QUALITY ASSURANCE PROJECT PLAN

Dry and Wet Weather Water Quality Sampling of Green Hill Pond, Ninigret Pond, Factory Brook, and Teal Brook-2001

Rhode Island Department of Environmental Management

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2.0 Table of Contents

2.1 List of Tables

2.2 List of Figures

2.3 Required Information Checklist

EPA Worksheet	Section	Location	Comments
1	**1.0**	**Title Page**	
2	**2.0**		
3	**3.0**	**Table 3.1**	**Eliminated title of each recipient and document control number.**
4	**3.0**	**NA**	**All personnel in the organization chart will be given a copy of the QA**
5a	**4.0**	**Figure 4.1**	
5b	**4.0**	**Section 4.2**	**Narrative**
6	**4.0**	**NA**	**Personnel responsibilities and qualifications. Not needed for a project of this scope.**
7	**4.0**	**Section 4.3**	**Narrative information on training. Will keep a list of all trained**
8a	**5.0**	**Section 5.4**	**Scoping meetings were informal among RIDEM personnel.**
8b	**5.0**	**Section 5.0**	**Narrative**
9a	**6.0**	**Section 5.0**	**Narrative**
9b	**6.0**	**NA**	**TMDL dictates action limits have already been exceeded. Other information available in other tables.**
9c	**6.0**	**Tables 6.1, 6.1.1**	**Combined Tables 9c and 9d. Included only applicable information.**
10	**6.0**	**Table 6.3**	
11a	**7.0**	**Section 7.0**	**Narrative**
11b	**7.0**	**Table 7.1**	
12a	**8.0**	**Section 8.1, Table A.1**	**Narrative**
12b	**8.0**	**Tables 8.1, A.2, A.5**	
13	**9.0**	**Table 9.1**	**SOP's in Attachment A**
14	**9.0**	**Table 9.2**	**No field equipment**
15	**9.0**	**Table 9.3**	**No field equipment**
16	**10.0**	**Table 10.2**	
17	**11.0**	**NA**	**No field analysis**
18	**11.0**	**NA**	**No field analysis**
19	**11.0**	**NA**	**No field analysis**
20	**12.0**	**Table 12.1**	
21	**12.0**	**NA**	
22a	**13.0**	**Table 13.1**	
22b	**13.0**	**NA**	**No multiple analytes for bacteria sampling.**
23a	**13.0**	**NA**	**No field analysis**
23b	**13.0**	**NA**	**No field analysis**
24a	**13.0**	**Table 13.2**	
24b	**13.0**	**NA**	**No multiple analytes for bacteria sampling**
25	**14.0**	**Table 14.1**	
26	**15.0**	**Table 15.1**	
27a	**16.0**	**NA**	**Assessment and Response Actions**
27b	**16.0**	**Table 16.1**	
27c	**16.0**	**NA**	**Project Assessment Plan**
28	**17.0**	**Table 17.1**	
29a	**19.0**	**Table 19.1**	
29b	**19.0**	**NA (Tables 7.1, 13.1, 13.2**	
29c	**19.0**	**NA**	
30	**20.0**	**NA (Tables 7.1, 13.1, 13.2)**	

3.0 Distribution List

Table 3.1 Distribution List.

QAPP Recipient	*Organization*	*Telephone Number*	*Address*
Wayne Jenkins	RIDEM	401.222.4700 ext. 7272	235 Promenade Street Providence, RI 02908 wjenkins@dem.state.ri.us
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4.0 Project Organization

4.1 Project Organizational Chart

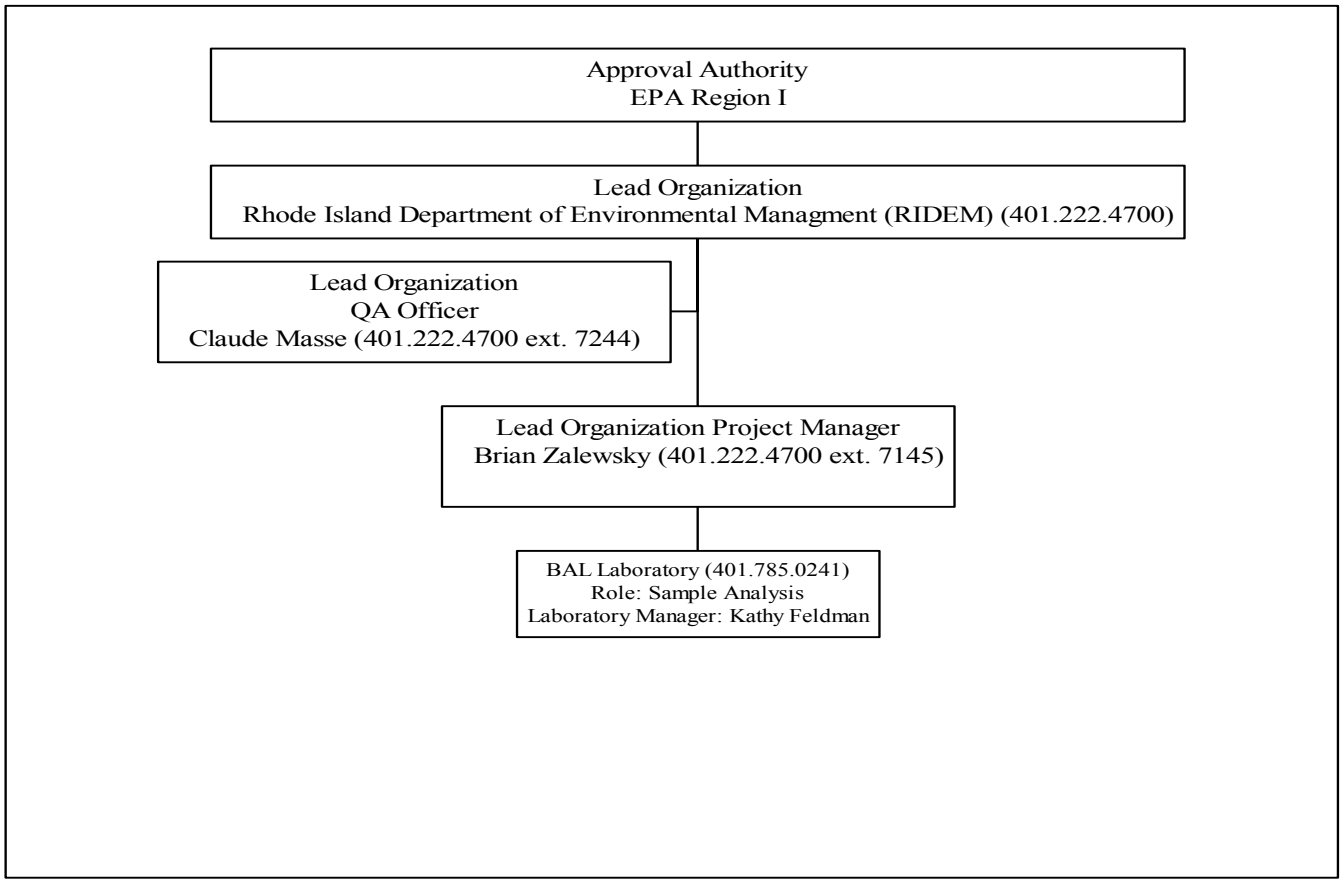


Figure 4.1 Project Organizational Chart.

4.2 Communication Pathways

Bacteriological samples will be collected during dry and wet weather. Dry and wet weather sampling criteria are discussed in Section 6.0 of this report. BAL Laboratory will analyze all samples for fecal coliform bacteria. Sampling teams will be comprised solely of RIDEM employees.

In regards to wet weather sampling, the Project Manager will keep track of atmospheric conditions and inform all potential samplers when conditions are favorable for a significant precipitation event to occur. Storm criteria are discussed in Section 6.1 Task 3. When a potential storm is forecast, the Project Manager will inform all potential samplers to be ready to begin collecting the pre-storm samples.

Before the 'sampling season' begins, the Project Manager will contact BAL Laboratory to arrange for sample bottles. These bottles will be kept at RIDEM and will be used for the pre-storm sampling. When a potential storm is forecast, the Project Manager will alert BAL Laboratory to arrange for the pickup of additional bottles. Sample bottles will be picked up from BAL Laboratory prior to all scheduled dry weather sampling surveys.

Changes to the sampling plan may occur over the course of the wet weather surveys. Some stations may be inaccessible in the dark or otherwise pose some unacceptable or unforeseen safety risk to the samplers. All changes made in the field by the field samplers will be documented in the field notes. The Project Manager will discuss these changes with the field sampler within three days after sampling. In addition, it may become necessary to add and/or drop stations prior to and/or during sampling. This decision will be made jointly by the QA Officer and the Project Manager. All changes to the QA Plan will be reported in each sampling event's Status Report and the Final Report.

4.3 Training

Each sampler will be given a Monitoring Plan outlining the station locations and sampling protocol before sampling begins. All samplers will also be given a tour of their sampling locations prior to sampling. Even with maps, stations may be hard to find in the dark or in the rain. The Project Manager will review the protocol for each station during the sampling station tour.

For those unfamiliar with the equipment being used, training will include an introduction to all possible sampling equipment.

The Project Manager will keep a list of all individuals trained. This list will include the names of the individuals trained, who trained them, and the date of training.

5.0 Problem Definition/Background

The Rhode Island Department of Environmental Management (RIDEM) is currently conducting a comprehensive water quality characterization of Green Hill Pond, eastern Ninigret Pond, Factory Brook, and Teal Brook. During this characterization, RIDEM will organize all existing information and gather any additional information needed to develop pathogen Total Maximum Daily Load reports (TMDLs) for these waterbodies. Currently, Green Hill Pond and the eastern section of Ninigret Pond (from the westernmost boundary of Tockwotten Cove to Heather Island- (Refer to Figure 5.1) are closed to shellfishing because of elevated bacteria levels. Factory Brook and Teal Brook are currently listed on the States 303(d) List of Impaired Waterbodies for fecal coliform. The goal of this sampling program therefore, is to characterize instream and in-pond water quality conditions and quantify pollution inputs into the ponds and streams during dry and wet weather conditions.

TMDLs are required under Section 303(d) of the Clean Water Act and USEPA's Water Quality Planning and Management Regulations (40 CFR Part 130). The goal of the TMDL study is to locate and quantify the existing point and nonpoint sources of bacterial pollution into the ponds and freshwater streams and to establish the impact that these sources have on instream or in-pond fecal coliform concentrations. At the completion of the study, the necessary pollution reductions needed to achieve water quality standards will be established.

