DEPARTMENT OF ECOLOGY
State of Washington

Addendum 2 to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring Water Column Program

February 2023

Publication 23-03-109

Publication Information

This Quality Assurance Monitoring Plan Addendum is on the Department of Ecology's website at https://apps.ecology.wa.gov/publications/SummaryPages/2303109.html This is an addition to an original Quality Assurance Monitoring Plan (QAMP). It is not a correction (errata) to the original plan.

This QAMP addendum was approved to begin work in December 2022. It was finalized and approved for publication in February 2023.

Suggested citation for this addendum:
Coleman, N., Pool, S., Young, H., Horwith, M., Krembs, C., and Ruffner, J. 2023. Addendum 2 to Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 23-03-109. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2303109.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at EIM Database. Search Study ID: MarineWater.

Activity Tracker code:
Ecology's Activity Tracker code for this addendum is 01-800.

Original Quality Assurance Project Plan:
Keyzers, M., Bos, J., Albertson, S. 2021. Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 21-03-108. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103108.html.

Contact Information

Publications Team
Environmental Assessment Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6764

Washington State Department of Ecology – ecology.wa.gov

Headquarters, Olympia	360-407-6000
Northwest Regional Office, Shoreline	206-594-0000
Southwest Regional Office, Olympia	360-407-6300
Central Regional Office, Union Gap	509-575-2490
Eastern Regional Office, Spokane	509-329-3400

Addendum 2 to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring, Water Column Program

by the following Marine Monitoring Unit staff:
Coleman, N., Pool, S., Young, H., Horwith, M., Krembs, C., and Ruffner, J.

February 2023

Approved by:

Signature: _____ Date: _____
Suzan Pool, Author / Marine Monitoring Scientist, MMU, EAP

Signature: _____ Date: _____
Natalie Coleman, Author / Ocean Acidification Scientist, MMU, EAP

Signature: _____ Date: _____
Holly Young, Author / Marine Water Field Lead, MMU, EAP

Signature: _____ Date: _____
Christopher Jendrey, Author / Marine Water Field Technician, MMU, EAP

Signature: _____ Date: _____
Micah Horwith, Author / Ocean Acidification Senior Scientist, WOS, EAP

Signature: _____ Date: _____
Christopher Krembs, Author / Senior Oceanographer, MMU, EAP

Signature: _____ Date: _____
Julianne Ruffner, Author's Unit Supervisor, MMU, EAP

Signature: _____ Date: _____
Stacy Polkowske, Author's Section Manager, WOS, EAP

Signature: _____ Date: _____
Dean Momohara, Acting Director, Manchester Environmental Lab, EAP

Signature: _____ Date: _____
Arati Kaza, Ecology Quality Assurance Officer

Signatures are not available on the Internet version.
EAP: Environmental Assessment Program
MMU: Marine Monitoring Unit
WOS: Western Operations Section

1.0 Table of Contents

The numbered headings in this document correspond to the headings in the original QAMP. Only relevant sections are included here; therefore, some numbered headings may be missing.

3.0 Background

This document describes changes planned for 2023 to the sampling effort by the Washington State Department of Ecology's Long-Term Marine Waters Monitoring (MWM) program. It is an addendum to Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program (Keyzers et al., 2020). This Quality Assurance Monitoring Plan (QAMP) addendum specifies which stations and parameters will be sampled during 2023.

The purpose of the MWM program is to examine and report marine water quality on a regular, long-term basis. Its objectives are to help us understand current existing conditions in the context of environmental factors, identify spatial and temporal trends, and provide high-quality information from sensor and lab sample collection.

All required sections not mentioned in this addendum are discussed in the original QAMP and referenced standard operating procedures (SOPs).

4.0 Project Description

4.4 Tasks required

4.4.1 Data collection

On a year-round, monthly basis, we collect vertical water column profile data for salinity, temperature, dissolved oxygen, turbidity, water clarity, in situ fluorescence, chlorophyll a, dissolved inorganic nutrient species (nitrate, nitrite, ammonium, orthophosphate, silicate), total nitrogen, total organic carbon, particulate organic carbon, particulate nitrogen, dissolved inorganic carbon, and total alkalinity. These data are collected at 39 marine water sampling stations, based on directives from the original Puget Sound monitoring plan for the water column (Keyzers et al., 2020).

