Measurements of Nutrients in Ridley Creek

CE 306 (Independent Project)

Conducted: 4/14/05

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Abstract

The Ridley Creek and Chester Creek watersheds are located next to one another in southeastern Pennsylvania, and both creeks serve as public water supplies and support recreational fisheries. The natural water quality of both Ridley and Chester Creeks may be expected to be similar due to their proximity to one another. However, there are differences in both water quality standards and the way that wastewater discharges are permitted for each creek. The objectives of this study were to create a snapshot of the nutrient levels throughout Ridley Creek during steady-flow conditions during the spring of 2005. These results were then compared with those from a similar study on Chester Creek conducted essentially during the same time period. It was found that Ridley Creek had lower nutrient mass loads (lb/day) than Chester Creek during this survey. Nitrate-nitrogen levels were below 10 mg/L N throughout the watershed, but surprisingly high nitrate-nitrogen levels (> 5 mg/l) were found in the background sample collected from the upper watershed.

Introduction

The Ridley Creek and Chester Creek watersheds are located next to one another in southeastern Pennsylvania, and both creeks serve as public water supplies and support recreational fisheries. The natural water quality of both Ridley and Chester Creeks may be expected to be similar due to their proximity to one another. However, there are differences in both water quality standards and the way that wastewater discharges are permitted for each creek. The objectives of this study were to create a snapshot of the nutrient levels throughout Ridley Creek during steady-flow conditions during the spring of 2005. These results were then compared with those from a similar study on Chester Creek conducted essentially during the same time period.

Methods and Procedures

Water samples were gathered from eleven locations along Ridley Creek (Figure 1). Sample sites were based on locations relative to wastewater discharges and accessibility. The locations of the samples in terms of stream miles from the mouth of Ridley Creek at the Delaware River are provided in Table 1. All samples were analyzed for nutrients and related water quality parameters within 24 hours of sampling. Samples were collected by standing in the stream. Facing upstream, the bottle was rinsed out with the creek water two or three times, and then the sample was collected. The samples were kept in on ice in a cooler until they were analyzed.

