Great Swamp Watershed Association
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Protecting our waters and our land for more than 30 years

Water Quality in the Upper Passaic River

Interim Report, August 2012

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Great Swamp Watershed Association

Beginning in early 2011, GSWA's Stream Team, under its Adopt-a-Stream program[1], initiated a 3-year program of quarterly water-quality monitoring at several sites on the Upper Passaic River and its tributaries. This report documents the results obtained during the first 18 months of this program.

1. Prior Monitoring of the Upper Passaic

From 1999 to 2008, the Ten Towns Great Swamp Watershed Management Committee (TTC) conducted water-quality monitoring of the five major streams in the Great Swamp Watershed. GSWA Stream Team staff and volunteers participated in some phases of that work, which focused on key nitrogen and phosphorus nutrients and total suspended solids. Some additional parameters, including total dissolved solids (TDS), were included in the last two years of the program. Reports prepared by TTC's consultants were issued[2] in 2002, 2007, and 2009. Overall, these studies indicated that the major streams in the less-developed western part of the watershed, Upper Passaic River and Primrose Brook, were significantly less impaired chemically than Great Brook, Loantaka Brook, and Black Brook in the east.

2. GSWA's Current Monitoring Program

To develop a more extensive characterization of the stream's water quality, six sites distributed along the Passaic and its tributaries were selected for monitoring. Four of these sites are located on the main stem of the stream, and two sites are on the tributaries Indian Grave Brook

[1] GSWA's Adopt-a-Stream program is aimed at studying one stream at a time within the Great Swamp Watershed over a three year period to collect baseline data on water quality

[2] TTC (F. X. Browne) 2002, http://www.tentowns.org/10t/docs_etc/wqrep602.pdf
TTC (Princeton Hydro) 2007, http://www.tentowns.org/10t/docs_etc/wqrep307.pdf
TTC (Princeton Hydro) 2009, The Loantaka Brook Watershed Report, pp 79 – 147, http://greatswamp.org/PDFs/Princeton%20Hydro%20Report%202009-07.pdf

and Penn's Brook, both in Somerset County. These monitoring sites and their geographic coordinates are shown in Attachment 1. The sampling and analytical procedures have been modeled on those followed in our 2005–2010 studies[3] of Loantaka Brook and Great Brook, and all monitoring activities are covered under a Quality Assurance Project Plan.

Quarterly samples are submitted for analysis to Environmental Compliance Monitoring, Inc. (ECM) a NJDEP-certified laboratory in Hillsborough, NJ. The concentrations of total dissolved solids (TDS), sodium, chloride, soluble reactive phosphate, total phosphorus, nitrate, nitrite, total Kjeldahl nitrogen and total suspended solids (TSS) are determined.

Supplementing the lab analyses, additional in-stream measurements are made using a portable multi-parameter water quality meter. A Horiba meter is leased for each sampling event and used for taking on-site measurements of water temperature, pH, dissolved oxygen (DO), turbidity, and conductivity.

On each monitoring date, measurements of stream flow volumes are made at several of the sites using the Volunteer Stream Monitoring Partnership protocol.

The samples covered by this report were collected on February 15, May 11, August 4, and November 14, 2011 and on February 13 and May 17, 2012. On the first five occasions, sampling was performed under baseflow conditions, meaning that less than 0.5 inches of precipitation had occurred during the 48 hours prior to each collection. However, during the 48 hours before the 05/17/12 collection greater than 0.5 inches of rain fell, resulting in higher than normal flows, especially at the downstream sites. Stormflow conditions are therefore indicated for the 05/17/12 sampling.

3. Interim Results

The results of the first six quarterly monitoring rounds are summarized in the appended Tables A1 and A2 (laboratory data) and B1 and B2 (on-site measurements). These tables also include applicable values of certain quality standards. The NJ standards developed by NJDEP relevant to the current study are provided for both "trout production" and "non-trout" waters, since as stated in the tables the Upper Passaic subwatershed contains stream segments of both these designations. In addition, more stringent criteria proposed as standards specific to the Upper Passaic[4] by the Ten Towns Great Swamp Watershed Management Committee (TTC) in 2002 are also shown.

Some specific results and inferences which may be drawn from them are as follows.

[3] GSWA 2008, http://www.greatswamp.org/GSWA-ST-NJDEP-LB-Report2008.pdf
GSWA 2011, http://www.greatswamp.org/PDFs/GSWA%20ST%20GreatBrook2010_FINAL.pdf
[4] TTC (F. X. Browne) 2002, http://www.tentowns.org/10t/docs_etc/wqstd602.pdf

3.1 Total Nitrogen

Total nitrogen (TN) was determined by summing the ECM "as N" concentrations of nitrates, nitrites, and total Kjeldahl nitrogen (i.e. organic-N plus ammonia-N). Figure 1 summarizes the total nitrogen values at the various sites, plotted as a function of the sampling date. At the five sites other than PEN1, TN concentrations are seen to mostly be less than 2 mg/l and have rather similar values on a given sampling date. The seasonal variation showing a pronounced low TN level in August is a behavior often seen in our streams, and is sometimes attributed to the warm-weather action of denitrification agents such as bacteria.

