New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Mill Creek

Biological Assessment

2008 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Mill Creek
Lower Hudson River Basin
Rensselaer County, New York

Survey date: July 10, 2008
Report date: March 6, 2010

Brian Duffy
Diana L. Heitzman
Lawrence E. Abele
Alexander J. Smith
Margaret A. Novak

Stream Biomonitoring Unit
Bureau of Water Assessment and Management
Division of Water
NYS Department of Environmental Conservation
Albany, New York

Table of Contents

Background 1
Results and Conclusions 1
Discussion 2
Literature Cited 3
Table 1. Station Locations 4
Figure 1a. Overview Map 6
Figure 1b. Approximate Location of the Proposed Village at Tempel Farms 7
Figure 2. Site Location Maps 8
Figure 3. Biological Assessment Profile (BAP) of Index Values 14
Table 2. Biological Assessment Profile Scores 14
Table 3. Overview of Field Data 15
Figure 4. Percent Land-cover, Mill Creek, 2008 15
Figure 5. Nutrient Biotic Index Values for Phosphorus (NBI-P) and Nitrogen (NBI-N) 16
Figure 6. Periphyton and Silt-Cover Index Scores 16
Table 4. Impact Source Determination 17
Table 5. Macroinvertebrate Species Collected in Mill Creek 18
Table 5a. Macroinvertebrate Data Report 19
Table 6. Laboratory Data Summary 25
Table 7. Field Data Summary 27
Appendix I. Biological Methods for Kick Sampling 29
Appendix II. Macroinvertebrate Community Parameters 30
Appendix III. Levels of Water Quality Impact in Streams 31
Appendix IV-A. Biological Assessment Profile 32
Appendix IV-B. Biological Assessment Profile: Plotting Values 33
Appendix V. Water Quality Assessment Criteria 34
Appendix VI. The Traveling Kick Sample 35
Appendix VII-A. Aquatic Macroinvertebrates Usually Indicative of Good Water Quality 36
Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of Poor Water Quality 37
Appendix VIII. The Rationale of Biological Monitoring 38
Appendix IX. Glossary 39
Appendix X. Methods for Calculation of the Nutrient Biotic Index 40
Appendix XI. Impact Source Determination Methods and Community Models 43
Appendix XII. Biological Assessment Profile of Slow, Sandy Streams. 49
Appendix XIII. Biological Impacts of Waters with High Conductivity 50
Appendix XIV. Pebble Count and Periphyton/Silt Cover Index 51

Stream: Mill Creek

Reach: Best Rd. to Rensselaer (Rensselaer County, NY)

River Basin: Lower Hudson

Background

The Stream Biomonitoring Unit sampled Mill Creek in East Greenbush and Rensselaer on July 10, 2008. Sampling was conducted to update a survey performed in 2001, to evaluate the effects of long-term development in the area and establish a baseline for another proposed 159-acre development east of routes 4 and 90 called the Village at Tempel Farms.

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each of six sites on Mill Creek. Methods used are described in the Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State (Smith et al., 2009) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of 100-specimen subsamples from each site. Macroinvertebrate community parameters used in the determination of water quality included: species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Expected variability of results is described in Smith and Bode (2004). Table 1 provides a list of sampling sites and Table 5 provides a list of all taxa collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions

1. Water quality in Mill Creek ranges from non-impacted to moderately impacted and has declined since the previous survey was performed in 2001. The most pronounced impacts to water quality occurred at the downstream urban sampling locations.

2. Additional development such as the proposed Village at Tempel Farm would likely lead to further loss of water quality and possible impairment of additional reaches.

Discussion

Mill Creek is a tributary of the Hudson River with its headwaters in East Greenbush and its mouth at the Hudson in Rensselaer, NY. This survey repeats a similar one that was conducted in 2001 that found water quality ranging from non-impacted to slightly impacted. The greatest impact to water quality occurred in the lowest reach sampled in the city of Rensselaer and was attributed to urban runoff (Bode et al., 2002). Analysis of crayfish tissue at the lowest reach found elevated levels of copper, nickel, selenium, titanium and some polyaromatic hydrocarbons (PAHs) (Bode et al., 2001a, 2001b). The source of these contaminants is not known but was also attributed to the urban conditions of the surrounding watershed.

On July 10, 2008, the Stream Biomonitoring Unit sampled the stream at six locations on Mill Creek in anticipation of a 159-acre proposed development called the Village at Tempel Farms. This development would be located along the western edge of routes 90 and 4 and north of Route 151 surrounding Tempel Lane in East Greenbush. It would include both townhomes and retail space (Carleo-Evangelist, 2007). Originally, project officials anticipated the start of construction in the spring of 2008, but the economic recession has stalled the construction indefinitely (Demasi, 2009). This survey also repeats the one conducted in 2001 with the addition of one site (Station 03) directly upstream of the proposed development site.

Water quality of Mill Creek ranged from non-impacted to moderately impacted. Since 2001, overall water quality has worsened at most of the sites sampled (Figure 3). The most upstream site, Station 00, remains very similar to previous conditions, likely due to its unchanging land use and the small pond just upstream of the site. The sites in the upper watershed appear to be affected by enrichment from agricultural inputs. Enrichment is increasing biomass and diversity, but not to the point at which the macroinvertebrate community shows negative effects of eutrophication. Field sampling staff noted unnaturally high biomass, typical of nutrient enrichment, at Stations 00 and 01. Station 01 has been sampled many times previously (1989, 1999, 2001and 2007) and the 2008 macroinvertebrate community indicates the most degraded conditions to date (Table 2).

Except for Station 02, there is a steady decrease in water quality moving downstream into the more heavily developed area of Rensselaer County, as indicated by land-use analysis (Figure 4). Eutrophic conditions are indicated by the Nutrient Biotic Index (NBI) for phosphorus at the lower three sites (stations 03, 04 and 05; Figure 5). Impact Source Determination (ISD) suggests impoundment/organic influences at Station 03 and nutrient enrichment at Station 04 (Table 4). Silt cover index scores increase from 0.6 to 4.6 from Station 02 to Station 03, respectively. In New York State, a silt cover index score of 3.6 is in the 75th percentile of all scores and a score of 0.6 is in the 25th percentile. Silt cover remains elevated downstream to Station 05 (Figure 6; see Appendix XIV for a more detailed explanation). Increased sedimentation embeds and covers coarse substrates that are essential to the survival and reproduction of many aquatic organisms (Chutter 1969, Berkman and Rabeni 1987, Asmus et al. 2009).

Cumulative effects of impervious surface, urban conditions, stormwater runoff and enrichment are seen at Station 05, where many sensitive mayfly, stonefly and caddisfly (Ephemeroptera, Plecoptera and Trichoptera or EPT) taxa have been lost, and overall diversity is lower (see Appendix VII-A for a more detailed explanation of EPT). Two taxa (*Stenelmis* sp. and *Cheumatopsyche* sp.) make up 64% percent of the community. The multiple influences on Station 05 are borne out in the ISD, which suggests likely sources of impact to be nutrient enrichment, toxic compounds, organic waste, municipal/industrial lands, and impoundment areas (Table 4). Previous assessments of Station 05 were conducted in 1998, 1999, 2001 and 2002. All but the 2001 assessment indicated moderate impact. The 2001 assessment indicated slight impact (Table 2).

The 2008 survey shows an overall reduction in the water quality of Mill Creek since the 2001 survey. Additional large scale development in the watershed would almost certainly put further pressure on already stressed aquatic communities and worsen water quality to the degree that biological impairment would be expected at stations 04 and 05.

Literature Cited

Asmus, B., J. Magner, B. Vondracek and J. Perry. 2009. Physical integrity: The missing link in biological monitoring and TMDLs. *Environmental Monitoring and Assessment* 159:443-463

Berkman, H. and C. Rabeni. 1987. Effect of siltation on stream fish communities. *Environmental Biology of Fishes* 18:285-294

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman. 2001a. Biological assessment of tributaries of the Lower Hudson River. New York State Department of Environmental Conservation, Technical Report, 157 pages.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman. 2001a. Biological assessment of tributaries of the Lower Hudson River, II. Targeted studies of stressed streams. New York State Department of Environmental Conservation, Technical Report, 123 pages.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, A. J. Smith. 2002. Biological Stream Assessment of Mill Creek, Rensselaer County, New York. New York State Department of Environmental Conservation, Technical Report, 36 pages.

Carleo-Evangelist, J. (October 21, 2007) "Village vision in the mix; Developments combining retail, residential arriving in region." *Times Union*. pD1, D3.

Chutter, F. M. 1969. The effects of silt and sand on the invertebrate fauna of streams and rivers. *Hydrobiologia* 34(1): 57-76.

Demasi, M. (2009, Jan 21) "Nigro Cos.' East Greenbush project in limbo." *The Business Review.* Retrieved from http://albany.bizjournals.com/albany/stories/2009/01/19/daily32.html.

Smith, A. J., D. L. Heitzman, and B. T. Duffy. 2009. Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State. New York State Department of Environmental Conservation, Division of Water. Technical Report, 153 pages.

Smith, A. J., and R. W. Bode. 2004. Analysis of Variability in New York State Benthic Macroinvertebrate Samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

Smith, A.J., R. W. Bode, and G. S. Kleppel. 2007. A nutrient biotic index for use with benthic macroinvertebrate communities. *Ecological Indicators* 7(200):371-386.

Table 1. Station Locations for Mill Creek, Rensselaer County, NY, 2008.

Station	Location
MILL-00	East Greenbush, NY east of Best Rd. Best Rd., 10m above bridge River Mile 9.3 Drainage Area: 6.0 mi^2 Latitude: 42.63028 Longitude: -73.66333

MILL-01	East Greenbush, NY, east of Couse Corners Michaels Rd., 20 m above bridge River Mile 6.7 Drainage Area: 9.8 mi^2 Latitude: 42.61278 Longitude: -73.69556

MILL-02	East Greenbush, NY, south of Couse Corners Rte. 4, 200m above bridge River Mile 5.5 Drainage Area: 10.2 mi^2 Latitude: 42.60361 Longitude: -73.70556

Table 1 cont'd. Station Locations for Mill Creek, Rensselaer County, NY, 2008.

MILL-03

East Greenbush, NY, at Couse Corners
between Red Mill Rd. and Rte. 151
River Mile 4.0
Drainage Area: 12.3 mi^2
Latitude: 42.61963
Longitude: -73.7091

MILL-04

East Greenbush, NY, at Clinton Park
0.7 mile above Barrack Rd (Rte. 151),
walk from cemetery
River Mile 2.3
Drainage Area: 13.3 mi^2
Latitude: 42.63472
Longitude: -73.72

MILL-05

Rensselaer, NY
50 m above South St. RR bridge
River Mile 0.6
Drainage Area: 14.7 mi^2
Latitude: 42.635
Longitude: -73.74083

Figure 1a. Overview Map, Mill Creek, Rensselaer County.

