Barnegat Bay

Long Term Ambient Monitoring Program

New Jersey Department of Environmental Protection

Water Monitoring and Standards

June 2013
Revision 1, June 2014

QUALITY ASSURANCE SAMPLING PLAN
Barnegat Bay Watershed, WMA 13
Revision 1, June 2014

Project Officer:

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Signature Date

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Office of Quality Assurance

1. **Project Name:** Barnegat Bay Long Term Ambient Monitoring Program

2. **Requesting Agency:** NJDEP, Water Monitoring and Standards

3. **Date of Project Requested:** June, 2013 (QAPP Revision 1 – June 2014)

4. **Date of Project Initiation:** July, 2013

5. **Project Officer:** Patricia Gardner, Director, WM&S

6. **Project Duration:** July 2013 thru June 2018

7. Special Training Needs/Certification

This project utilizes the assistance of several partners to conduct sample collection and field analysis. Approval of project partners will be performed annually by the Office of Quality Assurance. The Project Officer (OQA) or designee will be responsible for facilitating any necessary training and the project approval process with OQA.

8. Project Description

8.1. Background: Barnegat Bay Ambient Water Monitoring Project

On June 6, 2011, DEP and its partners launched a comprehensive ambient monitoring project that measured both water quality and water quantity in ways never done before in the Bay. The Department had enlisted numerous Partners, including local and county governments, State and Federal agencies, a science high school, a university and other organizations to assist the Department in sampling and sample analysis. Water quality was measured with grab samples taken at 12 streams which enter the Bay, as well as at 14 locations within the Bay. Water flow into the Bay was measured at 12 streams, and water flows into and out of the Bay at the three inlets from the Atlantic Ocean. Also, water circulation within the Bay was measured at 3 locations. Continuous monitoring (at select locations), intensive summer season monitoring, continuous temperature monitoring around the Oyster Creek facility, sediment monitoring and a survey to map the bottom of the Bay (i.e. bathymetric survey) was carried out. On a given sampling day, the Department and its Partners sampled water quality and measured flow at both stream and bay locations. The continuous and intensive monitoring components complemented the discrete sampling to capture the full range of daily, tidal and seasonal variations.

The purpose of this study was to address the following objectives:

1. Provide a more comprehensive assessment of the relevant water quality conditions throughout the Barnegat Bay both spatially and temporally;

2. Provide water quality and biomass data to better quantify biological productivity and its impact on dissolved oxygen (DO) concentrations in the Bay;
3. Estimate the nutrient loadings into the bay and establish boundary conditions for the significant tributaries to the bay;
4. Provide nutrient concentration and loading data needed to evaluate the effects of nutrient load reduction scenarios;
5. Provide an understanding of the physical factors affecting the bay water quality; such as the flushing rate, temperature, salinity and the depth of the bay. These factors play a major role in the physical, chemical and biological processes operating within the bay;
6. Collect data that captured daily and seasonal variability as well as variability between years;
7. Collect sufficient data (minimum 24 months) to develop water quality and hydrodynamics models;
8. Calibrate and validate modeling tools that can be used to direct water quality restoration of the bay.

This project was conducted in three phases, over a 2 year period, which included 3 intensive events. While the development of the water quality and hydrodynamics models continues, **THE MONITORING PROJECT WAS SUCCESSFULLY CONCLUDED ON JUNE 30, 2013.**

8.2 - Objective and Coverage: Barnegat Bay Long Term Ambient Monitoring Program

Building on the success of the completed monitoring project, the purpose of this new program is to monitor on-going quality of the bay and those tributaries with the most significant impacts/loadings to the bay, as well as different land uses. This monitoring program started on July 24, 2013.

The goals of the program are to:

1. Capture changes in water quality in the Barnegat Bay watershed over time.
2. Document changes in nutrient loadings to the Barnegat Bay watershed and its watershed resulting from the fertilizer legislation.
3. Document changes as a result of restoration actions taken as part of the Governor's Comprehensive Plan, including actions guided by the water quality and hydrodynamics models under development, as well as other restoration actions.
4. Data will also be used for assessment purposes as part of the Integrated Water Quality Monitoring and Assessment Report process.
5. Superstorm Sandy: On October 25, 2012, Superstorm Sandy directly hit the New Jersey coast including Barnegat Bay. While the damage and some of the impacts are evident, it will be years before the full impact of the storm on the Bay are known. This long term monitoring program will help capture those changes that impact water quality over time.
6. To be able to better characterize the normal fluctuations in water quality so that we can have a better definition of the uncertainty surrounding any given water quality measurement.
7. To provide water quality data that can be referenced to the biological research, which is occurring concurrently.
8. Interpretation of the narrative nutrient criteria requires water quality data to be collected at the same time as biological studies.

Sampling Network and Design Rationale

9.1 Station Selection

The stations included within Barnegat Bay Long Term Ambient Monitoring Program overlap with, but are not identical to those sampled by Barnegat Bay Ambient Water Monitoring Project. The station selection rationale was:

1. Major tributary stations where the major tributary loads come into the Bay.
2. Station BT 07 – NB Forked River, in the vicinity of the Oyster Creek Nuclear Generating Station. During the monitoring project, intensive monitoring was conducted in the vicinity of the Oyster Creek Plant to assure that the model being built can appropriately simulate the conditions pre- and post- plant closure. For the long term monitoring program BT 07 was included to keep a station in that area.
3. Tributary monitoring stations with long term historic records and located in the upper watershed were included in this network to track changes and for potential trend analysis. (During 2011-2013 sampling, tributary stations were selected at closest to the Head of Tide as possible with the goal to quantify the loading from the tributary to the Bay).
4. An analysis of the 2011-2013 data indicates some similarity among the data collected from different in-bay stations. For the long term monitoring program 9 out of 15 in-bay stations were selected as representative.
5. Four in-bay stations that have long-term historic records were included in this network to track changes and for potential trend analysis.

9.2 Continuous in-situ water quality monitoring

Continuous monitoring multi-parameter probes will be deployed at the monitoring sites in the Barnegat Bay. Table 1 specifies the list of parameters, frequency of collection and the number of sites for each phase of sampling. Figure 1 shows the location of all of the sampling sites.

Table 1: Continuous Monitoring Plan: Monitoring Parameters and Frequency of Collection

Continuous Monitoring Plan[1]				
Bay				
Sampling Stations	**Sampling Type**	**Sampling Matrix**	**Parameters**	**Frequency**
4 buoy locations and 1 fixed station, as identified in Table 2 and Figure 1 below[5]	Continuous monitoring probes at mid depth[2] using 4 buoy-located devices and 1 device housed within a fixed station (Mantoloking)	Aqueous	Dissolved Oxygen concentration (DO), pH, Temperature, Turbidity[4], Conductivity, Salinity[3], Chlorophyll-a; (possible deployment of NO_3[3] probe at Mantoloking using a buoy provided by USGS)	Measurements every 15 minutes.
Tributary				
Sampling Stations	**Sampling Type**	**Sampling Matrix**	**Parameters**	**Frequency**
Toms River near Toms River (USGS 01408500)	probes located within the existing gauging station	Aqueous	Dissolved Oxygen concentration (DO), pH, Temperature, Turbidity[4], Conductivity, Nitrate/Nitrite[3]	Measurements every 15 minutes.