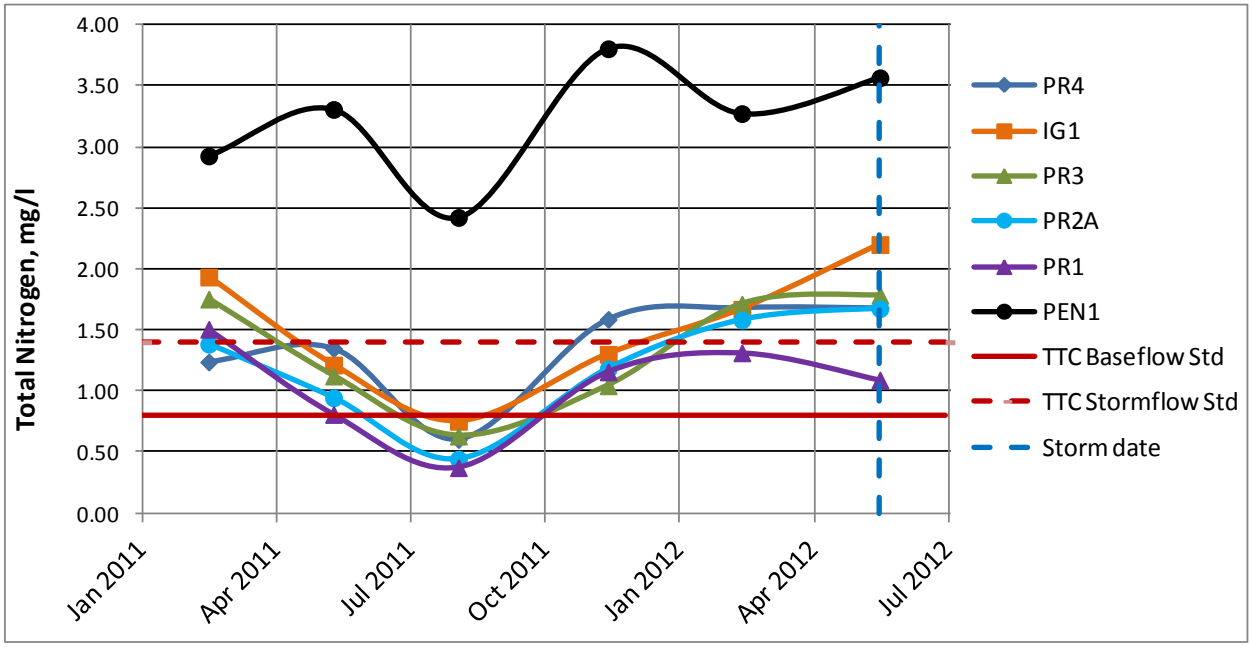


Figure 1. Total Nitrogen, Upper Passaic, 2011 – 2012

However, at PEN1 nitrogen values at all times were significantly higher than at the other sites. This site on Penn's Brook is located in largely urbanized downtown Bernardsville in a wooded area behind the Kings shopping center and a short distance from the high school playing fields. Under normal baseflow conditions it is a feeble trickle of a stream, highly vulnerable to any nutrients or contaminants which might drain into it. During storms, flow increases substantially from road and parking-lot runoff.

The values of total Kjeldahl nitrogen (TKN) listed in Tables A1 and A2 were clearly appreciably higher at most sites on 05/17/12, a stormflow date, than on the other sampling dates. TKN components are known to form on ground surfaces or in shallow soils in wooded watersheds and tend to be flushed into streams during and after storms.

Figure 1 includes indications of the TTC baseflow and stormflow standards, which, except in August 2011, were almost always exceeded. New Jersey has no total-nitrogen standard,

but has a nitrate standard of 10 mg/l maximum based on a human health criterion. Clearly all the Figure 1 data easily satisfy that standard.

3.2 Total Phosphorus

Results for total phosphorus are shown in Figure 2, which also displays the NJ and TTC standards. Phosphorus levels have been consistently low at all sites, including the PEN1 site. It is noteworthy that in no case was either the NJ standard or the TTC stormflow standard for this parameter exceeded, and the TTC baseflow standard was satisfied most of the time. There is again evidence of seasonal variation at some sites, with the lower values being more apparent during winter, in contrast to the nitrogen experience.

