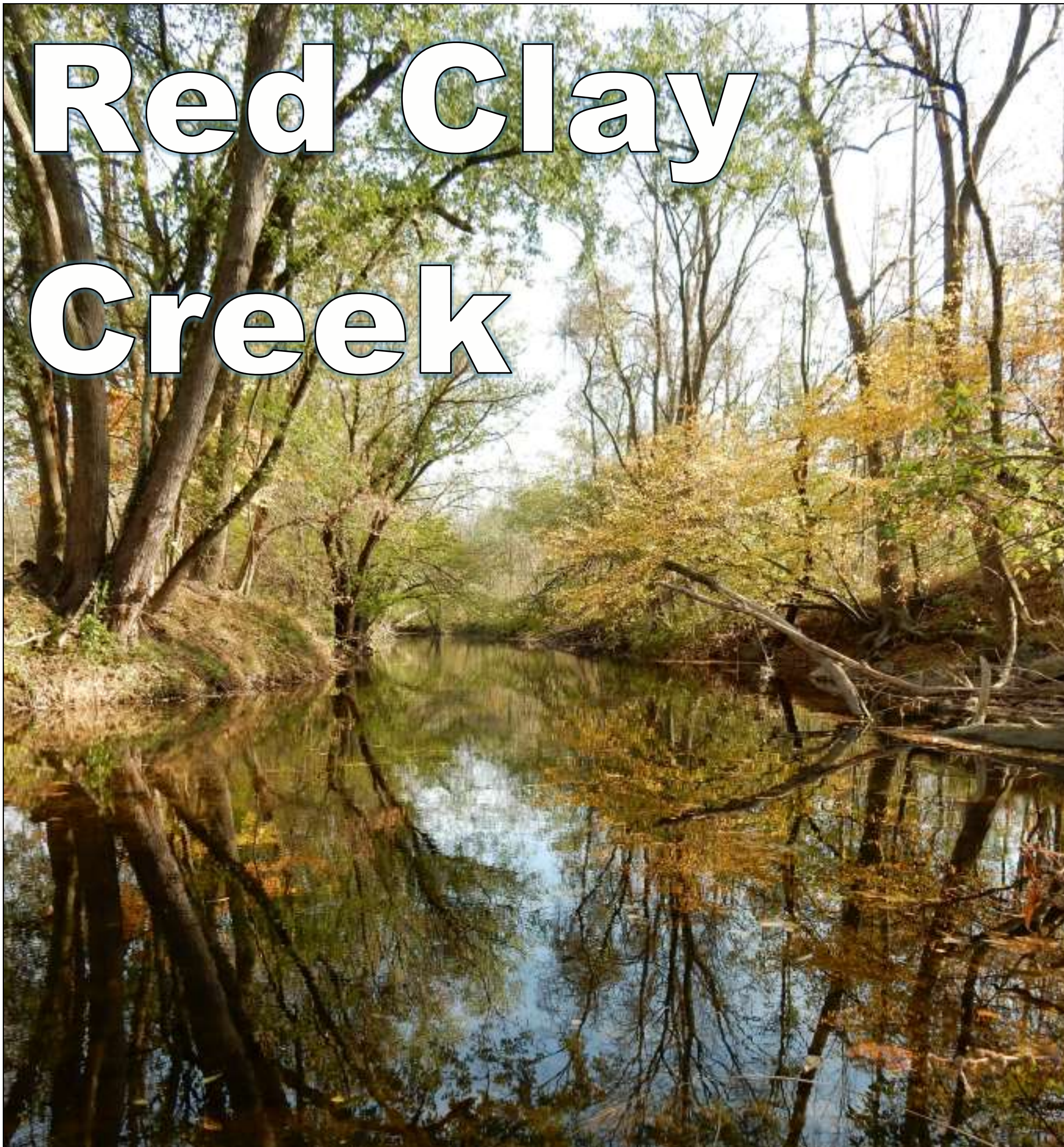
Red Clay Creek



Delaware Stream Watch

Volunteer Data Summary

2006 - 2015

Delaware Nature Society

Delaware Stream Watch

Data Summary 2006 - 2015

Delaware Stream Watch was established in 1992 to engage volunteers in providing baseline chemical and physical data on waterways primarily in the Christina Basin in Northern Delaware.

