September 28, 2021

VIA E-FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N. E.
Washington, DC 20426

Lowell Tannery Hydroelectric Project (FERC No. 4202-024)
Final License Application

Dear Secretary Bose:

On behalf of our client KEI (USA) Power Management Inc. (KEI (USA)), Kleinschmidt herein submits to the Federal Energy Regulatory Commission (FERC) the Final License Application (FLA) for Subsequent License (Minor Project) for the Lowell Tannery Hydroelectric Project (FERC No. 4202). The 1,000-kilowatt project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine. The current license, issued by the Commission on October 31, 1983, expires on September 30, 2023. KEI (USA) is required to file a FLA for Subsequent License with the FERC on or before September 30, 2021. The FLA is being provided consists of:

Initial Statement
Exhibit A – Project Description and Description of Operations
Exhibit E – Environmental Report
Exhibit F – General Design Drawings (provided to FERC only as CEII for security purposes)
Exhibit G – Project Boundary Maps
Exhibit H – the exhibit is not applicable based on the Lowell Tannery Project being defined as minor project under 1.5 megawatts, seeking a subsequent license

KEI (USA) has prepared this FLA to conform to the requirements of the Commission's regulations at 18 CFR § 4.61, as so required under the Traditional Licensing Process (TLP) which was approved by FERC on November 23, 2018. Pursuant to 18 CFR §4.38 and 16.8 KEI (USA) is providing the FLA (via email) to resource agencies, tribes, non-governmental organizations, and other potential interested parties included on the attached distribution list.

If there are any questions regarding this filing, please contact me at (207) 416-1246 or by email at Andy.Qua@KleinschmidtGroup.com.

Sincerely,

Kleinschmidt Associates

Andrew Qua
Senior Licensing Coordinator

ADQ:TMJ

Enclosures: Attachment A: Distribution List for the Lowell Tannery Project (FERC No. 4202)
Attachment B: Final License Application

ATTACHMENT A

DISTRIBUTION LIST FOR THE LOWELL TANNERY PROJECT (FERC NO. 4202)

Lowell Tannery distribution List
September 2021

Federal Agencies

John T. Eddins
Office of Project Review
Advisory Council on Historic Preservation
401 F Street, NW, Suite 308
Washington, DC, 20001-2637
achp@achp.gov

Mr. Harold Peterson
Bureau of Indian Affairs
545 Marriott Drive
Suite 700
Nashville, TN 37214
harold.peterson@bia.gov

Mr. Jeff Murphy
Maine Field Office
National Oceanic & Atmospheric Administration,
National Marine Fishieries Service
17 Godfrey Drive
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jeff.murphy@noaa.gov

Mr. Donald Dow
National Marine Fisheries Service
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Surface Water Branch Chief
U.S. Environmental protection Agency
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Migratory Fish/Hydropower
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Lowell Tannery distribution List
September 2021

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Environmental Coordinator
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Resource Coordinator
Maine Department of Marine Resources
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Augusta, ME 04330
casey.clark@maine.gov

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Review & Compliance / CLG Coordinator
Maine Historic Preservation Commission
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Augusta, ME 04333
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Lowell Tannery distribution List
September 2021

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Lowell, ME 04493
info@lowellme.org

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Old Town, ME 04468
bmayo@old-town.org

Licensee

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Andy Qua
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Kleinschmidt Associates
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Pittsfield, ME 4967
andy.qua@kleinshmidtgorup.com

ATTACHMENT B

FINAL LICENSE APPLICATION

Final License Application

Lowell Tannery Hydroelectric Project

FERC No. 4202

Application for Subsequent License
For Minor Project Less Than 5MW

Prepared for:

KEI (USA) Power Management Inc.

Prepared by:

Kleinschmidt Associates

September 2021

Initial Statement

United States of America
Before the
Federal Energy Regulatory Commission

Lowell Tannery Project **FERC Project No. 4202**

Application for Subsequent License
For A Minor Water Power Project (5 Megawatts or Less)
Existing Dam

Initial Statement
(Pursuant to 18 C.F.R. §4.61)

1. KEI (USA) Power Management Inc. (hereinafter the KEI (USA) or "Applicant") applies to the Federal Energy Regulatory Commission (hereinafter "FERC" or "Commission") for a New License for the Lowell Tannery Project ("Project"),

2. The location of the Project is:

State:	Maine
County:	Penobscot
Township or nearby Towns:	Lowell
Stream or other body of water:	Passadumkeag River

3. The exact name and business address of the Applicant are:

   KEI (Maine) Power Management (II) LLC
   c/o KEI (USA) Power Management Inc.
   423 Brunswick Avenue
   Gardiner, ME 04345

4. The exact name, business address, and telephone number of each person authorized to act as agent for the Applicant in this application are:

Lewis C. Loon, General Manager
Operations and Maintenance–USA
KEI (USA) Power Management Inc.
423 Brunswick Avenue
Gardiner, ME 04345
Phone: (207) 203-3025
Fax: (207) 582-0094
Email: LewisC.Loon@kruger.com

5. The Applicant is a domestic corporation organized under the laws of the State of Maine and is not claiming preference under section 7(a) of the Federal Power Act (See 16 U.S.C. 796).

6. (a) The statutory or regulatory requirements of the State of Maine, in which the Project is located, which would, assuming jurisdiction and applicability, affect the Project with respect to bed and banks, and to the appropriation, diversion and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act are:

   Water Quality Permit from the Maine Department of Environmental Protection to ashore compliance of Section 401 of the Federal Clean Water Act.

   (b) The steps which the Applicant has taken, or plans to take, to comply with each of the laws cited above are:

   The applicant will apply for the 401 Water Quality Certification per 18 CFR § 5.23 (b).

7. Brief Project description:

The single-development Lowell Tannery Hydroelectric Project is located on the Passadumkeag River within Penobscot County, near the community of Lowell, in east-central Maine. The Project is approximately 13 river miles upstream of the confluence with the Penobscot River. Project works include consists of a concrete gravity dam with spillway sections, topped with 3.5-foot-high flashboards, and outlet gate, and a log sluice section, a powerhouse with a single turbine-generator with a total rated capacity of 1,000 kW, upstream and downstream fishway passage facilities, a 200-foot-long transmission line, and appurtenant facilities. Table 4-1 provides the specifications for the Project. The Project was developed in 1986. As a run-of-river dam the project has no useable storage capacity. The project reservoir is approximately 341 acres at elevation 187.5 feet mean sea level. The Project boundary includes the dam, powerhouse, 4 miles upstream, and approximately 250 feet downstream of the powerhouse. The Lowell Tannery Project operates as a run-of-river facility. The project has an overall minimum flow requirement of 150 cfs (or inflow if less) minimum flow. KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. KEI (USA) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provided through the downstream fishway from November 1 to ice-in.

8. Lands of the United States.

The Lowell Tannery Hydroelectric Project (Project) is located entirely on private lands.

9. Construction of the Project.

This is an existing Project; KEI (USA) does not propose any construction at this time.

ADDITIONAL GENERAL INFORMATION

(*Pursuant to 18 C.F.R. § 5.18*)

(1) Identify every person, citizen, association of citizens, domestic corporation, municipality, or state that has or intends to obtain and will maintain any proprietary right necessary to construct, operate, or maintain the Project:

KEI (USA) holds and will maintain any proprietary rights necessary to construct, operate, or maintain the Lowell Tannery Hydroelectric Project (FERC No. 4202) (Project).

(2) Identify (providing names and addresses):

(i) Every county in which any part of the Project, and any Federal facilities that would be used by the Project is located:

The Project is located in Penobscot County, Maine.

Penobscot County Government Offices
97 Hammond St
Bangor, ME. 04401
207-942-8535

(ii) Every city, town, or similar local political subdivision:

(a) In which any part of the Project is or is to be located and any Federal facility that is or is to be used by the Project is located:

The Project is located in the State of Maine, Penobscot County on the Passadumkeag River in the town of Lowell and is located entirely on private lands.

Physical Location
129 West Old Main Road
Lowell, Maine 04493
Mailing Address
P.O. Box 166
Burlington, Maine 04417

(b) That has a population of 5,000 or more people and is located within 15 miles of the existing or proposed Project dam:

The adjacent town of Lincoln has an approximate population of 5,085. Office located at:

Ann Morrison
Town Clerk
29 Main Street
Lincoln, Maine 04457

(iii) Every irrigation district, drainage district, or similar special purpose political subdivision:

There are no irrigation district, drainage district, or similar special purpose political subdivision affected by the project.

(iv) Every other political subdivision in the general area of the Project that there is reason to believe would be likely to be interested in, or affected by, the application:

There is no other political subdivision in the general area of the Project that there is reason to believe would be likely to be interested in, or affected by, the application.

(v) All Indian Tribes that may be affected by the Project.

The project boundary includes a limited reach of the Passadumkeag River. KEI (USA) is not aware the Project affects any Native American tribe. There are no Native American lands, known Native American traditional cultural properties or religious properties, or National Register-eligible or -listed sites associated with Native American Nations within the Project boundary to KEI's knowledge.

(3) The Applicant has, in accordance with 18 CFR § 5.18 (3)(i), made a good-faith effort to notify, by certified mail, the following entities of the filing of this application:

(a) Every property owner of record of any interest within the bounds of the Project;

(b) The entities listed in (2) above; and

(c) Other governmental agencies that would likely be interested in or affected by the application.

A complete listing of appropriate agencies, tribes, local governments, non-governmental organizations, and abutting property owners to which this license application was distributed to are provided in Appendix A.

(4) In accordance with 18 CFR § 4.61 of the Commission's regulations, the following Exhibits are attached to and made a part of this application:

Exhibit A – Project Description and Description of Operations

Exhibit E – Environmental Report

Exhibit F – General Design Drawings (*provided under separate cover as CEII for security purposes*)

Exhibit G – Project Boundary Maps

SUBSCRIPTION

This Application for License for the Lowell Tannery Hydroelectric Project, FERC No. 4202, is executed in the State of Maine, County of Penobscot, by Signee of KEI (USA) Power Management Inc. (423 Brunswick Avenue, Gardiner, ME 04345), who, being duly sworn, deposes and says that the contents of this application are true to the best of his knowledge or belief and that he is authorized to execute this application. The undersigned have signed this application this 28th day of September, 2021.

KEI (USA) Power Management Inc.

By ____________________________________

VERIFICATION

By order dated July 26, 2021, the Commission extended waiver of notarization requirements.

CERTIFICATE OF SERVICE

I, Andrew Qua, Regulatory Coordinator, Kleinschmidt, hereby certify that I have this day served upon each person designated on the attached Distribution List notice of availability and/or a copy of the Lowell Tannery Hydroelectric Project, LLC, FERC No. 4202, Application for Final License. Dated this this 28th day of September, 2021.

By: ______________________________

Andrew Qua
Regulatory Coordinator
Kleinschmidt

Appendix A

Distribution List

EXHIBIT A

PROJECT DESCRIPTION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF APPENDICES

1.0 PROJECT LOCATION

The single-development Lowell Tannery Hydroelectric Project is located on the Passadumkeag River within Penobscot County, near the community of Lowell, in east-central Maine. The Project is approximately 13 river miles upstream of the confluence with the Penobscot River. Project works consists of a concrete gravity dam with spillway sections, topped with 3.5-foot-high flashboards, and outlet gate, and a log sluice section, a powerhouse with a single turbine-generator with a total rated capacity of 1,000 kW, upstream and downstream fishway passage facilities, a 200-foot-long transmission line, and appurtenant facilities. Table 2.1 provides the specifications for the Project. The Project was developed in 1986. As a run-of-river dam, the project has no useable storage capacity. The project reservoir is approximately 341 acres at elevation 187.5 feet mean sea level (FERC 2014). The Project boundary includes the dam, powerhouse, 4 miles upstream, and approximately 250 feet downstream of the powerhouse. The Lowell Tannery Project operates as a run-of-river facility. The project has an overall minimum flow requirement of 150 cfs (or inflow if less). KEI (USA) Power Management Inc. (KEI (USA)) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. KEI (USA) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provided through the downstream fishway from November 1 to ice-in.

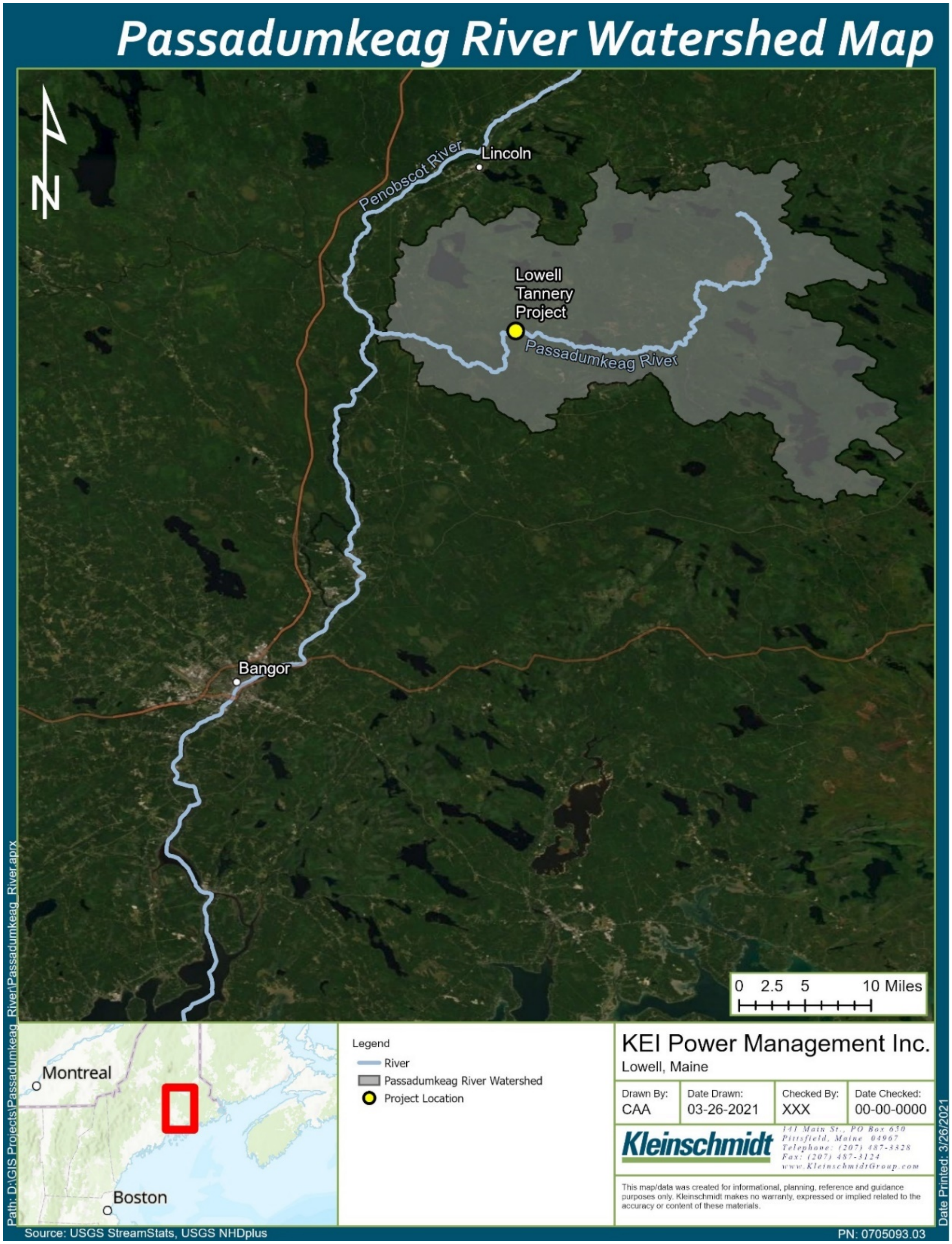


Figure 1.1 Watershed and Project Location

2.0 DESCRIPTION OF PROJECT

2.1 Project Facilities

2.1.1 Project Dam

Lowell Tannery Dam is a concrete structure with a total length of 230 feet (Photo 2.1). It has a maximum height of 27 feet. The principal spillway, which accounts for 30 feet of the 230-foot length, has a permanent crest at elevation 184.05 feet. The top of flashboards height (normal pond) is at elevation 187.5 feet. There is an auxiliary spillway that is 89-feet-long with crest elevation of 184.05 feet. There is also a seven-foot-wide log sluice and a ten-foot-wide Tainter gate used to bypass flows and draw the impoundment down.

Photo 2.1 Lowell Tannery project looking up from Fogg Brook road bridge

2.1.2 Powerhouse

The Project powerhouse is located near the north dam abutment and contains a single vertical Kaplan turbine-generator unit with a rated capacity of 1,000 kW. The maximum hydraulic capacity of the turbine is 905 cfs with a 90 cfs minimum capacity. The intake is "V" shaped with a 3-foot by 3-foot pier to support the 15-foot, 6-inch wide, 12-foot high trashracks which have 1.5 inch clear spacing (Photo 2.2). The rated net head is 18 feet.

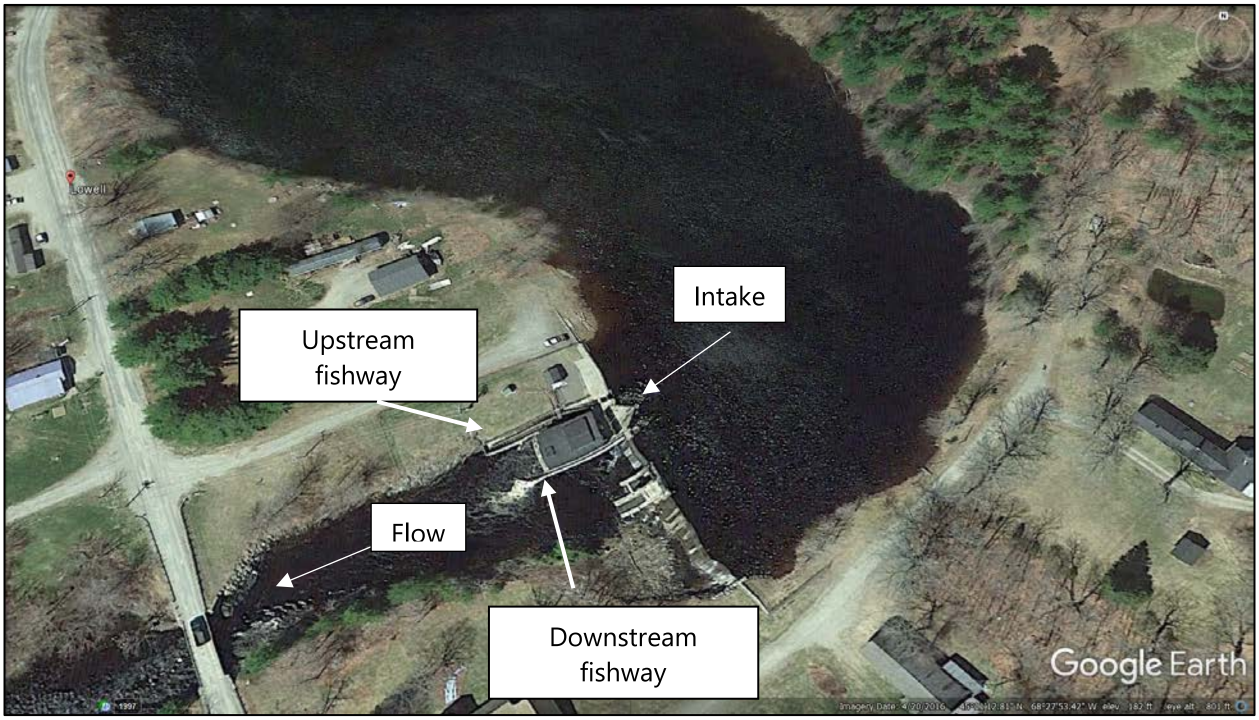


Photo 2.2 Aerial Imagery Showing Location of Upstream and Downstream Fishways and Angled Intake Racks at the Lowell Tannery Project.

2.1.3 Fishway Facilities

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam (Photo 2.2). The fishway is approximately 3 feet wide with 8-inch thick walls and consists of three runs and two switchbacks. Detailed dimensions will be included in the Final License Application. KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse.

Downstream fish passage is provided through a dedicated fish bypass (Photo 2.2). Adjacent to the eastern side of the intake racks, there is a downstream surface bypass gate that leads to an 18- inch bypass pipe, which discharges into a plunge pool next to the tailrace. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts (i.e., post-spawned adults) is provided through the downstream fishway from November 1 to ice-in.

2.1.4 Turbine/Generator

The Project contains a single vertical turbine-generator unit with a rated capacity of 1,000 kW. that can generate up to 905 cfs and a minimum capacity of 90 cfs. The project head of generation is approximately 18 feet.

2.1.5 Project Impoundment

The project reservoir is approximately 341 acres (Photo 2.3). Normal pond elevation for the Project is 187.5 feet. Because the Project is run-of-river, there is no useable storage behind the dam.

