

**2020**  
**Macroinvertebrate Sampling Study**  
**Downstream**  
**of**  
**Green Lake Dam**  
**Ellsworth Maine**  
**FERC No. 7189**

*Submitted by:*

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*Submitted to:*

**Green Lake Water Power Company**  
**Ellsworth, Maine**  
**Date: 3-15-21**

## **Introduction**

This macroinvertebrate sampling study was conducted in support of the relicensing of the Green Lake Hydroelectric Project, Federal Energy Regulatory Commission (FERC) Project No. 7189. This report details the 2020 study efforts as part of the Water Quality Certification Process.

## **Study Objectives**

The goal of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in Reeds Brook downstream of the Green Lake Dam and assess this community in terms of Maine's Aquatic Life Standards.

## **Study Area**

In 2020 we placed samples at three (3) sites in Reeds Brook to study aquatic macroinvertebrates (Figure 1) after conferring with the Maine Department of Environmental Protection (MDEP). **Site 1** was located approximately 290ft downstream of the existing dam. This site was located upstream of the Green Lake Hatchery discharge. **Site 2** was located approximately 240 ft downstream of the powerhouse and approximately 2240 ft downstream of the dam. Site 3 was located approximately 400 downstream of the confluence of Reeds Brook and the powerhouse tailrace, approximately 2350 ft downstream of the dam.

**Figure 1. Location of aquatic macroinvertebrate sampling site downstream of the Green Lake Dam. Reeds Brook, August, September 2020.**



## **Water Classification**

Reeds Brook downstream of the Green Lake Dam is classified Class B ((38 M.R.S.A § 467(7)(A)(7)). With respect to designated uses, the Maine Water Quality Law requires that “Class B waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired” (38 M.R.S.A. § 465(3)(A)). The word “unimpaired” is defined to mean “without a diminished capacity to support aquatic life” (38 M.R.S.A. § 466(11)). In addition, for Class B waters, “Discharges to Class B waters may not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community” (38 M.R.S.A. § 465(3)(C)). The term “resident biological community” is defined as “aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant” ((38 M.R.S.A. § 466(10)). The

term “without detrimental changes in the resident biological community” means no significant loss of species or excessive dominance by any species or group of species attributable to human activity” ((38 M.R.S.A. § 466(12)).

## **Study Methods**

The objective of the macroinvertebrate sampling study was to determine if the aquatic life, in this case the macroinvertebrate community, attained these Class B standards. The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides Revised 2014) were used as the basis of the field and laboratory procedures in the macroinvertebrate sampling study. A summary of these methods is given below.

The DEP standard rock bag samplers were used for this study. These samplers hold approximately 16 lbs. of clean, washed, bank-run cobble, graded to uniform diameter range of 1.5 to 3 inches. Three (3) samplers were placed at the sample sites; samplers were left in the river for approximately 28 days ( $\pm$  4 days) to allow for invertebrate colonization. Retrieval of the samplers was done using an aquatic D-net. The net was placed directly downstream of a sampler; the sampler was then picked up and placed in the net. The contents of each sampler and the net were washed through a sieve bucket and preserved in labeled jars. Habitat measurements including substrate type, depth, and temperature were collected at sampler collection retrieval.

Samples were collected, preserved, and transported to the Moody Mountain Environmental laboratory. The three (3) samplers (replicates) were sorted, identified, and enumerated.

## **Results**

The samplers were placed in the river on August 27, 2020. Samplers were retrieved on September 24, 2020. Upon retrieval it was evident that samplers at Site 2 had washed downstream and had been disturbed. In addition, samplers at Site 2 were impacted by water levels in Graham Lake and were in a Lentic habitat rather than a lotic habitat in the weeks prior to placement.

Samplers at Site 3 were also impacted by water levels in Graham Lake and were in a Lentic habitat rather than a lotic habitat during the colonization period. It was decided to not analyze the samples from Site 2 and 3 further. Habitat measurements for Site 1 are shown in Table 1 and Appendix 1. Photos of the areas around the sample site and substrates are included below.

