Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program

In-Progress Summary– Water Years 2023-2024 Update

June 2025

Prepared by the Clallam County Department of Community Development–
Streamkeepers Program and the Clallam County Health and Human Services– Environmental
Health Section, under WADOE Grant WQC-C1CHHS-00131

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Prepared for
The Sequim Bay-Dungeness Watershed Clean Water District's Clean Water Work Group
PIC Program

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Foreword

The Sequim-Dungeness Clean Water District (CWD) Pollution Identification and Correction Program (PIC) is designed to implement strategies for protecting and improving the health of aquatic ecosystems, as a partnership among the Clallam County Human and Health Services Department's Environmental Health Section (CCEH), Clallam County Department of Community Development–Streamkeepers Program (Streamkeepers), Washington State Department of Ecology (WADOE), Washington State Department of Health (WADOH), Clallam Conservation District (CCD), Jamestown S'Klallam Tribe (JK'ST), Dungeness River Management Team (DRMT), Clallam County Marine Resources Committee (MRC), Sequim-Dungeness Water Users Association, United States Fish and Wildlife Service (USFWS), and the City of Sequim, Washington. The primary objectives of PIC serve to attain environmentally protective levels for analytes-of-concern and incorporate exceedances into decision making processes. The objectives are achieved through the use of sound ecological science and risk-based management. The PIC Trends Project, overseen by stakeholders CCEH and Streamkeepers, forms a critical component of the Program; designed to detect baseline shifts that inform the CWD's environmental correction initiatives.

This report is a periodic update intended for public distribution and for the parameters reported, supersedes the conditions reported in previous summaries:

Clallam County. 2023. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– 2022 Annual Report. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Department of Community Development, Streamkeepers Program, Port Angeles, Washington.

Clallam County. 2022. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– 2020-2021 Report. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Department of Community Development, Streamkeepers Program, Port Angeles, Washington.

Clallam County. 2021. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– 2019 Annual Report. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Department of Community Development, Streamkeepers Program, Port Angeles, Washington.

Clallam County. 2019a. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– 2018 Annual Report. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Department of Community Development, Streamkeepers Program, Port Angeles, Washington.

Clallam County. 2019b. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– Annual Report April 2017 - March 2018. Clallam County Health & Human Services, Environmental Health Section and Clallam County Public Works, Streamkeepers Program, Port Angeles, Washington.

Clallam County. 2017a. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– Annual Report May 2016- March 2017. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Public Works-Roads, Streamkeepers program, Port Angeles, Washington.

Clallam County. 2017b. Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan–Trends Monitoring Program In-Progress Summary– Annual Report May 2015- April 2016. Prepared by the Clallam County Health & Human Services, Environmental Health Section and Clallam County Public Works-Roads, Streamkeepers Program, Port Angeles, Washington.

Primary updates, presented herein, consist of:

(1) Reporting of PIC Trends monitoring collected during WY 2023 and 2024,
(2) Summarizing of 2015-2024 Trends data by WY, and
(3) Inclusion of Washington State Water Quality Assessment 303(d)/305(b) List statuses for CWD streams.

The current report provides a basis for determining the need for improvements, a means of assessing the effectiveness of corrective actions and informs on adaptive management strategies needed to improve environmental quality and to protect aquatic resources of the CWD. The primary focus of this report is bacterial and nutrient pollution affecting designated shellfish growing areas. Ancillary environmental parameters–temperature, dissolved oxygen, pH, and turbidity–are also reported. These parameters are intended to be considered holistically, along with shellfish harvest area statuses, public health advisories, 303(d) listings and OSS areas of concern, to prioritize corrective actions.

Acknowledgements

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Field Monitoring – Lance Vail, Bob Phreaner, Linda Sumner, Peggy McClure, Paul Rogers

Data Input/Checking – Donna Spence, Jane Hutton

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Mapping – Alan Brackney

Equipment Management/Calibration – Sue Nattinger

Volunteer Linda Sumner pushes a water sample through a syringe filter to prepare the sample for laboratory analysis of nutrient content.

Summary

This report presents findings from the Sequim Bay-Dungeness Clean Water District (CWD) Pollution Identification and Correction (PIC) Trends Monitoring Program. The program assesses water quality in streams discharging to Dungeness Bay, Sequim Bay, and the East Straits and Jamestown Shellfish Growing Areas. Led by Clallam County Health and Human Services–Environmental Health Section and Clallam County Department of Community Development–Streamkeepers Program, it monitors fecal coliform, nutrients (nitrate, nitrite, ammonia, orthophosphate), and ancillary parameters (temperature, dissolved oxygen, pH, turbidity). These efforts support ecological assessments, pollution control prioritization, and adaptive management.

The PIC Trends Program objectives are to:

- Provide water quality data to identify high priority focus areas for pollution control actions to maximize environmental benefits.
- Maintain a baseline dataset to evaluate the effectiveness of corrective actions and inform continuous improvement of the PIC Program.
- Collect data to support the Washington State 303(d)-listing process for impaired waters.

Investigative Activities

Water quality sampling commenced in May 2015 and has continued monthly or quarterly through 2024, contingent on station priority and funding. The program encompasses 21 freshwater stream stations, categorized by discharge into the East Straits, Dungeness Bay, Jamestown, and Sequim Bay Shellfish Growing Areas within Water Resource Inventory Areas 17 and 18. Protocols follow Streamkeepers standards and Quality Assurance Project Plans, with analyses targeting fecal coliform, nutrients, and ancillary parameters. Spatial and temporal trends from 2015 to 2024, augmented by Washington State 303(d)/305(b) listings, have informed prioritization of corrective actions for impaired streams.

Primary Findings

Integrated assessments of fecal coliform concentrations, nutrient enrichment (including nitrate, nitrite, ammonia, and orthophosphate), turbidity, and dissolved oxygen levels across the CWD revealed consistent and multifaceted impairments in several streams, based on data collected from water years 2015 through 2024. These impairments, evaluated against Washington State water quality standards (WAC 173-201A), Total Maximum Daily Load (TMDL) benchmarks, and EPA Nutrient Ecoregion II guidance highlighted bacterial and nutrient pollution as primary concerns. Summary statistics, particularly from water years 2022–2024, underscored the severity in priority streams, where exceedances of fecal coliform geometric mean and 90th percentile thresholds, elevated nutrient medians surpassing ecoregion benchmarks (e.g., NO2+NO3 >0.26 mg/L, orthophosphate >12.1 µg/L), median turbidity values exceeding 5 FNU above the ecoregion baseline, and dissolved oxygen excursions below 10 mg/L or 95% saturation collectively indicated degraded conditions threatening shellfish harvesting, aquatic life, and ecosystem health in downstream Dungeness Bay, Sequim Bay, and East Straits Shellfish Growing Areas.

Among the most degraded streams, Matriotti Creek exhibited a three-year fecal coliform geometric mean of 127 cfu/100 mL and a 90th percentile of 807 cfu/100 mL, far exceeding TMDL criteria of 60 and 170 cfu/100 mL, respectively, with nitrate concentrations consistently above 1.0 mg/L and dissolved oxygen levels dropping as low as 4.5 mg/L during excursions. Similarly, Bell Creek recorded a geometric mean of 89 cfu/100 mL and a 90th percentile of 1,101 cfu/100 mL against criteria of 50 and 100 cfu/100 mL, compounded by nitrate levels over 1.8 mg/L and orthophosphate medians ranging from 46 to 65 µg/L,

which surpassed regional benchmarks and suggested ongoing nutrient enrichment from agricultural and stormwater sources. Cassalery Creek followed suit with a geometric mean of 76 cfu/100 mL and a 90th percentile of 597 cfu/100 mL, also violating the 50 and 100 cfu/100 mL criteria, alongside dissolved oxygen excursions reaching 7.9 mg/L in 2024. Meadowbrook Creek and Lotzgesell Creek faced comparable challenges, with fecal coliform geometric means of 64 and 55 cfu/100 mL and 90th percentiles of 394 and 436 cfu/100 mL, respectively. Meadowbrook Creek had low dissolved oxygen levels, with five measurements below 6 mg/L during 2023-2024, and no measurements meeting the dissolved oxygen water quality criterion of 10 mg/L during that period.

Other streams demonstrated episodic or parameter-specific impairments. For instance, McDonald, Gierin, and Agnew Creeks showed intermittent bacterial pollution, with 90th percentiles of 280, 202, and 170 cfu/100 mL. Dean and No Name Creeks exceeded turbidity benchmarks, ranging from 9–35 FNU and 10–18.5 FNU, respectively. Sequim Bay State Park Creek displayed elevated orthophosphate medians of 45–53 µg/L, contributing to nutrient concerns in the Sequim Bay Growing Area. The Dungeness River, while maintaining a relatively lower geometric mean of 34 cfu/100 mL, exceeded its 2024 bacterial load allocation (8,989 vs. 5,059), signaling cumulative impacts from upstream tributaries. Overall, these findings positioned Matriotti, Bell, Cassalery, Meadowbrook, and Lotzgesell Creeks as high priority focus areas for corrective actions, with integrated data from the PIC Trends Monitoring Program providing a robust baseline for evaluating pollution sources and informing adaptive management to restore water quality and protect beneficial uses across the district.

Acronyms and Abbreviations

BMP	Best Management Practice(s)
CCD	Clallam Conservation District
CCEH	Clallam County Human and Health Services Department
cfu	colony-forming units
CWA	Clean Water Act
CWD	Sequim-Dungeness Clean Water District
DQO	Data Quality Objective
DRMT	Dungeness River Management Team
EIM	Environmental Information Management System maintained by Washington State Department of Ecology
EPA	Environmental Protection Agency (U.S.)
FNU	Formazin Nephelometric Unit
JK'ST	Jamestown S'Klallam Tribe
MQO	Measurement Quality Objective
MRA	Marine Recovery Area
MRC	Clallam County Marine Resources Committee
NASQAN	National Stream Quality Accounting Network
NAWQA	National Water Quality Assessment
NSSP	National Shellfish Sanitation Program
NTU	Nephelometric Turbidity Unit
OSS	onsite septic system
PIC	Pollution Identification and Correction Program
QAPP	quality assurance project plan
QC	Quality Control
Streamkeepers	Clallam County Department of Community Development–Streamkeepers Program
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	standard operating procedure
STORET	Storage and Retrieval database (EPA water quality system)
TMDL	total maximum daily load
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WADOE	Washington State Department of Ecology
WADOH	Washington State Department of Health
WWTP	Wastewater Treatment Plant
WY	Water Year

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1.0 Introduction

The Sequim Bay-Dungeness Clean Water District (CWD), established in 2001 under Chapter 27.16 of the Clallam County Code and Washington State's shellfish protection provisions in RCW 90.72, encompasses "the Dungeness Watershed and those waters influenced by it through irrigation systems, and other independent tributaries to the Strait of Juan de Fuca, from Bagley Creek east to, and including, the Sequim Bay Watershed," in Clallam County, Washington (Figure 1). Formed to address threats to the region's shellfish harvesting economy from nonpoint source bacterial and nutrient pollution, the CWD facilitates coordination among multiple agencies to mitigate such pollution, safeguarding aquatic ecosystems vital for commercial and recreational activities, tourism, agriculture, and fisheries.

This pollution, primarily sourced from failing septic systems, agricultural runoff, and animal waste, has historically impaired water quality, posing risks to public health and prompting regulatory actions under the Clean Water Act (CWA) Section 303(d) (Streeter and Hempleman 2004; Ecology 2018). Concerns about bacterial pollution in the region emerged in the early 1990s, with initial focus on Dungeness Bay and its contributing watersheds, while Sequim Bay faced separate challenges. In 1990, local and state entities measured high counts of fecal coliform at the mouth of the Dungeness River (Streeter and Hempleman 2004). This was followed in 1991 by the first report of fecal coliform concentrations exceeding water quality standards in Matriotti Creek, a tributary to the Dungeness River which drains to Dungeness Bay (Hempleman and Sargeant 2002). Separately, in 1992, 200 acres of Sequim Bay were closed to shellfish harvest, with an additional 2,830 acres downgraded to conditionally approved status due to elevated fecal coliform levels primarily linked to WWTP (wastewater treatment plant) design. In 1993, bacterial contamination in Dungeness Bay was formally noted, attributed to livestock access to waterways and irrigation return flows from ditches (Cadmus 2010). Monitoring in 1995 revealed exceedances of federal fecal coliform limits at Dungeness River mouth station #113[1] (Streeter and Hempleman 2004). The following year, 1996, saw several creeks placed on Washington's 303(d) list of impaired waters: Matriotti and Cassalery Creeks (draining to Dungeness Bay and the waters nears the mouth, respectively), and Bell and Johnson Creeks (draining to Sequim Bay). In 1997, the Washington State Department of Health (DOH) reported increasing fecal coliform levels at Dungeness Bay station 113 near the Dungeness River mouth (DOH 1998), concurrent with the development of the Dungeness Bay Shellfish Closure Prevention Response Strategy (Hempleman and Sargeant 2002).

The late 1990s marked a transition to structured regulatory and monitoring responses, with notable improvements in Sequim Bay and persistent challenges in Dungeness Bay. In 1998, upgrades to the City of Sequim WWTP and relocation of its discharge facilitated the reclassification of 2,800 acres in Sequim Bay from conditionally approved to approved, restoring water quality. However, the area near the Dungeness River mouth in Dungeness Bay was closed to harvest, prompting DOH to convene a response team under RCW 90.72 with Clallam County as lead for a Shellfish Protection District. The Dungeness River and Matriotti Creek Fecal Coliform Bacteria TMDL Study commenced in 1999 (Sargeant 2002), alongside detections of elevated nitrate and total coliform in drinking water wells and a public system in Agnew, within the Dungeness watershed (Hempleman and Sargeant 2002). That year, Clallam County incorporated recommendations to create its OSS (onsite septic system) Maintenance Program Plan and began offering Septics 101 courses to property owners. In 2000, DOH closed 300 acres near the Dungeness River mouth (monitoring stations 104, 105, and 113) to shellfish harvest (Cadmus 2010), while Clallam County adopted "Guidance for Threatened Species of Salmonids in Clallam County," emphasizing riparian setbacks and best management practices (BMPs) in critical aquifer recharge areas (Hempleman and Sargeant 2004). The Clean Water Strategy for addressing fecal coliform in Dungeness Bay and its

[1] DOH marine waters sampling stations map: https://fortress.wa.gov/doh/oswpviewer/index.html

watershed was finalized by the Clean Water Work Group (Streeter and Hempleman 2004), and 750 acres in Sequim Bay were upgraded from prohibited to approved.

In 2001, the Clean Water District was established by Clallam County ordinance to replace the Shellfish Protection District and broaden focus on water quality issues, incorporating the Clean Water Strategy; its boundaries encompassed the Dungeness watershed (draining to Dungeness Bay), the Siebert and Bagley Creek watersheds on the west (draining to the Strait of Juan de Fuca), and the Sequim Bay watershed on the east to protect shellfish growing areas in both bays. An additional 100 acres were added to the Dungeness Bay closure near monitoring station 108 (Cadmus 2010), and Rensel Associates initiated bacteria sampling in Dungeness Bay and discharging irrigation ditches through 2002 for TMDL support (Rensel 2003). Clallam County and the Jamestown S'Klallam Tribe assumed water quality monitoring responsibilities in the CWD, and sample collections began for the Dungeness River and Matriotti Creek Post-TMDL Data Review (Sargeant 2004b). The Dungeness River and Matriotti Creek TMDL Study was published in 2002, including Dungeness Bay tributaries - Meadowbrook Creek, Cooper Creek, Golden Sands Slough, Matriotti Creek, and Hurd Creek (Sargeant 2002) - with the Clean Water Work Group updating its strategy accordingly. This was followed by the Water Cleanup Plan for Bacteria in the Lower Dungeness Watershed TMDL Submittal Report (Hempleman and Sargeant 2002).

Closures and TMDL implementation continued into the mid-2000s, with regulatory advancements supporting OSS management. In 2003, DOH classified 1,150 acres of inner Dungeness Bay as conditionally approved for harvest from February through October and added 50 acres near monitoring station 114 to year-round closure (Sargeant 2004a). The Dungeness Bay Fecal Coliform Bacteria TMDL Study, including irrigation ditches, was completed in 2004 (Sargeant 2004a), along with the Dungeness River and Matriotti Creek Post-TMDL Data Review (Sargeant 2004b). The U.S. Environmental Protection Agency (EPA) funded OSS education and irrigation piping projects, the Water Cleanup Plan for Bacteria in Dungeness Bay TMDL Submittal Report was published (Hempleman and Sargeant 2004), a Targeted Watershed Grant freshwater monitoring strategy was finalized (encompassing nutrient baseline, ambient bacteria, and BMP effectiveness through 2008) (Hines et al. 2004), and the Clean Water Strategy for Addressing Bacteria Pollution in Dungeness Bay and Watershed and Water Cleanup Detailed Implementation Plan was issued (Streeter and Hempleman 2004). Meadowbrook Creek (draining to Dungeness Bay) and Jimmycomelately Creek (draining to Sequim Bay) were added to the 303(d) for fecal coliform exceedances list in 2004.

State-level regulations progressed in the mid-2000s to enhance OSS oversight and marine recovery efforts. WAC 246-272A requiring OSS management plans was adopted in 2005, followed in 2006 by RCW 70.118A mandating Marine Recovery Areas (MRAs) for septic-related marine water quality issues. In 2007, Clallam County aligned the CWD boundaries with an MRA designation, and its Board of Health approved an OSS Management Plan, initiating phased implementation. DOH reclassified 725 acres of previously unclassified intertidal waters in between Dungeness and Sequim bays for commercial shellfish harvest in 2008 (excluding areas near Golden Sands Slough and Cassalery Creek mouths) (Cadmus 2010). Lotzgesell, Bear, Mudd, and Cooper Creeks were added to the 303(d) list; among these, Lotzgesell, Bear and Mudd creeks drain to Dungeness Bay, while Cooper Creek drains to the Strait of Juan de Fuca, between the bays. A TMDL Effectiveness Monitoring Study began in 2008 and in 2009 reported that 9 of 13 Dungeness Bay tributaries failed to meet water quality criteria (Cadmus 2010). The TMDL Effectiveness Study was complemented by the completion of Microbial Source Tracking Phases I and II reports (Woodruff et al. 2009).

The 2010s and beyond have demonstrated incremental progress through area upgrades and the formalization of the PIC Program. In 2011, 500 acres in Dungeness Bay were upgraded from prohibited to conditionally approved. Agnew Ditch (part of the Agnew irrigation system draining to the Strait) was added to the 303(d) list in 2012. That same year, Clallam County secured EPA National Estuary Program funding to develop a PIC plan for the CWD. Building upon over a decade of monitoring and strategic planning since the district's establishment, Clallam County, the Clallam Conservation District, the Jamestown S'Klallam Tribe, and community stakeholders formalized the Sequim Bay-Dungeness Watershed Pollution Identification and Correction Plan in 2014 to further reduce pollution sources and restore beneficial uses (CCD 2014). PIC Phase I (2015–2017) initiated focus area sampling in Golden Sands Slough, Meadowbrook Creek, and Meadowbrook Slough—all draining east of the Dungeness Bay mouth. In 2015, 688 acres in Dungeness Bay were upgraded from conditionally approved to approved, with 40 prohibited acres to conditionally approved. In 2016, 272 acres offshore from the Dungeness River mouth were upgraded from conditionally approved to approved. PIC Phase II (2017–2019) targeted Matriotti and Lotzgesell Creeks, both contributing to Dungeness Bay. Between 2008 and 2018, additional 94 acres in Sequim Bay were upgraded from prohibited to approved. PIC Phase III (2020–2022) focused on Upper Matriotti Creek (Dungeness Bay drainage) and Lower Bell Creek (Sequim Bay drainage), alongside the 2020 upgrade of 23 acres at the mouths of Golden Sands Slough and Cassalery Creek from prohibited to approved.

The PIC Program represents a comprehensive, multi-decade effort to address bacterial pollution impairing water quality in Dungeness Bay and Sequim Bay, with primary sources in Dungeness Bay including nonpoint sources such as onsite septic systems (OSS), agricultural runoff, and urban stormwater, while historical closures in Sequim Bay were predominantly caused by point sources like WWTP design deficiencies and marina-related pollution. The program utilizes fecal coliform as the primary indicator for assessing shellfish safety risks under National Shellfish Sanitation Program (NSSP) standards, as it signals the presence of possible harmful pathogens (e.g., bacteria and viruses) associated with human and animal waste, and aligns with Total Maximum Daily Load (TMDL) requirements established for Dungeness Bay and its tributaries. Nutrient monitoring is also incorporated to evaluate loads against Level III ecoregion reference conditions, addressing potential issues like harmful algal blooms and hypoxic zones.

The PIC Program integrates the monitoring and education activities of the CWD with the correction activities of the MRA, creating a structured framework for identifying, prioritizing, and remediating pollution sources. Central to this structure is the Water Quality Trends Monitoring Program (Trends Program), which provides long-term data on bacterial and nutrient levels at the outlets of streams and waterways throughout the CWD. These Trends data serve as the primary basis for identifying polluted water bodies and prioritizing sub-basins for focused pollution identification and correction activities, known as Focus Areas. Sub-basins are ranked through a thorough review of Trends monitoring data alongside additional factors, including shellfish harvest impairments, public health advisories, TMDL implementation, 303(d) listings, and OSS areas of concern (CCD 2014). This prioritization ensures that resources are directed toward high-impact areas, with follow-up monitoring to evaluate program effectiveness and adaptive management.

This historical trajectory underscores the evolution of monitoring, regulatory, and corrective actions that form the foundation of the PIC Trends Program. By assessing bacterial and nutrient levels in streams entering Dungeness and Sequim Bays against TMDL thresholds, water quality standards, and ecoregion reference conditions, the program prioritizes interventions, tracks water quality improvements, and supports ongoing efforts to restore and protect these vital ecosystems. Trends is the implementation monitoring of the Detailed Implementation Plan (Streeter and Hempleman 2004).