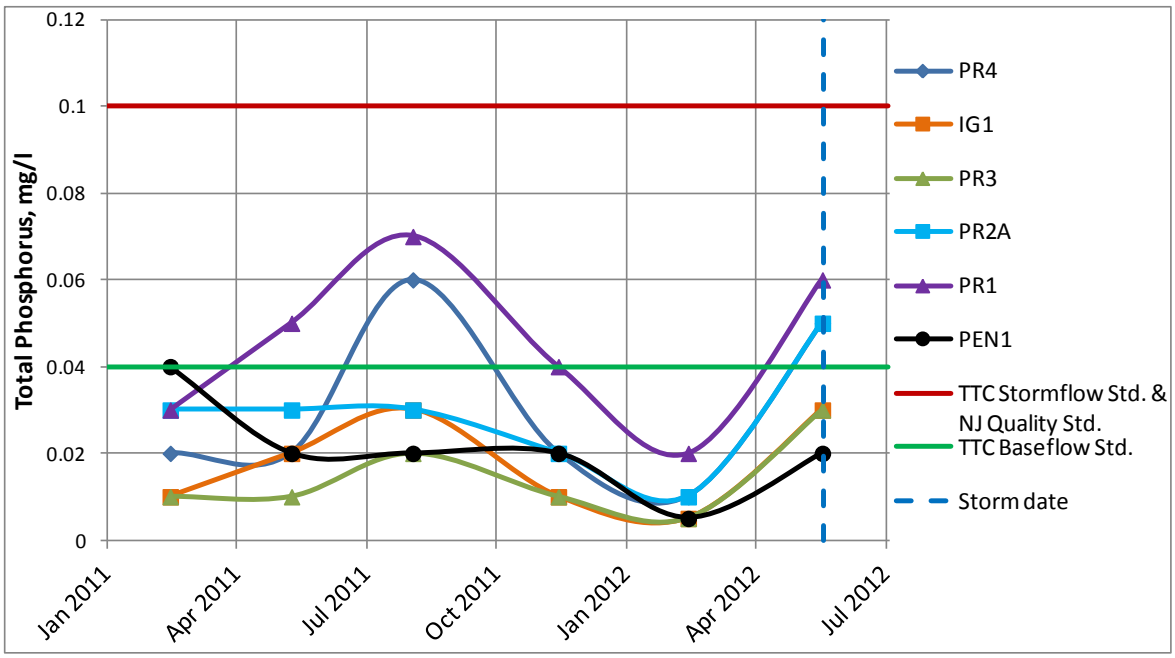


Figure 2. Total Phosphorus, Upper Passaic, 2011 – 2012

3.3 Total Dissolved Solids

Tables A1 and A2 contain the lab results for the concentrations of TDS and two of its principal components, sodium and chloride. These parameters frequently reflect the aftermath of road salt dispersion on local roads and parking lots, with winter surges being followed by prolonged declines as salt retained in local soils slowly leaches into a stream. Figure 3 shows that the highest TDS concentration at each site was seen in February 2011 during deicing season. Subsequently, somewhat lower TDS values were measured, and there was no surge in the milder 2012 winter comparable in magnitude with that of the previous year. TDS at PEN1 was significantly higher than at the other sites, as expected from the stream's proximity to roads and parking lots and its low volume of natural receiving

water. The NJ TDS standard was exceeded at PEN1 in four of the six quarters. There is no TTC standard for TDS, sodium or chloride.