**Table 1. Habitat measurements at Site 1 in Reeds Brook downstream of Green Lake Dam for aquatic macroinvertebrate sampling. August, September 2020**

### Macroinvertebrate Field Data Sheet

<b>Log</b> _____	Directions _____	Type of Sampler <b>RB</b>
<b>Station Number</b> _____	_____	Date Deployed <b>8/27/20</b>
Waterbody <b>Reeds Brk.</b>	_____	Number Deployed <b>3</b>
River Basin <b>Unioin R.</b>	Lat-Long Coordinates _____	Date Retrieved <b>9/24/20</b>
Town <b>Ellsworth</b>	<b>N44.626075</b>	Number Retrieved <b>3</b>
Stream Order <b>6</b>	<b>W68.443577</b>	Collector(s) <b>P Leeper MME</b>

<b>1. Land Use</b> (surrounding watershed) <input type="checkbox"/> Urban <input type="checkbox"/> Upland conifer <input type="checkbox"/> Cultivated <input type="checkbox"/> Swamp hardwood <input type="checkbox"/> Pasture <input type="checkbox"/> Swamp conifer <input checked="" type="checkbox"/> Upland hardwood <input type="checkbox"/> Marsh	<b>2. Terrain</b> <input type="checkbox"/> Flat <input type="checkbox"/> Rolling <input checked="" type="checkbox"/> Hilly <input type="checkbox"/> Mountains	<b>3. Canopy Cover</b> <input checked="" type="checkbox"/> Dense (75-100% shaded) <input type="checkbox"/> Partly open (25-75% shaded) <input type="checkbox"/> Open (0-25% shaded) (% daily direct sun) _____
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<b>4. Physical Characteristics of Bottom</b> estimate % over 12 m stretch					
	Bedrock	[40	Cobble (2.5" – 10")		Sand (<1/8")
	Boulders (>10")	[10	Gravel (1/8" – 2.5")		Clay
					Muck

<b>5. Habitat Characteristics</b> (immediate area)		Temp. Probe # _____	<b>7. Water Samples</b>
Time <b>1120h</b> Wetted Width <b>6.4m</b> Bank Fl Width _____ Depth <b>21cm</b> Velocity 9cm/s Diss. O <sub>2</sub> (ppm) 7.9 Temp ( C) 20.6 Turbidity _____ DO Meter # <u>YSI Pro 1</u> Cal? Y/	Time <b>0955h</b> Wetted Width (m) <b>6.4m</b> Bank Full Width _____ Depth <b>24cm</b> Velocity 1 cm/s Diss. O <sub>2</sub> (ppm) <u>8.9</u> Temp ( C) 17.2 Turbidity _____ DO Meter # <u>YSI Pro 1</u> Cal? Y/	<input type="checkbox"/> deployed <b>6. Observations</b>    	<input type="checkbox"/> Standard <input type="checkbox"/> Other Lab Number _____  <b>8. Photograph</b> <u>Put-In Yes</u> <u>Take-Out Yes</u>

**Photo 1. View north-northwest, upstream from sample site upstream to dam. Reeds Brk. 8/27/20 PCL**



**Photo 2. View southeast from sample site. Reeds Brk. 8/27/20 PCL**



**Photo 3. Typical substrate at sample site. Reeds Brk. 9/24/20 PCL**



**Photo 4. Typical substrate and sampler at sample site. Reeds Brk. 9/24/20 PCL**



## LDM Results

The LDM biocriteria results are shown in Table 2 and Appendix 1. To attain a particular class a site must have a 60% or greater score in the test for that class. DEP finds that the community was in attainment of Aquatic Life Class B Standards. The make-up of this community and a discussion of the results are presented below.

**Table 2. Results of the DEP linear discriminant model (LDM) for a site on Reeds Brk in Ellsworth Maine downstream of Green Lake Dam in 2020. A score of 60% or greater is needed to attain a particular class.**

Site	Probability of Class A	Probability of Class B	Probability of Class C	Probability of Non-Attainment
1	14%	99%	100%	0%

## Community Analysis

The macroinvertebrate community sampled downstream of the Green Lake Dam was not abundant but was relatively rich in taxa (Table 3 and Appendix 1). The community was populated with 26 different taxa with a Mean Total Abundance of 99. The community was dominated by sensitive mayflies, representing over 47% of Total Abundance. Structural indices for the sampled community are shown in Tables 3 and 4.

