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Characterization of Six Watersheds of Wayne County, New York

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Wayne County Soil & Water Conservation District

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Picture credit: Scott DeRue

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SUMMARY

1. From April 2009 to October 2009 the Wayne County Soil & Water Conservation District, in conjunction with the Department of Environmental Science and Biology at The College at Brockport, assessed the water quality of Canandaigua Outlet, Sodus Creek (locally known as Glenmark Creek), Crusoe Creek, Black Brook, Red Creek East, and Red Creek West in Wayne County, New York.

2. The creeks were sampled during hydrometeorological events and nonevent stream conditions.

3. Sampling consisted of stream water collection (grab sample) and preservation as well as velocity measurements, stage height, and staff gauge readings to estimate point discharge.

4. Comparing areal (g/ha/d) loss of phosphorus from the watershed to downstream systems, Crusoe Creek and Red Creek East had significantly higher losses than other Wayne County watersheds by a factor of nearly two. Compared to losses in other watersheds in western and central New York, these losses were at the higher end of the losses per unit area of watershed.

5. Not considering watershed area, Canandaigua Outlet had the highest losses of total phosphorus (TP) at 32.0 kg/d during nonevents and Crusoe Creek had the highest TP losses (125.6 kg/d) during event stream conditions.

6. Crusoe Creek, Red Creek East, and Red Creek West had elevated concentrations of TP. Canandaigua Outlet had the highest nitrate concentrations during both nonevent and event stream conditions.

7. For total suspended solids, an indicator of loss of soils from a watershed, Black Brook and Glenmark Creek had elevated concentrations; Canandaigua Outlet, Crusoe Creek, and Glenmark Creek had relatively high losses of solids during events from their watersheds.

8. Besides elevated losses of nutrients, Crusoe Creek also had depressed levels of dissolved oxygen especially during event stream conditions (mean = 3.91 mg/L). This suggests a biochemical oxygen demand (BOD) source within the watershed.

9. We recommend that the monitoring of these streams continues to increase the number of data points and therefore the reliability of the data set. In addition, samples could be taken over multiple seasons or for an entire annual cycle. Eventually, prioritization for this group of watersheds could be made for the identification of point and/or nonpoint sources of pollution using a process such as Stressed Stream Analysis.

INTRODUCTION

Located in central New York State, Wayne County is bordered by Lake Ontario to the north and the Finger Lakes region to the south. Water resources play a vital role in the economic viability of this region especially in terms of recreation, tourism, and industry. The close proximity to the moderating effects of Lake Ontario on the temperature extremes of the region allows for the production of a variety of crops. A large percentage of land use is in agriculture, including fruit trees, row crops, and vineyards. Agriculture has a major economic impact in Wayne County. Also, freshwater resources have historically played an instrumental role in community development and economic sustainability – especially on shoreline communities along Lake Ontario.

Wayne County Soil and Water Conservation District has a long history of working to keep soil and nutrients on the land and out of the water. Much of this work has focused on Sodus Bay and Port Bay (Makarewicz and Lewis 1989, 1990; Makarewicz *et al*. 1991, 1992, 1993, 1994; White *et al*. 2002). However, little is known about the environmental status of other major creeks in Wayne County away from the coastal area of Lake Ontario. As a result, the Wayne County Water Quality Coordinating Committee (WQCC) recommended a study to evaluate nutrient and soil loss from six watersheds and their creeks [Canandaigua Outlet, Glenmark (Sodus) Creek, Crusoe Creek, Black Brook, Red Creek East, and Red Creek West] not previously assessed. The purpose of the monitoring program was to collect water quality data in order to quantify the concentration and loading of nutrients and suspended sediments transported from these creeks and to evaluate the environmental health of each creek. In addition, the data serve as a database to make informed water quality management decisions, including the development of a watershed management plan, and as a benchmark of discharge and nutrient data to measure the success of future remediation efforts and to begin a data set that would lead to a priority listing of water quality goals.

Definitions

- **mg/L and µg/L** – units of concentration. One mg/L equals one part per million (ppm). For example, a concentration of 2 mg Na/L means there are two parts of sodium per I million parts of water. One µg/L equals one part per billion.

- **Total Phosphorus (TP**) - A measure of all forms of the element phosphorus. Phosphorus is an element required for plant growth on land or in water. In lakes, phosphorus is often the limiting factor of phytoplankton growth and is the cause of eutrophication, or overproduction, of lakes. Phosphorus may enter a watershed in soluble or organic form from several sources including sewage, heavy-duty detergents, fertilizer, and agricultural waste. Some forms of phosphorus are more available to, and cause more immediate activity in, plants.
- **Nitrate + Nitrite (NO_3+NO_2**) - A measure of the soluble forms of nitrogen used readily by plants for growth. Sources of nitrates in the environment are many and include barnyard waste and fertilizer.
- **Total Kjeldahl Nitrogen (TKN)** - The Kjeldahl method is a convenient method of analysis for nitrogen but cannot be used for all types of nitrogen compounds. It is, however, a good measure of organic nitrogen, including ammonia. Manure, for example, contains a large amount of organic nitrogen.
- **Total Suspended Solids (TSS)** - A measure of the loss of soil and other materials suspended in the water from a watershed. Water-borne sediments act as an indicator, facilitator and agent of pollution. As an indicator, they add color to the water. As a facilitator, sediments often carry other pollutants such as nutrients and toxic substances. As an agent, sediments smother organisms and clog pore spaces used by some species for spawning.

Study Sites

Canandaigua Outlet: Canandaigua Outlet begins at the northern end of Canandaigua Lake at State Route 5 and 20 and empties into the Erie Canal in the Village of Lyons at State Route 31.

Crusoe Creek: Crusoe Creek begins at Crusoe Lake in the Town of Savannah and empties into the Seneca River. The Crusoe Creek watershed also includes Black Creek and Butler Creek. Black Creek originates in the Town of Butler near the Hamlet of West Butler and enters Crusoe Creek south of Crusoe Lake. Butler Creek originates in the eastern portion of the Town of Butler and empties into the northern end of Crusoe Lake.

Red Creek West: Red Creek West originates in the Town of Walworth and empties into Ganargua Creek near the intersection of Schilling and N. Creek Road (at Swift's Landing Park) in the Town of Palmyra.

Red Creek East: Red Creek East originates in the northern portion of the Town of Marion and empties into Ganargua Creek south of Hydseville Road in the eastern portion of the Town of Palmyra.