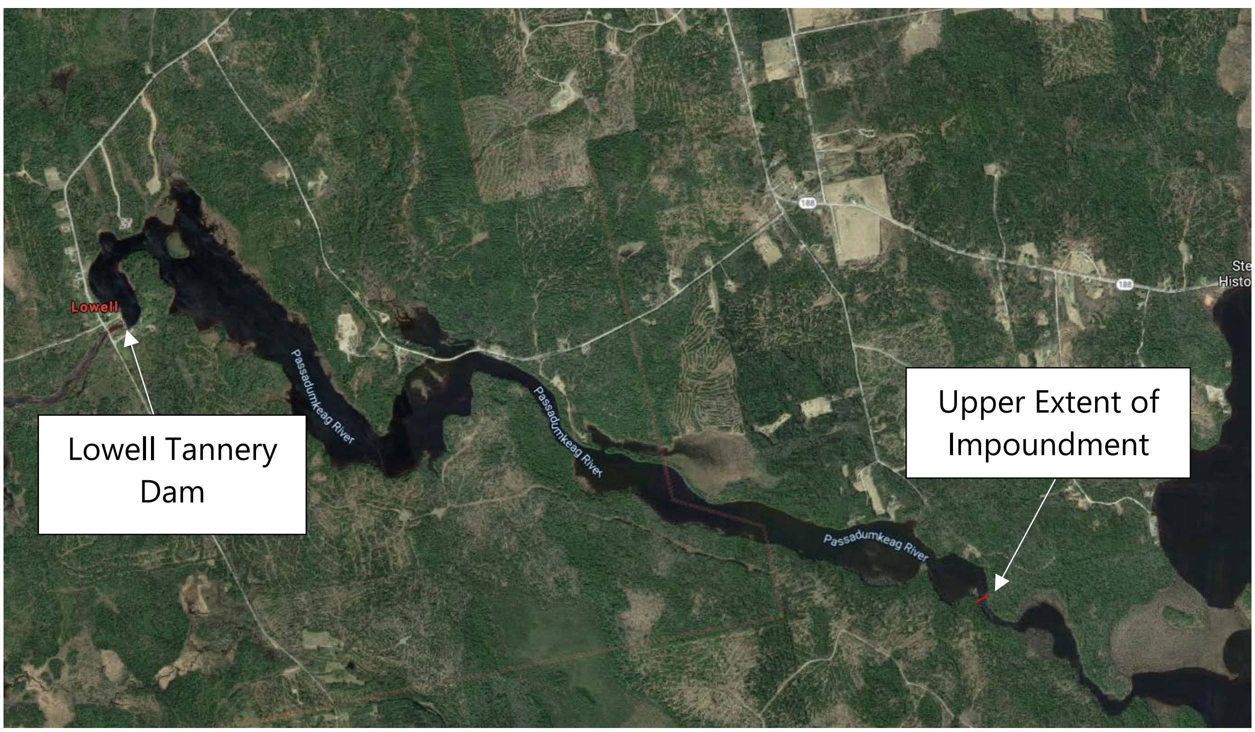


Photo 2.3 Lowell Tannery Impoundment

2.1.6 Tailrace

The Project has a normal tailwater elevation of 169.5 feet at a maximum unit discharge of 905 cfs. The tailrace extends approximately 250 feet downstream from the powerhouse to the bridge on Tannery Road (Fogg Brook Road).

2.1.7 Appurtenant Facilities and Equipment

The Project is equipped with a 1,000-kVA, 2.3/12.5-transformer and a 200-foot-long, 12.5-kV transmission line. The single line diagram for the Project considered CEII and is provided in Volume 2.

Table 2.1 Lowell Tannery Project Facilities and Descriptions

Lowell Tannery Project – FERC No. 4202	
Description	Number or Fact
General Information	
FERC Number	P-4202
License Issued	October 31, 1983
License Expiration Date	September 30, 2023
Licensed Capacity	1,000 kW
Project Location	On Passadumkeag River in Penobscot County, Maine.
Reservoir	
Surface Area of Reservoir	341 acres
Reservoir Elevation Normal Maximum	187.5 feet
Reservoir Storage Useable	0
Dam	
Dam Type	Concrete Gravity
Year Dam Constructed	1920s
Height	21.5 feet
Length of Dam	230 feet
Tainter Gate	10-feet-wide
Log Sluice	7-feet-wide
Flashboard type	Wooden
Flashboard height	3.5 feet
Elevation of Top of Flashboards	187.5 feet
Spillway	Two spillways, one 30-foot-long section and one 89-foot-long section

Lowell Tannery Project – FERC No. 4202	
Spillway permanent crest elevation	Spillway Crest 184.05 feet Emergency Spillway Crest 184.05 feet
Trashracks	1.5 inches clear spacing
Top of Trashrack Elevation	183 feet
Intake Structure	An integral, 22-foot, 2-inch concrete intake structure. The two intake openings are 15 feet 10 inches high, and two 15 feet 6 inches wide.
Powerhouse	
Length (Superstructure)	69-feet, 4 inches (not including the intake structure)
Width (Superstructure)	26-feet, 8 inches
Height (upstream)	32 feet 2 inches
Height (downstream)	43 feet 3 inches
Turbines/Generators	
Authorized Generation Capacity	1,000 kW
Number of units	1 vertical Kaplan unit
Rated Net Head	18 feet
Total Hydraulic Capacity	90 cfs minimum; 905 cfs maximum
Average Annual Generation	4,144 MWH
Fish Passage	
Upstream Passage	Denil Ladder
Downstream Passage	18-inch bypass pipe
Transmission Lines	
Type	12.5-kV
Length	200 feet
Transformer	1,000 kVA, 2.3/12.5

2.1.8 Proposed Facilities

KEI is not proposing any changes to the existing Project facilities.

2.1.9 Provisions for Future Units

There are no plans for additions or modifications for future units.

2.2 Project Operation

2.2.1 Current Project Operation

In accordance with the FERC Order 147 FERC ¶ 62,222, issued June 23, 2014, Ordering Paragraph (B)(2), Article 19, and the revised WQC for the Project (issued December 5, 2012), KEI (USA) is authorized to operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River while maintaining the headpond within one foot of elevation 187.5 feet. These flows may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods for fishery management purposes upon mutual agreement between the licensee and the Maine Department of Inland Fisheries and Wildlife. The project has an overall minimum flow requirement of 150 cfs (or inflow if less).

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam (Photo 2.2). KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse (Photo 2.2).

Downstream fish passage is provided through a dedicated fish bypass (Photo 2.2). Adjacent to the eastern side of the intake racks, there is a downstream surface bypass gate that leads to an 18- inch bypass pipe, which discharges into a plunge pool next to the tailrace. KEI (USA) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provided through the downstream fishway from November 1 to ice-in.

The Lowell Tannery Project is remotely monitored and operated 24 hours a day, 7 days a week. In addition, plant staff visit the site daily. A telephone paging system notifies project personnel of operational problems via cellular telephones. Plant staff are generally within 30 minutes of the Project at all times. Lowell Tannery is classified as a low hazard dam. Due to the low hazard classification of this dam, no Potential Failure Mode Analysis has been conducted at this site, and therefore, no Potential Failure Modes have been identified. The Dam Safety Surveillance and Monitoring Program and Report (DSSMP) defines the appropriate monitoring for the water retaining project works. The DSSMP for the Project was filed with the FERC in March 23, 2018.

In addition, Section 10(c) of the Federal Power Act (FPA) authorizes FERC to establish regulations requiring licensees to operate and properly maintain their Projects for the protection of life, health, and property. FERC Part 12 regulations include such safety measures as signage and exclusion devices.

KEI (USA) maintains a public safety plan for the Project, which depicts the public safety devices installed at the Project and their location.

2.2.2 Proposed Project Operation

KEI (USA) is proposing to continue operating the Lowell Tannery Project in a run-of-river mode. Therefore, KEI (USA) is proposing to eliminate the overall downstream minimum flow requirement of 150 cfs (or inflow if less) that is part of the current license. Operating in run-of-river requires that inflows and out flows from that project should be equal and maintaining aquatic habitat conditions downstream. All existing fishway passage flow requirements will be maintained as discussed in Section 2.2.1.

2.2.3 Proposed Environmental Measures

As discussed in Section 2.2.2, KEI (USA) does not propose any changes to the existing Project operations. Effects of the current operations on environmental resources are discussed in Exhibit E.

No additional environmental measures are proposed at this time.

2.3 Average Annual Generation

Project generation for the past five years (2016-2020) averaged 4,144 MWH; the monthly and yearly MWH totals are as follows:

Table 2.2 Monthly and Yearly Generation (MWH) for the Lowell Tannery Project

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2016	650	595	736	689	428	157	0	0	0	0	73	391	3,719
2017	490	365	520	641	450	363	25	0	0	61	210	323	3,448
2018	554	574	402	726	628	212	137	0	0	13	569	585	4,400
2019	548	474	431	669	702	448	297	192	265	427	510	690	5,653
2020	556	331	475	670	593	54	0	0	0	38	110	673	3,500
Average	559.6	467.8	512.8	679	560.2	246.8	91.8	38.4	53	107.8	294.4	532.4	4,144

2.4 Estimated Average Head

The Project is operated as run-of-river. The normal operating head for the Project is 18 feet.

2.5 Flow Data

2.5.1 Hydraulic Capacity of the Project

The total maximum hydraulic capacity of the Lowell Tannery Project generating unit is 905 cfs, at an operating head of approximately 18 feet. The minimum hydraulic capacity of the unit is 90 cfs.

2.5.2 River Flow Data

The Passadumkeag River is not currently gaged by the USGS. Monthly and annual mean flow and flow duration statistics at the Lowell Tannery dam were generated using the USGS StreamStats tool (USGS 2021). StreamStats estimates flow statistics for ungaged streams in Maine using regression equations from Dudley (2015). The annual mean flow at the Lowell Tannery Project is estimated to be 562 cfs (Table 2.3). The highest monthly mean flows are in April (1,170 cfs) and May (1,270 cfs). The lowest monthly mean flows are in August (153 cfs) and September (135 cfs) (Table 2.3). Annual and monthly flow duration curves are included in Appendix A.

Table 2.3 Monthly and Annual Average Flow at the Lowell Tannery Project

Month	Average Flow (cfs)
January	412
February	368
March	500
April	1,170
May	1,270
June	488
July	236
August	153
September	135
October	364
November	656
December	657
Annual	562

Source: USGS 2021

2.6 Dependable Capacity

Due to the absence of useable storage associated run-of-river operations, the Project is entirely dependent upon available inflows for generation. The dependable capacity ratings as identified in the ISO New England 2021 Capacity, Energy, Loads, and Transmission (CELT) Report are 0.795 MW for the winter seasonal claimed capacity (SCC) and 0.308 MW for the "expected" summer peak.

2.7 Estimated Cost of the Project

KEI (USA) proposes to install upstream and downstream eel passage measures and relocation of the downstream fish passage discharge at the project. The capital costs associated with these measures is estimated to be $100,000 with no appreciable change to annual operation and maintenance costs or loss in generation.

3.0 PURPOSE OF THE PROJECT

The Lowell Tannery Project is operated for the production of hydroelectric power. The power generated by this Project is integrated into KEI (USA), and sold to Versant Power, formerly Emera Maine. Versant Power provides reliable high voltage electric power to approximately 159,000 people within the state of Maine.

4.0 ESTIMATED COST OF RELICENSING

KEI (USA) estimates that the cost of relicensing the Lowell Tannery Hydroelectric Project is approximately $400,000. This cost includes both internal administrative costs and external expenses (e.g., consultant costs) over the course of the traditional licensing process (TLP), but does not include costs for proposed protection, mitigation, and enhancement measures (i.e., fish passage facilities and minimum flows).

5.0 VALUE OF PROJECT POWER

The Lowell Tannery Hydroelectric Project is operated in run-of-river mode and is part of KEI's (USA) portfolio of generation supply options. Power generated from the Lowell Tannery Hydroelectric Project has an average value of $276,600.

6.0 ESTIMATED CHANGE IN PROJECT GENERATION

The Project will continue to operate in a run-of-river mode.

7.0 UNDEPRECIATED NET INVESTMENT (BOOK VALUE) OF THE PROJECT

The undepreciated net investment for the Lowell Tannery project is approximately $978,000 as of April 30, 2021. The annual operation and maintenance costs of running the Lowell Tannery Hydroelectric Project facility $85,135 with the annual administrative expenses being approximately $42,886.

8.0 ESTIMATED ANNUAL COST OF THE PROJECT

The total annual cost to operate the project, including administrative costs, insurance, operations and maintenance, general and other expenses is as follows:

- Administrative costs $42,886
- Insurance $17,039
- Operations and maintenance $68,096
- General and other expenses (Included in the above)

9.0 PROJECT SAFETY PROGRAM

Lowell Tannery is classified as a low hazard dam. Due to the low hazard classification of this dam, no Potential Failure Mode Analysis has been conducted at this site, and therefore, no Potential Failure Modes have been identified. The Lowell Tannery Project is remotely monitored and operated 24 hours a day, 7 days a week. In addition, plant staff visit the site daily. A telephone paging system notifies project personnel of operational problems via cellular telephones. Plant staff are generally within 30 minutes of the Project at all times. The Dam Safety Surveillance and Monitoring Program and Report (DSSMP) defines the appropriate monitoring for the water retaining project works. The DSSMP for the Project was filed with the FERC on March 23, 2018.

In addition, Section 10(c) of the Federal Power Act (FPA) authorizes FERC to establish regulations requiring licensees to operate and properly maintain their Projects for the protection of life, health, and property. FERC Part 12 regulations include such safety measures as signage and exclusion devices.

KEI (USA) maintains a public safety plan for the Project, which depicts the public safety devices installed at the Project and their location.

10.0 REFERENCES

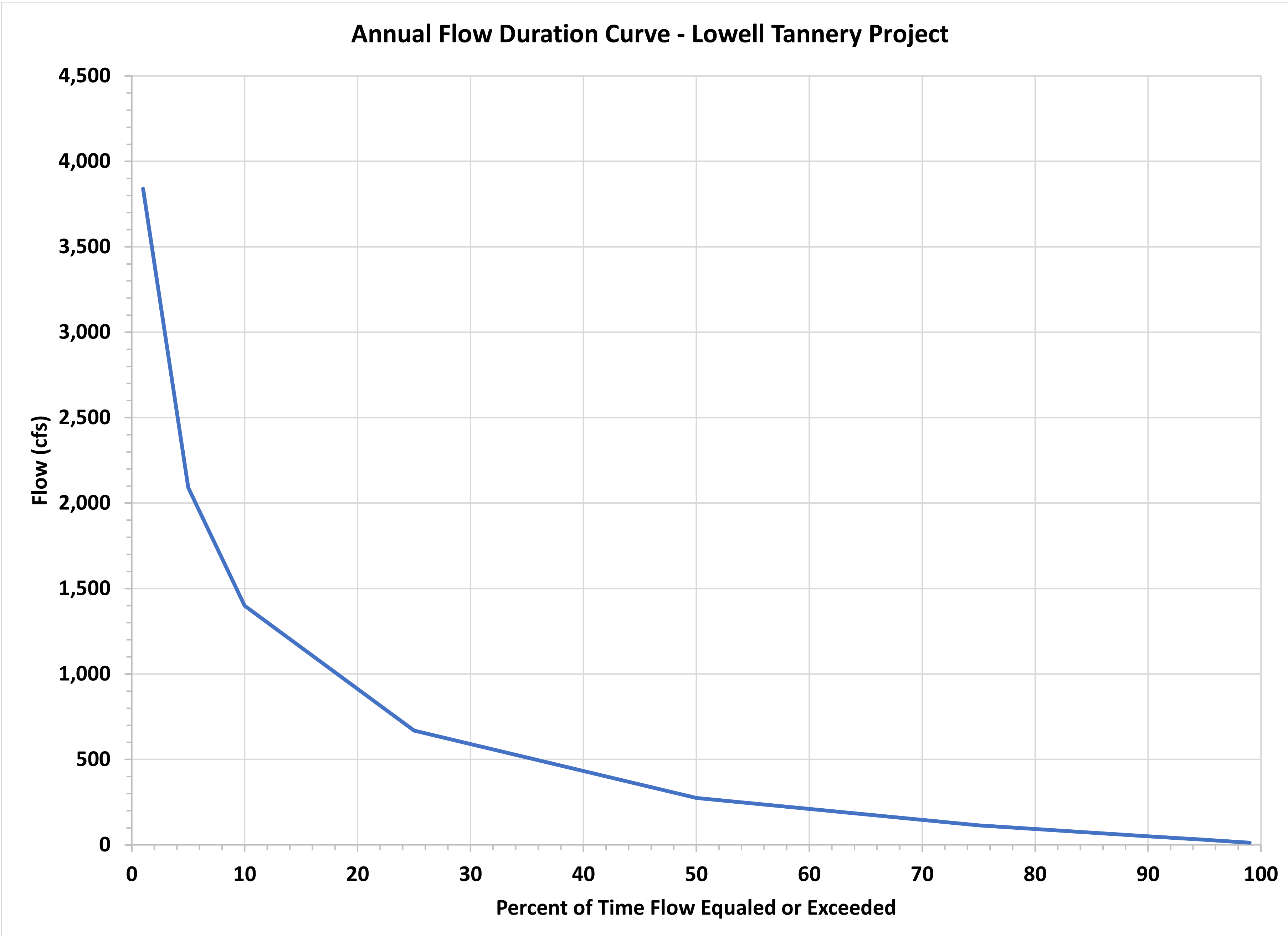
Federal Energy Regulatory Commission (FERC). 1983. Order Issuing License for Lowell Tannery Hydroelectric Project (FERC No. 4202). 25 FERC ¶62,134. Issued October 31, 1983.

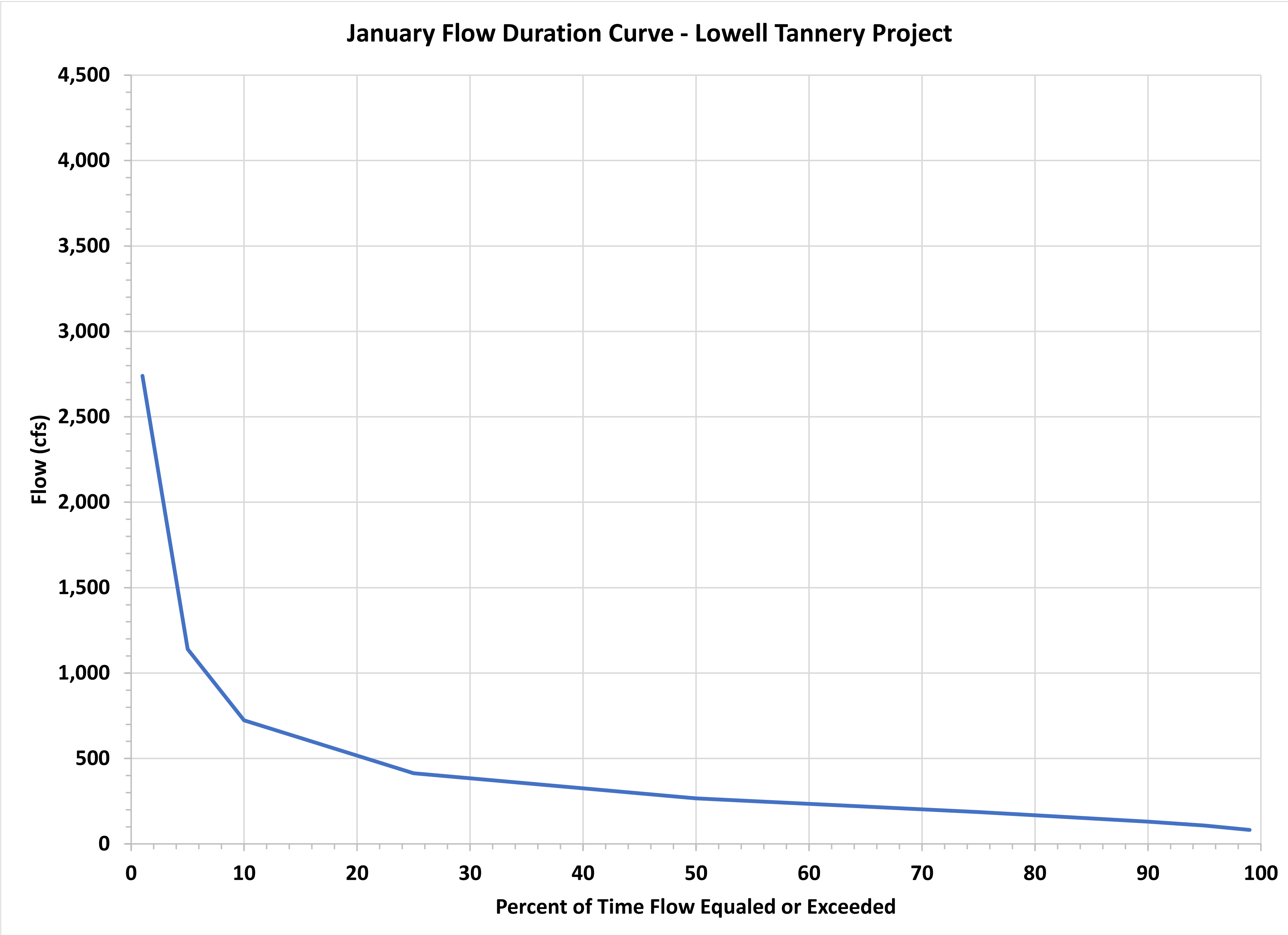
Federal Energy Regulatory Commission (FERC). 2014. Order Amending Licenses. [Online] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13577660. Accessed August 28, 2018.

