

Biological Assessment of Elevenmile Creek
Below Beulah Landfill
Escambia County
FDEP File No. 0078433-003-SF
WACS ID No. 1685

Conducted January 15, 2014

June 2014

Division of Environmental Assessment and Restoration

Northwest Regional Operation Center

Executive Summary

As requested by the Waste Management/Air Resources Cleanup Section, Department of Environmental Protection (DEP) staff from the Division of Environmental Assessment and Restoration conducted water quality sampling and biological assessments of Elevenmile Creek on January 15, 2014. The biological assessment locations are located above and below the Beulah Landfill located in Escambia County. The objectives of this study were to:

1) Measure the existing water quality and biological health of Elevenmile Creek below the closed cells of Beulah Landfill as compared to an upstream Control Site; and
2) Determine if previous disposal activities resulted in non-compliance with the biological integrity criterion as referenced in Rule 62-302.530 (10), Florida Administrative Code (F.A.C.).

The Beulah Landfill, which is a solid waste facility in long-term care, was in operation from 1950-1984 and was classified as a Class I (household and commercial solid waste) facility. The post-closure utilization of the facility is a model airplane landing strip used by a local club. Results from this study may be used to determine future permit revisions related to Beulah Landfill's Remedial Action Plan (RAP).

A review of groundwater monitoring well data (sampled in 2013 by county personnel) revealed elevated levels of ammonia, iron and polycyclic aromatic hydrocarbons (PAH). According to county personnel, elevated PAHs were measured from groundwater monitoring wells located on the southeastern corner of the southern section; however, at the time of this sampling event PAHs were undetected in nearby surface waters. Iron and ammonia samples were below their respective water quality criteria.

Four stream sites were sampled to assess the influence of the Beulah Landfill on water quality in Elevenmile Creek, one upstream and another downstream from the landfill and at two locations in Coffee Creek. The biological community was evaluated using the Stream Condition Index (SCI), Rapid Periphyton Survey (RPS), and the Linear Vegetation Survey (LVS) at the two Sites on Elevenmile

Creek. The aquatic macroinvertebrate community of Elevenmile Creek above and below the landfill achieved a healthy designation at both sites and the RPS and LVS did not indicate a floral imbalance.

Introduction

This study was conducted to assess the influence of the Beulah Landfill on water quality and biological communities of Elevenmile Creek. Although healthy, well-balanced stream and river communities may be maintained with some level of human activity, such activities may result in waterbody degradation. Human stressors may include increased inputs of nutrients, sediments, metals and/or pesticides from watershed runoff, adverse hydrologic alterations, undesirable removal of habitat or riparian buffer vegetation, and introduction of nuisance (generally exotic) plants and animals. DEP has field methods to evaluate if human activities have resulted in the condition where a particular waterbody has exceeded water quality criteria of Chapter 62-302, F.A.C., including whether adverse impacts to biological communities have occurred. DEP water quality standards are designed to protect designated uses of the waters of the state (*e.g.,* recreation, aquatic life support), and exceedances of these standards is associated with interference with the designated use. The SCI assesses how closely the macroinvertebrate community (*e.g.,* aquatic insects, clams, and crayfish) of a stream resembles the macroinvertebrate community of an undisturbed or "reference" condition. The habitat assessment evaluates the availability and quality of habitat for macroinvertebrates, and can help diagnose the cause of a low SCI score.

Site Information and Sampling Locations

The landfill is located approximately 3.5 miles southeast of Beulah and 1 mile south of Highway 90A, in Escambia County. Elevenmile Creek flows along the landfill's eastern border and is located in the Gulf Coast Flatwoods, Southern Coastal Plains 75a Ecoregion (Figure 1). The landfill is separated into two sections (north and south) by Coffee Creek, a third order tributary to Elevenmile Creek which

eventually flows into Perdido Bay. Elevenmile Creek is a fourth order stream at this location and for more than 70 years received pulp mill effluent until the end of 2012.