[1]Separate QAPPs have been developed for the Department's continuous monitoring efforts.
[2] Sampling sites where depth is greater than 12 feet, two samples will be taken at 1/3 and 2/3 depth.
[3] Salinity to be calculated from conductivity.
[4] Requires the use of a NJ Certified laboratory.
[5]One buoy station BB10 located in Manahawkin Bay is identified only in Figure 1, not Table 2, its coordinates are: - 74.206530 longitude and 39.660950 latitude.

Table 2: List of monitoring sites within the Barnegat Bay

Station ID	Site Description	Type: Grab/ Buoy/Fixed	Longitude	Latitude	Site Reference ID	Site Partner
BB01 (1605A)	Barnegat Bay at Mantoloking	G,F	-74.054320	40.038320	USGS-01408168	DEP-Leeds Pt.
BB03 (1629B)	Barnegat Bay by Route 37 Bridge	G	-74.101530	39.9481700	BMWM1629B	DEP-Leeds Pt.
BB04a	Barnegat Bay near the Mouth of Toms River	G,B	-74.14069	39.93289	BMWM1502A	DEP-Leeds Pt.
BB06	Barnegat Bay below Cedar Creek and above Forked River	G	-74.102080	39.8526200	BMWM1651D	DEP-Leeds Pt.
BB07a	Barnegat Bay below Oyster Creek and above Barnegat Inlet	G,B	-74.1571172	39.8012861	DEPMODELSITE	DEP-Leeds Pt.
1661F	Barnegat Bay at Station 1661F	G	-74.1018	39.80984	BMWM1661F	DEP-Leeds Pt.
BB08	Barnegat Bay by Barnegat Inlet	G	-74.108014	39.7633528	MU-Barnegat Inlet	DEP-Leeds Pt.
BB09 (1674B)	Barnegat Bay below Barnegat Inlet and close to Long Beach	G,F	-74.147920	39.7426200	BMWM1674B	DEP-Leeds Pt.
1707C	Manahawkin Bay at Station 1707C	G	-74.2051	39.6404	BMWM1707C	DEP-Leeds Pt.
1712	Manahawkin Bay at Station 1712	G	-74.2701	39.61679	BMWM1712	DEP-Leeds Pt.
BB12	Barnegat Bay in Little Egg Harbor	G	-74.268750	39.5815100	BMWM1834A	DEP-Leeds Pt.
1826A	Little Egg Harbor at Station 1826A	G	-74.2682	39.5354	BMWM1826A	DEP-Leeds Pt.
BB14	Little Egg Harbor Inlet near Beach Haven Heights	G,B	-74.297370	39.5112300	BMWM1824B	DEP-Leeds Pt.

9.3-Grab Water Quality Sampling

Grab samples will be collected at the Barnegat Bay locations listed on Table 2 and at tributary sites listed on Table 5. Locations are shown in Figure 1. The proposed frequency varies by season and is listed in Table 3. Samples will be collected in accordance with approved field sampling procedures and analyzed by a certified laboratory. The water quality parameters to be sampled are those listed in Table 3. The sampling

schedule through June 2015 is included in Appendix D. DEP staff will notify partners of any weather related sampling cancellations and rescheduling. This QAPP will be modified annually to include an updated sampling schedule.
All water quality grab samples will be collected following procedures found in "NJDEP Field Sampling Procedures Manual, August 2005". Sampling locations have been marked and verified with GPS. In addition NJDEP staff and project partners will utilize detailed site sketches to locate the sampling location on the first and subsequent visits. The freshwater tributary locations samples will be collected as center of flow grab samples. At tributary locations greater than 20 ft. wide specific conductance measurements were made along a transect and it was determined that at all locations the stream is well mixed and that a center of flow grab sample would be representative of the water quality at that location. Because the water depth at the tributary monitoring locations is never greater than 12 ft., samples will be collected at a depth of 1 ft. If the water depth is less than 1 foot, samples will be collected at mid-water level. Bay water quality samples will be taken as surface grab samples. All tributary samples not filtered in the field, will be transported to the BMWM Leeds Point Laboratory for filtration as reflected in Table 4 and Figures 2-3.

All sample containers are being supplied by the DEP and only these sample containers can be used for the project. All sample containers must be transported on ice in coolers to preserve the integrity of the samples and maintain sample temperature at greater then freezing and less than 6°C. Necessary preservatives will be added at the Bureau of Marine Water Monitoring (BMWM) Leeds Point Laboratory, except those stations sampled and processed in the field by Bureau of Freshwater and Biological Monitoring (BFBM) Staff.

Field Parameters

Field parameters, pH (Electronic SM 4500-H B-11), water temperature (Thermometric SM 2550B), dissolved oxygen (Electronic SM 4500-O G-11) and specific conductance (Wheatstone Bridge, SM 2510 B-11), will be measured on site. Collected turbidity samples will be measured at a project field station by staff certified for turbidity measurements. Sample filtration for tributary stations only for dissolved parameters will be conducted by BFBM staff in the field or BMWM staff at the Leeds Point Laboratory. At each sampling location, parameters requiring immediate analysis (i.e. pH, specific conductance, salinity (calculated from specific conductance), and dissolved oxygen,) will be taken using handheld meters or multi parameter sensors. The turbidity sample may be as a field measurement from the meter by BFBM staff or at the BMWM Leeds Point Laboratory.

