New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Normans Kill

Biological Assessment

2009 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Normans Kill
Schenectady County, New York
Hudson River Basin

Survey date: July 8, 2009
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Stream: Normans Kill

River Basin: Hudson

Reach: Duanesburg

Background

The Stream Biomonitoring Unit sampled two locations on the Normans Kill, in Duanesburg, Schenectady County, New York, on July 8, 2009. Sampling was conducted to evaluate the effects of a landfill groundwater seep on aquatic life in the main stem of the Normans Kill. The survey was performed at the request of the New York State Department of Environmental Conservation (NYSDEC) Region 4 office.

Benthic macroinvertebrate communities were used to characterize water quality and determine if biological impairment of aquatic communities occurred in the Normans Kill downstream of the Duanesburg landfill groundwater seep. Biological impairment criteria (Bode et al., 1990) were evaluated. Four replicate traveling-kick samples were collected from riffle areas at each of two sites. Details on the methods used are described in the Quality Assurance document (Bode et al., 2002), the Biological Impairment Criteria document (Bode et al., 1990) 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 a 100-specimen subsample 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). The amount of expected variability of results is stated in Smith and Bode (2004). Table 1 provides a listing of sampling sites, and Table 5 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions

1. Biological impairment in the Normans Kill was not indicated downstream of the Duanesburg landfill groundwater seep.

2. Water quality above and below the Duanesburg landfill groundwater seep was assessed as non-impacted. Invertebrate communities were diverse and indicated natural conditions.

Discussion

Between the months of September and November 2008, a local, volunteer water-quality monitoring organization, the Environmental Study Team (EST) of the Schoharie River Center, conducted a stream assessment of the Normans Kill in the area of Duanesburg, NY. Their report titled "Bio-Assessment of the Normanskill Creek Relative to the Duanesburg Sanitary Landfill" (EST 2008) summarized their findings.

The objective of their study was to, "*ascertain the impact that a discharge point from an unused landfill might be having on the Normans Kill*" (EST 2008). On two different days, water chemistry, bacteria and benthic macroinvertebrate samples were collected for analysis by EST. Four locations, three on the river and one right at the landfill discharge point, were sampled. The station furthest upstream was sampled on 11/2/2008. The remaining three stations were sampled on 9/7/2008. Water chemistries and bacteria were sampled at each station. Benthic macroinvertebrates were sampled only at the furthest upstream and downstream locations. The report concluded, "*The presence of the discharge site coming from the town dump negatively impacts the overall water quality of the stream.*"

A thorough review of EST's report (see Appendix XII) was conducted by NYSDEC's Stream Biomonitoring Unit (SBU), at which time it became clear that additional sampling was needed to clarify the findings of the report. As a result, SBU conducted its own sampling to determine water quality. Due to the need for a greater degree of accuracy in water quality surveys such as this, where a specific discharge point is suspected of causing stream impairment, SBU employs Biological Impairment Criteria (Bode et al., 1990). This form of sampling seeks to measure possible impairment of aquatic life by comparing indices of community structure and function at two locations: one upstream of the discharge point suspected of causing impairment and the other downstream of it. If significantly detrimental biological change occurs from the upstream to the downstream site, impairment is indicated. Replicated sampling is used at each location to increase the rigor of these comparisons (Bode et al., 1990).

On July 8, 2009, SBU collected four replicate travelling-kick samples at each of two sites on the Normans Kill (Table 1, Figure 1). The sites were upstream and downstream of the suspected discharge point, which we will refer to as the "landfill groundwater seep" (Figure 1). Sampling locations were selected to maximize the similarity of their in-stream and riparian habitat characteristics. In particular, substrate Phi-units (Bode et al., 1990) were calculated and used to determine the degree of similarity between the two sites. The difference between the Phi values of the sites must be within 3 Phi-units for proper comparison. Phi values were -6.4 (upstream) and -6.51 (downstream); a difference of only 0.11 Phi-units, which is well within the allowed range. In addition, habitat assessment scores were 95% similar between the two sites. This data suggests that both sampling locations were similar in their physical characteristics and, therefore, adequate for use in evaluating Biological Impairment Criteria above and below the landfill groundwater seep.

In order to determine biological impairment, three of the four replicate samples were subsampled in the lab, selecting 100 organisms for each subsample, and then compared using Bray-Curtis similarity analysis. In this case, raw taxonomic information was used from each site's subsamples. Results of this survey found all replicate pairings from each site were greater than 50% similar for the first three replicates subsampled (Figure 2, Table 2). Therefore, analysis of impairment was able to continue without further subsampling or processing the fourth replicate. For more details about these methods, see Bode et al. (1990).

Individual biological community metrics were averaged from the three replicates and the mean values were used to evaluate provisional impairment levels between sites. The criteria evaluated were: Hilsenhoff's Biotic Index (HBI) +1.5; Ephemeroptera, Plecoptera, Trichoptera

Richness (EPT) -4; Species Richness (Spp) -8; Species Dominance (Dom) +15; Percent Model Affinity (PMA) -20.

None of the criteria were violated when mean results from the downstream site were compared to those of the upstream site (Figure 3, Table 3). This indicates that no water-quality impairment occurred in the Normans Kill due to the landfill groundwater seep. As a result, no further analyses were required (See Bode et al., 1990 for details).

In addition to evaluating this set of criteria, a final water-quality assessment was determined using the three replicates to calculate mean Biological Assessment Profile Scores (Appendix IV-A and B) from each site. Water quality at both sites was determined to be non-impacted, indicating a diverse and natural community of aquatic life (Figure 3). Both sampling stations contained a macroinvertebrate community with many sensitive, pollution intolerant taxa such as stoneflies in the genera *Leuctra*, *Acroneuria*, and *Paragnetina*, as well as sensitive mayflies such as *Isonychia bicolor*, *Stenonema* sp., and *Leucrocuta* sp..

Although aesthetically unpleasant, the orange iron flocculate material noted streamside just upstream of Station 02A is not uncommon in areas of unlined landfills, especially where groundwater seepage occurs (Parisio et al 2006). These orange deposits, which typically consist of iron oxyhydroxides, have limited effect on the environment themselves in terms of toxicity to aquatic life. However, in areas where deposits of iron flocculate persist over extensive areas of a stream, physical effects can be significant (Wellnitz et al 1994). Additionally, arsenic is a common co-precipitate (Parisio et al 2006) with iron flocculate. Therefore, although there does not appear to be an impact on the biological community, we recommend continued monitoring of the discharge to measure both its extent and chemical composition.

An assessment of non-impacted means the water resource is currently in very good condition. Many rivers and streams throughout New York are degraded and aquatic life has suffered a great deal as a result. Therefore, it is important to make sure that a resource as significant as the Normans Kill, and its diverse community of aquatic life, is protected from further sources of pollution which may jeopardize its current, non-impacted water-quality status.