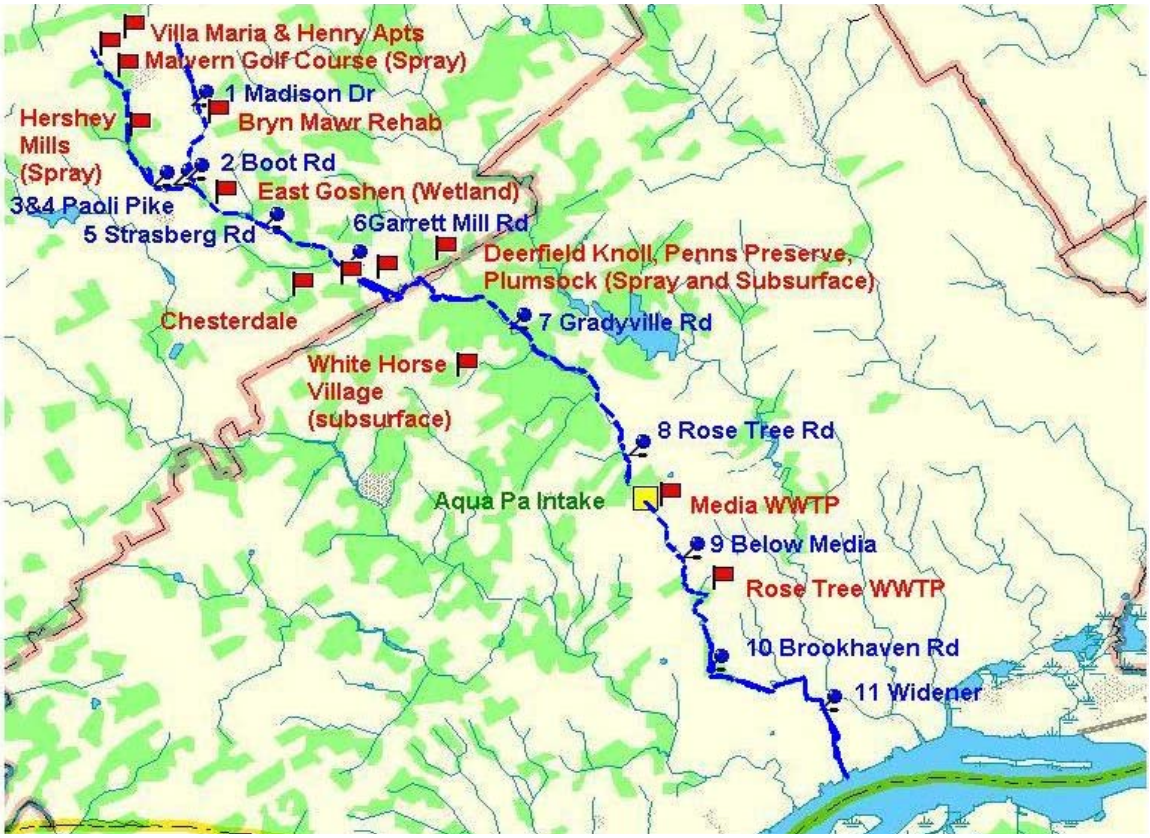


Figure 1: Sample Locations

Table 1: Sample distances from mouth of Delaware

Ridley Creek		
Sample #	Distance from Mouth (mi)	Location
1	20.33	Madison Rd
2	18.96	Boot Rd
3	22.24	Saratoga Dr.
4	21.87	Paoli Pike
5	17.3	Strsberg Rd
6	15.7	Garretts Mill Rd
7	11.92	Gradyville Rd
8	8.4	Rose Tree Rd
9	6.28	Below Media
10	3.77	Brookhaven Rd
11	1.1	Widener

Nutrient analyses were performed on all on the samples collected, including a field blank and a duplicate of sample of number 4 for quality assurance. Concentrations of phosphorous (PO_4-P), nitrate (NO_3-N), and ammonia (NH_3-N) were determined using a Hach DR 4000 spectrophotometer (Hach method numbers 8048, 10020, and 10031, respectively, Hach DR4000 Methods Manual). A calibration curve was created for each nutrient (see Appendix A).

The total inorganic nitrogen (TIN) was calculated, for each location where samples were taken, by adding the concentrations of ammonia and nitrate nitrogen. The TIN / Phosphorous ratio was calculated for each sample using Equation 1. This ratio is helpful in determining the limiting nutrient for algal growth. TIN/P (mg/mg) values greater than 7 may indicate that phosphorus is the limiting nutrient, while TIN/P values less than 7 indicate that nitrogen is the limiting nutrient.

The nutrient mass loads were calculated using Equation 2 for the data collected near the Ridley Creek flow gage below Rose Tree Road. The flow rate on April 14, 2005 was 75 ft^3/sec. The mass load of nutrients in Ridley Creek was then compared to the amount of the nutrients in Chester Creek.

Equation 1. TIN / PO_4-P

where: TIN= Nitrate concentration(mg/L)+Ammonia concentration(mg/L)

PO4-P = Phosphorous concentration

If: TIN / PO4-P > 7.0 then Phosphorous is limiting

If: TIN / PO4-P < 7.0 then Nitrogen is limiting

Equation 2. Mass Load (lb/ day) = Q * C * 5.4

where: Q = Flow rate = volume/time (ft^3/s)

C = Concentration = mass/volume (mg/L)

Results and Discussion

The nutrient concentration measurements at various locations along Ridley Creek are listed in Table 2.

Table 2. Nutrient Concentration Measurements.

Ridley Creek						
Sample	Phosphorus (mg/L)	Phosphorus (abs)	Nitrate (mg/L)	Nitrate (abs)	Ammonia (mg/L)	Ammonia (abs)
1	0.04	0.021	5.9	0.148	0	0
2	0.06	0.03	3.3	0.088	0.121	0.076
3	0.34	0.191	3.7	0.095	1.138	0.71
4	0.35	0.193	4.3	0.111	1.039	0.648
5	0.25	0.14	4.4	0.113	0.195	0.122
6	0.19	0.107	4	0.103	0	0
7	0.09	0.05	3.4	0.09	0	0
8	0.08	0.045	2.4	0.063	0.02	0.013
9	0.05	0.023	4.1	0.106	0.006	0.004
10	0.13	0.072	3.3	0.087	0.019	0.012
11	0.15	0.081	3.7	0.095	0.048	0.03
Field Blank	0.02	0.011	1	0.029	0	0
4QC	0.34	0.187	3.7	0.096	1.144	0.713

