# Water Quality Analysis of Eutrophication for the Seneca Creek Basin in Montgomery County, Maryland

## FINAL

DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard, Suite 540
Baltimore MD 21230-1718

Submitted to:

Water Protection Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

August 2009

EPA Submittal Date: August 25, 2009
EPA Approval Date: September 23, 2009

## Table of Contents

## List of Figures



## List of Tables

## List of Abbreviations

| | |
|---|---|
| BOD | Biochemical Oxygen Demand |
| BSID | Biological Stressor Identification |
| CES | Coastal Environmental Services |
| COMAR | Code of Maryland Regulations |
| CWA | Clean Water Act |
| DNR | Department of Natural Resources |
| DO | Dissolved Oxygen |
| EPA | United States Environmental Protection Agency |
| MBSS | Maryland Biological Stream Survey |
| MDE | Maryland Department of the Environment |
| MDP | Maryland Department of Planning |
| mg/l | Milligrams Per Liter |
| $mi^2$ | Square Miles |
| NPDES | National Pollution Discharge Elimination System |
| NRCS | National Resources Conservation Service |
| SCS | Soil Conservation Service |
| SSURGO | Soil Survey Geography |
| TMDL | Total Maximum Daily Load |
| TN | Total Nitrogen |
| TP | Total Phosphorus |
| TSI | Trophic State Index |
| USGS | United States Geological Survey |
| WQLS | Water Quality Limited Segment |
| µg/l | Micrograms Per Liter |

## EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS listed on the *Integrated Report of Surface Water Quality in Maryland* (Integrated Report), the State is required to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate via a Water Quality Analysis (WQA) that water quality standards are being met (CFR 2007).

The waters of Seneca Creek (MD basin code 02140208), located in Montgomery County, have been identified on the Integrated Report under Category 5 as impaired by nutrients (1996), sediments (1996), and impacts to biological communities (2002). All impairments are listed for non-tidal streams. The 1996 suspended sediment listing was refined in the 2008 Integrated Report to a listing for total suspended solids. Similarly, the 1996 nutrients listing were refined in the 2008 Integrated Report and phosphorus was identified as the specific impairing substance. Consequently, for the purpose of this report the terms "nutrients" and "phosphorus" will be used interchangeably. The listings for sediments and impacts to biological communities will be addressed separately at a future date.

A data solicitation for information pertaining to pollutants, including nutrients, in the Seneca Creek basin was conducted by MDE in November 2007, and all readily available data from the past five years have been considered. Currently, there are no specific numeric criteria for nutrients in Maryland's water quality standards. Nutrients typically do not have a direct impact on aquatic life; rather, they mediate impacts through excessive algal growth leading to low dissolved oxygen. Therefore, the evaluation of potentially eutrophic conditions due to nutrient over-enrichment will be based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair designated uses in the Seneca Creek (in this case, protection of aquatic life and wildlife, fishing, and swimming).

Recently, MDE developed a biological stressor identification (BSID) methodology to identify the most probable cause(s) of the existing biological impairments in Maryland 8-digit watersheds based on the suite of available physical, chemical, and land use data (MDE 2009a). The BSID analysis for Seneca Creek indicates inorganic pollutants, ammonia toxicity, high pH, and flow/sediment related stressors are associated with impacts to biological communities; these findings will be addressed separately. The BSID analysis did not identify any nutrient stressors present and/or nutrient stressors showing a significant association with degraded biological conditions (MDE 2009b). The results of the BSID study, combined with the analysis of recent water quality data presented in this report, indicate that the Seneca Creek watershed is not being impaired by nutrients.

This WQA supports the conclusion that a TMDL for nutrients is not necessary to achieve water quality standards in Seneca Creek. Although the waters of Seneca Creek do not display signs of eutrophication, the State reserves the right to require future controls if evidence suggests that nutrients from the basin are contributing to downstream water quality problems. Additional

reductions may also be required by the forthcoming Chesapeake Bay TMDL, currently under development and due to be established by EPA by the end of 2010.

Barring the receipt of contradictory data, this report will be used to support a revision of the phosphorus listing for the Seneca Creek watershed, from Category 5 ("waterbody is impaired, does not attain the water quality standard, and a TMDL is required") to Category 2 ("waterbodies meeting some [in this case nutrients-related] water quality standards, but with insufficient data to assess all impairments") when MDE proposes the revision of the Integrated Report.

## 1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS listed on the *Integrated Report of Surface Water Quality in Maryland* (Integrated Report), the State is required to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met (CFR 2007).

A segment identified as a WQLS may not require the development and implementation of a TMDL if more recent information invalidates previous findings. The most common scenarios that would eliminate the need for a TMDL are: 1) analysis of more recent data indicating that the impairment no longer exists (i.e., water quality standards are being met); 2) results of a more recent and updated water quality modeling which demonstrates that the segment is attaining standards; 3) refinements to water quality standards or to the interpretation of those standards accompanied by analysis demonstrating that the standards are being met; or 4) identification and correction of errors made in the initial listing.

The waters of Seneca Creek (MD basin code 02140208), located in Montgomery County, have been identified on the Integrated Report under Category 5 as impaired by nutrients (1996), sediments (1996), and impacts to biological communities (2002). All impairments are listed for non-tidal streams. The 1996 suspended sediment listing was refined in the 2008 Integrated Report to a listing for total suspended solids. Similarly, the 1996 nutrients listing were refined in the 2008 Integrated Report and phosphorus was identified as the specific impairing substance. Consequently, for the purpose of this report the terms "nutrients" and "phosphorus" will be used interchangeably. The listings for sediments and impacts to biological communities will be addressed separately at a future date.

This report provides an analysis of recent data that supports the removal of the nutrients (phosphorus) listing for the Seneca Creek watershed when MDE proposes the revision of the State's Integrated Report. The remainder of this report lays out the general setting of the Seneca Creek watershed area, and presents a discussion of the water quality characteristics in the basin in terms of the existing water quality standards relating to nutrients. This analysis supports the conclusion that the waters of the Seneca Creek watershed do not display signs of eutrophication, or nutrient over-enrichment.

## 2.0 GENERAL SETTING

### Location

Seneca Creek is the largest watershed located entirely within Montgomery County (see Figure 1). The Seneca Creek watershed originates near Damascus in the northwest portion of the County, flowing in a southerly direction through Germantown and Gaithersburg, until it joins the Potomac River near the town of Seneca. Two large tributary systems flow into Seneca Creek. These are Little Seneca Creek and Dry Seneca Creek. The drainage area of the Maryland 8-digit watershed Seneca Creek is 38,500 acres.

### Geology/Soils

The Seneca Creek watershed lies within the Piedmont Plateau province of Central Maryland. The Piedmont province is characterized by gentle to steep rolling topography, low hills, and ridges. Numerous rather deep and narrow stream valleys have been incised into it; the streams often show relatively steep gradient with many rapids (MGS 2007)**.** Bedrock in the eastern part of the Piedmont consists of schist, gneiss, slate, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin. In several places these rocks have been intruded by granitic plutons and pegmatites. These formations are resistant to short-term erosion and often determine the limits of stream bank and stream bed (MGS 2009).

Soils typically found in the Seneca Creek watershed are the Chrome, Baile, Penn, and Waynesboro series. The Chrome series consists of moderately deep, well drained soils. The Baile series consists of very deep, poorly drained, moderately low to moderately high saturated hydraulic conductivity, soils on upland depressions and footslopes. The Penn series consists of moderately deep, well drained soils formed in residuum weathered from noncalcareous reddish shale, siltstone, and fine-grained sandstone of the Triassic age. The Waynesboro series consist of very deep, well drained, moderately permeable soils that formed in old alluvium or unconsolidated material of sandstone, shale, and limestone origin (U.S. Department of Agriculture (USDA 1977) (CES 1995).

### Land Use

The Seneca Creek watershed contains urban, agricultural, and forested land use (see Figure 2). The land use distribution in the watershed is approximately 33% forest/herbaceous, 33% urban, 33% agricultural, and 1% water (MDP 2002).

### Point Sources

There are a total of five municipal and industrial point source facilities with permits regulating their discharges in the Seneca Creek. Of these, only three municipal wastewater treatment plants (WWTPs) have National Pollution Discharge Elimination System (NPDES) permits regulating the discharge of nutrients (see Table 1 below). The other two plants do not discharge nutrients.

