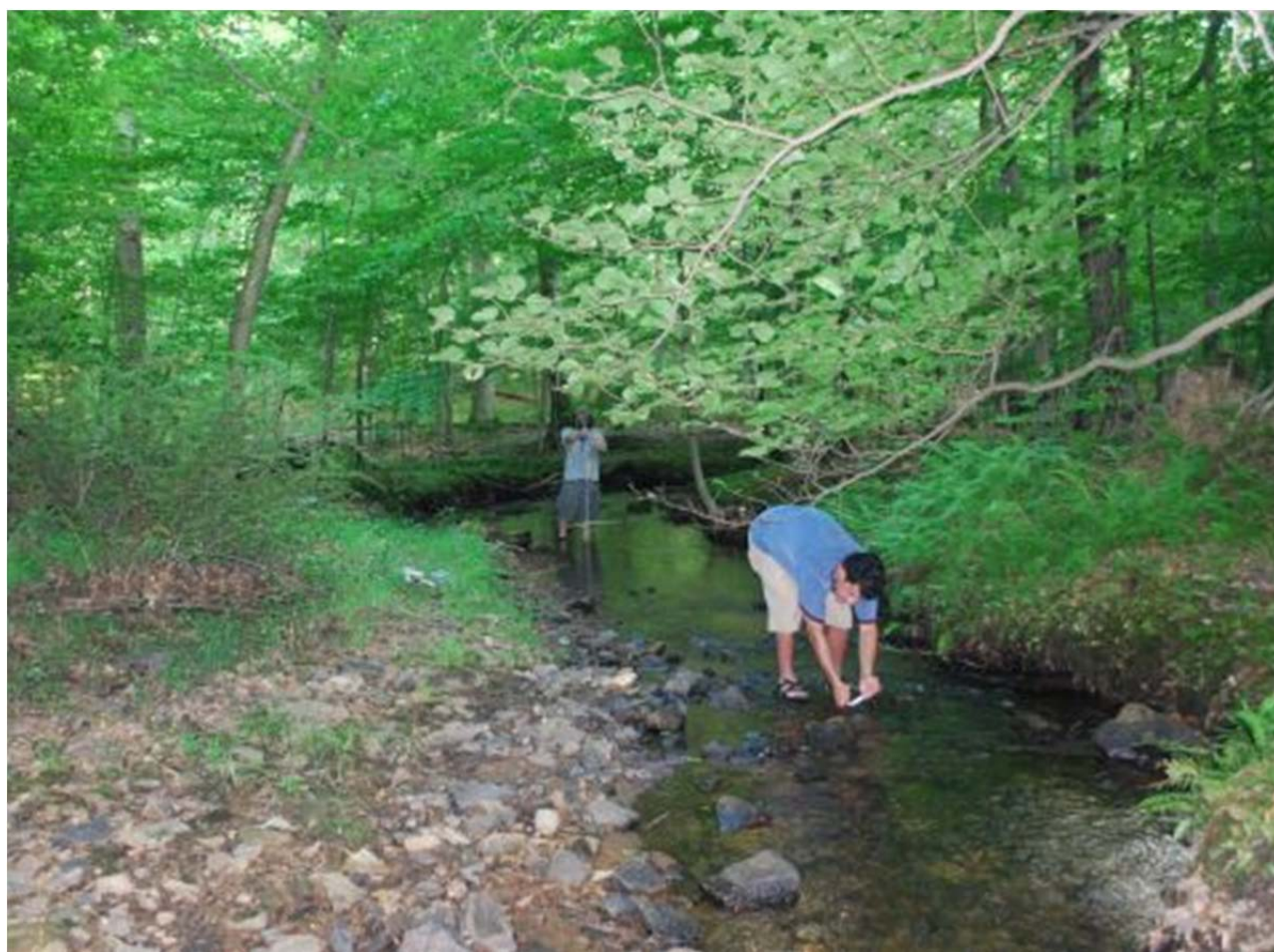




Water Quality Monitoring at Morristown National Historical Park

Northeast Temperate Network 2011 Summary Report

Natural Resource Data Series NPS/NETN/NRDS—2012/335



ON THE COVER

Measuring stream flow (discharge) at Primrose Brook, July 2011
Photograph by: Beth Arsenaault

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U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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Contents

	Page
Figures.....	iv
Tables.....	vii
Introduction.....	1
Sampling Sites	1
Methods.....	3
Water Quality Standards.....	3
Results.....	5
Water Quality.....	6
Specific Conductance.....	6
pH Level.....	7
Temperature	8
Dissolved Oxygen.....	9
Acid Neutralizing Capacity.....	10
Apparent Color.....	11
Nutrient Enrichment	12
Phosphorus.....	12
Total Nitrogen.....	13
Water Quantity.....	14
Invasive Aquatic Plants	15
Summary	15
Literature Cited	17
Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011.	19

Figures

	Page
Figure 1. NETN water monitoring sites at Morristown NHP.....	2
Figure 2. Explanation of box plot graph	5
Figure 3. Specific conductance from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.....	6
Figure 4. pH from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.....	7
Figure 5. Water temperature (surface) from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.	8
Figure 6. Dissolved oxygen (surface) from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.	9
Figure 7. Acid neutralizing capacity from 2011 spring and summer water samples overlaid on a box plot of measurements taken from 2006-2011.	10
Figure 8. Apparent color from 2011 spring and summer water samples overlaid on a box plot of measurements taken from 2006-2011.	11
Figure 9. Total phosphorus (TP), total dissolved phosphorus (TDP), and soluble reactive phosphorus (SRP) from spring and summer water samples. The data are overlaid on a box plot of measurements taken from 2006-2011. The New Jersey state water quality TP standard is 100 µg/L.....	12
Figure 10. Total nitrogen (TN), total dissolved nitrogen (TDN), nitrite + nitrate (NO ₂ +NO ₃), and nitrite (NO ₂) from 2011 spring and summer water samples. The data are overlaid on a box plot of measurements taken from 2006-2011.....	13
Figure 11. Stream stage obtained in 2011 by measuring from a permanent datum point down to the water surface.	14

Tables

	Page
Table 1. Water quality monitoring sites at Morristown NHP	1
Table 2. New Jersey stream water quality standards.	4
Table 3. EPA Ecoregion 9 nutrient criteria for streams.	4

Introduction

This report on the water quality of Morristown National Historical Park (MORR) generated by the Northeast Temperate Network (NETN) Water Quality Monitoring Program includes data gathered in the 2011 monitoring season and displays these results in graphic form, accompanied by a brief interpretation. Appendix A contains data collected from 2006 through 2011.

The vital signs for freshwater bodies included in the NETN Freshwater Monitoring Protocol (Lombard et al. 2006) are water chemistry, nutrient enrichment, water quantity, and the detection of invasive plant species. These metrics were chosen to address the NPS Inventory and Monitoring Program objective to detect change in the status of physical, chemical, or biological attributes of the ecosystem.

The NETN Freshwater Monitoring Protocol calls for a total of five park streams to be sampled monthly from May through October. A cooperator from the University of Vermont or a NETN hydrologic technician measured physical and in-situ water chemistry parameters each month and periodically collected water samples for analysis at the University of Maine's Sawyer Environmental Chemistry Research Laboratory. All monitoring data are incorporated into a series of comprehensive databases that ultimately feed the U.S. Environmental Protection Agency's "STORET" data system, the repository for all NPS water quality and quantity data.

Sampling Sites

Five water quality monitoring sites were selected at MORR for the NETN monitoring program (Table 1). Sites were chosen to represent the accessible, perennial streams in the Jockey Hollow and New Jersey Brigade Units, the two park units with significant freshwater resources. Historic water quality sampling sites were continued as these stations met the objectives of the vital-signs program (Lombard et al. 2006).

Three of the selected sites are in the Primrose Brook Watershed within the Jockey Hollow Unit. These sites are on the East Branch of Primrose Brook, the West Branch of Primrose Brook, and the main stem of Primrose Brook. The other sites are on the Passaic River and Indian Grove Brook in the New Jersey Brigade Unit (Figure 1). All streams monitored by NETN are classified as cold water fisheries (National Park Service 1993), loosely defined as waters that can support, on a year-round basis, wild and stocked brook trout (*Salvelinus fontinalis*) or other species requiring similar conditions.

Table 1. Water quality monitoring sites at Morristown NHP

Water Body	NETN Site Code	Latitude	Longitude	Site Remarks
Primrose Brook East Branch ("Stream A")	MORRSA	40.7701333	-74.5241167	Cold water fisheries
Primrose Brook confluence ("Stream B")	MORRSB	40.7643333	-74.5293667	Cold water fisheries
Primrose Brook West Branch ("Stream C")	MORRSC	40.7696667	-74.5362000	Cold water fisheries
Indian Grove Brook ("Stream D")	MORRSD	40.7446500	-74.5654167	Cold water fisheries
Passaic River ("Stream E")	MORRSE	40.7518667	-74.5514333	Cold water fisheries

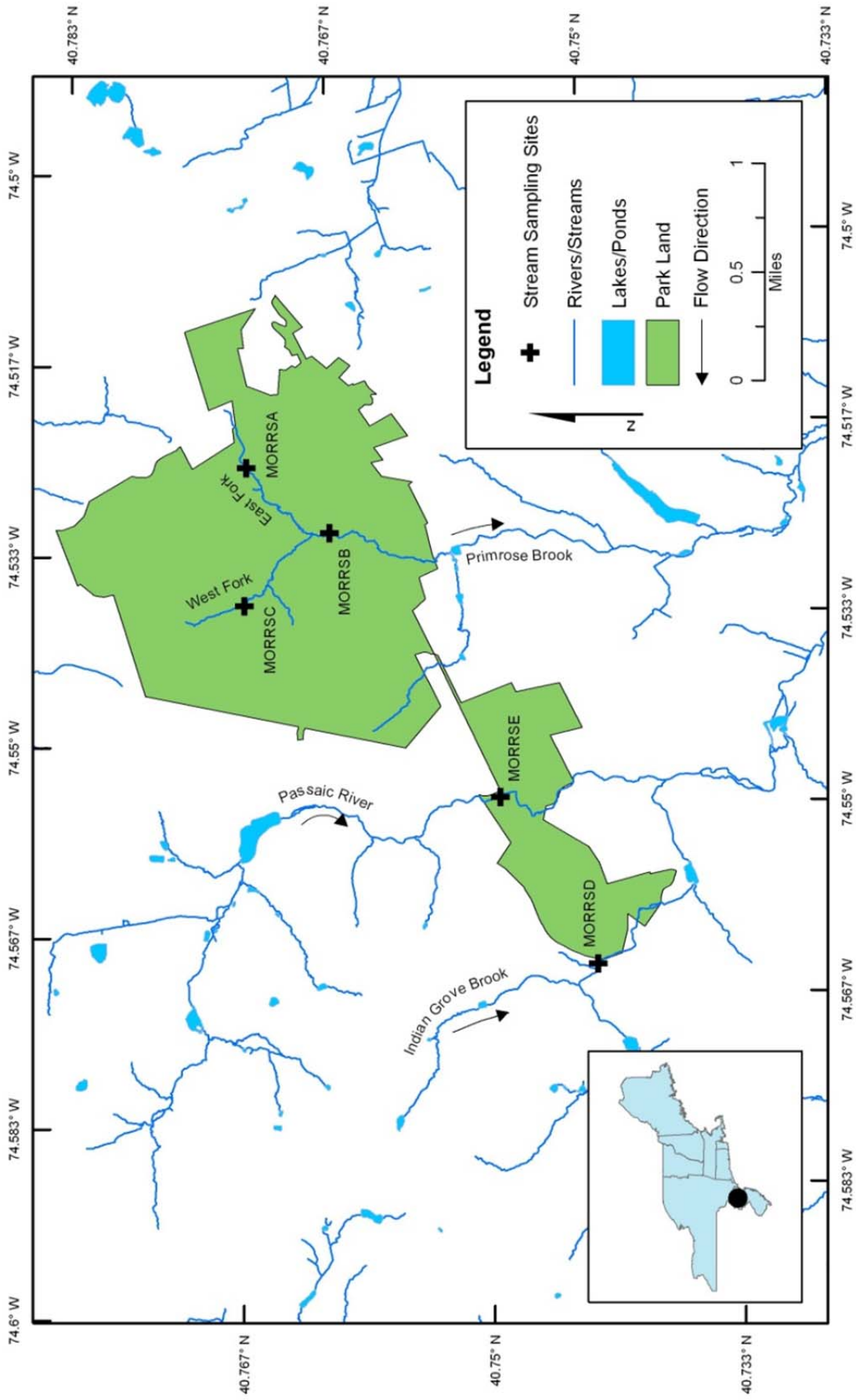


Figure 1. NETN water monitoring sites at Morristown NHP.

Methods

Detailed descriptions of all monitoring methods are found in the protocol (Lombard et al. 2006). Monthly sampling parameters included in-situ water quality measures (pH, specific conductance, temperature, and dissolved oxygen) determined with a YSI 600XL sonde, weather, stream flow (discharge), and stream stage (water level). Water samples obtained in May and August were analyzed for acid neutralizing capacity (ANC), color, and nutrients. Nutrient chemistry parameters were analyzed from a grab sample.

