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Segment Analysis of Oneida Creek: The Location of Sources of Pollution

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SEGMENT ANALYSIS OF ONEIDA CREEK
The Location of Sources of Pollution

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SUMMARY

1. Point and non-point sources of nutrients and soils within the Oneida Creek watershed were identified through a process called "segment analysis".
2. The purpose of identifying sources of nutrients and soil loss from the Oneida Creek watershed is to assist county and local agencies as to the location of sources in order to prioritize problem areas and to provide assistance in locating grant funding to correct them.
3. Concentrations of nutrients, sodium and total suspended solids were variable from the headwaters of Oneida Creek to Oneida Lake. This variability of concentrations along Oneida Creek suggests that sources, non-point and point, existing within the watershed contributed nutrients and soil to Oneida Lake.
4. The headwater tributary represented by segment 16 (Figure 1) contributed both nutrients and soil from several locations to the main stem of Oneida Creek.
   a. An increase in total phosphorus (e.g., 46 to 62 µg/L, October) and total suspended solids (6.4 to 14.1 mg/L, October) was observed in October, 2003 and April, 2004 between sites 16a (Glass Factory Road) and 16 on South Butler Road. An unidentified source existed.
   b. Between sites 16 and 16d in October near the Morrisville Eaton Central School, significant increases in soluble reactive phosphorus (8,909%), total phosphorus (528%), nitrate (520%), total Kjeldahl nitrogen, (103%) and total suspended solids (143%) were observed. The small increase in particulate fractions (TP and TSS) compared to dissolved fractions suggested that some soil was being lost through erosion but that other non-soil sources were likely. In fact, school officials did confirm to K. LaManche and S. Harrington (CNY RPDB) in April 2004 that construction occurred and that some soil loss had occurred. However, another source existed. A horse farm located on this segment and near a drainage ditch had heavily grazed fields with exposed soil. Sampling in April 2004, after the construction was completed, demonstrated that soluble reactive phosphorus and total phosphorus increased from site 16 to

site 16d by 526% and 482%, respectively. The horse farm was the most likely cause in the observed increase in April while construction practices were the major source in October.

c. Upstream of site 16c on Pleasant Valley Road south of Oxbow Road, a source of total phosphorus, SRP and TSS existed in fall 2003 (Figure 1). Small increases (<100%) in nitrate and total phosphorus were again observed in this area in April 2004. Total suspended solids were almost 400% higher at the most upstream site (site 16C1). At present, we have not been able to locate a source.

d. Segment 14 is a series of small tributaries at the far southern portion of the Oneida Lake watershed (Figure 1). The high loss of soil (64.8 mg/L) in September 2003 suggested erosion of a stream bank or loss from a field being tilled within this segment. Elevated levels of particulate fractions (TSS and TP) were observed on Blue Creek from sites 14a and 14c downstream to site 14. The elevated levels of TSS and TP observed downstream at site 14 were partially caused by losses in the segment between sites 14c and 14b (Figure 1). More specifically, the samples taken in April 2004 suggested that source was located within the tributary represented by site 14e. Compared to the downstream site 14b, levels at site 14e were 205%, 286%, 546%, and 192% higher in total phosphorus, total Kjeldahl nitrogen, nitrate and total suspended solids, respectively, from the downstream site. Site 14b smelled heavily of manure while site 14e was visibly turbid. This segment was in an area identified by the Madison County Planning Department as possessing a high soil erosion potential. Higher nitrate levels were also observed at site 14c (1.75 mg/L).

e. Site 14d at South Quarry Road drains a small sub-watershed that moves from east to west before entering segment 14 (Figure 1). Levels of TKN (800μg N/L) were slightly elevated but nitrate (1.6 mg N/L), SRP (18.7 μg P/L) and TP (108.9 μg P/L) were high compared to upstream sites within the segment in October. Similarly in April, nitrate levels were again elevated with concentrations just below 3mg/L. The high losses of nitrate and the slightly elevated levels of TKN suggested an animal source.

5. Mud Creek is a tributary (site 9c, Middle Road) of Oneida Creek and appeared to be a source of soil and nutrient loading. Results were not conclusive as to a single source, but TKN, TP and nitrate were elevated at sites 9c1, 9c3 and 9c4. Nitrate was particularly high at site 9c2, which is near a large dairy farm.

6. During non-events, the lower reach of Oneida Creek from site 8 northward to Oneida Lake was heavily influenced by discharges from sewage treatment plants (STP). During non-events, sites 1, 3, 4, 5, 7 and 8 on the main stem of Oneida Creek had high levels of total phosphorus (TP range: 61.7 to 367 μg P/l) and soluble reactive phosphorus (SRP range: 48 to 296 μg P/l) compared to sites 9 through 16 (TP range: 3.7 to 19.5 μg P/l; SRP range: 3.2 to 12.7 μg P/l). The source of the higher level of phosphorus (P) was located in Sconondoa Creek (site 6a) and between sites 8 and 9. In fact, P levels were elevated at site 6b (e.g., SRP = 362 μg P/l), which was just downstream of the Vernon Sewage Treatment Plant (STP, Figure 1) but were significantly lower above the Vernon STP discharge pipe (e.g., 7.6 μg P/l) at site 6c. Similarly, total phosphorus and soluble reactive phosphorus were also elevated from site 9 downstream to site 8 increasing by a factor of 500 to 800% for TP (18 to 126 μg P/l) and SRP (11 to 98 μg P/l), respectively. Similarly, TKN was slightly elevated from site 9 to 8. The Sherrill Sewage Treatment Plant is located between sites 8 and 9.

7. Three sewage treatment plants (STPs), Oneida, Sherrill and Vernon exist within the Oneida Creek watershed (Figure 1). Sampling was restricted to just above and below the sewage treatment plants at Oneida, Vernon and Sherrill to establish their contribution of nutrients to Oneida Creek. Total phosphorus, soluble reactive phosphorus, nitrate and sodium levels increased dramatically from above to below the Vernon and Sherrill STPs: that is, below the release point from the STP. For example, SRP increased from 2.4 to 1,798 μg P/L; TP from 10 to 2,695 μg P/L; nitrate from 1.16 to 3.16 mg N/L and sodium from 16.97 to 52.28 mg/L at the Vernon STP. At the Sherrill STP, a similar situation was observed. SRP increased from 3.4 to 1,013 μg P/L; TP from 18.7 to 1,239 μg P/L; nitrate from 1.00 to 6.29 mg N/L and sodium from 7.22 to 36.76 mg/L at the Sherrill STP. Clearly, the Sherrill and Vernon sewage treatment plants were delivering high levels of phosphorus, nitrate and sodium to

Oneida Creek. In particular, the levels of phosphorus at the Sherrill and Vernon below the discharge pipe appear to exceed EPA standards for effluent discharge into tributaries draining into waters of the Great Lakes. The Great Lakes Water Quality Agreement established common water quality objectives to be achieved in both the United States and Canada. The chief objective of this agreement was reduction of phosphorus levels to no more than 1 mg/L in discharges from sewage treatment plants into tributary waters of and waters of Lakes Erie and Ontario.

The tertiary treatment plant located in the City of Oneida did not appear to have a significant impact on Oneida Creek. Additional sampling of the creek above and below the discharge pipe may be warranted as since it was sampled only once.

8. Sodium and total Kjeldhal nitrogen levels were elevated at the base of the tributary at site 2 on Main Street on 22 September 2003. A source upstream of site 2 exists for nitrogen and sodium.

9. A tributary of Oneida Creek, Taylor Creek (site 10 and upstream), was noted as having several areas of concern (Figure 1). For example at site 10b, elevated levels of total suspended solids and total Kjeldahl nitrogen were observed and were associated with exposed soil at a new housing development. Similarly, levels of total suspended solids (81.5 mg/L), total Kjeldahl nitrogen (1,330 μg N/L), total phosphorus (167 μg P/L) and sodium (37.95 mg/L) were elevated above site 10g. A source was not noted, but the high values were indicative of soil loss from fields in agriculture. Also, site 10d had high levels of dissolved nutrients including soluble reactive phosphorus (52.8 μg P/L) and nitrate (7.78 mg N/L). No obvious source was observed as the area was forested. More investigation is needed upstream to determine any sources.

RECOMMENDATIONS

1. Likely sources of elevated levels of nutrients and soil loss are identified. A visual inspection of these areas with landowners is suggested to pinpoint potential land use practices that may be contributing soils and nutrients.

2. In general, control of water movement can be a means of significantly reducing non-point source pollution, whether it be nutrients or soil. Since water must come in

contact with the nutrient or soil source and then be transported to the surface (or subsurface) water body, the nutrients in our streams and lakes are functions of land use practices, soil fertility and quantities of transporting water. Management practices, which reduce surface runoff, are recommended to decrease the magnitude of soil and chemical losses from land areas.

3. Identified point and non-point sources of nutrients and solids can be remediated using Best Management Plans (BMPs). For example at site 16d, buffer strips near the culvert and rotational grazing pens are examples of how these effects can be minimized (See page 10 for some other examples). Also, it was quite clear that construction at the Morrisville Eaton Central School and at site 10b was not properly contained as large losses of soil were observed during one event. Better education of members of the community on construction practices is warranted.
4. Farm and land management programs (e.g., Agricultural Environmental Management) already exist and are ably sponsored through county Soil and Water Conservation Districts and Cornell Cooperative Extension. Efforts, if not already in place, should be made to contact and implement existing programs to reduce/remediate areas identified in this study.
5. Two different sewage treatment plants (Sherrill and Vernon) clearly are delivering elevated levels of nutrients, especially phosphorus and nitrates, to Oneida Lake. As mentioned earlier, the levels of phosphorus below the discharge pipe at the Sherrill and Vernon treatment plants appear to exceed EPA standards for effluent discharge into tributaries draining into waters of the Great Lakes. However, both the Sherrill (0.95 million gallons released per day) and Vernon (0.81 gallons released per day) plants are permitted by the NYSDEC to discharge above the EPA standard because each plants individual effluent release is less than 1 million gallons per day. Although these STPs are functioning within NYSDEC current guidelines, municipalities may with expanding human population, increases their capacity, or in an effort to stay under the 1 million gallons per day standard, choose new construction that will contribute a larger amount of nutrients to a lake of finite assimilatory capacities. An open discussion, workshop format, on the impacts of these STPs might be useful. This discussion could consider the establishment of phosphorus total maximum daily loadings (TMDL) for an individual watershed as a goal of management and could consider effects on lake sediment phosphorus levels. The TMDL approach is being considered for the Susquehanna River watershed in New York.
6. Follow up work is recommended within the series 9 and 10 segments in order to locate

sources of nutrient and sediment loading. Timing of the sampling is important. It would be best to sample water within these segments during spring tillage of the land.

7. The segment analysis approach has successfully identified several sources of pollution in the Oneida Creek watershed. Besides the follow up work suggested in item 6 above, we would recommend the following streams in priority for segment analysis: Cowaselon and Chittenango. Both creeks empty into Oneida Lake and were found in previous work (Makarewicz and Lewis, 2003) supported by the CNY RPDB to deliver large amounts of soil and other nutrients to Oneida Lake. Fish propagation on Chittenango Creek is also listed on the New York State Priority Water Bodies List as being threatened due to sediment.

INTRODUCTION

The water quality of Oneida Lake is directly influenced by land use practices in the lake's watershed. As precipitation falls on the landscape, it washes or carries materials, such as soil, cow manure, nutrients, pesticides, etc., from the land surface into nearby streams and eventually into Oneida Lake influencing water quality (CNY RPDB 2000). Thus different land usage greatly influences water quality of streams and lakes. For example, land usage that includes agriculture and urban living has a greater potential to deliver nutrients and soil to a lake than a forested watershed. If efforts are made to protect a lake's watershed, water quality, as well as fish spawning and nursery areas of sport fishes, is also protected and even enhanced over the long term. To understand the relative impact of the many tributaries draining the sub-watersheds that constitute the Oneida Lake watershed, the Central New York Regional Planning and Development Board began a series of studies (Makarewicz and Lewis 2000a, 2003) to determine the relative loss of nutrients from major sub-watersheds of Oneida Lake and to determine the location of sources within the priority sub-watersheds.

In the 2000 and 2003 reports, the relative impact of streams was evaluated by considering water chemistry, discharge and calculated loads of nutrients and soil to Oneida Lake. Water chemistry and soil loss at the base of the primary tributaries flowing into Oneida Lake (including Big Bay, Scriba, East Branch of Fish, Lower Fish, Wood, Oneida, Cowaselon, Canaseraga, Chittenango, Limestone, and Butternut Creeks) were monitored for loss of nutrients and materials. In 2003, the addition of the major tributaries of the north shore to the monitoring strategy (Makarewicz and Lewis 2003) allowed the evaluation and prioritization of the sub-watersheds in terms of nutrient and suspended solids (soil) loss to the lake from these tributaries. The monitoring program goal was to document nutrient and sediment loading to the lake and to prioritize the streams according to problem severity allowing direction on potential restoration and protection initiatives in affected sub-watersheds.

