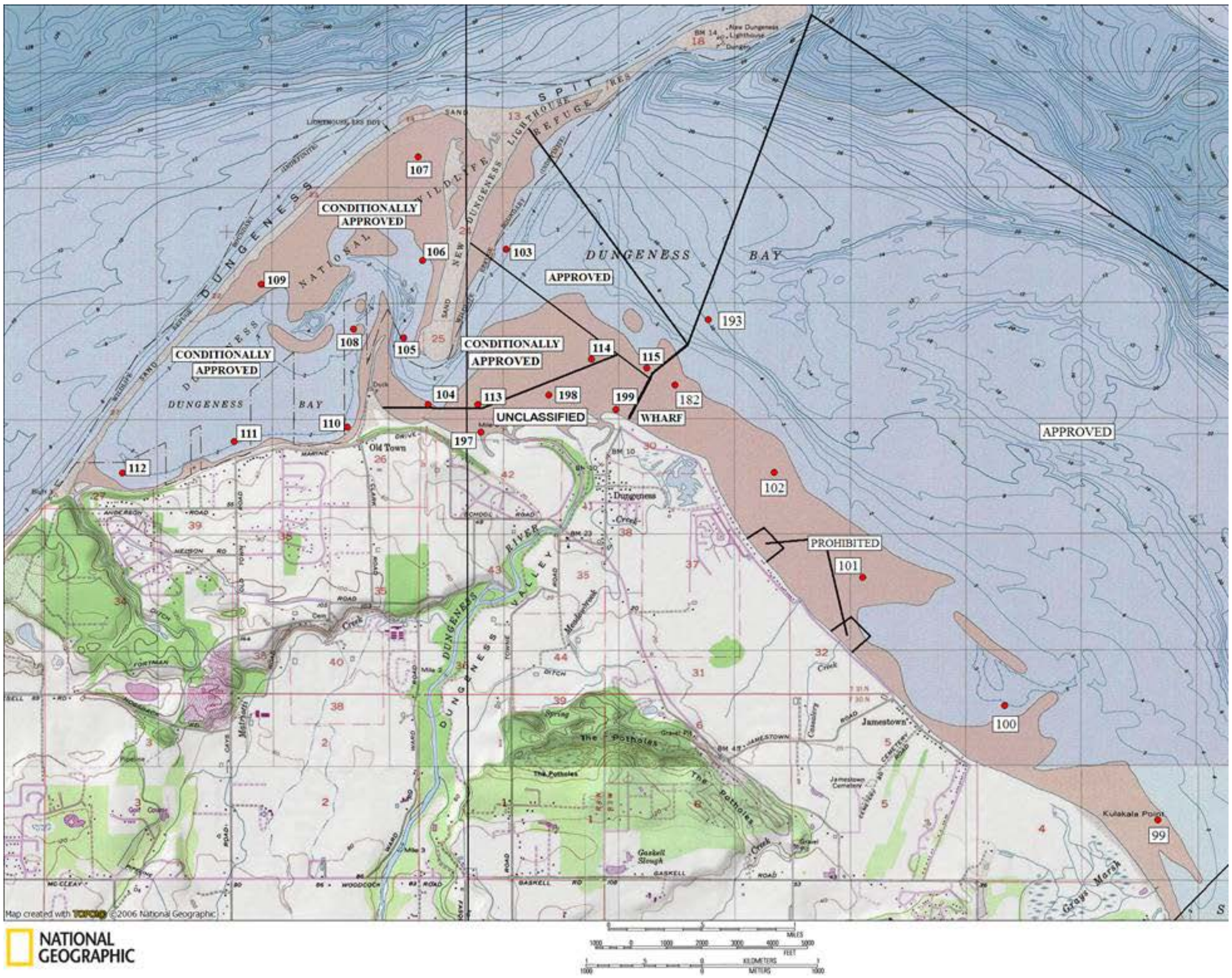


Figure 3 –Trends Monitoring Program Sites