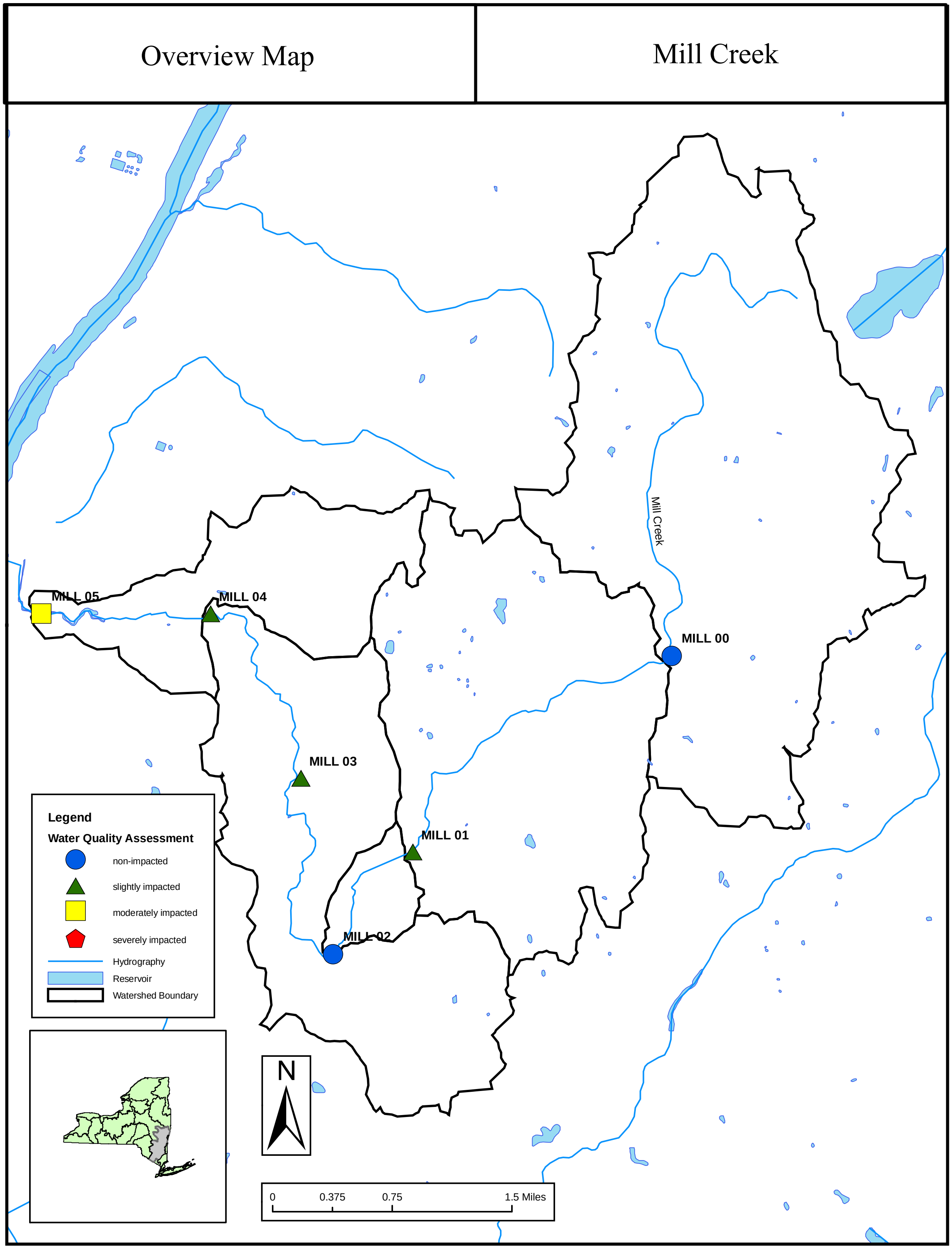


Figure 1b. Approximate Location of the Proposed Village at Tempel Farms

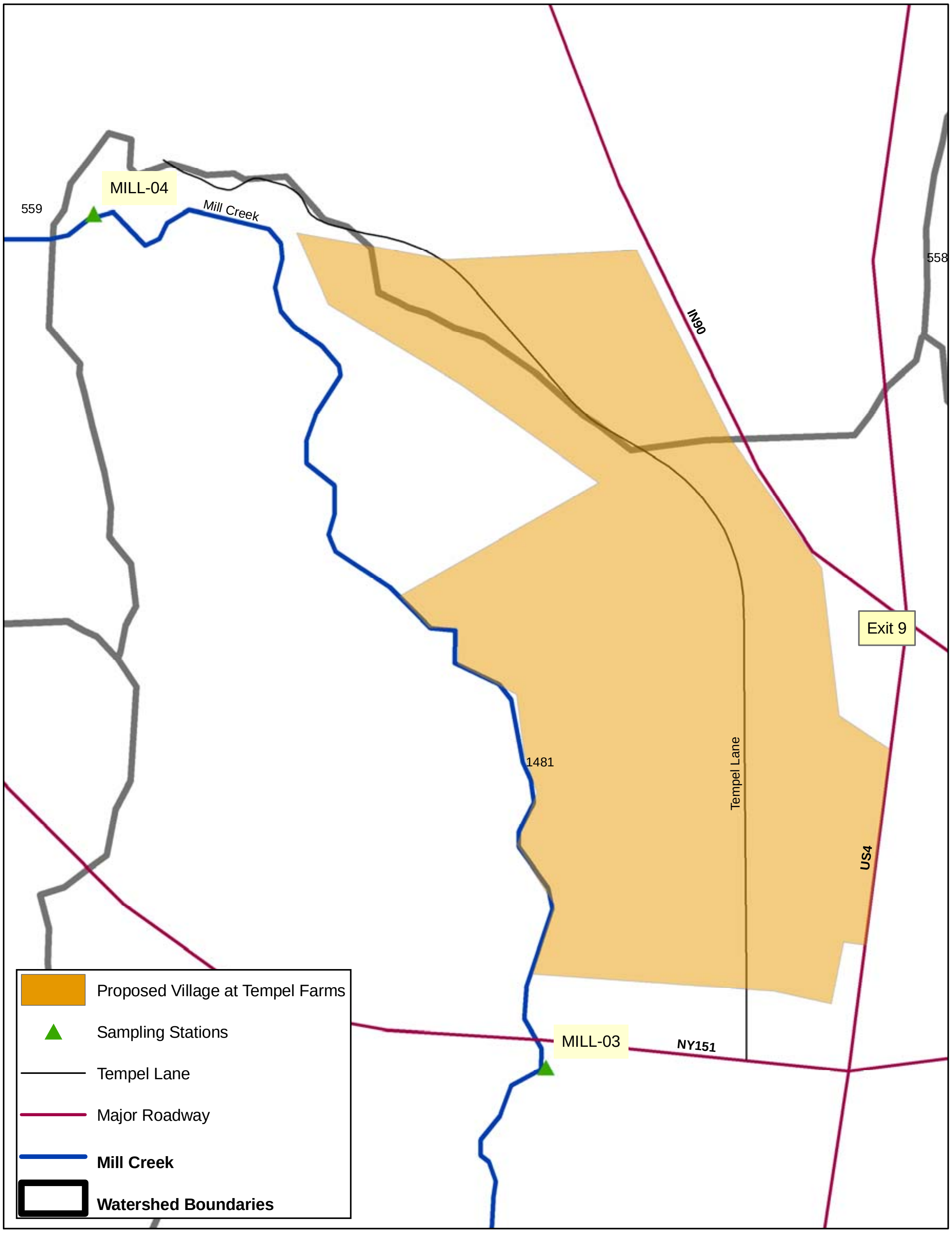


Figure 2a. Site Location Map

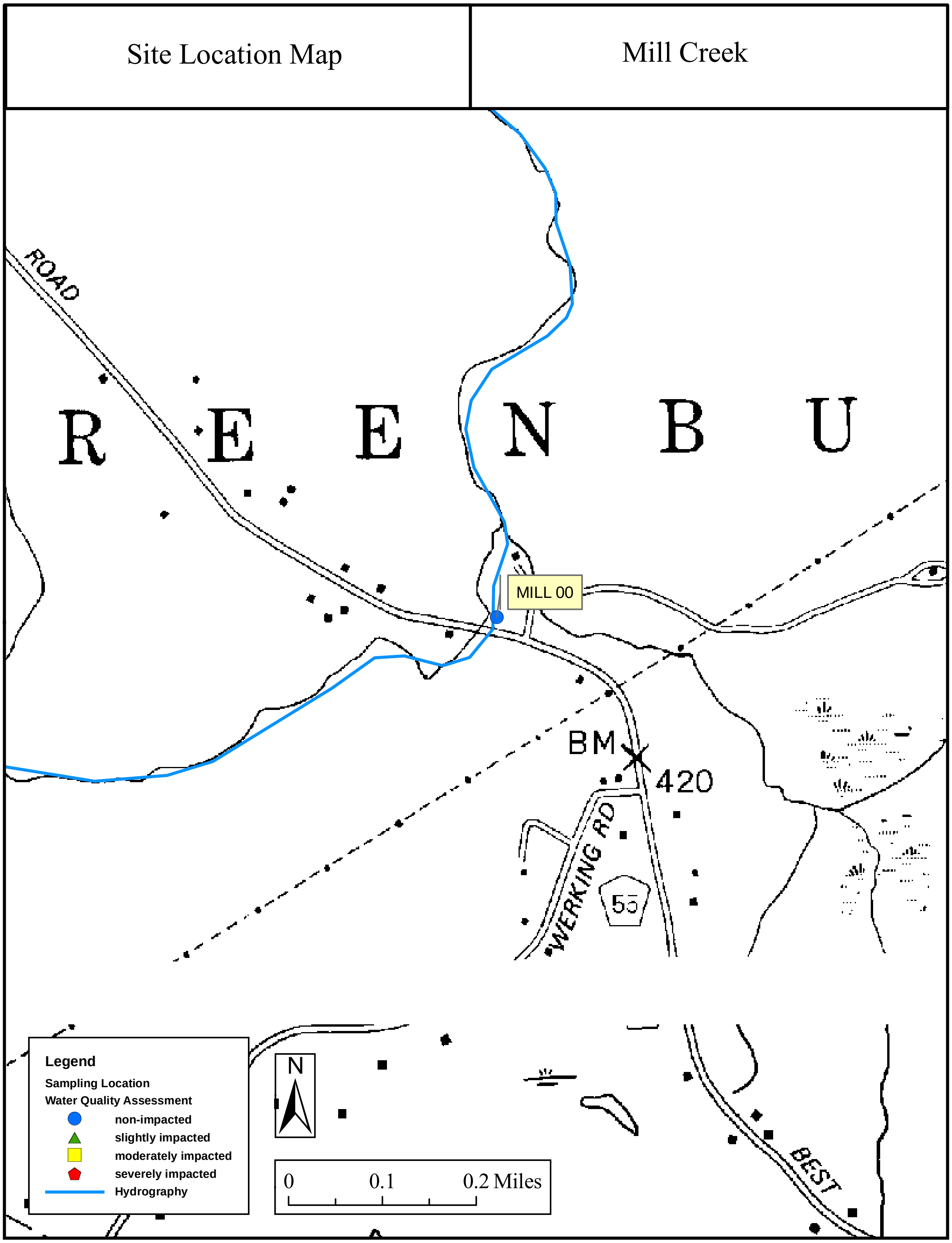


Figure 2b.

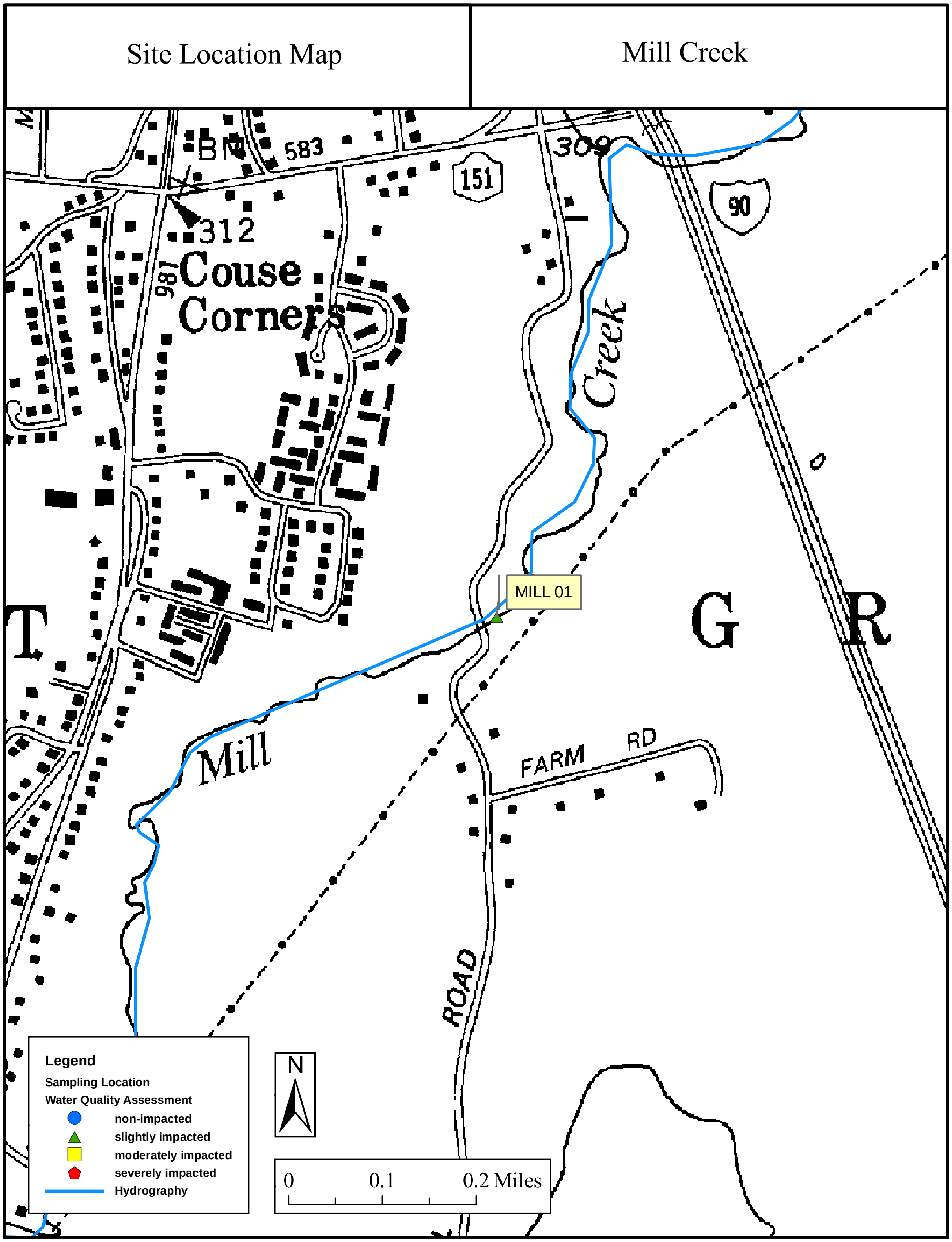

Site Location Map
Mill Creek
Couse Corners
Mill
Creek
FARM RD
ROAD
BM
583
151
309
90
312
981
T
G
R
MILL 01
Legend
Sampling Location
Water Quality Assessment
non-impacted
slightly impacted
moderately impacted
severely impacted
Hydrography
N
0
0.1
0.2 Miles

Figure 2c.