Sampling is conducted monthly to maintain a long-term record of water column conditions. Year-round sampling is necessary because many parameters – such as chlorophyll, nutrients, salinity, and dissolved oxygen – change seasonally. Sampling is conducted during all 12 months to capture hydrographic trends and to provide a complete data set for analysis of temporal trends (MMC, 1988).

4.4.2 pH sensors

In 2022, we discontinued using pH sensors made with glass electrodes. This discontinuation will remain in place for 2023.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1. Roles and responsibilities of staff involved with the MWM program.
All staff are with Ecology's Environmental Assessment Program (EAP).

Staff Name	Title	Responsibilities
Christopher Krembs Marine Monitoring Unit Phone: (360) 407-6675	Senior Oceanographer	Determines monitoring and data assessment strategy. Generates indicators of water quality conditions. Leads data review, analysis, interpretation, and reporting. Develops information products. Writes publications and presentations delivered to the agency and public. Performs and publishes EOPS aerial surveys.
Micah Horwith WOS Phone: (360) 485-5473	Ocean Acidification Senior Scientist	Coordinates ocean acidification science within Ecology. Provides recommendations to management to address ocean acidification. Oversees data compilation and analysis and reports findings.
NRS4 (vacant) Marine Monitoring Unit	Physical Oceanographer	Analyzes and reports on climate, weather, and ocean indicators. Generates data products and analytical tools. Conducts QA review of data; analyzes and interprets data. Writes reports and data summaries.
Suzan Pool Marine Monitoring Unit Phone: (360) 791-8337	Marine Monitoring Scientist	Manages data workflow, processing, and QA review. Analyzes, and interprets data, and manages data in both the EAPMW and EIM database systems. Generates analytical and QC products and develops tools. Writes reports and data summaries.
Holly Young Marine Monitoring Unit Phone: (564) 669-0458	Marine Waters Field Lead	Coordinates and conducts field sampling, laboratory analysis, instrument calibrations and instrument maintenance. Records and manages field information. Conducts QA review; analyzes and interprets data. Writes reports and data summaries.
Christopher Jendrey Marine Monitoring Unit Phone: (360) 764-9249	Marine Waters Field Scientist	Conducts field sampling, laboratory analysis, instrument calibrations, and instrument maintenance. Records and manages field information. Conducts QA review, analyzes, audits, and interprets data.
Natalie Coleman Marine Monitoring Unit Phone: (360) 790-5152	Ocean Acidification Scientist	Provides expertise to OA parameters. Leads/assists with field sampling. Conducts QA review, analyzes, audits, and interprets ocean acidification data. Assists with sensor assessment and annual calibrations. Writes reports and data summaries.
Julianne Ruffner Marine Monitoring Unit Phone: (360) 280-4518	Unit Supervisor	Provides internal review of the QAMP and addenda, manages the budget, and approves the final QAMP and QAMP addenda.
Stacy Polkowske WOS Phone: (360) 464-0674	Section Manager	Reviews and approves the final QAMP addendum.
Dean Momohara MEL Phone: (360) 871-8801	Acting Director	Reviews and approves the final QAMP addendum.
Arati Kaza Phone: (360) 407-6964	Ecology's QA Officer	Reviews the draft QAMP addendum and approves the final QAMP addendum.

EIM: Environmental Information Management database
MEL: Manchester Environmental Laboratory
MMU: Marine Monitoring Unit
NRS4: Natural Resource Scientist 4
QA: Quality Assurance; QC: Quality control
QAMP: Quality Assurance Monitoring Plan
WOS: Western Operations Section

5.4 Proposed project schedule

Table 2 provides a summary of activities conducted during a routine sampling year under the monitoring plan.

Table 2. Proposed schedule for completing field and laboratory work, data entry into the Environmental Information Management database (EIM), and reports.