Biological background conditions are not known prior to landfill activities or industrial pulp mill waste discharge; therefore, a SCI Control Site located upstream above the landfill was selected as a comparison to the SCI Test Site (Figures 2 & 3). The Test Site is located below the southeastern property line on Elevenmile Creek and downstream from the permitted surface water sampling location SW-3. The background or Control Site is located upstream from the landfill on Elevenmile Creek at the permitted surface water sampling location SW-8.

Two additional water quality samples were collected in Coffee Creek. One site is located at the confluence of Coffee and Elevenmile Creek and the other background site is upstream from the landfill located west of the western property line.

Methods

Water Chemistry and Stream Condition Index

This site was assessed on January 15, 2014 by the DEP's Northwest District Office. Surface water and biological samples were collected following DEP Standard Operating Procedures (SOPs, see http://www.dep.state.fl.us/water/sas/sop/sops.htm for details). Sampling and analyses met DEP quality assurance/ quality control standards (see http://www.dep.state.fl.us/water/sas/qa/index.htm). The SCI was conducted per DEP SOP FS7420 and calculated per DEP SOP LT7200. The SCI consists of collecting macroinvertebrates via 20 D-frame dip-net sweeps (0.5 m in length) in the most productive habitats in a 100 m reach of the stream. The organisms are sub-sampled, and identified to the lowest practical taxonomic level. The SCI is composed of ten metrics (see Table 2), eight of which decrease in response to human disturbance, with two metrics (% very tolerant and % dominant) increasing in response to human disturbance. According to DEP SOP LT 7000, the SCI score ranges and categories are: (68-100) Exceptional; (35-67) Healthy; and (0-34) Impaired. EPA approved biological health assessment criteria state that a Site is considered to meet designated

uses if the average of the two most recent SCI scores is 40 or higher and neither of those scores is less than 35.

Floral Assessment

Evaluations of stream flora include the Rapid Periphyton Survey (RPS, DEP SOP FS 7230), community composition information associated with dominant algal taxa, Linear Vegetation Survey (LVS, DEP SOP 7320), and chlorophyll *a*. The RPS assesses the extent and thickness of algae in the stream reach by making 99 observations within the 100m reach, while the LVS assesses how closely the in-stream plant community resembles a minimally disturbed condition. Results are assessed as described beginning on page 8 of "*Implementation of Florida's Numeric Nutrient Standards*," dated April 2013, using evidentiary thresholds derived from a population of minimally disturbed reference sites.

Habitat Assessment

The Stream and River Habitat Assessment was conducted per DEP SOP FT 3100. The Habitat Assessment is a rapid field method in which a sampler scores eight in-stream and riparian components to estimate the influence of habitat factors on the resident aquatic organisms. Habitat Assessment scores range from 11-160 and overall habitat quality is assigned to one of four categories: Optimal (120-160 points), Suboptimal (80-119 points), Marginal (40-79 points), and Poor (11-39 points).

Results and Discussion

Water Chemistry

All parameters of initial concern (iron, ammonia and polycyclic aromatic hydrocarbons [PAHs]) were within their respective Class III water quality standards. The iron concentration results were slightly higher at the Control Site (570 µg/L) than the Test Site (470 µg/L). The highest concentration was measured at the Coffee Creek and Elevenmile Creek confluence (720 µg/L). The unionized ammonia was negligible and all sites measured below 0.0002 mg/L as NH_3 (water quality

criterion is ≤0.02 mg/L as NH_3). PAHs were not detected in any of the samples. All remaining nutrient and metals analysis met the Class III surface water standards (see Table 1).

Field measurements were within normal ranges of western Panhandle streams; however, it was observed specific conductance (57 µmhos/cm) and pH (6.71 SU) were slightly lower at the Test Site below the landfill when compared to the specific conductance (65 µmhos/cm) and pH (7.0 SU) at the Control Site above the landfill. This observation is most likely due to a dilution affect caused by Coffee Creek which flows between the two assessment sites. Specific conductance at the Coffee Creek/ Elevenmile Creek confluence was 41 µmhos/cm and pH measured 6.13 S.U.