Literature Cited

Bode, R. W., M. A. Novak, and L. E. Abele. 1990. Biological Impairment Criteria for Flowing Waters in New York State. New York State Department of Environmental Conservation, Technical Report, 110 pages.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality Assurance Work Plan for Biological Stream Monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

EST. 2008. A Rapid Bio-Assessment of the Normanskill Creek Relative to the Duanesburg Sanitary Landfill. The Schoharie River Center, Esperance, NY 12066, 33 pages.

Parisio, S., A. R. Keimowitz, H. J. Simpson, A. Lent, and V. Blackman. 2006. Arsenic-Rich Iron Floc Deposits in Seeps Downgradient of Solid Waste Landfills. Soil and Sediment Contamination 15:443-453.

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.

Wellnitz, T. A., Grief, K. A. and S. P. Sheldon. 1994. Response of Macroinvertebrates to Blooms of Iron-Depositing Bacteria. Hydrobiologia 281:1-17.

Table 1. Station Locations: Normans Kill, Schenectady County, NY, 2009.

Station	Location
NORM-02A	Approximately 0.4 river mile upstream of the landfill groundwater seep Latitude: 42.77067 Longitude: -74.12512


Upstream


Downstream

Station	Location
NORM-02B	Approximately 100 meters below the landfill groundwater seep Latitude: 42.77301 Longitude: -74.12194


Upstream


Downstream

Figure 1. Map of Normans Kill Sampling Stations Used in the Present Survey Above (02A) and Below (02B) the Duanesburg Landfill Groundwater Seep

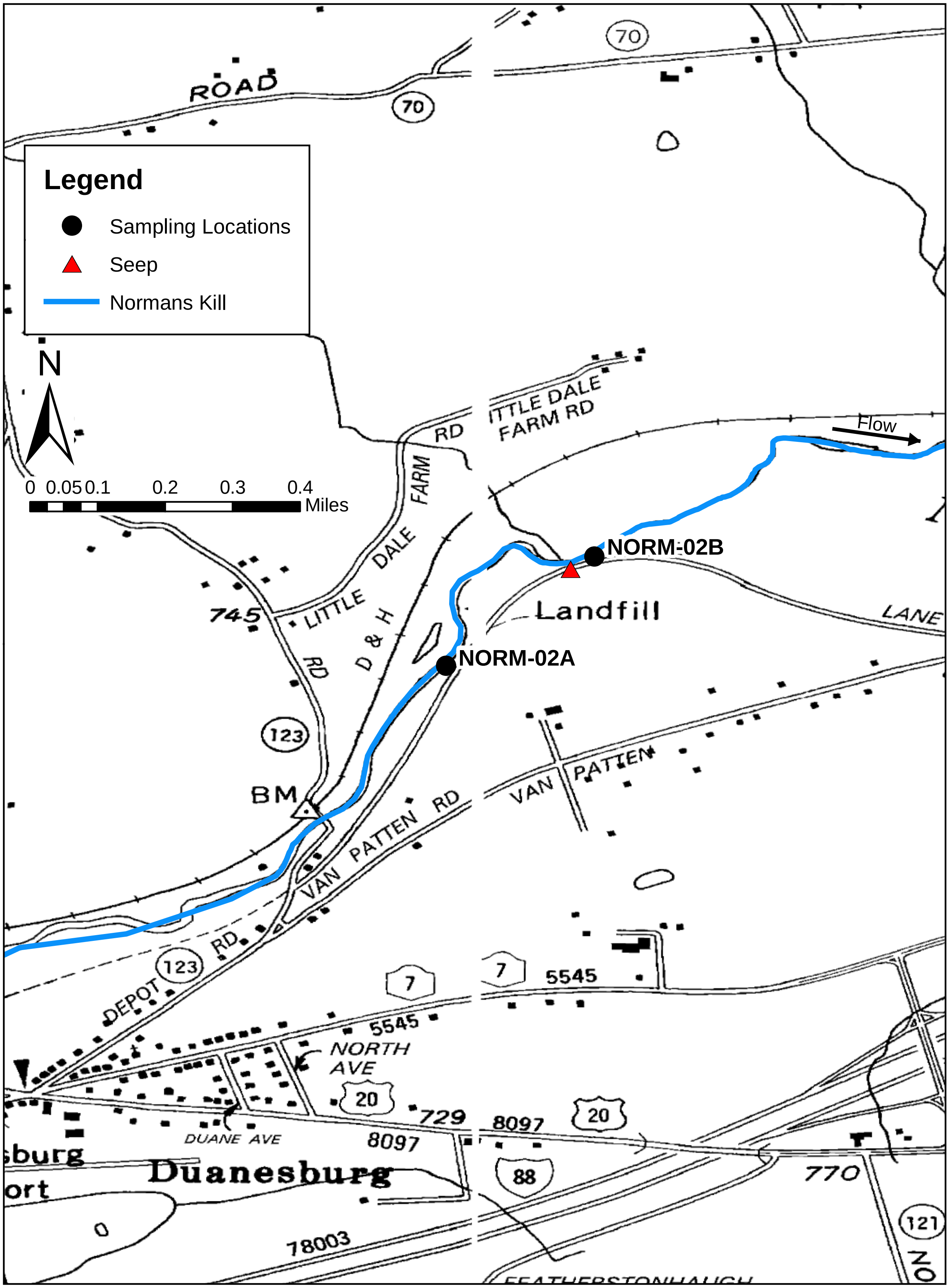


Figure 2. Bray-Curtis Similarity Tree, Normans Kill, 2009: Lines represent connections between subsamples based on the presence and number of macroinvertebrate taxa.

