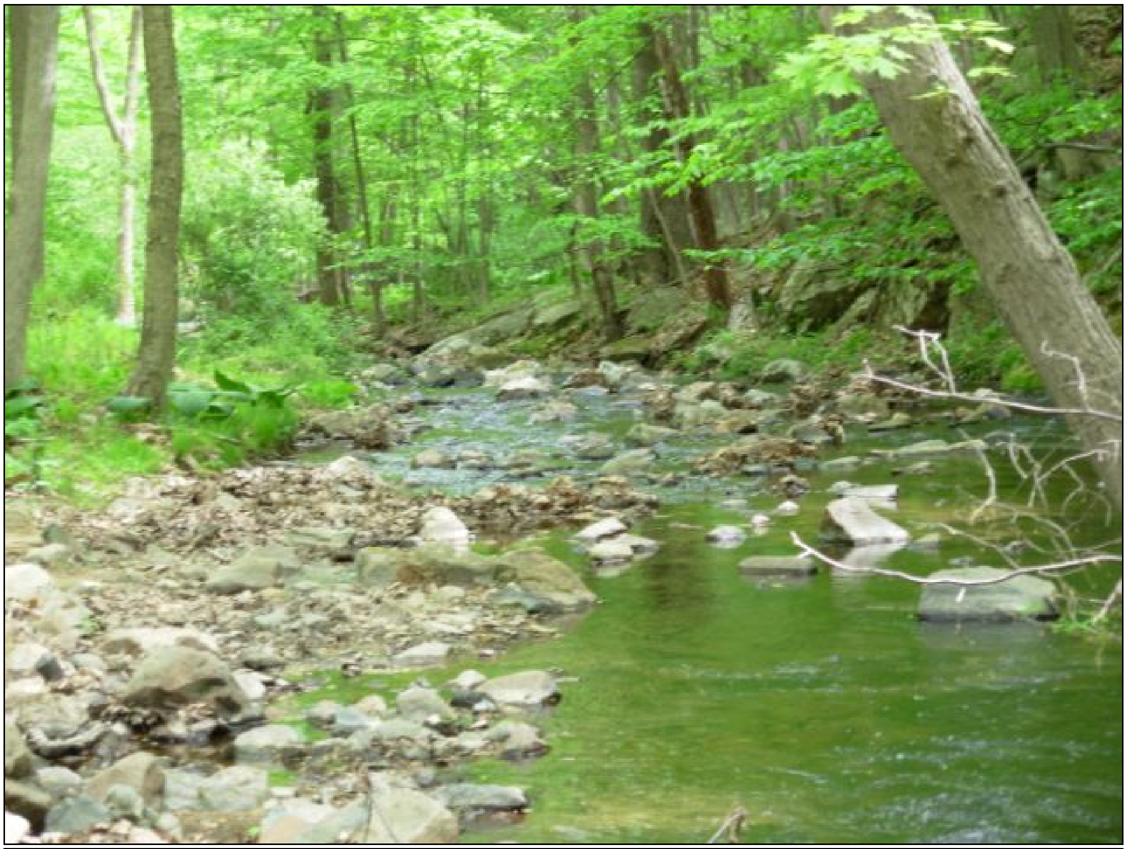
Section 319H Nonpoint Source Pollution Control and Management Implementation Grant Program

RP01-114

Design and Implementation of Nonpoint Source Pollution Control Measures in the Peapack Brook Subwatershed



Report of Biological and Chemical Monitoring

Produced by the Upper Raritan Watershed Association - January 2007
with support from the NJ Department of Environmental Protection
Division of Watershed Management
Bureau of Watershed Planning

Table of Contents

Introduction

Located in the Upper Raritan Watershed, the Peapack Brook is a significant waterway that drains into the North Branch of the Raritan River. This trout production stream flows through the Borough of Chester, Chester Township, the Borough of Peapack-Gladstone, and Bedminster Township. Including its tributaries, Peapack Brook continues for 22 miles from its headwaters to its effluence into the North Branch of the Raritan River in Bedminster.

Within the subwatershed, the drainage of which encompasses 11.7 square miles, land use varies. The headwaters of the Brook originate at the Chester Springs Shopping Center in Chester Borough. Through Chester Township, the stream corridor and its tributaries are wooded, while the surrounding area supports residential development. As the Brook flows into Gladstone, it courses through open fields, including the grounds and athletic fields of the Gill St. Bernard's School, abandoned agricultural fields, and those actively farmed. While the stream flows through a commercial and residential area in Peapack and Gladstone, the Brook enters a wooded residential area once again in Bedminster.

Despite these relatively rural characteristics, the subwatershed suffers from several problems, including physical degradation of ecosystems and non-point source pollution. Many stretches of Peapack Brook lack woody vegetation along the stream banks to shade the water and maintain the low temperatures necessary to support a breeding population of native trout. The absence of trees also exacerbates erosion as the banks lack stability. Soil that is deposited into streams is detrimental to the reproduction of both macroinvertebrates (aquatic insects) and native trout populations. Past studies have noted that soil erosion in this subwatershed may also have an impact on the North Branch of the Raritan River as the Brook is a high-gradient stream, and soil that is lost from this subwatershed may travel to the Raritan River before it is deposited (Lloyd, 1977).

Sedimentation and contamination of the waterway is further attributed to increasing development. The 1995 NJDEP land use/landcover data reveals that the subwatershed has 3.5 square miles of urban land and 5.5 square miles of forest. Due to local development trends, the area of urban land has increased, while the forest cover has decreased. Such shifts in natural vegetative cover and land use augment the amount of run-off that reaches the Brook from commercial and residential areas.

In addition to the non-point source pollution attributed to such run-off, the Peapack Brook is also impacted by domestic livestock that have unrestricted access to the stream. Aside from the fact that these animals compact and erode stream banks, their waste contributes to high fecal coliform and nutrient levels in the water. A mid-twentieth century study suggested that the Peapack Brook was "healthy-enriched" based upon the composition of the macroinvertebrate community sampled (Academy of Natural Sciences of Philadelphia, 1967). In a later water quality study of Peapack Brook, fecal coliform levels exceeded the NJ surface water quality criteria of 200 membrane filtration (MF) counts per 100 ml at three of the seven stations that were sampled (Lloyd, 1977). In addition to high levels of nutrients and sedimentation, studies have also detected warm temperatures and low quantities of dissolved oxygen. Results collected in 1976 showed that eight of ten sampled sites contained less dissolved oxygen than the NJ surface water quality criteria of 7mg/L.

Despite this early evidence of degradation, decades later the water quality in the Peapack Brook subwatershed still remains threatened, although Peapack Brook has been designated "non-impaired" on the State 303d list. Considering that Peapack Brook is classified as a trout production Category 1 waterway, the stream and its population of breeding trout are significant ecological and recreational assets. URWA monitored both biological and chemical parameters in the Brook to evaluate current water quality and assess the causes of degradation with the intention that subsequent efforts will address the issues that jeopardize this resource.

Methods

At eight locations within the Peapack Brook subwatershed, benthic macroinvertebrate data was collected annually and chemical water quality sampling was conducted on a quarterly basis each year to establish documentation sufficient to perform an assessment of the stream. Site location descriptions are included in Appendix I.