Black Brook: Black Brook originates in the northern portion of the Town of Lyons and empties into the Erie Canal south of Old Route 31 in the Town of Galen near the Hamlet of Lock Berlin.

Glenmark Creek: Sodus Creek East, or Glenmark Creek, originates in the town of Galen and empties into the southern end of Sodus Bay in the Town of Huron.

METHODS

In April 2009 the Wayne County Soil & Water Conservation District (WCSWCD), in conjunction with the Department of Environmental Science and Biology at the College at Brockport, began a survey of six streams located in Wayne County, New York [Canandaigua Outlet, Sodus Creek (locally known as Glenmark Creek), Crusoe Creek, Black Brook, Red Creek East, and Red Creek West]. All water samples were taken by WCSWCD personnel from April 2009 through October 2009 (Tables 1 and 2, Figure 1). The sites were also visited during hydrometeorological events on five dates. During visits to the sites, staff gauge readings were recorded and a grab water sample was taken for laboratory analysis.

Water samples were subsampled, filtered, and preserved immediately after sampling for the dissolved nutrient analysis of nitrate + nitrite using 0.45-µm MCI Magma Nylon 66 membrane filters and were frozen or put on ice and held at 4° C until analysis. The filtration unit and other processing apparatus were cleaned routinely with phosphate-free RBS. Samples were transported to SUNY Brockport for water chemistry analysis for total phosphorus (TP), total Kjeldahl nitrogen (TKN), nitrate + nitrite, and total suspended solids (TSS) (see detailed analytical methods below).

Water Chemistry

Nitrate + Nitrite: Dissolved nitrate + nitrite nitrogen analyses were performed by the automated (Technicon Autoanalyser) cadmium reduction method (APHA 1999).

Total Phosphorus: The persulfate digestion procedure was used prior to analysis by the automated (Technicon Autoanalyser) colorimetric ascorbic acid method (APHA 1999).

Total Kjeldahl Nitrogen: Analysis was performed using EPA Method 351.2 with the substitution of copper for mercury as the catalyst as per APHA Method 4500-N_{org} B (EPA 1979, APHA 1999).

Total Suspended Solids: APHA (1999) Method 2540D was employed for this analysis.

Stream Velocity, Cross-sectional Area, Discharge, and Loading

In general, velocity, cross-sectional area, and discharge for each stream were measured following Rantz (1982). Stream velocity and water depth were measured at equally spaced increments perpendicularly across the streams. Stream velocity was measured by WCSWCD personnel utilizing a 622 or 625 Gurley flow meter, depending upon the water depth. Water depth was measured and cross-referenced using manual staff gauges. A cross-section of the sampling sites was manually surveyed. The survey data and velocity readings were used to calculate a discharge for each increment of the stream. The discharge of each stream increment was summed to provide discharge at each site for that particular date and time. Instantaneous discharge (in cubic feet per second) was expanded into daily discharge (in cubic meters per day) by assuming constant discharge over the course of the day. Losses from the watershed as daily loadings were calculated by multiplying the daily discharge of each sampling date by the corresponding water chemistry.

Field Monitoring

Temperature, dissolved oxygen (DO), conductivity, and pH were measured in the field using a YSI Professional Plus multi-parameter meter (Item # 605596). All sensor calibrations were performed prior to sampling and followed the directions in the User Manual. pH measurements were taken with a glass combination electrode while the sensor for conductivity was a four electrode cell. Dissolved oxygen measurements were taken with a polarographic probe. The sensor was calibrated in Water Saturated Air by the “0ne-point calibration method” suggested by the vendor.

External Quality Control

Quality Control/Quality Assurance: Water samples were analyzed at the Water Chemistry Laboratory at The College at Brockport, State University of New York (NELAC – EPA Lab Code # NY01449). In general, the NELAC certification program includes biannual proficiency audits and annual inspections and documentation of all samples, reagents and equipment under good laboratory practices. All quality control (QC) measures are assessed and evaluated on an on-going basis. As required by NELAC and New York’s ELAP certification process, method blanks, duplicate samples, laboratory control samples, and matrix spikes are performed at a frequency of one per batch of 20 or fewer samples. Field blanks (events and nonevents) are routinely collected and analyzed. Analytical data generated with QC samples that fall within prescribed acceptance limits indicate the test method was in control. For example, QC limits for laboratory control samples and matrix spikes are based on the historical mean recovery plus or minus three standard deviations. QC limits for duplicate samples are based on the historical mean relative percent difference plus or minus three standard deviations. Data generated with QC samples that fall outside QC limits indicate the test method was out of control. These data are considered suspect and the corresponding samples are either reanalyzed or the results flagged with an appropriate explanation. As part of the NELAC certification, the lab participates semi-annually in a proficiency testing program (blind audits, Table 3) for each category of ELAP approval. If the lab fails the proficiency audit for an analyte, the lab director is required to identify the source and correct the problem to the satisfaction of the certification agency.

RESULTS

Total phosphorus (TP) (Figs. 2-3)

Mean nonevent total phosphorus concentrations ranged from 33.6 µg P/L in Glenmark Creek to 95.3 µg P/L in Crusoe Creek. Nonevent TP means were also relatively high in Red Creek East (92.1 µg P/L) and Red Creek West (85.7 µg P/L). Mean total phosphorus concentrations increased for all Wayne County streams studied under stream event conditions when compared to nonevent conditions. Mean event TP concentrations in descending order were 146.2 µg P/L (Red Creek West), 145.0 µg P/L (Crusoe Creek, 128.8 µg P/L (Glenmark Creek), 122.2 µg P/L (Red Creek East), 93.9 µg P/L (Canandaigua Outlet), and 91.0 µg P/L (Black Brook).

Nitrate (Figs. 2-3)
Canandaigua Outlet had the highest mean nitrate concentrations found in the Wayne County tributaries monitored under both nonevent (0.97 mg N/L) and event conditions (1.10 mg N/L). Glenmark Creek had the second highest nonevent mean nitrate concentration at 0.69 mg N/L and a mean event nitrate concentration of 0.34 mg N/L, which ranked third highest for the Wayne County streams. Crusoe Creek had the lowest mean nitrate concentrations under all stream conditions (nonevent = 0.07 mg N/L, event = 0.13 mg N/L).