Stream bank erosion and loss from fields in cultivation can be major sources of soil loss from a watershed. Soil erosion is also one of the major sources of nutrient loss from watersheds and was positively correlated with total phosphorus and total Kjeldahl nitrogen (TKN) loss in the eleven Oneida Lake tributaries (Makarewicz and Lewis 2003). For example, the percent increase in soil loss as total suspended solids from baseline to event flow conditions in streams was often substantial. They were as follows: Oneida Creek (847%, 10.3 to 97.5 mg/L), Scriba Creek (505%, 2.0 to 12.1 mg/L), Cowaselon Creek (398%, 14.8 to 73.7 mg/L). By calculating the amount of loss from the watershed (discharge times analyte concentration), several watersheds were observed to lose suspended materials at higher levels per unit area of watershed compared to other watersheds; Chittenango Creek (6,061g/ha/day), Cowaselon (4,500 g/ha/day), Oneida Creek (4,365 g/ha/day), Limestone (3,528 g/ha/day) and Fish Creek (3,395 g/ha/day) had the greatest loss of suspended matter from the watershed. Similar conclusions were observed in the 1999-2000 study (Makarewicz and Lewis 2000).

Based on the two previous studies that suggested that loss of soil from the Oneida Creek sub-watershed was relatively high and the fact that fish propagation is considered "impaired" because of sediment loss from agriculture (NYSDEC Priority Waterbodies List), the CNYRPD Technical Committee recommended that a segment analysis be performed to identify sources of soil and nutrient loss from the Oneida Creek sub-watershed.

The Segment Analysis Approach:

Point and non-point sources of nutrients and soils within a watershed may be identified through a process called "segment analysis" or in its fullest development "stressed stream analysis" (Makarewicz 1999). Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams. Within a subwatershed, stressed stream analysis is an approach for determining how and where a stream and its ecological community are adversely affected by a pollution source or other disturbances. It is a technique that identifies the sources, extent, effects and severity of pollution in a watershed. In its fullest use, it combines elements of the sciences of hydrology, limnology, ecology, organismal biology and genetics in an integrated approach to analyze cause and effect relationships in disturbed stream ecosystems.

Within a sub-watershed, the stream is used to monitor the "health" of the watershed. Because nutrients are easily transported by water, they can be traced to their source by systematic geographic monitoring of the stream. Segment analysis is a technique that divides the impacted sub-watershed into small distinct geographical units. Samples are taken at the beginning and end of each unit of the stream to determine if a nutrient source occurs within that reach. For example, high levels of a nutrient at the down-stream portion of a segment indicates a source within that segment. By systematically narrowing the size of the segment, a source can be identified. At completion, the cause and extent of pollution have been identified. If needed, the severity of the pollution within the impacted sub-watershed and or the entire watershed can then be evaluated by spatial analysis of the quantity and quality of biological indicators, such as fish and invertebrates, and by biological examination of structural and functional changes in individual organisms and populations in affected communities. Once identified, sources of chemical pollutants may be corrected using "Best Management Practices" (BMP). In this report, stressed stream analysis is limited to a spatial analysis or segment analysis of chemical sources of Oneida Creek. Examples of the successful application of the segment analysis process in identifying impacted sub-watersheds and their associated streams may be found in the following reports by Makarewicz and Lewis (1993, 2000, 2001, 2001a, 2002, 2002a) and Makarewicz *et al*. (1994).

DEFINITIONS

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.

Soluble Reactive Phosphorus (SRP) - A measure of the most available and active form of phosphorus.

Nitrate + Nitrite - 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.

Sodium (Na) - A measure of the mineral, most commonly found as sodium chloride (NaCl), dissolved in water. NaCl naturally occurs in deep layers of local bedrock. Mined, it is stored and spread as a de-icing agent on roads and other pavements.

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.

SAMPLING AND ANALYTICAL METHODS

Segment analysis was performed on eight dates on Oneida Creek (22 September 2003, 28 September 2003, 9 October 2003, 15 October 2003, 13 April 2004, 23 April 2004, 10 May 2004 and 25 May 2004.). Sampling locations are shown on Figure 1 and Table 2 (GPS coordinates and roads). All field collections were made by Stephanie Harrington and Kristy LaManche of the CNY RPDB.

All samples were analyzed for nitrate, soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, sodium and total suspended solids. During the initial stressed stream analysis on 22 September 2003, 18 sites were sampled under non-event conditions covering the major segments of the tributary (Figure 1). After this date, a variable number of sites were sampled during both hydrometeorological events [28 September 2003 (0.51"), 15 October 2003 (0.80"), 13 April 2004 (0.23"), 23 April 2004 (0.65"), 10 May 2004 (0.83"), 25 May 2004 (2.55")] and two non-events (22 September 2003, 9 October 2003). Rainfall levels reported were from the NOAA station at New London Lock 22, NY, which is just east of Oneida Lake.

All sampling bottles were labeled in the field ensure exact identification of the particular sample. All sample bottles were routinely cleaned at SUNY Brockport with phosphate free RBS between sampling dates. Containers were rinsed prior to sample collection with the water being collected. In general, all procedures followed EPA standard methods (1979) or Standard Methods for the Analysis of Water and Wastewater (APHA 1999). Sample water for dissolved nutrient analyses (SRP, nitrate + nitrite) was filtered immediately with a 0.45-µm MCI Magna Nylon 66 membrane and either frozen or analyzed within 24 hours of collection.

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

Soluble Reactive Phosphorus: Sample water was filtered through a 0.45-µm membrane filter. The filtrate was analyzed for orthophosphate using the automated (Technicon) colorimetric ascorbic acid method (APHA 1999). The formation of the phosphomolybdeum blue complex was read colorimetrically at 880nm.

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 a modification of the Technicon Industrial Method 329-74W/B. The following modifications were made:

- In the sodium salicylate-sodium nitroprusside solution, sodium nitroprusside was increased to 0.4 gm/L.
- The reservoir of the autoanalyser was filled with 2M H_2SO_4 instead of distilled water.

- Other reagents were made fresh prior to analysis.

Sodium: Sodium analysis was performed by Atomic Absorption Spectrophotometry (APHA 1999).

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

QUALITY CONTROL

The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439). This program includes bi-annual proficiency audits, annual inspections and good laboratory practices documentation of all samples, reagents and equipment. Results of the Semi-Annual New York State Environmental Assurance Program for the Water Quality Laboratory at SUNY Brockport are presented in Table 1.

RESULTS

Chronological Account of Segment Analysis

22 September 2003 (Figure 2, Table 3)

The initial sampling event occurred during nonevent conditions of 22 September 2003. The purpose of this sampling event was to determine the variability of nutrient concentrations along the major segments of Oneida Creek. Eighteen stations were sampled in the Oneida Creek watershed. Sample stations were generally at the base of first-order tributaries to the main stem of Oneida Creek. If a sub-watershed was identified as a potential source of pollution, further targeted sampling within the suspected sub-watershed was undertaken. In general, concentrations of nutrients, sodium, and total suspended solids (TSS) were variable, but not excessively, from the headwaters of Oneida Creek to Oneida Lake. This variability of analyte concentrations along the various segments (the distance between two sites) of Oneida Creek suggested that non-point and point sources existed within the watershed.

During non-events, sites 1, 3, 4, 5,7 and 8 on the main stem of Oneida Creek had high levels of total phosphorus (TP range: 61.7 to 367 μg P/l) and soluble reactive phosphorus (SRP range: 48 to 296 μg P/l) compared to sites 9 through 16 (TP range: 3.7 to 19.5 μg P/l; SRP range: 3.2 to 12.7 μg P/l). The source of the higher levels of phosphorus (P) was located in Sconondoa Creek (site 6a) and between sites 8 and 9. In fact, P levels were elevated at site 6b (e.g., SRP = 362 μg P/l), which was just downstream of the Vernon Sewage Treatment Plant (STP, Figure 1), but were significantly lower above the Vernon STP discharge pipe (e.g., 7.6 μg P/l) at site 6c. Similarly, total phosphorus and soluble reactive phosphorus were also elevated from site 9 upstream to site 8 increasing by a factor of 500 to 800% for TP (18 to 126 μg P/l) and SRP (11 to 98 μg P/l), respectively. Similarly, TKN was slightly elevated from site 9 to 8. The Sherrill Sewage Treatment Plant is located between sites 8 and 9. The Vernon and Sherrill STPs are major sources of phosphorus to Oneida Creek and to Oneida Lake.

Below the Vernon STP, nitrate, sodium and soil (total suspended solids) concentrations, unlike phosphorus, were not noticeably higher than other sites above the STP in Sconondoa Creek. However, total Kjeldahl nitrogen levels were elevated at the base of Sconondoa Creek at site 6a (620 μg N/l) and only slightly elevated at site 6b (440 μg N/l) just below the Vernon STP. Another, yet undefined, source of organic nitrogen downstream of the Vernon STP is present.

Nitrate increased by a factor of 200% from sites 6a and 5 downstream to (2.29 mg N/L) site 4 on the main stem of Oneida Creek. Further spatial analysis is required to locate a source in this area. The Oneida STP is upstream of site 4 (Figure 1). Further sampling will be needed in order to identify the impact, if any, of the Oneida STP.

Sodium and total Kjeldhal nitrogen levels were elevated at the base of the tributary at site 2 on Main Street. An unrecognized source exists upstream of this site. Nitrate and TKN levels were elevated at site 15 (1.06 mg N/L and 540 μg N/l) suggesting a source within this segment between South Butler Road (site 16) and Brown Road (site 15). More sampling is required on this segment in order to pinpoint a source.

In general, the highest concentrations of nutrients were observed in the northern half (site 8 northward) of the Oneida Creek watershed. Soil loss was negligible as might be expected during a non-event sampling. Clearly, most of the elevated phosphorus levels observed were in the dissolved form and originated from the Vernon and Sherrill and perhaps the Oneida Sewage Treatment Plants. The next sampling event will be during a rain event and concentrate along the same sites as on the 22 September sampling date.

28 September 2003 (Figures 3, Table 3)

During a moderate rain event (0.51 inches), elevated levels of total phosphorus, soluble reactive phosphorus and total Kjeldahl nitrogen were observed at site 16 (South Butler Road) compared to site 15. For example, significant increases from 15 to the upstream site 16 were observed for TP (10.2 to 255.8 μg P/L), SRP (1.8 to161.1 μg P/L), TKN (480 to 830 μg N/L) and slight increases for sodium and total suspended solids. More stations will be added upstream of site 16 for the next sampling.

Concentrations of total phosphorus and total suspended solids were elevated at the base of the tributary draining a relatively large headwater stream (Blue Creek) south of site 14 at County Road 49. The high loss of soil (64.8 mg/L) suggests erosion of a stream bank or loss from a field being tilled. Intensive sampling will be undertaken on this segment.

From site 11 on Peterboro Road at Bennett's Corner to site 9 at County Road 51 above the Sherrill Sewage Treatment Plant, a 153% increase in nitrate was observed (0.64 to 1.62 mg N/L). Similarly, a small increase (84%) of dissolved phosphorus was also observed (2.5 to 4.6 μg P/L) from site 11 to 9. No increase in any of the particulate fractions was observed. Further sampling in this area will be done during the next set of sampling.

From site 9 at County Route 51 above the Sherrill STP to site 8 west of Hamilton Avenue and below the STP, a 288% and 398 % increase in TP and SRP, respectively, was observed. No increases in sodium, TKN, nitrate or total suspended solids were observed. The Sherrill

Sewage Treatment Plant was the source of the elevated concentrations of the phosphorus fractions.

As previously stated, concentrations of nutrients (nitrates, soluble reactive phosphorus and total phosphorus) were elevated in Sconondoa Creek below the Vernon Sewage Treatment Plant (sites 6a and 6b) and lower above the STP (site 6c). Downstream of site 6 on Sconondoa Creek, both TP and SRP concentrations dropped to site 5 on the main stem of Oneida Creek. From site 5 on Sconondoa Road and above the Oneida STP to site 4 below the Oneida STP, both total phosphorus and soluble reactive phosphorus increased slightly by factors of 49% and 29%.

9 October (Figures 4, Table 3)

Sampling was restricted to above and below the sewage treatment plants at Vernon and Sherrill to establish their contribution of nutrients to Oneida Creek. Total phosphorus, soluble reactive phosphorus, nitrate and sodium levels increased dramatically above to below the STPs. For example, SRP increased from 2.4 to 1,798 µg P/L; TP from 10 to 2,695 µg P/L; nitrate from 1.16 to 3.16 mg N/L and sodium from 16.97 to 52.28 mg/L at the Vernon STP. At the Sherrill STP, a similar situation was observed. SRP increased from 3.4 to 1,013 µg P/L; TP from 18.7 to 1,239 µg P/L; nitrate from 1.00 to 6.29 mg N/L and sodium from 7.22 to 36.76 mg/L at the Sherrill STP. Clearly and perhaps not surprisingly, the Sewage Treatment Plants are delivering high levels of phosphorus, nitrate and sodium to Oneida Creek. Sampling above and below the Oneida STP will be performed during future sampling sessions.