Benthic Macroinvertebrate Monitoring

Procedure for Sample Collection

Samples were collected between June 15th-30th so that contents represented the typical summer flow. Field benthic macroinvertebrate sampling was performed in compliance with the following procedures:

1. Collect one riffle-habitat benthic macroinvertebrate sample at each sampling site using the traveling kick net method. Facing downstream, place net on a stream bottom perpendicular to the current and kick vigorously. Continue this procedure while moving slowly backward, making sure that the net makes contact with the stream bottom. Sample a section of riffle approximately 30 feet for a duration of two minutes. Duration is the critical factor in standardizing sample collection efforts at each site.
2. Place the collected sample into a sorting tray and carefully remove as much extraneous debris as possible. Be sure to remove all attached macroinvertebrates prior to discarding the debris. Rinse sample thoroughly in a collecting tray and check with a field magnifying glass.
3. Fill mason jar with ethyl alcohol and place entire collected sample in it. The labeled container is remitted to the laboratory for analysis.

Benthic Macroinvertebrate Sampling Analysis

The collected samples were delivered to Normandeau Associates in Spring City, Pennsylvania where the contents of each were sorted. The specimens were identified at the genus and species level using the USEPA's Rapid Bioassessment Protocol III. The results were then scored according to the NJ Impairment Scoring (NJIS) criteria established by the NJDEP Bureau of Fresh Water and Biological Monitoring (see Appendix II).

Chemical Monitoring

The following water quality parameters were measured on-site:

1. Dissolved Oxygen – Taken on site with a YSI Model 55-12 dissolved oxygen meter.
2. Temperature – Taken on site with a YSI Model 55-12 meter.
3. pH – Taken on site with a YSI Model 60-10 pH meter.

The following chemical parameters are analyzed by an independent lab:

1. Total Phosphate and Ortho Phosphate
2. Nitrate (inorganic nitrogen)
3. Total Suspended Solids
4. Turbidity
5. Fecal and Total Coliform

Discussion of Parameters and Results

URWA chose to assess the above-mentioned parameters through the biological and chemical monitoring efforts to evaluate the overall water quality as well as potential sources of environmental degradation. The relative richness and abundance of macroinvertebrate species in a stream community reflect the current quality of the environment at that site. All samples collected in 2002, 2003, 2004, and 2006 indicate that the Peapack Brook is "non-impaired" (see Appendix III), however the nature of chemical parameters offers more insight into factors that jeopardize the future health of the subwatershed.

Although the pH of a water resource, which normally ranges between 6.5 and 8.5, is primarily determined by the geology of the watershed, contaminants can considerably alter the acidity or basicity of the stream and negatively impact the viability of biotic communities. While a variety of pollutants can also cause abnormally low dissolved oxygen readings, the amount of dissolved oxygen present in the stream is directly related to the temperature as warmer water fails to support high oxygen levels. Water temperatures should not exceed 20 degrees Celsius in order to support a healthy trout population.

Both Nitrate, an inorganic form of Nitrogen, and Phosphate are limiting factors to the productivity of aquatic ecosystems, however eutrophication, nutrient overloads and the resulting excessive plant growth and decomposition, leads to depletion of dissolved oxygen supplies. Land usage in the vicinity of water resources greatly affects the levels of phosphates and nitrates detected as domestic, industrial, and agricultural wastes, especially fertilizers, significantly contribute to nutrient contamination of waterways.

Just as runoff from adjacent lands can carry contaminants, such as additional phosphates and nitrates, into streams, it also contributes soils and sediments that increase the total suspended solids and turbidity of a waterway. Turbidity, the relative clarity of the resource, depends on the amount of matter suspended in the sample. Measuring the solids leads to a total suspended solids (TSS) result which should not exceed 25 mg/L according to regulatory standards. Excessive TSS levels degrade aquatic ecosystems in many ways. Suspended solids can clog fish gills, smother eggs, and suffocate larvae, while they also indirectly decrease dissolved oxygen since they absorb heat from the sun and increase water temperatures. TSS further reduce dissolved oxygen by preventing adequate light from reaching underwater vegetation and reducing photosynthesis. If the affected plants die, bacteria will consume even more oxygen during the decomposition process. Additionally, increased turbidity also exacerbates health risks as microorganisms, which are more abundant in soils than in water, attach to particles suspended in water.

In order to evaluate the sanitary quality of a resource, fecal coliform and total coliform analyses are performed. Regulatory standards require that water used for activities such as swimming, rafting, or kayaking must not exceed 200 organisms/100 ml. Adjacent land uses greatly influence water quality as animal waste, failing septic systems, and inadequate sewage treatment facilities can be sources of coliform bacteria in streams.

Considering the chemical monitoring data collected quarterly from December 2001 through July 2004 (see Appendix IV), fecal coliform contamination is the most prevalent threat to water quality in the Peapack Brook. All sites sampled in December of 2001 had extremely high levels of fecal coliform with the lowest being about five times the maximum standard. In June 2002, six of the eight sample sites showed levels of fecal coliform exceeded the maximum standard of 200 MF/100 ml, and two of the sites surpassed the standard in October 2002. In January 2003, two of the samples exceeded the limit for fecal coliform, while only one resulted in high levels in March 2003. Again in June that year, four of the eight sites surpassed the safe levels of fecal coliform.

Aside from the coliform parameter, most samples met standards for water quality except for the following: In December 2001, results at site five indicated excessive TSS levels approximately four times the maximum standard, and the pH at site six slightly exceeded the limit for basicity in October 2002.

Conclusion

The biological and chemical monitoring results indicate that water quality and ecosystem health in the subwatershed of the Peapack Brook can be improved. In light of the results, conservation efforts need to address the contamination of Peapack Brook with fecal coliform and improve the aquatic ecosystem by reducing sedimentation of the waterway and increasing shading of the corridor.

In order to significantly mitigate the fecal coliform contamination, efforts must be targeted at landowners to reduce the sources of coliform in the watershed and also at the prevention of inappropriate land usage adjacent to water resources, such as the Peapack Brook. Fecal coliform often originates from human and animal waste products, so septic systems should be tested regularly to prevent failures that lead to water contamination. Pet waste should be disposed of properly, and agricultural operations should avoid allowing animals free access to watercourses that can easily be polluted by manure.

Additionally, the improvement of regional stormwater management will reduce contaminated runoff and flows through the corridor to mitigate nonpoint source pollution as well as erosion. Reducing impervious surfaces throughout the subwatershed, increasing the potential for groundwater recharge, and creating well-vegetated buffers along watercourses such as the Peapack Brook will aid in enhancing water and habitat quality. Tree plantings will reduce water temperatures and aid in preserving the qualities of the Peapack Brook that make it suitable trout production habitat. Considering the fact that the Brook is a high-gradient stream and has suffered from excessive erosion of the stream banks, remedies also include stream bank stabilization and restoration projects. Through such methods, human endeavors may restore and enhance the Peapack Brook subwatershed that has been greatly impacted by human activities.

