Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan Trends Monitoring Program 2018 Annual Report

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Sequim-Dungeness Clean Water District
Pollution Identification & Correction Plan
Trends Monitoring Program
2018 Annual Report

Introduction

In 2001 Clallam County established a shellfish protection district named the Sequim-Dungeness Clean Water District (District, or CWD) by adopting Chapter 27.16 of Clallam County Code (CCC). The boundaries of the District include "The Dungeness Watershed and those waters influenced by it through the irrigation system, and other independent tributaries to the Strait of Juan de Fuca, from Bagley Creek east to and including the Sequim Bay Watershed." (The boundaries of the District generally coincide with the boundaries of Clallam County's Marine Recovery Area, or MRA, where the County is also required to implement an enhanced Onsite Sewage Management Plan under RCW 70.118A).

State law (RCW 90.72) directs formation of shellfish protection districts where nonpoint pollution threatens water quality "…upon which the continuation or restoration of shellfish farming or harvesting is dependent." By 1997 water quality monitoring had begun to show increasing bacterial pollution in and around Dungeness Bay. In 2000, 2001, and 2003, the Washington State Department of Health downgraded portions of the Dungeness Bay shellfish growing area due to bacterial pollution understood to stem from nonpoint sources within the watershed.

In May 2015, Clallam County Environmental Health, with the assistance of staff and volunteers from Streamkeepers of Clallam County, initiated a Baseline Trends Monitoring Program to track surface water quality in the Sequim-Dungeness Clean Water District. This effort was called for by the Pollution Identification & Correction Plan for the Sequim Bay-Dungeness Watershed Clean Water District (PIC Plan). Created by PIC Project Partners for the District in 2014, the PIC Plan is one element of the shellfish downgrade response plan for the Sequim-Dungeness Clean Water District. The Baseline Trends Monitoring study area includes major freshwater drainages within the District.

This is the fourth annual PIC Trends Monitoring Report, covering calendar year 2018. Previous reports cover periods lasting from April of one year through March of the following year, primarily due to past grant timelines. PIC Project Partners have requested that Trends Monitoring Reports transition to a calendar year for more convenient consumption. As such, this report overlaps the previous report by three months (January, February, and March of 2018).

The information gathered through PIC Trends Monitoring, and presented in annual reports, helps guide Pollution Identification and Correction activities within the Clean Water District.

Water quality in Dungeness Bay appears to be improving with shellfish growing area upgrades in 2011, 2015, and 2016. As a corollary, minor shellfish growing area upgrades in Sequim Bay may soon lead to increased public access to recreational shellfish harvest.

Sampling Approach and Results

The objective of the Baseline Trends Monitoring Program is to consistently monitor long-term water quality in order to evaluate trends at or near the mouths of waterways throughout the Clean Water District. This information helps prioritize waterways for further targeted investigation and eventual pollution cleanup as described in the PIC Plan. Further, trends monitoring builds upon at least two decades of prior water quality studies. As in past investigations, we focused on water quality parameters associated with human sewage and animal waste such as fecal coliforms and nutrients.

Sampling locations were chosen as close to the discharge points of the streams as practical given ownership, access, and tidal conditions. Twelve streams were designated Tier 1 sites and nine streams were designated Tier 2 sites. Tier 1 sites were sampled monthly for both fecal coliforms (fecals or FC) and nutrients (nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, phosphate-phosphorous, silicate-silica, total nitrogen, and total phosphate). Tier 2 sites were sampled quarterly (January, April, August, November) for fecal coliforms only.

In addition to bacteria and nutrients sampling, temperature, and salinity data were recorded at all sample sites. Table 1 describes sites and sampling conducted while Figures 1-3 show sample site locations.

Barometric pressure, dissolved oxygen, pH, specific conductance, and turbidity data are readily recorded alongside standard in-situ measurements with a multi-meter probe. Stream stage is recorded where appropriate reference points exist and meters present on the Dungeness River and McDonald Creek provide readily-accessible discharge data. All of these data are available from the Clallam County Water Resources Database, though they are not presented here. Data collection not specifically called for in the Pollution Identification and Correction Quality Assurance Project Plan (QAPP) is performed following the Streamkeepers Program QAPP.

Table 1. Site locations and type of sampling performed from January 2018 through December 2018. Tier 1 sites were sampled monthly for fecal coliforms (F) and nutrients (N). Tier 2 sites were sampled quarterly for fecal coliforms only. Temperature and salinity data were collected at all sites on every visit. Dung. Bay/R. = Dungeness Bay/River. Seq. Bay = Sequim Bay. SJF = Strait of Juan de Fuca.

	Stream/Site Name	Receiving Waters	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Tier 1 Streams	Dungeness 0.7	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Meadowbrook 0.2	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Meadowbrook Slough 0.23	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Golden Sands Slough 0.0	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Cooper 0.1	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Cassalery 0.0/0.6 (Tide Dependent)	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Matriotti 0.3a	Dung. R.	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Lotzgesell 0.1	Dung. R.	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Sequim Bay State Park Creek 0.0/0.1 (Tide Dependent)	Seq. Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Bell 0.2	Seq. Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Johnson 0.0	Seq. Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
	Jimmycomelately 0.15	Seq. Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
Tier 2 Streams	Bagley 0.7a	SJF	F			F				F			F	
	Siebert 1.0	SJF	F			F				F			F	
	Agnew Creek/Ditch 0.3	SJF	F			F				F			F	
	McDonald 01.6	SJF	F			F				F			F	
	Hurd 0.2	Dung. R.	F			F				F			F	
	Gierin 1.8	Dung.Bay	F			F				F			F	
	Dean 0.17	Seq. Bay	*			F				*			*	
	No Name 0.03	Seq. Bay	F			F				F			F	
	Chicken Coop 0.24	Seq. Bay	F			F				F			F	

* No safe access at Dean Creek during January, August, or November quarterly monitoring tours (bridge failure).

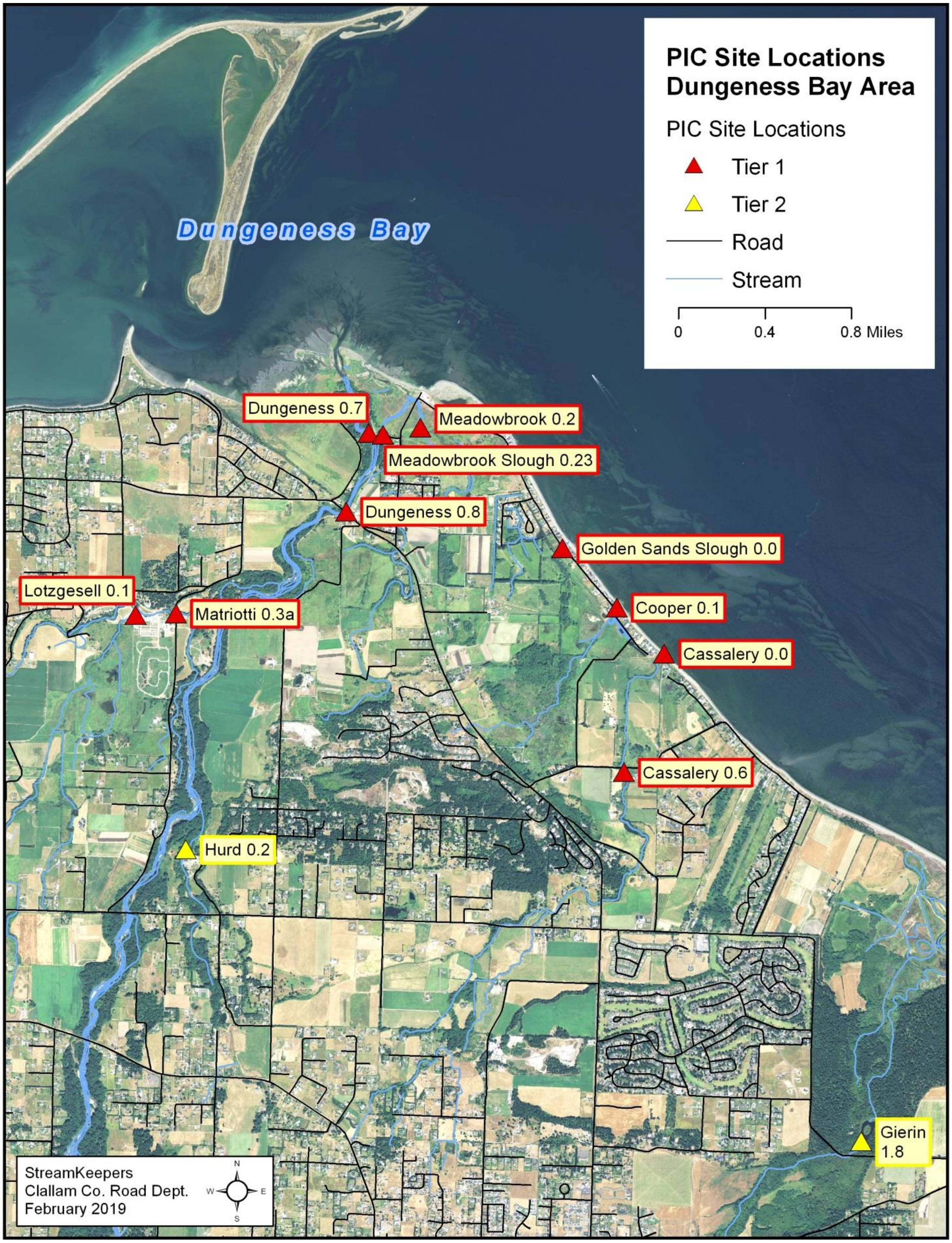

Figure 1. PIC Baseline Trends Monitoring sample sites, Dungeness Bay area. Dept. of Ecology real-time flow meter located at Dungeness 0.8.

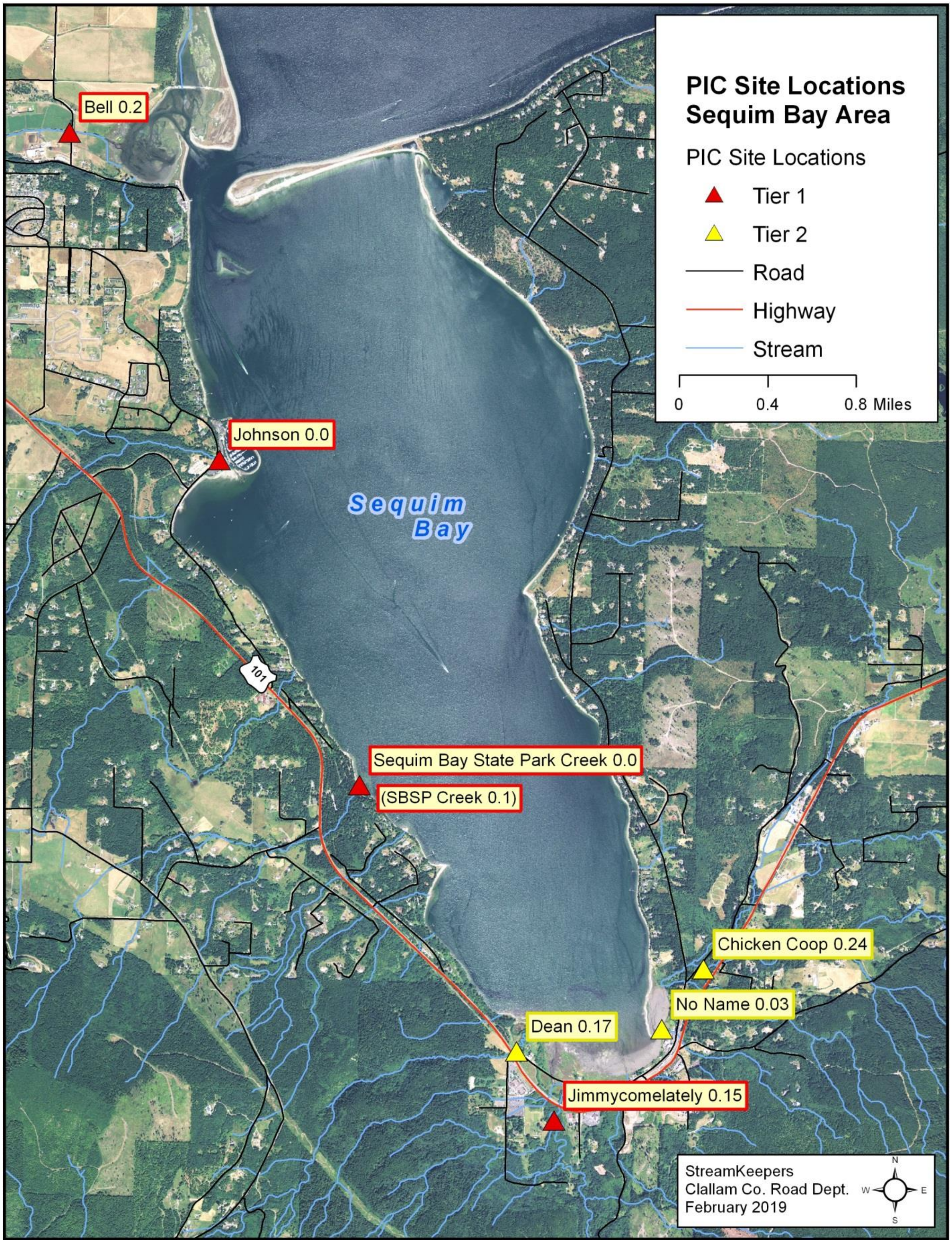

Figure 2. PIC Baseline Trends Monitoring sample sites, Sequim Bay area.