**Table 3. Indices of community structure for the aquatic invertebrate community downstream of the Green Lake Dam. Reeds Brook, August, September 2020.**

Tot. Abund.	Taxa Richness	S-W Div.	Hils. Biotic Index (HBN)	Water Quality indication from HBN	Mayfly, Stonefly, Caddisfly (EPT) Richness	Mayfly, Stonefly (EP)		Midge	
						Rich	% Ab	Rich	% Ab
99	26	3.37	4.28	Good	13	7	47	6	4

Indexes measuring the tolerance to poor water quality conditions revealed that mayflies, generally considered to be “clean water organisms” sensitive to poor water quality, dominated the community. The EP index of sensitive mayflies and stoneflies showed 7 taxa representing 47% of the community. Sensitive stoneflies were represented by one individual. The Hilsenhoff Biotic Index value, 4.28, indicated good water quality (Hilsenhoff 1987).



Dominant organisms (representing over 5% of the Total Abundance) in the community are shown in Table 4 arranged from the most sensitive organisms to the organisms most tolerant of poor water quality conditions. The community had five (5) organisms that made up 77% of the total abundance, among these were 3 sensitive organisms representing 61% of the community. No organisms tolerant to poor water quality conditions were dominant in the community.

**Table 4. Dominant aquatic invertebrate organisms downstream of the Green Lake Dam. Reeds Brook, July, August 2020.**

Sensitivity to Poor Water Quality	Dominant Organism	% of Community
Sensitive	Maccaffertium	25%
	Hydropsyche	25%
	Timpanoga	11%
Intermediate	Cheumatopsyche	9%
	Polycentropus	7%
Tolerant		

The community structure and function found downstream of the Green Lake Dam on Reeds Brook shows little evidence of disturbance from project operations or organic enrichment. It appears that water quality is very good as the dominant genera are predominantly sensitive to poor conditions and tolerant organisms make up a minor proportion of the community. Finally, the community is not dominated by filter-feeders, a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983).

Therefore, it is my professional opinion that the community sampled downstream of Green Lake Dam on Reeds Brook attains class B aquatic life standards.

## Summary

1. The objective of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in Reeds Brook downstream of the Green Lake Dam and

assess this community in terms of Maine's Aquatic Life Standards. Reeds Brook downstream of the dam is classified Class B.

2. The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides Revised 2014) were used as the basis of the field and laboratory procedures in this study.
3. Samplers were placed at 3 sites on August 27. Retrieval was on September 24. At retrieval it was found that samplers at sites 2 and 3 had been disturbed and/or been influenced by Graham Lake. These samples were not analyzed. Samplers at site 1, approximately 485 ft downstream of the dam, were collected within an acceptable colonization time frame.
4. The DEP finds that the LDM biocriteria results indicate that the community is in attainment of Class B Aquatic Life Standards.
5. The invertebrate community sampled downstream of the Green Lake Dam was not abundant but was relatively rich in taxa. Mayflies, generally considered to be sensitive to poor water quality conditions, represented 46% of the community. Taxa tolerant to poor water quality conditions make up a minor proportion of the community. This indicates that the water quality is very good, and there is little evidence of disturbance from project operations.
6. The community structure and function found downstream of the Green Lake Dam shows there have been no detrimental changes in the resident biological community; specifically, there has been no significant loss of species or excessive dominance by any species or group of species attributable to human activity.
7. It is my professional opinion that the macroinvertebrate community in the tailwater section of Green Lake Dam on Reeds Brook attains class B aquatic life standards.

## References

- Davies, S.P. and L. Tsomides. Revised 2014. Methods for biological sampling and analysis of Maine's rivers and streams. ME Dept. of Env. Prot. Augusta, ME. 31p.
- Hynes, H.B.N. 1970. The Ecology of Running Waters. Univ. of Toronto. Toronto, CA 555p.
- Parker, C.R. and J.R. Voshell Jr. 1983. Production of filter-feeding Trichoptera in an impounded and a free-flowing river. Can. J. Zool. 61:70-87.
- Spence, J.A., and H.B.N. Hynes. 1971. Differences in benthos upstream and downstream of an impoundment. J. Fish. Res. Bd. Canada 28: 35-43.

