

Water Quality Sampling Plan
First State National Park
 Summer 2015

Introduction

The University of Delaware Water Resources Center and The Nature Conservancy propose to conduct water quality sampling during summer 2015 to characterize Piedmont streams that flow west to the Brandywine Creek through the First State National Park at Woodlawn operated by the National Park Service and adjacent Brandywine Creek State Park owned by the Delaware Division of Parks and Recreation. Student research assistants will conduct water quality sampling along these tributaries that flow west toward Brandywine Creek near the Delaware/Pennsylvania line (Figures 1-8).

<u>Watershed</u>	<u>D.A (ac)</u>
Three Sisters Brook	262
Beaver Creek	2,592
Jonkat Run	128
Ramsey Run	230
Thompson's Creek	122
Rocky Run	<u>1,151</u>
	4,485 ac (7.0 mi ²)

Existing Water Quality

Streams in First State National Park have good water quality (Table 1). Streams are relatively cool even in July due to shade from forested riparian buffers with water temperatures less than 23 deg C (73 deg F) except for Three Sisters Brook with a water temperature of 26.4 deg C in an unshaded stream reach. Dissolved oxygen levels exceeded 7 mg/l even during the warm days of July. pH ranged between 7.5 and 8.0 which is slightly basic due to limestone or carbonate rock outcrops in the watersheds. Specific conductivity which detects the presence of total dissolved solids was relatively low although South Fork of Beaver Creek near Concord Pike recorded SC of 630 µS.

Table 1. Water quality along streams in the First State National Park

Site ID	Latitude	Longitude	Date	pH	Temp (°C)	DO (%)	DO (mg/L)	SC (µS)
Three Sisters Brook (TS1)	39.838015	75.578733	7/8/14	7.76	26.4	87	7.0	195
Jonkat Run (JR1)	39.831360	75.573390	7/7/14	7.37	20.0	83	7.5	134
Ramsey Run (RaR1)	39.828600	75.572900	7/7/14	7.59	20.5	87	7.0	196
Thompson Creek (TC1)	39.821200	75.573842	7/7/14	7.76	18.7	90	8.4	168
Beaver Creek (BC2)	39.834770	75.576480	7/7/14	7.86	20.2	91	8.2	338
Beaver Creek (BC3)	39.838600	75.572160	7/7/14	7.99	20.1	95	8.5	391
Beaver Creek (BC4)	39.839444	75.571111	7/7/14	7.81	20.4	84	7.6	307
Beaver Creek (BC5)	39.839427	75.571119	7/7/14	7.74	20.3	85	7.7	482
Beaver Creek (BC6)	39.846389	75.565278	7/7/14	7.96	20.5	88	7.9	329
Beaver Creek (BC7)	39.839173	75.548003	7/8/14	7.55	21.3	93	8.2	630
Rocky Run (RoR1)	39.811667	75.566667	7/7/14	7.74	21.9	88	7.5	368
Brandywine Creek (BR1)	39.835260	75.577460	7/7/14	7.93	22.2	91	7.9	328

Streams in the Rocky Run watershed met chemical water quality criteria based on sampling conducted during summer 2013. Hurricane Run had the highest nitrate nitrogen level (Table 2).

Table 2. Water quality sampling in Rocky Run watershed during summer 2013

Parameter	Unit	Criteria	Hurricane Run	L. Rocky Run	Brandywine Confluence	Residential Greenway	202 Overpass
pH		6.5-8.5 ¹	7.8	7.7	7.6	7.5	7.6
EC	(µhos/cm)	150-500 ²	280	420	300	280	610
Al	(mg/L)	0.75 ³	0.061	0.037	0.082	0.081	0.090
Cu	(mg/L)	0.0134 ³	0.003	0.001	0.001	0.001	0.003
Fe	(mg/L)	1.0 ²	0.056	0.045	0.063	0.106	0.059
Mg	(mg/L)		9.566	12.276	9.323	8.826	16.006
Mn	(mg/L)	0.50 ⁴	0.001	0.000	0.000	0.001	0.001
Na	(mg/L)		15.52	28.98	18.50	17.95	53.75
P	(mg/L)	0.05	0.003	0.052	0.036	0.105	0.085
Zn	(mg/L)	0.117 ³	0.000	0.001	0.000	0.000	0.001
NH4-N	(mg/L)		0.00	0.00	0.00	0.00	0.00
NO3-N	(mg/L)	10.0 ⁵	2.20	0.69	1.08	0.96	0.91

1. Delaware fresh water quality standards. 2. EPA Criteria for Freshwater Habitat. 3. Delaware water quality criteria for aquatic life protection, acute water quality standards, values calculated by Kiliszek (2010) assuming a pH of 7.0 and a hardness of 100mg/L CaCO₃. 4. EPA Gold Book criteria. 5. Delaware water quality criteria for human health protection.

