



BOOTHBAY REGION  
LAND TRUST

# Boothbay Coastal Water Monitoring Project Quality Assurance Project Plan

Boothbay Region Land Trust (BRLT)

February 20, 2020

## Acknowledgments

Many thanks are extended to the Kennebec Estuary Land Trust (KELT) and Friends of Casco Bay for the development of this Quality Assurance Project Plan (QAPP). In particular, thanks go to Ruth Indrick of KELT for her assistance in establishing the Boothbay Coastal Water Monitoring (BCWM) Project in its first year, 2015. The KELT QAPP of 2016 included the Boothbay Region effort. Much information found herein has been blatantly extracted from that KELT plan.

Thank you to Angela Brewer (Maine Department of Environmental Protection, ME DEP), Ruth Indrick (KELT), and Celeste Mosher (Maine Coastal Observing Alliance, MCOA) for their help in guiding the development of the methods used in the Project. Thanks to staff from the Bigelow Laboratory for Ocean Sciences for their technical support.

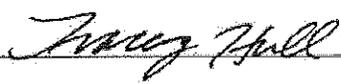
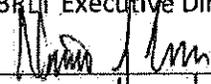
Support from the John Sage Foundation helped to fund the development of this Quality Assurance Project Plan.

# Boothbay Coastal Water Monitoring Project Quality Assurance Project Plan

## Section A: Project Management

### A1: Approval Page

#### Approvals:

Tracey Hall BRLT Environmental Educator  Date: <u>1/30/20</u>	Angela D. Brewer ME DEP Marine Section Leader  Date: <u>3/2/20</u>
Nick Ullo BRLT Executive Director  Date: <u>1/30/20</u>	Bill Longfellow ME DEP QAPP Review Coordinator  Date: <u>3/2/20</u>

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## A2: Distribution List

Angela Brewer, ME DEP Marine Section Leader (Science Advisory Board member)

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Sarah Gladu, Chair, MCOA

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Celeste Mosher, MCOA (Science Advisory Board member)

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Kathleen Thornton, University of Maine Darling Marine Center (Science Advisory Board member)

Nick Ullo, Executive Director, BRLT

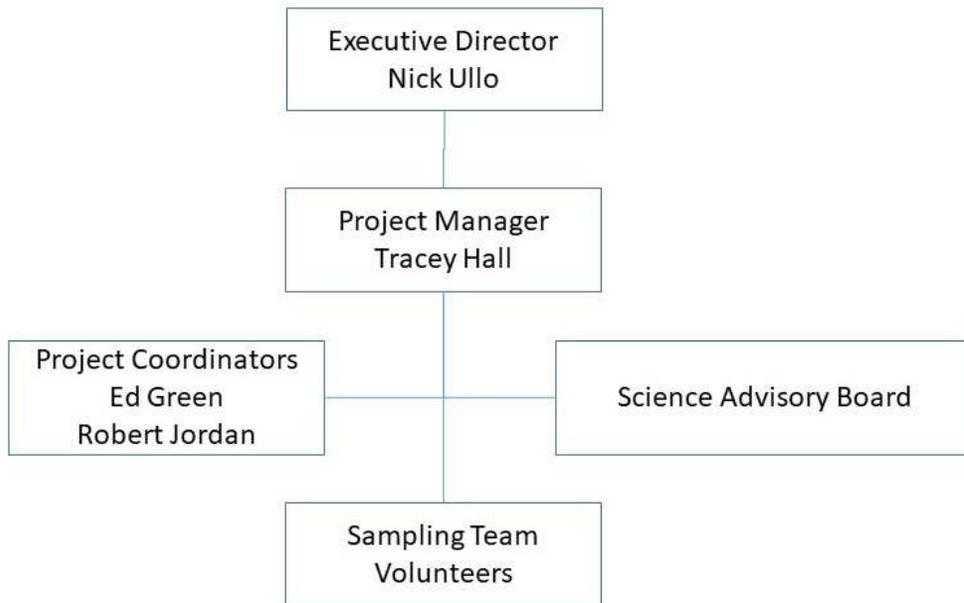
## A3: Project / Task Organization

The organization of the Boothbay Coastal Water Monitoring (BCWM) Project is shown in Figure 1.

The Boothbay Region Land Trust (BRLT) Environmental Educator will serve as the BCWM Project Manager (PM) to execute the overall water quality Project. The PM is responsible for maintaining the QAPP (i.e. regular review and revision, when appropriate) and for all data/information sharing. The PM will also approve the Quality Assurance Project Plan (QAPP), train volunteers in approved water sampling methods, and provide technical assistance throughout the project. The Project Coordinators (PC) will conduct volunteer training and Quality Assurance (QA) sessions, review collected data, network with other water quality monitoring projects, work to raise awareness of water quality issues within the community, oversee (with the PM) the selection and maintenance of equipment for the coastal water monitoring project and will be responsible for digitization and integrity of all data collected as well as any data reduction required for analysis.

In 2019 a BCWM Science Advisory Board (SAB) was established to include other land trusts, government, research organizations, and academia. The intent of this Board is to ensure the technical integrity of this BCWM Project and that future direction is shaped consistent with the needs of the Boothbay community. The SAB members include: Angela Brewer, Maine DEP; Deborah Bronk, Bigelow Laboratory for Ocean Sciences; Celeste Mosher, MCOA; and Kathleen Thornton, University of Maine Darling Marine Center.

FIGURE 1 ORGANIZATION CHART



#### A4: Problem Definition and Background

The Boothbay Harbor economy is diversified among several business categories. However, the waterfront represents a most important component of the town's economic base. Jobs associated with marine resources, marine infrastructure repair and service, and the boat trades have been part of the Boothbay Harbor economy throughout the town's history. Marine resources are also highly valued for tourism, recreation, and habitat preservation. The continuity and growth of the community's marine-related activities and the need to create more public access to the shore continue to be priorities of this region.

A 2010 report, *The Kennebec Estuary: Restoration Challenges and Opportunities*, stated "without a better understanding of the processes and potential factors influencing local water quality conditions in the estuary, the need for and feasibility of adjustments to current water quality management will remain uncertain." In response, KELT developed the Water Awareness in Kennebec Estuary (WAKE) water monitoring program to take action to gather that missing information and share it with the region. With the same stimulation and motivation, the BCWM project began in 2015 through a strong connection with the KELT program. Through coordination between the BRLT and KELT, Ruth Indrick helped establish the BRLT water

monitoring project under the same premise, sampling goals, and procedures as the KELT WAKE program.

In a 2015 report entitled “Boothbay Harbor Comprehensive Plan” the vision statement includes the following:

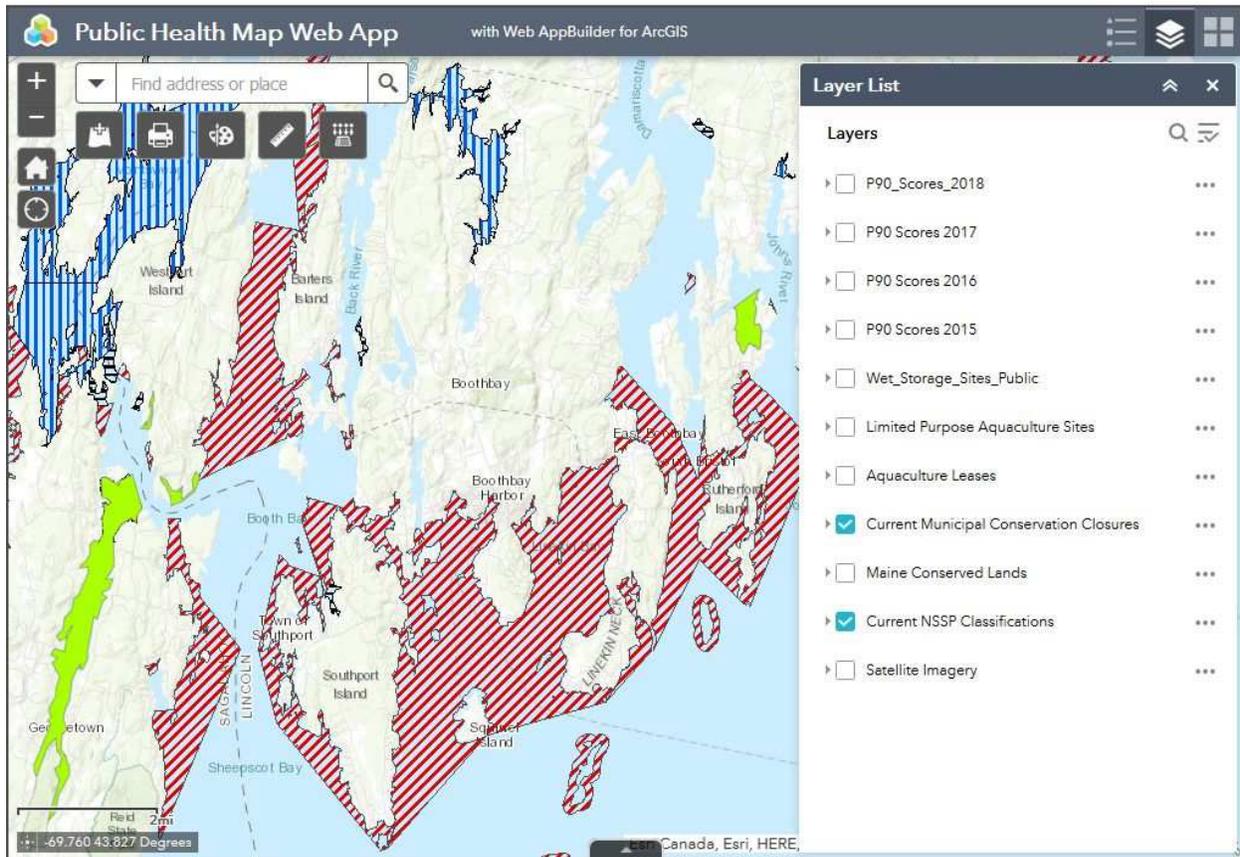
“Fresh water, tidal flats, wetlands, and coastal and ocean waters—water is integral to most every aspect of life in Boothbay Harbor. From shellfish and fishery resources, wildlife habitats, scenic views and recreation, to shipbuilding, real estate and tourism, these assets are the foundation of this community, our sense of place and our economic future”. “Boothbay Harbor’s work in coordination with state and federal agencies will continue to improve the quality of harbor and coastal waters and benefit local fisheries, boating, aquaculture, and tourism sectors.” “The Town will monitor rising sea levels and storm surges, and take steps to plan to protect susceptible areas or reduce potential adverse impacts.”