Stream discharge was measured using U.S. Geological Survey protocols (Rantz et al. 1982), employing a measuring tape, wading rod, and SonTek FlowTracker current meter (a Price Pygmy current meter was used at the Passaic River [Stream E]) to measure a particular cross-sectional area of the stream and the velocity of the water at that cross section.

In-situ stream water chemical and physical measurements and water samples were collected within 5 meters from the location of the discharge measurement. Sonde measurements were taken in the main stream flow with care taken that the sonde was not resting directly on the stream bottom. Grab samples were obtained by submerging the sample bottle directly in the stream with a gloved hand. A peristaltic pump and Tygon tubing were used to collect samples if water levels were too low to completely submerge a bottle.

Water Quality Standards

New Jersey water quality standards (Table 2; State of New Jersey Administrative Code 2004) designate the general surface-water classification applied to fresh waters as FW. FW1 means those fresh waters that are to be maintained in their natural state of quality and not subjected to any man-made wastewater discharges or increases in runoff from anthropogenic activities. These waters are set aside for posterity because of their clarity, color, scenic setting, or other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resource(s).

“FW1 surface waters shall be maintained as to quality in their natural state” (State of New Jersey Administrative Code 2004). The tributaries in the Passaic River Watershed in MORR are all listed as FW2 waters. Surface-water quality criteria for FW2 Waters states that “FW2 TP [Trout Production] waters shall have DO concentrations that shall not be less than 7.0 mg/L at any time. pH shall range from 6.5 to 8.5 standard units at all times. Phosphorus concentration as total P shall not exceed 0.05 mg/L in any lake, pond or reservoir, or in a tributary at the point where it enters such waterbodies. Concentrations of total P shall not exceed 0.1 mg/L [100 µg/L] in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses” (State of New Jersey Administrative Code 2004).

Table 2. New Jersey stream water quality standards.

Water quality classification code	Minimum Dissolved Oxygen (mg/L)	pH range (standard units)	Maximum Total Nitrogen (µg/L)	Maximum Total Phosphorus (µg/L)
FW2	7.0	6.5-8.5	--	100

EPA Ecoregion 9 water quality criteria (Table 3; U.S. Environmental Protection Agency 2000) are also used as a benchmark in this report. EPA water quality criteria for nutrients help translate narrative criteria within State or Tribal water quality standards by establishing values for causal variables (e.g., total nitrogen and total phosphorus) and response variables (e.g., turbidity and chlorophyll *a*). Causal variables are necessary to provide sufficient protection of designated uses before impairment occurs and to maintain downstream uses. Early response variables are necessary to provide warning signs of possible impairment and to integrate the effects of variable and potentially unmeasured nutrient loads (U.S. Environmental Protection Agency 2002).

Table 3. EPA Ecoregion 9 nutrient criteria for streams.

Nutrient Criteria	Value
Total Phosphorus	36.56 µg/L
Total Nitrogen	0.69 mg/L

These criteria were developed specifically for Ecoregion 9 (which includes Morristown NHP) and are designed to represent conditions of surface waters that are minimally impacted by human activities and thus protect against the adverse effects of nutrient over-enrichment from cultural eutrophication. The values are EPA's scientific recommendations regarding ambient concentrations of nutrients that protect aquatic resource quality. They do not have any regulatory impact or meaning.

The criteria were established based on the lower 25th percentile of streams for which the EPA found data. This percentile of all streams is expected to approximately correspond to the 75th percentile of reference (undisturbed) streams. In other words, 75% of streams in the ecoregion do not meet the criteria, nor do roughly 25% of reference streams. (U.S. Environmental Protection Agency 2000).

Results

Monitoring results for 2011 are displayed in scatter-plot graphs showing all data for each site for a given parameter. The scatter plots of 2011 data are overlaid on box plots representing the overall range and distribution of data values collected from 2006 through 2011 for the specified parameter and site (Appendix A contains all data in tabular form). A box plot (Figure 2) is a summary plot that graphs data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers (error bars) above and below the box indicate the 90th and 10th percentiles respectively. Outliers are displayed as black filled circles. If EPA or other water quality criteria exist for a particular parameter they are displayed on the graphs as specification lines.

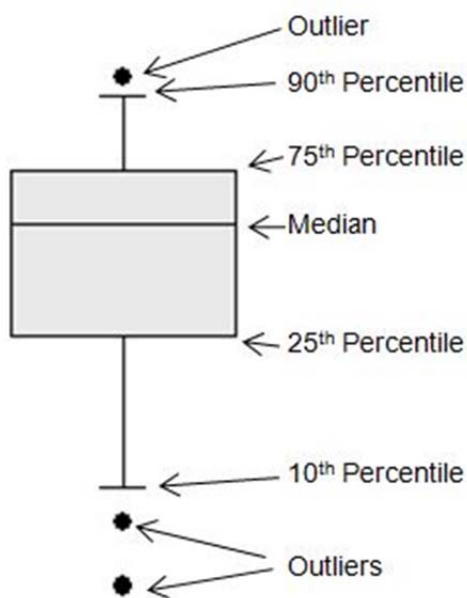


Figure 2. Explanation of box plot graph

Water Quality

Measures of water quality include specific conductance, pH, water temperature, dissolved oxygen (DO), acid neutralizing capacity (ANC), and apparent color. Assessment of water quality data aids in the interpretation of the biotic condition and ecological processes of surface water resources.

Specific Conductance

Specific conductance (Figure 3) is a measure of the ability of water to carry an electrical current, and is directly related to the level of dissolved ions in the water. An increase in specific conductance can be an indicator of pollutants in the water. Naturally occurring values range from less than 20 to more than 1,000 microsiemens per centimeter ($\mu\text{S}/\text{cm}$). Specific conductance values from 2011 were within the appropriate range for moderate to high ionic strength waters, and were generally within the range of values shown on the box plot. May specific conductance values for all sites fell in the lower range of variability.

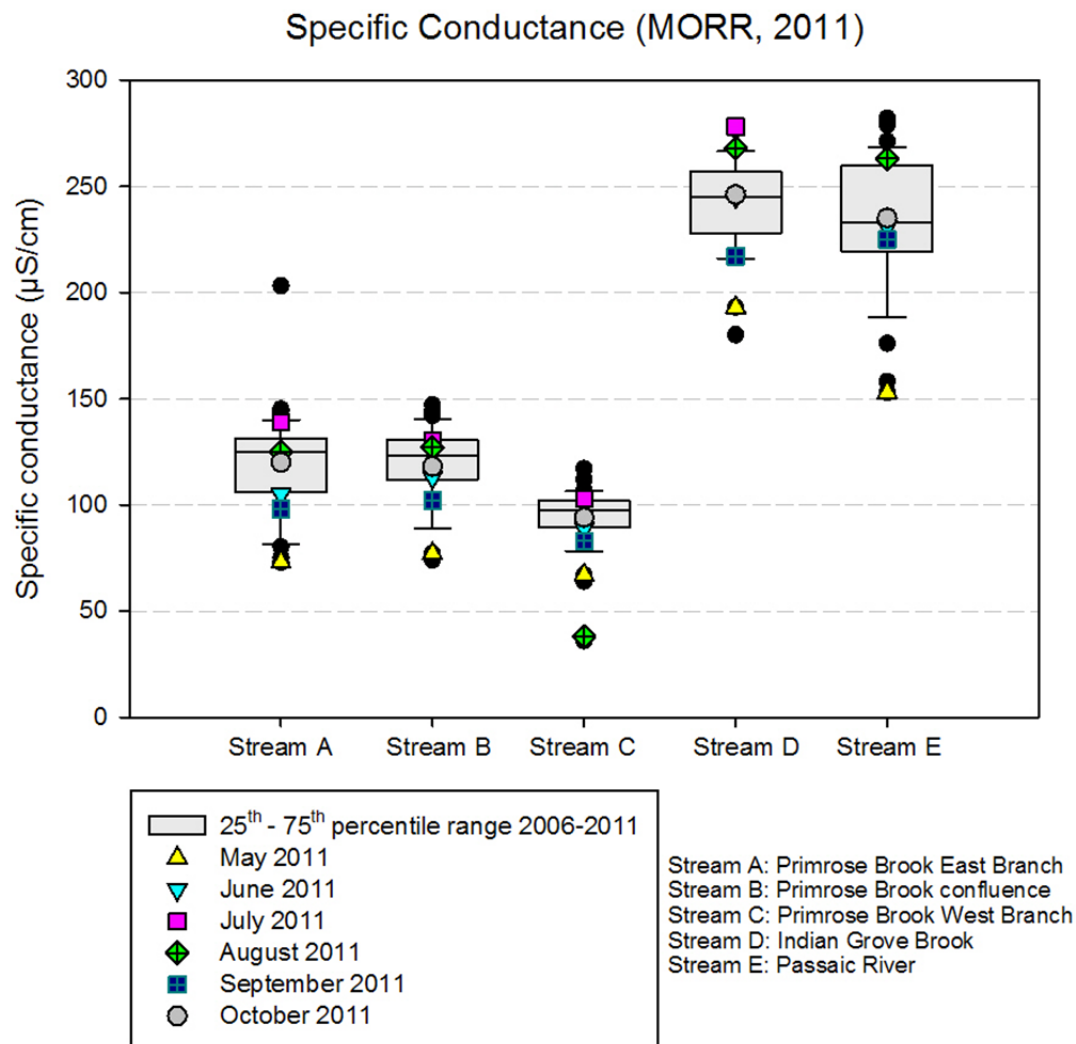


Figure 3. Specific conductance from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.

pH Level

The pH of a water body reflects how acidic or basic the water is, measured on a scale of 1 to 14, with 7 being neutral. Acid waters are below 7, and alkaline waters are above 7. A one-unit change in pH represents a 10-fold change in acidity or alkalinity. New Jersey standards, like those of most northeast states, indicate that a pH between 6.5 and 8.5 is within the acceptable range. pH values from the 2011 monitoring season (Figure 4) were generally basic, except for Primrose Brook West Branch, where most readings were slightly acidic. All values were between the upper and lower New Jersey water quality standards.

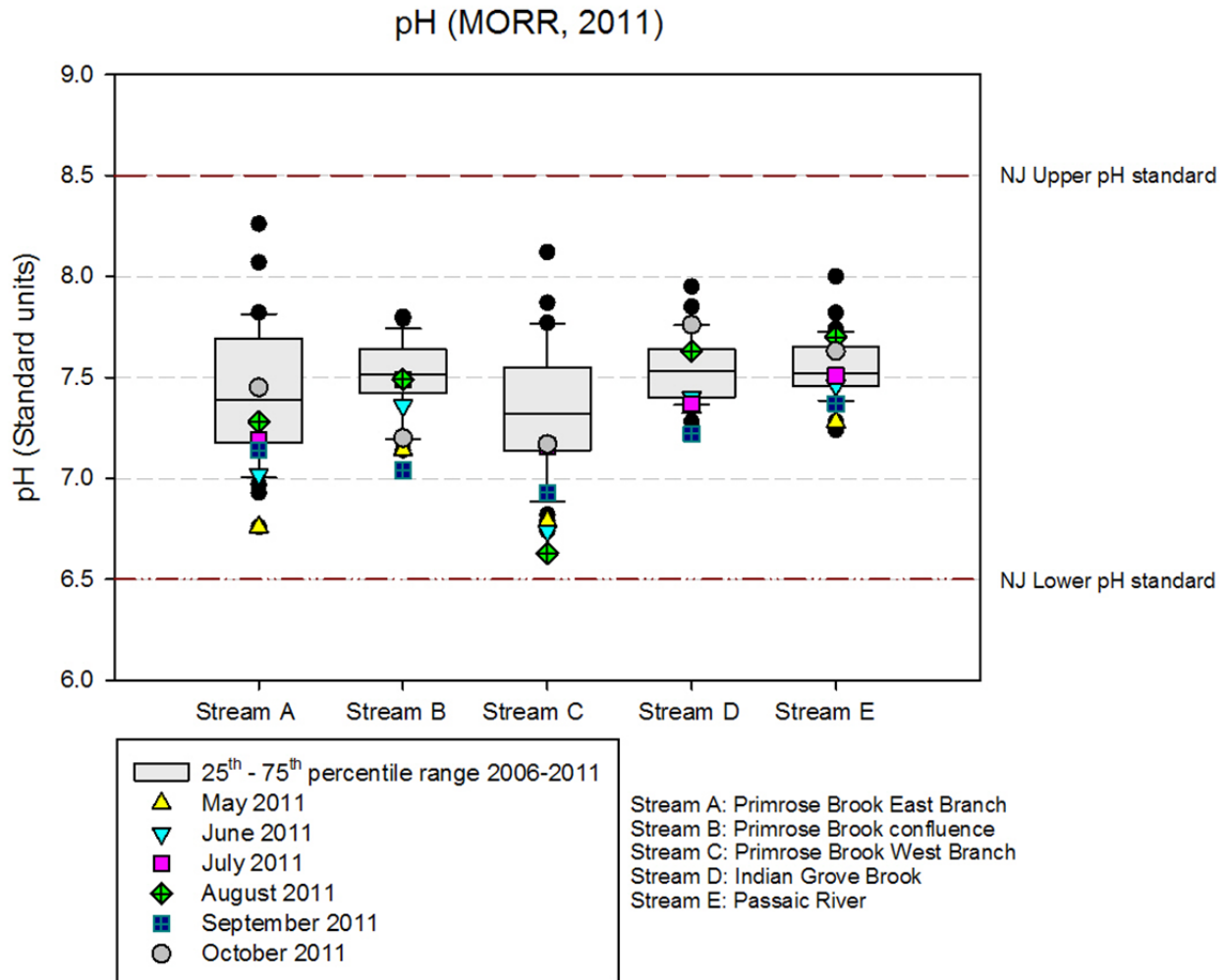


Figure 4. pH from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.