15 October (Figure 5, Table 3)

Event sampling (0.80 inches) focused on the sub-watershed associated with sites 9, 14 and 16 (Figure 1). Sites 9, 14 and 16 were identified previously as having high levels of nutrient and soil loss from their respective sub-watershed.

Site 16 Segment: Five sites were sampled and three separate sources of pollution appeared to exist within this segment.

a. Between sites 16 and 16d, significant increases in soluble reactive phosphorus (8,909%), total phosphorus (528%), nitrate (520%), total Kjeldahl nitrogen, (103%) and total suspended solids (143%) were observed. This site, just south of site 16, received storm water runoff from the nearby Morrisville Eaton Central School and the horse farms.
b. Between sites 16a (Glass Factory Road) and 16 on South Butler Road, there was an increase in total phosphorus (46 to 62 μg/L) and total suspended solids (6.4 to 14.1 mg/L). This small increase in particulate fractions and not dissolved fractions suggested that soil was being lost through erosion.
c. Upstream of site 16c on Pleasant Valley Road south of Oxbow Road, a source of total phosphorus, SRP and TSS existed. More sampling is required upstream of this site.

Site 14 Segment: Five sites were sampled within this segment. Elevated levels of particulate fractions (TSS and TP) were observed on Blue Creek from sites 14a and 14c downstream to site 14. Total phosphorus increased from 50.7 (site 14a) and 60.4 (site 14c) to 189.6 μg P/L at site 14, while total suspended solids increased from 18.6 (site 14a) and 22.0 (site 14c) to 101.3 mg/L at site 14. The elevated levels of TSS and TP observed downstream at site 14 were caused by losses, probably soil, within the segment between sites 14c and 14b and perhaps from site 14d to site 14. Further segmenting of the stream is required on the next sampling day.

Site 14d at South Quarry Road drains a small sub-watershed that flows from east to west before entering segment 14. Levels of TKN (800 μg N/L), nitrate (1.7 mg N/L), SRP (18.7 μg P/L), TP (108.9 μg P/L) were much greater than other upstream sites within the segment (sites 14a and 14c). The high losses of nitrate and the slightly elevated levels of TKN suggested an animal source.

Site 9: Four sites were sampled during the rain event of 15 October 2003. The tributary (Mud Creek) at the base of the sub-watershed at site 9c (Middle Road) appeared to be a source of soil and nutrient loading to Oneida Creek. Total phosphorus (541.8 μg P/L), soluble reactive phosphorus (134.1 μg P/L), nitrate (0.78 mg N/L), total Kjeldhal nitrogen (1500 μg N/L), total suspended solids (71.4 mg/L) were all elevated above background levels in other tributaries. Clearly a source of nutrients and soil loss existed in this sub-watershed. The high loss of dissolved and particulate fractions suggested an agricultural source – perhaps manure being spread on farms fields. More investigation of this site is necessary.

13 April 2004 (Figure 6, Table 3)

During this modest event (~0.20 inches), sampling was concentrated to segments 9, 14 and 16.

Site 16 Segment: During the previous event in October 2003, an increase in total phosphorus (46 to 62 μg/L) and total suspended solids (6.4 to 14.1 mg/L) was observed between sites 16a (Glass Factory Road) and 16 on South Butler Road. A similar observation occurred on 13 April 2004 when total phosphorus (11.3 to 12.2 μg/L) and total suspended solids (2.2 to 3.5 mg/L) increased. This small increase in particulate fractions and not dissolved fractions suggested that soil was being lost through erosion.

In fall 2003, between sites 16 and 16d (or site 16d1), significant increases in soluble reactive phosphorus (8,909%), total phosphorus (528%), nitrate (520%), total Kjeldahl nitrogen, (103%) and total suspended solids (143%) were observed. Site 16d is a culvert/drainage ditch entering Oneida Creek at site 16. School groundskeepers and maintenance staff confirmed to K. LaManche and S. Harrington in April 2004 that construction occurred last fall on the Morrisville Eaton Central school grounds. This project at the Morrisville Eaton Central School is the likely cause of the soil loss. Another possibility was the horse farm (Figure 7) located in this segment. Note the bare land on this heavily grazed pasture and the 16 grazing horses. Results from April 2004 indicated that levels of soluble reactive phosphorus and total phosphorus increased from site 16 to site 16d by 526% and 482%, respectively. Soil loss, as total suspended solids, increased slightly (3.5 to 4.6 mg/L) suggesting that erosion was not the cause. The horse farm pictured in Figure 7 is a likely source. The autumn losses of particulate fractions were most likely related to the construction at the Morrisville Eaton

Central School, while the loss of dissolved fraction in the spring were most likely associated with land-use practices at the horse farm.

Upstream of site 16c on Pleasant Valley Road south of Oxbow Road, a source of total phosphorus, SRP and TSS existed in fall 2003. Small increases (<100%) in nitrate and total phosphorus were again observed in this area in April 2004. Total suspended solids were almost 400% higher at the most upstream site (site 16c1).

Site 14 Segment: During October 2003, elevated levels of SRP, TP and nitrate observed downstream at site 14 were, in part, caused by losses from segment represented by site 14d. In April, nitrate levels were again high in segment 14d and also above a new site on another tributary (site 14d1). Nitrate levels at both sites were just below 3 mg N/L. The high losses of nitrate and the slightly elevated levels of TKN suggested an animal source.

As in October 2003, a source of elevated levels of nutrients was between sites 14c and 14b. A new site was added (site 14e) to assess a tributary that enters this segment from the west. The samples taken in April 2004 suggested that the source was located within the tributary represented by site 14e. Compared to the downstream site 14b, levels at site 14e were 205%, 286%, 546%, and 192% higher in total phosphorus, total Kjeldahl nitrogen, nitrate and total suspended solids, respectively, from the downstream site. Site 14b smelled heavily of manure while site 14e was visibly turbid. This segment is in an area identified by the Madison County Planning Department as possessing a high soil erosion potential (Figure 8). Higher nitrate levels were also observed at site 14c (1.75 mg/L).

Figure 7. Ditch that runs into a culvert at site 16. Note extensive area of exposed soil in pasture of grazing horses.

Site 9 Segment: The high loss of dissolved and particulate fractions from this segment during October 2003 suggested an agricultural source – perhaps manure being spread on the land. In April 2004, sampling was conducted at several new sites located in the upper portion of this sub-watershed. As before, at the base of this sub-watershed (site 9c) total Kjeldahl nitrogen, total phosphorus, dissolved phosphorus and nitrate were elevated compared to other sites on the main stem of Oneida Creek. Results were not conclusive as to a single source, but TKN, TP and nitrate were elevated at sites 9c1, 9c3 and 9c4. Nitrate, total phosphorus, total Kjeldahl nitrogen and dissolved phosphorus were particularly high at site 9c4. At site 9c2 located adjacent to a dairy farm, levels of nitrate (2.31 mg/L) were the highest among all of the samples collected from this sub-watershed.

23 April 2004 (Table 3)

Sampling on this date was restricted to sampling just above and below the Oneida Sewage Treatment Plant. The Oneida Sewage Treatment Plant is a tertiary treatment facility, and unlike the Sherrill and Vernon Treatment Plants, elevated levels of nitrate, soluble reactive phosphorus, total phosphorus and total Kjeldahl nitrogen were not evident in Oneida Creek below the discharge point.

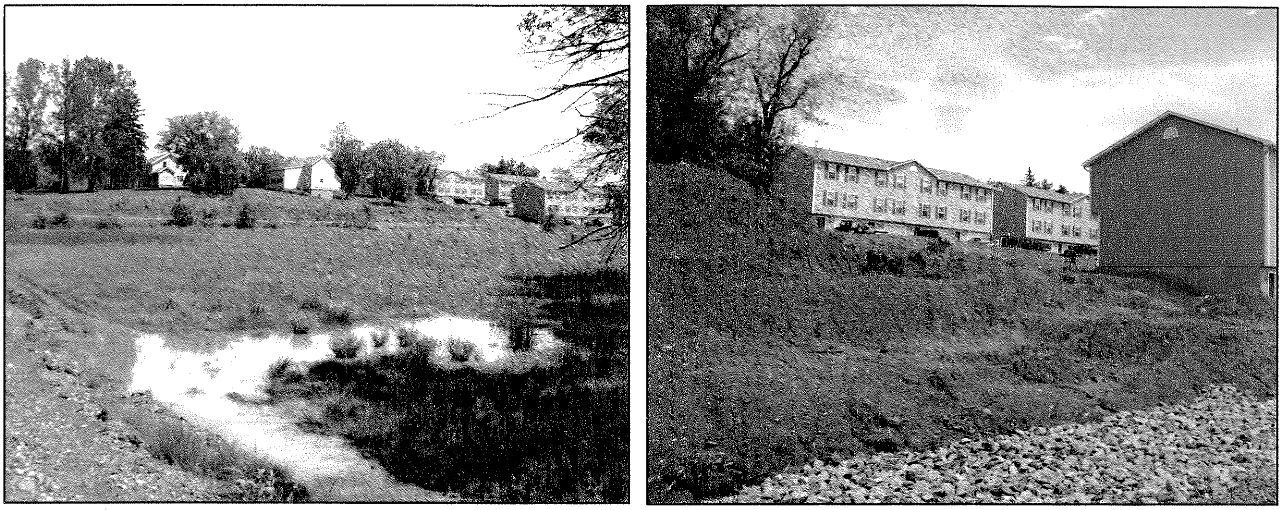

Figure 10. Construction at site 10b showing exposed soil on a steep embankment and proximity of creek, 25 May 2004.

10 May 2004 (Figure 9, Table 3)

The purpose of this event (0.83 inches of rain) sampling trip was to note if any new areas of concern were identified along the entire reach of the main stem of Oneida Creek during the period when tillage of fields was likely. The data indicated that the levels of total phosphorus (65.5 μg P/L), dissolved phosphorus (11.8 μg P/L), total Kjeldahl nitrogen (1,700 μg N/L) and total suspended solids (90.2 mg/L) were very high at the site 10 suggesting a source within this sub-watershed. Site 10 is at the base of Taylor Creek. The decision was made to sample the entire tributary upstream of site 10 during the next rain event.

25 May 2004 (Figure 9, Table 3)

Samples were limited to segment analysis on Taylor Creek. As a result of heavy rains (2.55 inches) during the previous evening, flow rates in Oneida Creek reached 1250 cubic feet per second at the U.S.G.S. Oneida gauging station. Several areas within this segment were identified as having problems. A 100+% increase in total phosphorus (411 to 1,076 μg P/L) and total suspended solids (270 to 489 mg/L) was observed from site 10a downstream to site 10. Similarly, at site 10b, elevated levels of total phosphorus, total suspended solids and total

Kjeldahl nitrogen were observed from site 10b to site 10a. These increases in soil loss and the particulate phase of phosphorus was likely caused by exposed soil (Fig. 10) at a new housing development and the lack of management practices to prevent soil erosion near site 10b.

Levels of total suspended solids (81.5 mg/L), total Kjeldahl nitrogen (1,330 μg N/L), total phosphorus (167 μg P/L) and sodium (37.95 mg/L) were elevated upstream of site 10g. A source was not noted by field technicians, but the high values were indicative of soil loss from fields in agriculture.

Site 10d had high levels of dissolved nutrients including soluble reactive phosphorus (52.8 μg P/L) and nitrate (7.27 mg N/L). No obvious source was observed as the area was forested. More investigation is needed upstream to determine the potential sources of these nutrients.

At site 10f, bright blue-green water was observed entering the creek from a drainage ditch. A private pond existed in a nearby yard that also had a similar color. Analysis of the water indicated that levels of sulfate were high (199 mg/L). This result suggested that the pond was treated with copper sulfate to reduce weed growth and improve the aesthetic value of the location.

DISCUSSION

The quality and quantity of runoff from a watershed into a stream are ultimately influenced by people. 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. Excess precipitation is determined primarily by climate, vegetation, infiltration capacity, surface storage and land use by people. Impervious landscapes (e.g., rooftops, 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. Similarly, land usage contributes to the quality of the water in the stream. For example, deicing salt spread on roads is easily dissolved and accumulates in streams raising the concentration of sodium in water. Another example is the spreading of manure on the land. If done properly, this can be a reasonable practice enriching the soil. If not, the result may be elevated levels of fecal coliform bacteria and increased levels of phosphorus, organic nitrogen and nitrates that cause health concerns or cause eutrophication of downstream systems. Land use 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.