Total Suspended Solids (TSS)(Figs. 2-3)
Mean nonevent total suspended solids concentrations ranged from a low of 2.6 mg/L in Red Creek East to a high of 10.9 mg/L in Black Brook which was more than twice as high as any of the other streams monitored. As expected, TSS concentrations increased in all streams under event conditions. Glenmark Creek (30.9 mg/L) and Black Brook (24.2 mg/L) had relatively high event TSS concentrations while conversely Red Creek East (3.4 mg/L) and Red Creek West (5.5 mg/L) were relatively low in event suspended solids concentrations.

Total Kjeldahl nitrogen (TKN)(Figs. 2-3)
Three Wayne County creeks had mean total Kjeldahl nitrogen nonevent concentrations that exceeded 1,000 µg N/L (Crusoe Creek - 1,223 µg N/L; Black Brook - 1,084 µg N/L; and Red Creek East - 1,084 µg N/L). Compared to its mean nonevent TKN concentration (650 µg N/L), Canandaigua Outlet's mean event TKN concentration was 226% higher at 2,121 µg N/L. Crusoe Creek (1,189 µg N/L) and Black Brook (1,109 µg N/L) also had mean event TKN concentrations over 1,000 µg N/L.

Physical Field parameters (Temperature, Dissolved Oxygen, Conductivity, and pH (Table 4)
Temperature ranged from 8.8 to 22.4 °C during the April to October study period. Dissolved oxygen (DO) ranged from an overall mean of 6.29 mg/L in Red Creek East to 10.31 mg/L in Glenmark Creek. Of particular concern is the low mean DO of 3.91mg/L in Crusoe Creek during events, suggesting some source of oxygen demand in the watershed. Overall, conductivity was highest in Red Creek West (mean = 933 µmhos/cm) while Glenmark Creek had the lowest overall mean conductivity at 432 µmhos/cm. pH had relatively little variability as it ranged from an overall mean of 7.61 in Crusoe Creek to 8.27 in Glenmark Creek. The low pH readings in Crusoe Creek appear to be associated with the oxygen demand that reduced the levels of DO in that stream.

Losses (Flux) from Streams (Table 4)

While the mean water quality chemistry concentrations were the most reliable measurements made during this study to prioritize the creeks of Wayne County, flux or losses from the watershed considers both discharge and concentration – mass loss. The mass loss (kg/d) of these constituents from the watersheds should be considered when evaluating the impact of each stream on its downstream ecosystem. Discharge for each stream sampling visit is reported in Table 4 and represents a physical measurement of stream stage height and mean velocity. Preliminary rating curves developed from those discharge measurements for each watershed (Fig. 4) predict the discharge from the stage height of the stream. Many more points and a larger range in stage height are necessary to completely rely on these curves for accurately estimating discharge (see outlying point in Red Creek East rating curve). Thus one must be cautious when using the loading estimates derived from the methodology employed for this comparison study, as the temporal range was only six months. While the loading estimate for each sampling date is valid, the error of extrapolating that reading increases with the time-frame of that extrapolation. In other words, the instantaneous snapshot loading that was measured on each sampling date could be expanded to a daily, weekly, monthly or even an annual value by multiplying the instantaneous measurement by that time frame; however, each expansion increases the error inherent in that estimate. We have chosen to use a daily loading value for this analysis and will use that estimate only for comparative purposes and prioritization within this intra-county study.

Total phosphorus (TP)(Figs. 2-3)
Canandaigua Outlet had the highest loss of TP at 32.0 kg/d during nonevent and the second highest loss at 84.8 kg/d during event stream conditions. While the TP loss at Crusoe Creek was relatively low during nonevent conditions (6.1 kg/d), it had the highest mean event losses of TP at 125.6 kg/d for all the Wayne County streams monitored. Glenmark Creek (0.7 kg/d) and Black Brook (0.8 kg/d) had the lowest nonevent TP losses, and Black Brook (8.2 kg/d) and Red Creek West (13.4 kg/d) ranked the lowest under event stream conditions.

Nitrate (Figs. 2-3)
Canandaigua Outlet had the highest losses of nitrate during both nonevent (693.7 kg/d) and event conditions (1,058.7 kg/d) during the 2009 study period. The losses from this larger creek dwarfed the losses of nitrate from all of the other streams monitored. For example the next highest mean nonevent loss of nitrate was Red Creek East at 40.2 kg/d and the next highest mean event loss was for Crusoe Creek at 132.1 kg/d.

Total suspended solids (TSS)(Figs. 2-3)
The highest losses of solids found in the Wayne County streams in this study were from Canandaigua Outlet (2,384 kg/d during nonevents and 9,385 kg/d during events). Four other streams had nonevent losses of over 200 kg/d: Red Creek West (259 kg/d), Black Brook (237 kg/d), Crusoe Creek (217 kg/d), and Red Creek East (823 kg/d). During event conditions, different streams (Crusoe Creek – 7,695 kg/d, Glenmark Creek – 5,187 kg/d) had surprisingly high losses (fluxes), suggesting that erosion is occurring in these watersheds during event runoff conditions.

Total Kjeldahl nitrogen (TKN)(Figs. 2-3)

As with nitrate and TSS, Canandaigua Outlet had the highest losses of TKN during this study at 464.4 kg/d during nonevents and 1340.6 kg/d during stream event conditions. Red Creek East had the next highest loss of TKN during nonevents (311.5 kg/d), while Glenmark Creek had the smallest loss of TKN at 14.4 kg/d. During event conditions, the losses of TKN of the remaining monitored streams were 848.3 kg/d (Crusoe Creek), 176.3 kg/d (Red Creek East), 118.5 kg/d (Glenmark Creek), 100.8 kg/d (Black Brook), and 63.1 kg/d (Red Creek West).

DISCUSSION

Six creeks within Wayne County were monitored for baseline and storm event sediment and nutrient loads over a seven-month period to assess the current status of these water bodies in relation to other watersheds within Wayne County and central New York, to provide scientific data to update the Priority Waterbodies List, and to prioritize local projects for further study. Some conclusions can be reached. Considerable variability existed in the concentrations and losses of nutrients from the six watersheds (Figs. 2 and 3). This is expected and is due to differences in land use and point and nonpoint sources within each watershed. Crusoe Creek, Red Creek East, and Red Creek West had elevated concentrations of TP. Canandaigua Outlet had the highest nitrate concentrations during nonevent and event stream conditions. For TSS, Black Brook and Glenmark Creek had elevated concentrations; Canandaigua Outlet, Crusoe Creek, and Glenmark Creek had relatively high losses of solids from their watersheds. For example, Canandaigua Outlet had the highest losses of TP at 32.0 kg/d during nonevents and Crusoe Creek had the highest TP losses (125.6 kg/d) during event stream conditions. In general, losses from watersheds were higher during event versus nonevent conditions due to increase overland runoff and erosion (Table 4). An exception to this is TKN loss from Red Creek East which was lower for events (311.5 kg/d) versus nonevents (176.3 kg/d), as some constituents can be diluted during heavy precipitation or snow melt.

