


# Brandywine Creek

*State of the Watershed*

# REPORT



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Cover Photo: Brandywine Creek,  
near Smith's Bridge  
Photo Location: 39.834298° -75.576689°  
Photo by Rod Hampton

# The State of the Brandywine Creek Watershed

## The Watershed

The Brandywine Creek watershed is part of the larger Christina Basin, which flows into the Delaware River. While most of the 325 square mile Brandywine Creek watershed lies in Pennsylvania, the mouth of creek is located in Delaware. The area is known for its historic significance, as the location of the Revolutionary War's Battle of the Brandywine and as the birthplace of the DuPont Company.

The Brandywine is also noted for its beauty, especially from a canoe. Many private and public park areas protect the rolling hills of the Delaware piedmont adjacent to the stream. All of the Technical Monitoring sites are located in these park areas and are second or third order streams.

## The Monitoring Sites

Technical Monitoring Volunteers monitor seven locations along the Brandywine Creek and its tributaries in Delaware.

Sites #1 and #2 are the only monitoring locations on the main stem of the Brandywine Creek. Site #1 is adjacent to the Brandywine Zoo, where the creek is broad and rocky and framed by moderate tree cover. Similarly, site #2 is a moderately wooded location near the Hagley Museum. The remaining monitoring locations are on tributaries of the Brandywine Creek. Site #3 is on Husbands Run at the DuPont Country Club. This site is on the manicured grounds of a golf course with few trees.

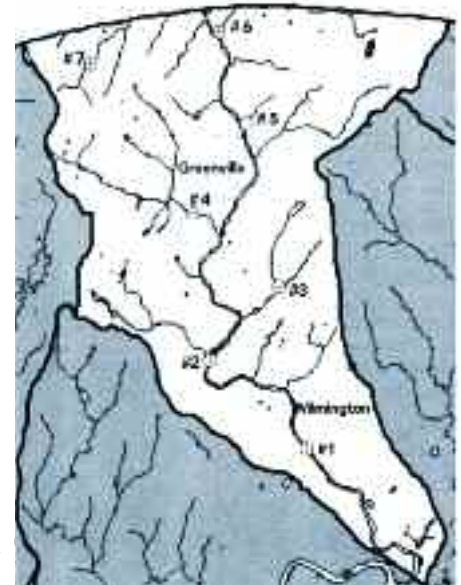
Site #4 is on Wilson Run at the main entrance to Brandywine Creek State Park. Open meadow areas with a few scattered trees characterize this location. Brandywine Creek sites #5 and #6 are in heavily used recreational areas. Site #5 is on Rocky Run in Brandywine Creek State Park. This site is accessible through the Thompson's

Bridge entrance and is frequented by cyclists and hikers. A new pedestrian bridge was installed over Rocky Run as part of the East Link of the Northern Delaware Greenway trail.

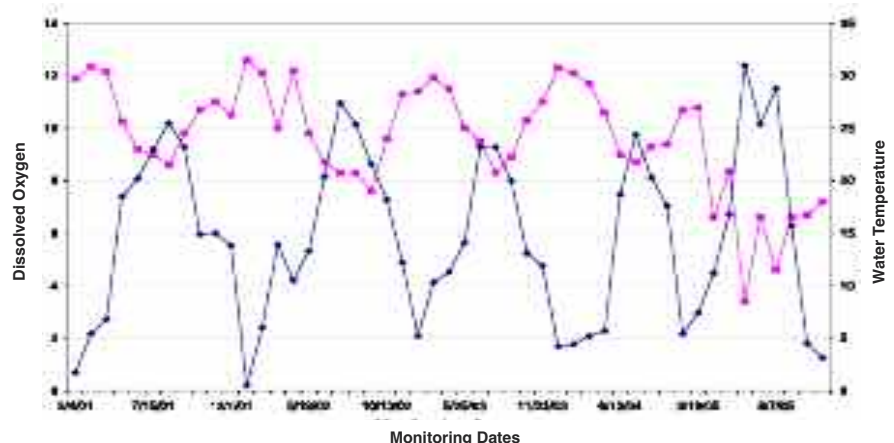
Site #6 is on Beaver Run below Creek Road. This area is wooded parkland managed by the Woodlawn Trustees. The proximity of this site to Brandywine Creek makes this location very popular for day use.