According to the draft Delaware Clean Water Act Section 303d list of impaired streams (DNREC 2014), Brandywine Creek and several tributaries that run through First State National Park are impaired (Table 3). For Brandywine Creek, bacteria was delisted in 2006 and relisted in 2008 and nutrients were listed in 1996 and delisted in 2014. The eastern tributary of Beaver Creek from the headwaters to the main stem is impaired for biology and habitat. The tributary just below Beaver Creek (Jonkat Run) is impaired for habitat. The eastern tributary of headwaters of Rocky Run is impaired for habitat in the upper half and for habitat and biology in the lower half.

Table 3. Delaware Section 303d List of impaired streams (DNREC 2014)

WATERBODY ID	WATERSHED NAME	SEGMENT	Overall CALM Code	DESCRIPTION	SIZE	POLLUTANT OR STRESSOR	PROBABLE SOURCE(S)	YEAR LISTED	TARGET DATE FOR TMDL	TMDL DATE	Pollutant CALM Code	Year Changed from Category 5 Per 305(b) Assessment and Methodology	Notes							
DE040-002	Brandywine Creek	Upper Brandywine	5	From State Line to Wilmington	9.3 miles	Bacteria	PS, NPS, SF	1996	2004	2005	4a	1	2014	Bacteria, listed in 1996, delisted 2006, relisted 2008						
						Nutrients		1996	2000	2003	4a			Nutrients, Listed 1996, Delisted 2014						
						PCBs		1996	2003	2003	4a			2012	EPA TMDL for PCBs in Delaware River Zone 5 and tributaries					
						Dioxin		2002	2017	5		Target date changed to 2017 in the 2012 Cycl, per the WATAR plan in the appendix								
				From State line to the confluence with the Christina River	8.0 miles	Habitat	NPS	1998	2009	5										
DE040-003	Brandywine Creek	All tributaries on Brandywine Creek from the headwaters at PA-DE line to the confluence with the Christina River	5	Eastern tributary of Beaver Creek, from headwaters to the confluence with mainstem Beaver Creek	0.96 miles	Biology and Habitat	NPS	1998	2009	5										
						Tributary originating in Pennsylvania on the western side of Brandywine Creek									0.26 miles	Biology and Habitat	NPS	1998	2009	5
						Tributary of Brandywine Creek, off Route 100 (near PA-DE border)									0.92 miles	Habitat	NPS	1998	2009	5
						Tributary of Brandywine Creek just below Beaver Creek									0.85 miles	Habitat	NPS	1998	2009	5
						Eastern tributary of the headwaters of Rocky Run (upper half)									1.16 miles	Habitat	NPS	1998	2009	5
						Eastern tributary of the headwaters of Rocky Run (lower half)									1.16 miles	Biology and Habitat	NPS	1998	2009	5
						From the confluence of the headwaters of Wilson Run to the next larger stream order (lower half)									0.64 miles	Habitat	NPS	1998	2009	5

Field Methods

- 1. Sampling Stations:** Conduct water quality sampling along 6 creeks at 12 stations: Three Sisters (upstream from mouth of stream), Beaver Creek (main stem, north fork, south fork, Concord Pike), Jonkat Run (upstream from mouth of stream), Ramseys Run (upstream from mouth of stream), Thompsons Creek (upstream from mouth of stream), Rocky Run (main stem, Hurricane Run, Rocky Run at Hurricane Run, near Concord Pike)
- 2. Water Quality Probes:** Once per week utilize water quality probes to record pH, water temp, dissolved oxygen, turbidity/TDS, and specific conductivity at each of the 12 locations.
- 3. Grab Samples:** Twice per month (one low flow and one high flow), obtain grab samples at each of the 12 locations and send to the City of Wilmington water quality laboratory for analysis in accordance with protocols summarized in Table 4.
- 4. Materials:** High density polyethylene (HDPE) bottles (500 mL) x 24 (sterilized), Preservative: 1:1 HNO₃ (v/v) solution for total metal analysis, Temperature/DO/conductivity probes x 3, Ice box for sample storage (at 4 °C) x 3, 0.45 µm syringe filter x 24, Graduated Cylinder x 3
- 5. Analysis:** At least 200 mL of duplicate samples will be collected for analysis. One additional sample at each site for total metal analysis will be collected with 2 mL of preservative HNO₃ solution. Samples will be stored in the 4 °C ice box or corresponding facility for further analysis.

Table 4. Water quality sampling methods

Parameters	Measurement Methods	Required Pretreatment
Total Nitrogen, Nitrate (mg/L)	Ion Chromatography	At least 10 mL filtrated with 0.45 µm syringe filter
Total Phosphorous (mg/L)		
Arsenic(III), Cadmium, Chromium(III), Copper, Lead, Zinc, Nickel (mg/L)		
DO (mg/L)		
Temperature(°C)	Probe (on site)	.
Conductivity (mS/cm)	Probe (on site)	.
pH	Probe (on site)	.
Turbidity	Nephelometer	.
TSS, TDS	Filtration, Evaporation 155 °C	.
Enterococcus Bacteria	Microscope	.