Temperature

Temperature can affect water chemistry and biology. For example, the amount of oxygen that water can hold is directly related to the temperature of the water. The higher the temperature, the less oxygen water can hold, which can be observed in both diel (day and night) and seasonal shifts. Oxygen will naturally decline during the summer months as water temperatures rise. Temperature can also determine the kinds of plants and animals found in the lake or pond. Certain species of fish, insects, and algae will predominate during the cooler temperatures of the spring and fall, yet be less apparent during the warmer temperatures of summer. Surface water temperatures (Figure 5) appeared to be within the normal range of variability in 2011, though the July and August values reflected the contributions of high air temperature and solar radiation.

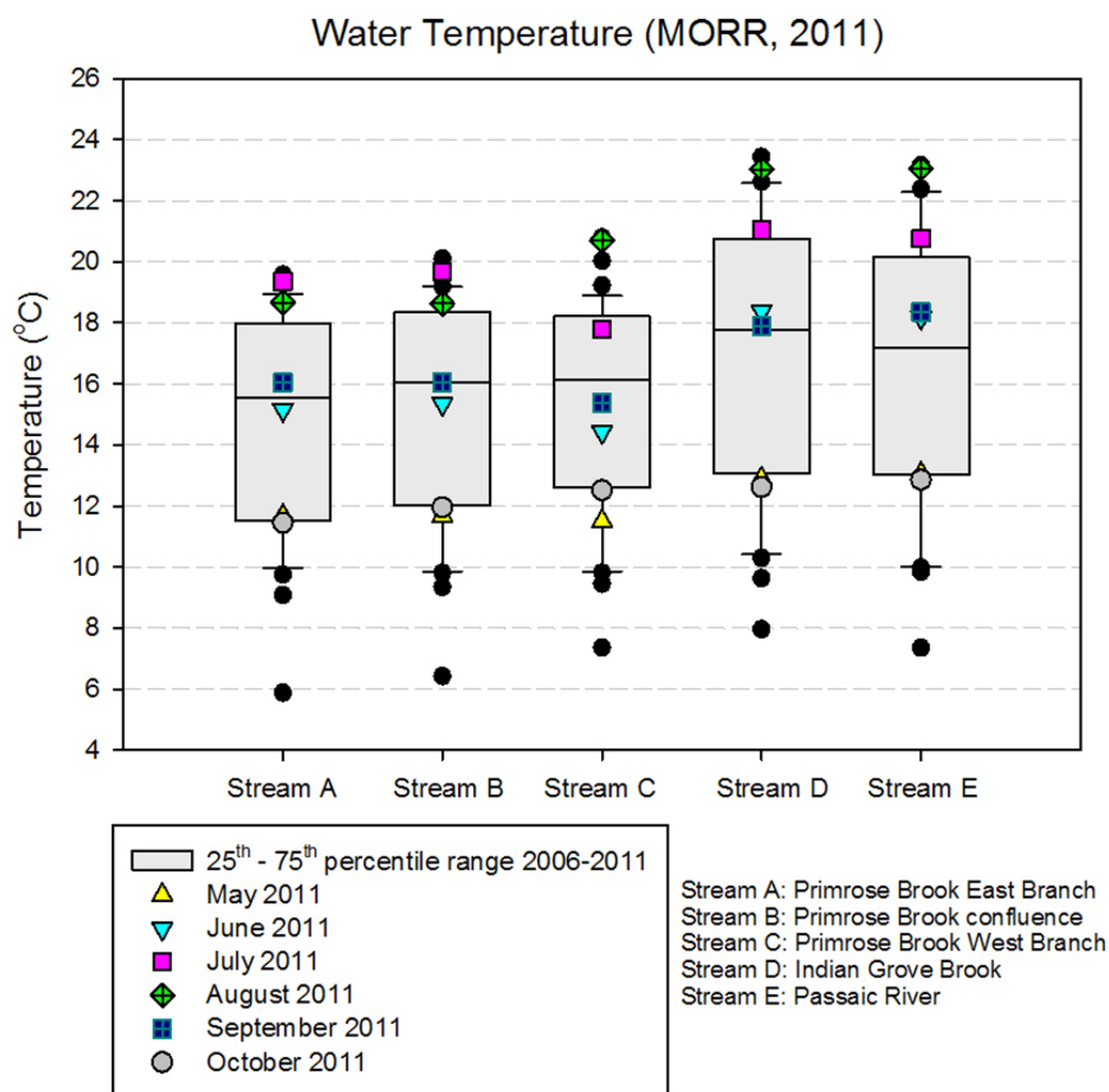
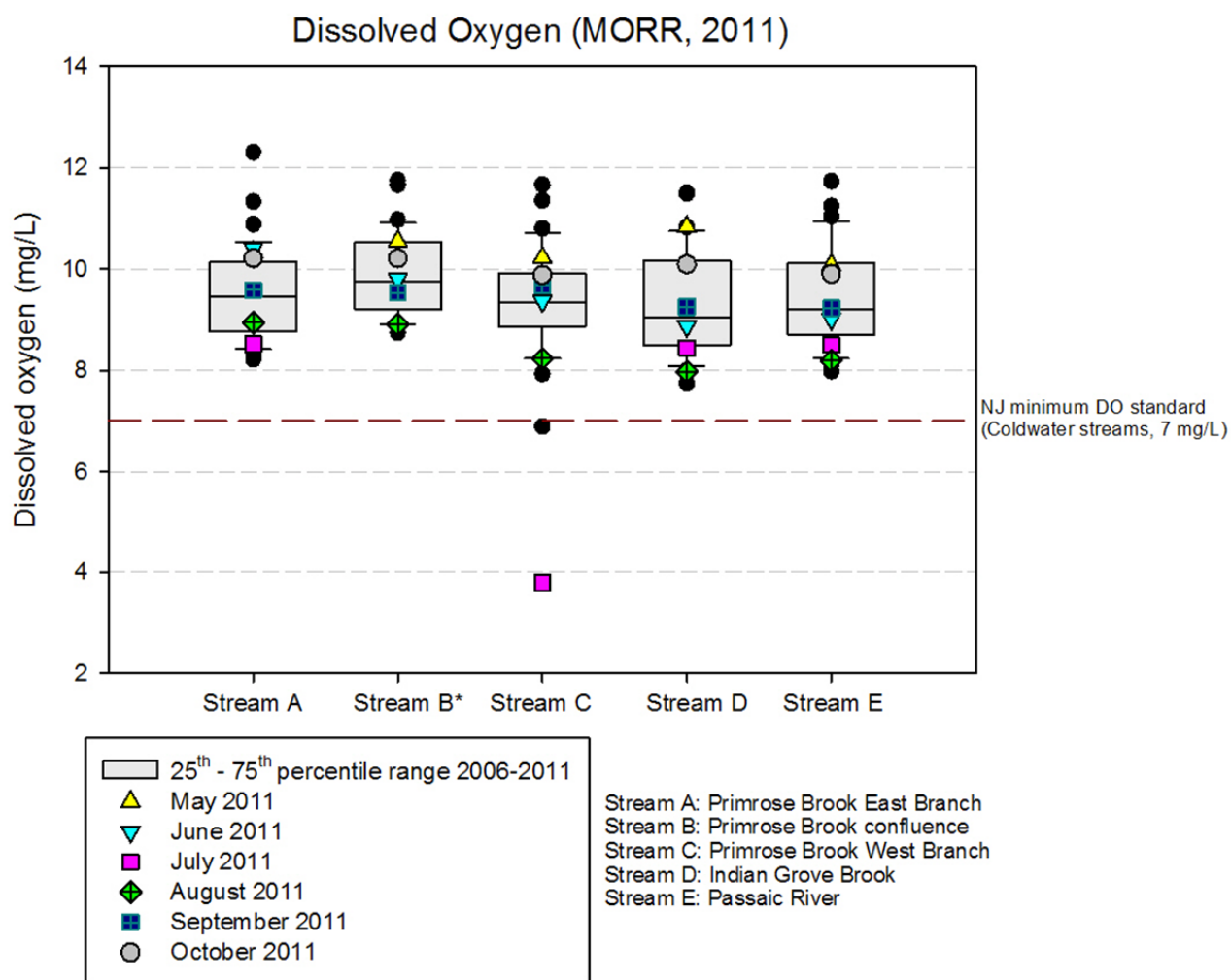


Figure 5. Water temperature (surface) from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.

Dissolved Oxygen

Dissolved oxygen (DO) is a critical indicator of water quality because aquatic life generally needs DO concentrations at or above 5 mg/L to thrive. Low oxygen can directly kill or stress organisms such that they will not be able to successfully reproduce or grow. Water with less than 1 part per million (ppm) of oxygen is considered anoxic (no oxygen present). All MORR sites were well oxygenated in 2011 (Figure 6), except for the July 2011 measurement of 3.78 mg/L at Primrose Brook West Branch (Stream C). This low reading is suspect, since the field crew noted their inability to obtain a DO measurement at Primrose Brook confluence (Stream B) during the July monitoring visit due to problems with the YSI dissolved oxygen probe. All other 2011 DO measurements were above the most stringent (7 mg/L) state DO standard.



**Missing July 2011 value not collected due to probe malfunction*

Figure 6. Dissolved oxygen (surface) from 2011 YSI sonde in-situ measurements overlaid on a box plot of measurements taken from 2006-2011.

Acid Neutralizing Capacity

Acid neutralizing capacity (ANC) is also known as alkalinity, or buffering capacity. It is due primarily to the presence of naturally available bicarbonate, carbonate, and hydroxide ions, with bicarbonate being the major form. Most states do not have numerical criteria for ANC in their water-quality standards. ANC values greater than 100 $\mu\text{eq/L}$ are considered well-buffered, while values less than zero typify acidic waters (Stoddard et al. 2003). Acid neutralizing capacity measured in the 2011 samples (Figure 7) illustrates that MORR streams were well-buffered, likely due to the underlying geology. Four of five May (spring) 2011 ANC measurements were the lowest in NETN data history at MORR. These values, along with lower May pH values, may illustrate the effects of episodic acidification from spring snowmelt and runoff (as well as the ability of the robust ANC to counteract the acidification pulses).

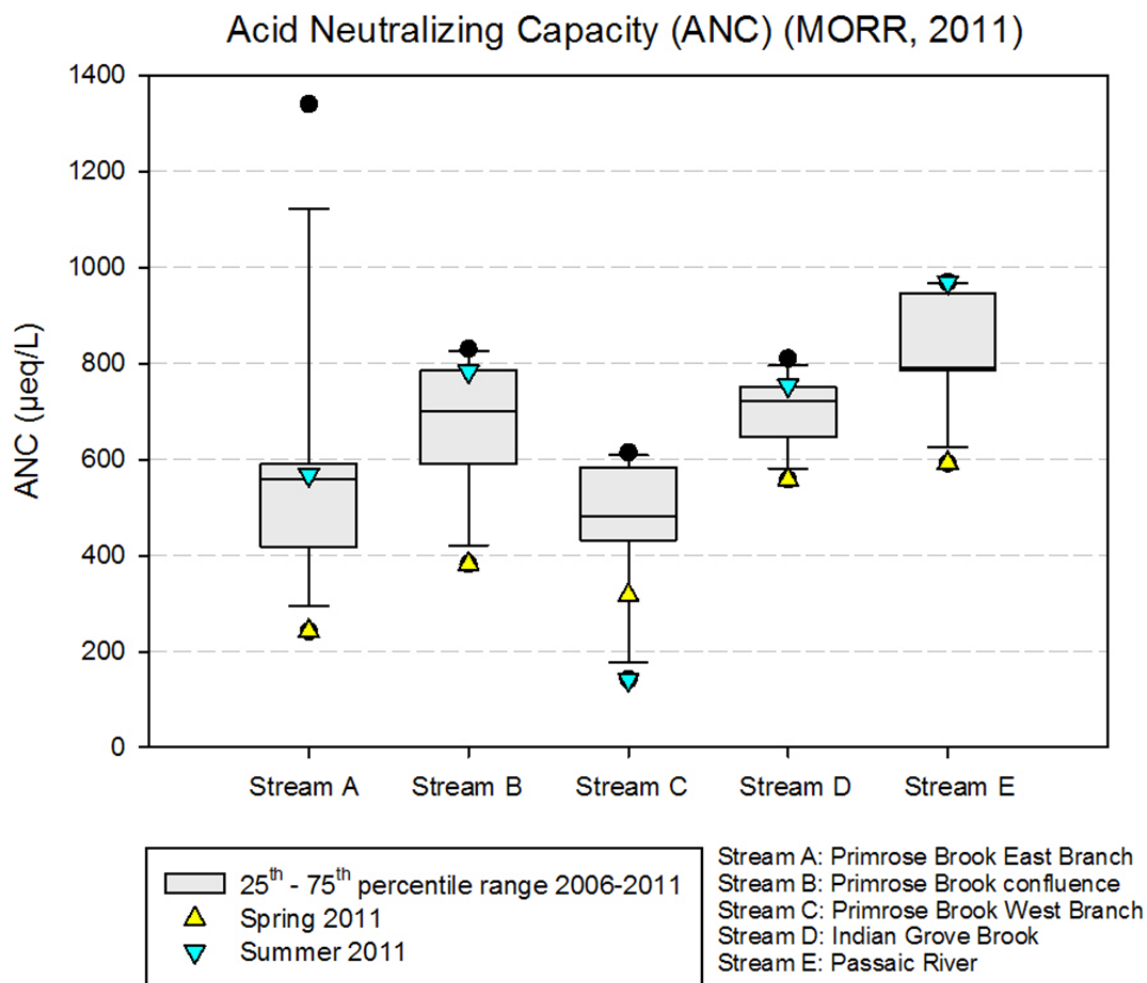


Figure 7. Acid neutralizing capacity from 2011 spring and summer water samples overlaid on a box plot of measurements taken from 2006-2011.