Site Location Map	Mill Creek

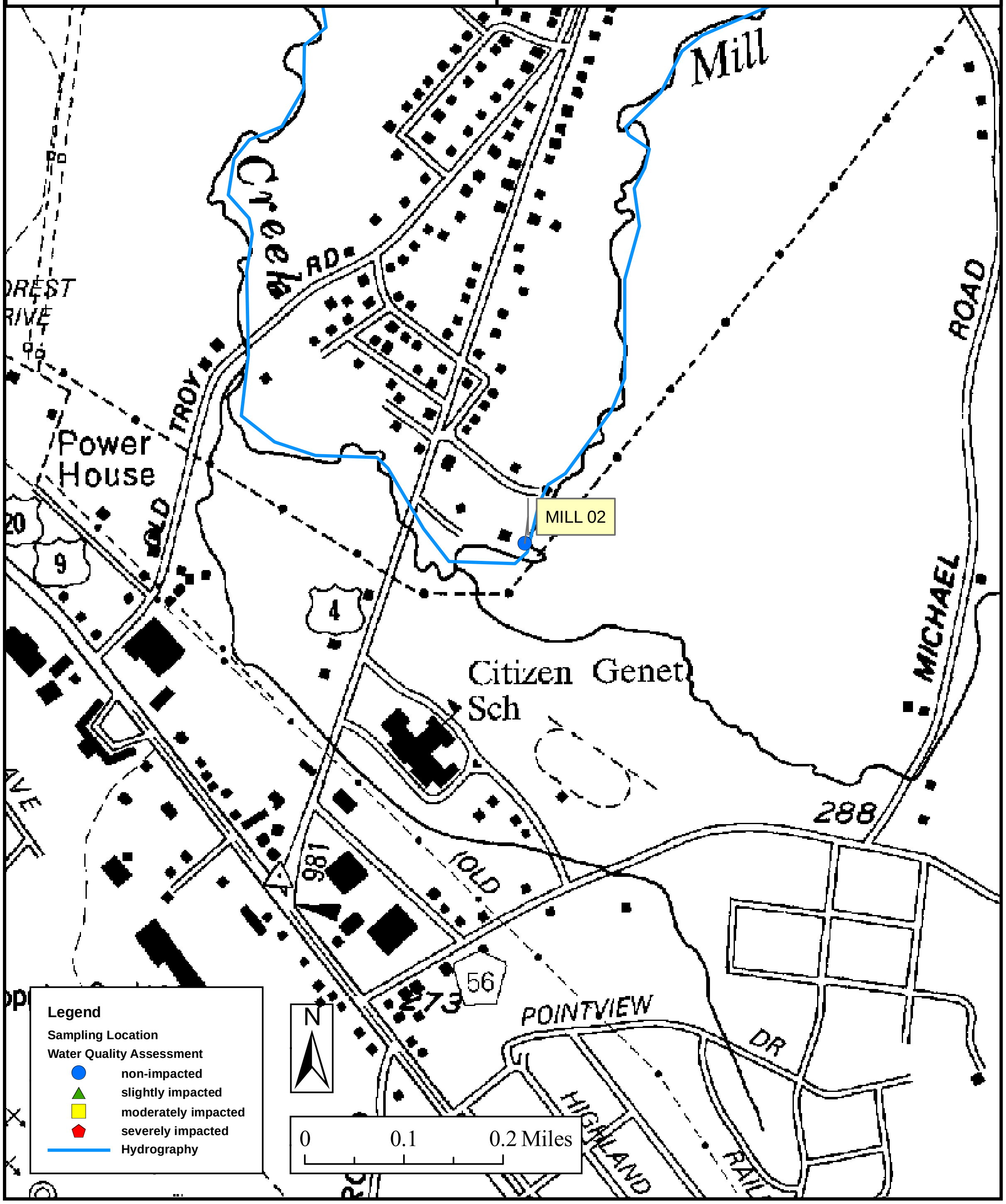


Figure 2d.

Site Location Map	Mill Creek

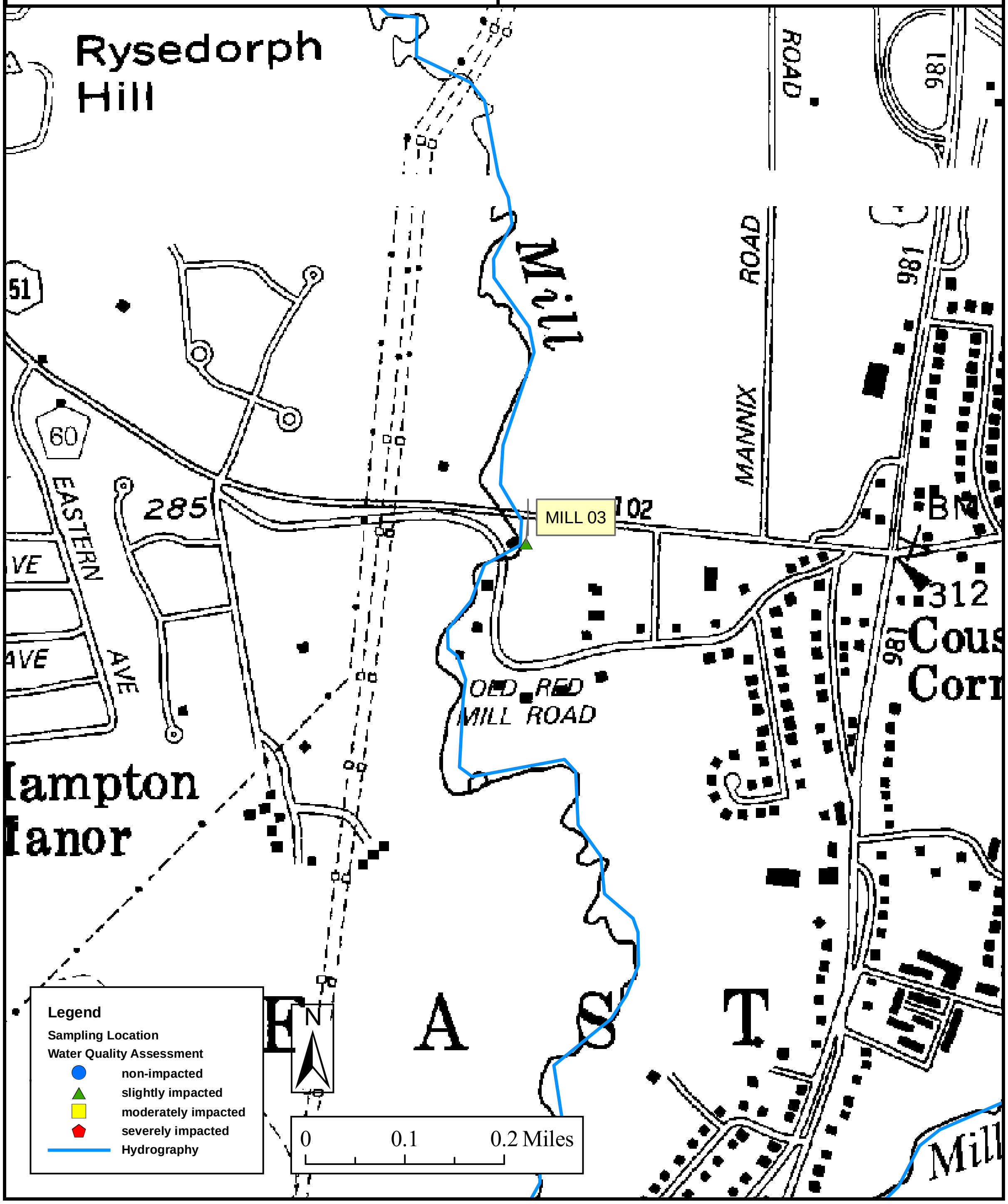


Figure 2e.

Site Location Map	Mill Creek

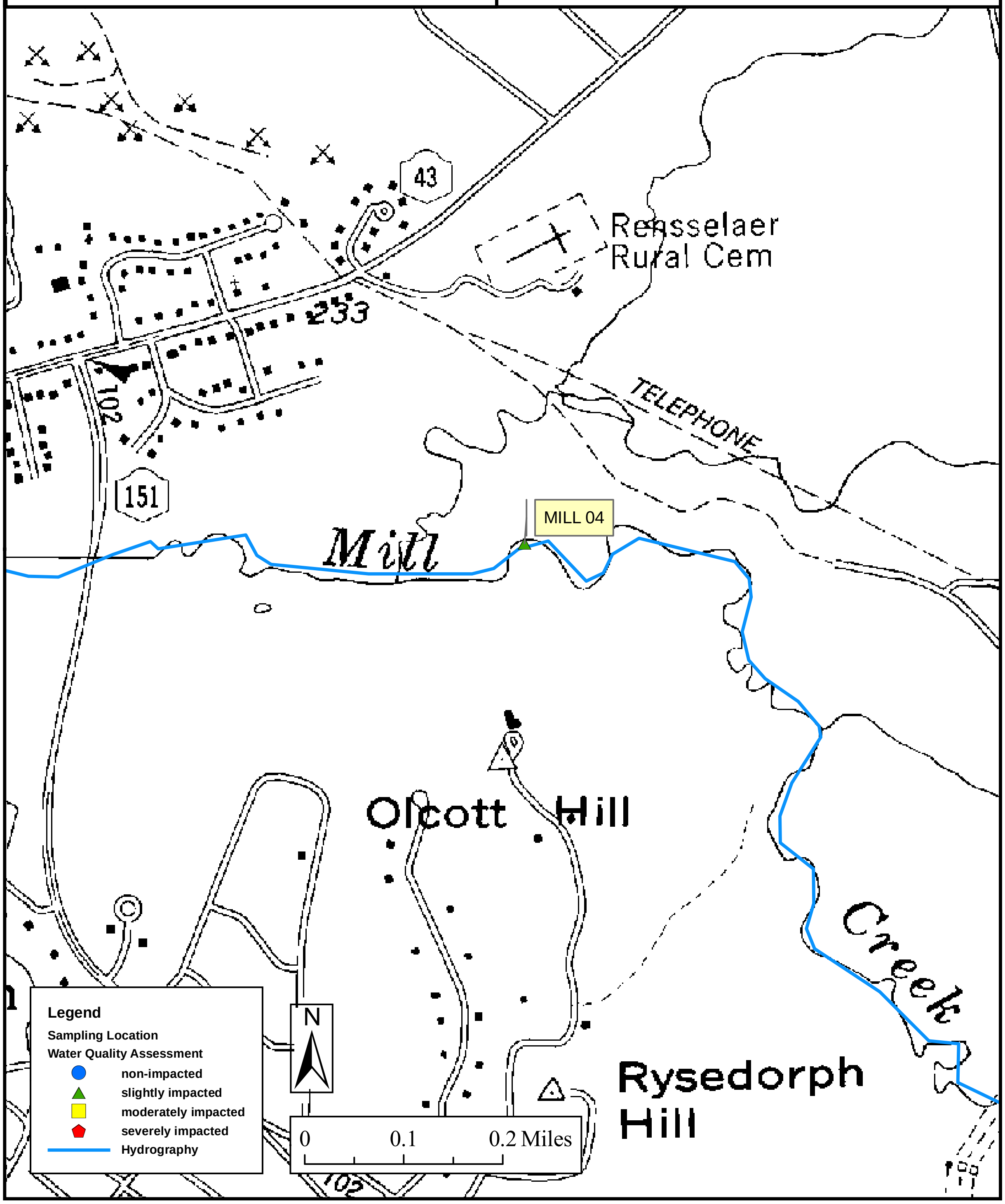


Figure 2f.

Site Location Map	Mill Creek

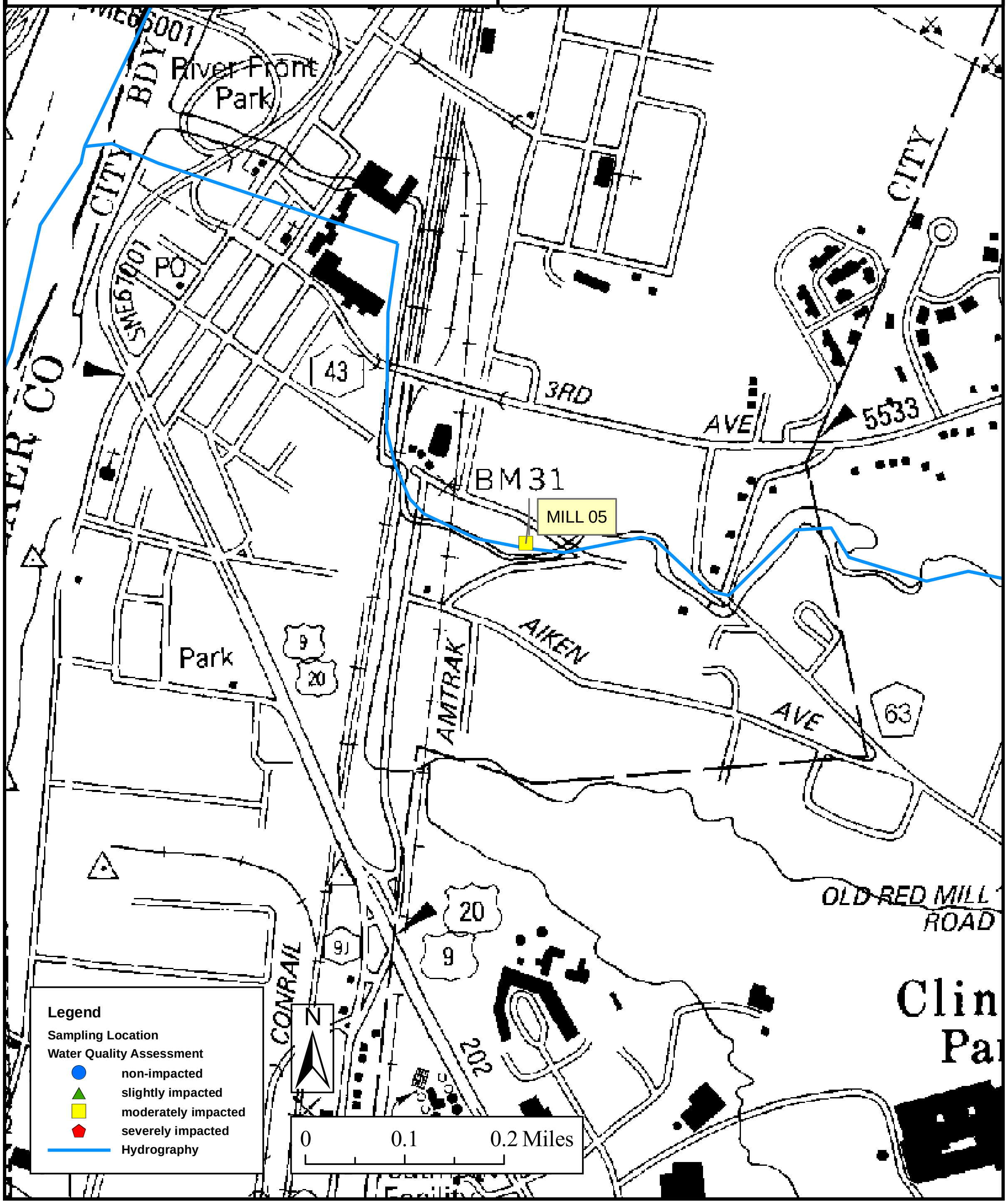


Figure 3. Biological Assessment Profile (BAP) of Index Values, Mill Creek, 2008 and 2001. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index (HBI), and Percent Model Affinity (PMA). See Appendix IV for a more complete explanation.