Type of work	Due date	Lead staff
Field work completed – sample collection, instrument deployment, data retrieval	Monthly	H. Young, N. Coleman, C. Jendrey
Internal laboratory (MML, MEL) analyses completed	1 month post collection (chlorophyll *a* samples, salinity, bath Winklers, total organic carbon, total nitrogen, particulate carbon, and nitrogen)	H. Young, N. Coleman, C. Jendrey
External laboratory (UW, PMEL) laboratory analyses completed	3 months post collection (nutrients), 2 years (TA/DIC samples)	H. Young, N. Coleman
Aerial observation photos for Eyes Over Puget Sound (EOPS) survey completed	Once a month or as needed	C. Krembs
Instrument and sensor data uploads and subsequent processing and transfer to EAPMW database	Same month as collection	S. Pool, H. Young
Internal laboratory data (MML, MEL) – receipt, processing, and transfer	1 month post analyses	C. Jendrey, H. Young
External laboratory data (UW, PMEL) – receipt, processing, and transfer	3 months post analyses	H. Young, N. Coleman
Instrument and sensor data review and QA/QC and subsequent data adjustments	1 month post collection	S. Pool, NRS4 (vacant), H. Young, N. Coleman, M. Horwith, C. Krembs, C. Jendrey
Sensor assessment bath and performance tests	1 month pre collection	H. Young, N. Coleman, C. Jendrey
Factory and in-house calibrations	Annually pre collection	S. Pool, N. Coleman, C. Jendrey, H. Young
Internal laboratory data (MML, MEL) – review and QA/QC	2 months post analyses	C. Jendrey, S. Pool, H Young, N. Coleman, C. Krembs
External laboratory data (UW, PMEL) – review and QA/QC	4 months post analyses	NRS4 (vacant), S. Pool, N. Coleman, M. Horwith, H. Young, C. Krembs, C. Jendrey
EIM data loaded to study ID MarineWaters	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
EIM data entry review	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
EIM complete	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
Eyes Over Puget Sound (EOPS) Publication	Monthly or as needed	C. Krembs
PSEMP Puget Sound Marine Waters Report	Annually in April	NRS4 (vacant), S. Pool, C. Krembs
Final data products and QA/QC summarized	Annually in May	C. Krembs, NRS4 (vacant), S. Pool
Final performance data quality objectives calculated and submitted to Office of Financial Management	Annually in July	S. Pool

MML: Marine Monitoring Laboratory
PMEL: NOAA Pacific Marine Environmental Laboratory
UW: University of Washington

5.5 Budget and funding

The estimated 2023 budget for Seabird Electronic instruments and sampling platforms (i.e., research vessel) remains similar to the budget provided in Addendum 1 of the QAMP (Bos et al., 2022). The 2023 budget estimates for sample analyses are provided in Tables 4 and 5. These tables do not include ocean acidification samples (TA/DIC) to PMEL as PMEL is supported by a different funding source. This is not the entire cost of the program as it excludes items such as staffing, some internal laboratory samples and supplies, and some field equipment costs (e.g., repairs, administrative costs).

Table 3. The 2023 budget estimate for internal laboratory (MEL) costs.

Parameter	Number of monitoring samples	Number of QA samples	Total number of samples	Cost per sample	Lab subtotal cost
Particulate organic carbon and nitrogen	456	24	480	$46.00	$22,080.00
Total organic carbon	456	24	480	$35.00	$16,800.00
Total nitrogen	456	24	480	$20.00	$9,600.00
Totals	**1,368**	**72**	**1,440**	**$101.00**	**$48,480.00**

Table 4. The 2023 budget estimate for external laboratory costs.

Parameter	Number of monitoring samples	Number of QA samples	Total number of samples	Cost per sample	Lab subtotal cost
Nutrients	1,416	108	1,524	$21.00	$32,004
Salinity	7	3	10	$21.61	$216.10
Totals	**1,423**	**111**	**1,534**	**$42.61**	**$32,220.10**

6.0 Quality Objectives

6.1 Data quality objectives

The data quality objectives will continue to follow those stated in Addendum 1 of the QAMP (Bos et al., 2022).

6.2 Measurement quality objectives

The measurement quality objectives will continue to follow those stated in Addendum 1 of the QAMP (Bos et al., 2022), with the exception of total nitrogen lab analysis. Manchester Environmental Laboratory (MEL) is currently setting up new instrumentation where method detection limits are to be determined.