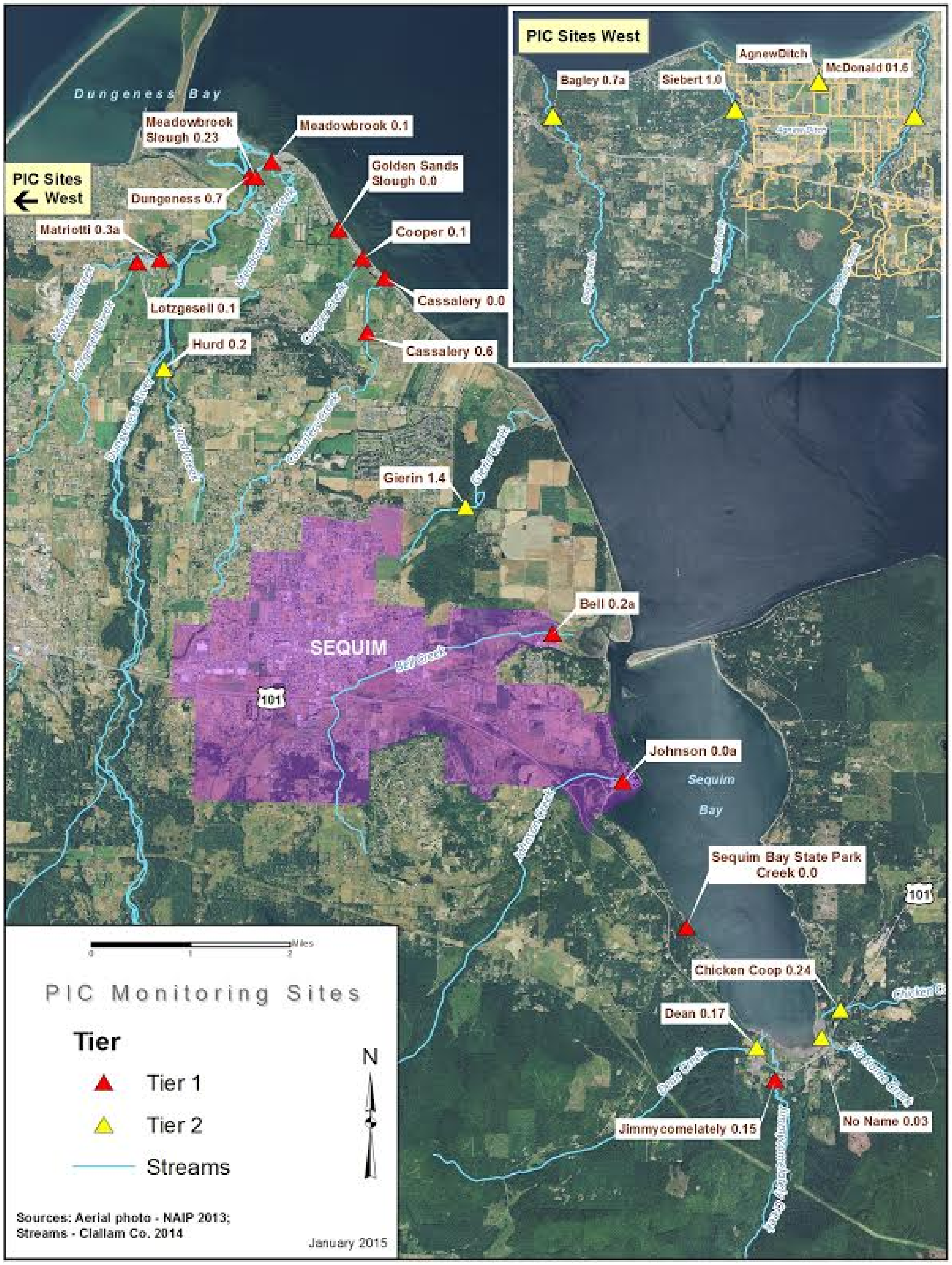
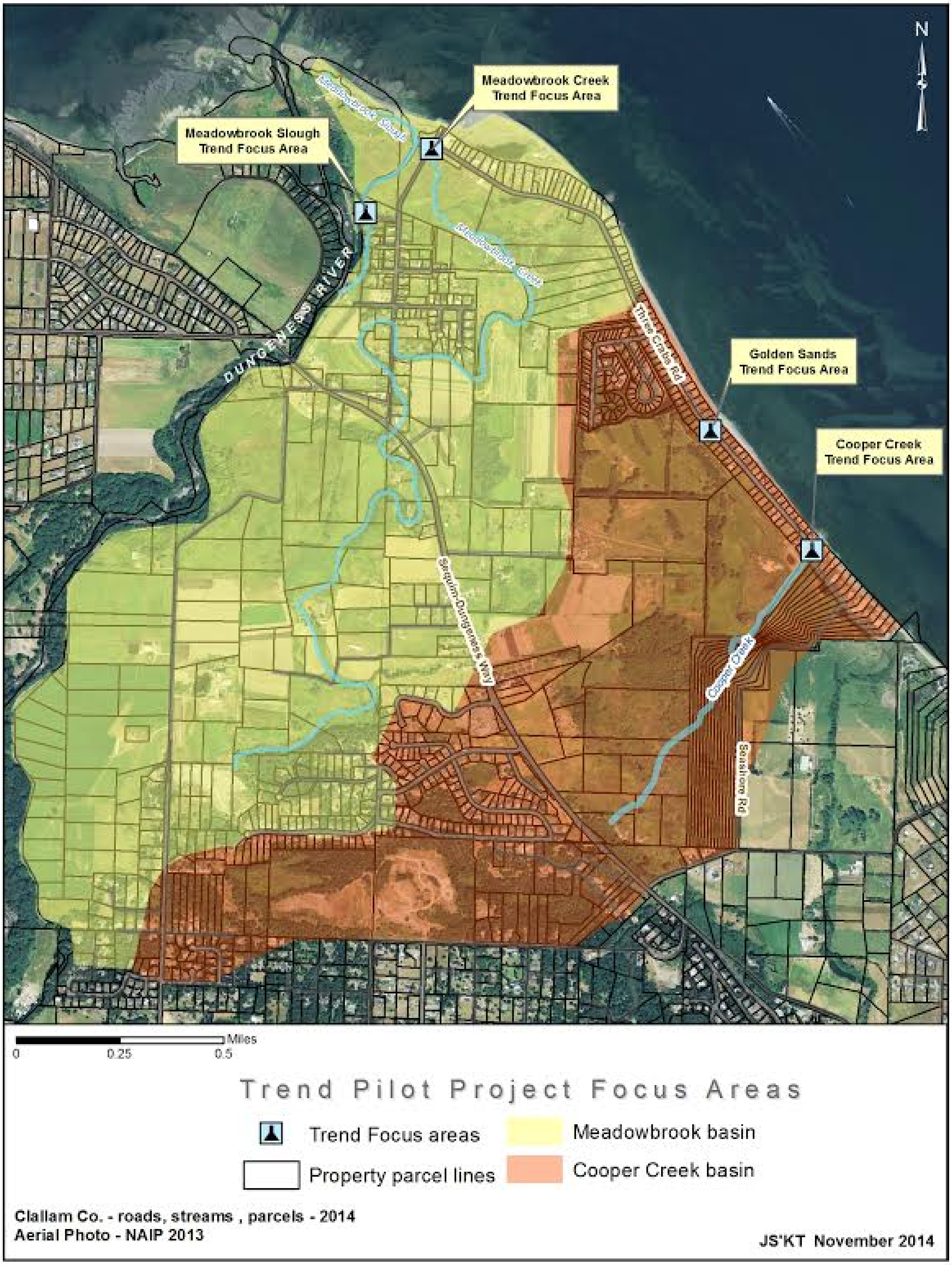