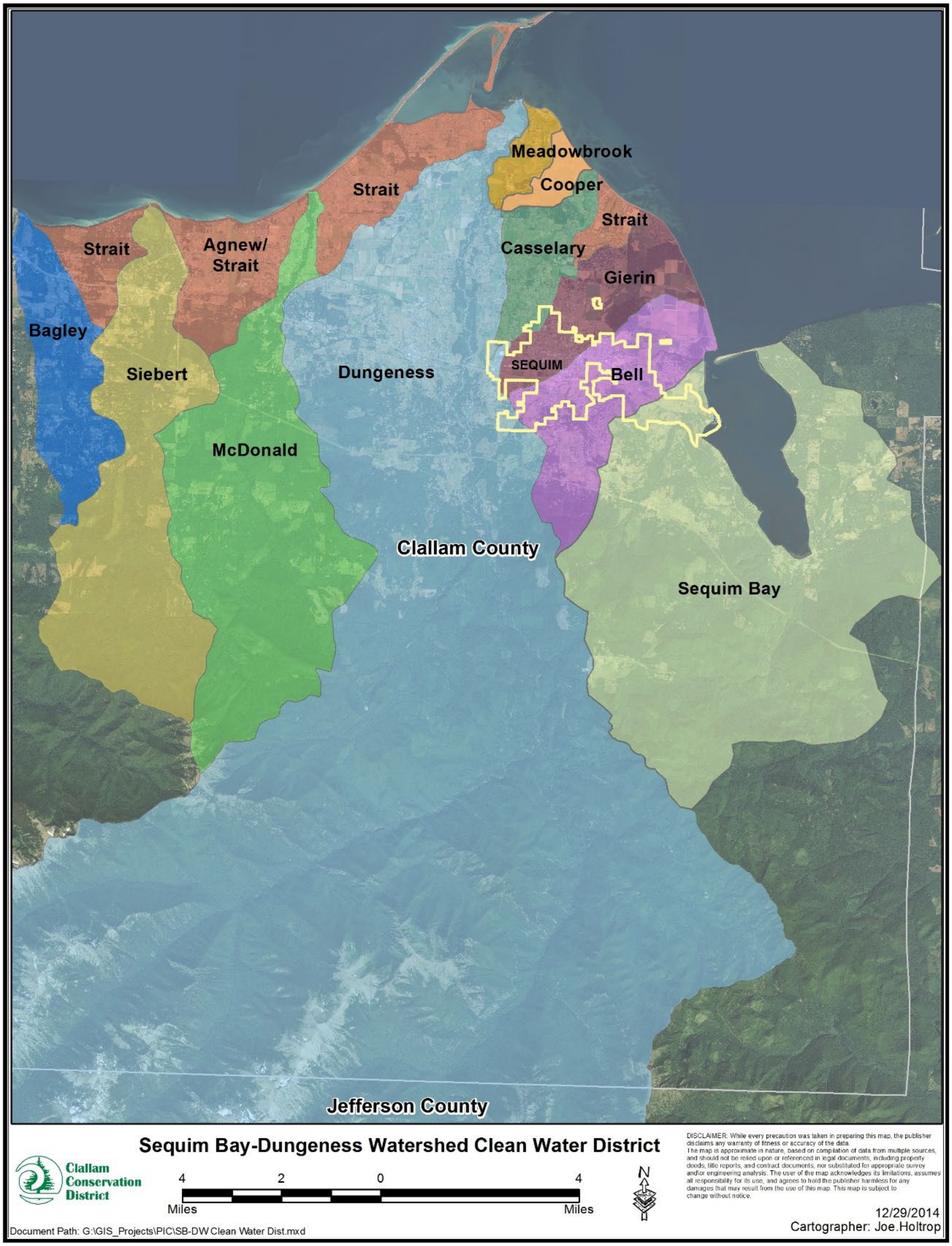

Figure 1. Sequim Bay-Dungeness Watershed Clean Water District and sub-watersheds.

2.0 Objectives

Data from the CWD network of monitoring stations are evaluated to assess the impacts of pollution, characterize the status and trends of ecological resources, and determine whether discharges from all sources are protective of beneficial uses, including aquatic life. The data provide a basis for determining the need for improvement, assessing the effectiveness of corrective actions, and informing adaptive management actions needed to improve environmental quality and protect aquatic resources. In WAC 173-201A (2024), Washington State has assigned the following protected uses for waters within the CWD:

1. Salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans, and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning)
2. Shellfish (clam, oyster, and mussel) harvesting
3. Primary contact recreational use
4. Wildlife habitat
5. Harvesting (salmonid and other fish harvesting, and crustacean, and other shellfish [crabs, shrimp, scallops, etc.] harvesting)
6. Commerce and navigation
7. Boating
8. Aesthetic values

Freshwaters have been assigned the following additional use protections:

1. Domestic, industrial, and agricultural water supply
2. Stock watering

Toward stewarding these protections, CWD PIC Trends Project objectives are as follows:

1. Provide the water quality status data for selection of Focus Areas where pollution control actions will have the greatest benefit
2. Maintain the baseline dataset for assessing effectiveness of control actions and to inform continuous process improvement of the PIC Program, and
3. Obtain data for the 303(d)-listing process

PIC Trends efforts primarily address the statuses of lower-reach areas of CWD streams, informing the Clean Water Work Group on the transport of upstream pollution and load transfers to marine shellfish growing areas. In addition, the program aligns with state and federal frameworks, including the Clean Water Act, and contributes data to regulatory assessments.

3.0 Sampling Design

This section addresses the technical approach taken, defines stations at which samples were collected, and summarizes collection windows for Phase IV efforts from 2023-2024. All aspects of the CWD PIC program adhere to the phased Quality Assurance Project Plans (QAPP) (Chadd and Bond 2015 [PIC Phase I]; Chadd et al. 2017 [PIC Phase II]; Bond et al. 2019 [PIC Phase III]; and Strivens et al. 2025 [PIC Phase IV]) and are periodically reviewed by the Streamkeepers of Clallam County and the CWD Clean Water Work Group for reconciliation with dynamic regulatory and scientific conclusions.

3.1 Technical Approach

Twenty-one freshwater stream monitoring stations, in lower-reach areas of The Sequim Bay-Dungeness CWD, have been adopted by the PIC Trends Program. These stations are routinely sampled following Streamkeepers protocols (Chadd 2016, 2019) and are documented in the CWD QAPP (Strivens et al. 2025). Monitoring at many of these stations is a continuation of efforts initiated under TMDL studies and the Targeted Watershed Grants Program (Hines et al. 2004). Site selection prioritized all significant waterways discharging into Sequim Bay, Dungeness River and Bay, and the East Straits Growing Area on the Strait of Juan de Fuca, which fall within Water Resource Inventory Areas 17 (Sequim Bay) and 18. There are no authorized point-sources on any of the streams.

Under PIC, Streamkeepers initiated sampling in May of 2015 and subsequent collections have been conducted monthly or quarterly, dependent upon Clean Water Work Group priority designation and available grant funding. Stations designated Tier 1 have been sampled monthly for fecal coliform and monthly (PIC Phases I and II) or quarterly (PIC Phases III and IV) for nitrate, nitrite, ammonia, and orthophosphate. Stations designated Tier 2 have been sampled quarterly for fecal coliform. Temperature and salinity have been recorded during each collection to determine if tidal influence was present. Dissolved oxygen, pH, and turbidity were also recorded for comprehensive assessment of water quality. In addition, stream stages have been recorded at the nearest reference points.

Monitored streams include four main groups, those draining to (1) the East Straits Shellfish Growing Area, (2) the Dungeness Bay Shellfish Growing Area, (3) the Jamestown Shellfish Growing Area, and (4) the Sequim Bay Shellfish Growing Area.

The resulting data are reviewed and summarized by Clallam County for use by the Clean Water Work Group, regulators, and compliance managers as a component of the CWD approach to ecological protection.

The following list, grouped by primary affected Shellfish Growing Area, summarizes the attributes of each stream, including sampling mile, drainage area, and prominent tributaries.

East Straits Growing Area

Bagley Creek (CM 0.7)—is a medium-sized, 5.32 square mile, independent drainage, entering the Strait 2 miles west of Green Point. It is the westernmost watershed of the CWD. The drainage has approximately 9.5 miles of streams and tributaries. With its headwaters in the foothills, the Bagley Creek watershed is comprised mostly of very shallow soils over glacial till, making it highly susceptible to flooding and channel erosion.

Siebert Creek (CM 1.0)—is 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.

Agnew Creek/Ditch (CM0.3)—is part of Sequim's irrigation ditch system, originating from the Dungeness River. It is 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.

McDonald Creek (CM 1.6)—is a significant independent drainage, entering the Strait of Juan de Fuca between the western end of Dungeness Spit and Green Point. It's 13.6 miles drain 23.0 square miles of the northwest flank of Blue Mountain, with headwaters originating at 4,700'. The creek flows through a deeply incised coastal upland and marine bluff.

Dungeness Bay Growing Area

Lotzgesell Creek (CM 0.1)—is a 2-mile-long tributary to Matriotti Creek, entering at CM 0.6.

Matriotti Creek (CM 0.3)—Matriotti Creek is the largest low elevation tributary to the lower Dungeness River, running approximately 8.5 miles and draining 13.6 square miles, and entering the river at RM 1.3. Bebe (CM 0.25), Lotzgessell (CM 0.6), Mudd (CM 1.9) and Bear (CM 3.8) creeks are tributaries; Bear creek received Clallam Company irrigation returns originating from the Dungeness River. A large exotic animal park, the Olympic Game Farm, is located near the mouth of Matriotti Creek.

Meadowbrook Creek (CM 0.1/0.2)—is approximately 3 miles long and drains a 0.5 square mile, low elevation watershed, flowing north toward Dungeness Bay, approximately 0.4 miles east of the Dungeness River mouth. A Dungeness District irrigation ditch flows into Meadowbrook Creek at CM 1.75. This ditch also receives irrigation tailwater return and stormwater from Sequim-Dungeness Way.

Meadowbrook Slough (CM 0.23)—Meadowbrook Slough (also referred to as Dungeness Slough, by neighbors) is approximately 0.5 miles long and parallels a dike along the lower reaches of the Dungeness River. The slough is fed with water from an outtake at Dungeness RM 0.3; a landowner on the Dungeness controls flow at the outtake. The points of discharge of the Dungeness River, Meadowbrook Slough, and Meadowbrook Creek are dynamic—occasionally the lesser waterways discharge directly into the bay, while other times they first join the Dungeness River which in turn discharges into the bay.

Hurd Creek (CM 0.2)—is a short, low-elevation tributary approximately one mile long that flows into the Dungeness River on the right bank at RM 2.7. It is low-gradient and spring-fed in the lower 1/4 mile of stream, and which provides significant high quality tributary rearing and refuge habitat for salmonids and other fish. The channel flows through a Washington Department of Fish and Wildlife fish hatchery facility. Hurd is also augmented at times by tailwater from the Dungeness District irrigation system.

Dungeness River (RM 0.7)—flows north into the outer Dungeness Bay just east of the opening between Graveyard and Cline Spits, draining 270 square miles. The mainstem extends 31.9 miles; a primary tributary, the Gray Wolf River extends for 17.4 miles, with a total of 546 miles of streams and tributaries in the watershed (including Matriotti, Lotzgesell and Hurd Creeks). The river contributes the vast majority of freshwater to the Bay.

Jamestown Growing Area

Golden Sands Slough (CM 0.0)—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 stagnant and there is a tide gate at the mouth of the slough.

Cooper Creek (CM 0.1)—is a wetlands-fed creek that discharges into Dungeness Bay just southeast of Golden Sands Slough. The 1-mile-long creek is fed by groundwater, 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 (CM 0.0/0.6)—is a relatively small independent drainage east of the Dungeness. It is approximately 4 miles in length, draining a 3.2 square mile watershed of low elevation land on the east side of the lower Dungeness Valley. Cassalery Creek is fed by groundwater discharge.

Gierin Creek (CM 1.8)—Gierin Creek is a small, 3.3 mile long, 3.1 square mile independent drainage on the east side of the Dungeness plain, entering the Strait north of Sequim Bay. It is fed by groundwater discharges and from irrigation diversions from the Dungeness River. The headwaters are within the City of Sequim and may be impacted by urban land uses.

Sequim Bay Growing Area

Bell Creek (CM 0.2)—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.

Johnson Creek (CM 0.0)—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 (RM) 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.

Sequim Bay State Park Creek (CM 0.0/0.1)—is 1.8 miles long and 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.

Dean Creek (CM 0.17)—is an intermittent stream draining 3 square miles, consisting of the east side of Burnt Hill and the northwest side of Lookout Hill, and flowing 4 miles from headwaters at an elevation of ~1900’ into the southwest corner of Sequim Bay.

Jimmycomelately Creek (CM 0.15)—is the largest stream in the Sequim Bay watershed. It flows nearly 19 miles from its headwaters at about 3,800 feet in Olympic National Forest to its mouth in South Sequim Bay. The creek drains approximately 15.4 square miles. A broad, flat valley is a central feature in the creek’s upper watershed. Several major sub-drainages contribute to JCL Creek, and west and south forks flow north into the head of Sequim Bay. The relatively steep portion of the watershed ends approximately 1.8 miles from saltwater, where the creek enters a more gently sloping area that was historically wetlands.

No Name Creek (CM 0.03)—has a 0.6-mile-long main stem and drains 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.

Chicken Coop Creek (CM 0.24)—enters the southeast corner of Sequim Bay to the northeast of Jimmycomelately Creek. The mainstem is 1.3 miles in length with an additional 3.1 miles in tributaries. The mouth of Chicken Coop Creek shares a high intertidal zone with No Name Creek, a few dozen meters to the southwest.

3.2 Sampling Station Maps

Sampling station coordinates and downstream Shellfish Growing Areas are listed in Table 1. Stations along the East Straits Growing Area are mapped in Figure 2, streams draining to the Dungeness Bay and Jamestown Growing Areas are mapped in Figure 3, and stations on Sequim Bay are mapped in Figure 4. Tier designations on maps reflect WY 2023 prioritization statuses.

Table 1. Sequim Bay-Dungeness CWD PIC monitoring stations.

Site/mile	Latitude	Longitude	Growing Area	Tier 2015-23	Tier 2024
Bagley 0.7	48.105043	-123.337320	East Straits	2	2
Siebert 1.0	48.106598	-123.279115	East Straits	2	2
Agnew ditch 0.3	48.112531	-123.252448	East Straits	2	1
McDonald 1.6	48.105289	-123.221855	East Straits	2	1
Lotzgesell 0.1	48.135822	-123.150510	Dungeness Bay	1	1
Matriotti 0.3	48.136294	-123.145535	Dungeness Bay	1	1
Meadowbrook 0.1			Dungeness Bay	1	1
Meadowbrook 0.2	48.149264	-123.121623	Dungeness Bay	1	1
Meadowbr. Slough 0.23	48.148703	-123.125340	Dungeness Bay	1	1
Hurd 0.2	48.120962	-123.143386	Dungeness Bay	2	2
Dungeness River 0.7	48.148809	-123.126787	Dungeness Bay	1	1
Golden Sands Slough 0.0	48.141454	-123.107041	Jamestown	1	1
Cooper 0.1	48.137380	-123.101586	Jamestown	1	2
Cassalery 0.0	48.134584	-123.096532	Jamestown	1	1
Cassalery 0.6	48.126596	-123.100089	Jamestown	1	1
Gierin 1.8	48.102269	-123.075367	Jamestown	2	1
Bell 0.2	48.083494	-123.057191	Sequim Bay	1	1
Johnson 0.0	48.062146	-123.041126	Sequim Bay	1	2
Sequim Bay SP 0.0			Sequim Bay	1	2
Sequim Bay SP 0.1	48.040194	-123.027956	Sequim Bay	1	2
Dean 0.17	48.024208	-123.011028	Sequim Bay	2	2
Jimmycomelately 0.15	48.020600	-123.006780	Sequim Bay	1	2
No Name 0.03	48.025929	-122.996952	Sequim Bay	2	2
Chicken Coop 0.24	48.029061	-122.996131	Sequim Bay	2	2

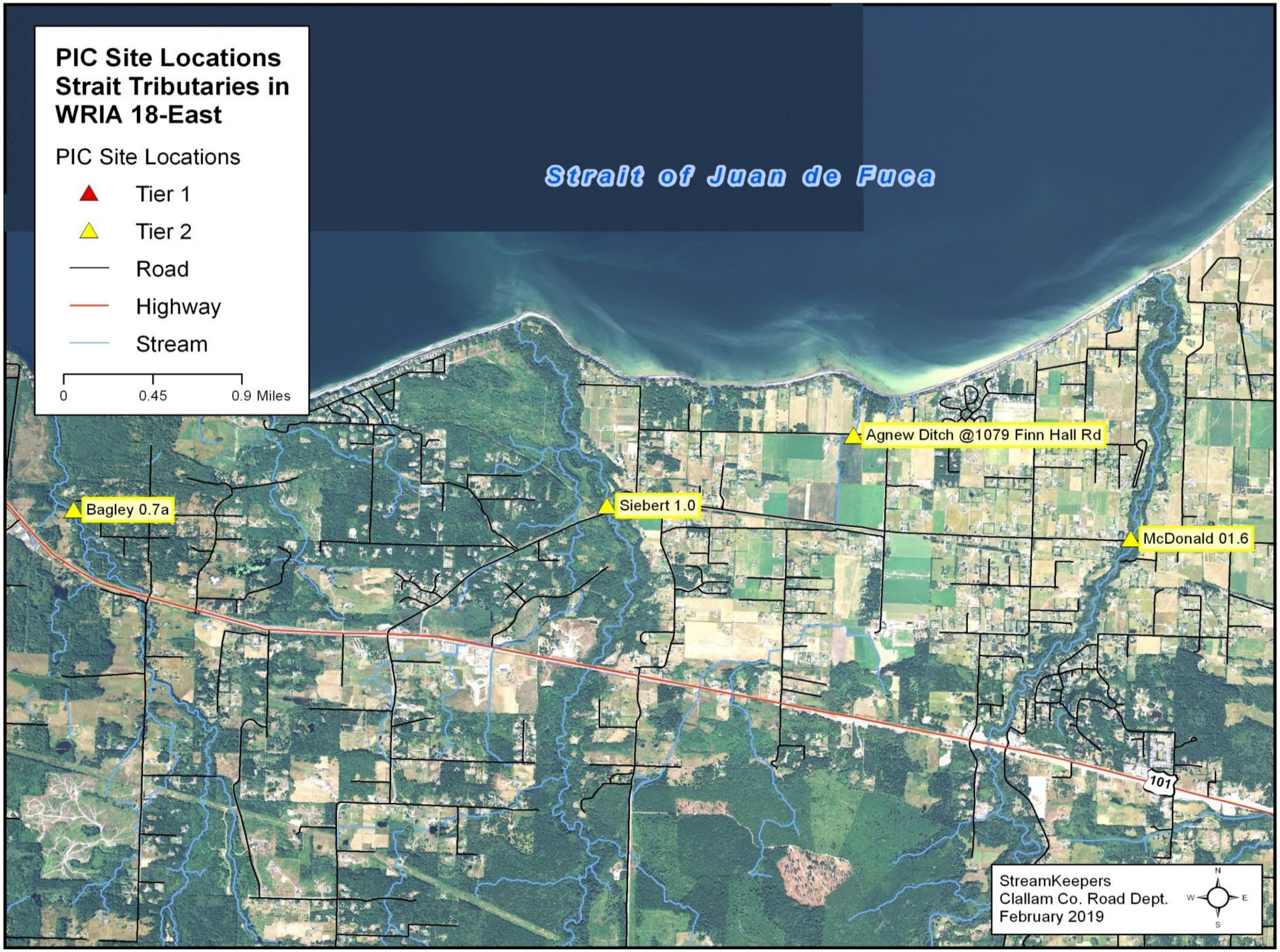

Figure 2. PIC baseline Trends monitoring sample sites on surface waters draining to the East Straits Shellfish Growing Area.

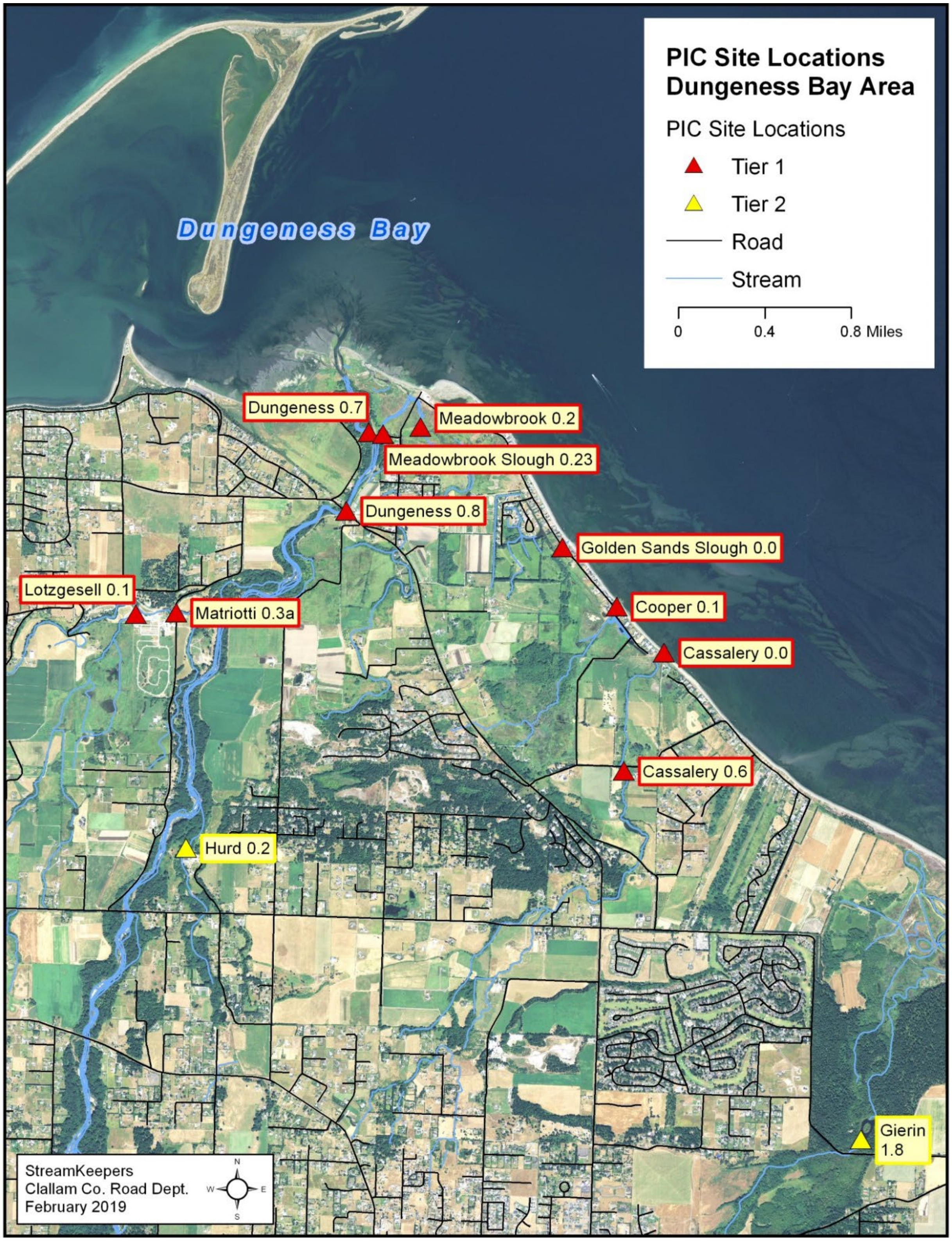

Figure 3. PIC baseline Trends monitoring sample sites on surface waters draining to the Dungeness Bay and Jamestown Shellfish Growing Areas.