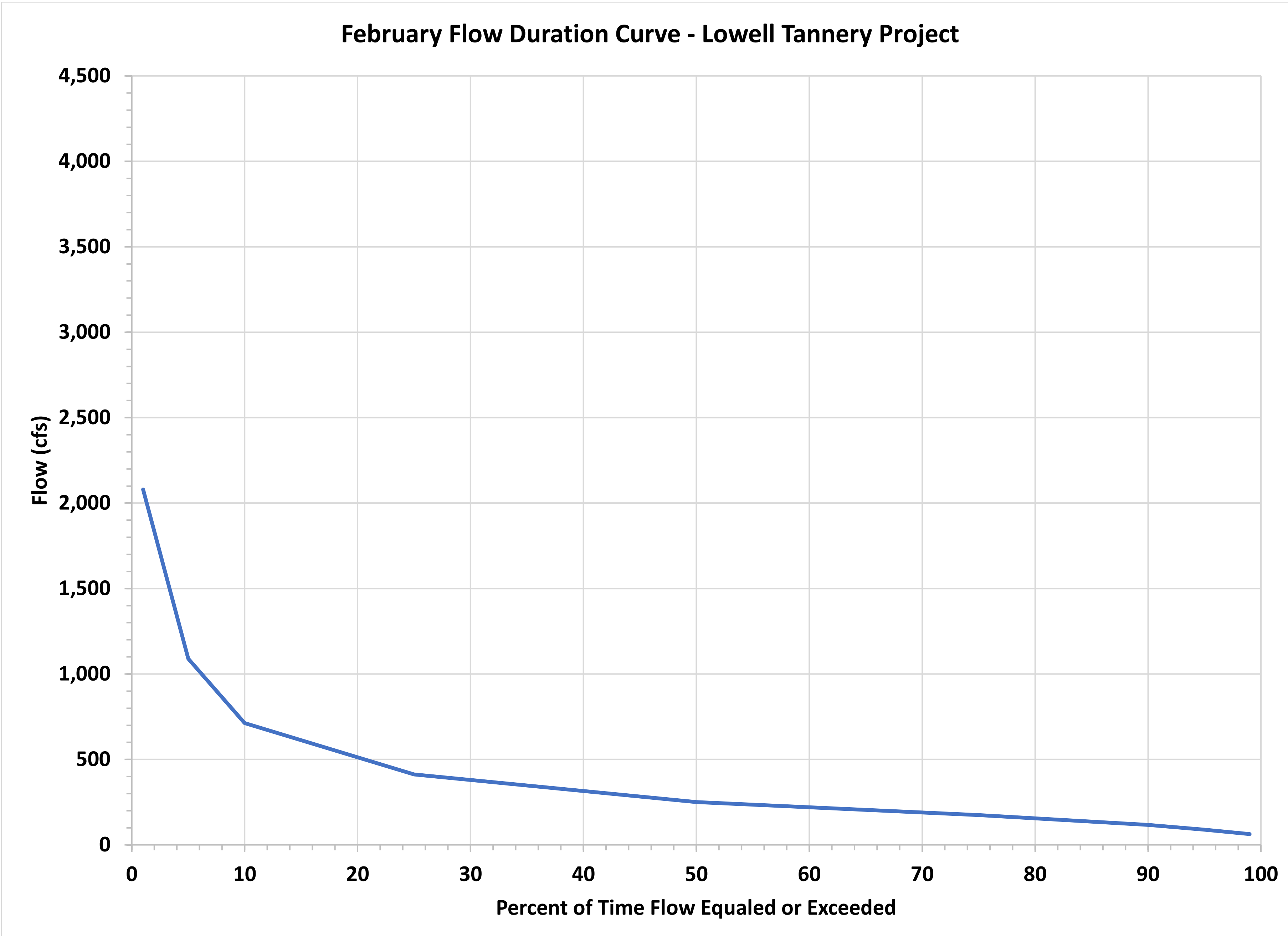
United States Geological Survey (USGS). 2021. StreamStats. [Online] URL: https://streamstats.usgs.gov/ss/. Accessed April 5, 2021.

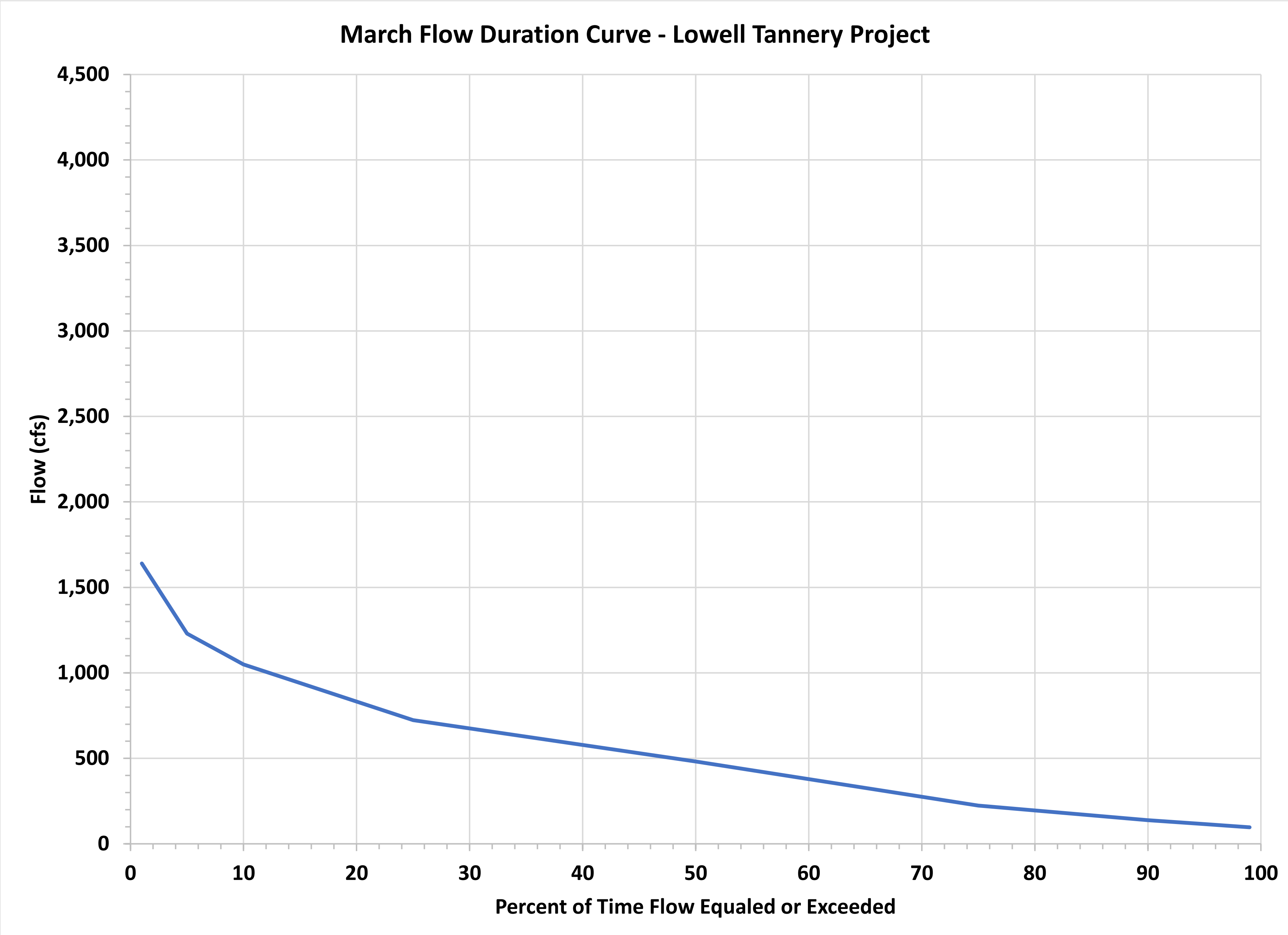
APPENDIX A

FLOW DURATION CURVES

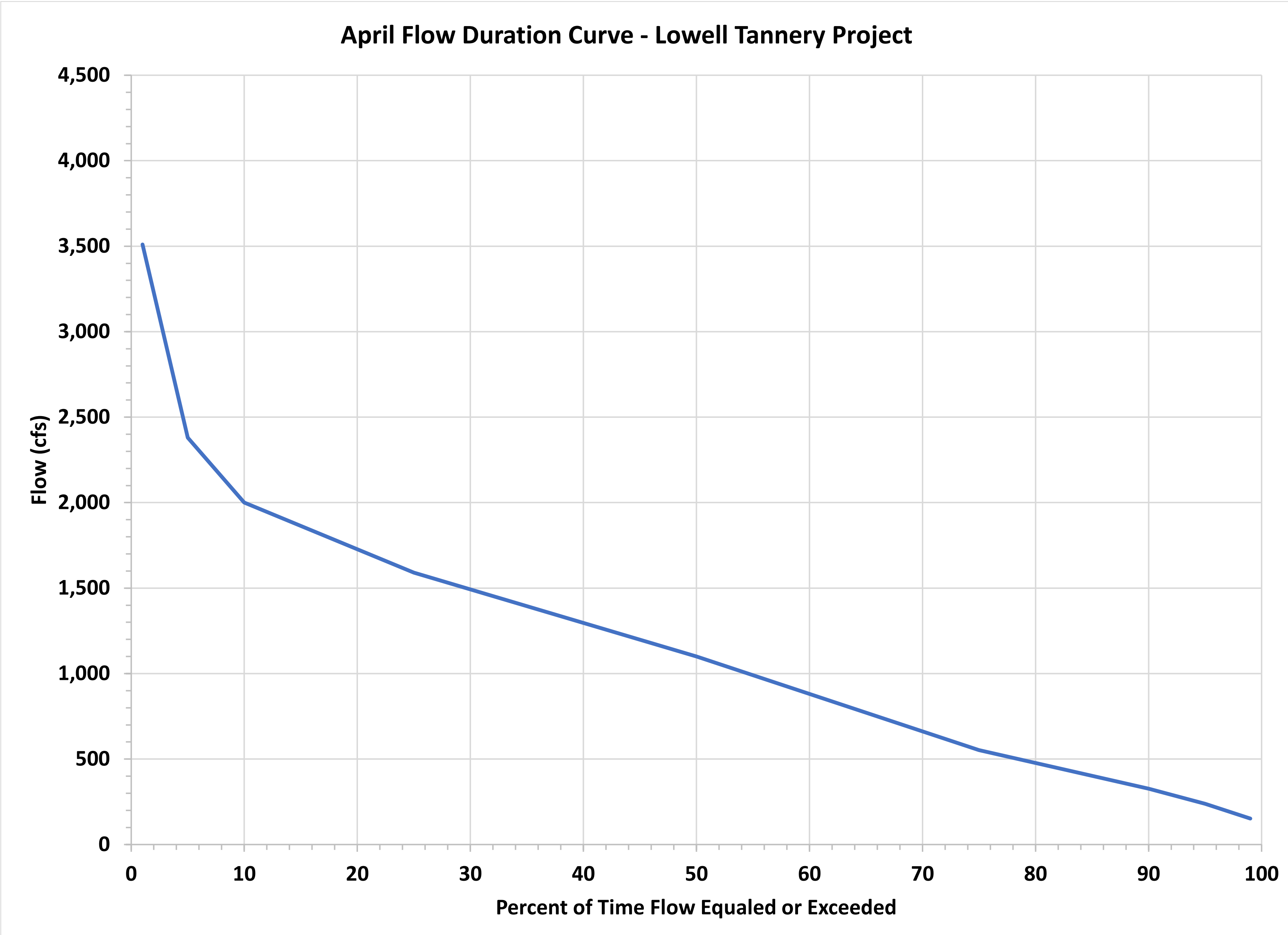

Annual Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


January Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

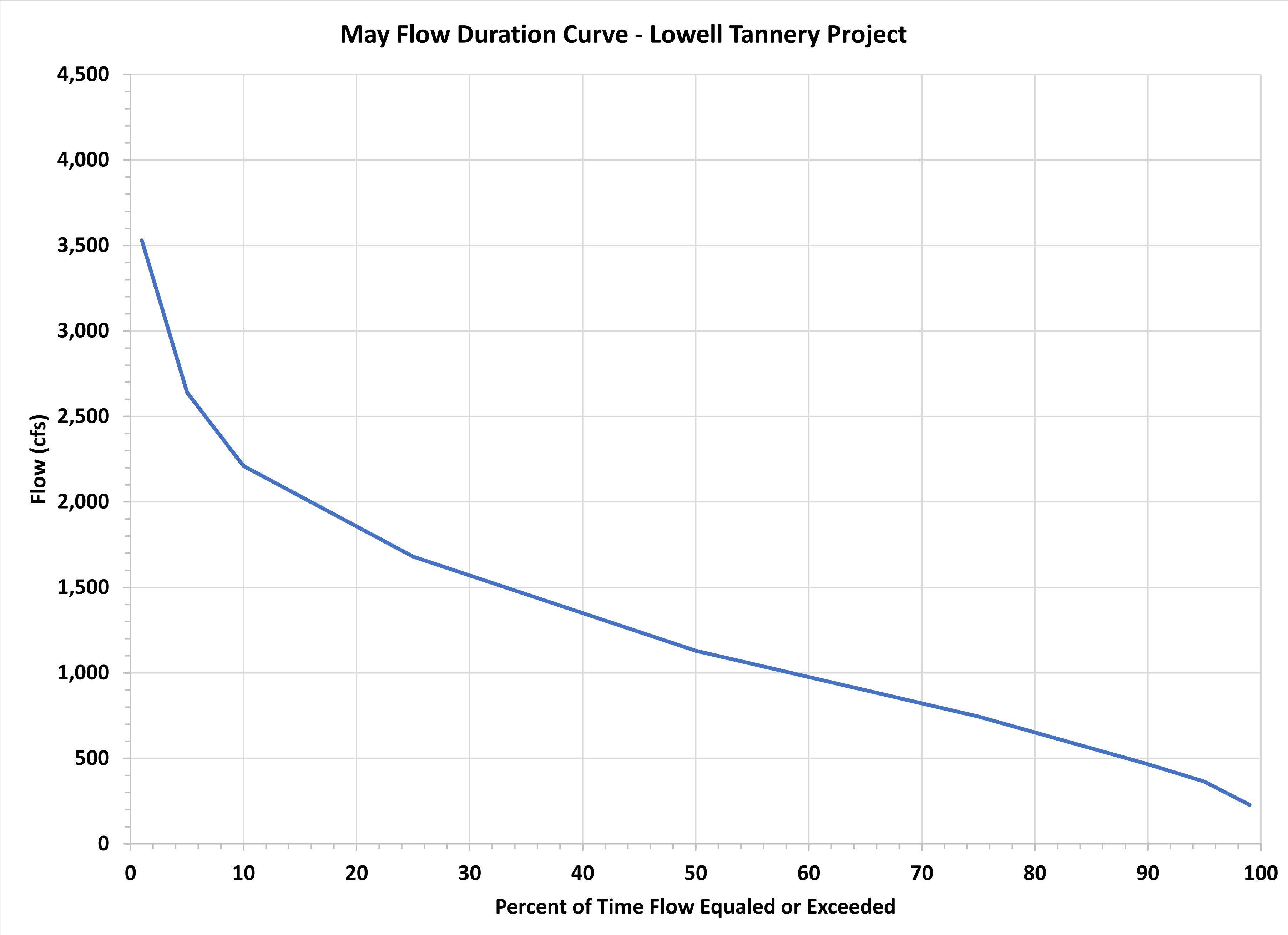

February Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

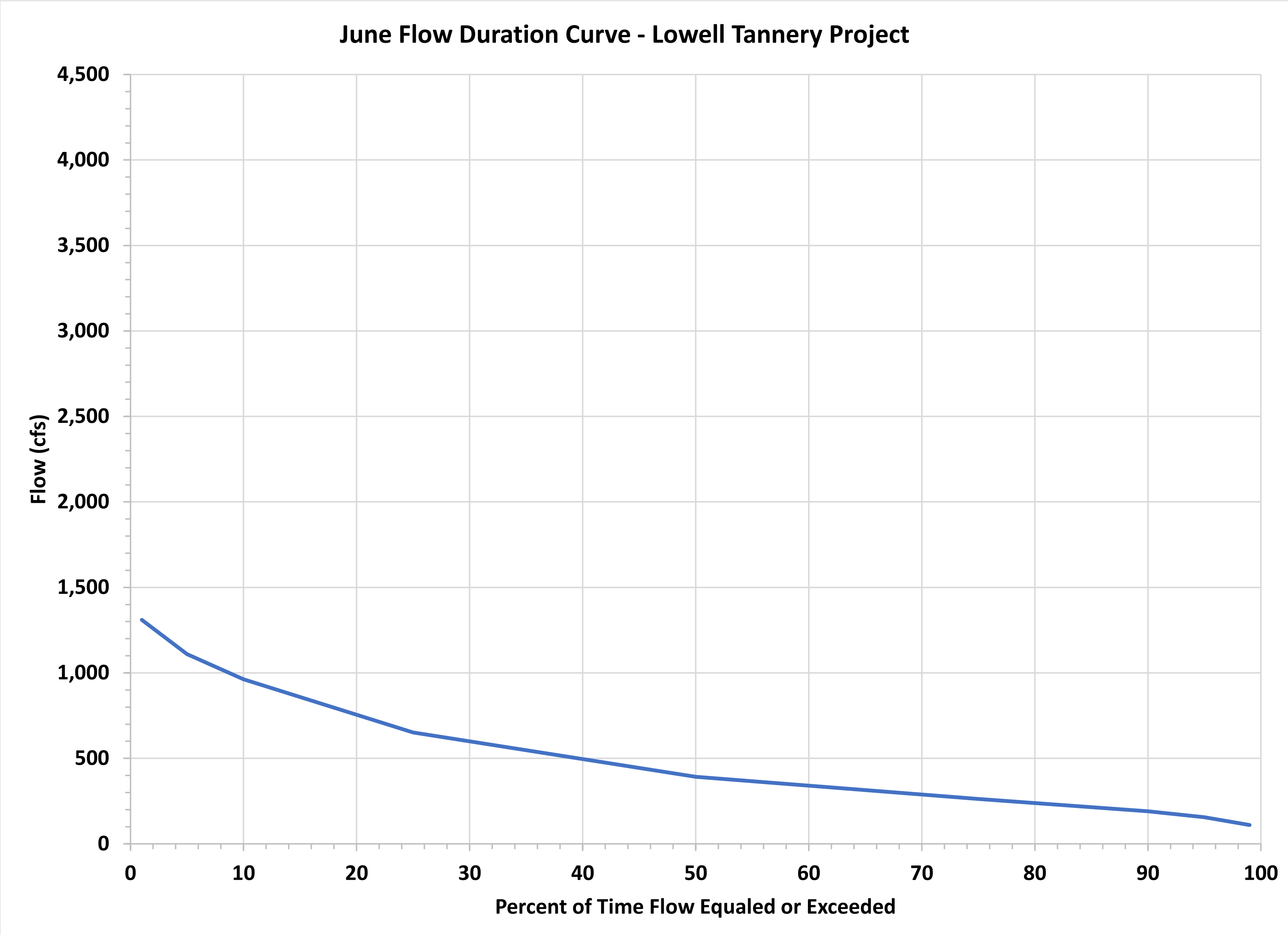


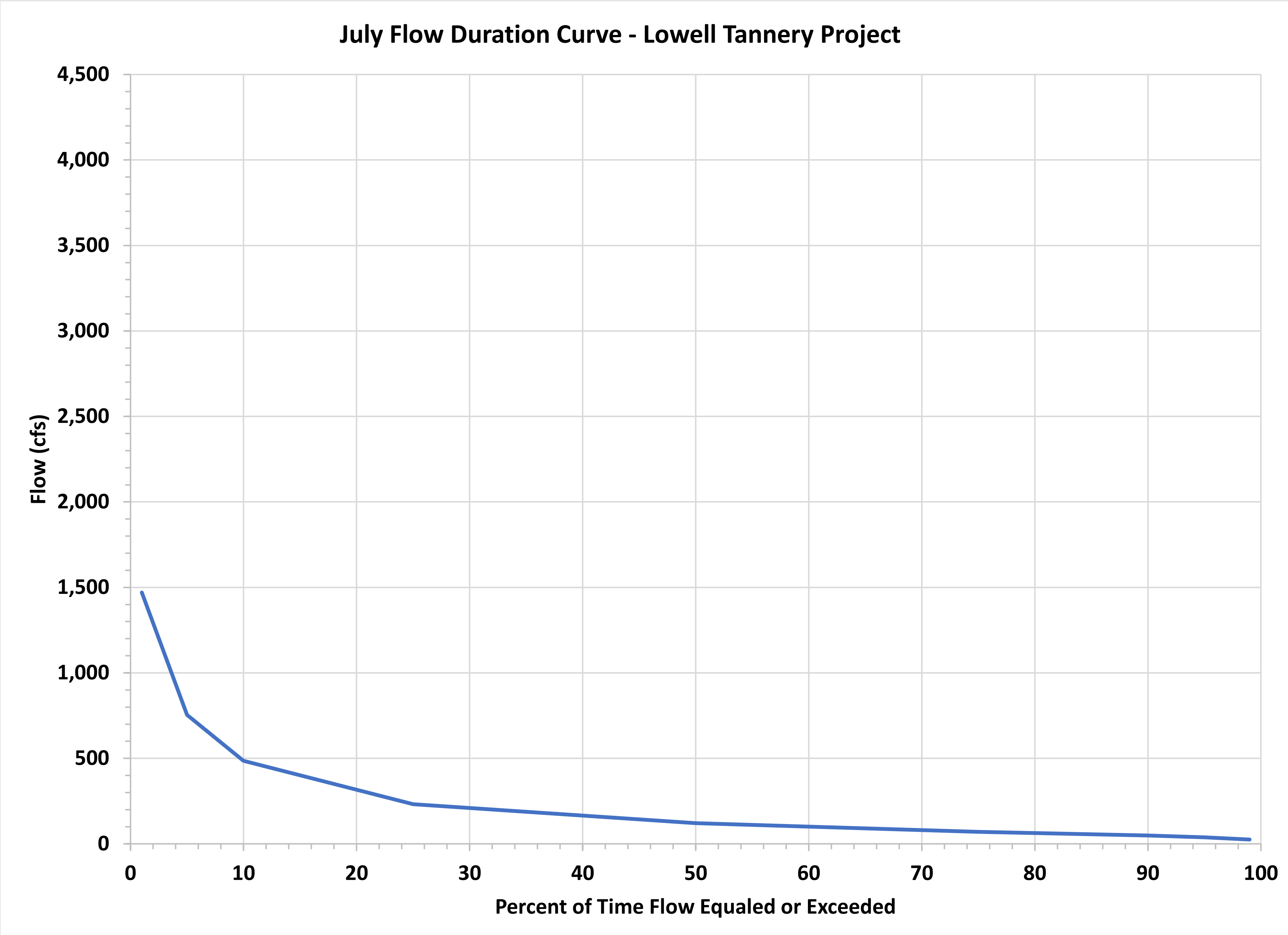
March Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