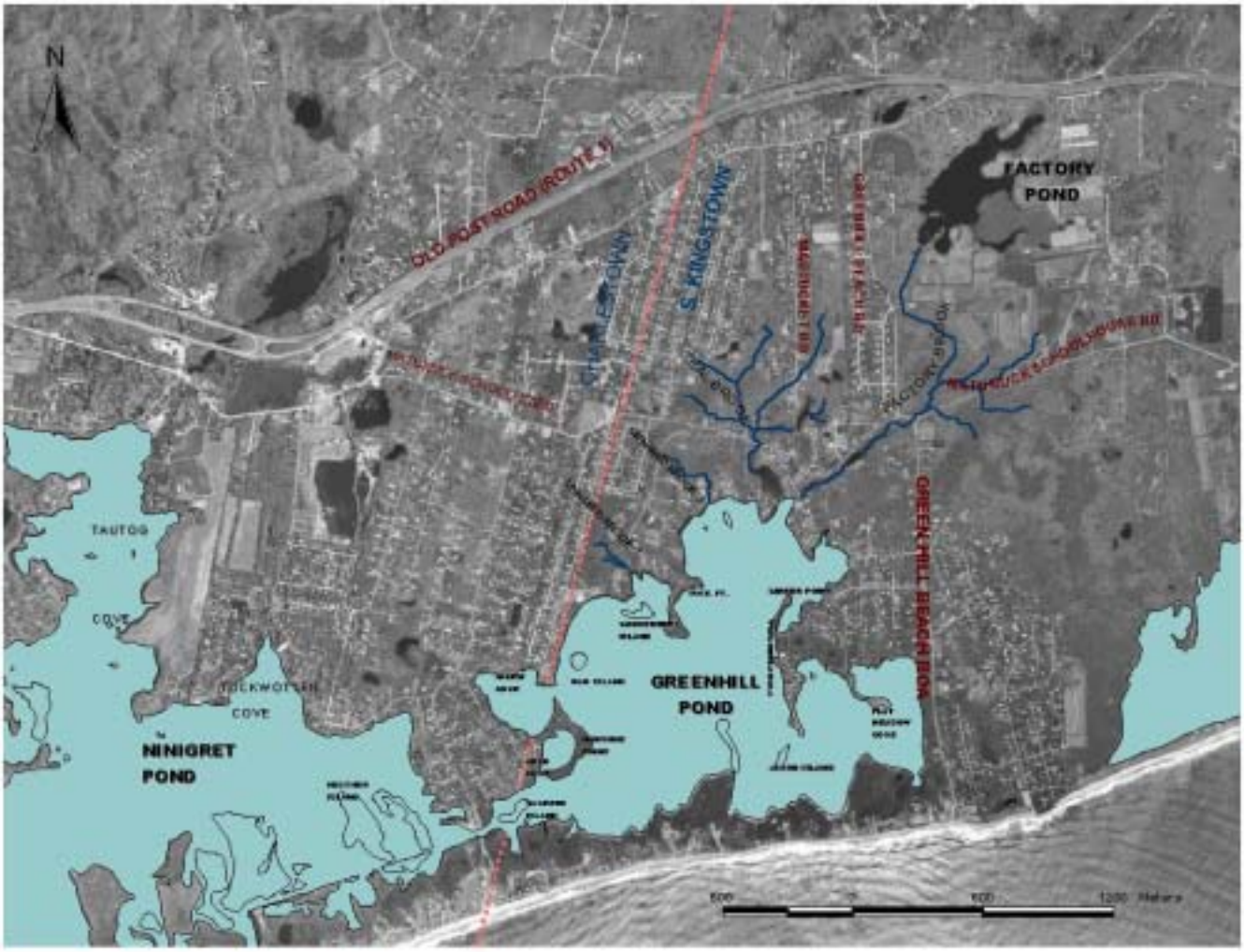
5.1 Green Hill-Ninigret Pond Watershed

The Charlestown lagoon system, (Figure 5.1) located on the southern coast of Rhode Island, consists of two major basins, Ninigret Pond (6 km long and 1.4 km wide) and Green Hill Pond (1.5 km long and 1.4 km wide). Both of these shallow coastal lagoons are microtidal estuaries, receiving restricted tidal flushing through a narrow man-made breachway. The surface area of Ninigret Pond is 6.23×10^6 m^2 with a volume of 7.91×10^6 m^3 and an average depth of 1.27 m. Ninigret Pond is located entirely within the town of Charlestown and is bounded on its northern side by Route 1 and the Charlestown end moraine. The surface area of Green Hill Pond is 1.55×10^6 m^2 with a volume of 1.22×10^6 m^3 and an average depth of 0.79 m (Isaji et al 1985). Green Hill Pond is located primarily in the southwestern corner of the town of South Kingstown, with a small portion of the pond extending into southeastern Charlestown.

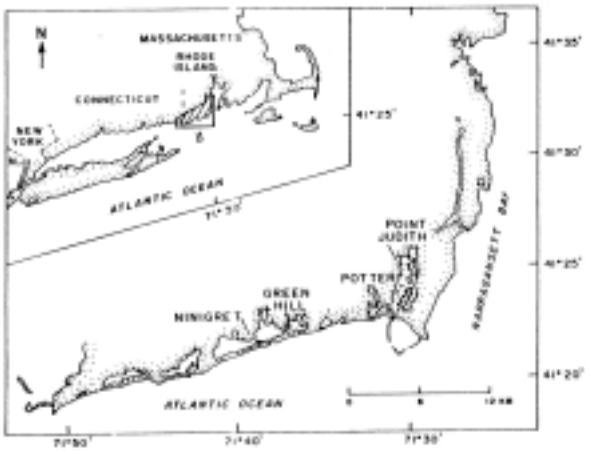
The Charlestown lagoon watershed is approximately 10,154 acres in size (3,039 acres-Green Hill Pond watershed, 6,025 acres- Ninigret Pond watershed) and encompass the towns of South Kingstown and Charlestown. Green Hill and Ninigret Ponds lie on a low and level glacial outwash plain separated from the ocean by low narrow barriers.

The entire Salt Pond region is located in one of the fastest growing areas of the state and has experienced steady growth over the past forty years. Most of the existing residential and commercial development in the Green Hill and Ninigret Pond watersheds are not sewered and rely on Individual Sewage Disposal Systems (ISDS) for sewage disposal. The majority of the area surrounding the ponds is high density residential. Many of these houses which were originally constructed as summer cottages have since been converted to year-round residences without updating or replacing the existing ISDSs. The Green Hill area of Charlestown is a prime example in that most of the homes were built pre-1970 (the year Rhode Island ISDS regulations went into effect) and the houses are on small lots with hand dug cesspools. In addition, to complete this worst case scenario, drinking water in the area is provided by individual, shallow dug wells.

Figure 5.1. Green Hill-Ninigret Pond study area.



locus map



The watershed's population has increased dramatically since the 1950's and 60's when hundreds of vacation cottages were built on small lots clustered on the shores of Green Hill and Ninigret Ponds. During the 1980's, new construction spread throughout the watershed, and by 1997, residential development occupied about 37 percent of the watershed, with about 2,200 homes. Based on present zoning, approximately 600 additional homes could be built in the Green Hill Pond watershed. Most of this buildable land is in sensitive wellhead areas or close to the pond and its streams where the threat of water quality impact is the greatest.

RIDEM has concluded that Green Hill Pond and eastern Ninigret Pond are impaired due to fecal coliform concentrations, which exceed state water quality standards. RIDEM's Shellfish Growing Area Monitoring has determined that both waterbodies do not meet the National Shellfish Sanitation Program (NSSP) mandated statistical criteria.

5.2 Factory Brook and Teal Brook Watershed

Teal Brook and Factory Brook are freshwater streams that flow into a small cove in the northwest corner of Green Hill Pond (Figure 5.2). Several small tributaries make up the headwaters of Teal Brook. The largest tributary originates in a small wetland area located east of Mautucket Road and west of Bedford Drive. As this stream crosses Matunuck Schoolhouse Road, it is joined by three smaller tributaries that originate in wetland areas between Mautucket Road and Hemlock Road. Teal Brook then flows south-southeast as a third-order stream approximately 0.6 kilometers before emptying into Teal Pond. Teal Pond drains directly to Green Hill Pond via a small rock lined channel approximately 1.5 meters in length and 1.0 meters in width. Teal Brook is a slow moving shallow stream ranging 1.0-1.5 meters in width.

Factory Brook originates in Factory Pond, a small pond approximately 10 ha in size, located just south of Route 1. At its outlet, Factory Brook flows south approximately 0.4 km before turning southeast and flowing into the northeast corner of Green Hill Swamp. Here, the mainstem is joined by three smaller tributaries that drain the middle and upper sections of the swamp. Factory Brook then continues through Green Hill Swamp for approximately 0.6 km before flowing into a small impoundment approximately 1.0 ha in size. The brook then flows SSE approximately 0.1 km and empties into Green Hill Pond as a second order stream approximately 10 meters east of Teal Brook.

The Factory Brook and Teal Brook watersheds are small- approximately 225 ha and 67 ha in size, respectively and consist of forestland, forested wetland, and swamp, with some low-density residential areas situated in the lower portion of the watershed. The watersheds rely on ISDS for the treatment of wastewater. Soils in the Factory Brook drainage are characterized as having rapid permeability, slow runoff, high water table, and a high susceptibility to flooding. The Soil Survey of Rhode Island (Rector 1981) describes these soils as having severe limitations for the placement of septic tank absorption fields.

Salt Pond Watcher monitoring data and RIDEM preliminary data have indicated that the two tributary streams, Teal and Factory Brooks, which enter Green Hill Pond exhibit elevated fecal coliform concentrations.

Figure 5.2. Factory Brook and Teal Brook study area.

5.3 Water Quality History

Public involvement has been very active concerning issues within Green Hill and Ninigret Ponds, as well as the entire Salt Pond Region. Public concern over deteriorating habitat and water quality- leading to the recent shellfish closures in Green Hill and Ninigret Ponds, has been the driving force behind much of the scientific research in this area. Numerous studies have been conducted in the ponds in an attempt to characterize water quality, understand changes in the ecology and cumulative impacts of development, and identify sources of pollution impacting the ponds.

As far back as 1981, studies conducted by the R.I. Department of Health (RIDOH) and University of Rhode Island (URI) researchers revealed that fecal coliform concentrations exceeded the Class SA shellfishing standard in Green Hill Pond.

The RIDEM Shellfish Growing Area Monitoring Program is part of the state of Rhode Island's agreement with the U.S. Food and Drug Administrations (FDA) National Shellfish Sanitation Program (NSSP). As part of this agreement, the state of Rhode Island is required to conduct continuous bacteriological monitoring of the shellfish harboring waters of the state, including the south shore coastal ponds, in order to maintain certification of these waters for shellfish harvesting for direct human consumption. Since 1981, RIDEM's Shellfish Unit have sampled 12 stations in Green Hill Pond and Ninigret Pond. In 1994, based on composite bacterial monitoring results, Green Hill Pond's shellfishing status was reclassified from Conditionally Approved/Seasonal to Prohibited. In 1996, eastern Ninigret Pond (all waters east of a line from Tockwotten Cove (in its entirety) to a range marker located on the opposite side of the Pond) was reclassified from Approved to Prohibited based on elevated bacterial concentrations

Volunteers, known as the "Salt Pond Watchers" (SPW) began an annual monitoring program in the salt ponds in 1985 with funding from the Rhode Island Sea Grant Program, RIDEM, and the FDA. Under the direction of the URI Coastal Resources Center, a water quality monitoring program was established with sampling at 22 water chemistry and bacteria stations in Green Hill and Ninigret Ponds and 9 bacteria stations in Factory Brook and Teal Brook. The SPW dataset shows that the elevated in-pond bacteria concentrations are localized, and consistently occur in several isolated coves. SPW data have also shown that Factory and Teal Brook are a prime source of bacterial loading and that these streams are violating state water quality standards.