**Table 1: Point Source Facilities Discharging Nutrients to Seneca Creek**

| Facility | NPDES Number | Maximum Permitted Flow (mgd) |
|---|---|---|
| Poolesville WWTP | MD0023001 | 0.625 |
| Damascus WWTP | MD0020982 | 1.500 |
| Seneca WWTP | MD0021491 | 20.00 |

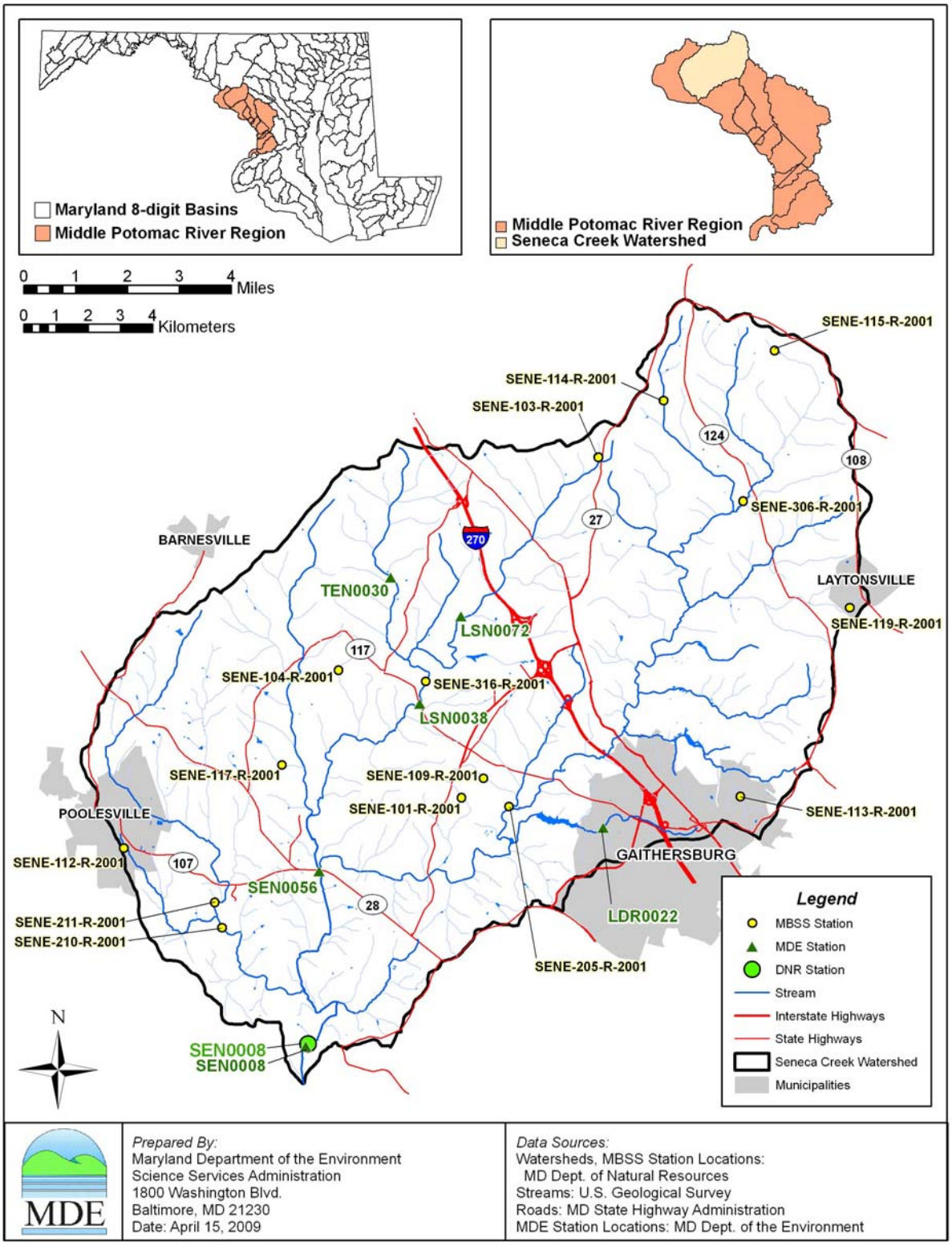


**Figure 1: Location Map and Monitoring Stations of the Seneca Creek Watershed**

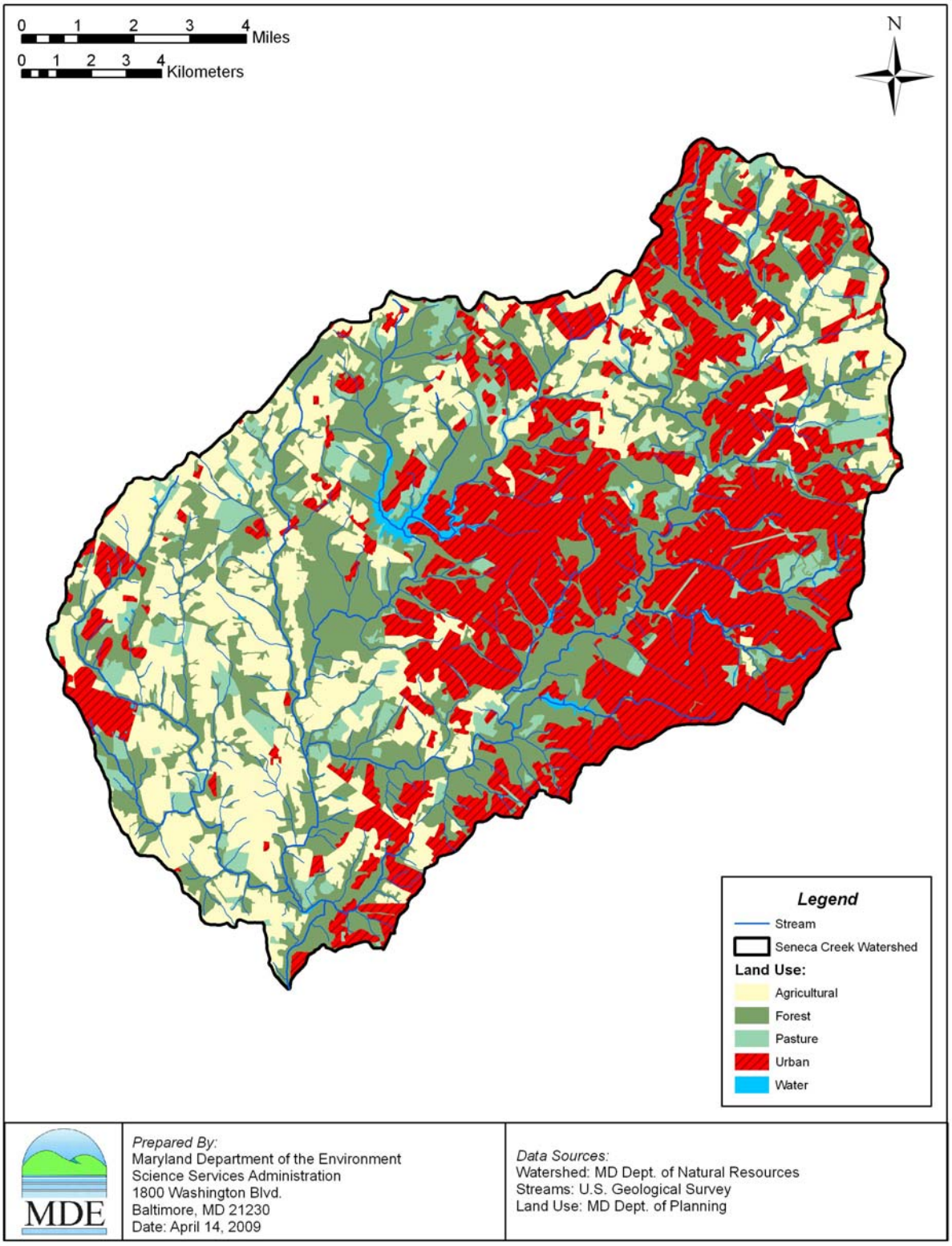


**Figure 2: Land Use of the Seneca Creek Watershed**

## 3.0 WATER QUALITY CHARACTERIZATION

The Maryland Surface Water Use Designation in the Code of Maryland Regulations (COMAR) for the waters of Seneca Creek is Use I-P (Water Contact Recreation, Protection of Nontidal Warmwater Aquatic Life, and Public Water Supply). Two tributaries, Little Seneca Creek (and its tributaries) from the stream's confluence with Bucklodge Branch to the B&O railroad bridge, and Wildcat Branch (and its tributaries), are designated as Use III-P (Nontidal Cold Water and Public Water Supply). The remaining portion of Little Seneca Creek (and its tributaries) are designated as Use IV-P (Recreational Trout Waters and Public Water Supply) (COMAR 2009 a,b,c). A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include support of aquatic life, primary or secondary contact recreation, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. The criteria developed to protect the designated use may differ and are dependent on the specific designated use(s) of a waterbody.