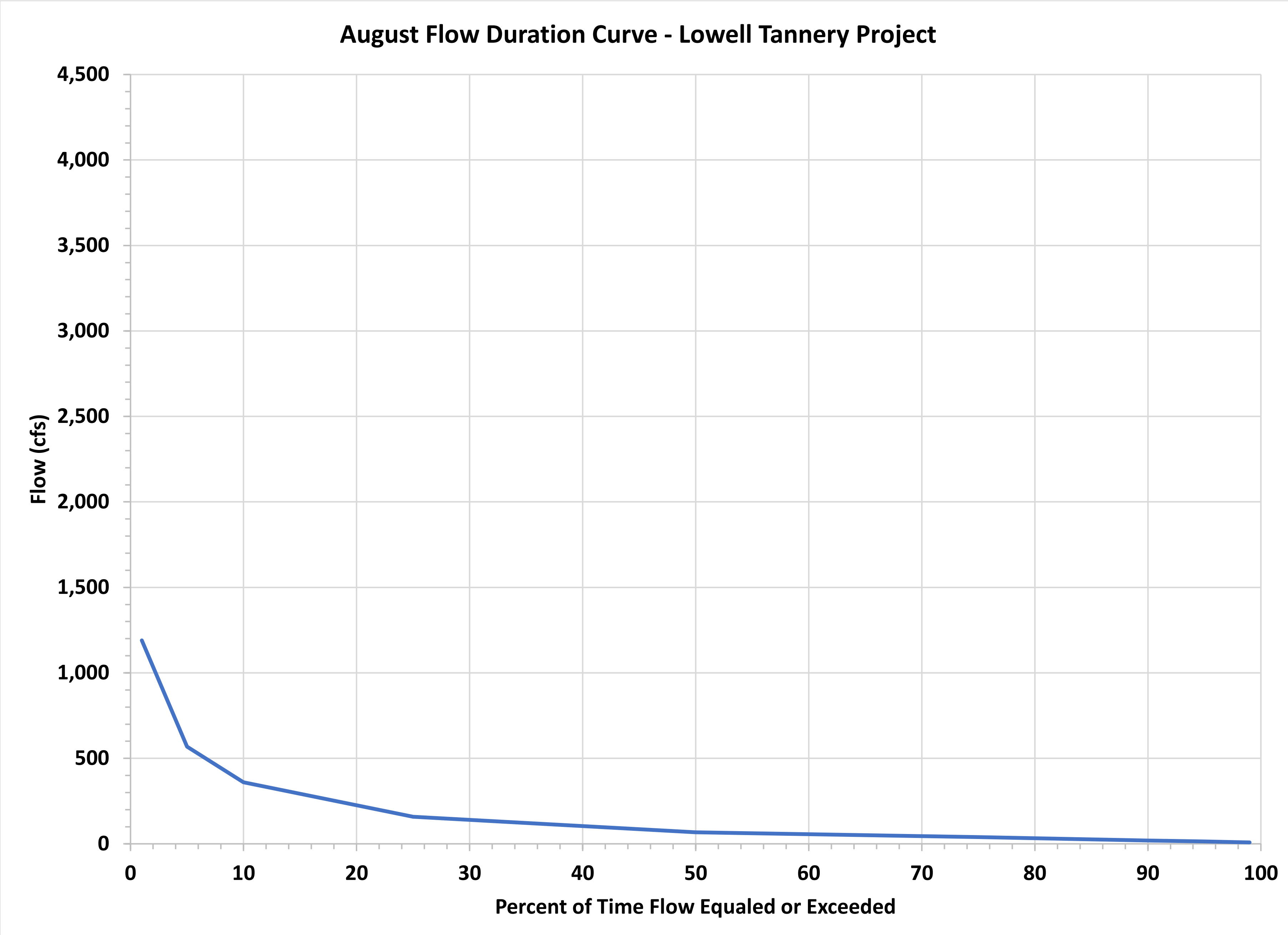


April Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

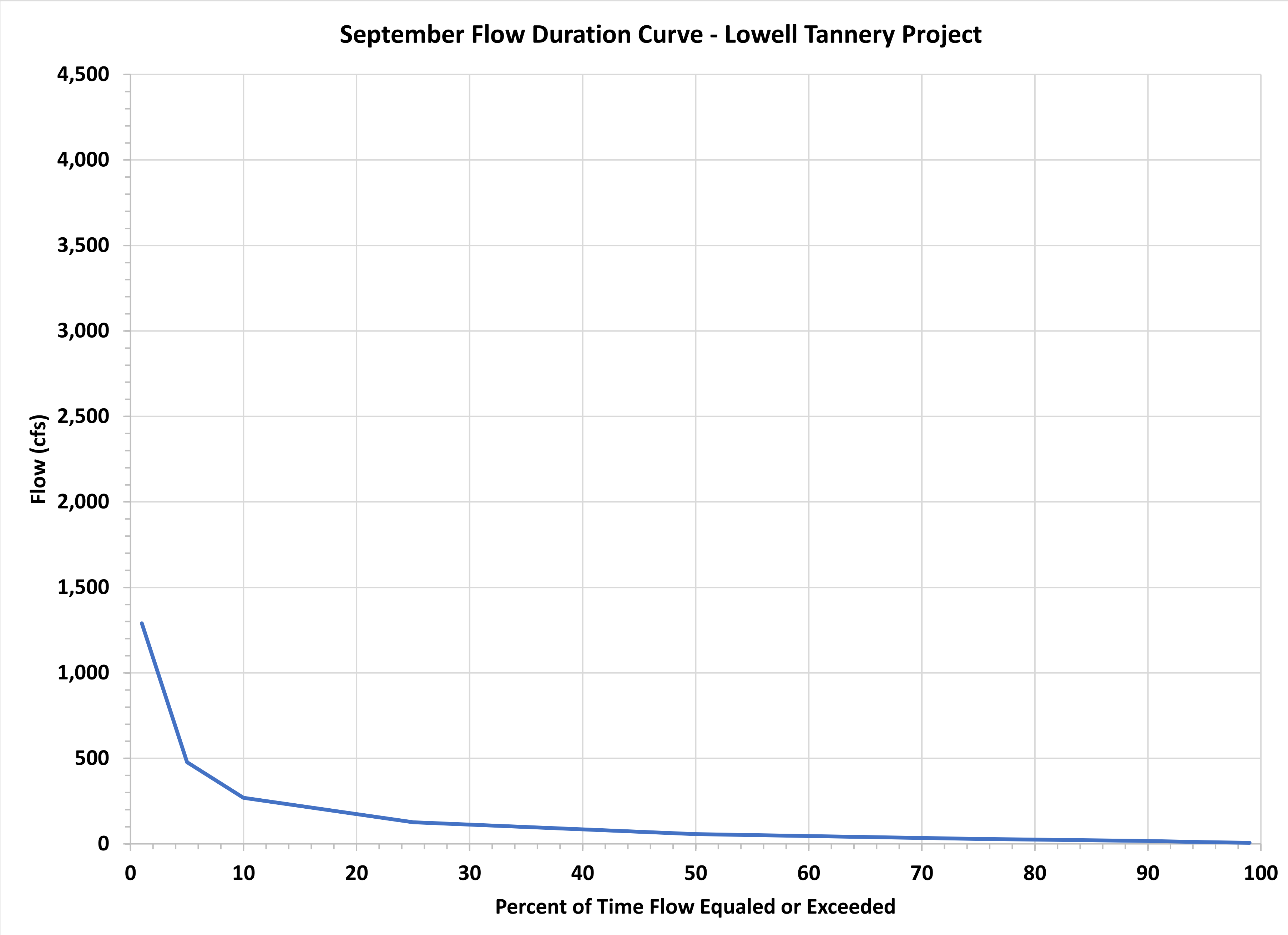

May Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

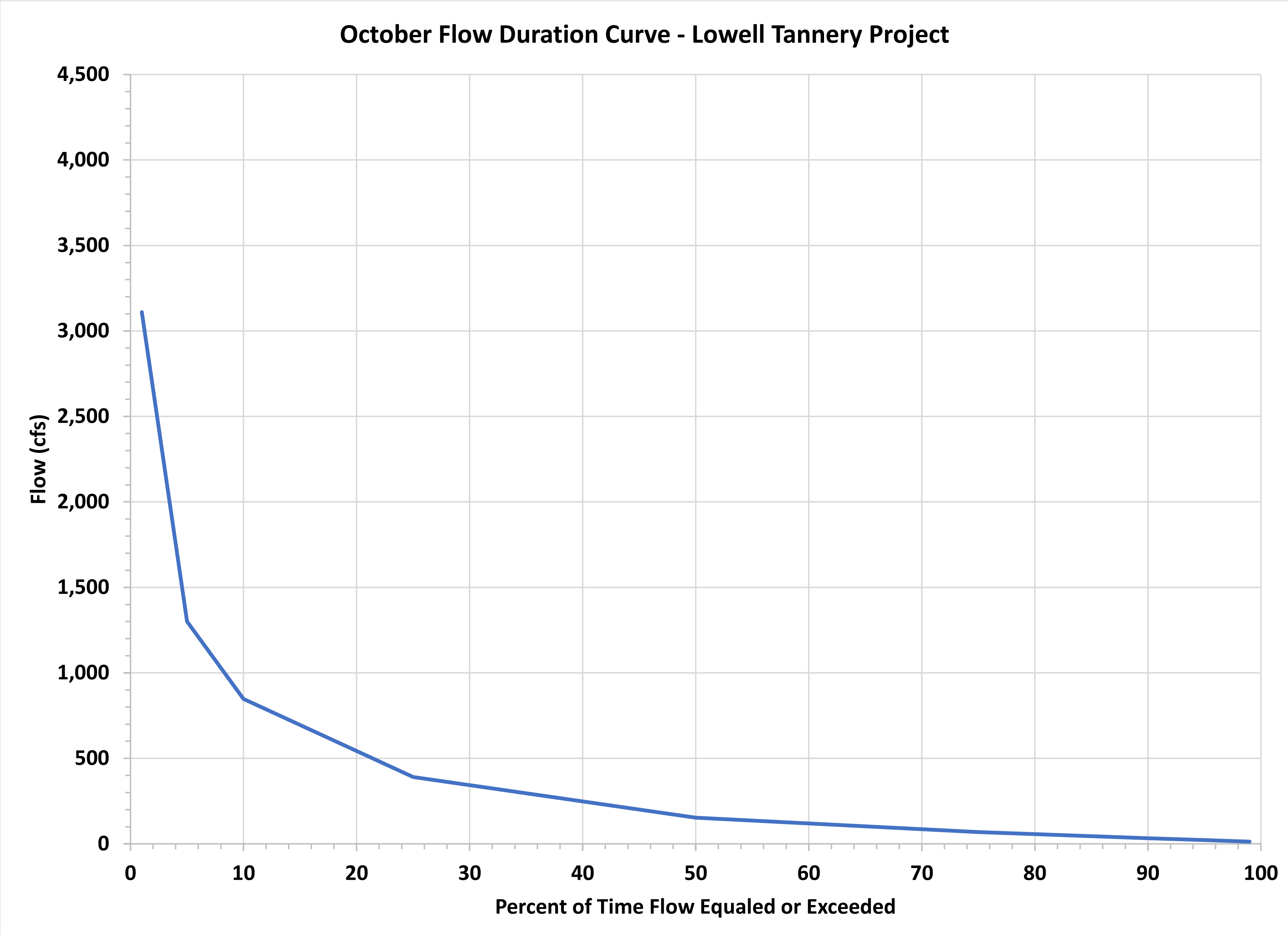

June Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

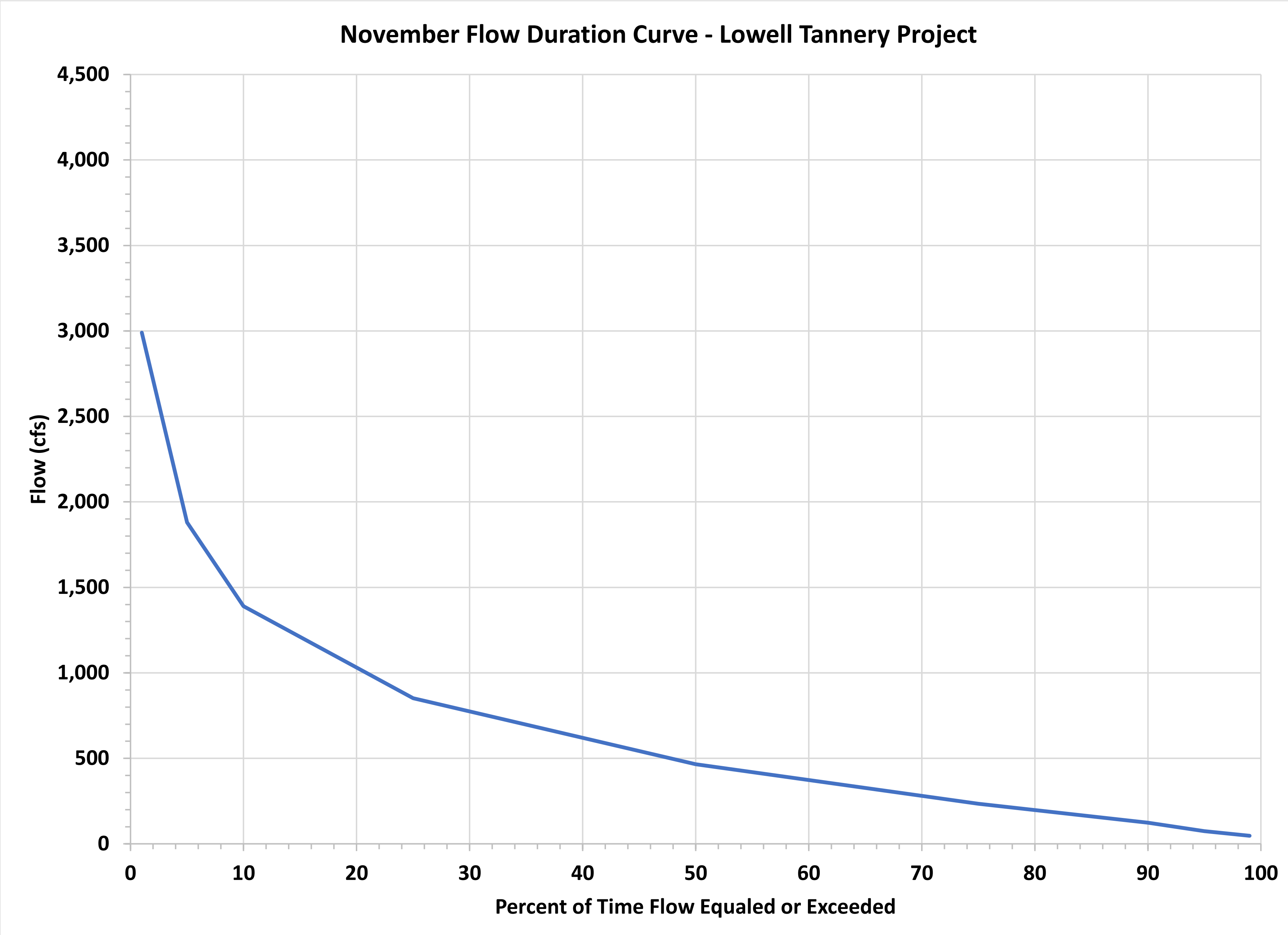

July Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

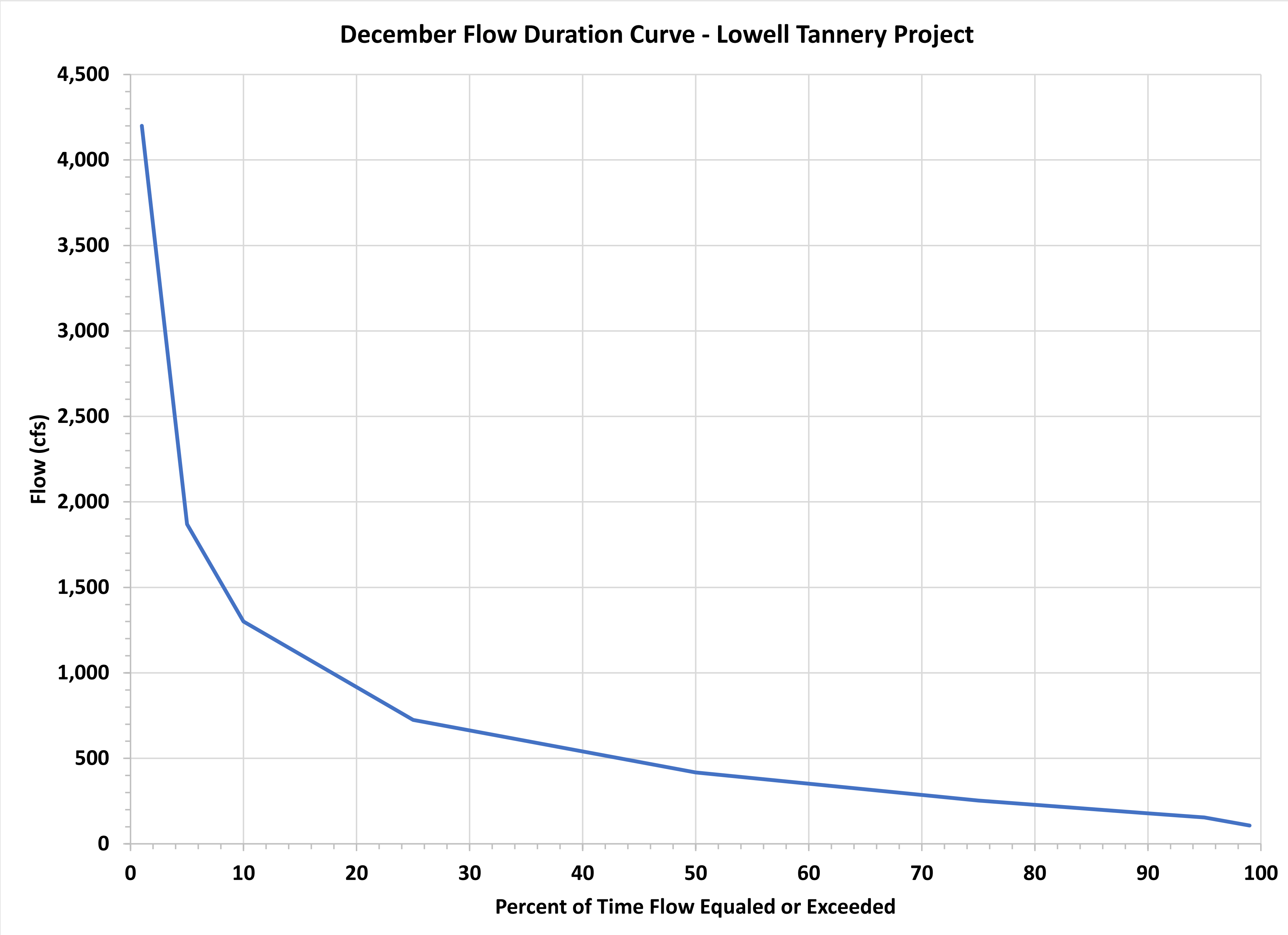


August Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


September Flow Duration Curve - Lowell Tannery Project
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


October Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


November Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


December Flow Duration Curve - Lowell Tannery Project
Flow (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

Appendix B

Single Line Diagram

Filed Separately as CEII

EXHIBIT E

ENVIRONMENTAL REPORT

TABLE OF CONTENTS

Table of Contents (Cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF APPENDICES

1.0 INTRODUCTION

KEI (USA) Power Management Inc. (KEI USA) is using the Federal Energy Regulatory Commission's (FERC or Commission) Traditional Licensing Process (TLP) for the relicensing of the Lowell Tannery Hydroelectric Project (Project).