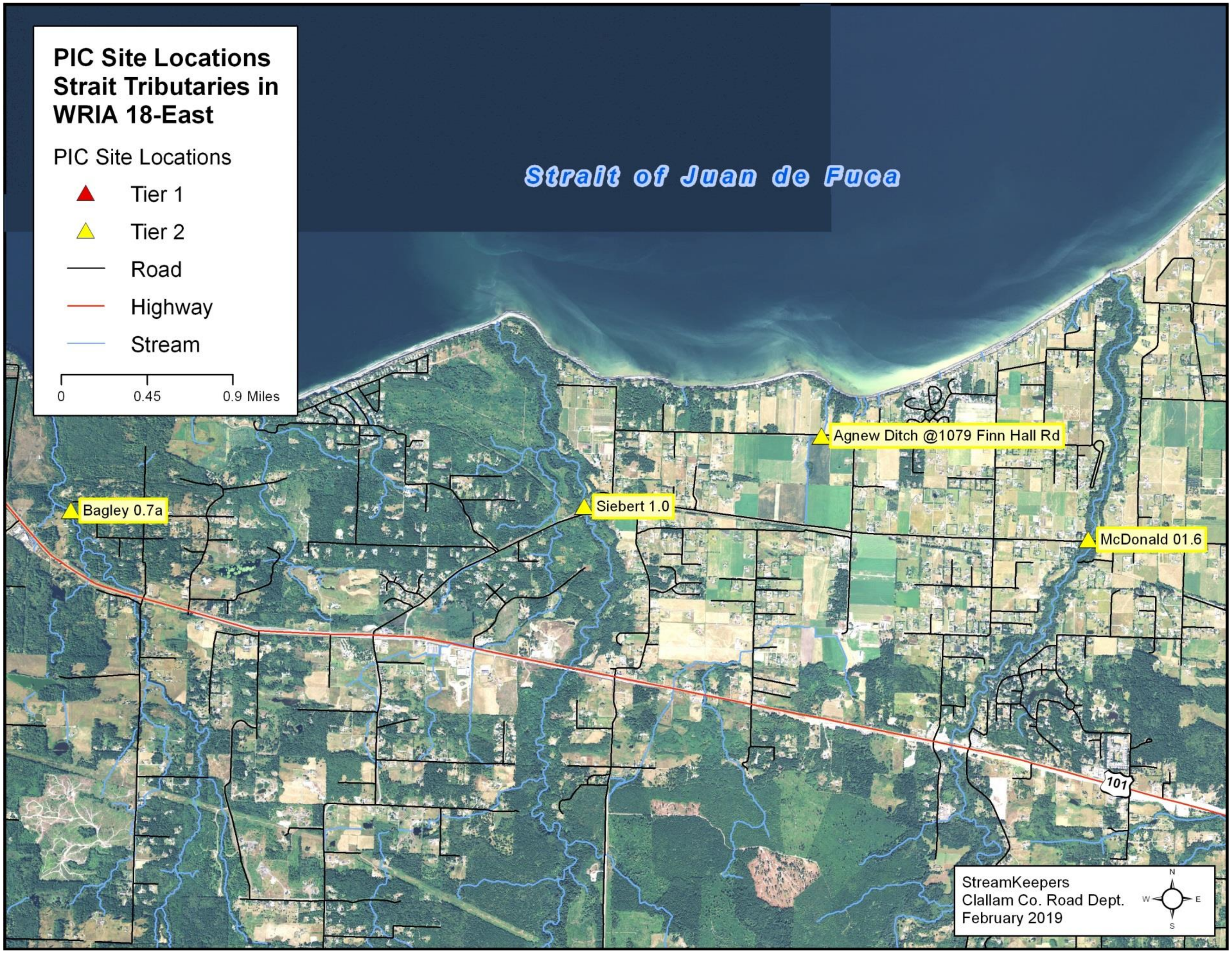

Figure 3. PIC Baseline Trends Monitoring sample sites, waters west of Dungeness Bay.

Data Caveats

- Nutrients samples were analyzed by the University of Washington Marine Chemistry Lab (UW). Data quality assessment is performed on all sample results. Any samples that do not meet quality assurance or quality control measures are flagged in the Clallam County Water Resources database. Flagged data is not used for 303(d) purposes under the Clean Water Act. Flagged data may be used for general descriptive purposes if deemed appropriate.
- Data qualifiers used are per Ecology's Environmental Information Management (EIM) system.
- No rejected (REJ) data were used in our analyses.
- Field replicates were averaged with primary samples.
- Field blanks were recorded and used for quality control (QC) analyses but were not used in this report to generate statistics or figures.
- Some of the sites are tidally influenced, as can be seen in the salinity data presented below. We tried sampling during low-tide conditions, but this was not always possible. Alternate sites were sampled at Cassalery Creek and Sequim Bay State Park when tides prohibited collection of freshwater observations at the primary sample sites.

Data Quality Analysis

Various data quality analyses helped PIC Project Partners decide where Measurement Quality Objectives (MQO) had been met.

Blanks Analysis—Fecal Coliforms

In general, one fecal coliform field blank (FB) is prepared each sampling tour. From January 2018 through December 2018, all fecal coliform field blanks were "non-detects." This would indicate proper handling of grab samples and no fecal coliform data were rejected or qualified due to blanks analysis.

In addition to field blanks, the Clallam County Water Laboratory prepares and analyzes a lab blank 1) before running samples, 2) after every ten samples, and 3) after running all samples. Lab blank results are not reported to the PIC Baseline Trends Monitoring Program. Rather, these blanks serve as an internal control for the laboratory. For the period of this report no fecal coliform data were rejected or qualified due to laboratory blanks. Clallam County Environmental Health Laboratory is accredited by Washington Department of Ecology and follows Membrane Filter Standardized Method SM9222D.

Blanks Analysis—Nutrients

At least one nutrient field blank is prepared for each PIC Basleline Trends Monitoring tour. Table 2 summarizes nutrient field blank results. UW Marine Chemistry Laboratory provides annual Minimum Detection Limits (MDL). Synthesized Reporting Limit (RL) is calculated as the larger of 3.18 * Annual MDL *or* FB mean + 1 Standard Deviation (SD), per Chadd et al. 2017. For 2018, reporting limit was determined in all cases using 3.18 * MDL as this value consistently exceeded FB mean + 1 SD.

Various field blanks contained high nutrient concentrations and prompted speculation around potential sources of contamination. This became most pronounced in January 2018 where all nutrient field blanks appeared problematic. The entire blank preparation protocol was reviewed and updated, field kits were stocked with new sample preparation bottles, and a fresh source of deionized water was supplied.

Further, the current iteration of the Pollution Identification and Correction QAPP is inadequate in addressing the problematic nutrient field blanks and associated environmental data. As such, Tukey's method for identifying outliers was used to flag nutrient blanks for exclusion when calculating mean and standard deviation of the field blanks dataset (statistics needed to generate the synthesized reporting limit). Environmental data corresponding to these outlier blanks have been qualified as "J-variants" (laboratory data estimates) following lengthy discussions between PIC partners and Washington Department of Ecology Environmental Assessment Program. Factors considered include 1) sample sites with expected low nutrient concentrations produced nutrient levels below field blank values, 2) sample sites with expected high nutrient concentrations produced nutrient levels above field blank values, 3) potential negative consequences of including nutrient data estimates in analyses are minimal, and 4) nutrients data are already assumed not suitable for inclusion in Washington State's EIM database. Various proposed edits have been compiled in order to guide future QAPP updates.

Beyond field blanks, UW Marine Chemistry Laboratory internal QA/QC involves nutrient lab blank preparation and analysis. These analyses are not presented here, as the lab only reports data that have passed internal controls. To date, laboratory nutrient blanks have never prompted data qualification or corrective action.

Table 2. Nutrients field blank (FB) results, Tukey fence calculations, outlier analysis, and synthetic reporting limit (RL) calculations. All values in [µg/L]. Field blank outliers were excluded from mean, standard deviation (SD), and RL calculations.

Arrival date	**[PO_4-P]**	**[SiO_4-Si]**	**[NO_3-N]**	**[NO_2-N]**	**[NH_4-N]**	**TP**	**TN**
8-Jan-18	~~48.9~~ [1]	~~3875.8~~ [1]	~~236.8~~ [1]	~~3.4~~ [1]	~~45.4~~ [1]	~~57.1~~ [1]	~~480.8~~ [1]
13-Feb-18	~~33.8~~ [1]	~~40.1~~ [1]	0.0	0.0	3.6	~~34.4~~ [1]	10.8
13-Mar-18	1.3	8.3	2.9	0.0	~~18.5~~ [1]	1.9	45.0
16-Apr-18	1.5	2.6	~~10.1~~ [1]	0.0	~~11.7~~ [1]	1.2	61.4
15-May-18	0.3	8.5	0.0	0.0	2.0	2.2	68.1
12-Jun-18	0.5	~~25.3~~ [1]	0.3	0.0	0.0	1.1	19.1
10-Jul-18	0.0	8.8	0.3	0.0	1.0	0.8	10.3
13-Aug-18	0.1	11.6	0.4	0.1	6.9	2.0	43.9
11-Sep-18	0.3	10.8	0.2	0.1	0.5	1.0	45.2
9-Oct-18	0.6	10.6	0.6	0.0	0.8	0.3	13.7
13-Nov-18	0.0	9.6	1.5	0.0	0.0	1.1	11.3
11-Dec-18	0.6	6.2	0.1	0.0	0.9	4.9	15.2

[1] *Field blanks with values above Tukey's upper fence and below Tukey's lower fence were classified as outliers and excluded from subsequent mean and SD calculations.*

Median	0.5	10.1	0.35	0.02	1.5	1.5	31.5
1st quartile	0.3	8.4	0.18	0.00	0.8	1.0	13.1
3rd quartile	1.3	15.0	1.89	0.06	8.1	2.9	49.3
IQR [2]	1.1	6.6	1.71	0.06	7.4	1.9	36.2
Upper Fence [3]	2.9	24.9	4.5	0.15	19.2	5.7	103.5
Lower Fence [4]	-1.3	-1.5	-2.4	-0.1	-10.3	-1.8	-41.2

[2] *Inter-Quartile Range*
[3] *Tukey's upper fence, defined as 3rd quartile + k(IQR) where k = 1.5 (a standard formula).*
[4] *Tukey's lower fence, defined as 1st quartile – k(IQR) where k = 1.5 (a standard formula).*

Total Outliers	2	3	2	1	1	2	1
Percent Outliers	16.7%	25.0%	16.7%	8.3%	8.3%	16.7%	8.3%
Blanks Mean	0.5	8.6	0.6	0.03	4.18	1.65	31.3
Blanks SD	0.5	2.8	0.9	0.05	5.96	1.29	21.9
2018 MDL [5]	0.5	6.8	5.2	0.4	3.4	1.6	27.1
3.18 * MDL	1.6	21.6	16.5	1.3	10.8	5.1	86.2
Synthetic RL [6]	1.6	21.6	16.5	1.3	10.8	5.1	86.2
Total FB > RL	2	3	1	1	3	2	1
Percent FB > RL	16.7%	25.0%	8.3%	8.3%	25.0%	16.7%	8.3%

[5] *Minimum Detection Limit provided annually by UW Marine Chemistry Laboratory.*
[6] *Synthetic RL defined as maximum of 3.18 * MDL or Mean + SD per QAPP (Chadd et al. 2017).*

Field Replicate Analysis—Fecal Coliforms

Field replicates of fecal coliform grab samples are collected at the rate of one for every 5% of sites or at least one per sampling tour. Field replicates help assess precision and confidence in sampling procedures.

Primary samples and replicates from each sampling day are compared in terms of relative standard deviation (RSD). In general, Clallam County Water Laboratory analyzes the field replicate and a laboratory duplicate of the field replicate; the mean of these two values is reported as "replicate" in Table 3, below.

QAPP section 6.2 describes the desired level of agreement between qualifying pairs of primary FC samples and field replicates (after pairs with averages below 20 CFU/100mL have been excluded). Half of all pairs should have less than or equal to 20% RSD, ninety percent of qualifying pairs should have less than or equal to 50% RSD, and all qualifying pairs should have less than 85% RSD. Table 4, below, compares observed results against these criteria for the reporting period.

No fecal coliform data were qualified based on field replicate analyses, as replicate pairs met measurement quality objectives described in QAPP section 6.2 (Chadd et al. 2017).

Table 3. Fecal coliform field replicate results. Here each field replicate and a laboratory duplicate of the field replicate are averaged and reported as a single, composite value called "replicate."