Currently, there are no specific numeric criteria for nutrients in Maryland's water quality standards. Therefore, the evaluation of potentially eutrophic conditions due to nutrient over-enrichment will be based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair designated uses in the Seneca Creek. The dissolved oxygen (DO) concentration to protect Use I-P waters "may not be less than 5 milligrams per liter (mg/l) at any time" and to protect Use III-P waters "may not be less than 5 mg/l at any time, with a minimum daily average of not less than 6 mg/l" (COMAR 2009d). The water quality data presented in this section will show that DO concentrations in the Seneca Creek and its tributaries meet these criteria, and that Maryland's narrative criteria for chlorophyll *a* are also met.

In addition to the DO and chlorophyll *a* data analysis, the results of the BSID analysis of the Seneca Creek watershed demonstrate that any biological impairment in the watershed is not caused by nutrient enrichment. Instead, the analysis suggests that the degradation to biological communities in Seneca Creek is strongly associated with the extensive urban nature of the watershed, which results in altered hydrology and elevated levels of ammonia[1], chlorides, high pH, and conductivity (a measure of the presence of dissolved substances) (MDE 2009b).

A data solicitation was conducted in 2007. All readily available water quality data from the past five years have been considered for this analysis. Water quality data from MDE surveys conducted along the Seneca Creek from October 2000 through December 2005 were used. Maryland Department of Natural Resources (DNR) data used in the analysis were from January 1998 through June 2007. Data from Maryland Biological Stream Survey (MBSS) sampling conducted in July and August 2001 were also used. Table 2 lists the water quality monitoring stations in the Seneca Creek watershed with their geographical coordinates. Figures 3 through 6 provide graphical representation of the collected data for the parameters discussed below.

[1] Ammonia is a nitrogen nutrient species which, in excessive amounts, has potential toxic effects on aquatic life. Maryland has numeric toxic substance criteria for ammonia for the protection of fresh water aquatic life (COMAR 26.08.02.03-2(H).

**Table 2: Water Quality Stations in Seneca Creek Watershed Monitored During 1998-2007**

| Station ID | Agency/Program | Latitude (Decimal-Degrees) | Longitude (Decimal-Degrees) |
|---|---|---|---|
| LDR0022 | MDE | 39.14 | 77.23 |
| LSN0038 | MDE | 39.17 | 77.29 |
| LSN0072 | MDE | 39.19 | 77.28 |
| SEN0008 | MDE | 39.08 | 77.34 |
| SEN0056 | MDE | 39.13 | 77.33 |
| TEN0030 | MDE | 39.21 | 77.31 |
| SEN0008 | DNR/CORE | 39.08 | 77.34 |
| SENE-101-R-2001 | DNR/MBSS | 39.14 | 77.28 |
| SENE-103-R-2001 | DNR/MBSS | 39.24 | 77.23 |
| SENE-104-R-2001 | DNR/MBSS | 39.18 | 77.32 |
| SENE-109-R-2001 | DNR/MBSS | 39.15 | 77.27 |
| SENE-112-R-2001 | DNR/MBSS | 39.13 | 77.40 |
| SENE-113-R-2001 | DNR/MBSS | 39.14 | 77.18 |
| SENE-114-R-2001 | DNR/MBSS | 39.26 | 77.21 |
| SENE-115-R-2001 | DNR/MBSS | 39.27 | 77.17 |
| SENE-117-R-2001 | DNR/MBSS | 39.15 | 77.34 |
| SENE-119-R-2001 | DNR/MBSS | 39.20 | 77.14 |
| SENE-205-R-2001 | DNR/MBSS | 39.14 | 77.26 |
| SENE-210-R-2001 | DNR/MBSS | 39.11 | 77.37 |
| SENE-211-R-2001 | DNR/MBSS | 39.11 | 77.37 |
| SENE-306-R-2001 | DNR/MBSS | 39.23 | 77.18 |
| SENE-316-R-2001 | DNR/MBSS | 39.18 | 77.29 |

### 3.1 Dissolved Oxygen

DNR samples were taken in the Seneca Creek from January 1998 through June 2007. MDE samples were taken from October 2000 through December, and MBSS samples were taken in July and August 2001. Samples taken during the growing season (May through October) show DO concentrations ranging from 6.5 to 11.8 mg/l, all above the water quality criterion of 5 mg/l for Use I-P and Use III-P waters. The DO data are presented graphically in Figure 3 and in tabular form in Appendix A. Based on this analysis, MDE considers that the water quality standard for DO is being met in the Seneca Creek.

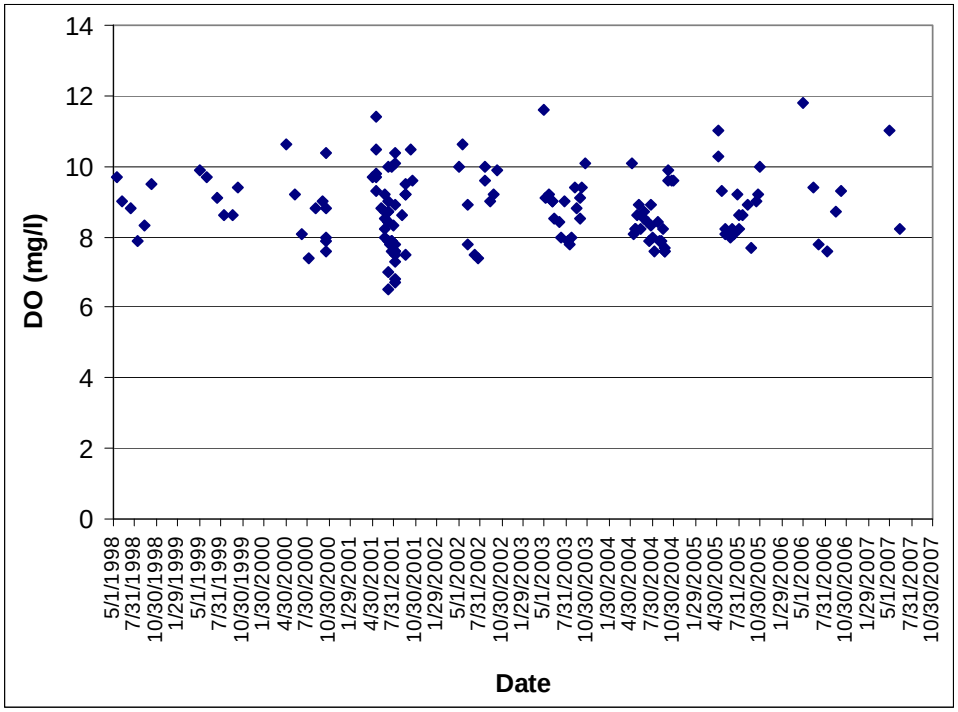


**Figure 3: Seneca Creek Dissolved Oxygen Data for Growing Season Periods May 1998 through October 2007**

### 3.2 Chlorophyll *a*

Currently, Maryland water quality standards do not specify numeric criteria for chlorophyll *a*. However, pollution of waters of the State by any material in amounts sufficient to create a nuisance or interfere with designated uses is prohibited (COMAR 2009e). Elevated chlorophyll *a* concentrations, a measure of algal growth, may indicate poor water quality that cannot support a waterbody's designated uses and may constitute a nuisance condition. Nuisance levels of algae can interfere with uses related to recreational activities such as fishing, boating, and aesthetic appreciation. High chlorophyll *a* levels can also present taste, odor, and treatment problems in water supply systems.

Narrative water quality criteria are an important component of the State's water quality standards, but are difficult to incorporate into quantitative water quality or TMDL analyses. In the case of free-flowing non-tidal waters, there is an insufficient understanding of the relationship between chlorophyll *a* concentrations and the waterbody's designated use impairment. However, COMAR includes narrative criteria for acceptable chlorophyll *a* levels in tidal waters. Maryland's numeric interpretation of these criteria for application in estuarine waters, as described in previously approved nutrient TMDLs, is as follows:

> The chlorophyll *a* concentration goal used by the State in estuarine TMDL analyses is based on guidelines set forth by Thomann and Mueller (1987) and by the EPA Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (USEPA 1997). The chlorophyll *a* narrative criterion (COMAR 26.08.02.03-3C(10)) states: "Chlorophyll *a* - Concentrations of chlorophyll *a* in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in ecologically undesirable consequences that would render tidal waters unsuitable for designated uses." The Thomann and Mueller guidelines acknowledge that "'Undesirable levels of phytoplankton [chlorophyll *a*] vary considerably depending on water body." MDE has determined, per Thomann and Mueller, that it is acceptable to maintain chlorophyll *a* concentrations below a maximum of 100 µg/L, and to target, with some flexibility depending on waterbody characteristics, a 30-day rolling average of approximately 50 µg/L (with some flexibility depending on waterbody characteristics). (MDE 2006)

Maryland has also developed guidelines for application of the narrative criteria in drinking water reservoirs. The guidelines, as described in previously approved TMDLs, are as follows:

> The chlorophyll *a* endpoints selected for public water supply reservoirs are (a) a ninetieth-percentile instantaneous concentration not to exceed 30 µg/l in the surface layers, and (b) a 30-day moving average concentration not to exceed 10 µg/l in the surface layers. The concentration of 10 µg/l corresponds to a score of approximately 53 on the Carlson's Trophic State Index (TSI). This is at the boundary of mesotrophic and eutrophic conditions, which is an appropriate trophic state at which to manage these reservoirs. Mean chlorophyll *a* concentrations exceeding 10 µg/l are associated with peaks exceeding 30 µg/l, which in turn are associated with a shift to blue-green assemblages, which present taste, odor and treatment problems (Walker 1984). Achieving these chlorophyll *a* endpoints should thus safeguard such reservoirs from nuisance algal blooms. (MDE 2008b).

