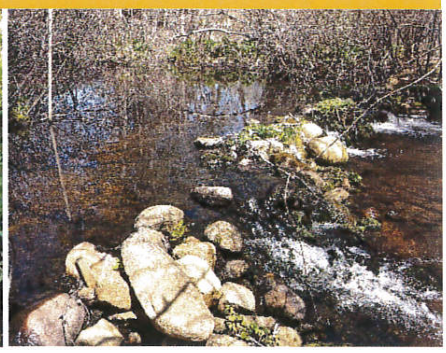
Mill Brook Watershed Study

West Tisbury, Massachusetts





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Project No. T329-000
September 30, 2016

www.essgroup.com

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EXECUTIVE SUMMARY

ESS Group, Inc. (ESS) conducted a baseline assessment of the Mill Brook Watershed with assistance from the Martha's Vineyard Commission (MVC) and the Polly Hill Arboretum (PHA) for the Town of West Tisbury (Town) and the Mill Brook Watershed Committee. The goals of the assessment included the following:

- Identify sources of pollution or nutrients that may be negatively impacting water quality throughout the watershed and, ultimately, Tisbury Great Pond
- Continuously collect water level data to allow the quantification of water withdrawals and diversions from Mill Brook

The assessment included water flow measurement, water quality measurement, sediment sampling, and rainfall measurement, as follows.

Water Flow Measurement

- Water level data loggers were installed at six locations within the watershed and set to read every fifteen minutes. The loggers also collected temperature data at each location.
- Water levels were converted to discharge estimates using stage-discharge rating curves developed for each location
- More than one year of water flow measurement was completed at each location, except for Mill Brook at State Road

Water Quality Measurement

- Six rounds of baseflow water quality were collected at six locations within the watershed. The baseflow water quality measurements included at least one event from each season of the year.
- Two rounds of stormflow water quality were collected at four locations within the watershed. The two rounds were collected approximately 30 to 40 minutes apart during the same storm event.

Sediment Sampling

- One sample was collected from each site and tested for pesticides
- No detectable levels of pesticides were reported

Rainfall Measurement

- Nitrate/nitrite and pH were analyzed from rainfall samples collected during ten major storm events (0.5 inches or greater) at Polly Hill Arboretum

INTRODUCTION

ESS Group, Inc. (ESS) conducted a baseline assessment of the Mill Brook Watershed with assistance from the Martha's Vineyard Commission (MVC) and the Polly Hill Arboretum (PHA) for the Town of West Tisbury (Town) and the Mill Brook Watershed Committee. The goals of the assessment included the following:

- Identify sources of pollution or nutrients that may be negatively impacting water quality throughout the watershed and, ultimately, Tisbury Great Pond
- Continuously collect water level data to allow the quantification of water withdrawals and diversions from Mill Brook

MONITORING APPROACH

ESS worked closely with the Mill Brook Watershed Committee, MVC and PHA to collect data for the watershed assessment study. At the start of the project, ESS met with the Mill Brook Watershed Committee to select the site locations for the Mill Brook Watershed study. ESS was responsible for preparing and directing MVC and PHA personnel for data collection over the course of the study.

Water Flow Measurement

In order to understand the hydrologic and pollutant budgets within the watershed the relationship between flows and water quality was closely examined. In particular, water level data loggers were installed at six locations within the watershed (Figure 1). Except where noted, the sampling sites were located on Mill Brook, as follows:

1. Headwaters at Waskosim's Rock Reservation
2. Outlet from Crocker Pond
3. Indian Hill Brook at North Road
4. State Road
5. Scotchman's Lane
6. Outlet of Mill Pond

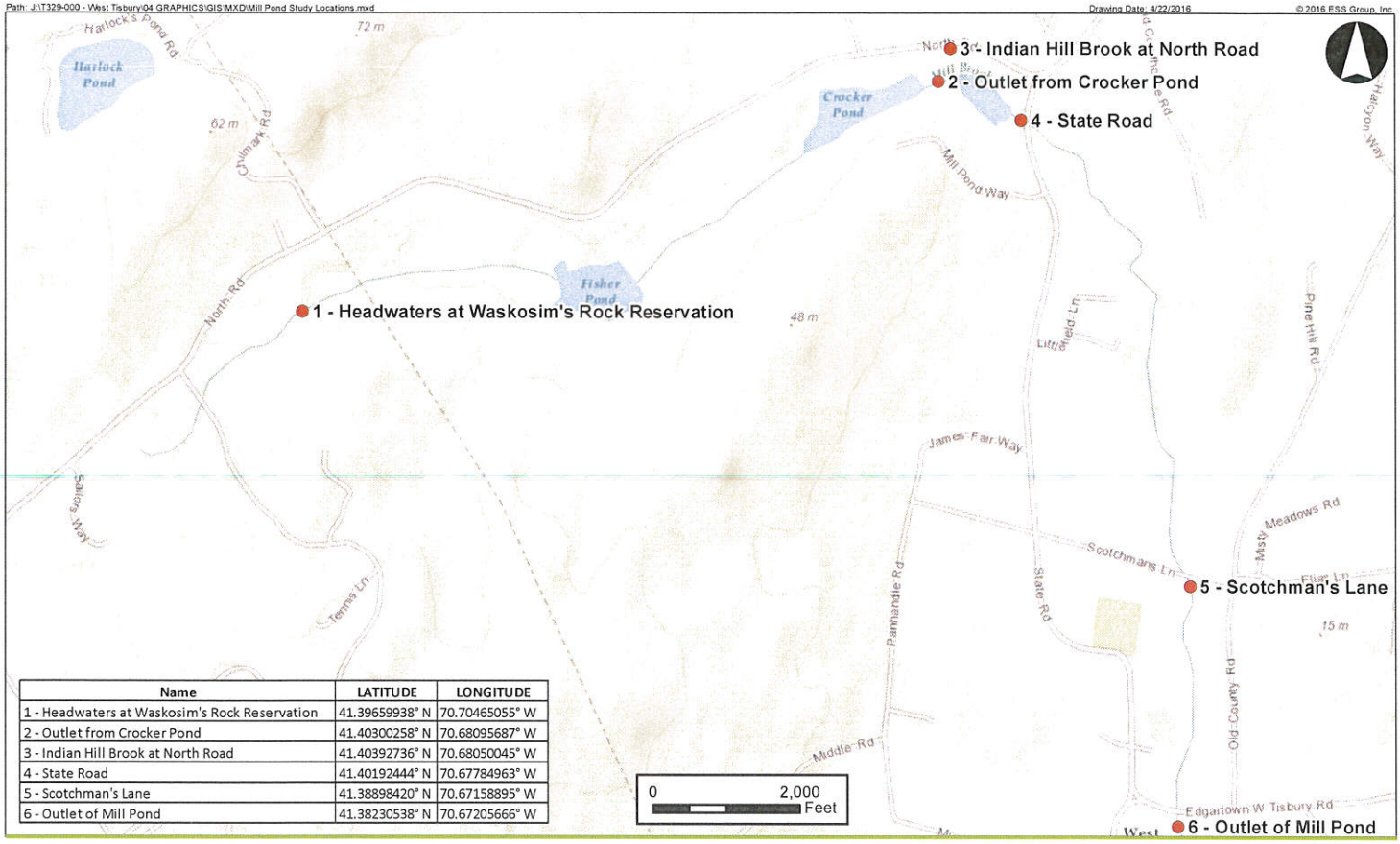
The data loggers used for this study were In-Situ Rugged Troll 100 non-vented (absolute) pressure transducers. Data loggers were deployed at each of the six locations for approximately one year. The loggers were installed at the bottom of pools to enable the collection of data under low-flow conditions.