Best Management Practices:

Identified point and non-point sources of nutrients and solids can be remediated using Best Management Practices (BMP). Whether or not management practices include a reduction of cropland or fertilization, control of water movement can be a means of significantly reducing non-point source pollution. Since water must come in contact with the nutrient source and then be transported to the surface (or subsurface) water body, the nutrients in water bodies are functions of soil fertility and quantities of transporting water. Management practices, which reduce surface runoff, have been shown to dramatically decrease the magnitudes of sediment and chemical losses from land areas (Haith 1975).

Agriculture: Haith (1975) and Morton (1985, 1992) recommend use of buffer strips of forest or grass between the pollutant source and a stream to intercept the runoff, resulting in removal by deposition or filtering by the vegetative cover. Other cropland management practices include diversions, terraces contour cropping, strip cropping, waterways, minimum and no tillage. Livestock operation controls include barnyard runoff management, manure storage facilities and livestock exclusion from woodlands. They may also include structural devices such as grassed waterways, sediment retention basins, erosion control weirs and animal waste holding tanks. BMP's are designed to reduce sediment and nutrient transport to streams and lakes. They may benefit the farmer in the long term by decreasing fuel and fertilizer costs and by improving soil productivity. Furthermore, with the advent of Concentrated Animal and Feed Operations (CAFO) permits, regulatory control of farms with large numbers of animals may be inevitable.

ACKNOWLEDGEMENTS

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Meaney (CNY RPDB), Dan Ramer (Oneida STP) and Scott Ingmire (Madison County Planning Department) assisted in site selection and mapping. David Longley (New Channel 8) and his staff provide weather updates and storm tracking. We especially thank personnel at the Oneida, Sherrill and Vernon Sewage treatment Plants for permission to sample near their discharge. We especially thank the Oneida Lake and Watershed Advisory Council for their assistance in reviewing this document.

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Table 1. Results of the semi-annual New York State Environmental Laboratory Assurance Program (ELAP Lab # 11439, SUNY Brockport) Non-Potable Water Chemistry Proficiency Test, July 2003. Score Definition: 4 (Highest) = Satisfactory, 3 = Marginal, 2 = Poor, 1 = Unsatisfactory.

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

Proficiency Test Report

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

Shipment 265 Non Potable Water Chemistry Shipment Date: 21-Jul-2003

Analyte	Sample ID	Result	Mean/Target	Warning Limits	Method	Score
Sample: **Water Residue**						
Solids, Total Suspended 293 passed out of 304 reported results. EPA Code: 0072	6502	47.7	44.5	39.3-49.7	SM 18-20 2540D	Satisfactory
Sample: **Organic Nutrients**						
Kjeldahl Nitrogen, Total 102 passed out of 108 reported results. EPA Code: 0034	6504	14.37	14	11.5-16.5	EPA 351.3	Satisfactory
Phosphorus, Total 119 passed out of 132 reported results. EPA Code: 0035	6504	5.59	5.31	4.56-6.06	SM18-20 4500-P E	Satisfactory
Sample: **Inorganic Nutrients**						
Nitrate (as N) 123 passed out of 128 reported results. EPA Code: 0032	6507	34.10	34.7	30.2-39.3	SM18-20 4500-NO3 F	Satisfactory
Orthophosphate (as P) 88 passed out of 94 reported results. EPA Code: 0033	6507	3.96	4.15	3.73-4.56	SM18-20 4500-P F	Satisfactory
Sample: **Metals I and II**						
Sodium, Total 106 passed out of 120 reported results. EPA Code: 0025	6511	25.24	24.1	22.3-26	SM 18-20 2450D	Satisfactory

Table 2. Location of all stations sampled in the Oneida Creek watershed as determined by Global Positioning System (GPS). Also see Figure 1. GPS locations provided by K. LaManche.

Site	Location	GPS	
1	Swallow Road before Route 316	43° 08' 22.82"N	75° 42' 28.25"W
2	Main Street	43° 07' 53.72"N	75° 40' 28.25"W
3	Route 46	43° 06' 54.50"N	75° 40' 07.45"W
4	Bennett Rd., Below Oneida STP on Harden Street	43° 06' 21.21"N	75° 40' 28.25"W
5	Sconondoa Road, Above Oneida STP	43° 05' 51.64"N	75° 38' 53.63"W
6a	Route 365 near Morgan Road (Scononda Creek)	43° 05' 40.63"N	75° 37' 30.41"W
6b	Williams Road (CR 48A), Below VernonSTP on	43° 04' 48.32"N	75° 35' 22.39"W
STP	Vernon	43° 04' 56.51"N	75° 32' 51.18"W
6c	Route 31N, Above Vernon STP	43° 05' 00.89"N	75° 32' 30.36"W
7	Route 5 (South of Town of Oneida)	43° 04' 43.74"N	75° 38' 24.67"W
8	West of Hamilton Ave., Below Sherrill STP on	43° 04' 36.47"N	75° 37' 55.24"W
9	County Route 51, Above Sherrill STP	43° 03' 54.11"N	75° 36' 18.84"W
STP	Sherrill	43° 04' 10.07"N	75° 36' 58.81"W
9a	Union Street	43° 03' 18.84"N	75° 34' 52.82"W
9b	Middle Road – North site- inaccessible-no sample	43° 03' 26.55"N	75° 36' 14.09"W
9c	Middle Road – South site	43° 03' 26.55"N	75° 36' 27.42"W
9c1	Route 46 near Savon Gas Station	43° 02' 21.87"N	75° 37' 20.95"W
9c2	Route 46 near large dairy operation	43° 01' 49.29"N	75° 37' 04.72"W
9c3	Route 46 near house #6085	43° 00' 56.90"N	75° 36' 42.73"W
9c4	Peterboro Road	43° 02' 14.47"N	75° 36' 46.68"W
9d	Kenwood Avenue (CR 51)	43° 02' 58.28"N	75° 36' 14.09"W
10	Taylor Creek on Hamilton Avenue (County Rt. 25)	43° 04' 29.19"N	75° 37' 04.96"W
10a	Kinsley Road	43° 04' 22.58"N	75° 35' 59.78"W
10b	Betsinger Road north site	43° 04' 23.33"N	75° 35' 25.55"W
10c	Betsinger Road south site	43° 04' 13.52"N	75° 35' 26.25"W
10d	Indiantown Road	43° 03' 38.04"N	75° 34' 29.65"W
10f	Peterboro Road	43° 03' 49.73"N	75° 33' 00.06"W
10g	Hogan Road	43° 03' 19.95"N	75° 33' 10.40"W
10h	Arquint Road near CR 25	43° 03' 30.18"N	75° 32' 45.72"W
10i	Hogan Road near CR 12	43° 02' 48.26"N	75° 33' 06.20"W
11	Peterboro Rd. near Bennett's Corner	43° 02' 42.61"N	75° 35' 59.43"W
12	Valley Mills Road before County Rt. 36	43° 00' 45.24"N	75° 35'24.48"W
13	Munnsville at Valley Mills Road	42° 58' 37.54"N	75° 35' 13.39"W
14	Blue Creek at County Rd. 49 (Pratt Road)	42° 57' 41.48"N	75° 35' 29.27"W
14a	Falls Road	42° 56' 31.82"N	75° 36' 23.45"W
14b	Pratt Road – north	42° 56' 38.87"N	75° 35' 28.38"W
14b3	Lynch Road	42° 55' 20.59"N	75° 35' 50.18"W
14c	Pratt Road – south	42° 55' 36.83"N	75° 36' 06.19"W

14d	S. Quarry Road	42° 57' 20.14"N	75° 34' 52.82"W
14d1	Morris Road	42° 56' 55.45"N	75° 34' 41.22"W
14e	Pratts Road (west side of road) south of Streeter	42° 55' 56.14"N	75° 35' 56.88"W
15	Oneida Creek at Brown Road	42° 57' 05.58"N	75° 36' 32.69"W
16	Oneida Creek at South Butler Road	42° 56' 59.03"N	75° 39' 20.57"W
16a	Glass Factory Road east of Swamp Road	42° 57' 55.20"N	75° 40' 46.60"W
16b	Pleasant Valley Road	42° 58' 05.38"N"	75° 41' 15.97"W
16c	Oxbow Road	42° 58' 23.49"N	75° 41' 49.70"W
16c1	Old County Road	42° 58' 52.63"N	75° 41' 52.15"W
16d	South Butler Road at drainage ditch confluence	42° 56' 58.02"N	75° 39' 21.56"W
16d1	South Butler Road in drainage ditch before confluence	42° 56' 58.02"N	75° 39' 21.56"W
14f	Pratts Road (east side of road)	42° 56' 36.54"N	75° 35' 28.68"W

Table 3. Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Oneida Crk.-SSA #1	9/22/03	179.7	155.1	1.39	2.0	450	28.46
Oneida Crk.-SSA #2	9/22/03	35.3	11.4	0.22	1.5	690	45.96
Oneida Crk.-SSA #3	9/22/03	367.0	296.3	1.76	9.8	470	26.52
Oneida Crk.-SSA #4	9/22/03	337.7	258.6	2.29	3.7	590	27.35
Oneida Crk.-SSA #5	9/22/03	150.4	147.5	0.72	3.0	410	19.89
Oneida Crk.-SSA #6A	9/22/03	410.9	369.7	0.71	2.9	620	26.44
Oneida Crk.-SSA #6B	9/22/03	372.8	362.1	1.05	2.9	440	19.44
Oneida Crk.-SSA #6C	9/22/03	9.3	7.6	0.95	2.5	320	15.49
Oneida Crk.-SSA #7	9/22/03	61.7	48.0	0.96	7.9	590	14.93
Oneida Crk.-SSA #8	9/22/03	125.7	97.7	1.01	6.1	470	15.17
Oneida Crk.-SSA #9	9/22/03	17.8	11.2	0.84	4.6	350	12.25
Oneida Crk.-SSA #10	9/22/03	19.5	12.7	0.33	2.2	470	17.02
Oneida Crk.-SSA #11	9/22/03	10.8	10.6	0.82	2.4	300	10.58
Oneida Crk.-SSA #12	9/22/03	13.0	11.7	1.95	5.0	330	8.57
Oneida Crk.-SSA #13	9/22/03	7.0	3.2	0.89	1.4	330	7.96
Oneida Crk.-SSA #14	9/22/03	15.4	11.0	0.75	5.2	290	10.79
Oneida Crk.-SSA #15	9/22/03	3.7	3.7	1.06	<0.2	540	5.27
Oneida Crk.-SSA #16	9/22/03	10.5	9.0	0.63	<0.2	540	8.74

Table 3 (Continued). Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non=-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Oneida Crk.-SSA #1	9/28/03	211.8	80.0	1.45	5.0	560	22.35
Oneida Crk.-SSA #2	9/28/03	59.5	11.1	0.28	4.3	610	36.14
Oneida Crk.-SSA #3	9/28/03	296.1	138.3	1.57	22.0	570	20.50
Oneida Crk.-SSA #4	9/28/03	274.3	121.6	1.34	24.7	590	17.89
Oneida Crk.-SSA #5	9/28/03	184.6	94.5	0.99	20.4	560	14.77
Oneida Crk.-SSA #6A	9/28/03	441.0	372.2	1.62	8.0	500	21.35
Oneida Crk.-SSA #6B	9/28/03	445.3	328.1	1.07	4.1	600	18.25
Oneida Crk.-SSA #6C	9/28/03	22.1	5.3	0.98	6.1	410	13.86
Oneida Crk.-SSA #7	9/28/03	130.2	16.9	0.58	23.4	500	10.69
Oneida Crk.-SSA #8	9/28/03	184.6	22.9	0.57	25.0	550	6.87
Oneida Crk.-SSA #9	9/28/03	47.6	4.6	0.57	20.6	570	8.58
Oneida Crk.-SSA #10	9/28/03	50.5	6.5	0.46	19.3	450	15.46
Oneida Crk.-SSA #11	9/28/03	45.0	2.5	1.13	30.0	670	10.42
Oneida Crk.-SSA #12	9/28/03	44.3	4.8	0.97	21.2	550	8.82
Oneida Crk.-SSA #13	9/28/03	43.9	2.1	0.92	29.3	470	7.77
Oneida Crk.-SSA #14	9/28/03	101.5	2.5	0.73	64.8	540	9.81
Oneida Crk.-SSA #15	9/28/03	10.2	1.8	0.58	2.7	480	6.77
Oneida Crk.-SSA #16	9/28/03	255.8	161.1	0.48	9.4	840	10.23