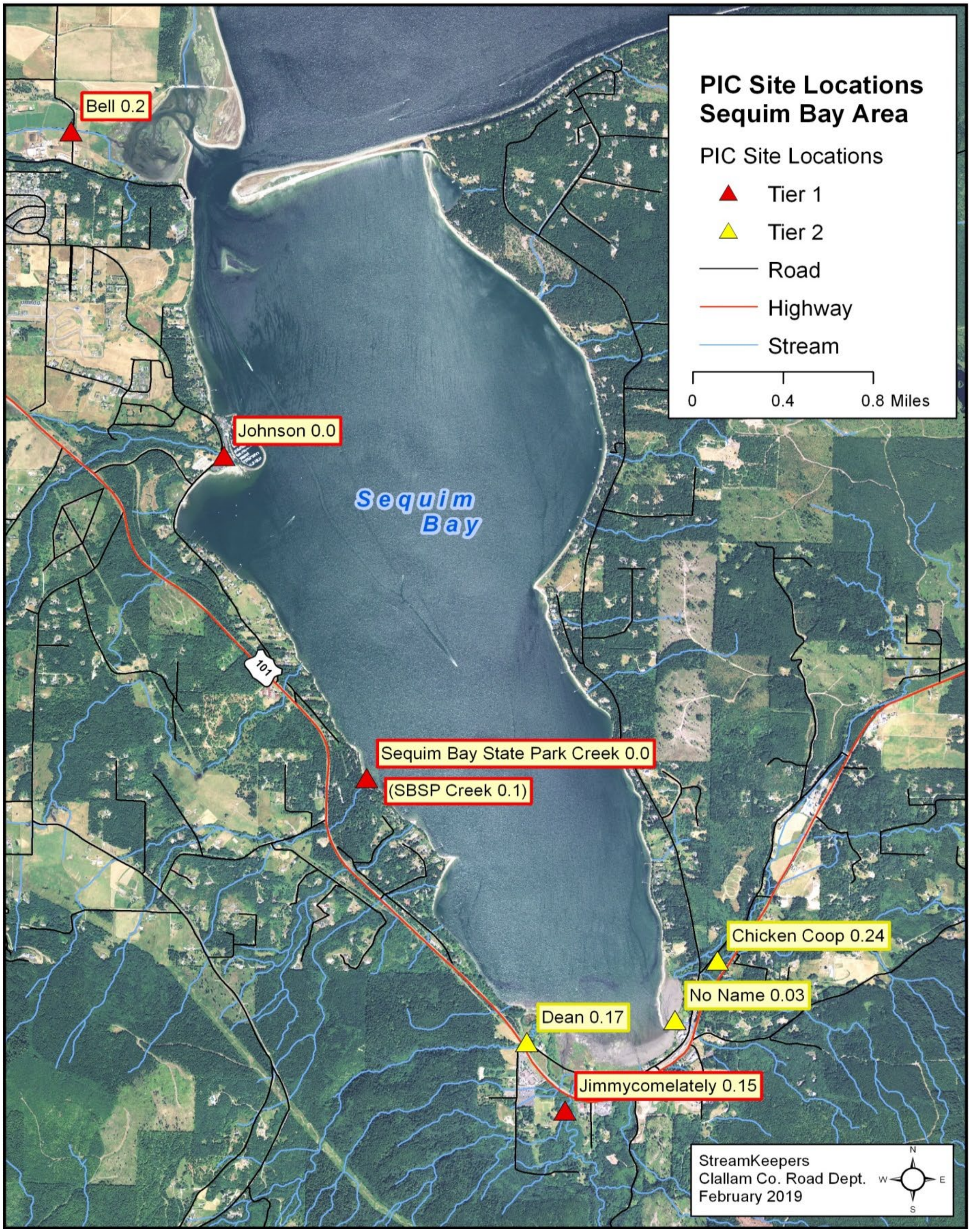

Figure 4. PIC baseline Trends monitoring sample sites on surface waters draining to the Sequim Bay Shellfish Growing Area.

3.3 Schedule

This section summarizes the monitoring frequency maintained by Streamkeepers during calendar years 2023 and 2024; monitoring frequency for prior calendar years is reported in previous in-progress summary updates.

Tier 1 sites were sampled monthly, as possible, for fecal coliform and nutrients. Tier 2 sites were sampled quarterly for fecal coliform only. Water temperature, salinity, dissolved oxygen, pH, and turbidity data were collected at all sites on every visit (Table 2 and Table 3).

Table 2. Site locations and type of sampling performed from January 2023 through December 2023.

	Stream/ Mile	Receiving Waters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tier 1 Streams	Dungeness 0.7	Dungeness Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Meadowbrook 0.2	Dungeness Bay	A	F	F N	F	F N	F	F	F	F N	F	F N	F
	Golden Sands Slough 0.0	Dungeness Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Cooper 0.1	Dungeness Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Cassalery 0.0/0.6*	Dungeness Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Matriotti 0.3a	Dungeness River	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Lotzgesell 0.1	Dungeness River	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Sequim Bay State Park Creek 0.0/0.1*	Sequim Bay	F N	F N	F N	F	F N	F	IF	D	D	D	F N	F
	Bell 0.2	Sequim Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Johnson 0.0	Sequim Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
	Jimmycomelately 0.15	Sequim Bay	F N	F	F N	F	F N	F	F	F	F N	F	F N	F
Tier 2 Streams	Bagley 0.7a	Strait	F				F			F			F	
	Siebert 1.0	Strait	F				F			F			F	
	Agnew Creek/Ditch 0.3	Strait	F				F			F			F	
	McDonald 1.6	Strait	F				F			F			F	
	Hurd 0.2	Dungeness R.	F				F			F			F	
	Gierin 1.8	Dung. Bay	F				F			F			F	
	Dean 0.17	Sequim Bay	F				F			IF			IF	
	No Name 0.03	Sequim Bay	F				F			D			D	
	Chicken Coop 0.24	Sequim Bay	A				F			F			A	

F = fecal coliform, N = nutrients, IF = insignificant flow, D = no flow, A = not safely accessible, * = tide dependent.

Table 3. Site locations and type of sampling performed from January 2024 through December 2024.

	Stream/ Site Name	Receiving Waters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tier 1 Streams	Agnew Creek/ Ditch 0.3	Strait	F	T	F N	F	F N	F	F N	F	F N	F	F N	F
	McDonald 1.6	Strait	F	T	F N	F	F N	F	F N	F	F N	F	F N	F
	Dungeness 0.7	Dungeness Bay	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Gierin 1.8	Dungeness Bay	F	T	F N	F	F N	F	F N	F	F N	F	F N	F
	Golden Sands Slough 0.0	Dungeness Bay	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Meadowbrook 0.2	Dungeness Bay	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Cassalery 0.0/0.6*	Dungeness Bay	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Matriotti 0.3a	Dungeness River	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Lotzgesell 0.1	Dungeness River	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
	Bell 0.2	Sequim Bay	F N	F	F N	F	F N	F	F N	F	F N	F	F N	F
Tier 2 Streams	Bagley 0.7a	Strait	F			F				F			F	
	Siebert 1.0	Strait	F			F				F			F	
	Cooper 0.1	Dungeness Bay	F N	F		F				F			F	
	Hurd 0.2	Dungeness R.	F			F				F			F	
	Dean 0.17	Sequim Bay	F			F				F			F	
	Jimmycomelately 0.15	Sequim Bay	F N	F		F				F			F	
	Johnson 0.0	Sequim Bay	F N	F		F				F			F	
	Sequim Bay State Park Creek 0.0/0.1*	Sequim Bay	F N			F				D			F	
	No Name 0.03	Sequim Bay	F			F				F			F	
	Chicken Coop 0.24	Sequim Bay	A			F				F			F	

F = fecal coliform, N = nutrients, T = change in Tier designation, D = no flow, A = not safely accessible, * = tide dependent.

Streamkeepers volunteer Linda Sumner collects samples from the Dungeness River for fecal coliform analyses.

4.0 Regulatory Criteria and Project Quality Assurance

This section summarizes 1) the Washington Administrative Code water quality standards for surface waters of the state, 2) established Total Maximum Daily Load criteria for CWD streams, 3) EPA ecoregion guidance for nutrient levels in streams, and 4) Washington State Water Quality Assessments. Following this, data quality objectives, quality assurance, and quality control of the reported monitoring efforts are summarized.

4.1 Designated Use Criteria

Table 4 summarizes the water quality standards, for Trends monitored parameters, for freshwater and marine environments as specified in WAC 173-201A (last updated 11/27/2024). These criteria, derived from WAC 173-201A-200 (freshwater), 173-201A-210 (marine), and 173-201A-240 (toxic substances), provide regulatory benchmarks for protecting aquatic life, recreational uses, and, where applicable, domestic water supply and shellfish harvesting. Notably, while E. coli and enterococci are the current indicators for recreational uses in freshwater and marine waters, respectively, following the 2019 updates and the end of the transition period on December 31, 2020, fecal coliform remains the designated indicator for shellfish growing areas and for existing freshwater streams with established Total Maximum Daily Loads (TMDLs), particularly those designed to protect downstream shellfish harvest uses (Ecology 2019).

Supplemental spawning and incubation criteria of 13°C (as a 7-day average of daily maximum temperatures) from September 1 to June 15 are established for Trends monitored sections of Siebert, McDonald, Dungeness, Matriotti, Golden Sands, Cooper, Bell, and Jimmycomelately to protect reproduction, as outlined in Payne (2011).

Table 4. Summary WAC 173-201A surface water quality standards.

Parameter	Freshwater Standards	Marine Standards
Temperature	**Aquatic Life Uses**: - Char Spawning and Rearing: ≤12°C (7-DADMax) - Core Summer Salmonid Habitat: ≤16°C (7-DADMax) - Salmonid Spawning, Rearing, and Migration: ≤17.5°C (7-DADMax) - Salmonid Rearing and Migration Only: ≤17.5°C (7-DADMax) **Conditions**: Measured as 7-day average of daily maximums (7-DADMax). Not to exceed criteria more than once every 10 years on average. Some streams have a more stringent temperature criterion that is applied seasonally to further protect salmonid spawning and egg incubation.	**Aquatic Life Uses**: - Extraordinary Quality: ≤13°C (1-DMax) - Excellent Quality: ≤16°C (1-DMax) - Good Quality: ≤19°C (1-DMax) - Fair Quality: ≤22°C (1-DMax) **Conditions**: Measured as 1-day maximum (1-DMax). Not to exceed criteria more than once every 10 years on average.

Parameter	Freshwater Standards	Marine Standards
Dissolved Oxygen	**Aquatic Life Uses**: - Char Spawning and Rearing: ≥10 mg/L or 90% saturation (1-day min, water column) - Core Summer Salmonid Habitat: ≥10 mg/L or 95% saturation (1-day min) - Salmonid Spawning, Rearing, and Migration: ≥10 mg/L or 90% saturation (1-day min) - Salmonid Rearing and Migration Only: ≥6.5 mg/L (1-day min) **Conditions**: When naturally lower than criteria (or within 0.2 mg/L), human actions cannot decrease >10% or 0.2 mg/L below natural (whichever smaller). Not to fall below criteria more than once every 10 years on average.	**Aquatic Life Uses**: - Extraordinary Quality: ≥7.0 mg/L (1-day min) - Excellent Quality: ≥6.0 mg/L (1-day min) - Good Quality: ≥5.0 mg/L (1-day min) - Fair Quality: ≥4.0 mg/L (1-day min) **Conditions**: Not to fall below criteria more than once every 10 years on average.
Turbidity	**Aquatic Life Uses**: - Char Spawning/Rearing, Core Summer Salmonid, Salmonid Spawning/Rearing/Migration: ≤5 NTU over background (if ≤50 NTU) or ≤10% increase (if >50 NTU) - Salmonid Rearing/Migration Only: ≤10 NTU over background (if ≤50 NTU) or ≤20% increase (if >50 NTU) **Conditions**: Temporary mixing allowed for in-water construction with BMPs.	**Aquatic Life Uses**: - Extraordinary/Excellent Quality: ≤5 NTU over background (if ≤50 NTU) or ≤10% increase (if >50 NTU) - Good/Fair Quality: ≤10 NTU over background (if ≤50 NTU) or ≤20% increase (if >50 NTU)
pH	**Aquatic Life Uses**: - Char Spawning/Rearing, Core Summer Salmonid: 6.5-8.5, human variation <0.2 units - Other categories: 6.5-8.5, human variation <0.5 units	**Aquatic Life Uses**: - Extraordinary Quality: 7.0-8.5, human variation <0.2 units - Excellent/Good Quality: 7.0-8.5, human variation <0.5 units - Fair Quality: 6.5-9.0, human variation <0.5 units
Fecal Coliform	**Recreational Uses (Primary Contact, expired 12/31/2020)**: Geometric mean ≤100 cfu/100 mL; not >10% samples >200 cfu/100 mL **Conditions**: Minimum 3 samples for geometric mean; averaging period ≤30 days for effluent, ≤90 days for ambient. **Note**: Current criteria use E. coli (GM ≤100 cfu/100 mL; not >10% >320 cfu/100 mL).	**Shellfish Harvesting**: Geometric mean ≤14 cfu/100 mL; not >10% samples >43 cfu/100 mL **Recreational Uses (Primary Contact, expired 12/31/2020)**: Geometric mean ≤14 cfu/100 mL; not >10% samples >43 cfu/100 mL **Conditions**: For shellfish, averaging preferably by season, ≤12 months max; for recreation, similar to freshwater. **Note**: Current recreation uses enterococci (GM ≤30 cfu/100 mL; not >10% >110 cfu/100 mL).

Parameter	Freshwater Standards	Marine Standards
Ammonia	**Aquatic Life - Freshwater**: criteria are dependent on the temperature and pH of the water.	**Aquatic Life - Marine**: - Acute (1-hour avg, once/3 yrs): 0.233 mg N/L (total ammonia nitrogen) - Chronic (4-day avg, once/3 yrs): 0.035 mg N/L (total ammonia nitrogen) **Conditions**: Expressed as un-ionized ammonia concentrations (mg N/L). Not to exceed criteria more than once every 3 years on average.
Nitrate	No numeric criteria for aquatic life. For waters designated as domestic water supply, must meet drinking water MCL of 10 mg/L (as N) per 40 CFR 141 and chapter 246-290 WAC.	Narrative criteria for nutrients apply (e.g., no introduction above natural levels causing adverse effects).
Nitrite	No numeric criteria for aquatic life. For waters designated as domestic water supply, must meet drinking water MCL of 1 mg/L (as N) per 40 CFR 141 and chapter 246-290 WAC.	Narrative criteria for nutrients apply (e.g., no introduction above natural levels causing adverse effects).
Orthophosphate	No specific numeric criteria. Narrative criteria for nutrients apply (e.g., no introduction above natural levels causing adverse effects).	Narrative criteria for nutrients apply (e.g., no introduction above natural levels causing adverse effects).

4.2 TMDL Benchmarks

Table 5 presents the Total Maximum Daily Load based water quality criteria for fecal coliform concentrations in the Lower Dungeness Watershed, as established by the Dungeness River and Matriotti Creek Fecal Coliform Bacteria TMDL Study (Sargeant 2002). These criteria define the maximum allowable concentrations to ensure compliance with Washington State water quality standards and NSSP requirements for safe commercial shellfish harvesting. Additionally, the table includes the rollback calculated values, which represent the necessary concentrations to meet the TMDL targets, based on data collected in WY 2000. These values guide the assessment of current stream conditions against the established standards to evaluate progress toward restoring water quality in the affected waterbodies.

Table 5. Total Maximum Daily Load target geometric mean and 90th percentile criteria and calculated rollback benchmarks required to meet criteria.

Site/Mile	Target GMV (fc/100mL)	Target 90th Percentile (fc/100mL)	Rollback GMV (fc/100mL)	Rollback 90th Percentile (fc/100mL)	Load Allocation (conc x flow)
Cooper Creek	≤ 50	≤ 100	35	100	214
Dungeness RM 0.1	≤ 13	≤ 43	13	43	6812
Dungeness RM 0.3	≤ 13	≤ 43	9	43	5288
Dungeness RM 0.8	≤ 13	≤ 43	9	43	5059
Irrigation return at Dungeness River RM 1.0	≤ 60	≤ 170	60	170	24
Matriotti Creek	≤ 60	≤ 170	60	170	1267
Hurd Creek	≤ 60	≤ 170	12	100	316
Dungeness RM 3.2	≤ 13	≤ 43	6	28	3279
Meadowbrook Creek CM 0.2	≤ 50	≤ 100	14	100	200
Golden Sands Slough	≤ 50	≤ 100	19	100	33

Site/Mile	Target GMV (fc/100mL)	Target 90th Percentile (fc/100mL)	Rollback GMV (fc/100mL)	Rollback 90th Percentile (fc/100mL)	Load Allocation (conc x flow)
Irrigation Ditch 1[a]	≤ 100	≤ 200	100	182	12
Irrigation Ditch 2[b]	≤ 100	≤ 200	24	200	<1

[a] Ditch was piped in 2004
[b] Ditch was piped in 2007

4.3 Ecoregion Guidance

The U.S. Environmental Protection Agency's guidance for Nutrient Ecoregion II, specifically for rivers and streams in Level III Ecoregion 2 (Puget Lowlands), provides recommended ambient water quality criteria to address nutrient over-enrichment, including nitrate plus nitrite (NO_2+NO_3) and turbidity. According to the EPA's document (U.S. EPA 2000), the recommended criteria for nitrate plus nitrite and turbidity in Level III Ecoregion 2 streams are derived from the 25th percentile of the distribution of median values from a representative sample of streams, reflecting minimally impacted conditions protective of aquatic life and recreational uses. For Level III Ecoregion 2, which includes the Sequim Bay-Dungeness CWD, the guidance utilizes historical data from 1990 to 1998, sourced from Legacy STORET, NASQAN, NAWQA, and EPA Region 10. These criteria serve as a starting point for States and Tribes to develop localized standards, with flexibility to refine values using site-specific data or other scientifically defensible methods to ensure protection of designated uses while accounting for regional variability in the Puget Lowlands' ecological conditions.

The EPA's nutrient criteria guidance for Nutrient Ecoregion II was calculated using a statistical approach outlined in the Rivers and Streams Nutrient Criteria Technical Guidance Manual (U.S. EPA 2000). This method involves aggregating historical nutrient data from multiple sources, reducing the data to median values per stream to avoid over-representation of heavily sampled sites, and determining the 25th percentile of these medians across all streams in the ecoregion or sub-ecoregion to establish a reference condition. When reference streams are unavailable, the 25th percentile of the entire stream population serves as a surrogate for minimally impacted conditions. In the current technical report, the authors followed this methodology to calculate a 25th percentile benchmark for orthophosphate in streams within the Sequim Bay-Dungeness CWD. The calculation utilized median orthophosphate values over a 10-year period (WY2015-2024) from 8 streams: Bell (n=78), Cassalery (n=80), Dungeness (n=83), Jimmycomelately (n=74), Johnson (n=74), Lotzgesell (n=82), Matriotti (n=84), and Sequim Bay State Park (n=57). This approach ensures consistency with EPA's guidance while reflecting local conditions in the Sequim Bay-Dungeness CWD.

Table 6. Ecoregion reference criteria and calculated CWD benchmark.

Parameter	No. of Streams	Reported Values		25th Percentile (all seasons)	75th Percentile (all seasons)
		Min	Max		
NO_2 + NO_3 (mg/L)	129	0.01	3.7	0.26	0.89
Turbidity (NTU)	117	0.22	40.5	1.95	--
PO_4^{3-} (µg/L)	8	0.142	650	12.1	47.7

4.4 Water Quality Assessments

The following tables summarize the Washington State Water Quality Assessment 303(d)/305(b) listings for key water quality parameters—fecal coliform, temperature, dissolved oxygen, pH, and turbidity—relevant to the Sequim Bay-Dungeness CWD. These tables compile listing statuses from 1996 through 2022, providing a comprehensive overview of impaired waters under Section 303(d) and overall water quality conditions under Section 305(b) of the Clean Water Act. The data reflect assessments conducted by the Washington State Department of Ecology, identifying waterbodies that fail to meet state water quality standards for the specified parameters. Footnotes accompanying the tables detail inconsistencies in the listing processes over the years, such as changes in assessment methodologies, and note specific cases where previously listed irrigation lines have been piped. These tables serve as a critical reference for understanding historical and current water quality impairments in the study area and inform water quality management strategies.

Table 7. Water Quality Assessments for fecal coliform in Clean Water District Streams, 303(d) and 305(b), 1996–2022.