A general assessment of the nutrient levels are provided in Table 3. For phosphorus, low or background concentrations were set at less then 0.1 mg/L. Typical phosphorus concentrations were between 0.1 and 0.3 mg/L, and high concentrations were set at greater than 0.3 mg/L. The background concentration for nitrate-N was less then 1.5 mg/L. Typical nitrate-N concentrations were between 2 and 5 mg/L, and high nitrate-

N concentrations were greater than 5 mg/L. The background concentration for ammonia-N was less then 0.5 mg/L, and the high concentrations were set as greater than 0.5 mg/L.

The high levels of Nitrate at sample location 1 may be due to a high level of development with individual household septic systems. The high levels of phosphorous and ammonia at sample locations 3 and 4 may be related to discharges of wastewater.

Table 3. General Assessment.

General Assessment			
Sample	Phosphorus (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)
1	Background	High	Background
2	Background	Typical	Background
3	High	Typical	High
4	High	Typical	High
5	Typical	Typical	Background
6	Typical	Typical	Background
7	Background	Typical	Background
8	Background	Typical	Background
9	Background	Typical	Background
10	Typical	Typical	Background
11	Typical	Typical	Background
Field Blank	Background	Background	Background
4QC	High	Typical	High

TheTIN/P ratio at each location on Ridley Creek has been provided in Table 4. The TIN/P ratio at each location along Ridley Creek was greater than 7.0, indicating that phosphorus may be the limiting nutrient for algal growth in the stream.

Table 4. TIN and N/P Results

Ridley Creek		
Sample	TIN (mg/L)	N/P
1	5.900	147.500
2	3.421	57.017
3	4.838	14.229
4	5.339	15.254
5	4.595	18.380
6	4.000	21.053
7	3.400	37.778
8	2.420	30.250
9	4.106	82.120
10	3.319	25.531
11	3.748	24.987
Field Blank	1.000	50.000
4QC	4.844	14.247

The mass of each nutrient flowing through Ridley and Chester Creeks in a day is provided in Table 5. The mass load of each nutrient in Ridley Creek was found to be significantly less than the mass load of nutrients found in Chester Creek at the Dutton Mill flow gage.

Table 5. Comparison of nutrient mass loads.

Ridley Creek			
Sample	Mass P (lb/day)	Mass Nitrate (lb/day)	Mass Ammmonia (lb/day)
8	32.363	970.885	8.091
Chester Creek			
Sample	Mass P (lb/day)	Mass Nitrate (lb/day)	Mass Ammmonia (lb/day)
unknown	150	3900	32

Conclusions

It was found that the concentrations of each nutrient measured in Ridley Creek were generally low or moderate except for a few locations in the upper watershed. However, during summer months, the nutrient concentration levels would increase due to

the decrease in flow-rate with the same amount of wastewater present as when this study was conducted. Therefore, the percentage of wastewater in the creek in the summer would be greater than the percentage of wastewater in winter months, thus yielding higher nutrient concentration levels.

Ridley Creek is a source of drinking water at the Aqua PA intake in Media, PA, below sample location number eight. The concentrations of Nitrates at each sample location were below the 10mg/L drinking water level. Therefore, Ridley Creek is a good source of drinking water during winter months. Additional nutrient tests should be conducted during summer months of low flow in order to determine if the concentration of Nitrates exceeds 10mg/L. It was also surprising to see nitrate-n concentrations above 5.0 mg/L at Sample 1 in the upper watershed. It was found that phosphorus was the limiting nutrient at the sample sites for this study based on the TIN/P ratios greater than 7.0