Table 3: Grab Samples: Monitoring Parameters and Frequency of Collection in Barnegat Bay and its Tributaries

Monitoring Parameters and Frequency of Collection						
Sampling Stations	**Sampling Type**	**Sampling Matrix**	**Parameters**	**Lab**	**Frequency**	
			Total Suspended Solids (TSS)	Leeds Point	Bay	Tributaries
Locations are identified in Tables 2 and 5.	Surface grabs	Aqueous	Chlorophyll-a (w/species ID)	Leeds Point	One sample: Twice monthly – May/June thru September *	One sample: Twice monthly – May/June thru September *
			Total Nitrogen (TN)	Leeds Point		
			Dissolved Total N	Leeds Point		
			Dissolved Ammonia	Leeds Point		
			Dissolved Nitrate+Nitrite	Leeds Point		
			Total Phosphorus (TP)	Leeds Point		
			Dissolved Total Phosphorus	Leeds Point		
			Dissolved Ortho-P	Leeds Point		
			Total Organic Carbon (TOC)	Leeds Point		
			Dissolved Organic Carbon	Leeds Point		
			Dissolved Inorganic Carbon	Leeds Point		
			Alkalinity	Leeds Point		
			Biogenic Si**	Leeds Point	Monthly – October thru April/May *	Monthly – October, December, February & April
			Turbidity	Leeds/BFBM		
			Secchi depth	Field		
			Transmissometry	Field		
			pH	Field		
			Dissolved Oxygen (DO)	Field		
			DO Saturation	Field		
			Temperature	Field		
			Conductivity (Salinity)	Field		

*** Need for second sampling event in April or May dependent on arrival of spring conditions**
**** Samples will be filtered for Biogenic Silica by the testing laboratory**

Table 4: The Analytical Method Table

Org	Parameter		Prep	Code	Method	Container	Preservative	Holding Time	Bottle
NJDEP BFBM	Turbidity	FwSw	U	Turb	SM 2130 B-11	50 mL centrifuge tube	Ice, 4°C	48 hours	T1
NJDEP Leeds Point Lab	Total Suspended Solids	FwSw	U	TSS	USGS I-3765-85	Amber 500 mL HDPE	Ice, 4°C	24 hours	L1
	Chlorophyll a (bay only)	Sw	U	Chla	SM 10200-H 1+2	Amber 500 mL HDPE	Ice, 4°C	24 hours	L1
	Total Nitrogen	FwSw	U	TN	USGS I-4650-03	50 mL centrifuge tubes	Ice, 4°C	28 days	L2
	Total Phosphorus	FwSw	U	TP	USGS I-4650-03	50 mL centrifuge tubes	Ice, 4°C	28 days	L2
	Dissolved Ammonia	FwSw	F	DNH3	350.1 MOD	50 mL centrifuge tubes	2 ml 3.5% Phenol	14 days	L3
	Dissolved Nitrite + Nitrate	FwSw	F	DNO3	EPA 353.4	50 mL centrifuge tubes	Ice, 4°C	28 days	L4
	Dissolved Orthophosphate	FwSw	F	DPO4	EPA 365.5	50 mL centrifuge tubes	Ice, 4°C	28 days	L4
	Dissolved Nitrogen	FwSw	F	DN	USGS I-4650-03	50 mL centrifuge tubes	Ice, 4°C	28 days	L4
	Dissolved Phosphorus	FwSw	F	DP	USGS I-4650-03	50 mL centrifuge tubes	Ice, 4°C	28 days	L4
	Total Organic Nitrogen	FwSw	NA	TON	Calculated	NA	NA	NA	NA
	Dissolved Organic Nitrogen	FwSw	NA	DON	Calculated	NA	NA	NA	NA
	Dissolved Organic Phosphorus	FwSw	NA	DOP	Calculated	NA	NA	NA	NA
	Particulate Organic Nitrogen	FwSw	NA	PON	Calculated	NA	NA	NA	NA
	Particulate Phosphorus	FwSw	NA	PP	Calculated	NA	NA	NA	NA
	Dissolved Organic Carbon	Sw	F	DOC	SM 5310 C-11	Glass, 250ml	Conc. H2SO4, pH<2	28 days	L7
		Fw	F	DOC	SM 5310 C-11	250 mL HDPE	Conc. H2SO4, pH<2	28 days	
	Total Organic Carbon	Sw	U	TOC	SM 5310 C-11	Glass, 250ml	Conc. H2SO4, pH<2	28 days	L8
		Fw	U	TOC	SM 5310 C-11	250 mL HDPE	Conc H2SO4, pH<2	28 days	
	Alkalinity	FwSw	U	Alk	SM 2320 B-11	250 mL HDPE	Ice, 4°C	14 days	E1
	Biogenic Silica	FwSw	U	Si	EPA 366.0 MOD	125 mL HDPE	Ice, 4°C	6 months	E2

Table 5: Tributary Sampling Locations

Station ID	Site #	Description	LATITUDE	LONGITUDE	Flow-Measurement Type	Flow Site Partner	Water Quality Site Partner
01408100*		North Branch Metedeconk River at Lakewood	40.109722	-74.219167	NA staff gage present	NA	NJDEP/BFBM
USGS-01408123	BT01	North Branch Metedeconk R near Laurelton	40.081648	-74.151811	Extrapolate from existing gage	NA	Brick MUA
USGS-01408152	BT02	SB Metedeconk River near Laurelton (Chambers Bridge Rd)	40.078763	-74.156729	Gage (see Table 6)	USGS	Brick MUA
01408136**		South Branch Metedeconk River at Bennetts Mills	40.126667	-74.277778	NA	NA	NJDEP/BFBM
01408260**		Toms River near Van Hiseville	40.109722	-74.373611	NA	NA	NJDEP/BFBM
01408492**		Ridgeway Brook at Route 70 near Lakehurst	40.020833	-74.273611	NA	NA	NJDEP/BFBM
USGS-01408505*	BT03	Toms River near Toms River	39.976389	-74.218333	Gage	USGS	NJDEP/BFBM
USGS-01408640	BT04	Wrangle Brook near South Toms River	39.952854	-74.218515	Measure	NJDEP/BFBM	NJDEP/BFBM
01408830*		Cedar Creek at Cedar Crest	39.897222	-74.316389	NA* staff gage present	NA	NJDEP/BFBM
USGS-01408950	BT06a	Cedar Creek (at RR)	39.8711111	-74.1738889	Gage1	USGS	MATES
USGS-01409055	BT07	NB Forked R at Forked River	39.836035	-74.196013	Measure	NJDEP/BFBM	MATES
BFBM000167	BT10	Oyster Creek (upstream Rt 9 @ JCPL)	39.810584	-74.204626	Gage	USGS	NJDEP/BFBM
USGS-01409210	BT11	Mill Ck at Manahawkin (Bay Avenue)	39.695405	-74.259527	Gage (new)	USGS	BBP
USGS-01409281	BT12	Westecunk Ck at Railroad Ave at West Ck	39.640297	-74.30797	Extrapolate from upstream gage USGS-01409280	USGS	BBP

***is also sampled as part of the Ambient Surface Water Quality Monitoring Network**
****is also sampled as part of the Supplemental Ambient Surface Water Quality Monitoring Network**

9.4 -Flow monitoring

The locations of existing gages are presented in Table 6 and shown in Figure 1. At selected tributary locations where gages are absent, flow will be measured using hand held equipment such as SONTEK Flow Tracker (or equivalent). Flow measurement SOP is available in Flow Tracker Handheld ADV User's Manual (SonTek/YSI 2009 FlowTracker Handheld ADV User's Manual Firmware Version 3.7). References are available online at http://pubs.er.usgs.gov/usgspubs/sir/sir20055183 and http://pubs.er.usgs.gov/usgspubs/fs/fs20083096.