Shellfish Growing Area	Waterbody	T/R/S	Listing ID	Classification[a,b] 1996	1998	2004	2008	2010	2012	2018	2022 (draft)
East Straits	**Bagley Creek[c]**	**30N / 05W / 08**	**6971**	**Y(A)**	**N(A)**	**2**	**2**	**2**	**2**	**2**	
East Straits	**Siebert Creek[c]**	**30N / 05W / 02**	**21475**	**N(A)**	**N(A)**	**1**	**2**	**2**	**2**	**2**	
East Straits	**Agnew Ditch[c]**	**30N / 04W / 07**	**74742**	**N(A)**	**N(A)**	**3**	**3**	**3**	**5**	**5**	**5**
East Straits	**McDonald Creek[c]**	**30N / 04W / 05**	**74727**	**N(A)**	**N(A)**	**3**	**3**	**3**	**3**	**2**	
East Straits	Unnamed Ditch (*trib. Strait of Jaun de Fuca*)	31N / 04W / 39	74849	N(A)	N(A)	3	3	3	5	2	
Dungeness Bay	**Dungeness River[c,e]**	**31N / 04W / 41**	**9907**	**N(A)**	**N(A)**	**1**	**1**	**1**	**1**	**2[g]**	
Dungeness Bay	**Dungeness River[c,e]**	**31N / 04W / 41**	**46535**	**N(A)**	**N(A)**	**3**	**1**	**1**	**1**	**1[g]**	
Dungeness Bay	Dungeness River	31N / 04W / 41	45904	N(A)	N(A)	3	3	3	1	1	
Dungeness Bay	Dungeness River	30N / 04W / 01	9911	N(A)	N(A)	1	1	1	1	1	
Dungeness Bay	**Matriotti Creek[c,(d1)]**	**31N / 04W / 43**	**6969**	**Y(A)**	**Y(A)**	**4A**	**4A**	**4A**	**4A**	**4A[g]**	**4A[g]**
Dungeness Bay	Matriotti Creek[(d1)]	30N / 04W / 22	9920	N(A)	N(A)	4A	4A	4A	4A	4A[g]	4A[g]
Dungeness Bay	Matriotti Creek[(d1),e]	30N / 04W / 10	88196	--	--	--	--	--	--	5[g]	5[g]
Dungeness Bay	**Lotzgezell[c,(d2)]**	**31N / 04W / 40**	**45707**	**N(A)**	**N(A)**	**3**	**5**	**5**	**5**	**5**	**5**
Dungeness Bay	Lotzgezell[(d2)]	30N / 04W / 02	74736	N(A)	(A)	3	3	3	5	5	5
Dungeness Bay	Bear Creek[(d2)]	30N / 04W / 10	45201	N(A)	N(A)	3	5	5	5	5	5
Dungeness Bay	Mudd Creek[(d2)]	30N / 04W / 15	45709	N(A)	N(A)	3	5	5	5	5	5
Dungeness Bay	**Hurd Creek[c,(d2),e]**	**30N / 04W / 01**	**9927**	**Y(A)**	**N(A)**	**5**	**5**	**5**	**1**	**1[g]**	
Dungeness Bay	**Meadowbrook Creek[c]**	**31N / 03W / 30**	**9923**	**N(AA)**	**N(AA)**	**4A**	**4A**	**4A**	**4A**	**4A[g]**	**4A[g]**
Dungeness Bay	Unnamed Ditch[(d3)]	31N / 03W / 37	74741	N(A)	N(A)	3	3	3	5	5	5
Dungeness Bay	Unnamed Ditch[(d3)]	31N / 03W / 31	74803	N(A)	N(A)	3	3	3	5	5	5
Dungeness Bay	Unnamed Ditch[(d3)]	31N / 04W / 44	9922	N(A)	N(A)	1	3	3	5	5	5
Dungeness Bay	Anderson Road Ditch[(d3)]	31N / 04W / 36	45725	N(A)	N(A)	3	5	5	5	5	
Dungeness Bay	**Meadowbrook Slough[c]**	**31N / 04W / 41**	**9921**	**N(AA)**	**N(AA)**	**2**	**2**	**2**	**4A**	**4A[g]**	**4A[g]**
Dungeness Bay	Unnamed Ditch (*trib. Dungeness Bay*)[e]	31N / 04W / 39	74971	N(A)	N(A)	3	3	3	2	5[g]	5[g]
Dungeness Bay	Unnamed Ditch (*trib. Dungeness Bay*)[e]	31N / 04W / 38	74970	N(A)	N(A)	3	3[h]	3[h]	3[h]	5[g,h]	5[g,h]
Dungeness Bay	Cline Ditch[e]	31N / 04W / 38	88260	--	--	--	--	--[h]	--[h]	5[g,h]	5[g,h]
Dungeness Bay	Cline Ditch[e]	31N / 04W / 38	45824	N(A)	N(A)	3	5[h]	5[h]	5[h]	5[g,h]	5[g,h]
Jamestown	**Golden Sands Slough[c,e,f]**	**31N / 03W / 37**	**45868**	**N(AA)**	**N(AA)**	**3**	**2**	**2**	**1**	**5**	**5**
Jamestown	Golden Sands Slough[e,f]	31N / 03W / 37	88910	--	--	--	--	--	--	5	5
Jamestown	Golden Sands Slough[e,f]	31N / 03W / 37	88373	--	--	--	--	--	--	5	5
Jamestown	Golden Sands Slough[e,f]	31N / 03W / 37	88435	--	--	--	--	--	--	5	5

Shellfish Growing Area	Waterbody	T/R/S	Listing ID	Classification[a,b] 1996	1998	2004	2008	2010	2012	2018	2022 (draft)
	Golden Sands Slough[e]	31N / 03W / 37	88316	--	--	--	--	--	--	5	5
	Golden Sands Slough[e]	31N / 03W / 37	89092	--	--	--	--	--	--	2	
	Cooper Creek[c,e]	**31N / 03W / 32**	**45823**	**N(AA)**	**N(AA)**	**3**	**5**	**5**	**5**	**5[g]**	**5[g]**
	Casselery Creek[c]	**31N / 03W / 32**	**6973**	**Y(A)**	**Y(A)**	**5**	**5**	**5**	**5**	**5**	**5**
Sequim Bay	**Bell Creek[c]**	**30N / 03W / 22**	**7685**	**Y(AA)**	**Y(AA)**	**5**	**5**	**5**	**5**	**5**	**5**
	Bell Creek	30N / 03W / 21	74743	N(AA)	N(AA)	3	3	3	5	5	5
	Bell Creek	30N / 03W / 20	15601	N(AA)	N(AA)	2	2	2	5	5	5
	Bell Creek	30N / 03W / 19	15604	N(AA)	N(AA)	2	2	2	5	5	5
	Bell Creek	30N / 03W / 32	74739	N(AA)	N(AA)	3	3	3	5	5	5
	Bell Creek	30N / 03W / 20	74744	N(AA)	N(AA)	3	3	3	2	2	
	Unnamed Creek (*trib. Bell Creek*)	30N / 03W / 30	89022	--	--	--	--	--	--	5	5
	Unnamed Ditch (*trib. Bell Creek*)	30N / 03W / 21	74738	N(AA)	N(AA)	3	3	3	5	2	
	Johnson Creek[c]	**30N / 03W / 27**	**7674**	**Y(AA)**	**Y(AA)**	**5**	**5**	**5**	**5**	**5**	**5**
	Dean Creek[c]	**29N / 03W / 12**	**15578**	**N(AA)**	**N(AA)**	**1**	**1**	**1**	**1**	**1**	
	Jimmycomelately Creek[c]	**29N / 03W / 12**	**21543**	**N(AA)**	**N(AA)**	**5**	**5**	**5**	**5**	**5**	**5**
	Chicken Coop Creek[c]	**29N / 02W / 06**	**7668**	**Y(AA)**	**Y(AA)**	**2**	**2**	**2**	**2**	**2**	
	Chicken Coop Creek	29N / 02W / 05	7669	Y(AA)	N(AA)	2	2	2	2	2	

[a] Category 1- meets standards; Category 2- water-of-concern; Category 3- insufficient data; Category 4A- an EPA approved TMDL is in place; Category 5- polluted waters that require a pollution control plan; Y- listed; N- not listed.

[b] Listed classifications determined prior to August 2003 were based on water class thresholds protective of contact and shellfish uses: AA- extraordinary (geomean ≤50 cfu/100mL, ≤10% of samples exceeding 100 cfu/100mL); A- excellent (geomean ≤100 cfu/100mL, ≤10% of samples exceeding 200 cfu/100mL); both CWD TMDL studies utilized these designations (Sargeant 2002, 2004). Classifications made between August 2003 and 2019 assessed contact use with identical thresholds, wherein Class AA was renamed Extraordinary and Class A was renamed Excellent, while shellfish harvest was protected by site-specific freshwater criteria. Classifications made post-2019 reflect elimination of the Extraordinary class, wherein all water became designated as Primary Contact and adopted the Excellent class Fecal Coliform thresholds.

[c] Stream/segment is monitored by Streamkeepers of Clallam County under the PIC Trends project.

[d] Tributary to a stream with a TMDL: 1- Dungeness River; 2- Matriotti Creek; 3- Meadowbrook Creek.

[e] An EPA approved TMDL is in place (Streeter and Hempleman 2004) but is not indicated in the Washington State Water Quality Assessment List.

[f] Assessment classifications are in reference to Class AA/Extraordinary Marine thresholds, due to salinity exceeding 10ppt (14 cfu or MPN per 100 mL and no more than 10 percent of all samples exceeding 43 cfu).

[g] Assessments use contact criteria that are less restrictive than the EPA approved TMDL.

[h] Irrigation ditch has been piped, and assessment is outdated.

Table 8. Water Quality Assessments for temperature in Clean Water District Streams, 303(d) and 305(b), 1996–2022.

			Classification[a,b]							
Waterbody	T/R/S	Listing ID	1996	1998	2004	2008	2010	2012	2018	2022 (draft)
Siebert Creek[c,d]	**30N / 05W / 02**	**21477**	**N**	**N**	**1**	**3**	**3**	**5**	**2**	
McDonald Creek[c,d]	**30N / 04W / 05**	**73261**	**N**	**N**	**3**	**3**	**3**	**3**	**2**	
Dungeness River[c,d]	**31N / 04W / 41**	**73294**	**N**	**N**	**3**	**3**	**3**	**3**	**2**	
Dungeness River[c,d]	**31N / 04W / 41**	**10944**	**N**	**N**	**1**	**3**	**3**	**5**	**5**	**5**
Dungeness River[d]	30N / 04W / 01	73263	N	N	3	3	3	2	2	
Dungeness River[d]	31N / 04W / 26	72660	N	N	3	3	3	5	5	5
Matriotti Creek[c,d]	**31N / 04W / 43**	**73262**	**N**	**N**	**3**	**3**	**3**	**3**	**2**	
Lotzgezell[c]	**31N / 04W / 40**	**73293**	**N**	**N**	**3**	**3**	**3**	**2**	**2**	
Canyon Creek	29N / 04W / 12	94148	--	--	--	--	--	--	2	
Meadowbrook Creek[c]	**31N / 03W / 30**	**73292**	**N**	**N**	**3**	**3**	**3**	**5**	**2**	
Meadowbrook Slough[c]	**31N / 04W / 41**	**73287**	**N**	**N**	**3**	**3**	**3**	**3**	**2**	
Unnamed Ditch (*trib. Meadowbrook*)	31N / 03W / 31	73267	N	N	3	3	3	2	2	
Golden Sands Slough[c,e]	**31N / 03W / 37**	**73303**	**N**	**N**	**3**	**3**	**3**	**5**	**5**	**5**
Golden Sands Slough[d]	31N / 03W / 37	94058	--	--	--	--	--	--	5	5
Golden Sands Slough[d]	31N / 03W / 37	94515	--	--	--	--	--	--	5	5
Golden Sands Slough[d]	31N / 03W / 37	94307	--	--	--	--	--	--	5	5
Golden Sands Slough	31N / 03W / 37	93792	--	--	--	--	--	--	5	5
Golden Sands Slough	31N / 03W / 37	94425	--	--	--	--	--	--	2	
Cooper Creek[c,d]	**31N / 03W / 32**	**73295**	**N**	**N**	**3**	**3**	**3**	**5**	**5**	**5**
Bell Creek[c,d]	**30N / 03W / 22**	**6813**	**N**	**N**	**1**	**3**	**3**	**3**	**2**	
Bell Creek	30N / 03W / 21	73305	N	N	3	3	3	5	5	5
Unnamed Ditch (*trib. Bell Creek*)	30N / 03W / 21	73268	N	N	3	3	3	2	2	
Dean Creek[c]	**29N / 03W / 12**	**94412**	**--**	**--**	**--**	**--**	**--**	**--**	**2**	
Jimmycomelately Creek[c,d]	**29N / 03W / 12**	**72659**	**N**	**N**	**3**	**3**	**3**	**5**	**5**	**5**

[a] Category 1- meets standards; Category 2- water-of-concern; Category 3- insufficient data; Category 5- polluted waters that require a pollution control plan; N- not listed.
[b] Classifications determined between 1996 and 2003 reflected Ecology's A/B Class system. After 2003, habitat-based criteria (7-day average of the daily maximum temperatures [7-DADMax]) were used: Char Spawning and Rearing (12°C); Core Summer Salmonid Habitat (16°C); Salmonid Spawning, Rearing, and Migration (17.5°C); Salmonid Rearing and Migration Only (17.5°C). Current freshwater assessments in the CWD are designated Core Summer Salmon Habitat, with the exception of Canyon Creek which is designated Char Spawning and Rearing.
[c] Stream/segment is monitored by Streamkeepers of Clallam County under the PIC Trends project.
[d] Stream/segment has supplemental spawning criteria of 13°C from Sept 1-June15 (Payne 2011).
[e] Listing classifications are in reference to Class AA/Extraordinary Marine thresholds, due to salinity exceeding 1ppt (Highest 1-day max: 13°C).

Table 9. Water Quality Assessments for dissolved oxygen in Clean Water District Streams, 303(d) and 305(b), 1996–2022.

Waterbody	T/R/S	Listing ID	Classification[a,b] 1996	1998	2004	2008	2010	2012	2018	2022 (draft)
Bagley Creek[c]	**30N / 05W / 09**	**42958**	**N**	**N**	**2**	**2**	**2**	**2**	**2**	
Siebert Creek[c]	**30N / 05W / 02**	**82194**	**--**	**--**	**--**	**--**	**--**	**--**	**2**	
Siebert Creek	29N / 05W / 22	42979	N	N	5	5	5	5	5	5
Agnew Ditch[c]	**30N / 04W / 07**	**77812**	**N**	**N**	**3**	**3**	**3**	**2**	**5**	**5**
McDonald Creek[c]	**30N / 04W / 05**	**77810**	**N**	**N**	**3**	**3**	**3**	**2**	**2**	
Unnamed Ditch (*trib. Strait of Jaun de Fuca*)	31N / 04W / 39	77557	N	N	3	3	3	3	5	5
Cline Ditch	31N / 04W / 39	82199	--	--	--	--[d]	--[d]	--[d]	5[d]	5[d]
Cline Ditch	31N / 04W / 39	81709	--	--	--	--[d]	--[d]	--[d]	5[d]	5[d]
Dungeness River[c]	**31N / 04W / 41**	**10945**	**N**	**N**	**1**	**3**	**3**	**5**	**5**	**5**
Dungeness River	30N / 04W / 01	47786	N	N	3	3	3	5	5	5
Matriotti Creek[c]	**31N / 04W / 43**	**47788**	**N**	**N**	**3**	**3**	**3**	**5**	**5**	**5**
Matriotti Creek	30N / 04W / 03	82008	--	--	--	--	--	--	5	5
Lotzgezell[c]	**31N / 04W / 35**	**47796**	**N**	**N**	**3**	**3**	**3**	**5**	**5**	**5**
Lotzgezell	30N / 04W / 02	81701	--	--	--	--	--	--	2	
Bear Creek	30N / 04W / 10	47804	N	N	3	2	2	2	2	
Meadowbrook Creek[c]	**31N / 03W / 30**	**47775**	**N**	**N**	**3**	**5**	**5**	**5**	**5**	**5**
Meadowbrook Slough[c]	**31N / 04W / 41**	**47773**	**N**	**N**	**3**	**2**	**2**	**5**	**5**	**5**
Golden Sands Slough[c,e]	**31N / 03W / 37**	**81239**	**--**	**--**	**--**	**--**	**--**	**--**	**5**	**5**
Cooper Creek[c]	**31N / 03W / 31**	**48099**	**N**	**N**	**3**	**5**	**5**	**5**	**5**	**5**
Casselery Creek[c]	**31N / 03W / 32**	**42819**	**N**	**N**	**5**	**5**	**5**	**5**	**5**	**5**
Bell Creek[c]	**30N / 03W / 22**	**42965**	**N**	**N**	**5**	**5**	**5**	**5**	**5**	**5**
Bell Creek	30N / 03W / 21	78090	N	N	3	3	3	5	5	5
Bell Creek	30N / 03W / 30	78089	N	N	3	3	3	5	5	5
Bell Creek	30N / 03W / 32	78088	N	N	3	3	3	5	5	5
Bell Creek	30N / 03W / 20	42967	N	N	2	5	5	5	2	
Unnamed Ditch (*trib. Bell Creek*)	30N / 03W / 21	78087	N	N	3	3	3	5	2	
Johnson Creek[c]	**30N / 03W / 27**	**48090**	**N**	**N**	**3**	**3**	**3**	**2**	**2**	
Dean Creek[c]	**29N / 03W / 12**	**81285**	**--**	**--**	**--**	**--**	**--**	**--**	**2**	
Jimmycomelately Creek[c]	**29N / 03W / 12**	**42824**	**N**	**N**	**5**	**5**	**5**	**5**	**5**	**5**

[a] Category 2- water-of-concern; Category 3- insufficient data; Category 5- polluted waters that require a pollution control plan; N- not listed.
[b] Classifications determined between 1996 and 2003 reflected Ecology's A/B Class system. After 2003, aquatic life based 1-day minimum thresholds replaced the A/B classes: Class AA (≥ 9.5mg/L) became Char Spawning and Rearing/Core Summer Salmonid Habitat; Class A (≥ 8.0mg/L) became Salmonid Spawning, Rearing, and Migration; Class B (≥ 6.5mg/L) became Salmon Rearing and Migration Only. In 2022, Ecology increased former Class AA thresholds: spawning, rearing, and migration surface-DO requirements became ≥ 10mg/L or 90% saturation; Core Summer Habitat became ≥ 10mg/L or 95% saturation. All freshwater streams assessed are currently designated Core Summer Habitat.

[c] Stream/segment is monitored by Streamkeepers of Clallam County under the PIC Trends project.
[d] Irrigation ditch has been piped and assessment is outdated.
[e] Listing classifications are in reference to Class AA/Extraordinary Marine thresholds, due to salinity exceeding 1ppt (lowest 1-day minimum 7.0mg/L).

Table 10. Water Quality Assessments for pH in Clean Water District Streams, 303(d) and 305(b), 1996–2022.

			Classification[a,b]							
Waterbody	T/R/S	Listing ID	1996	1998	2004	2008	2010	2012	2018	2022 (draft)
Bagley Creek[c]	**30N / 05W / 08**	**21431**	**N**	**N**	**1**	**3**	**3**	**2**	**2**	
Bagley Creek	30N / 05W / 33	81396	--	--	--	--	--	--	2	
Dungeness River[c]	**31N / 04W / 41**	**51013**	**N**	**N**	**3**	**2**	**2**	**2**	**2**	
Dungeness River[c]	**31N / 04W / 41**	**10946**	**N**	**N**	**1**	**1**	**1**	**3**	**2**	
Dungeness River	30N / 04W / 01	51015	N	N	3	2	2	2	2	
Matriotti Creek[c]	**31N / 04W / 43**	**51016**	**N**	**N**	**3**	**2**	**2**	**2**	**2**	
Matriotti Creek	30N / 04W / 03	81390	--	--	--	--	--	--	2	
Matriotti Creek	30N / 04W / 22	51022	N	N	3	2	2	2	2	
Canyon Creek	29N / 04W / 12	81405	--	--	--	--	--	--	2	
Anderson Road Ditch	31N / 04W / 36	51008	N	N	3	2	2	2	2	
Meadowbrook Creek[c]	**31N / 03W / 30**	**51004**	**N**	**N**	**3**	**2**	**2**	**2**	**2**	
Meadowbrook Slough[c]	**31N / 04W / 41**	**51002**	**N**	**N**	**3**	**2**	**2**	**5**	**5**	**5**
Golden Sands Slough[c,d]	**31N / 03W / 37**	**70863**	**N**	**N**	**3**	**3**	**3**	**2**	**2**	
Independent Main Canal	30N / 03W / 17	51385	N	N	3	2	2	2	2	
Cooper Creek[c,d]	**31N / 03W / 32**	**51388**	**N**	**N**	**3**	**2**	**2**	**2**	**2**	
Bell Creek[c]	**30N / 03W / 22**	**6814**	**N**	**N**	**1**	**2**	**2**	**2**	**2**	
Bell Creek	30N / 03W / 21	71929	N	N	3	3	3	5	2	
Bell Creek	30N / 03W / 20	21442	N	N	1	2	2	5	2	
Bell Creek	30N / 03W / 19	71926	N	N	3	3	3	2	2	
Unnamed Ditch (*trib. Bell Creek*)	30N / 03W / 21	71922	N	N	3	3	3	2	2	
Johnson Creek[c]	**30N / 03W / 27**	**21549**	**N**	**N**	**2**	**2**	**2**	**5**	**2**	
Jimmycomelately Creek[c]	**29N / 03W / 12**	**21544**	**N**	**N**	**2**	**2**	**2**	**2**	**2**	

[a] Category 1- meets standards; Category 2- water-of-concern; Category 3- insufficient data; Category 5- polluted waters that require a pollution control plan; N- not listed.
[b] Classifications determined between 1996 and 2003 reflected Ecology's A/B Class system. After 2003, a habitat-based pH range of 6.5-8.5 was adopted for Char and Salmon and Trout Spawning, Rearing, and Migration—which is applicable to all assessments.
[c] Stream/segment is monitored by Streamkeepers of Clallam County under the PIC Trends project.
[d] Listing classifications are in reference to Class A/Excellent Marine thresholds, due to salinity exceeding 10 ppt (range 7.0 to 8.5).

Table 11. Water Quality Assessments for turbidity in Clean Water District Streams, 303(d) and 305(b), 1996–2022.

Waterbody	T/R/S	Listing ID	Classification[a,b] 1996	1998	2004	2008	2010	2012	2018	2022 (draft)
Bagley Creek[c]	30N / 05W / 08	79009	N	N	3	3	3	2	2	
McDonald Creek[c]	30N / 04W / 05	79020	N	N	3	3	3	2	2	
Casselery Creek[c]	31N / 03W / 32	79012	N	N	3	3	3	5	5	5

[a] Category 2- water-of-concern; Category 3- insufficient data; Category 5- polluted waters that require a pollution control plan; N- not listed

[b] Classifications determined between 1996 and 2003 reflected Ecology's A/B Class system. After 2003, habitat-based criteria were used: Char Spawning and Rearing, Salmonid Spawning, Rearing, and Migration, and Core Summer Salmonid Habitat (5 NTU over background when the background is 50 NTU or less; or a 10 percent increase in turbidity when the background turbidity is more than 50 NTU) or Salmonid Rearing,and Migration only (Turbidity shall not exceed: 10 NTU over background when the background is 50 NTU or less; or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU). All assessments are currently designated Core Summer Salmonid Habitat.

[c] Stream/segment is monitored by Streamkeepers of Clallam County under the PIC Trends project.

4.5 Project Data Quality Objectives

The primary data quality objective (DQO) for this project is to collect a sufficient number of samples to accurately identify and characterize potential sources of bacteria and nutrients within the project area, with all samples analyzed using EPA and Standard Methods. Measurement quality objectives (MQOs) are established to define the acceptable level of error inherent in field sampling procedures and laboratory analyses. Precision and bias serve as key indicators of data quality, used to evaluate compliance with MQOs. The specific targets for precision, bias, and sensitivity are detailed in the project documentation and summarized in Table 12 and Table 13, ensuring the reliability and accuracy of the project results.

Table 12. Project measurement quality objectives.

Parameter	Laboratory Duplicate (RPD)	Field Duplicate (RSD)	Matrix Spike Duplicate (RPD)	Lab Control Standard (% Recovery)	Matrix Spike (% Recovery)	Standard Reference Material (% Recovery)	Lowest Concentrations of Interest
Fecal coliform	≤ 20%	≤ 20% & 90% of replicate pairs ≤ 50%	n/a	n/a	n/a	n/a	1 cfu/100 mL
E. coli	≤ 20%		n/a	n/a	n/a	n/a	24 cfu/100 mL
NO_3 - N	≤ 10%	≤ 10%	≤ 20%	90-110%	90-110%	85-115%	0.0028 mg/L
NO_2 - N	≤ 10%	≤ 10%	≤ 20%	90-110%	90-110%	80-120%	0.0003 mg/L
NH_4 - N	≤ 15%	≤ 15%	≤ 20%	90-110%	90-110%	80-120%	0.0006 mg/L
PO_4 - P	≤ 10%	≤ 10%	≤ 20%	90-110%	90-110%	80-120%	0.0006 mg/L

Table 13. Quality control samples, types, and frequency.

Parameter	Field Blanks	Field Replicates	Laboratory Check Standards	Laboratory Method Blanks	Analytical Duplicates	Laboratory Matrix Spikes
Bacteria	≥ 1 per tour and 5% of sites		n/a	2 per ≤ 10 samples	1 per ≤ 10 samples	n/a
Dissolved Nutrients			2 per run	2 per run	1 per ≤ 20 samples	1 per ≤ 20 samples
Temperature Salinity Dissolved Oxygen pH Turbidity	n/a	≥ 1 per tour & 5% of sites	n/a	n/a	n/a	n/a

4.6 Analytical Quality Assurance and Quality Control

Defensible data, capable of distinguishing incremental shifts in ecosystem quality over a variable background, are required to ascertain a true measure of process improvement. The following subsections summarize the laboratory and field quality control and the overall usability of the data. If data fail to meet quality objectives, standard Washington State Department of Ecology Environmental Information Management (EIM) data qualifiers are assigned.

4.6.1 Accuracy

Accuracy is achieved through the use of laboratory control samples (LCS), matrix spikes (MS), matrix spike duplicates (MSD), and standard reference materials (SRM). The LCS, MS/MSD, and SRM results are summarized in Analytical Chemistry Reports. The 2023-2024 datasets were reviewed by the Streamkeepers Coordinator and found to have acceptable measures of each of these variables.