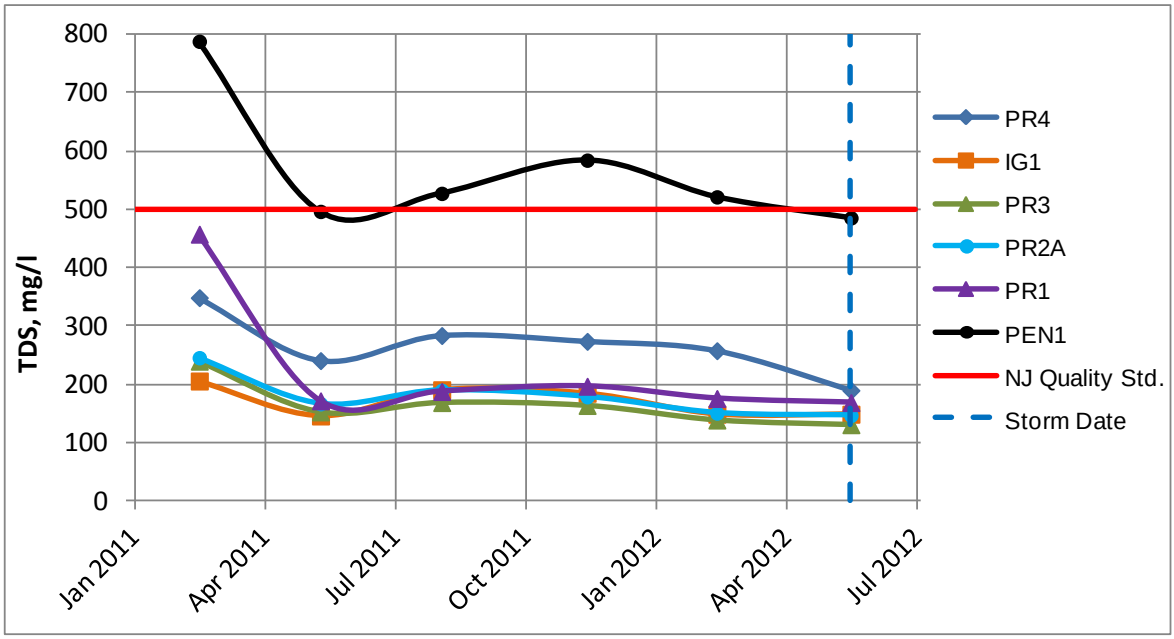


Figure 3. Total Dissolved Solids, Upper Passaic, 2011 – 2012

The sodium and chloride patterns generally reflected the TDS behavior, but showed small increases in February 2012, most notably at the low-flow sites PR4 and PEN1 which are especially vulnerable to road salt contamination. There were two exceedances of the NJ chloride chronic toxicity standard at PEN1, in Feb 2011 and Feb 2012. As indicated in the final column of the A1 and A2 tables, the combined sodium and chloride percentage of TDS was highest in February 2011, with a more modest increase in February 2012. This percentage indicates the influence of road salt on TDS values, with higher percentages signifying higher input from road salt. The February 2012 increases in sodium and chloride were not accompanied by corresponding increases in TDS, implying that one or more other TDS components had decreased. Lower-than-normal levels of such components, for instance calcium, magnesium, and carbonate, are sometimes seen in winter monitoring, including measurements of the Upper Passaic at PR4 made by the USGS in 2001 – 2002.[5]

Inspection of the TDS levels measured at the main stem sites in upstream-to-downstream order shows relatively high values at the upstream PR4 site where the low-volume Passaic is vulnerable to runoff from Mendham roads. The stream then passes for several miles through extensive tracts of undeveloped land where the cleaner water draining into it provides dilution and leads to much lower TDS numbers. For this reason the Upper Passaic in the vicinity of the next site, PR3, probably is one of the least-contaminated reaches in the watershed's five major streams. Subsequently, after flowing past busier highways and

[5] USGS 2003, Water-Data Report NJ-02-3, pp82-84, http://pubs.usgs.gov/wdr/WDR-NJ-02-3/pdf/wdr02-3.pdf

developed parts of Basking Ridge, there is a slight rise in TDS as the higher-volume stream receives more contaminated runoff.

The Indian Grave Brook tributary measured at the IG1 site also contains a low level of TDS content, closely comparable to that of the PR3 site.

3.4 Other Parameters

No exceedance of the NJ or TTC stormflow standards for total suspended solids was seen at any of the sites, but there were several failures to meet the much more stringent TTC baseflow standard. With regard to the on-site meter measurements, a high water temperature of 23.8 ^{o}C was seen at PR4 on 08/04/11, exceeding the trout-production NJ standard of 22 ^{o}C. On three occasions, pH failed to meet the NJ standard; all measurements of dissolved oxygen and turbidity satisfied the standards.