Table 3 (Continued). Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non=-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Vernon STP upstream sample	10/9/03	10.0	2.4	1.16	5.6	340	16.97
Vernon STP downstream sample	10/9/03	2695.1	1798.4	3.16	3.0	430	52.28
Sherrill STP upstream	10/9/03	18.7	3.4	1.00	9.3	540	7.22
Sherrill STP downstream	10/9/03	1239.2	1013.3	6.29	3.7	430	36.76
Site 4 Oneida Crk – SSA #4	10/9/03	197.1	47.72	1.38	2.6	100	23.72
Site 3 baseline –SSA #3	10/9/03	140.3	55.8	1.51	8.2	330	20.88
Oneida Crk.-SSA #9	10/15/03	173.1	19.7	0.80	102.8	1030	10.57
Oneida Crk.-SSA #9A	10/15/03	70.2	16.2	0.30	22.3	620	13.29
Oneida Crk.-SSA #9C	10/15/03	541.8	134.1	0.78	71.4	1500	14.45
Oneida Crk.-SSA #9D	10/15/03	137.3	10.3	0.61	78.1	890	9.16
Oneida Crk.-SSA #14	10/15/03	189.6	17.0	0.54	101.3	990	6.18
Oneida Crk.-SSA #14A	10/15/03	50.7	4.1	0.36	18.6	560	2.07
Oneida Crk.-SSA #14B	10/15/03	193.4	5.6	0.17	135.2	760	1.16
Oneida Crk.-SSA #14C	10/15/03	60.4	4.2	0.86	22.0	750	8.26
Oneida Crk.-SSA #14D	10/15/03	108.9	18.7	1.67	17.8	800	5.04
Oneida Crk.-SSA #16	10/15/03	62.0	3.2	0.15	14.1	670	6.50
Oneida Crk.-SSA #16A	10/15/03	46.0	4.7	0.16	6.4	650	8.26
Oneida Crk.-SSA #16B	10/15/03	30.3	2.9	0.11	1.1	980	4.97
Oneida Crk.-SSA #16C	10/15/03	55.8	8.1	<.02	6.9	980	5.11
Oneida Crk.-SSA #16D	10/15/03	389.3	288.3	0.93	34.3	1360	7.49

Table 3 (Continued). Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non=-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Oneida Crk.-SSA #9C	4/13/04	41.2	7.2	1.60	8.8	510	12.58
Oneida Crk.-SSA #9C1	4/13/04	20.3	1.9	1.48	12.8	370	8.49
Oneida Crk.-SSA #9C2	4/13/04	7.2	1.5	2.31	10.2	140	7.07
Oneida Crk.-SSA #9C3	4/13/04	31.6	2.6	0.84	26	350	1.00
Oneida Crk.-SSA #9C4	4/13/04	50.7	22.6	1.90	4.5	390	11.22
Oneida Crk.-SSA #14	4/13/04	9.9	ND	1.45	9.1	210	9.86
Oneida Crk.-SSA #14B	4/13/04	18.6	2.4	0.28	24	140	4.89
Oneida Crk.-SSA #14B3	4/13/04	32.2	ND	1.02	6.3	420	4.95
Oneida Crk.-SSA #14C	4/13/04	11.3	1.8	1.75	17.4	80	11.97
Oneida Crk.-SSA #14D	4/13/04	10.4	ND	2.57	3.3	320	3.13
Oneida Crk.-SSA #14D1	4/13/04	15.9	ND	2.92	18.7	280	2.87
Oneida Crk.-SSA #14E	4/13/04	56.8	2.7	1.81	70.9	540	3.28
Oneida Crk.-SSA #14F	4/13/04	10.1	1.9	1.34	13.7	230	9.77
Oneida Crk.-SSA #16	4/13/04	12.2	4.6	0.42	3.5	330	6.51
Oneida Crk.-SSA #16A	4/13/04	11.3	4.5	0.38	2.2	280	5.08
Oneida Crk.-SSA #16B	4/13/04	4.1	2.4	0.39	2.3	280	3.70
Oneida Crk.-SSA #16C	4/13/04	10.7	5.8	0.13	3.8	390	7.36
Oneida Crk.-SSA #16C1	4/13/04	14.8	1.5	0.22	11.1	250	1.43
Oneida Crk.-SSA #16D	4/13/04	71	28.8	0.46	4.8	460	10.93
Upstream Oneida STP	4/23/04	76.7	25.9	1.10	11.9	660	14.80
Downstream Oneida STP	4/23/04	81.3	27.0	1.06	11.1	700	16.35

Table 3 (Continued). Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non=-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Oneida Crk.-SSA #2	5/10/04	33.6	5.7	ND	7.7	1,060	21.17
Oneida Crk.-SSA #5	5/10/04	141.3	33.8	1.00	43.4	950	15.69
Oneida Crk.-SSA #6A	5/10/04	280.3	155.1	0.93	28.2	510	18.64
Oneida Crk.-SSA #6B	5/10/04	249.3	105.7	0.69	32.3	740	16.27
Oneida Crk.-SSA #6C	5/10/04	79.8	9.9	0.74	56.6	870	15.10
Oneida Crk.-SSA #7	5/10/04	70.1	10.6	0.97	69.6	760	10.91
Oneida Crk.-SSA #8	5/10/04	114.8	16.3	1.04	58.9	1,170	11.36
Oneida Crk.-SSA #9	5/10/04	65.5	9.1	0.91	24.5	1,750	10.33
Oneida Crk.-SSA #10	5/10/04	235.6	11.8	0.86	90.2	1,700	11.98
Oneida Crk.-SSA #11	5/10/04	32.2	6.1	0.92	6.9	670	7.87
Oneida Crk.-SSA #12	5/10/04	21.6	1.6	0.81	10.7	660	8.07
Oneida Crk.-SSA #13	5/10/04	19.0	1.8	0.64	3.8	620	7.45
Oneida Crk.-SSA #14	5/10/04	25.9	4.7	0.98	7.0	460	10.89
Oneida Crk.-SSA #15	5/10/04	14.4	1.1	0.45	2.5	490	5.35
Oneida Crk.-SSA #16	5/10/04	21.0	5.9	0.27	1.9	320	5.44
Oneida Crk.-SSA #8	5/25/04	86.9	19.8	2.18	370.0	3,130	8.45
Oneida Crk.-SSA #9	5/25/04	97.2	13.7	2.39	370.5	2,470	8.76
Oneida Crk.-SSA #10	5/25/04	1,076	20.5	1.87	488.5	2,440	7.87
Oneida Crk.-SSA #10a	5/25/04	411.3	29.1	2.04	269.5	2,320	7.57
Oneida Crk.-SSA #10b	5/25/04	77.4	34.2	1.96	245.5	2,150	6.16
Oneida Crk.-SSA #10c	5/25/04	358.1	82.6	5.16	74.5	1,630	4.21
Oneida Crk.-SSA #10d	5/25/04	342.3	52.8	7.27	65.2	1,470	7.78
Oneida Crk.-SSA #10f	5/25/04	208.6	5.8	1.11	98.2	1,470	4.03

Table 3 (Continued). Water chemistry results from Oneida Creek. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non=-detectable.

Sample Site	Date Collected	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	TKN (µg N/L)	Sodium (mg/L)
Oneida Crk.-SSA #10g	5/10/04	166.9	9.4	1.07	81.5	1,330	3.52
Oneida Crk.-SSA #10h	5/10/04	179.8	13.2	1.11	88.5	1,330	3.32
Oneida Crk.-SSA #10i	5/10/04	67.6	6.2	1.91	29.2	630	1.46

Figure 1. Map of sampling stations for the Oneida Creek Stressed Stream analysis. Areas in orange indicate suspected segments where sources of nutrient and soil loss are occurring.

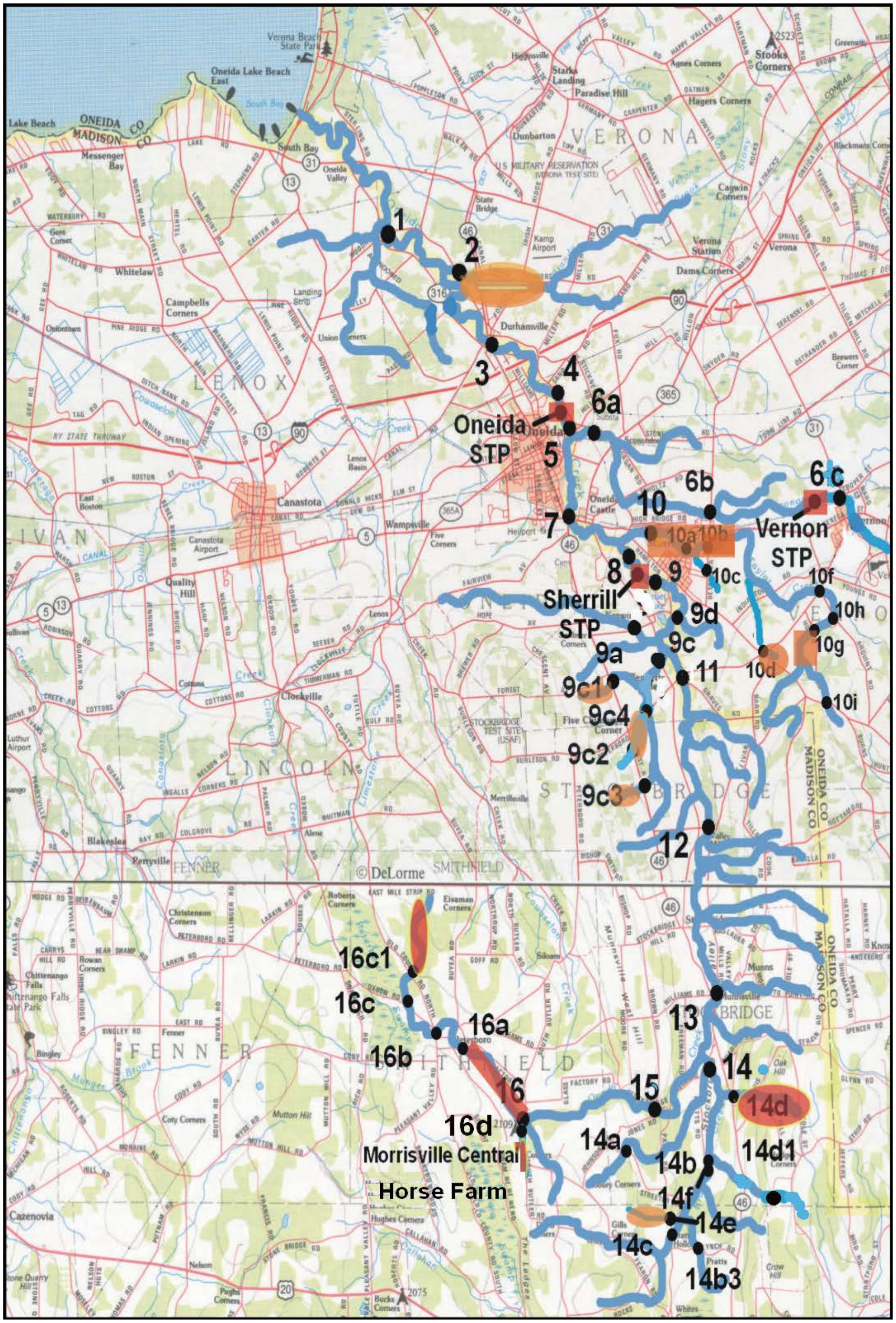

Figure 2. Segment analysis of Oneida Creek, 22 September 2003.