Volunteers in Delaware Stream Watch Technical Monitoring program monitor designated long-term monitoring sites on a monthly basis, testing for dissolved oxygen, pH, alkalinity, nitrate nitrogen, phosphates, conductivity, and temperature. Annual quality control helps to ensure consistency and control in sampling techniques. Data is collect through a combination of field test kits and meters.

Special thanks to the dedicated volunteers who take time out of their busy schedules to make a difference for our waterways!

Delaware Stream Watch

Delaware Stream Watch is a citizen science program, run by the Delaware Nature Society, that engages volunteers in monitoring the quality of local waters.

Data is shared on the Delaware Nature Society website and is used to inform watershed planning and outreach efforts.

Learn more & become involved:

Delnature.org/streamwatch

The Red Clay Creek Watershed

The Watershed

The Red Clay Creek, along with the Brandywine, White Clay and Christina creeks combine to form the Christina Basin which flows into the Delaware River at Wilmington DE. These waterways are an important drinking water supply for residents of Chester County PA and New Castle County DE. The Christina Basin is part of the broader Delaware River Basin that supplies drinking water to over 15million people.

The Red Clay Creek watershed covers 54 square miles in Delaware and Pennsylvania and has a long industrial history, having served as the site of several mills. The Wilmington and Western Railroad, which winds through the valley following the creek, once brought goods from the mills to the ports in Wilmington. In April 2005, twenty-eight road segments within the watershed were designated as the Red Clay Valley Scenic Byway. This designation recognizes the significant quality of the remaining natural and scenic resources in this area.

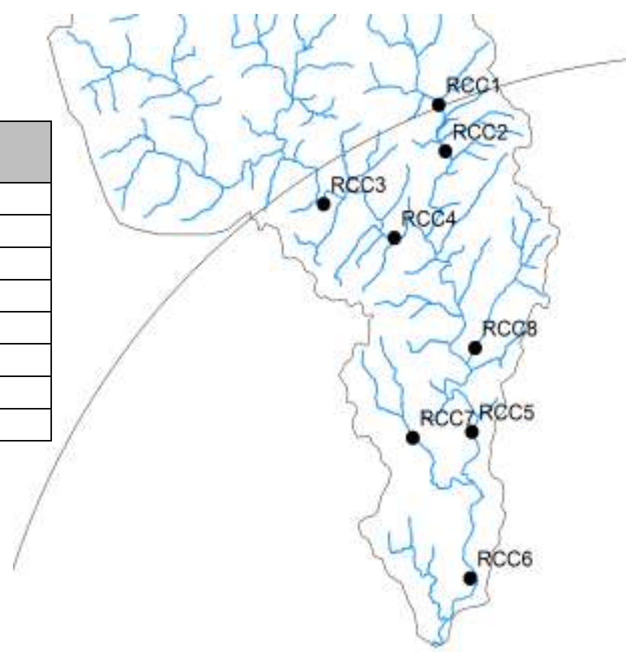
Major land uses in the watershed include agriculture (39%), forest/wetland (33%), and urban (27%).

The Monitoring Sites

Technical Monitoring volunteers monitored 8 locations along the Red Clay Creek and its tributaries in Delaware collecting chemistry data on a monthly basis.

Volunteer monitoring site locations 2006 - 2015

Site	Location
RCC1	Burrows Run @ State Line
RCC2	Burrows Run @ Coverdale Farm Preserve
RCC3	Mainstem @ Benge Road
RCC4	Ashland Nature Center
RCC5	Woodale
RCC6	Kiamensi Rd
RCC7	Hyde Run @ Faulkland Rd
RCC8	Hoopes Reservoir outfall



Summary Result

A ***Summary result*** of **Good**, **Average** or **Poor** is included next to each parameter. This rating is provided as a quick summary of the overall findings for that specific parameter across sites.

Chemical Data Collected 2006 - 2015 in the Red Clay Creek Watershed

Dissolved Oxygen (DO) ***Summary result: Good***

Dissolved oxygen (DO) is an important water quality indicator for aquatic life. DO levels below 3-5mg/L can harm or kill fish and other aquatic organisms. Temperature influences DO levels - the warmer the water is, the less dissolved oxygen it can hold. Cold water can hold more dissolved oxygen. Wind or wave action or turbulence from churning over rocks can add oxygen to water. Aquatic plants both add (photosynthesis) and consume (respiration) oxygen. DO levels can vary by time of day and by time of year.