The Salt Pond Watcher data has been incorporated into the Rhode Island *State of the State's Waters* 305(b) Report to the Environmental Protection Agency. It also provides a basis for revising the state's construction standards for on-site sewage disposal systems. Bacteria data collected from Green Hill and Ninigret Ponds has also helped DEM to localize monitoring efforts for TMDL development.

A list of applicable studies appears in Table 5.1. More details about each study can be found in the Preliminary Data Report for the Green Hill-Ninigret Pond watershed (RIDEM 2001). Section 14.0 discusses data acquisition requirements.

Table 5.1 Water Quality Monitoring Programs in the Green Hill Study Area.

Organization	*Report/Monitoring*	*Date of Report*	*Approx. date of Study*
Salt Pond Coalition	SPW Technical Report 1985-1994; Ongoing Data Collection	1996	1985-1994, ongoing water quality monitoring
RIDEM-Shellfish Unit	Review: Shellfish Surface Water Monitoring Program	Yearly summaries	Ongoing water quality monitoring
RIDEM	Preliminary Data Report for Green Hill Pond, Ninigret Pond, Factory Brook, and Teal Brook	January 2001	Summary of previous water quality data

5.4 Project Planning

Project Planning meetings were informally held at RIDEM between the Project Manager, Brian Zalewsky and the Project Managers supervisor, Wayne Jenkins. The meetings consisted of discussions regarding project goals, sampling locations, and project action limits.

6.0 Project Description and Schedule

A Total Maximum Daily Load (TMDL) report is required by the Clean Water Act for all waterbodies that do not meet their designated use. Green Hill Pond and eastern Ninigret Pond are currently closed to shellfishing due to elevated levels of fecal coliform bacteria. Factory Brook and Teal Brook are currently listed on the State's 303(d) list of water quality impaired waterbodies. The TMDL reports will include the quantification of the dry and wet weather pollution sources to these waterbodies

Beginning in the spring of 2001, RIDEM will conduct three dry weather surveys and one wet weather survey in Green Hill Pond, eastern Ninigret Pond, Factory Brook, and Teal Brook.

6.1 Tasks

The following tasks outline the steps needed to accomplish the objectives of the sampling program. The tasks relate to both dry and wet weather monitoring surveys

Task 1 Water Quality Monitoring: Review Existing Water Quality Data

Table 5.1 lists the various water quality studies that have been completed in the watersheds over the last sixteen years, as well as those programs that currently collect water quality data. Table A.1 in Appendix A details water quality data from these programs. Since 1981, RIDEM's Shellfish Unit has sampled 12 stations in Green Hill Pond and eastern Ninigret Pond. A volunteer monitoring group called the 'Salt Pond Watchers' (SPW) have sampled Green Hill Pond, Ninigret Pond, Factory Brook, and Teal Brook from 1985 to present.

RIDEM and SPW data will be used to localize monitoring efforts and focus sampling in areas of concern. Land use investigations and aerial photo analysis combined with fieldwork that included talking with local residents and walking up the length of channels looking for potential pollution sources have also helped RIDEM staff in the determination of station locations. In addition, other factors that influence the selection of sampling sites include accessibility to the site and tidal influences.

Task 2 Water Quality Monitoring: Dry Weather Monitoring Protocol

The purpose of the dry weather survey is to characterize in-pond and in-stream water quality and to identify the areas contributing to the dry weather discharge of fecal coliform. All stations will be sampled once (twice if a replicate sample was taken at that station) throughout the duration of each survey. A total of 38 stations will be sampled during each dry weather survey. Replicate samples will be taken randomly at 5% of the stations for quality control purposes. BAL Laboratory will utilize the mTEC method when analyzing bacteria samples. Table A.2 in Appendix A details the monitoring protocol and sampling rationale for the dry weather surveys. Appendix A.1 details each teams instructions for each dry weather survey. All dry weather station locations are shown in Figures A. 1 and A.2 in Appendix A. All in-stream stations can be accessed on foot while the in-pond samples will be taken from a RIDEM boat. All samples will be collected following the field sampling standard operating procedures (SOP) presented in Attachment A.

Table 6.1. Analytical Services Table for Dry Weather Sample Stations.

Medium/ Matrix	*Analytical Parameter*	*Analytical Method/ SOP*	*No. of Sampling Locations*[1]	*No. of Field Duplicates*	*Total No. Samples to Lab.*	*Data Package Turnaround*	*Laboratory Name*
Surface Water	Fecal Coliform	mTEC	114	5%	120	7 Days	BAL

[1] Number of Sampling Locations includes all three dry weather surveys.

Task 3 Water Quality Monitoring: Wet Weather Monitoring Protocol

The objective of the wet weather sampling program is to isolate the effect of a discrete rainfall event to permit the characterization of runoff and the determination of the impact on receiving water quality.

To be considered a storm event, the following precipitation characteristics must apply:

- Minimum rainfall of 0.5 inches in a 24-hr period
- Minimum duration of 5 hours
- Minimum antecedent dry period (ADP) of 3 days

Each station will be sampled seven to eight times (depending on if a replicate sample was taken at that station) throughout the duration of the storm. A total of 55 stations will be sampled during the wet weather survey. Replicate samples will be taken randomly at 5% of the stations for quality control purposes. BAL Laboratory will utilize the mTEC method when analyzing bacteria samples.

During wet weather, all stations will be sampled before the storm (pre-storm sample) and at hours 1, 3, 6, 12, 24, 48, and 60. Table A.3 in Appendix A details the monitoring protocol and sampling rationale for each station. The locations of wet weather stations are shown in Figures A.3, A.4, and A.5 in Appendix A. Appendix A.1 details team instructions for the wet weather survey.

Stormwater discharges will only be sampled when they are flowing. In general, all stormwater conveyances will be sampled before the storm, if they are flowing, and then at hours 1, 2, 4, and 6. They will be sampled at hour 12 if they are still flowing. All stormwater conveyances and in-stream stations can be accessed on foot while the in-pond samples will be taken from a RIDEM boat. All samples will be collected following the field sampling standard operating procedures (SOP) presented in Attachment A.

Table 6.1.1 Analytical Services Table for Wet Weather Sample Stations.

Medium/ Matrix	*Analytical Parameter*	*Analytical Method/ SOP*	*No. of Sampling Locations*[1]	*No. of Field Duplicates*	*Total No. of Samples to Lab*[1].	*Data Package Turnaround*	*Laboratory Name*
Surface Water	Fecal Coliform	mTEC	328/339	5%	344/356	7 Days	BAL

[1]Samples taken at separate times at the same location count as a separate sampling location/station. First number indicates total samples if stormwater discharges are not flowing at hour 12. Second number indicates the number of samples if they are flowing at hour 12.

6.2 Project Schedule

Table 6.2 Project Schedule.

Task	*Deliverable*	*2000*				*2001*											
		S	***O***	***N***	***D***	***J***	***F***	***M***	***A***	***M***	***J***	***J***	***A***	***S***	***O***	***N***	***D***
Review Existing Data[1]	Monitoring Plan																
QAPP Preparation	QAPP Document																
Site Preparation	NA																
Sample Collection	NA																
Laboratory Analysis	Laboratory Report																
Final Data Report	Final Data Report																

[1]Section 14.0 of this report documents the existing data used to establish sampling stations and any data limitations.

7.0 Project Quality Objectives and Measurement Performance Criteria

Collecting high quality data is one of the most important goals of this project. Specific data quality objectives include method detection limits, precision, accuracy, representativeness, comparability, and completeness. All the data quality objectives will be met if the data collected are sufficient to complete the TMDL.

7.1 Measurement Performance Criteria

Representativeness

The selected stations and sampling frequency were chosen for their representativeness of conditions during dry and wet weather. Wet weather sampling is important because this is when water quality in the ponds and streams is most frequently compromised. The extent to which the measurements represent actual environmental conditions will be somewhat restricted by the time of year the samples are taken and the overall weather conditions of that year (i.e. wet versus dry year).

Comparability

To maximize the quality of the data collected, and to collect data that is comparable with other studies, accepted sampling procedures will be used during this study. All samples collected will be sent to laboratories that use Standard Methods. The mTEC method will be used to analyze all bacteria samples.

Sensitivity

Analytical methods were selected such that detection limits will not limit the usefulness of the data set.

Completeness

If the data collected is sufficient to complete the TMDL report, than the data is considered to be complete. Measurement performance criteria help determine the completeness of a data set. Table 7.1 documents the measurement performance criteria for this project.

Table 7.1 Measurement Performance Criteria.

Sampling SOP	S-1
Medium/Matrix	Surface Water
Analytical Parameter	Fecal Coliform
Concentration Level	<1

Data Quality Indicator	***Analytical Method/ SOP Reference/ Laboratory***	***Measurement Performance Criteria***	***QC Sample and/or Activity Used to Assess Measurement Performance***	***QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S/A)***
Precision	mTEC/ Standard Method 9213D/ BAL	Within 95% Confidence Interval	Field Duplicates	S/A
Accuracy/bias Contamination	mTEC/ Standard Method 9213D/ BAL	Positive Growth (>2)	Method Blank	A
Accuracy/bias Contamination	mTEC/ Standard Method 9213D/ BAL	No Growth	Reagent Blank	A
Data - Completeness	mTEC/ Standard Method 9213D/ BAL		Anticipate 100%	A
Accuracy	mTEC/ Standard Method 9213D/ BAL	Within 95% Confidence Interval	Field Duplicates	S/A

8.0 Sampling Process Design

8.1 Sampling Design Rationale

Task 1 In-stream/In-pond Sampling

Section 6.1 Task 1 describes the process for deciding the locations of the dry and wet weather sampling stations. Stations were chosen based on land use information, historic water quality data, and previous field investigations. Sample stations were selected with the intention of quantifying pollution sources during dry and wet weather and establishing the link between pollution source and in-stream or in-pond water quality. Tables A.2 and A.3 in Appendix A describe the exact location and monitoring protocol for each station. BAL Laboratory will use the mTEC analysis method to analyze all bacteria samples. Table 8.1 contains information about sampling and analysis methods.

Table 8.1 Sampling and Analysis Method/SOP Requirements.

Lab	***Medium/ Matrix***	***Depth***	***Analytic Parameter***	***SOP***		***Container[1]***			***Container[1] Requirements***	***Temperature***	***Holding Time[2]***
				Sampling	***Analytical***	***No.***	***Size***	***Type***			
BAL	Surface Water	6-12 inches	Fecal Coliform	S-1	mTEC	1	250 mL	Polyethylene	Ice	4°C	6 Hours

[1] The laboratory that completes the sample analysis will provide sterile bottles.
[2] Samples may be held for up to twenty-four hours before being analyzed, however most samples will be delivered to the laboratory within six hours.