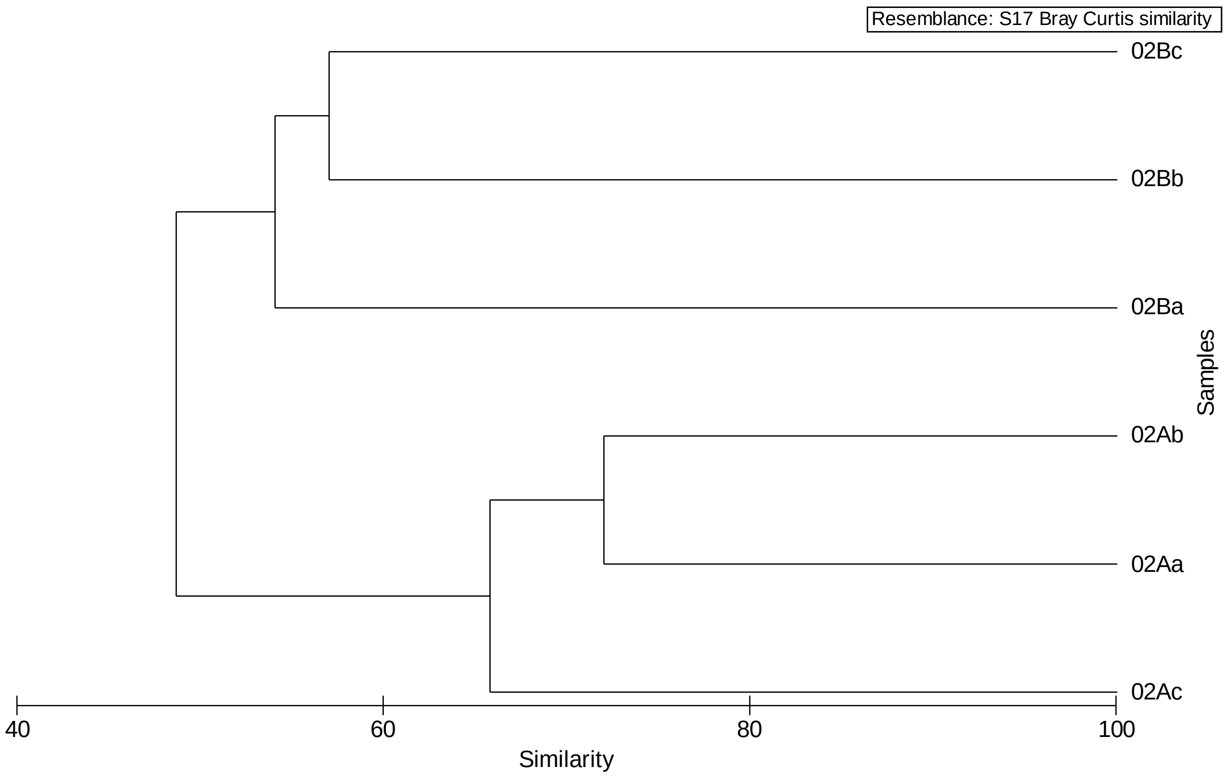


Table 2. Resemblance Matrix Showing Bray-Curtis Percent Similarity of Raw Taxonomic Data Between Replicate Macroinvertebrate Samples: Shaded cells highlight relationships between sites that needed to be greater that 50% similar for impairment analysis to continue.

Station, replicate	02A, rep. a	02A, rep. b	02A, rep. c	02B, rep. a	02B, rep. b
02A, rep. a					
02A, rep. b	72				
02A, rep. c	63	68			
02B, rep. a	46	45	50		
02B, rep. b	52	52	56	54	
02B, rep. c	42	40	55	54	57

Figure 3. Biological Assessment Profile (BAP) of Index Values, Normans Kill, 2009: Values are plotted on a normalized scale of water quality. The BAP is the mean of the four values for each site: species richness (Spp); EPT richness; Hilsenhoff biotic index (HBI), and percent model affinity (PMA). Box plots represent the individual BAP scores for each of the three replicates from each station. The solid lines represent median replicate scores. See Appendix IV for a more complete explanation.

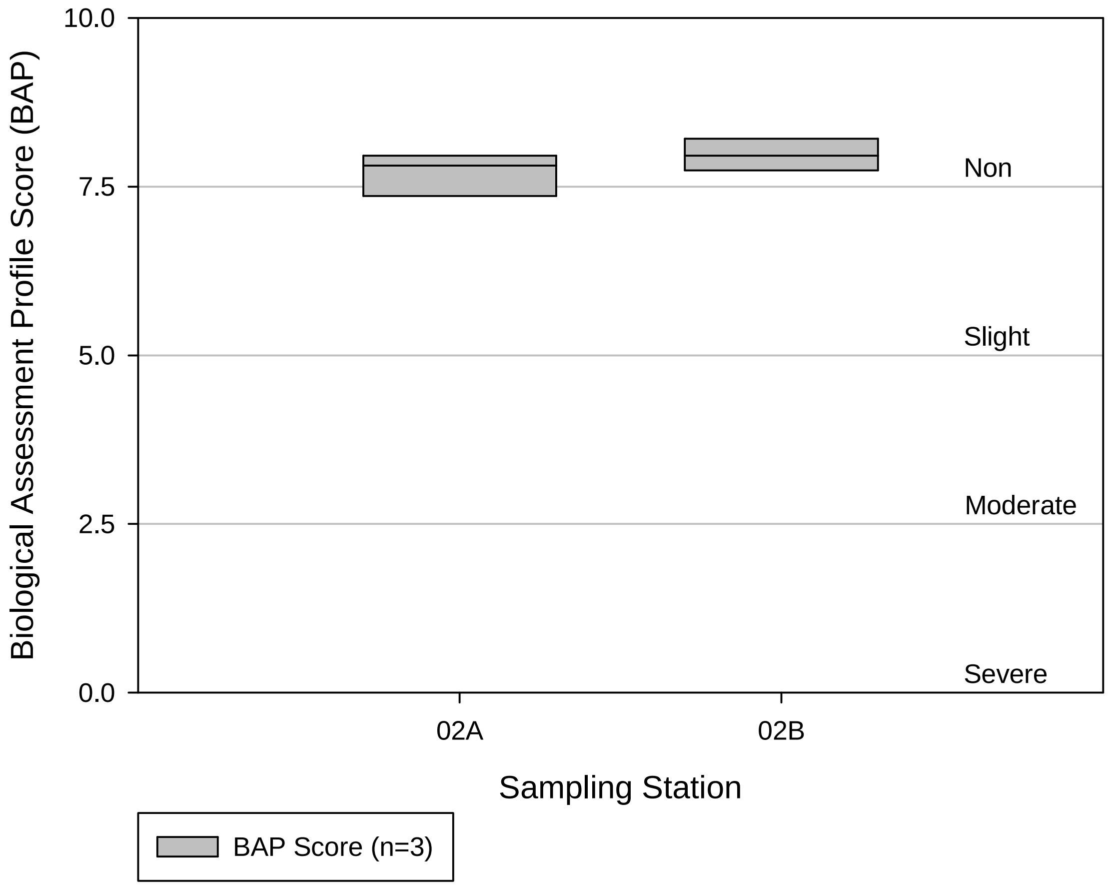


Table 3. Results of Individual Water Quality Metrics for Each Replicate Sample: Comparing results from downstream to upstream did not result in a determination of provisional impairment. Determination of impairment occurs when one or more of the following biological criteria are violated: Hilsenhoff's Biotic Index (HBI) +1.5; Ephemeroptera, Plecoptera, Trichoptera Richness (EPT) -4; Species Richness (Spp) -8; Species Dominance (Dom) +15; Percent Model Affinity (PMA) -20.