Using the chlorophyll *a* targets for tidal waters and public water supply reservoirs described above as screening values for non-tidal waters, the following data analysis reflects an absence of excessive algal growth in Seneca Creek, as indicated by low chlorophyll *a* concentrations in comparison with those values.

DNR and MDE monitoring data in Seneca Creek show growing season (May through October) averages, by station, between 0.5 and 2.2 µg/l. These samples show observed chlorophyll *a* concentrations ranging from 0.0 to 10.76 µg/l, with only one out of 88 samples greater than 10 µg/l. These monitoring data values suggest that chlorophyll *a* concentrations are not causing any nuisance in the Seneca Creek or interfering with its designated uses.

The chlorophyll *a* data for the growing seasons 1998-2007 are presented graphically in Figure 4. The complete dataset is presented in tabular form in Appendix A.

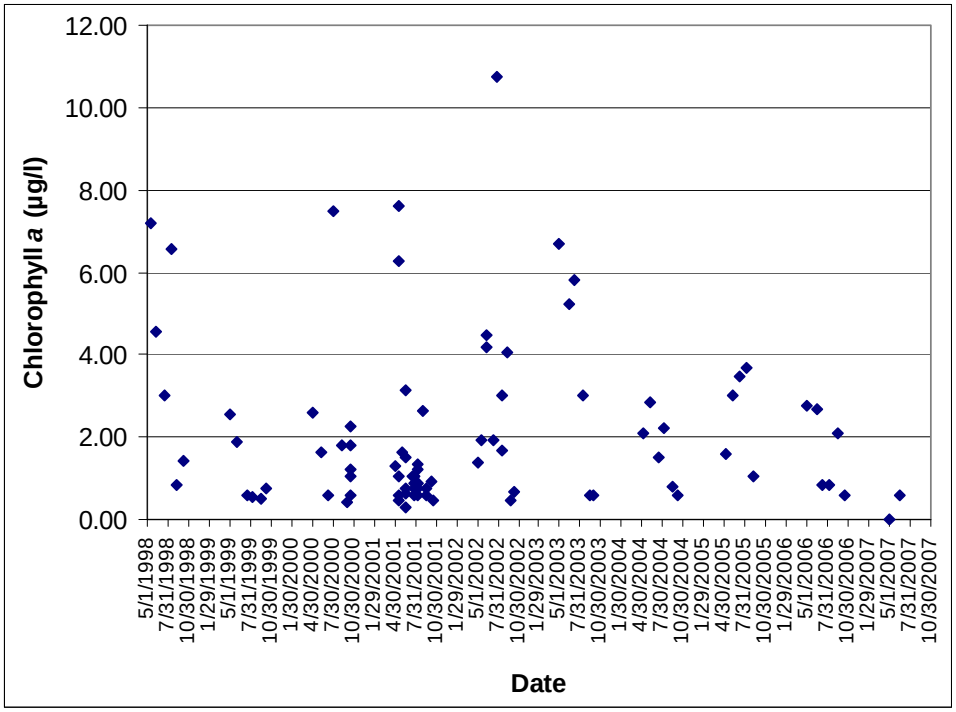


**Figure 4: Seneca Creek Chlorophyll *a* Data for Growing Season Periods May 1998 through October 2007**

### 3.3 Nutrients

In the absence of State water quality standards with specific numeric limits for nutrients, evaluation of potentially eutrophic conditions is based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair the designated uses in Seneca Creek (in this case protection of aquatic life and wildlife, fishing, and swimming). Consequently, the nutrients data presented in this section are for informational purposes only.

Total nitrogen (TN) and total phosphorus (TP) data for Seneca Creek have been collected as part of this study and the results are presented here for informational purposes, graphically in Figures 5 and 6, and in tabular form in Appendix A. In general, DNR, MDE, and MBSS data show TN concentrations during the growing season (May through October) ranging from 0.86 to 6.2 mg/l and TP concentrations ranging from 0.006 to 0.84 mg/l.

In the absence of specific numeric criteria to assess the TP and TN monitoring data results, MDE evaluated these results using its BSID methodology, which compared Seneca Creek parameters to the results from similar control sites (i.e., watersheds with no biological impairments) and concluded that nutrients are not likely stressors associated with the degraded biological conditions (MDE 2009b). Current DO conditions in Seneca Creek further support this conclusion.