9.0 Sampling Procedures and Requirements

9.1 Sampling Procedures

Standard operating procedures for field sampling are located in Attachment A of this report.

Table 9.1 Project Sampling SOP Reference Table.

Reference Number /Title	*Originating Organization*	*Equipment Identification*	*Modified for Work Project*
Field Sampling SOP 1 (S-1) Fecal Coliform Sampling	RIDEM	Not Applicable	No

9.2 Equipment Cleaning

BAL Laboratory will provide sterile bottles for bacteriological sampling.

9.3 Field Equipment Calibration and Maintenance

The Project Manager will ensure that all field equipment is operating properly. The only equipment needed for sampling is a 16-foot jon boat and associated safety and maintenance gear, and sampling sticks.

10.0 Sample Handling, Tracking, and Custody Requirements

10.1 Field Notes & Sample Tracking

Task 1 Water Quality Monitoring

Two sampling teams-consisting of two persons per team, will be needed for each dry weather survey. Team instructions for each team are provided in Appendix A.1. Three sampling teams-consisting of two persons per team, will be needed for the wet weather survey. Team instructions for the wet weather survey are provided in Appendix A.1.

Task 2 Field Notes & Sample Tracking

All sampling teams will be provided with a Nalgene field notebook. Each team member should ensure that a log of events is faithfully and articulately maintained in one of the Nalgene notebooks used to document field studies. A minimum log includes the date, samplers name, station location, sample name and run (wet weather), sample collection times, and any other significant information.

The proper identification of the sample is important. Before it is filled, the sample bottle should be labeled with the following information: sample station, date of collection, time of collection, and the samplers initials. For wet weather sampling-after writing the sample station on the bottle a number corresponding to the hour of collection (run) should be inserted. For example, a team member collecting the pre-storm sample (hour 0) at station GH16 would label the bottle "GH16-0", at hour 2 (run 2) the sample would be labeled "GH16-2", etc. A replicate sample would be labeled with an "R" at the end of the station field. A replicate sample from station GH16 at hour four would have the following information in the station field of the label: GH16-4R. When taking a sample, the sampler should fill in the Sample ID on both the Nalgene Notebook and the Sample Bottle Label (shown in Figure 10.1). The bottle should be labeled with permanent marker prior to collecting the sample as it is difficult to write on wet sample bottles.

STATION_____

DEPTH_____ **TEMP.**_____ **DATE**_____

INITIALS_____ **SALIN.**_____ **TIME**_____

SAMPLE TYPE_____

REMARKS _____ **LAB. NO.**

_____

BAL

Figure 10.1 BAL Sample Bottle Label (The station, date, time, and initial fields should be filled in on the sample bottle).

Figure B.1 in Appendix B shows the chain of custody form for BAL Laboratory. Before the samples are handed over to the laboratory, all fields must be filled in, especially the sample ID and the time of sample collection field. The laboratory gives each sample a BAL Sample Number. This number is written on both the sample bottle and on the chain of custody form by laboratory personnel. The laboratory and RIDEM are given a copy of the completed chain of custody form.

10.2 Sample Handling

All samples will be placed in a cooler with ice immediately after the sample is taken. The sample will be delivered to the laboratory within six hours. In some cases, samples may be kept for up to twenty-four hours, providing the are kept at 4°C. A designee of the Project Manger will deliver the samples to the laboratory. Table 8.1 documents the sample container size and preservation techniques.

Table 10.2 Sample Handling System.

	Responsible Party	*Samples*
Sample Collection	RIDEM staff	Source, In-pond, In-stream
Sample Delivery	RIDEM staff	Source, In-pond, In-stream
Sample Analysis	BAL Laboratory	Source, In-pond, In-stream
Sample Archival	None	Not Applicable
Sample Disposal	BAL Laboratory	Source, In-pond, In-stream

11.0 Field Analytical Method Requirements

During sampling, no field analyses will take place.

12.0 Fixed Laboratory Analytical Method Requirements

Samples collected from each survey will be taken to BAL Laboratory in Cranston, Rhode Island. These samples will be analyzed using the mTEC method. Attachment C describes the standard operating procedures for BAL Laboratory.

Table 12.1 Fixed Laboratory Analytical Method/SOP Reference Table.

Reference Number	*Fixed Laboratory Performing Analysis*	*Title*	*Definitive or Screening Data*	*Analytical Parameter*	*Instrument*	*Modified for Work Project*
L-1	BAL	BAL Laboratory mTEC Method for Detection of Fecal Coliform and Escherichia Coli	Definitive	Fecal Coliform	NA	N

13.0 Quality Control Requirements

Table 13.1 Field Sampling QC: Fecal Coliform.

Sampling SOP	S-1					
	Surface Water					
Analytical Parameter	Fecal Coliform					
Concentration Level	<1					
Analytical Method/ SOP Reference	S-1					
QC	***Frequency/ Number***	***Method/SOP QC Acceptance Limits***	***Corrective Action***	***Person Responsible for Corrective Action***	***Data Quality Indicator***	***Measurement Performance Criteria***
Field Duplicates	Minimum 1 per 20 samples	L-1	Discuss any problems in the field with sampler.	Project Manager	Precision	Within 95% Confidence Interval

Table 13.2 Fixed Laboratory Analytical QC: Fecal Coliform, mTEC at BAL Laboratory.

Sampling SOP	S-1					
	Surface Water					
Analytical Parameter	Fecal Coliform					
Concentration Level	<1					
Analytical Method/ SOP Reference	Standard Method 9213D					
QC	***Frequency/ Number***	***Method/SOP QC Acceptance Limits***	***Corrective Action***	***Person Responsible for Corrective Action***	***Data Quality Indicator***	***Measurement Performance Criteria***
Method Blank	1 Per Batch	L-1	Re-prepare Batch	Kathy Feldman	Bias-Contamination	Positive Growth (>2)
Reagent Blank	1 Per Batch	L-1	Re-prepare Batch	Kathy Feldman	Bias-Contamination	No Growth
Laboratory Duplicate	1 per 10 samples	L-1	Reanalyze	Kathy Feldman	Precision-Lab	Within 95% Confidence Interval

14.0 Data Acquisition Requirements

RIDEM's Shellfish Unit has monitored the Green Hill-Ninigret Pond watershed since 1981. In the following years, a volunteer monitoring group called the "Salt Pond Watchers" began to sample in-pond and in-stream stations during the summer months. These two studies, along with field investigations and land use and aerial photo analysis have provided the basis for determining the wet and dry weather fecal coliform sampling sites for RIDEM's 2001 studies. The major limitation to the above-mentioned water quality monitoring programs is that the data do not sample pollution sources or establish the relationship between instream or in-pond water quality and pollution sources. A summary of fecal coliform data from previous water quality studies is presented in Table A.1 in Appendix A.

During wet weather, RIDEM will utilize precipitation information from the National Weather Service Kingston weather station, located in Kingston, Rhode Island. The weather station is located approximately 8 km from the Green Hill-Ninigret Pond watershed. Table 14.1 summarizes non-direct measurements used in setting up the dry and wet weather studies.

Table 14.1 Non-Direct Measurements Criteria and Limitations.

Non-Direct Measurement (Secondary Data)	*Data Source*	*Data Generator*	*How Data Will Be Used*	*Limitations on Data Use*
Rainfall	National Weather Service Cooperative Observer, Kingston, RI station	URI Plant Sciences Dept.	Quantify amount of rainfall received in watershed.	None
Bacteriological Monitoring	Green Hill-Ninigret Ponds RI Shellfish Growing Area 11 Survey and Classification Considerations	Food and Drug Administration (FDA)	Rank fecal coliform sources. Evaluate instream water quality.	1. No comprehensive monitoring of sources. 2. Sample not representative of wet weather conditions.
	SPW Salt Pond water quality monitoring program.	SPW	Evaluate in-pond and instream water quality	1. Summer sampling only. 2. Different analysis than that used by BAL Laboratory (not comparable)

15.0 Documentation, Records, and Data Management

All samplers will be given a Nalgene field notebook. The monitoring plans that will be distributed when each sampler collects his/her equipment includes specific information on what needs to be recorded in the notebook. All notebooks will be given to field leader at the conclusion of sampling. Initials on these sheets identify the sampler. The Project Manager will review the sheets within three days to identify any possible errors or omissions. The Project Manager will contact any sampler whose sheet shows any discrepancies. In addition, the Project Manager will try to contact all samplers to identify any problems or additional feedback that would make future sampling easier.

The Project Manager will designate a person to collect all samples from each sampler during the storm. Each sampler will be responsible for filling out the chain of custody sheets (Appendix B). When the samples are picked up from the samplers, the Project Manager or designee will check the chain of

custody sheets. The samples and chain of custody sheets are also checked at the laboratory. A copy of the chain of custody form will be given to RIDEM when the samples are dropped off at the laboratory. After analysis is complete, sample results from the laboratory will be mailed to RIDEM.

After each sampling report, a brief Status Report will be written to document any changes to the Monitoring Plan. All information collected throughout the project will be summarized in the Final Data Report. Information included in the Final Data Report is described in Section 17.0. Table 15.1 lists records that will be generated throughout this project.

The Project Manager is responsible for the storage of all project files. RIDEM has a central filing system at its Providence Office where all original documents will be kept.

Table 15.1 Project Documentation and Records.

Sample Collection Records	*Field Analysis Records*	*Fixed Laboratory Records*	*Data Assessment Records*
Field Notes/Log Sheets	Field Notes/Log Sheets	Chain of Custody Records	Status Reports
Chain of Custody Records		Tabulated Data Summary Forms: draft and final	Final Data Report
Monitoring Plan			

16.0 Assessments and Response Actions

The Project Manager or designee will be responsible for each of the project tasks and their associated quality assurance and quality control procedures. The Project Manger will provide consistency between sampling events and sampling teams. Continual reports to the QA Officer about the status of sampling, quality assurance, and quality control will highlight any problems that are encountered during sampling. If needed, the QA Officer and Project Manager will halt sampling until problems are remedied.

Table 16.1 Project Assessment Table.

Assessment Type	*Frequency*	*Internal or External*	*Person Responsible for Performing Assessment and Implementing Corrective Actions*	*Person Responsible for Monitoring the Effectiveness of the Corrective Action*
Field Sampling Technical Systems Audit	Start of Sampling	I	Brian Zalewsky RIDEM	Wayne Jenkins RIDEM
BAL Laboratory Technical Systems Audit	Prior to Sample Receipt	E	Kathy Feldman BAL Laboratory	Brian Zalewsky RIDEM

17.0 QA Management Reports

Table 17.1 lists the QA Management Reports that will be generated throughout this study.

As needed during this project, the Project Manager and the QA Officer will meet to discuss any issues related to sampling. These meetings will consist of verbal status reports. Problems encountered in the field will be discussed and any appropriate actions determined and implemented. Any changes and/or problems will be included in the final report.