Table 6 shows updated measurement quality objectives for water sample analyses not reflected in Addendum 1 of the QAMP (Bos et al., 2022). In addition, we plan to add an optical optode and an integrated conductivity-temperature-depth (CTD) instrument. The optode will serve as a reference check alongside a SBE 43 dissolved oxygen sensor during each cast. The integrated instrument will be deployed in coastal bays and is likely to replace a larger profiling package of multiple sensors. Both new instruments are listed in Table 7.

Table 6. Measurement quality objectives for laboratory analyses of water samples.

Laboratory	Parameter	Recovery Limits (%)	Reporting Limit[1]	Method Detection Limit (MDL) or Lowest Concentration of Interest
MEL	Particulate Organic Carbon	±10%	NA	16.5 µg/L
MEL	Particulate Nitrogen	±10%	NA	0.78 µg/L
MEL	Total Organic Carbon	±10%	NA	0.12 mg/L
MEL	Total Nitrogen	±20%	NA	To be determined

[1]See Table 9.
MEL: Manchester Environmental Laboratory

Table 7. Measurement quality objectives for field instrument measurement methods.

Measurement	Precision (relative standard deviation)	Manufacturer (model number)	Manufacturing reported range	Manufacturing reported accuracy	Lowest value
Temperature	±0.005 °C	RBR Duet T.ODO *fast*	-5°C to 35°C	±0.002 °C	-5 °C
Dissolved oxygen	±10 µM	RBR Duet T.ODO *fast*	0 to 500 µM	±8 µM	0 µM
Conductivity	±0.002 mS/cm	RBR *Concerto*	0 to 85 mS/cm	±0.003 mS/cm	0 mS/cm
Pressure	0.25 dbar	RBR *Concerto*	0 to 500 dbar	0.25 dbar	0 dbar
Temperature	±0.005 °C	RBR *Concerto*	-5°C to 35 °C	±0.002 °C	-5 °C
Dissolved oxygen	±10 µM	RBR *Concerto*	0 to 500 µM	±8 µM	0 µM

7.0 Study Design

7.2 Field Data Collection

7.2.1 Sampling locations and frequency

We plan to retain the sampling locations and frequency identified in Addendum 1 of the QAMP (Bos et al., 2022).

7.2.2 Field parameters and laboratory analytes to be measured

We plan to continue to use one CTD package at each station as identified in Addendum 1 of the QAMP (Bos et al., 2022).

With one exception, we plan to continue collecting sample types and depths identified in Addendum 1 of the QAMP (Bos et al., 2022). The exception is a change in salinity replicate samples. Starting in January 2023, we will collect ten replicate samples from annual in-house bath assessments and send them to the University of Washington (UW) for external analysis. The annual assessment will occur in September/October to ensure an annual check of field conductivity sensors and an internal benchtop salinometer used for Marine Monitoring Lab analysis of salinity (Coleman, 2022). Also, we will collect three replicates from monthly in-house bath assessments. The monthly assessments evaluate field sensor performance and benchtop salinometer. We will compare the three sample replicates with the benchtop salinometer and evaluate this instrument against international seawater standards for calibration (Young et al., 2023).

8.0 Field Procedures

8.2 Measurement and sampling procedures

We plan to continue deploying a CTD package with SBE 25*plus* and to use research vessels as the sampling platform. One change is that we plan to use RBR's CTD package integrated with an optical dissolved oxygen sensor. This package is intended for sampling in coastal bays where we have shallow station depths and therefore less discrete bottle samples to collect for lab analysis. A six-month side-by-side comparison of our SBE 25*plus* against the RBR CTD package will be conducted prior to deployment of RBR's CTD package for sole coastal bay data acquisition.

Table 8 shows the sampling plan for each of the 39 stations, showing which parameters are collected by depth. Samples are collected from 0, 10, 30, 80, 140 meters depth and near-bottom (NB), depending on parameter and location. Replicate samples are also listed for each survey, by depth and location

Table 8. Individual sampling plans for the 39 stations sampled monthly.