Table 6: Gauging Stations*

Station Description	Latitude	Longitude	Type
Westecunk Creek at Stafford Forge NJ	39.666667	-74.320278	Tributary
Cedar Creek at RR	39.87917	-74.1906	Tributary
North Branch Metedeconk River near Lakewood NJ	40.091667	-74.1525	Tributary
Point Pleasant Canal at Point Pleasant, NJ	40.070278	-74.059722	Outlet/Inlet
Barnegat Bay at Mantoloking Bridge at Mantoloking	40.04	-74.057222	In Bay
Barnegat Bay at Route 37 Bridge near Bay Shore,	39.946111	-74.103056	In Bay
Barnegat Inlet at Barnegat Light, NJ	39.766389	-74.099167	Outlet/Inlet
Barnegat Bay at Route 72 Bridge near Ship Bottom	39.663333	-74.206944	In Bay
Little Egg Harbor Inlet near Beach Haven Heights	39.5075	-74.3075	Outlet/Inlet
Oyster Creek near Brookville, NJ	39.798333	-74.250556	Tributary
S.B. Metedeconk River at New Hampshire Ave. near Lakewood, NJ	40.083055	-74.179722	Tributary
Mill Creek at Manahawkin, NJ	39.695278	-74.26	Tributary

* NOTE: Maintaining all of the existing gauging stations over the entire project term will depend on the availability of continuing funding.

10. Data Usage

Water quality data sampled under this project will be used to assess water quality and other purposes discussed in Section 8.2. All sampling procedures must be in conformance with NJDEP or USGS (URL http://water.usgs.gov/owq/FieldManual/index.html) field sampling procedures as well as other applicable guidance. If a method or procedure requires change and is not contained in Table 3 and Table 4, this information must be brought to the attention of the signatories of this QAPP in writing and needs approval prior to being used. Data sampled outside of this project plan which have been collected under an approved QAPP and analyzed in a New Jersey certified laboratory may also be utilized.

11. Reports and Data Storage

Data will be stored locally in electronic format (MS Access). All raw data records shall be maintained for a period of no less than five years. All water quality data collected, locations of final sampling sites, and related field notes should be entered in the New Jersey Water Quality Data Exchange (WQDE) and USEPA STORET Data Warehouse. Data quality assurance reviews will be by BMWM staff using protocols found in USGS open file Report 02-383 "Methods for Quality Assurance Review of Water Quality Data in New Jersey". In addition to WQDE and USEPA STORET, data is also available by clicking on a station on the Barnegat Bay Interactive Map found on the DEP website at **http://www.nj.gov/dep/barnegatbay/bbmapviewer.htm**.

12. Project area

Watershed project area covered under this program is the Barnegat Bay Watershed in WMA 13 (see Figure 1 for the spatial extent of the study). The GIS map provided identifies bay and tributary water quality station locations, gauging station locations and the watershed boundary.

13. Data Representativeness

The same methods and techniques will be used by all field collection staff, except that sample filtration in the field will only be performed by BFBM staff. Technical assessments in the field and laboratory audits performed by NJDEP's Office of Quality Assurance will ensure that all samples are collected and analyzed per the QAPP. Any deviations from the QAPP will be documented and will be resolved prior to the next sampling event.

14. Data Validation

Method blank (lab), equipment blank, duplicate, and replicate samples will add approximately 10 percent more to the total number of samples collected. The sample data is validated using the QC data. The QC sample must fall between two standard deviations at the 95th percentile confidence level to be valid. All laboratory and field spikes must be within 80-120%. Water quality results will be assessed against available, historical water quality data from the locations monitored. Data will also be assessed using USGS Open-File Report 02-383 "Methods for Quality Assurance Review of Water-Quality Data in New Jersey ". That report provides information on standard ranges of specific parameters in New Jersey streams and standard relationships between specific parameters. All data collected will be provided to NJDEP and BMWM staff will perform the data validation process. Data that cannot be confirmed by these reviews or explained by circumstances (i.e. heavy rain, drought) or project QA data will be classified as questionable by NJDEP. In addition, quality

assurance protocols will be used by BMWM staff for the data validations under the supervision of a quality assurance officer.

15. Data Quality Requirements

Continuous Data Quality

Data recorders are calibrated and programmed within 24 hours of each deployment following the manufacturer's manual. Duplicate DO measurements are made at the time of meter deployment and meter retrieval with a second meter, calibrated on site. Comparative DO readings not within the stated accuracy of the meters used will be reviewed against historical water quality data from that site as an additional quality review step. Data outside the stated accuracy of the meters used in the comparative readings and outside the historical range for DO at that location will not be used. At each sampling event, water quality grab samples will be taken at the location of the continuous meters and analyzed for the parameters listed in Table 4. This data will be utilized to validate the data collected by the continuous meters.

Field Quality Assurance and Quality Control

NJDEP and Partner group's field staff will be approved by DEP's Office of Quality Assurance for field measurements, which include: specific conductance (Wheatstone Bridge, SM 2510 B-11), dissolved oxygen (electronic SM 4500-O G-11), pH (Electronic SM 4500-H B-11) and temperature (Thermometric SM 2550B). Program staff will follow manufacturer's manuals regarding calibration and operating procedures for specific meters. Results of daily pH calibrations, DO air calibrations and specific conductance calibrations will be recorded on field calibration forms. Quarterly temperature ASTM-QC checks and weekly Winkler DO checks are also recorded. Turbidity samples may be as a field measurement using the meter by BFBM staff or will be analyzed at the Leeds Point Laboratory by BMWM staff who are certified for the measurement of turbidity (Nephelometric, SM 2130 B-11), The marine sample field quality control will consist of analyzing in the laboratory, the remaining sample not used for filtration for salinity; in addition, a dissolved oxygen Winkler titration sample will be collected at the time of sample collection and preserved immediately with manganous sulfate and alkaline-iodide-azide solutions. This data will be used to validate the data collected by the sondes in the field. The Winkler titration sample must be protected from the intrusion of atmospheric oxygen and needs to be analyzed prior to the validation for the salinity.