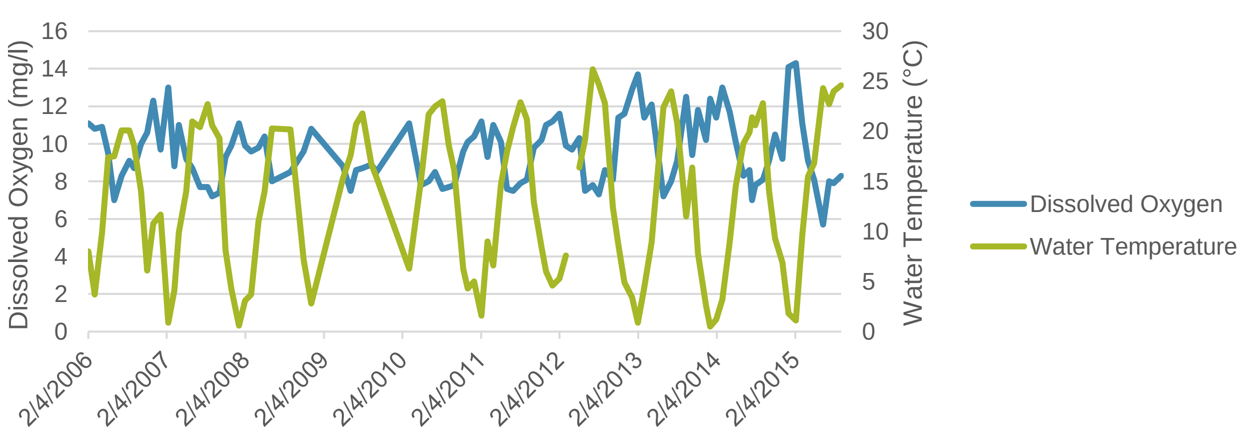
Oxygen levels may be reduced by elevated water temperatures (e.g. removal of trees that shade the water or by industrial/municipal discharges) or by the excessive growth and subsequent oxygen depleting decomposition of algae. A DO reading measures how much oxygen is dissolved in the water but not how much oxygen the water is capable of holding at that time and temperature. When water holds all the DO it can hold at a given temperature, it is said to be 100% saturated with oxygen. Percent saturation therefor refers to the amount of DO in the water compared to the amount that could be present at the same temperature. Levels between 80 – 120% are ideal.

Data was collected using Fisher brand Traceable Dissolved Oxygen Meters.

The DO standards set by the State of Delaware are a minimum of 4.0 mg/L for most waters. In general, DO levels were good throughout the watershed. Sites RCC 7 and RCC8 did have average percent saturation below 80%. Overall, no sites saw a significant increase or decrease in trend over the monitoring period.

As data was collected during the daytime, the lowest dissolved oxygen levels (typically found near dawn) may not be truly reflect.

Water Temperature vs. Dissolved Oxygen Red Clay Creek @ RCC4 (Ashland) 2006-2015



RCC5: Mainstem @ Woodale

pH *Summary result: Good*

pH is a measure of how acidic or basic the water is based on the hydrogen ion concentration of the water. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic while a pH greater than 7 is basic. Because values of pH are based on a logarithmic scale, each 1.0 change in pH represents a factor of ten change in acidity. This means that a pH of 3.0 is 10 times more acidic than a pH of 4.0.

LaMotte pH field kits were used for data collection.

pH readings in the Red Clay Creek fell within the target range of 6.5 – 8.5 across all sites. Only two data points were measured above the target range (RCC1 and RCC5) but these were single isolated reading and not considered problematic.

Alkalinity *Summary result: Good*

Alkalinity measures the acid neutralizing, or buffering, capacity of a solution. Most natural waters, based on their underlying geology, contain certain ions that can neutralize acidic ions. Streams that flow through limestone deposits have the highest alkalinity values and therefore the highest buffering capacity. The alkalinity of streams can vary due to the amount of rainfall, the season, as well as the geology of the watershed.

Data was collected using LaMotte Alkalinity field kits.

Alkalinity values were all above the minimum DNREC target of 20 mg/l. Values average from 40 – 80 mg/l with main stem sites generally averaging slightly higher values then tributary sites.