References

Academy of Natural Sciences of Philadelphia, Department of Limnology. 1967. Water Quality Survey, Upper Raritan Watershed. *(Unpublished).*

Fennessy, M.S. and J.K. Cronk. 1997. The effectiveness and restoration potential of riparian ecotones for the management of nonpoint source pollution, particularly nitrate. *Critical Reviews in Environmental Science and Technology* 27(4):285-317.

Lloyd, Thomas. 1977. An assessment of water quality in Peapack Brook and an analysis of factors affecting water quality. *(Unpublished).*

Schueler, T. 1995. Site Planning for Urban Stream Protection. The Center for Watershed Protection. Silver Springs, MD. 232 p.

Upper Raritan Watershed Association. 1976. Water Quality Survey of Headwaters Streams of the Upper Raritan Watershed. *(Unpublished).*

Vought, L.B.-M., J. Dahl, C.L. Pedersen and J.O. Lacoursire. 1994. Nutrient retention in riparian ecotones. *Ambio* 23(6):343-348.

Appendix I. Peapack Brook Sampling Sites

1. Tiger Brook tributary at Cooper Lane in Chester Township. This is the first stream crossing that you come to as you drive down Cooper Lane from Route 206. The sampling site is upstream from the bridge. Neighbors have placed a statue of Mary by the stream. This site will sample the water quality of this tributary that originates from the Chester Springs Shopping Mall in Chester Borough. (No biological sampling)

2. Peapack Brook at Cooper Lane in Chester Township. This is the second stream crossing that you come to as you drive down Cooper Lane from Route 206. The sampling site is at a riffle just upstream from the bridge. (No biological sampling)

3. Peapack Brook at Fox Chase Road in Chester Township. The sample site is located downstream of the bridge, after the curve in the stream. There is a large sycamore at this curve. (Two minute kick)

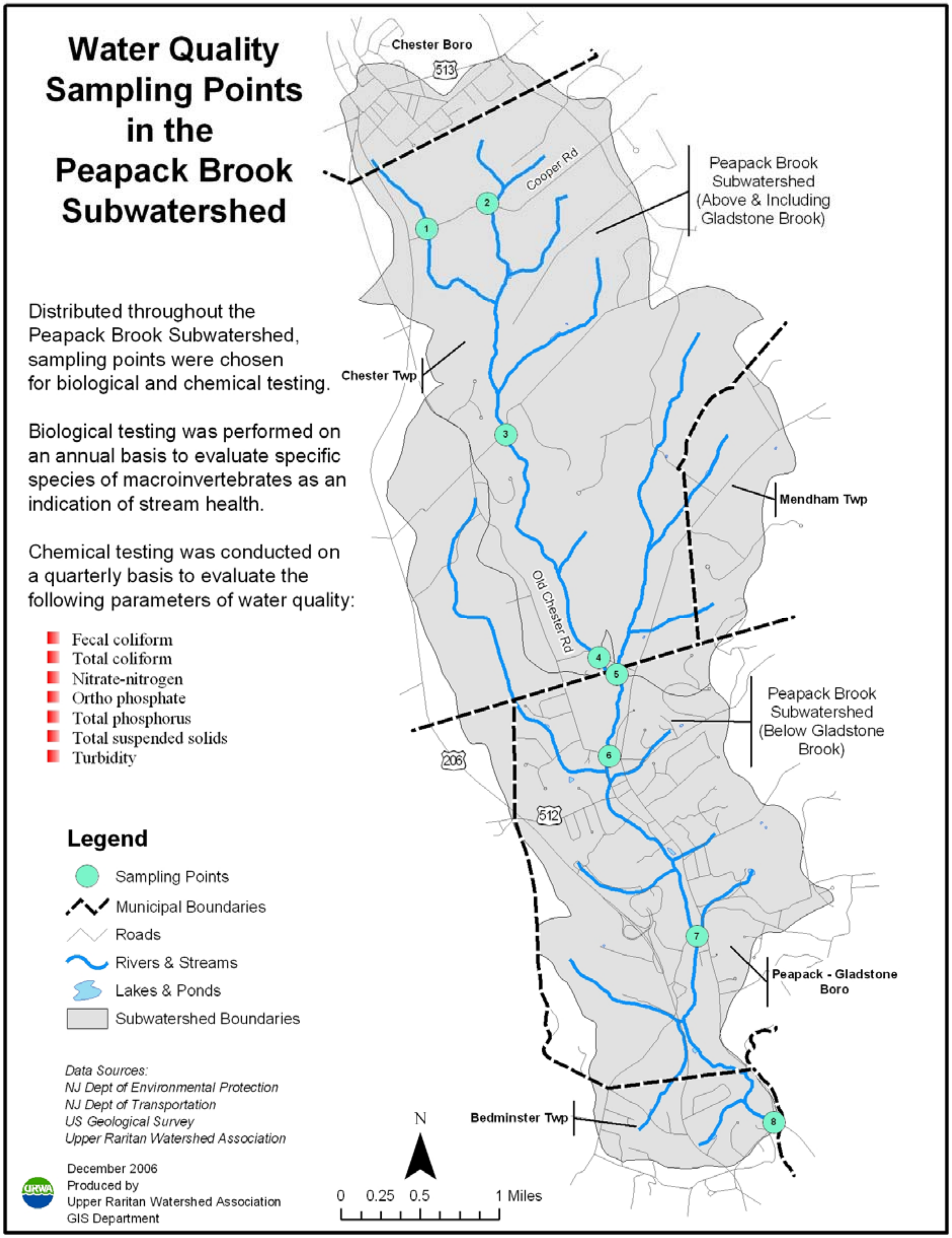
4. Peapack Brook at St. Bernard's Road. The sample site is just downstream from the bridge. It is located across from a large ash and a large walnut tree. This site does not include the influences of the cattle operation, and is upstream from the equestrian operation. It is a site that is also monitored by the Gill St. Bernard School students through the school's environmental club. (Two minute kick)

5. Gladstone Brook at St. Bernard's Road. This sampling site is located downstream of the bridge, and upstream of the log cabin site, where the two streams converge. Samples are taken just downstream from a small footbridge. This site is just upstream from the site that is monitored by the Gill St. Bernard's School Environmental Club. This site is in between the cattle operation and the equestrian operation. (Two minute kick)

6. Peapack Brook at Jackson Ave in Gladstone. This site is located just upstream of the bridge. This site is downstream of the livestock that have access to the stream, and upstream of the town. (Two minute kick)

7. Peapack Brook at the Peapack Train Station in Peapack. This site is located downstream from the bridge, near a willow tree. The site is downstream of the effects of the town, and upstream from the Department of Public Works facility. (Two minute kick)

8. Peapack Brook at Old Dutch Road. The site is upstream of the bridge crossing, where the stream is channeled around a gravel bar, and there is streambank erosion. This is the last site before the stream meets the North Branch of the Raritan River. (Two minute kick)