4.0 Future Monitoring Plans

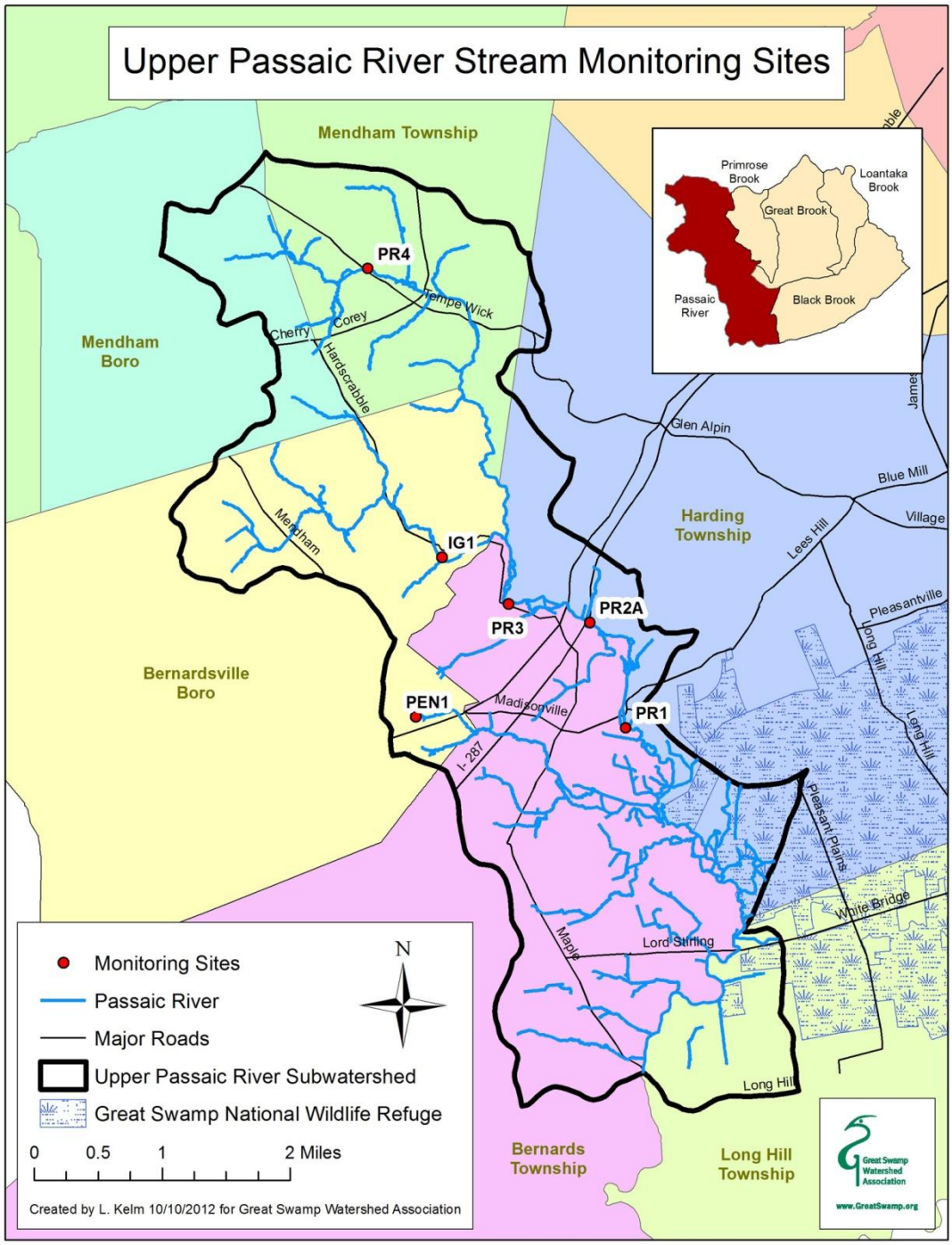
GSWA intends to continue the quarterly monitoring of Upper Passaic through 2013. It is planned to include an additional sampling site, at the point near Millington where the river leaves the Great Swamp watershed, for the remainder of the 3-year study. This will enable us to develop more information regarding the overall quality of the water flowing downstream from our watershed. As was done in our earlier Adopt-a-Stream monitoring, we expect to review the range of monitored parameters and sampling sites from time to time, and will make changes in the program if it appears useful in expanding our knowledge of the river's health.

Acknowledgements

This study was initiated by Kelley Curran, GSWA's former Director of Water Quality Programs. The work completed under the Adopt-a-Stream program in 2011 was made possible through a grant from The Watershed Institute. Thanks are due to the following Stream Team volunteers and GSWA staff members for their enthusiastic participation in this work: Joe Balwierczak, Wesley Boyce, Mike Duffy, Gene Fox, Chuck Gullage, Charlotte Henderson, Tatiana Ivanova, Bill Marshall, Sally Rubin, and Ben Wolkowitz.

Questions or comments relating to this report may be directed to Laura Kelm, Director of Water Quality Programs for the Great Swamp Watershed Association at lkelm@greatswamp.org or 973-538-3500, extension 16.

Attachment 1



Site	Location	Latitude	Longitude
PR4	Off Tempe Wick Rd. above Ledells Pond	40 ^{o} 46' 18.9" N	74 ^{o} 34' 11.0" W
IG1	Indian Grave Brook below Chestnut Ave. bridge	40 ^{o} 44' 20.5" N	74 ^{o} 33' 30.7" W
PR3	Off Hardscrabble Rd. opposite Butternut Lane	40 ^{o} 44' 01.6" N	74 ^{o} 32' 57.1" W
PR2A	Above I-287 bridge near Olde Mill Inn	40 ^{o} 43' 56.7" N	74 ^{o} 32' 20.1" W
PR1	Off Madisonville Rd. below Osborn Pond	40 ^{o} 43' 14.7" N	74 ^{o} 31' 55.2" W
PEN1	Penn's Brook near Bernards High School	40 ^{o} 43' 14.7" N	74 ^{o} 33' 39.6" W