Appendix 1- LDM data files including field data, and individual replicate data.



Maine Department of Environmental Protection  
 Biological Monitoring Program  
 Aquatic Life Classification Attainment Report

**Station Information**

<b>Station Number:</b> S-1190	River Basin:
Waterbody: Reeds Brook - Station 1190	HUC8 Name:
Town: Ellsworth	Latitude:
Directions: GREEN LAKE HATCHERY, DRIVE UP ROAD TO DAM, SITE IS JUST UPSTREAM OF HATCHERY DISCHARGE	Longitude:
	Stream Order: 3

**Sample Information**

<b>Log Number:</b> 2860	Type of Sample: ROCK BAG	Date Deployed: 8/27/2020
Subsample Factor: X1	Replicates: 3	Date Retrieved: 8/27/2020

**Classification Attainment**

<b>Statutory Class:</b> B	<b>Final Determination:</b> B	Date: 2/18/2021
Model Result with P $\geq$ 0.6: B	<b>Reason for Determination:</b> Model	
Date Last Calculated: 2/16/2021	Comments:	

**Model Probabilities**

<u>First Stage Model</u>		<u>C or Better Model</u>	
Class A	0.45	Class C	0.16
Class B	0.39	NA	0.00
<u>B or Better Model</u>		<u>A Model</u>	
Class A or B	0.99	Class A	0.14
Class C or Non-Attainment	0.01	Class B or C or Non-Attainment	0.86

**Model Variables**

01 Total Mean Abundance	99.33	18 Relative Abundance Ephemeroptera	0.47
02 Generic Richness	26.00	19 EPT Generic Richness	13.00
03 Plecoptera Mean Abundance	0.33	21 Sum of Abundances: <i>Dicrotendipes</i> , <i>Micropsectra</i> , <i>Parachironomus</i> , <i>Helobdella</i>	0.00
04 Ephemeroptera Mean Abundance	46.67	23 Relative Generic Richness- Plecoptera	0.04
05 Shannon-Wiener Generic Diversity	3.37	25 Sum of Abundances: <i>Cheumatopsyche</i> , <i>Cricotopus</i> , <i>Tanytarsus</i> , <i>Ablabesmyia</i>	9.33
06 Hilsenhoff Biotic Index	4.28	26 Sum of Abundances: <i>Acroneuria</i> , <i>Maccaffertium</i> , <i>Stenonema</i>	24.33
07 Relative Abundance - Chironomidae	0.04	28 EP Generic Richness/14	0.50
08 Relative Generic Richness Diptera	0.27	30 Presence of Class A Indicator Taxa/7	0.00
09 <i>Hydropsyche</i> Abundance	24.67		
11 <i>Cheumatopsyche</i> Abundance	8.67		
12 EPT Generic Richness/ Diptera Generic Richness	1.86		
13 Relative Abundance - Oligochaeta	0.00		
15 Perlidae Mean Abundance (Family Functional Group)	0.33		
16 Tanypodinae Mean Abundance (Family Functional Group)	0.00		
17 Chironomini Abundance (Family Functional Group)	2.33		

**Five Most Dominant Taxa**

Rank	Taxon Name	Percent
1	<i>Hydropsyche</i>	24.83
2	<i>Maccaffertium</i>	24.50
3	<i>Timpanoga</i>	11.07
4	<i>Cheumatopsyche</i>	8.72
5	<i>Attenella</i>	4.70
6	<i>Oecetis</i>	4.70



**Maine Department of Environmental Protection  
Biological Monitoring Program  
Aquatic Life Classification Attainment Report**

**Station Number: S-1190**      Town: Ellsworth      Date Deployed: 8/27/2020  
**Log Number: 2860**      Waterbody: Reeds Brook - Station 1190      Date Retrieved: 8/27/2020