Each logger was programmed to automatically collected water level data and water temperature data at 0.25-hour intervals, beginning on March 25, 2015. This interval was considered to be sufficient to capture rain events, withdrawals and diversions while allowing the logger battery life to extend throughout the study period.

To correct for barometric pressure, one In-Situ Baro Troll 100 was also deployed above the water at Site 1.

The Rugged Troll 100 and Baro Troll 100 loggers were left in place to continue recording data through August 22, 2016. However, the logger at Site 4 ceased recording data on August 22, 2016, resulting in a period of missing data until the problem was identified and the logger manually restarted on February 17, 2016.

Path: J:\T329-000 - West Tisbury\04 GRAPHICS\GIS\MXD\Mill Pond Study Locations.mxd Drawing Date: 4/22/2016



Name	LATITUDE	LONGITUDE
1 - Headwaters at Waskosim's Rock Reservation	41.39659938° N	70.70465055° W
2 - Outlet from Crocker Pond	41.40300258° N	70.68095687° W
3 - Indian Hill Brook at North Road	41.40392736° N	70.68050045° W
4 - State Road	41.40192444° N	70.67784963° W
5 - Scotchman's Lane	41.38898420° N	70.67158895° W
6 - Outlet of Mill Pond	41.38230538° N	70.67205666° W

ESS group
environmental consulting & engineering services

Mill Brook Watershed Study

West Tisbury, MA

1 inch = 1,800 feet

Source: 1) ESRI, 2015
2) ESS, GPS Locations, 2015

Mill Brook Study Locations

Figure 1

A stream cross section was established at each site. Cross sections were aligned perpendicular to the mean flow vector of the active stream channel and marked with rebar driven into the ground at each end. ESS measured stream discharge at these cross sections three times over the course of the study to develop a relationship (rating curve) between stage (water level) and flow. Discharge measurements were made using a streamlined current-meter method comparable to protocols used by the US Geological Survey (Rantz et al. 1982). A Hach FH950 portable electromagnetic velocity meter mounted on a calibrated rod was used to obtain velocity measurements. Width and depth were measured with a measuring tape and extended ruler, respectively.

Typical stream flow monitoring setup, showing established cross section marked by rebar (left), data logger installed inside protective PVC case and fastened to rebar (center), and discharge measurement with an electromagnetic current meter (right)

Baseflow Water Quality Measurement

Baseflow water quality measurements were collected at each of the six sampling stations on six dates, as follows:

- March 25, 2015
- May 7, 2015
- July 30, 2015
- August 19, 2015
- October 26, 2015
- February 2, 2016

Field-measured water quality parameters included temperature, dissolved oxygen, pH, color, specific conductance, turbidity, and total dissolved solids. Additionally, water samples were collected and sent to Phoenix Environmental Laboratory (the lab) of Manchester, Connecticut (a Massachusetts-certified lab) for analysis of the following: total alkalinity, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl nitrogen (TKN), ammonia-nitrogen, dissolved phosphorus, total suspended solids, and total phosphorus.

A blind duplicate sample was collected during each baseflow sampling round and submitted to the lab for quality assurance purposes.

Collection of water quality data at Site 3

Stormflow Water Quality Measurement

MVC collected two rounds of stormwater samples from four (Sites 3, 4, 5 and 6) of the six sampling stations during one storm event. The samples were collected during the early portion of a major storm event on September 10, 2015. This event produced a total of 2.65 inches of rain (as measured at PHA). The first round of samples was collected early in the storm event and intended to represent the first flush of stormwater into the stream. The second round of samples was collected approximately 30 to 40 minutes later at each location.

Samples were sent to the lab for analysis of the following: total alkalinity, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl nitrogen (TKN), ammonia-nitrogen, dissolved phosphorus, total suspended solids, and total phosphorus.

Sediment Sampling

Pesticide residues may persist in the sediments long after they have been flushed out of the water column in the stream channel. Therefore, to assess whether the Mill Brook system has been impacted by pesticide use in the watershed, ESS collected one sediment sample from each site on May 7, 2015.

Samples were collected from fine sediments (most likely to retain organic pesticide residues) with a stainless steel bucket auger. Sampling equipment was decontaminated using alconox detergent, isopropyl alcohol and distilled water between locations to avoid cross-contamination of samples. Each sample was submitted to the lab and analyzed for total pesticides.


Collection of sediment sample using soil bucket auger at Site 5

Rainfall Measurement

The PHA weather station was used to quantify rainfall totals of ten major storm events (0.5 inches or greater). Samples from each of these events were measured for pH and analyzed for nitrate/nitrite-nitrogen. All nitrate/nitrite-nitrogen samples were sent to the lab for analysis. The first pH sample was also sent to the lab. However, subsequent pH samples were measured directly by PHA staff using a Hach mid-range pH test kit (Model 17F).

RESULTS

Results obtained as part of the Mill Brook Watershed Study are presented in the following sections.

Water Flow Measurement

Stage-discharge rating curves established for each site are presented in Figure 2 and Table 1.

Table 1. Stage and Discharge Measurements Used to Develop a Rating Curve

Date	Discharge (cfs)						Stage (ft)					
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
3/25/2015	0.60	6.88	0.42	8.41	8.44	8.97	0.73	1.35	1.01	0.65	0.92	0.84
5/7/2015	0.34	3.73	0.20	4.47	3.86	5.23	0.60	1.05	0.92	0.49	0.80	0.64
7/30/2015	0.09	0.64	0.05	1.94	3.02	1.60	0.42	1.04	0.83	0.37	0.74	0.38