Date	Type	FC CFU	Mean	%RSD
1/8/2018	primary	12	N/A—Excluded	
	replicate	2		
1/9/2018	primary	10	N/A—Excluded	
	replicate	7		
2/13/2018	primary	40	34.5	22.5%
	replicate	29		
3/13/2018	primary	18	N/A—Excluded	
	replicate	16		
4/16/2018	primary	196	205	6.2%
	replicate	214		
4/17/2018	primary	76	59	40.7%
	replicate	42		
5/15/2018	primary	38	30.5	34.8%
	replicate	23		
6/12/2018	primary	214	235.5	12.9%
	replicate	257		
7/10/2018	primary	44	46.5	7.6%
	replicate	49		
8/13/2018	primary	56	59.5	8.3%
	replicate	63		
8/14/2018	primary	36	50.5	40.6%
	replicate	65		
9/11/2018	primary	266	267	0.5%
	replicate	268		
10/9/2018	primary	1536	1424	11.1%
	replicate	1312		
11/13/2018	primary	8	N/A—Excluded	
	replicate	5		
11/14/2018	primary	10	N/A—Excluded	
	replicate	5		
12/11/2018	primary	16	N/A—Excluded	
	replicate	22		
				Total Pairs: 16 Excluded Pairs: 6 Qualifying Pairs: 10

Primary/replicate pairs with means less than 20 CFU are excluded from MQO analysis.

Table 4. Fecal coliform data Measurement Quality Objectives.

QC Tiers:	Pairs in Tier	% Pairs in Tier	% Pairs Required	MQO Met?
Pairs ≤ 20% RSD	6	60%	50%	YES
Pairs ≤ 50% RSD	10	100%	90%	YES
Pairs ≤ 85% RSD	10	100%	100%	YES

Field Replicate Analysis—Nutrients

Nutrient field replicates are also collected alongside 5% of all samples (or at least one replicate each tour). These replicates are again compared against their primary samples to calculate Relative Standard Deviation. Primary/replicate pairs with means less than five times the reporting limit are excluded from RSD calculation. QAPP Table 1 (Chadd et al. 2017) describes acceptable annual median RSD values, and sampling results are compared against the criteria below.

Nutrient sample replicate analysis generally showed a high degree of precision among primary/replicate pairs and no data were qualified as a result of this analysis.

Table 5. Nutrients field replicate results and QC analysis.

Analyte	Data Pairs	Median RSD	RSD Criterion	Data Qualified
Ammonia	1	0.91%	15%	none
Nitrate	12	0.50%	10%	none
Nitrite	4	0.60%	10%	none
Phosphate	12	0.37%	10%	none
Silicate	12	0.57%	10%	none
Total N	12	0.65%	10%	none
Total P	12	1.35%	10%	none

Field Replicate Analysis—Physical and Chemical Parameters

The PIC Baseline Trends Water Quality Monitoring Program calls for in situ measurements of water temperature and salinity at all sample sites.

Barometric pressure (BP), dissolved oxygen (DO), pH, specific conductance (SpC), and turbidity measurements are also collected (though not required), given the facility of data collection with multimeter probes. These data are collected in accordance with the Streamkeepers Program QAPP (Chadd 2017). The quality of these data are reported here, though results are not included in the below discussion. Again, all data are available from the Clallam County Water Resources Database.

Measurement quality objectives of physical and chemical data are described in terms of maximum allowable percent relative standard deviation and/or maximum allowable difference between primary samples and replicates. Where two criteria are provided, at least one must be met for data to pass unqualified and avoid corrective action. Table 6, below, summarizes comparison of environmental data against MQO criteria. Salinity and tempreature criteria stem from the PIC Project QAPP (Chadd et al. 2017) while all other criteria are inherited from the Streamkeepers Program QAPP (Chadd 2017).

Table 6. Physical/chemical water quality field replicate QC analysis.

Parameter	Units	Data Pairs	Max. RSD	RSD Criterion	Max. Difference	Difference Criterion	Data Qualified
BP	in Hg	17	-	N/A	0.01	0.05	none
DO	mg/L	17	-	1% per pair	0.1	0.2	none
pH	-	17	-	N/A	0.1	0.2	none
Salinity	ppt/PSU	17	-	5% per pair	0	0.02	none
SpC	µS/cm	17	0%	5% per pair	N/A	N/A	none
Temp.	deg. C	17	-	N/A	0	0.2	none
Turbidity	FNU	17	-	7% per pair	1	1	none

Laboratory Standards Checks—Nutrients

In addition to internal controls metioned previously, UW Marine Chemistry Laboratory uses check standards to assess bias stemming from analytical methods. Wherever standards are not met, analyses are repeated. Data reported by the lab have passed all internal QA/QC screening. To date no nutrient data have required qualification or corrective action following laboratory data quality analyses.

Compliance with Project QAPP and SOPs

In compliance with the project QAPP (Chadd et al. 2017), environmental data were collected following standard operating procedures (SOP).

Water samples for the purpose of fecal coliform testing were collected in sterile polypropylene (PP) bottes, stored in coolers with ice packs for less than 8 hours, and analyzed at Clallam County Water Laboratory.

Meanwhile, samples for nutrients testing were collected in either acid-washed PP or acid-washed high-density polyethylene (HDPE) bottles, chilled with ice packs in coolers, and shipped overnight to UW Marine Chemistry Laboratory in Seattle, WA.

In situ physical and chemical water quality measurements (temperature, dissolved oxygen concentration, pH, specific conductance, salinity, turbidity) were collected using a YSI ProDSS field meter which was calibrated prior to sampling episodes and checked afterward.

Where necessary, data have been flagged with appropriate qualifiers based on QA/QC measures.

In one notable instance, two FC grab samples collected on February 13, 2018 at sites Sequim Bay State Park 0.1 and Cassalery 0.6 contained small amounts of ice upon receipt by Clallam County Water Laboratory. Ice was observed in the streams at the time of sample collection, and samples were chilled in a cooler with ice packs during transport to the lab.

It is unlikely that freezing appreciably influenced sample results in this case. However, SOPs were updated to underscore the importance of using bubble wrap to separate grab samples from ice packs during storage, transport, and shipping in coolers.

Environmental Data Summary

PIC Baseline Trends Monitoring environmental data collected between January 1, 2018 and December 31, 2018 are presented in Appendix 1. These data are explored visually and descriptively, below. Rejected data have been excluded. Data not specifically called for in the project QAPP are not presented.

Fecal Coliforms

All PIC Baseline Trends Monitoring streams fecal coliform data for the reporting period are summarized below.

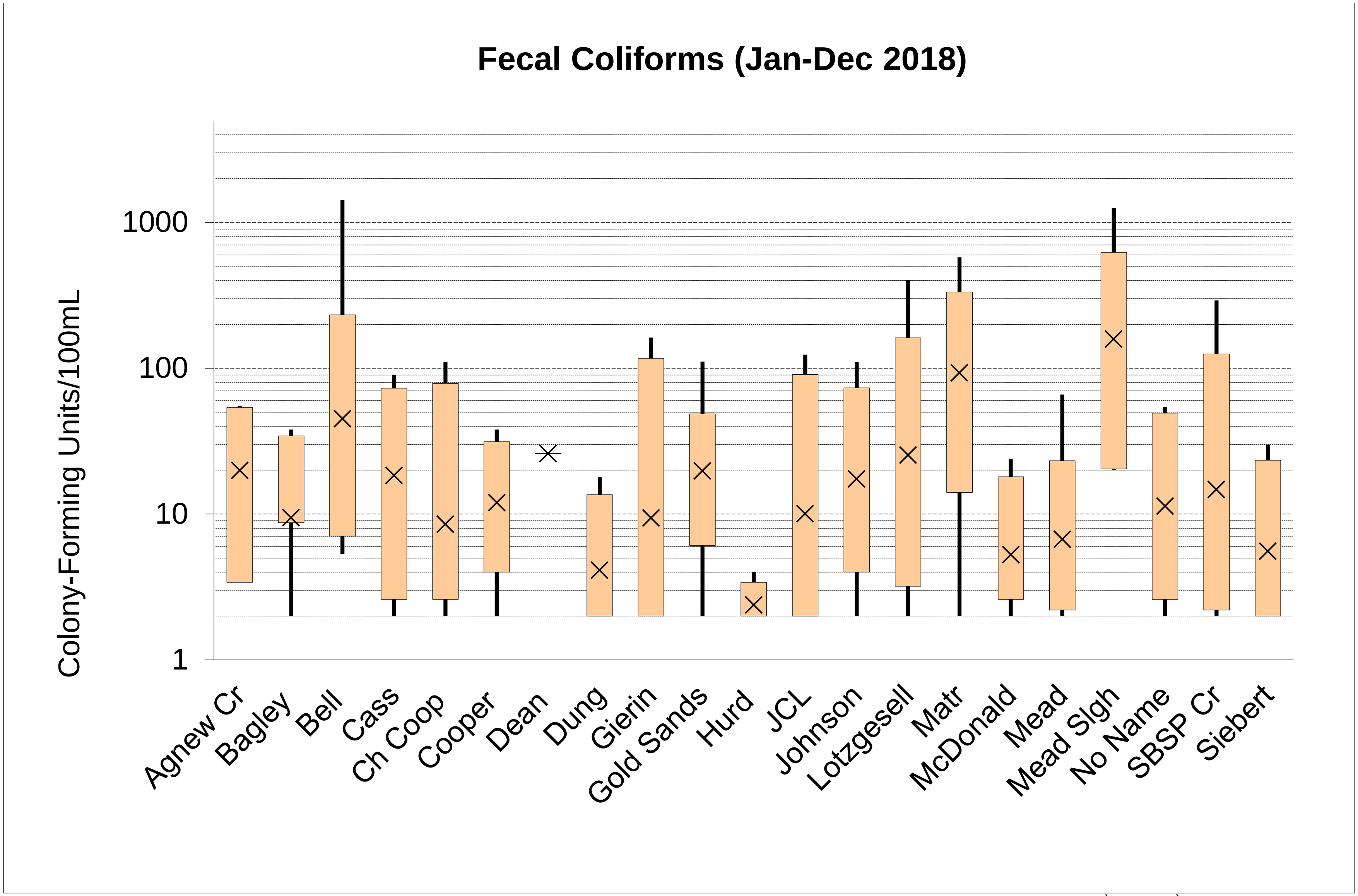

Figure 4. Fecal Coliforms, all CWD streams. Note log scale. X marks geometric mean; bottom and top of box represent observed 10th and 90th percentiles; ends of whiskers represent extremes.

Nutrients

Nutrients results are summarized below. Nutrients data are collected monthly at Clean Water District Tier 1 streams only.