The BMWM Leeds Point Laboratory is certified to perform the parameters conducted for ambient water quality monitoring and will follow the Laboratory methods as outlined in Table 7. Any changes to the methods used must be pre-approved by the DEP before sample testing continues. Quality control procedures (including required calibrations and quality control procedures required by regulation or by the method) shall be defined in the laboratory's Quality Manual (QM) or Standard Operating Procedures (SOPs). The QM and SOPs must be approved by the OQA

The field meters or multi parameter meters will be calibrated using manufacturer specifications and the OQA requirements for accuracy and precision. Calibration and verification will be performed with the following:

Temperature

Temperature thermistors are factory calibrated. Thermistors must be checked against a National Institute of Standards and Technology (NIST)-certified/traceable thermometer on a quarterly basis. If not found to be accurate within + 0.5 °C of the certified thermometer an offset value will be applied to correct the reading or if drift is continuing to take place sonde/sensor will be replaced. Any change will be noted in the calibration log and will be applied to all temperature measurements. Temperature units will be

degrees Celsius (°C). On June 26 and 27, 2014, the temperature monitoring devices were calibrated by DEP personnel against a NIST certified thermometer. This calibration must be repeated quarterly thereafter through the duration of the program. Duplicate testing is required once every 20 samples tested.

Salinity/Specific Conductance

Specific conductance is calibrated using a factory prepared conductivity standard with a value of 50 mS/cm or a 35 ppt salinity standard for the marine samples and 1.412 mS/cm for the fresh water locations, although alternative mS/cm solutions can be utilized as long as they are in the range of expected sample results. Specific conductance units will be mS/cm, Salinity will be expressed in parts per thousand (ppt). For sonde/sensor verification, another standard from a different source will be analyzed. The calibration must be checked in the measure mode with a standard. The required accuracy is that the calibration check data must be within 1% of the true value of the standard used to be acceptable for analysis. Duplicate testing is required once every 20 samples tested.

Dissolved Oxygen

Calibration of a dissolved oxygen (DO) meter at 100 percent oxygen saturation is made by adjusting the meter reading for air saturated with water vapor, as per the manufacturer's instructions. Sonde/Sensors will record both DO milligrams/liter (mg/l) and DO percent saturation (%). Samples for the Winkler titration will be collected at the marine water sites for sonde/sensor verification. Each week of use the DO meter must be verified against a Winkler titration procedure. The accuracy required between the reading from the DO meter and the results of the Winkler test must be within +/- 0.3 mg/L of each other to be acceptable. Duplicate testing is required once every 20 samples tested.

pH

Most multi-meters require the use of a three point calibration with 4, 7 and 10 pH buffers. A three point calibration is the preferred approach to a quality calibration. All calibrations must meet the accuracy requirement of being within 0.05 s.u. of the true value of the buffer used to be considered acceptable. A two point calibration can be performed using 7 and 10 buffers for the marine locations and 4 and 7 buffers for the fresh water locations as long as a calibration check (with the instrument in the measure mode) is conducted with the second of the two buffers used for calibration (i.e., 10 buffer for the marine and 7 buffer for the freshwater). The required calibration check result must be within 0.10 s.u. of the true value of the buffer used. Every three hours of use the meter must be checked with the calibration check buffer and must be accurate to 0.2 s.u. of the true value to be considered acceptable for continued use. The field staff may also recalibrate the meter at each site as an alternative to the three hour calibration check requirement. All readings for pH must be made in standard units. Duplicate testing is required once every 20 samples tested. Millivolt readings are also taken as a check of probe performance. For sonde/sensor verification, another certified pH buffer from a different source will be analyzed.

Turbidity

Turbidity samples will be analyzed in the field or at the Leeds Point Laboratory using a Hach model 2100P turbidimeter. Calibration of the turbidity meter will be accomplished by a 4 point method using HACH produced microbead synthetic turbidity primary standards every 3 months. The calibration is checked against HACH Gelex secondary standards and deionized water (0NTU) each day of use. Turbidity units will be (NTU). Duplicate testing is required once every 20 samples tested. A formazin standard or a standard from a different source will be analyzed for sonde/sensor verification.

Filtration Quality Control

Filtration quality control will consist of analyzing a filtration blank, that will be deionized water run through the pump tubes and the filter, preserved and analyzed as the other nutrient samples, prior to the filtration of samples. Between each sample, the pump tubes will be flushed with a cycle of deionized water/ 10% HCl/ deionized water. The filtration blank will be repeated after roughly half (13 samples) and at the end of the processing of 27 samples. This will ensure the validity of the data and the pump cleansing process. In addition, 2 filtration spikes and replicates will be performed for each sample run. The spike will consist of adding a known amount of analyte to a volume of sample, and the sample will be filtered and processed as the other samples, the spike will ensure that there are no interferences, loss of analyte or contamination of the sample. Filtrations must be performed within 8 hours of sample collection or sooner and the time of filtration will be documented in the laboratory records or on the chain of custody form for the project.

Table 7: Lab Methods

Lab	Parameter		Prep	Code	Lab Reporting Limit	Method	Holding Time
Leeds Point	Turbidity	FwSw	U	Turb	0.1 NTU	SM 2130 B-11	48 hours
Leeds Point	Total Suspended Solids	FwSw	U	TSS	1.0 mg/l	USGS I-3765-85	24 hours
Leeds Point	Chlorophyll a (bay only)	Sw	U	Chla	0.42 ug/l	SM 10200-H 1+2	24 hours
Leeds Point	Total Nitrogen	FwSw	U	TN	0.1 mg/l	USGS I-4650-03	28 days
Leeds Point	Total Phosphorus	FwSw	U	TP	0.010 mg/l	USGS I-4650-03	28 days
Leeds Point	Dissolved Ammonia	FwSw	F	DNH3	0.025 mg/l	350.1 MOD	14 days
Leeds Point	Dissolved Nitrite + Nitrate	FwSw	F	DNO3	0.025 mg/l	EPA 353.4	28 days
Leeds Point	Dissolved Orthophosphate	FwSw	F	DPO4	0.005 mg/l	EPA 365.5	28 days
Leeds Point	Dissolved Nitrogen	FwSw	F	DN	0.1 mg/l	USGS I-4650-03	28 days
Leeds Point	Dissolved Phosphorus	FwSw	F	DP	0.01 mg/l	USGS I-4650-03	28 days
Leeds Point	Total Organic Nitrogen	FwSw	NA	TON	NA	Calculated	NA
Leeds Point	Dissolved Organic Nitrogen	FwSw	NA	DON	NA	Calculated	NA
Leeds Point	Dissolved Organic Phosphorus	FwSw	NA	DOP	NA	Calculated	NA
Leeds Point	Particulate Organic Nitrogen	FwSw	NA	PON	NA	Calculated	NA
Leeds Point	Particulate Phosphorus	FwSw	NA	PP	NA	Calculated	NA
Leeds Point	Alkalinity	FwSw	U	Alk	1.0 mg/l	SM 2320 B-11	14 days
Leeds Point	Biogenic Silica	FwSw	U	Si	0.05mg/l	EPA 366.0 MOD	6 months
Leeds Point	Total Organic Carbon	Fw/Sw	U	TOC	1.0 mg/l	SM 5310 C-11	28 days
Leeds Point	Dissolved Organic Carbon	Fw/Sw	F	DOC	1.0 mg/l	SM 5310 C-11	28 days
Leeds Point	Particulate Organic Carbon	Fw/Sw	NA	POC	NA	Calculated	NA