PIC Sites West
Bagley 0.7a
Siebert 1.0
AgnewDitch
McDonald 01.6
Dungeness Bay
Meadowbrook Slough 0.23
Meadowbrook 0.1
PIC Sites West
Dungeness 0.7
Golden Sands Slough 0.0
Matriotti 0.3a
Cooper 0.1
Lotzgesell 0.1
Cassalery 0.0
Hurd 0.2
Cassalery 0.6
Gierin 1.4
Bell 0.2a
SEQUIM
Bell Creek
101
Johnson 0.0a
Sequim Bay
Sequim Bay State Park Creek 0.0
101
Chicken Coop 0.24
Dean 0.17
Jimmycomelately 0.15
No Name 0.03
PIC Monitoring Sites
Tier
Tier 1
Tier 2
Streams
N
Sources: Aerial photo - NAIP 2013;
Streams - Clallam Co. 2014
January 2015

Figure 4 – PIC Pilot Project Area



17.0 Tables

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18.0 Appendices

APPENDIX A – ACRONYMS

ACRONYMS

PIC – Pollution Identification & Correction

CCD – Clallam Conservation District

DOE – Washington State Department of Ecology

WSU – Washington State University

CCEH – Clallam County Environmental Health

DOH – Washington State Department of Health

EPA – Environmental Protection Agency

JST – Jamestown S'Klallam Tribe

CCDCD – Clallam County Department of Community Development

OSS – Onsite Septic System

SK – Streamkeepers of Clallam County

CCWR – Clallam County Water Database

APPENDIX B – SAMPLE FIELD/CHAIN OF CUSTODY LOG

GRAB SAMPLE TOUR DATA SHEET - STREAMKEEPERS OF CLALLAM COUNTY - PORT ANGELES, WASHINGTON, USA - (360) 417-2281

Date: ___/___/___ (Incl. last name + all initials:) Sampler in charge: ________________________________ *Tour ID (from database entry): ___________*

Other samplers: ____ *Episode ID (if tour is an entire episode): ___________*

Project codes: SK--Streamkeepers regular fecal sampling; PA--City of Port Angeles special project; Other (list): ____________________

Check sampling plan to determine projects and sites for samples & replicates; enter each bottle-grab on a separate line (so sample + replicate = 2 lines)

Complete in lab:

Bottle #	Site name	Site description	Enter "FR" if a field replicate	Time of fecal sample collection (military)	Sample collector (all initials)	Water temp (°C)	Weather past 12 / 24 / 48 hr., or other tour-wide comments: *In cells below, make notes about specific sites (water clarity, etc.):*	Lab #	Sample/ Lab Rep (LR) fecal reading *(colonies per 100 mL)*	EIM Qualifier

Lab samples submitted by (incl. initials): ________________________ Date: ________ Time: _______ Rec'd by: ________________________ Date: ________ Time: _______

Lab samples analyzed by (incl. initials): ________________________ Analysis date: ________ Time: _______

When finished, leave original form with water samples at lab and bring signed copy back to be filed at Streamkeepers Office

K:\Streamkeepers\Monitoring\Forms_SK regular forms\Field forms\GrabSampForm.xls Master printed 4/24/2014