1.1 Document Organization

The format of Exhibit E generally follows FERC's guidelines for preparing an Environmental Report (ER). The purpose of the ER format is to describe:

- the existing and proposed project facilities, including project lands and waters;
- the existing and proposed project operation and maintenance (O&M) plan, to include measures for protection, mitigation, and enhancement (PME) with respect to each resource potentially affected by the proposed project; and
- steps taken by the applicant in consulting with federal, state, and local agencies.

Issues that are addressed in Exhibit E include fishery resources, water quality, wetlands, aquatic habitat, instream flows, entrainment, state and federally protected and rare species, cultural and historical resources, tribal, and recreational access.

Exhibit E contains the content specified by 18 Code of Federal Regulation (C.F.R.) § 4.61 and includes the following sections:

Section 1.0 – Introduction - including purpose of action and need for power, statutory and regulatory requirements, and public review and comment

Section 2.0 – Proposed Action - including a description of existing and proposed project facilities, proposed project operation, and proposed protection mitigation and enhancement measures.

Section 3.0 – Pre-filing consultation

Section 4.0 – Environmental Analysis

Section 5.0 – Economic Analysis

1.2 Statutory and Regulatory Requirements

1.2.1 Section 401 of the Clean Water Act

The Applicant is subject to Water Quality Certification under Section 401(a)(1) of the federal Clean Water Act of 1977. The Maine Department of Environmental Protection establishes numeric water-quality standards consistent with the Clean Water Act and state law under Title 38, Chapter 3.

1.2.2 Endangered Species Act

Under provisions of Section 7(a)(2) of the Endangered Species Act (ESA), a federal agency that authorizes, permits, or carries out activities must consult with the United States Fish and Wildlife Service (USFWS) to ensure that its actions will not jeopardize the continued existence of any listed species. A federal agency is required to consult USFWS if an action "may affect" listed species or designated critical habitat, even if the effects are expected to be beneficial. A "may affect" determination will include actions that are "not likely to adversely affect," as well as "likely to adversely affect" listed species. If the action is "not likely to adversely affect" listed species (i.e., the effects are beneficial, insignificant, or discountable), and the USFWS agrees with that determination, the USFWS will provide concurrence in writing and no further consultation is required. If the action is "likely to adversely affect" listed species, the federal action agency must request initiation of formal consultation. This request is made in writing to the USFWS and must include a complete initiation package. Formal consultation concludes with the USFWS's issuance of a biological opinion to the federal action agency.

Critical habitat has been designated for the Atlantic salmon within the Penobscot River however, The Passadumkeag River is not classified as critical habitat for species recovery (74 FR 29300; June 19, 2009) (i.e., critical to the recovery of the species).

1.2.3 Coastal Zone Management Act

This act, administered by NOAA, provides for the management of the nation's coastal resources, including the Great Lakes. The goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." The Project is not located within a Coastal Zone and therefore is not anticipated to be subject to the Coastal Zone Management Act (CZMA). KEI (USA) will consult with the Maine Department of Marine Resource (MDMR) to confirm this conclusion.

1.2.4 National Historic Preservation Act

The National Historic Preservation Act (NHPA) (Public Law 89-665; 16 US Code [U.S.C.] 470 et seq.) is legislation intended to preserve historical and archaeological sites in the United States of America. Information related to protecting sensitive archaeological or other culturally important information is also restricted under Section 106 of the National Historic Preservation Act (NHPA)[1] as amended and its implementing regulations (36 C.F.R. 800). In comments on the Pre-Application Document (PAD) for the Lowell Tannery Project (August 21, 2018), the Maine State Historic Preservation Officer (SHPO) did not identify any information needs or study requests associated with the relicensing of the Project.

1.2.5 Magnuson-Stevens Fishery Conservation and Management Act

This act is the primary law governing marine fisheries management in U.S. federal waters. First passed in 1976, the Magnuson-Stevens Act fosters long-term biological and economic sustainability of our nation's marine fisheries out to 200 nautical miles from shore. The New England Fishery Management Council (NEFMC) is one of eight regional fishery management councils created by the 1976 Magnuson Fisheries Conservation and Management Act, renamed Magnuson Stevens Fisheries Conservation and Management Act in 1996, to manage living marine resources within that area. The NEFMC is responsible for the creation of management plans for fishery resources (FMPs) in Federal waters off of the New England States (which include Maine).

Critical habitat has been designated for the Atlantic salmon within the Penobscot River however, The Passadumkeag River is not classified as critical habitat for species recovery (74 FR 29300; June 19, 2009) (i.e., critical to the recovery of the species).

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[1] Section 106 of the NHPA of 1966, as amended, 54 U.S.C. § 306108, Pub. L. No. 113-287, 128 Stat. 3188 (2014). The NHPA was recodified in Title 54 in December 2014.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes the Lowell Tannery Project and KEI (USA)'s proposal for continued operation of the Lowell Tannery Project. This section includes a description of the project as it exists and is operated under the existing license, a description of proposed operations and measures for the new license, and an analysis of proposed operations and measures on existing resources.

2.1 Project Description

2.1.1 Existing Project Description

The Lowell Tannery Project operates as a run-of-river facility. The project has an overall minimum flow requirement of 150 cfs (or inflow if less) minimum flow. KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. KEI (USA) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam into a series of bedrock pools at the toe of the dam (Photo 2.1). KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provided through the downstream fishway from November 1 to ice-in. The project has a total rated capacity of 1,000 kilowatts (kW).

Photo 2.1 View of the Pools at Toe of Lowell Tannery Dam During Spill

2.1.2 Existing Project Facilities

Project works include consists of a concrete gravity dam with spillway sections, topped with 3.5-foot-high flashboards, and outlet gate, and a log sluice section, a powerhouse with a single turbine-generator with a total rated capacity of 1,000 kW, upstream and downstream fishway passage facilities, a 200-foot-long transmission line, and appurtenant facilities. A full description of existing project facilities can be found in Exhibit A.

2.2 Project Lands and Waters

The FERC project boundary for the Lowell Tannery Project is provided in Exhibit G. The project boundary encompasses the dam, powerhouse, approximately four miles upstream, and approximately 250 feet downstream of the powerhouse. There are no Federal lands within or adjacent to the project boundary.

2.3 Existing Operations

In accordance with the FERC Order 147 FERC ¶ 62,222, issued June 23, 2014, Ordering Paragraph (B)(2), Article 19, and the revised WQC for the Project (issued December 5, 2012), KEI (USA) is authorized to operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River while maintaining the headpond within one foot of elevation 187.5'. These flows may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods for fishery management purposes upon mutual agreement between the licensee and the Maine Department of Inland Fisheries and Wildlife. The project has an overall minimum flow requirement of 150 cfs (or inflow if less) minimum flow.

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam (Photo 4.6). KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse (Photo 4.6).

Downstream fish passage is provided through a dedicated fish bypass (Photo 4.4). Adjacent to the eastern side of the intake racks, there is a downstream surface bypass gate that leads to an 18-inch bypass pipe, which discharges into a plunge pool next to the tailrace. KEI (USA) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provided through the downstream fishway from November 1 to ice-in.

2.4 Proposed Project Facilities

KEI (USA) proposes to install upstream and downstream eel passage facilities as new license implementation measures. While facility designs will be developed in consultation with fisheries agencies, KEI (USA) proposes an upstream eel ladder, located based upon observations from the 2020 nighttime visual surveys. KEI (USA) proposes to install downstream eel passage consisting of two siphon style passage systems, similar to the system recently implemented at KEI (USA)'s American Tissue Project (FERC No. 2809) located at the east and west downstream extents of the intake rack structure. KEI (USA) also proposes to install full depth seasonal intake rack overlays consisting of 7/8-inch hole diameter punch plate. Due to results of the 2021 upstream radio telemetry study for alewives, KEI (USA) proposes to modify the discharge location for the existing downstream fish passage pipe to discharge adjacent to the existing upstream fish ladder entrance. KEI (USA) will make this modification prior to the 2022 upstream migration season for alewives and re-conduct the 2021 telemetry study to assess whether this modification improves effectiveness of the upstream fish ladder.

2.4.1 Proposed Project Operations

KEI (USA) is proposing to continue operating the Lowell Tannery Project in a run-of-river mode. Therefore, KEI (USA) is proposing to eliminate the overall downstream minimum flow requirement of 150 cfs (or inflow if less) that is part of the current license. With operating in run-of-river there should not be a need to specify a downstream minimum flow of 150 cfs, because inflows and out flows from that project should be equal and maintain aquatic habitat conditions downstream. All existing fishway passage flow requirements will be maintained as discussed in Section 2.3. KEI (USA) proposes to develop a project and fishway operations and management plan (operations plan) in consultation with resources agencies.

2.4.2 Proposed Environmental Measures

KEI (USA) proposes to continue to operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River while maintaining the headpond within one foot of elevation 187.5 feet.

KEI (USA) proposes to continue to provide 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse.

KEI (USA) also proposes to continue to provide the fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) proposes to modify the discharge location of the downstream bypass to adjacent to the upstream fishway.

KEI (USA) proposes install upstream and downstream American eel passage measures as discussed above. KEI (USA) proposes to develop an operations plan in consultation with resources agencies.

2.4.3 References

Federal Energy Regulatory Commission (FERC). 2014. Order Amending Licenses. Project Nos. 3562-024, 4202-023, 11132-028, 11472-060, 11482-030. 147 FERC ¶62,222. Issued June 23, 2014.

3.0 PRE-FILING CONSULTATION RECORD

3.1 Stakeholder Consultation

The Notice of Intent (NOI) and PAD for the Lowell Tannery Project were issued to stakeholders and filed with FERC on September 26, 2018. FERC approved the use of the TLP on November 23, 2018. KEI (USA) conducted a joint meeting and site visit on January 11, 2019. A summary of consultation correspondence over the course of the relicensing process is provided with this Final License Application.

Comments on the DLA were provided by USFWS, MHPC, MDEP, and MDMR. NMFS requested an extension of time to provide comments. A summary of comments and responses is included in Appendix A.

4.0 ENVIRONMENTAL ANALYSIS

4.1 General Description of the River Basin

The Project is located approximately 13-miles upstream from the confluence of the Penobscot River, on the Passadumkeag River, in Penobscot County, Lowell, Maine. The Passadumkeag River originates at Weir Pond and Number Three Pond in Twombly Township near Lee and Burlington, Maine. The Passadumkeag River then flows south-southwest through forest and wetlands to converge with the Penobscot River in Passadumkeag, Maine. The Lowell Tannery Project is approximately 13 river miles upstream of the confluence with the Penobscot River in the town of Lowell, Maine. The Passadumkeag River has a drainage area of approximately 397-square-miles (USGS 2018). The drainage area at the Lowell Tannery Project is approximately 297-square-miles (Dudley 2004; USGS 2018).

The Passadumkeag River is part of the Penobscot River watershed (See Figure 4.1) which includes the West Branch of the Penobscot River near Penobscot Lake on the Maine and Quebec border; the East Branch of the Penobscot River at East Branch Pond near the headwaters of the Allagash River; and the main stem which empties into Penobscot Bay near the town of Bucksport (Maine Rivers 2018). The watershed has a total drainage of 8,570-square-miles (sq mi) (NOAA 2018). At approximately 240-miles-long, the Penobscot River is the second largest river in Maine (Maine Rivers 2018 and NOAA 2018). The Penobscot River basin contains over 100 dams, many of which are used for hydropower generation (ENSR, 2007).

As stated in the U.S. Fish and Wildlife Service (USFWS) letter dated March 14, 2019, the Passamaquoddy and Penobscot Tribes both have Trust lands in the headwaters of the Passadumkeag watershed. Passamaquoddy Trust lands are in the Pistol Stream portion of the watershed while Penobscot Nation Trust lands are located along the Passadumkeag River headwaters and near Number Three Pond.

Penobscot County is located in north central Maine. The County encompasses 60 municipalities and one sovereign nation. Approximately 75 percent or 2,668-square-miles of the land area of the County are forested, 23 percent is agricultural or open space and 2 percent is classified as urban. Development is heaviest along the corridor of Interstate 95 and the Penobscot River. Select areas along this corridor within the county have become urbanized, most of which have many homes, businesses, and schools.

Development within the remainder of the county consists of scattered communities, recreational properties, and timber harvesting (PCEMA, 2016).

The Passadumkeag River is not currently gaged by the USGS. Monthly and annual mean flow and flow duration statistics at the Lowell Tannery dam were generated using the USGS StreamStats tool (USGS 2021). StreamStats estimates flow statistics for ungaged streams in Maine using regression equations from Dudley (2015). The annual mean flow at the Lowell Tannery Project is estimated to be 562 cfs (Table 4.4). The highest monthly mean flows are in April (1,170 cfs) and May (1,270 cfs). The lowest monthly mean flows are in August (153 cfs) and September (135 cfs) (Table 4.4). Annual and monthly flow duration statistics are provided in Table 4.5, and the flow duration curves are included in Exhibit A.

4.1.1 Major Land Uses

The Project lies wholly within Penobscot County, Maine, which has a land area of approximately 3,397-square-miles (U.S. Census, 2016a). The Passadumkeag River watershed is dominated by forestland, approximately 68 percent of the total land cover, followed by woody wetland at approximately 17 percent of the land cover (MRLC 2011). As such, the major land uses in Penobscot County are forested, woody wetland, scrub/shrub, open water and agriculture (MRLC 2011).

4.1.2 Major Water Uses

The Penobscot River was historically home to many industrial sites that took advantage of the river as an energy source and water supply. The main types of industry developed were lumber and paper industries and other industries such as shoe manufacturing, leather tanning, and fishing, used the basin. These industries used water resources for industrial processes and to transport materials and products (FERC 2010).

The Project is the only dam located on the Passadumkeag River approximately 13-miles upstream from the confluence of the Penobscot River. There are two dams located on upstream tributaries of the Project, one on Eskutassis River at Gristmill Pond approximately 3 miles away and one on Craig Brook, Cold Stream Pond, owned by the State of Maine Department of Inland Fisheries and Wildlife, approximately 6 miles northwest (USACE, 2018).

The Penobscot River is also utilized for recreational purposes; the majority of which are fishing and boating. In comments provided on the DLA, agencies cited phased restoration efforts in the basin, identifying an estimate of 845,000 alewife to move past the Project within the next 10 year. KEI (USA) is not aware how this estimate was developed but notes that trap counts at the Orono Project on the mainstem have averaged less than 20 percent of that projection for this mainstem tributary over the past four years.

Figure 4.1 Penobscot River Basin

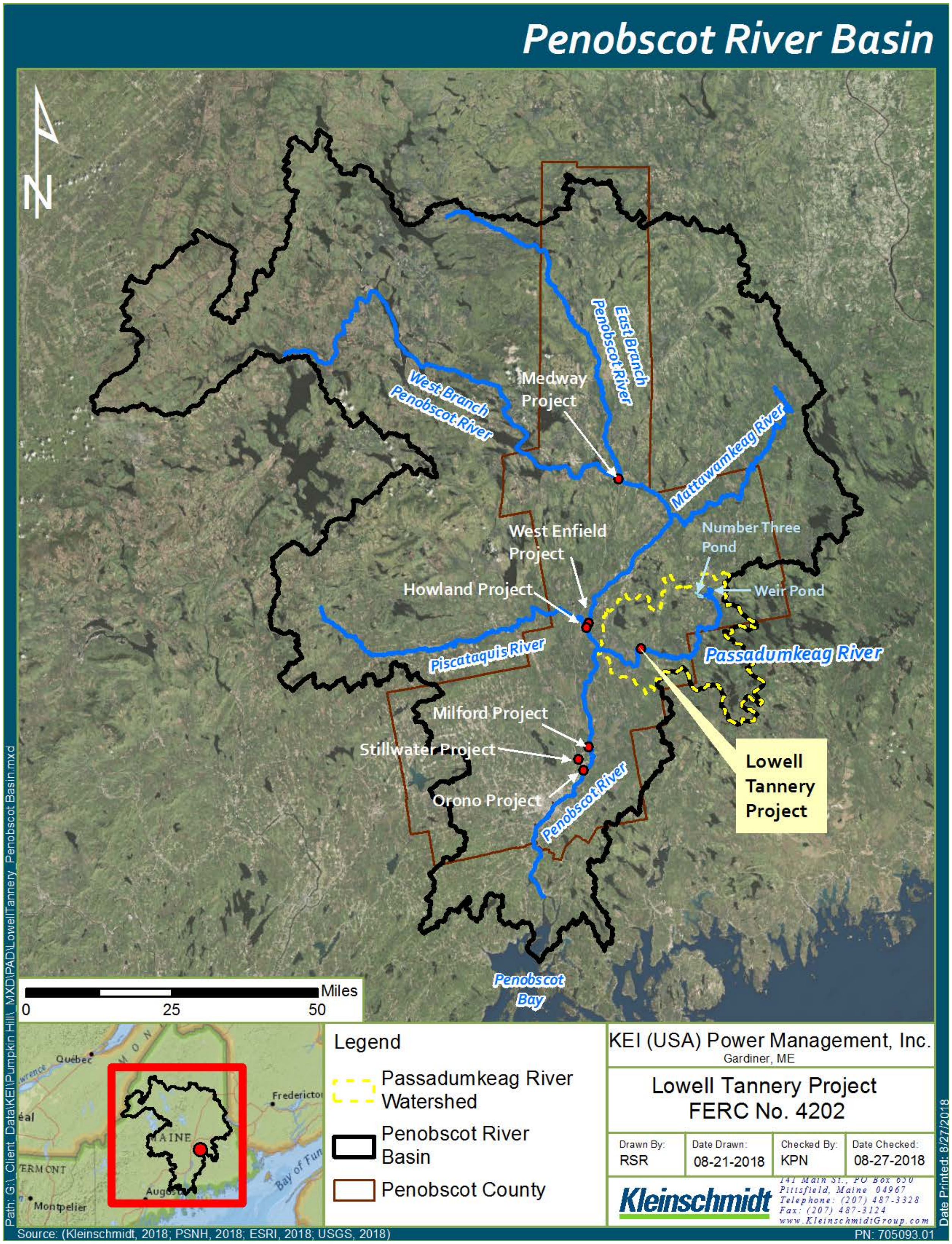


Figure 4.2 Location of Lowell Tannery Project.