16. Chain Of Custody

Chain of custody procedures will be instituted for this project. Chain of custody procedures will be employed until samples reach the Leed's Point Laboratory. Once samples reach the laboratory the laboratory's internal sample tracking procedures will be utilized. (See Appendix A for sample forms)

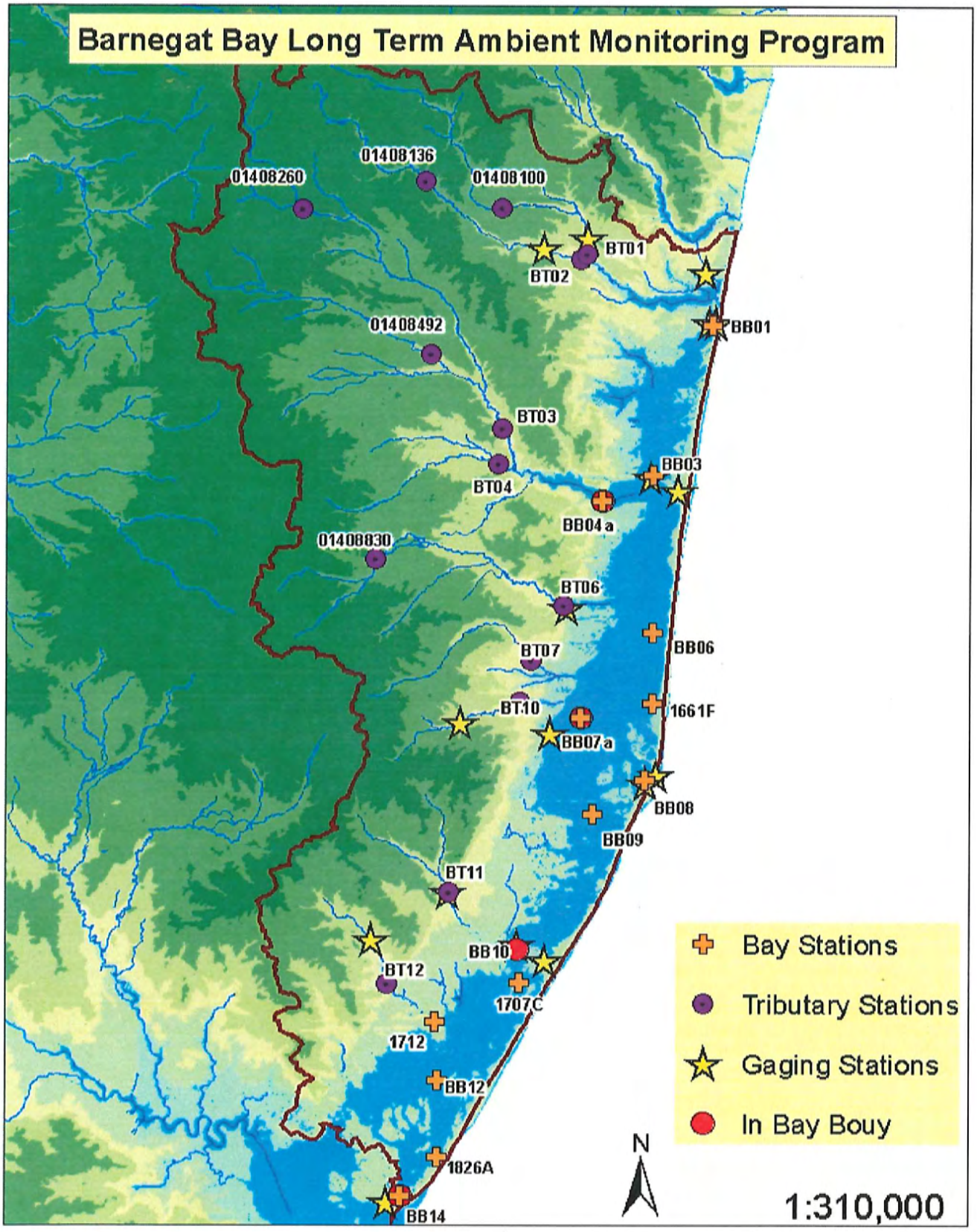
17. Corrective Action

The Leeds Point Laboratory is required to maintain standard operating procedures which outline specific action to pursue should corrective action be necessary. If acceptable results cannot be obtained due to: either field or laboratory errors (calibration standards, proficiency testing samples, blanks, spikes, or duplicates falling out of range) the affected samples will be re-analyzed and steps will be taken to ensure that the data produced is accurate. Standards and reagents will be replaced, equipment will be checked, or other action, will be taken to remedy the situation. NJDEP designated project officers and the NJDEP QAO will be notified in writing anytime a deviation from the approved work plan has occurred.

18. Assessment, Oversight and Response

The Project Officer or designee will be responsible for ensuring the oversight of all activities relating to this program. The Project Officer or designee will assess field collection functions and make corrections when necessary to maintain the data accuracy as defined in this plan. If any changes or modifications are made to this plan regarding data collection, as it relates to the objectives(s) and data accuracy required in this project, all original signees of the QAPP will be notified.

Figure 1: Barnegat Bay sampling sites



Appendix A:

Sample Chain of Custody Form

Barnegat Bay Ambient Monitoring Program Chain of Custody Form (June 2014)

General Information

Site #		Site Description		Sample #	
Sample Collection Date (mm/dd/yyyy)		Sample Collector		Sample Type (circle one)	Sample Blank Replicate
Sample Collection Time (hh:mm)		Collector Organization			

Filtration Time (hh:mm)		Turbidity Measurements	Turbidity (NTU)		Time (hh:mm)

Field Measurements/Observations

	Surface	Bottom (Bay samples only)		Surface	Bottom (Bay samples only)	Site Notes
Field Measurement Time (hh:mm)			pH			
Sample Depth (ft)			Specific Conductance uS/cm			
Uncorrected Water Temperature (deg C)			Ambient Transmissionmetry			
Corrected Water Temperature (deg C)			Underwater Transmissionmetry			
Dissolved Oxygen (mg/l)			Salinity (ppth)			
Dissolved Oxygen Saturation (%)			Secchi Depth (ft)			

Raw Sample

Container ID	Container	Matrix	Parameter	Fraction	Preservative
[] L 1 - U	Amber HDPE, 500 mL	Freshwater / Saltwater	TSS, Chlorophyll a	Total	Ice, 4 deg C
[] R 1 - U	HDPE, 2L	Freshwater / Saltwater	NH3, NO2+NO3, PO4, TN, TP, Turbidity, TOC, DOC, Silica,Total	Total	Ice, 4 deg C
[] L 6 - U	Polyethylene , 2 X 1L	Saltwater	Phytoplankton	Total	0.5 % (v/v) glutaraldehyde, Ice