**Sample Collection and Processing Information**

Sampling Organization: PCL      Taxonomist: PAUL LEEPER (MOODY MOUNTAIN ENVIRONMENTAL)

**Waterbody Information - Deployment**

Temperature: 20.1 deg C  
Dissolved Oxygen: 7.9 mg/l  
Dissolved Oxygen Saturation:  
Specific Conductance:  
Velocity: 9 cm/s  
pH:  
Wetted Width: 6.4 m  
Bankfull Width:  
Depth: 21 cm

**Waterbody Information - Retrieval**

**Water Chemistry**

**Summary of Habitat Characteristics**

<u>Landuse Name</u>	<u>Canopy Cover</u>	<u>Terrain</u>	
Upland Hardwood	Dense	Hilly	
<u>Potential Stressor</u>	<u>Location</u>	<u>Substrate</u>	
Regulated Flows	Below Dam	Boulder	40 %
		Gravel	20 %
		Rubble/Cobble	40 %

**Landcover Summary - 2004 Data**

**Sample Comments**

DOWNSTREAM OF DAM, UPSTREAM OF HATCHERY DISCHARGE



**Maine Department of Environmental Protection  
Biological Monitoring Program  
Aquatic Life Taxonomic Inventory Report**

**Station Number: S-1190**      Waterbody: Reeds Brook - Station 1190      Town: Ellsworth  
**Log Number: 2860**      Subsample Factor: X1      Replicates: 3      Calculated: 2/16/2021

Taxon	Maine Taxonomic Code	Count (Mean of Samplers)		Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance %	
		Actual	Adjusted			Actual	Adjusted
<i>Hyalella</i>	09010203006	2.67	2.67	8	CG	2.7	2.7
<i>Orconectes</i>	09010301008		0.33		CG		0.3
<i>Orconectes limosus</i>	09010301008013	0.33			--	0.3	
Perlidae	09020209	0.33	0.33		--	0.3	0.3
<i>Boyeria</i>	09020301004	1.00	1.00	2	PR	1.0	1.0
<i>Argia</i>	09020309048	0.67	0.67	7	PR	0.7	0.7
Baetidae	09020401	2.33	2.33		--	2.3	2.3
<i>Baetis</i>	09020401001	0.33	0.33	4	CG	0.3	0.3
<i>Maccaffertium</i>	09020402015	24.33	24.33	4	SC	24.5	24.5
<i>Paraleptophlebia</i>	09020406026	4.00	4.00	1	CG	4.0	4.0
<i>Attenella</i>	09020410032	4.67	4.67	3	CG	4.7	4.7
<i>Timpanoga</i>	09020410038	11.00	11.00		CG	11.1	11.1
<i>Chimarra</i>	09020601003	2.00	2.00	2	CF	2.0	2.0
Polycentropodidae	09020603	1.67	1.67		--	1.7	1.7
<i>Cheumatopsyche</i>	09020604015	8.67	8.67	5	CF	8.7	8.7
<i>Hydropsyche</i>	09020604016	24.67	24.67	4	CF	24.8	24.8
<i>Oxyethira</i>	09020607028	0.33	0.33	3	P	0.3	0.3
<i>Oecetis</i>	09020618078	4.67	4.67	8	PR	4.7	4.7
<i>Nigronia</i>	09020701003	0.33	0.33	0	PR	0.3	0.3
<i>Cricotopus</i>	09021011037	0.67	0.67	7	SH	0.7	0.7
<i>Nanocladius</i>	09021011049	0.33	0.33	3	CG	0.3	0.3
<i>Rheotanytarsus</i>	09021011072	1.00	1.00	6	CF	1.0	1.0
<i>Microtendipes</i>	09021011094	1.33	1.33	6	CF	1.3	1.3
<i>Polypedilum</i>	09021011102	0.33	0.33	6	SH	0.3	0.3
<i>Stenochironomus</i>	09021011105	0.67	0.67	5	CG	0.7	0.7
<i>Simulium</i>	09021012047	0.33	0.33	4	CF	0.3	0.3
Hydrobiidae	10010104	0.67	0.67		--	0.7	0.7