Station	Rep.	BAP	Wqa	Spp	HBI	EPT	Dom	PMA
02A	A	7.36	Slt	21	4.7	12	36	67
02A	B	7.81	Non	23	5.04	14	37	74
02A	C	7.96	Non	24	4.74	16	31	68
02A	Mean	7.71	Non	23	4.83	14	35	70
02B	A	7.74	Non	25	4.34	13	19	63
02B	B	7.96	Non	25	4.7	12	15	80
02B	C	8.21	Non	27	4.69	15	16	67
02B	Mean	7.97	Non	26	4.58	13	17	70

Table 4. Impact Source Determination (ISD), Normans Kill, 2009: 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 stressor(s) to the community. See Appendix XI for further explanation.

	Station					
Community Type	02A Rep A	02A Rep B	02A Rep C	02B Rep A	02B Rep B	02B Rep C
Natural: minimal human disturbance	65	63	61	60	60	54
Nutrient Enrichment: mostly nonpoint, agricultural	45	40	48	55	50	64
Toxic: industrial, municipal, or urban run-off	37	33	40	37	37	44
Organic: sewage effluent, animal wastes	24	25	28	36	40	46
Complex: municipal/industrial	36	26	35	32	36	54
Siltation	23	25	31	34	41	44
Impoundment	34	27	38	37	40	52

Note: ISDs are intended as supplemental data to macroinvertebrate community assessments.

Table 5. Macroinvertebrate Species Collected in the Normans Kill, Schenectady County, NY, 2009.

PLATYHELMINTHES
TURBELLARIA
TRICLADIDA

Undetermined Turbellaria

ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea sp.

DECAPODA
Cambaridae
Orconectes rusticus
Undetermined Cambaridae

INSECTA
EPHEMEROPTERA
Isonychiidae
Isonychia bicolor
Baetidae
Acentrella turbida
Baetis flavistriga
Baetis intercalaris
Baetis tricaudatus
Heptageniidae
Leucrocuta sp.
Stenacron interpunctatum
Stenonema ithaca
Stenonema sp.
Leptophlebiidae
Choroterpes sp.

PLECOPTERA
Leuctridae
Leuctra sp.
Perlidae
Acroneuria carolinensis
Acroneuria sp.
Paragnetina media

COLEOPTERA
Psephenidae
Psephenus herricki
Elmidae
Stenelmis crenata
Stenelmis sp.
Undetermined Coleoptera

TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche alhedra
Hydropsyche bronta
Hydropsyche slossonae
Hydropsyche sparna
Hydropsyche sp.
Glossosomatidae
Glossosoma sp.

LEPIDOPTERA
Undetermined Lepidoptera

DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Hexatoma sp.
Simuliidae
Simulium tuberosum
Simulium sp.
Athericidae
Atherix sp.
Chironomidae
Thienemannimyia gr. spp.
Diamesa sp.
Cardiocladius obscurus
Cricotopus tremulus gr.
Parametriocnemus sp.
Tvetenia bavarica gr.
Microtendipes pedellus gr.
Polypedilum aviceps
Polypedilum flavum
Undetermined Chironomini
Rheotanytarsus sp.
Tanytarsus sp.
Undetermined Tanytarsini

Table 6a. Macroinvertebrate Data Report (MDR), Station 02A.

STREAM SITE: Normanskill, Station 02A
LOCATION: Schenectady, NY, Approximately 0.4 river mile upstream of the landfill groundwater seep
DATE: 7/8/2009
SAMPLE TYPE: Kick
SUBSAMPLE: 100

			A	B	C
ARTHROPODA					
CRUSTACEA					
ISOPODA	Asellidae	*Caecidotea* sp.	-	1	-
DECAPODA	Cambaridae	Undetermined Cambaridae	1	1	2
INSECTA					
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	3	-	2
	Baetidae	*Acentrella turbida*	-	2	1
		Baetis flavistriga	10	7	5
		Baetis intercalaris	8	11	-
		Baetis tricaudatus	36	37	31
	Heptageniidae	*Leucrocuta* sp.	1	2	2
		Stenonema ithaca	-	-	2
		Stenonema sp.	1	2	-
PLECOPTERA	Leuctridae	*Leuctra* sp.	2	-	1
		Acroneuria carolinensis	-	-	1
	Perlidae	*Paragnetina media*	-	1	-
COLEOPTERA	Psephenidae	*Psephenus herricki*	2	2	3
		Stenelmis crenata	-	-	1
	Elmidae	*Stenelmis* sp.	1	-	-
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	14	3	3
		Dolophilodes sp.	-	1	-
	Hydropsychidae	*Cheumatopsyche* sp.	2	2	2
		Hydropsyche alhedra	3	5	8
		Hydropsyche bronta	-	-	4
		Hydropsyche slossonae	-	1	1
		Hydropsyche sparna	2	1	6
		Hydropsyche sp.	3	2	1
	Glossosomatidae	*Glossosoma* sp.	-	-	1
DIPTERA	Tipulidae	*Antocha* sp.	-	1	1
		Dicranota sp.	1	-	-
		Hexatoma sp.	2	-	-
	Simuliidae	*Simulium tuberosum*	-	-	1
	Chironomidae	*Thienemannimyia* gr. spp.	-	1	-
		Cardiocladius obscurus	-	1	-
		Cricotopus tremulus gr.	1	-	-
		Parametriocnemus sp.	2	-	-
		Microtendipes pedellus gr.	1	11	3
		Polypedilum aviceps	4	4	4
		Polypedilum flavum	-	1	1
		SPECIES RICHNESS:	21	23	24
		BIOTIC INDEX:	4.7	5.04	4.74
		EPT RICHNESS:	12	14	16
		MODEL AFFINITY:	67	74	68
		ASSESSMENT:	Slight	Non	Non

Table 6b. MDR, Station 02B.