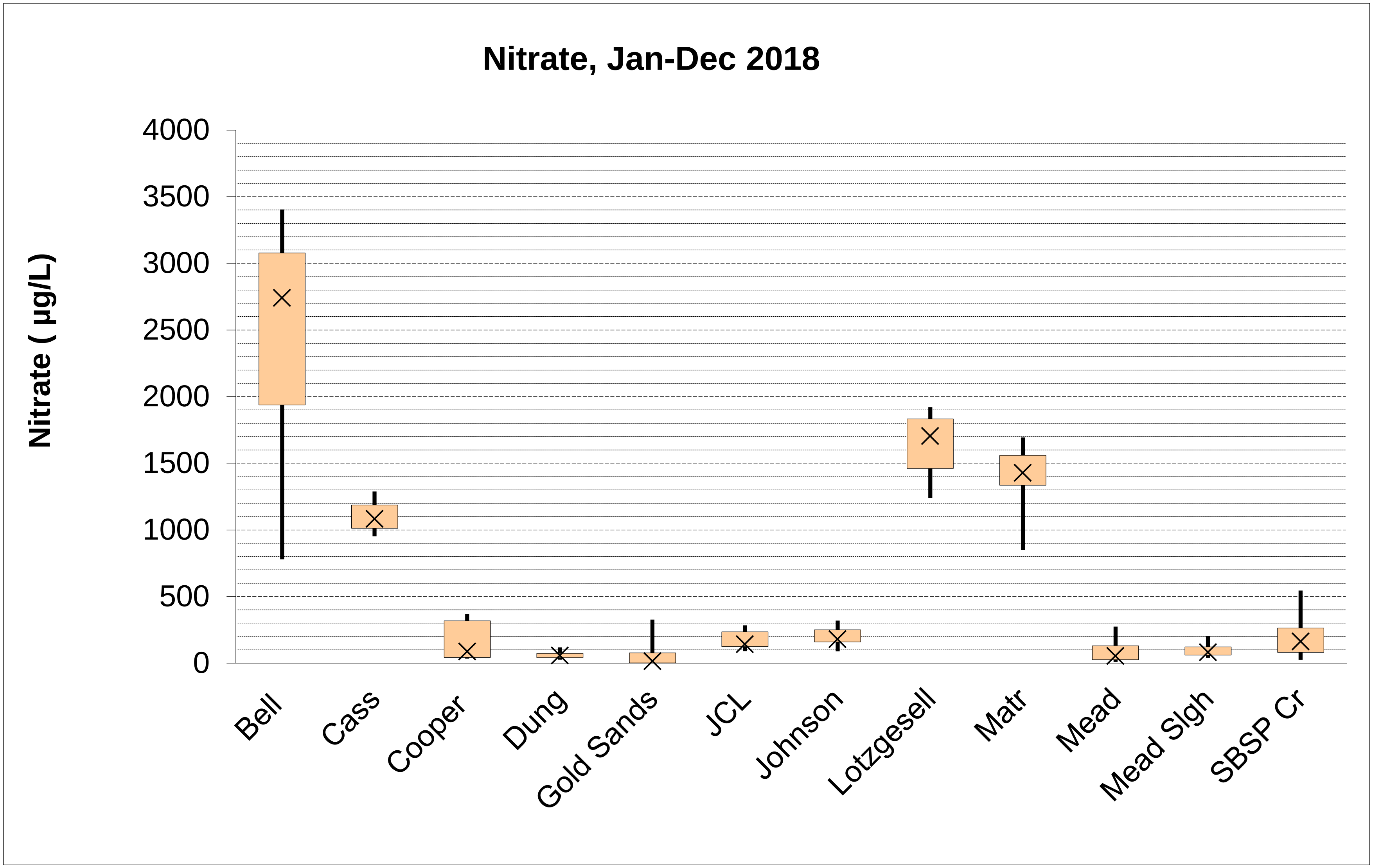

Figure 5. Nitrate as N. Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

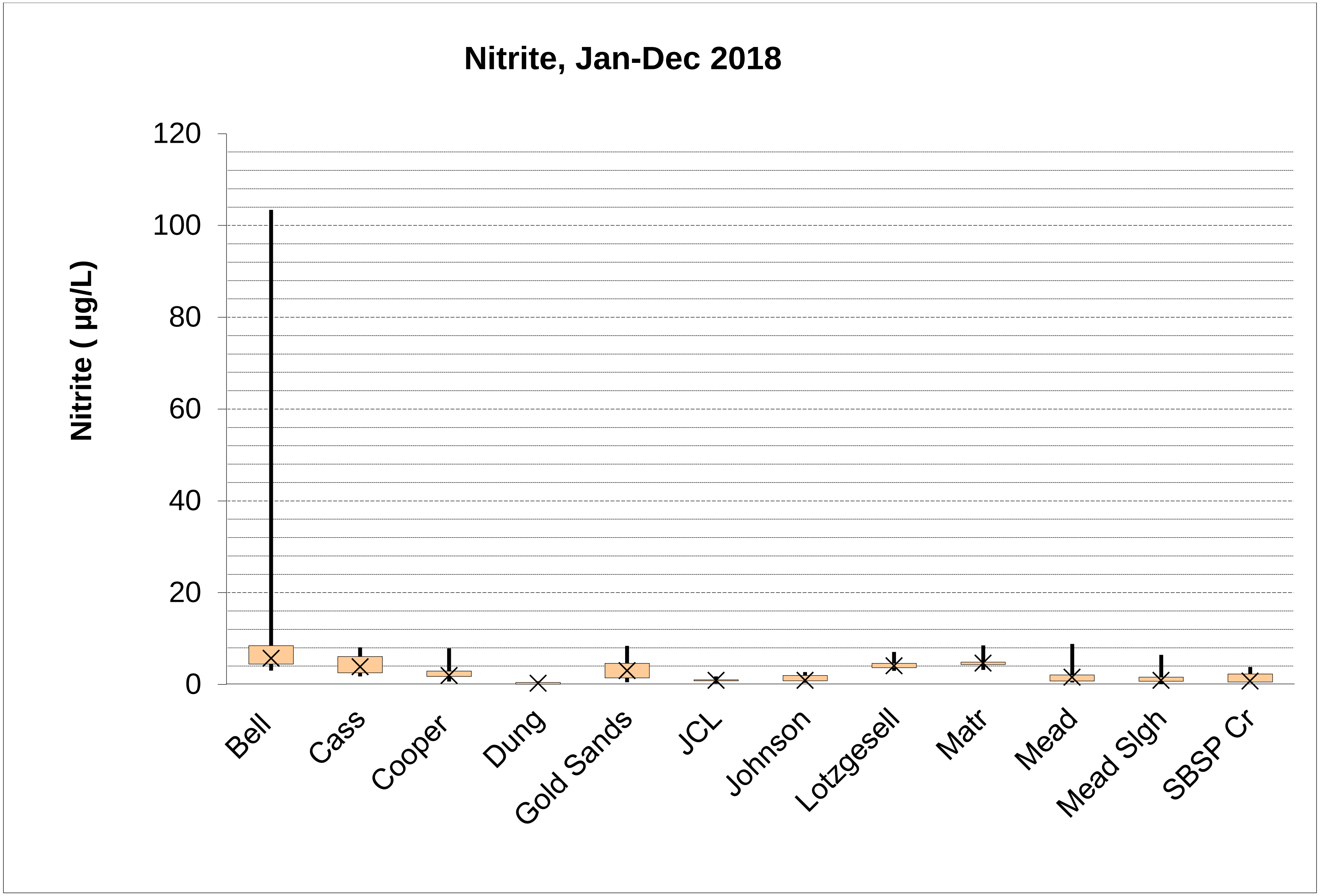

Figure 6. Nitrite as N. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

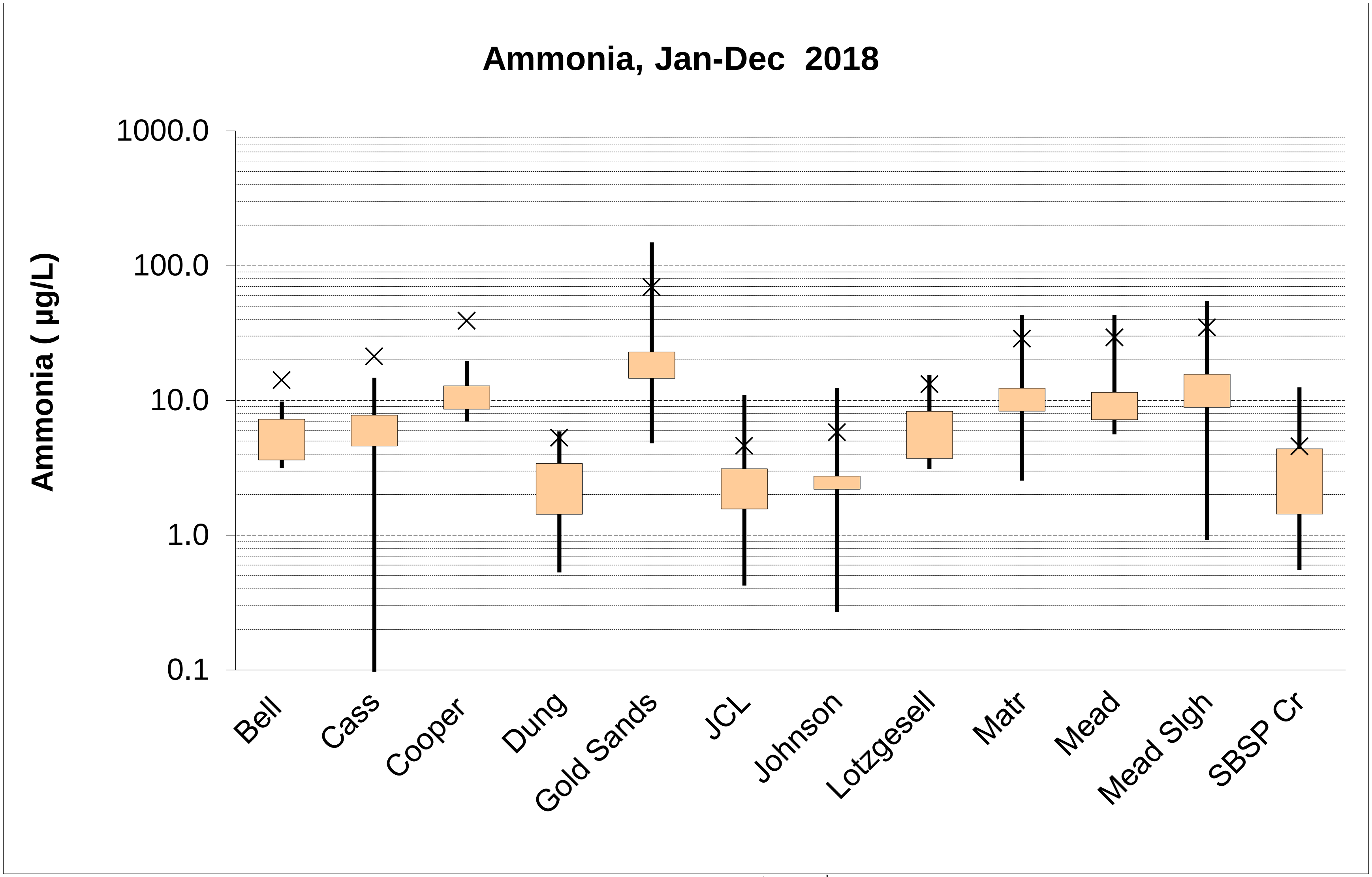

Figure 7. Ammonia. Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

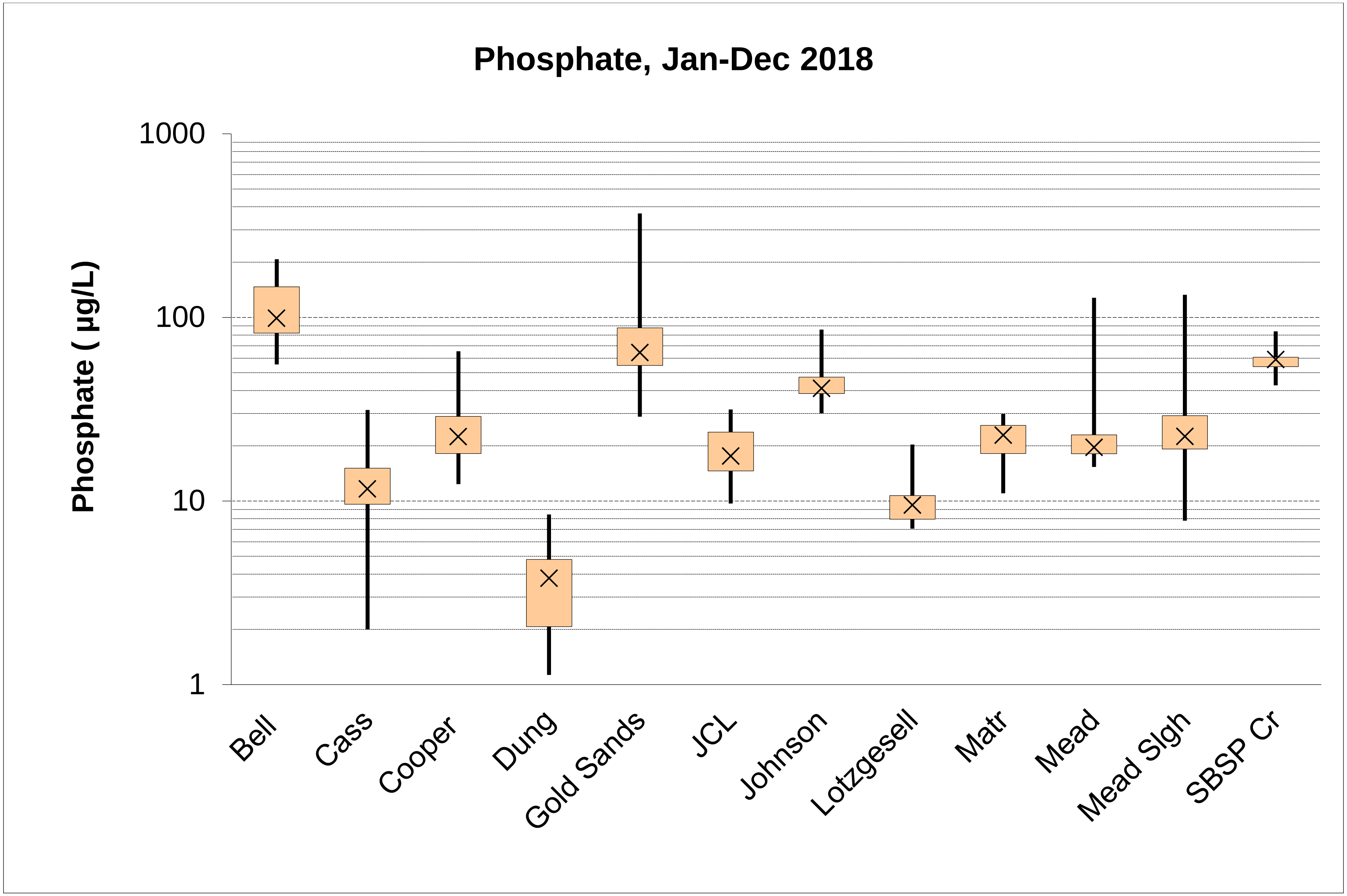

Figure 8. Phosphate as P. Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

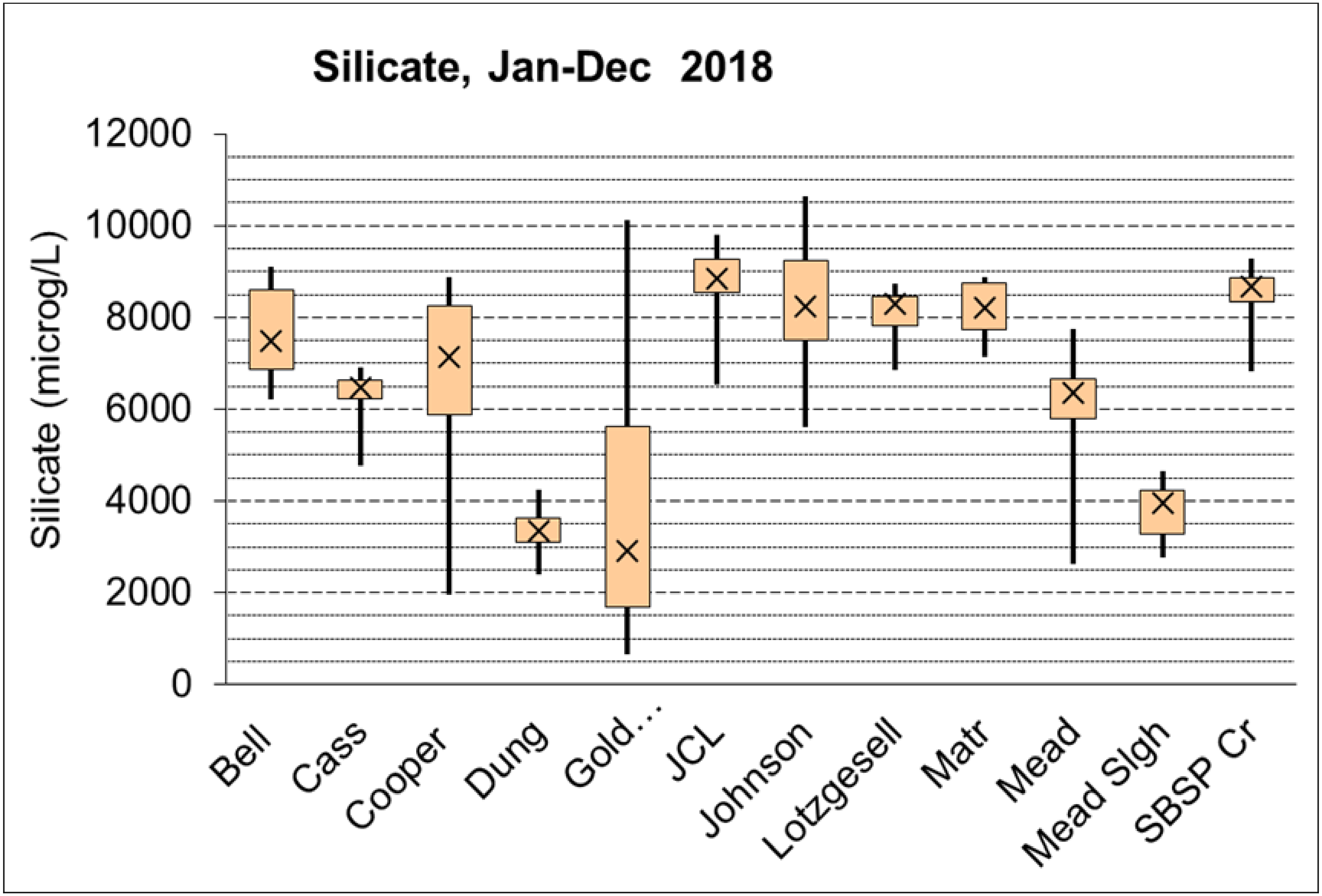

Figure 9. Silicate as Si. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

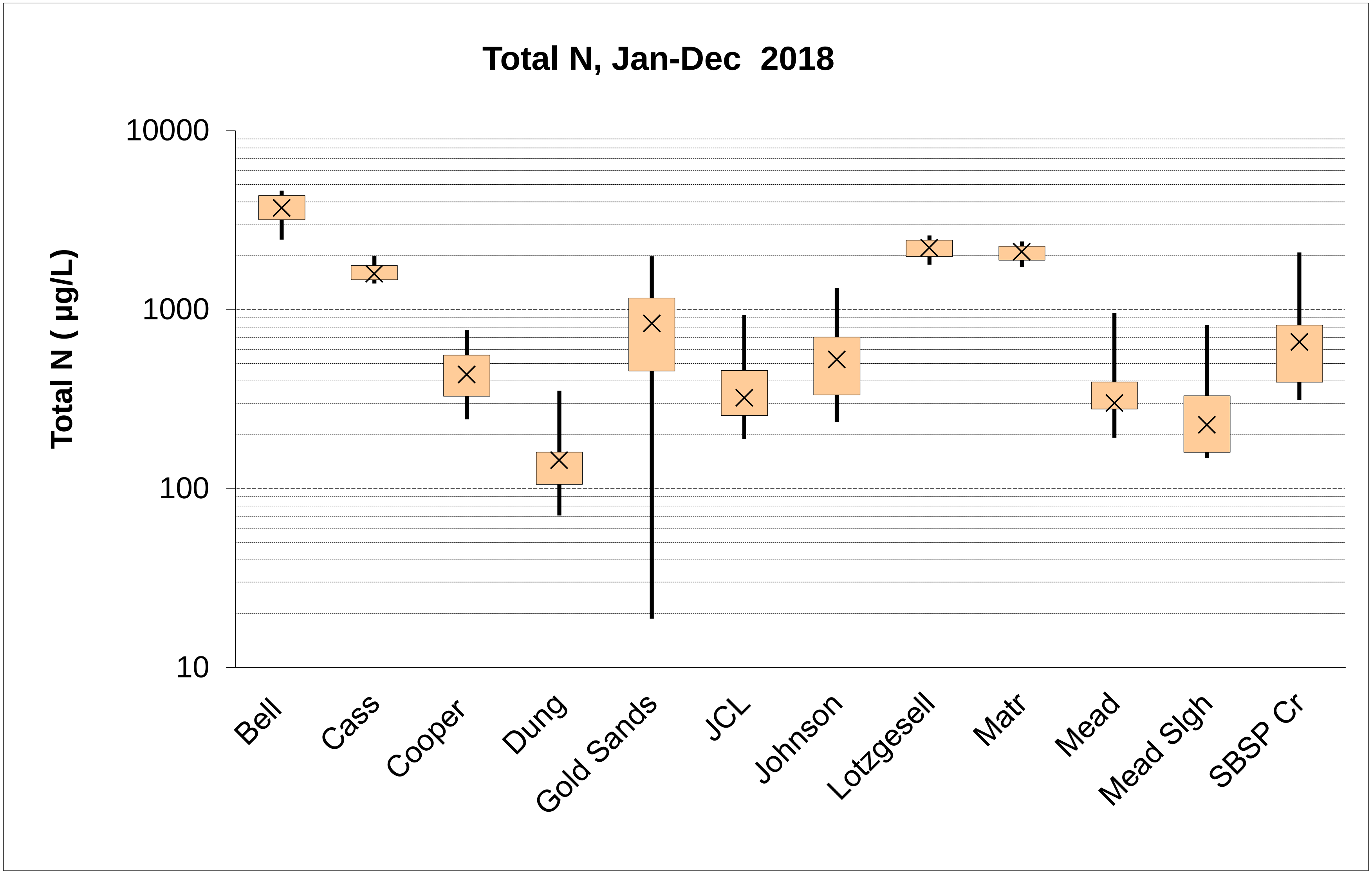

Figure 10. Total nitrogen. Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