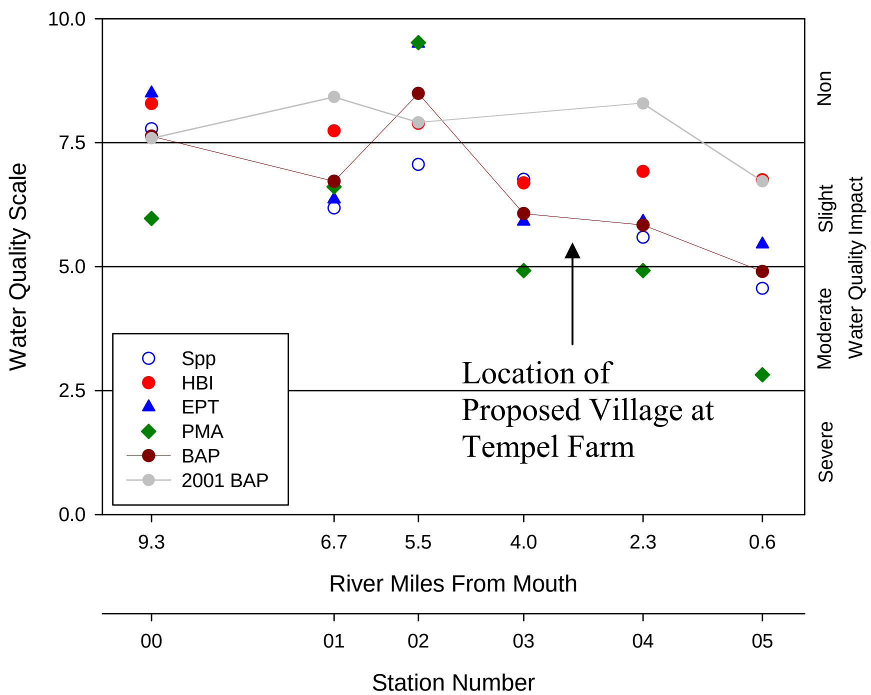


Table 2. Biological Assessment Profile Scores for current and previous assessments made within the index period of July to September.

Location	Date	Assessment	BAP
MILL-00	7/2/2001	non	7.59
	7/10/2008	non	7.63
MILL-01	7/14/1989	non	8.4
	8/17/1989	non	7.72
	7/20/1999	non	7.83
	7/2/2001	non	8.42
	9/12/2007	slight	7.25
	7/10/2008	slight	6.72
MILL-02	7/2/2001	non	7.91
	7/10/2008	non	8.49
MILL-03	7/10/2008	slight	6.07
MILL-04	7/2/2001	non	8.29
	7/10/2008	slight	5.84
MILL-05	9/30/1998	moderate	4.32
	7/20/1999	moderate	4.91
	7/2/2001	slight	6.72
	9/18/2002	moderate	3.87
	7/10/2008	moderate	4.9

Table 3. Overview of Field Data.

Location/Station	Width (meters)	Depth (meters)	Current (cm/s)	Canopy (%)	Embed. (%)	Temp (˚C)	Cond. (umhom/cm)	DO (mg/L)	pH
MILL-00	2.5	0.1	100	75	20	18.6	249	8.11	7.94
MILL-01	6	0.1	71	50	40	22.2	329	8.52	8.68
MILL-02	7	0.1	91	50	10	20.6	357	7.47	8.03
MILL-03	5	0.1	83	90	25	22.8	360	6.64	7.93
MILL-04	5	0.1	83	75	25	21.4	466	8.6	8.06
MILL-05	8	0.2	91	25	60	21.3	471	8.7	8.3

Figure 4. Percent Land-cover, Mill Creek, 2008, for each sampling station. Percent impervious surface is included independent of land-cover/use. Land-use data is based on NLCD2001.

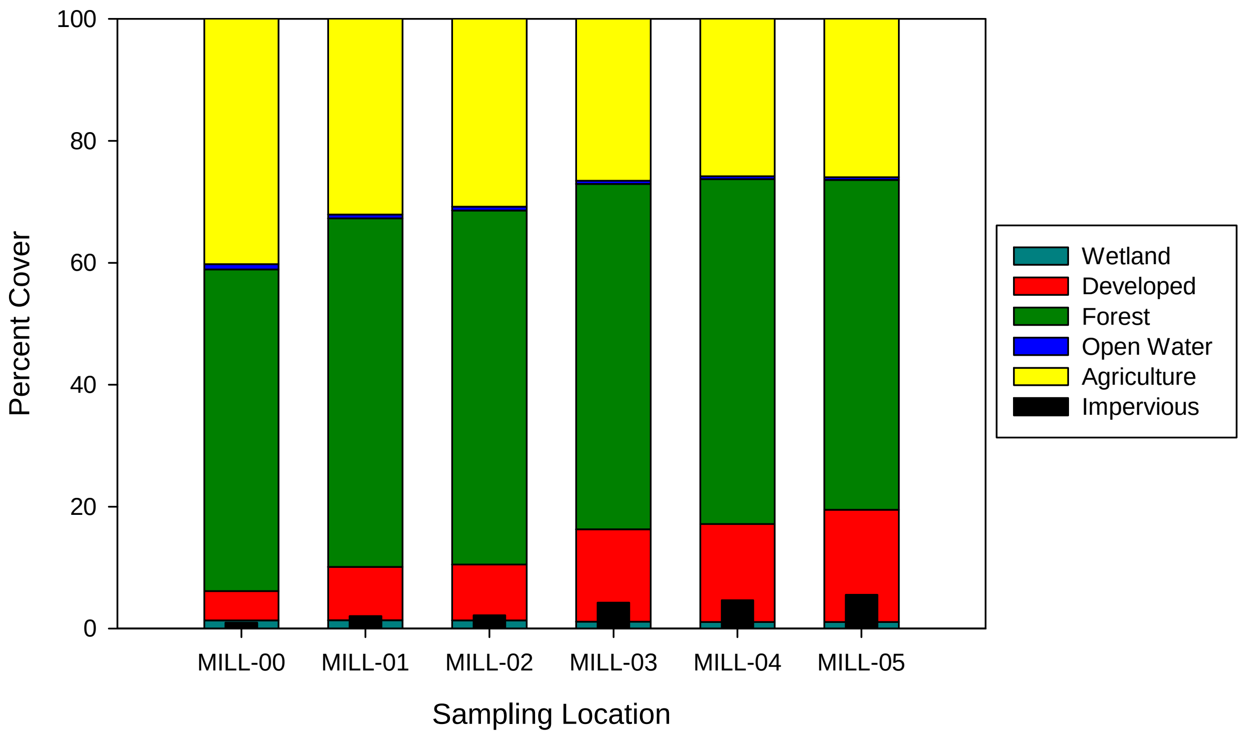


Figure 5. Nutrient Biotic Index Values for Phosphorus (NBI-P) and Nitrogen (NBI-N). NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. See Appendix X for a detailed explanation of the index.

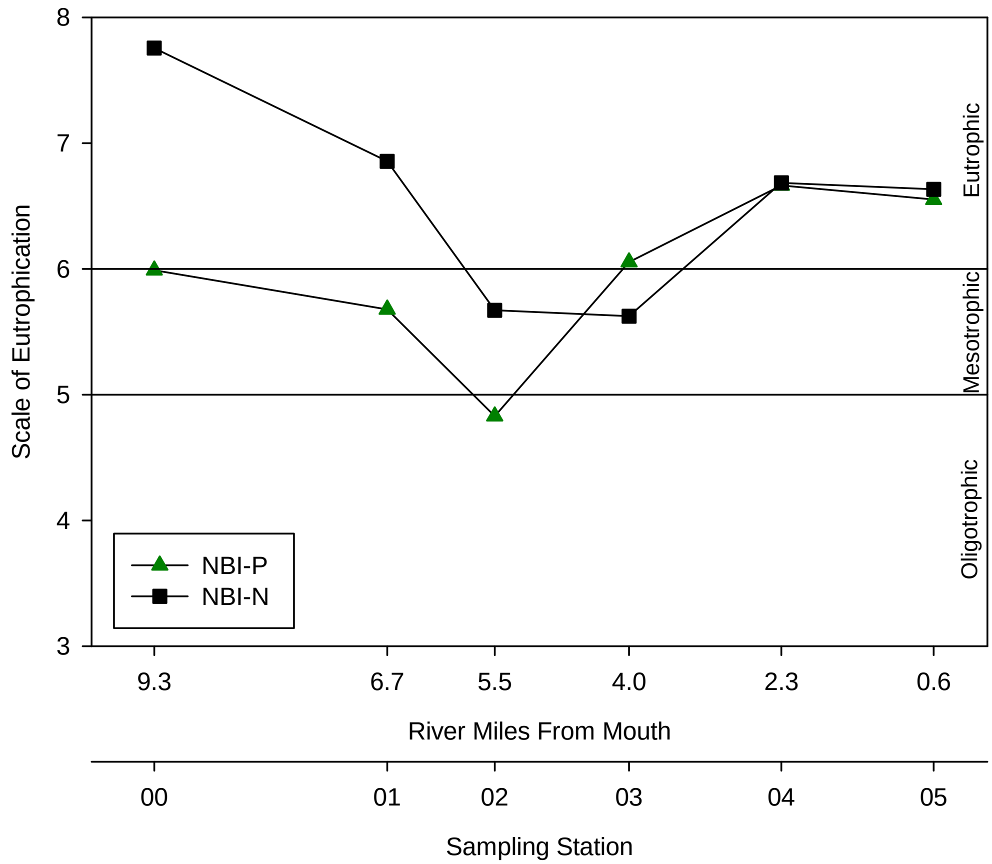


Figure 6. Periphyton and Silt-cover Index Scores for Mill Creek, 2008. See Appendix VIX for details.

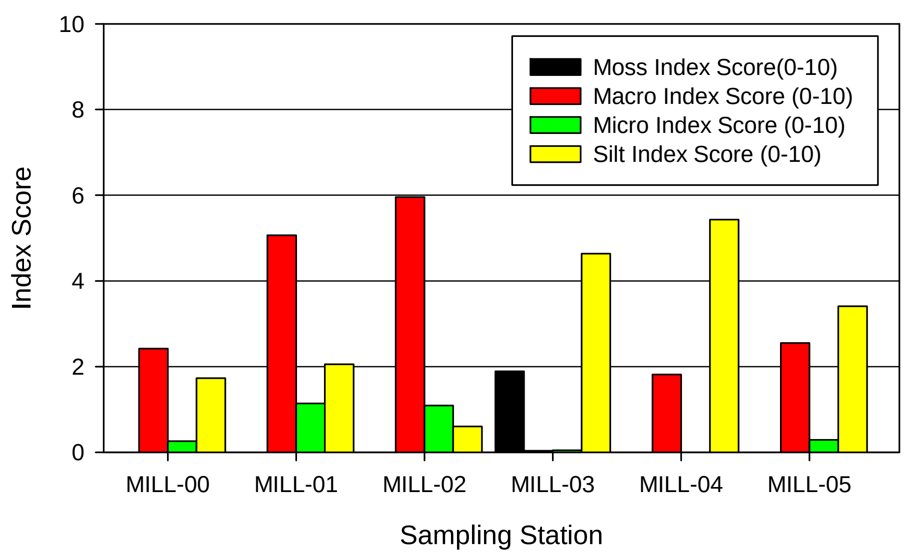


Table 4. Impact Source Determination (ISD), Mill Creek, 2008. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix XI for further explanation.

Community Type	MILL-00	MILL-01	MILL-02	MILL-03	MILL-04	MILL-05
Natural: minimal human disturbance	54	47	56	44	55	39
Nutrient Enrichment: mostly nonpoint, agricultural	54	48	54	46	63	60
Toxic: industrial, municipal, or urban run-off	35	26	31	38	45	60
Organic: sewage effluent, animal wastes	42	25	29	51	40	63
Complex: municipal/industrial	43	30	37	45	36	62
Siltation	43	33	47	45	42	53
Impoundment	51	31	35	52	52	60

Note: Many of the Mill Creek macroinvertebrate communities are similar to more than one impact model. Impact Source Determinations (ISD) are intended as supplemental data to macroinvertebrate community assessments.

Table 5. Macroinvertebrate Species Collected in Mill Creek, Rensselaer County, NY.

ANNELIDA
 OLIGOCHAETA
  Undetermined Oligochaeta

MOLLUSCA
 PELECYPODA
  VENEROIDEA
   Sphaeriidae
    Sphaerium sp.

ARTHROPODA
 CRUSTACEA
  AMPHIPODA
   Gammaridae
    Gammarus sp.

 INSECTA
  EPHEMEROPTERA
   Baetidae
    Baetis flavistriga
    Baetis intercalaris
    Baetis tricaudatus
   Heptageniidae
    Epeorus sp.
    Stenonema modestum
    Undetermined Heptageniidae
   Ephemerellidae
    Ephemerella sp.
    Serratella deficiens
    Serratella serrata
   Leptohyphidae
    Tricorythodes sp.

  ODONATA
   Aeshnidae
    Undetermined Aeshnidae

PLECOPTERA
 Perlidae
  Agnetina capitata
  Perlesta sp.

COLEOPTERA
 Psephenidae
  Psephenus herricki
 Elmidae
  Optioservus fastiditus
  Optioservus trivittatus
  Optioservus sp.
  Promoresia elegans
  Stenelmis crenata
  Stenelmis sp.