Stream Condition Index

The SCI scores for the Control and Test Sites on Elevenmile Creek were similar, scoring in the Healthy Category; see Appendix A for a brief explanation of these results. The Test Site SCI (61A) scored slightly lower than that of the Control Site SCI (66A). Sensitive taxa collected below the landfill was slightly higher by 1 taxa; however a stonefly (Perlidae) was collected at the Control Site but not at the Test Site (Appendix B). Stoneflies are sensitive aquatic insects found in many unpolluted Northwest Florida streams. There were 25% fewer filter-feeding taxa collected at the Test Site (22%) than the Control Site (48%). Some filter-feeding insects rely on good water flow and sufficient organic material in the water to survive. A change in water flow or quality of organic matter in the stream column could be an indication of organic pollution. In addition, there was a 35% reduction of Tanytarsini midges collected at the Test Site (9%) compared to the Control Site (44%). These insects are sensitive to human disturbance (Table 2).

Floral Assessment

The floral assessments did not indicate an imbalance of the floral community. Although there were some algal mats observed, the Rapid Periphyton Survey did not show signs of eutrophication. Chlorophyll-a results were well below the evidentiary thresholds of 3.2 µg/L. The attached algal community in the stream above and below the landfill consisted mainly of diatoms (80%) with some filamentous algae (see Appendix B). Some growth of algae (typically diatoms) is expected in a fully

functioning stream, but an overabundance of algae (especially filamentous algae) may reduce habitat quality (from smothering) and lead to excess organic matter production (and decomposition), which can harm fish and invertebrates. The Linear Vegetative Survey (LVS) indicated there were no excessive nuisance plants. It should be noted that the LVS was conducted during the dormant season for most aquatic plants.

Habitat Assessment

The Habitat Assessment scores were identical (113), scoring in the mid-suboptimal range. Five productive habitats may be present in Florida streams; snags or woody material, leaf pack, submersed roots and aquatic vegetation and rocks. It is considered a major productive habitat when ≥ 2 m^2 is present and a minor habitat when ≤ 2 m^2 is present within the 100 m assessment Site. A diversity of habitat is the key to a more diverse aquatic macroinvertebrate community. Three productive habitats were observed at both sites (snags, roots & leaf packs) giving a suboptimal score for substrate diversity. Unstable banks can cause sand and silt smothering making habitat unavailable for aquatic insects and fish. Moderate to severe sand smothering was observed at the Test Site as well as the control resulting in a poor score for substrate availability. There was less than 5% available habitat due to sand/silt smothering which limits habitat for fish and aquatic insects. Water velocities scored in the optimal range at both assessment Sites. Fish and sensitive aquatic insects require sufficient water velocity to maintain high dissolved oxygen concentrations. Although riparian buffer zone width was greater than 18m, vegetation quality received a marginal rating as several exotic species were observed along the stream banks (e.g., *Sapium sebiferum*; Chinese tallowtree and *Ligustrum sinense*; Chinese privet).

Conclusions

This assessment was initiated to determine if water quality violations found in nearby ground water monitoring wells were affecting downstream surface waters. Overall the water quality in Elevenmile Creek below the Beulah Landfill were good, meeting the designated use of this Class III waterbody. Although iron samples collected were below the state standard of 1000 µg/L some iron bacteria was noted along the left stream bank which may impact areas further downstream. The most obvious adverse impact to the biological community in Elevenmile Creek is sedimentation which was observed below as well as above the landfill (Figure 4). This is most likely due to historical silviculture, dirt roads and storm water inputs in the upper watershed.

Table 1. Physical/Chemical Water Quality Values for Beulah Landfill Facility study Sites collected January 15, 2014. The SCI scores were calculated per protocols for the Panhandle West region.