4.6.2 Precision

Precision is achieved through meeting both field and laboratory replication criteria. Quality assurance for field duplicate samples collected for bacteria and nutrient analyses in this monitoring project follows the precision measurement approach recommended by Mathieu (2006), based on a review of replicate precision data from 12 TMDL studies conducted by WADOE. For bacteria parameters (i.e., fecal coliform), replicate pairs are divided into those with means ≤ 20 cfu/100 mL, which are reviewed individually by the Streamkeepers Coordinator, and those > 20 cfu/100 mL, where precision for datasets with 10 or more pairs is assessed using a cumulative frequency distribution, requiring 50% of pairs to have ≤20% RSD and 90% to have ≤50% RSD to ensure reliable variability characterization. For nutrient parameters (e.g., ammonia, nitrite/nitrate, and orthophosphate), replicate pairs are categorized by concentration relative to the reporting limit: pairs with values above 5 times the reporting limit (and with at least 10 pairs per dataset) are evaluated using the mean relative standard deviation (RSD), which must meet parameter-specific targets ranging from 10% to 15% RSD as outlined in Table 12; datasets with fewer than 10 pairs or lower concentrations are reviewed by the Streamkeepers Coordinator for data usability.

Table 14 and Table 15 compare observed fecal coliform results against these criteria for the 2023-2024 reporting period. MQOs were met in 2023, but not in 2024 (Table 16 and Table 17). The sample-duplicate pair collected that did not meet that criterion (Agnew Creek/Ditch 3.0 on January 11, 2024) was qualified as “REJ”. Quality control measures were reviewed with the volunteer field collection team.

Table 14. Fecal coliform field replicate results, 2023.

Date	Site	Type[a]	FC (cfu)	Mean	%RSD
1/9/2023	Bell 0.2	Primary Replicate	30 18	24.0	35.4%
2/13/2023	Bell 0.2	Primary Replicate	36 40	38.0	7.4%
3/13/2023	Bell 0.2	Primary Replicate	46 78	62.0	36.5%
4/10/2023	Bell 0.2	Primary Replicate	144 144	144.0	0.0%
5/15/2023	Bell 0.2	Primary Replicate	2688 2352	2520.0	9.4%
6/12/2023	Bell 0.2	Primary Replicate	420 440	430.0	3.3%
7/10/2023	Bell 0.2	Primary Replicate	229 396	312.5	37.8%
8/14/2023	Bell 0.2	Primary Replicate	640 400	520.0	32.6%
9/11/2023	Bell 0.2	Primary Replicate	192 168	180.0	9.4%
10/9/2023	Bell 0.2	Primary Replicate	336 320	328.0	3.4%
11/13/2023	Bell 0.2	Primary Replicate	1 16	8.5	N/A Excluded
12/11/2023	Bell 0.2	Primary Replicate	36 16	26.0	54.4%
1/10/2023	Agnew Creek/Ditch 3.0	Primary Replicate	116 116	116.0	0.0%
4/11/2023	Agnew Creek/Ditch 3.0	Primary Replicate	8 8	8.0	N/A Excluded
8/15/2023	Agnew Creek/Ditch 3.0	Primary Replicate	62 60	61.0	2.3%
11/14/2023	Agnew Creek/Ditch 3.0	Primary Replicate	24 20	22.0	12.9%

[a] Replicate refers to the mean of the field replicate and a laboratory duplicate of the field replicate.

Table 15. Fecal coliform field replicate results, 2024.

Date	Site	Type[a]	FC (cfu)	Mean	%RSD
1/9/2024	Bell 0.2	Primary Replicate	520 572	546.0	6.7%
2/22/2024	Bell 0.2	Primary Replicate	228 292	260.0	17.4%
3/12/2024	Bell 0.2	Primary Replicate	40 28	34.0	25.0%
4/2/2024	Bell 0.2	Primary Replicate	36 60	48.0	35.4%
5/14/2024	Bell 0.2	Primary Replicate	420 164	292.0	62.0%
6/11/2024	Bell 0.2	Primary Replicate	64 54	59.0	12%
7/9/2024	Bell 0.2	Primary Replicate	960 640	800.0	28.3

Date	Site	Type[a]	FC (cfu)	Mean	%RSD
8/13/2024	Bell 0.2	Primary Replicate	98 56	77.0	38.6%
9/17/2024	Bell 0.2	Primary Replicate	66 86	76.0	18.6%
10/8/2024	Bell 0.2	Primary Replicate	38 108	73.0	67.8%
11/12/2024	Bell 0.2	Primary Replicate	20 10	15.0	N/A Excluded
12/10/2024	Bell 0.2	Primary Replicate	12 16	14.0	N/A Excluded
1/11/2024	Agnew Creek/Ditch 3.0	Primary Replicate	44 508	276	118.9%
4/4/2024	Chicken Coop 0.24	Primary Replicate	36 32	34.0	8.3%
8/21/2024	Chicken Coop 0.24	Primary Replicate	24 46	35.0	44.4%
11/13/2024	Chicken Coop 0.24	Primary Replicate	22 16	19.0	N/A Excluded

[a] Replicate refers to the mean of the field replicate and a laboratory duplicate of the field replicate.

Table 16. Fecal coliform data Measurement Quality Objectives assessment, 2023.

QC tiers	Duplicate Pairs	% Pairs meeting criteria	% Pairs meeting criteria needed to meet MQOs	MQO Met?
Pairs <= 20% RSD	9	64.3%	50.0%	YES
Pairs <= 50% RSD	13	92.9%	90.0%	YES
Pairs <= 85% RSD	14	100.0%	100.0%	YES

Table 17. Fecal coliform data Measurement Quality Objectives assessment, 2024.

QC tiers	Duplicate Pairs	% Pairs meeting criteria	% Pairs meeting criteria needed to meet MQOs	MQO Met?
Pairs <= 20% RSD	6	46.2%	50.0%	NO
Pairs <= 50% RSD	9	69.2%	90.0%	NO
Pairs <= 85% RSD	12	92.3%	100.0%	NO

Table 18 summarizes nutrient duplicate results, for the 2023-2024 reporting period, and denotes datasets assigned a qualifier following the assessment described in Mathieu (2006).

Table 18. Nutrients field replicate results and QC analysis.

Analyte	Data Pairs[a]	Median RSD	RSD Criterion	Data Qualified
Ammonia	0	N/A	15%	1/9/2024, 7/9/2024
Nitrate	11	0.6%	10%	none
Nitrite	5	1.4%	10%	7/9/2024, 11/12/2024
Phosphate	11	5.3%	10%	3/13/2023, 3/12/2024, 5/14/2024, 7/9/2024

[a] For measures of replicate samples of ammonia-N, Data Pairs = 0 because ammonia concentrations always had means less than five times the reporting limit and so were excluded from RSD calculation. Likewise, 5 of 11 replicate samples had measured nitrite concentrations less than five times the reporting limit and so were excluded from RSD calculation.

MQOs for physical and chemical data collected by field instrumentation are defined in terms of RSD and/or maximum allowable difference between primary samples and their replicates, as specified in the QAPP by

Strivens et al. (2025). To meet MQO standards without requiring corrective action, data must satisfy at least one of these criteria. Table 19 summarizes the comparison of environmental data against these MQO criteria. Two instances of nonconformance were identified: specific conductivity at Chicken Coop Creek on April 4, 2024, and turbidity at Bell Creek on September 11, 2023, where environmental duplicate data did not meet the RSD or maximum difference criteria. In both cases, the remaining 31 data pairs complied with the MQO standards, indicating that these were isolated incidents likely due to environmental variability or errors in field data recording rather than equipment malfunctions or systemic issues in data collection procedures. Consequently, the specific conductivity measurement at Chicken Coop Creek on April 4, 2024, and the turbidity measurement at Bell Creek on September 11, 2023, were qualified as Estimate (EST).

Table 19. Physical/chemical water quality field replicate QC analysis.

Parameter	Units	Data Pairs	Max RSD (by pairs)	RSD Criterion	Max Difference Observed	Difference Criterion	Data Qualified
Dissolved Oxygen	mg/L	32		2% per pair	0.2	0.2	None
pH	N/A	31			0.1	0.2	None
Salinity	PSU (ppt)	32		5% per pair	0.0	0.02	None
Specific Conductivity	µs/cm	32	13.0%	5% per pair			Ch. Coop 4/4/2024
Water Temperature	◦C	32			0.1	0.2	None
Turbidity	FNU	32	28.3%	7% per pair	2	1	Bell 9/11/2023

4.6.3 Sensitivity

Sensitivity is addressed primarily through the selection of appropriate analytical methods, equipment, and instrumentation. The methods selected for the PIC program were chosen to provide the sensitivity required for the end use of the data. This is a quantitative assessment and is monitored through the instrument calibrations and calibration verification samples and the analysis of procedural blanks with every analytical batch. Method detection limits (MDLs) were determined annually according to 40 CFR Part 136 Appendix B for each method of interest by instrument, matrix, and compound of interest.


Volunteer Lance Vail using a multiparameter meter to measure water quality in Golden Sands Slough.

4.6.4 Sample Handling Bias

To ensure the reliability of stream water quality data, field blanks were collected and analyzed alongside environmental samples for fecal coliform bacteria and key nutrients, including orthophosphate (as phosphate-P), nitrate (as nitrate-N), nitrite (as nitrite-N), and ammonia (as ammonia-N). During the current reporting period, fecal coliform field blanks exceeded the RL on three occasions: January 11, 2024 (16 cfu/100 mL), July 9, 2024 (4 cfu/100 mL), and September 17, 2024 (24 cfu/100 mL); in each case, quality control (QC) procedures were promptly reviewed with field volunteers to prevent recurrence. No nutrient field blanks exceeded the 2023-2024 RL for phosphate-P or nitrate-N. However, exceedances were noted for nitrite-N in March 2023 and for ammonia-N in March 2023, November 2023, and March 2024 (Table 20). All environmental data for a given nutrient collected on dates when the corresponding field blank exceeded the RL were qualified as estimates (flagged with code J in Ecology's Environmental Information Management [EIM] database) to reflect potential contamination influences.

Table 20. Nutrients field blank results and reporting limits.

Arrival date	[PO_4-P]	[NO_3-N]	[NO_2-N]	[NH_4-N]
9-Jan-23	0.2	1.1	0.0	5.8
13-Mar-23	0.2	0.0	2.3	313.4
15-May-23	0.0	1.6	0.0	4.9
11-Sep-23	0.3	0.8	0.0	7.8
13-Nov-23	0.2	5.8	0.0	13.6
9-Jan-24	0.8	0.8	0.0	3.2
12-Mar-24	2.0	1.8	1.2	9.9
14-May-24	0.4	4.1	0.8	2.8
9-Jul-24	0.4	2.2	0.0	0.0
8-Oct-24	0.0	6.5	0.1	0.0
12-Nov-24	0.9	2.4	0.3	3.3
2023-2024 FB Mean	0.5	2.5	0.42	5.1
2023-2024 SD	0.6	2.1	0.74	4.3
FB Mean + 1 SD	1.1	4.6	1.2	9.4
2023-4 MDL	0.9	2.5	0.1	1.3
3.18 × MDL	2.9	8.0	0.3	4.1
Synthesized 2023-4 RL	2.9	8.0	1.2	9.4

Field blanks greater than the synthesized RL in 2023 and 2024 are shaded in yellow. Outliers are shaded in grey. Outliers were excluded from calculation of mean and SD.

5.0 Methods

This section summarizes sample collection, preparation, and analytical methods used for the Sequim Bay-Dungeness CWD PIC Program. For consistency, methods and analytical laboratories have remained constant, from the initiation of the program.

5.1 Sample Collection Methods

A detailed description of the sampling methods is provided in the Streamkeepers QAPP (Chadd 2019). Briefly, stream water samples for bacterial and nutrient analyses were collected following a standardized grab sampling protocol to ensure data quality. Samplers wore clean gloves to prevent contamination and followed the Streamkeepers of Clallam County Anti-Contamination Protocol (Chadd, 2016), compliant with Ecology Standard Operating Procedures (SOP) EAP070 and EAP071, to avoid cross-contamination of invasive species between sites. Samples were collected at well-mixed, flowing stream sections, ideally 6 inches or deeper, using a sampling wand to minimize sediment disturbance. For bacterial samples, sterile polypropylene bottles were filled 8-12 inches below the surface (or midway in shallower water) without rinsing, ensuring the bottle interior remains uncontaminated; samples were collected facing upstream with a forward motion to avoid external contamination. Nutrient sample collection bottles were rinsed twice with stream water; samples were then field-filtered into either acid-washed polypropylene or acid-washed high-density polyethylene using surfactant-free cellulose acetate filters. In shallow or still water, samples were taken in fast-moving sections or at drop-offs to ensure flow. Tidal interference was avoided, when possible, by sampling freshwater runoff sites after mean high tide, confirmed using tide tables or salinity meters, with any tidal influence effects noted on the Streamkeepers Sample Tracking Sheets. Any deviations from protocol were documented on tracking sheets for data usability assessments.

Bacteria samples were held at $< 4°C$ during transit to the Clallam County Water Laboratory and were delivered within 6 hours after collection by Streamkeepers staff. Upon arrival at Clallam County, samples were moved to a 4°C storage area until further processing. Sample custody records associated with the physical possession and/or storage history of each individual sample were documented in accordance with Clallam County sample login and sample chain-of-custody standard operating procedures.

Nutrient samples were held at $4 \pm 2°C$ and shipped, on ice, overnight to UW Marine Chemistry Laboratory in Seattle, WA, on the date on collection.

5.2 Laboratory Analytical Methods

The analytical methods employed for this project are detailed in Table 21. Bacterial samples are analyzed at the CCEH Water Lab in Port Angeles, WA (accreditation # M421), with the lab contracted for monthly trends and segmented analysis of fecal coliform samples. Nutrient samples, including nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), ammonium-nitrogen (NH_4-N), and orthophosphate (PO_4-P), are analyzed bi-monthly at the University of Washington School of Oceanography Marine Chemistry Laboratory in Seattle, WA, with dissolved nutrients batched for processing. To meet project DQOs for reporting limits and ensure accurate salinity corrections, a Washington State Department of Ecology laboratory accreditation waiver was obtained for nutrient analyses using EPA Method 353.4 (NO_3-N and NO_2-N), EPA Method 349 (NH_4-N), and EPA Method 365.5 (PO_4-P), as no laboratories are currently accredited for these specific methods. This waiver supports the project's commitment to producing scientifically valid and defensible data while addressing regulatory and practical constraints.

Table 21. Laboratory analytical methods.

Analyte	Expected Range of Results	Detection Limit	Sample Prep Method	Analytical Method
Fecal coliform	1 - >2000 cfu / 100 mL	1 cfu * 100 mL /volume used in the analysis	Up to ten-fold dilution	SM 9222 D
NO_3 - N	0.0134 - >13.0 mg/L	0.0028 mg/L	Field filter with surfactant-free cellulose acetate filter	EPA 353.4
NO_2 - N	0.0010 - >13.0 mg/L	0.0003 mg/L		
NH_4 - N	0.0049 - >200.0 mg/L	0.0006 mg/L		EPA 349
PO_4 - P	0.0113 - >218.0 mg/L	0.0006 mg/L		EPA 365.5

Streamkeepers volunteer Peggy McClure collects a sample for nutrient analysis at Sequim Bay State Park Creek.

5.3 Field Analytical Methods

The methods for measuring temperature, pH, dissolved oxygen, and flow are detailed in the PIC QAPP (Strivens et al. 2025). The method for measuring turbidity is detailed in the Streamkeepers of Clallam County QAPP (Chadd 2019).

Temperature: Temperature is measured in situ using a YSI water quality multiparameter meter equipped with a thermistor. Measurements are taken at all Trends monitoring sites, with a bias target of ±0.2°C (two-point calibration) and a precision of ±0.2°C, ensuring an expected range of 0–30°C. Calibration verification is performed by 2-point (~0° & 20°C) check vs. a NIST traceable thermometer before and after each sampling tour to minimize bias, with field replicates collected at a minimum of 5% of sites to assess precision (Strivens et al., 2025, Section 6.2.1, Table 10).

pH: The pH is measured in situ at Trends monitoring stations using the YSI multiparameter meter. The MQOs specify a bias of ±0.2 standard units and a precision of ±0.2 standard units, with an expected range of 6.5–9. Calibration with NIST-traceable standards is conducted before and after each sampling tour, and field replicates are collected at a minimum of 5% of sites to ensure precision.

Dissolved Oxygen (DO): DO is measured in situ using the YSI multiparameter meter. The MQOs include a bias target of ±2% and a precision of ±0.5%, with an expected range of 85–100% saturation. Calibration is performed before and after each sampling tour using NIST-traceable standards, and field replicates are taken at a minimum of 5% of sites to assess variability.

Flow: Flow is measured at monitoring sites using a SonTek FlowTracker2 or a stream gage, following the standard operating procedures outlined in the QAPP. Measurements are recorded concurrently with water quality sampling to contextualize pollutant loads. Field staff are trained to ensure accurate flow measurements, following either the 0.6 method or the 0.2/0.8 method for depths greater than 1 ft.

Turbidity: Turbidity is measured in situ at all monitoring sites using the YSI ProDSS multiparameter meter with a turbidity sensor. The MQOs include a bias target of ±5% of reading or ±0.3 NTU (whichever is greater) and a precision of ±5% of reading or ±0.3 NTU, with an expected range of 0–100 NTU. Calibration is conducted before and after each sampling tour using NIST-traceable turbidity standards (e.g., 0 and 20 NTU), following the YSI ProDSS Multimeter pH-Turbidity protocol. Field replicates are collected at a minimum of 10% of sites to assess precision, and field blanks are used to check for contamination (Chadd, 2019, Table 4, Section 6.2.1, Table 6).

6.0 Data Analysis and Presentation

This section provides an overview of the methodologies employed for the analysis and presentation of water quality data, with a primary focus on quantifying upstream pollutant loading to inform PIC strategies. The parameters evaluated include fecal coliform, nitrate, nitrite, ammonia, orthophosphate, turbidity, and dissolved oxygen, which are critical for assessing compliance with water quality standards and evaluating ecological health in streams draining to estuarine systems. All data for the current sampling period are archived and accessible through the Washington State Department of Ecology's Environmental Information Management system under project ID WQC-2023-00131. To ensure data integrity, measurements flagged as "REJ" (rejected) in the EIM system due to quality assurance/quality control (QA/QC) failures—such as analytical errors, equipment malfunctions, or procedural deviations—are excluded from all statistical analyses.

Sampling frequencies varied across sites, with some locations sampled monthly and others quarterly, and a subset of sites transitioned between monthly and quarterly schedules during the study period. This variability introduces inherent statistical effects that influence the interpretation of results. Monthly sampling provides higher temporal resolution, capturing short-term fluctuations driven by seasonal or episodic events, such as precipitation or agricultural runoff, but may over-represent extreme values in smaller datasets. Conversely, quarterly sampling offers lower resolution, potentially masking transient peaks or troughs, which reduces statistical power for detecting trends in parameters sensitive to temporal dynamics. Sites with schedule transitions (e.g., from monthly to quarterly or vice versa) further complicate temporal comparisons, as changes in sampling frequency can affect the detection of trends and the robustness of statistical summaries. To address these challenges, data aggregation and statistical methods were carefully selected to balance temporal coverage and analytical precision, as detailed in subsequent sections.

To mitigate the influence of tidal intrusion on upstream loading assessments, certain sites, identified by their stream mile, have dual sampling locations designed to capture conditions minimally affected by tidal backflow. For statistical purposes, data from these paired sites are combined over time, with only one location sampled per event, to represent upstream water quality conditions consistently. The analytical focus of this report is to quantify upstream pollutant loading rather than tidal inflow effects; consequently, marine-influenced conditions are not comprehensively discussed.

Additional methodological considerations include the analytical dilutions applied to fecal coliform samples, which result in a fluctuating reporting limit ranging from 1 to 4 colony-forming units per 100 milliliters (cfu/100 mL). This variability may introduce minor uncertainty in datasets with low concentrations, particularly when comparing sites or time periods, and is accounted for in statistical interpretations. Other parameters measured include temperature and pH. Temperature data, collected to identify sites warranting continuous temperature logging, are summarized in Appendix B but are not presented or discussed in the results sections, as they serve a supplementary role in this study. Similarly, pH measurements, which consistently met WAC 173-201A criteria, are excluded from the results sections to maintain focus on parameters with potential exceedances or ecological significance.

Data visualizations in this report utilize box-and-whisker plots to depict statistical distributions effectively. In these plots, the lower and upper hinges correspond to the first and third quartiles (Q1 and Q3, respectively), encapsulating the interquartile range (IQR). Whiskers extend from the hinges to the largest or smallest values within 1.5 times the IQR, and data points beyond this range are plotted as maximum outliers to highlight extreme values. Additionally, in-line numbers on box plot figures indicate the number of samples included in each statistical calculation, providing transparency regarding sample size and statistical robustness. These analytical and presentation approaches ensure that the data provide a robust foundation for assessing water quality trends, identifying pollution sources, and guiding management actions to protect aquatic ecosystems and downstream bays.

7.0 Results

7.1 Fecal Coliform

Fecal coliform bacteria are critical indicators of fecal contamination in freshwater systems, signaling potential risks to public health, recreational water use, aquatic ecosystems, and shellfish growing areas. These bacteria, originating from the intestinal tracts of warm-blooded animals, are monitored to assess compliance with state water quality standards and TMDLs established to protect shellfish harvesting areas and ensure safe consumption. Elevated fecal coliform levels can lead to closures of shellfish beds due to pathogen risks, necessitating rigorous monitoring to meet regulatory thresholds. Common sources of fecal coliforms in streams include failing OSS, which can leach untreated wastewater into groundwater or surface water; agricultural activities, such as manure runoff from farms and livestock operations; wildlife contributions from animals like deer, birds, and rodents; urban stormwater runoff carrying pet waste or sewage overflows; and other non-point sources, including recreational activities and improper waste disposal. In rural or mixed-use watersheds, a combination of these sources often contributes to elevated levels, necessitating targeted monitoring and mitigation strategies to protect water quality.

The fecal coliform data analyzed in this report were collected at the mouths of the studied streams, with results summarized across multiple tables to highlight temporal trends and variations. Table 22 presents the geometric means and 90th percentiles of fecal coliform concentrations, calculated by water year for each stream mouth, providing a snapshot of annual conditions and upper-end distributions; this is the classic assessment method prescribed in the PIC Plan for rating work areas [CCD 2014 (Appendix F)]. To mitigate the influence of short-term environmental fluctuations—such as precipitation events or seasonal anomalies—Table 23 smooths these metrics by applying a three-year rolling average, offering a more stable representation of long-term trends. For insights into intra-annual patterns, Table 24 details seasonal geometric means by water year, disaggregating data to reveal potential influences from wet versus dry periods. Finally, Table 25 quantifies fecal coliform loading values, estimating the mass of bacteria delivered to the receiving zones, which supports assessments of source contributions and the effectiveness of pollution control measures.