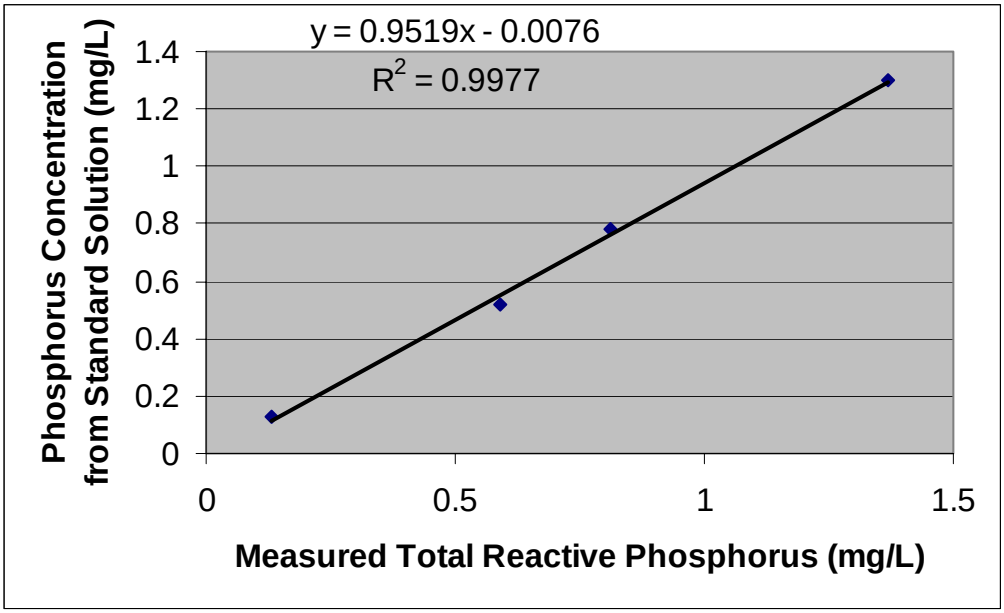
References:

Hach DR 4000 Methods Manual.

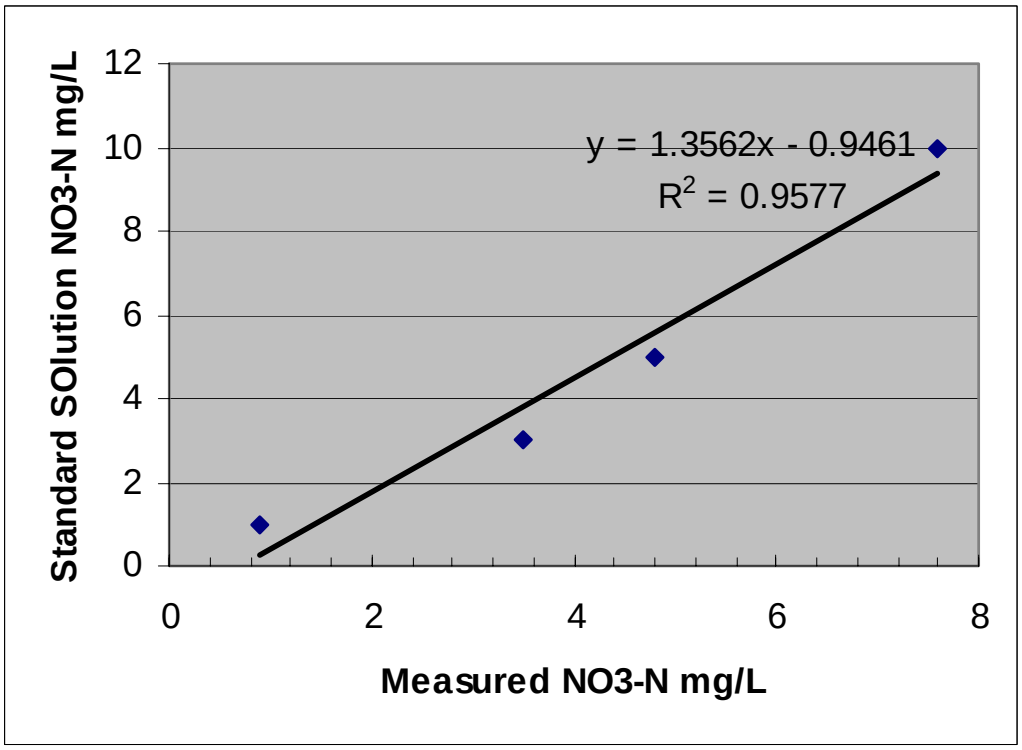
"Ridley Creek Conservation Plan" prepared by the Natural Lands Trust on February 21, 1997

Appendix A

Calibration Curve: Phosphorous



Calibration Curve: Nitrate



Calibration Curve: Ammonia