After each survey event, the Project Manager will generate a Status Report. This Status Report will be the written record of any changes to the QA Plan. If a station was not sampled, or if a station was

added, it will be documented here. Issues discussed during the Verbal Status Report can also be included. At the completion of all four events, the Project Manager will write a final report summarizing the four sampling events. Information in this final report will include the following information:

- Brief description of each sampling event
- Data tables of all data collected during the sampling event (including rainfall)
- Attachments
  - Status Reports
  - Sampling Logs
  - Chain of Custody forms
  - Laboratory data sheets provided by the labs

Table 17.1 QA Management Reports.

Type of Report	*Frequency*	*Person(s) Responsible for Report Preparation*	*Report Recipient*
Verbal Status Report	As needed	Brian Zalewsky RIDEM	Wayne Jenkins RIDEM
Written Status Report	After each wet weather survey	Brian Zalewsky RIDEM	Wayne Jenkins RIDEM
Final Report	Completion of sampling	Brian Zalewsky RIDEM	Wayne Jenkins RIDEM

18.0 Verification and Validation Requirements

Both the Project Manager and the QA Officer will review all data collected during this study to determine if the data meets QAPP Objectives. Decisions to qualify or reject data will be made by the Project Manager and QA Officer. All data collected will be included in the Final Report. To ensure correct interpretation of the data, all problems encountered in the field will be included in an Appendix to the report and discussed in the general text of the report. Problems will also be documented in each survey's written Status Report. To assist in data interpretation, statistical information on sampling events, including sampling size, sample mean, and sample variance, will be reported, where applicable. A discussion on duplicate precision and accuracy criteria and results will also be discussed in the Final Report.

19.0 Verification and Validation Procedures

All data collected during each study will be included in the appendix of the Final Data Report. Once the data has been collected, it will be entered into Microsoft Excel files. The Project manager will proofread the data entry for errors. Errors will be corrected. Outliers and inconsistencies will be flagged for further review with the QA Officer. The decision to discard data will be made by the Project Manager and QA Officer. Problems will be discussed in the Final Report. Table 19.1 discusses the data verification process.

Table 19.1 Data Verification Process.

Verification Task	*Description*	*I/E*	*Responsible for Verification*
Field Notes	Field notes will be collected at the end of each day and reviewed. Any required corrective actions will be addressed with the field samplers prior to further sampling. After the field notes will be entered into Excel, the data will be proofread for any data entry errors. Copies of the field notes will be maintained in the project file.	I	Brian Zalewsky/RIDEM
Chain of Custody Forms	Chain of custody forms will be reviewed when samples are collected for delivery to the laboratory in the field and at the laboratory. The forms will be maintained in the project file.	I/E	Brian Zalewsky/RIDEM Kathy Feldman/BAL
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness prior to submittal. The data packages will be also reviewed by the sampling organization.	I/E	Brian Zalewsky/RIDEM Kathy Feldman/BAL

Internal E- External

Data validation will utilize the measurement performance criteria documented in Tables 7.1, 13.1, and 13.2 of this report.

20.0 Data Usability/Reconciliation with Project Quality Objectives

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators meet those measurement performance criteria documented throughout this QA Plan, the project will be considered a success. If there are data that do not meet the measurement performance criteria established in this QA Plan, the data may be discarded and sampled again or the data may be used with stipulations written about its accuracy in the Final Report. The cause of the error will be evaluated. If the cause is equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is sampling team error, retraining will occur. Any limitations with the data will be documented in the Status Reports and the Final Report.

References

Isaji T., Spaulding M., 1981. A simplified model for assessing the impact of breachway modifications on coastal pond circulation and flushing dynamics. *Proc., Oceans* 81, Boston, Mass., 824-828.

Rector, Dean. 1981. Soil Survey of Rhode Island. U.S. Dept. of Agriculture. Soil Conservation Service.

RIDEM. 2001. Preliminary Data Report for Green Hill Pond, Ninigret Pond, Factory Brook, and Teal Brook. RIDEM, Providence, RI.

Appendix A Sampling Station & Sampling Protocol Information

Table A.1 Summary of fecal coliform data from previous water quality studies-RIDEM Shellfish Monitoring.

Station	*Location*	*No. of years*	*n*	*Geometric Mean (fc/100ml)*	*90th Percentile Value*	*% Greater than 49 fc/100ml*
11	Ninigret Pond- Approximate Center of Tockwotten Cove	10	62	8	75	11
12	Ninigret Pond- Midway along a line from the northern end of Ward Island to the flagpole on the opposite northern shore.	10	62	9	230	13
13	Green Hill Pond- Mid channel under the Charlestown Beach Rd. bridge.	10	62	7	43	10
14	Just off the western edge of Horseshoe Point	10	62	8	43	10
14A	Just inside the entrance to Allen Cove	10	62	7	43	10
14B	Between Gooseberry and Ram Islands, just off the yellow house with dock.	10	62	6	43	8
15	Approximately 100 meters south of the southern tip of High Neck	10	62	4	23	7
16	Midway across the mouth of cove at northeast corner of Green Hill Pond.	10	62	11	93	19
16A	Midway between the two points of land at the entrance to the cove at Limber Point.	10	62	6	43	3
16B	Approximately 50 meters west of the point of land at the middle of Twin Peninsula	10	62	5	23	7
17	At the entrance to Flat Meadow Cove midway between the northern end of Goose Island and the southern tip of Twin Peninsula.	10	62	5	23	3
18	Approximately 100 meters west of the eastern shore of Flat Meadow Cove midway between north and south shores	10	62	7	43	10

Table A.1 cont. Summary of fecal coliform data from previous water quality studies-SPW monitoring.

Station	*Location*	*n (dry)*	*n (wet)*	*Geomean (dry) fc/100ml*	*Geomean (wet) fc/100ml*	*90th Percentile (dry)*	*90th Percentile (wet)*
16M	Factory Brook mainstem- Upstream side of dirt road in South Shore Management Area.	28	14	10	13	130	300
16S	Factory Brook mainstem- Downstream side of intersection between Matunuck Schoolhouse Road and Green Hill Beach Road.	29	9	127	208	350	1600
16F	Factory Brook mainstem- Upstream of impoundment.	11	13	39	284	130	1381
16G	Factory Brook mainstem- Downstream of impoundment.	46	25	65	251	328	1601
16J	Teal Brook tributary headwaters- Dawley Way.	8	9	27	111	80	512
16E	Teal Brook tributary- Intersection with Mautucket Road.	5	8	61	684	1051	1601
16K	Teal Brook mainstem- Downstream side of Matunuck Schoolhouse Road	41	18	154	126	540	1600
16D	Teal Brook outlet downstream of Teal Pond	20	17	87	181	300	1601

Table A.2 Monitoring Protocol and Sampling Rationale- Dry Weather Surveys.

Station	*Location*	*Monitoring Protocol*	*Sampling Rationale*
N15	Ninigret Pond-Northern Tockwotten Cove	In-situ grab sample	Possible contamination from waterfowl
N11	Ninigret Pond- Southern Tockwotten Cove	In-situ grab sample	Possible contamination from waterfowl
N13	Ninigret Pond- Northern Unnamed Cove	In-situ grab sample	Possible contamination from waterfowl
N12	Ninigret Pond- Southern Unnamed Cove	In-situ grab sample	Possible contamination from waterfowl
N14	Ninigret Pond- Marina	In-situ grab sample	Possible contamination from marina
GHCC	Green Hill Pond- Crab Cove near shore	In-situ grab sample	Possible contamination from nearby houses and waterfowl
GH14	Green Hill Pond- Outlet of Crab Cove	In-situ grab sample	Possible contamination from waterfowl
GH25a	Green Hill Pond- Allen Cove near discharge pipe	In-situ grab sample	Characterize dry weather water quality
GH25	Green Hill Pond- Middle of Allen Cove	In-situ grab sample	Characterize dry weather water quality
GH14A	Green Hill Pond- Outlet of Allen Cove	In-situ grab sample	Characterize dry weather water quality
GH24A	Green Hill Pond- Unnamed Cove near mouth of UN2	In-situ grab sample	Determine dry weather impacts from UN1
GH24	Green Hill Pond- Unnamed Cove-middle	In-situ grab sample	Control
GH23	Green Hill Pond- Near mouth of UN1	In-situ grab sample	Determine dry weather impacts from UN2
GH22	Green Hill Pond- NNE of GH16	In-situ grab sample	Determine extent of impacts from Factory and Teal Brook
GH16	Green Hill Pond- NNE of GH22	In-situ grab sample	Determine extent of impacts from Factory and Teal Brook
FT	Green Hill Pond- Near mouth of Teal and Factory Brook	In-situ grab sample	Determine immediate impact from Factory and Teal Brook
GH16B	Green Hill Pond-Cove northeast of GH16A	In-situ grab sample	Water quality characterization in isolated cove
GH16A	Green Hill Pond- Cove northeast of Limber Point	In-situ grab sample	Water quality characterization in isolated cove
GH21	Green Hill Pond- Inside of Limber Point	In-situ grab sample	Water quality characterization in isolated cove
GH19	Green Hill Pond- Northern Flat Meadow Cove	In-situ grab sample	Characterize dry weather water quality
GH18B	Green Hill Pond- Middle of Flat Meadow Cove	In-situ grab sample	Characterize dry weather water quality
GH18	Green Hill Pond- Lower Flat Meadow Cove	In-situ grab sample	Characterize dry weather water quality
GH15	Green Hill Pond- Middle of Green Hill Pond and NNW of Hog Hill Island	In-situ grab sample	Control
FB01	Factory Brook at outlet of Factory Pond	In-situ grab sample	Characterize water quality from Factory Pond and control
FB02	Factory Brook mainstem	In-situ grab sample	Isolate wetland
FB07	Factory Brook tributary from Green Hill Swamp	In-situ grab sample	Isolate wetland-control
FB08	Factory Brook tributary from Green Hill Swamp	In-situ grab sample	Isolate wetland-control
FB03	Factory Brook mainstem	In-situ grab sample	Isolate wetland
FB04	Factory Brook mainstem upstream of impoundment	In-situ grab sample	Isolate impoundment
FB05	Factory Brook mainstem downstream of impoundment	In-situ grab sample	Isolate impoundment
FB06	Mouth of Factory Brook	In-situ grab sample	Determine impacts from Factory Brook to Green Hill Pond
TB03	Mouth of Teal Brook	In-situ grab sample	Determine impacts from Teal Brook to Green Hill Pond
TB02	Teal Brook mainstem	In-situ grab sample	Potential pollution source
TB01	Teal Brook tributary	In-situ grab sample	Potential pollution source
TB00	Teal Brook tributary	In-situ grab sample	Tributary characterization
TBa	Teal Brook headwaters	In-situ grab sample	Headwater characterization
UN2	Mouth of Unnamed Brook 2	In-situ grab sample	Water quality characterization- Determine impacts from UN2 on Green Hill Pond
UN1	Mouth of Unnamed Brook 1	In-situ grab sample	Water quality characterization- Determine impacts from UN1 on Green Hill Pond

Table A.3. Monitoring Protocol and Sampling Rationale- Wet Weather Survey.