Table A1. Lab Results: Nutrients, TSS, TDS, Na^+ & Cl^-, Passaic River Upper Headwaters, 2011- 2012

Sampling Site	Sampling Date	Flow Volume[1] cf/s	Water Temp. ^{0}C	Results of Lab Analysis[2], concentrations in milligrams/liter: Total Kjeldahl Nitrogen "as N"	Nitrate "as N"	Nitrite "as N"	Total Nitrogen "as N"	Soluble Reactive Phosphate "as P"	Total Phosphorus "as P"	Total Suspended Solids	Total Dissolved Solids	Major TDS Components: Sodium	Chloride	Sum of $Na^+ + Cl^-$ Percent of TDS
PR4	02/15/11	6.0	2.0	0.23	**1.0**	0.008	**1.24**	0.008	0.02	3	349	73.2	141	61.4%
Tempe	05/11/11	4.2	17.2	0.37	**0.97**	0.008	**1.35**	0.005	0.02	**6**	241	22.3	60.7	34.4%
Wick Rd.	08/04/11	3.0	**23.8**	0.19	**0.41**	0.003	0.60	0.002	**0.06**	**8**	284	20.2	68.7	31.3%
	11/14/11		9.6	0.28	**1.3**	0.007	**1.59**	0.005	0.02	4	274	20.3	65	31.1%
	02/13/12		2.2	0.28	**1.4**	0.003	**1.68**	0.006	0.01	ND <3	258	29.6	90	46.4%
(Stormflow)	05/17/12		19.7	0.84	**0.83**	0.010	**1.68**	0.009	0.05	5	190	12.9	32	23.6%
IG1	02/15/11	3.6	3.8	0.13	**1.8**	0.004	**1.93**	0.006	0.01	ND <2	206	36.1	70.2	51.6%
Indian Grave	05/11/11	5.5	13.7	0.24	**0.97**	0.003	**1.21**	0.006	0.02	**6**	146	16.2	37.5	36.8%
Brook	08/04/11	2.8	21.6	0.12	**0.63**	0.002	0.75	0.018	0.03	ND <3	191	15.9	47.1	33.0%
(tributary)	11/14/11	6.0	11.2	0.20	**1.1**	0.001	**1.30**	ND <0.002	0.01	3	185	15.9	41	30.8%
Chestnut Ave.	02/13/12	5.6	4.3	0.17	**1.5**	ND <0.001	**1.67**	0.003	ND <0.01	ND <3	149	14.2	43	38.4%
(Stormflow)	05/17/12	4.4	16.8	**1.20**	**1.0**	0.002	**2.20**	0.009	0.03	4	149	12.6	27	26.6%
PR3	02/15/11	15.9	2.4	0.25	**1.5**	0.003	**1.75**	0.008	0.01	ND <2	240	40.0	80.8	50.3%
nr Butternut	05/11/11		15.8	**0.41**	**0.71**	0.003	**1.12**	0.006	0.01	ND <2	153	15.3	36.6	33.9%
Road	08/04/11		21.3	0.12	**0.49**	0.021	0.63	0.011	0.02	ND <3	169	14.3	40.8	32.6%
	11/14/11	13.5	9.2	0.23	**0.81**	0.003	**1.04**	0.003	0.01	3	164	15.0	41	34.1%
	02/13/12	31.7	3.7	0.21	**1.5**	0.002	**1.71**	0.003	ND <0.01	ND <3	139	14.1	41	39.6%
(Stormflow)	05/17/12		16.8	0.93	**0.85**	0.004	**1.78**	0.009	0.03	4	131	10.8	25.0	27.3%

NJ Quality Standards	TP waters[3]	22 ^{o}C			10.0				0.1	25	500			230 (chronic toxicity)
(mg/l except for Temp.)	NT waters[3]	31 ^{o}C			10.0				0.1	40	500			230 (chronic toxicity)
Ten Towns Upper	Base			0.4	0.4		0.8	0.02	0.04	4.0				
Passaic Stds. (mg/l)	Storm			1.0	0.4		1.4	0.02	0.1	25				

Millington Flow	02/15/11	108
(USGS)	05/11/11	55
cf/s	08/04/11	14
	11/14/11	64
	02/13/12	52
(Stormflow)	05/17/12	160

1. Flow volume was estimated using float travel time & stream cross-section (Volunteer Stream Monitoring Partnership method).. On 05/17/12 stormflow conditions resulted from significant rainfall in the region during the 48 hours preceding the sampling.
2. Samples were analysed by Environmental Compliance Monitoring, Inc., Hillsborough, NJ.
3. The upstream waters of the Passaic subwatershed, containing the sites PR2A, PR3, IG1 and PR4, are classified by NJDEP as "trout production" (TP) waters. Those downstream from Osborn Pond (containing PEN1 and PR1) are classified "non-trout" (NT).