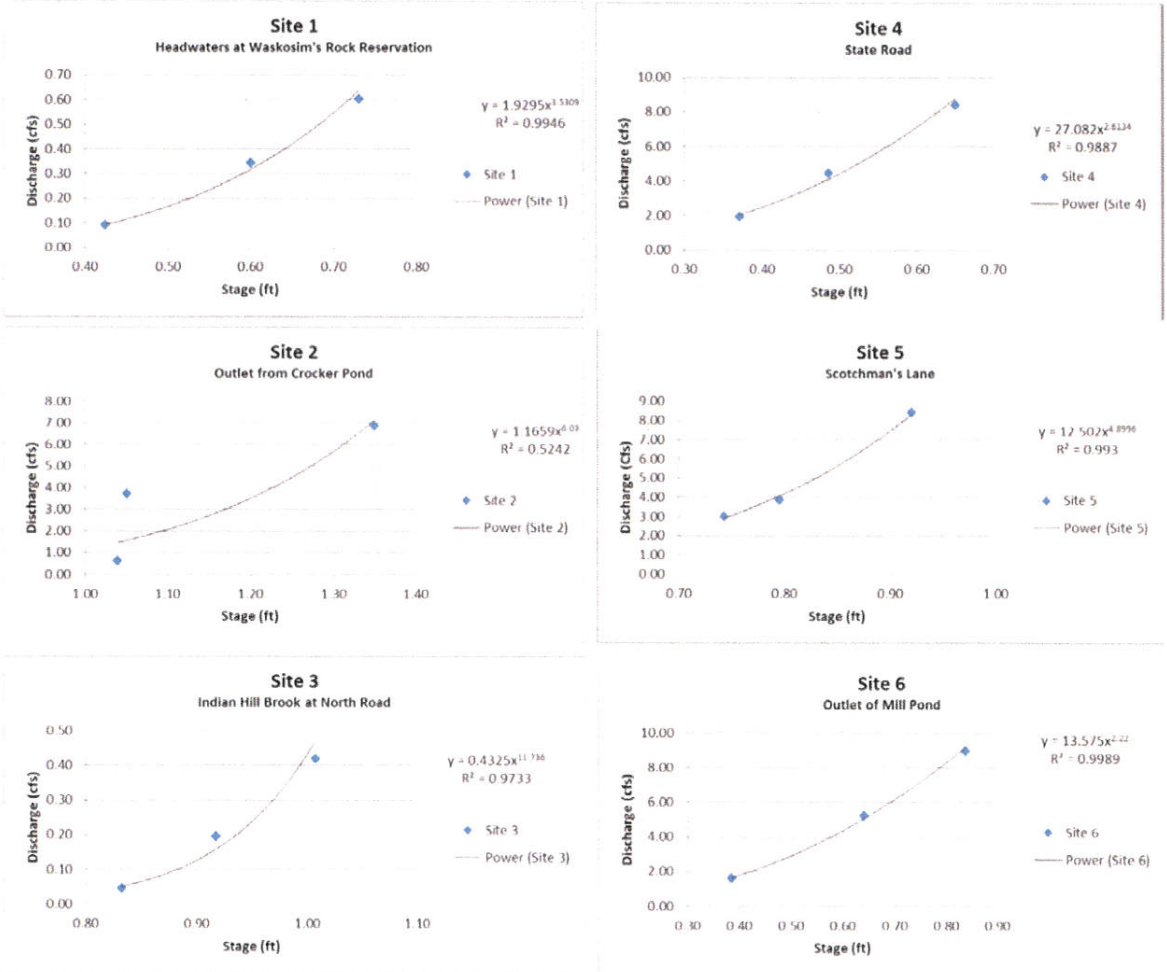


Figure 2. Stage-Discharge Rating Curves

The continuous discharge series for each site is presented in Figure 3. The complete data record, including stage, temperature, and discharge (calculated using site-specific rating curves) is presented in Appendix

A. Note that the discharge record for Site 4 is truncated due to instrument outage. The discharge record for each of the remaining locations is more than 99% complete, with only minor discontinuities in the record.

Although the water level loggers used in this study are highly accurate with regard to stream stage, the accuracy of the discharge series data is dependent on whether the recorded stage is within the range of the calibrated rating curve. Therefore, the discharge calculations falling within range of the calibrated rating curve are the most accurate. Calculations outside of this range are subject to increasing error with distance from the calibrated range and should be interpreted with caution.

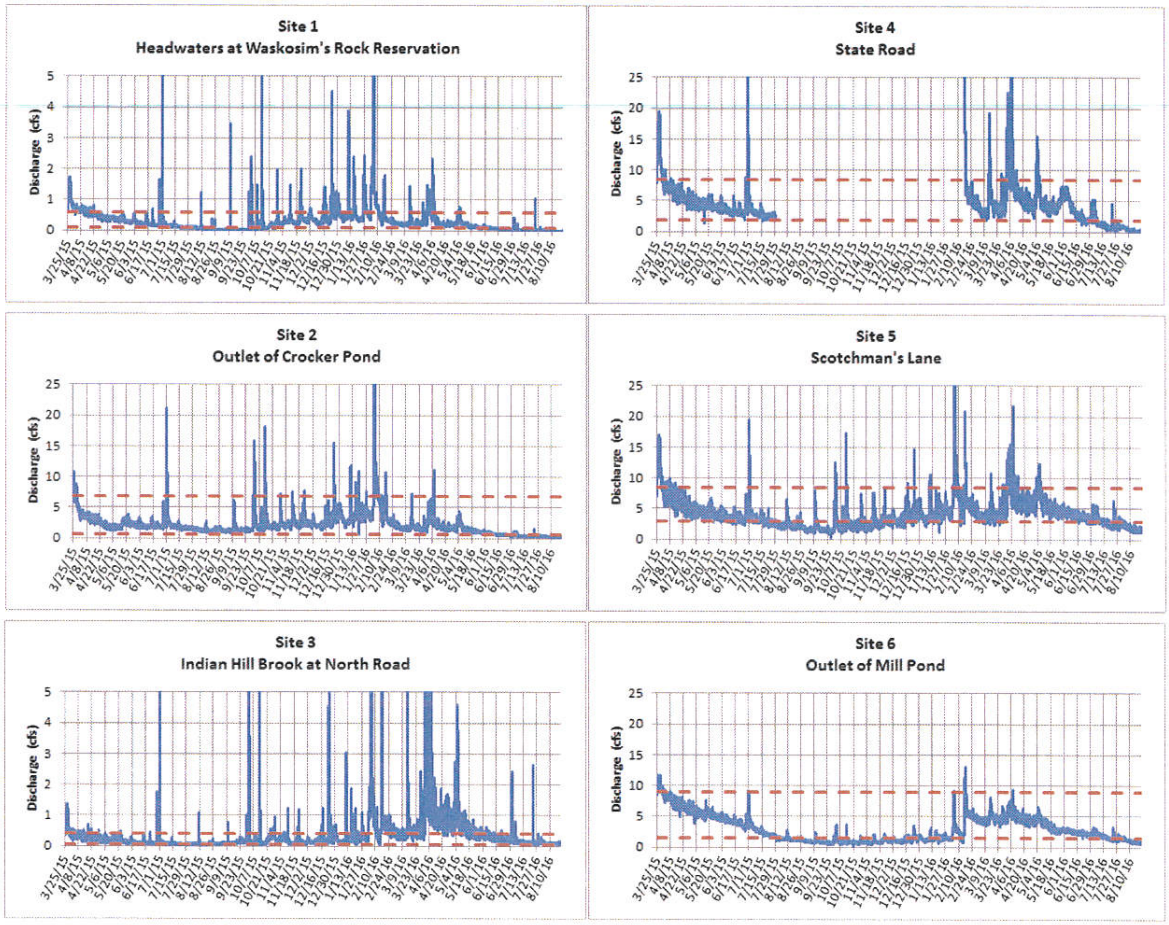


Figure 3. Continuous Discharge Series for March 25, 2015 to August 22, 2016

Note: Solid blue line represents discharge. Dashed red lines represent the upper and lower discharge values falling within the calibrated range of the rating curve. Site 4 flow record is incomplete due to instrument outage.