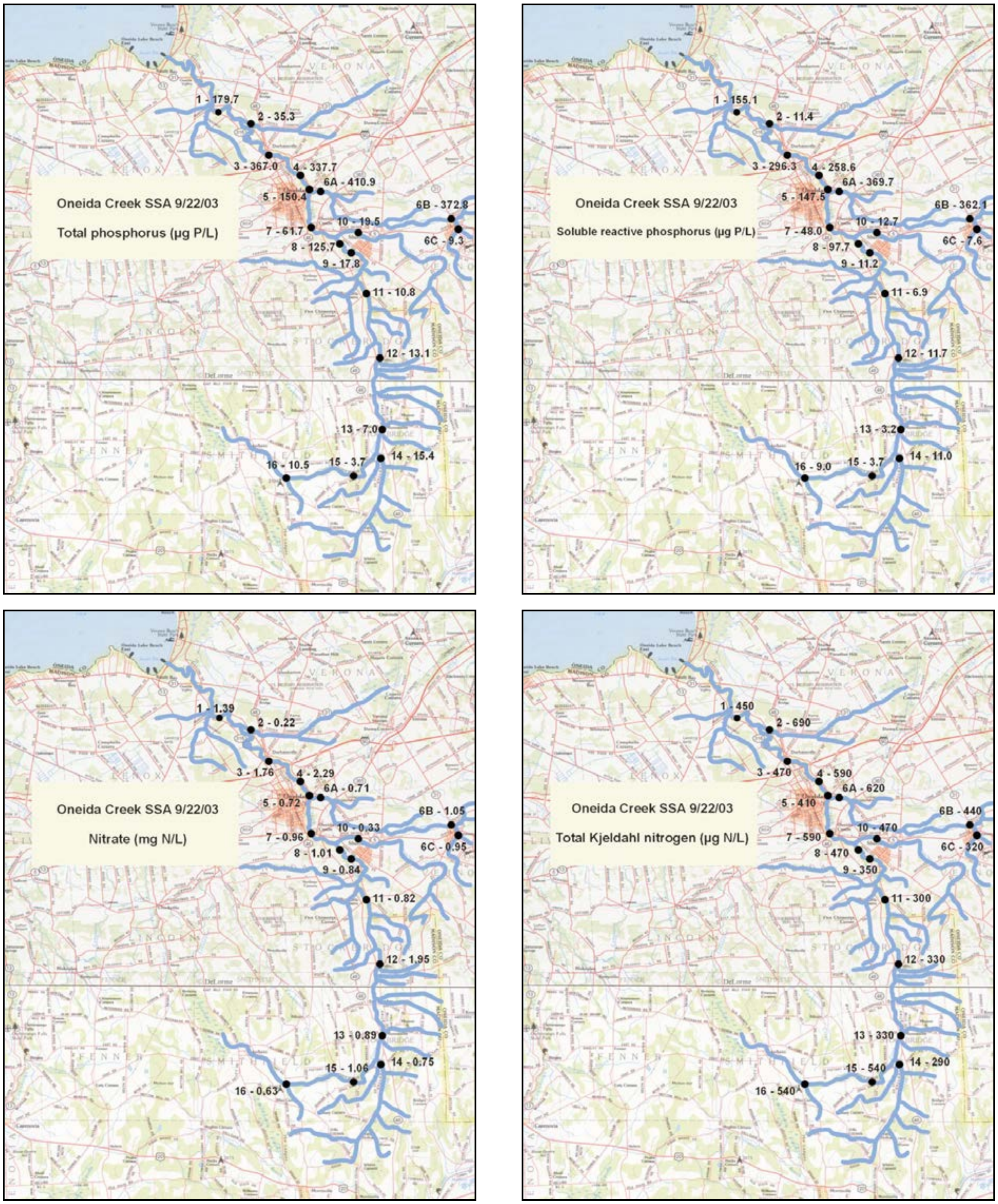

Figure 2. Segment analysis of Oneida Creek, 22 September 2003.

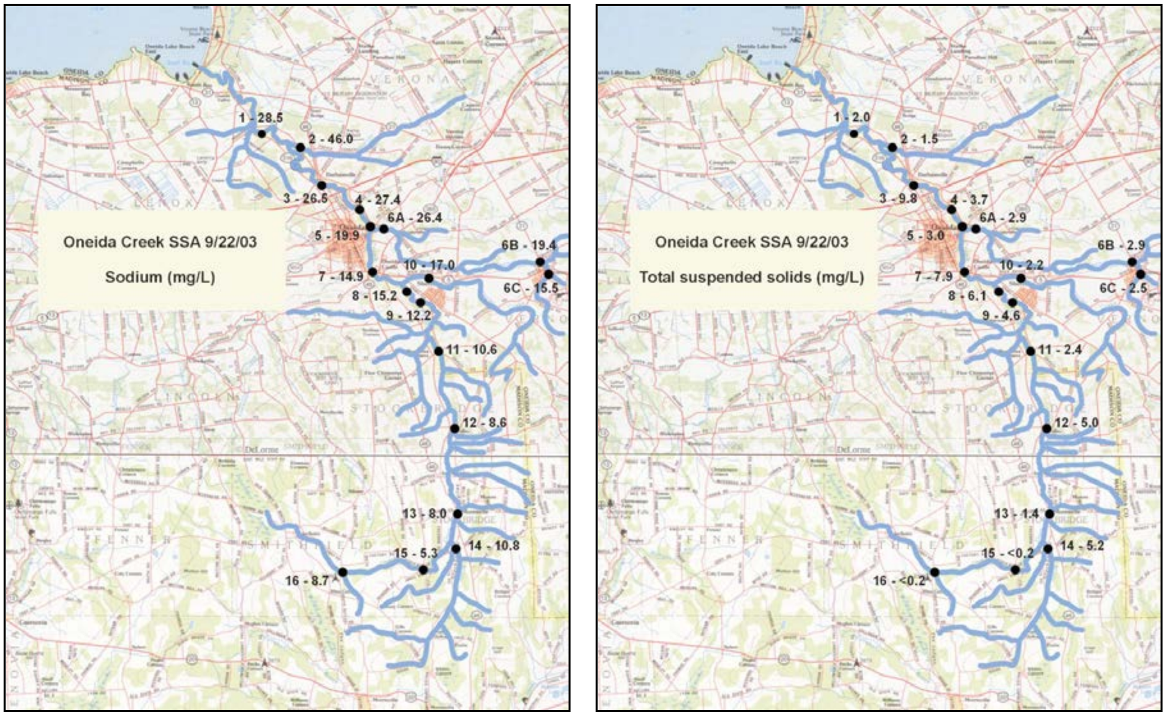

Figure 3. Segment analysis of Oneida Creek, 28 September 2003.

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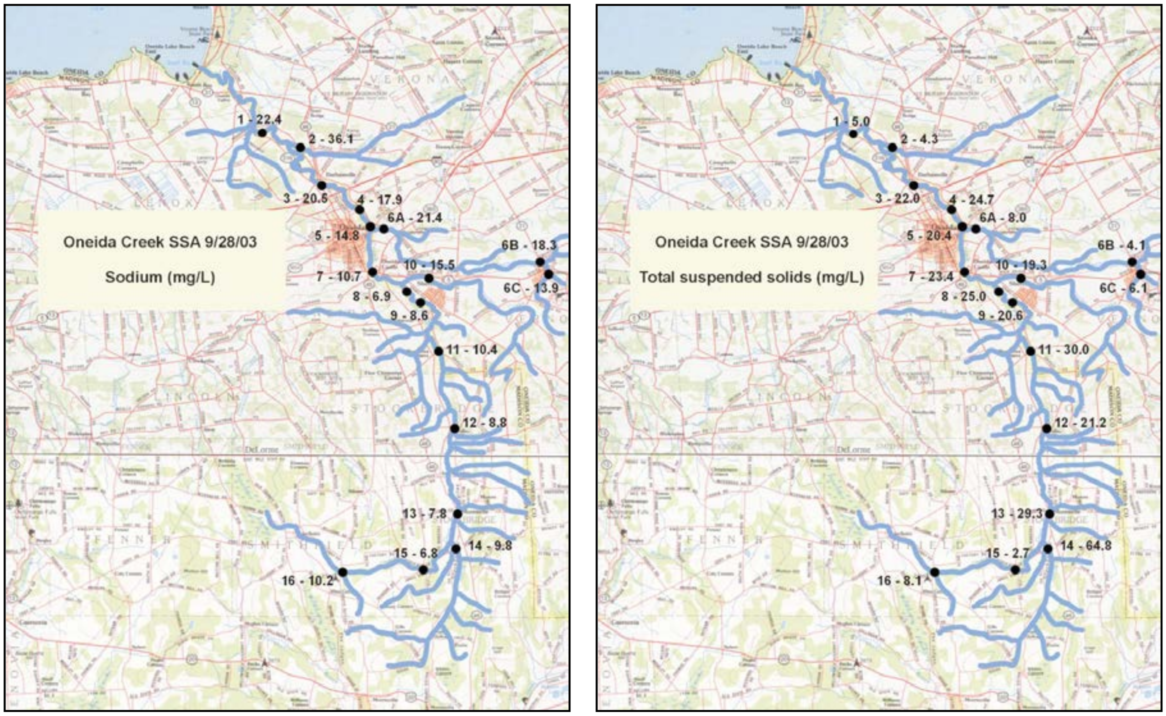


Figure 4. Segment analysis of Oneida Creek, 9 October 2003.

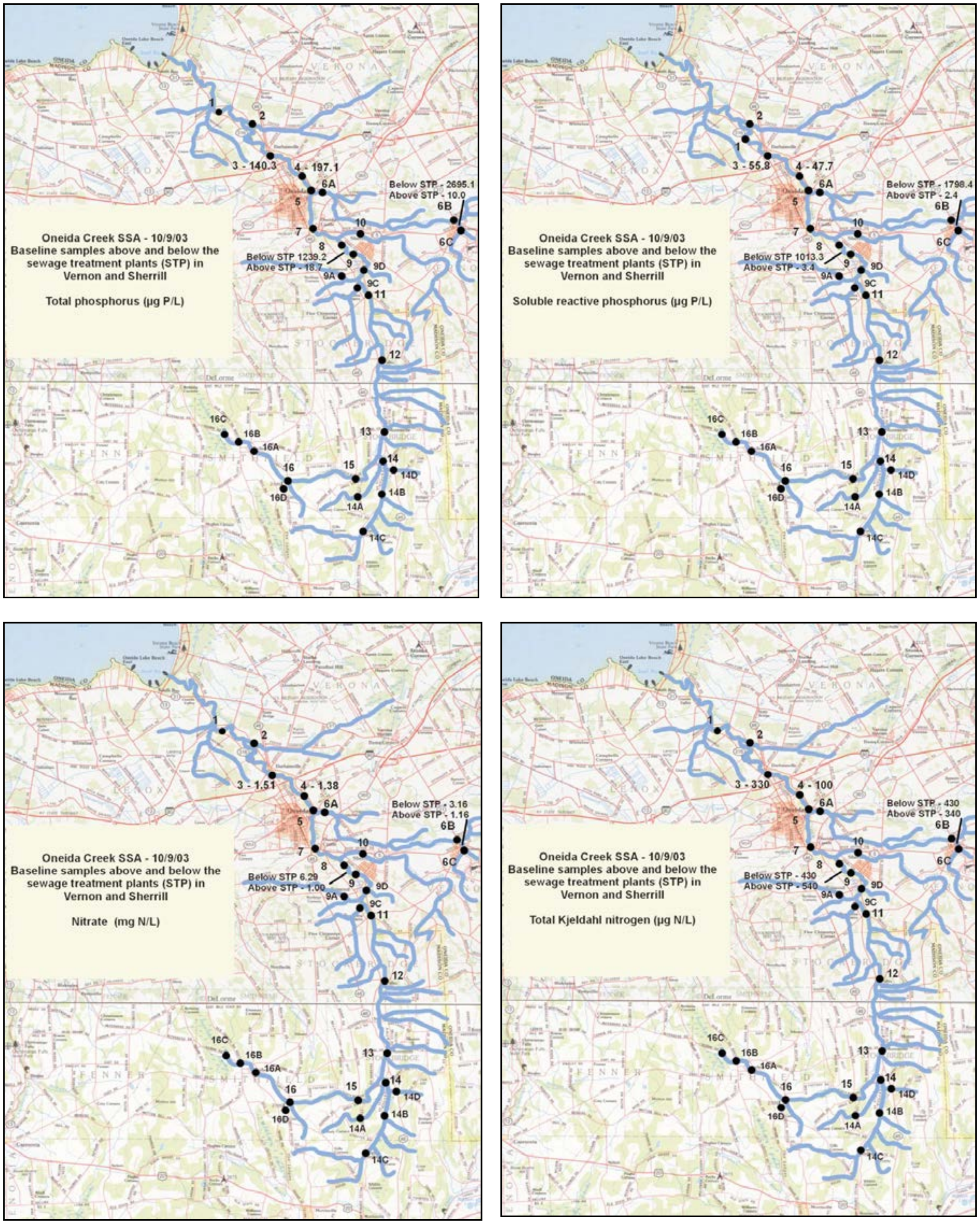


Figure 4. Segment analysis of Oneida Creek, 9 October 2003.