Red entries indicate failure to meet the applicable NJ Surface Water Quality Standard.

Green entries indicate failure to meet the applicable Ten Towns Upper Passaic River Quality Standard.

Table A2. Lab Results: Nutrients, TSS, TDS, Na^+ & Cl^-, Passaic River Lower Headwaters, 2011- 2012

Sampling Site	Sampling Date	Flow Volume[1] cf/s	Water Temp. ^{0}C	Results of Lab Analysis[2], Concentrations in milligrams/liter: Total Kjeldahl Nitrogen "as N"	Nitrate "as N"	Nitrite "as N"	Total Nitrogen "as N"	Soluble Reactive Phosphate "as P"	Total Phosphorus "as P"	Total Suspended Solids	Total Dissolved Solids	Major TDS Components: Sodium	Chloride	Sum of $Na^+ + Cl^-$ Percent of TDS
PR2A	02/15/11		2.0	0.08	**1.3**	0.004	**1.38**	0.006	0.03	ND <2	246	42.7	86.5	52.5%
nr Olde	05/11/11	21.0	15.8	0.26	**0.68**	0.004	**0.94**	0.008	0.03	ND <2	167	16.3	38.4	32.8%
Mill Inn	08/04/11		21.3	0.12	0.32	0.002	0.44	0.010	0.03	ND <3	190	14.6	40.8	29.2%
	11/14/11		8.8	0.23	**0.95**	0.002	**1.18**	0.014	0.02	ND <3	179	15.7	41	31.7%
	02/13/12		3.3	0.28	**1.3**	0.002	**1.58**	0.005	0.01	ND <3	151	15.0	45	39.7%
(Stormflow)	05/17/12	25.8	16.7	0.84	**0.83**	0.005	**1.68**	0.007	0.05	7	147	12.4	26	26.1%
PR1	02/15/11		1.6	0.40	**1.1**	0.006	**1.51**	0.005	0.03	4	458	117	202	69.7%
Madisonville	05/11/11		16.0	**0.41**	0.39	0.008	**0.81**	0.006	**0.05**	**9**	172	20.3	43.7	37.2%
Road	08/04/11	30.9	23.3	0.24	0.13	0.002	0.37	0.020	**0.07**	ND <3	188	17.7	48.6	35.3%
	11/14/11	29.0	8.1	0.34	**0.81**	0.007	**1.16**	0.017	0.04	**11**	197	20.5	49	35.3%
	02/13/12	18.7	2.1	0.21	**1.1**	0.003	**1.31**	0.006	0.02	ND <3	176	20.4	56	43.4%
(Stormflow)	05/17/12	30.3	17.8	0.23	**0.85**	0.010	1.09	0.015	0.06	10	169	19.1	38	33.8%
PEN1	02/15/11		3.5	0.22	**2.7**	0.006	**2.93**	0.009	0.04	**15**	**789**	217	**370**	74.4%
Penn's Brook	05/11/11		16.7	0.32	**3.0**	0.007	**3.31**	0.010	0.02	ND <2	497	82.1	156	47.9%
(tributary)	08/04/11		20.7	0.12	**2.3**	0.002	**2.42**	0.006	0.02	ND <3	**528**	80.9	188	50.9%
nr Bernards	11/14/11		12.9	0.20	**3.6**	0.004	**3.80**	0.002	0.02	**5**	**585**	78.6	198	47.3%
High School	02/13/12		6.6	0.17	**3.1**	0.003	**3.27**	0.002	ND <0.01	ND <3	**522**	94.7	**260**	68.0%
(Stormflow)	05/17/12		15.1	0.76	**2.8**	0.006	**3.57**	0.006	0.02	ND <3	486	65.7	146	43.6%
NJ Quality Standards	TP waters[3]	22 ^{o}C			10.0				0.1	25	500			230 (chronic toxicity)
(mg/l except for Temp.)	NT waters[3]	31 ^{o}C			10.0				0.1	40	500			230 (chronic toxicity)
Ten Towns Upper	Base			0.4	0.4		0.8	0.02	0.04	4.0				
Passaic Stds. (mg/l)	Storm			1.0	0.4		1.4	0.02	0.1	25				

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Table B1. On-site Measurements: Flow and Meter Measurements, Passaic River Upper Headwaters, 2011 - 2012