The table lists routes, stations, and parameters to collect at specified nominal depths (0, 10, 30, 80, 140 m) or near bottom (NB).
The table also shows the total number of samples for each route and parameter and the monthly totals of stations and samples per parameter.

Route	Station	Nutrients	Chlorophyll	POC & PN	TOC	TN	TA/DIC	Salinity	DO	Zooplankton
Coast	GYS008	0	0	-	-	-	0	0	-	-
Coast	GYS016	0,10	0,10	-	-	-	0	0	10	-
Coast	WPA004	0,10	0,10	-	-	-	0	0	-	-
Coast	WPA113	0,10	0,10	-	-	-	0	0	-	-
Coast	WPA006	0,10	0,10	-	-	-	0	0	10	-
Coast	WPA007	0,10	0,10	-	-	-	0	0	-	-
Coast	WPA008	0,10	0,10	-	-	-	0	0	-	-
Coast	WPA003	0	0	-	-	-	0	0	-	-
Coast totals	**8**	**14**	**14**	**0**	**0**	**0**	**8**	**8**	**2**	**0**
Hood Canal	HCB007	0,10,NB	0,10	10,NB	10,NB	10,NB	-	-	NB	-
Hood Canal	HCB004	0,10,30	0,10,30	-	-	-	0,30,30	0,30,30	-	Complete profile vertical tow
Hood Canal	HCB003	0,10,10, 10, 30,NB	0,10,30	10,NB	10,NB	10,NB	-	-	NB	Complete profile vertical tow
Hood Canal	HCB010	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
Hood Canal totals	**4**	**16**	**11**	**6**	**6**	**6**	**5**	**5**	**2**	**2**
South Sound	BUD005	0,10,NB	0,10	10,NB	10,NB	10,NB	0	0	-	-
South Sound	DNA001	0,10,30	0,10,30	-	-	-	0,30,30	0,30,30	-	-
South Sound	NSQ002	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
South Sound	GOR001	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	-	-	NB	-
South Sound	CRR001	0,10,30,NB	0,10,30	10,10,NB	10,10,NB	10,10,NB	0,30	0,30	NB	-
South Sound	CSE001	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
South Sound	OAK004	0,10,10,10	0,10	-	-	-	0	0	-	-
South Sound totals	**7**	**26**	**19**	**11**	**11**	**11**	**10**	**10**	**2**	**0**
Central Sound	OCH014	0,10,NB	-	10,NB	10,NB	10,NB	-	-	-	-
Central Sound	PSB003	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
Central Sound	SIN001	0,10,NB	0,10	10,NB	10,NB	10,NB	-	-	-	-
Central Sound	ELB015	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
Central Sound	EAP001	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	NB	-
Central Sound	CMB003	0,10,30,NB	0,0,0,10,30	10,NB	10,NB	10,NB	0,30	0,30	NB	-
Central Sound totals	**6**	**22**	**16**	**12**	**12**	**12**	**8**	**8**	**2**	**0**
San Juan Islands	BLL009	0,10	0,10	10	10	10	0	0	-	-
San Juan Islands	BLL040	0,10,NB	-	10,NB	10,NB	10,NB	-	-	NB	-
San Juan Islands	RSR837	0,10,30	0,10,30	-	-	-	0,30	0,30	-	-
San Juan Islands	GRG002	0,10,30	0,10,30	-	-	-	0,30,30	0,30,30	NB	-
San Juan Islands totals	**4**	**11**	**8**	**3**	**3**	**3**	**6**	**6**	**2**	**0**
Strait of Juan de Fuca	SJF000	0,30,80,140	0,30,80	-	-	-	-	-	140	-
Strait of Juan de Fuca	SJF001	0,30,80,140	0,0,0,30,80	-	-	-	-	-	-	-