Nitrate-Nitrogen ***Summary result: Average***

Nitrogen makes up about 80% of the air we breathe. It is an essential component of proteins and is found in the cells of all living things. Inorganic nitrogen may exist as a gas, or as nitrites, nitrates, or ammonia. Nitrates represent the most completely oxidized states of nitrogen commonly found in water. Nitrates in water come from soil, fertilizer runoff, malfunctioning septic systems, sewage treatment plants, manure from livestock animal wastes and from car exhausts. In abundance, these nitrates become detrimental to aquatic systems through a process called eutrophication. Eutrophication refers to the natural aging process of a water body that may be greatly accelerated by human activities, causing algal blooms and a corresponding decrease in dissolved oxygen.

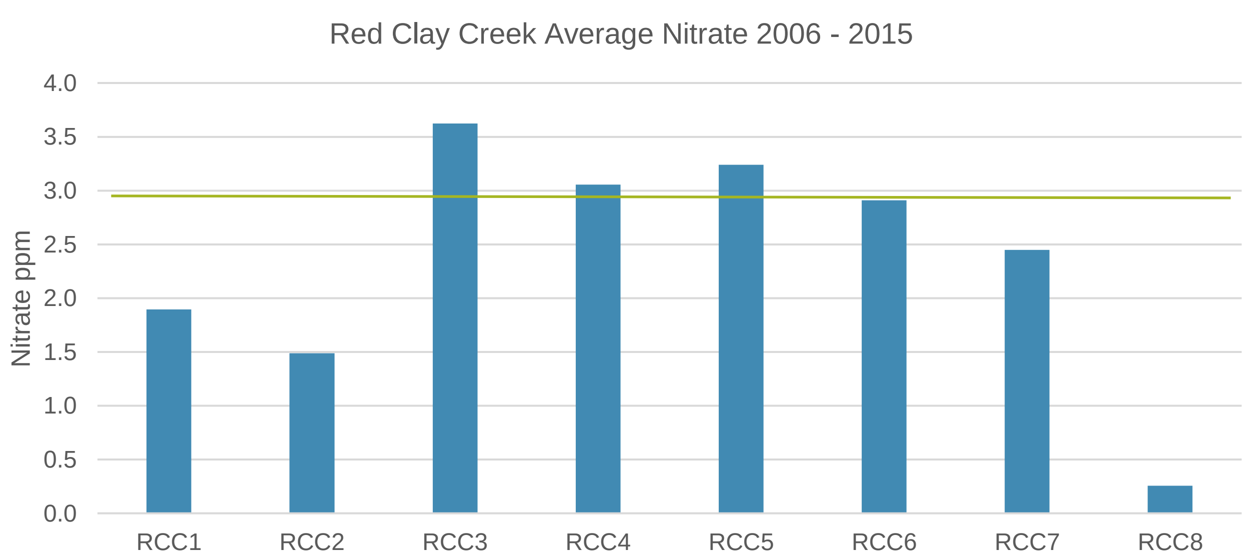
Data was collected using LaMotte Nitrate Nitrogen Field Kits.

The target level for total nitrogen (all forms of nitrogen combined) in Delaware freshwater is below 3.0 mg/L. Delaware Nature Society volunteers measure nitrate-nitrogen, which is only one component of total nitrogen.

All mainstem sites had numerous data points over 3.0 mg/l with RCC3 (Benge Rd. just south of Pennsylvania border) having the highest percent of values above the target value. This indicates the need for better restoration/management of nutrient sources coming from the upper Red Clay Watershed in Chester Co. Nitrate averages were higher in the Red Clay then observed in the Brandywine or Christina. No significant increasing or decreasing trend during the monitoring period was observed.

Percent Red Clay mainstem nitrate values >3.0

Site	% of values greater than 3.0 mg/l
RCC3 @ Benge Rd	54%
RCC4 @ Ashland	36%
RCC5 @ Woodale	48%
RCC6 @ Stanton	45%



Phosphate *Summary result: Average*

Phosphorus is an essential nutrient. Phosphates in water come from a variety of sources such as soil, fertilizer runoff, malfunctioning septic systems, sewage treatment plants, and manure from livestock animals. Since this nutrient is usually found in small amounts, even small increases can have large effects on aquatic systems. Excess phosphates can cause extensive algal blooms and a corresponding decrease in dissolved oxygen.