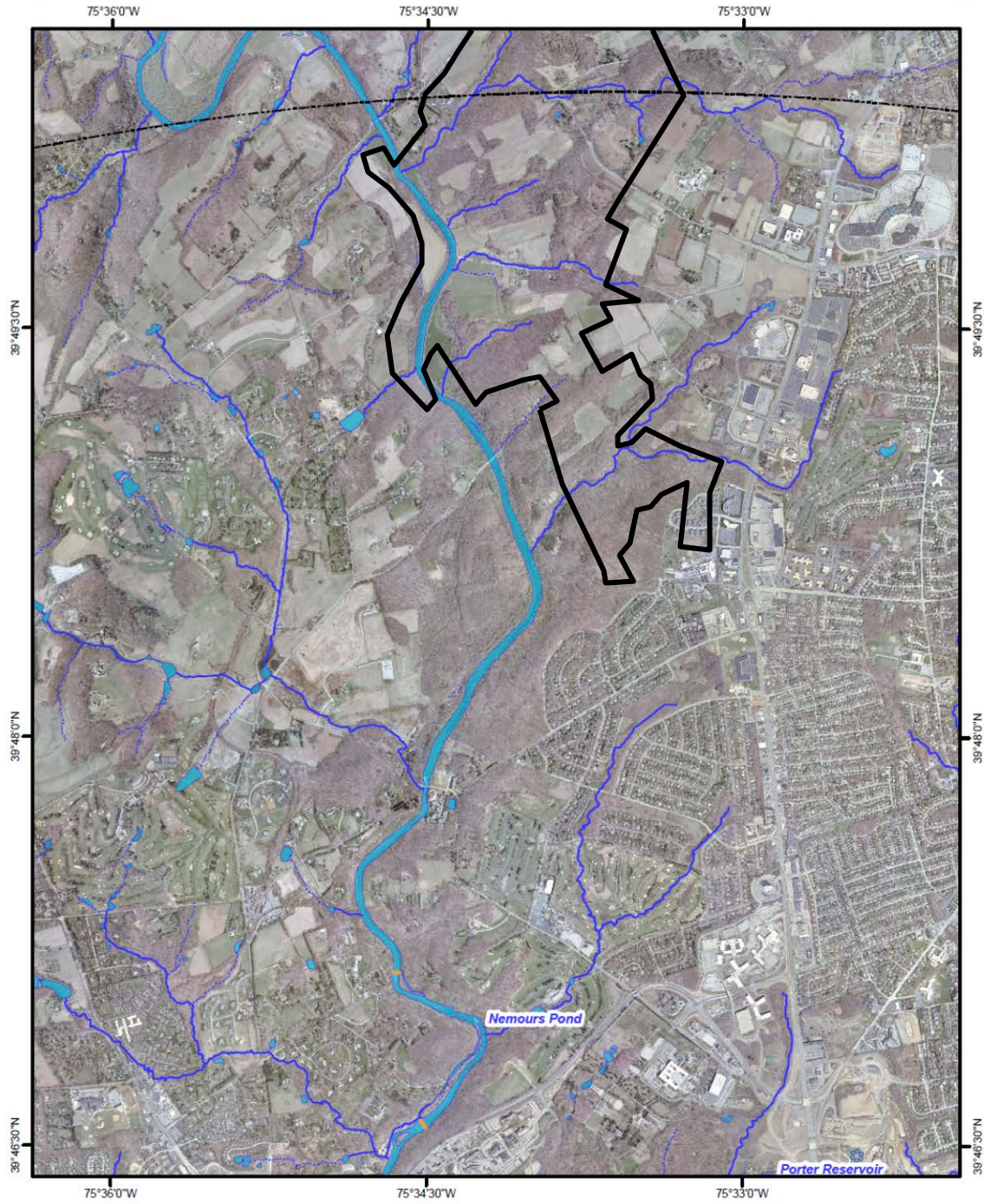
- 6. Schedule:** Conduct water quality sampling during an 8 week period during June/July 2015.

Table 5. Water quality sampling schedule during summer 2015

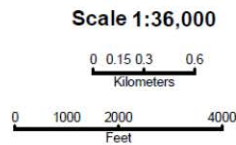
Week	Task	WQ Probe	Grab Samples
Jun 8	Orientation/Training		
Jun 15	WQ Probe/Grab Sample	12	12
Jun 22	WQ Probe/Grab Sample	12	
Jun 29	WQ Probe/Grab Sample	12	12
Jul 6	WQ Probe/Grab Sample	12	
Jul 13	WQ Probe/Grab Sample	12	12
Jul 20	WQ Probe/Grab Sample	12	
Jul 23-24	Water Quality Blitz		
Jul 27	WQ Probe/Grab Sample	12	12
Aug 3	Statistics/Field Report		




State of Delaware



Data on map are based on Delaware framework data layers. The Delaware DataMIL is maintained by the Delaware Geological Survey (DGS) and served via the Delaware Department of Technology and Information (DTI) internet.