Site #7 is on Meadow Brook in the Flint Woods Preserve, which is owned and managed by the Delaware Nature Society. This location is densely wooded, old growth forest and receives very little human traffic, as the area is only accessible to small groups during special programs offered by the Society.

- #7 FLINT WOODS
- #6 BEAVER RUN
- #5 ROCKY RUN
- #4 WILSON RUN
- #3 HUSBANDS RUN
- #2 HAGLEY MUSEUM
- #1 BRANDYWINE ZOO



**Figure 1.** Dissolved oxygen and water temperature at Hagley Museum (Jan. 2001 to Dec. 2005)



## Brandywine Creek Watershed

### Dissolved Oxygen - DO (see Figure 1)

The DO standards set by the State of Delaware are a minimum of 4.0 mg/L and a seasonal average of greater than 5.5 mg/L in the months June to September. Based on data collected through the Technical Monitoring program, the minimum state standards of DO were met at all sampling sites on the Brandywine Creek from 2001 to 2005 except for one time each at Brandywine Zoo (3.8 mg/L on 7/31/05), Hagley Museum (3.4 mg/L on 6/26/05), and Husband's Run (3.8 mg/L on 7/17/02) (Table 1). Average DO levels at the monitoring sites were between 6.8 mg/l and 13.4 mg/l during summer months. The inverse relationship of dissolved oxygen and water temperature is clearly illustrated by data collected year round at Hagley Museum on the main stem of Brandywine Creek (Figure 1).

Site lows for DO ranged from 3.4 mg/L (Hagley Museum) to 7.9 mg/L (Beaver Run). It is important to note that samples were taken during the day for the safety of our volunteers and do not reflect the lowest DO values possible at the sites. Site highs for DO ranged from 8.4 mg/L (Husband's Run) to 18.5 mg/L (Flint Woods).

### pH (see Figure 2)

Site lows for pH ranged from 6.5 (Flint Woods) to 7.5 (Brandywine Zoo) (Table 1). Site highs for pH ranged from 7.5 (Flint Woods) to 9 (Brandywine Zoo, Hagley Museum, Husbands Run).

The average levels of pH in the Brandywine Creek fell within the standard range of 6.5 to 8.5 and do not vary drastically over time because of the buffering effect of alkaline ions in the water.

### Alkalinity

The State standard for alkalinity was met at each of the Brandywine Creek sites (Table 1). Site lows for alkalinity ranged from 20 mg/L (Flint Woods) to 43 mg/L (Beaver Run). Site highs for alkalinity ranged from 59 mg/L (Flint Woods) to 151 mg/L (Beaver Run).

Tributary sites tend to have lower values of alkalinity because their watersheds are smaller, decreasing the opportunity for ions to become dissolved in the water. As part of a larger watershed, sites on the main stem of the Brandywine Creek receive the combined input of several tributaries and therefore tend to have higher values of alkalinity.