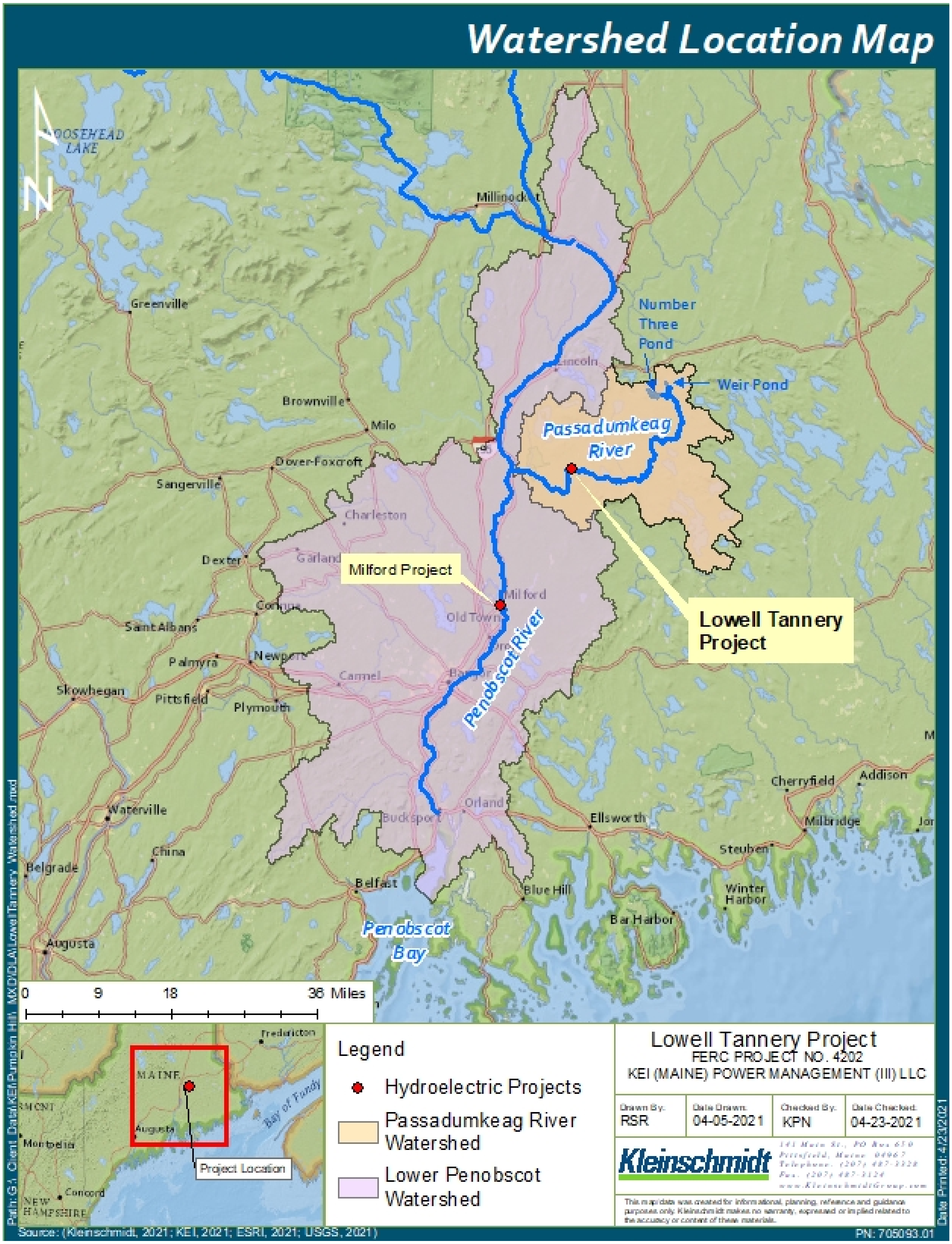
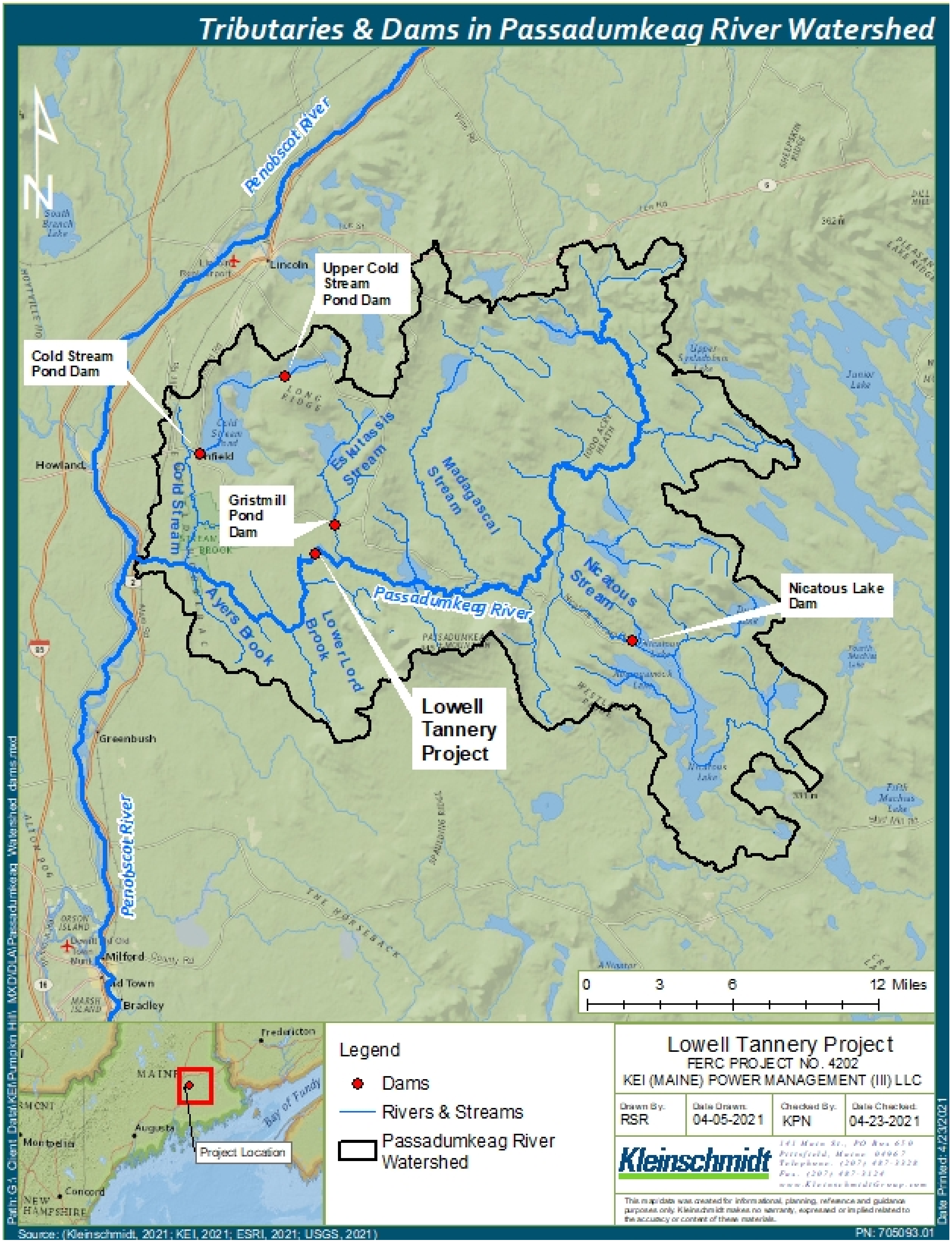


Figure 4.3 Tributaries and Location of Dams in the Passadumkeag River Watershed.



The Project is the only dam located on the Passadumkeag River approximately 13-miles upstream from the confluence of the Penobscot River. There are two dams located on upstream tributaries of the Project, one on Eskutassis River at Gristmill Pond approximately 3 miles away and one at the outlet of Nicatous Lake (Figure 4.3). The Cold Stream Pond dam and Upper Cold Stream Pond dam are downstream of the Lowell Tannery Project; Cold Stream enters the Passdumkeag River approximately 10.5 river miles downstream of the Lowell Tannery dam (USACE, 2018).

Table 4.1 Hydro Projects Upstream and Downstream From the Project

Project	Owner	Waterbody
Gristmill Pond	Private	Eskutassis River
Cold Stream Pond	State of Maine IFW	Craig Brook
Stanhope Mill #2 (Upper Cold Stream Pond)	Private	Smelt Brook
Nicatous Stream	Maine Bureau of Parks & Lands	Nicatous Stream
Milford	Black Bear Hydro Partners, LLC	Penobscot River
Gilman Falls	Black Bear Hydro Partners, LLC	Stillwater River
Stillwater	Black Bear Hydro Partners, LLC	Stillwater River
Orono	Black Bear Hydro Partners, LLC	Stillwater River

Source: USACE 2018

4.2 Project Reservoir and Storage

The Project was developed in 1986. As a run-of-river dam the project has no useable storage capacity. The project reservoir is approximately 341 acres at elevation 187.5 feet mean sea level.

4.3 Project Drainage Basins' Tributary Streams

The Passadumkeag River is a minor tributary to the Penobscot River (Maine Legislature 1989). The drainage area for the project is approximately 297-square-miles (USGS Gage No. 01035000 Passadumkeag River at Lowell, Maine).

Tributaries to the Passadumkeag River include Cold Stream, Ayers Brook, Fogg Brook, Brown Brook, Taylor Brook, Nicatous Stream, Trout Brook, Lord Brook, and Madagascal Stream. Lakes within the Passudumkeag River drainage area include Saponac Pond, Gristmill Pond, Spring Pond, Madagascal Pond, Hot Pistol Pond, Eskatassis Pond, Pickerel Lake, Cold Stream Pond, and Duck Lake (Barrows 1912).

4.4 Climate

The climate in the area is generally described as cool, humid, continental type and exhibits large temperature ranges, both daily and annually. The total precipitation at Millinocket (just outside the basin) averages 42 inches annually. This total includes snowfall, which averages 95 inches per year (FERC 2010).

The National Weather Service monitoring station (USW00094644) located in Old Town, Maine shows the July air temperatures ranging from an average maximum high of just over 78°F to an average minimum low of 56°F. Overall average temperatures in July are approximately 67°F. The average maximum air temperature for January is 27°F while the average minimum air temperature for January is 3°F. Overall, average temperatures in January are approximately 15°F. The average total snowfall is 84 inches (Sperling's 2018). The average annual total precipitation is 3.7 inches (NOAA, 2018).

4.5 References

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4.6 Cumulative Effects

4.6.1 Geographic Scope

The geographic scope of analysis for cumulatively affected resources is defined by the physical limits or boundaries of the proposed action's effect on the resources and the limits or boundaries of contributing effects from other activities within the river basin. Because the proposed action can affect resources differently, the geographic scope for each resource may vary.

4.6.2 Temporal Scope

The temporal scope of the environmental analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected. Based on the potential term of a new license for the Project, the temporal scope for analysis of cumulatively affected resources will look 30-50 years into the future, with focus on how reasonably foreseeable future actions affect resources. The discussion of historical information is limited to available information for the resource areas.

4.7 Geology and Soils

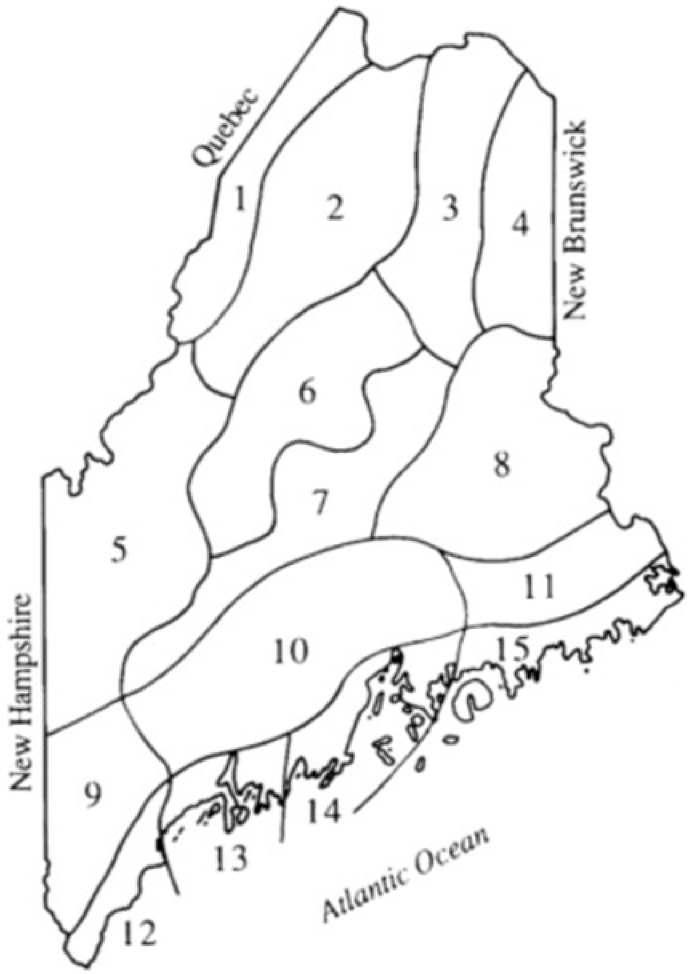
4.7.1 Affected Environment

Historically, Maine has been divided into two or three ecoregions, however more recently, the state has been delineated into 15 biophysical regions, which are based on climate variables, topography and soil characteristics (Figure 4.4). The Project is located in the Eastern Interior Biophysical Region of Maine. This region is part of the Northeastern Mixed Forest Province and the Fundy Coastal and Interior Ecoregion Section (MFIGP 2016). The Eastern Interior Biophysical Region is 98 percent forested, with 44 percent of those acres categorized as spruce-fir forest type and also include intolerant communities to semi-rich hardwoods (MFIGP 2016 and MDC 2009).

This area is identified by its low relief sections with elevations ranging from 200 to 600 feet – except for a few taller hills. The region contains the largest concentration of peatlands, marshes, and swamps in Maine and its many lakes, rivers and associated wetlands (MDC 2009).

The general topography of the state is presented in Figure 4.5. The highest mountains in Maine are Mount Katahdin, at an elevation of 5,267 feet, followed by Sugarloaf Mountain, at 4,237 feet (MDACF, 2018). The tallest peak in Penobscot County is East Turner Mountain in Maine Transit 4 Region 8 (T4 R8 WELS). East Turner Mountain is 2,455 feet high and is located approximately 54 miles north of the Project (Peakbagger, 2018). The topography of the project vicinity, Penobscot County, is heavily forested with low, rolling hills. Penobscot County contains or boards 3,605 lakes and ponds as well as approximately 5,180 miles of rivers and streams (USGS, 2007).

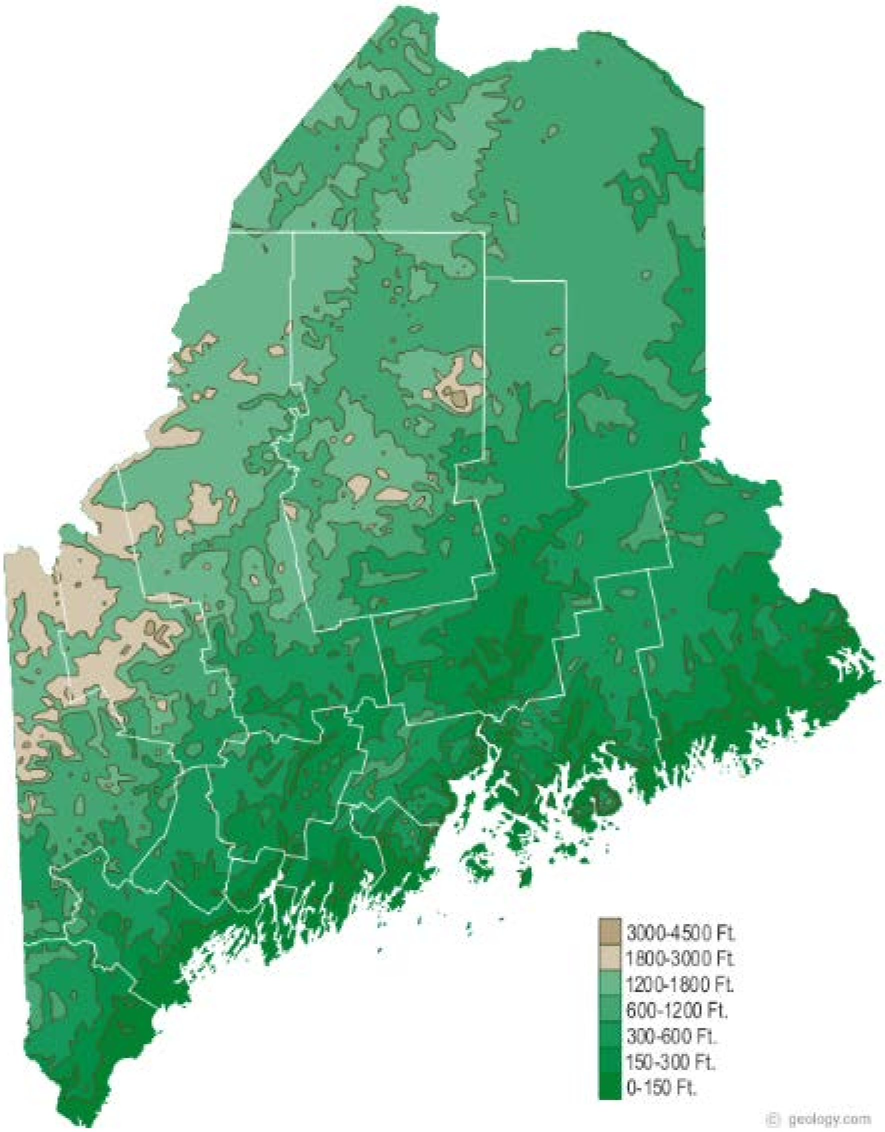
Figure 4.4 Geographical Provinces of Maine



1. Boundary Plateau
2. Saint John Uplands
3. Aroostook Hills
4. Aroostook Lowlands
5. Western Mountains
6. Central Mountains
7. West Foothills
8. Eastern Lowlands
9. Southwest Interior
10. Central Interior
11. Eastern Interior
12. South Coastal Region
13. Midcoast Region
14. Penobscot Bay Region
15. East Coastal Region

Source: Wilson 2017, modified

Figure 4.5 General Topography of Maine



Source: GNI 2018

4.7.1.1 Bedrock Geology and Physiography

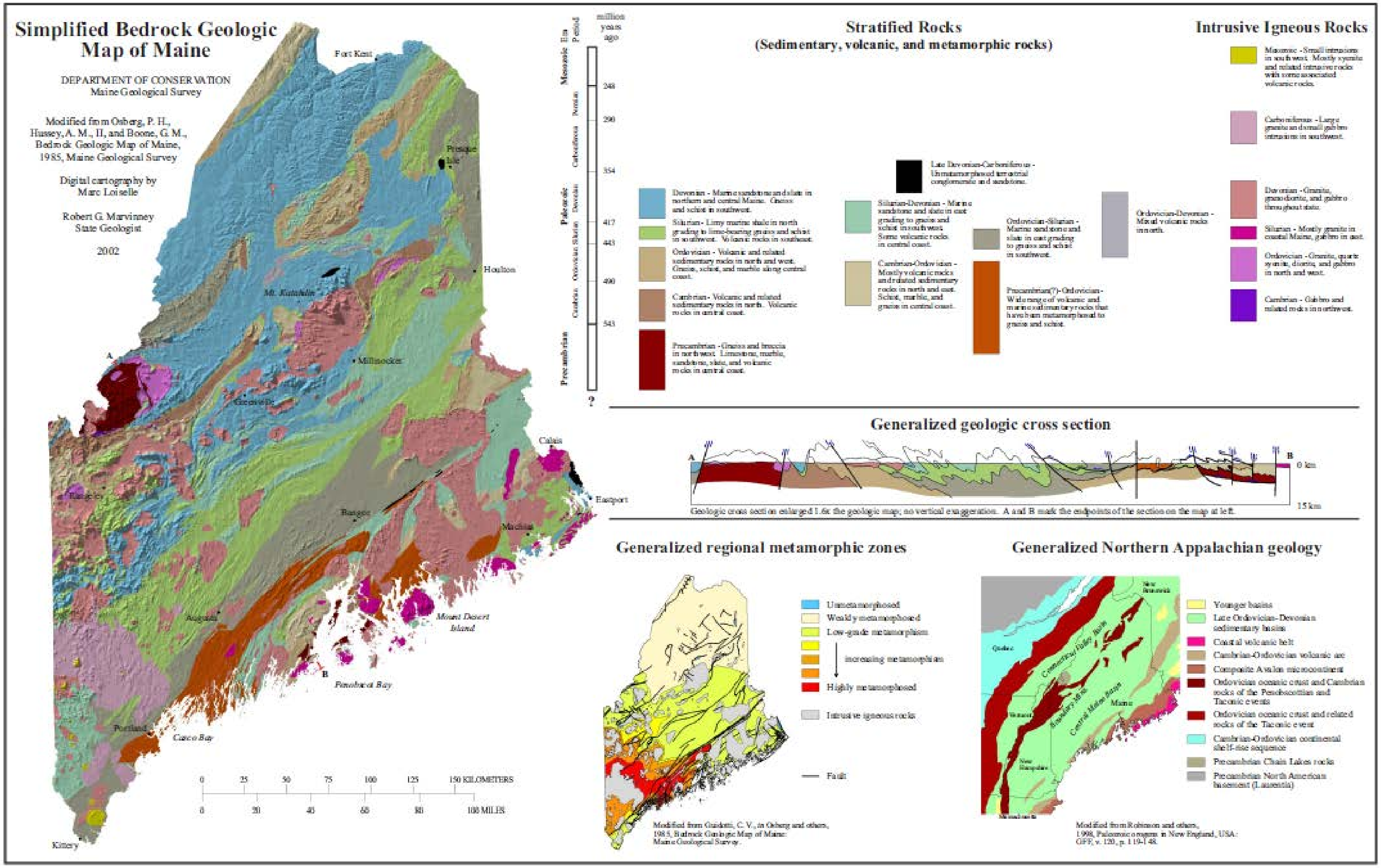
Scouring of thick glacial ice is responsible for rounding hills and carving lake basins throughout the region. Soils in the region are heavily influenced by this glacial history and tend to be coarse, and well drained. Waterbodies within the region drain to the Downeast rivers, including the St. Croix, Machias, and Penobscot Rivers (MDC 2009). Obscuring the bedrock geology throughout the region is a thick sequence of glacial units, deposited during both the advance and melting of the last great ice sheet. Much of the landscape is covered in till dating from this time. Other glacial features include eskers which were formed by water flowing through tunnels in the glacier, depositing coarse sediment (MDC 2009).