			Monitoring Protocol									
			Time of Sample									
Station	Location	P/S/SR	1	2	3	4	6	12	24	48	60	Sampling Rationale
N15	Ninigret Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
N11	Ninigret Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
N13	Ninigret Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
N12	Ninigret Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
N14	Ninigret Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GHCC	Green Hill Pond[1]	P	X		X		X	X	X	X		Wet weather water quality characterization
GH14	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH25a	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH25	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH14A	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH24A	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from UN1
GH24	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from UN1
GH23	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from UN2
GH22	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from Factory and Teal Brook
GH16	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from Factory and Teal Brook
FT	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Determine wet weather impacts from Factory and Teal Brook
GH16B	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH16A	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH21	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH19	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH18B	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH18	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
GH15	Green Hill Pond[1]	P	X		X		X	X	X	X	X	Wet weather water quality characterization
FB01	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB02	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB07	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB07U	Upstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs
FB07D	Downstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs

[1]Station description given above in Table A.2.
P (Pond) **S** (Stream) **SR** (Stormwater Runoff)

Table A.3 cont. Monitoring Protocol and Sampling Rationale- Wet Weather Survey.

			Monitoring Protocol Time of Sample									
Station	**Location**	**P/S/PS**	**1**	**2**	**3**	**4**	**6**	**12**	**24**	**48**	**60**	**Sampling Rationale**
FB03	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
DP03	Drainage Pipe to Factory Brook	SR	X	X		X	X	X				Determine stormwater strengths
DP04	Drainage Pipe to Factory Brook	SR	X	X		X	X	X				Determine stormwater strengths
FB04	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB05	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB06	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
TB03	Teal Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
TB02	Teal Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
TB01	Teal Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
TB00	Teal Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
TBA	Teal Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
DP01	Drainage Pipe to Unnamed Cove in Ninigret Pond	SR	X	X		X	X	X				Characterize fecal coliform concentrations from pipe
DP02	Drainage Pipe- Green Hill Pond-Allen Cove	SR	X	X		X	X	X				Characterize fecal coliform concentrations from pipe
DP07	Drainage Pipe-Green Hill Pond-Allen Cove	SR	X	X		X	X	X				Characterize fecal coliform concentrations from pipe
DP06	Drainage Pipe-Green Hill Pond-Allen Cove	SR	X	X		X	X	X				Characterize fecal coliform concentrations from pipe
UN2	Unnamed Brook 2[1]	S	X		X		X	X	X	X	X	Establish upstream sources
IPU	Upstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs
IPD	Downstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs
UN1D	Stromwater conveyance to Unnamed Brook 1	SR	X	X		X	X	X				Determine stormwater strengths
UN1	Unnamed Brook 1[1]	S	X		X		X	X	X	X	X	Establish upstream sources
DP05	Drainage Pipe to Green Hill Pond	SR	X	X		X	X	X				Characterize fecal coliform concentrations from pipe
FB08	Factory Brook[1]	S	X		X		X	X	X	X	X	Establish upstream sources
FB08U	Upstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs
FB08D	Downstream of discharge	S	X		X		X	X	X	X	X	Characterize upstream and downstream of stormwater inputs
DC05	Stormwater Conveyance to Factory Brook	SR	X	X		X	X	X				Determine stormwater strengths
DC07	Stromwater conveyance to Factory Brook	SR	X	X		X	X	X				Determine stormwater strengths
DC04	Stormwater Conveyance to Factory Brook	SR	X	X		X	X	X				Determine stormwater strengths

[1]Station description given above in Table A.2.
P (Pond) **S** (Stream) **SR** (Stormwater Runoff)

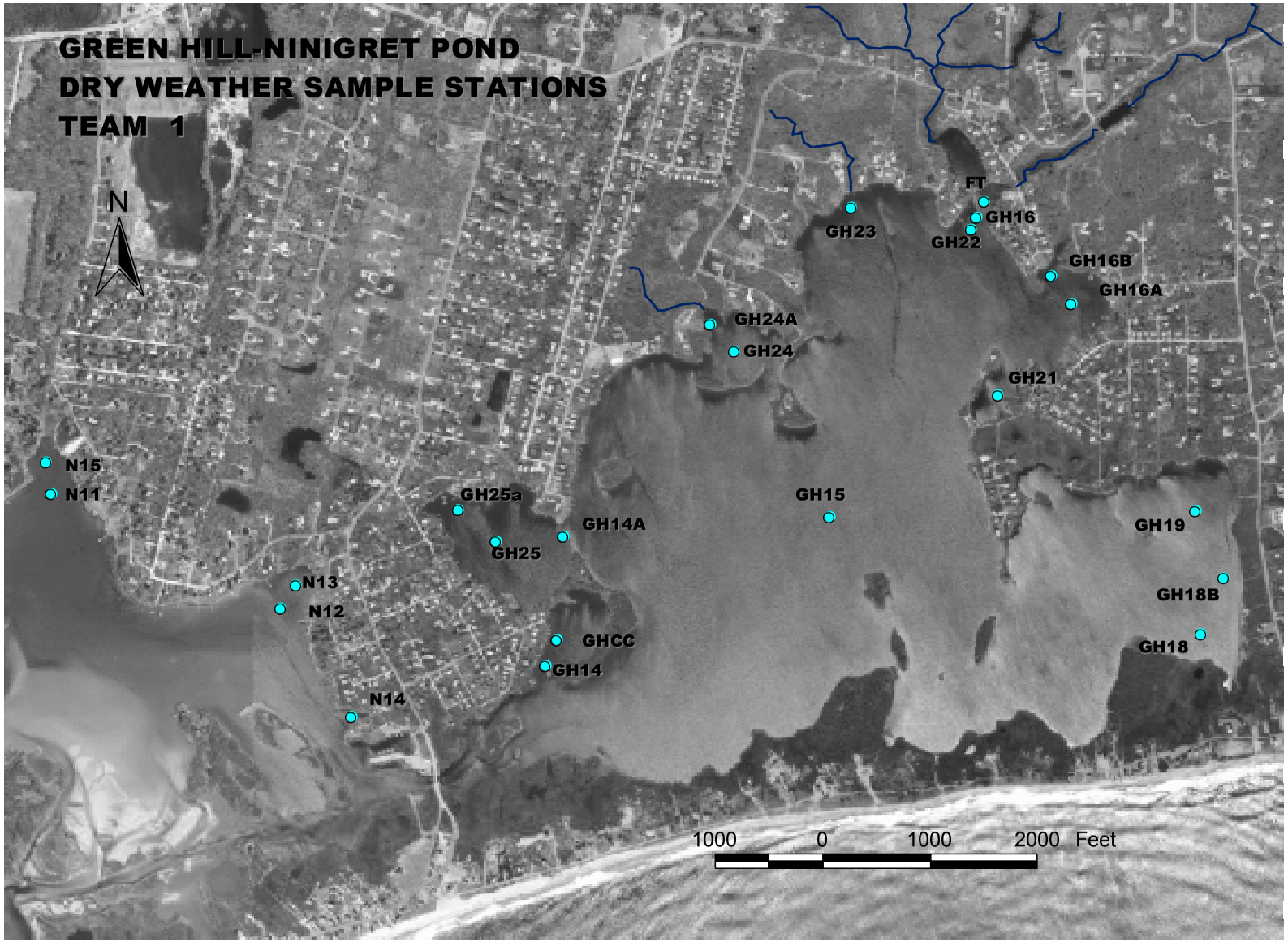


Figure A.1. Green Hill Pond and Ninigret Pond Dry Weather Sample Locations-Team 1.

Figure A. 2. Factory Brook and Teal Brook Dry Weather Sample Locations-Team 2.

Figure A.3. Green Hill Pond/Ninigret Pond (Area 1/Team 1) Wet Weather Sample Locations.

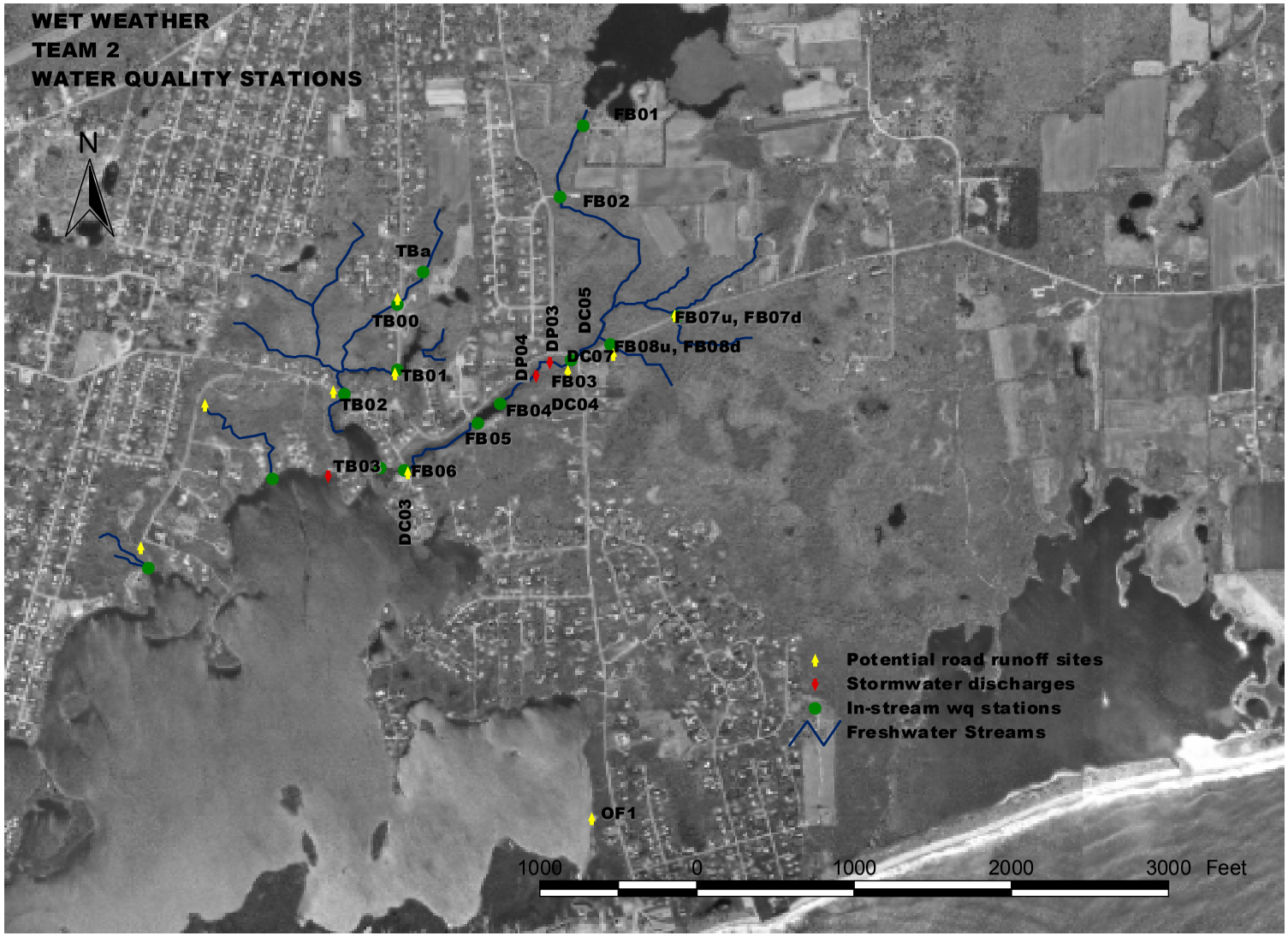


Figure A.4. Factory Brook- Teal Brook (Area 2/Team 2)- Wet Weather Sample Locations.