Baseflow Water Quality

Baseflow water quality results, including field-measured and laboratory data, are presented in Tables 2 and 3 and Figures 4 and 5. Laboratory reports for each sampling event are attached in Appendix B.

Stormflow Water Quality

Stormwater quality results are presented in Table 4 and Figure 6. The laboratory report is attached in Appendix B.

Table 2. Baseflow Water Quality Results, Field-measured Parameters

Site	Date	Time	Field-measured Parameters							
			Temperature (°C)[b]	Dissolved Oxygen (mg/L)[b]	Dissolved Oxygen (%)[b]	pH (SU)[b]	Color (PCU)[b]	Specific Conductance (uS/cm)[b]	Turbidity (NTU)[b]	Total Dissolved Solids (mg/L)[b]
Site 1 - Headwaters at Waskosim's Rock Reservation										
1	3/25/2015	13:30	6.6	12.68	103.2	5.5	45	88.9	0.24	57.8
1	5/7/2015	14:40	17.0	7.57	77.9	5.5	15	97.8	0.92	63.7
1	7/30/2015	11:00	17.2	5.69	59.2	6.1	75	109.2	13.93	71.0
1	8/19/2015	10:30	16.0	6.2	64.3	7.1	NM	116.6	NM	75.8
1	10/26/2015	11:35	11.2	5.51	52.1	6.3	NM	116.6	NM	75.8
1	2/2/2016	10:25	6.5	8.91	72.1	4.8	NM	94.9	NM	61.6
Site 2 - Outlet of Crocker Pond										
2	3/25/2015	14:15	5.5	15.86	125.9	6.6	55	75.2	0.45	48.9
2	5/7/2015	9:45	16.9	10.30	107.1	6.5	15	86.3	0.58	56.1
2	7/30/2015	10:05	22.4	5.81	66.9	6.2	60	124.2	2.87	81.5
2	8/19/2015	9:50	26.2	7.26	89.8	7.2	NM	92.2	NM	59.8
2	10/26/2015	11:35	11.8	9.36	87.1	6.6	NM	87.3	NM	56.7
2	2/2/2016	10:25	6.4	12.04	98.6	5.5	NM	83.5	NM	54.3
Site 3 - Indian Hill Brook at North Road										
3	3/25/2015	15:00	8.7	12.36	103.3	6.3	45	46.1	0.31	30.0
3	5/7/2015	10:55	12.5	11.67	108.9	6.0	5	92.4	1.44	60.1
3	7/30/2015	9:15	17.4	4.30	45.5	6.0	20	95.0	1.00	61.6
3	8/19/2015	9:35	12.9	2.83	27.6	6.8	NM	109.2	NM	71.0
3	10/26/2015	11:35	11.6	3.71	37.2	6.2	NM	105.5	NM	68.6
3	2/2/2016	10:25	7.2	9.14	76.1	5.4	NM	100.2	NM	65.1
Site 4 - State Road										
4	3/25/2015	15:30	8.9	12.58	108.7	6.6	65	72.7	0.55	47.0
4	5/7/2015	11:45	17.9	11.81	124.1	6.5	15	89.7	1.77	58.3
4	7/30/2015	11:45	26.7	6.27	78.1	6.7	65	88.2	2.48	88.2
4	8/19/2015	9:05	25.8	6.12	74.7	7.6	NM	95.5	NM	62.1
4	10/26/2015	11:35	10.2	9.23	82.6	6.6	NM	44.2	NM	28.7
4	2/2/2016	10:25	6.3	11.80	95.7	5.7	NM	85.2	NM	55.4
Site 5 - Scotchman's Lane										
5	3/25/2015	16:00	8.5	12.72	108.8	6.8	45	86.5	0.94	56.2
5	5/7/2015	12:50	18.2	10.80	114.6	7.0	5	97.5	3.08	63.0
5	7/30/2015	8:20	22.9	6.14	71.8	6.6	15	97.0	0.49	62.9
5	8/19/2015	8:45	23.8	6.25	74.6	7.5	NM	106	NM	68.9
5	10/26/2015	11:35	10.4	9.41	84.4	6.4	NM	105.9	NM	68.8
5	2/2/2016	10:25	7.0	11.66	95.7	6.0	NM	95.5	NM	62.1
Site 6 - Outlet of Mill Pond										
6	3/25/2015	16:45	8.0	10.48	89.3	6.1	30	92.0	0.50	59.8
6	5/7/2015	13:50	18.7	11.25	120.5	7.0	20	94.2	1.10	63.4
6	7/30/2015	7:15	23.4	6.37	74.8	6.5	40	84.4	1.74	54.8
6	8/19/2015	8:00	24.7	5.85	70.4	7.9	NM	NM	NM	NM
6	10/26/2015	11:35	10	9.5	85.6	6.7	NM	105.2	NM	68.4
6	2/2/2016	10:25	6.5	11.88	96.8	5.9	NM	96.1	NM	62.5

Notes:
(a) Duplicate sample collected and indicated as "Site 7" on Chain of Custody.
(b) Parameters obtained from field measurements
(c) Parameters were analyzed by Phoenix Environmental Laboratory, Manchester, Connecticut