Areal flux (g/ha/d) considers the loss of nutrients and soil from a watershed weighted by the size of the watershed. This calculation provides a better comparison of flux between watersheds as the factor watershed size is normalized. When comparing areal (g/ha/d) loss of phosphorus from the watershed to downstream systems, Crusoe Creek and Red Creek East have significantly higher losses than other Wayne County watersheds by a factor of nearly two (Table 5). This strongly suggests that there are sources of phosphorus being delivered from these watersheds that are not typical of other area watersheds. Compared to losses in other watersheds in western and central New York (Table 6), these losses are at the higher end of the losses per unit area of watershed. Further effort in these watersheds may be needed to identify the sources and provide remediation. Also, the dissolved oxygen concentrations and perhaps the lower pH values observed at Crusoe Creek during events suggest with the phosphorus data that a source(s) of nutrients exists in this watershed. Other creeks (Canandaigua Outlet and Glenmark Creek, for example) in this study had phosphorus losses that are comparable to land use associated with agriculture (Table 6). Caution should be exercised when using these comparisons because the Wayne County values are based on only eight sample dates while many of the watersheds in Table 6 were monitored for an entire annual cycle.

Nonpoint Sources: How Do Nutrients and Soils Move from the Land to Streams?

The quality and quantity of runoff from a watershed into a stream are ultimately influenced by the land use and interactions with inhabitants of the watershed. The amount of runoff is determined by the amount of excess precipitation, that which neither sinks into the ground nor is stored at the surface. Precipitation excess is determined primarily by climate, vegetation, infiltration capacity, surface storage, and land use by people. Impervious landscapes (e.g., parking lots), removal of wetlands and vegetation in general, storm sewers, blockage of streams by debris, etc., all contribute to rapid rises in stream level and potential flooding. Surface runoff dissolves constituents, such as the soluble forms of nutrients (phosphate and nitrate) and salts (sodium) from the soil and other surfaces it contacts, carrying them to the stream. Runoff also scours and erodes the surfaces it flows over, sweeping soil particles containing phosphorus and nitrogen from the watershed into the stream. Land use and surface conditions determine, to a large degree, the magnitude of the loss of these constituents from the watershed to the stream via these processes. For example, a tilled agricultural field that is subjected to surface runoff from precipitation or snowmelt will lose a large amount of soil and nutrients to the stream as that water flows over the exposed surfaces. Land use and agricultural practices initiated by people can and do affect stream water quality and stream discharge. If we can identify the sources of pollution, remedial action plans and best management plans can be initiated that mitigate downstream and lake effects.

RECOMMENDATIONS

Determination of sources and magnitude of soil and nutrient losses from a watershed is prerequisite to remedial action and essential to making cost-effective land management decisions as it reduces the likelihood of costly miscalculations based on the assumption of soil and nutrient sources and modeling rather than on their actual identification. The goal of this study was not to evaluate the causes of the variability in loss of nutrients from the various watersheds. However, they clearly exist and are likely amenable to mitigation through management programs such as Whole Farm Planning in agricultural watersheds. We recommend that the monitoring of these streams continues to increase the number of data points and therefore the reliability of the data set. In addition, samples could be taken over multiple seasons or for an entire annual cycle. Eventually, prioritization for this group of watersheds could be made for the identification of point and/or nonpoint sources of pollution using a process such as Stressed Stream Analysis (Makarewicz 1993).

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Table 1. Geographic coordinates of the Wayne County water quality monitoring stations.

Watershed	Latitude	Longitude	Description of Location
Red Creek West	N 43° 05.261'	W 77° 14.313'	Due north of the "T" of Division St. onto Maple Ave. in Palmyra, NY.
Red Creek East	N 43° 05.483'	W 77° 09.188'	Left off of N Creek Rd. on Hydesville Rd. on the property of Ruth Herman 4800 N. Creek Rd. Newark, NY.
Black Brook	N 43° 04.595	W 76° 56.083	Railroad track bridge south of Old Rt. 31 in Clyde, NY. Get on CSX maintenance road at Sunderville Rd. off of Old Rt. 31 in Lyons, NY and follow east.
Sodus (Glenmark) Creek	N 43° 12.162'	W 76° 54.834'	Dead end of Briggs Rd. W in North Rose, NY south of Rt. 104
Crusoe Creek	N 43° 05.392'	W 76° 45.732'	North on Rt. 89 from Rt. 31 in the Village of Savannah, NY.
Canandaigua Outlet	N 43° 03.459'	W 76° 59.789'	Railroad track bridge south of Rt. 31 between Leach Rd. and Rt. 14 in Lyons, NY.

Table 2. The watershed areas of Wayne County streams as determined by the Wayne County Soil and Water Conservation District.

Creek	Watershed Area (acres)	Watershed Area (ha)
Red Creek West	30,748	12,444
Red Creek East	18,315	7,412
Black Brook	13,090	5,298
Sodus (Glenmark) Creek	9,788	3,961
Crusoe Creek	30,439	12,319
Canandaigua Outlet	85,298	34,520

Table 3. Proficiency audit of the Water Quality Laboratory at The College at Brockport.