This same report indicates the following five areas of concern that are primary motivating factors for the BCWM Project:

1. Clamming, shellfish harvesting, and worming: There are a number of families that depend on these endeavors for their livelihood. For the Boothbay Region, many areas are prone to shellfish closures as shown in Figure 2.

FIGURE 2 MAINE DMR SHELLFISHING PROHIBITED AREAS

EXTRACTED FROM [HTTPS://WWW.MAINE.GOV/DMR/SHELLFISH-SANITATION-MANAGEMENT/MAPS/INDEX.HTML](https://www.maine.gov/dmr/shellfish-sanitation-management/maps/index.html), AUG 2019



2. These closures include nearly all of the coastal waters of Boothbay Harbor and areas of point-source pollution: It should be noted that the Boothbay Region has one of the highest concentrations of overboard discharge (OBD) systems in the Maine Mid-Coast.
3. Concern that the closing of clam or worm flats has threatened the shellfishing industry, and that sources of contamination are not fully known: See Figure 2 for areas prone to shellfish closures, which include nearly all of the coastal waters of the Boothbay Harbor Region. Water quality can be degraded by multiple factors resulting from natural occurrences and from human activity. Point source pollution originates from a single point, such as an outflow pipe or an overboard discharge. Non-point source pollution can result from storm water runoff of fertilizer, phosphorus, or other chemicals. Dissolved oxygen in Linekin Bay is decreasing and creating stresses for marine life. Causes for this may include both point and non-point sources such as storm water runoff, changes in circulation, and bacteria and chlorine from overboard discharges. As stated in this 2015 report, “Additional monitoring of oxygen levels in the harbor is recommended”

4. The cause and effect of sea-level rise: The Lincoln County Regional Planning Commission, the Maine Geological Survey, the Maine Coastal Program and the National Oceanic and Atmospheric Administration (NOAA) completed a study of the potential impacts of sea level rise on Lincoln County including Boothbay Harbor. For study results see <http://lcrpc.org/sea-level-rise-scenarios>. Many scientists believe that sea level will increase between 2 feet and 6 feet along the Lincoln County coastline in the next 100 years. In fact, considering only current Antarctic and Greenland ice sheet and polar ice cap melting rates and the effects of ocean thermal expansion, sea level is projected to rise 12.6 inches by 2050 alone. There are concerns that rising sea temperatures could affect lobstering and lead to the introduction of warm water intruders, such as green crabs, into a formerly cold-water habitat.
5. Ocean and Coastal Acidification: About half of the CO<sub>2</sub> released into the atmosphere by human related activities is absorbed by the atmosphere. The rest is absorbed by the oceans and the terrestrial biosphere. During the past several decades the amount of CO<sub>2</sub> absorbed by the atmosphere has increased greatly. Coastal acidification differs from ocean acidification in that ocean acidification is a global process where the pH of oceans decreases primarily by the absorption of CO<sub>2</sub> from the atmosphere. Coastal acidification is fueled by nutrients entering the water from land (e.g., runoff) stimulating phytoplankton blooms that decompose on or near the seabed. Consequences are lower pH (higher acidity) and lower concentrations of dissolved oxygen (DO). Currently the BCWM Project is partnering with the UMaine, NOAA and the Northeast Coastal Acidification Network (NECAN) to support future efforts for 2019 and beyond.

The BCWM Project will continue to sample at the eleven sites identified in 2015 for water quality sampling, (see Table 2 and Figure 3 in Section A6). This BCWM effort will utilize equipment, tools and standardized procedures to measure pH, salinity, dissolved oxygen, water clarity, and water temperature. Through the measurement, recording, and dissemination of these data, the primary goals of this Project are the following:

- Continue a sustainable volunteer water quality-monitoring program in the Boothbay region that follows state-approved methods and procedures;
- Raise awareness about the region's coastal ecosystems and water quality in local communities and in statewide settings;
- Allow ongoing and expanded water monitoring in subsequent years that will enhance public awareness and guide water resources management by the region's towns to better sustain local fisheries, recreation, and residents' health;
- Provide the data we collect to appropriate state, university, and research venues to assist in the determination of the impact of water quality on the coastal environment and ecosystem.

This BCWM Project will continue the collaboration initiated in 2015 with the following: The Bigelow Laboratory of Ocean Sciences, a nonprofit institution located in East Boothbay that is dedicated to research, education, and the promotion and use of knowledge related to ocean sciences; KELT, which assisted in establishing the initial BCWM water quality monitoring project in 2015, and MCOA, a consortium of local citizen groups seeking to build a regional perspective of estuarine water quality.

## A5: Project / Task Description

The goal of the BCWM Project is to collect water quality data at coastal sites in the designated Boothbay Region between the months of May and October. Currently, sampling will take place in the morning every other week based on a schedule defined before the beginning of the sampling season. All samples are collected within 1.5 hours of high tide. Characteristics tested include: water temperature, salinity, dissolved oxygen, pH, and water clarity. Environmental conditions such as cloud cover, wind speed and direction and air temperature are also noted. In the future, sampling may occur at ebbing tides and low tides. These events will be considered based on scientific need and BRLT resources.

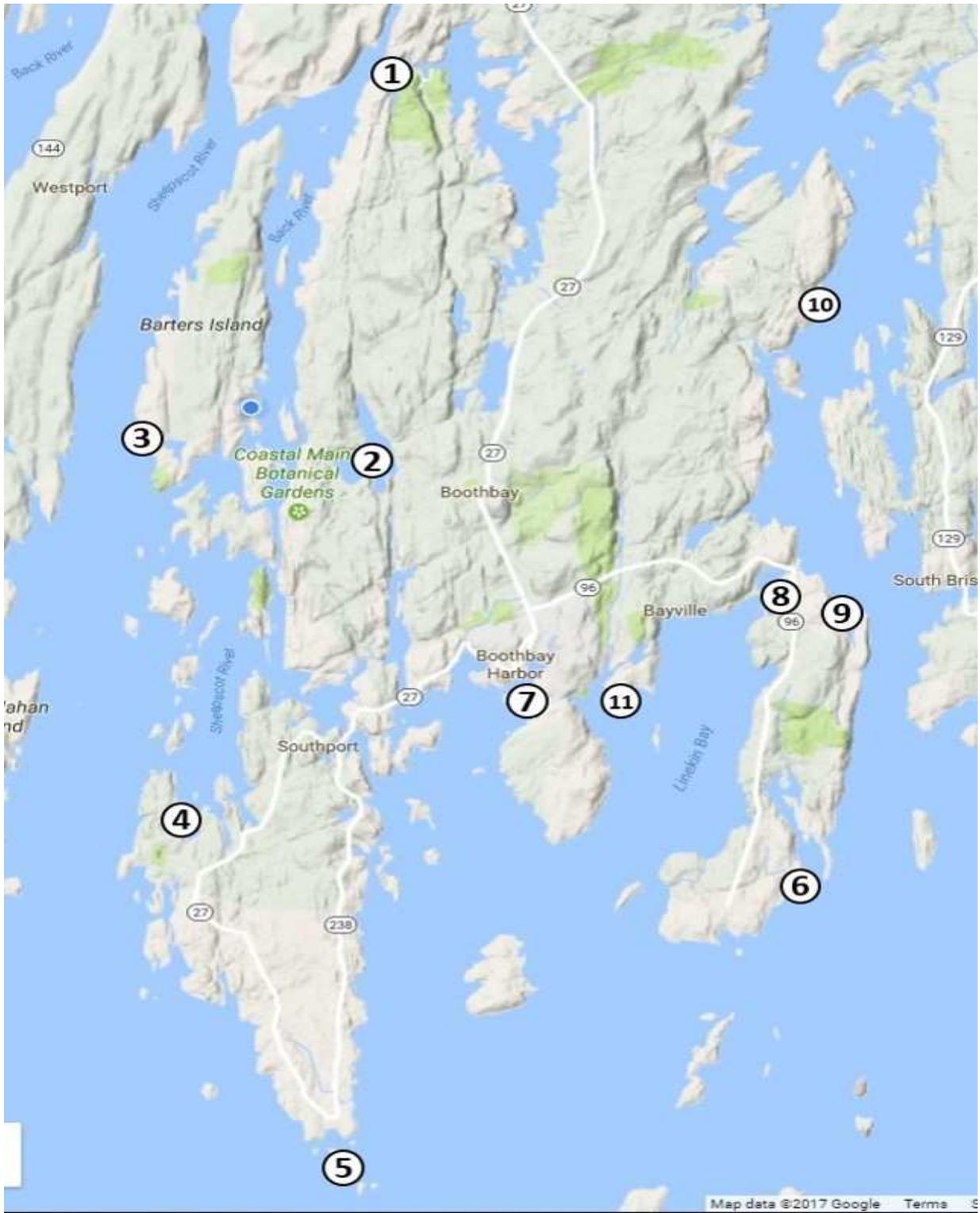
All tasks, including planning, training/certifying, monitoring, supporting volunteers, documenting, submitting, and analyzing, will follow the procedures outlined in this QAPP. Table 2 shows an outline of tasks that will take place in each month and participants for each task.