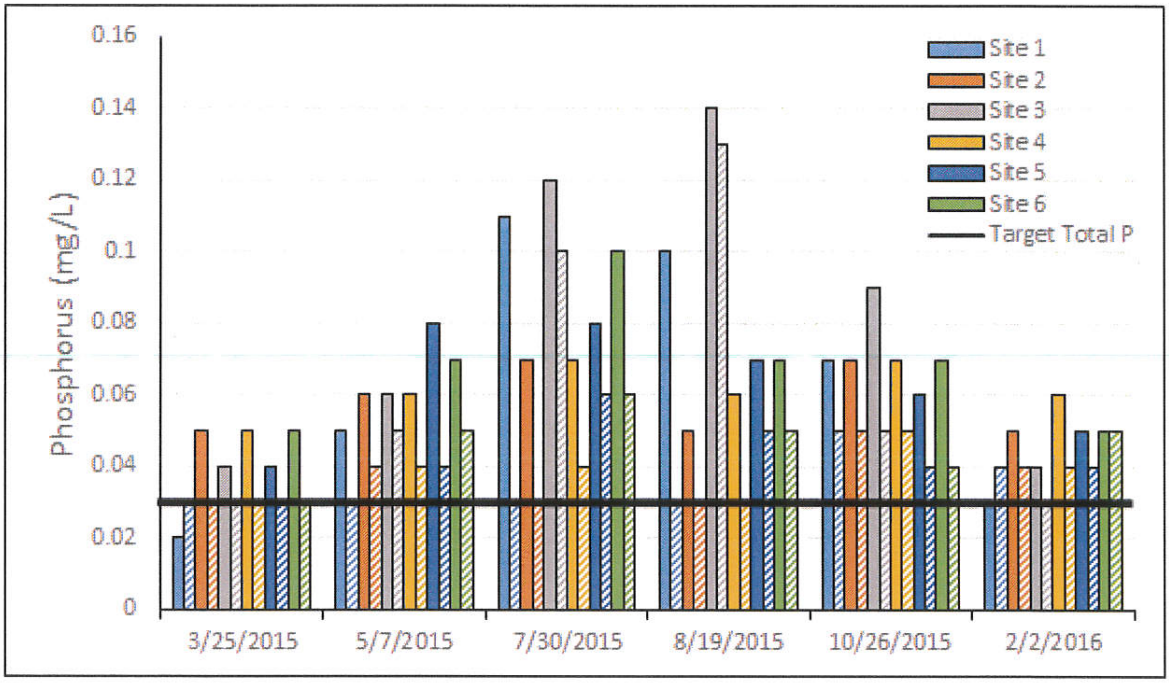


Figure 4. Baseflow Phosphorus Concentrations
Solid bars indicate *total phosphorus*. Hatched bars indicate *dissolved phosphorus*