Magnetic Declination
Approx. 11 mils

DataMIL Mini Map



Figure 1. Aerial photograph of streams at First State National Park (2007)

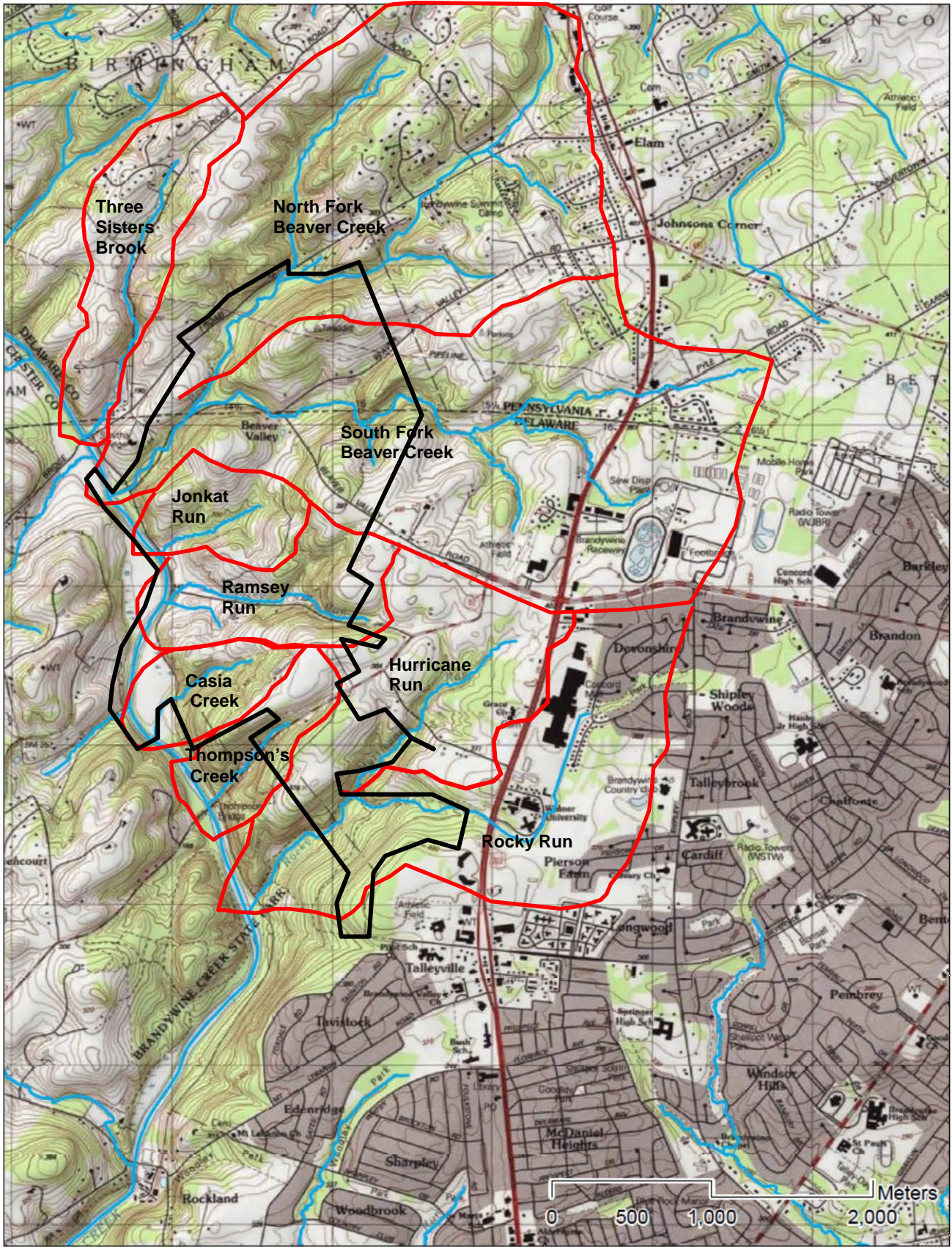