The sampling sites for the Boothbay Region are shown in Table 1 and Figure 3. These sites are located in the lower reaches of the Sheepscot and Damariscotta Rivers and the bays that connect these two estuaries. This region is marked by the Sheepscot River Estuary to the west, the Damariscotta River Estuary to the east, and the numerous islands, coves and bays that constitute the region of Sheepscot Bay, Booth Bay, and Linekin Bay. This area is rich in its support of commercial lobstering and fishing as well as recreational boating. All of these attributes provide a strong basis for a vibrant economy for the Boothbay Region.

**TABLE 1 LIST OF SAMPLING SITES**

<b>Site ID</b>	<b>Site Description</b>	<b>Latitude</b>	<b>Longitude</b>
B 1	Oven's Mouth	43.934520	-69.646957
B 2	Knickercane Landing	43.880323	-69.663514
B 3	Robert's Wharf	43.880053	-69.684300
B 4	Dogfish Head	43.828802	-69.679429
B 5	Newagen	43.786284	-69.655321
B 6	Little River	43.825035	-69.584009
B 7	Boothbay Harbor Footbridge	43.850950	-69.625813
B 8	Linekin Bay	43.861729	-69.590452
B 9	Bigelow Dock	43.860532	-69.578157
B 10	Damariscotta River	43.902886	-69.580232
B 11	Linekin Bay Resort	43.845842	-69.611534

FIGURE 3 MAP OF SAMPLING SITES



**TABLE 2 PROJECT TASKS**

1. Project Planning											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators, BRLT Executive Director</li> </ul>											
2. QA Refresher for existing trained volunteers											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators, Water Quality Monitoring Volunteers</li> </ul>											
3. Training for new volunteers											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators, Water Quality Monitoring Volunteers</li> </ul>											
4. Volunteer Support and Sampling Kit Maintenance											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators</li> </ul>											
5. Volunteer Water Quality Monitoring											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators, Water Quality Monitoring Volunteers</li> </ul>											
6. Site Visits with Volunteers											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators, Water Quality Monitoring Volunteers</li> </ul>											
7. Data Entry, Data Review, and Database Management											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<ul style="list-style-type: none"> <li>Participants: Project Manager, Project Coordinators</li> </ul>											

8. Submit Data to Maine DEP

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
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- Participants: Project Manager

9. Data Analysis and Preparation of Annual Report

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
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- Participants: Project Manager, Project Coordinators

## A6: Data Quality Objectives and Criteria for Measurement

The BCWM Project collects the highest quality data possible using relatively simple and affordable methods and tools that can be utilized by volunteers who may not have prior experience in water quality testing.

Data quality indicators include: precision, sensitivity, accuracy, bias, representativeness, comparability, and completeness. The objectives for data quality are outlined in Table 3, and descriptions of how the project will meet the objectives are detailed below.

### A: Precision:

- Temperature, Salinity, pH
  - Dependent upon the precision capabilities of the instrument.
- Dissolved Oxygen
  - Dependent upon the precision capabilities of the instrument.
  - Two dissolved oxygen readings will be taken. If the difference between these two readings is greater than 0.6mg/L, the Volunteer will take a third reading. The average of the two closer values will be used.
- Water Clarity
  - Dependent upon the precision capabilities associated with the Secchi Disk technique and associated training.

### B: Sensitivity:

- Temperature, Salinity, Dissolved Oxygen
  - Determined by the smallest measurement increments presented on the equipment.
- pH, Water Temperature (from pH meter)
  - Determined by sensitivity capabilities of the instrument.
- Water Clarity
  - Determined to the nearest 0.1m using the transect tape attached to the Secchi disk.

### C: Accuracy:

- Temperature, Salinity, pH, DO
  - Calibration procedures, described in Section B5, will be used to ensure the accuracy of the temperature and salinity measurements. The pH meters will also be calibrated on each sampling date using a pH7.01 buffer and a pH10.01 buffer. DO meters are calibrated on each sampling date.
- Water Clarity
  - All Secchi disks are attached to nylon covered fiberglass 30 meter transect tapes marked in centimeters.

### D: Bias:

Sampling dates are scheduled at the beginning of the season to limit bias caused by weather or river discharge conditions. Bias, in relation to tide, is acknowledged and is a recognized

component of this sampling protocol. Morning bias seeks to monitor the sites when dissolved oxygen concentrations may be lowest. All sites are accessible at high and low tide.

- Temperature, Salinity, pH
  - Calibration procedures as described in Section B5 will be used to ensure the accuracy and lack of bias, of the temperature, salinity, and pH measurements. pH meters will also be calibrated on each sampling date using a pH7.01 buffer and a pH10.01 buffer. The volunteer trainings, refreshers, and field visits will ensure that volunteer technique does not introduce bias during the field sampling.
- Dissolved Oxygen
  - Two dissolved oxygen readings will be taken. If the difference between these two readings is greater than 0.6mg/L, the Volunteer will take a third reading.
- Water Clarity
  - All Secchi disks are attached to nylon covered fiberglass 30 meter transect tapes. The volunteer trainings, refreshers, and field visits will ensure that volunteer technique does not introduce bias during the field sampling.

#### E: Representativeness:

Seasonality, rainfall, river discharge, tide stage, air temperature, wind, and cloud cover are all factors that affect the representativeness of temperature, salinity, dissolved oxygen, pH, and water clarity measurements recorded. These seven (7) influencing factors will be recorded at each site on each sampling date so that they can be taken into account during data analysis. Sampling dates are scheduled at the beginning of the season so that spring, summer, and fall seasons are represented and so that sampling dates are not selected on the basis of rainfall, river discharge, tide stage, air temperature, wind, or cloud cover.

All sampling will take place within a 3 hour window, 1.5 hours on either side of high tide as predicted by NOAA for Boothbay Harbor, and thus sampling is not representative of all tide stages. Low tide sampling is currently not represented in this project but may in the future.

The samples collected in this project are also not representative of all times of day. Sampling will target the morning hours. Previous volunteer sampling by the Friends of Casco Bay Volunteer Water Quality Monitoring Program has found that DO concentrations are lowest in the morning. As the day progresses, DO values increase as increased light results in increased photosynthesis. Sampling will take place between the hours of 8-10 am. The tide schedule will result in some sampling that takes place before 8:00 am or after 10:00 am.

#### F: Comparability

Sampling methods were selected because they are relatively easy for volunteers, affordable, and they align with methods in use by other coastal volunteer water quality monitoring projects in Maine. All project Volunteers will be trained in the same techniques and will follow the same set of sampling procedures. All project Volunteers will use the same datasheets.

- Temperature, Salinity

- The calibration procedures will ensure that the temperature readings on all digital instruments are comparable.
- Dissolved Oxygen
  - All volunteers will use the same methods, and the same make and model of instruments. DO meters are calibrated each sampling day before use.
- pH
  - pH meters will be calibrated to ensure that pH readings on all pH meters are comparable. pH meters will be calibrated each day before use in water quality monitoring using pH7.01 and pH10.01 buffer solutions.
- Water Clarity
  - All Secchi disks are attached to nylon covered fiberglass 30 meter transect tapes.

G: Completeness:

Attempts will be made to sample at all sites on all scheduled sampling dates, but unforeseen circumstances, including dangerous weather conditions, closed roads, or personal emergencies, may occur. As a result, the dataset will be considered complete if no more than four sampling dates are missed for each site.

**TABLE 3 DATA QUALITY OBJECTIVES**

Parameter	Method	Equipment	Calibration Method	Method Range of Detection	Units	Sensitivity	Precision	Accuracy
Dissolved Oxygen	Digital Meter	Extech DO600	Internal Meter Calibration	0 – 20	Mg/l	0.01 mg/l	NA	+/-2.0% FS (Full Scale)
				0-200	% Sat	0.1%		+/- 2.0% FS
Water Temperature	Digital Meter	Extech EC170	Internal Meter Calibration	0 - 50	Degrees C	0.1	+/- 0.1	+/- 0.5
Air Temperature	Digital Meter	Drok 100128 digital thermometer and B3950-10K, waterproof sensor	NA	-50 ~ 110 °	°C	NA	+/- 0.1	+/- 0.1
Salinity	Digital Meter	Extech EC170	Internal Meter Calibration	10.1 – 70.0	Parts per Thousand (ppt)	0.1	NA	+/- 1 Digit
pH	Digital Meter	Extech pH100	pH Buffer 7.01 and 10.01	0.00 - 14.00	Standard pH Units	0.01	NA	./- 0.01
Water Clarity	Secchi disk without mask	Secchi Disk; 8" B&W	30 meter nylon covered fiberglass transect tape	0-30m	Meters (m)	0.01	NA	0.01

- NA: Not Available
- Except for Water Clarity and air temperature, all data for Sensitivity, Precision, and Accuracy are from Extech documentation

## A7: Training Requirements / Certification

### A: Training:

#### Project Managers and Project Coordinators;

- The PM and PC's must undergo the same training as a Volunteer as described below.
- PM and PC must have two years of experience in the BCWM Water Quality Monitoring Project or similar program. A Bachelor's degree and experience in project management is desired.