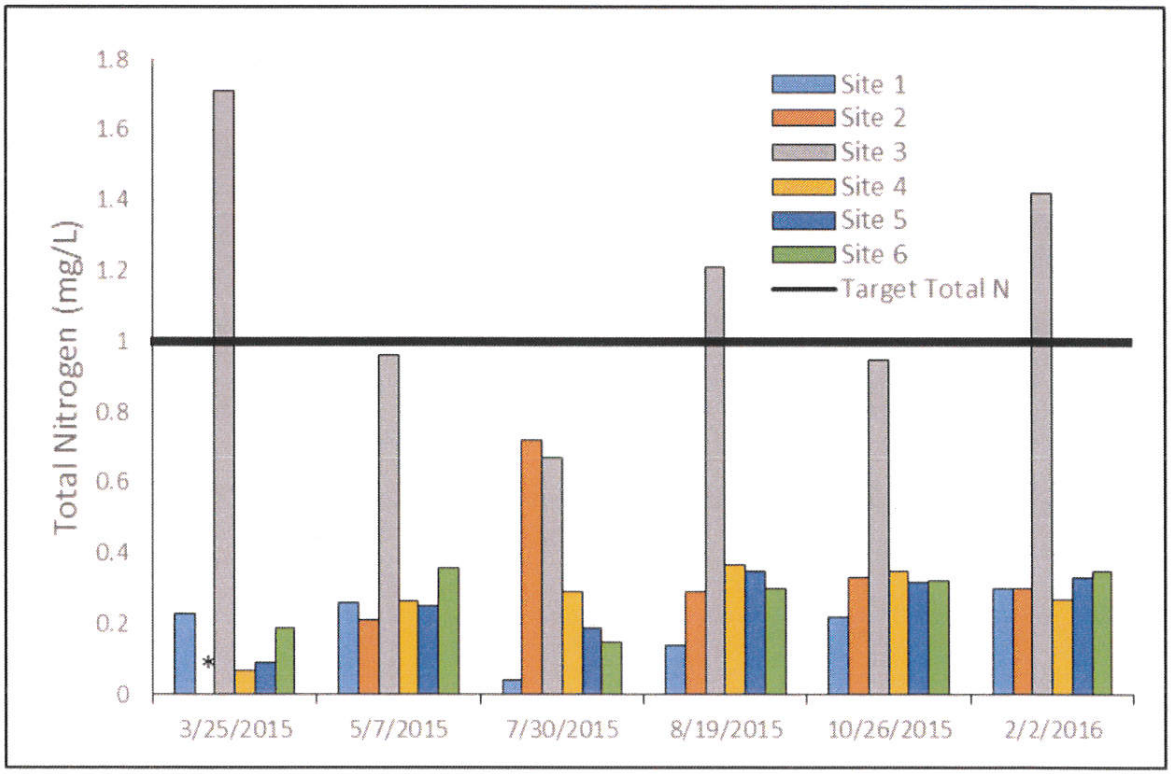


Figure 5. Baseflow Nitrogen Concentrations

Table 3. Baseflow Water Quality Results, Laboratory Analytes

Site	Date	Time	Laboratory Analytes							
			Alkalinity (mg/L)[c]	Ammonia-N (mg/L)[c]	Nitrite-N (mg/L)[c]	Nitrate-N (mg/L)[c]	Total Kjeldahl Nitrogen (mg/L)[c]	Total Phosphorus (mg/L)[c]	Dissolved Phosphorus (mg/L)[c]	TSS (mg/L)[c]
Site 1 - Headwaters at Waskosim's Rock Reservation										
1	3/25/2015	13:30	< 20	< 0.05	< 0.01	< 0.05	0.31	0.02	0.03	< 5.0
1[a]	3/25/2015	13:35	<20	<0.05	<0.01	<0.05	0.15	0.02	0.02	<5.0
1	5/7/2015	14:40	< 5.0	0.05	< 0.01	0.03	0.23	0.05	0.03	< 5.0
1	7/30/2015	11:00	< 5.0	< 0.05	< 0.01	0.04	<0.10	0.11	0.03	< 5.0
1	8/19/2015	10:30	< 20	< 0.05	< 0.01	0.03	0.11	0.1	0.03	< 5.0
1	10/26/2015	11:35	7.7	0.07	< 0.01	<0.02	0.22	0.07	0.05	<5.0
1	2/2/2016	10:25	<20	0.06	<0.01	0.03	0.27	0.03	0.04	<5.0
Site 2 - Outlet of Crocker Pond										
2	3/25/2015	14:15	< 20	< 0.05	< 0.01	< 0.05	< 0.10	0.05	0.03	< 5.0
2	5/7/2015	9:45	5.7	< 0.05	< 0.01	< 0.02	0.21	0.06	0.04	< 5.0
2	7/30/2015	10:05	7.1	< 0.05	< 0.01	0.03	0.72	0.07	0.03	< 5.0
2	8/19/2015	9:50	< 20	0.10	< 0.01	< 0.02	0.29	0.05	0.03	< 5.0
2	10/26/2015	12:00	6.4	0.06	<0.1	< 0.02	0.33	0.07	0.05	<5.0
2	2/2/2016	10:50	<20	0.07	<0.01	<0.02	0.3	0.05	0.04	<5.0
Site 3 - Indian Hill Brook at North Road										
3	3/25/2015	15:00	< 20	< 0.05	< 0.01	0.7	1.01	0.04	0.03	< 5.0
3	5/7/2015	10:55	7.9	< 0.05	< 0.01	0.51	0.45	0.06	0.05	< 5.0
3	7/30/2015	9:15	10.5	0.06	0.02	0.29	0.36	0.12	0.1	< 5.0
3	8/19/2015	9:35	< 20	0.71	0.01	0.19	1.01	0.14	0.13	< 5.0
3	10/26/2015	11:00	10.6	0.08	0.01	0.51	0.43	0.09	0.05	< 5.0
3	2/2/2016	11:05	<20	0.08	<0.01	0.97	0.49	0.04	0.03	< 5.0
3[a]	2/2/2016	11:10	<20	0.07	<0.01	0.97	0.41	0.04	0.03	<5.0
Site 4 - State Road										
4	3/25/2015	15:30	< 20	< 0.05	< 0.01	0.07	< 0.10	0.05	0.03	< 5.0
4	5/7/2015	11:45	7	< 0.05	< 0.01	0.03	0.22	0.06	0.04	< 5.0
4[a]	5/7/2015	11:45	7.5	< 0.05	< 0.01	0.04	0.24	0.06	0.04	< 5.0
4	7/30/2015	11:45	7.5	< 0.05	< 0.01	0.02	0.27	0.07	0.04	< 5.0
4	8/19/2015	9:05	< 20	0.07	< 0.01	0.02	0.35	0.06	0.03	< 5.0
4	10/26/2015	10:45	7	0.07	< 0.01	0.02	0.33	0.07	0.05	<5.0
4	2/2/2016	11:20	<20	<0.05	<0.01	0.03	0.24	0.06	0.04	<5.0
Site 5 - Scotchman's Lane										
5	3/25/2015	16:00	< 20	< 0.05	< 0.01	0.09	< 0.10	0.04	0.03	< 5.0
5	5/7/2015	12:50	6.8	< 0.05	< 0.01	0.03	0.22	0.08	0.04	< 5.0
5	7/30/2015	8:20	7.5	< 0.05	< 0.01	0.06	0.13	0.08	0.06	< 5.0
5[a]	7/30/2015	8:20	7.7	< 0.05	< 0.01	0.06	0.13	0.09	0.06	< 5.0
5	8/19/2015	8:45	< 20	< 0.05	< 0.01	0.09	0.26	0.07	0.05	< 5.0
5	10/26/2015	10:20	7.4	0.08	<0.01	0.04	0.28	0.06	0.04	<5.0
5	2/2/2016	11:45	<20	0.05	<0.01	0.06	0.27	0.05	0.04	<5.0

Site	Date	Time	Laboratory Analytes							
			Alkalinity (mg/L)[c]	Ammonia-N (mg/L)[c]	Nitrite-N (mg/L)[c]	Nitrate-N (mg/L)[c]	Total Kjeldahl Nitrogen (mg/L)[c]	Total Phosphorus (mg/L)[c]	Dissolved Phosphorus (mg/L)[c]	TSS (mg/L)[c]
Site 6 – Outlet of Mill Pond										
6	3/25/2015	16:45	< 20	< 0.05	< 0.01	0.08	0.11	0.05	0.03	< 5.0
6	5/7/2015	13:50	6.8	< 0.05	< 0.01	< 0.02	0.36	0.07	0.05	< 5.0
6	7/30/2015	7:15	7.8	< 0.05	< 0.01	< 0.02	0.15	0.10	0.06	< 5.0
6	8/19/2015	8:00	< 20	0.05	< 0.01	0.02	0.26	0.07	0.05	< 5.0
6[a]	8/19/2015	8:10	<20	<0.05	<0.01	0.02	0.30	0.07	0.05	< 5.0
6	10/26/2015	9:50	6.7	0.07	<0.01	0.03	0.30	0.07	0.04	<5.0
6[a]	10/26/2015	10:10	6.5	0.05	<0.01	0.03	0.29	0.07	0.04	<5.0
6	2/2/2016	11:35	<20	0.06	<0.01	0.06	0.29	0.05	0.05	<5.0

Notes:
(a) Duplicate sample collected and indicated as "Site 7" on Chain of Custody
(b) Parameters obtained from field measurements
(c) Parameters were analyzed by Phoenix Environmental Laboratory, Manchester, Connecticut

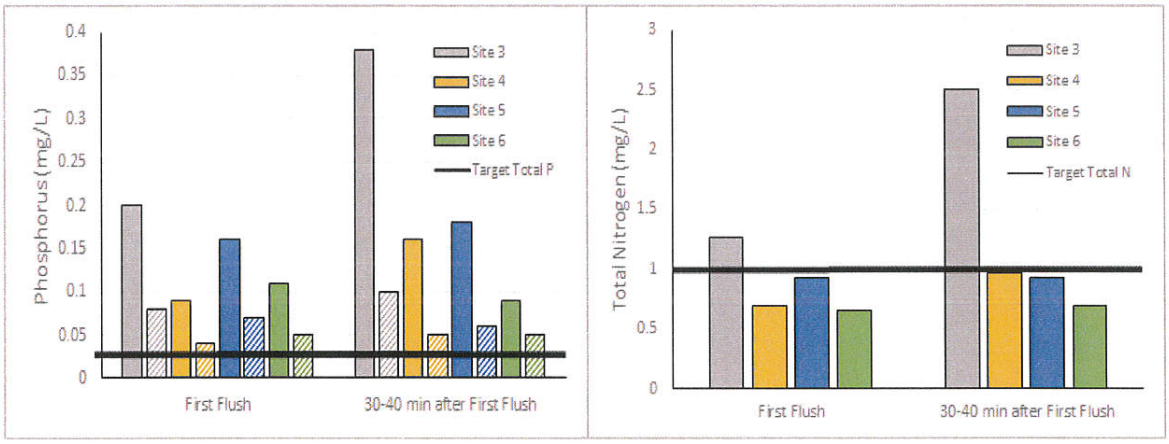


Figure 6. Stormflow Phosphorus and Nitrogen Concentrations
Solid bars indicate *total phosphorus*. Hatched bars indicate *dissolved phosphorus*.