Route	Station	Nutrients	Chlorophyll	POC & PN	TOC	TN	TA/DIC	Salinity	DO	Zooplankton
Strait of Juan de Fuca	SJF002	0,30,80,140	0,30,80	-	-	-	0,30	0,30	-	40-0 and 120-80
Strait of Juan de Fuca totals	**3**	**12**	**11**	**0**	**0**	**0**	**3**	**3**	**1**	**2**
Admiralty/Whidbey	PTH005	0,10,10,10,NB	0,10	-	-	-	-	-	-	-
Admiralty/Whidbey	ADM001	0,10,30	0,10,30	-	-	-	-	-	-	-
Admiralty/Whidbey	ADM002	0,10,30	0,10,30	-	-	-	0,30	0,30	-	-
Admiralty/Whidbey	ADM003	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	-	-
Admiralty/Whidbey	SKG003	0,10,NB	0,10	10,NB	10,NB	10,NB	0	0	-	-
Admiralty/Whidbey	SAR003	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	NB	-
Admiralty/Whidbey	PSS019	0,10,30,NB	0,10,30	10,NB	10,NB	10,NB	0,30	0,30	NB	-
Admiralty/Whidbey totals	**7**	**26**	**19**	**8**	**8**	**8**	**9**	**9**	**2**	**0**
Monthly totals	**39**	**127**	**98**	**40**	**40**	**40**	**49**	**49**	**13**	**4**

8.8 Other activities

We will continue to collect zooplankton samples for the Salish Sea Marine Survival Project (SSMSP) at the Strait of Juan de Fuca station, SJF002, along with two vertical net tows for zooplankton at Hood Canal stations HCB003 and HCB004. For more information on SSMSP see Pacific Salmon Foundation's Salish Sea Marine Survival Project –2017-2018 Research Plan (PSF, 2016).

9.0 Laboratory Procedures

9.1 Laboratory procedures table

Table 9 lists the laboratory methods we will use to analyze water samples during 2023. This shows no change from the 2022 methods identified in Addendum 1 of the QAMP (Bos et al., 2022) except for total nitrogen. The analyte's reporting limit will be determined after the lab completes the method detection limit study.

Table 9. Laboratory measurement methods, expected ranges, and reporting limits. (TBD = to be determined)

Measurement Lab Analyte	Matrix	Expected Range	Reporting Limit	Analytical Methods
Total Alkalinity	Seawater	500-2180 (µmol kg^{-1})	±0.1% µmol kg^{-1}	Dickson et al., 2003; Dickson et al., 2007 (SOP 3b)
Dissolved Inorganic Carbon	Seawater	550-2160 (µmol kg^{-1})	±0.1% µmol kg^{-1}	Dickson et al., 2007 (SOP 2); Johnson et al., 1985, 1987, 1993
Particulate Organic Carbon	Seawater	40-15000 µg/L	40 µg/L	EPA 440.0
Particulate Nitrogen	Seawater	1-1600 µg/L	5 µg/L	EPA 440.0
Total Organic Carbon	Seawater	1-8 mg/L	0.5 mg/L	SM 5310B
Total Nitrogen	Seawater	0.025-1.00 mg/L	TBD	SM 4500NB
Dissolved Inorganic Nitrate	Seawater	0.00 - 40.00 µM	0.15 µM	EPA 353.4; UNESCO, 1994
Dissolved Inorganic Nitrite	Seawater	0.00 - 2.00 µM	0.01 µM	EPA 353.4; UNESCO, 1994
Dissolved Inorganic Ammonium	Seawater	0.00 - 10.00 µM	0.05 µM	EPA 349; UNESCO, 1994
Dissolved Inorganic Orthophosphate	Seawater	0.00 - 4.00 µM	0.02 µM	EPA 365.5; UNESCO, 1994
Dissolved Inorganic Silicate	Seawater	0.00 - 200.00 µM	0.21 µM	EPA 366; UNESCO, 1994
Chlorophyll *a*	Seawater	0.00 - 200.00 µg/L	0.01 mg/L	EPA 445.0
Salinity	Seawater	0.00 - 36.00 PSU	0.002 PSU	UNESCO, 1994
Salinity	Seawater	0.05 – 39.00 PSU	0.05 PSU	Ecology SOP EAP053; Coleman, 2022

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

Data audits are conducted every month, on sensor and lab data after they have been processed and uploaded to the EAPMW database. Annual audits are conducted for every sampling year, after data have been finalized. These audits occur four to six months after the sampling year is completed.