### Nitrate-Nitrogen

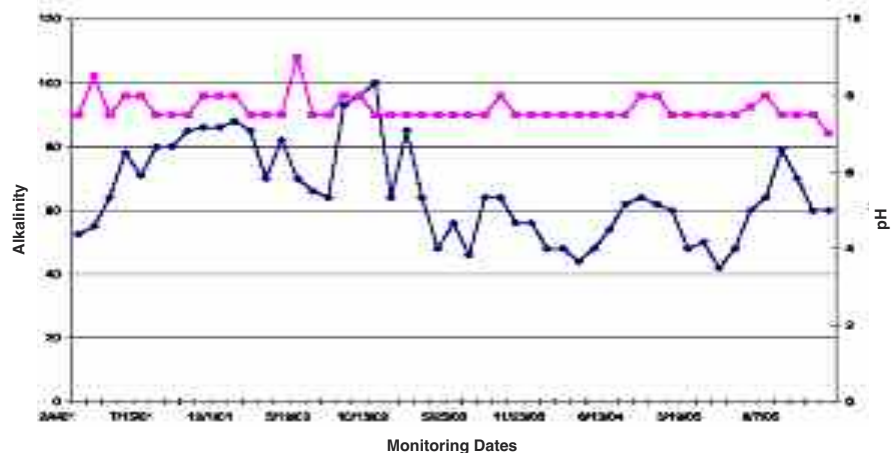
The target level for total nitrogen (all forms of nitrogen combined) in Delaware freshwater is 1.0 to 3.0 mg/L. Our data indicate that this target is probably being exceeded at most of the sites, at least intermittently, as the maximum nitrate-nitrogen values equal or exceed the upper limit of the desired range (Table 1). These maximums do not reflect single events but are reached multiple times (Table 2). Only Wilson Run and Rocky Run have maximums below the target range (Table 2).

Site lows for nitrate-nitrogen ranged from 0.0 mg/L (Beaver Run, Flint Woods) to 0.25 mg/L (Brandywine Zoo, Hagley Museum, Husbands Run, Wilson Run, Rocky Run). Site highs for nitrate-nitrogen ranged from 2.0 mg/L (Wilson Run, Rocky Run) to 5 mg/L (Flint Woods). This high nitrate-nitrogen value at Flint Woods could be an anomaly. A value of 5 mg/L was only measured once on 8/25/02; the next highest value is 3 mg/L and the average is 1.63 mg/L.

### Conductivity (see Figure 3)

The average conductivity values in the Brandywine Creek watershed fell within the typical range of piedmont streams (Table 1). Site lows for conductivity ranged from 60 mS (Hagley Museum) to 231 mS (Beaver Run). Site highs for conductivity ranged from 260 mS (Wilson Run) to 2940 mS (Rocky Run). Uncharacteristically high conductivity was measured at Rocky Run in January 2001, December 2002, January and February 2003, and January 2005, likely as the result of the addition of salt to remove ice on the pedestrian bridge located at this site (Figure 3). Although there is runoff associated with parking lots off of Rte.202, these are located much further up in the watershed and probably do not contribute to the conductivity at this site.

Figure 2. Alkalinity and pH at Rocky Run (Jan. 2001 to Dec. 2005)



The presence of ice in the stream was recorded on all of these dates. Because the pH and alkalinity of the water was not affected, these short-term changes in conductivity most likely did not harm aquatic wildlife.

### Phosphate

Orthophosphate was added as parameter in the Delaware Nature Society's Technical Monitoring program in the spring of 2002. Although there is not a full 5 years of data, there is enough to begin to see trends. The Delaware target range for phosphate is 0.3 to 0.6 mg/L. The average phosphate values at all sites were below the lower end of the target range. The minimum phosphate value was 0.00 mg/L for all sites. The maximum values ranged from 0.2 mg/L (Rocky Run, Beaver Run, Flint Woods) to 0.6 mg/L (Brandywine Zoo, Hagley Museum).