MEGALOPTERA
 Corydalidae
  Nigronia serricornis

TRICHOPTERA
 Philopotamidae
  Chimarra aterrima
  Dolophilodes sp.
 Psychomyiidae
  Psychomyia flavida
 Hydropsychidae
  Cheumatopsyche sp.
  Hydropsyche betteni
  Hydropsyche bronta
  Hydropsyche morosa
  Hydropsyche slossonae
  Hydropsyche sparna
 Rhyacophilidae
  Rhyacophila fuscula
 Brachycentridae
  Micrasema sp.
 Limnephilidae
  Undetermined Limnephilidae

DIPTERA
 Tipulidae
  Antocha sp.
  Dicranota sp.
  Hexatoma sp. 2
  Hexatoma sp.
  Tipula sp.
 Simuliidae
  Simulium tuberosum
  Simulium sp.
 Athericidae
  Atherix sp.
 Empididae
  Hemerodromia sp.
 Chironomidae
  Conchapelopia sp.
  Thienemannimyia gr. spp.
  Diamesa sp.
  Pagastia orthogonia
  Potthastia gaedii gr.
  Cricotopus bicinctus
  Cricotopus sp.
  Eukiefferiella sp.
  Orthocladius sp.
  Parachaetocladius sp.
  Parametriocnemus sp.
  Rheocricotopus robacki
  Tvetenia bavarica gr.
  Microtendipes pedellus gr.
  Microtendipes rydalensis gr.
  Nilothauma sp.
  Polypedilum aviceps
  Polypedilum flavum
  Polypedilum illinoense
  Micropsectra dives gr.
  Micropsectra sp.
  Rheotanytarsus exiguus gr.
  Rheotanytarsus pellucidus
  Rheotanytarsus sp.
  Tanytarsus sp.

Table 5a. Macroinvertebrate Data Report (MDR)

STREAM SITE: Mill Creek, Station 00
LOCATION: East Greenbush, NY
DATE: 7/10/2008
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis tricaudatus*	3
	Heptageniidae	*Epeorus sp.*	2
	Ephemerellidae	*Serratella deficiens*	1
	Leptohyphidae	*Tricorythodes sp.*	1
PLECOPTERA	Perlidae	*Agnetina capitata*	2
		Perlesta sp.	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	5
	Elmidae	*Optioservus fastiditus*	16
		Promoresia elegans	1
TRICHOPTERA	Philopotamidae	*Dolophilodes sp.*	7
	Hydropsychidae	*Hydropsyche betteni*	1
		Hydropsyche slossonae	23
		Hydropsyche sparna	10
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Limnephilidae	Undetermined Limnephilidae	1
DIPTERA	Tipulidae	*Antocha sp.*	1
		Dicranota sp.	2
		Hexatoma sp. 2	4
	Simuliidae	*Simulium tuberosum*	1
	Chironomidae	*Pagastia orthogonia*	1
		Cricotopus bicinctus	1
		Eukiefferiella sp.	1
		Parachaetocladius sp.	1
		Tvetenia bavarica gr.	2
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	3
		Micropsectra dives gr.	6
		SPECIES RICHNESS:	27
		BIOTIC INDEX:	3.71
		EPT RICHNESS:	12
		MODEL AFFINITY:	55
		ASSESSMENT:	Non

DESCRIPTION: This site supports a community that is diverse and largely intolerant of pollution. The elevated number of filter-feeding caddisflies is likely the result of a small impoundment upstream of the sampling site.

Table 5b.

STREAM SITE:	Mill Creek, Station 01		
LOCATION:	East Greenbush, NY		
DATE:	7/10/2008		
SAMPLE TYPE:	Kick		
SUBSAMPLE:	100 organisms		
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2
	Ephemerellidae	*Serratella serrata*	4
PLECOPTERA	Perlidae	*Perlesta sp.*	3
COLEOPTERA	Psephenidae	*Psephenus herricki*	9
	Elmidae	*Optioservus fastiditus*	17
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	1
		Hydropsyche bronta	6
		Hydropsyche slossonae	3
		Hydropsyche sparna	11
	Rhyacophilidae	*Rhyacophila fuscula*	1
DIPTERA	Tipulidae	*Dicranota sp.*	11
		Hexatoma sp.	4
		Tipula sp.	1
	Chironomidae	*Potthastia gaedii gr.*	1
		Cricotopus sp.	1
		Orthocladius sp.	2
		Parametriocnemus sp.	3
		Rheocricotopus robacki	2
		Polypedilum aviceps	14
		Polypedilum flavum	1
		Micropsectra sp.	2
		Rheotanytarsus sp.	1
		SPECIES RICHNESS:	22
		BIOTIC INDEX:	4.26
		EPT RICHNESS:	8
		MODEL AFFINITY:	59
		ASSESSMENT:	Slight

DESCRIPTION: EPT and species richness have decreased at this site with an increase in the Biotic Index, indicating some enrichment effects here.

Table 5c.

STREAM SITE:	Mill Creek, Station 02		
LOCATION:	East Greenbush, NY		
DATE:	7/10/2008		
SAMPLE TYPE:	Kick		
SUBSAMPLE:	100 organisms		
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	1
		Baetis intercalaris	7
		Baetis tricaudatus	1
	Heptageniidae	*Epeorus sp.*	1
		Undetermined Heptageniidae	2
	Ephemerellidae	*Serratella serrata*	16
	Leptohyphidae	*Tricorythodes sp.*	10
PLECOPTERA	Perlidae	*Perlesta sp.*	2
COLEOPTERA	Elmidae	*Optioservus fastiditus*	6
		Optioservus trivittatus	5
TRICHOPTERA	Hydropsychidae	*Hydropsyche betteni*	2
		Hydropsyche bronta	4
		Hydropsyche slossonae	1
		Hydropsyche sparna	15
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Brachycentridae	*Micrasema sp.*	1
DIPTERA	Tipulidae	*Dicranota sp.*	3
		Hexatoma sp.	3
	Simuliidae	*Simulium sp.*	1
	Chironomidae	*Potthastia gaedii gr.*	2
		Cricotopus bicinctus	2
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	9
		Rheotanytarsus exiguus gr.	2
		Tanytarsus sp.	2
		SPECIES RICHNESS:	25
		BIOTIC INDEX:	4.11
		EPT RICHNESS:	14
		MODEL AFFINITY:	85
		ASSESSMENT:	Non

DESCRIPTION: This site has recovered somewhat from upstream and may be due to improved habitat and less adjacent agriculture to add nutrients to the stream. This site shows the greatest biological integrity of the Mill Creek sites sampled.

Table 5d.

STREAM SITE:	Mill Creek, Station 03		
LOCATION:	East Greenbush, NY		
DATE:	7/10/2008		
SAMPLE TYPE:	Kick		
SUBSAMPLE:	100 organisms		
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	2
INSECTA			
EPHEMEROPTERA	Heptageniidae	*Stenonema modestum*	1
	Ephemerellidae	*Ephemerella sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	5
	Elmidae	*Optioservus sp.*	4
		Stenelmis crenata	12
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	6
		Hydropsyche betteni	5
		Hydropsyche bronta	3
		Hydropsyche morosa	3
		Hydropsyche sparna	7
DIPTERA	Tipulidae	*Antocha sp.*	1
		Dicranota sp.	1
	Athericidae	*Atherix sp.*	3
	Chironomidae	*Conchapelopia sp.*	2
		Diamesa sp.	1
		Parametriocnemus sp.	2
		Tvetenia bavarica gr.	1
		Microtendipes rydalensis gr.	1
		Polypedilum illinoense	1
		Micropsectra sp.	2
		Rheotanytarsus exiguus gr.	19
		Rheotanytarsus pellucidus	14
		Tanytarsus sp.	3
		SPECIES RICHNESS:	24
		BIOTIC INDEX:	5.15
		EPT RICHNESS:	7
		MODEL AFFINITY:	49
		ASSESSMENT:	Slight

DESCRIPTION: This site showed a significant spike in the Biotic Index score compared to the upstream site, along with a loss of EPT diversity. Pollution tolerant *Cheumatopsyche* sp. is beginning to increase in dominance as stressors increase below routes 4 and 90.

Table 5e.

STREAM SITE:	Mill Creek, Station 04
LOCATION:	East Greenbush, NY
DATE:	7/10/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Baetidae	*Baetis flavistriga*	1
		Baetis tricaudatus	1
ODONATA	Aeshnidae	Undetermined Aeshnidae	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	22
		Stenelmis crenata	28
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Psychomyiidae	*Psychomyia flavida*	1
	Hydropsychidae	*Cheumatopsyche sp.*	8
		Hydropsyche betteni	3
		Hydropsyche bronta	4
		Hydropsyche sparna	2
DIPTERA	Athericidae	*Atherix sp.*	5
	Chironomidae	*Thienemannimyia gr. spp.*	4
		Diamesa sp.	2
		Parametriocnemus sp.	2
		Microtendipes pedellus gr.	6
		Nilothauma sp.	1
		Rheotanytarsus exiguus gr.	5
		Rheotanytarsus pellucidus	2
		Tanytarsus sp.	1
		SPECIES RICHNESS:	20
		BIOTIC INDEX:	4.96
		EPT RICHNESS:	7
		MODEL AFFINITY:	49
		ASSESSMENT:	Slight

DESCRIPTION: The substrate at this site was largely bedrock, but sufficient moveable material was found to get a good kick sample. The macroinvertebrate community metrics at this site are very similar to those just upstream.

Table 5f.

STREAM SITE:	Mill Creek, Station 05
LOCATION:	Rensselaer, NY
DATE:	7/10/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA		Undetermined Oligochaeta	1
MOLLUSCA			
PELECYPODA			
VENEROIDEA	Sphaeriidae	*Sphaerium sp.*	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	3
		Baetis tricaudatus	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	3
	Elmidae	*Optioservus sp.*	6
		Stenelmis sp.	24
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*	2
	Hydropsychidae	*Cheumatopsyche sp.*	40
		Hydropsyche betteni	3
		Hydropsyche sparna	6
DIPTERA	Athericidae	*Atherix sp.*	1
	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Parametriocnemus sp.*	1
		Microtendipes pedellus gr.	5
		Polypedilum flavum	1
		Rheotanytarsus exiguus gr.	1
		SPECIES RICHNESS:	17
		BIOTIC INDEX:	5.1
		EPT RICHNESS:	6
		MODEL AFFINITY:	36
		ASSESSMENT:	Moderate

DESCRIPTION: This site was marked by turbid water, silt and gray algae on the rocks. Species and EPT richness are the lowest of the survey, with *Chuematopsyche* sp. dominating this community.

Table 6. Laboratory Data Summary, Mill Creek, Rensselaer County, NY, 2008.

LABORATORY DATA SUMMARY				
STREAM NAME: Mill Creek				
DATE SAMPLED: 7/10/2008				
SAMPLING METHOD: Kick				
LOCATION	MILL	MILL	MILL	MILL
STATION	00	01	02	03
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Hydropsyche slossonae 23 % intolerant caddisfly	Optioservus fastiditus 17 % intolerant beetle	Serratella serrata 16 % intolerant mayfly	Rheotanytarsus exiguus gr. 19 % facultative midge
Intolerant = not tolerant of poor water quality	2. Optioservus fastiditus 16 % intolerant beetle	Polypedilum aviceps 14 % facultative midge	Hydropsyche sparna 15 % facultative caddisfly	Rheotanytarsus pellucidus 14 % intolerant midge
Facultative = occurring over a wide range of water quality	3. Hydropsyche sparna 10 % facultative caddisfly	Hydropsyche sparna 11 % facultative caddisfly	Tricorythodes sp. 10 % intolerant mayfly	Stenelmis crenata 12 % facultative beetle
Tolerant = tolerant of poor water quality	4. Dolophilodes sp. 7 % intolerant caddisfly	Dicranota sp. 11 % intolerant crane fly	Polypedilum aviceps 9 % facultative midge	Hydropsyche sparna 7 % facultative caddisfly
	5. Micropsectra dives gr. 6 % intolerant midge	Psephenus herricki 9 % intolerant beetle	Baetis intercalaris 7 % facultative mayfly	Cheumatopsyche sp. 6 % facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	16 (8.0)	27 (9.0)	18 (6.0)	46 (10.0)
Trichoptera (caddisflies)	43 (6.0)	22 (5.0)	24 (6.0)	24 (5.0)
Ephemeroptera (mayflies)	7 (4.0)	6 (2.0)	38 (7.0)	2 (2.0)
Plecoptera (stoneflies)	4 (2.0)	3 (1.0)	2 (1.0)	0 (0.0)
Coleoptera (beetles)	22 (3.0)	26 (2.0)	11 (2.0)	21 (3.0)
Oligochaeta (worms)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mollusca (clams and snails)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.0)
Other insects (odonates, diptera)	8 (4.0)	16 (3.0)	7 (3.0)	5 (3.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	27	22	25	24
BIOTIC INDEX	3.71	4.26	4.11	5.15
EPT RICHNESS	12	8	14	7
PERCENT MODEL AFFINITY	55	59	85	49
FIELD ASSESSMENT	VG	VG		G
OVERALL ASSESSMENT	non-impacted	slightly impacted	non-impacted Not recorded	slightly impacted

Table 6. (cont'd) Laboratory data summary, Mill Creek, Rensselaer County, NY, 2008.