Figure 2. Watersheds and topography at First State National Park

Three Sisters Brook Watershed Delineation

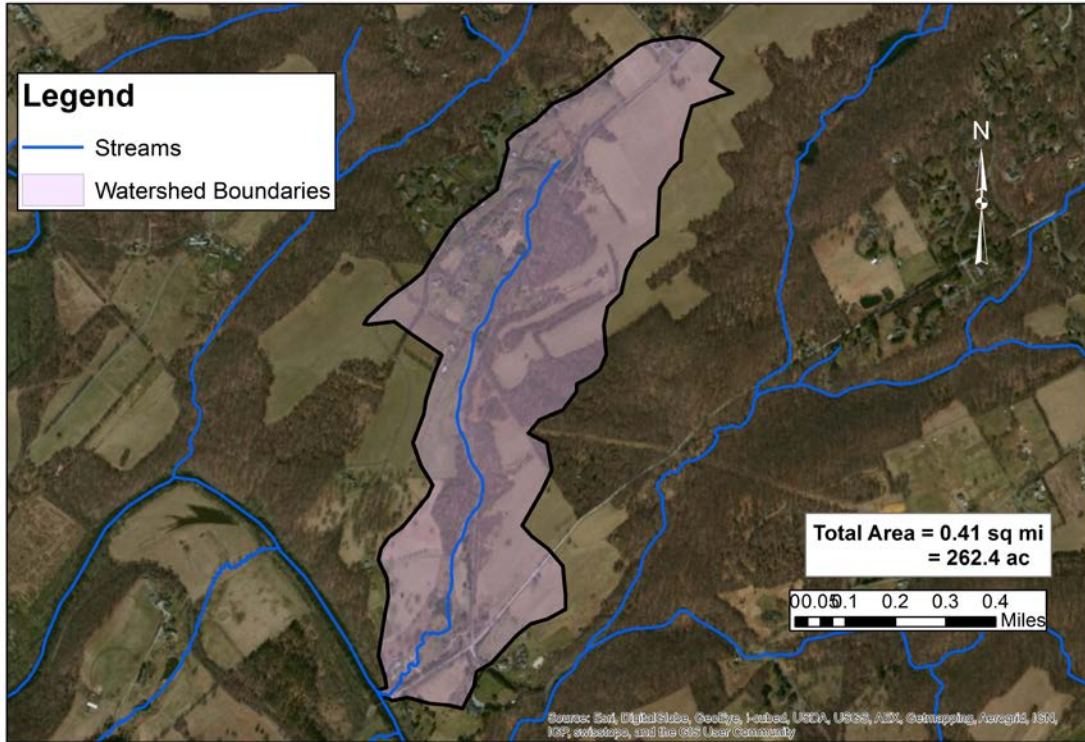


Figure 3. Three Sisters Brook watershed

Beaver Creek Watershed Delineation