Sampling Site	Sampling Date	Flow Volume[1]	Water Temperature	Conductivity	pH	Dissolved Oxygen		Turbidity
						DO meas.	Approx. %	
		cf/s	^{0} C	µS/cm		mg/l	of Saturation	NTU
PR4	02/15/11	6.0	2.0	598	6.86	12.39	90.5%	7
Tempe	05/11/11	4.2	17.2	355	7.70	11.23	117.0%	0
Wick Rd.	08/04/11	3.0	**23.8**	415		9.3	110.7%	3.8
	11/14/11		9.6	453	6.61	10.9	93.8%	0.5
	02/13/12		2.2	435	7.23	13.71	100.7%	
(Stormflow)	05/17/12		19.7	217	7.33	8.77	92.8%	5.9
IG1	02/15/11	3.6	3.8	354	6.84	12.21	93.6%	0
Indian Grave	05/11/11	5.5	13.7	224	6.64	11.02	107.0%	0
Brook (irib.)	08/04/11	2.8	21.6	281		8.21	93.3%	0.4
Chestnut Ave.	11/14/11	6.0	11.9	292	**6.23**	11.5	104.7%	0.0
	02/13/12	5.6	4.3	232	7.37	13.48	104.7%	
(Stormflow)	05/17/12	4.4	16.8	157	7.33	10.62	106.2%	0.8
PR3	02/15/11	15.9	2.4	414	6.93	11.65	86.0%	0
nr Butternut	05/11/11		15.8	218	6.65	10.88	109.9%	0
Road	08/04/11		21.3	258		11.40	129.5%	0.2
	11/14/11	13.5	9.2	277	7.52	13.65	116.7%	0.8
	02/13/12	31.7	3.7	232	7.39	14.09	107.7%	
(Stormflow)	05/17/12		16.8	140	7.43	11.15	111.5%	0.3
NJ Quality Standards		TP waters[2]	22 ^{o}C		6.5 to 8.5	4.0 mg/l		50 NTU
		NT waters[2]	31 ^{o}C		6.5 to 8.5	7.0 mg/l		50 NTU

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Sampling Site	Sampling Date	Flow Volume[1]	Water Temperature	Conductivity	pH	Dissolved Oxygen		Turbidity
						DO meas.	Approx. %	
		cf/s	^{0} C	µS/cm		mg/l	of Saturation	NTU
PR2A nr Olde Mill Inn	02/15/11		2.0	437	6.82	10.50	76.7%	4
	05/11/11	21.0	15.83	229	7.26	11.36	114.7%	0
	08/04/11		21.29	265		9.24	105.0%	0.8
	11/14/11		8.8	292	7.09	12.88	109.2%	1.1
	02/13/12		3.3	244	6.82	14.11	106.8%	
(Stormflow)	05/17/12	25.8	16.7	164	7.56	9.89	98.9%	1.4
PR1 Madisonville. Road	02/15/11		1.6	852	6.73	10.60	76.6%	11
	05/11/11		16.0	249	7.53	12.42	126.7%	1
	08/04/11	30.9	23.30	294		6.60	77.6%	0.9
	11/14/11	29.0	8.1	324	6.56	10.01	83.4%	5.8
	02/13/12	18.7	2.1	304	6.89	13.40	98.2%	
(Stormflow)	05/17/12	30.3	17.8	221	7.53	9.90	101.0%	1.6
PEN1 Penn's Brook (tributary) nr Bernards High School	02/15/11		3.5	1540	**6.30**	12.50	95.1%	29
	05/11/11		16.7	726	6.90	10.02	103.3%	0
	08/04/11		20.68	758		6.85	77.0%	6.6
	11/14/11		12.9	901	**6.24**	5.51	51.2%	1.9
	02/13/12		6.6	872	6.61	12.47	102.7%	
(Stormflow)	05/17/12		15.1	678	6.99	8.66	83.3%	0.0
NJ Quality Standards		TP waters[2]	22 ^{o}C		6.5 to 8.5	4.0 mg/l		50 NTU
		NT waters[2]	31 ^{o}C		6.5 to 8.5	7.0 mg/l		50 NTU

Millington Flow (USGS)	02/15/11	108
	05/11/11	55
	08/04/11	14
	11/14/11	64
	02/13/12	52
(Stormflow)	05/17/12	160

1. Flow volume was estimated using float travel time & stream cross-section (Volunteer Stream Monitoring Partnership method). On 05/17/12 stormflow conditions.resulted from significant rainfall in the region during the 48 hours preceding the sampling.
2. The upstream waters of the Passaic subwatershed, containing the sites PR2A, PR3, IG1 and PR4, are classified by NJDEP as "trout production" (TP) waters. Those downstream from Osborn Pond (containing PEN1 and PR1) are classified "non-trout" (NT).

Red entries indicate failure to meet the applicable NJ Surface Water Quality Standard.