Apparent Color

Color in pond and stream water is caused by natural metallic ions, humus and peat materials, plankton, weeds, and industrial wastes. Color is reported in Pt-Co units (PCU). True color is the color measurement of water from which suspended particles have been removed by filtration. Apparent color (the measurement method utilized by NETN) is determined on original samples without filtration. Color can be a rough indicator for organic acidity.

Water bodies with apparent color values of greater than 25 PCU are considered to be highly colored, and often exhibit reduced water clarity and high phosphorus concentrations. Values of color are usually not included in water quality standards, except to note that they should be as naturally occurs.

Median color values from 2006 to 2011 monitoring (Figure 8) show most MORR streams to be moderately colored. The elevated color measured in the May (spring) 2011 samples further indicates the possibility of substantial runoff and sediment input to the streams prior to the May monitoring visit, especially since the samples were not filtered before analysis. Field notes indicate that the August (summer) 2011 monitoring at Primrose Brook West Branch (Stream C) was conducted during a heavy rain event that caused extremely turbid water (described as appearing “like chocolate milk”) and an exceptionally high apparent color measurement of 886 PCU. Monthly turbidity measurements, which will begin in 2012, may provide additional information on the impacts to MORR streams from episodic runoff events.

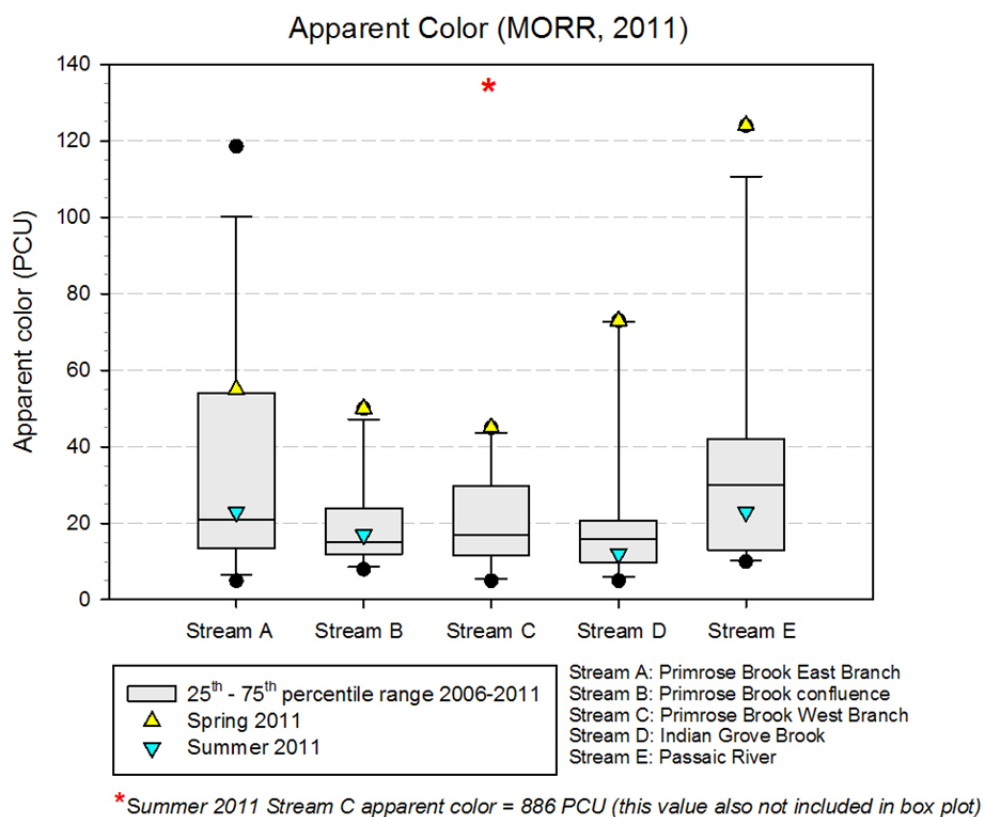


Figure 8. Apparent color from 2011 spring and summer water samples overlaid on a box plot of measurements taken from 2006-2011.

Nutrient Enrichment

Nutrient enrichment and the acceleration of eutrophication have been identified in most NETN parks as one of the stressors of greatest concern. Several forms of total and dissolved phosphorus and nitrogen are measured to give managers information regarding the trophic status and productivity of freshwater systems.

Phosphorus

Phosphorus (P) is one of the major nutrients needed for plant growth. It is generally present in small amounts and limits the plant growth in streams and ponds. Several forms of phosphorus were tested individually. Total phosphorus (TP) is a measure of both inorganic and organic forms of phosphorus, and is the common water quality standard or criteria metric. Phosphorus can be present as dissolved or particulate matter, and filtered samples were analyzed for total dissolved phosphorus (TDP). Soluble reactive phosphorus (SRP, or “orthophosphate”) is a measure of the inorganic oxidized form of soluble phosphorus. This form of phosphorus is the most readily available for uptake during photosynthesis. High concentrations of SRP generally occur in conjunction with algal blooms.

In 2011, most phosphorus concentrations (Figure 9) were in the moderate range, and generally showed the expected seasonal variation of lower spring values. The heavy rain event during the August (summer) 2011 monitoring at Primrose Brook West Branch (Stream C) likely caused the exceptionally high TP measurement of 1,910 $\mu\text{g/L}$. All other TP values were near or below the EPA Region 9 criterion of 36.56 $\mu\text{g/L}$. As described above (“Water Quality Standards”), the EPA criteria do not have any regulatory meaning.

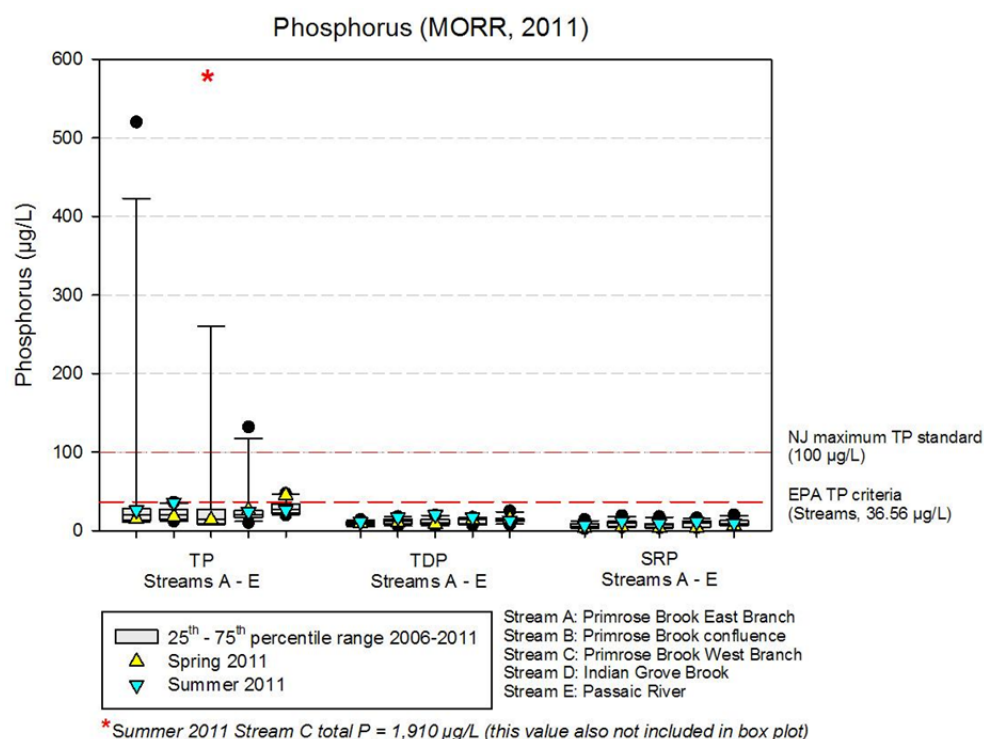


Figure 9. Total phosphorus (TP), total dissolved phosphorus (TDP), and soluble reactive phosphorus (SRP) from spring and summer water samples. The data are overlaid on a box plot of measurements taken from 2006-2011.

Total Nitrogen

Total nitrogen (TN) is a measure of all forms of nitrogen (organic and inorganic). Nitrogen is an essential plant element and is often the limiting nutrient in marine waters, and it can also limit some freshwater systems. Filtered samples were analyzed for total dissolved nitrogen (TDN). The importance of nitrogen in the aquatic environment varies according to the relative amounts of the forms of nitrogen present, including nitrate, nitrite, and ammonia.

Test results for several forms of nitrogen are shown in Figure 10. Half of the 2011 TN values exceeded the EPA Region 9 criterion of 0.69 mg/L, although as with TP this criterion does not have regulatory meaning. All but one of the TN and TDN results were below 2.0 mg/L, the value used as a TN standard in several northeast states (New Jersey has no numeric TN standard). The heavy rain event during the August (summer) 2011 monitoring at Primrose Brook West Branch (Stream C) likely caused the exceptionally high TN measurement of 11.8 mg/L. Nitrate (NO_3) is the most oxidized and stable form of nitrogen in a water body, and is the primary form of nitrogen used by plants as a nutrient. Nitrite (NO_2) is an unstable form of nitrogen that is either rapidly oxidized to nitrate (nitrification) or reduced to nitrogen gas (de-nitrification). This form of nitrogen can also be used as a source of nutrients for plants. NETN water samples were analyzed with a combined test for nitrate and nitrite, and most results were within the historic range of variability. Nitrite concentrations were very low, with several test results below the method reporting limit of 0.005 mg/L. All 2011 ammonia (NH_3 , another inorganic, bioavailable form of concern) test results were below the method reporting limit of 0.08 mg/L.

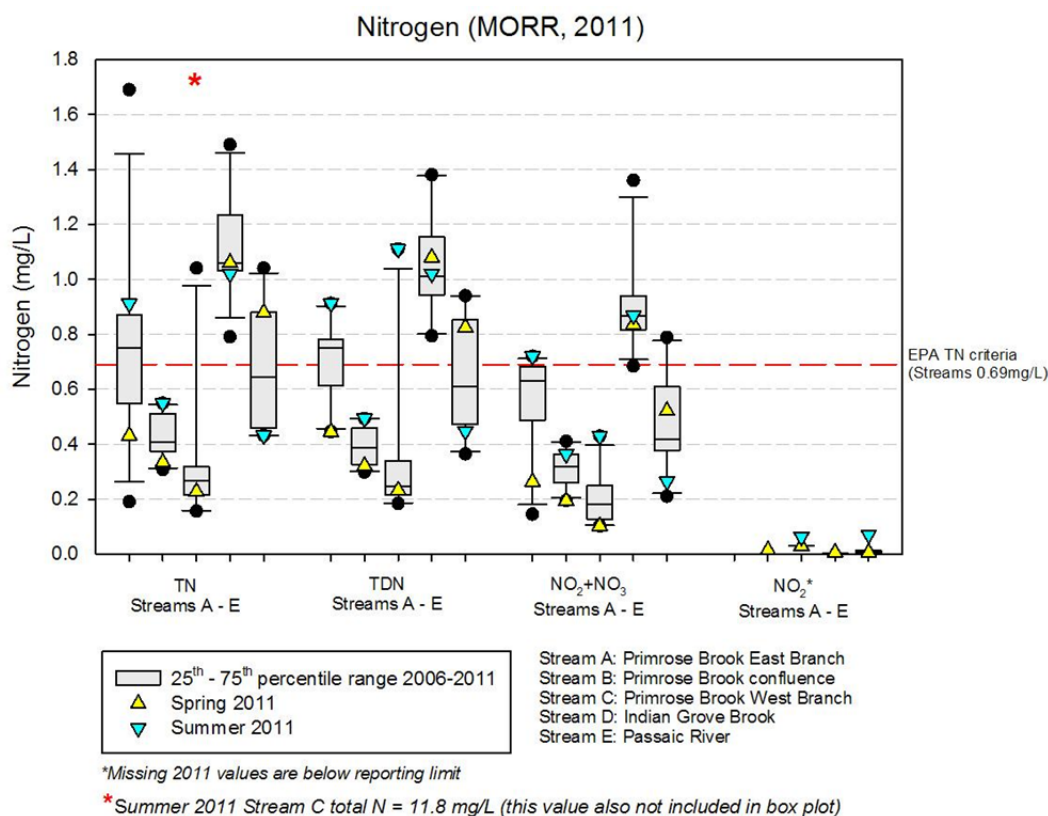


Figure 10. Total nitrogen (TN), total dissolved nitrogen (TDN), nitrite + nitrate ($\text{NO}_2 + \text{NO}_3$), and nitrite (NO_2) from 2011 spring and summer water samples. The data are overlaid on a box plot of measurements taken from 2006-2011.