Water Quality Sampling Points in the Peapack Brook Subwatershed
Distributed throughout the Peapack Brook Subwatershed, sampling points were chosen for biological and chemical testing.
Biological testing was performed on an annual basis to evaluate specific species of macroinvertebrates as an indication of stream health.
Chemical testing was conducted on a quarterly basis to evaluate the following parameters of water quality:
Fecal coliform
Total coliform
Nitrate-nitrogen
Ortho phosphate
Total phosphorus
Total suspended solids
Turbidity
Legend
Sampling Points
Municipal Boundaries
Roads
Rivers & Streams
Lakes & Ponds
Subwatershed Boundaries
Data Sources:
NJ Dept of Environmental Protection
NJ Dept of Transportation
US Geological Survey
Upper Raritan Watershed Association
December 2006
Produced by
Upper Raritan Watershed Association
GIS Department
Chester Boro
513
Cooper Rd
Peapack Brook Subwatershed (Above & Including Gladstone Brook)
Chester Twp
Mendham Twp
Old Chester Rd
Peapack Brook Subwatershed (Below Gladstone Brook)
206
512
Peapack - Gladstone Boro
Bedminster Twp
N
0 0.25 0.5 1 Miles
1
2
3
4
5
6
7
8

Appendix II. New Jersey Impairment Scoring System

The benthic macroinvertebrate samples are scored using the New Jersey Impairment Scoring (NJIS) Criteria for Rapid Bioassessments. This protocol evaluates a 100 organism subsample on five criteria: Taxa Richness, EPT families, Contribution of Dominant Family, Percent EPT, and Family Biotic Index.

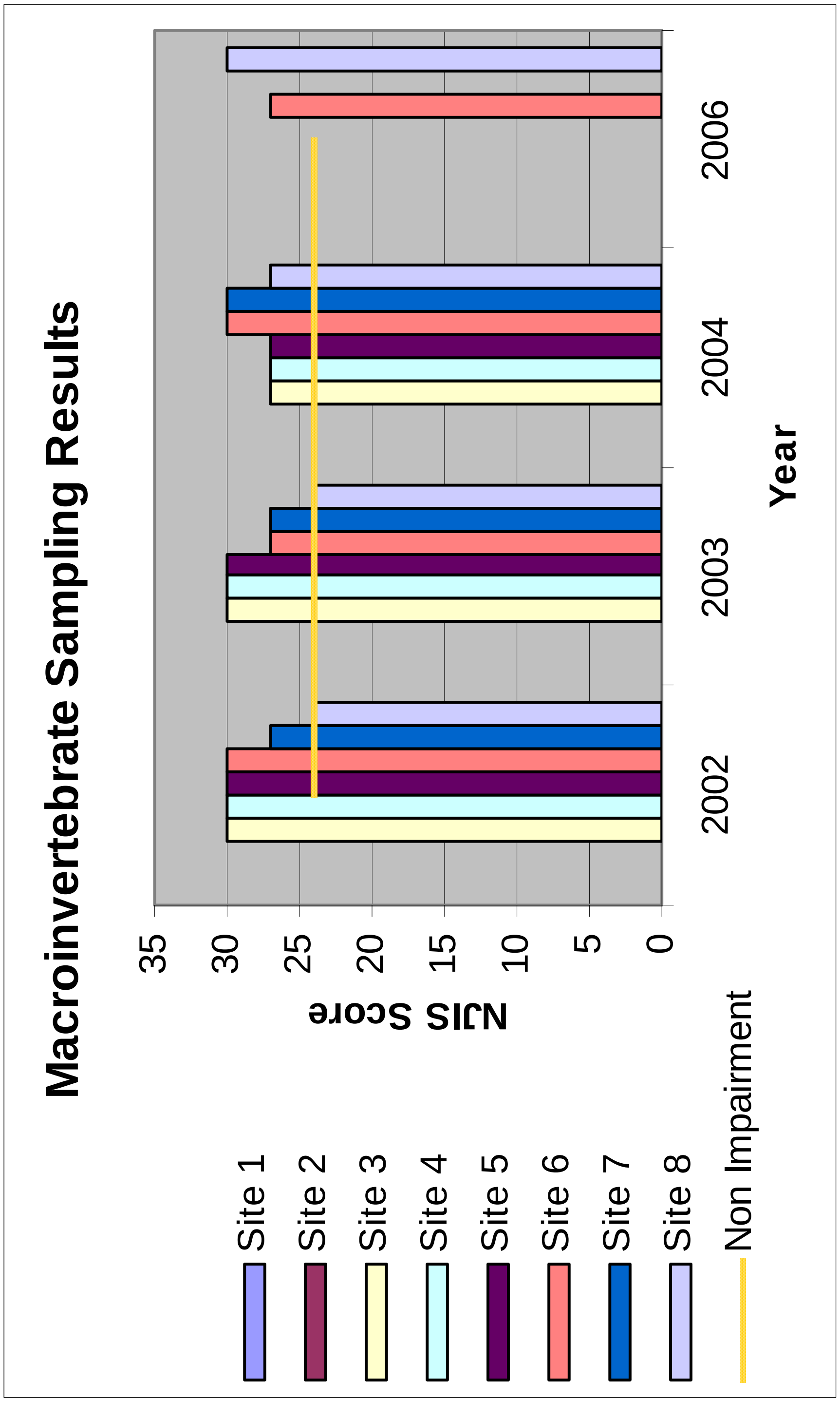
1) Taxa Richness refers to the total number of macroinvertebrate families found at the sampling location; a more diverse sample typically indicates a healthier site.
2) "EPT Families" refers to the total combined number of organisms in the sample that belong to the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies) families. Generally, the presence of more EPT families indicates a healthier site.
3) Percent Dominance refers to the proportion of the total sample comprised of the dominant family; a smaller percentage of the total sample dominated by one family indicates a healthier site.
4) Percent EPT refers to the proportion of the total sample comprised of EPT organisms. A greater percentage of the total sample comprised of EPT organisms indicates a healthier site.
5) Family Biotic Index represents the summation of standardized tolerance values for each family in the sample. The standardized tolerance value for each family is determined by multiplying the Hilsenhoff Family Tolerance Value by the number of individuals present in the family and dividing that number by the total number of organisms in the sample. A lower biotic index value indicates a healthier site.

Each of the five criteria is given a value of 0, 3, or 6 depending on where it falls on the scale, and then all are totaled. The possible scores range from 0 – 30 where 30 indicates the high end of non-impaired, and 0 indicates a site which is severely impaired. The biological conditions and their attributes are discussed below:

> Non-impaired: Total Score: 24 – 30. Benthic community is comparable to other undisturbed streams within the region. A community characterized by a maximum of taxa richness, balanced taxa groups, and good representation of intolerant species.
>
> Moderately Impaired: Total Score: 9 – 21. Macroinvertebrate richness is reduced in particular EPT taxa. Taxa composition changes result in reduced community balance and intolerant taxa become absent.
>
> Severely Impaired: Total Score: 0 – 6. A dramatic change in the benthic community has occurred. Macroinvertebrates are dominated by a few taxa which are very abundant. Tolerant taxa are the only individuals present.