STREAM SITE: Normanskill, Station 02B
LOCATION: Schenectady, NY, Approximately 100 meters below the landfill groundwater seep
DATE: 7/8/2009
SAMPLE TYPE: Kick
SUBSAMPLE: 100

			A	B	C
PLATYHELMINTHES					
TURBELLARIA					
TRICLADIDA		Undetermined Turbellaria	-	-	1
ARTHROPODA					
CRUSTACEA					
DECAPODA	Cambaridae	*Orconectes rusticus*	-	-	2
		Undetermined Cambaridae	1	-	-
INSECTA					
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	-	2	4
	Baetidae	*Acentrella turbida*	1	-	-
		Baetis flavistriga	4	10	-
		Baetis intercalaris	2	5	1
		Baetis tricaudatus	9	15	16
	Heptageniidae	*Leucrocuta* sp.	5	2	-
		Stenacron interpunctatum	1	-	-
		Stenonema ithaca	-	5	-
		Stenonema sp.	-	-	1
	Leptophlebiidae	*Choroterpes* sp.	-	-	1
PLECOPTERA	Leuctridae	*Leuctra* sp.	3	1	1
	Perlidae	*Acroneuria* sp.	-	-	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	2	2	-
	Elmidae	*Stenelmis* sp.	-	3	2
		Undetermined Coleoptera	-	1	-
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	4	1	3
		Dolophilodes sp.	-	-	1
	Hydropsychidae	*Cheumatopsyche* sp.	2	4	4
		Hydropsyche alhedra	3	7	10
		Hydropsyche slossonae	-	-	1
		Hydropsyche sparna	2	3	10
		Hydropsyche sp.	2	-	2
LEPIDOPTERA		Undetermined Lepidoptera	-	2	-
DIPTERA	Tipulidae	*Dicranota* sp.	1	1	-
		Hexatoma sp.	3	-	3
	Simuliidae	*Simulium tuberosum*	-	1	-
		Simulium sp.	-	-	3
		Atherix sp.	1	-	-
	Chironomidae	*Thienemannimyia* gr. spp.	-	2	-
		Diamesa sp.	-	-	1
		Cardiocladius obscurus	-	1	-
		Parametriocnemus sp.	1	1	-
		Tvetenia bavarica gr.	2	-	-
		Microtendipes pedellus gr.	5	6	2
		Polypedilum aviceps	19	11	13
		Polypedilum flavum	5	-	3
		Undetermined Chironomini	-	-	1
		Rheotanytarsus sp.	2	2	2
		Tanytarsus sp.	1	-	-
		Undetermined Tanytarsini	-	10	4
		SPECIES RICHNESS:	25	25	27
		BIOTIC INDEX:	4.34	4.7	4.69
		EPT RICHNESS:	13	12	15
		MODEL AFFINITY:	63	80	67
		ASSESSMENT:	Non	Non	Non

Table 7. Laboratory Data Summary, Normans Kill, Schenectady County, NY, 2009.

LABORATORY DATA SUMMARY			
STREAM NAME: Normans Kill			
DATE SAMPLED: 07/08/2009			
SAMPLING METHOD: Kick			
LOCATION	NORM	NORM	NORM
STATION	02A, Rep A	02A, Rep B	02A, Rep C
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME			
Tolerance Definitions: Intolerant = not tolerant of poor water quality Facultative = occurring over a wide range of water quality Tolerant = tolerant of poor water quality	Baetis tricaudatus 36% Facultative Mayfly	Baetis tricaudatus 37% Facultative Mayfly	Baetis tricaudatus 31% Facultative Mayfly
	Chimarra aterrima? 14% Intolerant Caddisfly	Baetis intercalaris 11% Facultative Mayfly	Hydropsyche alhedra 8% Facultative Caddisfly
	Baetis flavistriga 10% Intolerant Mayfly	Microtendipes pedellus grp. 11% Facultative Midge	Hydropsyche sparna 6% Facultative Caddisfly
	Baetis intercalaris 8% Facultative Mayfly	Baetis flavistriga 7% Intolerant Mayfly	Baetis flavistriga 5% Intolerant Mayfly
	Polypedilum aviceps 4% Facultative Midge	Hydropsyche alhedra 5% Facultative Caddisfly	Hydropsyche bronta 4% Facultative Caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)			
Chironomidae (midges)	8 (4)	18 (5)	8 (3)
Trichoptera (caddisflies)	24 (5)	15 (7)	26 (8)
Ephemeroptera (mayflies)	59 (6)	61 (6)	43 (6)
Plecoptera (stoneflies)	2 (1)	1 (1)	2 (2)
Coleoptera (beetles)	3 (2)	2 (1)	4 (2)
Oligochaeta (worms)	0 (0)	0 (0)	0 (0)
Mollusca (clams and snails)	0 (0)	0 (0)	0 (0)
Crustacea (crayfish, scuds, sowbugs)	1 (1)	2 (2)	2 (1)
Other insects (odonates, diptera)	1 (2)	1 (1)	2 (2)
Other (Nemertea, Platyhelminthes)	0 (0)	0 (0)	0 (0)
SPECIES RICHNESS	21	23	24
BIOTIC INDEX	4.7	5.04	4.74
EPT RICHNESS	12	14	16
PERCENT MODEL AFFINITY	67	74	68
OVERALL ASSESSMENT	Slightly Impacted	Non-Impacted	Non-Impacted

Table 7 cont'd. Laboratory Data Summary, Normans Kill, Schenectady County, NY, 2009.

LABORATORY DATA SUMMARY			
STREAM NAME: Normans Kill			
DATE SAMPLED: 07/08/2009			
SAMPLING METHOD: Kick			
LOCATION	NORM	NORM	NORM
STATION	02B, Rep A	02B, Rep B	02B, Rep C
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME			
Tolerance Definitions: Intolerant = not tolerant of poor water quality Facultative = occurring over a wide range of water quality Tolerant = tolerant of poor water quality	Polypedilum aviceps 19% Facultative Midge	Baetis tricaudatus 15% Facultative Mayfly	Baetis tricaudatus 16% Facultative Mayfly
	Baetis tricaudatus 9% Facultative Mayfly	Polypedilum aviceps 11% Facultative Midge	Polypedilum aviceps 13% Facultative Midge
	Leucrocuta sp. 5% Intolerant Mayfly	Baetis flavistriga 10% Intolerant Mayfly	Hydropsyche alhedra 10% Facultative Caddisfly
	Microtendipes pedellus grp. 5% Facultative Midge	Undetermined Tanytarsini 10% Facultative Midge	Hydropscyhe sparna 10% Facultative Caddisfly
	Polypedilum flavum 5% Facultative Midge	Hydropsyche alhedra 7% Facultative Caddisfly	Hydropsyche bronta 7% Facultative Caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)			
Chironomidae (midges)	35 (7)	33 (7)	26 (7)
Trichoptera (caddisflies)	17 (6)	17 (5)	38 (8)
Ephemeroptera (mayflies)	22 (6)	39 (6)	23 (5)
Plecoptera (stoneflies)	3 (1)	1 (1)	2 (2)
Coleoptera (beetles)	2 (1)	6 (3)	2 (1)
Oligochaeta (worms)	0 (0)	0 (0)	0 (0)
Mollusca (clams and snails)	0 (0)	0 (0)	0 (0)
Crustacea (crayfish, scuds, sowbugs)	1 (1)	0 (0)	2 (1)
Other insects (odonates, diptera)	5 (3)	4 (3)	6 (2)
Other (Nemertea, Platyhelminthes)	0 (0)	0 (0)	2 (1)
SPECIES RICHNESS	25	25	27
BIOTIC INDEX	4.34	4.7	4.69
EPT RICHNESS	13	12	15
PERCENT MODEL AFFINITY	63	80	67
OVERALL ASSESSMENT	Non-Impacted	Non-Impacted	Non-Impacted

Table 8. Field Data Summary, Normans Kill, Schenectady County, NY, 2009.