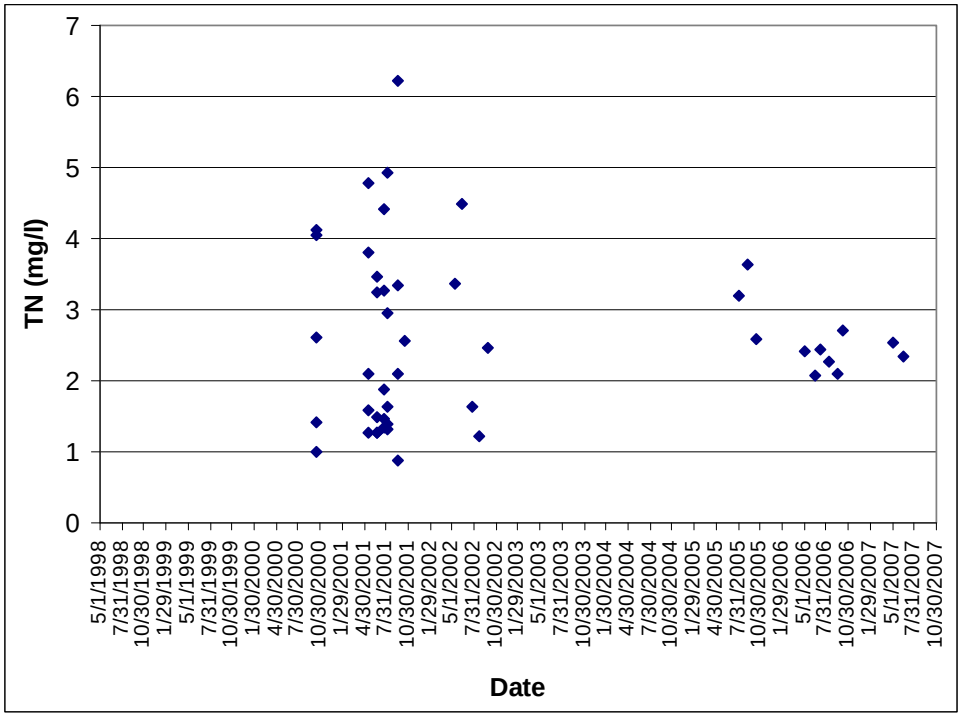


**Figure 5: Seneca Creek Total Nitrogen Data from May 1998 through October 2007**

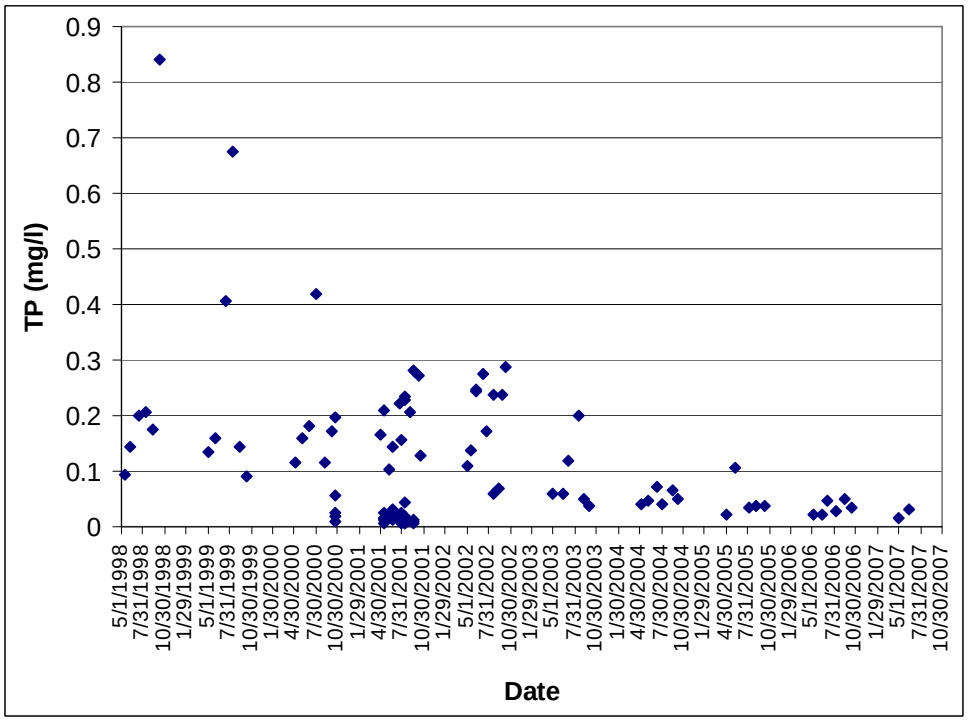


**Figure 6: Seneca Creek Total Phosphorus Data from May 1998 through October 2007**

### 3.4 Biological Stressor Identification Analysis

In the process of evaluating the existing biological impairments, MDE developed a biological stressor identification (BSID) methodology (MDE 2009a). The BSID methodology uses data available from the statewide DNR MBSS. These data are presented in Appendix A. The current MDE biological assessment methodology is a three-step process: (1) a data quality review, (2) a systematic vetting of the dataset, and (3) a watershed assessment that presents the results of this assignment in terms of currently used Integrated Report listing categories.

The BSID analysis for the Seneca Creek watershed did not identify nutrients as potential stressors or indicate any significant association between current nutrient levels and the degraded biological conditions (MDE 2009b). According to this report, nutrients are not causing any impairment to aquatic life or biological communities in Seneca Creek.

The BSID analysis results suggest rather that the degradation of biological communities in the Seneca Creek watershed is strongly associated with the urban nature of the watershed, which has resulted in altered hydrology and elevated levels of ammonia, chlorides, high pH, and conductivity (a measure of the presence of dissolved substances). As explained in the BSID report, the urbanization of landscapes creates broad and interrelated forms of degradation (i.e., hydrological, morphological, and water chemistry) that can affect stream ecology and biological composition. Peer-reviewed scientific literature establishes a link between highly urbanized landscapes and degradation in the aquatic health of non-tidal stream ecosystems.

## 4.0 CONCLUSION

Based on the analysis of data presented in the preceding section of this report, indicating that DO and chlorophyll *a* concentrations are meeting water quality criteria, and on the results of the Seneca Creek BSID analysis, MDE concludes that currently the Seneca Creek watershed is not being impaired by nutrients. (The BSID analysis indicates inorganic pollutants, ammonia toxicity, high pH, and flow/sediment related stressors are associated with impacts to biological communities; these findings will be addressed separately.) Barring the receipt of contradictory data, this report will be used to support a revision of the phosphorus listing for the Seneca Creek watershed, from Category 5 ("waterbody is impaired, does not attain the water quality standard, and a TMDL is required") to Category 2 ("waterbodies meeting some [in this case nutrients-related] water quality standards, but with insufficient data to assess all impairments"), when MDE proposes the revision of Maryland's Integrated Report.

Although the waters of Seneca Creek do not display signs of eutrophication, the State reserves the right to require future controls if evidence suggests that nutrients from the basin are contributing to downstream water quality problems. On the same principle, additional reductions may also be required by the forthcoming Chesapeake Bay TMDL, currently under development and due to be established by EPA by the end of 2010.

## REFERENCES

CES (Coastal Environmental Service, Inc.). 1995. *Patapsco/Back River Watershed Study*, prepared for MDE.

CFR (Code of Federal Regulations). 2007. *40 CFR 130.7*. http://a257.g.akamaitech.net/7/257/2422/22jul20061500/edocket.access.gpo.gov/cfr_2006/julqtr/40cfr130.7.htm (Accessed March, 2007).

COMAR (Code of Maryland Regulations). 2009a. *26.08.02.08O(1)*. http://www.dsd.state.md.us/comar/26/26.08.02.08.htm (Accessed June, 2009).

————. 2009b. *26.08.02.08O(4)(a) and 26.08.02.08O(4)(b)*. http://www.dsd.state.md.us/comar/26/26.08.02.08.htm (Accessed June, 2009).

————. 2009c. *26.08.02.08O(6)*. http://www.dsd.state.md.us/comar/26/26.08.02.08.htm (Accessed June, 2009).

————. 2009d. *26.08.02.03-3A(2)* and *26.08.02.03-3D(2)* http://www.dsd.state.md.us/comar/26/26.08.02.03%2D3.htm (Accessed June, 2009).

————. 2009e. 26.08.02.03B(2). http://www.dsd.state.md.us/comar/26/26.08.02.03.htm (Accessed June, 2009).

MDE (Maryland Department of the Environment). 2002. 2002 List of Impaired Surface Waters [303(d) List] and Integrated Assessment of Water Quality in Maryland. Baltimore, MD: Maryland Department of the Environment.

————. 2004. 2004 List of Impaired Surface Waters [303(d) List] and Integrated Assessment of Water Quality in Maryland. Baltimore, MD: Maryland Department of the Environment.

————. 2006. Total Maximum Daily Loads of Nitrogen and Phosphorus for the Upper and Middle Chester Rivers in Kent and Queen Anne's Counties, Maryland.

————. 2008a. The 2008 Integrated Report of Surface Water Quality in Maryland. Baltimore, MD: Maryland Department of the Environment. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/2008_Final_303d_list.asp (Accessed December, 2008).

————. 2008b. Total Maximum Daily Loads of Phosphorus and Sediments for Triadelphia Reservoir and Total Maximum Daily Loads of Phosphorus for Rocky Gorge Reservoir, Howard, Montgomery and Prince George's Counties, Maryland. Baltimore, MD: Maryland Department of the Environment.

————. 2009a. Maryland Biological Stressor Identification Process. Baltimore, MD: Maryland Department of the Environment.

————. 2009b. Watershed Report for Biological Impairment of the Seneca Creek Watershed in Montgomery County, Maryland - Biological Stressor Identification Analysis Results and Interpretation. Baltimore, MD: Maryland Department of the Environment.

MGS (Maryland Geological Survey). 2007. *A Brief Description of the Geology of Maryland*. http://www.mgs.md.gov/esic/brochures/mdgeology.html (Accessed May, 2009).

MDP (Maryland Department of Planning). 2002. 2002 Land Use, Land Cover Map Series.

SCS (Soil Conservation Service). 1977. U.S. Department of Agriculture. Soil Survey of Montgomery County, MD.

Thomann, Robert V., John A. Mueller. 1987. Principles of Surface Water Quality Modeling and Control. HarperCollins Publisher Inc., New York.

USDA (U.S. Department of Agriculture). 1995. Natural Resources Conservation Service (NRCS). State Soil Geographic (STATSGO) DataBase.

USEPA (U.S. Environmental Protection Agency). 1997. , Technical Guidance Manual for Developing Total Maximum Daily Loads, Book2: Streams and Rivers, Part 1: Biochemical Oxygen Demand/ Dissolved Oxygen and Nutrients/Eutrophication. Office of Water, Washington D.C., March 1997.

Walker, W.W., Jr. 1984. Statistical Bases for Mean Chlorophyll *a* Criteria. *Lake and Reservoir Management: Proceedings of Fourth Annual Conference*. North American Lake Management Society, pp. 57 – 62.