WADSWORTH CENTER
NEW YORK STATE DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY APPROVAL PROGRAM

Proficiency Test Report

Lab 11439 | SUNY BROCKPORT, WATER LAB LENNON HALL, BROCKPORT, NY 14420, USA | EPA Lab ID NY01449 | Page 1 of 1

Shipment: 320 Non Potable Water Chemistry | Shipment Date: 20-Jan-2009

Analyte	Sample ID	Result	Mean/Target	Acceptance Limits	Method	Score
Approval Category : **Non Potable Water**						
Sample: **Residue**						
Solids, Total Suspended 198 passed out of 207reported results.	2002	85.1	85.8	70.4 - 95.3	SM18-20 2540D (97)	Satisfactory
Sample: **Organic Nutrients**						
Kjeldahl Nitrogen, Total 89 passed out of 89 reported results.	2004	27.4	29.3	19.3 – 37.6	EPA 351.2 Rev. 2.0	Satisfactory
Phosphorus, Total 98 passed out of 106 reported results.	2004	9.00	8.62	7.13 – 10.2	SM18-20 4500-PF	Satisfactory
Sample: **Inorganic Nutrients**						
Nitrate (as N) 119 passed out of 120 reported results.	2007	27.98	27.1	21.1 – 32.7	SM18-20 4500-NO3 F (00)	Satisfactory
Orthophosphate (as P) 90 passed out of 97 reported results.	2007	3.00	2.94	2.58 – 3.51	SM18-20 4500-PF	Satisfactory
Sample: **Minerals II**						
Sodium, Total 80 passed out of 81 reported results.	2037	72.9	67.0	56.9 – 76.9	SM 18-20 3111B (99)	Satisfactory
Sample: **Nitrite**						
Nitrite as N 107 passed out of 111 reported results.	2041	2.89	2.87	2.43 – 3.31	SM 18-20 4500-NO2 B	Satisfactory

Table 4. Discharge, concentration and loading parameters for Wayne County stream sites during 2009.

Canandaigua Outlet

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/27/2009	Non-Event	1,983,218	24.3	0.52	3.6	292	48.2	1031.3	7139.6	579.9				
4/28/2009	Event	873,669									16.6	11.50	660	8.47
5/11/2009	Non-Event	743,115	29.6	0.85	0.4	1276	22.0	631.6	297.2	948.2	14.9	12.83	839	8.50
6/8/2009	Non-Event	388,866	50.7	0.88	6.3	741	19.7	342.2	2449.9	288.0	18.8	11.40	934	8.50
6/22/2009	Event	3,404,241												
7/14/2009	Non-Event	622,533	78.8	1.45	5.0	491	49.1	900.0	3112.7	305.7	18.4	9.34	860	8.13
8/11/2009	Event	1,261,485	95.8	1.30	10.0	589	120.9	1639.9	12614.9	743.0	22.4	6.38	831	7.83
9/8/2009	Non-Event	517,781	48.5	0.98	1.7	338	25.1	507.4	880.2	175.0	20.1	8.69	722	8.23
10/13/2009	Non-Event	640,488	43.6	1.17	0.7	764	27.9	749.4	427.0	489.5	10.1	11.67	738	8.39
10/29/2009	Event	530,581	91.9	0.90	11.6	3653	48.8	477.5	6154.7	1938.2	11.7	8.95	565	7.84
Canandaigua Outlet	Mean	1,096,598	57.9	1.01	4.9	1018	45.2	784.9	4134.5	683.4	16.6	10.10	769	8.24
Canandaigua Outlet	Non-Event Mean	816,000	45.9	0.97	2.9	650	32.0	693.7	2384.4	464.4	16.5	10.79	819	8.35
Canandaigua Outlet	Event Mean	1,517,494	93.9	1.10	10.8	2121	84.8	1058.7	9384.8	1340.6	16.9	8.94	685	8.05

Glenmark

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/28/2009	Event	65,292	25.4	0.34	5.7	369	1.7	22.2	372.2	24.1	14.1	9.20	476	8.42
5/11/2009	Non-Event	20,527	27.5	0.41	3.2	1582	0.6	8.4	65.7	32.5	12.7	12.04	476	8.48
6/8/2009	Non-Event	10,982	40.8	0.84	4.4	260	0.4	9.2	48.3	2.9	16.0	10.26	526	8.42
6/22/2009	Event	75,503												
7/14/2009	Non-Event	20,142	39.9	0.68	5.5	355	0.8	13.7	110.8	7.2	16.1	11.45	503	8.37
8/11/2009	Event	213,903	134.9	0.30	54.0	965	28.9	64.2	11550.8	206.4	21.4	8.25	241	7.86
9/8/2009	Non-Event	6,869	32.3	0.90	1.7	281	0.2	6.2	11.7	1.9	15.9	9.38	496	8.31
10/13/2009	Non-Event	46,206	27.5	0.61	2.0	596	1.3	28.2	92.4	27.5	8.8	11.40	440	8.47
10/29/2009	Event	110,256	226.0	0.37	33.0	1134	24.9	40.8	3638.5	125.0	10.8	10.51	297	7.84
Glenmark	Mean	63,298	69.3	0.56	13.7	693	7.3	24.1	1986.3	53.4	14.5	10.31	432	8.27
Glenmark	Non-Event Mean	20,945	33.6	0.69	3.4	615	0.7	13.1	65.8	14.4	13.9	10.91	488	8.41
Glenmark	Event Mean	116,238	128.8	0.34	30.9	823	18.5	42.4	5187.1	118.5	15.4	9.32	338	8.04

Crusoe Creek

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/28/2009	Event	67,099	116.7	0.05	16.3	861	7.8	3.4	1093.7	57.8	19.6	5.91	646	7.77
5/11/2009	Non-Event	58,956	77.2	0.06	8.0	1506	4.6	3.5	471.6	88.8	15.5	9.71	566	8.06
6/22/2009	Event	171,546	140.4	0.15	3.6	1516	24.1	25.7	617.6	260.1				
7/14/2009	Non-Event	68,779	118.5	0.06	4.7	1028	8.2	4.1	323.3	70.7	18.5	6.83	540	7.52
8/11/2009	Event	2,788,468	148.0	0.16	9.0	931	412.7	446.2	25096.2	2596.1	22.0	2.27	312	7.17
9/8/2009	Non-Event	37,350	101.6	0.06	0.7	1022	3.8	2.2	26.1	38.2	18.6	3.48	465	7.53
10/13/2009	Non-Event	93,702	83.9	0.10	0.5	1335	7.9	9.4	46.9	125.1	9.3	6.30	478	7.87
10/29/2009	Event	330,997	175.0	0.16	12.0	1447	57.9	53.0	3972.0	479.1	11.1	3.56	454	7.36
Crusoe Creek	Mean	452,112	120.2	0.10	6.9	1206	65.9	68.4	3955.9	464.5	16.4	5.44	494	7.61
Crusoe Creek	Non-Event Mean	64,696	95.3	0.07	3.5	1223	6.1	4.8	217.0	80.7	15.5	6.58	512	7.75
Crusoe Creek	Event Mean	839,528	145.0	0.13	10.2	1189	125.6	132.1	7694.9	848.3	17.6	3.91	471	7.43