FIELD DATA SUMMARY				
STREAM NAME: Normans Kill	**DATE SAMPLED:** 07/08/2009			
REACH: Duanesburg, NY				
FIELD PERSONNEL INVOLVED: Smith/Duffy				
STATION	02A	02B		
ARRIVAL TIME AT STATION	10:55	9:35		
LOCATION	NORM	NORM		
PHYSICAL CHARACTERISTICS				
Width (meters)	10	13		
Depth (meters)	0.2	0.2		
Current speed (cm per sec.)	91	100		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	20	25		
Rubble (6.35 – 25.4 cm)	30	40		
Gravel (0.2 – 6.35 cm)	40	25		
Sand (0.06 – 2.0 mm)	10	10		
Silt (0.004 – 0.06 mm)	0	0		
Embeddedness (%)	40	40		
CHEMICAL MEASUREMENTS				
Temperature (˚C)	16	16		
Specific Conductance (umhos)	269	265		
Dissolved Oxygen (mg/l)	11.3	11.1		
pH	7.8	8.0		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	75	80		
Aquatic Vegetation				
Algae – suspended				
Algae – attached,filamentous				
Algae – diatoms	X	X		
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			
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X	X		
Simuliidae (black flies)				
Decapoda (crayfish)	X	X		
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other				
Field Assessment of Faunal Condition	Very Good	Good		

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 then 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 the organisms 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, taken from kick samples, expected assessment 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-organism subsample. These are considered to be clean-water organisms, and their presence is generally correlated with good water quality (Lenat, 1987). Expected assessment ranges in 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 Hilsenhoff 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.

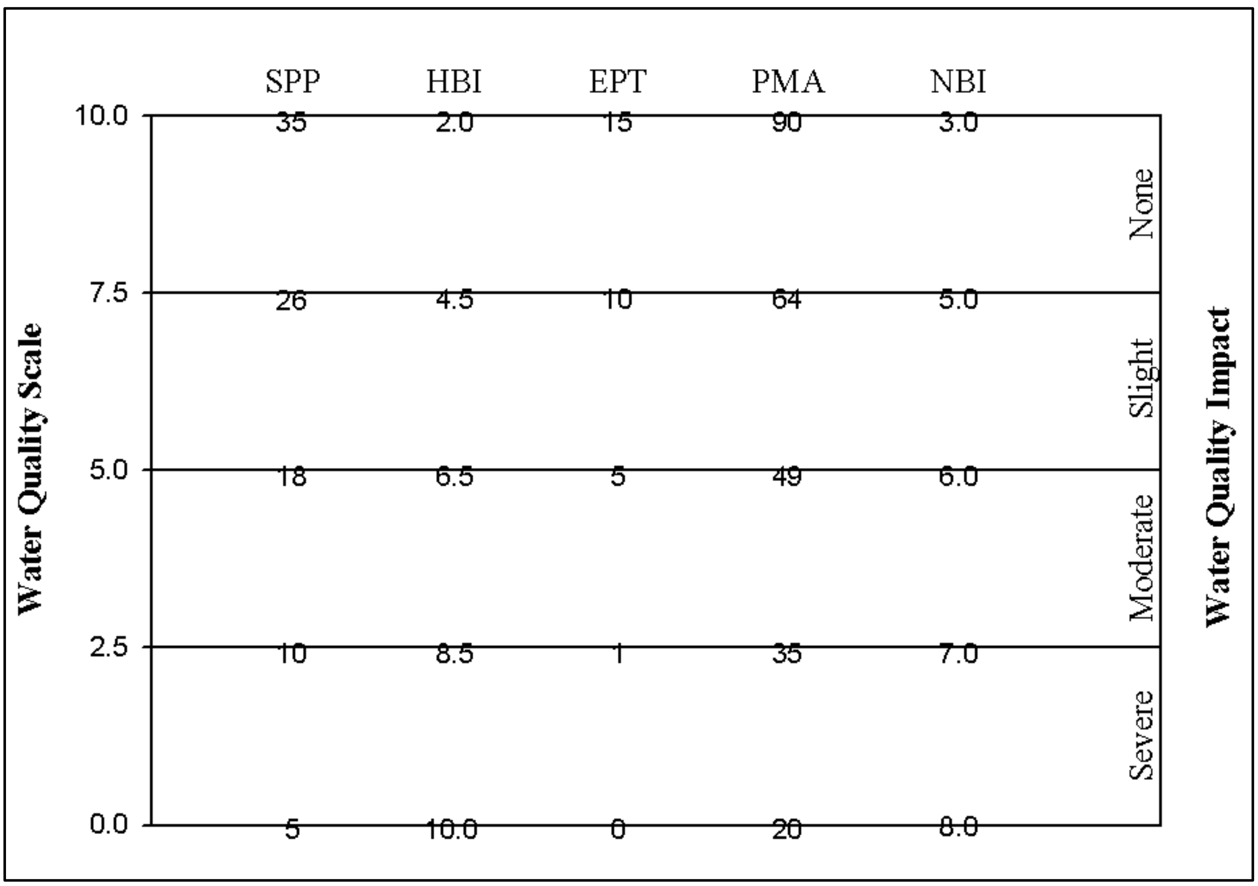
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted to more tolerant varieties, with EPT richness values of 6-10. The Hilsenhoff 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 to more tolerant varieties, with EPT richness values of 2-5. The Hilsenhoff 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, with EPT richness values of 0-1. The Hilsenhoff 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, 1or 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 then displayed as shown in the figure below.