LABORATORY DATA SUMMARY				
STREAM NAME: Mill Creek				
DATE SAMPLED: 7/10/2008				
SAMPLING METHOD: Kick				
LOCATION	MILL	MILL		
STATION	04	05		
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Stenelmis crenata 28 % facultative beetle	Cheumatopsyche sp. 40 % facultative caddisfly		
Intolerant = not tolerant of poor water quality	2. Optioservus fastiditus 22 % intolerant beetle	Stenelmis sp. 24 % facultative beetle		
Facultative = occurring over a wide range of water quality	3. Cheumatopsyche sp. 8 % facultative caddisfly	Hydropsyche sparna 6 % facultative caddisfly		
Tolerant = tolerant of poor water quality	4. Microtendipes pedellus gr. 6 % facultative midge	Optioservus sp. 6 % intolerant beetle		
	5. Atherix sp. 5 % intolerant snipe fly	Microtendipes pedellus gr. 5 % facultative midge		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	23 (8.0)	8 (4.0)		
Trichoptera (caddisflies)	18 (5.0)	51 (4.0)		
Ephemeroptera (mayflies)	2 (2.0)	4 (2.0)		
Plecoptera (stoneflies)	0 (0.0)	0 (0.0)		
Coleoptera (beetles)	50 (2.0)	33 (3.0)		
Oligochaeta (worms)	0 (0.0)	1 (1.0)		
Mollusca (clams and snails)	0 (0.0)	1 (1.0)		
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)		
Other insects (odonates, diptera)	7 (3.0)	2 (2.0)		
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)		
SPECIES RICHNESS	20	17		
BIOTIC INDEX	4.96	5.1		
EPT RICHNESS	7	6		
PERCENT MODEL AFFINITY	49	36		
FIELD ASSESSMENT		G		
OVERALL ASSESSMENT	slightly impacted Not recorded	moderately impacted		

Table 7. Field Data Summary, Mill Creek, Rensselaer County, NY, 2008.

FIELD DATA SUMMARY				
STREAM NAME: Mill Creek	**DATE SAMPLED:** 7/10/2008			
REACH: Best Rd. to Rensselaer				
FIELD PERSONNEL INVOLVED: Duffy/Heitzman				
STATION	00	01	02	03
ARRIVAL TIME AT STATION	4:00	3:05	2:25	1:20
LOCATION	MILL	MILL	MILL	MILL
PHYSICAL CHARACTERISTICS				
Width (meters)	2.5	6	7	5
Depth (meters)	0.1	0.1	0.1	0.1
Current speed (cm per sec.)	100	71	91	83
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	5		10
Rubble (6.35 - 25.4 cm)	40	30	10	5
Gravel (0.2 - 6.35 cm)	44	30	50	3
Sand (0.06 - 2.0 mm)	5	15	30	2
Silt (0.004 - 0.06 mm)	1	20	10	
Embeddedness (%)	20	40	<10	25
CHEMICAL MEASUREMENTS				
Temperature (Celsius)	18.6	22.25	20.6	22.8
Specific Conductance (umhos)	249	329	357	360
Dissolved Oxygen (mg/l)	8.11	8.52	7.47	6.64
pH	7.94	8.68	8.03	7.93
BIOLOGICAL ATTRIBUTES				
Canopy (%)	75	50	50	90
Aquatic Vegetation				
Algae - suspended				
Algae - attached,filamentous	X	X	X	
Algae - diatoms	70	20		15
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	X
Megaloptera (dobsonflies, damselflies)	X			X
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)	X	X		
Decapoda (crayfish)				X
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)		X		
Other	X		X	X
FAUNAL CONDITION	VG	VG	Not recorded	G

Table 7. (cont'd) Field Data Summary, Mill Creek, Rensselaer County, NY, 2008.

FIELD DATA SUMMARY				
STREAM NAME: Mill Creek	**DATE SAMPLED:** 7/10/2008			
REACH: Best Rd. to Rensselaer				
FIELD PERSONNEL INVOLVED: Duffy/Heitzman				
STATION	04	05		
ARRIVAL TIME AT STATION	1:25	10:20		
LOCATION	MILL	MILL		
PHYSICAL CHARACTERISTICS				
Width (meters)	5	8		
Depth (meters)	0.1	0.2		
Current speed (cm per sec.)	83	91		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	70			
Rubble (6.35 - 25.4 cm)	10	20		
Gravel (0.2 - 6.35 cm)	10	40		
Sand (0.06 - 2.0 mm)		20		
Silt (0.004 - 0.06 mm)	10	20		
Embeddedness (%)	25	60		
CHEMICAL MEASUREMENTS				
Temperature (Celsius)	21.4	21.3		
Specific Conductance (umhos)	466	471		
Dissolved Oxygen (mg/l)	8.6	8.7		
pH	8.06	8.3		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	75	25		
Aquatic Vegetation				
Algae - suspended				
Algae - attached, filamentous	X	X		
Algae - diatoms		20		
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X	X		
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)	X	X		
Megaloptera (dobsonflies, damselflies)	X	X		
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X	X		
Simuliidae (black flies)				
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)		X		
Oligochaeta (worms)				
Other	X			
FAUNAL CONDITION	Not recorded	G		

Appendix I. Biological Methods for Kick Sampling

A. Rationale: The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection: Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel and sand; depth should be one meter or less, and current speed should be at least 0.4 meter per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling: Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that organisms are dislodged and carried into the net. Sampling is continued for a specified time and distance in the stream. Rapid assessment sampling specifies sampling for five minutes over a distance of five meters. The contents of the net are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling: In the laboratory, the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereomicroscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification: All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species and the total number of individuals in the subsample are recorded on a data sheet. All organisms from the subsample are archived (either slide-mounted or preserved in alcohol). If the results of the identification process are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

Appendix II. Macroinvertebrate Community Parameters

1. Species Richness: the total number of species or taxa found in a sample. For subsamples of 100-organisms each that are taken from kick samples, expected ranges in most New York State streams are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted, and less than 11, severely impacted.

2. EPT Richness: the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organisms subsample. These are considered to be clean-water organisms, and their presence is generally correlated with good water quality (Lenat, 1987). Expected assessment ranges from most New York State streams are: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted, and 0-1, severely impacted.

3. Hilsenhoff Biotic Index: a measure of the tolerance of organisms in a sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For the purpose of characterizing species tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Tolerance values are listed in Hilsenhoff (1987). Additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in Quality Assurance document, Bode et al. (2002). Impact ranges are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted, and 8.51-10.00, severely impacted.

4. Percent Model Affinity: a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percentage abundances in the model community are: 40% Ephemeroptera; 5% Plecoptera; 10% Trichoptera; 10% Coleoptera; 20% Chironomidae; 5% Oligochaeta; and 10% Other. Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted, and less than 35, severely impacted.

5. Nutrient Biotic Index: a measure of stream nutrient enrichment identified by macroinvertebrate taxa. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals with assigned tolerance values. Tolerance values ranging from intolerant (0) to tolerant (10) are based on nutrient optima for Total Phosphorus (listed in Smith, 2005). Impact ranges are: 0-5.00, non-impacted; 5.01-6.00, slightly impacted; 6.01-7.00, moderately impacted, and 7.01-10.00, severely impacted.

Appendix III. Levels of Water Quality Impact in Streams

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT richness, biotic index, and percent model affinity (see Appendix II). The consensus is based on the determination of the majority of the parameters. Since parameters measure different aspects of the macroinvertebrate community, they cannot be expected to always form unanimous assessments. The assessment ranges given for each parameter are based on subsamples of 100-organisms each that are taken from macroinvertebrate riffle kick samples. These assessments also apply to most multiplate samples, with the exception of percent model affinity.

1. *Non-impacted*: Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well represented; EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Nutrient Biotic Index is 5.00 or less. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

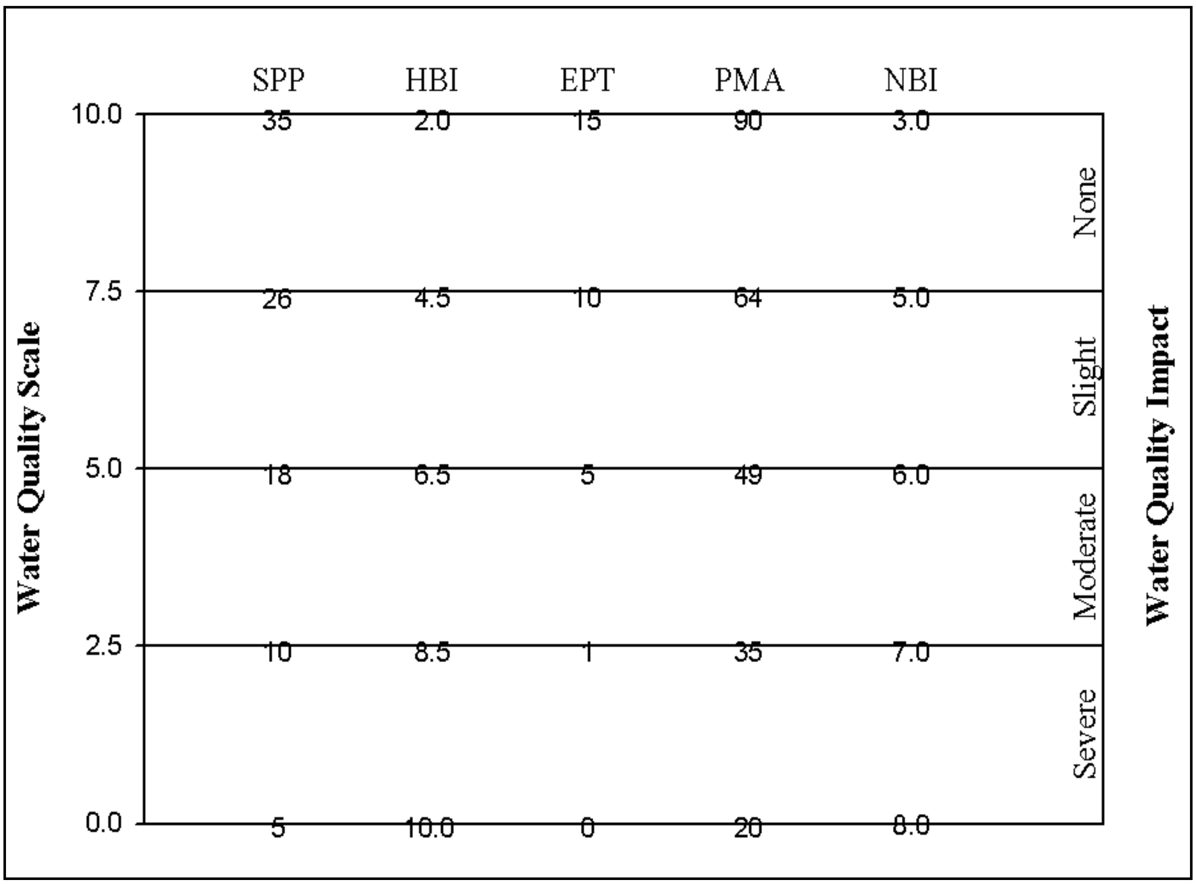
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Nutrient Biotic Index is 5.01-6.00. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. *Moderately impacted*: Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness is usually 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51-8.50. Percent model affinity is 35-49. Nutrient Biotic Index is 6.01-7.00. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. *Severely impacted*: Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or fewer. Mayflies, stoneflies and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. Nutrient Biotic Index is greater than 7.00. The dominant species are almost all tolerant, and are usually midges and worms. Often, 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Appendix IV-A. Biological Assessment Profile: Conversion of Index Values to a 10-Scale

The Biological Assessment Profile (BAP) of index values, developed by Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the five indices -- species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI)-- defined in Appendix II are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, et al., 2002), and as shown in the figure below.



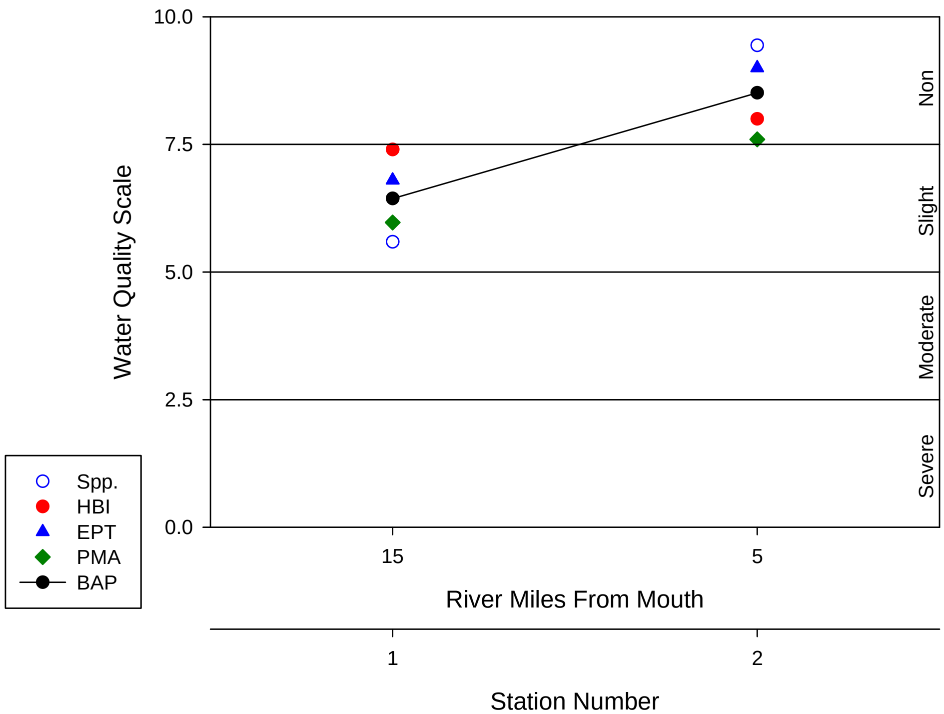
Appendix IV-B. Biological Assessment Profile: Plotting Values

To plot survey data:
1. Position each site on the x-axis according to miles or tenths of a mile upstream of the mouth.
2. Plot the values of the four indices for each site as indicated by the common scale.
3. Calculate the mean of the four values and plot the result. This represents the assessed impact for each site.

Example data:

	Station 1		Station 2	
	metric value	10-scale value	metric value	10-scale value
Species richness	20	5.59	33	9.44
Hilsenhoff Biotic Index	5.00	7.40	4.00	8.00
EPT richness	9	6.80	13	9.00
Percent Model Affinity	55	5.97	65	7.60
Average		6.44 (slight)		8.51 (non-)

Sample BAP plot:



Appendix V. Water Quality Assessment Criteria

Non-Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity*	Diversity **
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

* Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
** Diversity criteria are used for multiplate samples but not for traveling kick samples.

Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Species Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI. The Traveling Kick Sample

← current

Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters

Appendix VII-A. Aquatic Macroinvertebrates Usually Indicative of Good Water Quality

Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides and acidity. Most mayflies are found clinging to the undersides of rocks.

MAYFLIES

Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.

STONEFLIES

Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.

CADDISFLIES

The most common beetles in streams are riffle beetles (adult and larva pictured) and water pennies (not shown). Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

BEETLES

Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of Poor Water Quality

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called “bloodworms” indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.

MIDGES

Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.

BLACK FLIES

The segmented worms include the leeches and the small aquatic worms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.

WORMS

Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. They are classic indicators of sewage pollution, and can also thrive in toxic situations.

SOWBUGS

Digital images by Larry Abele, New York State Department of Environmental Conservation, Stream Biomonitoring Unit.

Appendix VIII. The Rationale of Biological Monitoring

Biological monitoring refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

Concept:
Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

Advantages:
The primary advantages to using macroinvertebrates as water quality indicators are that they:

- are sensitive to environmental impacts
- are less mobile than fish, and thus cannot avoid discharges
- can indicate effects of spills, intermittent discharges, and lapses in treatment
- are indicators of overall, integrated water quality, including synergistic effects
- are abundant in most streams and are relatively easy and inexpensive to sample
- are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
- are vital components of the aquatic ecosystem and important as a food source for fish
- are more readily perceived by the public as tangible indicators of water quality
- can often provide an on-site estimate of water quality
- can often be used to identify specific stresses or sources of impairment
- can be preserved and archived for decades, allowing for direct comparison of specimens
- bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

Limitations:
Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

Appendix IX. Glossary

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

Benthos: organisms occurring on or in the bottom substrate of a waterbody

Bioaccumulate: accumulate contaminants in the tissues of an organism

Biomonitoring: the use of biological indicators to measure water quality

Community: a group of populations of organisms interacting in a habitat

Drainage basin: an area in which all water drains to a particular waterbody; watershed

Electrofishing: sampling fish by using electric currents to temporarily immobilize them, allowing capture

EPT richness: the number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a sample or subsample

Eutrophic: high nutrient levels normally leading to excessive biological productivity

Facultative: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

Fauna: the animal life of a particular habitat

Impact: a change in the physical, chemical, or biological condition of a waterbody

Impairment: a detrimental effect caused by an impact

Index: a number, metric, or parameter derived from sample data used as a measure of water quality

Intolerant: unable to survive poor water quality

Longitudinal trends: upstream-downstream changes in water quality in a river or stream

Macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

Mesotrophic: intermediate nutrient levels (between oligotrophic and eutrophic) normally leading to moderate biological productivity

Multiplate: multiple-plate sampler, a type of artificial substrate sampler of aquatic macroinvertebrates

Non Chironomidae/Oligochaeta (NCO) richness: the number of taxa neither belonging to the family Chironomidae nor the subclass Oligochaeta in a sample or subsample

Oligotrophic: low nutrient levels normally leading to unproductive biological conditions

Organism: a living individual

PAHs: Polycyclic Aromatic Hydrocarbons, a class of organic compounds that are often toxic or carcinogenic.

Rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around time; usually involves kick sampling and laboratory subsampling of the sample

Riffle: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

Species richness: the number of macroinvertebrate taxa in a sample or subsample

Station: a sampling site on a waterbody

Survey: a set of samplings conducted in succession along a stretch of stream

Synergistic effect: an effect produced by the combination of two factors that is greater than the sum of the two factors

Tolerant: able to survive poor water quality

Trophic: referring to productivity

Appendix X. Methods for Calculation of the Nutrient Biotic Index

Definition: The Nutrient Biotic Index (Smith et al., 2007) is a diagnostic measure of stream nutrient enrichment identified by macroinvertebrate taxa. The frequency of occurrences of taxa at varying nutrient concentrations allowed the identification of taxon-specific nutrient optima using a method of weighted averaging. The establishment of nutrient optima is possible based on the observation that most species exhibit unimodal response curves in relation to environmental variables (Jongman et al., 1987). The assignment of tolerance values to taxa based on their nutrient optimum provided the ability to reduce macroinvertebrate community data to a linear scale of eutrophication from oligotrophic to eutrophic. Two tolerance values were assigned to each taxon, one for total phosphorus, and one for nitrate (listed in Smith, 2005). This provides the ability to calculate two different nutrient biotic indices, one for total phosphorus (NBI-P), and one for nitrate (NBI-N). Study of the indices indicates better performance by the NBI-P, with strong correlations to stream nutrient status assessment based on diatom information.

Calculation of the NBI-P and NBI-N: Calculation of the indices [2] follows the approach of Hilsenhoff (1987).

$$\text{NBI Score}_{(\text{TP or NO3}^-)} = \sum (a \times b) / c$$

Where ***a*** is equal to the number of individuals for each taxon, ***b*** is the taxon's tolerance value, and ***c*** is the total number of individuals in the sample for which tolerance values have been assigned.

Classification of NBI Scores: NBI scores have been placed on a scale of eutrophication with provisional boundaries between stream trophic status.

Index	Oligotrophic	Mesotrophic	Eutrophic
NBI-P	< 5.0	> 5.0 - 6.0	> 6.0
NBI-N	< 4.5	> 4.5 - 6.0	> 6.0

Jongman, R. H. G., C. J. F. ter Braak and O. F. R. van Tongeren. 1987. Data analysis in community and landscape ecology. Pudoc Wageningen, Netherlands, 299 pages.

Smith, A.J., R. W. Bode, and G. S. Kleppel. 2007. A nutrient biotic index for use with benthic macroinvertebrate communities. Ecological Indicators 7(200):371-386.

Tolerance values assigned to taxa for calculation of the Nutrient Biotic Indices

TAXON	TP T-Value	NO3 T-Value
Acentrella sp.	5	5
Acerpenna pygmaea	0	4
Acroneuria abnormis	0	0
Acroneuria sp.	0	0
Agnetina capitata	3	6
Anthopotamus sp.	4	5
Antocha sp.	8	6
Apatania sp.	3	4
Atherix sp.	8	5
Baetis brunneicolor	1	5
Baetis flavistriga	7	7
Baetis intercalaris	6	5
Baetis sp.	6	3
Baetis tricaudatus	8	9
Brachycentrus appalachia	3	4
Caecidotea racovitzai	6	2
Caecidotea sp.	7	9
Caenis sp.	3	3
Cardiocladius obscurus	8	6
Cheumatopsyche sp.	6	6
Chimarra aterrima?	2	3
Chimarra obscura	6	4
Chimarra socia	4	1
Chimarra sp.	2	0
Chironomus sp.	9	6
Cladotanytarsus sp.	6	4
Corydalus cornutus	2	2
Cricotopus bicinctus	7	6
Cricotopus tremulus gr.	8	9
Cricotopus trifascia gr.	9	9
Cricotopus vierriensis	6	5
Cryptochironomus fulvus gr.	5	6
Diamesa sp.	10	10
Dicranota sp.	5	10
Dicrotendipes neomodestus	10	4
Dolophilodes sp.	4	3
Drunella cornutella	4	4
Ectopria nervosa	10	9
Epeorus (Iron) sp.	0	0
Ephemerella sp.	4	4
Ephemerella subvaria	4	1
Ephoron leukon?	1	1
Eukiefferiella devonica gr.	9	9
Ferrissia sp.	9	5
Gammarus sp.	8	9
Glossosoma sp.	6	0
Goniobasis livescens	10	10
Helicopsyche borealis	1	2
Hemerodromia sp.	5	6
Heptagenia sp.	0	0
Hexatoma sp.	0	1
Hydropsyche betteni	7	9
Hydropsyche bronta	7	6
Hydropsyche morosa	5	1
Hydropsyche scalaris	3	3

TAXON	TP T-Value	NO3 T-Value
Hydropsyche slossonae	6	10
Hydropsyche sp.	5	4
Hydropsyche sparna	6	7
Hydroptila consimilis	9	10
Hydroptila sp.	6	6
Hydroptila spatulata	9	8
Isonychia bicolor	5	2
Lepidostoma sp.	2	0
Leucotrichia sp.	6	2
Leucrocuta sp.	1	3
Macrostemum carolina	7	2
Macrostemum sp.	4	2
Micrasema sp. 1	1	0
Micropsectra dives gr.	6	9
Micropsectra polita	0	7
Micropsectra sp.	3	1
Microtendipes pedellus gr.	7	7
Microtendipes rydalensis gr.	2	1
Nais variabilis	5	0
Neoperla sp.	5	5
Neureclipsis sp.	3	1
Nigronia serricornis	10	8
Nixe (Nixe) sp.	1	5
Ophiogomphus sp.	1	3
Optioservus fastiditus	6	7
Optioservus ovalis	9	4
Optioservus sp.	7	8
Optioservus trivittatus	7	6
Orthocladius nr. dentifer	3	7
Pagastia orthogonia	4	8
Paragnetina immarginata	1	2
Paragnetina media	6	3
Paragnetina sp.	1	6
Paraleptophlebia mollis	2	1
Paraleptophlebia sp.	2	3
Parametriocnemus lundbecki	8	10
Paratanytarsus confusus	5	8
Pentaneura sp.	0	1
Petrophila sp.	5	3
Phaenopsectra dyari?	4	5
Physella sp.	8	7
Pisidium sp.	8	10
Plauditus sp.	2	6
Polycentropus sp.	4	2
Polypedilum aviceps	5	7
Polypedilum flavum	9	7
Polypedilum illinoense	10	7
Polypedilum laetum	7	6
Polypedilum scalaenum gr.	10	6
Potthastia gaedii gr.	9	10
Promoresia elegans	10	10
Prostoma graecense	2	7
Psephenus herricki	10	9
Psephenus sp.	3	4

NBI tolerance values (cont'd)

TAXON	TP T-Value	NO3 T-Value
Psychomyia flavida	1	0
Rheocricotopus robacki	4	4
Rheotanytarsus exiguus gr.	6	5
Rheotanytarsus pellucidus	3	2
Rhithrogena sp.	0	1
Rhyacophila fuscula	2	5
Rhyacophila sp.	0	1
Serratella deficiens	5	2
Serratella serrata	1	0
Serratella serratoides	0	1
Serratella sp.	1	1
Sialis sp.	5	6
Simulium jenningsi	6	2
Simulium sp.	7	6
Simulium tuberosum	1	0
Simulium vittatum	7	10
Sphaerium sp.	9	4
Stenacron interpunctatum	7	7
Stenelmis concinna	5	0
Stenelmis crenata	7	7
Stenelmis sp.	7	7
Stenochironomus sp.	4	3
Stenonema mediopunctatum	3	3
Stenonema modestum	2	5
Stenonema sp.	5	5
Stenonema terminatum	2	3
Stenonema vicarium	6	7
Stylaria lacustris	5	2
Sublettea coffmani	3	5

TAXON	TP T-Value	NO3 T-Value
Synorthocladius nr. semivirens	6	9
Tanytarsus glabrescens gr.	5	6
Tanytarsus guerlus gr.	5	5
Thienemannimyia gr. spp.	8	8
Tipula sp.	10	10
Tricorythodes sp.	4	9
Tvetenia bavarica gr.	9	10
Tvetenia vitracies	7	6
Undet. Tubificidae w/ cap. setae	10	8
Undet. Tubificidae w/o cap. setae	7	7
Undetermined Cambaridae	6	5
Undet. Ceratopogonidae	8	9
Undet. Enchytraeidae	7	8
Undet. Ephemerellidae	3	6
Undetermined Gomphidae	2	0
Undet. Heptageniidae	5	2
Undetermined Hirudinea	9	10
Undetermined Hydrobiidae	6	7
Undetermined Hydroptilidae	5	2
Undet. Limnephilidae	3	4
Undet. Lumbricina	8	8
Undet. Lumbriculidae	5	6
Undetermined Perlidae	5	7
Undetermined Sphaeriidae	10	8
Undetermined Turbellaria	8	6
Zavrelia sp.	9	9

Appendix XI. Impact Source Determination Methods and Community Models

Definition: Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. ISD uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods: The method found to be most useful in differentiating impacts in New York State streams was the use of community types based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural nonpoint, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group, four clusters were identified. Each cluster was usually composed of 4-5 sites with high biological similarity. From each cluster, a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for ISD (see tables following). The method was tested by calculating percent similarity to all the models and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

Use of the ISD methods: Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural," lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified. If no model exhibits a similarity to the test data of greater than 50 percent, the determination is inconclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations: These methods were developed for data derived from subsamples of 100-organisms each that are taken from traveling kick samples of New York State streams. Application of these methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

ISD Models

	NATURAL												
	A	B	C	D	E	F	G	H	I	J	K	L	M
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	5	-	5	-	5	5	-	-	-	5	5
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia	5	5	-	5	20	-	-	-	-	-	-	-	-
BAETIDAE	20	10	10	10	10	5	10	10	10	10	5	15	40
HEPTAGENIIDAE	5	10	5	20	10	5	5	5	5	10	10	5	5
LEPTOPHLEBIIDAE	5	5	-	-	-	-	-	-	5	-	-	25	5
EPHEMERELLIDAE	5	5	5	10	-	10	10	30	-	5	-	10	5
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
Psephenus	5	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	5	-	20	5	5	-	5	5	5	5	-	-	-
Promoresia	5	-	-	-	-	-	25	-	-	-	-	-	-
Stenelmis	10	5	10	10	5	-	-	-	10	-	-	-	5
PHILOPOTAMIDAE	5	20	5	5	5	5	5	-	5	5	5	5	5
HYDROPSYCHIDAE	10	5	15	15	10	10	5	5	10	15	5	5	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	5	5	-	-	-	20	-	5	5	5	5	5	-
SIMULIIDAE	-	-	-	5	5	-	-	-	-	5	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	5	-	-	10	-	-	5	-	-	5	5	5
Eukiefferiella/ Tvetenia	5	5	10	-	-	5	5	5	-	5	-	5	5
Parametriocnemus	-	-	-	-	-	-	-	5	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	20	-	-	10	20	20	5	-
Polypedilum (all others)	5	5	5	5	5	-	5	5	-	-	-	-	-
Tanytarsini	-	5	10	5	5	20	10	10	10	10	40	5	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