Black Brook

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/28/2009	Event	35,147	61.2	0.34	19.7	631	2.1	11.9	692.4	22.2	16.9	7.54	565	7.91
5/11/2009	Non-Event	40,506	41.9	0.30	18.2	2290	1.7	12.2	737.2	92.7	15.8	10.10	578	8.04
6/8/2009	Non-Event	7,313	73.2	0.45	17.2	631	0.5	3.3	125.8	4.6	18.3	9.50	725	8.01
6/22/2009	Event	120,192												
7/14/2009	Non-Event	22,883	40.6	0.50	9.0	762	0.9	11.5	205.9	17.4	15.9	9.05	588	7.87
8/11/2009	Event	116,311	101.2	0.50	27.7	1056	11.8	58.2	3221.8	122.8	20.4	5.56	461	7.50
9/8/2009	Non-Event	8,199	49.1	0.65	8.0	874	0.4	5.3	65.6	7.2	17.0	7.89	620	8.04
10/13/2009	Non-Event	22,000	28.9	0.29	2.2	865	0.6	6.4	48.4	19.0	9.1	9.75	531	8.10
10/29/2009	Event	96,019	110.7	0.89	25.3	1640	10.6	85.5	2424.5	157.5	10.8	4.16	440	7.47
Black Brook	Mean	52,063	63.3	0.49	15.9	1094	3.6	24.3	940.2	55.4	15.5	7.94	563	7.87
Black Brook	Non-Event Mean	20,180	46.7	0.44	10.9	1084	0.8	7.7	236.6	28.2	15.2	9.26	608	8.01
Black Brook	Event Mean	91,917	91.0	0.58	24.2	1109	8.2	51.9	2112.9	100.8	16.0	5.75	489	7.63

Red Creek East

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/28/2009	Event	499,744	100.7	0.16	3.7	566	50.3	80.0	1849.1	282.7	17.3	6.21	669	7.67
5/12/2009	Non-Event	529,180	95.3	0.12	4.4	1549	50.4	63.5	2328.4	819.8	12.4	9.22	752	8.11
6/22/2009	Event	342,422	152.0	0.30	4.5	806	52.0	102.7	1540.9	276.0				
7/14/2009	Non-Event	229,025	82.0	0.16	3.3	904	18.8	35.9	755.8	207.0	16.2	4.77	662	7.49
8/11/2009	Event	86,521	101.2	0.24	3.3	749	8.8	20.8	285.5	64.8	20.9	4.14	760	7.45
9/8/2009	Non-Event	21,777	111.4	0.12	1.6	703	2.4	2.6	34.8	15.3	16.9	5.94	823	7.81
10/13/2009	Non-Event	172,809	79.8	0.34	1.0	1179	13.8	58.8	172.8	203.7	9.0	8.77	694	8.37
10/29/2009	Event	85,503	134.8	0.21	2.2	955	11.5	18.0	188.1	81.6	10.5	4.95	669	7.51
Red Creek East	Mean	245,872	107.1	0.21	3.0	926.3	26.0	47.8	894.4	243.9	14.7	6.29	718	7.77
Red Creek East	Non-Event Mean	238,198	92.1	0.18	2.6	1084	21.4	40.2	823.0	311.5	13.6	7.18	733	7.95
Red Creek East	Event Mean	253,547	122.2	0.23	3.4	769	30.7	55.4	965.9	176.3	16.2	5.10	699	7.54

Red Creek West

Date	Event/Non-Event	Discharge (m3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	TP (kg/d)	Nitrate (kg/d)	TSS (kg/d)	TKN (kg/d)	Temp (°C)	DO (mg/L)	Cond (µmhos/cm)	pH
4/28/2009	Event	136,728	105.5	0.22	6.0	664	14.4	30.1	820.4	90.8	18.1	8.11	648	7.96
5/12/2009	Non-Event	102,296	90.0	0.18	6.2	1353	9.2	18.4	634.2	138.4	12.4	9.22	752	8.11
6/9/2009	Non-Event	20,361	130.6	0.37	3.5	609	2.7	7.5	71.3	12.4	16.4	6.46	1059	7.77
6/22/2009	Event	404,222												
7/14/2009	Non-Event	84,427	44.9	0.22	6.3	815	3.8	18.3	531.9	68.8	17.0	8.06	722	7.80
8/11/2009	Event	29,283	108.3	0.31	6.0	156	3.2	9.1	175.7	4.6	19.7	5.48	1118	7.53
9/8/2009	Non-Event	4,165	66.9	0.25	0.6	429	0.3	1.0	2.5	1.8	16.2	6.65	1329	7.64
10/13/2009	Non-Event	57,096	95.9	0.11	1.0	708	5.5	6.3	57.1	40.4	10.1	10.19	1045	8.04
10/29/2009	Event	100,624	224.7	0.09	4.4	932	22.6	9.1	442.7	93.8	10.9	8.32	788	7.70
Red Creek West	Mean	104,356	108.3	0.22	4.3	708	7.7	12.5	342.0	56.4	15.1	7.81	933	7.82
Red Creek West	Non-Event Mean	53,669	85.7	0.23	3.5	783	4.3	10.3	259.4	52.4	14.4	8.12	981	7.87
Red Creek West	Event Mean	167,714	146.2	0.21	5.5	584	13.4	16.1	479.6	63.1	16.2	7.30	851	7.73

Table 5. Average phosphorus loss from various Wayne County watersheds.

Creek	Watershed Area (ha)	Mean TP Loss (kg/d)	Mean TP Loss (g/ha/d)
Canandaigua Outlet	34,520	45.2	1.31
Glenmark Creek	3,961	7.3	1.85
Crusoe Creek	12,319	65.9	5.35
Black Brook	5,298	3.6	0.68
Red Creek East	7,412	26.0	3.51
Red Creek West	12,444	7.7	0.62

Table 6. Comparison of phosphorus loading in subbasins of the Irondequoit Bay watershed, other Monroe County creeks, tributaries of Sodus and Port Bays, and Lake Neatahwanta tributaries. Irondequoit basin data are from 1980-81.