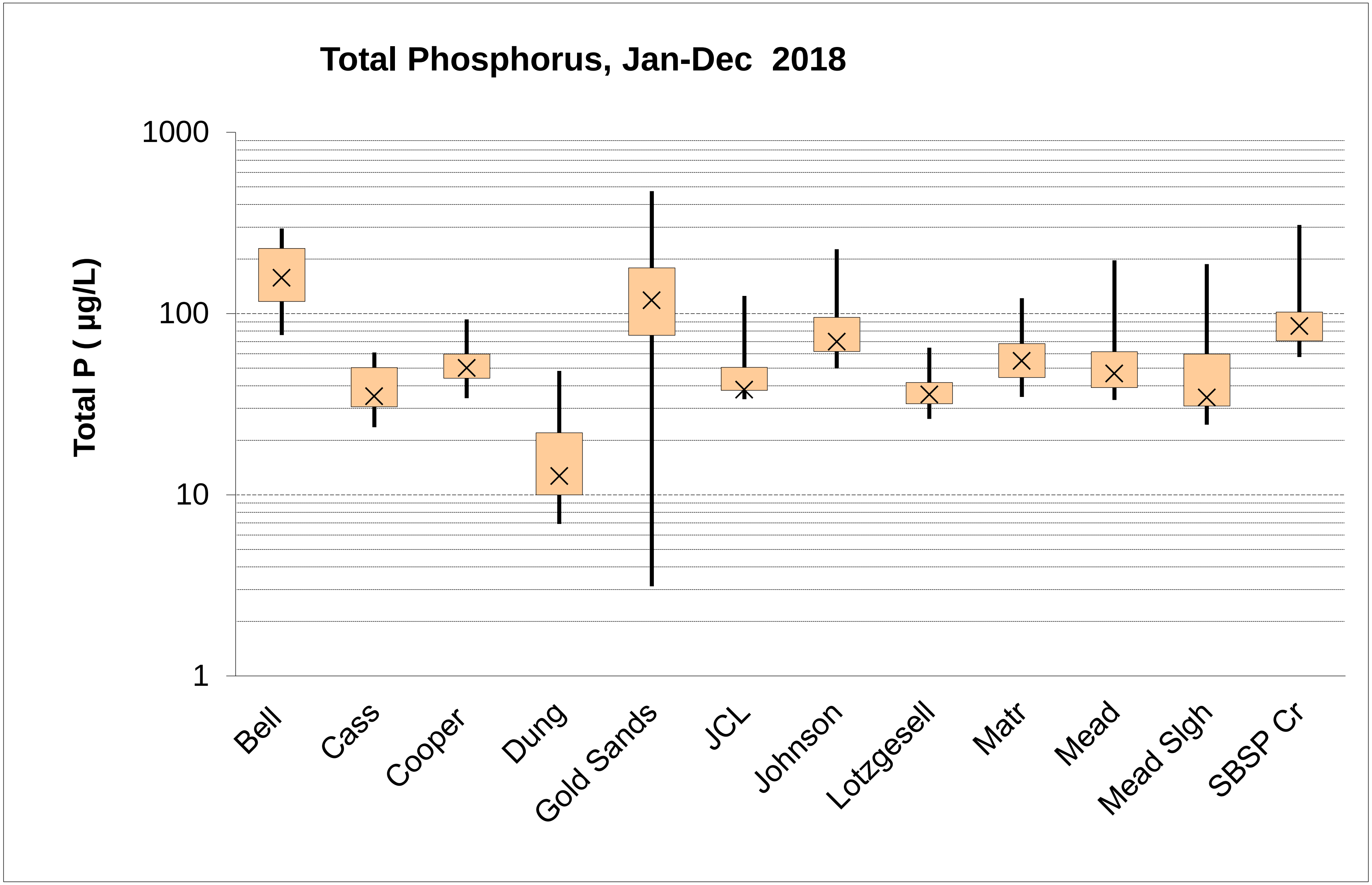

Figure 11. Total phosphorus. Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

Water Temperature and Salinity

Summaries of water temperature and salinity data covering the reporting period follow. Physical and chemical data are collected monthly at Tier I streams and quarterly at Tier II streams. Additional measurements collected following the Streamkeepers program QAPP include barometric pressure, dissolved oxygen, pH, specific conductance, and turbidity data. These measurements are not specifically required by the PIC QAPP and are not discussed here, though they are available from the Clallam County Water Resources Database.