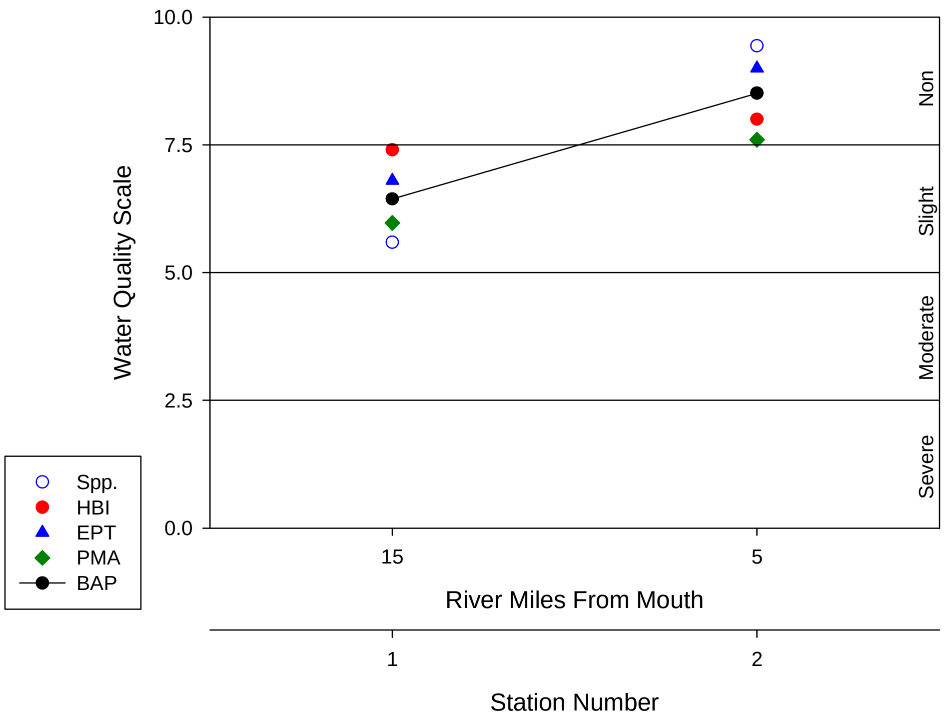
Appendix IV-B. Biological Assessment Profile: Plotting Values

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

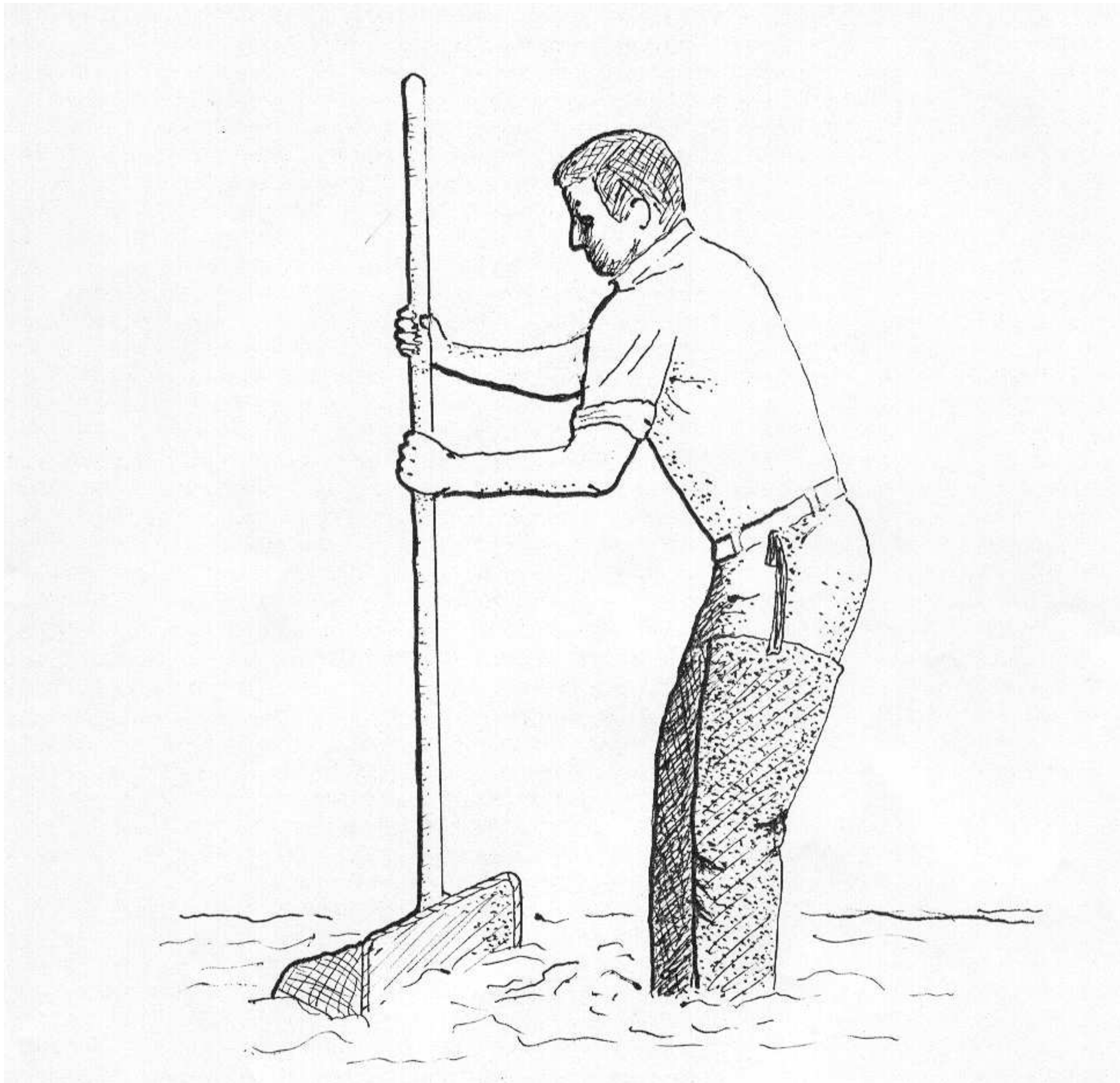
	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity*	Diversity **
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

* 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

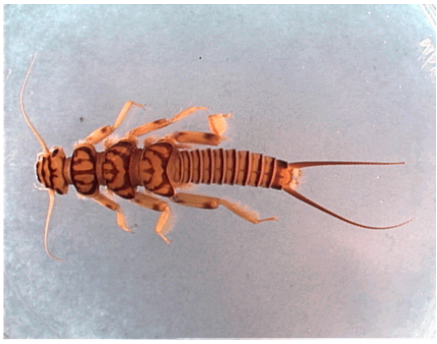
Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

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. Their larvae occur in almost any aquatic situation. Many species are very tolerant of 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.

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

SOWBUGS

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 field-verified metric values of the community, compared to expected metric values in four research-defined ranges of water-quality impact.

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, and
- 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 considered equivalent to 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).

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

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 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

Tolerance Values (cont'd.)

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

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
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

Tolerance Values (cont'd.)

TAXON	TP T-Value	NO3 T-Value
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 the percent model affinity method (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 or 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 the ISD method (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 method: ISD is based on similarity of test data 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 at the site associated with that data, or may indicate "natural," lacking any impact. In the graphic representation of ISD for a given site, only test data with greater than 50 percent similarity to one or more of the impact source type models is identified as possibly impacted by that source. If none of the models exhibits a similarity to the test data of greater than 50 percent, ISD for that site 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 to data derived by other sampling methods, or from other 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. Official Review of the EST Bio-Assessment Report of the Normans Kill, 2008.