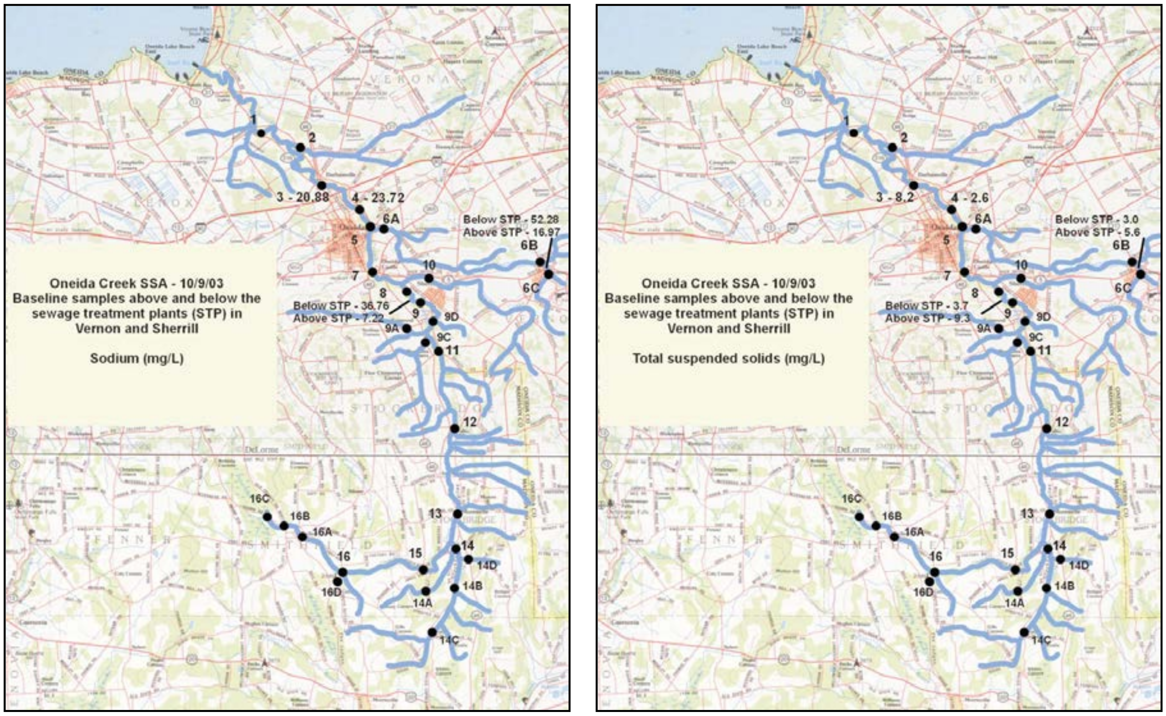
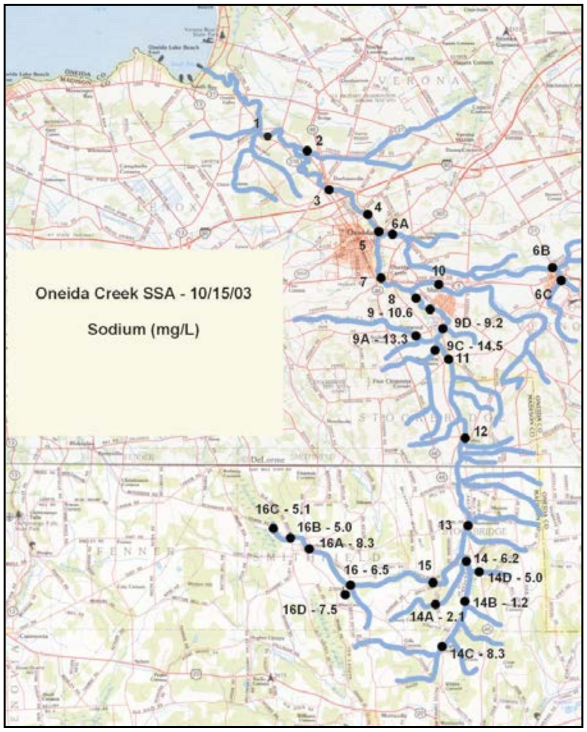


Figure 5. Segment analysis of Oneida Creek, 15 October 2003.

Figure 5. Segment analysis of Oneida Creek, 15 October 2003.



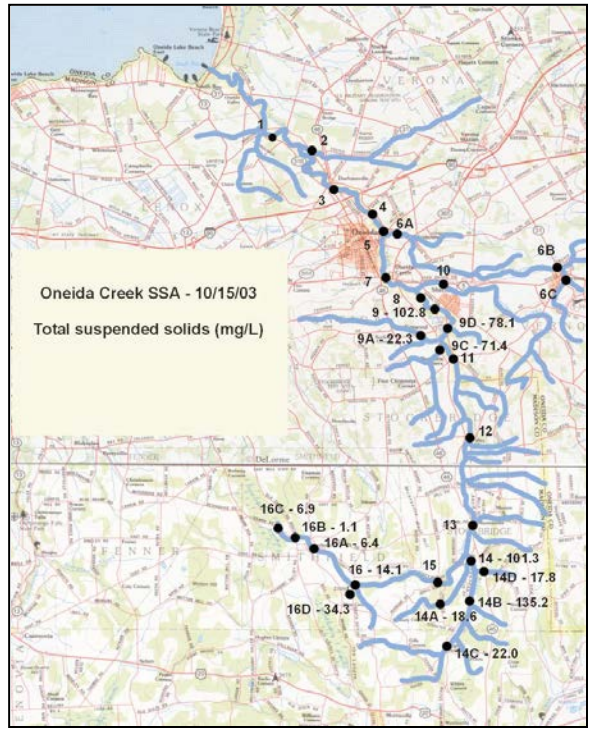


Figure 6. Segment analysis of Oneida Creek, 13 April 2004.

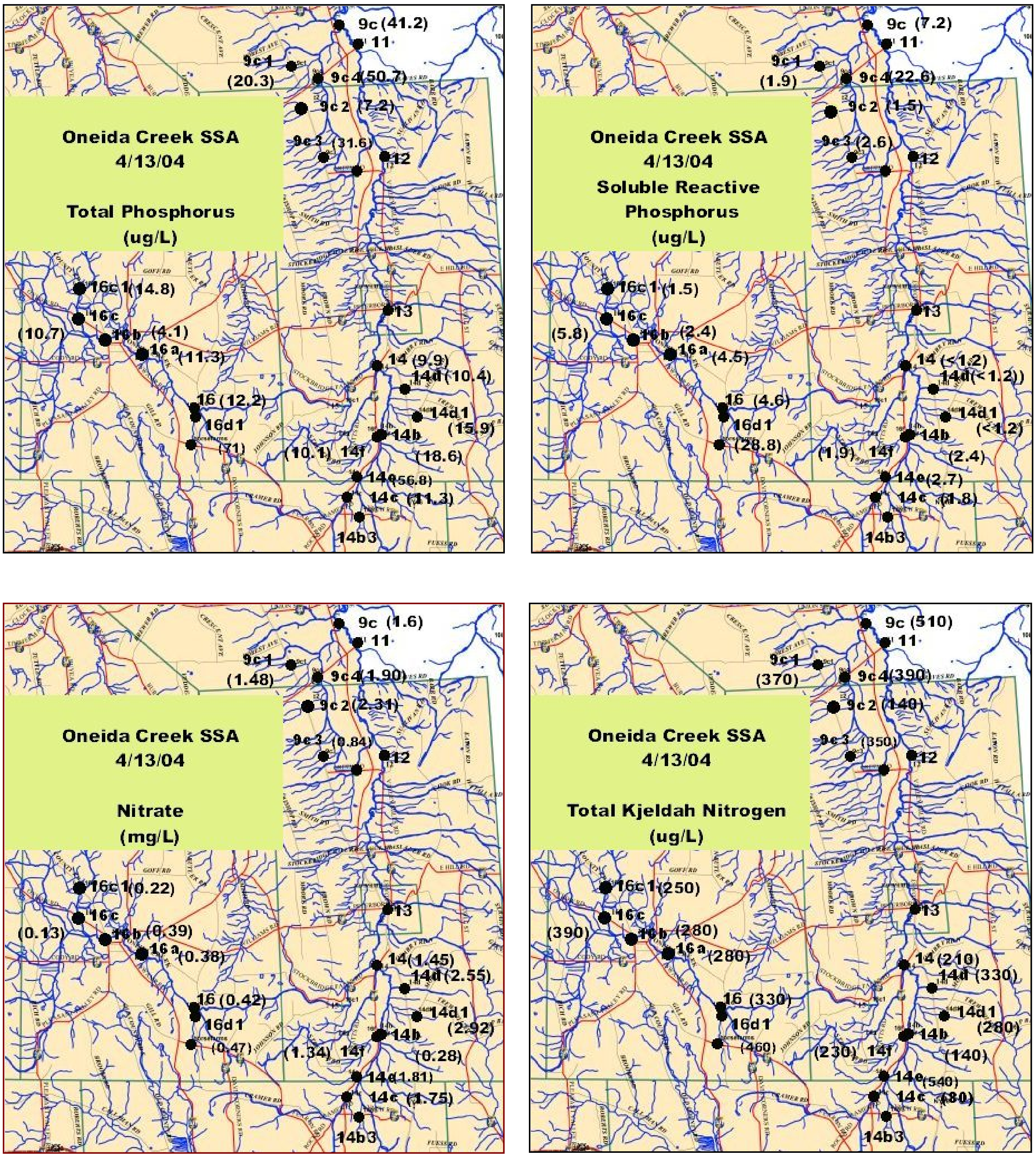


Figure 6. Segment analysis of Oneida Creek, 13 April 2004.