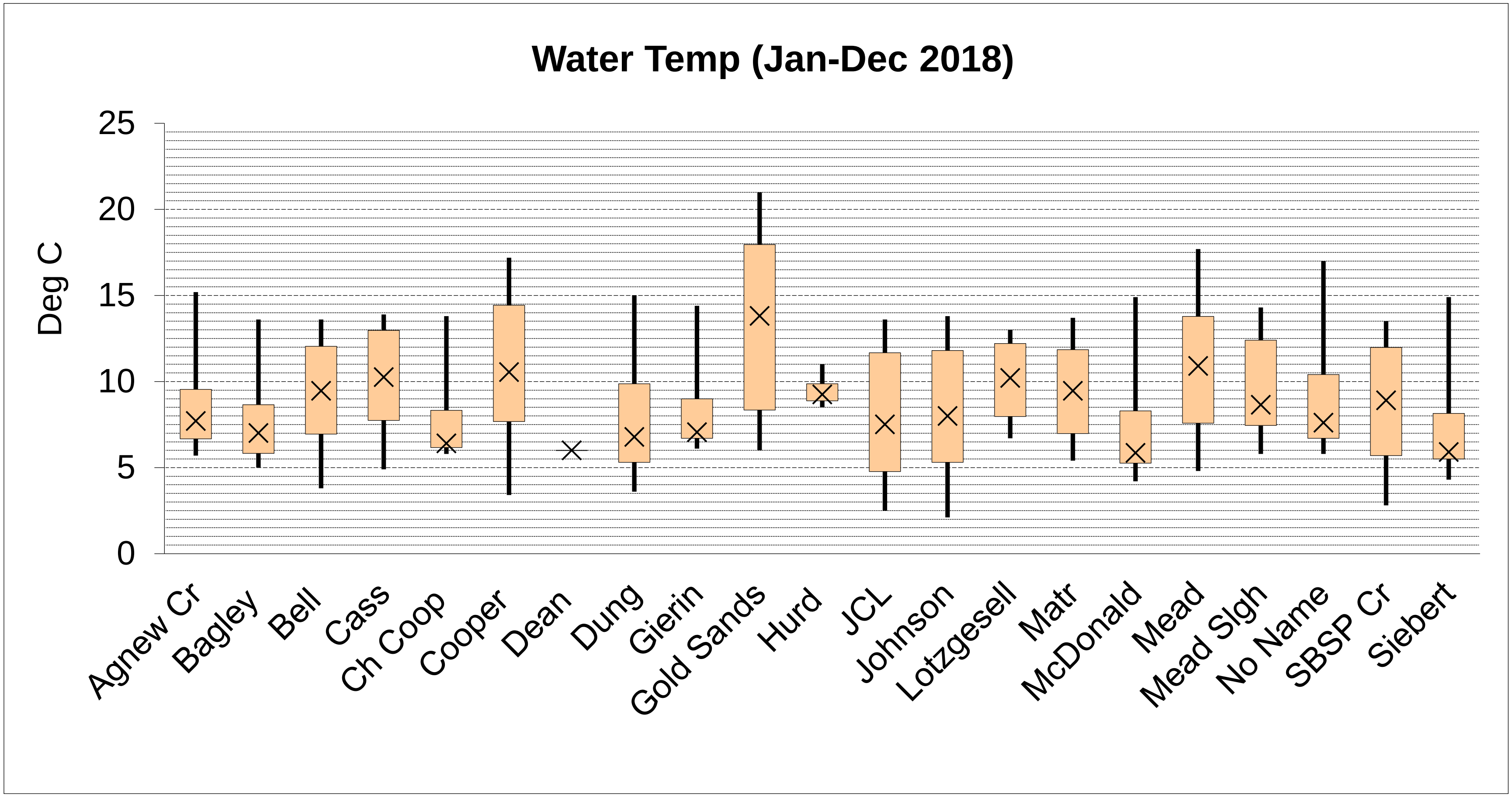

Figure 12. Water temperature. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values. For evaluative purposes, the State's maximum 7-day average of daily maxima for salmonid core summer habitat (the designated use for all sites) is 16°C (Washington Department of Ecology 2006).

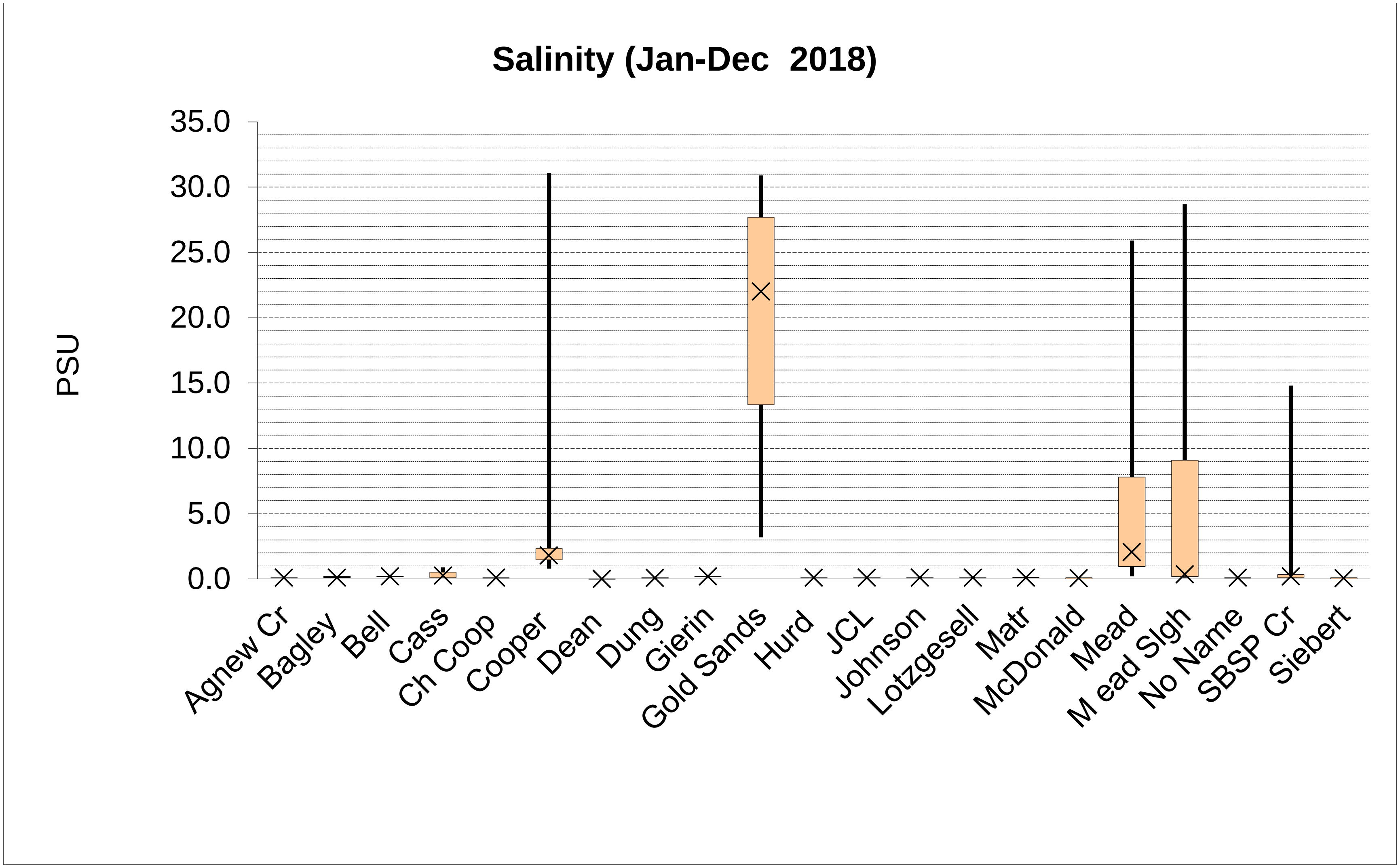

Figure 13. Salinity (PSU). X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

Discussion

Fecal Coliforms

Pollution Identifican and Correction work revolves around seeking and correcting upland sources of bacterial pollution that impact streams and receiving marine waters—especially where shellfish harvest activities exist. Baseline Trends Water Quality Monitoring helps highlight sub-watersheds for selection as PIC Focus Areas for further targeted investigation and pollution control. To date, Baseline Trends data have helped select Golden Sands and Meadowbrook Sloughs (2015-2017 PIC Focus Area), lower Matriotti and Lotzgesell Creeks (2017-2019 PIC Focus Area), and upper Matriotti and lower Bell Creeks (2020-2022 projected PIC Focus Area).

Throughout 2018, Baseline Trends fecal coliform data appeared to indicate relatively high bacteria concentrations in Meadowbrook Slough and Matriotti Creek, with geometric mean, 90th percentile, and upper extrema exceeding those of most other waterways. Bell Creek also experienced "high hits" of bacteria on occasion, as evidenced by a high bacteria concentration upper extreme and high 90th percentile. Meanwhile, Golden Sands Slough bacteria concentractions appeared lower than in past years.

Various pollution correction activities took place near Meadowbrook Slough in 2017 and 2018 with at least two failing septic systems replaced. Ideally, water quality should improve following these corrections. However, PIC Baseline Trends data appear to indicate a lack of improvement in Meadowbrook Slough bacteria concentractions. Continued monitoring may help determine 1) if benefits are out of phase with corrections (i.e. following a history of failing septic systems—possibly on the order of decades—does it take time for the basin to recover), 2) if the volume of water in the slough could be changing, thereby influencing bacteria concentrations, or 3) if some unknown source of bacterial pollution remains and adverseley impacts the waterway.

Anecdotal reports describe the water level of Meadowbrook Slough dropping significantly through 2018, apparently coupled with the migration of the Meadowbrook Creek mouth away from the slough. A spillway at the upper end of Meadowbrook Slough also lets Dungeness River water through the Dungeness River Dike and into the slough. It is unclear if the flow of water through this spillway has changed. Further analysis of Meadowbrook Slough stage data might help quantify any changes in Meadowbrook Slough water levels, though monthly stage data could also prove insufficient in separating trends in Meadowbrook Slough stage from seasonal and tidal influence.

Through 2018 Environmental Health performed segmented sampling for bacteria coupled with surveys of properties bordering Matriotti and Lotzgesell Creeks. Some pollution correction actions were queued up while EH also prepared for a round of septic inspection enforcement in the watershed (approximately 50 septic systems lacking a current operation and maintenance inspection). One hillside seep with high bacteria levels, upstream of Ward Road, was diverted away from Matriotti Creek where it now infiltrates into the ground. Parcel surveys noted a lack of intact stream buffers all along the creek on both commercial and residential properties.

In mid-2018 twenty three acres of shellfish growing area just outside Washington Harbor in Sequim Bay were upgraded from "prohibited" to "approved." This change could lead to increased access for recreational shellfish harvesters at DNR Beach 411A. PIC Baseline Trends Monitoring data from Bell Creek were used as a line of evidence to justify the shellfish growing area upgrade (along with many other reasons including good marine water quality). On October 9, 2018 an uncharastically high bacteria "hit" of 1,424 CFU/100mL was recorded at the Bell Creek PIC Baseline Trends Monitoring site on Schmuck Road (Bell 0.2). As of mid-2019 PIC Project Partners consider adding lower Bell Creek as a future PIC Focus Area to seek and eliminate any potential sources of bacterial pollution and avoid taking steps backward from the recent gains in shellfish growing area upgrades. For the time being, marine water quality appears good near DNR Beach 411A and it is possible some mechanism of bacteria die-off or attenuation in Washington Harbor exists that is protective of marine water quality just outside the harbor.

Golden Sands Slough has shown very high levels of fecal indicator bacteria in past years and the very first PIC Focus Area attempted to enumerate and eliminate bacteria pollution sources in and around the slough (2015-2017 PIC Focus Area). While many problematic wastewater disposal problems were found, including holding tanks, direct discharges, and other non-conforming wastewater systems, corrections took years to complete. Notably, one key septic system installation in 2018 eliminated various pollution problems in the Golden Sands area, and another septic system installation was scheduled for 2019.

Throughout 2018, relatively low concentractions of bacteria were measured at site Golden Sands 0.0 (the Golden Sands Slough culvert under 3-Crabs Road, with highest observed value 111 CFU/mL. Still, we should apply caution when interpreting Golden Sands Baseline Trends Monitoring data, as periodic high salinity measurements would indicate marine water influence. That is, we may not always capture the freshwater component of the slough when monitoring.

Nutrients

This year Bell Creek appears to stand out with relatively high levels of total nitrogen, total phosporous, nitrate, nitrite, and phosphate as P as compared to other Clean Water district Streams. Geometric means, observed 3rd quartiles, and upper extrema rank higher than other streams for these parameters.

Meanwhile, Golden Sands Slough and Matriotti Creek ammonia levels appear higher than those observed in other Clean Water District Streams upon comparison of geometric means, 3rd quartiles, and maximum values.

Physical and Chemical Water Quality Parameters

Cooper Creek, Golden Sands Slough, Meadowbrook Creek, and Meadowbrook Slough salinity data suggest at least periodic marine water influence at these sites.

Secondary sample sites were added at Sequim Bay State Park Creek (0.1) and Cassalery Creek (0.6) to avoid complications with low flow events and tides that occasionally confound data collection. The highest salinity measurements at Sequim Bay State Park Creek and Cassalery Creek come from the lower, primary sample sites when the secondary site was not used.

Cooper Creek, Golden Sands Slough, and Meadowbrook Creek sample sites generally lack shading from vegetation and various high water temperatures were recorded at these sites, above all during the summer months.

Conclusion

Long-Term PIC Baseline Trends Monitoring continues to help project partners adaptively manage the PIC Program and select focus areas where limited resources will lead to the greatest improvements in water quality.