Tables 22–25 reveal persistent fecal coliform contamination across streams in the Sequim Bay-Dungeness CWD from 2016 to 2024, with several sites consistently exceeding Washington State water quality criteria and TMDL targets. Table 22 shows annual geometric means and 90th percentiles frequently surpassing standards, notably at Matriotti Creek (2024: 202/759 cfu/100 mL vs. 60/170 cfu/100 mL criteria), Bell Creek (2024: 105/663 cfu/100 mL vs. 50/100 cfu/100 mL), and Cassalery Creek (2024: 117/258 cfu/100 mL vs. 50/100 cfu/100 mL). Table 23's three-year rolling averages confirm ongoing issues, with Matriotti Creek (2022–24: 127/807 cfu/100 mL) and Bell Creek (2022–24: 89/1101 cfu/100 mL) showing sustained exceedances. Table 24 highlights higher contamination during the irrigation season (April 15–September 15) for streams like Matriotti (2024: 251 cfu/100 mL) and Lotzgesell (2024: 157 cfu/100 mL), likely due to agricultural runoff. Table 25 indicates excessive fecal coliform loading in the Dungeness River (2024: 8989 vs. 5059 allocation), underscoring the need for enhanced pollution control measures to meet TMDL goals and protect shellfish harvesting and recreational uses.

Table 22. Annual fecal coliform geometric means and 90th percentiles by stream mouth and water year.

Growing Area	Site/mile	Geometric Means and 90th Percentiles by Water Year[b,c]										Criteria	Priority tier		Focus Area
		2000[a]	2016	2017	2018	2019	2020	2021	2022	2023	2024		2015-2023	2024	
East Straits	Bagley 0.7	--	33(390)	6(22)	20(28)	11(61)	21(101)	27(107)	54(93)	12(109)	31(226)	50(100)[d]	2	2	--
East Straits	Siebert 1.0	--	8(81)	2(6)	5(20)	8(60)	12(29)	28(175)	14(45)	17(85)	13(61)	50(100)[d]	2	2	--
East Straits	Agnew ditch 0.3	--	120(621)	56(93)	27(87)	36(293)	100(299)	38(174)	66(285)	45(202)	53(141)	50(100)[d]	2	1	--
East Straits	McDonald 1.6	--	22(373)	3(8)	7(22)	6(47)	33(122)	58(563)	43(146)	60(485)	82(317)	50(100)[d]	2	1	--
Dungeness Bay	Lotzgesell 0.1	--	39(149)	25(61)	25(198)	43(403)	49(368)	94(514)	51(343)	31(350)	112(556)	50(100)[d,e]	1	1	Phase II
Dungeness Bay	Matriotti 0.3	279(783)	116(402)	81(312)	96(479)	138(1046)	198(730)	296(1303)	95(660)	110(966)	202(759)	60(170)[f]	1	1	Phase II-IV
Dungeness Bay	Meadowbrook 0.1/0.2	33(243)	12(59)	6(21)	6(17)	17(102)	55(206)	75(219)	86(357)	68(238)	62(520)	50(100)[f,h]	1	1	Phase I
Dungeness Bay	Meadowbr. Sl. 0.23	20(1/18>100)	30(322)	23(190)	86(460)	182(1375)	160(737)	--	--	--	--	50(100)[f]	1	1	Phase I
Dungeness Bay	Hurd 0.2	12(100)	9(77)	4(13)	4(9)	3(13)	10(43)	8(46)	5(25)	9(73)	12(127)	60(170)[f,h]	2	2	--
Dungeness Bay	**Dungeness River 0.7**	17(81)	5(24)	3(4)	5(14)	7(34)	16(45)	13(59)	12(37)	20(96)	34(91)	13(43)[f,g]	1	1	--
Jamestown	Golden Sands Sl. 0.0	109(565)	75(513)	25(100)	18(128)	41(206)	44(367)	28(206)	36(347)	18(102)	35(143)	50(100)[f,h]	1	1	Phase I
Jamestown	Cooper 0.1	49(140)	14(112)	11(41)	11(45)	21(89)	32(178)	31(220)	29(120)	25(83)	40(153)	50(100)[f,h]	1	2	--
Jamestown	Cassalery 0.0/0.6	--	71(304)	11(71)	15(107)	41(144)	57(246)	35(169)	52(593)	108(684)	117(258)	50(100)[d]	1	1	--
Jamestown	Gierin 1.8	--	46(122)	10(53)	15(154)	14(100)	17(42)	*n* < 3	83(210)	27(96)	71(236)	50(100)[d]	2	1	--
Sequim Bay	Bell 0.2	--	84(518)	12(57)	35(172)	67(686)	103(258)	150(1023)	140(1250)	150(957)	105(663)	50(100)[d,e]	1	1	Phase III, IV
Sequim Bay	Johnson 0.0	--	24(114)	5(19)	16(104)	13(118)	11(73)	35(356)	20(84)	36(337)	31(91)	50(100)[d,e]	1	2	--
Sequim Bay	Sequim Bay SP 0.0/0.1	--	5(15)	20(192)	16(162)	12(56)	10(54)	6(36)	13(75)	4(27)	44(955)	50(100)[d,e]	1	2	--
Sequim Bay	Dean 0.17	--	24(411)	4(16)	*n* < 3	--	*n* < 3	*n* < 3	53(140)	6(18)	27(39)	50(100)[d,e]	2	2	--
Sequim Bay	Jimmycomelately 0.15	--	6(29)	6(29)	8(36)	18(176)	8(25)	20(168)	15(94)	12(68)	41(255)	50(100)[d,e]	1	2	--
Sequim Bay	No Name 0.03	--	4(17)	7(41)	10(108)	10(75)	20(190)	15(150)	22(270)	8(49)	36(69)	50(100)[d,e]	2	2	--
Sequim Bay	Chicken Coop 0.24	--	6(16)	11(57)	11(80)	8(81)	12(95)	77(410)	47(83)	13(196)	*n* < 3	50(100)[d,e]	2	2	--

[a] November 1999 through October 2000 geometric means and 90th percentiles taken from the Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study (Sargeant 2002)—the baseline prior to cleanup implementation.

[b] Fecal coliform concentrations (cfu/100mL) are given as geometric means, followed by 90th percentiles in parenthesis. Boxes are coded green when both values meet the referenced criteria, orange when one criterion is not met, or red when neither criterion are met.

[c] CWD Water years begin September 15th to statistically separate irrigation season from wet season.

[d] Clallam County Department of Community Development. 2004. State of the waters of Clallam County, 2004. Clallam County. Available at: https://www.clallamcountywa.gov/1028/State-of-the-Waters-of-Clallam-County

[e] Washington Administrative Code, Title 173 - Ecology, Department of (1995 - 2003). Office of the Code Reviser, Washington State Legislature, Olympia, WA. Available at: https://leg.wa.gov/state-laws-and-rules/state-rules-wac/past-versions-of-state-rules/

[f] Sargeant D. 2002. Dungeness River and Matriotti Creek fecal coliform bacteria total maximum daily load study. Olympia (WA): Washington State Department of Ecology (US). Available at https://fortress.wa.gov/Ecology/publications/summarypages/0203014.html

[g] Sargeant D. 2004. Dungeness Bay fecal coliform bacteria total maximum daily load study. Olympia (WA): Washington State Department of Ecology (US). Available at https://fortress.wa.gov/Ecology/publications/summarypages/0403012.html

[h] Site has a TMDL calculated rollback or mass balance target which is lower than the criteria used for PIC water quality assessments: Meadowbrook 14(100); Hurd 12(100); Golden Sands Slough 19(100); Cooper 35(100) cfu/100mL (Streeter and Hempleman 2004).

Table 23. Three-year rolling average fecal coliform geometric means and 90^{th} percentiles by stream mouth.

Growing Area	Site/mile	GM and 90^{th} Percentile Rolling Average[a] 2016-18	2017-19	2018-20	2019-21	2020-22	2021-23	2022-24	Criteria	2015-2023	2024	Focus Area
East Straits	Bagley 0.7	16(105)	11(49)	16(72)	18(83)	31(110)	26(131)	27(162)	50(100)[b]	2	2	--
	Siebert 1.0	4(23)	4(21)	8(33)	14(73)	17(63)	19(81)	15(55)	50(100)[b]	2	2	--
	Agnew ditch 0.3	57(220)	38(146)	46(221)	52(254)	63(235)	48(188)	54(170)	50(100)[b]	2	1	--
	McDonald 1.6	8(57)	5(21)	11(65)	22(201)	43(203)	53(304)	64(280)	50(100)[b]	2	1	--
Dungeness Bay	Lotzgesell 0.1	29(131)	30(184)	37(296)	59(431)	63(402)	54(418)	55(436)	50(100)[b,e]	1	1	Phase II
	Matriotti 0.3	96(387)	102(537)	135(723)	203(1050)	179(958)	194(1034)	127(807)	60(170)[d]	1	1	Phase II-IV
	Meadowbrook 0.1/0.2	8(28)	9(38)	17(101)	42(209)	71(251)	68(307)	64(394)	50(100)[d,f]	1	1	Phase I
	Meadowbr. Sl. 0.23	40(339)	72(632)	102(957)	--	--	--	--	50(100)[d]	1	1	Phase I
	Hurd 0.2	5(22)	4(10)	5(18)	6(29)	8(33)	7(39)	8(55)	60(170)[d,f]	2	2	--
	Dungeness River 0.7	4(12)	4(15)	8(31)	11(48)	13(46)	15(60)	20(76)	13(43)[d,e]	1	1	--
Jamestown	Golden Sands Sl. 0.0	31(206)	26(142)	31(213)	37(240)	35(278)	26(188)	28(173)	50(100)[d,f]	1	1	Phase I
	Cooper 0.1	12(57)	13(56)	19(92)	27(150)	31(163)	29(131)	30(108)	50(100)[d,f]	1	2	--
	Cassalery 0.0/0.6	23(169)	19(117)	32(1810)	43(179)	47(292)	57(429)	76(597)	50(100)[b]	1	1	--
	Gierin 1.8	21(120)	13(80)	15(84)	25(164)	56(234)	60(225)	59(202)	50(100)[b]	2	1	--
Sequim Bay	Bell 0.2	27(218)	30(230)	54(381)	90(709)	115(851)	101(1258)	89(1101)	50(100)[b,c]	1	1	Phase III, IV
	Johnson 0.0	12(73)	10(69)	13(93)	18(161)	21(147)	30(219)	28(149)	50(100)[b,c]	1	2	--
	Sequim Bay SP 0.0/0.1	10(77)	15(102)	12(77)	9(47)	9(50)	7(43)	11(118)	50(100)[b,c]	1	2	--
	Dean 0.17	14(127)	10(72)	27(66)	36(179)	44(148)	25(159)	21(86)	50(100)[b,c]	2	2	--
	Jimmycomelately 0.15	7(30)	9(61)	10(60)	14(103)	14(83)	15(101)	17(109)	50(100)[b,c]	1	2	--
	No Name 0.03	6(39)	9(59)	13(99)	15(105)	19(160)	14(116)	18(126)	50(100)[b,c]	2	2	--
	Chicken Coop 0.24	9(40)	10(62)	10(71)	19(189)	35(206)	40(244)	29(140)	50(100)[b,c]	2	2	--

[a] Fecal coliform concentrations (cfu/100mL) are given as geometric means, followed by 90^{th} percentiles in parenthesis. Boxes are coded green when both values meet the reference criteria, orange when one criterion is not met, or red when neither criterion are met.

[b] Clallam County Department of Community Development. 2004. State of the waters of Clallam County, 2004. Clallam County. Available at: https://www.clallamcountywa.gov/1028/State-of-the-Waters-of-Clallam-County

[c] Washington Administrative Code, Title 173 - Ecology, Department of (1995 - 2003). Office of the Code Reviser, Washington State Legislature, Olympia, WA. Available at: https://leg.wa.gov/state-laws-and-rules/state-rules-wac/past-versions-of-state-rules/

[d] Sargeant D. 2002. Dungeness River and Matriotti Creek fecal coliform bacteria total maximum daily load study. Olympia (WA): Washington State Department of Ecology (US). Available at https://fortress.wa.gov/Ecology/publications/summarypages/0203014.html

[e] Sargeant D. 2004. Dungeness Bay fecal coliform bacteria total maximum daily load study. Olympia (WA): Washington State Department of Ecology (US). Available at https://fortress.wa.gov/Ecology/publications/summarypages/0403012.html

[f] Site has a TMDL calculated rollback or mass balance target which is lower than the criteria used for PIC water quality assessments: Meadowbrook 14(100); Hurd 12(100); Golden Sands Slough 19(100); Cooper 35(100) cfu/100mL (Streeter and Hempleman 2004).

Table 24. Seasonal fecal coliform Geometric means by stream mouth and water year.

Growing Area	Site/mile	Season[a]	Geometric Means by Water Year/Season										
			2000[b]	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
East Straits	Agnew ditch 0.3	wet	--	--	--	--	--	--	--	--	--	--	33
		irrig.	--	--	--	--	--	--	--	--	--	--	76
	McDonald 1.6	wet	--	--	--	--	--	--	--	--	--	--	73
		irrig.	--	--	--	--	--	--	--	--	--	--	92
Dungeness Bay	Lotzgesell 0.1	wet	--	--	30	24	10	10	31	72	25	17	93
		irrig.	50	56	63	27	71	177	107	129	106	76	157
	Matriotti 0.3	wet	--	--	93	44	44	52	118	175	76	50	178
		irrig.	1119	105	160	187	236	368	495	548	119	337	251
	Meadowbrook 0.1/0.2	wet	--	--	12	6	5	8	40	55	88	61	98
		irrig.	51	3	12	6	8	37	96	118	83	79	28
	Meadowbr. Sl. 0.23	wet	--	--	32	10	63	193	107	--	--	--	--
		irrig.	28	7	27	72	125	172	405	--	--	--	--
	Dungeness River 0.7	wet	--	--	5	3	4	3	12	8	8	11	44
		irrig.	35	4	4	3	5	18	24	23	17	50	26
Jamestown	Golden Sands Sl. 0.0	wet	--	--	67	24	12	19	44	26	34	13	52
		irrig.	--	60	90	28	29	78	45	31	37	28	18
	Cooper 0.1	wet	--	--	17	11	13	24	28	19	26	34	53
		irrig.	--	5	10	9	9	18	40	57	33	17	--
	Cassalery 0.0/0.6	wet	--	--	114	11	9	30	31	33	29	45	100
		irrig.	--	9	37	12	26	57	184	38	94	368	156
	Gierin 1.8	wet	--	--	--	--	--	--	--	--	--	--	--
		irrig.	--	--	--	--	--	--	--	--	--	--	54
Sequim Bay	Bell 0.2	wet	--	--	73	7	17	30	74	62	56	63	78
		irrig.	--	--	108	24	78	150	183	417	351	501	180
	Johnson 0.0	wet	--	--	19	3	6	6	5	17	15	14	39
		irrig.	--	--	35	9	51	27	50	84	28	119	--
	Sequim Bay SP 0.0/0.1	wet	--	--	5	--	16	6	5	5	4	3	44
		irrig.	--	--	4	13	26	22	28	10	34	--	--
	Jimmycomelately 0.15	wet	--	--	4	5	6	8	7	12	10	10	49
		irrig.	--	--	15	7	10	37	11	35	24	15	--

[a] Sequim-Dungeness irrigation season runs from April 15th through September 15th. Wet season in Western Washington is typically defined as the period between October 1st and April 30th. To eliminate overlap with the irrigation season, wet season in this report refers to the period between September 16th and April 14th. Wet season in the 2002 Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study was defined as November through February.

[b] Geometric means of samples collected during the irrigation season (April 15 - September 15, 2020) of the Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study (Sargeant 2002).

Table 25. Annual fecal coliform loading values by stream mouth.

Growing Area	Site/mile	Fecal Coliform Loads and TMDL Allocations[a]										
		2000[b]	2016	2017	2018	2019	2020	2021	2022	2023	2024	Allocation[b]
East Straits	Bagley 0.7	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Siebert 1.0	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Agnew ditch 0.3	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	McDonald 1.6	--	--	--	--	--	--	--	--	--	--	--
Dungeness Bay	Lotzgesell 0.1	623	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Matriotti 0.3	5939	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	1267
	Meadowbrook 0.1/0.2	215	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	200
	Meadowbr. Sl. 0.23	69	[c]	[c]	[c]	[c]	[c]	--	--	--	--	--
	Hurd 0.2	316	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	316
	Dungeness River 0.7[d]	9493	2352	1143	2248	2404	5674	7267	4669	5625	8989	5059
Jamestown	Golden Sands Sl. 0.0	187	--	--	--	--	--	--	--	--	--	33
	Cooper 0.1	299	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	214
	Cassalery 0.0/0.6	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Gierin 1.8	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
Sequim Bay	Bell 0.2	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Johnson 0.0	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Sequim Bay SP 0.0/0.1	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Dean 0.17	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Jimmycomelately 0.15	--	--	--	--	--	--	--	--	--	--	--
	No Name 0.03	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--
	Chicken Coop 0.24	--	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	--

[a] Water year loading averages (conc.[cfu/100mL] x flow[cfs]).
[b] River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study (Sargeant 2002).
[c] Streamkeepers of Clallam County collected stage but has not completed a discharge curve.
[d] Flows retrieved from Washinton State Department of Ecology Station 18A050, at RM 0.8.

7.2 Nitrate and Nitrite

Nitrogen compounds, specifically nitrate and nitrite, are key indicators of nutrient dynamics in freshwater streams, particularly in watersheds draining to estuarine and coastal ecosystems where nitrogen often limits primary productivity. Nitrate, the thermodynamically stable form of nitrogen in aerobic environments, results from the complete oxidation of nitrogen in natural waters. It originates from natural sources, such as weathering of geological deposits, and anthropogenic sources, including agricultural fertilizer runoff, sewage effluent, and urban landscapes. Nitrite, an intermediate compound, forms during microbial reduction of nitrate or oxidation of ammonia. These sources contribute to nitrogen loading in streams, influencing downstream ecosystems and potentially driving eutrophication and algal blooms.

The CWD PIC program monitors nitrate and nitrite to assess nitrogen cycling and associated ecological risks. Nitrate serves as a reliable indicator of chronic nutrient loading from sources such as agricultural runoff and sewage, facilitating evaluation of long-term pollution trends. Nitrite, being more reactive and toxic, signals active microbial processes, recent contamination, or inefficiencies in treatment systems, enabling timely interventions to mitigate acute impacts. Monitoring both compounds supports accurate source attribution, ecosystem health assessments, and evaluation of pollution control measures.

This section presents findings from nitrate and nitrite monitoring at the mouths of streams in the Sequim Bay-Dungeness CWD from 2016 to 2024. Table 26 summarizes median annual NO_2+NO_3 concentrations by stream mouth, benchmarked against EPA Nutrient Ecoregion II reference criteria (25th percentile: 0.26 mg/L; 75th percentile: 0.89 mg/L for NO_2+NO_3). Figures 5 and 6 provide aggregated statistical analyses of nitrate and nitrite concentrations, respectively, across water years 2022–2024, illustrating variability and central tendencies.

Monitoring results reveal persistent exceedances of reference criteria at Lotzgesell (2024: 1.45 mg/L), Matriotti (2024: 1.31 mg/L), Cassalery (2024: 0.77 mg/L), and Bell Creek (2024: 1.89 mg/L). Bell Creek consistently exceeds the 75th percentile reference condition, indicating significant nutrient loading likely from fertilizer runoff. Figure 5 and Figure 6 highlight stable but elevated nitrate levels in Lotzgesell, Matriotti, and Bell Creek, with nitrite spikes in Lotzgesell, Bell, and Cassalery suggesting enhanced microbial activity or recent contamination. These findings underscore the need for targeted interventions to reduce nitrogen inputs and mitigate eutrophication risks in downstream estuarine ecosystems.

Table 26. Median annual NO_2+NO_3 concentrations by stream mouth compared to ecoregion reference values.

Growing Area	Site/mile	Median by Water Year[a] 2016	2017	2018	2019	2020	2021	2022	2023	2024	Criteria[b]	Priority tier 2015-2023	Priority tier 2024
East Straits	Bagley 0.7	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2
	Siebert 1.0	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2
	Agnew ditch 0.3	--	--	--	--	--	--	--	--	0.02	0.26(0.89)	2	1
	McDonald 1.6	--	--	--	--	--	--	--	--	0.08	0.26(0.89)	2	1
Dungeness Bay	Lotzgesell 0.1	1.94	1.56	1.76	1.56	1.6	1.76	1.97	1.51	1.45	0.26(0.89)	1	1
	Matriotti 0.3	1.41	1.41	1.43	1.33	1.28	1.51	1.36	1.36	1.31	0.26(0.89)	1	1
	Meadowbrook 0.1/0.2	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Meadowbr. Slough 0.23	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Hurd 0.2	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2
	Dungeness River 0.7	0.06	0.05	0.07	0.06	0.05	0.04	0.05	0.05	0.05	0.26(0.89)	1	1
Jamestown	Golden Sands Sl. 0.0	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Cooper 0.1	--	--	--	--	--	--	--	--	--	--[c]	1	2
	Cassalery 0.0/0.6	1.57	0.97	1.09	0.93	1.08	0.83	1.02	0.78	0.77	0.26(0.89)	1	1
	Gierin 1.8	--	--	--	--	--	--	--	--	1.60	0.26(0.89)	2	1
Sequim Bay	Bell 0.2	3.18	3.28	2.61	2.92	2.97	2.67	2.35	2.68	1.89	0.26(0.89)	1	1
	Johnson 0.0	0.17	0.28	0.25	0.16	0.23	0.15	0.22	0.28	$n < 3$	0.26(0.89)	1	2
	Sequim Bay SP 0.0/0.1	0.33	$n < 3$	0.16[c]	0.14	0.05	0.11	0.04	0.19	$n < 3$	0.26(0.89)	1	2
	Dean 0.17	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2
	Jimmycomelately 0.15	0.15	0.23	0.14	0.16	0.23	0.16	0.23	0.31	$n < 3$	0.26(0.89)	1	2
	No Name 0.03	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2
	Chicken Coop 0.24	--	--	--	--	--	--	--	--	--	0.26(0.89)	2	2

[a] $NO_2 + NO_3$ (mg/L) are given as water year medians. Boxes are coded green when the median is below the referenced 25th percentile criterion, orange when the 25th percentile criterion is exceeded, or red when the 75th percentile reference condition median is exceeded.

[b] Criteria are the annual 25th and 75th percentile reference conditions for Level III ecoregion 2, detailed in: U.S. Environmental Protection Agency. 2000. Ambient water quality criteria recommendations: Information supporting the development of state and tribal nutrient criteria for rivers and streams in nutrient ecoregion II (Western Forested Mountains) (EPA 822-B-00-015). Office of Water, Office of Science and Technology, Health and Ecological Criteria Division. Available at https://www.epa.gov/nutrientpollution/ecoregional-nutrient-criteria-rivers-and-streams

[c] The majority of samples collected at this station exceed a salinity of 1ppt.