Figure A.5 Green Hill Pond-Ninigret Pond (Area 3/Team 3) Wet Weather Sample Locations.

Appendix A.1 Survey Team Instructions

Dry Weather Surveys Team Instructions:

TEAM 1 (Stations N15, N11, N13, N12, N14, GHCC, GH14, GH14A, GH25, GH25a, GH24, GH23, GH16, GH22, FT, GH16A, GH16B, GH21, GH15, GH19, GH18B, GH18)

Team 1 will be sampling all in-pond stations in Green Hill Pond and Ninigret Pond. A map showing station locations is included. Team 1 should begin sampling in Ninigret Pond at station N15, working back along the shore to the bridge at Charlestown Beach Road. Station GHCC should be the first station sampled in Green Hill Pond. Team 1 should continue collecting samples clockwise around the pond until GH18. The last sample after GH18 should be GH15. Duplicate samples should be collected from stations GHCC, GH25A, GH24A, GH23, FT, GH16B, or GH18B ONLY.

TEAM 2 Team 2 will be simultaneously sampling all freshwater stations in Teal Brook, Factory Brook, Unnamed Brook 1, and Unnamed Brook 2. Take all duplicate samples at UN1, UN2, TB00, FB07, or FB08.

(UN2) Sampling should begin with station **UN2**. From Matunuck Schoolhouse Road, turn left onto Indigo Point Road and follow this all the way down until it ends and turns into a small dirt road (A circle will be on your left). Bear to your left and follow that dirt road. Unnamed Brook passes through a culvert before draining to Green Hill Pond. Collect the sample at this culvert.

(UN1) Drive up Indigo Point Road and take a right on 110 Indigo Point Road. Follow this to house 110C. Behind house is a small footbridge. Sample here (need permission of landowner to access UN1).

(TBa) Bedford Drive off Green Hill Beach Road. Take a left onto Dawley Way and proceed until road ends (at a new house). Behind this house is a path to the stream channel (need permission of landowner to access TBa).

(TB00) Located off Mautucket Road approximately 200 yards upstream of station TB01.

(TB01) Located at downstream side of Mautucket Road crossing approximately 200 yards south of TB00.

(TB02) Located at downstream side of Matunuck Schoolhouse Road crossing.

(TB03) Located at outlet of Teal Pond.

(FB01) Located at downstream side of South Kingstown Water District access Road (just north of Dartmouth Lane).

(FB02) Located upstream side of dirt road in South Shore Management Area (off Green Hill Beach Road opposite of Auburn Road to the west).

(FB03) Upstream side of Matunuck Schoolhouse Road crossing.

(FB04) Located just north of impoundment off Matunuck Schoolhouse Road. A trail leads to a small derelict house and bridge where sample is obtained.

(FB05) Located south of impoundment along a private drive. Sample upstream side of road.

(FB06) From Matunuck Schoolhouse Road turn onto Marine Drive. Take a left at Teal Drive and park in *Mautucket By the Sea Association* Parking Lot. Sample at mouth of Factory Brook.

(FB07) Small tributary to Factory Brook located off Matunuck Schoolhouse Road. Sample downstream side of brook.

(FB08) Small tributary to Factory Brook located off Matunuck Schoolhouse Road approximately 200 yards southwest of FB07. Sample downstream side of brook.

Wet Weather Survey Team Instructions:

TEAM 1 (Stations N15, N11, N13, N12, N14, GHCC, GH14, GH14A, GH25, GH25a, GH24, GH23, GH16, GH22, FT, GH16A, GH16B, GH21, GH15, GH19, GH18B, GH18)

Directions for wet weather sampling:
Team 1 will be sampling all in-pond stations in Green Hill Pond and Ninigret Pond. A map showing station locations is included. Team 1 should begin sampling in Ninigret Pond at station N15, working back along the shore to the bridge at Charlestown Beach Road. Station GHCC should be the first station sampled in Green Hill Pond. Team 1 should continue collecting samples clockwise around the pond until GH18. The last sample after GH18 should be GH15. Duplicate samples should be collected from stations GHCC, GH25A, GH24A, GH23, FT, GH16B, or GH18B ONLY.

TEAM 2
(Stations FB01, FB02, FB07u, FB07d, FB08u, FB08d, DC05, FB03u, FB03d, DC04, DC07, DP03, DP04, FB04, FB05, FB06, TB03, TB02, TB01, TB00, TBa, OF1).

Directions for wet weather sampling:
Team 2 will be sampling in-stream stations in Factory Brook and Teal Brook, all stormwater discharges to these two streams, and a stormwater discharge to Flat Meadow Cove. A map showing station locations is included. Sampling frequency is given in attached chart. All stations will be marked with flagging.

Sampling will begin at **FB01**, inside of the South Kingstown South Shore management area off of Green Hill Beach Rd. The next site will be **FB02**. **FB02** is located on Green Hill Beach Rd. Across from Auburn Drive. Factory Brook flows through a culvert under the dirt road into the back area of the South Shore Management area. A sampling stick may be needed for this site. The next site will be **FB07**. This station is located off Matunuck Schoolhouse Road. If road runoff is evident, sample upstream and downstream of the road. If no runoff is evident, collect one sample at upstream side of road. Do the same for station **FB08**, located approximately 200 yards southwest of FB07. The next station will be **OF1**, located off Green Hill Beach Road. Park on the side of the road and follow the trail to this station. Both the trail and the station will be flagged. Drive back up Green Hill Beach Road to the intersection with Matunuck Schoolhouse Road. The next stations will be runoff samples from stormwater drains and conveyances. At the north side of the Matunuck Schoolhouse Road-Green Hill Beach Road intersection runoff to Factory Brook should be collected and labeled **DC07** (marked with flagging tape).
DC05 and **DC04** drain runoff from Matunuck Schoolhouse Road and Green Hill Beach Road to Factory

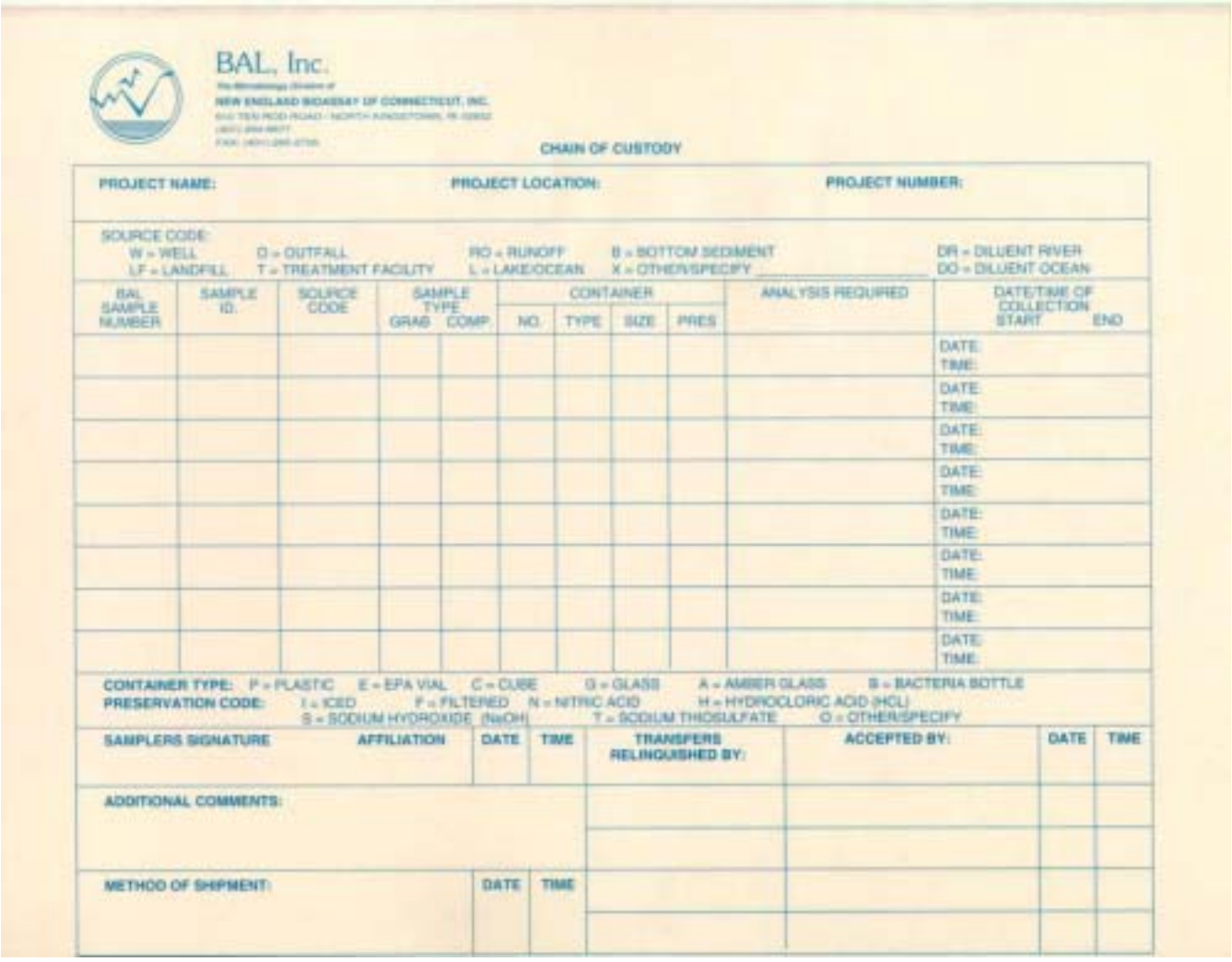
Brook upstream of FB03. Station **FB03**, located at the intersection of Green Hill Beach Road and Matunuck Schoolhouse Road, should be sampled upstream and downstream of the road. Samples should be collected from **DP04** and **DP03** next. Continuing west on Matunuck School House Rd. the next sample site is **FB04**. **FB04** is located just east of tel. Pole #38 on the downstream side of a NO PARKING sign. **FB04** will be marked with flagging tape. There is a trail leading to a small derelict house with a bridge. Collect the sample at the bridge. The next sample site is **FB05**, which is off Matunuck School House Road across from Corey Road. **FB05** is located off a dirt road downstream of a small impoundment near a fish ladder. Head west on Matunuck Schoolhouse Road and take a right and then the next right on Marine Drive. The next sample site will be **FB06,** which is located on Marine Dr., 5yds past Sand Spit Drive. Any stormwater runoff from the road at **FB06** should be sampled and labeled **DC03**. **TB03** will also be sampled at this time. Access to **TB03** can be gained through the properties near Marine Dr. and Teal Pond. The next sample site is **TB02**, which is on the downstream side of Matunuck Schoolhouse Rd. crossing. The site is approximately 10yds west of Marine Drive. A discharge measurement and staff gauge reading should also be taken at Teal Brook at this location. Water run-off at this location should also be sampled and labeled **DC01**. The next sample site is **TB01**. Get back onto Mautucket Road and take a left, heading north. Approximately 500 ft north, look for the road-stream crossing. This will be marked with flagging tape. Approximately 50 feet south of TB01 is a stormwater runoff site. Any runoff collected here should be labeled **DC02**. Further north on Mautucket Road is TB00. **TB00** will be marked with flagging tape. Collect the sample on the downstream side of the road. The last station is **TBa**. Get back on Green Hill Beach Road and head north. Take a right at Auburn Drive and then a left on Bedford Drive. Take another left on Dawley Way. Follow Dawley Way to the end of the road. There is a new house on your right. Behind that house is a small footpath to TBa.