### Conclusions on the Water Quality of the Brandywine Creek Watershed in Delaware

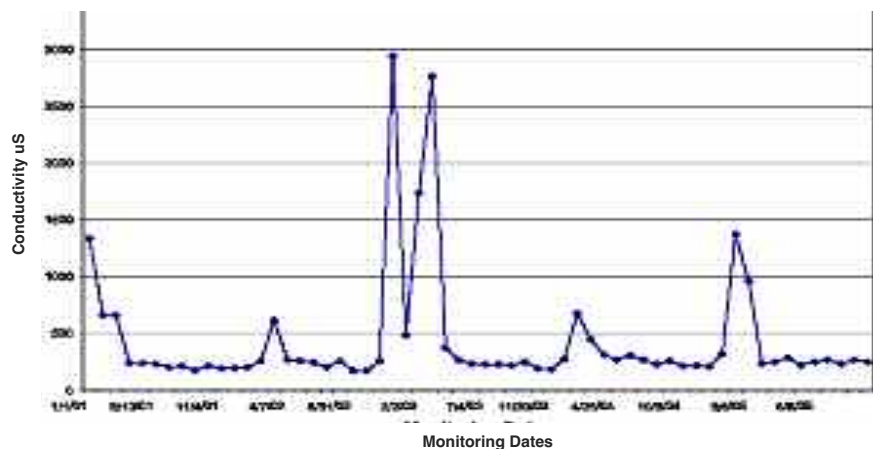
Results indicate that the suggested levels for total nitrogen are being exceeded in the main stem and all tributaries of the Brandywine Creek except Rocky Run and Wilson Run, as the maximum level of nitrate-nitrogen was repeatedly exceeding the recommended upper limit. With the addition of phosphate data, the nitrate levels are seen in a different context. Since both phosphate and nitrate are needed for growth, a high level of one without a high level of the other will not produce the algae blooms that are the cause for concern. Phosphate is a limiting factor in this system as it is present in very low levels. The relatively high levels of nitrate present will not cause the problems associated with nutrient loading without higher levels of phosphate available. The maximum nitrate-nitrogen levels recorded for this time period were lower than for the previous time period (1995-2000) and none of the average levels were over limit, but the decrease is modest. The nitrate-nitrogen data will need to be followed over a longer time period to see if this is a statistical trend.



While the data collected through this program indicate that dissolved oxygen values in the watershed generally meet state standards during the day, the standard minimum was not met in the mainstem and one of the tributaries (Husbands Run). During the summer months the mainstem is not always reaching minimum levels during the daylight hours, which is when oxygen levels are at their highest. This suggests that oxygen may fall to deadly levels for several hours each day, if not for the entire day. This is enough time to diminish the diversity of organisms that can live in a given waterway and potentially cause fish kills.

All other parameters measured through the Technical Monitoring program were within the standard ranges established by the Delaware Department of Natural Resources and Environmental Control.

Figure 3. Conductivity at Rocky Run (Jan. 2001 to Dec. 2005)



◆ Conductivity (uS)

Monitoring Dates

**Table 1.** Summary of data collected Jan. 2001 - Dec. 2005 at monitoring sites on the Brandywine Creek and its tributaries.**SITE #1 - BRANDYWINE ZOO**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	3.5	1	3.8	7.5	42	0.25	63	0
maximum	33.5	27.7	9.5	9	114	4	378	0.6
average	18.4	15.0	7.56	7.6	68.9	1.94	265	0.2
median	18.25	15.45	8.7	7.5	66	2	260	0.22
# of samples	49	50	17	49	50	50	50	37

**SITE #2 - HAGLEY MUSEUM**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	3.3	0.5	3.4	7	42	0.25	61	0
maximum	31.5	31	9.8	9	100	4	395	0.6
average	19.03	14.68	8.11	7.66	65.83	2.07	264	0.235
median	18.50	14.10	8.70	7.50	64	2	265	0.20
# of samples	47	49	19	49	49	48	49	37

**SITE #3 - HUSBANDS RUN**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	5	6	3.8	7	39	0.25	150	0
maximum	27	23.5	8.4	9	82	4	460	0.53
average	19.82	17.12	6.8	7.17	58.04	1.75	288	0.21
median	21	17.50	7.1	7	61	2	290	0.20
# of samples	23	17	10	23	23	23	22	12