#### New Volunteers

- New Volunteers will complete a Volunteer Training Program before collecting samples for the Water Quality Monitoring Project. This training includes:
  - Introduction to what, why, and how monitoring is completed: The Project Manager or the Project Coordinator will lead a discussion of the site characteristics that are recorded, all characteristics that are tested (pH, DO, salinity, temperature, and water clarity), the reason these characteristics are important to Maine's estuaries, and a discussion of the methods our project uses to test these characteristics.
  - Field sampling practice: After the initial introduction, the Project Manager or the Project Coordinator will go with the Volunteers to a field site to practice the methods used for sampling. Alternatively, volunteers will complete the field sampling practice in a classroom with pre-collected buckets of water. Volunteers will fill out the environmental conditions, pH, and salinity sections of the datasheet. Volunteers will be trained for the testing of salinity, DO, pH and the recording of water temperature and air temperature. All volunteers will be trained in the use of a Secchi disk at a field site.
  - All completed datasheets will be signed and dated by the Project Manager or the Project Coordinator to confirm completion of the training. Volunteer attendance will be recorded on the Volunteer Database Spreadsheet (Table 4).
  - All new Volunteers will be given a copy of the BCWM Volunteer Manual; Volunteers can use this during the training to follow along with the introduction, as an aid during the field sampling practice, and as a reference for the duration of their time as a Volunteer.

#### Existing Volunteers

- Existing Volunteers who have already completed the Volunteer Training will be expected to complete a Quality Assurance Refresher annually. Both group and individual options for a refresher will be available. The Project Manager or the Project Coordinator will observe volunteers during the refresher.

- A volunteer field visit scheduled on one of the first three sampling dates that the Volunteer is able to attend can also qualify as an annual QA refresher for a returning Volunteer
- If any significant errors in sample collection or data entry are noted on a field visit that takes place during the second or third sampling date, the data collected by this Volunteer on the first or second sampling date will be considered invalid.
- All completed sampling datasheets will be signed and dated by the Project Manager or the Project Coordinator to confirm completion of the refresher. Volunteer attendance will be recorded on the Volunteer Database Spreadsheet, (Table 4).
- If an existing Volunteer has been inactive in the BCWM Project for one or more years and seeks to return to volunteering, that Volunteer will be considered a new Volunteer and will be expected to follow the guidelines for new Volunteers.
- In addition, an on-line training video exists on the BRLT YouTube page ([https://www.youtube.com/watch?v=PlIA\\_2pSW88&t=1462s](https://www.youtube.com/watch?v=PlIA_2pSW88&t=1462s)). This video walks the volunteer through all phases of the site observations, sampling procedures, and recording practices.

## B: Volunteer Field Visit:

### New Volunteers

- The Project Manager or the Project Coordinator will make a field visit to the Volunteer's field site while they are collecting their sample once during the sampling season for all new volunteers. During this field visit they will make observations about the Volunteer's methods and data entry to ensure that all data collection follows the procedures in the BCWM Volunteer Manual and meets the guidelines outlined in this QAPP. Additionally, the PM or PC will sample alongside the volunteer using their own meters to ensure that the volunteer's data are comparable. These observations will be recorded on the Field Visit Notes sheet.
- If instances of inconsistent data or errors are noted on a Volunteer's datasheet, the Project Coordinator will contact the Project Manager and the Volunteer to inform them of the inconsistency or error and an additional field visit may be scheduled.

### Existing Volunteers

- The Project Manager or the Project Coordinator will make a site visit to an existing Volunteer's field site while they are collecting their sample once every two years for all existing Volunteers. During this field visit, they will make observations about the Volunteer's methods and data entry to ensure that all data collection follows the procedures in the BCWM Volunteer Manual and meets the guidelines outlined in this QAPP. Additionally, the PM or PC will sample alongside the volunteer using their own meters to ensure that the

volunteer's data are comparable. These observations will be recorded on the Field Visit Notes sheet.

- If instances of inconsistent data or errors are noted on a Volunteer's datasheet, the Project Coordinator will contact the Project Manager and the Volunteer to inform them of the inconsistency or error and an additional field visit may be scheduled.

## A8: Documentation and Records

### 1. BCWM Quality Assurance Project Plan

- The PM will be responsible for all data and information sharing.
- Digital copies of the approved QAPP will be emailed to all members of the Distribution List.
- Hard copies of the plan will be made available by request.
- A copy of the approved plan will be posted on the BRLT website (<https://bbrlt.org/what-we-do/coastal-water-monitoring/>).

Data Storage: The BCWM Quality Assurance Project Plan will be saved on the BRLT server. The server is continuously backed up locally on a duplicate hard drive as well as in the cloud.

### 2. BCWM Volunteer Manual (Appendix A)

- The PM will be responsible for all data and information sharing.
- A copy of the BCWM Volunteer Manual will be given to each water quality monitoring volunteer.
- A copy of the BCWM Volunteer Manual will be posted on the BRLT website (<https://bbrlt.org/what-we-do/coastal-water-monitoring/>).

Data Storage: The BCWM Volunteer Manual will be saved on the BRLT server.

### 3. Calibration Datasheet (Figure 4)

- The calibration datasheet will be filled in twice annually for all equipment used to monitor temperature, salinity, and pH. pH calibration data will be recorded on the Water Sampling Datasheet at each site sampling event. (see Figure 6)

Data Storage: Hard copies of the Calibration Datasheet will be filed at the BRLT office and kept on-hand for 2 years. These datasheets will be scanned and saved in digital format on the BRLT server.

### 4. Volunteer Database Spreadsheet (Table 4)

- Volunteer completion of trainings, refreshers, and field visits will be entered into this spreadsheet.

Data Storage: The Volunteer Database Spreadsheet will be saved in digital format on the BRLT server.

### 5. Field Visit Notes (Figure 5)

- The PM or PC will fill out this form during all field visits.

- The information recorded will both certify that a volunteer is following quality assurance (QA) procedures outlined in this QAPP and will help to inform the content of future volunteer trainings and refreshers.

Data Storage: Hard copies of the Field Visit Notes will be filed at the BRLT office and kept on-hand for 2 years. These datasheets will be scanned and saved in digital format on the BRLT server.

6. Water Quality Monitoring Datasheet (Figure 6)

- Volunteers will enter all data onto these datasheets during sample collection.
- These datasheets will also be used during New Volunteer Trainings and QA Volunteer Refreshers for data entry.
- Volunteers will only enter data into unshaded sections of the datasheet.
- The PM or PC will enter these data into the Water Quality Monitoring Database.

Data Storage: Hard copies of the Water Quality Monitoring Datasheets that are filled out during water quality monitoring will be filed at the BRLT office and kept on-hand for two years. These datasheets will be scanned and saved in digital format on the BRLT server. The information from the datasheets will be entered into the BCWM Water Quality Monitoring Database. Hard copies of the Water Quality Monitoring Datasheet that are filled out during volunteer trainings or volunteer refreshers will be filed at the BRLT office and kept on-hand for two years. These datasheets will be scanned and saved in digital format on the BRLT server.

7. BCWM Water Quality Monitoring Database

- All information recorded on the Water Quality Monitoring Datasheets will be entered into this database.

Data Storage: The BCWM Water Quality Monitoring Database will be saved on the BRLT server.

8. BCWM Project Annual Reports

- The reports will be compiled from analysis of the water sampling data.
- Copies of the reports will be emailed to volunteers and will be posted on the BRLT website.

Data Storage: The BCWM Project Annual Reports will be saved on the BRLT server.

**FIGURE 4 CALIBRATION DATA SHEET**

Coastal Water Quality Monitoring Calibration Data Sheet							
<b>Temperature</b>							
Instrument type	ID #	Date	Temperature within 0.5°C of NIST certified thermometer reading?	Action	Completed by:		
			Yes / No				
			Yes / No				
<b>Salinity</b>							
Instrument type	ID #	Date	Low salinity within 1.0 ppt of calibrated conductivity meter?	Medium salinity within 1.0 ppt of calibrated conductivity meter?	High salinity within 1.0 ppt of calibrated conductivity meter?	Action	Completed by:
			Yes / No	Yes / No	Yes / No		
			Yes / No	Yes / No	Yes / No		
<b>pH</b>							
Instrument type	ID #	Date	7.01 buffer within 0.05 pH units?	10.01 buffer within 0.05 pH units?	Action	Completed by:	
			Yes / No	Yes / No			
			Yes / No	Yes / No			

**TABLE 4 VOLUNTEER DATABASE SPREADSHEET**

Volunteer Name	Volunteer Address	Volunteer Phone #	Volunteer Training Phase 1 (Date)	Volunteer Training Phase 2 (Date)	Volunteer Site Visit 2019 (Date)	Volunteer Refresher 2020 (Date)	Volunteer Site Visit 2021 (Date)	Volunteer Refresher 2022 (Date)	Notes

(Note: Spreadsheet will be expanded to add more 'Volunteer Refresher' and 'Volunteer Site Visit' columns for future years.)