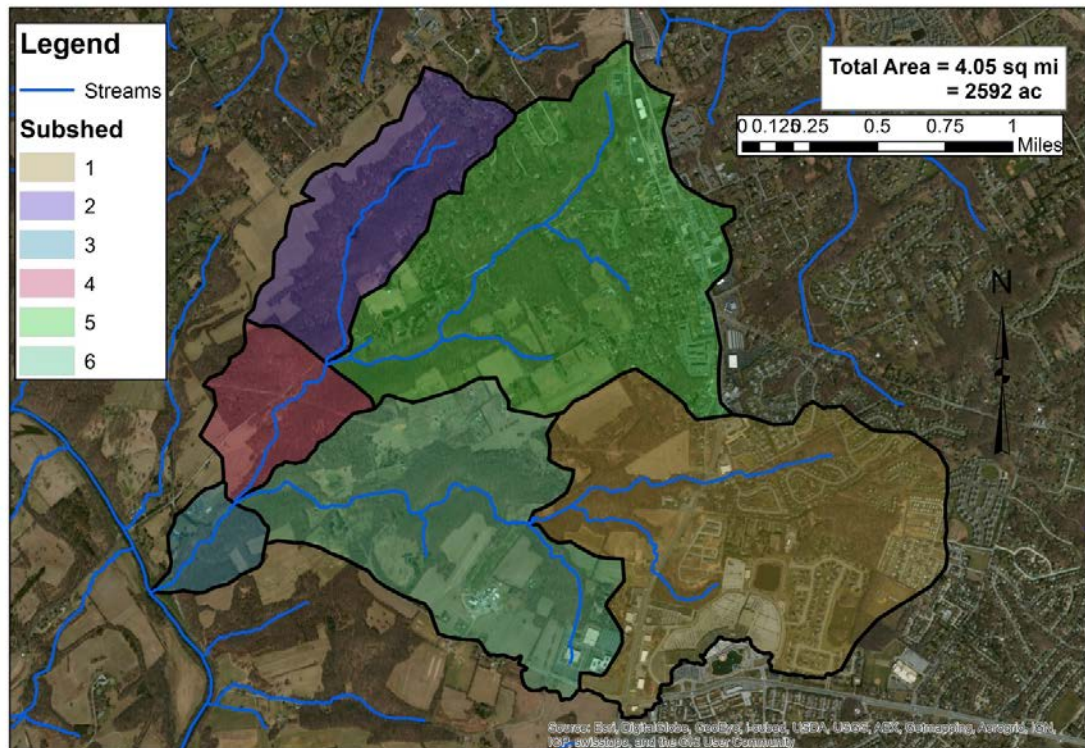


Figure 4. Beaver Creek watershed

Jonkat Run Watershed 20 Foot Contours

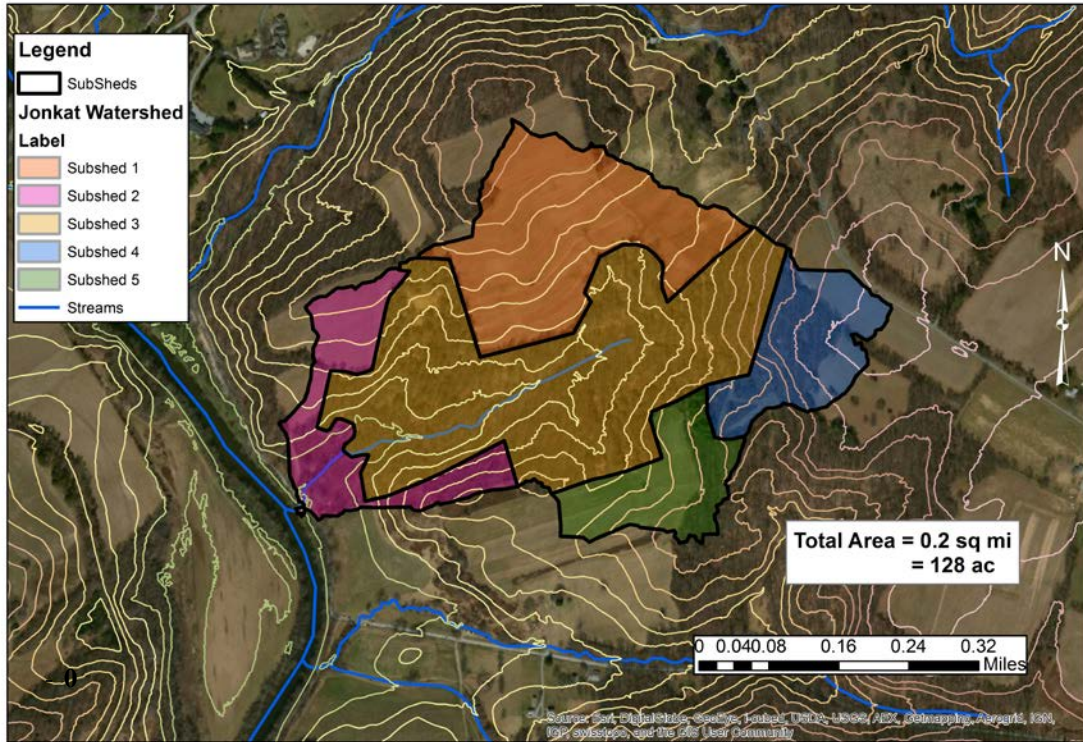


Figure 5. Jonkat Run watershed

Ramsey Run Watershed Twenty Foot Contours