Subbasin or Creek	Land Use	Total Phosphorus Loading (g P/ha/d) Annual	
Sucker Brook	Agriculture/Urban	7.66	
Irondequoit Creek at Browncroft Blvd. 1975-77 (pre-diversion)	Several Sewage Plants	5.60	
1978-79 (post-diversion)		2.00	
Larkin	Suburban	0.70	
Buttonwood	Suburban	1.58	
Lower Northrup	Sewage Plant	6.64	
Upper Northrup	Urban	3.23	
First	Forested	0.11	
Clark	Forested	0.22	
Sodus East	Agriculture	8.57	
Wolcott	Agriculture	5.01	
Bobolink	Forested	0.02	
Sheldon	Muckland	27.41	
Summerville	Suburban	5.47	
		1997-98	1998-99
Oak Orchard		3.48	2.86
Johnson		1.81	1.17
Sandy		0.98	0.77
		1998-99	1999-00
		1998-2002	
Twelvemile Creek East	Agriculture	0.30	
		1999-2002	
Twelvemile Creek West	Agriculture	0.67	
		2003-2005	
Eighteenmile Creek	Urban/Agriculture	3.83	

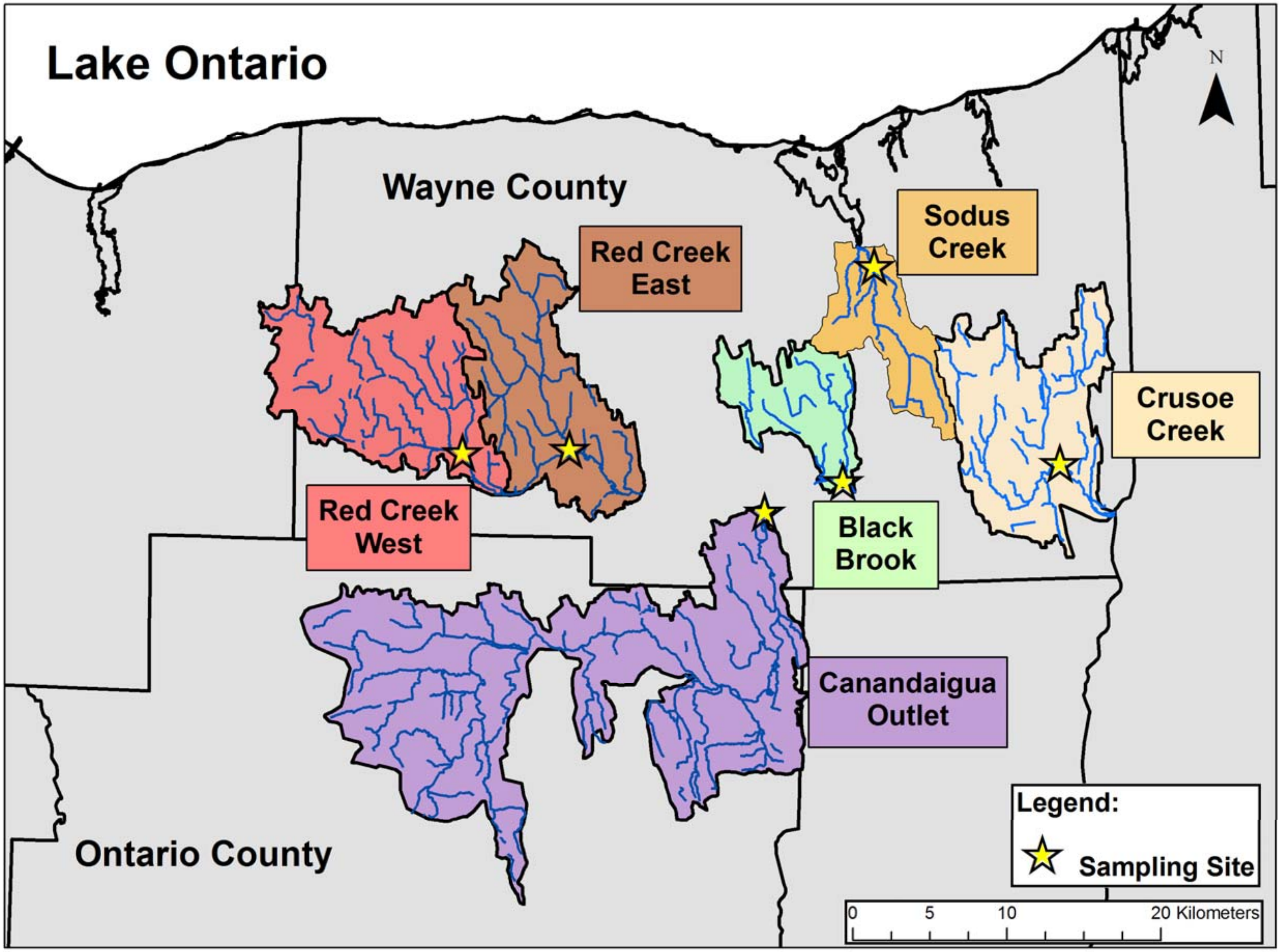

Figure1. Map of Wayne County stream sampling sites for this 2009 study. Information on sample locations and descriptions can be found in Table 2.

Figure 2. Mean nonevent concentrations and losses of nutrients and soil from Wayne County watersheds 2009. CO = Canandaigua Outlet, RCE = Red Creek East, and RCW = Red Creek West.