To audit lab data, we track, reconcile, and monitor the status of samples delivered to all laboratories for analyses, and track any problems that arise. After the sampling year is completed, we conduct several audits to assess overall attainment, identify missing or erroneous results and summarize overall completeness.

We audit sensor data results from initial collection through processing and review to finalization. We monitor counts by month and station, auditing at multiple points in the workflow, looking for missing, duplicate, or irregular data results. A final step audits our EAPMW database and after loading, the agency EIM database. This tracking to determine "conservation of data points" ensures all data have been flagged appropriately and no data are overlooked, duplicated, or lost.

12.2 Responsible personnel

Table 5. Staff responsible for data quality assurance and audits.

Marine Monitoring Staff	Title	Responsibilities
Christopher Krembs	Senior Oceanographer	Audits of historical sensor and lab data sets. Monthly participation in CTD data reviews. Monthly data statistical analysis of bath sensor assessment. Leads routine data finalization work and special data QC and management projects.
Micah Horwith	Ocean Acidification Senior Scientist	Leads data statistical analysis, QA/QC and audits of the TA/DIC and salinity data. Monthly review of the TA/DIC field and laboratory data. Leads routine O.A. data finalization work.
Vacant	Physical Oceanographer	Monthly review of the CTD temperature, salinity, and density data. Rotating data duties to run monthly audits at all stages of QC. Does variety of audits on an as-needed basis. Leads routine data finalization work and special data QC and management projects.
Suzan Pool	Marine Monitoring Scientist	Business lead for marine waters data management with EAP Information Technology group; monthly review of CTD, dissolved oxygen, and nitrate data. Rotating data duties to run monthly audits at all stages of QC. Conducts routine, historical, and current data audits; leads routine data finalization work and special data QC and management projects.
Holly Young	Marine Waters Field Lead	Monthly review of the CTD fluorescence data. Leads the monthly tracking, reconciliation, QA/QC and audits of field and laboratory data. Supports variety of audits on an as-needed basis.
Christopher Jendrey	Marine Waters Field Scientist	Monthly review of the CTD transmissometer and turbidity data. Monthly tracking, reconciliation, QA/QC and audits of field and laboratory data. Supports variety of audits on an as-needed basis.
Natalie Coleman	Ocean Acidification Scientist	Leads the tracking, reconciliation, QA/QC and audits of the TA/DIC and salinity data and other field and lab data. Monthly review of the TA/DIC field and lab data. Supports variety of audits on an as-needed basis.

TA/DIC: Total alkalinity/dissolved inorganic carbon

15.0 References

Bos, J., Coleman, N., Horwith, M. Rauschl, E., Albertson, S., Ruffner, J., Krembs, C. 2022. Addendum 1 to Quality Assurance Project Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 22-03-103. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2203103.html.

Coleman, N. 2022. Standard Operating Procedure EAP053, Version 1.0: Marine Water Salinity Sample Analysis. Publication 22-03-201. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2203201.html

Gonski, S., C. Krembs, and G. Pelletier. 2019. Quality Assurance Project Plan; Ocean Acidification Monitoring at Ecology's Greater Puget Sound Stations. Publication 19-03-102. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1903102.html

Keyzers, M., Bos, J., Albertson, S. 2020. Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 21-03-108. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103108.html.

Monitoring Management Committee (MMC). 1988. Puget Sound Ambient Monitoring Program: Final Report. Puget Sound Water Quality Authority, Olympia, WA. https://www.eopugetsound.org/sites/default/files/features/resources/PugetSoundCommResearch1988Optimized.pdf

Pacific Salmon Foundation (PSF). 2016. Salish Sea Marine Survival Project –2017-2018 Research Plan. PSF, 300-1682 West 7th Ave., Vancouver BC Canada V6J 4S6. https://marinesurvival.wpengine.com/wp-content/uploads/Strait-of-Georgia-Marine-Survival-Research-Plan-2017-2018.pdf

Young, H., Coleman, N., Pool, S., Krembs, C. 2023. Standard Operating Procedure EAP086, Version 4.0: Marine Waters Sensor Performance Assessment – Lab Procedures. (In Publication). Washington State Department of Ecology, Olympia.