**FIGURE 5 FIELD VISIT NOTES**

**Coastal Water Quality Monitoring Field Visit Notes**

<b>Project Manager or Project Coordinator</b>				
<b>Volunteer Name</b>				
<b>Date</b>		<b>Time</b>	<b>Town</b>	
<b>Site 1</b>		<b>Site 2</b>		

<b>Weather Conditions</b>		
<b>Characteristic</b>	<b>Completed Correctly Alone (Circle)</b>	<b>Needed Assistance to Complete Correctly (Describe)</b>
% Cloud Cover	Yes / No	
Air Temperature	Yes / No	
Wind Speed	Yes / No	
Wind Direction	Yes / No	
Tide	Yes / No	
Precipitation	Yes / No	
Observations	Yes / No	

<b>Water Sample</b>		
<b>Characteristic</b>	<b>Completed Correctly Alone (Circle)</b>	<b>Needed Assistance to Complete Correctly (Describe)</b>
pH	Yes / No	
Temperature	Yes / No	
Salinity	Yes / No	
DO	Yes / No	
Water Clarity	Yes / No	

Other Comments

**FIGURE 6 WATER QUALITY MONITORING DATASHEET**

Site #		Site Description			Town					
Date			Start Time							
Sampler(s)										
<b>Environmental Conditions</b>										
% Cloud Cover (circle)  (0%=clear, 100%=all clouds)	0%	25%	50%	75%	100%	Precipitating now? (circle) Yes / No				
						Precipitation in the last 24 hours? Yes / No				
Wind Speed Record Beaufort Number (1-6)					Tide (circle one)	Incoming / Outgoing / Slack High or Low				
Direction Wind is Coming From (circle)	N	NW	W	SW	S	SE	E	NE	Air Temperature	°C
Observations (within 100m)										
Description of Observations										
<b>Salinity meter tests</b>										
Salinity Reading							Water Temperature			°C
<b>pH meter calibration test</b>							Calibrated 7.01			Yes/No
pH Reading							Calibrated 10.01			Yes/No

<b>Dissolved Oxygen test</b>		
Dissolved Oxygen Reading 1	_____ • _____ mg/L	
Dissolved Oxygen Reading 2	_____ • _____ mg/L	Difference: _____
Dissolved Oxygen Reading 3 (if req'd)	_____ • _____ mg/L	If the difference between Reading 1 and Reading 2 is greater than 0.6mg/L, the Volunteer will take a third reading.

**Optional: if Site is at Dock or Bridge**

<b>Water Clarity-Secchi Disk</b>				
Hit Bottom?	Yes / No			
<u>If Yes:</u>	Depth to Bottom	_____ • _____ meters		
<u>If No:</u>	Depth Disk Disappears	_____ • _____ meters	Depth Disk Reappears	_____ • _____ meters

<b>Comments :</b>	
-------------------	--

<b>Sampling Verification</b>			
Sampling Signature		End Time	
Receiver Signature		Receive Time	

<b>BCWM Staff Data Entry</b>			
Entered By		Date	

<b>BCWM Staff Data Review</b>			
Reviewed By		Date	

## Section B: Measurement/Data Acquisition & Validation

### B1: General Sampling Procedures

#### Monitoring Sites

Water sampling will take place from the shore at designated water quality monitoring sites as shown in Table 2 and Figure 3. These sites are set up to gather water quality information from a variety of distinct areas in the Boothbay Harbor region, to target areas where there are concerns about water quality, or to target areas adjacent to town shellfish flat resources. These sites were defined in 2015 in coordination with recommendations made by Bigelow Lab. Consideration was given to location of complimentary existing sites (example: Maine Department of Marine Resources - DMR Shellfish Growing Area Classification Program sites) in order to augment existing datasets of water quality information. If there is not an existing site near a location where we seek to carry out water quality monitoring, we will work with the Science Advisory Board, local residents, Volunteers, and Community Project Guides to identify and approve new sample site locations. Currently all 11 sites utilize a pier or float to gain access to the site. In the future, if there is no pier or float, volunteers will wade into their site and collect water from a location where it is at least 12 inches deep. All sites will be identified with a site ID #, site description, photograph, and decimal degree coordinates. Volunteers will sample within 100ft of the site location. It is possible that water quality monitoring may be expanded to new sites and new towns in future years.

#### Water Quality Monitoring Schedule

Annual planning: All monitoring will be conducted from May through October (see Table 2). Currently, all piers and floats are in place for a May water sampling start-up. This will avoid times of year when low temperatures and ice are detrimental to volunteer safety. A schedule of monitoring dates for each season will be developed before the initial sampling in May to prevent bias.

Tide: Currently, all monitoring will take place within a three hour window, 1.5 hours on either side of high tide to ensure that water is present at the sample sites. Monitoring dates will be scheduled every two weeks depending on the timing of the tides. Sampling for each volunteer group will take place on a consistent day of the week. If other than high tide sampling is performed, this QAPP will be updated to reflect those considerations.

Hours: Monitoring will be carried out between the hours of 8 and 10 am in order to minimize the impact of submerged plant photosynthesis.

Rescheduling: In the event of unsafe conditions, like severe weather events, on a scheduled water quality monitoring date, sampling may be rescheduled to another date (as soon as possible) before the next scheduled water quality monitoring event assuming Volunteers are available and a date can be found where the timing of the tides allows the monitoring to take place within the hours identified above. Rescheduling will be for the entire set of Volunteers if possible. If not possible, a subset of the sites will be rescheduled. If unsafe conditions lead to sampling being missed at one individual site, sampling at that site will not be rescheduled.

## Water Quality Monitoring Procedures

As stated earlier, current sites are accessible by piers and/or floats so water depth is not an issue. Samples will be collected in a two-gallon bucket and monitoring will be carried out for the water that is in the bucket. This is done to collect a mixed water sample from at least the first foot of the water column, preventing the sampling from testing the characteristics in only the very top layer of water. Volunteers are directed to dip the bucket completely underwater to collect the sample, avoid shaking or splashing the water in the bucket, and to carry the bucket gently to the shore in order to prevent the introduction of oxygen to the sample. The volunteer monitoring procedures are outlined in Section B2 and described in detail in the BCWM Project Volunteer Manual.

Volunteers who consistently fail to follow correct techniques, as outlined in the sampling procedures, after they have received direct guidance from the PM or PC on the areas where they are having difficulty following techniques, will be asked to leave the project.

### **B2: Required Sampling Methods**

The methods and equipment used for monitoring pH, DO, water and air temperature, salinity, and water clarity are outlined in Table 3, and specific instructions are provided in the BCWM Project Volunteer Manual. Water temperature, pH, DO, and salinity are all measured via digital meters. An Extech Model DO600 is used to measure dissolved oxygen; an Extech EC 170 is used to measure water temperature and salinity; an Extech pH100 is used to measure pH; a Drok electronic digital thermometer is used to measure air temperature. The pH and DO meters are calibrated at the sampling site by the water sampler the day that water samples are taken in accordance with procedures defined in the BCWM Project Volunteer Manual.

### **B3: Sample Handling and Custody Requirements**

In order to safeguard all equipment and ensure the integrity of the recorded data, all Volunteers will have sole custody of their recording equipment, their data recordings, and their signed datasheet until delivered to the Project Manager the day of the water sampling event. At the conclusion of each water sampling event, all equipment is returned to the Project Manager or designee for kit replenishment and any required maintenance.

No samples are collected for later laboratory analysis.

## B4: Analytical Methods Requirements

The methods and equipment used for monitoring pH, DO, water and air temperature, salinity, and water clarity are outlined in Table 3, and specific instructions are provided in the BCWM Volunteer Manual. Any system failures will be noted by the volunteer and assessed by the PM. The PM will repair or replace any failed systems. Similarly, the PM is responsible for correcting, documenting, publishing and distributing any necessary process changes including notification of approving authorities (e.g. Maine DEP).

## B5: Quality Control Requirements

### Quality of Equipment and Supplies

All volunteers will be trained in the correct use of equipment and supplies, as outlined in Section A7.

Digital meters for DO and pH will be calibrated on site by each water sampler in accordance with the calibration procedures defined in BCWM Project Volunteer Manual. If equipment falls outside of the range of acceptable values (as defined below for each sampling parameter) it will be addressed as outlined below:

- pH: Calibrated pH meters that are more than 0.05 pH units away from the 7.01 standard and the 10.01 standard, when the standard buffer is analyzed, will have the electrodes and/or batteries replaced. If the readings are still more than 0.05 away from the National Institute of Standards and Technology (NIST) certified buffer solutions, the meter will be replaced.
- Water Temperature: Salinity meters are used to measure water temperature. Meters are calibrated against a NIST certified thermometer at the Darling Marine Center. Meters that cannot be calibrated to within 0.5°C will be replaced.
- Air Temperature: Drok Digital Thermometer will be tested annually against known values during a calibration session at the Darling Marine Center. Meters that are more than 0.5°C difference will be replaced.
- Salinity: salinity meters are calibrated at the BRLT office twice annually against a known sample and are not calibrated at the sampling site by the volunteer.
- Water Clarity: Secchi disks are attached to a 30 meter nylon coated fiberglass transect tape. Disks and tapes will be visually inspected for flaws at the beginning of each monitoring season, and repaired or replaced as necessary.

Volunteers will be asked to report any equipment damage or malfunctions to the PM or PC as soon as possible.

Supplies will be inspected and accepted based on the guidelines outlined in Section B7.

Volunteers will be asked to report if any supplies are running low either directly to the PM or PC or in the comments section of the BCWM Water Sampling Datasheet.

### Quality of Volunteer Procedures

The BCWM Volunteer Training, BCWM QA Refresher, and Field Visits are all set-up so that Volunteers know what is expected of them as a Volunteer Water Quality Monitor and so that all Volunteers are following the same procedures. The training and refresher outline and review the procedures. They provide a place for Volunteers to ask initial questions. The BCWM Project continues to provide opportunities for the Volunteers to ask questions throughout the season. The BRLT Executive Director, the BCWM PC, or a PC will be present at the BRLT office or by phone at (207) 633-4818 on every collection date until 12:00 pm so that Volunteers have an opportunity to ask questions about things that happened in the field part of the monitoring or ask for guidance. Volunteers will be provided phone numbers for the PM and PCs for questions in the field. Volunteers have more opportunities to ask for guidance during the biannual Field Visits. The PM or PC is also able to assess volunteer procedures during these field visits to ensure that Volunteers are following the correct techniques.