TEAM 3 (Stations DP01, DP02, DP06, DP05, DP07, UN1, IPD, upstream and downstream of confluence of IPD and UN2, UN1D, and UN2D)

Directions for wet weather sampling:
Team 3 will be sampling in-stream stations in Unnamed Brook 1 and Unnamed Brook 2, all stormwater discharges to these two streams, and stormwater discharges to Allen Cove, Ninigret Pond, and Green Hill Pond. A map showing station locations is included. Sampling frequency is given in attached chart. All stations will be marked with flagging.

Begin sampling at station **DP05**. Follow Matunuck Schoolhouse Road and take an immediate left onto Sandpiper Rd. Follow the road until the small boat yard is on the right. The site DP05 can be found on the shore inside the boat yard. It is on the right side. DP05 is a small pipe approximately 4 inches in diameter. Return to Matunuck Schoolhouse Road and take a left. Take another left at Indigo Point Road and Follow this to the end. If there is runoff from Indigo Point Road, take note of where it enters the channel. This stream is Unnamed Brook 2. Sample upstream and downstream of the runoff site. These stations would be **IPu** and **IPd**. At the end of Indigo Point Road (the paved section) bear left and follow this dirt road to a culvert and the mouth of Unnamed Brook 2. Runoff will be collected and labeled **UN2D**, and the mouth of the brook will be sampled and labeled **UN2**. Follow Indigo Point Road back up towards Matunuck Schoolhouse Road. Take a right on 110 Indigo Point Road and follow this road until you see 110C. Behind this house is a small footbridge where the sample **UN1** will be taken. Follow this to the end and look for the mouth of Unnamed Brook 1 **(need access permission)**. After sampling UN1, get back onto Matunuck Schoolhouse Road and take a left, heading west about two miles and take a left onto Charlestown Beach Rd. Travel for about two miles and take a right onto Arches Rd. The next sample site is **DP01**, which is located off Arches Rd. between houses #20 and #30. Follow Arches Rd back to Charlestown Beach Rd. and take a left, take the next right onto Shore Dr. Take a left onto East Shore Rd. The next sample, **DP02**, is on East Shore Rd. across the street from house #28 to the left of the dock. Samples **DP06** and **DP07** are located off Shore Drive. **DP06** is located at the end of a boat ramp (gravel drive to pond). This small pipe is submerged during high tide, however flow can usually be seen coming from the pipe. **DP07** is another small pipe located east of **DP06.** To reach **DP07**, walk up the drive that leads to **DP06** and turn right, walking towards the next house. Continue towards the house, keeping to the left of it, and walk through a small area of cattails. A short trail will lead you to the ponds edge. If you are facing the pond, turn right and the pipe will be on your right.

Appendix B Chain of Custody Forms



BAL, Inc.

NEW ENGLAND BIOASSAY OF CONNECTICUT, INC.

CHAIN OF CUSTODY

PROJECT NAME: PROJECT LOCATION: PROJECT NUMBER:

SOURCE CODE:
W = WELL O = OUTFALL RO = RUNOFF B = BOTTOM SEDIMENT DR = DILUENT RIVER
LF = LANDFILL T = TREATMENT FACILITY L = LAKE/OCEAN X = OTHER/SPECIFY _____ DO = DILUENT OCEAN

BAL SAMPLE NUMBER	SAMPLE ID.	SOURCE CODE	SAMPLE TYPE GRAB	SAMPLE TYPE COMP.	CONTAINER NO.	CONTAINER TYPE	CONTAINER SIZE	CONTAINER PRES	ANALYSIS REQUIRED	DATE/TIME OF COLLECTION START	END
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	
										DATE: TIME:	

CONTAINER TYPE: P = PLASTIC E = EPA VIAL C = CUBE G = GLASS A = AMBER GLASS B = BACTERIA BOTTLE
PRESERVATION CODE: I = ICED F = FILTERED N = NITRIC ACID H = HYDROCLORIC ACID (HCL)
S = SODIUM HYDROXIDE (NaOH) T = SODIUM THIOSULFATE O = OTHER/SPECIFY

SAMPLERS SIGNATURE	AFFILIATION	DATE	TIME	TRANSFERS RELINQUISHED BY:	ACCEPTED BY:	DATE	TIME
ADDITIONAL COMMENTS:							
METHOD OF SHIPMENT:		DATE	TIME				

Figure B.1 BAL Chain of Custody Form.

Attachment A Field Sampling Standard Operating Procedures (SOP)

Field Sampling SOP 1 (S-1): Fecal Coliform Sampling

1. The laboratory-provided autoclaved sample bottles will be distributed to each team.

2. The following information is on the sample bottle label. The fields that should be filled in prior to sampling are in bold below. Label the bottle before taking the sample. It is difficult to write on wet sample bottles. The Station field should be composed of the Station ID followed by the hour when the sample was taken. A sample taken at hour 4 at Station HB07 would become HB07-4.

   Sample Bottle Label

Station:		
Depth:	Temp:	**Date:**
Initials	Salin.	**Time:**
Sample Type:		
Remarks:		

   The fields in **bold**, the station, date, time, and initial fields should be labeled on the sample bottle.

3. If you are using a sample stick, place the bottle in the stick.

4. When you are ready to take the sample, take the cap off the sample bottle. Hold the lid in your other hand. Do not touch the inside of the bottle or cap. Do not put the cap on the ground.

5. Avoid contaminating the samples by not allowing the sample water to come in contact with anything before it is placed in the bottle. Be careful not to bring the rim or cap of the sample bottle into contact with anything. If possible, samples will be taken with a sample stick to avoid causing upstream disturbance prior to and during sampling.

6. Holding the bottle upside down, push the bottle through the water to mid-depth or as far as you can reach. Turn the bottle forward and scoop it forward and up and out of the water. Do this in one sweeping motion. Make sure you sample forward and away from you so that there is no chance that you will contaminate the sample with bacteria from your arm.

7. Pour off water to the neck of the bottle. Water should reach to within an inch to an inch and half of the top of the sample bottle. This provides space for mixing.

8. Cap the bottle tightly. Place the bottle upright in a cooler with ice to maintain a temperature of 4°C.

9. Be sure to record the time that the sample was taken in the sample log.

10. All bacteria samples (including field duplicates) should be taken using the steps discussed in Step 1 through Step 9.

Attachment B. Fixed Laboratory Analytical Methods and Standard Operating Procedure

Fixed Laboratory Method 1 (L-1): BAL Laboratory mTEC Method for Detection of Fecal Coliform and *Escherichia Coli*

Prepared

BAL LABORATORY
185 Frances Avenue
Cranston, RI 02910

Sample Collection

Representative samples from water systems are collected using aseptic technique with sterile glass or plastic containers. Suggested sample volumes are between 250 and 500 mls. Samples are kept on ice (4 ^{o}C) and transferred to the laboratory for analysis preferably within 6 hours, however, samples may be analyzed up to 24 hours following collection.

A chain-of-custody form is to be completed for each set of samples. One copy remains with the samples and a second copy is given to the client. Upon receipt at the laboratory, lab personnel log samples into the log book and assign them a unique sample number. Also noted is the time/date of receipt, the condition of sample, and the person accepting/dropping off the sample(s).

Sample Analysis

Samples are usually analyzed immediately upon receipt or before the 6 h recommended holding period, however, under special circumstances they may be analyzed anytime within 24 h as long as samples are maintained at 4 ^{o}C.

The procedure outlined in Standard Methods 9213D is used to analyze the samples. mTEC media is purchased from Difco and is prepared according to package directions. Media is poured into sterile petri plates (Fisher Scientific) at 50 ^{o}C.

Membrane filter holders are sterilized with UV light prior to usage. Membrane filters are purchased sterile from Gelman Sciences. Sample volumes are filtered through the membrane filter and rinsed several times with sterile phosphate buffer. The membrane is removed aseptically from the filter holder and placed onto mTEC agar. Plates are incubated at 35 $\pm$ 0.5 ^{o}C for 2 h to rejuvenate injured or stressed bacteria, and then incubated at 44.5 $\pm$ 0.2 ^{o}C for 22 h.

After 24 hours yellow colonies are counted as fecal coliforms. The membrane filters are then transferred to a filter pad saturated with urea substrate. After 15 min, the yellow or yellow-brown colonies are considered to be *E. coli*. Note, any blue colonies are usually *Klebsiella sp*.

Report

Following completion of analysis a final report is prepared and submitted to the client. In addition to the results, information in the report includes time/date of collection, time/date of receipt at lab, time/date of analysis and any unusual observations noted during sample handling. Results are reported as colony forming units per 100 ml of sample (CFU/100ml).

Quality Control

Temperatures for incubators and refrigerators are noted twice per day at two different locations.

Prior to use, each batch of mTEC media undergoes a QC check in which 5 plates of the new batch are compared with 5 plates of the previous batch by inoculation with a stock culture of *E. coli* which has been incubated according to Standard Methods (see above).

Prior to use, each batch of membrane filters undergoes a QC check in which 5 membranes of the new lot are compared with 5 membranes of the previous lot by inoculation with a stock culture of *E. coli* which is plated on mTEC or mENDO-LES media and incubated according to Standard Methods.

A positive and negative control is run with each set of analysis. The positive control is *E. coli* A (isolated from a river sample in 1995). The negative control is sterile phosphate buffer.

Ten percent of all samples received are analyzed in duplicate. All other samples are analyzed once only.

Ten percent of all positive mTEC plates are confirmed by transferring 10 well isolated colonies to EC medium (Difco) and incubated at 44.5 ^{o}C for 24 hours. Tubes producing gas are considered positive for fecal coliform. If confirmation of *E. coli* is required, colonies are transferred to EC MUG medium (Difco) and incubated at 44.5 ^{o}C for 24 h. Tubes producing fluorescence are positive for *E. coli*.