Water Quantity

Monthly stream discharge measurements, taken with a current meter and wading rod, can be used to calculate loading of nutrient chemical constituents (flow times concentration), and also provide a record of variations in stream flow. Stream stage (height of water) measurements can be paired with discharge values and over time a stage to discharge relationship can be calculated. Once this relationship is established, investigators can interpolate the stream discharge from the stage measurement alone. Numerous discharge measurements at all ranges of streamflow are required to establish and maintain an accurate stage to discharge relationship. Stream stage measurements from 2011 are graphed in Figure 11. Discharge and stage measurements from 2006 to 2011 are listed in Table A3 in Appendix A.

Streamflow followed the expected seasonal sequence of high discharge in May to minimal flow in July and August, with gradual recovery in September and October. NETN staff are currently reviewing discharge and stage measurement methodology and quality assurance/quality control procedures in order to enhance the quality and utility of the water quantity data. A stage to discharge relationship graph will be produced once sufficient data are collected.

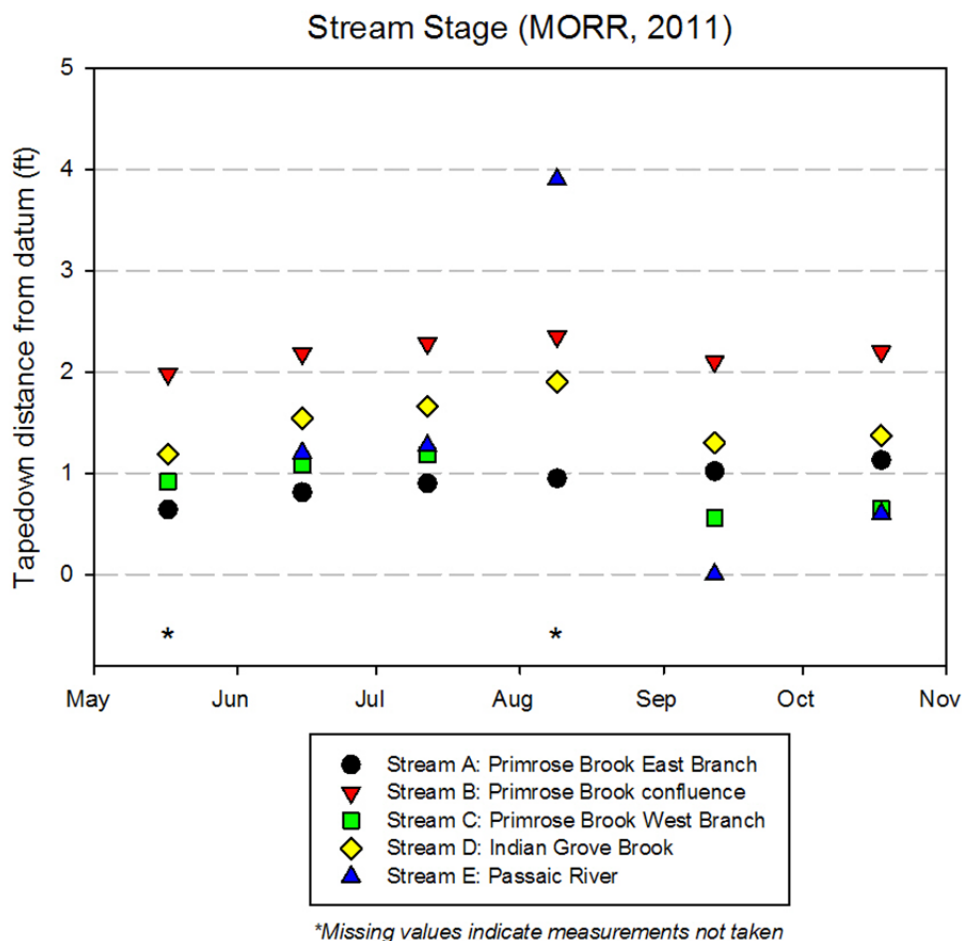


Figure 11. Stream stage obtained in 2011 by measuring from a permanent datum point down to the water surface. Note: Larger tapedown distances indicate LOWER water levels.

Invasive Aquatic Plants

Invasive aquatic plant monitoring was not conducted at MORR during the 2011 monitoring season, since the protocol specifies that targeted invasive aquatic plant monitoring is only conducted at pond and lake sites. However, during future visits to all NETN parks, monitoring crews will be increasingly attentive for the presence of Didymo (*Didymosphenia geminata*), also known as “rock snot”, a highly invasive alga that has recently invaded the northern reaches of the Connecticut River in New Hampshire and in the White River and Battenkill River in Vermont. This species has a great potential to alter habitats and displace native species, and is of great concern to officials in regions where infestations have been established.

Didymo is easily spread by even just one cell of the alga breaking off and drifting downstream in infested reaches. It is also very easily spread by waders, and potentially, water monitoring equipment and other gear that touches the bottoms of streams in infested areas. Enhanced equipment cleaning and decontamination procedures are being included in the latest NETN monitoring protocol revision.

The early detection of an invasive plant infestation can make eradication or control more feasible, and it can lead to efforts that reduce the spread of the plant to neighboring water bodies. Designating the early detection of these plants as a NETN vital sign and the ongoing partnership with state and local monitoring and eradication efforts are highly effective prevention strategies.

Summary

Most water quality parameters for the streams monitored in the Morristown National Historical Park are within state standards, and are generally within the range of EPA criteria, where applicable. The majority of values are within the ranges of the historic NETN monitoring data from MORR. Apparent color, TP, and TN measurements from the August (summer) Primrose Brook confluence samples clearly demonstrate the effects of the substantial precipitation and runoff event that occurred during the sampling visit.

ANC measurements showed that all streams were very well-buffered, however most of the May ANC values were also the lowest in NETN data history at MORR. Consideration of the ANC and color result sets suggests that spring snowmelt and runoff preceding the May sample visit likely contributed acidity and sediment to the stream water. Fortunately, the naturally high ANC of MORR streams provided sufficient buffering to avoid severely depressed pH values.

Test results for TN, TDN, and NO_3 were moderately high in most 2011 samples. Results for NO_2 were low at all sites. All ammonia (NH_3) test results were below the method reporting limit of 0.08 mg/L.

Monitoring under the NETN protocol builds on the historic water quality monitoring by park staff and other agencies to provide critical baseline information on the chemical and physical status of the water resources Morristown National Historical Park. Several changes will be implemented in the 2012 monitoring season, including taking monthly stream turbidity measurements, and the addition of sulfate, chloride, and dissolved organic carbon (DOC) analyses to the spring and summer water chemistry testing. These changes will expand the scope and usefulness of the monitoring data. As more data are collected, the ability to detect changes

outside this natural range of variability will increase, which in turn will more clearly indicate the status of the vital signs of water quality, nutrient enrichment, water quantity, and the detection of invasive plant species.

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Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011.

Table A1. YSI sonde in-situ water quality measurements collected at MORR. *Missing values indicate data are unavailable.*

Site	Date	Depth (m)	Temp (C)	DO (mg/L)	pH	SpCond $\mu\text{S/cm}$
East Primrose Brook (Stream A)	5/23/2006	0.14	9.76	9.91	7.15	107
East Primrose Brook (Stream A)	6/20/2006	0.08	16.10	8.41	7.17	118
East Primrose Brook (Stream A)	7/25/2006	0.07	18.28	8.21	7.52	129
East Primrose Brook (Stream A)	8/15/2006	0.05	17.82	8.42	7.74	121
East Primrose Brook (Stream A)	9/19/2006	0.00	16.24	8.85	7.47	82
East Primrose Brook (Stream A)	10/17/2006	0.02	10.03	10.16	8.26	115
East Primrose Brook (Stream A)	4/17/2007	0.30	5.89	11.33	7.33	75
East Primrose Brook (Stream A)	5/22/2007	0.12	11.62	10.27	7.74	110
East Primrose Brook (Stream A)	6/12/2007	0.09	15.51	9.39	7.65	115
East Primrose Brook (Stream A)	7/10/2007	0.06	17.79	9.02	7.67	134
East Primrose Brook (Stream A)	8/7/2007	0.07	18.85	8.67	7.74	126
East Primrose Brook (Stream A)	9/5/2007	0.10	16.19	9.25	7.70	126
East Primrose Brook (Stream A)	10/2/2007	0.00	13.92	9.79	7.80	144
East Primrose Brook (Stream A)	5/13/2008	0.21	10.97	10.09	7.03	101
East Primrose Brook (Stream A)	6/11/2008	0.51	17.81	8.30	7.21	129
East Primrose Brook (Stream A)	7/16/2008	0.41	19.58	8.47	7.26	129
East Primrose Brook (Stream A)	8/25/2008	0.07	18.86	8.62	7.49	132
East Primrose Brook (Stream A)	9/17/2008	0.11	15.56	9.46	8.07	138
East Primrose Brook (Stream A)	10/8/2008	0.18	10.73	10.45	7.81	80
East Primrose Brook (Stream A)	5/12/2009	0.11	10.34	10.10	7.07	103
East Primrose Brook (Stream A)	5/12/2009	0.11	10.34	10.10	7.07	103
East Primrose Brook (Stream A)	6/16/2009	0.12	13.60	9.67	6.97	102
East Primrose Brook (Stream A)	7/28/2009	0.18	18.13	10.02	7.33	133
East Primrose Brook (Stream A)	8/25/2009	0.06	18.52	8.63	7.28	132
East Primrose Brook (Stream A)	9/21/2009	0.35	14.77	9.72	7.24	130
East Primrose Brook (Stream A)	10/14/2009	0.34	9.09	10.88	6.93	145
East Primrose Brook (Stream A)	5/11/2010	0.22	10.01	12.30	7.19	128
East Primrose Brook (Stream A)	5/11/2010	0.23	10.01	11.46	7.18	128
East Primrose Brook (Stream A)	6/8/2010	0.28	14.64	9.83	7.5	126
East Primrose Brook (Stream A)	7/20/2010	-0.01	19.50	8.54	7.49	124
East Primrose Brook (Stream A)	7/20/2010	0.03	19.41	9.03	7.49	124
East Primrose Brook (Stream A)	8/24/2010	0.34	17.35	8.98		119
East Primrose Brook (Stream A)	9/14/2010	0.08	16.73	9.07	7.82	203
East Primrose Brook (Stream A)	10/11/2010	0.15	14.59	9.36	7.65	128
East Primrose Brook (Stream A)	5/17/2011	0.13	11.68	10.33	6.76	73
East Primrose Brook (Stream A)	6/15/2011	0.36	15.16	10.40	7.02	105
East Primrose Brook (Stream A)	7/12/2011	0.13	19.35	8.52	7.19	139

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A1. YSI sonde in-situ water quality measurements collected at MORR (continued).