On an annual basis, the PM or PC will travel to the field site and perform a “side-by-side” comparison of sampling procedures and data recordings.

Volunteers who consistently fail to follow correct techniques, as outlined in the sampling procedures, after they have received direct guidance from the PM or PC on the areas where they are having difficulty following techniques, will be asked to leave the project.

### Quality of Data Recorded

All Volunteers will be trained in using the datasheet for data entry during the initial volunteer training and the volunteer refreshers. In order to prevent Volunteers from inadvertently leaving sections blank, the datasheets have been formatted so that the sections that the Volunteer is expected to fill in are white, and the PM or the PC will fill in the fields marked “Filled in by PC/PM”. Datasheets will be checked for completion when the Volunteer is signing the 'Sampling Signature' space on the datasheet and the PM or PC is signing the 'Receiver Signature' space on the datasheet. The process of data review is described in detail in Sections C3 and C4.

### Quality of Data Collected

The calibration of equipment (Section B6) and the volunteer trainings (Section A7) are both set up to ensure that consistent data are collected by all volunteers, across all sample sites. This project will use the outlined calibration procedures and trainings in order to generate high quality data that meet these guidelines.

## **B6: Instruments - Calibration, Maintenance, and Frequency**

Figure 4 outlines the calibration requirements for the project for each parameter that is tested. Buffer solutions used for pH calibration are checked annually for shelf life suitability. Calibration for salinity is performed annually at DMC using a consumable sodium chloride standard and distilled water at low, medium and high salinity concentrations per manufacturer’s requirements. Instrument calibration for dissolved oxygen and pH is performed prior to each monitoring event. Procedures are included in the Boothbay Coastal Water Monitoring Project Volunteer Manual. All other instruments are calibrated twice per year.

Annual maintenance for all instruments consists of conducting periodic maintenance per the Operator's Manual for each instrument. Annual maintenance for Secchi Disk transect tapes consists of ensuring integrity of the connection from the measuring tape to the disk.

## B7: Supplies - Inspection/Acceptance Requirements

Before it is distributed to the volunteers, equipment in each water sampling kit will be inspected by the PM or PC to ensure that all equipment is present and in good condition.

The only consumable supplies in the water quality monitoring kits that volunteers will use are pH 7.01 and pH 10.01 buffer solutions, and distilled water. Volunteers will be asked to report if they are running low on any solutions. Solutions will not be used once they have exceeded their expiration date.

The PM or PC will use consumable pH buffer solutions to calibrate the pH meters and a consumable sodium chloride standard to calibrate the salinity meters twice a year. No solutions that have exceeded their expiration date will be used for calibration.

## B8: Data Acquired from Other Sources

Site coordinates: For future water sampling sites that correspond to DMR Shellfish Growing Area Classification Program water sampling sites, coordinates will be acquired from staff at the DMR program.

River Discharge and Rainfall: For the purpose of data analysis, external information concerning rainfall and river discharge will be used.

River discharge information for average daily discharge will be acquired from the United States Geological Survey (USGS) webpage for the gauge on the Sheepscot River at North Whitefield, Maine, #01038000.

Rainfall information for total daily rainfall amounts will be acquired from a combination of local Weather Underground weather stations that are reported on the website [www.wunderground.com](http://www.wunderground.com) and from the National Weather Service's station KIWI at the Wiscasset Airport. Rainfall information will be recorded as:

- Rain > 1in within 2 days of sample day - yes/no
- Rain < 1in but >0in within 2 days of sample day - yes/no
- No rain within 2 days of sample day - yes/no

An approximate rainfall value to the nearest 0.01 inch will be determined using rainfall values from nearby Weather Underground stations. If one rain gauge is significantly closer to a site than any others, the rainfall values from that gauge will be used at that site. If a site is a similar distance from two rain gauges, an average of the rainfall values from those two gauges will be used at that site. The rainfall values from the three nearest Weather Underground stations will be compared to ensure that the values at each individual site fall within a reasonable range of spatial variability for rainfall. The Weather Underground values will only be used if they appear reasonable relative to the Wiscasset Airport values and the values of the nearby weather stations.

## B9: Data Management

Volunteers will enter data onto the BCWM Water Quality Datasheet on the day of sampling.

The information on each datasheet will be entered into the Water Quality Monitoring Database within two months of sample collection by the PM or PC. The data will be reviewed on a separate date by the PM or PC before they are accepted as final in the database.

The data will be stored as identified in Section A8.

The data will be shared on request with Maine DMR, the Maine Coastal Observing Alliance, Water Quality Monitoring Volunteers, and any others who are interested.

The PM will send all data collected and entered during the season to the ME DEP on CD or via email attachment in a format that is compatible with DEP's target database EGAD<sup>1</sup>.

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<sup>1</sup> Maine DEP EGAD Database: <http://www.maine.gov/dep/maps-data/egad/index.html>

## Section C: Assessment and Oversight

### C1: Assessment and Response Actions

Volunteer sampling performance is evaluated as detailed in Section A8. Data recorded on the BCWM Water Quality Monitoring Datasheets will be reviewed three times for accuracy before they are accepted in their final form in the BCWM Water Quality Database Spreadsheet to check for missed data, errors in measuring or reporting, or errors in digital data entry. The initial review will take place when the Volunteer and the PM or PC signs the completed Water Quality Monitoring Datasheet on the day of sampling. The second review will take place within seven days when the data are entered into the BCWM Water Quality Database by the PM or PC. The third review will take place when the PM or the PC reviews the data at the end of the sampling season (Table 2). Every attempt will be made to ensure that the second and third reviews are completed by different people.

If any errors or inconsistencies in data entry are noted on one of the BCWM Water Sampling Data Sheets, the PM or the PC will discuss these concerns with the Volunteer who filled in that datasheet before the next collection date.

Any changes that are made to the data form after it is initially signed by the Volunteer and the PM/PC will be dated and initialed. Only the PM or the Volunteer Water Quality Monitor that initially filled out the form may make changes.

Data will not be used if:

- They are not legible.
- Calibrations were not completed as described in Section B5.
- Site #, Date, Time, or Signature are missing from the datasheet and cannot be confirmed by the volunteer who collected the sample.
- None of the volunteers monitoring water quality at the site have completed the required volunteer trainings and volunteer refreshers as described in Section A7.

Outliers will be identified using statistical analysis but kept in the database.

### C2: Reports

The BCWM Project Annual Report will be developed at the end of the water quality monitoring season from a compilation of the data collected throughout the year (Table 2). Data from each water quality monitoring season will be provided to Maine DEP in the format that is required.

### C3: Data Review, Verification, and Validation

If any significant components of the sample collection or analysis or data management procedures were carried out in a way that is contrary to the processes and methods outlined in Section B: Measurement/Data Acquisition & Validation of this QAPP, data will not be considered valid and will not be entered into the BCWM Water Quality Monitoring Database. The reason for data exclusion will be noted in the 'Notes' column of the BCWM Water Quality Monitoring Database.

Data sheets will be reviewed as they are turned in. Recorded values will be reviewed for conformity with expected ranges (Data Quality Objectives) and repeated outliers will be addressed by inspection of the meters for accuracy and precision. The PM or PC will revisit the site to ensure standard procedures as defined in the Volunteer Manual are being followed.

Data Outliers are identified as indicated in Section C1: Any outliers to the entered data will be identified in a Flag field and each Flag will be defined in the 'Notes' column of the Water Quality Database.

#### C4: Verification and Validation Methods

Initial data verification procedures are described in Section C1.

#### C5: Reconciliation with Project's Data Quality Objectives

Volunteer trainings, refreshers, and field visits as well as the interactions that take place on each sampling date between the Volunteers, the PC, and the PM are set up to ensure that any problems in data collection or reporting will be readily identified and corrected. The responsibility for deciding to take corrective action when issues with data collection are noted rests with the PM. The PM has the authority to question data, call for retraining, and recommend replacement of volunteers when necessary. The PM is responsible for assessment of uncertainty in the validated data.

Data that were acquired using methods that do not meet the requirements of this QAPP will be identified as unacceptable in the Water Quality Database Spreadsheet and will not be reported in the Project Annual Report.

## C6: References and Links

Maine DEP Overboard Discharges map

<https://www.maine.gov/dep/gis/datamaps/>

Shellfish Water Quality Classifications and Aquaculture Leases Map

<https://www.maine.gov/dmr/shellfish-sanitation-management/maps/index.html>

Boothbay Harbor Comprehensive Plan

Comprehensive Plan Committee, May 2015. *“Boothbay Harbor Comprehensive Plan”*. pp. 5-6, pp.69-90

[https://www.maine.gov/dacf/municipalplanning/comp\\_plans/Boothbay\\_Harbor\\_2015.pdf](https://www.maine.gov/dacf/municipalplanning/comp_plans/Boothbay_Harbor_2015.pdf)

Kennebec Estuary Report

Moore, S., and J. Reblin. 2010. *“The Kennebec Estuary: Restoration Challenges and Opportunities”*, Biological Conservation, Bowdoinham, Maine. pp.30-31

<https://www.kennebecestuary.org/publications>

MCOA 2014 Estuarine Monitoring Program Report

Thornton, K., and Mayer, L. November 2015. *“MCOA Estuarine Monitoring Program Summary Report 2014”*. pp 7-15, p. 56.