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Alexander B. Grannis
Commissioner

Document Review

Document Title: A Rapid Bio-Assessment of the Normanskill Creek Relative to the Duanesburg Sanitary Landfill

Document Author: The Schoharie River Center Environmental Study Team

Report Date: 2008

Review Date: January 7, 2008

Reviewer:
Alexander J. Smith
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Summary:

At the request of Andrea Dzierwa, NYSDEC Region 4, I have reviewed the above titled report on benthic macroinvertebrate sampling of the Normans Kill, in the vicinity of Duanesburg, NY. The report was written by the Schoharie River Center Environmental Study Team (EST), Esperance, NY, which is a student volunteer group. The objective of the study was to "*ascertain the impact that a discharge point from an unused landfill might be having on the Normans Kill*." On two different dates, water chemistry, bacteria, and benthic macroinvertebrate samples were collected for analysis by the EST. Four locations were sampled: two upstream of the suspected landfill runoff, one directly from the suspected landfill runoff and one immediately below. The most upstream station was sampled on 11/2/2008 while the remaining three stations were sampled on 9/7/2008. Water chemistries and bacteria were sampled at each station while benthic macroinvertebrates were only sampled at the most upstream and downstream locations.

The report states that based upon the data presented "*the presence of the discharge site coming from the town dump negatively impacts the overall water quality of the stream*." However, this statement is not supported by the data. Data presented in this report actually contradict the above statement, with water quality improving slightly at the station downstream of the suspected landfill runoff. Moreover, most of the findings can be attributed to differences in sampling dates and natural seasonal fluctuations in stream water chemistries, effects of heavy rain events prior to sampling, and significant differences in benthic habitat characteristics between sampling stations.

It is my professional judgment that there is no documented impact to stream water chemistries or benthic macroinvertebrate communities as a result of the suspected landfill runoff,

at least none which could be detected given this investigations study design and monitoring parameters. Furthermore I do not feel the situation warrants immediate sampling actions by the NYSDEC Stream Biomonitoring Unit (SBU) to further document the conditions. It is possible that at the request of Region 4 the SBU would sample two or more locations on the Normans Kill during the summer of 2009. I do believe the circumstances warrant a detailed evaluation of the exact constituents of the runoff and its source.

The following is a detailed review of the report and my professional opinion regarding their results and conclusions:

Sampling Site and Date Selection:

The sampling sites selected in this study may have bracketed the questionable runoff; however the habitat characteristics between them are not consistent enough for direct comparisons. Based on photographs in the report it appears the most upstream station consists of course gravel/gravel/sand substrate while the remaining stations are predominately bedrock/rock/rubble. The stark contrast between these substrate types can explain much of the variation noted in the dataset, especially between invertebrate community types. For site comparisons of this type, substrate conditions are converted to a Phi-scale (Bode et al 1990). If two sites are within 3 Phi-units of each other the sites are considered comparable. From the photographs presented, the differences between these two sites appear greater than 3 Phi-units and would therefore not be comparable.

Benthic Macroinvertebrate Sampling:

Benthic macroinvertebrate sampling was conducted in a manner consistent with SBU methods. The water quality metrics used in the evaluation of the benthic community were those recommended and intended for use by volunteer organizations. Although the study utilized family level identifications, our own internal research suggests similar findings when compared to genus/species level identification (Smith 2004). Therefore the sampling, sample processing, and results of such efforts are trusted to be accurate.

Non-impacted water quality was determined at both stations where macroinvertebrates. In fact, the site immediately downstream of the suspected landfill runoff resulted in a better water quality assessment than upstream. This information does not support the statement cited earlier which suggests a negative impact on the stream from the runoff.

At the downstream invertebrate sampling station less than 100 organisms were sorted from the entire sample, which indicates low biomass. This is different from the upstream station where the 100 organisms required for assessment were sorted from the sample. The difference in invertebrate abundance is most likely the result of habitat constraints on the invertebrate community at the downstream station and inexperienced sample collectors targeting less than desirable habitat. The dominance of bedrock at this station provides less than ideal substrate for invertebrate community colonization and can make sample collection difficult. Despite this, water quality metrics still indicated non-impacted water quality.

Bacteria Sampling:

The report indicates bacteria samples resulted in "*sites 2 and 4 above the state standards of 1200/100ml for allowable E-Coli levels.*" The E. coli values are as follows Station 01 (800/100ml), Station 02 (1900/100ml), and Station 04 (1600/100ml). NYS standards for *E. coli* are for public bathing beaches only; NYS water quality regulations (NYSDEC 1999) contain standards for fecal and total coliform. The results of this study are not in exceedence of any NYS water quality standard for coliform. For total coliform the standard reads "The monthly median value and more than 20 percent of the samples, from a minimum of five examinations, shall not exceed 2,400 and 5,000 respectively." For fecal coliform the standard reads "The monthly geometric mean, from a minimum of five examinations, shall not exceed 200."

These results are not representative of the actual bacterial conditions of the stream since they were one-time grab samples. The observations were not collected from a mean of not less than five examinations as dictated by the standard. Additionally the difference noted between Stations 01, and 02-04 are likely the result of the heavy rain event which occurred within 24 hours prior to sampling Stations 02 and 04. The reason for the standard using a mean of several examinations is because of fluctuations in stream flows as a result of weather events. It is the combination of base flow and high flow sampling events which combine to provide an accurate assessment of coliform levels in the stream.

Water Chemistry Sampling:

Major differences noted between Stations 01 and 02-04 of the mainstem Normans Kill should be attributed to 2 major factors 1) The difference in sampling dates (2 months apart) and 2) A heavy rain event within 24 hours prior to the sampling of Stations 02 and 04 but not experienced during the sampling of Station 01.

Temperature: The cold temperature at Station 01 is likely due to the much colder air temperatures experienced during November when the sample was collected compared to September.

Conductance: Increased specific conductance at downstream sites is a common occurrence as greater amounts of runoff contribute to a stream as drainage size increases. In addition runoff from rain events typically contain larger concentrations of charged ions from impervious surfaces contributing to higher specific conductance. Without the rain event the downstream conductance measurements would likely have been more similar to upstream. The observations at all sites were well below our level of concern for biological impairment of 800 µsiemen/cm.

Nutrients: Highest nutrient values were observed upstream of the suspected landfill runoff, not downstream. The higher values upstream are likely due to plant dormancy because sample collection was outside of the growing season, therefore decreasing the amount of nutrient uptake.

Turbidity: Higher turbidity values at downstream stations are most likely the result of the rain event experienced.

Oxygen: Higher DO and % Saturation values upstream are most likely due to colder temperatures.

If there are questions regarding my review, please contact me.

Sincerely,

Alexander J. Smith