Hach Orthophosphate Field Kits were used to collect the data.

RCC2: Burrows Run

Delaware considers total phosphorus (which includes organic phosphorus) levels higher than 0.2 mg/l as a potential problem. Stream Watch measures orthophosphate, the inorganic dissolved form of phosphate that is readily available to aquatic plants. As our results only measure a component of total phosphorus, values approaching 0.2 mg/l would be considered high.

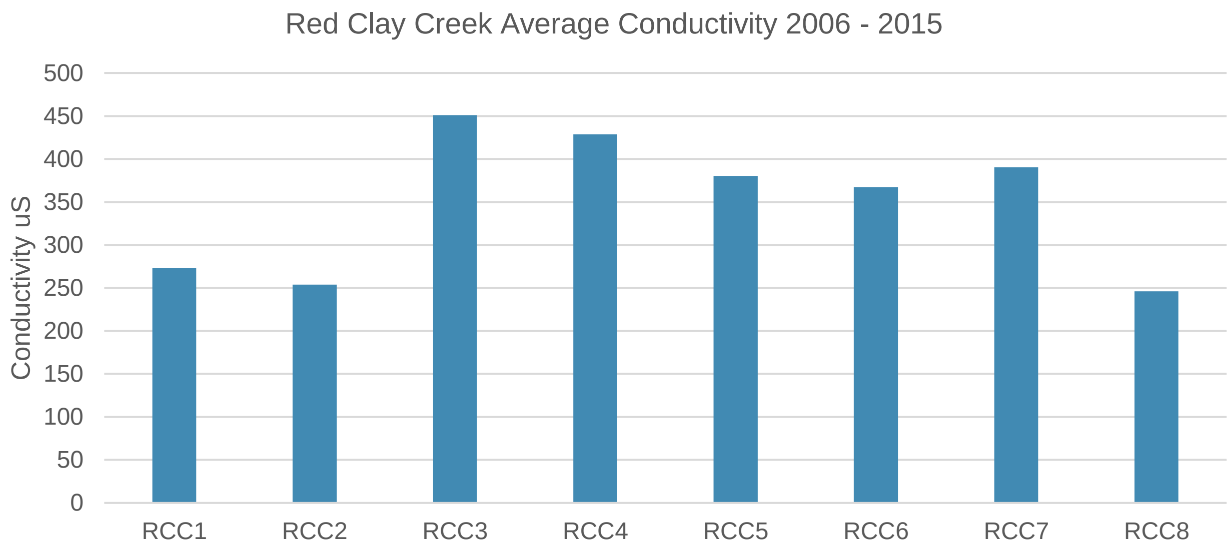
Similar to nitrates, all mainstem sites had consistently high values of phosphates with tributary sites having lower average values. No significant increase or decrease in trend was found between 2006 - 2015.

Percent Red Clay mainstem phosphate values >0.15

Site	% of values greater than 0.15 mg/l
RCC3 @ Benge Rd	63%
RCC4 @ Ashland	63%
RCC5 @ Woodale	61%
RCC6 @ Stanton	64%