<https://www.midcoastconservancy.org/wp-content/uploads/2017/01/MCOA-report-Final-small-vers.-17nov15.pdf>

Weather Underground

<https://www.wunderground.com/weather/us/me/boothbay/43.88%2C-69.62>

Community Collaborative Rain, Hail and Snow Network

[Community Collaborative Rain, Hail and Snow Network](https://www.cocorahs.org/)

<https://www.cocorahs.org/>

## Appendix A: BCWM Volunteer Manual

The manual will be updated periodically to increase ease of use for volunteers. The newest version of the manual will be found at <https://bbrlt.org/what-we-do/coastal-water-monitoring/>



**BOOTHBAY REGION  
LAND TRUST**

# **Boothbay Coastal Water Monitoring Project Volunteer Manual**



**January 9, 2020**

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## **Welcome:**

Thank you for your participation in the Boothbay Coastal Water Monitoring (BCWM) Project. We are excited to have you join us as a citizen scientist for this very important work.

## **Overview of Program:**

By testing the water along our shores, the BCWM project can monitor threats to the health of the ocean, such as oxygen depletion and rising seawater temperatures. BRLT is entering its fourth year of monitoring the coastal water quality of the Boothbay Region. Prior to 2015, there was no monitoring program that provided consistent and reliable water quality information for the coastline of the Boothbay Peninsula.

Clean water is necessary for the survival of the economically important and ecologically sensitive species in the waters of the Boothbay region, and for the health of its inhabitants. A thorough understanding of the condition of the region's marine waters will allow the towns of Boothbay, Boothbay Harbor, Edgecomb, and Southport to assess with more confidence the actions they need to take to ensure public health and economic vitality in their communities.

In 2014, volunteer-supported organizations and researchers along the coast of Maine formed the Maine Coastal Observing Alliance (MCOA), in recognition of their common interests in understanding and promoting the ecological health of Maine's estuaries between Casco Bay and Penobscot Bay. BRLT joined forces in 2015 with the MCOA to begin recording pH, temperature, dissolved oxygen, salinity, and turbidity at eleven sites around the Boothbay Region.

The summary report from the first year's monitoring found that the estuaries were generally in a healthy state, but that low pH and DO levels are a concern. As BRLT and other organizations continue to submit data to MCOA, we will gain more insight into the quality of the water and the impact it has on the environment and economy.

The recorded results of water sampling are shared with MCOA, the University of Maine, the National Oceanic and Atmospheric Administration (NOAA) as well the public through press releases, informational displays at community events, and articles in BRLT's newsletters.

## **Sampling Day Agenda**

Sampling will take place biweekly from early May through October. Specific dates and times will be disseminated to volunteers in late April. Volunteers will be assigned a testing site based on their availability and preference, if possible. On the day before testing, Volunteers may drop by the office of the Boothbay Region Land Trust at any hour to pick up their water sampling kit.

The kit should be stored overnight in a temperature stable location that is safe. On the morning of testing, follow the schedule for water sampling start time, allowing drive time to site if need be. Find a safe spot for your kit at your site, preferably somewhere flat and away from the edge of the water. Please be careful around slippery rocks covered in seaweed and algae.

Follow the sampling procedure directions found in this manual and attached to the clipboard. Please make sure equipment is accounted for and you return it to the kit after sampling. Please leave your kit and data sheet at the Boothbay Region Land Trust after completing the sampling.

## Sampling Sites

Site ID	Site Description	Latitude	Longitude
B 1	Oven's Mouth	43.934520	-69.646957
B 2	Knickercane Landing	43.880323	-69.663514
B 3	Robert's Wharf	43.880053	-69.684300
B 4	Dogfish Head	43.828802	-69.679429
B 5	Newagen	43.786284	-69.655321
B 6	Little River	43.825035	-69.584009
B 7	Boothbay Harbor Footbridge	43.850950	-69.625813
B 8	Linekin Bay	43.861729	-69.590452
B 9	Bigelow Dock	43.860532	-69.578157
B 10	Damariscotta River	43.902886	-69.580232
B 11	Linekin Bay Resort	43.845842	-69.611534



## **Equipment List**

- 1 clipboard that includes:
  - Sampling directions on rite-in-the-rain paper
  - 1 Beaufort wind scale sheet on rite-in-the-rain paper
  - 1 BCWM Water Quality Monitoring Datasheet on rite-in-the-rain paper
  
- 1 Toolbox
  - 1 digital air temp thermometer
  - 1 round compass
  - 1 pH meter
  - 1 Dissolved Oxygen meter
  - 1 Salinity/sea water temp meter
  - 1 jar buffer solution 7.01 green
  - 1 jar buffer solution 10.01 blue
  - 1 pen
  - 1 250 mL water bottle with spray top, filled with distilled water
  
- 1 Secchi disk attached to nylon covered fiberglass 30 meter transect tape
  
- 1 white 2-gallon bucket

# Water Sampling Procedures

Record all data on attached BCWM Water Quality Monitoring Datasheet

## 1. Record Site and Date Information

- a. Record the Site #, Site Description, Town, Date, Start Time, and name(s) of Sampler(s) (Please list everyone participating in the sampling.)

## 2. Observations about Weather Conditions, Tide, Air Temperature, and Wind Direction

- a. Observe and circle the % Cloud Cover; record the Precipitation (two variables); use the Beaufort wind scale to determine the wind speed, and record the Beaufort Number. A copy of the Beaufort wind scale is included on the clipboard.
- b. Observe the water at your site and record if the Tide is coming in, going out, or slack at high or low tide. If you are unable to tell, leave the tide section blank.
  - Incoming: Water is flowing upriver, upstream, or toward the shore; sand and rocks above the water level are dry
  - Outgoing: Water is flowing downriver, downstream, or toward the ocean; sand and rocks above the water level are wet
  - Slack: Water appears still; sand and rocks above the water level are dry
- c. Take the digital thermometer out of the toolbox and place it out of direct sun. Wait to record air temperature until step 8.
  - The toolboxes are often warmer than the air, so waiting to record temperature will give the thermometer time to equilibrate with the outside air. You can let the thermometer probe hang in the shade behind the box while you go on to the next few steps.
  - Make sure the thermometer is dry for the air temperature measurement. (If it is raining, don't worry about it, but do try to keep your wet thermometer out of the wind.)
- d. Using the compass, determine which direction the wind is blowing from. Circle the Wind\_Direction on the data sheet.

## 3. Observations about Conditions at the Site

- a. Check off any conditions you observe in the Observations section.
- b. In the Environmental Conditions section, record information about precipitation, tide and observations.
  - Descriptions of precipitation could include: fog, sprinkle, light rain, downpour
  - Descriptions of tide could include: tide noticeably higher than usual at the site, tide noticeably lower than usual at the site
  - Descriptions of observations could include: fish- type, number, alive, dead, size; crabs- type, number, alive, dead, size; birds- type, number, on water or on land; animals- type, number, on water or on land; boats- approximate size, number, moorings present or absent; odd color- color of the water if not clear, sediment in the water turning it brown and turbid, oily sheen on top of water; debris- type and amount of trash, loose seaweed, or marine debris; waves- wave intensity (small ripples, glassy crests, whitecaps) angle of waves; other- animal or bird feces, anything else interesting at site.

#### **4. Rinse and Fill Bucket**

- a. Downstream from your sampling site, fill and empty your bucket 3 times to rinse it.
- b. Bring the bucket to your site and dip it gently underwater until it is submerged.
  - Be careful to avoid splashing the water around; splashing and shaking the water in the bucket can increase the dissolved oxygen content of your sample. Holding the rope, *gently* fill your bucket and push it under the surface. Sample in at least 12 inches of water.
  - We are using the bucket in order to get a mix of water from both the surface and deeper in the water column.
- c. Pull the bucket out by the handle and gently place it somewhere out of direct exposure to wind or sun.

#### **5. Test for Salinity and Temperature**

- a. Find the salinity meter inside the water sampling kit.
- b. Remove the protective cap covering the meter's probe by pulling the cap firmly downward.
- c. Press the power button to power on the meter. The meter display will cycle through several icons before settling on the main display.
- d. Insert the probe (end of meter that was capped) into the water sample, ensuring that the electrodes are completely submersed (up to the cuff).
- e. Slowly stir the water with the probe to remove air bubbles. Allow sufficient time for the probe and the sample to reach temperature equilibrium. The reading will stabilize when it reaches equilibrium.
- f. Record the salinity and temperature readings on the data sheet. The meter will display the salinity reading at the center of the display screen, with the temperature reading shown on the lower screen in smaller digits.
- g. Press the power button momentarily to power OFF the meter.
- h. Rinse the salinity meter probe and electrode well with distilled water and allow to air dry.
- i. Affix the protective cap over the probe and return to the water sampling kit.

#### **6. Test for pH**

- a. Find the pH meter inside the water sampling kit.
- b. Remove the protective cap covering the meter's probe by pulling the cap firmly downward. (*NOTE: Make sure the small sponge stays in the meter's cap.*)
- c. Rinse the electrode with distilled water.
- d. Press the ON/OFF key to turn the meter ON.
- e. Place the electrode into buffer solution number 7.01 (green) and momentarily push the "CAL" key.
- f. The meter automatically recognizes the buffer solution and calibrates itself to that value. (*NOTE: if the solution is more than 1 pH unit off from the standard, the meter will assume an error and abort the calibration. CAL/END will be displayed.*) During calibration the pH reading flashes on the main display. When calibration is complete END is displayed. A circled number 7 will appear on the display. Record calibration values on datasheet.
- g. Rinse the electrode with distilled water, place into buffer solution 10.01 (blue) and repeat the steps listed in 'f'. A circled number 10 will appear on the display. Rinse the electrode with distilled water. Record calibration values on datasheet.
- h. Place the electrode in the sample to be measured. Stir the electrode in the sample to remove any trapped air bubbles from the membrane surface. Do not submerge the electrode to the point that the sample liquid reaches the meter's electrode collar.