# Appendix A – Tabular Water Quality Data

## Table A-1: MDE Water Quality Data

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| LDR0022 | 10/18/2000 | 8 | 2.24 | 2.62 | 0.06 |
| LDR0022 | 11/16/2000 | 11.3 | 0.96 | 1.18 | 0.03 |
| LDR0022 | 12/6/2000 | 14 | 1.94 | 2.62 | 0.02 |
| LDR0022 | 1/10/2001 | 13.2 | | 3.52 | 0.03 |
| LDR0022 | 2/7/2001 | 13.2 | 4.64 | 2.15 | 0.13 |
| LDR0022 | 3/21/2001 | 11.1 | 9.57 | 1.13 | 0.17 |
| LDR0022 | 4/18/2001 | 10.5 | 5.83 | 1.54 | 0.04 |
| LDR0022 | 5/16/2001 | 11.4 | 7.63 | 2.10 | 0.02 |
| LDR0022 | 6/20/2001 | 8.2 | 0.62 | 1.49 | 0.03 |
| LDR0022 | 7/25/2001 | 7.9 | 1.05 | 1.88 | 0.03 |
| LDR0022 | 8/8/2001 | 7.3 | 1.35 | 1.64 | 0.04 |
| LSN0038 | 10/18/2000 | 7.6 | 1.05 | 4.04 | 0.03 |
| LSN0038 | 11/16/2000 | 9.7 | 2.78 | 0.79 | 0.01 |
| LSN0038 | 12/6/2000 | 12.3 | 3.74 | 0.92 | 0.01 |
| LSN0038 | 1/10/2001 | 11.8 | 3.14 | 0.96 | 0.02 |
| LSN0038 | 2/7/2001 | 12.6 | 5.38 | 1.08 | 0.01 |
| LSN0038 | 3/21/2001 | 11.4 | 4.19 | 1.19 | 0.03 |
| LSN0038 | 4/18/2001 | 9.7 | 7.23 | 1.45 | 0.03 |
| LSN0038 | 5/16/2001 | 10.5 | 6.28 | 1.28 | 0.01 |
| LSN0038 | 6/20/2001 | 9.2 | 3.14 | 1.27 | 0.02 |
| LSN0038 | 7/25/2001 | 10 | 0.90 | 1.33 | 0.01 |
| LSN0038 | 8/8/2001 | 10.4 | 0.90 | 1.33 | 0.01 |
| LSN0038 | 9/18/2001 | 9.2 | 0.75 | 0.87 | 0.01 |
| LSN0072 | 10/18/2000 | 8.8 | 1.20 | 0.99 | 0.02 |
| LSN0072 | 11/16/2000 | 12.1 | 2.46 | 3.28 | 0.01 |
| LSN0072 | 12/6/2000 | 11.8 | 1.20 | 4.17 | 0.02 |
| LSN0072 | 1/10/2001 | 13.5 | | 4.43 | 0.02 |
| LSN0072 | 2/7/2001 | 13.1 | 1.64 | 3.95 | 0.01 |
| LSN0072 | 3/21/2001 | 11.2 | 37.38 | 2.92 | 0.26 |
| LSN0072 | 4/18/2001 | 11.2 | 1.09 | 3.52 | 0.01 |
| LSN0072 | 5/16/2001 | 9.7 | 0.45 | 3.80 | 0.01 |
| LSN0072 | 6/20/2001 | 8.5 | 0.75 | 3.47 | 0.02 |
| LSN0072 | 7/25/2001 | 7.9 | 1.05 | 3.27 | 0.02 |
| LSN0072 | 8/8/2001 | 7.6 | 0.90 | 2.95 | 0.02 |
| LSN0072 | 9/18/2001 | 9.2 | | 3.33 | 0.01 |
| SEN0008 | 10/18/2000 | 10.4 | 1.79 | 4.13 | 0.20 |
| SEN0008 | 11/16/2000 | 13 | 1.50 | 3.97 | 0.15 |
| SEN0008 | 12/6/2000 | 14.6 | 1.35 | 4.05 | 0.21 |
| SEN0008 | 1/10/2001 | 13.2 | 2.39 | 4.01 | 0.10 |
| SEN0008 | 2/7/2001 | 13.6 | 3.44 | 3.82 | 0.08 |
| SEN0008 | 3/21/2001 | 10.6 | 52.76 | 3.51 | 0.14 |
| SEN0008 | 4/18/2001 | 10.3 | 2.99 | 2.99 | 0.05 |
| SEN0008 | 5/16/2001 | 9.8 | 1.05 | 4.77 | 0.21 |
| SEN0008 | 6/20/2001 | 8.7 | 1.50 | 3.25 | 0.14 |
| SEN0008 | 7/25/2001 | 7.6 | 0.75 | 4.42 | 0.16 |

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0008 | 8/8/2001 | 7.5 | 0.75 | 4.93 | 0.23 |
| SEN0008 | 9/19/2001 | 9.5 | 0.60 | 6.21 | 0.28 |
| SEN0008 | 10/18/2001 | 9.6 | 0.45 | 2.57 | 0.13 |
| SEN0008 | 11/7/2001 | 13.8 | 2.39 | 3.42 | 0.17 |
| SEN0008 | 12/19/2001 | 10.9 | 1.79 | 2.83 | 0.10 |
| SEN0008 | 1/24/2002 | 11.8 | 7.78 | 4.32 | 0.10 |
| SEN0008 | 2/21/2002 | 12.5 | 2.54 | 4.96 | 0.19 |
| SEN0008 | 3/21/2002 | 10.9 | 9.72 | 2.47 | 0.13 |
| SEN0008 | 4/18/2002 | 8.6 | 2.39 | 2.66 | 0.14 |
| SEN0008 | 5/16/2002 | 10.6 | 1.94 | 3.36 | 0.14 |
| SEN0008 | 6/12/2002 | 8.9 | 4.19 | 4.48 | 0.25 |
| SEN0008 | 7/25/2002 | 7.4 | 10.77 | 1.63 | 0.17 |
| SEN0008 | 8/21/2002 | 10 | 2.99 | 1.22 | 0.06 |
| SEN0008 | 9/25/2002 | 9.2 | 0.45 | 2.47 | 0.24 |
| **Note:** Station SEN0056 was sampled as part of a sediment survey, thus nutrients and chlorophyll *a* data are not available. | | | | | |
| SEN0056 | 1/9/2003 | 12.3 | | | |
| SEN0056 | 1/15/2003 | 13.7 | | | |
| SEN0056 | 2/6/2003 | 13.8 | | | |
| SEN0056 | 2/24/2003 | 12.6 | | | |
| SEN0056 | 2/24/2003 | 12.6 | | | |
| SEN0056 | 3/6/2003 | 11.5 | | | |
| SEN0056 | 3/6/2003 | 11.5 | | | |
| SEN0056 | 3/20/2003 | 11.7 | | | |
| SEN0056 | 4/29/2003 | 10.3 | | | |
| SEN0056 | 5/8/2003 | 9.1 | | | |
| SEN0056 | 5/22/2003 | 9.2 | | | |
| SEN0056 | 6/5/2003 | 9 | | | |
| SEN0056 | 6/5/2003 | 9 | | | |
| SEN0056 | 6/19/2003 | | | | |
| SEN0056 | 7/10/2003 | 8 | | | |
| SEN0056 | 7/24/2003 | 9 | | | |
| SEN0056 | 8/7/2003 | 7.9 | | | |
| SEN0056 | 8/21/2003 | 8 | | | |
| SEN0056 | 9/11/2003 | 8.8 | | | |
| SEN0056 | 9/25/2003 | 8.5 | | | |
| SEN0056 | 10/9/2003 | 9.4 | | | |
| SEN0056 | 10/23/2003 | 10.1 | | | |
| SEN0056 | 11/6/2003 | 8.4 | | | |
| SEN0056 | 11/6/2003 | 8.4 | | | |
| SEN0056 | 11/13/2003 | 11.6 | | | |
| SEN0056 | 11/20/2003 | 9.8 | | | |
| SEN0056 | 11/20/2003 | 9.8 | | | |
| SEN0056 | 12/4/2003 | 12.6 | | | |
| SEN0056 | 12/11/2003 | 11.7 | | | |
| SEN0056 | 12/11/2003 | 11.7 | | | |
| SEN0056 | 12/18/2003 | 12.2 | | | |
| SEN0056 | 1/8/2004 | 13.9 | | | |
| SEN0056 | 1/23/2004 | 14.1 | | | |
| SEN0056 | 1/29/2004 | 14.1 | | | |
| SEN0056 | 2/9/2004 | 13.4 | | | |
| SEN0056 | 2/20/2004 | 12.3 | | | |