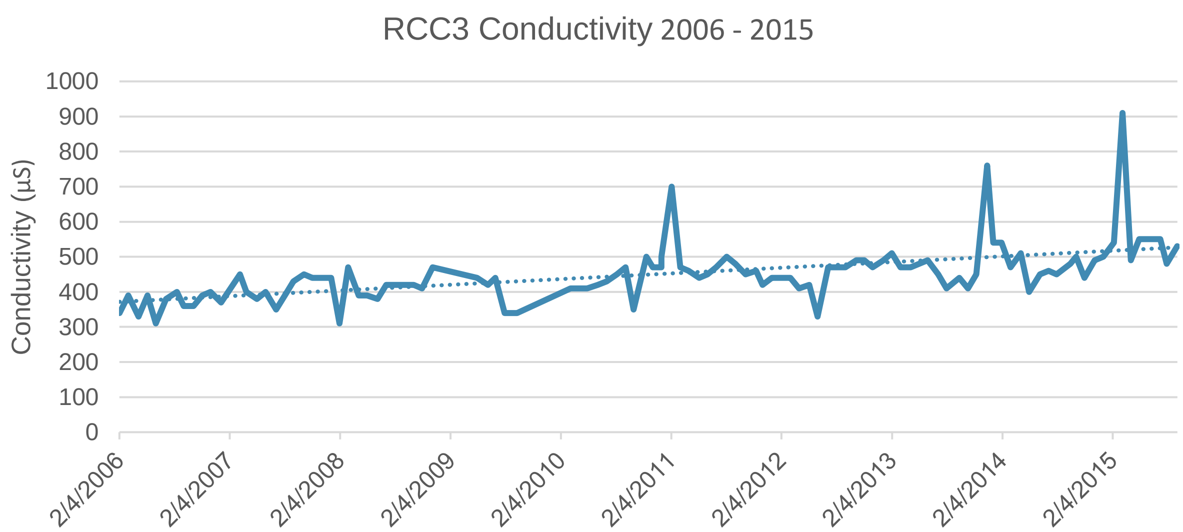
Conductivity *Summary result: Average*

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as chlorides, sulfides and carbonate compounds. Geology can naturally influence the base conductivity level of streams. The application of road salt during winter months and runoff from urbanized areas can result in high conductivity levels. National and regional data sets point to winter road salt application as a potential concern as salts may accumulate in soils and shallow groundwater and slowly enter streams throughout the year.



Sites RCC3 (mainstem @ Benge Rd.) and RCC4 (mainstem @ Ashland) had the highest median conductivity values along with the highest maximum values. These higher values (>500uS) were primarily during winter months and attributed to road salt application but several values in 2015 occurred between May – August. The lowest average values were at tributary sites with less upstream development (RCC1, RCC2, RCC8).

Figure 2: Conductivity @ RCC3 (Benge Rd)



Water Quality Trends in the Red Clay Creek Watershed in Delaware

In general, most sites stayed fairly consistent across the monitored parameters over the 9 year period. No significant (R-squared > 0.5) increasing/decreasing trends were observed at any site for the measured parameters.

While no significant decreases in nitrate and phosphate trend was observed, the fact that site values stayed fairly consistent over the time frame can be viewed in a positive light as the population in the watershed has increased. That said, volunteers were not able to measure all forms of nitrogen and phosphorous so the true amount of these nutrients passing through the sites may be underestimated.

All Red Clay Creek sites except RCC7 showed a slightly increasing trend in conductivity, a trend being observed nationally due to increasing road salt application. Enhanced monitoring of conductivity at select sites would be useful in the future.

While not reported here, habitat and macroinvertebrates were surveyed at a subset of sites between 2010 –2015. Combined with the chemistry, these data point to the negative impact of stormwater runoff (e.g., eroded streambanks, low diversity of pollution sensitive taxa) associated with non-point source pollution.

Red Clay Creek 2006 - 2015 Average Site Chemistry

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
RCC1	67	7.5	273	1.9	0.08	14	9.1	85.9
RCC2	52	7.5	254	1.5	0.07	12	9.9	91.6
RCC3	84	7.7	451	3.6	0.29	13	10.2	94.6
RCC4	84	7.7	429	3.1	0.28	13	9.6	89.1
RCC5	72	7.6	380	3.2	0.26	13	8.9	84.0
RCC6	70	7.7	367	2.9	0.27	16	8.1	84.3
RCC7	40	7.2	390	2.5	0.07	14	7.9	73.1
RCC8	69	7.3	246	0.3	0.07	13	8.1	75.5

Red Clay Creek Summary Data 2006 - 2015

SITE 1: RCC1 - Burrows Run @ State line

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	48	6.8	210	0.3	0.00	1.0	4.2	47.2
Maximum	88	10.0	450	5.0	0.50	30.0	14.1	127.1
Average	67	7.5	273	1.9	0.08	13.7	9.1	85.9
Median	66	7.5	270	2.0	0.06	14.9	8.6	88.4
# samples	57	60	56	57	60	60	53	54

SITE 2: RCC2 – Burrows Run @ Old Kennett Pike

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	34	6.5	92	0.3	0.00	0.0	6.6	56.1
Maximum	83	8.5	369	7.0	0.30	27.5	15.5	124.8
Average	52	7.5	254	1.5	0.07	12.4	9.9	91.6
Median	52	7.5	260	1.5	0.06	12.2	9.8	90.1
# samples	92	92	88	89	92	92	84	84