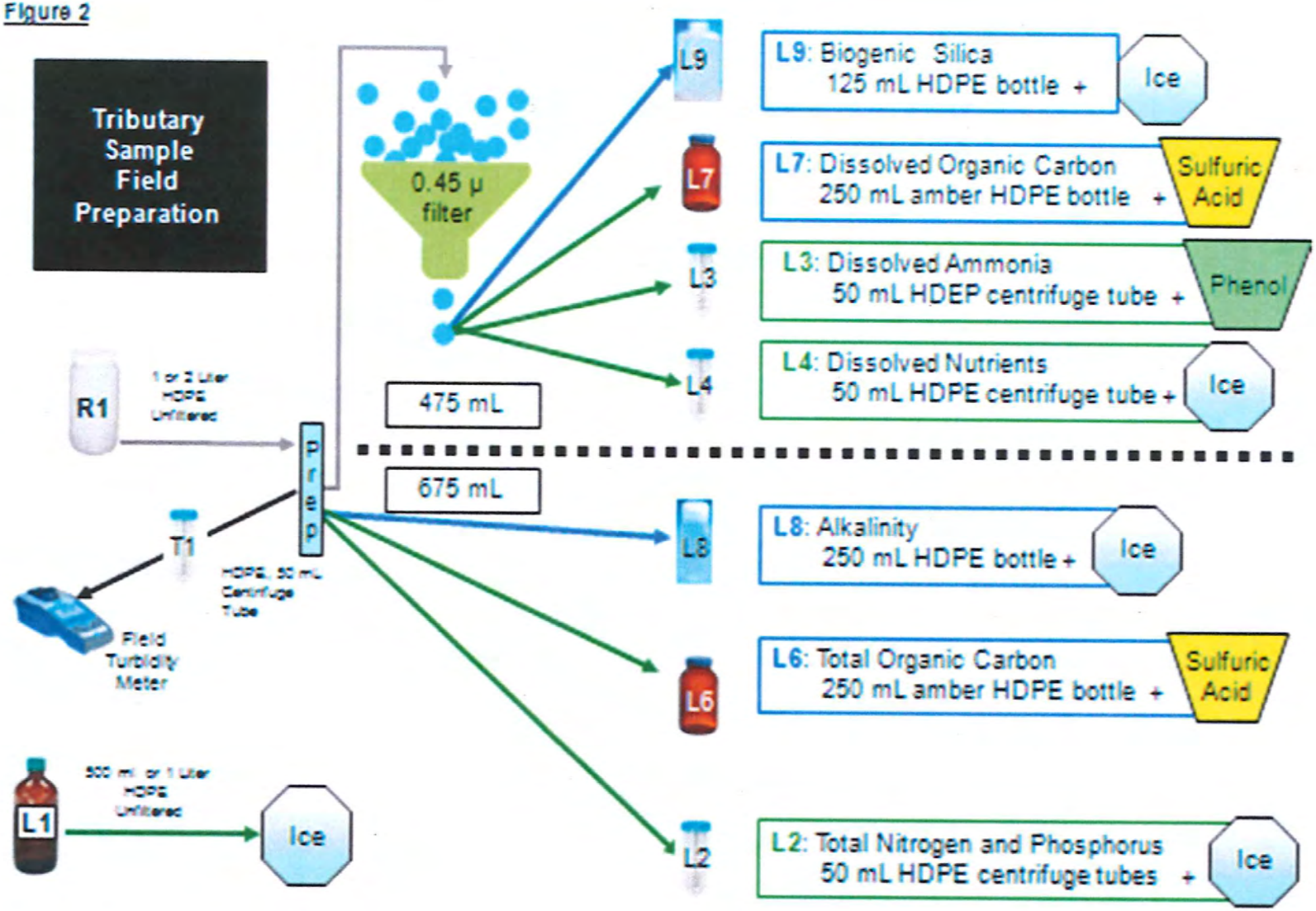
NJDEP Leeds Point Laboratory (NJ Lab Certification #: 01179)

Container ID	Container	Matrix	Parameter	Fraction	Preservative
[] L 1 - U	Amber HDPE, 500 mL	Freshwater / Saltwater	TSS, Chlorphyll a	Total	Ice, 4 deg C
[] L 2 - U	50 mL HDPE centrifuge tube	Freshwater / Saltwater	TN, TP	Total	Ice, 4 deg C
[] L 3 - F	50 mL HDPE centrifuge tube	Freshwater / Saltwater	DNH3	Dissolved	2 ml 3.5% Phenol
[] L 4 - F	50 mL HDPE centrifuge tube	Freshwater / Saltwater	DNO3, DPO4, DN, DP	Dissolved	Ice, 4 deg C
[] L 5 - U	HDPE, 125 mL	Freshwater / Saltwater	BSi	Total	Ice, 4 deg C
[] L 6 - U	Polyethylene , 2 X 1 L	Saltwater	Phytoplankton	Total	0.5 % (v/v) glutaraldehyde, Ice
[] L 7 - U	HDPE, 125 mL	Freshwater/Saltwater	TOC	Total	conc H_2SO_4 pH<2
[] L 8 - F	HDPE, 125 mL	Freshwater/Saltwater	DOC	Dissolved	conc H_2SO_4 pH<2
[] L 9 - U	50 mL HDPE centrifuge tube	Freshwater / Saltwater	Turbidity	Total	Ice, 4 deg C
[] L 10- U	HDPE, 250 mL	Freshwater / Saltwater	Total Alkalinity	Total	Ice, 4 deg C

Chain of Cusody

Container ID	Relinquished	Received	Date/Time	Reason
L1-_____, R1-U			Date: Time:	Sample drop off at LEEDS
L1-_____, R1-U			Date: Time:	Placement in coolers for lab transfer (runner signs received)
L1-_____, R1-U			Date: Time:	Transfer to lab for analysis

Figure 2


Tributary Sample Field Preparation
0.45 µ filter
L9
L9: Biogenic Silica
125 mL HDPE bottle +
Ice
L7
L7: Dissolved Organic Carbon
250 mL amber HDPE bottle +
Sulfuric Acid
L3
L3: Dissolved Ammonia
50 mL HDEP centrifuge tube +
Phenol
L4
L4: Dissolved Nutrients
50 mL HDPE centrifuge tube +
Ice
R1
1 or 2 Liter HDPE Unfiltered
475 mL
prep
675 mL
T1
HDPE, 50 mL Centrifuge Tube
Field Turbidity Meter
L8
L8: Alkalinity
250 mL HDPE bottle +
Ice
L6
L6: Total Organic Carbon
250 mL amber HDPE bottle +
Sulfuric Acid
L1
500 mL or 1 Liter HDPE Unfiltered
Ice
L2
L2: Total Nitrogen and Phosphorus
50 mL HDPE centrifuge tubes +
Ice