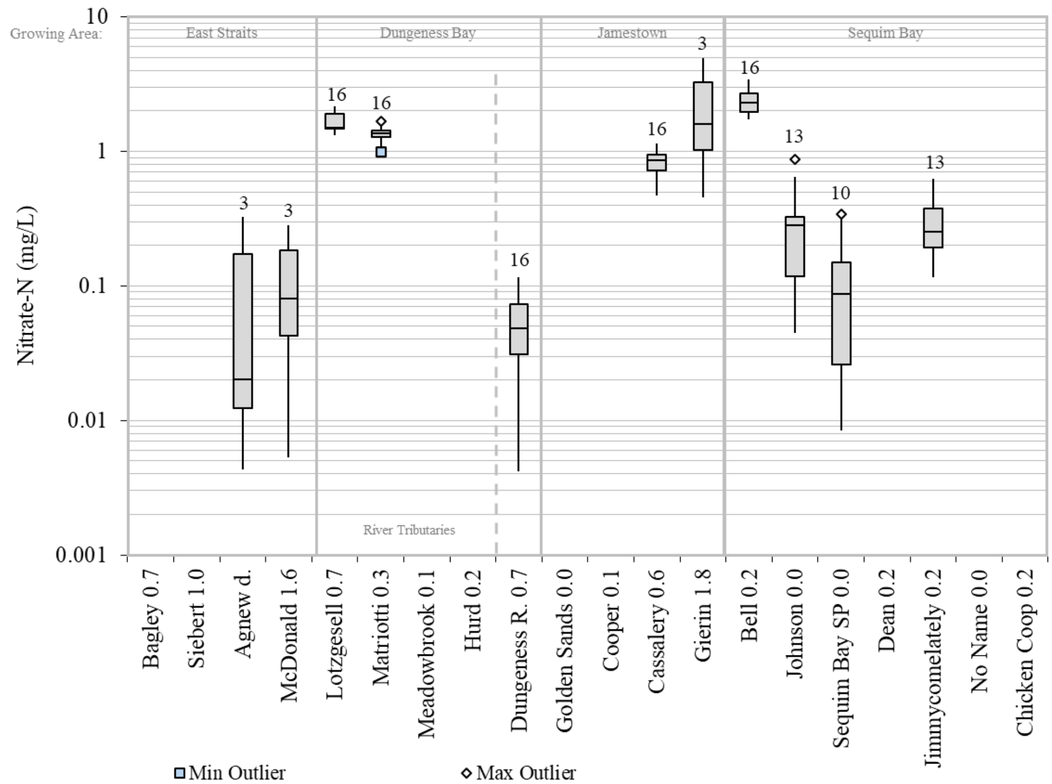

Figure 5. Statistical summary of nitrate concentrations across water years 2022–2024.

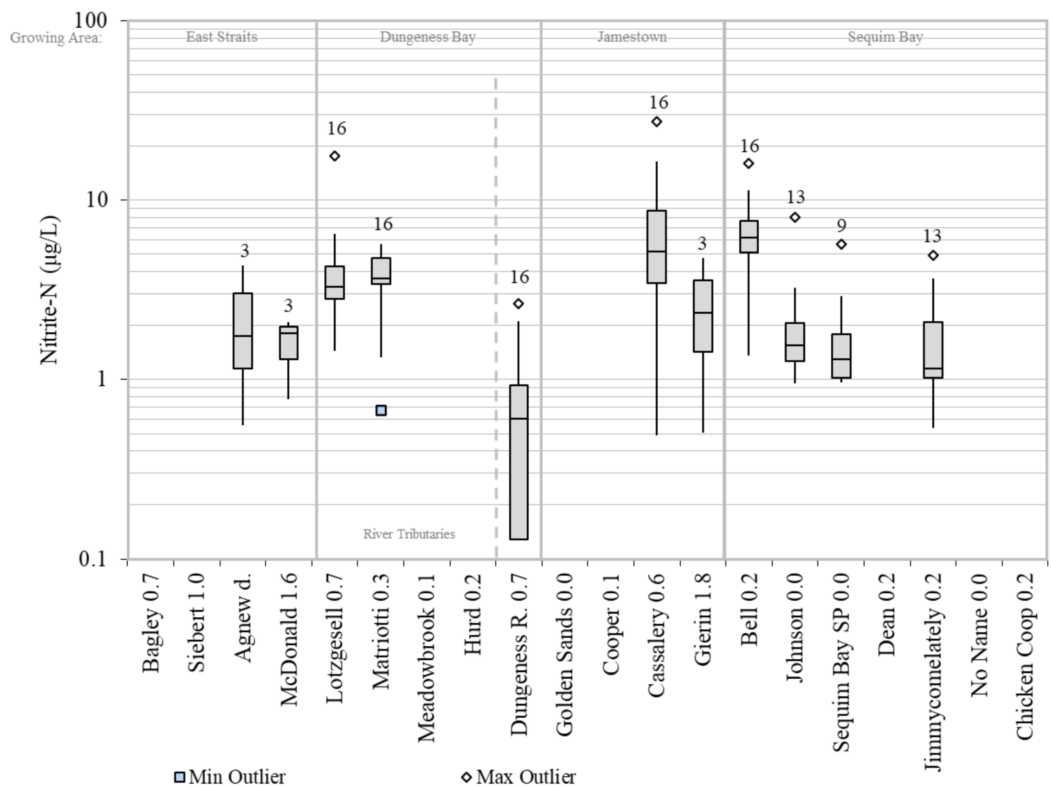

Figure 6. Statistical summary of nitrite concentrations across water years 2022–2024.

7.3 Ammonia

Ammonia is a critical parameter in the CWD PIC program due to its toxicity to aquatic life and its role in nutrient dynamics. In freshwater streams, ammonia exists in ionized and un-ionized forms, with the un-ionized form being highly toxic to fish and other organisms at low concentrations, disrupting respiratory and metabolic processes. The CWD PIC program monitors ammonia to ensure compliance with aquatic life criteria, identify contamination sources, and assess impacts on downstream ecosystems. Sources of ammonia include agricultural runoff from fertilizers and manure, failing septic systems, natural decomposition by proteolytic bacteria, and direct excretion by aquatic invertebrates.

Ammonia loading significantly affects estuarine and coastal ecosystems, as it is the most reduced form of inorganic nitrogen, readily assimilated by phytoplankton. Unlike nitrate, which requires reduction to ammonia for incorporation into amino acids, ammonia drives rapid algal growth, potentially causing eutrophication, oxygen depletion, and harmful algal blooms in nutrient-sensitive bays.

Ammonia concentrations in monitored streams from water years 2016–2025 were below state aquatic life criteria, indicating minimal acute risk to aquatic organisms during the study period. Figure 7 summarizes ammonia concentrations across stream mouths from water years 2022-2025, aggregating data to highlight trends and variability. Median concentrations ranged from 1 µg/L in Agnew Ditch to 23 µg/L in Matriotti Creek and Cassalery Creek. Outliers, such as Jimmycomelately (128 µg/L), Matriotti (72 µg/L), and Johnson Creek (47 µg/L), suggest episodic inputs from organic decomposition or anthropogenic discharges. Streams lacking data are either classified as Tier II waters-of-concern or are categorized as marine waters, limiting comprehensive assessment.

These findings highlight spatial heterogeneity, with elevated concentrations in agriculturally influenced streams, emphasizing the need for targeted source identification to protect ecosystem health. Ongoing loading calculations by the Streamkeepers program will further clarify total nitrogen impacts toward marine waters.

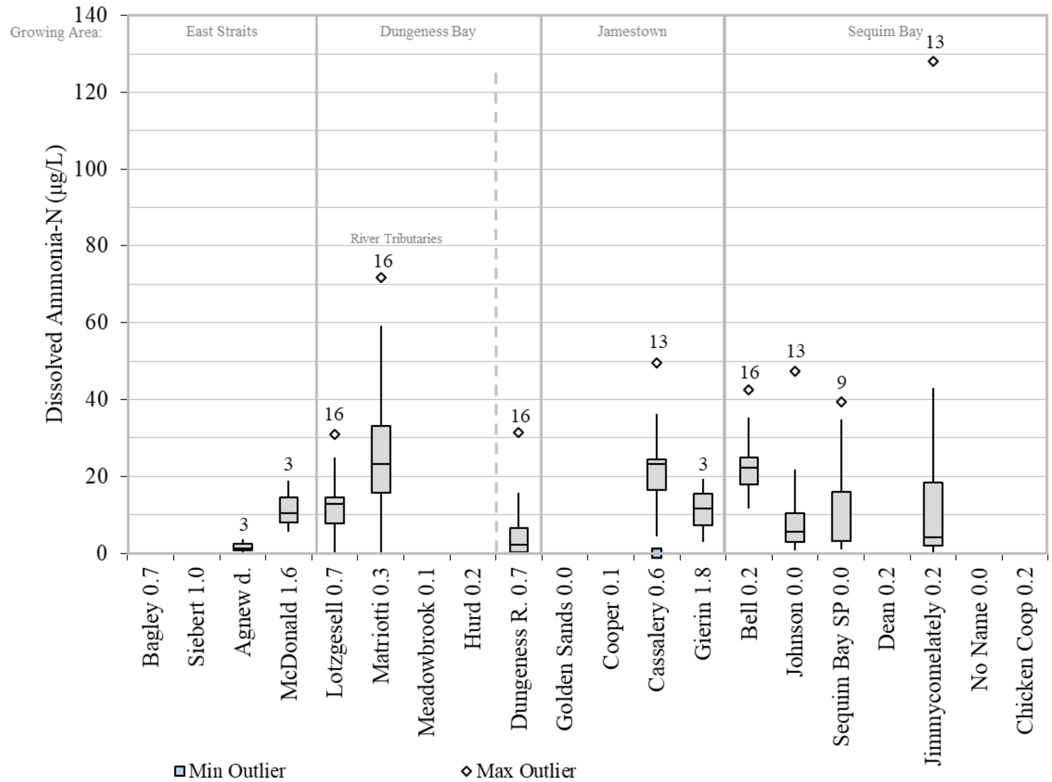

Figure 7. Statistical summary of ammonia concentrations across water years 2022–2024 by stream mouth.

7.4 Orthophosphate

Orthophosphate, the dissolved and bioavailable form of phosphorus, is a key indicator of nutrient enrichment in the CWD PIC program, as it can drive eutrophication. Elevated orthophosphate levels promote excessive algal growth, leading to reduced dissolved oxygen and impaired aquatic life. The program monitors orthophosphate to identify anthropogenic sources and assess risks to downstream ecosystems, particularly in bays where phosphorus exacerbates coastal eutrophication alongside nitrogen. Major sources include agricultural fertilizer runoff, failing septic systems, urban stormwater containing detergents or eroded soils, and natural weathering of phosphate-rich rocks, with human activities amplifying inputs in developed areas.

The interplay between nitrate, nitrite, and orthophosphate in streams creates synergistic effects that amplify ecological impacts beyond those of individual nutrients. Elevated levels of nitrate and nitrite, which are highly mobile forms of nitrogen, can interact with orthophosphate to intensify eutrophication, as both nitrogen and phosphorus are essential for algal and cyanobacterial growth. In streams like Bell Creek, where median NO_2+NO_3 concentrations (1.89–3.28 mg/L) and orthophosphate levels (46.3–122 µg/L) consistently exceed reference criteria, this synergy likely exacerbates algal blooms, further depleting dissolved oxygen and stressing aquatic ecosystems. These interactions can also alter nutrient ratios, potentially shifting phytoplankton communities toward species that are more harmful, such as toxin-producing cyanobacteria, which pose risks to downstream bays and human health. Effective management requires addressing both nitrogen and phosphorus sources concurrently to mitigate these compounded effects.

Orthophosphate data were evaluated using EPA's nutrient criteria methodology for rivers and streams, with reference conditions derived from CWD streams. Table 27 presents annual median orthophosphate concentrations (µg/L) at stream mouths for water years 2016–2024, compared against the 25th (12.1 µg/L) and 75th (47.7 µg/L) percentile benchmarks to assess long-term trends. Figure 8 provides a statistical summary of orthophosphate concentrations across water years 2022–2024, illustrating variability and central tendencies via box plots. These analyses inform phosphorus pollution assessments, source management strategies, and efforts to mitigate nutrient loading to downstream bays.

Table 27 indicates that median orthophosphate concentrations varied widely across streams. For example, Bell Creek (46.3–122 µg/L) and Sequim Bay State Park Creek (45.8–70.5 µg/L) consistently exceeded the 75th percentile, suggesting significant anthropogenic influence. Matriotti (10.5–29.7 µg/L) showed declining trends, reflecting effective source control. Figure 8 highlights median concentrations ranging from 4 µg/L (Dungeness River) to 61 µg/L (Sequim Bay SP), with interquartile ranges (IQRs) indicating greater variability in streams like Bell (IQR: 45–94 µg/L) and Meadowbrook (IQR: 16–25 µg/L). Outliers, in Bell (232 µg/L), suggest episodic inputs from agricultural or urban sources. Streams lacking data (e.g., Bagley, Siebert, Hurd) are classified as Tier II waters-of-concern.

Table 27. Median annual orthophosphate concentrations by stream mouth compared to CWD reference conditions.

Growing Area	Site/mile	Median by Water Year[a]									Criteria[b]	Priority tier	
		2016	2017	2018	2019	2020	2021	2022	2023	2024		2015-2023	2024
East Straits	Bagley 0.7	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2
East Straits	Siebert 1.0	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2
East Straits	Agnew ditch 0.3	--	--	--	--	--	--	--	--	21.7	12.1(47.7)	2	1
East Straits	McDonald 1.6	--	--	--	--	--	--	--	--	13.1	12.1(47.7)	2	1
Dungeness Bay	Lotzgesell 0.1	12.7	10.7	9.30	11.5	11.0	9.50	9.00	9.67	4.98	12.1(47.7)	1	1
Dungeness Bay	Matriotti 0.3	29.7	21.7	22.5	22.6	21.8	20.4	17.7	13.9	10.5	12.1(47.7)	1	1
Dungeness Bay	Meadowbrook 0.1/0.2	--	--	--	--	--	--	--	--	--	--[c]	1	1
Dungeness Bay	Meadowbr. Slough 0.23	--	--	--	--	--	--	--	--	--	--[c]	1	1
Dungeness Bay	Hurd 0.2	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2
Dungeness Bay	**Dungeness River 0.7**	5.20	3.24	4.81	3.41	3.47	3.05	3.81	4.64	5.77	12.1(47.7)	1	1
Jamestown	Golden Sands Sl. 0.0	--	--	--	--	--	--	--	--	--	--[c]	1	1
Jamestown	Cooper 0.1	--	--	--	--	--	--	--	--	--	--[c]	1	2
Jamestown	Cassalery 0.0/0.6	14.4	14.9	10.7	13.4	14.8	11.3	10.3	8.06	6.89	12.1(47.7)	1	1
Jamestown	Gierin 1.8	--	--	--	--	--	--	--	--	4.65	12.1(47.7)	2	1
Sequim Bay	Bell 0.2	105	86.1	122	114	85.2	70.4	64.6	46.4	46.3	12.1(47.7)	1	1
Sequim Bay	Johnson 0.0	46.2	52.2	41.9	38.2	40.8	39.7	43.1	45.3	*n* < 3	12.1(47.7)	1	2
Sequim Bay	Sequim Bay SP 0.0/0.1	64.2	*n* < 3	57.5	57.9	70.5	52.2	52.5	45.8	*n* < 3	12.1(47.7)	1	2
Sequim Bay	Dean 0.17	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2
Sequim Bay	Jimmycomelately 0.15	19.1	17.8	16.9	20.8	17.7	22.8	15.9	16.4	*n* < 3	12.1(47.7)	1	2
Sequim Bay	No Name 0.03	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2
Sequim Bay	Chicken Coop 0.24	--	--	--	--	--	--	--	--	--	12.1(47.7)	2	2

[a] Dissolved Orthophosphate as P concentrations (µg/L) are given as water year medians. Boxes are coded green when the median is below the 25th percentile criterion, orange when the 25th percentile is exceeded, or red when the 75th percentile reference condition median is exceeded.

[b] The 25th percentile criterion and 75th percentile reference condition were calculated from CWD streams over the period of WY2015-2024. Streams included in the criteria are: Bell (*n*=78), Cassalery (*n*=80), Dungeness (*n*=83), Jimmycomelately (*n*=74), Johnson (*n*=74), Lotzgesell (*n*=82), Matriotti (*n*=84), and Sequim Bay State Park (*n*=57).

[c] The majority of samples collected at this station exceeded a salinity of 1 ppt.

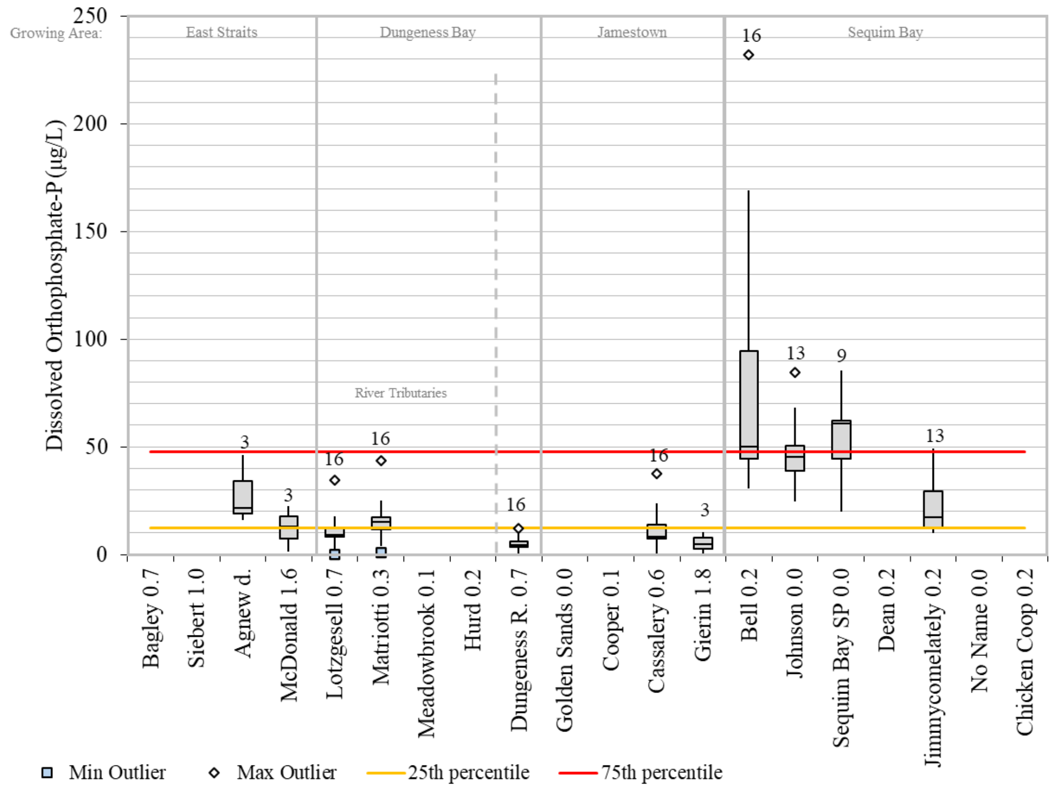

Figure 8. Statistical summary of orthophosphate concentrations across water years 2022–2024 by stream mouth.

7.5 Turbidity

Turbidity, a critical measure of water quality, quantifies the cloudiness caused by suspended particles such as sediment, organic matter, and microorganisms, which reduce light penetration, impair photosynthesis, and degrade aquatic habitats. Elevated turbidity directly threatens aquatic life by clogging fish gills, smothering benthic communities, and disrupting food chains. Turbidity often correlates with fecal coliform and nutrient levels, as suspended solids from agricultural runoff, urban development, or erosion can transport bacteria and adsorb nutrients like phosphorus and ammonia, exacerbating eutrophication in downstream estuaries. The CWD PIC program monitors turbidity to assess sediment pollution, track synergies with microbial and nutrient contaminants, ensure compliance with standards, and protect aquatic life, recreational uses, and downstream coastal ecosystems.

Turbidity monitoring results, summarized in Table 28, provide insights into sediment dynamics and compliance with Washington's aquatic life criteria under WAC 173-201A-200(1)(e), which limits turbidity increases to 5 NTU above background for sensitive habitats. Table 28 compares annual median turbidity values (FNU) for water years 2016–2024 against the ecoregion 25th percentile (1.95 FNU) and the 5 NTU threshold (6.95 FNU). Streams like No Name (median: 5.8–19.0 FNU), Dean (9.0–35.0 FNU), and Agnew Ditch (2.5–10.8 FNU) frequently exceeded the 6.95 FNU threshold, indicating potential impairment from sediment inputs, likely linked to agricultural or urban runoff. In contrast, streams such as Hurd (0.0–1.5 FNU) and Dungeness River (1.0–4.4 FNU) consistently met criteria, reflecting minimal sediment disturbance. Elevated turbidity in streams such as Matriotti (4.0–9.0 FNU), which also showed high ammonia levels (median 23 µg/L), suggests shared sources such as agricultural runoff, where sediments may carry bound nutrients. These findings highlight the need for targeted sediment and nutrient control measures to protect sensitive aquatic ecosystems and comply with state standards.

Table 28. Median annual turbidity by stream mouth compared to ecoregion reference values and state aquatic life use criteria.

Growing Area	Site/mile	2016	2017	2018	2019	2020	2021	2022	2023	2024	Criteria[b]	Priority tier 2015-2023	Priority tier 2024
		Median by Water Year[a]											
East Straits	Bagley 0.7	1.8	3.5	9.0	2.0	5.5	3.5	12.5	2.0	3.0	1.95(6.95)	2	2
	Siebert 1.0	--	1.0	7.5	1.0	2.1	3.0	16.5	2.5	1.5	1.95(6.95)	2	2
	Agnew ditch 0.3	4.8	8.0	4.5	4.0	9.5	10.8	2.5	3.0	2.5	1.95(6.95)	2	1
	McDonald 1.6	0.9	2.4	11.0	2.0	2.0	3.0	11.5	1.5	1.5	1.95(6.95)	2	1
Dungeness Bay	Lotzgesell 0.1	8.7	6.5	7.0	5.0	4.0	6.0	5.0	4.0	5.5	1.95(6.95)	1	1
	Matriotti 0.3	7.7	6.0	9.0	7.0	6.0	7.0	9.0	4.0	6.0	1.95(6.95)	1	1
	Meadowbrook 0.1/0.2	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Meadowbr. Sl. 0.23	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Hurd 0.2	0.1	1.5	1.0	0.5	0.9	1.5	1.0	0.0	1.0	1.95(6.95)	2	2
	Dungeness River 0.7	4.4	4.0	2.5	1.0	1.0	2.0	3.0	3.5	3.0	1.95(6.95)	1	1
Jamestown	Golden Sands Sl. 0.0	--	--	--	--	--	--	--	--	--	--[c]	1	1
	Cooper 0.1	--	--	--	--	--	--	--	--	--	--[c]	1	2
	Cassalery 0.0/0.6	2.0	4.0	4.0	3.0	3.0	5.0	7.0	6.0	3.0	1.95(6.95)	1	1
	Gierin 1.8	--	6.5	5.0	7.0	7.0	9.0	7.0	6.5	7.5	1.95(6.95)	2	1
Sequim Bay	Bell 0.2	4.2	3.5	4.0	3.0	3.0	4.0	6.0	4.0	5.0	1.95(6.95)	1	1
	Johnson 0.0	3.6	3.0	3.0	2.0	1.0	2.0	3.5	2.0	3.0	1.95(6.95)	1	2
	Sequim Bay SP 0.0/0.1	3.0	--	3.0	1.5	1.0	1.0	2.0	3.0	4.0	1.95(6.95)	1	2
	Dean 0.17	--	--	--	--	--	--	35.0	13.0	9.0	1.95(6.95)	2	2
	Jimmycomelately 0.15	3.3	3.7	2.0	3.0	2.0	1.0	3.5	2.0	4.0	1.95(6.95)	1	2
	No Name 0.03	5.8	10.0	19.0	6.0	11.0	7.0	18.5	9.0	10.0	1.95(6.95)	2	2
	Chicken Coop 0.24	1.9	4.5	4.5	3.0	9.5	1.5	16.0	1.0	--	1.95(6.95)	2	2

[a] Turbidity (FNU) are given as water year medians. Boxes are coded green when the median is below the 25th percentile criterion, orange when the 25th percentile is exceeded, or red when the 25th percentile is exceeded >5FNU.