Table 4. Stormflow Water Quality Results

Site	Date	Time	Laboratory Analytes						
			Alkalinity (mg/L)[c]	Ammonia-N (mg/L)[c]	Nitrate-Nitrite-N (mg/L)[c]	Total Kjeldahl Nitrogen (mg/L)[c]	Total Phosphorus (mg/L)[c]	Dissolved Phosphorus (mg/L)[c]	Total Suspended Solids (mg/L)[c]
Site 3 – Indian Hill Brook at North Road (First Flush)	9/10/2015	12:50	10.9	0.23	0.25	1.01	0.2	0.08	46
Site 3 - Indian Hill Brook at North Road (40 Minutes After First Flush)	9/10/2015	13:30	8.6	0.29	0.21	2.29	0.38	0.1	89
Site 4 - State Road (First Flush)	9/10/2015	12:50	6.6	0.17	0.04	0.65	0.09	0.04	14
Site 4 - State Road (30 Minutes After First Flush)	9/10/2015	13:20	6.4	0.17	0.03	0.93	0.16	0.05	18
Site 5 - Scotchman's Lane (First Flush)	9/10/2015	12:40	6.3	0.2	0.1	0.83	0.16	0.07	6.0
Site 5 - Scotchman's Lane (30 Minutes After First Flush)	9/10/2015	13:10	5.8	0.19	0.1	0.83	0.18	0.06	29
Site 6 - Outlet of Mill Pond (First Flush)	9/10/2015	12:30	5.6	0.16	0.07	0.58	0.11	0.05	10
Site 6 - Outlet of Mill Pond (30 Minutes After First Flush)	9/10/2015	13:00	5.6	0.26	0.05	0.64	0.09	0.05	< 5.0

Notes:

(b) Parameters obtained from field measurements

(c) Parameters were analyzed by Phoenix Environmental Laboratory, Manchester, Connecticut

Sediment Quality

Pesticides were not detected in any of the samples collected and submitted for laboratory analysis. The laboratory report for this sampling event is attached in Appendix B.

Rainfall

Results from the rainfall analyses are presented in Table 5

Table 5. Polly Hill Arboretum Rainfall Water Chemistry

Date	pH (SU)[a]	Nitrate/Nitrite - N (mg/L)[b]	Event Precipitation (in)[c]
3/27/2015	5.35	0.28	0.74
6/02/2015	5.5	0.16	0.75
6/15/2015	5.0	0.09	0.95
6/22/2015	5.5	0.24	0.60
6/29/2015	4.5	0.08	1.35
8/12/2015	5.0	0.05	1.85
8/26/2015	5.0	0.07	0.65
9/11/2015	4.5	0.12	2.65
10/01/2015	5.0	0.04	2.25
12/02/2015	5.5	0.03	0.55

Notes:

(a) pH was directly measured by Polly Hill Arboretum staff using a Hach wide-range pH testing kit

(b) Nitrate/Nitrite - N was analyzed by Phoenix Environmental Laboratory, Manchester, Connecticut

(c) Precipitation data was obtained from Polly Hill Arboretum rain gauge

Appendix A

Continuous Discharge Series Data (Electronic)

Appendix B

Laboratory Reports

Site	Date	Time	Laboratory Analytes						
			Alkalinity (mg/L)	Ammonia-N (mg/L)	Nitrate-Nitrite-N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Phosphorus (mg/L)	Total Suspended Solids (mg/L)
Site 3 – Indian Hill Brook at North Road (First Flush)	9/10/2015	12:50	10.9	0.23	0.25	1.01	0.2	0.08	46
Site 3 - Indian Hill Brook at North Road (40 Minutes After First Flush)	9/10/2015	13:30	8.6	0.29	0.21	2.29	0.38	0.1	89
Site 4 - State Road (First Flush)	9/10/2015	12:50	6.6	0.17	0.04	0.65	0.09	0.04	14
Site 4 - State Road (30 Minutes After First Flush)	9/10/2015	13:20	6.4	0.17	0.03	0.93	0.16	0.05	18
Site 5 - Scotchman's Lane (First Flush)	9/10/2015	12:40	6.3	0.2	0.1	0.83	0.16	0.07	6
Site 5 - Scotchman's Lane (30 Minutes After First Flush)	9/10/2015	13:10	5.8	0.19	0.1	0.83	0.18	0.06	29
Site 6 - Outlet of Mill Pond (First Flush)	9/10/2015	12:30	5.6	0.16	0.07	0.58	0.11	0.05	10
Site 6 - Outlet of Mill Pond (30 Minutes After First Flush)	9/10/2015	13:00	5.6	0.26	0.05	0.64	0.09	0.05	< 5.0

Site	Date	Time	Field-measured Parameters							
			Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH (SU)	Color (PCU)	Specific Conductance (uS/cm)	Turbidity (NTU)	Total Dissolved Solids (mg/L)
Site 1 - Headwaters at Waskosim's Rock Reservation										
1	3/25/2015	13:30	6.6	12.68	103.2	5.5	45	88.9	0.24	57.8
1	5/7/2015	14:40	17	7.57	77.9	5.5	15	97.8	0.92	63.7
1	7/30/2015	11:00	17.2	5.69	59.2	6.1	75	109.2	13.93	71
1	8/19/2015	10:30	16	6.2	64.3	7.1	NM	116.6	NM	75.8
1	10/26/2015	11:35	11.2	5.51	52.1	6.3	NM	116.6	NM	75.8
1	2/2/2016	10:25	6.5	8.91	72.1	4.8	NM	94.9	NM	61.6
Site 2 - Outlet of Crocker Pond										
2	3/25/2015	14:15	5.5	15.86	125.9	6.6	55	75.2	0.45	48.9
2	5/7/2015	9:45	16.9	10.3	107.1	6.5	15	86.3	0.58	56.1
2	7/30/2015	10:05	22.4	5.81	66.9	6.2	60	124.2	2.87	81.5
2	8/19/2015	9:50	26.2	7.26	89.8	7.2	NM	92.2	NM	59.8
2	10/26/2015	11:35	11.8	9.36	87.1	6.6	NM	87.3	NM	56.7
2	2/2/2016	10:25	6.4	12.04	98.6	5.5	NM	83.5	NM	54.3
Site 3 - Indian Hill Brook at North Road										
3	3/25/2015	15:00	8.7	12.36	103.3	6.3	45	46.1	0.31	30
3	5/7/2015	10:55	12.5	11.67	108.9	6	5	92.4	1.44	60.1
3	7/30/2015	9:15	17.4	4.3	45.5	6	20	95	1	61.6
3	8/19/2015	9:35	12.9	2.83	27.6	6.8	NM	109.2	NM	71
3	10/26/2015	11:35	11.6	3.71	37.2	6.2	NM	105.5	NM	68.6
3	2/2/2016	10:25	7.2	9.14	76.1	5.4	NM	100.2	NM	65.1
Site 4 - State Road										
4	3/25/2015	15:30	8.9	12.58	108.7	6.6	65	72.7	0.55	47
4	5/7/2015	11:45	17.9	11.81	124.1	6.5	15	89.7	1.77	58.3
4	7/30/2015	11:45	26.7	6.27	78.1	6.7	65	88.2	2.48	88.2
4	8/19/2015	9:05	25.8	6.12	74.7	7.6	NM	95.5	NM	62.1
4	10/26/2015	11:35	10.2	9.23	82.6	6.6	NM	44.2	NM	28.7
4	2/2/2016	10:25	6.3	11.8	95.7	5.7	NM	85.2	NM	55.4
Site 5 - Scotchman's Lane										
5	3/25/2015	16:00	8.5	12.72	108.8	6.8	45	86.5	0.94	56.2
5	5/7/2015	12:50	18.2	10.8	114.6	7	5	97.5	3.08	63
5	7/30/2015	8:20	22.9	6.14	71.8	6.6	15	97	0.49	62.9
5	8/19/2015	8:45	23.8	6.25	74.6	7.5	NM	106	NM	68.9
5	10/26/2015	11:35	10.4	9.41	84.4	6.4	NM	105.9	NM	68.8
5	2/2/2016	10:25	7	11.66	95.7	6	NM	95.5	NM	62.1
Site 6 - Outlet of Mill Pond										
6	3/25/2015	16:45	8	10.48	89.3	6.1	30	92	0.5	59.8
6	5/7/2015	13:50	18.7	11.25	120.5	7	20	94.2	1.1	63.4
6	7/30/2015	7:15	23.4	6.37	74.8	6.5	40	84.4	1.74	54.8
6	8/19/2015	8:00	24.7	5.85	70.4	7.9	NM	NM	NM	NM
6	10/26/2015	11:35	10	9.5	85.6	6.7	NM	105.2	NM	68.4
6	2/2/2016	10:25	6.5	11.88	96.8	5.9	NM	96.1	NM	62.5