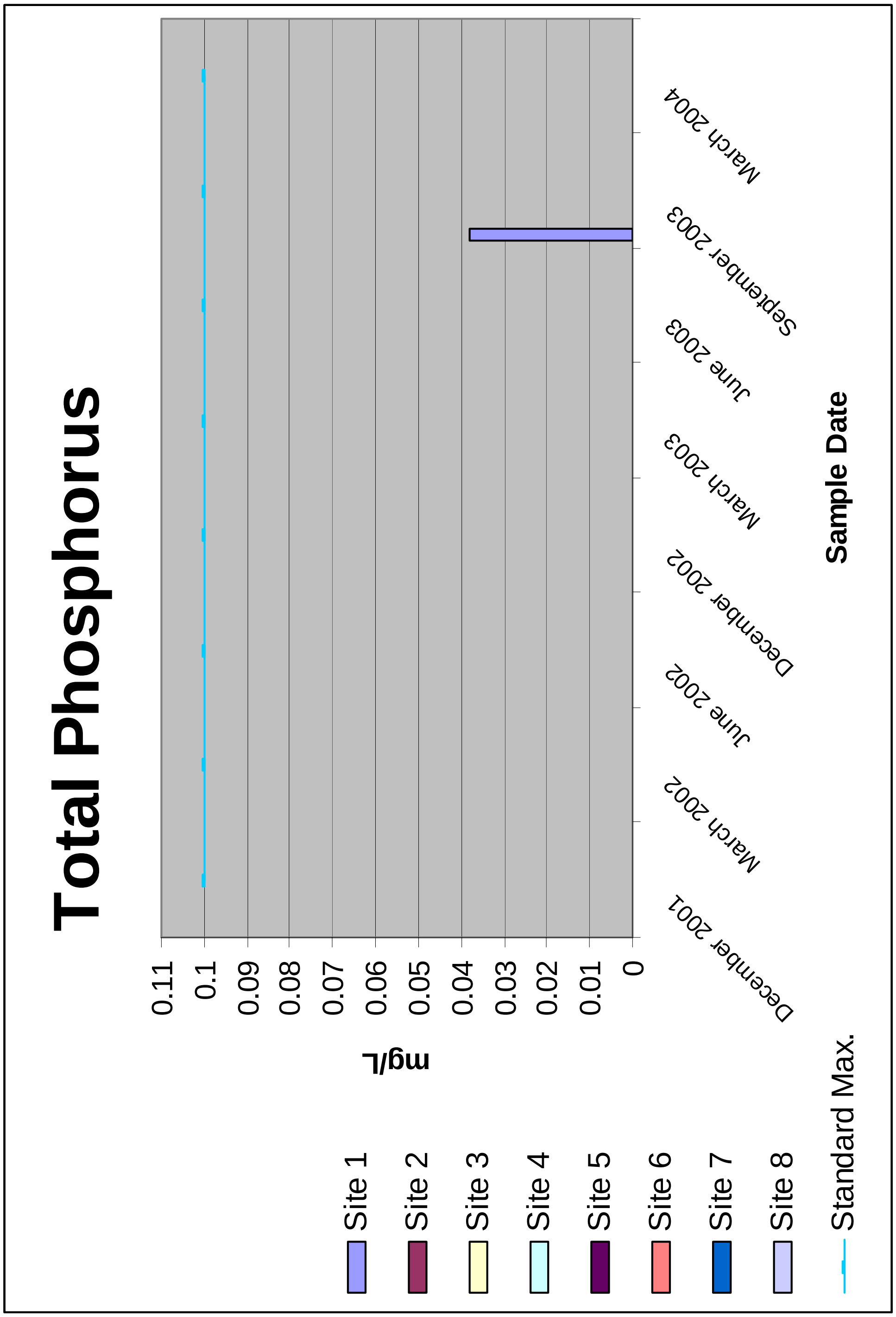
Appendix III. Biological Monitoring Data

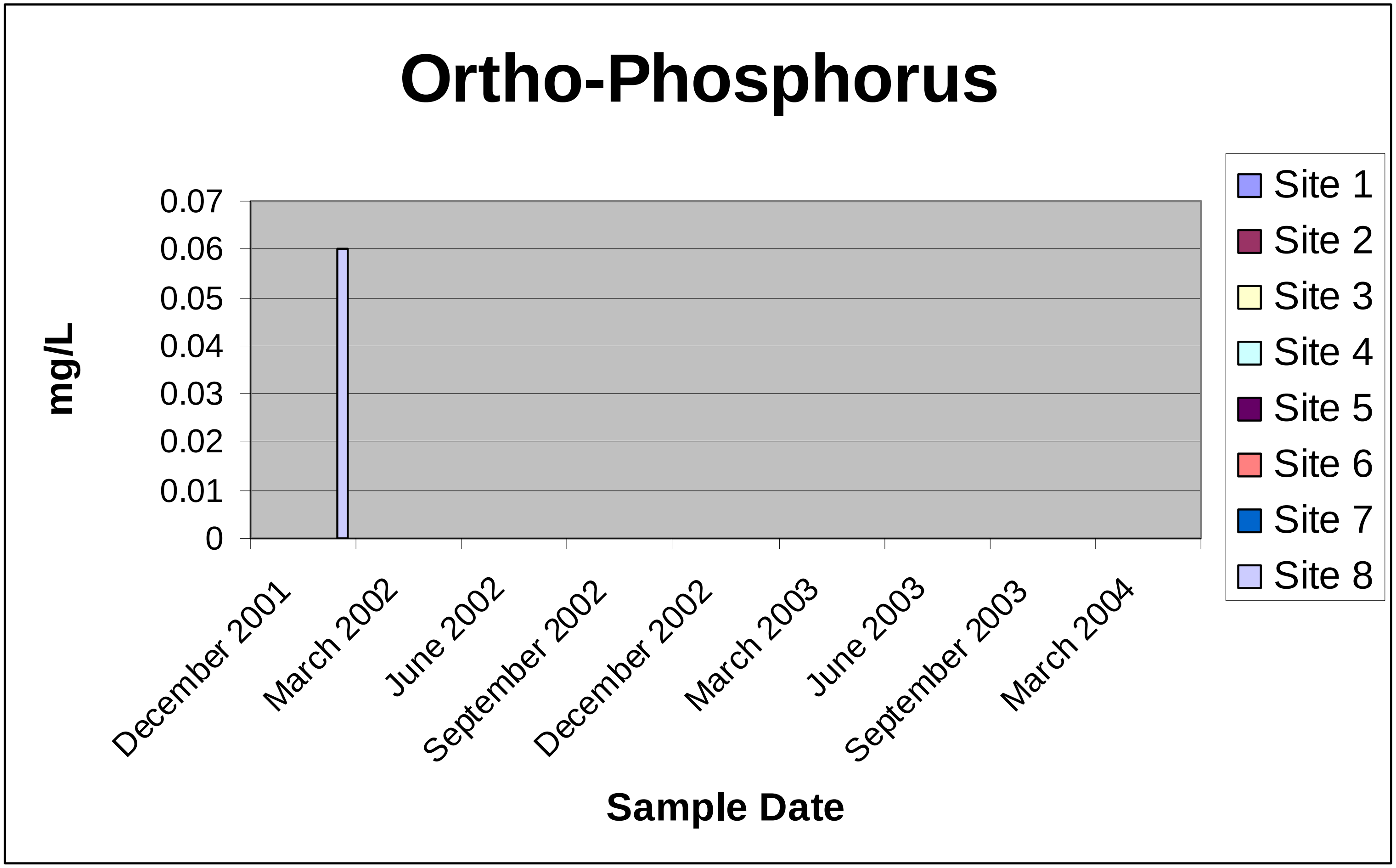
*Due to severe weather which led to flooding and scouring of aquatic habitats, meaningful scores could not be assessed at every site each year.