[b] Criteria are the annual 25th percentile reference condition for Level III ecoregion 2, detailed in U.S. Environmental Protection Agency (2000), and 5 NTU over background, prescribed in WAC 173-201A (2024).

[c] The majority of samples collected at this station exceed a salinity of 1 ppt. Marine baseline conditions have not been established.

7.6 Dissolved Oxygen

Dissolved oxygen (DO) is a fundamental indicator of water quality and aquatic ecosystem health in freshwater streams, essential for the respiration of fish, invertebrates, and other aerobic organisms. Low DO levels can cause stress, reduced growth, behavioral changes, or mortality, particularly in sensitive species such as salmonids. The CWD PIC program monitors DO to ensure compliance with aquatic life criteria, detect oxygen-depleting pollution, and evaluate impacts from nutrients (ammonia and orthophosphate) and turbidity. Elevated orthophosphate and nitrogen levels (e.g., Bell Creek) can trigger eutrophication, leading to algal blooms and organic matter decomposition that consume DO. High turbidity (e.g., No Name: median 5.8–19.0 FNU, Dean: median 9.0–35.0 FNU) reduces light penetration, limiting photosynthetic oxygen production, while suspended solids transport organic pollutants, increasing biochemical oxygen demand. In stream mouths draining to bays, adequate DO levels are crucial to prevent hypoxic conditions in estuarine environments, where tidal influences and saltwater mixing reduce oxygen solubility and availability, increasing risks to coastal ecosystems.

DO conditions at stream mouth sampling sites were assessed for excursions below protective thresholds, as summarized in Table 29, 30, and 31. Table 29 (WY2024) reports freshwater DO excursions below 10 mg/L and 95% saturation, per WAC 173-201A-200 for core summer salmonid habitat, with notable instances in Matriotti (4.5 mg/L, 44% saturation on 7/9/2024), Cooper (7.6 mg/L, 62% saturation on 12/11/2023), and Cassalery (7.9 mg/L, 74% saturation on 5/14/2024), indicating poor habitat conditions. Appendix A provides a comprehensive excursion record across WY2016–2024, including saltwater criteria adjustments for tidal sites. Table 30, Appendix A, (WY2016–2024) shows persistent freshwater excursions, particularly in Cassalery (44 instances, e.g., 7.0 mg/L, 61% saturation on 11/12/2019) and Meadowbrook (18 instances, e.g., 6.3 mg/L, 55% saturation on 10/18/2016). Table 31, Appendix A, (WY2016–2024) highlights marine water excursions below 7.0 mg/L at tidally influenced sites, with severe hypoxia in Meadowbrook Slough (e.g., 1.1 mg/L on 10/18/2016) and Cooper (e.g., 3.0 mg/L on 10/12/2020). These findings underscore the need for targeted mitigation of nutrient and sediment inputs, particularly in tidally influenced streams like Cassalery and Meadowbrook, where tidal intrusion exacerbates DO depletion through organic matter and nutrient loading, requiring integrated management to protect aquatic life across freshwater-to-marine transitions.

Table 29. Dissolved oxygen excursions in fresh waters (WY2024): below 10 mg/L and 95% saturation.

Station name	Date	DO (mg/L)	DO %sat
Agnew Creek-Ditch 0.3	8/13/2024	9.3	93
Bell	7/9/2024	8.4	83
	8/13/2024	9.7	94
Cassalery 0.0/0.6	10/9/2023	9.2	86
	11/13/2023	9.9	85
	12/11/2023	9.9	84
	5/14/2024	7.9	74
	6/11/2024	9.5	90
	7/9/2024	8.9	91
	8/13/2024	9.0	86
	9/17/2024	9.8	92
Chicken Coop 0.24	8/21/2024	9.6	91
Cooper 0.1	12/11/2023	7.6	62
	11/13/2024	8.1	89
Dean 0.17	8/21/2024	9.4	91
Hurd 0.2	11/14/2023	9.6	83
	1/11/2024	9.9	85
	8/21/2024	9.0	82

	11/13/2024	8.6	78
Jimmycomelately 0.15	10/9/2023	8.3	77
	8/21/2024	9.6	92
Lotzgesell 0.1	10/9/2023	9.2	85
	11/13/2023	9.4	83
	12/11/2023	6.5	78
	1/9/2024	8.8	75
	2/22/2024	9.9	86
	4/2/2024	9.6	86
	5/14/2024	9.9	90
	6/11/2024	9.7	90
	7/9/2024	9.2	89
	8/13/2024	9.3	89
	9/17/2024	9.5	88
	10/8/2024	9.6	88
	11/12/2024	9.7	82
Matriotti 0.3	10/9/2023	9.1	84
	11/13/2023	9.4	81
	12/11/2023	9.1	78
	1/9/2024	9.2	77
	4/2/2024	9.4	83
	5/14/2024	9.9	88
	6/11/2024	5.7	52
	7/9/2024	4.5	44
	8/13/2024	9.3	88
	9/17/2024	9.5	87
	10/8/2024	9.6	89
	11/12/2024	9.9	86
No Name 0.03	11/13/2024	9.7	87

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Appendix A – Dissolved Oxygen Excursions (2015-2024)

Table 30. Dissolved oxygen excursions in fresh waters (WY2016-2024): below 10 mg/L and 95% saturation.

Station name	Date	DO (mg/L)	DO %sat
Agnew Creek-Ditch 0.3	8/14/2018	8.8	88
	8/18/2020	9.0	91
	8/15/2023	8.8	93
	8/13/2024	9.3	93
Bagley 0.7	8/15/2023	9.5	94
Bell	6/13/2017	9.9	91
	7/18/2017	9.3	88
	8/14/2017	9.7	92
	7/10/2018	9.8	93
	8/12/2019	9.5	93
	7/12/2021	9.7	92
	8/9/2021	9.8	94
	9/13/2021	9.7	90
	7/12/2022	9.5	92
	8/8/2022	8.7	85
	9/12/2022	9.3	92
	8/14/2023	9.2	92
	9/11/2023	9.9	94
	7/9/2024	8.4	83
	8/13/2024	9.7	94
Cassalery 0.0/0.6	10/18/2016	9.6	86
	11/14/2016	9.0	81
	6/13/2017	9.8	92
	7/18/2017	9.5	92
	8/14/2017	9.4	89
	11/13/2017	9.5	83
	4/16/2018	9.7	85
	5/15/2018	9.4	90
	7/10/2018	9.5	91
	8/13/2018	9.5	92
	9/11/2018	9.5	90
	10/9/2018	9.6	88
	7/9/2019	9.7	94
	7/9/2019	9.4	89
	8/12/2019	9.4	92
	9/10/2019	9.5	92
	10/8/2019	9.2	82
	11/12/2019	7.0	61
	12/10/2019	9.5	80
	1/21/2020	9.9	83
	5/12/2020	9.5	92
	7/14/2020	9.8	93
	8/12/2020	9.7	93
	10/12/2020	9.0	81
	11/16/2020	9.3	78
	6/14/2021	9.9	94
	7/12/2021	9.3	92
	8/9/2021	8.9	89
	9/13/2021	9.4	88
	6/13/2022	9.7	91

	7/12/2022	8.7	88
	9/12/2022	9.2	91
	4/10/2023	9.7	85
	7/10/2023	9.4	89
	8/14/2023	8.8	88
	9/11/2023	8.6	83
	10/9/2023	9.2	86
	11/13/2023	9.9	85
	12/11/2023	9.9	84
	5/14/2024	7.9	74
	6/11/2024	9.5	90
	7/9/2024	8.9	91
	8/13/2024	9.0	86
	9/17/2024	9.8	92
Chicken Coop 0.24	8/18/2020	9.6	93
	8/15/2023	9.1	92
	8/21/2024	9.6	91
Cooper 0.1	10/18/2016	4.7	42
	4/17/2017	7.1	67
	5/9/2017	7.8	75
	7/18/2017	8.8	93
	3/12/2019	9.0	72
	12/10/2019	8.0	66
	8/12/2020	7.4	75
	9/28/2020	4.7	43
	12/11/2023	7.6	62
	11/13/2024	8.1	89
Dean 0.17	8/10/2021	7.3	72
	8/9/2022	8.4	84
	8/21/2024	9.4	91
Hurd 0.2	11/15/2016	8.7	78
	1/10/2017	9.8	83
	8/15/2017	9.3	84
	11/14/2017	9.0	79
	1/9/2018	9.5	82
	8/14/2018	9.2	84
	11/14/2018	9.4	82
	1/8/2019	9.7	83
	8/13/2019	9.2	83
	11/19/2019	8.7	77
	1/22/2020	9.4	81
	8/18/2020	9.4	85
	11/17/2020	8.7	78
	8/10/2021	9.5	86
	8/9/2022	9.3	83
	1/10/2023	9.7	84
	8/15/2023	9.3	84
	11/14/2023	9.6	83
	1/11/2024	9.9	85
	8/21/2024	9.0	82
	11/13/2024	8.6	78
Jimmycomelately 0.15	8/14/2017	9.7	92
	7/10/2018	9.9	93
	8/13/2018	9.6	92
	9/11/2018	9.6	90
	9/10/2019	9.6	93

	8/12/2020	9.7	92
	9/28/2020	9.7	87
	10/12/2020	9.6	85
	7/12/2021	9.6	91
	8/9/2021	9.5	91
	9/13/2021	9.7	90
	7/12/2022	9.9	94
	8/8/2022	9.4	92
	9/12/2022	8.4	81
	10/10/2022	7.6	69
	7/10/2023	9.9	93
	8/14/2023	9.0	90
	9/11/2023	9.2	87
	10/9/2023	8.3	77
	8/21/2024	9.6	92
Lotzgesell 0.1	10/18/2016	7.9	71
	11/14/2016	7.9	71
	12/13/2016	9.9	78
	6/13/2017	9.7	90
	7/18/2017	9.4	89
	8/14/2017	9.3	88
	9/19/2017	9.6	89
	10/10/2017	9.9	89
	11/13/2017	8.0	70
	12/12/2017	9.5	77
	1/8/2018	8.6	73
	5/15/2018	9.8	91
	7/10/2018	9.5	90
	8/13/2018	9.4	89
	9/11/2018	9.3	87
	10/9/2018	8.9	82
	11/13/2018	9.8	82
	12/11/2018	9.2	78
	1/7/2019	9.9	82
	6/11/2019	9.5	89
	7/9/2019	9.2	86
	8/12/2019	9.2	87
	9/10/2019	9.2	87
	10/8/2019	9.5	86
	11/12/2019	8.1	71
	12/10/2019	8.8	74
	1/21/2020	9.6	81
	6/15/2020	9.4	88
	7/14/2020	9.3	88
	8/12/2020	9.3	87
	9/28/2020	9.2	85
	10/12/2020	9.1	83
	11/16/2020	9.0	76
	12/7/2020	9.9	85
	6/14/2021	9.7	90
	7/12/2021	9.5	91
	8/9/2021	9.3	48
	9/13/2021	9.5	88
	11/8/2021	9.9	85
	12/13/2021	9.6	81
	6/13/2022	9.8	91

	7/12/2022	9.2	87
	8/8/2022	9.3	88
	9/12/2022	9.3	88
	10/10/2022	9.8	89
	11/14/2022	8.8	74
	12/5/2022	9.8	80
	1/9/2023	9.6	83
	5/15/2023	9.6	93
	6/12/2023	9.6	90
	7/10/2023	9.6	89
	8/14/2023	9.1	87
	9/11/2023	9.3	88
	10/9/2023	9.2	85
	11/13/2023	9.4	83
	12/11/2023	6.5	78
	1/9/2024	8.8	75
	2/22/2024	9.9	86
	4/2/2024	9.6	86
	5/14/2024	9.9	90
	6/11/2024	9.7	90
	7/9/2024	9.2	89
	8/13/2024	9.3	89
	9/17/2024	9.5	88
	10/8/2024	9.6	88
	11/12/2024	9.7	82
Matriotti 0.3	10/18/2016	8.5	77
	11/14/2016	8.4	76
	6/13/2017	9.8	92
	7/18/2017	9.5	92
	8/14/2017	9.5	90
	9/19/2017	9.7	88
	11/13/2017	8.3	72
	5/15/2018	9.4	87
	7/10/2018	9.4	88
	8/13/2018	9.5	92
	9/11/2018	9.2	86
	10/9/2018	9.0	81
	12/11/2018	9.9	82
	5/14/2019	9.9	89
	6/11/2019	9.7	89
	7/9/2019	9.2	86
	8/12/2019	9.0	86
	9/10/2019	8.8	84
	10/8/2019	9.2	82
	11/12/2019	8.2	71
	12/10/2019	9.4	79
	4/12/2020	9.8	86
	5/12/2020	9.3	90
	6/15/2020	9.6	89
	7/14/2020	9.3	88
	8/12/2020	9.3	88
	9/28/2020	9.1	83
	10/12/2020	9.7	80
	11/16/2020	9.2	78
	12/7/2020	9.8	83
	1/11/2021	9.6	82

	6/14/2021	9.9	90
	7/12/2021	9.4	88
	8/9/2021	9.0	46
	9/13/2021	9.2	83
	11/8/2021	9.9	83
	6/13/2022	9.8	89
	7/12/2022	9.2	87
	8/8/2022	9.2	88
	9/12/2022	9.1	87
	10/10/2022	9.8	87
	11/14/2022	9.4	77
	4/10/2023	9.9	86
	5/15/2023	9.2	86
	6/12/2023	9.3	86
	7/10/2023	9.4	87
	8/14/2023	8.7	85
	9/11/2023	9.3	87
	10/9/2023	9.1	84
	11/13/2023	9.4	81
	12/11/2023	9.1	78
	1/9/2024	9.2	77
	4/2/2024	9.4	83
	5/14/2024	9.9	88
	6/11/2024	5.7	52
	7/9/2024	4.5	44
	8/13/2024	9.3	88
	9/17/2024	9.5	87
	10/8/2024	9.6	89
	11/12/2024	9.9	86
Meadowbrook 0.1/0.2	10/18/2016	6.3	55
	12/13/2016	8.0	60
	2/14/2017	9.5	73
	3/14/2017	8.3	73
	4/17/2017	8.4	79
	5/9/2017	8.2	77
	6/13/2017	8.2	82
	7/18/2017	7.2	76
	10/10/2017	7.9	70
	9/11/2018	6.7	64
	9/10/2019	8.2	83
	10/8/2019	8.7	80
	2/11/2020	8.1	67
	4/12/2020	8.8	81
	8/12/2020	8.3	84
	4/19/2021	9.1	89
	5/10/2021	9.4	93
	8/9/2021	7.8	83
Meadowbrook Slough 0.23	2/14/2017	6.8	55
	3/14/2017	6.9	56
	4/17/2017	7.2	60
	5/9/2017	7.2	61
	6/13/2017	6.5	57
	9/19/2017	6.0	57
	10/10/2017	5.9	55
	2/13/2018	9.8	78
	3/13/2018	9.0	73

	5/15/2018	9.5	82
	6/12/2018	8.1	72
	7/10/2018	7.9	73
	8/13/2018	7.1	69
	9/11/2018	6.7	64
	10/9/2018	6.6	62
	4/15/2019	9.0	78
	5/14/2019	8.3	72
	6/11/2019	8.4	78
	7/9/2019	8.7	81
	8/12/2019	8.4	83
	9/10/2019	6.9	68
	10/8/2019	7.5	70
	11/12/2019	6.6	59
	2/11/2020	9.0	74
	3/10/2020	9.9	80
	4/12/2020	9.2	77
	5/12/2020	8.6	77
	6/15/2020	8.3	74
	7/14/2020	7.7	71
No Name 0.03	8/15/2017	9.2	91
	8/18/2020	8.9	91
	8/9/2022	8.9	92
	8/21/2024	7.2	73
	11/13/2024	9.7	87
Sequim Bay State Park Creek 0.0/0.1	7/10/2018	8.5	79
	8/13/2018	7.3	70
	6/11/2019	9.7	90
	7/9/2019	9.4	88
	8/12/2019	8.1	80
	9/10/2019	3.2	32
	7/14/2020	9.4	86
	8/12/2020	8.4	80
	9/28/2020	9.4	85
	7/12/2021	5.4	51
	8/9/2021	7.9	76
	7/12/2022	9.5	90
	5/15/2023	9.9	93
	6/12/2023	9.8	91

Table 31. Dissolved oxygen excursions in marine waters (WY2016-2024): below 7.0 mg/L.

Station name	Date	DO (mg/L)
Cassalery 0.0/0.6	5/15/2023	6.9
Cooper 0.1	11/23/2015	4.5
	10/10/2017	6.3
	11/13/2017	6.2
	5/15/2018	6.0
	7/10/2018	6.7
	8/13/2018	6.5
	9/11/2018	6.1
	10/9/2018	5.7
	11/13/2018	6.5
	5/14/2019	6.2
	7/9/2019	6.7

	8/12/2019	6.6
	9/10/2019	6.2
	10/8/2019	6.9
	11/12/2019	4.2
	5/12/2020	4.8
	10/12/2020	3.0
	12/7/2020	6.5
	6/14/2021	5.7
	7/12/2021	6.3
	8/9/2021	5.9
	9/13/2021	4.7
	10/11/2021	4.5
	8/8/2022	5.8
	9/12/2022	5.8
	10/10/2022	6.9
	5/15/2023	6.5
	6/12/2023	6.9
	7/10/2023	6.3
	8/14/2023	5.6
	9/11/2023	6.1
	10/9/2023	5.8
	8/21/2024	6.2
Meadowbrook 0.1/0.2	11/23/2015	6.4
	2/17/2016	6.2
	8/14/2017	6.6
	11/13/2017	6.8
	1/8/2018	6.6
	6/12/2018	6.7
	11/13/2018	6.2
	12/11/2018	6.3
	11/12/2019	5.2
	12/10/2019	6.3
	10/12/2020	5.1
	11/8/2021	6.7
	8/8/2022	6.1
	11/14/2022	6.5
	12/5/2022	6.2
	10/9/2023	5.7
	11/13/2023	5.7
	2/22/2024	6.7
	8/13/2024	6.3
	10/8/2024	4.9
	11/12/2024	4.8
	12/10/2024	5.1
Meadowbrook Slough 0.23	10/18/2016	1.1
	11/14/2016	2.9
	12/13/2016	5.2
	1/9/2017	6.0
	7/18/2017	5.9
	8/14/2017	2.7
	11/13/2017	5.8
	12/12/2017	5.5
	1/8/2018	5.9
	11/13/2018	5.5
	12/11/2018	5.8
	1/7/2019	6.2

	12/10/2019	6.1
Sequim Bay State Park Creek 0.0/0.1	7/18/2017	1.1
	8/14/2017	1.5
	9/19/2017	3.2
	9/11/2018	2.7

Values highlighted in yellow fall below Excellent Quality criteria, orange below Good Quality, and red below Fair Quality.

Appendix B – Temperature Excursions (2015-2024)

Table 32. Temperature excursions in fresh waters (WY2016-2024): above 16°C.

Station name	Date	Temp (°C)
Agnew Creek-Ditch 0.3	8/16/2016	17.3
	8/10/2021	16.9
	8/15/2023	18.0
	7/9/2024	18.5
Cooper 0.1	5/12/2015	17.1
	6/11/2015	16.8
	7/7/2015	16.6
	8/13/2015	18.8
	7/19/2016	17.4
	8/15/2016	18.3
	6/13/2017	16.4
	7/18/2017	18.4
Dungeness 0.7	8/13/2015	17.6
	8/14/2023	16.7
Gierin 1.8	8/15/2023	16.5
Lotzgesell 0.1	5/12/2015	18.5
	6/11/2015	17.8
	8/13/2015	20.1
Matriotti 0.3	5/12/2015	16.4
	6/11/2015	16.9
	8/13/2015	19.4
McDonald 1.6	8/15/2023	17.2
	7/9/2024	16.1
Meadowbrook 0.1/0.2	7/7/2015	16.2
	8/13/2015	19.7
	7/19/2016	17.2
	8/15/2016	17.4
	7/18/2017	18.0
	8/12/2019	17.9
	8/12/2020	16.2
	8/9/2021	18.1
No Name 0.03	8/14/2018	17.0
	8/18/2020	16.5
	8/9/2022	17.0
	8/21/2024	16.5
Siebert 1.0	8/15/2023	16.6

Table 33. Temperature excursions in fresh waters (WY2016-2024): above 13°C.

Station name	Date	Temp (°C)
Bell 0.2	9/12/2022	14.6
	5/15/2023	13.3
	9/11/2023	13.3
Cooper 0.1	5/12/2015	17.1
	6/11/2015	16.8
	5/17/2016	15.0
	5/9/2017	13.6
	6/13/2017	16.4

Dungeness 0.7	6/11/2015	13.7
	9/10/2015	13.3
	9/10/2019	14.6
	9/13/2021	13.1
	9/12/2022	13.9
	9/11/2023	14.7
Jimmycomelately 0.15	9/10/2019	13.6
	9/12/2022	13.3
Matriotti 0.3	5/12/2015	16.4
	6/11/2015	16.9
	9/10/2015	13.3
	9/12/2022	13.2

Table 34. Temperature excursions in marine waters (WY2016-2024): above 13°C.

Station name	Date	Temp (°C)
Cassalery 0.0/0.6	5/15/2023	17.4
	7/9/2024	16.0
Cooper 0.1	8/14/2017	16.8
	7/10/2018	17.2
	8/13/2018	16.4
	6/11/2019	18.1
	7/9/2019	16.7
	8/12/2019	17.7
	7/14/2020	16.4
	8/12/2020	16.3
	7/12/2021	18.7
	7/12/2022	18.6
	8/8/2022	18.2
	5/15/2023	18.6
	6/12/2023	17.5
	8/14/2023	18.4
Johnson 0.0	8/14/2023	16.0
Meadowbrook 0.1/0.2	8/14/2017	15.0
	8/13/2018	17.0
	7/10/2018	17.7
	6/11/2019	17.7
	7/9/2019	16.0
	7/14/2020	16.8
	7/12/2021	17.7
	7/12/2022	17.9
	8/8/2022	19.0
	5/15/2023	18.8
	6/12/2023	17.4
	8/14/2023	19.9
	6/11/2024	16.0
	7/9/2024	20.0
Meadowbrook Slough 0.23	7/7/2015	14.7
Sequim Bay SP Creek 0.0/0.1	7/18/2017	13.7
	8/14/2017	13.9