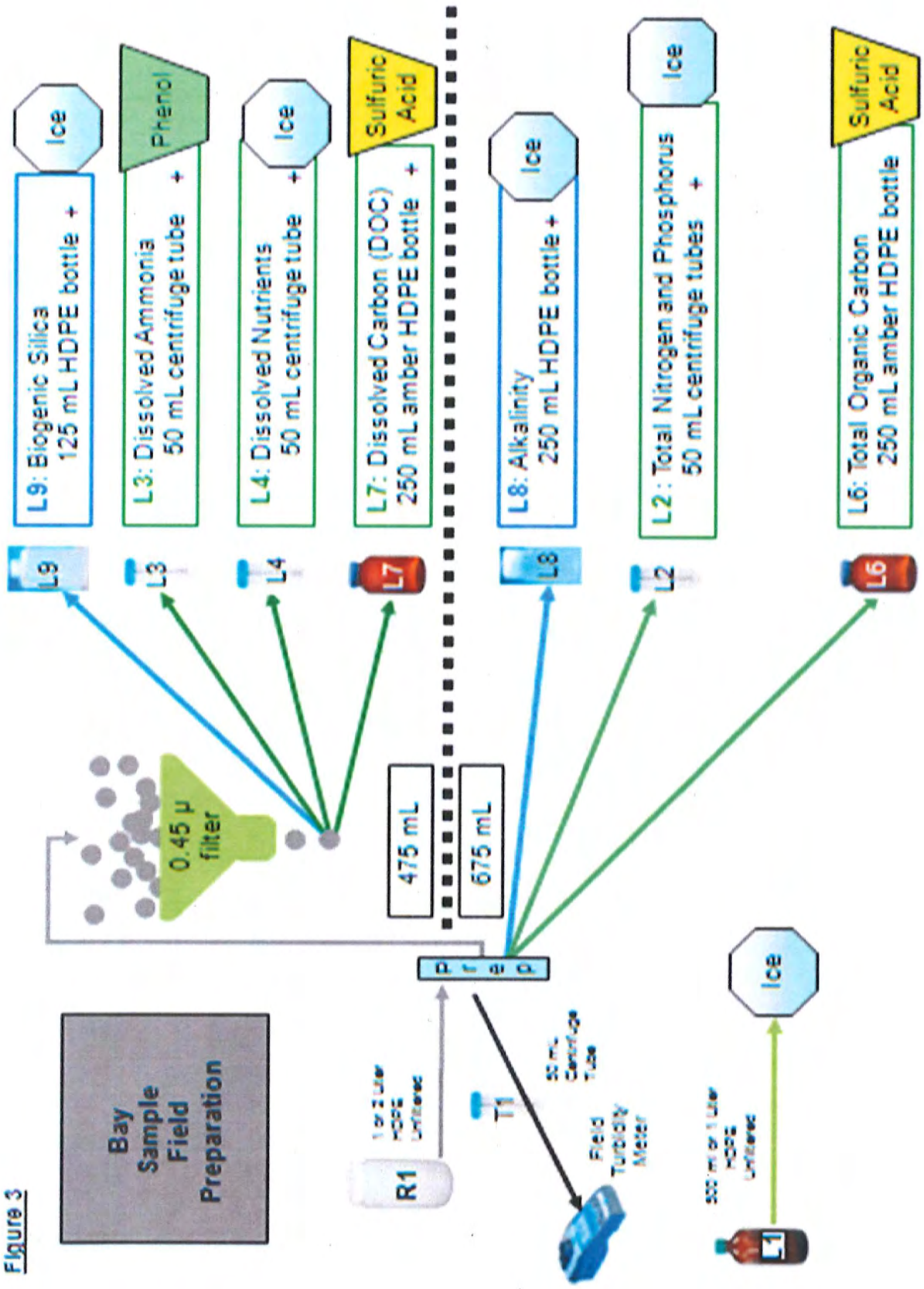

Bay
Sample
Field
Preparation
R1
T1
Field
Turbidity
Meter
L1
Ice
0.45 µ
filter
475 mL
675 mL
L9
L3
L4
L7
L8
L2
L6
L9: Biogenic Silica
125 mL HDPE bottle +
Ice
L3: Dissolved Ammonia
50 mL centrifuge tube +
Phenol
L4: Dissolved Nutrients
50 mL centrifuge tube +
Ice
L7: Dissolved Carbon (DOC)
250 mL amber HDPE bottle +
Sulfuric
Acid
L8: Alkalinity
250 mL HDPE bottle +
Ice
L2 : Total Nitrogen and Phosphorus
50 mL centrifuge tubes +
Ice
L6: Total Organic Carbon
250 mL amber HDPE bottle
Sulfuric
Acid

Figure 3

Appendix C: Example Field Calibration

Field Calibration Record-Barnegat Bay Monitoring Program

pH Meter Calibration
Required Accuracy: ± 0.05 standard units (su) of the true value for the calibration buffers used, ± 0.10 for the mid-range calibration check buffer. The temperature of the buffers must be recorded (if available).

Buffer	Temp	"As Found" Meter Reading	Set Meter Reading	Time	Date	Tech
4.00						
7.00						
10.00						

Buffer used for Calibration Check:_____ Temp of Buffer:_____
Calibration Check Buffer result (performed in measure mode):_____
Time of Calibration Check and Tech:_____

Conductivity Meter Calibration
Required Accuracy: Within 1% of the true value for the standard used.
Meter is calibrated according to manufacturer's instructions. Standard check is required each day of use.
mS/cm Standard used for Calibration Check (performed in measure mode):_____
Date of Calibration Check: _____
Tech:_____

DO Meter Calibration
Meters are to be calibrated each day of use against air or water saturated air.
Meters also require a Winkler test each week of testing.
Required Accuracy between the Winkler titration and meter: ± 0.3 mg/L
Normality of Titrant (from container of sodium thiosulfate):_____
Beginning mls:_____
Ending mls:_____
Change in mls:_____
DO reading from Meter for the sample used for Winkler:_____
Tech:_____
Date:_____

Temperature Calibration
Thermometer calibrations must be performed on a quarterly basis prior to use for any sampling events. Records of the calibration will be retained.

Appendix D: Sampling Schedule

July 9, 2014

July 23, 2014

August 6, 2014

August 20, 2014

September 10, 2014

September 24, 2014

October 15, 2014

December 17, 2014

February 11, 2015

April 15, 2015

May 6, 2015

May 20, 2015

June 3, 2015

June 17, 2015

Note: this QAPP will be modified annually to add scheduled sampling dates beyond June 2015.