Site	Date	Time	Laboratory Analytes							
			Alkalinity (mg/L)	Ammonia-N (mg/L)	Nitrite-N (mg/L)	Nitrate-N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Phosphorus (mg/L)	TSS (mg/L)
Site 1 - Headwaters at Waskosim's Rock Reservation										
1	3/25/2015	13:30	< 20	< 0.05	< 0.01	< 0.05	0.31	0.02	0.03	< 5.0
1[a]	3/25/2015	13:35	<20	<0.05	<0.01	<0.05	0.15	0.02	0.02	<5.0
1	5/7/2015	14:40	< 5.0	0.05	< 0.01	0.03	0.23	0.05	0.03	< 5.0
1	7/30/2015	11:00	< 5.0	< 0.05	< 0.01	0.04	<0.10	0.11	0.03	< 5.0
1	8/19/2015	10:30	< 20	< 0.05	< 0.01	0.03	0.11	0.1	0.03	< 5.0
1	10/26/2015	11:35	7.7	0.07	< 0.01	<0.02	0.22	0.07	0.05	<5.0
1	2/2/2016	10:25	<20	0.06	<0.01	0.03	0.27	0.03	0.04	<5.0
Site 2 - Outlet of Crocker Pond										
2	3/25/2015	14:15	< 20	< 0.05	< 0.01	< 0.05	< 0.10	0.05	0.03	< 5.0
2	5/7/2015	9:45	5.7	< 0.05	< 0.01	< 0.02	0.21	0.06	0.04	< 5.0
2	7/30/2015	10:05	7.1	< 0.05	< 0.01	0.03	0.72	0.07	0.03	< 5.0
2	8/19/2015	9:50	< 20	0.1	< 0.01	< 0.02	0.29	0.05	0.03	< 5.0
2	10/26/2015	12:00	6.4	0.06	<0.1	< 0.02	0.33	0.07	0.05	<5.0
2	2/2/2016	10:50	<20	0.07	<0.01	<0.02	0.3	0.05	0.04	<5.0
Site 3 - Indian Hill Brook at North Road										
3	3/25/2015	15:00	< 20	< 0.05	< 0.01	0.7	1.01	0.04	0.03	< 5.0
3	5/7/2015	10:55	7.9	< 0.05	< 0.01	0.51	0.45	0.06	0.05	< 5.0
3	7/30/2015	9:15	10.5	0.06	0.02	0.29	0.36	0.12	0.1	< 5.0
3	8/19/2015	9:35	< 20	0.71	0.01	0.19	1.01	0.14	0.13	< 5.0
3	10/26/2015	11:00	10.6	0.08	0.01	0.51	0.43	0.09	0.05	< 5.0
3	2/2/2016	11:05	<20	0.08	<0.01	0.97	0.49	0.04	0.03	< 5.0
3[a]	2/2/2016	11:10	<20	0.07	<0.01	0.97	0.41	0.04	0.03	<5.0
Site 4 - State Road										
4	3/25/2015	15:30	< 20	< 0.05	< 0.01	0.07	< 0.10	0.05	0.03	< 5.0
4	5/7/2015	11:45	7	< 0.05	< 0.01	0.03	0.22	0.06	0.04	< 5.0
4[a]	5/7/2015	11:45	7.5	< 0.05	< 0.01	0.04	0.24	0.06	0.04	< 5.0
4	7/30/2015	11:45	7.5	< 0.05	< 0.01	0.02	0.27	0.07	0.04	< 5.0
4	8/19/2015	9:05	< 20	0.07	< 0.01	0.02	0.35	0.06	0.03	< 5.0
4	10/26/2015	10:45	7	0.07	< 0.01	0.02	0.33	0.07	0.05	<5.0
4	2/2/2016	11:20	<20	<0.05	<0.01	0.03	0.24	0.06	0.04	<5.0
Site 5 - Scotchman's Lane										
5	3/25/2015	16:00	< 20	< 0.05	< 0.01	0.09	< 0.10	0.04	0.03	< 5.0
5	5/7/2015	12:50	6.8	< 0.05	< 0.01	0.03	0.22	0.08	0.04	< 5.0
5	7/30/2015	8:20	7.5	< 0.05	< 0.01	0.06	0.13	0.08	0.06	< 5.0
5[a]	7/30/2015	8:20	7.7	< 0.05	< 0.01	0.06	0.13	0.09	0.06	< 5.0
5	8/19/2015	8:45	< 20	< 0.05	< 0.01	0.09	0.26	0.07	0.05	< 5.0
5	10/26/2015	10:20	7.4	0.08	<0.01	0.04	0.28	0.06	0.04	<5.0
5	2/2/2016	11:45	<20	0.05	<0.01	0.06	0.27	0.05	0.04	<5.0
Site 6 – Outlet of Mill Pond										
6	3/25/2015	16:45	< 20	< 0.05	< 0.01	0.08	0.11	0.05	0.03	< 5.0
6	5/7/2015	13:50	6.8	< 0.05	< 0.01	< 0.02	0.36	0.07	0.05	< 5.0
6	7/30/2015	7:15	7.8	< 0.05	< 0.01	< 0.02	0.15	0.1	0.06	< 5.0
6	8/19/2015	8:00	< 20	0.05	< 0.01	0.02	0.26	0.07	0.05	< 5.0
6[a]	8/19/2015	8:10	<20	<0.05	<0.01	0.02	0.3	0.07	0.05	< 5.0
6	10/26/2015	9:50	6.7	0.07	<0.01	0.03	0.3	0.07	0.04	<5.0
6[a]	10/26/2015	10:10	6.5	0.05	<0.01	0.03	0.29	0.07	0.04	<5.0
6	2/2/2016	11:35	<20	0.06	<0.01	0.06	0.29	0.05	0.05	<5.0

Notes:

(a) Duplicate sample collected and indicated as "Site 7" on Chain of Custody.