Bedrock near the Project is composed of two stratified rock formations, Silurian and Ordovician-Silurian (MDACF 2018) (Figure 4.6).

Stratified Rocks	Definition
Silurian	Limy marine shale in north grading to lime-bearing gneiss and schist in southwest, volcanic rocks in southeast.
Ordovician-Silurian	Marine sandstone and slate in east grading to gneiss and schist in southwest.

Source: MDACF 2018

Figure 4.6 Bedrock geology of Maine



Source: MDACF 2018

4.7.1.2 Soils and Rock Types

Maine soils were formed when the last glacier in Maine melted approximately 12,500 years ago and moved across the state in a northwest to southeasterly direction. Rock fragments and soil material were deposited as till, or as water-sorted sediments in streams, rivers, lake and the ocean (Figure 4.7). Land, depressed by the glacier, rebounded slowly, creating a complex pattern of soils derived from till, sediments, sands, and gravel (Ferwerda et. al, 1997).

Penobscot County is composed of mainly loamy soils formed in till derived mainly from slate, phyllite, metasandstone, and schist. Soil types within Penobscot County are included in Table 4.2) (Ferwerda et. al, 1997). Specifically, within the project vicinity, there is a wide array of soil types, as depicted in Figure 4.7.

Table 4.2 Soils Types in Penobscot County, Maine

Soil Type	Composition	Percentage in Maine
Telos-Monarda-Monson-Elliotsville	Loamy soils formed in till derived mainly from slate, phyllite, metasandstone, and schist.	18%
Danforth-Masardis-Shirley	Loamy and sandy soils formed in loose till or gravel deposits derived mainly from fine grained metasandstone and lesser amounts of granite, gneiss and schist	1%
Dixfield-Colonel-Lyman-Brayton	Loamy soils are formed in till derived mainly from schist, granite, phyllite and gneiss	23%
Dixmont-Thorndike-Monarda-Burnham	Loamy soils formed in till derived mainly from slate, phyllite, and metasandstone	3%
Hermon-Brayton-Dixfield	Sandy and loamy soils formed in till derived mainly from granite, gneiss, schist, and phyllite	4%

Soil Type	Composition	Percentage in Maine
Masardis-Stentson-Adams	Sandy soils formed in sandy or gravelly glaciofluvial materials derived mainly from slate, shale, phyllite and some granite, gneiss and limestone	2%
Swanville-Boothbay-Biddeford	Loamy and clayey soils formed in glaciolacustrine or glaciomarine sediments	4%
Vassalboro-Sebago-Wonsqueak	Organic material	1%

Source: Ferwerda et. al, 1997

Figure 4.7 Soils Surrounding the Project

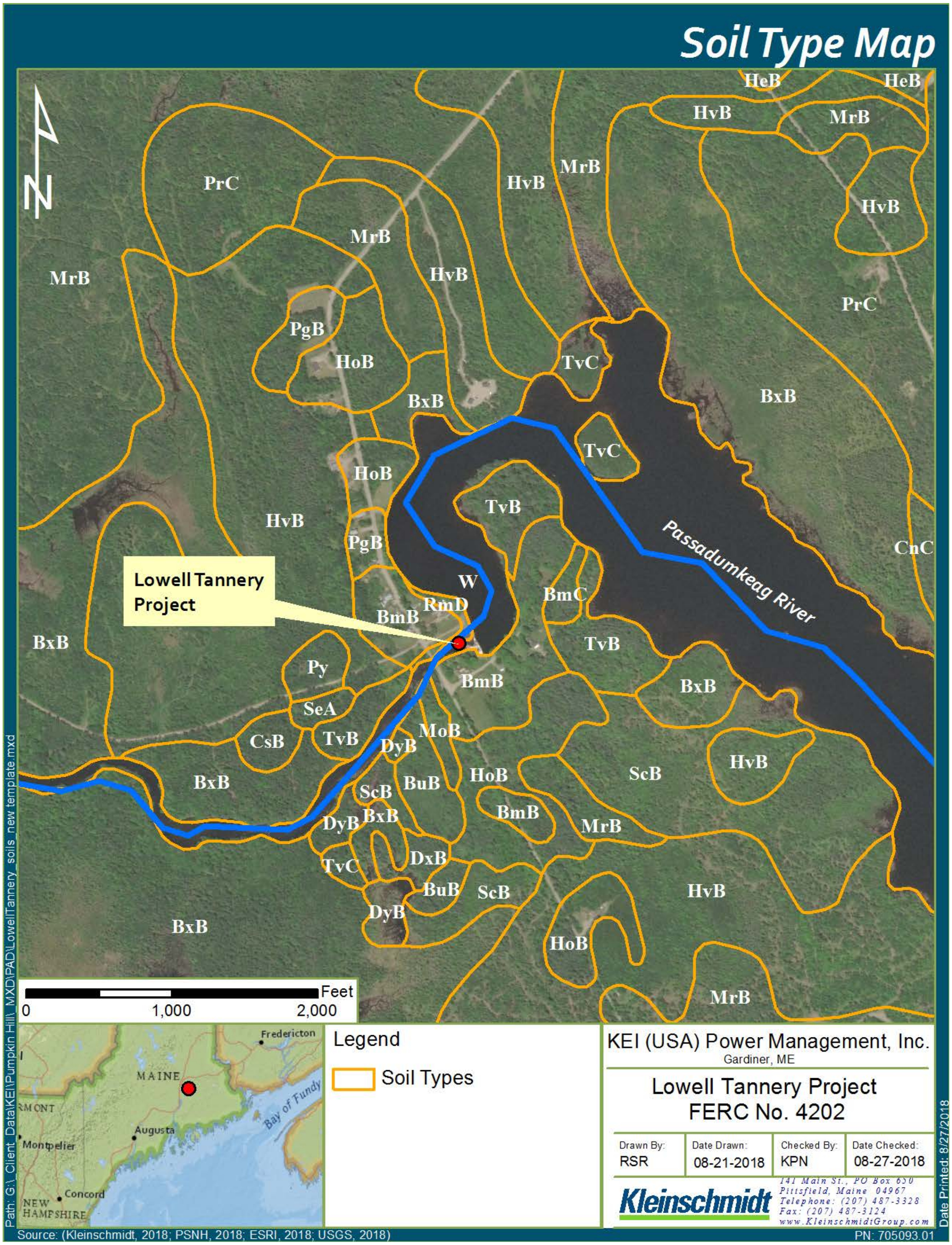


Table 4.3 List of Soils by Type, Size (Acres), and Percent within a 1-mile Radius of the Project

Soil Name	Soil Type	Area (acre)	Percent of Area (%)
AgA	Allagash fine sandy loam, 0 to 2 percent slopes	7	0.4
AgB	Allagash fine sandy loam, 2 to 8 percent slopes	7	0.3
BmB	Bangor silt loam, moderately deep, 2 to 8 percent slopes	25	1.2
BmC	Bangor silt loam, moderately deep, 8 to 15 percent slopes	2	0.1
BoA	Biddeford silt loam, 0 to 3 percent slopes	14	0.7
BuB	Buxton silt loam, 2 to 8 percent slopes	13	0.7
BxB	Buxton, Scantic, and Biddeford stony silt loams, 0 to 8 percent slopes	479	23.9
CnA	Colton gravelly sandy loam, dark materials, 0 to 2 percent slopes	22	1.1
CnB	Colton gravelly sandy loam, dark materials, 2 to 8 percent slopes	14	0.7
CnC	Colton gravelly sandy loam, dark materials, 8 to 15 percent slopes	38	1.9
CsB	Colton loamy fine sand, dark materials, 2 to 8 percent slopes	3	0.2
DxB	Dixmont silt loam, 2 to 8 percent slopes	3	0.1
DyB	Dixmont very stony silt loam, 2 to 8 percent slopes	6	0.3
HeB	Hermon very stony sandy loam, 2 to 8 percent slopes	21	1.1
HoB	Howland gravelly loam, 0 to 8 percent slopes	45	2.2
HvB	Howland very stony loam, 0 to 8 percent slopes	392	19.5
Lk	Limerick silt loam	25	1.2
Mn	Mixed alluvial land	15	0.8
MoB	Monarda silt loam, 0 to 8 percent slopes	2	0.1
MrB	Monarda and Burnham very stony silt loams, 0 to 8 percent slopes	329	16.4
PgB	Plaisted gravelly loam, 2 to 8 percent slopes	9	0.5
PrC	Plaisted very stony loam, 5 to 15 percent slopes	119	5.9
PrE	Plaisted very stony loam, 15 to 45 percent slopes	26	1.3
Py	Podunk fine sandy loam	20	1.0
RaB	Red Hook and Atherton silt loams, 0 to 8 percent slopes	13	0.7
RdB	Red Hook and Atherton fine sandy loams, 0 to 8 percent slopes	42	2.1
RmD	Rockland, thorndike material, strongly sloping	1	0.1
ScB	Scantic silt loam, 0 to 8 percent slopes	69	3.4
SeA	Stetson fine sandy loam, 0 to 2 percent slopes	2	0.1
SeB	Stetson fine sandy loam, 2 to 8 percent slopes	3	0.1
TkC	Thorndike very rocky silt loam, 8 to 15 percent slopes	30	1.5
TvB	Thorndike very stony silt loam, 2 to 8 percent slopes	19	0.9
TvC	Thorndike very stony silt loam, 8 to 15 percent slopes	8	0.4
W	Water bodies	185	9.2
	Total	2009	100

Source: USDA NRCS 2018

The dominant soil types within a 1-mile radius of the Lowell Tannery Project are Buxton, Scantic, and Biddeford stony silt loams (23.9 percent), Howland very stony loam (19.5 percent), and Monarda and Burnham very stony silt loams (16.4 percent) (Table 4.3) all with 0 to eight percent slopes (Table 4.3, Figure 4.7).

4.7.1.3 Reservoir Shoreline and Streambank Conditions

Just upstream of the dam, soils along the immediate shoreline are composed of Thorndike very stony silt loam, with 2-15 percent slopes (TvB, TvC); Howland gravelly and very stony loam with 0-8 percent slopes (HoB, HvB); Bangor silt loam with 2-8 percent slopes (BmB); Plaisted gravelly loam with 2-8 percent slopes (PgB); and Rockland, thorndike material, strongly sloping (RmD) (Table 4.3, Figure 4.7). These soils range from being poorly drained (BxB) to moderately well drained (HoB, HvB), to well drained (BmB, PgB, TvB, TvC), and to somewhat excessively drained (RmD).

The immediate shoreline downstream of the dam consists of Bangor silt loam (2-8 percent slope, BmB); Buxton silt loam (2-8 percent slope, BuB); Buxton, Scantic, and Biddeford stony silt loams (0-8 percent BxB); Thorndike very stony silt loam (2-8 percent slope, TvB), Dixmont very stony silt loam (2-8 percent slope, DyB), Rockland, thorndike material, strongly sloping (RmD), Scantic silt loam (0-8 percent slope, ScB), and Monarda silt loam (0-8 percent slope, MoB). Soils downstream of the dam range from poorly drained (BxB, MoB, ScB), to somewhat poorly drained (DyB, BuB), to well drained (BmB, TvB), to somewhat excessively drained (RmD).

4.7.1.4 Erosion

According to the 2013 State Hazard Mitigation Plan, all areas in Maine are susceptible to erosion, due to farming and crop cultivation throughout the state. Erosion can also occur in the area because of hurricanes, flooding, and wildfires, among other reasons (MDDVEM, 2013).

The Natural Resources Conservation Service has assessed the susceptibility of the soils surrounding the Project to erosion (i.e., the K Factor) caused by water including rainfall and stormwater run-off. K Factor estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity with values ranging from 0.02 to 0.69; larger values indicate greater susceptibility to sheet and rill erosion by water (USDA NRCS 2018). The K Factor values for the soils surrounding the Lowell Tannery Project range from 0.20 (Howland gravelly loam) to 0.37 (Dixmont and

Bangor silt loams), indicating a moderate susceptibility to erosion from water (USDA NRCS 2018).

4.7.2 Environmental Effects

4.7.2.1 Proposed Action

KEI (USA) proposes to continue operating the Lowell Tannery Hydroelectric Project as a run-of river facility. Run-of-river operations minimize large fluctuations of flow in downstream reaches and provide stable flows. Such stability will minimize the potential for erosion within the Project boundary.

Infrequent, short duration impoundment drawdowns, associated with maintenance or emergency operations, are unlikely to contribute to erosion within the Project boundary, because these events occur only on a very rare basis. Soils present along the riverbank is moderately susceptible to erosion. Recreational use at the project is limited, providing access to the impoundment from a hand carry boat access area on the north side of the dam, a parking area, and a canoe portage from the impoundment access area to a location near the bridge on Fogg Brook Road. Recreation that may occasionally occur near the Project is not expected to have significant adverse effects on soil stability within the Project boundary. Maintenance and grading will occur only in areas where the soil is already disturbed; these activities would not likely contribute to additional erosion.

4.7.2.2 No-Action Alternative

Under the no-action alternative, the Project would operate in the same manner as under the previous license. The Lowell Tannery Hydroelectric Project would continue to operate as a run-of river facility, with all inflow to the project being passed downstream. This mode of operation will minimize large fluctuations of flow in downstream reaches and provide stable flows. Such stability minimizes the potential for erosion within the Project boundary. Periodic impoundment drawdowns associated with maintenance or emergency operations or natural flood events may have the potential to contribute to erosion within the Project boundary. These events, though, occur on very rare occasions. By continuing run-of-river operations at the Lowell Tannery Hydroelectric Project, Project operations are not expected to have significant adverse effects on the local soil and geology.

4.7.2.3 Unavoidable Adverse Effects

Unavoidable adverse effects are those effects that may still occur after implementation of protection, mitigation, and enhancement (PME) measures. Some small amounts of erosion and sedimentation do have the potential to occur within the Project boundary if flooding events were to occur. Such events would contribute to erosion or scouring downstream of the Project. However, operation of the Project has a limited effect, if any, on geological resources and soil; therefore, additional PME measures are not warranted.

4.7.3 References

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4.8 Water Resources

4.8.1 Affected Environment

4.8.1.1 Water Quantity

The Lowell Tannery Project is operated in run-of-river mode and can generate electricity at river flows ranging from 90 cfs to 905 cfs, which are the approximate minimum and maximum hydraulic capacities of the turbine. Flows that pass through the turbine are discharged directly downstream of the powerhouse into the Passadumkeag River. Run-of-river operations minimize water level fluctuations in the impoundment; protect water quality, fishery, wildlife, and visual resources; and provide stable river flows downstream.

The 341-acre Lowell Tannery impoundment extends upstream approximately 4 river miles. The water depth immediately upstream of the dam is approximately 20 feet. The Lowell Tannery Project has no useable storage capacity. The drainage area upstream of the Lowell Tannery dam is approximately 297 square miles.

The Passadumkeag River is not currently gaged by the USGS. Monthly and annual mean flow and flow duration statistics at the Lowell Tannery dam were generated using the USGS StreamStats tool (USGS 2021). StreamStats estimates flow statistics for ungaged streams in Maine using regression equations from Dudley (2015). The annual mean flow at the Lowell Tannery Project is estimated to be 562 cfs (Table 4.4). The highest monthly mean flows are in April (1,170 cfs) and May (1,270 cfs). The lowest monthly mean flows are in August (153 cfs) and September (135 cfs) (Table 4.4). Annual and monthly flow duration statistics are provided in Table 4.5, and the flow duration curves are included in Exhibit A.

Table 4.4 Monthly and Annual Average Flow at the Lowell Tannery Project

Month	Average Flow (cfs)
January	412
February	368
March	500
April	1,170
May	1,270
June	488
July	236
August	153

Month	Average Flow (cfs)
September	135
October	364
November	656
December	657
Annual	562

Source: USGS 2021

Table 4.5 Monthly and Annual Average Flow Duration Statistics for the Lowell Tannery Project

Percent Exceedance	Annual	January	February	March	April	May	June	July	August	September	October	November	December
99	3,840	2,740	2,080	1,640	3,510	3,530	1,310	1,470	1,190	1,290	3,110	2,990	4,200
95	2,090	1,140	1,090	1,230	2,380	2,640	1,110	754	568	478	1,300	1,880	1,870
90	1,400	724	713	1,050	2,000	2,210	962	485	360	269	848	1,390	1,300
75	669	414	412	724	1,590	1,680	651	232	158	126	391	852	725
50	274	266	251	482	1,100	1,130	392	121	67.5	57.2	153	466	418
25	114	186	174	224	553	745	262	70.6	39.3	29.3	68.3	235	253
10	49.9	130	117	138	326	466	190	48.4	19.2	16.5	33.3	124	178
5	30.5	107	89.3	115	239	364	156	38.1	14.4	9.5	21.4	74.5	154
1	12.6	81.8	63.2	96.7	152	228	110	25.1	8.2	6.0	12.8	47.1	107

Source: USGS 2021

4.8.1.2 Existing Uses of Water

The Passadumkeag River is used for hydroelectric power generation, fish and wildlife habitat, and recreation. The Lowell Tannery Project is the only hydroelectric project on the Passadumkeag River. There are four other dams in the Passadumkeag River watershed (see Section 4.1 General Description of the River Basin). MDIFW stocks the Passadumkeag River, Cold Stream, Cold Stream Pond, and Trout Pond with brook trout and landlocked salmon each year. There are no new proposed water withdrawals or consumptive uses of water at the Lowell Tannery Project.

4.8.1.3 Existing Water Rights

KEI (USA) holds all the flowage easements necessary to operate the Lowell Tannery Project. There is no development within the project boundary aside from project structures.

4.8.1.4 Water Quality

Water Quality Standards

Maine statute 38 MRSA §464-470 establishes the state of Maine's classification system for surface waters. The Passadumkeag River from the Lowell Tannery dam to the confluence with the Penobscot River is Class AA; the Passadumkeag River upstream of the Lowell Tannery dam is Class A (Maine Legislature 2020). Class AA waters are the highest classification in the state of Maine and are "applied to waters which are outstanding natural resources which should be preserved because of their ecological, social, scenic or recreational importance" (Maine Legislature 2020). The quality of Class AA waters must support the designated uses of drinking water supply after disinfection, fishing, agriculture, recreation in and on the water, navigation, and habitat for fish and other aquatic life; aquatic life, dissolved oxygen (DO) and bacteria content shall be as naturally occurs. Class A waters are the second highest classification and must be of such quality to support the designated uses of drinking water after disinfection, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and habitat for fish and other aquatic life (Maine Legislature 2020). Class AA and Class A water quality standards are provided in Table 4.6.