Parameter	Elevenmile Creek		Coffee Creek		Applicable Class III Water Quality Criteria
	Control	Test	Above	Confluence	
SCI Score	66A	61A			
Habitat Score	113	113			
Temperature Field (˚C)	13.24	11.72	11.35	11.21	
Specific Conductance Field (µmhos/cm)	65	57	39	41	Shall not be increased more than 50% above background or to 1275, whichever is greater.
Dissolved Oxygen Field (mg/L)	9.69	9.50	9.53	9.59	
Dissolved Oxygen Field (%)	92.5	87.6	87.1	87.4	No more than 10% of the daily average percent DO saturation values shall be below 67%
pH Field	7.00	6.71	5.78	6.13	
Turbidity (Nephelometric Turbidity Units)	6.8	6.4	4.8	5.5	≤29 above natural background conditions

TDS (mg/L)	41	51	19 I	35	
TSS (mg/L)	4 I	4 I	4 I	5 I	
Organic Carbon (mg C/L)	3.9	3.8	4.9	5.1	
Biological Oxygen Demand-5 day (mg/L)	0.75 I	0.91 I	0.34 I	0.20 U	
Chlorophyll-a (µg/L)	1.2 I	1.6 I	0.55 U	0.55 U	
Total Phosphorus (mg/L)	0.012	0.018	0.008	0.008	* ≤ 0.06
Ortho-Phosphate (mg P/L)	0.004 U	0.13	0.004 U	0.006 I	
Nitrate+Nitrite (mg/L)	0.30	0.27	0.16	0.15	
Total Ammonia (mg/L)	0.055	0.008	0.006	0.085	
Total Kjeldahl Nitrogen (mg/L)	0.23	0.19 I	0.18 I	0.25	
Total Nitrogen (mg/L)	0.585	0.468	0.346	0.485	* ≤ 0.67
Un-ionized Ammonia (mg/L as NH_3)	1.59E-04	1.06E-05	9.05E-07	2.84E-05	≤ 0.02
Sulfate (mg SO4/L)	4.4	4.5 A	2.5	2.6	
Chloride (mg Cl/L)	6.3	6.3 A	6.7	6.6	
Fluoride (mg F/L)	0.038 I	0.039 I	0.040 I	0.035 U	
Color (PCU)	34	34	39	41	
Alkalinity (mg CaCO3/L)	12	12	0.85 I	1.8 I	
Calcium (mg/L)	5.79	6.06	1.33	1.63	
Iron (ug/L)	570	470	560	720	≤ 1000
Magnesium (mg/L)	1.18	1.14	0.83	0.88	
Potassium (mg/L)	0.86 I	0.83 I	0.46 I	0.58 I	
Sodium (mg/L)	4.8	5.0	4.2	4.4	
Zinc (mg/L)	5.0 U	5.6 I	5.0 U	5.0 U	
Arsenic (µg/L)	0.26 U	0.25 U	0.25 U	0.25 U	≤ 50
Cadmium (µg/L)	0.050 U	0.050 U	0.050 U	0.050 U	
Chromium (µg/L)	0.40 I	0.40 I	0.38 I	0.42 I	
Copper (µg/L)	0.50 U	0.57 I	0.50 U	0.50 U	
Lead (µg/L)	0.32 I	0.32 I	0.24 I	0.25 I	
Nickel (µg/L)	0.47 I	0.66 I	0.31 I	0.30 I	
Silver (µg/L)	0.025 U	0.025 U	0.025 U	0.025 U	
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Acenaphthylene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Anthracene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	

Benzo(a)anthracene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Benzo(a)pyrene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Benzo(b)fluoranthene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Benzo(k)fluoranthene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Benzo(g,h,i)perylene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Chrysene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Dibenzo(a,h)anthracene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Fluoranthene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Fluorene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Indeno(1,2,3-cd)pyrene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
2-Methylnaphthalene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Naphthalene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Phenanthrene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Pyrene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
Biphenyl** (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
2,6-Dimethylnaphthalene** (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
1-Methylnaphthalene (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
1-Methylphenanthrene** (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	
2,3,5-Trimethylnaphthalene** (ug/L)	0.05 U	0.052 U	0.049 U	0.050 U	

* Panhandle West nutrient region. **U** – Analyzed for but not detected. **A** – Mean of two or more determinations. **I** – Reported value is between the laboratory method detection limit and the laboratory practical quantitation limit. **The laboratory is not NELAP certified for this analyte/method, or certification is not applicable.