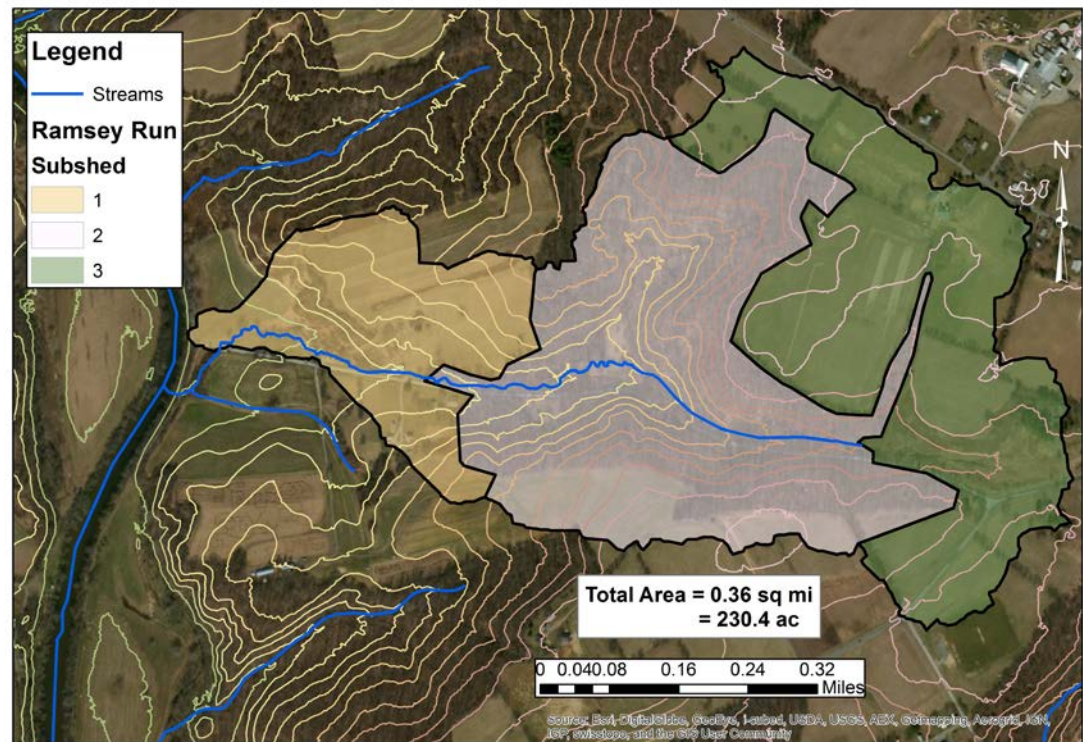


Figure 6. Ramsey Run watershed

Thompson's Creek Watershed Twenty Foot Contours

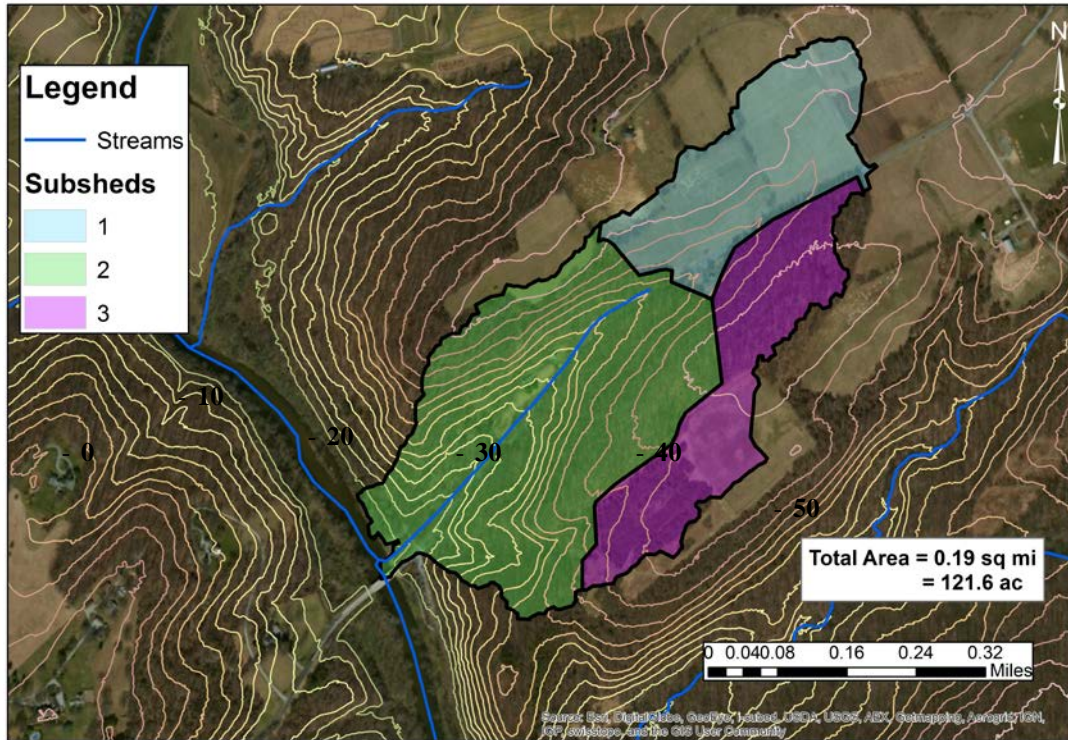


Figure 7. Thompson's Creek watershed