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0056 | 2/25/2004 | 12.6 | | | |
| SEN0056 | 3/4/2004 | 11.8 | | | |
| SEN0056 | 3/8/2004 | 12.4 | | | |
| SEN0056 | 3/18/2004 | 13.2 | | | |
| SEN0056 | 4/8/2004 | 10.7 | | | |
| SEN0056 | 4/13/2004 | 10.4 | | | |
| SEN0056 | 4/13/2004 | 10.4 | | | |
| SEN0056 | 4/22/2004 | 9.7 | | | |
| SEN0056 | 5/13/2004 | 8.1 | | | |
| SEN0056 | 5/18/2004 | 8.2 | | | |
| SEN0056 | 5/18/2004 | 8.2 | | | |
| SEN0056 | 5/27/2004 | 8.6 | | | |
| SEN0056 | 6/10/2004 | 8.2 | | | |
| SEN0056 | 6/24/2004 | 8.5 | | | |
| SEN0056 | 6/28/2004 | 8.7 | | | |
| SEN0056 | 7/9/2004 | 8.4 | | | |
| SEN0056 | 7/22/2004 | 8.9 | | | |
| SEN0056 | 7/27/2004 | 8.3 | | | |
| SEN0056 | 8/12/2004 | 7.6 | | | |
| SEN0056 | 8/26/2004 | 8.4 | | | |
| SEN0056 | 8/31/2004 | 7.9 | | | |
| SEN0056 | 9/10/2004 | 7.9 | | | |
| SEN0056 | 9/18/2004 | 7.6 | | | |
| SEN0056 | 9/18/2004 | 7.6 | | | |
| SEN0056 | 9/23/2004 | 7.7 | | | |
| SEN0056 | 10/7/2004 | 9.9 | | | |
| SEN0056 | 10/21/2004 | 9.6 | | | |
| SEN0056 | 10/26/2004 | 9.6 | | | |
| SEN0056 | 11/10/2004 | 11.7 | | | |
| SEN0056 | 11/22/2004 | 9.8 | | | |
| SEN0056 | 12/8/2004 | 12.2 | | | |
| SEN0056 | 12/15/2004 | 12.5 | | | |
| SEN0056 | 12/21/2004 | 10.5 | | | |
| SEN0056 | 1/5/2005 | 10.4 | | | |
| SEN0056 | 1/13/2005 | 13 | | | |
| SEN0056 | 1/20/2005 | 15.4 | | | |
| SEN0056 | 2/2/2005 | 13.5 | | | |
| SEN0056 | 2/14/2005 | 12.5 | | | |
| SEN0056 | 2/22/2005 | 12.3 | | | |
| SEN0056 | 3/16/2005 | 12.1 | | | |
| SEN0056 | 4/14/2005 | 11.2 | | | |
| SEN0056 | 4/27/2005 | 9.6 | | | |
| SEN0056 | 5/5/2005 | 10.3 | | | |
| SEN0056 | 5/19/2005 | 9.3 | | | |
| SEN0056 | 6/8/2005 | 8.2 | | | |
| SEN0056 | 6/23/2005 | 8 | | | |
| SEN0056 | 7/13/2005 | 8.1 | | | |
| SEN0056 | 7/27/2005 | 9.2 | | | |
| SEN0056 | 8/4/2005 | 8.6 | | | |
| SEN0056 | 8/18/2005 | 8.6 | | | |
| SEN0056 | 9/15/2005 | | | | |
| SEN0056 | 9/21/2005 | 7.7 | | | |

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0056 | 10/20/2005 | 9.2 | | | |
| SEN0056 | 10/27/2005 | 10 | | | |
| SEN0056 | 11/3/2005 | 10 | | | |
| SEN0056 | 11/21/2005 | 12 | | | |
| SEN0056 | 12/1/2005 | 11.8 | | | |
| SEN0056 | 12/15/2005 | 12.7 | | | |
| TEN0030 | 10/18/2000 | 7.9 | 0.60 | 1.42 | 0.01 |
| TEN0030 | 11/16/2000 | 11.4 | 0.21 | 1.08 | 0.02 |
| TEN0030 | 12/6/2000 | 12.7 | 0.75 | 1.57 | 0.00 |
| TEN0030 | 1/10/2001 | 13 | | 1.87 | 0.01 |
| TEN0030 | 2/7/2001 | 13.1 | 0.75 | 1.52 | 0.01 |
| TEN0030 | 3/21/2001 | 12 | 43.36 | 1.62 | 0.18 |
| TEN0030 | 4/18/2001 | 11.5 | 0.62 | 1.05 | 0.01 |
| TEN0030 | 5/16/2001 | 9.3 | 0.60 | 1.58 | 0.01 |
| TEN0030 | 6/20/2001 | 8 | 0.30 | 1.27 | 0.01 |
| TEN0030 | 7/25/2001 | 7.8 | 0.60 | 1.45 | 0.01 |
| TEN0030 | 8/8/2001 | 6.8 | 0.60 | 1.40 | 0.01 |
| TEN0030 | 9/18/2001 | 7.5 | | 2.09 | 0.01 |

## Table A-2: DNR Water Quality Data

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0008 | 1/21/1998 | 13 | 3.39 | | 0.06 |
| SEN0008 | 2/4/1998 | 12.1 | 6.98 | | 0.20 |
| SEN0008 | 3/4/1998 | 11.7 | 5.98 | | 0.06 |
| SEN0008 | 4/1/1998 | 10 | 23.30 | | 0.05 |
| SEN0008 | 5/13/1998 | 9.7 | 7.18 | | 0.10 |
| SEN0008 | 6/10/1998 | 9 | 4.56 | | 0.15 |
| SEN0008 | 7/15/1998 | 8.8 | 2.99 | | 0.20 |
| SEN0008 | 8/12/1998 | 7.9 | 6.56 | | 0.21 |
| SEN0008 | 9/9/1998 | 8.3 | 0.82 | | 0.18 |
| SEN0008 | 10/7/1998 | 9.5 | 1.43 | | 0.84 |
| SEN0008 | 11/12/1998 | 11.2 | 2.67 | | 0.08 |
| SEN0008 | 12/9/1998 | 11.2 | 17.64 | | 0.15 |
| SEN0008 | 1/6/1999 | 13.4 | | | 0.11 |
| SEN0008 | 2/3/1999 | 11.3 | 2.99 | | 0.10 |
| SEN0008 | 3/10/1999 | 15.8 | 2.09 | | 0.04 |
| SEN0008 | 4/7/1999 | 11.1 | 4.04 | | 0.05 |
| SEN0008 | 5/5/1999 | 9.9 | 2.54 | | 0.13 |
| SEN0008 | 6/2/1999 | 9.7 | 1.87 | | 0.16 |
| SEN0008 | 7/14/1999 | 9.1 | 0.60 | | 0.41 |
| SEN0008 | 8/11/1999 | 8.6 | 0.56 | | 0.68 |
| SEN0008 | 9/15/1999 | 8.6 | 0.50 | | 0.14 |
| SEN0008 | 10/13/1999 | 9.4 | 0.75 | | 0.09 |
| SEN0008 | 11/9/1999 | 12 | 0.80 | | 0.16 |
| SEN0008 | 12/1/1999 | 15 | 1.08 | | 0.10 |
| SEN0008 | 1/12/2000 | 12.7 | 2.09 | | 0.09 |
| SEN0008 | 2/9/2000 | 14.1 | 1.89 | | 0.11 |
| SEN0008 | 3/8/2000 | 12.4 | 2.69 | | 0.09 |
| SEN0008 | 4/5/2000 | 11.4 | 3.49 | | 0.06 |
| SEN0008 | 5/3/2000 | 10.6 | 2.58 | | 0.12 |
| SEN0008 | 6/7/2000 | 9.2 | 1.64 | | 0.16 |
| SEN0008 | 7/6/2000 | 8.1 | 0.60 | | 0.18 |
| SEN0008 | 8/2/2000 | 7.4 | 7.48 | | 0.42 |
| SEN0008 | 9/6/2000 | 8.8 | 1.79 | | 0.12 |
| SEN0008 | 10/4/2000 | 9 | 0.40 | | 0.17 |
| SEN0008 | 11/1/2000 | 11.9 | 3.09 | | 0.15 |
| SEN0008 | 12/6/2000 | 15.1 | 2.39 | | 0.18 |
| SEN0008 | 1/3/2001 | 12.9 | 1.50 | | 0.17 |
| SEN0008 | 2/7/2001 | 13.4 | 3.44 | | 0.09 |
| SEN0008 | 3/14/2001 | 13.7 | 1.31 | | 0.08 |
| SEN0008 | 4/11/2001 | 9.2 | 10.47 | | 0.11 |
| SEN0008 | 5/2/2001 | 9.7 | 1.30 | | 0.17 |
| SEN0008 | 6/6/2001 | 8.8 | 1.64 | | 0.10 |
| SEN0008 | 7/18/2001 | 7.8 | 1.05 | | 0.22 |
| SEN0008 | 8/8/2001 | 7.8 | 1.20 | | 0.23 |
| SEN0008 | 9/5/2001 | 8.6 | 2.62 | | 0.21 |
| SEN0008 | 10/10/2001 | 10.5 | 0.93 | | 0.27 |
| SEN0008 | 11/7/2001 | 13.5 | 2.69 | | 0.16 |
| SEN0008 | 12/5/2001 | 12.1 | 0.90 | | 0.19 |
| SEN0008 | 1/2/2002 | 14.8 | 2.09 | | 0.22 |
| SEN0008 | 2/6/2002 | 14.8 | 1.99 | | 0.15 |