Table 2. Stream Condition Index metric score results, Elevenmile Creek above and below Beulah Landfill, January 15 2014. Note: results are an average of 2 replicates except Ephemeroptera, Trichoptera, Long-lived, Sensitive taxa and Total Taxa.

Stream Condition Index Metric	**Control Site**	**Test Site**
Total taxa	40	40
Ephemeroptera taxa	4	4
Trichoptera taxa	8	9
% Filterer	48	22
Long-lived taxa	1	0

Clinger taxa	7	8
% Dominance	29	26
% Tanytarsini	44	9
Sensitive taxa	9	10
% Very tolerant	2	0

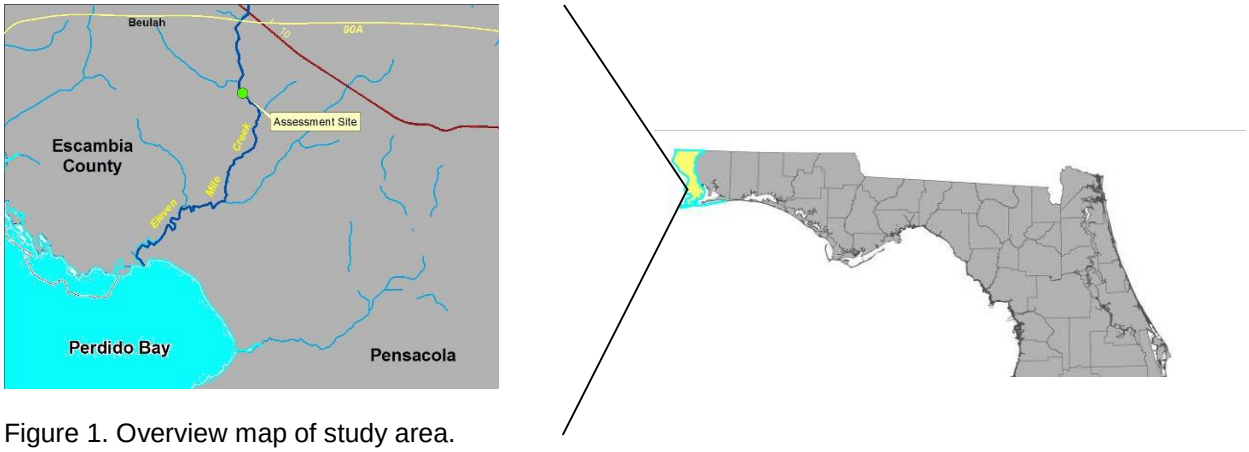
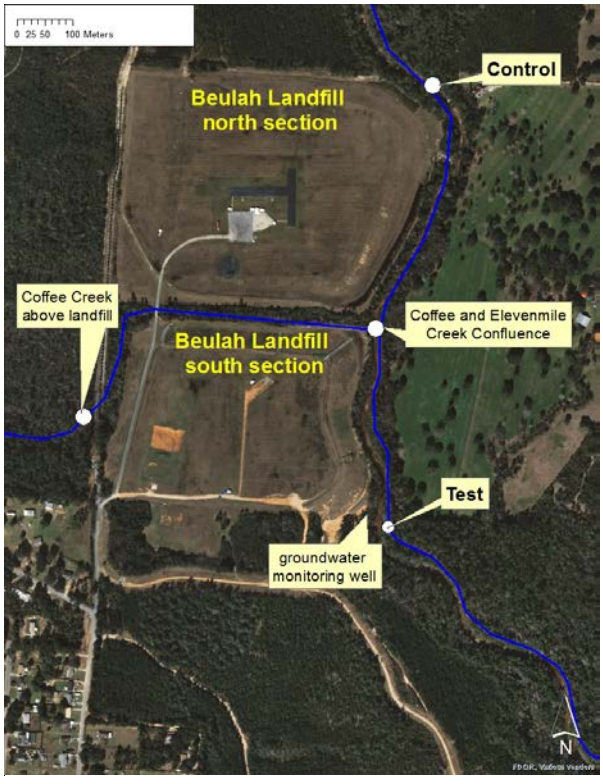


Figure 1. Overview map of study area.