Rocky Run Site Map

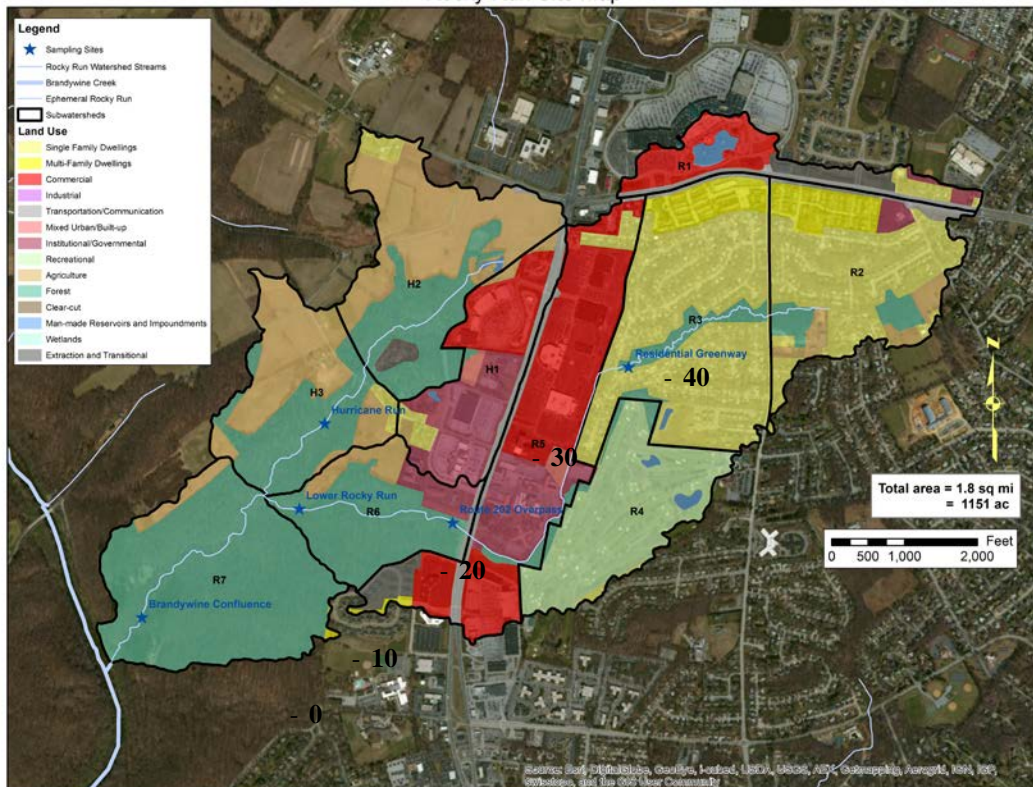


Figure 8. Rocky Run watershed

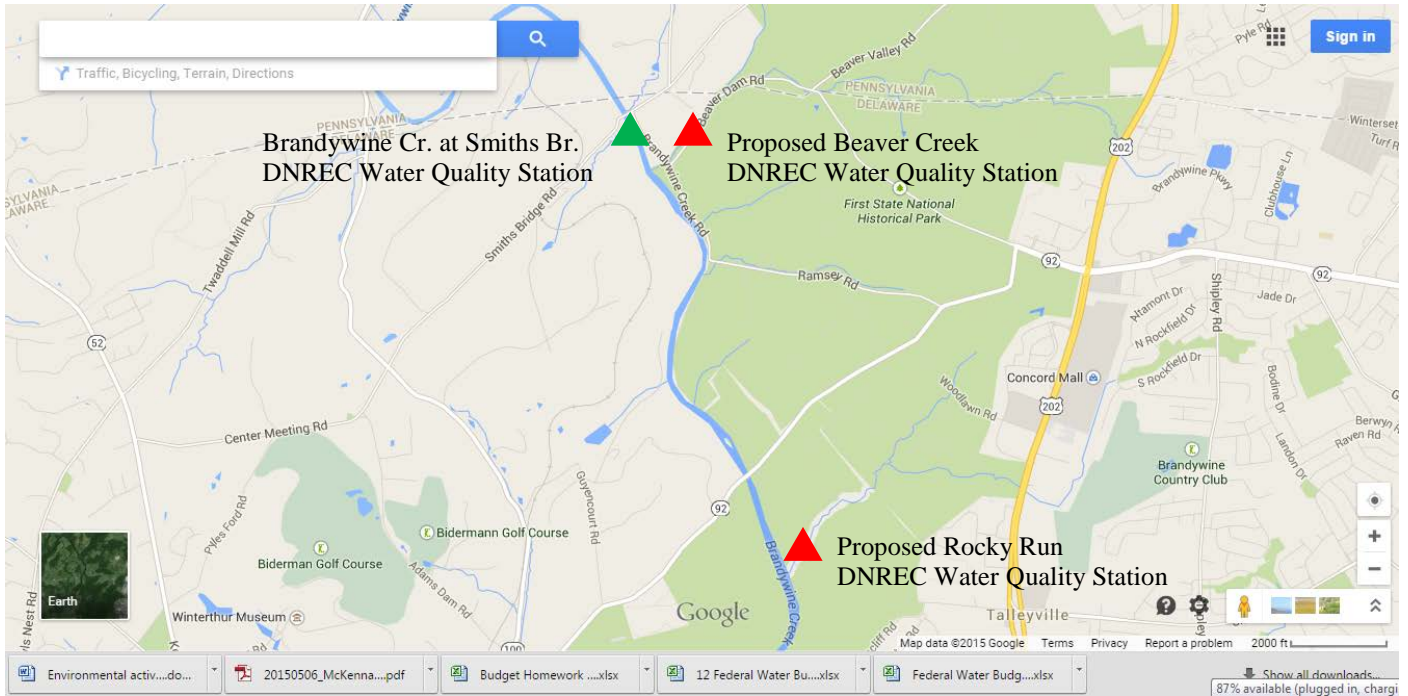


Figure 9. Delaware DNREC water quality monitoring stations