Many needed changes identified in the 2015-2017 PIC Focus Area have finally come online in 2018, though PIC Segmented Sampling and Investigations have moved on to lower Matriotti Creek and Lotzgesell Creeks. Specifically, various conforming septic systems have been installed in the Golden Sands Slough and Meadowbrook Slough neighborhoods. Some of these septic system installations happened thanks to low interest loans (such as Clean Water Loans offered by Craft3) and/or cost-share funding accessed by Clallam Conservation District. To continue gains, Clallam County Environmental Health will have to keep track of recalcitrant wastewater disposal problems and use all available tools to compel use of conforming wastewater treatment only.

The bulk of 2018 pollution source investigations and PIC Segmented Water Quality Sampling happened in the Matriotti/Lotzgesell area (2017-2019 PIC Focus Area). Here, pollution correction had just begun by the end of 2018. One hillside seep was directed away from Matriotti Creek where it now infiltrates into the ground, just upstream of Ward Road. One abandoned septic system was identified for decommission and another for repair or replacement, again near Ward Road. Clallam Conservation District updated farm conservation plans for operations in the project area and Clallam County Environmental Health prepared to enforce septic inspection requirements for approximately 50 parcels in the watershed.

Parcel surveys and source investigations along Matriotti and Lotzgesell Creeks noted many potential critical areas problems, namely, removed vegetated buffers. Cleared stream corrider appears prevalent across properties of varying uses from commercial, to residential, to agricultural. Clallam County's Clean Water Strategy for Addressing Bacteria Pollution in Dungeness Bay and Watershed (Streeter and Hempleman 2004) notes: "Although not considered a pollution source, the lack of vegetation along ditches and stream banks limits the landscape's ability to filter contaminated run-off." It is possible Matriotti and Lotzgesell Creek water quality will not improve appreciably—especially in terms of pathogens and water temperature—unless a concerted effort is made to protect the remaining vegetated corridor bording the streams and to restore vegetated buffers previously removed contrary to criticial areas codes.

The high levels of total nitrogen, total phosporous, nitrate, nitrite, and phosphate as P in Bell Creek, as well as the ammonia levels in Golden Sands Slough and Matriotti Creek, are of interest and will be investigated further.

In addition to ongoing PIC work, Environmenal Health and Environmental Protection Agency Region 10/Manchester Laboratory are exploring a possible Microbial Source Tracking (MST) study to complement pathogens reduction efforts in the Dungeness Watershed. Sites on Matriotti Creek and Meadowbrook slough are proposed for bacteria source tracking. This may help illuminate the range of pollution sources still present in the watershed, while addressing bacteria "hotspots" that persist in spite of pollution corrections such as repair of failing septic systems and exclusion of domesticated animals from streams. The additional line of evidence may help overcome the activation energy required to tackle needed changes such as restoring vegetated buffers that keep contaminated run-off out of streams.

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Appendix 1: Data from January 2018 – December 2018

Site	Date	FC CFU/ 100mL	NO_3-N µg/L	NO_2-N µg/L	NH_3-N µg/L	PO_4-P µg/L	$SiSO_4$-Si µg/L	TN µg/L	TP µg/L	Temp. H_2O deg. C	PSU
Agnew Creek/Ditch 0.3	1/9/2018	8								5.7	0.1
Agnew Creek/Ditch 0.3	4/17/2018	53								8.2	0.1
Agnew Creek/Ditch 0.3	8/14/2018	55								15.2	0.1
Agnew Creek/Ditch 0.3	11/14/2018	7								7.2	0.1
Bagley 0.7a	1/9/2018	4								5.0	0.1
Bagley 0.7a	4/17/2018	26								7.0	0.0
Bagley 0.7a	8/14/2018	38								13.6	0.1
Bagley 0.7a	11/14/2018	2								7.0	0.1
Bell 0.2	1/8/2018	5	1944.4	8.4	24.0	139.5	8448.2	3385.8	173.8	6.5	0.2
Bell 0.2	2/13/2018	20	3042.9	12.7	20.2	122.4	8491.2	4327.0	294.5	3.8	0.2
Bell 0.2	3/13/2018	17	3226.0	8.5	14.2	82.5	7019.2	4623.3	130.6	7.5	0.2
Bell 0.2	4/16/2018	142	779.3	4.3	30.9	87.3	7524.2	2464.2	228.9	8.3	0.2
Bell 0.2	5/15/2018	28	2207.2	4.5	9.2	70.7	6370.3	3244.5	140.5	11.8	0.2
Bell 0.2	6/12/2018	243	2604.8	6.5	14.1	207.1	7331.9	3419.7	272.4	10.6	0.2
Bell 0.2	7/10/2018	47	2875.9	4.9	11.4	167.4	7464.3	4061.0	206.4	13.4	0.2
Bell 0.2	8/13/2018	61	1689.2	3.0	7.5	104.8	6216.4	2989.4	103.9	13.6	0.2
Bell 0.2	9/11/2018	82	1916.7	3.7	7.4	92.9	6422.6	2760.3	120.8	12.8	0.2
Bell 0.2	10/9/2018	1424	2959.0	103.4	27.8	170.5	9112.2	4353.6	228.6	11.3	0.2
Bell 0.2	11/13/2018	6	3180.6	4.5	8.1	55.4	8967.5	3973.0	76.1	6.5	0.2
Bell 0.2	12/11/2018	20	3404.7	6.9	17.7	81.1	9083.8	4441.9	99.3	7.1	0.2
Cassalery 0.0	4/16/2018	76	990.5	5.0	51.3	31.3	4752.4	1997.7	61.0	9.1	0.9
Cassalery 0.0	5/15/2018	8	1080.1	6.1	0.0	2.0	5882.1	1727.4	38.9	13.2	0.4
Cassalery 0.0	6/12/2018	16	1091.9	4.2	20.0	11.5	5773.8	1447.8	37.4	12.5	0.5
Cassalery 0.0	7/10/2018	38	1239.1	3.4	23.5	15.6	6408.7	1735.3	30.7	13.9	0.6
Cassalery 0.0	8/13/2018	20	1196.9	2.7	22.7	11.7	6590.3	1857.7	30.2	13.9	0.6
Cassalery 0.0	9/11/2018	46	1085.7	2.2	10.4	9.9	6548.7	1510.9	30.3	12.9	0.3
Cassalery 0.0	10/9/2018	16	951.9	1.8	12.5	18.2	6658.3	1398.2	32.4	11.4	0.3
Cassalery 0.6	1/8/2018	2	1003.6	6.1	22.5	14.9	6921.7	1478.1	32.6	7.9	0.1
Cassalery 0.6	2/13/2018	2	1182.9	8.1	25.9	10.7	6369.0	1658.3	48.3	4.9	0.1
Cassalery 0.6	3/13/2018	90	1287.7	6.9	23.0	8.6	6327.6	1876.0	58.0	9.0	0.1
Cassalery 0.6	11/13/2018	18	1062.4	2.2	0.0	8.0	6622.2	1415.3	23.6	6.6	0.1
Cassalery 0.6	12/11/2018	42	1016.2	3.2	16.7	11.9	6917.4	1473.4	56.2	7.3	0.1
Chicken Coop 0.24	1/9/2018	6								5.8	0.1

Site	Date	FC CFU/ 100mL	NO_3-N µg/L	NO_2-N µg/L	NH_3-N µg/L	PO_4-P µg/L	$SiSO_4$-Si µg/L	TN µg/L	TP µg/L	Temp. H_2O deg. C	PSU
Chicken Coop 0.24	4/17/2018	4								6.3	0.0
Chicken Coop 0.24	8/14/2018	110								13.8	0.1
Chicken Coop 0.24	11/14/2018	2								6.5	0.1
Cooper 0.1	1/8/2018	6	368.0	7.2	73.5	40.8	5326.4	768.9	50.1	7.8	26.6
Cooper 0.1	2/13/2018	4	330.0	2.8	39.4	38.7	3483.2	691.0	69.2	3.4	2.0
Cooper 0.1	3/13/2018	32	314.6	1.8	24.4	18.8	7087.6	516.7	59.4	8.6	1.6
Cooper 0.1	4/16/2018	4	64.3	0.7	20.1	25.6	6084.5	432.9	49.9	9.6	1.4
Cooper 0.1	5/15/2018	2	34.7	1.9	41.3	22.3	7034.3	337.4	61.3	15.4	2.2
Cooper 0.1	6/12/2018	18	38.1	1.4	32.0	18.2	7216.0	307.7	52.6	14.1	2.0
Cooper 0.1	7/10/2018	12	48.3	2.6	42.3	22.7	8179.0	335.1	47.8	17.2	1.4
Cooper 0.1	8/13/2018	14	41.5	2.0	46.2	17.8	8082.5	288.5	41.6	16.4	2.8
Cooper 0.1	9/11/2018	26	45.2	1.5	25.8	12.4	8459.5	244.1	34.1	13.6	1.5
Cooper 0.1	10/9/2018	38	110.4	1.8	38.7	22.5	8748.5	435.9	44.8	11.5	1.6
Cooper 0.1	11/13/2018	20	234.4	7.9	65.7	65.5	1953.3	467.9	92.8	7.3	31.1
Cooper 0.1	12/11/2018	24	356.2	3.3	26.4	13.0	8877.3	678.3	37.3	5.3	0.8
Dean 0.17	4/17/2018	26								6.0	0.0
Dungeness 0.7	1/8/2018	2	74.2	0.3	5.5	6.1	3638.4	165.9	17.0	5.3	0.1
Dungeness 0.7	2/13/2018	2	67.9	0.0	8.2	4.8	3407.7	124.6	21.9	3.6	0.1
Dungeness 0.7	3/13/2018	14	57.1	0.1	13.8	1.6	3893.3	169.7	22.2	5.3	0.1
Dungeness 0.7	4/16/2018	10	118.6	0.1	16.4	8.4	4246.1	352.2	31.8	6.0	0.1
Dungeness 0.7	5/15/2018	4	31.8	0.3	2.1	1.1	2400.2	157.7	48.2	9.1	0.0
Dungeness 0.7	6/12/2018	2	27.4	0.0	2.5	2.7	2867.5	99.1	14.0	9.6	0.0
Dungeness 0.7	7/10/2018	2	26.2	0.2	6.7	4.8	2796.5	70.7	6.9	13.1	0.1
Dungeness 0.7	8/13/2018	18	55.6	0.4	3.6	2.2	3310.5	156.9	10.3	15.0	0.1
Dungeness 0.7	9/11/2018	6	82.8	0.7	5.1	3.6	3610.9	133.5	10.0	7.6	0.1
Dungeness 0.7	10/9/2018	6	45.1	0.0	2.9	4.0	3426.8	91.5	9.8	10.7	0.1
Dungeness 0.7	11/13/2018	2	58.7	0.5	0.8	1.4	3163.1	154.4	9.9	5.7	0.1
Dungeness 0.7	12/11/2018	2	72.9	0.6	8.4	4.6	3235.7	107.6	11.4	4.7	0.1
Gierin 1.8	1/9/2018	2								6.1	0.2
Gierin 1.8	4/17/2018	12								7.2	0.2
Gierin 1.8	8/14/2018	162								14.4	0.1
Gierin 1.8	11/14/2018	2								6.9	0.2
Golden Sands 0.0	1/8/2018	2	326.9	4.5	69.2	65.9	1549.2	754.9	60.8	7.8	30.9
Golden Sands 0.0	2/13/2018	7	115.9	3.4	56.3	58.0	7254.3	1108.8	160.0		
Golden Sands 0.0	3/13/2018	17	181.6	4.9	69.6	79.9	4955.0	1146.7	133.1	8.9	8.0