Site	Permit Monitoring Locations	Latitude	Longitude
Control - Elevenmile Creek above the landfill	SW8	30° 30' 13"	087° 20' 33"
Test - Elevenmile Creek below the landfill	SW3	30° 30' 43"	087° 20' 28"
Coffee Creek above the landfill	SW9	30° 30' 53"	087° 20' 55"
Coffee Creek at confluence to Elevenmile Creek	SW7	30° 30' 58"	087° 20' 34"

Figure 1. Map of study site and sampling locations on Elevenmile Creek and Beulah Landfill in Escambia County.



Figure 2. SCI location on Elevenmile Creek above Beulah Landfill.



Figure 3. SCI location on Elevenmile Creek below Beulah Landfill.


Figure 4. Elevenmile Creek above Beulah Landfill showing sand smothering.

Contact and resources for more information

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Literature Cited

Florida Department of Environmental Protection. Standards and Assessment Section Bureau of Assessment and Restoration Support DEP-SAS-003/1. 2011. Development of Aquatic Life Use Support Attainment Thresholds for Florida's Stream Condition Index and Lake Vegetation Index

http://www.dep.state.fl.us/water/bioassess/docs/attainment-thresholds-sci-and-lvi.pdf

Implementation of Florida's Numeric Nutrient Standards. April 2013. Document Submitted to EPA in Support of the Department of Environmental Protection's Adopted Nutrient Standards for Streams, Spring Vents, Lakes, and Selected Estuaries *Implementation of Florida's Numeric Nutrient Standards*

Appendix A

Table LT 7200-2 Determination of Biological Indices

SCI Score	SCI 2007 Category Name	Example Description
68–100	**Category 1 ("exceptional")**	Higher diversity of taxa than for Category 2, particularly for Ephemeroptera and Trichoptera; several more clinger and sensitive taxa than found in Category 2; high proportion for Tanytarsini; few individuals in the dominant taxon; very tolerant individuals make up a very small percentage of the assemblage.
48–67	**Category 2 ("healthy")**	Diverse assemblage with 30 different species found on average; several different taxa each of Ephemeroptera, Trichoptera, and long-lived and, on average, 5 unique clinger and 6 sensitive taxa routinely found; small increase in dominance by a single taxon relative to Category 1; very tolerant taxa represent a small percentage of individuals, but noticeably increased from Category 1.
35-47	**Category 2 ("healthy")**	Diverse assemblage with 30 different species found on average; several different taxa each of Ephemeroptera, Trichoptera, and long-lived and, on average, 5 unique clinger and 6 sensitive taxa routinely found; small increase in dominance by a single taxon relative to Category 1; very tolerant taxa represent a small percentage of individuals, but noticeably increased from Category 1. **Note:** any score of 35 and above is not impaired using the current interpretation categories.

0–34	**Category 3 ("impaired")**	Notable loss of taxonomic diversity; Ephemeroptera, Trichoptera, long-lived, clinger, and sensitive taxa uncommon or rare; half the number of filterers than expected; assemblage dominated by a tolerant taxon; very tolerant individuals represent a large proportion of the individuals collected.

Appendix B

Below Landfill

STORET station -> 33010090
Sample date -> 1/15/2014

Stream Condition Index

Order	Taxon Name / Repnum ->	Rep 1NCounted	Rep 2NCounted
Acariformes	Hygrobates	8	3
Amphipoda	Hyalella azteca	2	6
Bivalvia	Sphaeriidae(mollusca)	0	2
Coleoptera	Stenelmis	36	39
	Dubiraphia vittata	4	8
	Microcylloepus pusillus	0	2
	Ancyronyx variegatus	4	2
	Gonielmis dietrichi	1	0
	Neoporus	0	2
Diptera	Simulium	9	3
	Chironomidae	4	4
	Potthastia	1	0
	Phaenopsectra	1	0
	Polypedilum laetum	0	1
	Tribelos jucundum	0	1
	Rheotanytarsus pellucidus	2	2
	Neoplasta	0	2
	Thienemannimyia grp.	1	2
	Polypedilum scalaenum grp.	1	0
	Rheotanytarsus exiguus grp.	9	5
	Tanytarsus sp. c epler	1	0
	Polypedilum flavum	1	0
	Tvetenia tshernovskii	5	4
Ephemeroptera	Baetis intercalaris	0	5
	Acerpenna pygmaea	6	5
	Eurylophella doris	1	1
	Maccaffertium	5	0
Gastropoda	Hydrobiidae	1	0
Isopoda	Caecidotea	0	1