- i. Record the pH reading onto the data sheet. The meter's display screen will flash until the reading stabilizes. The main display and bar graph indicate the pH reading.
- j. Press the ON/OFF key to power OFF the meter.
- k. Rinse the pH probe and electrode with distilled water and allow to air dry.
- l. Affix the protective cap over the probe and return to the water sampling kit.

Note: Always turn the meter off and then on before calibrating to allow sufficient time to complete the calibrations during one power cycle. If the meter auto powers off during calibration the calibrations remain valid, but new calibrations will turn the circled indicators off.

Note: The Automatic Temperature Compensation (ATC) circuit is not active during calibration. To ensure a more accurate calibration, make sure that the calibration buffers are at 25°C (77°F).

## **7. Test for Dissolved Oxygen**

- a. Find the dissolved oxygen meter inside the water sampling kit.
- b. Carefully remove the protective cap covering the meter's probe and examine the electrode membrane for any damage, tears, or large air bubbles. Small air bubbles should not affect the results. IMPORTANT NOTES: (1) Do not touch the membrane (probe tip) as skin oils will interfere with the results (2) The sensor is removed by twisting counterclockwise so it is important to not twist the cap when removing it—doing so may loosen the sensor and allow fluid to leak.
- c. Carefully place the cap back on the meter for calibration. Be sure that the electrode membrane is clean and dry or the calibration will be incorrect.
- d. CALIBRATION: With the protective cap STILL ON, press the ON/OFF key to turn the meter ON. Wait until the temperature and dissolved oxygen numbers stabilize.
- e. Press and hold the CAL/RECALL button until CAL is shown in the lower display. The readings will blink "101.7" and "SA", followed by "END".
- f. SALINITY COMPENSATION: press the CAL/RECALL button twice ("SAL" is shown in the lower temperature display). Immediately press the MODE/HOLD button as many times as needed to match your measured salinity ppt reading from your salinity meter. As soon as the salinity value is reached, press the CAL/RECALL button to lock in/ register your entry.
- g. MEASUREMENT: If not already displayed, select the desired units of measure by pressing and holding the MODE/HOLD button until "mg/l" are shown in the display.
- h. Carefully remove the protective cap and place the electrode in the sample to be measured. Stir the electrode in the sample to remove any trapped air bubbles from the membrane surface. Do not submerge the electrode to the point that the sample liquid reaches the meter's electrode collar.
- i. CONTINUE TO SLOWLY STIR THE METER IN THE SAMPLE, allowing the meter time to settle to the final measurement value. (NOTE: *The larger the difference in temperature between the electrode and the water sample, the longer it will take for the reading to stabilize. Stabilization time can vary from thirty seconds to five minutes. Once the temperature reading stops moving, it is considered stabilized.*)
- j. Record the dissolved oxygen reading onto the data sheet.
- k. Press the ON/OFF key to power OFF the meter.
- l. Repeat steps b through k a second time recording the reading onto the data sheet. If the difference between Reading 1 and Reading 2 is greater than .6 mg/L, take a third reading.
- m. Rinse the dissolved oxygen meter probe and electrode with distilled water and let them air dry.
- n. Affix the protective cap over the probe and return to the water sampling kit.

## **8. Measure Air Temperature**

- a. Turn on the digital thermometer by moving the battery switch to the “on” position. Read the thermometer and record the air temperature in °C on the data sheet.
- b. Turn the battery switch to “off” and coil the thermometer cord and sensor back into the water sampling kit.

## **9. Determine Water Clarity**

- a. Locate the Secchi disk and bring it to the edge of your dock.
- b. Get as close to the water surface as possible, so kneeling is best. Make sure the disk goes in on the shady side of structure. Do not wear sunglasses.
- c. Slowly unroll the transect tape and lower your Secchi disk into the water. Lower the Secchi disk until it just barely disappears from sight. Record the Depth Disk Disappears to the nearest 0.1 meter.
- d. Lower the disk further, until it completely disappears. Slowly raise it until it just begins to reappear. Record the Depth Disk Reappears to the nearest 0.1 meter.
- e. If the disk hits the bottom, record that occurrence and the Depth to Bottom on the datasheet.
- f. Rewind the transect tape and store the Secchi disk and transect tape in white bucket.

## **10. Sign and Record Time**

- a. Note concerns or comments about anything that happened during the sampling or about the condition of any of the supplies in the Comments section.
- b. Sign the data sheet and record End Time of sampling.
- c. Ensure that all equipment is rinsed with fresh water, dry and stored properly.

## **11. Return Equipment and Data Sheet**

- a. Return equipment (bucket, toolbox, data sheet, Secchi disk) to the BRLT office before 4 pm.

## **Details on Data Collected:**

### **Weather Conditions: Why Record the Weather?**

Weather has the potential to cause variations in the conditions we observe while sampling. We might see slightly low dissolved oxygen conditions, but realize that the day was overcast so less photosynthesis was happening. Maybe one day the salinity will show up a bit low, but we can use the weather information to tie it to a heavy rainfall event.

### **Water Temperature: Why Test Temperature?**

Temperature is an important characteristic of the water to test for both its direct and indirect impacts on marine life. On their own, temperature measurements can give valuable information about the conditions at a sample site.

Understanding the rate that water warms up in the spring and summer and cools down in the fall can help to define characteristics of an area. Temperature's relationship to pH, dissolved oxygen, water density, and the metabolic rates of organisms makes it essential that temperature is tested at the same time as any of these other characteristics.

### **Salinity: What Can Salinity Measurements Tell Us?**

The Boothbay Region is a huge mixing place of fresh water, from rivers and from the land's surface, and salt water, from the ocean. Salinity measurements are key to identifying where the water at each site is coming from. Water with low salinity suggests that there is a contribution from the rivers and town. High salinity water suggests that the impact is from offshore and tidal areas.

### **Water Clarity: Why Measure Water Clarity?**

Water clarity has a large impact on organisms living in the water. The more clear the water, the more sunlight can penetrate the water and reach plants under the surface. The more sunlight plants have access to, the more they can photosynthesize and produce oxygen, raising the amount of DO in the water. In the BBH region, suspended sediment and phytoplankton are probably most of the cause for reduced clarity. General detrital (non-algal) material and water color from dissolved organic matter will also contribute.

### **Dissolved Oxygen: What is Dissolved Oxygen?**

Dissolved oxygen (DO) is the oxygen gas that is contained in the water. It is essential for all marine organisms except for anaerobic bacteria. Cold water has the ability to hold more gases than warm water. High water temperatures can result in low DO levels. Salinity has a similar relationship to DO. The higher the salinity, the less oxygen the water is able to hold. .

## BCWM Water Quality Monitoring Datasheet

<b>Site #</b>		<b>Site Description</b>		<b>Town</b>		
<b>Date</b>		<b>Start Time</b>				
<b>Sampler(s)</b>						
<b>Environmental Conditions</b>						
<b>% Cloud Cover (circle)</b> <small>(0%=clear, 100%=all clouds)</small>	0%   25%   50%   75%   100%				<b>Precipitating now? (circle)</b>	Yes / No
					<b>Precipitation in the last 24 hours?</b>	Yes / No
<b>Wind Speed Record Beaufort Number (1-6)</b>				<b>Tide (circle one)</b>	Incoming / Outgoing / Slack High or Low	
<b>Direction Wind is Coming From (circle)</b>	N   NW   W   SW   S   SE   E   NE			<b>Air Temperature</b>	°C	
<b>Observations (within 100m)</b>	<input type="checkbox"/> Jellyfish <input type="checkbox"/> Fish <input type="checkbox"/> Crabs <input type="checkbox"/> Birds <input type="checkbox"/> Animals <input type="checkbox"/> Boats <input type="checkbox"/> Odd Color <input type="checkbox"/> Debris <input type="checkbox"/> Waves <input type="checkbox"/> Other					
<b>Description of Observations</b>						
<b>Salinity meter tests</b>						
<b>Salinity Reading</b>	_____ . _____			<b>Water Temperature</b>	_____ . _____ °C	
<b>pH meter calibration test</b>				<i>Calibrated 7.01</i>	Yes/No	
<b>pH Reading</b>	_____ . _____			<i>Calibrated 10.01</i>	Yes/No	

<b>Dissolved Oxygen test</b>		
Dissolved Oxygen Reading 1	_____ • _____ mg/L	
Dissolved Oxygen Reading 2	_____ • _____ mg/L	Difference: _____
Dissolved Oxygen Reading 3 (if req'd)	_____ • _____ mg/L	If the difference between Reading 1 and Reading 2 is greater than 0.6mg/L, the Volunteer will take a third reading.

**Optional: if Site is at Dock or Bridge**

<b>Water Clarity-Secchi Disk</b>				
Hit Bottom?	Yes / No			
<u>If Yes:</u>	Depth to Bottom	_____ • _____ meters		
<u>If No:</u>	Depth Disk Disappears	_____ • _____ meters	Depth Disk Reappears	_____ • _____ meters

**Comments :**

<b>Sampling Verification</b>			
Sampling Signature		End Time	
Receiver Signature		Receive Time	

<b>BCWM Staff Data Entry</b>			
Entered By		Date	

<b>BCWM Staff Data Review</b>			
Reviewed By		Date	

## Beaufort Wind Scale Chart

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	