Site	Date	Depth (m)	Temp (C)	DO (mg/L)	pH	SpCond $\mu\text{S/cm}$
East Primrose Brook (Stream A)	8/9/2011	0.18	18.66	8.94	7.28	125
East Primrose Brook (Stream A)	9/12/2011	0.31	16.04	9.58	7.14	98
East Primrose Brook (Stream A)	10/18/2011	0.25	11.46	10.21	7.45	120
Primrose Brook Confluence (Stream B)	5/23/2006	0.13	10.04	11.08	7.47	0
Primrose Brook Confluence (Stream B)	5/23/2006	0.14	10.13	10.76	7.49	74
Primrose Brook Confluence (Stream B)	6/20/2006	0.10	16.98	9.22	7.52	122
Primrose Brook Confluence (Stream B)	7/25/2006	0.13	18.50	9.04	7.63	107
Primrose Brook Confluence (Stream B)	8/15/2006	0.08	17.89	9.21	7.66	115
Primrose Brook Confluence (Stream B)	9/19/2006	0.02	16.50	9.34	7.53	123
Primrose Brook Confluence (Stream B)	10/17/2006	0.03	9.87	10.76	7.79	123
Primrose Brook Confluence (Stream B)	4/17/2007	0.30	6.43	11.75	7.30	74
Primrose Brook Confluence (Stream B)	5/22/2007	0.19	12.55	10.48	7.67	112
Primrose Brook Confluence (Stream B)	6/12/2007	0.06	16.64	9.36	7.56	120
Primrose Brook Confluence (Stream B)	7/10/2007	0.12	18.67	9.22	7.54	129
Primrose Brook Confluence (Stream B)	8/7/2007	0.12	19.18	8.90	7.54	131
Primrose Brook Confluence (Stream B)	9/5/2007	0.14	16.26	9.48	7.60	132
Primrose Brook Confluence (Stream B)	10/2/2007	0.06	14.07	9.90	7.66	134
Primrose Brook Confluence (Stream B)	5/13/2008	0.29	12.07	10.53	7.44	107
Primrose Brook Confluence (Stream B)	6/11/2008	0.57	17.93	9.02	7.49	124
Primrose Brook Confluence (Stream B)	7/16/2008	0.43	19.20	8.85	7.50	131
Primrose Brook Confluence (Stream B)	8/25/2008	0.13	18.40	9.06	7.60	140
Primrose Brook Confluence (Stream B)	9/17/2008	0.12	15.52	9.79	7.80	144
Primrose Brook Confluence (Stream B)	10/8/2008	0.21	11.05	10.54	7.58	147
Primrose Brook Confluence (Stream B)	5/12/2009	0.15	10.52	10.88	7.42	106
Primrose Brook Confluence (Stream B)	6/16/2009	0.13	13.68	10.03	7.37	112
Primrose Brook Confluence (Stream B)	7/28/2009	0.20	18.29	9.98	7.46	126
Primrose Brook Confluence (Stream B)	8/25/2009	0.09	18.86	8.95	7.51	92
Primrose Brook Confluence (Stream B)	9/21/2009	0.34	14.46	9.71	7.40	127
Primrose Brook Confluence (Stream B)	10/14/2009	0.41	9.35	10.97	7.18	142
Primrose Brook Confluence (Stream B)	5/11/2010	0.26	9.82	11.66	7.47	114
Primrose Brook Confluence (Stream B)	6/8/2010	0.32	14.74	9.78	7.72	120
Primrose Brook Confluence (Stream B)	7/20/2010	0.01	20.06	9.06	7.69	127
Primrose Brook Confluence (Stream B)	7/20/2010	0.03	20.10	8.74	7.68	127
Primrose Brook Confluence (Stream B)	8/24/2010	0.36	17.23	9.35		126
Primrose Brook Confluence (Stream B)	9/14/2010	0.08	16.23	9.43	7.80	131
Primrose Brook Confluence (Stream B)	10/11/2010	0.23	14.27	9.80	7.64	125
Primrose Brook Confluence (Stream B)	5/17/2011	0.22	11.67	10.55	7.14	77
Primrose Brook Confluence (Stream B)	6/15/2011	0.40	15.35	9.80	7.36	113
Primrose Brook Confluence (Stream B)	7/12/2011	0.11	19.68		7.49	130
Primrose Brook Confluence (Stream B)	8/9/2011	0.29	18.63	8.91	7.49	127
Primrose Brook Confluence (Stream B)	9/12/2011	0.30	16.04	9.53	7.04	102

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A1. YSI sonde in-situ water quality measurements collected at MORR (continued).

Site	Date	Depth (m)	Temp (C)	DO (mg/L)	pH	SpCond $\mu\text{S/cm}$
Primrose Brook Confluence (Stream B)	10/18/2011	0.28	11.96	10.21	7.20	118
West Primrose Brook (Stream C)	5/23/2006	0.14	10.37	10.58	7.24	88
West Primrose Brook (Stream C)	6/20/2006	0.06	16.82	8.92	7.42	94
West Primrose Brook (Stream C)	7/25/2006	0.06	18.40	8.98	7.53	97
West Primrose Brook (Stream C)	8/15/2006	0.07	18.03	9.15	7.87	97
West Primrose Brook (Stream C)	9/19/2006	-0.01	16.69	9.22	7.56	97
West Primrose Brook (Stream C)	10/17/2006	0.03	9.82	10.80	8.12	96
West Primrose Brook (Stream C)	4/17/2007	0.33	7.37	11.35	7.14	64
West Primrose Brook (Stream C)	5/22/2007	0.14	13.21	10.22	7.61	91
West Primrose Brook (Stream C)	6/12/2007	0.04	16.85	9.34	7.51	98
West Primrose Brook (Stream C)	7/10/2007	0.06	18.69	9.16	7.59	100
West Primrose Brook (Stream C)	7/10/2007	0.07	18.75	8.88	7.55	100
West Primrose Brook (Stream C)	8/7/2007	0.09	19.22	8.75	7.61	104
West Primrose Brook (Stream C)	9/5/2007	0.11	16.31	9.38	7.59	102
West Primrose Brook (Stream C)	5/13/2008	0.35	12.89	9.91	7.08	86
West Primrose Brook (Stream C)	6/11/2008	0.50	17.73	8.60	7.18	99
West Primrose Brook (Stream C)	7/16/2008	0.40	18.65	8.62	7.28	105
West Primrose Brook (Stream C)	8/25/2008	0.11	18.42	8.55	7.39	106
West Primrose Brook (Stream C)	9/17/2008	0.12	15.99	9.34	7.77	112
West Primrose Brook (Stream C)	10/8/2008	0.21	11.86	6.89	7.11	117
West Primrose Brook (Stream C)	5/12/2009	0.11	11.17	10.21	6.94	86
West Primrose Brook (Stream C)	6/16/2009	0.13	13.23	9.65	7.00	90
West Primrose Brook (Stream C)	7/28/2009	0.19	18.28	9.41	7.24	100
West Primrose Brook (Stream C)	8/25/2009	0.07	18.51	8.86	7.30	103
West Primrose Brook (Stream C)	9/21/2009	0.31	14.76	9.67	7.32	101
West Primrose Brook (Stream C)	10/14/2009	0.36	9.45	10.67	7.41	107
West Primrose Brook (Stream C)	5/11/2010	0.21	9.87	11.66	7.23	88
West Primrose Brook (Stream C)	6/8/2010	0.26	14.59	9.65	7.48	95
West Primrose Brook (Stream C)	7/20/2010	0.00	20.02	8.48	7.49	100
West Primrose Brook (Stream C)	7/20/2010	0.02	20.04	8.36	7.52	100
West Primrose Brook (Stream C)	8/24/2010	0.28	16.89	9.20		100
West Primrose Brook (Stream C)	9/14/2010	0.04	16.38	9.00	7.76	100
West Primrose Brook (Stream C)	10/11/2010	0.17	14.59	9.29	7.50	102
West Primrose Brook (Stream C)	5/17/2011	0.11	11.50	10.22	6.79	67
West Primrose Brook (Stream C)	6/15/2011	0.32	14.43	9.36	6.74	89
West Primrose Brook (Stream C)	7/13/2011	0.17	17.78	3.78	7.16	103
West Primrose Brook (Stream C)	8/9/2011	0.19	20.80	7.93	6.82	36
West Primrose Brook (Stream C)	8/9/2011	0.20	20.70	8.23	6.63	38
West Primrose Brook (Stream C)	9/12/2011	0.28	15.38	9.67	6.93	83
West Primrose Brook (Stream C)	10/18/2011	0.21	12.52	9.88	7.17	94
Indian Grove Brook (Stream D)	5/23/2006	0.22	12.29	10.25	7.46	216

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A1. YSI sonde in-situ water quality measurements collected at MORR (continued).

Site	Date	Depth (m)	Temp (C)	DO (mg/L)	pH	SpCond μ S/cm)
Indian Grove Brook (Stream D)	6/20/2006	0.16	20.46	8.31	7.43	234
Indian Grove Brook (Stream D)	7/25/2006	0.14	20.43	8.70	7.58	223
Indian Grove Brook (Stream D)	8/15/2006	0.10	20.92	8.73	7.56	230
Indian Grove Brook (Stream D)	9/19/2006	0.07	18.90	8.79	7.55	224
Indian Grove Brook (Stream D)	10/17/2006	0.05	10.44	10.73	7.67	217
Indian Grove Brook (Stream D)	4/17/2007	0.42	7.97	11.50	7.28	180
Indian Grove Brook (Stream D)	5/22/2007	0.19	12.57	10.21	7.85	226
Indian Grove Brook (Stream D)	6/12/2007	0.16	18.70	8.67	7.61	237
Indian Grove Brook (Stream D)	7/10/2007	0.14	21.44	8.17	7.95	238
Indian Grove Brook (Stream D)	8/7/2007	0.11	21.47	8.10	7.76	233
Indian Grove Brook (Stream D)	9/5/2007	0.27	17.78	9.03	7.59	244
Indian Grove Brook (Stream D)	10/2/2007	0.02	14.29	9.81	7.54	247
Indian Grove Brook (Stream D)	5/13/2008	0.26	9.64	10.61	7.40	216
Indian Grove Brook (Stream D)	6/11/2008	0.62	22.62	7.74	7.38	246
Indian Grove Brook (Stream D)	7/17/2008	0.50	20.57	8.51	7.44	248
Indian Grove Brook (Stream D)	7/17/2008	0.50	20.57	8.51	7.44	248
Indian Grove Brook (Stream D)	8/25/2008	0.17	20.59	8.34	7.55	265
Indian Grove Brook (Stream D)	9/17/2008	0.07	17.69	9.22	7.47	254
Indian Grove Brook (Stream D)	10/9/2008	0.20	13.21	9.93	7.64	265
Indian Grove Brook (Stream D)	5/12/2009	0.19	13.98	10.29	7.41	248
Indian Grove Brook (Stream D)	6/16/2009	0.22	16.68	9.40	7.40	239
Indian Grove Brook (Stream D)	7/28/2009	0.20	22.57	8.88	7.43	251
Indian Grove Brook (Stream D)	8/25/2009	0.03	21.85	8.49	7.43	231
Indian Grove Brook (Stream D)	9/21/2009	0.31	16.72	9.44	7.40	260
Indian Grove Brook (Stream D)	10/14/2009	0.40	10.30	10.69	7.68	266
Indian Grove Brook (Stream D)	5/11/2010	0.27	11.46	11.49	7.41	247
Indian Grove Brook (Stream D)	5/11/2010	0.28	11.45	11.03	7.41	248
Indian Grove Brook (Stream D)	6/9/2010	0.40	15.10	9.66	7.66	266
Indian Grove Brook (Stream D)	7/20/2010	0.07	23.44	8.00	7.57	248
Indian Grove Brook (Stream D)	8/24/2010	0.39	18.51	8.84		233
Indian Grove Brook (Stream D)	9/14/2010	0.12	17.34	9.03	7.68	277
Indian Grove Brook (Stream D)	10/11/2010	0.26	15.14	9.41	7.52	263
Indian Grove Brook (Stream D)	5/17/2011	0.19	12.90	10.83	7.35	193
Indian Grove Brook (Stream D)	6/15/2011	0.39	18.38	8.87	7.40	245
Indian Grove Brook (Stream D)	7/13/2011	0.11	21.04	8.44	7.37	278
Indian Grove Brook (Stream D)	8/8/2011	0.31	23.01	7.98	7.65	268
Indian Grove Brook (Stream D)	8/8/2011	0.36	23.03	7.97	7.63	268
Indian Grove Brook (Stream D)	9/12/2011	0.37	17.89	9.25	7.22	217
Indian Grove Brook (Stream D)	10/19/2011	0.36	12.62	10.09	7.76	246
Passaic River (Stream E)	7/25/2006	0.29	19.59	8.75	7.51	176

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A1. YSI sonde in-situ water quality measurements collected at MORR (continued).

Site	Date	Depth (m)	Temp (C)	DO (mg/L)	pH	SpCond μ S/cm
Passaic River (Stream E)	8/15/2006	0.17	19.95	8.71	8.00	206
Passaic River (Stream E)	10/17/2006	0.03	10.03	10.85	7.74	211
Passaic River (Stream E)	4/17/2007	0.39	7.36	11.73	7.24	158
Passaic River (Stream E)	5/22/2007	0.19	12.54	10.19	7.82	221
Passaic River (Stream E)	6/12/2007	0.47	18.61	8.80	7.66	237
Passaic River (Stream E)	7/10/2007	0.11	21.09	8.45	7.65	219
Passaic River (Stream E)	8/7/2007	0.23	20.92	8.38	7.67	238
Passaic River (Stream E)	9/5/2007	0.13	17.01	9.31	7.63	263
Passaic River (Stream E)	10/2/2007	0.09	13.22	10.20	7.63	271
Passaic River (Stream E)	5/13/2008	0.30	9.99	10.60	7.49	201
Passaic River (Stream E)	6/11/2008	0.60	22.38	7.98	7.41	246
Passaic River (Stream E)	7/17/2008	0.50	19.54	8.72	7.46	266
Passaic River (Stream E)	8/25/2008	0.21	19.81	8.68	7.57	264
Passaic River (Stream E)	9/17/2008	0.24	17.18	9.39	7.61	259
Passaic River (Stream E)	10/8/2008	0.18	11.61	10.39	7.41	279
Passaic River (Stream E)	5/12/2009	0.25	14.82	10.03	7.52	219
Passaic River (Stream E)	6/16/2009	0.36	17.11	9.27	7.52	230
Passaic River (Stream E)	7/28/2009	0.36	22.18	8.96	7.52	249
Passaic River (Stream E)	8/25/2009	0.10	21.60	8.27	7.49	204
Passaic River (Stream E)	9/21/2009	0.66	15.38	9.64	7.45	264
Passaic River (Stream E)	10/14/2009	0.55	9.85	11.24	7.52	282
Passaic River (Stream E)	5/11/2010	0.26	11.49	11.04	7.41	231
Passaic River (Stream E)	6/8/2010	0.34	17.18	9.16	7.62	251
Passaic River (Stream E)	7/20/2010	0.01	23.16	8.11	7.65	219
Passaic River (Stream E)	8/24/2010	0.36	18.71	8.88		229
Passaic River (Stream E)	9/14/2010	0.35	16.53	9.17	7.71	254
Passaic River (Stream E)	10/11/2010	0.21	14.39	9.60	7.52	241
Passaic River (Stream E)	5/17/2011	0.23	13.06	10.08	7.28	153
Passaic River (Stream E)	6/15/2011	0.35	18.18	9.01	7.46	231
Passaic River (Stream E)	7/13/2011	0.17	20.76	8.50	7.51	225
Passaic River (Stream E)	8/8/2011	0.20	23.05	8.19	7.70	263
Passaic River (Stream E)	9/12/2011	0.28	18.35	9.22	7.37	225
Passaic River (Stream E)	10/19/2011	0.34	12.86	9.90	7.63	235