Odonata	Enallagma	2	1
	Argia	0	2
Oligochaeta	Eclipidrilus	0	1
Trichoptera	Chimarra	0	3
	Cernotina	1	14
	Cheumatopsyche	12	9
	Hydropsyche	0	1
	Hydroptila	1	1
	Oxyethira	1	0
	Triaenodes	8	10
	Oecetis georgia	13	7
	Nectopsyche	1	2

Qualitative Periphyton Results

Scientific name	Counts
Phylum Cyanobacteria	
Synechocystis sp.	3
Oscillatoria tenuis	4
Schizothrix calcicola	11
Pseudanabaena mucicola	4
Jaaginema gracile	3
Geitlerinema acutissimum	2
Komvophoron schmidlei	3
Phylum Bacillariophyta (Diatoms)	260
Phylum Chlorophycota (green algae)	
Scenedesmus brasiliensis	3
Closterium libellula intermedium	2
Cosmarium contractum pachydermum	2
Cosmarium phaseolus phaseolus	1
Actinotaenium inconspicuum	1
Oedogonium sp.	2

Above Landfill

STORET station ->	33010087
Sample date ->	1/15/2014

Stream Condition Index

Order	Taxon Name	Rep 1NCounted	Rep 2NCounted

Acariformes	Hygrobates	3	2
Amphipoda	Hyalella azteca	5	3
Coleoptera	Dytiscidae	2	2
	Elmidae	0	1
	Stenelmis	9	2
	Microcylloepus pusillus	1	1
	Ancyronyx variegatus	1	1
Diptera	Cecidomyiidae	1	0
	Simulium	1	1
	Chironomidae	8	8
	Corynoneura	1	0
	Cricotopus bicinctus	1	3
	Rheocricotopus robacki	1	0
	Stenochironomus	1	0
	Tribelos fuscicornis	1	1
	Paratanytarsus	1	0
	Rheotanytarsus pellucidus	14	11
	Thienemannimyia grp.	6	7
	Rheotanytarsus exiguus grp.	37	39
	Tanytarsus sp. l epler	1	3
	Tanytarsus sp. c epler	2	5
	Tanytarsus sp. u epler	4	2
	Cricotopus or orthocladius	1	1
	Polypedilum flavum	2	2
	Tvetenia tshernovskii	6	9
Ephemeroptera	Heptageniidae	4	1
	Baetidae	0	1
	Baetis intercalaris	2	0
	Acerpenna pygmaea	15	15
	Eurylophella doris	0	1
	Maccaffertium smithae	3	5
Heteroptera	Belostoma	0	1
Odonata	Neurocordulia	0	1
	Calopteryx	0	1
	Enallagma	0	1
Plecoptera	Perlidae	0	1
Trichoptera	Chimarra	0	1
	Hydropsychidae	1	0
	Cheumatopsyche	9	7
	Hydropsyche	1	0
	Hydroptila	1	0
	Oxyethira	1	0
	Triaenodes	3	1

Oecetis georgia	3	2
Ceraclea	0	1

Qualitative Periphyton Results

Scientific name	Counts
Phylum Cyanobacteria	
Synechocystis sp.	3
Oscillatoria tenuis	4
Schizothrix calcicola	11
Pseudanabaena mucicola	4
Jaaginema gracile	3
Geitlerinema acutissimum	2
Komvophoron schmidlei	3
Phylum Bacillariophyta (Diatoms)	260
Phylum Chlorophycota (green algae)	
Scenedesmus brasiliensis	3
Closterium libellula intermedium	2
Cosmarium contractum pachydermum	2
Cosmarium phaseolus phaseolus	1
Actinotaenium inconspicuum	1
Oedogonium sp.	2