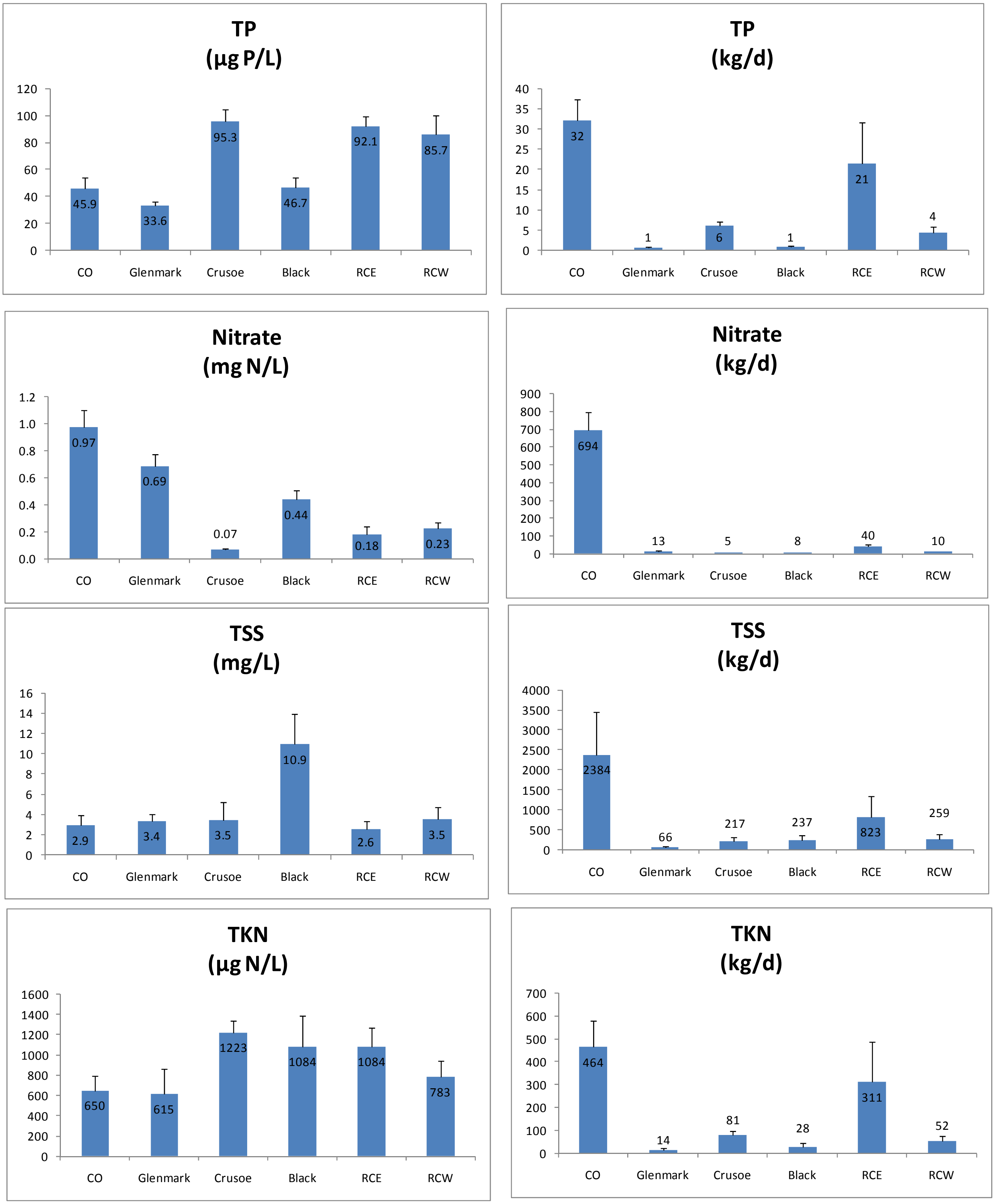

Figure 3. Mean event concentrations and losses of nutrients and soil from Wayne County watersheds 2009. CO = Canandaigua Outlet, RCE = Red Creek East, and RCW = Red Creek West.

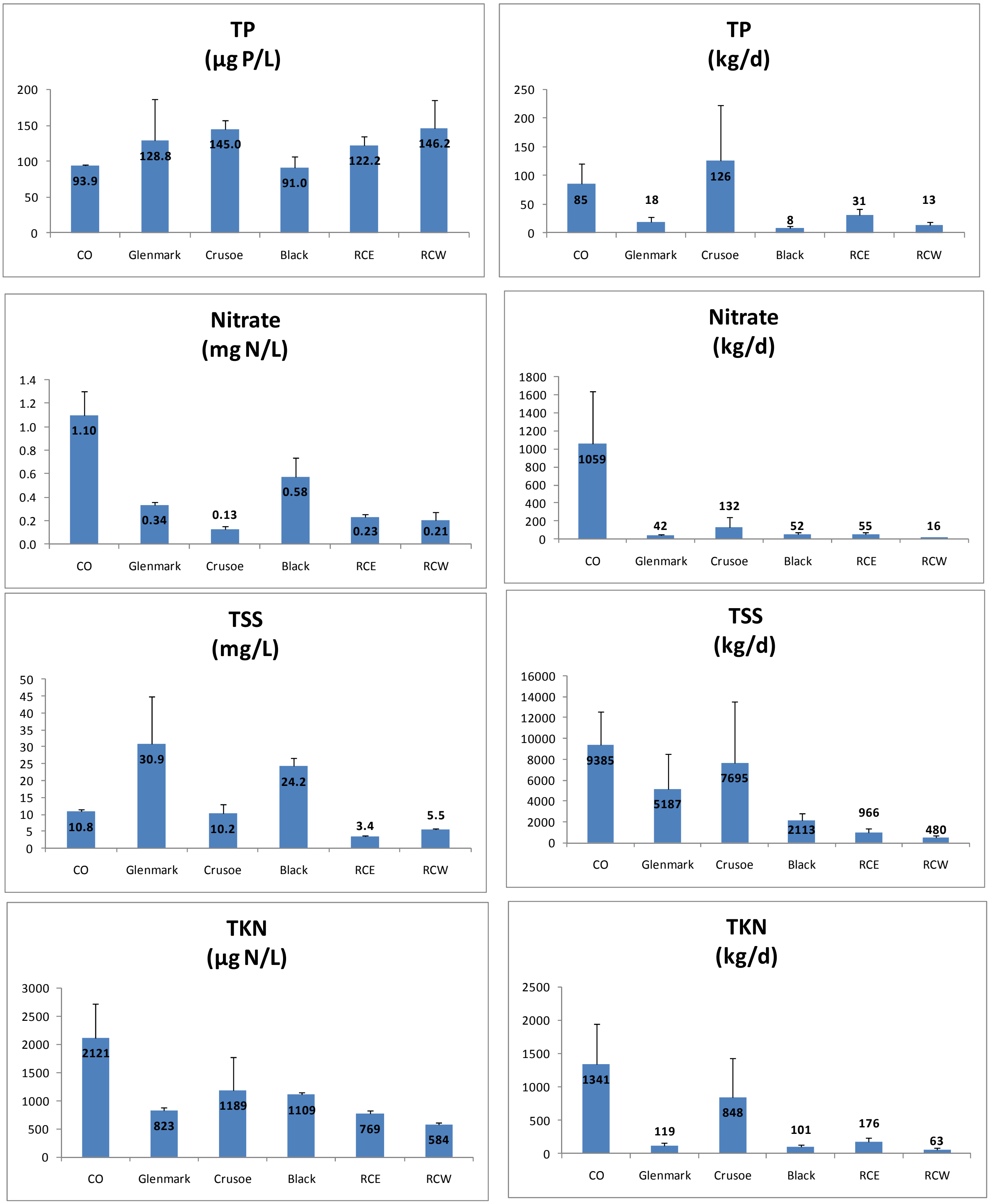

Figure 4. Preliminary rating curves for six tributaries in Wayne County, NY.