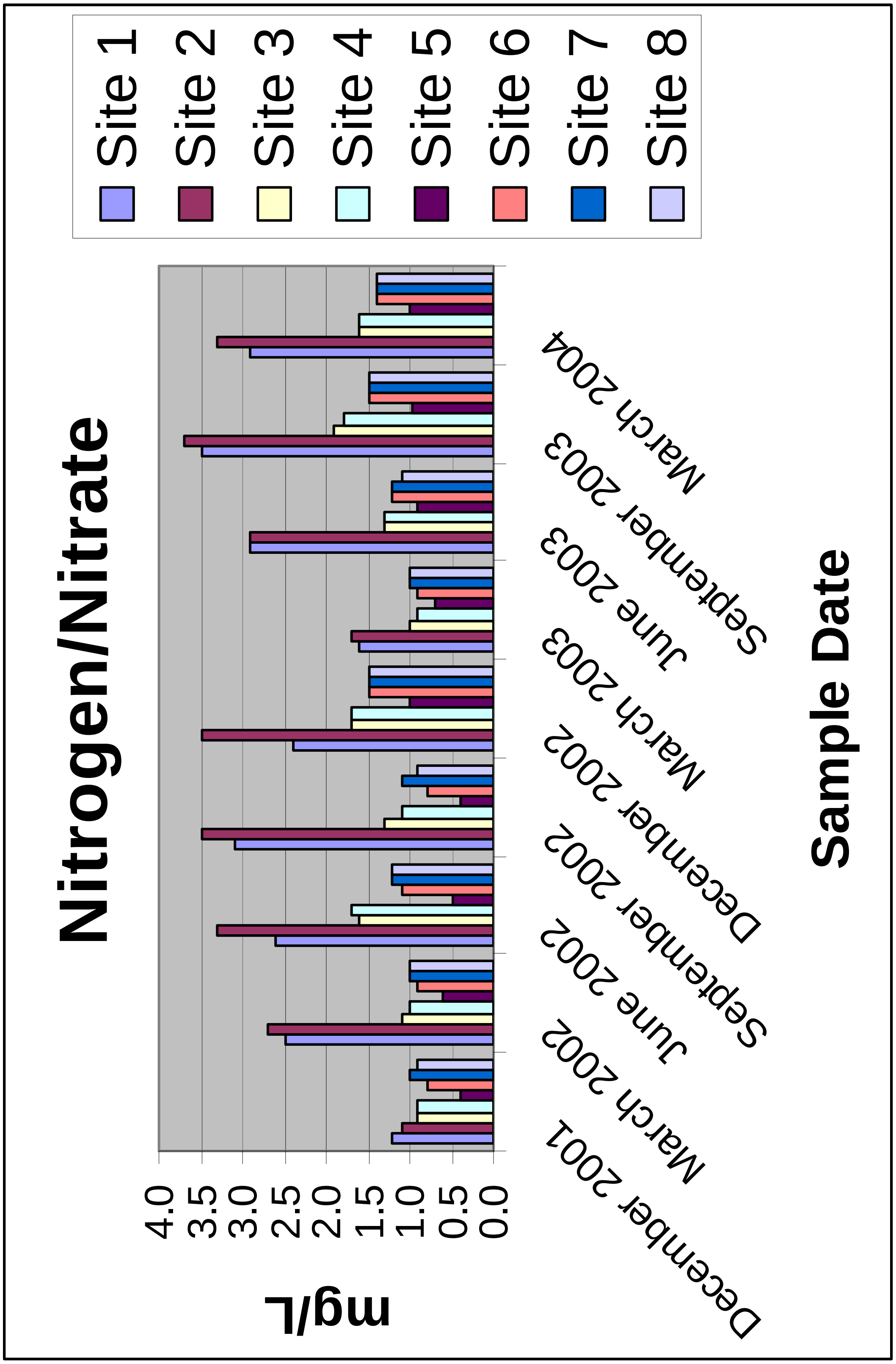


Appendix IV. Chemical Monitoring Data

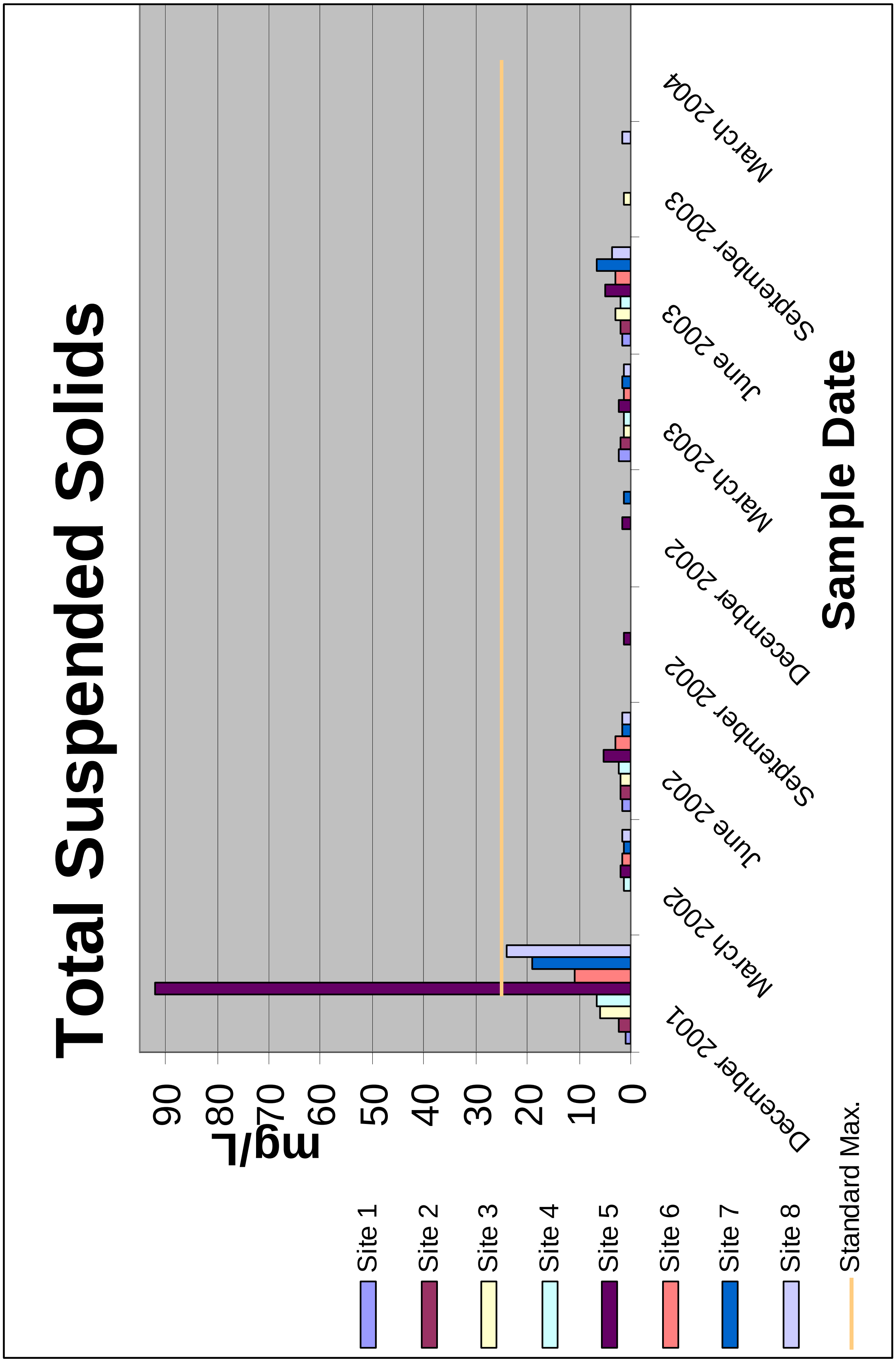
*Samples were not collected in the final quarter of 2003 due to severe weather and unavailability of personnel.