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A2. Laboratory nutrient chemistry data for MORR. “<MRL” indicates the result was below the method reporting limit (provided after the abbreviation). *Missing values indicate data are unavailable.*

Site	Date	ANC (µeq/L)	Apparent Color (PCU)	TP (µg/L)	TDP (µg/L)	SRP (µg/L)	TN (mg/L)	TDN (mg/L)	NO ₂ +NO ₃ (mg/L)	NO ₂ (mg/L)	NH ₃ (mg/L)
East Primrose Brook (Stream A)	6/20/2006	560.0	13	20		9.0	0.74		0.483	0.001	0.006
East Primrose Brook (Stream A)	8/15/2006	1,340.0	5	<MRL 20		7.0	0.19		0.145	<MRL 0.002	0.008
East Primrose Brook (Stream A)	8/7/2007	611.7	15	28	11.0	14.0	0.86	0.820	0.681	0.002	<MRL 0.02
East Primrose Brook (Stream A)	5/22/2007	418.8	10	15	5.0	8.0	0.73	0.750	0.636	0.001	<MRL 0.02
East Primrose Brook (Stream A)	5/13/2008	413.0	16	11	7.1	3.6	0.53	0.629	0.496	<MRL 0.005	
East Primrose Brook (Stream A)	8/25/2008	598.0	119	520	14.0	8.4	1.69	0.751	0.639	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	8/25/2009	560.0	57	35	8.6	4.2	0.87	0.770	0.691	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	5/12/2009	443.0	22	11	8.5	2.5	0.59	0.564	0.584	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	5/12/2009	443.0	22	11	8.5	2.5	0.59	0.564	0.584	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	5/11/2010	418.0	20	13	5.0	4.6	0.85	0.759	0.683	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	8/24/2010	560.0	51	26	9.8	4.4	0.76	0.738	0.624	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	8/9/2011	568.0	23	26	11.0	6.7	0.91	0.912	0.720	<MRL 0.005	<MRL 0.08
East Primrose Brook (Stream A)	5/17/2011	242.0	55	15	9.9	3.1	0.43	0.445	0.263	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	8/15/2006	700.0	20	20		15.0	0.52		0.278	<MRL 0.002	0.005
Primrose Brook Confluence (Stream B)	8/7/2007	806.7	13	23	14.0	19.0	0.45	0.450	0.343	0.001	<MRL 0.02
Primrose Brook Confluence (Stream B)	5/22/2007	590.6	8	15	6.0	9.0	0.51	0.490	0.410	0.001	<MRL 0.02
Primrose Brook Confluence (Stream B)	8/25/2008	830.0	15	27	18.0	12.0	0.38	0.379	0.324	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	5/13/2008	594.0	11	12	9.2	5.4	0.37	0.343	0.282	<MRL 0.005	
Primrose Brook Confluence (Stream B)	5/12/2009	598.0	14	14	8.9	4.4	0.31	0.298	0.250	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	8/25/2009	775.0	24	22	13.0	9.4	0.41	0.396	0.317	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	8/24/2010	784.0	36	32	13.0	9.6	0.38	0.328	0.259	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	5/11/2010	578.0	12	14	6.7	5.7	0.49	0.425	0.396	<MRL 0.005	<MRL 0.08

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A2. Laboratory nutrient chemistry data for MORR (continued).

Site	Date	ANC (µeq/L)	Apparent Color (PCU)	TP (µg/L)	TDP (µg/L)	SRP (µg/L)	TN (mg/L)	TDN (mg/L)	NO ₂ +NO ₃ (mg/L)	NO ₂ (mg/L)	NH ₃ (mg/L)
Primrose Brook Confluence (Stream B)	8/9/2011	783.0	17	36.0	17.0	12.0	0.55	0.493	0.363	<MRL 0.005	<MRL 0.08
Primrose Brook Confluence (Stream B)	5/17/2011	382.0	50	18.0	10.0	4.5	0.33	0.321	0.194	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	8/15/2006	580.0	20	<MRL 20		13.0	0.28		0.159	<MRL 0.002	0.006
West Primrose Brook (Stream C)	8/7/2007	614.7	13	31.0	14.0	18.0	0.41	0.390	0.248	<MRL 0.002	<MRL 0.02
West Primrose Brook (Stream C)	5/22/2007	480.7	5	8.0	6.0	9.0	0.25	0.240	0.180	0.001	<MRL 0.02
West Primrose Brook (Stream C)	8/25/2008	583.0	32	260.0	14.0	8.4	1.04	0.322	0.267	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	5/13/2008	454.0	12	8.7	8.4	4.3	0.18	0.184	0.128	<MRL 0.005	
West Primrose Brook (Stream C)	8/25/2009	587.0	20	16.0	11.0	7.9	0.29	0.282	0.217	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	5/12/2009	432.0	14	8.8	8.8	3.6	0.16	0.196	0.119	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	8/24/2010	583.0	29	22.0	12.0	7.7	0.29	0.251	0.196	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	5/11/2010	458.0	10	9.6	6.1	5.2	0.23	0.222	0.163	<MRL 0.005	<MRL 0.08
West Primrose Brook (Stream C)	8/9/2011	142.0	886	1,910.0	20.0	8.6	11.80	1.110	0.429	0.062	<MRL 0.08
West Primrose Brook (Stream C)	5/17/2011	317.0	45	14.0	8.7	3.3	0.23	0.232	0.102	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	8/15/2006	740.0	13	10.0		15.0	1.07		0.863	0.003	0.007
Indian Grove Brook (Stream D)	6/20/2006	760.0	10	20.0		11.0	1.06		0.809	0.002	0.008
Indian Grove Brook (Stream D)	8/7/2007	733.1	8	22.0	15.0	16.0	1.03	1.000	0.854	0.002	<MRL 0.02
Indian Grove Brook (Stream D)	5/22/2007	659.2	5	15.0	8.0	8.0	1.27	1.350	1.160	0.003	<MRL 0.02
Indian Grove Brook (Stream D)	5/13/2008	641.0	19	17.0	9.3	4.3	1.12	0.971	0.940	<MRL 0.005	
Indian Grove Brook (Stream D)	8/25/2008	810.0	10	82.0	16.0	12.0	0.79	0.794	0.684	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	5/12/2009	677.0	20	17.0	8.6	3.9	1.03	1.000	0.930	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	8/25/2009	730.0	21	21.0	16.0	12.0	1.04	1.090	0.939	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	5/11/2010	633.0	20	19.0	7.0	5.6	1.49	1.380	1.360	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	8/24/2010	711.0	72	132.0	14.0	9.2	1.39	0.860	0.764	<MRL 0.005	<MRL 0.08
Indian Grove Brook (Stream D)	8/8/2011	754.0	12	24.0	17.0	11.0	1.02	1.020	0.868	<MRL 0.005	<MRL 0.08

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A2. Laboratory nutrient chemistry data for MORR (continued).

Site	Date	ANC (µeq/L)	Apparent Color (PCU)	TP (µg/L)	TDP (µg/L)	SRP (µg/L)	TN (mg/L)	TDN (mg/L)	NO ₂ +NO ₃ (mg/L)	NO ₂ (mg/L)	NH ₃ (mg/L)
Indian Grove Brook (Stream D)	5/17/2011	558.0	73	26.0	14.0	4.0	1.06	1.080	0.836	<MRL 0.005	<MRL 0.08
Passaic River (Stream E)	8/15/2006	760.0	20	20.0		13.0	0.72		0.487	0.004	0.009
Passaic River (Stream E)	5/22/2007	785.9	10	22.0	8.0	7.0	0.95	0.940	0.729	0.012	0.029
Passaic River (Stream E)	8/7/2007	946.0	13	22.0	15.0	15.0	0.61	0.580	0.419	0.001	<MRL 0.02
Passaic River (Stream E)	5/13/2008	791.0	40	27.0	16.0	9.2	0.83	0.703	0.608	0.006	
Passaic River (Stream E)	8/25/2008	963.0	11	27.0	13.0	9.0	0.44	0.479	0.380	<MRL 0.005	<MRL 0.08
Passaic River (Stream E)	5/12/2009	784.0	42	26.0	14.0	6.1	0.61	0.619	0.404	<MRL 0.005	<MRL 0.08
Passaic River (Stream E)	8/25/2009	860.0	57	47.0	25.0	20.0	0.64	0.597	0.376	<MRL 0.005	<MRL 0.08
Passaic River (Stream E)	8/24/2010	859.0	40	33.0	14.0	7.3	0.46	0.364	0.210	<MRL 0.005	<MRL 0.08
Passaic River (Stream E)	5/11/2010	790.0	30	34.0	9.0	8.1	1.04	0.932	0.788	0.012	<MRL 0.08
Passaic River (Stream E)	5/17/2011	592.0	124	45.0	15.0	6.5	0.88	0.825	0.521	0.008	<MRL 0.08
Passaic River (Stream E)	8/8/2011	969.0	23	26.0	13.0	9.3	0.43	0.446	0.264	0.070	<MRL 0.08

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A3. Stream stage and discharge data for MORR. *Missing values indicate data are unavailable.*

Site	Date	Tapedown from datum (ft)	Total cross section area (sqft)	Average velocity (f/s)	Discharge (cfs)
East Primrose Brook (Stream A)	5/23/2006				
East Primrose Brook (Stream A)	6/20/2006		0.71	0.23	0.15
East Primrose Brook (Stream A)	7/25/2006	1.46	0.44	0.25	0.11
East Primrose Brook (Stream A)	8/15/2006	1.55	0.28	0.67	0.19
East Primrose Brook (Stream A)	9/19/2006	1.71	0.70	0.20	0.15
East Primrose Brook (Stream A)	10/17/2006		0.25	0.34	0.09
East Primrose Brook (Stream A)	4/17/2007	1.46	1.38	1.08	1.47
East Primrose Brook (Stream A)	5/22/2007	0.79	0.57	0.58	0.33
East Primrose Brook (Stream A)	6/12/2007	0.90	0.66	0.50	0.30
East Primrose Brook (Stream A)	7/10/2007	0.98	0.35	0.40	0.14
East Primrose Brook (Stream A)	8/7/2007	0.98	0.16	0.29	0.05
East Primrose Brook (Stream A)	9/5/2007	1.00	0.22	0.23	0.05
East Primrose Brook (Stream A)	10/2/2007	1.00	0.26	0.23	0.05
East Primrose Brook (Stream A)	5/13/2008	0.81	0.85	0.56	0.40
East Primrose Brook (Stream A)	6/11/2008	0.88	0.81	0.29	0.22
East Primrose Brook (Stream A)	7/16/2008	0.92	0.69	0.24	0.12
East Primrose Brook (Stream A)	8/25/2008	0.98			
East Primrose Brook (Stream A)	9/17/2008	1.00		0.22	
East Primrose Brook (Stream A)	10/8/2008	0.98	0.33	0.22	0.07
East Primrose Brook (Stream A)	5/12/2009	0.85	1.41	0.22	0.29
East Primrose Brook (Stream A)	5/12/2009	0.85	1.41	0.22	0.29
East Primrose Brook (Stream A)	6/16/2009	0.78	0.79	0.35	0.27
East Primrose Brook (Stream A)	7/28/2009	0.96	0.67	0.18	0.12
East Primrose Brook (Stream A)	8/25/2009	0.90	0.69	0.15	0.11
East Primrose Brook (Stream A)	9/21/2009	0.93	0.66	0.13	0.09
East Primrose Brook (Stream A)	10/14/2009	0.90	1.13	0.09	0.11
East Primrose Brook (Stream A)	5/11/2010	0.79	1.42	0.27	0.39
East Primrose Brook (Stream A)	6/8/2010	0.85	1.20	0.15	0.19
East Primrose Brook (Stream A)	7/20/2010	0.85	0.85	0.15	0.13
East Primrose Brook (Stream A)	8/24/2010	0.90	0.79	0.12	0.09
East Primrose Brook (Stream A)	9/14/2010	0.90	0.64	0.11	0.07
East Primrose Brook (Stream A)	10/11/2010	0.92	1.24	0.04	0.05
East Primrose Brook (Stream A)	5/17/2011	0.64	2.19	0.55	1.19
East Primrose Brook (Stream A)	6/15/2011	0.81	1.55	0.27	0.42
East Primrose Brook (Stream A)	7/12/2011	0.90	1.15	0.18	0.20
East Primrose Brook (Stream A)	8/9/2011	0.95	0.97	0.11	0.11
East Primrose Brook (Stream A)	9/12/2011	1.02	0.15	0.15	0.02
East Primrose Brook (Stream A)	10/18/2011	1.13	1.30	0.22	0.29
Primrose Brook Confluence (Stream B)	5/23/2006				
Primrose Brook Confluence (Stream B)	6/20/2006		2.44	0.47	0.95
Primrose Brook Confluence (Stream B)	7/25/2006	2.35	1.76	0.64	1.11
Primrose Brook Confluence (Stream B)	8/15/2006	2.32	2.07	0.64	1.33
Primrose Brook Confluence (Stream B)	9/19/2006	2.35	2.07	0.43	0.95
Primrose Brook Confluence (Stream B)	10/17/2006	2.36	2.03	0.48	0.89
Primrose Brook Confluence (Stream B)	4/17/2007	1.94	6.60	2.00	12.89
Primrose Brook Confluence (Stream B)	5/22/2007	2.27	3.06	0.74	1.99
Primrose Brook Confluence (Stream B)	6/12/2007	2.33	2.52	0.60	1.40
Primrose Brook Confluence (Stream B)	7/10/2007	2.42	2.12	0.34	0.62
Primrose Brook Confluence (Stream B)	8/7/2007	2.44	1.51	0.34	0.44
Primrose Brook Confluence (Stream B)	9/5/2007	2.44	1.52	0.40	0.39
Primrose Brook Confluence (Stream B)	10/2/2007	2.46	1.75	0.39	0.39
Primrose Brook Confluence (Stream B)	5/13/2008	2.21	3.18	0.60	1.84

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A3. Stream stage and discharge data for MORR (continued).