**SITE #4 - WILSON RUN**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	5	4	7.1	7	23	0.25	120	0
maximum	30	25	8.7	8	72	2	260	0.58
average	20.84	17.41	7.98	7.10	41.41	1.01	195	0.17
median	22	18	8.05	7	41	1	190	0.18
# of samples	23	19	7	23	23	23	22	12

**SITE #5 - ROCKY RUN**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	0.00	0.40	7.7	7	34	0.25	169.90	0.00
maximum	29.00	23.60	9.8	8	66	2	2940.00	0.20
average	16.38	12.23	8.74	7.34	49.19	0.56	436	0.02
median	17	12.30	8.75	7.50	48	0.50	252	0.00
# of samples	60	57	20	60	59	60	60	43

**SITE #6 - BEAVER RUN**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-1	0.8	7.9	7	43	0	231	0
maximum	29	23.2	9.8	8	151	3	1185	0.2
average	15.69	12.02	8.92	7.48	67.53	1.30	388	0.02
median	16.75	12.70	9.10	7.50	66.00	1.00	330	0.00
# of samples	60	59	20	60	60	60	60	45

**SITE #7 - FLINT WOODS**

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-2.5	1	6.9	6.5	20	0	143.2	0
maximum	27	23	18.5	7.5	59	5	314	0.2
average	14.68	12.75	13.40	7.06	35.07	1.63	231	0.07
median	16.90	12.40	8.20	7	34.50	2	225	0.08
# of samples	44	42	15	44	44	42	44	34

\*Average, median, and # of samples for Dissolved Oxygen data are for the months of June through September only.

**Table 2.** Summary of site-by-site compliance with Delaware standards and recommendations

	Dissolved Oxygen	pH (SU)	Alkalinity	Nitrate-Nitrogen	Conductivity	Phosphate
<b>State standard or guidelines</b>	>4.0 mg/L and a seasonal average >5.5 mg/L	6.5 to 8.5	>20 mg/L	Target level: Total nitrogen 1.0 to 3.0 mg/L	Typical range for Delaware piedmont streams: 120 to 400 µS Seawater: 17,500 µS	Target level: 0.3 to 0.6 mg/L
<b>Brandywine Zoo</b>	Average seasonal standard met; Single sample not meeting minimum standard*	Standards met	Standards met	17% of samples ≥3.0 mg/L of nitrate-nitrogen**	Results within typical range	Results below minimum target level
<b>Hagley Museum</b>	Average seasonal standard met; Single sample not meeting minimum standard*	Standards met	Standards met	17% of samples ≥3.0 mg/L of nitrate-nitrogen**	Results within typical range	Results below minimum target level
<b>Husbands Run</b>	Average seasonal standard met; Single sample not meeting minimum standard*	Standards met	Standards met	0% of samples ≥3.0 mg/L of nitrate-nitrogen**	Single result above range	Results below minimum target level
<b>Wilson Run</b>	Standards met*	Standards met	Standards met	0% of samples ≥3.0 mg/L of nitrate-nitrogen**	Results within typical range	Results below minimum target level
<b>Rocky Run</b>	Standards met*	Standards met	Standards met	0% of samples ≥3.0 mg/L of nitrate-nitrogen**	18% of samples were >400uS all during the winter months	Results below minimum target level
<b>Beaver Run</b>	Standards met*	Standards met	Standards met	13% of samples ≥3.0 mg/L of nitrate-nitrogen**	23% of samples were >400uS all during the winter months	Results below minimum target level
<b>Flint Woods</b>	Standards met*	Standards met	Standards met	10% of samples ≥3.0 mg/L of nitrate-nitrogen**	Results within typical range	Results below minimum target level

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\* Based on daytime dissolved oxygen levels. These results do not reflect the lowest dissolved oxygen levels possible.

\*\* Nitrate-nitrogen was the only form of nitrogen measured. It is assumed that values of total nitrogen would be even higher.