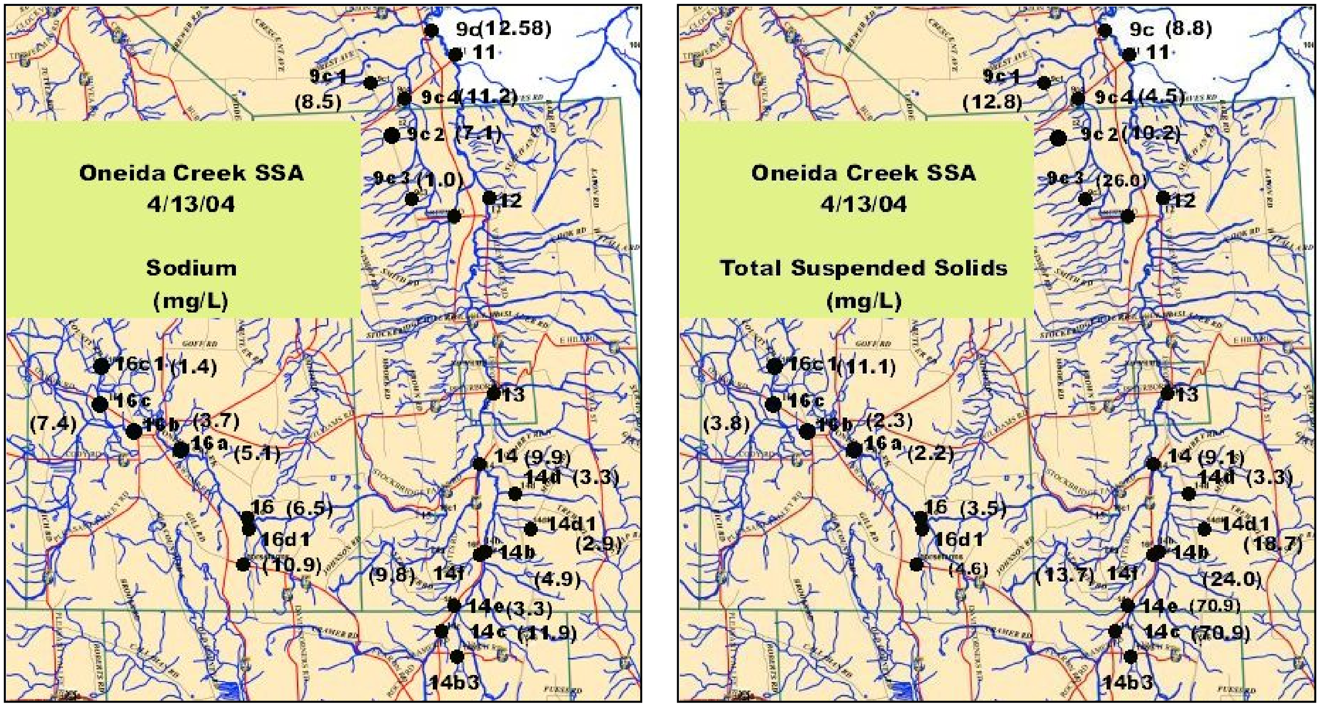


Figure 8. Erosion hot spots in the Oneida Creek watershed

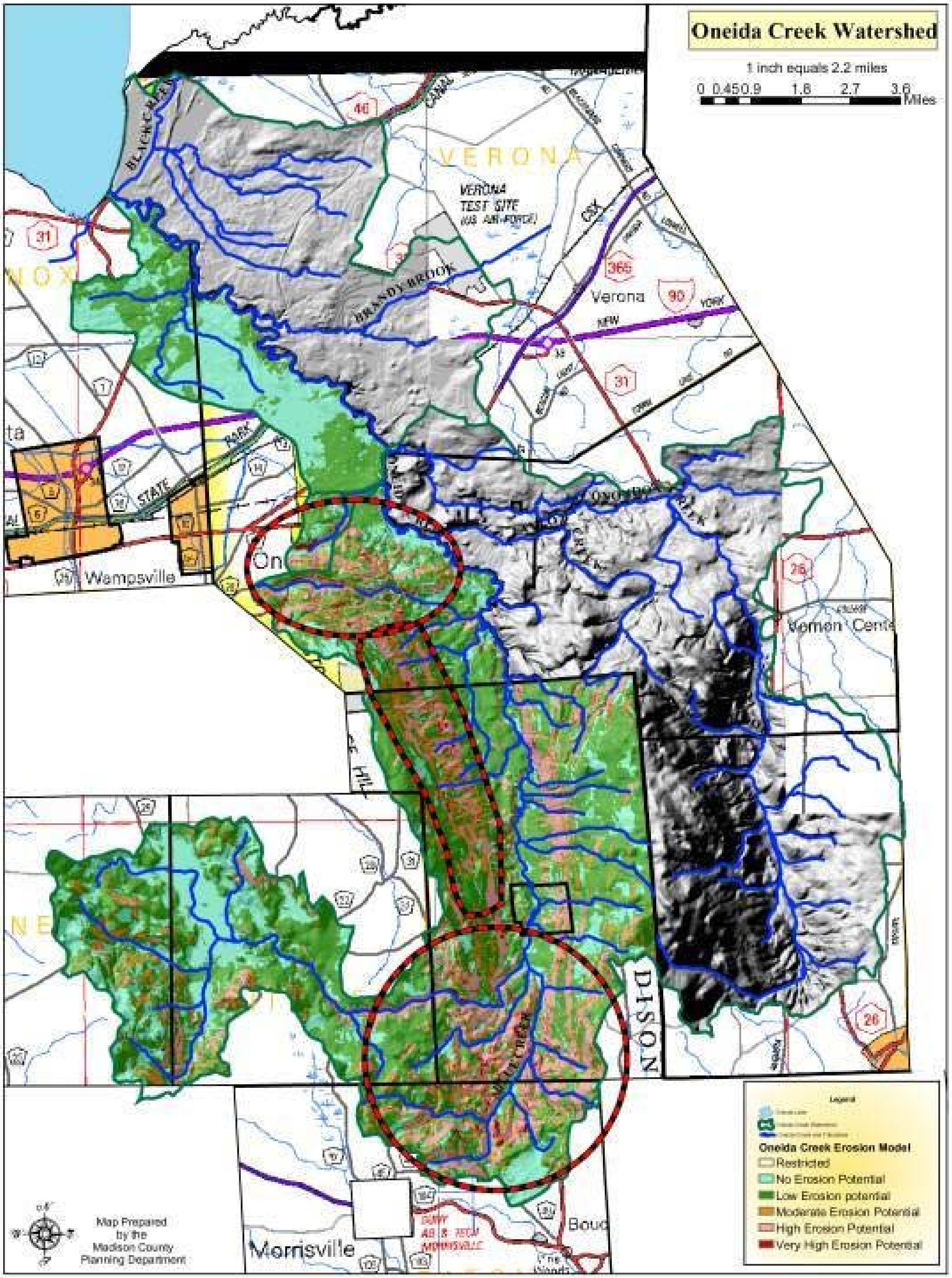


Figure 9. Segment analysis of Oneida Creek, 10 May 2004

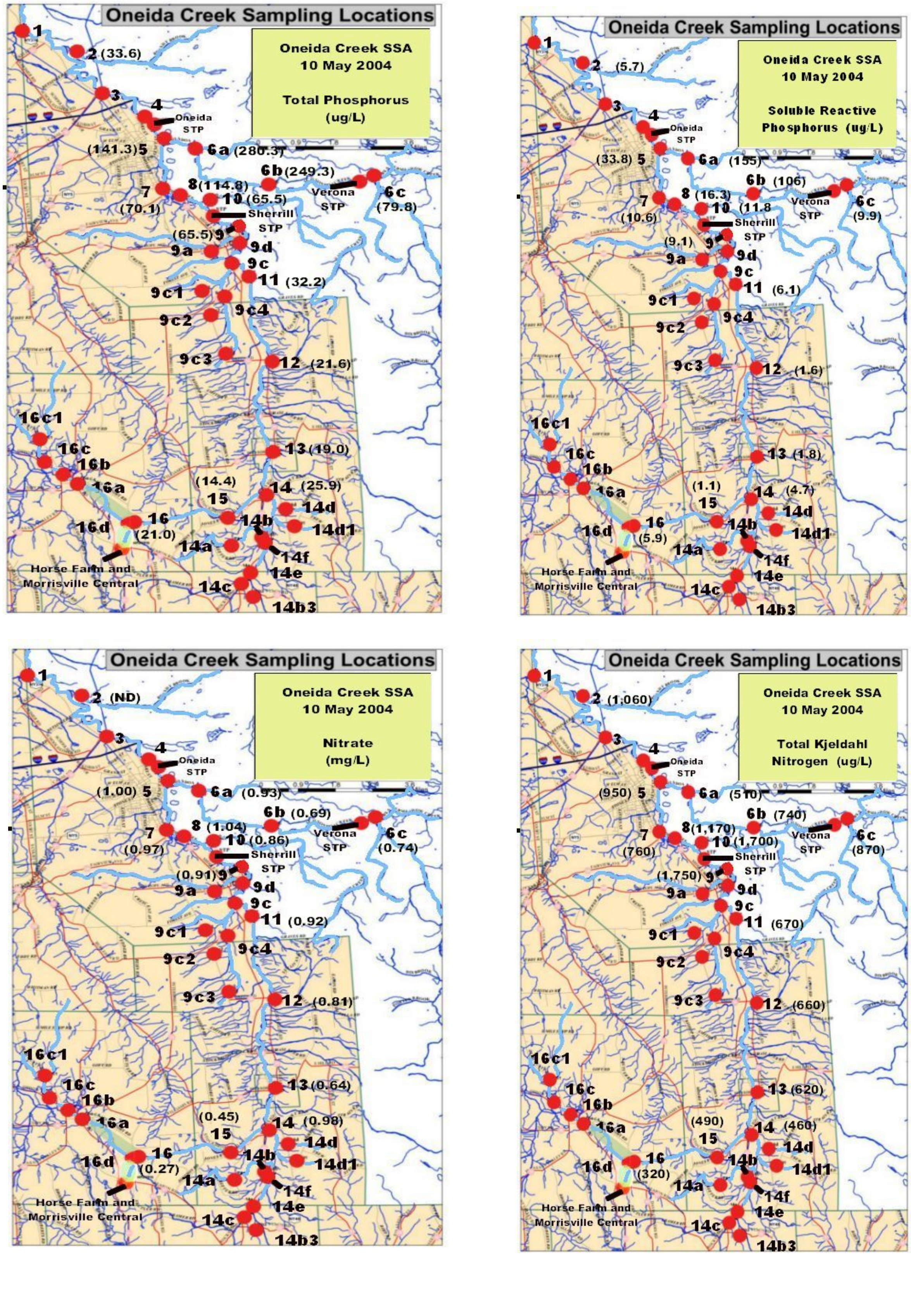
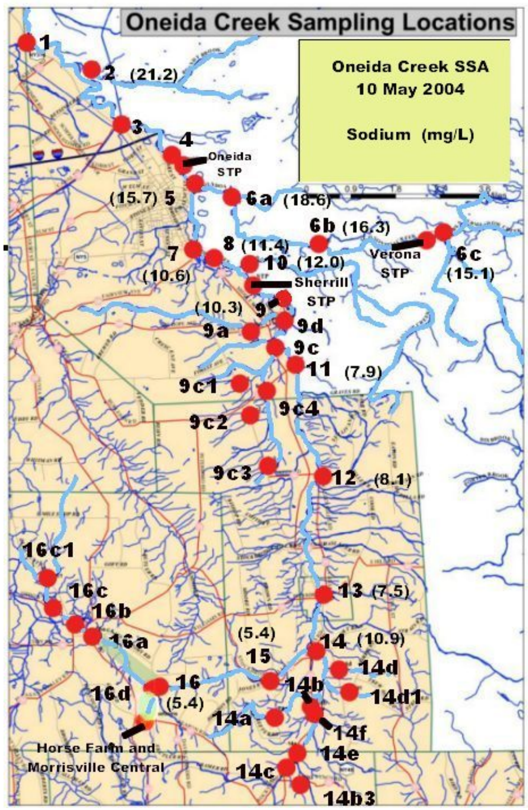


Figure 9. Segment analysis of Oneida Creek, 10 May 2004.



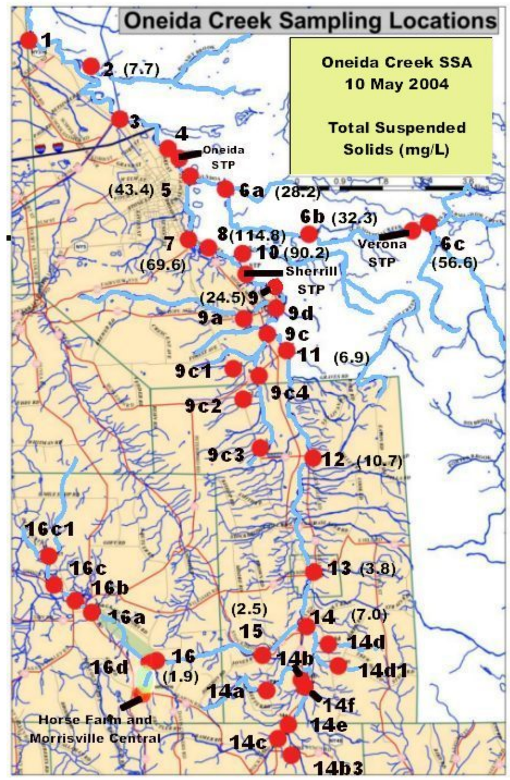


Figure 10. Segment analysis of Oneida Creek, 24 May 2004.

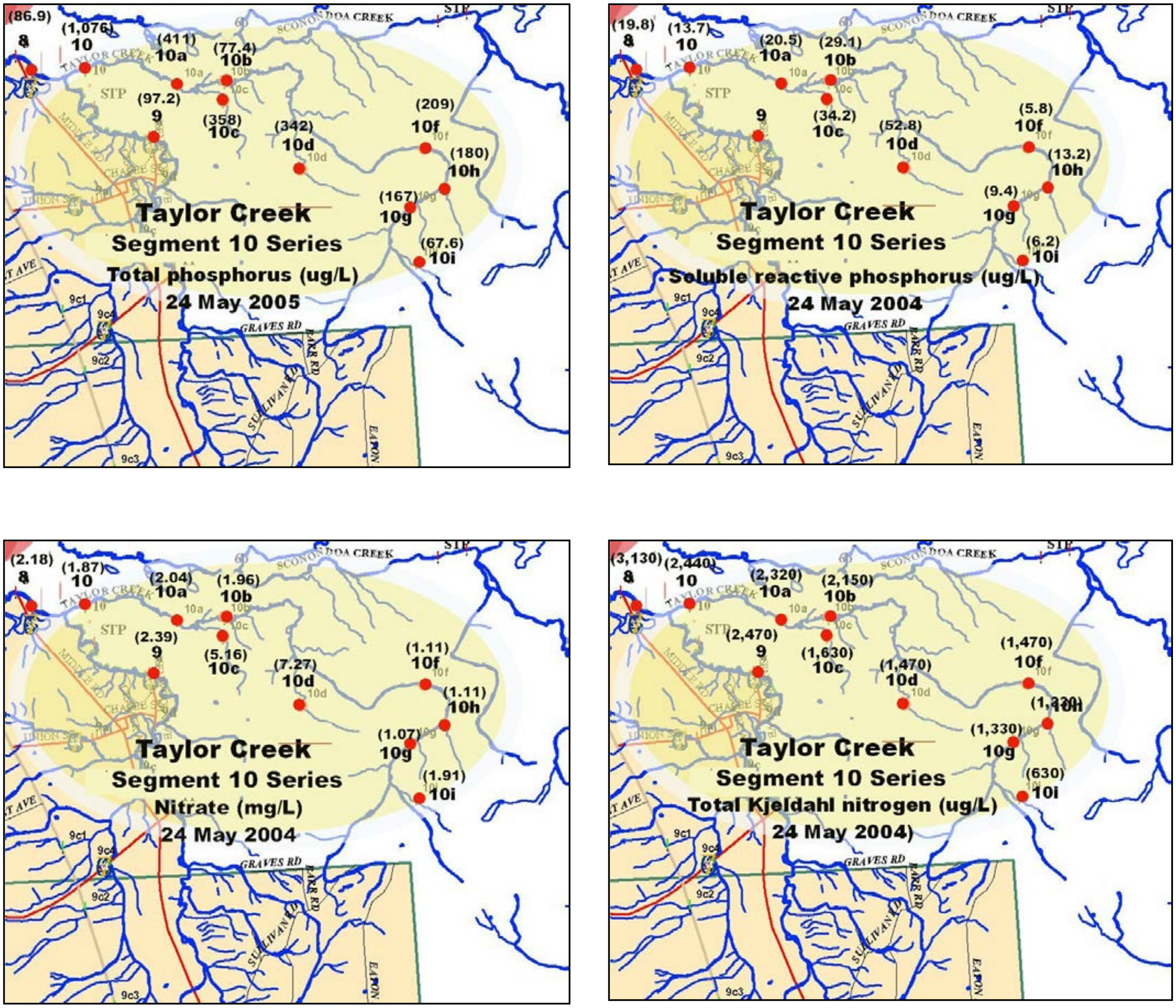


Figure 10. Segment analysis of Oneida Creek, 24 May 2004.