Site	Date	Tapedown from datum (ft)	Total cross section area (sqft)	Average velocity (f/s)	Discharge (cfs)
Primrose Brook Confluence (Stream B)	6/11/2008	2.33	2.71	0.46	1.20
Primrose Brook Confluence (Stream B)	7/16/2008	2.40	1.88	0.29	0.54
Primrose Brook Confluence (Stream B)	8/25/2008	2.46			
Primrose Brook Confluence (Stream B)	9/17/2008	2.46		0.47	
Primrose Brook Confluence (Stream B)	10/8/2008	2.44	1.98	0.29	0.41
Primrose Brook Confluence (Stream B)	5/12/2009	2.20	3.63	0.51	1.68
Primrose Brook Confluence (Stream B)	6/16/2009	2.14	3.30	0.50	1.65
Primrose Brook Confluence (Stream B)	7/28/2009	2.20	2.60	0.34	0.88
Primrose Brook Confluence (Stream B)	8/25/2009	2.28	3.15	0.25	0.79
Primrose Brook Confluence (Stream B)	9/21/2009	2.33	2.63	0.21	0.55
Primrose Brook Confluence (Stream B)	10/14/2009	2.25	3.20	0.15	0.49
Primrose Brook Confluence (Stream B)	5/11/2010	2.08	5.00	0.37	1.84
Primrose Brook Confluence (Stream B)	6/8/2010	2.25	3.42	0.27	0.92
Primrose Brook Confluence (Stream B)	7/20/2010	2.30	3.03	0.21	0.65
Primrose Brook Confluence (Stream B)	8/24/2010	2.33	2.93	0.20	0.57
Primrose Brook Confluence (Stream B)	9/14/2010	2.35	2.65	0.14	0.38
Primrose Brook Confluence (Stream B)	10/11/2010	2.30	2.95	0.13	0.37
Primrose Brook Confluence (Stream B)	5/17/2011	1.98	4.96	1.58	7.86
Primrose Brook Confluence (Stream B)	6/15/2011	2.18	2.96	0.66	1.96
Primrose Brook Confluence (Stream B)	7/12/2011	2.28	3.19	0.28	0.90
Primrose Brook Confluence (Stream B)	8/9/2011	2.35	3.15	0.21	0.67
Primrose Brook Confluence (Stream B)	9/12/2011	2.10	4.37	1.18	5.14
Primrose Brook Confluence (Stream B)	10/18/2011	2.20	3.09	0.52	1.59
West Primrose Brook (Stream C)	6/20/2006		0.90	0.38	0.32
West Primrose Brook (Stream C)	7/25/2006	1.13	0.83	0.30	0.24
West Primrose Brook (Stream C)	8/15/2006	1.17	11.35	0.39	
West Primrose Brook (Stream C)	9/19/2006	1.15	0.63	0.34	0.25
West Primrose Brook (Stream C)	10/17/2006	1.13	0.80	0.33	0.22
West Primrose Brook (Stream C)	4/17/2007	0.77	2.31	1.69	3.90
West Primrose Brook (Stream C)	5/22/2007	1.08	1.11	0.46	0.49
West Primrose Brook (Stream C)	6/12/2007	1.15	0.73	0.33	0.24
West Primrose Brook (Stream C)	7/10/2007	1.17	0.63	0.21	0.13
West Primrose Brook (Stream C)	8/7/2007	1.17	0.37	0.25	0.08
West Primrose Brook (Stream C)	9/5/2007	1.20	0.27	0.35	0.09
West Primrose Brook (Stream C)	10/2/2007	1.21	0.27	0.27	0.07
West Primrose Brook (Stream C)	5/13/2008	1.08	0.81	0.48	0.39
West Primrose Brook (Stream C)	6/11/2008	1.17	0.72	0.37	0.29
West Primrose Brook (Stream C)	7/16/2008	1.21	0.56	0.27	0.14
West Primrose Brook (Stream C)	8/25/2008	1.23			
West Primrose Brook (Stream C)	9/17/2008	1.25		0.07	
West Primrose Brook (Stream C)	10/8/2008	1.21	1.26	0.08	0.08
West Primrose Brook (Stream C)	5/12/2009	1.10	1.25	0.40	0.50
West Primrose Brook (Stream C)	6/16/2009	1.10	1.40	0.30	0.42
West Primrose Brook (Stream C)	7/28/2009	1.16	1.37	0.13	0.17
West Primrose Brook (Stream C)	8/25/2009	0.98	1.52	0.12	0.18
West Primrose Brook (Stream C)	9/21/2009	1.00	0.94	0.14	0.13
West Primrose Brook (Stream C)	10/14/2009		1.04	0.11	0.11
West Primrose Brook (Stream C)	5/11/2010	0.99	1.47	0.35	0.52
West Primrose Brook (Stream C)	6/8/2010	1.02	1.26	0.18	0.23
West Primrose Brook (Stream C)	7/20/2010	1.10	0.80	0.14	0.11
West Primrose Brook (Stream C)	8/24/2010	1.10	0.68	0.14	0.09
West Primrose Brook (Stream C)	9/14/2010	1.12	0.60	0.09	0.06
West Primrose Brook (Stream C)	10/11/2010	1.15	0.61	0.12	0.07

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A3. Stream stage and discharge data for MORR (continued).

Site	Date	Tapedown from datum (ft)	Total cross section area (sqft)	Average velocity (f/s)	Discharge (cfs)
West Primrose Brook (Stream C)	5/17/2011	0.92	1.78	0.99	1.75
West Primrose Brook (Stream C)	6/15/2011	1.08	1.31	0.34	0.44
West Primrose Brook (Stream C)	7/13/2011	1.18	0.98	0.23	0.23
West Primrose Brook (Stream C)	9/12/2011	0.56	1.71	0.75	1.28
West Primrose Brook (Stream C)	10/18/2011	0.65	0.67	0.62	0.41
Indian Grove Brook (Stream D)	6/20/2006	1.40	8.25	0.21	
Indian Grove Brook (Stream D)	7/25/2006	1.60	7.01	0.39	2.48
Indian Grove Brook (Stream D)	8/15/2006	1.64	8.30	0.26	2.20
Indian Grove Brook (Stream D)	9/19/2006	1.59	7.29	0.30	2.08
Indian Grove Brook (Stream D)	4/17/2007	0.92	17.12	0.95	17.33
Indian Grove Brook (Stream D)	5/22/2007	1.45	7.15	0.57	3.40
Indian Grove Brook (Stream D)	6/12/2007	1.54	5.91	0.46	2.37
Indian Grove Brook (Stream D)	7/10/2007	1.71	4.42	0.35	1.26
Indian Grove Brook (Stream D)	8/7/2007	1.65	4.36	0.30	1.10
Indian Grove Brook (Stream D)	9/5/2007	1.73	5.13	0.26	1.06
Indian Grove Brook (Stream D)	10/2/2007	1.51	1.06	0.81	0.77
Indian Grove Brook (Stream D)	5/13/2008	1.42	7.43	0.49	3.70
Indian Grove Brook (Stream D)	6/11/2008	1.58	7.76	0.28	2.14
Indian Grove Brook (Stream D)	7/17/2008	1.67	5.57	0.29	1.42
Indian Grove Brook (Stream D)	7/17/2008	1.67	5.57	0.29	1.42
Indian Grove Brook (Stream D)	8/25/2008	1.83			
Indian Grove Brook (Stream D)	9/17/2008	1.75		0.16	
Indian Grove Brook (Stream D)	10/9/2008	1.75	5.91	0.24	0.97
Indian Grove Brook (Stream D)	5/12/2009	1.38	10.15	0.32	3.22
Indian Grove Brook (Stream D)	6/16/2009	1.52	8.86	0.27	2.35
Indian Grove Brook (Stream D)	7/28/2009	1.58	7.07	0.25	1.76
Indian Grove Brook (Stream D)	8/25/2009		8.28	0.26	1.94
Indian Grove Brook (Stream D)	9/21/2009		9.52	0.22	2.07
Indian Grove Brook (Stream D)	10/14/2009	1.67	9.35	0.12	1.10
Indian Grove Brook (Stream D)	5/11/2010		9.64	0.38	3.71
Indian Grove Brook (Stream D)	6/9/2010		9.22	0.19	1.70
Indian Grove Brook (Stream D)	7/20/2010	1.75	6.28	0.21	1.35
Indian Grove Brook (Stream D)	8/24/2010	1.80	8.29	0.15	1.20
Indian Grove Brook (Stream D)	9/14/2010	1.80	9.16	0.10	0.94
Indian Grove Brook (Stream D)	10/11/2010	1.75	9.09	0.11	1.00
Indian Grove Brook (Stream D)	5/17/2011	1.19	13.32	0.67	8.96
Indian Grove Brook (Stream D)	6/15/2011	1.54	11.80	0.27	3.17
Indian Grove Brook (Stream D)	7/13/2011	1.66	8.50	0.20	1.66
Indian Grove Brook (Stream D)	8/8/2011	1.90	7.28	0.16	1.14
Indian Grove Brook (Stream D)	9/12/2011	1.30	7.38	1.27	9.34
Indian Grove Brook (Stream D)	10/19/2011	1.37	16.19	0.33	5.37
Passaic River (Stream E)	5/23/2006				
Passaic River (Stream E)	7/25/2006	1.34	13.00	0.44	5.59
Passaic River (Stream E)	8/15/2006		11.35	0.41	4.47
Passaic River (Stream E)	4/17/2007	0.71			
Passaic River (Stream E)	5/22/2007	1.23	12.84	0.46	5.86
Passaic River (Stream E)	6/12/2007	1.32	11.69	0.34	3.84
Passaic River (Stream E)	7/10/2007	1.50	10.40	0.31	2.99
Passaic River (Stream E)	8/7/2007	1.52	8.40	0.33	2.15
Passaic River (Stream E)	9/5/2007	1.48	7.86	0.43	2.43
Passaic River (Stream E)	10/2/2007	1.54	7.78	0.40	3.10
Passaic River (Stream E)	5/13/2008	1.17	14.28	0.52	6.61
Passaic River (Stream E)	6/11/2008		10.90	0.43	4.32

Appendix A. Morristown National Historical Park (MORR) Water Monitoring Data, 2006-2011 (continued).

Table A3. Stream stage and discharge data for MORR (continued).

Site	Date	Tapedown from datum (ft)	Total cross section area (sqft)	Average velocity (f/s)	Discharge (cfs)
Passaic River (Stream E)	7/17/2008	1.42	10.80	0.30	2.18
Passaic River (Stream E)	8/25/2008	1.54			
Passaic River (Stream E)	9/17/2008	1.46		0.27	
Passaic River (Stream E)	10/8/2008	1.46	9.82	0.28	1.88
Passaic River (Stream E)	5/12/2009	1.20	11.84	0.46	5.48
Passaic River (Stream E)	6/16/2009	1.20	11.57	0.49	5.63
Passaic River (Stream E)	7/28/2009	1.34	9.23	0.30	2.75
Passaic River (Stream E)	8/25/2009	1.06	10.44	0.42	4.04
Passaic River (Stream E)	9/21/2009		8.28	0.18	1.46
Passaic River (Stream E)	10/14/2009	1.40	9.57	0.21	2.01
Passaic River (Stream E)	5/11/2010	1.08	13.81	0.50	6.05
Passaic River (Stream E)	6/8/2010	1.30	9.82	0.34	3.43
Passaic River (Stream E)	7/20/2010	1.40	9.24	0.37	2.79
Passaic River (Stream E)	8/24/2010	1.30	9.29	0.30	2.72
Passaic River (Stream E)	9/14/2010	1.50	8.36	0.25	1.85
Passaic River (Stream E)	10/11/2010	1.45	8.28	0.25	1.80
Passaic River (Stream E)	6/15/2011	1.20	12.86	0.50	7.14
Passaic River (Stream E)	7/13/2011	1.27	10.55	0.41	3.79
Passaic River (Stream E)	8/8/2011	3.90	9.57	0.34	
Passaic River (Stream E)	9/12/2011	0.00	17.73	0.77	14.83
Passaic River (Stream E)	10/19/2011	0.60	18.44	0.94	17.28

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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