Site 3: RCC3 – Mainstem @ Benge Road

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	52	7.0	310	0.3	0.00	0.4	7.4	77.3
Maximum	109	8.5	910	8.0	1.00	26.3	16.1	153.8
Average	84	7.7	451	3.6	0.29	13.1	10.2	94.6
Median	84	7.8	445	4.0	0.24	13.1	10.0	92.9
# samples	102	104	104	103	103	103	103	103

SITE 4: RCC4 – Mainstem @ Ashland

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	54	7.0	270	0.3	0.00	0.5	5.7	67.3
Maximum	110	8.5	860	7.0	0.98	26.2	14.3	114.6
Average	84	7.7	429	3.1	0.28	13.1	9.6	89.1
Median	84	7.8	430	3.0	0.20	14.0	9.4	89.4
# samples	104	104	103	101	104	103	104	103

SITE 5: RCC5 – Mainstem @ Woodale

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	42	7.0	180	0.3	0.00	0.0	4.7	49.0
Maximum	100	9.0	520	6.0	0.88	26.0	15.2	158.2
Average	72	7.6	380	3.2	0.26	12.9	8.9	84.0
Median	70	7.5	380	3.0	0.21	14.0	8.6	80.9
# samples	110	109	109	108	110	109	104	103

SITE 6: RCC6 – Mainstem @ Stanton

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	50	7.0	280	1.5	0.10	6.5	5.7	62.7
Maximum	103.00	8.0	440	4.0	0.64	26.3	10.3	102.7
Average	70	7.7	367	2.9	0.27	15.7	8.1	84.3
Median	65	7.8	360	3.0	0.19	12.0	8.3	89.1
# samples	10	11	11	11	11	11	7	7

SITE 7: RCC7 - DE School for the Blind (Hyde Run)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	27	6.5	290	0.3	0.02	2.9	2.4	27.7
Maximum	69	7.8	670	4.0	0.17	29.7	15.3	120.5
Average	40	7.2	390	2.5	0.07	13.9	7.9	73.1
Median	39	7.3	370	3.0	0.06	13.2	7.9	78.7
# samples	35.00	35.00	35.00	35.00	35.00	35.00	32.00	32.00

SITE 8: RCC8 - Hoopes Reservoir (outflow)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	34	7.0	180	0.3	0.00	0.0	4.8	44.5
Maximum	102	8.5	380	0.5	0.40	25.0	15.1	154.1
Average	69	7.3	246	0.3	0.07	12.5	8.1	75.5
Median	72	7.5	250	0.3	0.06	12.7	7.8	74.3
# samples	104	105	104	103	105	103	99	97

Making a Difference

Healthy waterways are important community assets providing opportunities for recreation, a source of drinking water, and habitat for wildlife. Stream monitoring provides data on the quality of these waters but each of us can also play a part in improving the health of our waterways.

Many opportunities exist to directly improve the health of our local streams – join us in making a difference!

- **Go green to help protect blue (water that is):** Make protecting water part of your everyday life – little changes in our behavior can go a long way to improving our environment. Many opportunities exist to help the environment so go wild naturally**.** delnature.org/greenlivingguide
    - Choose household cleaners that are the least toxic
    - Pick-up pet poo
    - Volunteer at a stream clean-up

- **Branch out:** Native trees, shrubs, and plants help to improve water quality by filtering pollutants and helping to absorb excess water. An added bonus, native plants are adapted to our climate and need little extra care including extra water or fertilizers.
    - Volunteer at a local tree planting or other habitat restoration project. Establishing a restoration project such a rain garden is wonderful for our waterways but these projects need to be maintained over time. Contact Delaware Nature Society or other local conservation organization to help maintain a habitat or restoration project.
    - Improve water while supporting wildlife by creating a ***Certified Wildlife Habitat*** at your home, school, business or place of worship – learn more: delnature.org/CWH
    - Install a raingarden or rain barrel

- **Voice it!** Let your elected officials know that you care about clean water. Sign-up for the Delaware Nature Society's **Voice It!** alerts for information on upcoming policy changes that might impact water, the protection of our natural lands and other environmental issues.
    - Follow and participate in the **Clean Water: Delaware's Clear Choice Campaign** cleanwaterdelaware.org/

Water Connect Us All