Site	Date	FC CFU/ 100mL	NO_3-N µg/L	NO_2-N µg/L	NH_3-N µg/L	PO_4-P µg/L	$SiSO_4$-Si µg/L	TN µg/L	TP µg/L	Temp. H_2O deg. C	PSU
Golden Sands 0.0	4/16/2018	43	65.4	2.8	99.7	60.2	3360.7	1202.6	103.3	13.8	16.8
Golden Sands 0.0	5/15/2018	111	0.4	1.0	71.9	111.4	2467.5	919.1	233.8	18.8	16.3
Golden Sands 0.0	6/12/2018	32	0.6	0.5	31.9	62.8	1738.0	470.8	143.4	17.6	23.9
Golden Sands 0.0	7/10/2018	46	1.1	0.8	12.7	44.9	659.1	477.7	80.0	21.0	26.0
Golden Sands 0.0	8/13/2018	6	2.7	2.2	45.6	28.8	842.8	383.5	63.5	18.3	29.8
Golden Sands 0.0	9/11/2018	15	4.0	3.2	52.4	38.1	2073.6	403.3	84.4	9.7	29.4
Golden Sands 0.0	10/9/2018	49	5.9	1.6	85.3	74.6	5069.4	18.7	3.1	13.9	22.0
Golden Sands 0.0	11/13/2018	16	21.9	5.9	304.2	289.1	10126.4	1949.0	412.6	6.0	3.2
Golden Sands 0.0	12/11/2018	30	38.8	8.4	925.6	368.8	8917.9	1988.4	474.2	6.7	10.4
Hurd 0.2	1/9/2018	2								8.5	0.1
Hurd 0.2	4/17/2018	4								9.0	0.1
Hurd 0.2	8/14/2018	2								11.0	0.1
Hurd 0.2	11/14/2018	2								9.5	0.1
Jimmycomelately 0.15	1/8/2018	2	284.6	1.7	7.3	14.7	8453.3	562.1	38.1	5.0	0.0
Jimmycomelately 0.15	2/13/2018	6	245.1	0.8	35.4	13.4	8874.2	452.6	55.9	2.5	0.1
Jimmycomelately 0.15	3/13/2018	4	230.8	1.4	2.1	9.7	7921.7	474.6	56.3	4.6	0.1
Jimmycomelately 0.15	4/16/2018	60	245.5	1.8	19.0	14.9	6538.1	936.6	125.1	6.1	0.0
Jimmycomelately 0.15	5/15/2018	2	135.5	0.8	3.4	14.3	9799.3	336.2	37.8	11.4	0.1
Jimmycomelately 0.15	6/12/2018	8	91.5	0.7	3.8	16.9	8679.2	258.2	36.0	8.9	0.1
Jimmycomelately 0.15	7/10/2018	10	107.8	0.9	2.2	23.1	9428.1	243.1	37.9	12.9	0.1
Jimmycomelately 0.15	8/13/2018	16	138.1	0.8	6.3	26.5	9292.1	306.3	40.5	13.6	0.1
Jimmycomelately 0.15	9/11/2018	6	107.4	0.9	5.0	25.6	9253.1	188.9	37.8	12.5	0.1
Jimmycomelately 0.15	10/9/2018	124	171.9	0.2	4.2	31.5	8577.8	364.1	48.6	9.8	0.1
Jimmycomelately 0.15	11/13/2018	2	131.1	0.9	0.6	18.2	8854.2	248.9	33.7	4.7	0.1
Jimmycomelately 0.15	12/11/2018	94	147.9	0.9	7.3	21.2	8857.9	266.2	37.4	4.8	0.1
Johnson 0.0	1/8/2018	4	248.1	2.7	4.5	37.9	9103.1	768.0	80.6	5.4	0.1
Johnson 0.0	2/13/2018	10	217.5	1.7	6.0	35.8	9351.6	641.7	91.8	2.1	0.1
Johnson 0.0	3/13/2018	4	320.0	2.6	9.2	30.1	9208.5	793.8	110.0	5.5	0.1
Johnson 0.0	4/16/2018	76	284.7	2.7	41.0	43.2	7629.4	1320.0	226.8	6.7	0.1
Johnson 0.0	5/15/2018	38	154.2	1.0	6.2	38.7	7542.4	433.6	62.9	11.5	0.1
Johnson 0.0	6/12/2018	22	196.4	0.8	4.8	41.0	8171.5	421.7	65.4	9.3	0.1
Johnson 0.0	7/10/2018	110	161.4	0.8	5.6	47.1	7405.0	679.4	74.3	13.6	0.1
Johnson 0.0	8/13/2018	50	87.9	0.5	5.1	40.0	5618.8	250.9	49.9	13.8	0.1
Johnson 0.0	9/11/2018	48	130.2	0.8	6.0	49.5	7312.4	235.7	62.0	12.7	0.1
Johnson 0.0	10/9/2018	24	257.9	0.4	2.8	85.8	9284.7	620.2	106.0	10.4	0.1

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Johnson 0.0	11/13/2018	2	160.9	1.0	0.3	47.5	10653.3	319.0	60.9	5.0	0.2
Johnson 0.0	12/11/2018	6	162.9	0.8	6.5	40.9	8313.4	338.4	58.3	5.0	0.1
Lotzgesell 0.1	1/8/2018	2	1240.7	6.3	23.0	15.2	8494.0	1945.0	38.4	8.0	0.1
Lotzgesell 0.1	2/13/2018	16	1646.4	3.1	54.3	11.5	8072.6	2334.6	58.7	6.7	0.1
Lotzgesell 0.1	3/13/2018	20	1772.2	3.7	24.6	9.3	7773.5	2003.1	31.0	9.1	0.1
Lotzgesell 0.1	4/16/2018	14	1584.7	2.9	10.0	7.9	6841.1	2460.8	26.3	9.4	0.1
Lotzgesell 0.1	5/15/2018	38	1825.9	3.9	27.8	8.0	7602.6	2563.5	39.1	12.1	0.1
Lotzgesell 0.1	6/12/2018	404	1854.5	4.1	12.2	10.0	7837.2	2193.0	41.4	11.0	0.1
Lotzgesell 0.1	7/10/2018	36	1887.5	4.8	14.2	9.7	8188.7	2442.0	33.2	13.0	0.1
Lotzgesell 0.1	8/13/2018	168	1920.7	4.6	7.7	7.1	8446.4	2595.0	32.0	12.9	0.1
Lotzgesell 0.1	9/11/2018	102	1760.5	4.0	7.4	8.0	8464.1	2245.1	32.8	12.5	0.1
Lotzgesell 0.1	10/9/2018	26	1467.0	4.5	9.5	20.3	8722.3	1993.4	42.3	11.4	0.1
Lotzgesell 0.1	11/13/2018	2	1440.4	3.5	8.1	7.4	8514.8	1841.8	27.6	7.9	0.1
Lotzgesell 0.1	12/11/2018	16	1252.1	7.1	26.1	10.4	8409.7	1780.3	64.8	7.6	0.1
Matriotti 0.3a	1/8/2018	12	966.6	5.2	28.3	26.3	8662.8	1822.4	57.3	6.6	0.1
Matriotti 0.3a	2/13/2018	33	1302.5	4.4	59.4	22.7	8376.2	2085.0	84.5	5.4	0.1
Matriotti 0.3a	3/13/2018	254	1429.6	4.6	33.7	22.5	7791.2	2314.0	74.5	8.6	0.2
Matriotti 0.3a	4/16/2018	208	851.0	3.2	29.2	27.7	7135.9	1728.9	52.4	8.4	0.1
Matriotti 0.3a	5/15/2018	106	1539.8	5.2	5.7	19.2	7506.2	2214.3	66.1	11.8	0.1
Matriotti 0.3a	6/12/2018	340	1426.3	4.1	19.4	22.9	7295.0	1867.5	62.4	10.3	0.1
Matriotti 0.3a	7/10/2018	150	1693.6	4.8	26.2	24.2	8071.0	2368.2	48.6	12.7	0.1
Matriotti 0.3a	8/13/2018	576	1614.2	4.7	196.8	29.8	7918.0	2403.9	121.6	13.7	0.1
Matriotti 0.3a	9/11/2018	267	1659.6	4.4	26.0	14.3	8727.7	2249.2	38.9	12.0	0.1
Matriotti 0.3a	10/9/2018	236	1485.9	4.7	38.9	25.7	8862.5	2118.6	46.2	10.9	0.2
Matriotti 0.3a	11/13/2018	50	1424.9	3.8	22.6	11.0	8804.2	1893.0	34.7	6.9	0.2
Matriotti 0.3a	12/11/2018	2	1347.5	8.5	47.3	15.0	8875.6	1941.2	37.9	7.0	0.1
McDonald 01.6	1/9/2018	4								4.2	0.0
McDonald 01.6	4/17/2018	4								5.6	0.0
McDonald 01.6	8/14/2018	24								14.9	0.1
McDonald 01.6	11/14/2018	2								6.1	0.1
Meadowbrook 0.2	8/13/2018	8	10.2	1.5	28.0	19.1	6403.9	223.5	39.4	17.0	2.7
Meadowbrook 0.2	1/8/2018	4	232.9	3.4	48.8	47.2	3886.3	491.7	57.9	7.7	22.8
Meadowbrook 0.2	2/13/2018	2	204.7	0.8	22.2	20.0	7749.2	433.2	64.6	4.8	0.2
Meadowbrook 0.2	3/13/2018	10	105.3	0.4	15.3	15.3	6611.8	291.3	60.6	8.6	0.5
Meadowbrook 0.2	4/16/2018	4	66.2	0.6	30.6	19.1	5191.9	349.4	38.2	9.5	1.3

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Meadowbrook 0.2	5/15/2018	16	40.6	1.8	24.6	15.4	5981.7	296.8	48.5	14.7	1.8
Meadowbrook 0.2	6/12/2018	24	36.3	1.6	39.3	23.1	6149.9	381.9	77.3	13.4	2.3
Meadowbrook 0.2	7/10/2018	4	31.3	2.1	37.0	19.0	6366.9	303.4	43.3	17.7	2.8
Meadowbrook 0.2	9/11/2018	4	11.1	1.0	15.7	15.5	6846.8	192.5	33.4	13.5	0.4
Meadowbrook 0.2	10/9/2018	4	12.3	0.6	16.9	22.9	7508.2	240.0	37.3	12.3	1.1
Meadowbrook 0.2	11/13/2018	2	75.2	2.1	32.6	21.5	6339.6	298.3	44.9	7.2	23.3
Meadowbrook 0.2	12/11/2018	66	274.1	8.8	197.2	128.0	2619.1	956.2	197.0	6.8	25.9
Mead. Slough 0.23	1/8/2018	60	205.8	3.0	103.4	45.6	2778.0	455.2	52.4	7.6	28.7
Mead. Slough 0.23	2/13/2018	20	109.9	0.9	33.6	20.2	4150.1	265.4	58.9	5.8	0.1
Mead. Slough 0.23	3/13/2018	410	101.3	1.0	39.3	25.1	3798.3	309.0	94.9	6.1	0.4
Mead. Slough 0.23	4/16/2018	24	65.9	0.1	17.2	14.6	3858.2	188.8	29.7	7.7	9.1
Mead. Slough 0.23	5/15/2018	20	40.0	0.8	1.6	7.8	3332.6	162.6	24.4	9.3	0.1
Mead. Slough 0.23	6/12/2018	140	41.2	0.5	38.3	16.3	4062.4	149.2	32.6	10.2	0.3
Mead. Slough 0.23	7/10/2018	440	48.1	0.9	36.1	21.3	4126.4	148.6	25.3	12.3	0.2
Mead. Slough 0.23	8/13/2018	438	73.0	0.8	28.9	21.0	4416.1	163.5	31.3	14.3	0.4
Mead. Slough 0.23	9/11/2018	300	92.2	1.1	31.6	23.7	4574.5	274.9	36.2	13.8	0.3
Mead. Slough 0.23	10/9/2018	160	70.6	0.4	22.4	23.9	4643.1	149.0	31.4	12.7	0.2
Mead. Slough 0.23	11/13/2018	1254	160.2	5.6	103.8	41.5	2833.7	393.4	62.7	8.0	9.1
Mead. Slough 0.23	12/11/2018	644	199.4	6.5	264.9	132.8	3053.7	822.5	187.8	7.0	23.5
No Name 0.03	1/9/2018	38								5.8	0.1
No Name 0.03	4/17/2018	54								7.0	0.0
No Name 0.03	8/14/2018	4								17.0	0.1
No Name 0.03	11/14/2018	2								8.2	0.1
SBSP 0.0	3/13/2018										0.1
SBSP 0.0	4/16/2018	130	154.1	3.8	36.7	76.0	6833.6	2090.1	308.2	7.6	0.1
SBSP 0.0	5/15/2018	2	181.1	1.2	1.1	55.2	9289.4	659.2	85.4	11.7	0.2
SBSP 0.0	6/12/2018	12	81.8	0.7	4.6	59.4	8448.0	488.9	82.2	10.2	0.2
SBSP 0.0	7/10/2018		304.2	0.6	11.3	60.7	9286.8	313.0	57.6		14.8
SBSP 0.0	8/13/2018	84	545.7	0.4	1.8	69.7	8795.6	884.2	77.1	13.5	0.5
SBSP 0.0	9/11/2018	4	63.3	2.2	41.7	52.8	7549.8	386.1	69.3	13.2	3.1
SBSP 0.0	10/9/2018	36	263.9	0.5	2.8	83.9	8311.1	937.3	109.1	10.6	0.2
SBSP 0.0	1/8/2018	74	163.6	2.8	3.9	57.5	8871.7	819.8	91.1	5.4	0.1
SBSP 0.0	2/13/2018	4	197.0	2.3	15.5	49.3	8804.8	758.0	102.0	2.8	0.1
SBSP 0.0	3/13/2018	4	104.1	2.3	3.3	42.6	8682.9	619.9	95.7	6.4	0.1
SBSP 0.0	7/10/2018	292	304.2	0.6	11.3	60.7	9286.8	313.0	57.6	12.8	0.4

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SBSP 0.0	11/13/2018	2	47.2	0.7	0.8	58.8	8336.1	392.5	70.7	5.8	0.2
SBSP 0.0	12/11/2018	4	25.0	0.7	4.7	53.9	8580.3	802.5	161.8	5.3	0.2
Siebert 1.0	1/9/2018	2								4.3	0.0
Siebert 1.0	4/17/2018	2								5.9	0.0
Siebert 1.0	8/14/2018	8								14.9	0.1
Siebert 1.0	11/14/2018	30								5.9	0.1