ISD Models (cont'd)

	NONPOINT NUTRIENTS, PESTICIDES									
	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
Isonychia	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
Caenis/Tricorythodes	-	-	-	-	5	-	-	5	-	5
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	5	-	-	5	-	5	5	-	-	-
Optioservus	10	-	-	5	-	-	15	5	-	5
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	15	-	10	15	5	25	5	10	5
PHILOPOTAMIDAE	15	5	10	5	-	25	5	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-
Simulium vittatum	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	10	15	10	5	-	-	-	-	5	5
Eukiefferiella/ Tvetenia	-	15	10	5	-	-	-	-	5	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Microtendipes	-	-	-	-	-	-	-	-	-	20
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	20	10	5	10	5	5
Tanytarsini	10	10	10	5	20	5	5	10	-	10
TOTAL	100	100	100	100	100	100	100	100	100	100

ISD Models (cont'd)

	MUNICIPAL/INDUSTRIAL								TOXIC					
	A	B	C	D	E	F	G	H	A	B	C	D	E	F
PLATYHELMINTHES	-	40	-	-	-	5	-	-	-	-	-	-	5	-
OLIGOCHAETA	20	20	70	10	-	20	-	-	-	10	20	5	5	15
HIRUDINEA	-	5	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	5	-	-	-	5	-	-	-	5
SPHAERIIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	10	5	10	10	15	5	-	-	10	10	-	20	10	5
GAMMARIDAE	40	-	-	-	15	-	5	5	5	-	-	-	5	5
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10	10	15	10	20	-	-	5
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	-	-	10	5	-	5	5	10	15	-	40	35	5
PHILOPOTAMIDAE	-	-	-	-	-	-	-	40	10	-	-	-	-	-
HYDROPSYCHIDAE	10	-	-	50	20	-	40	20	20	10	15	10	35	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	25
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	10	20	-	5	10	5	5	15	10	25	10	5	10
Eukiefferiella/ Tvetenia	-	-	-	-	-	-	-	-	-	-	20	10	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	-	-	-	10	20	40	10	5	10	-	-	-	-	5
Tanytarsini	-	-	-	10	10	-	5	-	-	-	-	-	-	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

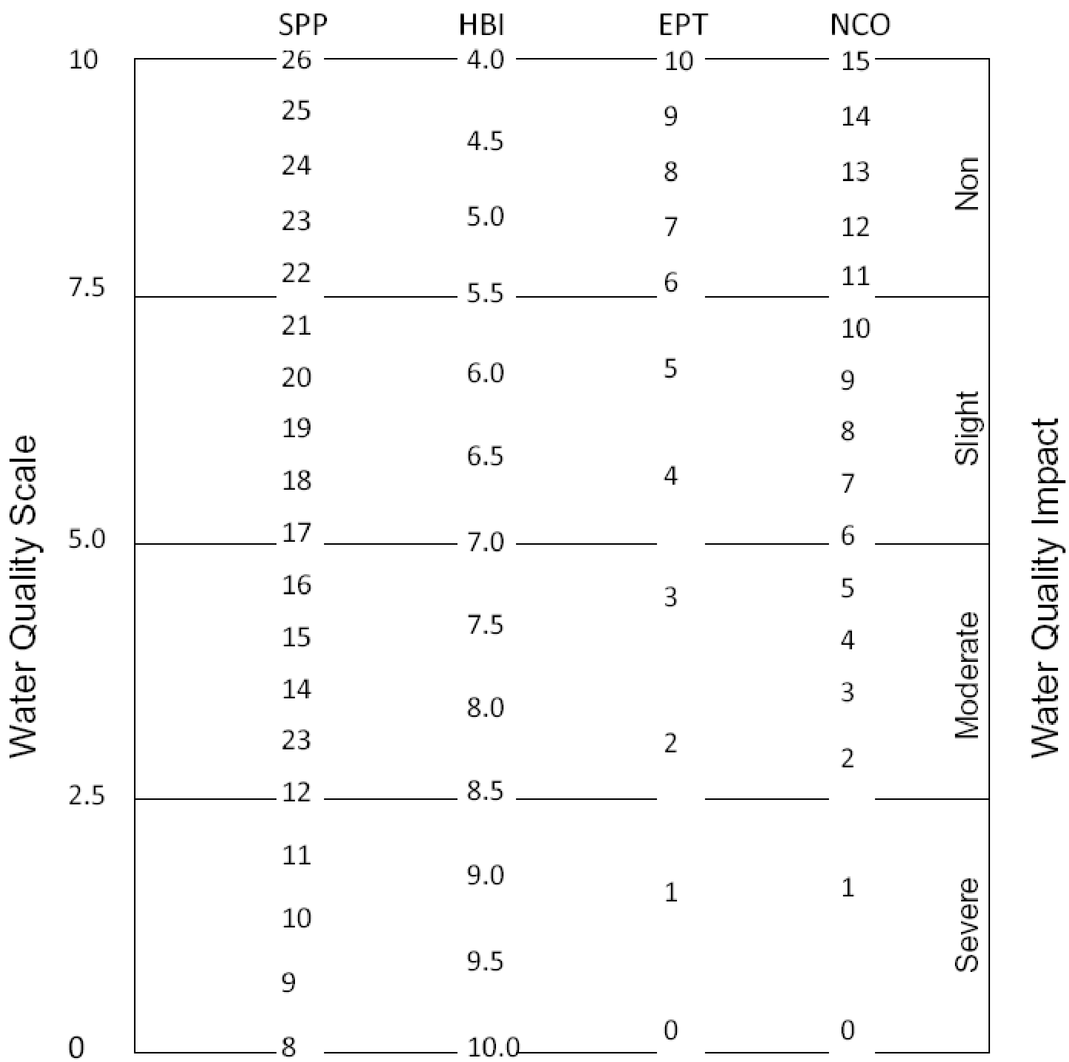
ISD Models (cont'd)

	SEWAGE EFFLUENT, ANIMAL WASTES									
	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

ISD Models (cont'd)

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Optioservus	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
Eukiefferiella/ Tvetenia	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix XII. Biological Assessment Profile of Slow, Sandy Streams.



The Biological Assessment Profile of index values is a method of plotting biological index values on a common scale of water quality impact. For kick-net samples from slow, sandy streams, these indices are used: SPP (species richness), HBI (Hilsenhoff Biotic Index), Ephemeroptera, Plecoptera, and Trichoptera (EPT richness), and non Chironomidae/Oligochaeta (NCO richness). Values from the four indices are converted to a common 0-10 scale as shown in this figure. The mean scale value of the four indices represents the assessed impact for each site.

Appendix XIII. Biological Impacts of Waters with High Conductivity

Definition: Conductivity is a measure of the ability of an aqueous solution to carry an electric current. It may be used to estimate salinity, total dissolved solids (TDS), and chlorides. Salinity is the amount of dissolved salts in a given amount of solution. TDS, although not precisely equivalent to salinity, is closely related, and for most purposes can be considered synonymous. EPA has not established ambient water-quality criteria for salinity; for drinking water, maximum contaminant levels are 250 mg/L for chlorides, and 500 mg/L for dissolved solids (EPA, 1995).

Measurement: Conductivity is measured as resistance and is reported in micromhos per centimeter (µmhos/cm), which is equivalent to microsiemens per centimeter (µS/cm). To estimate TDS and salinity, multiply conductivity by 0.64 and express the result in parts per million. For marine waters, salinity is usually expressed in parts per thousand. To estimate chlorides, multiply conductivity by 0.21 and express the result in parts per million. Departures from these estimates can occur when elevated conductivity is a result of natural conditions, such as in situations of high alkalinity (bicarbonates), or sulfates.

Effects on macroinvertebrates: Bioassays on test animals found the toxicity threshold for *Daphnia magna* to be 6-10 parts per thousand salinity (6000-10,000 mg/L) (Ingersoll et al., 1992). Levels of concern for this species were set at 0.3-6 parts per thousand salinity (300-6000 mg/L) (U.S. Dept. of Interior, 1998).

Stream Biomonitoring findings: Of 22 New York State streams sampled with specific conductance levels exceeding 800 µmhos/cm, 9% were assessed as severely impacted, 50% were assessed as moderately impacted, 32% were assessed as slightly impacted, and 9% were assessed as non-impacted. Many of the benthic communities in the impacted streams were dominated by oligochaetes, midges, and crustaceans (scuds and sowbugs). Thirty-five percent of the streams were considered to derive their high conductance primarily from natural sources, while the remainder were the result of contributions from point and nonpoint anthropogenic (human caused) sources. For nearly all streams with high conductivity, other contaminants are contained in the water column, making it difficult to isolate effects of high conductance.

Recommendations**:** Conductivity may be best used as an indicator of elevated amounts of anthropogenic-source contaminants. Based on findings that the median impact at sites with specific conductance levels exceeding 800 µmhos/cm is moderate impact, 800 µmhos/cm is designated as a level of concern with expected biological impairments. Eight-hundred umhos/cm corresponds to ~170 mg/L chlorides, ~510 parts per million Total Dissolved Solids, and ~0.51 parts per thousand salinity.

References:

US Dept. of Interior. 1998. Guidelines for interpretation of the biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Program Information Report No. 3.

Ingersoll, C.G., F.J. Dwyer, S.A. Burch, M.K. Nelson, D.R. Buckler, and J.B. Hunn. 1992. The use of freshwater and saltwater animals to distinguish between the toxic effects of salinity and contaminants in irrigation drain water. *Environmental Toxicology and Chemistry*, 11:503-511.

U.S. EPA. 995. Drinking water regulations and health advisories. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., 11 pages.

Appendix XIV. Pebble Count and Periphyton/Silt Cover Index

Pebble Count

This method is used to describe the substrate particle size classes within the "riffle" habitat of high gradient stream types that are targeted by the NYSDEC for macroinvertebrate community assessments. The method is based on the more rigorous technique developed by Wolmen (1954) to describe coarse river bed materials, and modifications of this technique developed by the Forest Service to describe channel bed materials within stream reaches Bevenger and King (1995).

1. A minimum of 100 particles are to be recorded on a tally sheet.

2. Diagonal transects across the stream are paced off until a minimum 100 count is reached. Transects begin at the lower end of the wetted portion of the stream bed within the macroinvertebrate sampling section or riffle. A pebble is selected as described in step 3; every two paces in streams > 20m across, or every pace in streams < 20m across.

3. With eyes closed, a pebble is randomly selected from the bottom. The pebble is then categorized by its particle size. Size categories were initially based on Wentworth's size classes, which were then lumped into larger biologically based size classes used by the NYSDEC to describe substrate composition. The NYSDEC size categories are: Sand < 2mm (.08"), Gravel 2-16mm (.08-2.5"), Course Gravel 16-64mm (.63-2.5"), Cobble 64-256mm (2.5-10.1"), Boulder > 256mm (>10.1").

4. Size categories are determined by using a gravelometer, essentially a metal plate with squares of the above size classes cut out. The particle must be placed thru the smallest cut out so that the intermediate axis is perpendicular to the sides (not diagonally across) of the cut out. The smallest size class which the pebble falls through is called out to a recorder, who keeps track of the tally until the 100-particle minimum is reached, at which time the transect is completed.

Characterize the amount of moss, macro-algae, micro-algae, and silt cover separately. If substrates are less than 2 cm in diameter, do not tally an entry, but measure the substrate size with the gravelometer as described previously. Record moss and macro-algae cover using a scale from 0-3 with separate estimates for each, where:

0 = no moss or macro-algae present;
1 = some moss or macro-algae present, but < 5% coverage;
2 = 5-25% cover of substratum by moss or macro-algae, and
3 = > 25% cover of substratum by moss or macro-algae.

Appendix XIV. cont'd.

Estimate average thickness of micro-algae (periphyton) on the rock with a 0-6 thickness scale, where:

0 = substrate is rough with no apparent growth;
1 = substrate is slimy, but biofilm is not visible (tracks cannot be drawn in the film with the back of your fingernail; endolithic algae can appear green but will not scratch easily from the substratum);
2 = a thin layer of microalgae is visible (tracks can be drawn in the film with the back of your fingernail);
3 = accumulation of microalgae to a thickness of 0.5-1 mm;
4 = accumulation of microalgae from 1-5 mm thick;
5 = accumulation of microalgae from 5-20 mm;
6 = layer of microalgae is > 20 mm.

(Note that if substrate is too large to pickup, algal growth should still be characterized.)

Weighted Periphyton and Silt Index Calculation (PI) (0-10)

Moss and Macro Algae percent cover
= ((%Cat. 0*0) + (%Cat. 1*2) + (%Cat. 2*6) + (%Cat. 3*10))/100

Micro Algae Thickness
= ((%Cat. 0*0)+(%Cat. 1*5)+(%Cat. 2*2)+(%Cat. 3*4)+(%Cat. 4*7)+(%Cat. 5*10))/100

Silt Cover Index
= (%Cat0*0)+(%Cat1*3)+(%Cat2*6)+(%Cat3*8)+(%Cat4*10)

Percentile analyses for periphyton and silt index scores in NYS.

	Percentiles			
Index	25th	50th	75th	90th
Moss	0	0	0	0.34
Macro-aglae	0.85	2.63	5.96	7.98
Micro-algae	0.44	0.50	0.83	1.55
Silt Cover	0.60	1.89	3.63	4.45

Bevenger, G. S. and R. M. King (1995). A pebble count procedure for assessing watershed cumulative effects. Research paper RM (USA).

Wolman, M. G. (1954). A method of sampling coarse river-bed material. *Transactions of the American Geophysical Union*, 35(6): 951-956.