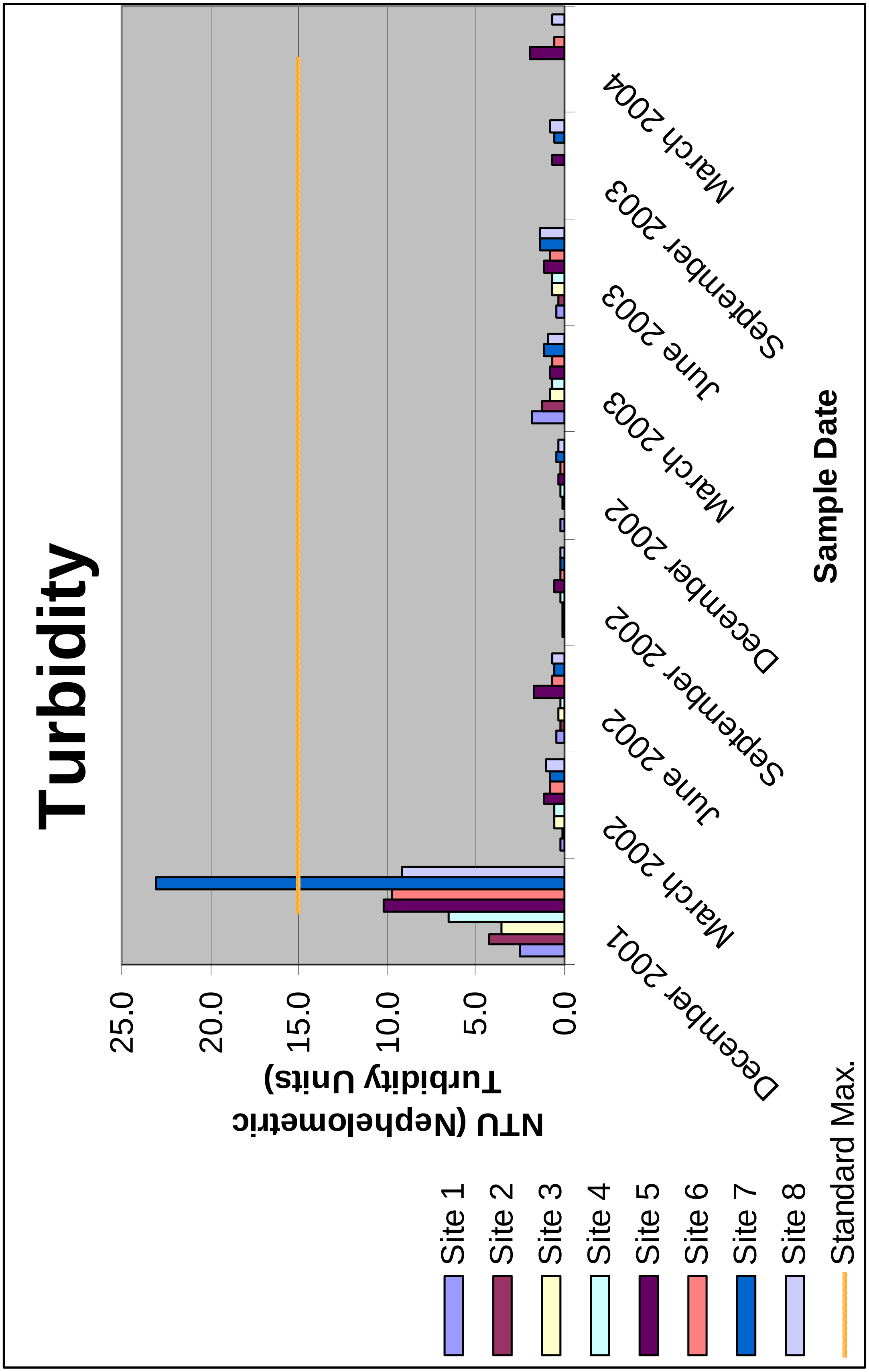


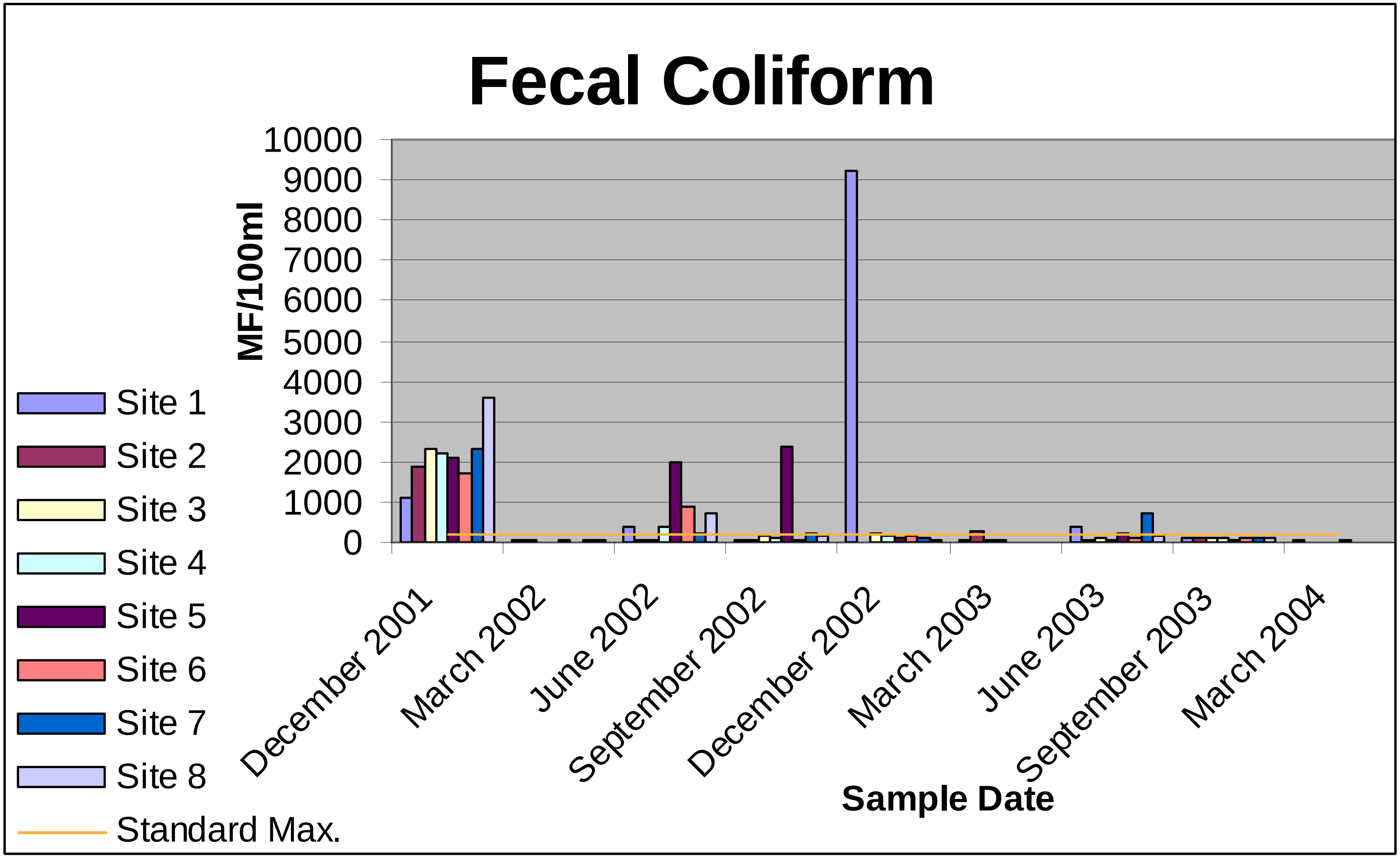

Ortho-Phosphorus
mg/L
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
December 2001
March 2002
June 2002
September 2002
December 2002
March 2003
June 2003
September 2003
March 2004
Sample Date
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8

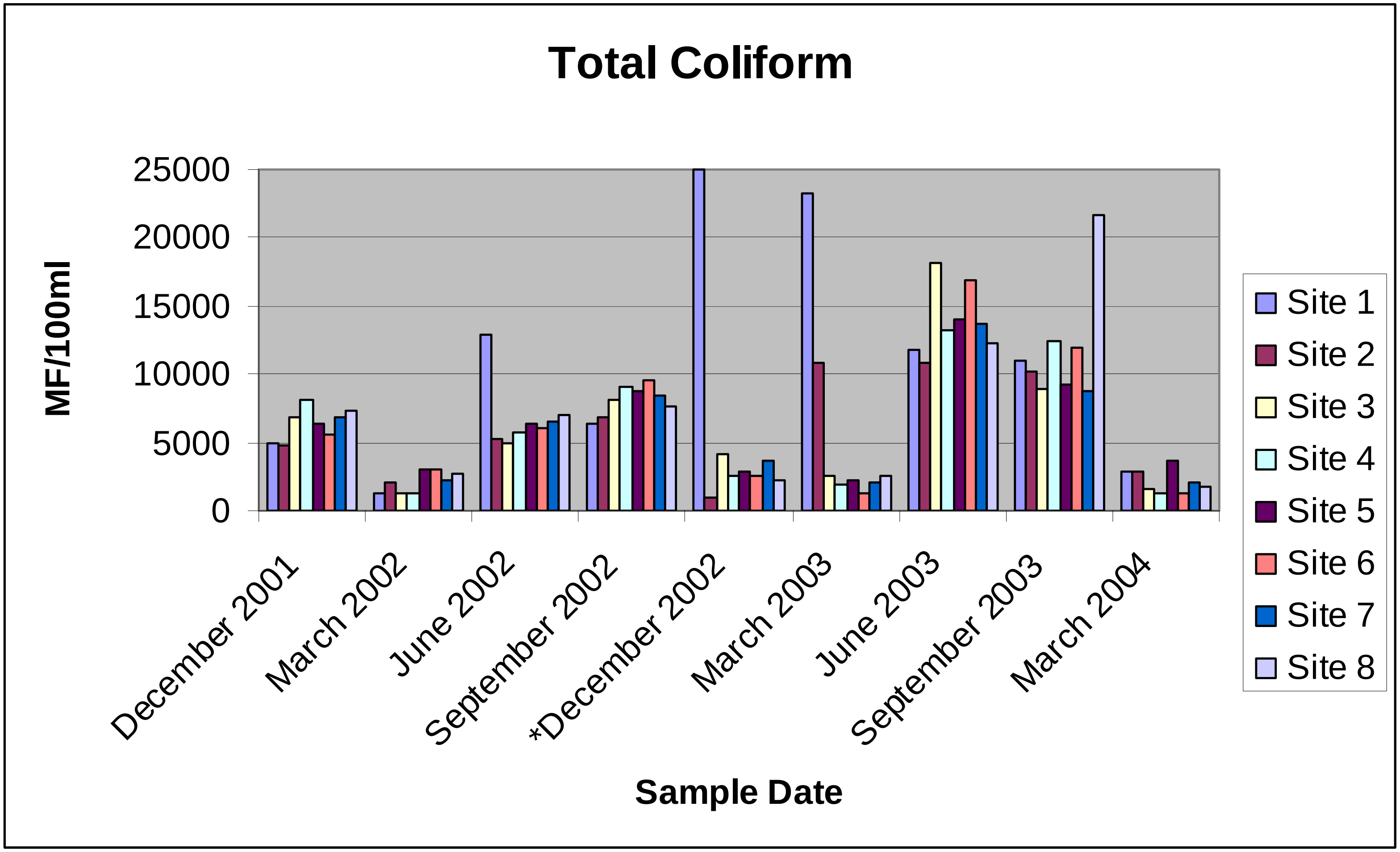


Nitrogen/Nitrate
mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
December 2001
March 2002
June 2002
September 2002
December 2002
March 2003
June 2003
September 2003
March 2004
Sample Date
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8


Total Suspended Solids
mg/L
90
80
70
60
50
40
30
20
10
0
December 2001
March 2002
June 2002
September 2002
December 2002
March 2003
June 2003
September 2003
March 2004
Sample Date
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Standard Max.


Turbidity
NTU (Nephelometric Turbidity Units)
25.0
20.0
15.0
10.0
5.0
0.0
December 2001
March 2002
June 2002
September 2002
December 2002
March 2003
June 2003
September 2003
March 2004
Sample Date
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Standard Max.


Fecal Coliform
MF/100ml
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
December 2001
March 2002
June 2002
September 2002
December 2002
March 2003
June 2003
September 2003
March 2004
Sample Date
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Standard Max.



* December 2002 Total Coliform results at Site 1 were “too numberous to count”.