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0008 | 3/6/2002 | 13.6 | 2.24 | | 0.14 |
| SEN0008 | 4/3/2002 | 11.4 | 2.09 | | 0.13 |
| SEN0008 | 5/1/2002 | 10 | 1.38 | | 0.11 |
| SEN0008 | 6/12/2002 | 7.8 | 4.49 | | 0.25 |
| SEN0008 | 7/10/2002 | 7.5 | 1.94 | | 0.28 |
| SEN0008 | 8/19/2002 | 9.6 | 1.69 | | 0.24 |
| SEN0008 | 9/11/2002 | 9 | 4.04 | | 0.07 |
| SEN0008 | 10/9/2002 | 9.9 | 0.65 | | 0.29 |
| SEN0008 | 11/6/2002 | 10 | 3.59 | | 0.14 |
| SEN0008 | 12/4/2002 | 14.1 | 1.30 | | 0.12 |
| SEN0008 | 1/8/2003 | 12.5 | 2.09 | | 0.07 |
| SEN0008 | 2/5/2003 | 13.1 | 5.38 | | 0.10 |
| SEN0008 | 3/5/2003 | 12.4 | 2.87 | | 0.06 |
| SEN0008 | 4/2/2003 | 12 | 5.88 | | 0.06 |
| SEN0008 | 5/1/2003 | 11.6 | 6.68 | | 0.06 |
| SEN0008 | 6/11/2003 | 8.5 | 5.23 | | 0.06 |
| SEN0008 | 7/2/2003 | 8.4 | 5.83 | | 0.12 |
| SEN0008 | 8/13/2003 | 7.8 | 2.99 | | 0.20 |
| SEN0008 | 9/10/2003 | 9.4 | 0.60 | | 0.05 |
| SEN0008 | 10/1/2003 | 9.1 | 0.60 | | 0.04 |
| SEN0008 | 11/12/2003 | 10.1 | 2.78 | | 0.10 |
| SEN0008 | 12/10/2003 | 12 | 1.50 | | 0.03 |
| SEN0008 | 1/7/2004 | 13.2 | 1.89 | | 0.03 |
| SEN0008 | 2/11/2004 | 12.3 | 4.11 | | 0.12 |
| SEN0008 | 3/10/2004 | 12.5 | 5.08 | | 0.02 |
| SEN0008 | 4/7/2004 | 11.7 | 4.29 | | 0.03 |
| SEN0008 | 5/5/2004 | 10.1 | 2.09 | | 0.04 |
| SEN0008 | 6/2/2004 | 8.9 | 2.84 | | 0.05 |
| SEN0008 | 7/14/2004 | 7.9 | 1.50 | | 0.07 |
| SEN0008 | 8/4/2004 | 8 | 2.21 | | 0.04 |
| SEN0008 | 9/15/2004 | 8.2 | 0.80 | | 0.07 |
| SEN0008 | 10/6/2004 | 9.6 | 0.60 | | 0.05 |
| SEN0008 | 11/3/2004 | 12.3 | 2.54 | | 0.07 |
| SEN0008 | 12/1/2004 | 10.2 | 12.96 | | 0.08 |
| SEN0008 | 1/5/2005 | 10.2 | 2.24 | | 0.02 |
| SEN0008 | 2/9/2005 | 12.7 | 2.54 | | 0.04 |
| SEN0008 | 3/9/2005 | 12.8 | 5.68 | | 0.02 |
| SEN0008 | 4/13/2005 | 11 | 3.09 | | 0.03 |
| SEN0008 | 5/4/2005 | 11 | 1.59 | | 0.02 |
| SEN0008 | 6/8/2005 | 8.1 | 2.99 | | 0.11 |
| SEN0008 | 7/6/2005 | 8.2 | 3.49 | | |
| SEN0008 | 8/3/2005 | 8.2 | 3.69 | 3.19 | 0.03 |
| SEN0008 | 9/7/2005 | 8.9 | 1.05 | 3.63 | 0.04 |
| SEN0008 | 10/12/2005 | 9 | | 2.58 | 0.04 |
| SEN0008 | 11/9/2005 | 10.1 | 0.90 | 3.29 | 0.04 |
| SEN0008 | 12/7/2005 | 12.6 | | 4.19 | 0.03 |
| SEN0008 | 1/4/2006 | 12.3 | 3.59 | 2.85 | 0.04 |
| SEN0008 | 2/1/2006 | 12.4 | 2.39 | 2.78 | 0.03 |
| SEN0008 | 3/1/2006 | 13.5 | 1.79 | | 0.02 |
| SEN0008 | 4/12/2006 | 11.8 | 3.14 | 2.41 | 0.02 |
| SEN0008 | 5/3/2006 | 11.8 | 2.78 | 2.41 | 0.02 |
| SEN0008 | 6/14/2006 | 9.4 | 2.69 | 2.06 | 0.02 |

| Station | Sampling Date | DO (mg/l) | Chlorophyll *a* (µg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SEN0008 | 7/5/2006 | 7.8 | 0.85 | 2.43 | 0.05 |
| SEN0008 | 8/9/2006 | 7.6 | 0.83 | 2.28 | 0.03 |
| SEN0008 | 9/13/2006 | 8.7 | 2.09 | 2.10 | 0.05 |
| SEN0008 | 10/11/2006 | 9.3 | 0.60 | 2.72 | 0.04 |
| SEN0008 | 11/8/2006 | 9.3 | 14.20 | 1.94 | 0.29 |
| SEN0008 | 12/6/2006 | 13.2 | 0.60 | 3.00 | 0.01 |
| SEN0008 | 1/3/2007 | 12.6 | | 2.14 | 0.02 |
| SEN0008 | 2/7/2007 | 15.2 | 1.79 | 3.26 | 0.02 |
| SEN0008 | 3/7/2007 | 13 | 1.35 | 2.76 | 0.02 |
| SEN0008 | 4/4/2007 | 10.3 | 5.77 | 2.22 | 0.02 |
| SEN0008 | 5/2/2007 | 11 | 0.00 | 2.54 | 0.02 |
| SEN0008 | 6/13/2007 | 8.2 | 0.60 | 2.35 | 0.03 |

## Table A-3: MBSS Water Quality Data

| Station | Stream | Date | DO (mg/l) | TN (mg/l) | TP (mg/l) |
|---|---|---|---|---|---|
| SENE-101-R-2001 | Great Seneca Creek UT2 | 3/19/2001 | | 8.59 | 0.014 |
| SENE-103-R-2001 | Little Seneca Creek | 3/19/2001 | | 6.50 | 0.018 |
| SENE-113-R-2001 | Whetstone Run | 3/19/2001 | | 4.12 | 0.007 |
| SENE-114-R-2001 | Magruder Branch | 3/19/2001 | | 2.06 | 0.007 |
| SENE-115-R-2001 | Great Seneca Creek UT1 | 3/19/2001 | | 2.61 | 0.039 |
| SENE-119-R-2001 | Goshen Branch UT1 | 3/19/2001 | | 0.31 | 0.014 |
| SENE-205-R-2001 | Gunners Branch | 3/19/2001 | | 2.68 | 0.022 |
| SENE-306-R-2001 | Great Seneca Creek | 3/19/2001 | | 3.27 | 0.012 |
| SENE-316-R-2001 | Little Seneca Creek | 3/19/2001 | | 1.20 | 0.013 |
| SENE-104-R-2001 | Little Seneca Creek UT3 | 3/20/2001 | | 1.78 | 0.011 |
| SENE-109-R-2001 | Gunners Branch UT1 | 3/20/2001 | | 3.07 | 0.010 |
| SENE-112-R-2001 | Russell Branch | 3/20/2001 | | 1.87 | 0.030 |
| SENE-117-R-2001 | Bucklodge Branch UT2 | 3/20/2001 | | 5.90 | 0.021 |
| SENE-210-R-2001 | Dry Seneca Creek | 3/20/2001 | | 2.72 | 0.070 |
| SENE-211-R-2001 | Dry Seneca Creek | 3/20/2001 | | 3.04 | 0.095 |
| SENE-104-R-2001 | Little Seneca Creek UT3 | 7/9/2001 | 9.0 | | |
| SENE-112-R-2001 | Russell Branch | 7/9/2001 | 6.5 | | |
| SENE-117-R-2001 | Bucklodge Branch UT2 | 7/9/2001 | 10.0 | | |
| SENE-109-R-2001 | Gunners Branch UT1 | 7/10/2001 | 8.7 | | |
| SENE-113-R-2001 | Whetstone Run | 7/10/2001 | 7.0 | | |
| SENE-114-R-2001 | Magruder Branch | 7/10/2001 | 8.4 | | |
| SENE-115-R-2001 | Great Seneca Creek UT1 | 7/10/2001 | 8.7 | | |
| SENE-101-R-2001 | Great Seneca Creek UT2 | 7/11/2001 | 7.9 | | |
| SENE-103-R-2001 | Little Seneca Creek | 7/11/2001 | 8.4 | | |
| SENE-306-R-2001 | Great Seneca Creek | 8/2/2001 | 8.3 | | |
| SENE-119-R-2001 | Goshen Branch UT1 | 8/7/2001 | | | |
| SENE-210-R-2001 | Dry Seneca Creek | 8/7/2001 | 7.6 | | |
| SENE-316-R-2001 | Little Seneca Creek | 8/7/2001 | 10.1 | | |
| SENE-205-R-2001 | Gunners Branch | 8/8/2001 | 8.9 | | |
| SENE-211-R-2001 | Dry Seneca Creek | 8/8/2001 | 6.7 | | |