Table 4.6 Class A/AA Water Quality Standards

Parameter	Criteria[a]	Water Classification
Dissolved Oxygen[a]	>7 mg/L or 75% saturation	Class A
	As naturally occurs	Class AA
Iron[b]	1000 µg/L or 1 mg/L	Statewide
Chloride[b]	230,000 µg/L or 230 mg/L	Statewide
Aluminum[b]	87 µg/L or 0.087 mg/L	Statewide
Total Phosphorus[c]	≤ 18 µg/L (0.018 mg/L) (mean of samples collected during sampling season)	Class AA/A
Water Column Chlorophyll-a[c]	≤ 3.5 µg/L (0.0035 mg/L)	Class AA/A
Secchi Disk Depth[c]	≥ 2.0 m	Class AA/A
pH[c]	6.0 – 9.0	Class AA/A

[a]Maine Legislature 2020
[b]MDEP 2020a
[c]MDEP 2020b

Water Quality Monitoring

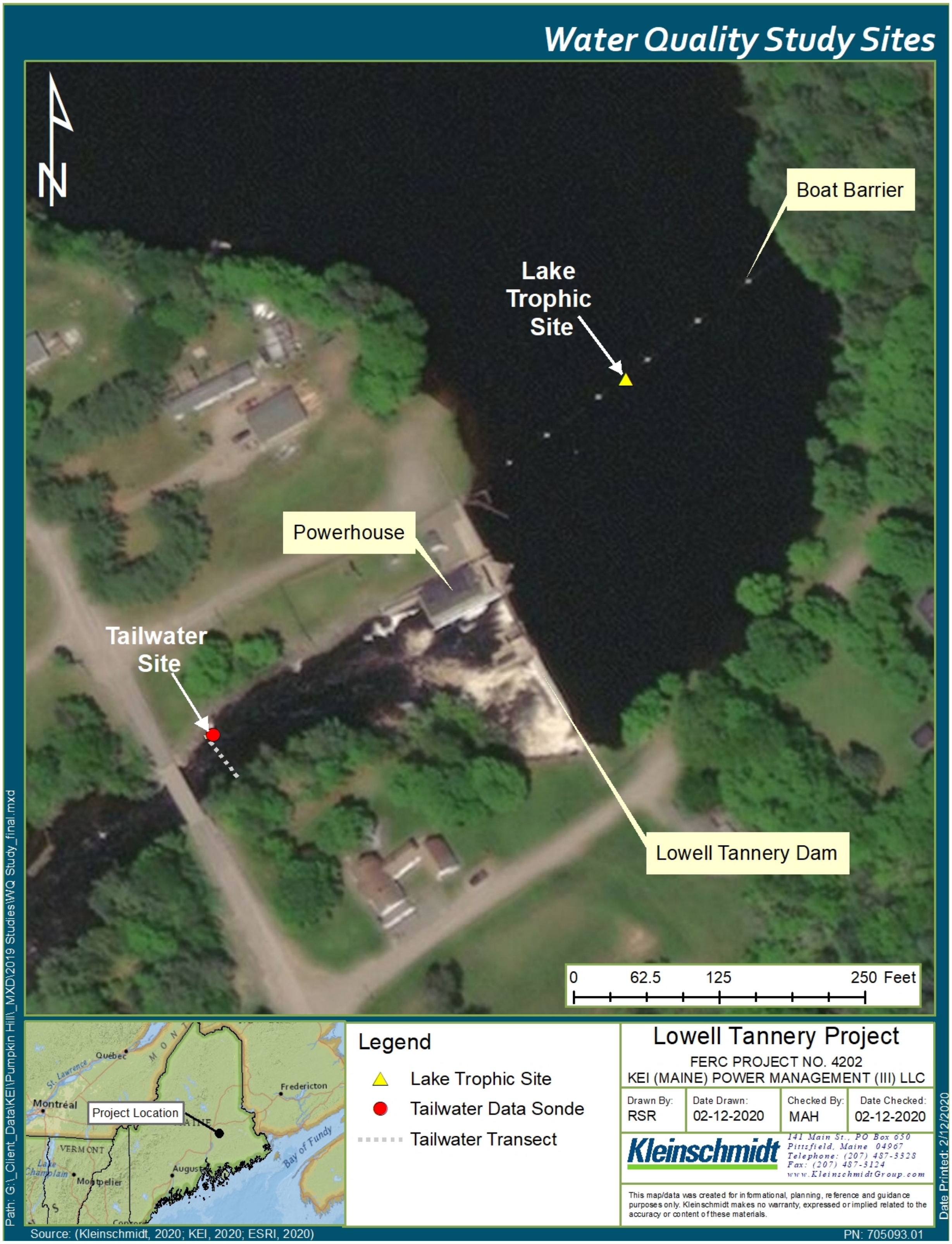
KEI (USA) completed four water quality studies in 2019 and 2020 to evaluate the potential effects of project operations on water quality and benthic macroinvertebrates. The goal of these studies was to collect baseline water quality information and to use the information to assess whether the Passadumkeag River in the Lowell Tannery Project area meets applicable water quality standards and provides for the designated uses (i.e., recreation in and on the water, habitat for fish and other aquatic life) of the waterway. The full study reports are provided as Appendix B.

2019 Impoundment Water Quality Monitoring

KEI (USA) performed lake trophic sampling in the Lowell Tannery impoundment twice a month from June to October 2019 in accordance with MDEP protocols (MDEP 2019). The sampling was conducted at the deepest, safety accessible spot upstream of the boat barrier. The site was approximately 250 feet upstream of the dam in approximately 20 feet (6 m) of water (Figure 4.8).

Water samples for analysis of total phosphorus, chlorophyll-a, color, total alkalinity, and pH were collected using an epilimnetic core. The samples were stored on ice and delivered within 24 hours to the state of Maine's Health and Environmental Testing Laboratory in Augusta, Maine. On August 15, 2019, and in accordance with MDEP protocols, KEI (USA) collected and submitted additional late summer water samples for analysis of nitrate, dissolved organic carbon (DOC), iron, dissolved aluminum, calcium, magnesium, sodium, potassium, conductivity, chloride, and sulfate. Furthermore, during each sampling event, KEI (USA) collected Secchi disk transparency measurements and water temperature and DO profiles at 1-meter intervals with a YSI-ProODO handheld meter.

Figure 4.8 2019 Water Quality Study Sampling Sites



The main findings of the water quality monitoring in the Lowell Tannery impoundment were that:

- Total phosphorus ranged from 15.0 μg/L to 33 μg/L with an average 20 μg/L. Five of the 10 samples had total phosphorus levels above the standard for Class A/AA waters (18 μg/L).
- Color ranged from 85 to 180 PCU with an average of 136 PCU.
- Chlorophyll-a ranged from 0.002 to 0.005 mg/L with an average of 0.003 mg/L which is less than the standard of 0.0035 mg/L for Class A/AA waters.
- Based on the mean chlorophyll-a concentration, the Trophic State Index for the Lowell Tannery impoundment was calculated to be 41 which is characterized as mesotrophic (MDEP 1996).
- Total alkalinity ranged from 6.0 to 8.0 mg/L with an average of 7.3 mg/L.
- pH ranged from 6.4 to 7.1 with an average of 6.6. All pH values were within the recommended range of 6.0 to 9.0 for Class A/AA waters.
- The Secchi disk transparency ranged from 1.9 to 2.9 meters with an average of 2.3 meters. Nine of the ten Secchi disk readings were greater than the 2.0 m standard.
- The average water temperatures throughout the water column at the beginning (June) and end (October) of the monitoring period were 21.8°C and 12.4°C, respectively (Table 4.7). The highest water temperatures were observed in mid-July through mid-August (water column average temperatures ranged from 23.1°C to 25.3°C). The water temperature steadily decreased from late August through the end of monitoring in October (Table 4.7).
- The DO concentration was highest at the beginning and end of the monitoring period with average values throughout the water column of 8.1 mg/L on June 18, 7.9 mg/L on June 25, and 7.9 mg/L to 9.0 mg/L in the last three profiles (Table 4.8). In July and August, the water column average DO concentration ranged from 6.5 mg/L to 6.8 mg/L; instantaneous values ranged from 6.3 mg/L to 7.3 mg/L. The profile average DO concentrations in July and August were below the standard for Class A waters.
- The average DO percent saturation in the water column was highest in the two June profiles (92.3 percent and 89.6 percent) (Table 4.8). The average DO percent saturation ranged from 73.3 percent to 84.2 percent in the remaining profiles with instantaneous values of 72.1 percent to 91 percent. The DO percent saturation was above the 75 percent standard except on August 26 (range 72.1 percent to 75.1 percent, average 73.3 percent) (Table 4.8).

- The impoundment did not thermally stratify and was well mixed.

Table 4.7 Average, Minimum, and Maximum Water Temperature in the Lowell Tannery Impoundment during the Lake Trophic Sampling, June to October 2019.

Sample Date	Average (°C)	Minimum (°C)	Maximum (°C)
6/18/2019	21.8	20.9	24.1
6/25/2019	21.4	20.9	22.1
7/16/2019	23.9	23.3	24.8
7/29/2019	25.3	24.3	26.9
8/15/2019	23.1	22.7	24.2
8/26/2019	21.2	21.1	21.3
9/6/2019	19.4	19.3	19.9
9/19/2019	16.3	16.0	17.2
10/2/2019	15.0	15.0	15.0
10/16/2019	12.4	12.1	13.2

Table 4.8 Average, Minimum, and Maximum DO Concentration and DO Percent Saturation in the Lowell Tannery Impoundment during the Lake Trophic Sampling, June to October 2019.

Sample Date	DO (mg/L)			DO (% Saturation)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
6/18/2019	8.1	8.0	8.3	92.3	89.3	98.5
6/25/2019	7.9	7.8	8.0	89.6	87.4	92.0
7/16/2019	6.7	6.6	6.9	79.6	76.8	82.9
7/29/2019	6.7	6.3	7.3	81.8	75.2	91.0
8/15/2019	6.8	6.7	7.0	79.3	77.7	83.2
8/26/2019	6.5	6.4	6.7	73.3	72.1	75.1
9/6/2019	7.1	7.1	7.3	77.6	76.6	79.8
9/19/2019	8.3	8.2	8.3	84.2	82.7	86.4
10/2/2019	7.9	7.8	8.0	78.0	77.0	78.9
10/16/2019	9.0	8.9	9.2	83.9	82.3	86.9

2019 Downstream Water Quality Monitoring

In accordance with MDEP's Sampling Protocol for Hydropower Studies (MDEP 2019), KEI (USA) completed a tailwater DO and water temperature study in 2019 to evaluate compliance with water quality standards. KEI (USA) continuously monitored DO and water temperature at a single location approximately 200-feet downstream of the tailrace on river right (from the perspective of an observer looking downstream) with a water depth of approximately 2 to 3 feet. The data sonde was programmed to sample water temperature and DO at 1-hour intervals from June 25 to September 17, 2019, during the summer low flow, high temperature period.

The main findings of the downstream monitoring were:

- The water temperature ranged from 16.0ºC on June 28 to 26.8ºC on August 1. The average temperature was 22.3ºC (Table 4.9, Figure 4.9).
- DO ranged from 6.2 mg/L on August 19 to 10.0 mg/L on June 28 (Table 4.9, Figure 4.10). The average DO concentration was 7.9 mg/L.
- The DO percent saturation ranged from 70.9 percent on August 19, to 104.5 percent on July 2 and July 3 (Table 4.9, Figure 4.10). The average DO percent saturation was 90.4 percent.
- During some of the times when the Lowell Tannery Project was generating in July and August 2019, the DO concentration and percent saturation decreased below the Class A water quality standard (7 mg/L). When generation stopped, DO levels downstream of the dam increased reflecting aeration and mixing during spill conditions (for example on August 3 and August 19, 2019) (Figure 4.10).

Table 4.9 Water Temperature and DO Statistics Downstream of the Lowell Tannery Dam, June 25 to September 17, 2019.

Statistic	Water Temperature (ºC)	DO (mg/L)	DO Percent Saturation
Average	22.3	7.9	90.4
Minimum	16.0	6.2	70.9
Maximum	26.8	10.0	104.5

Figure 4.9 Hourly Water Temperature Time Series Downstream of the Lowell Tannery Dam (June 25 to September 17, 2019)

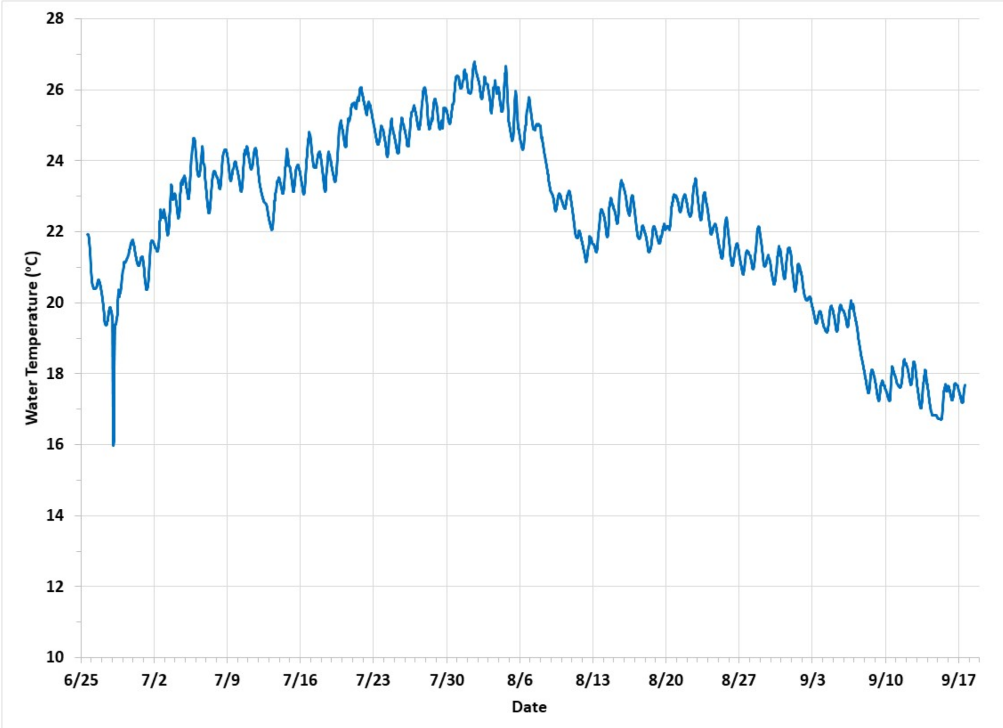
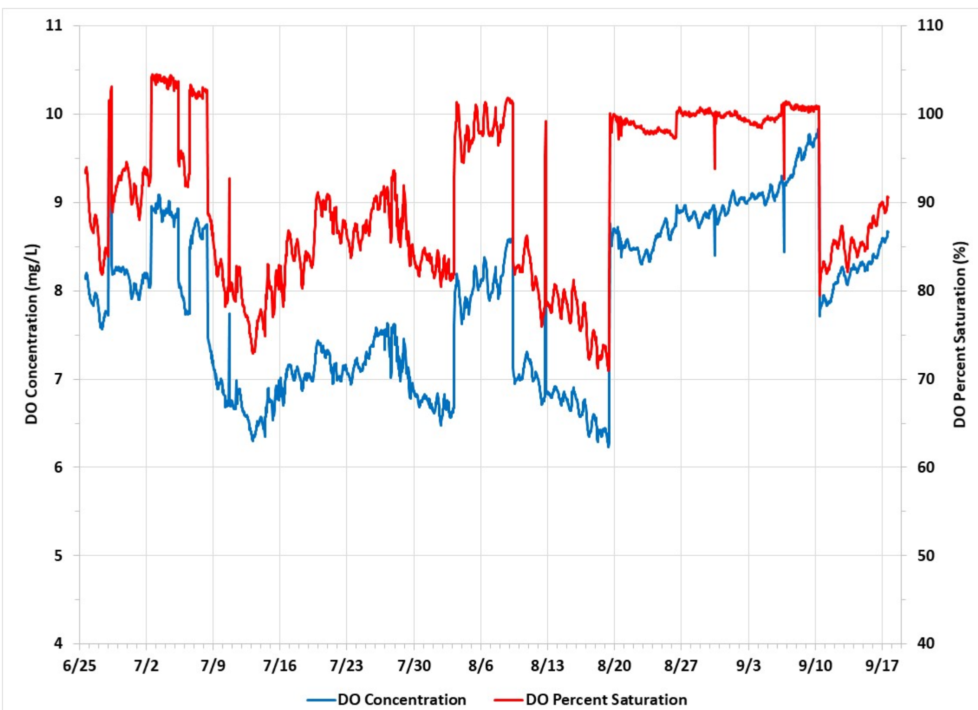


Figure 4.10 Hourly DO Time Series Downstream of the Lowell Tannery Dam (June 25 to September 17, 2019)



2020 Water Quality Monitoring

Based on recommendations from the MDEP, KEI (USA) monitored DO and water temperature throughout the Lowell Tannery project area in 2020 to evaluate whether upstream waters (i.e., impounded waters or inflowing waters to the impoundment) may have contributed to the low DO values near the dam and in the tailwater that were observed in 2019. Due to low river flows, KEI (USA) was not able to operate the project during the 2020 monitoring period; all water was spilled or passed through the fishways. KEI (USA) installed Onset Hobo U-26 dataloggers in the Passadumkeag River at the following four locations, which were approved by the MDEP,[2] and recorded hourly DO and water temperature data between July 15 and August 24, 2020 (Figure 4.12):

- Site 1 Upstream - approximately river 3.8 miles upstream from the dam at the transitional point between river and impounded habitat;
- Site 2 Impoundment- at the deepest spot within the impoundment (approximately 250 feet upstream of dam, water depth approximately 20 feet);
- Site 3 Tailwater – in the tailwater directly downstream of the dam; and
- Site 4 Downstream - one mile downstream of the dam.

The 2020 monitoring showed that inflowing waters to the impoundment regularly had DO concentrations and percent saturation levels below the Class A/AA standards (Figure 4.12). The DO concentration and percent saturation at the deep spot in the impoundment were consistently between 6.0 mg/L and 7.5 mg/L and 60 percent to 90 percent, respectively, and were occasionally below the standards. In the tailwater and downstream of the dam, the DO concentration and percent saturation were above the Class AA standards throughout the monitoring period.

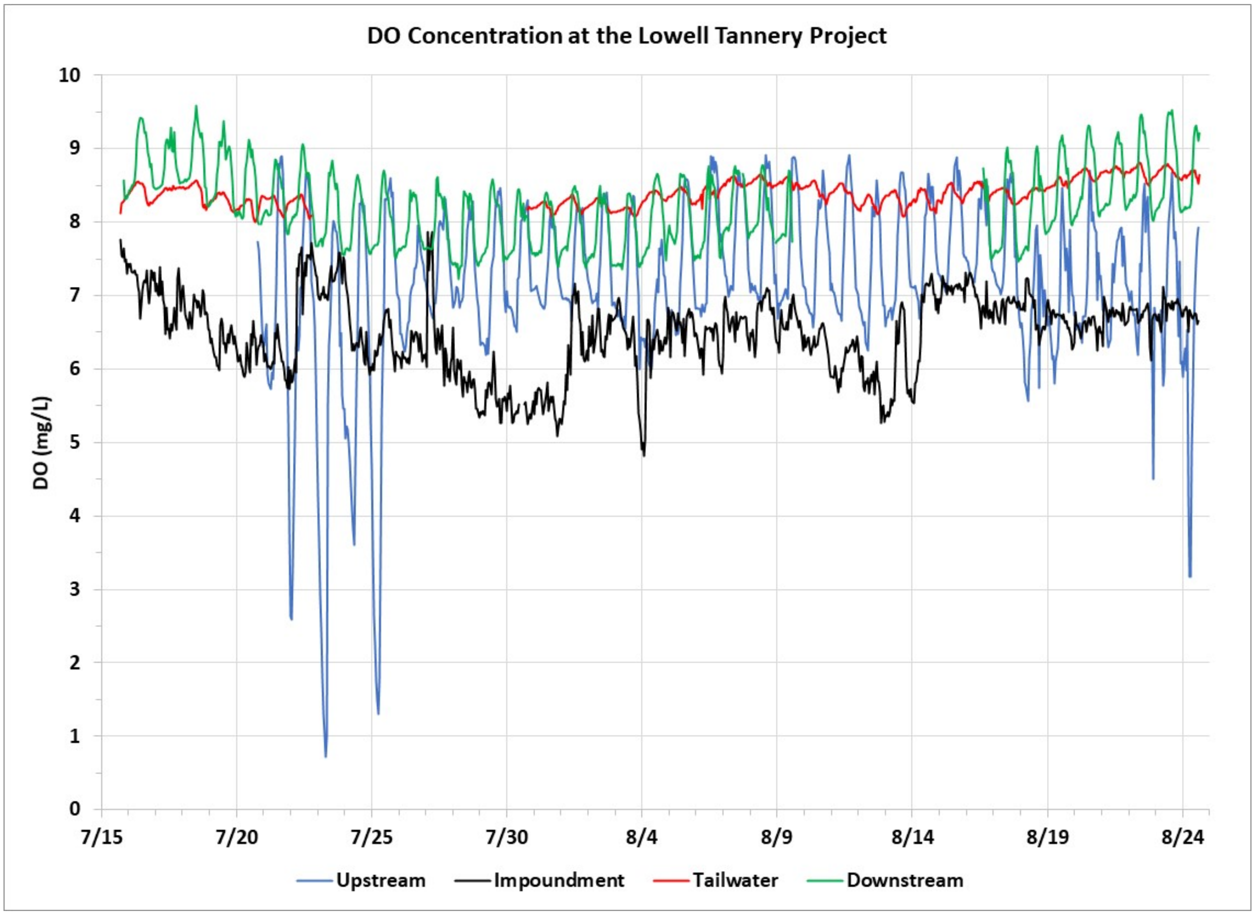
The 2020 monitoring demonstrated that multiple factors may contribute to DO levels being below the standards in the Lowell Tannery impoundment. Anecdotal information suggests that water quality in the Passadumkeag River has been poor historically due to an intrusion of saw dust from past logging practices near Saponac Pond,[3] which is just upstream of the Lowell Tannery project; the logger at Site 1 Upstream was approximately 0.7 river miles downstream of Saponac Pond. In addition, there is a large amount of dead and decaying tree root wads and snags and submerged aquatic vegetation throughout

[2] Conference call, Kleinschmidt with MDEP staff, May 26, 2020.
[3] https://www.maine.gov/ifw/docs/lake-survey-maps/penobscot/saponac_pond.pdf

the impoundment which may consume DO through decomposition of detritus and decaying plant matter.

Figure 4.11 2020 Water Quality Study Sampling Sites

Figure 4.12 Hourly DO concentration (mg/L) time series throughout the Lowell Tannery Project area (July 15 to August 24, 2020)



4.8.1.5 Benthic Macroinvertebrates

In accordance with MDEP's Sampling Protocol for Hydropower Studies (MDEP 2019), KEI (USA) conducted an aquatic life criteria study (i.e., benthic macroinvertebrate sampling) to assess whether the Passadumkeag River attains Class A water quality standards and the designated use of "habitat for fish and other aquatic life" at the Lowell Tannery Project. The objectives of the benthic macroinvertebrate study were to obtain information on the aquatic macroinvertebrate community in the Passadumkeag River downstream of the Lowell Tannery dam and assess the community in terms of Maine's Aquatic Life Standards. KEI (USA) followed guidelines from "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2014) as the basis of the field and laboratory procedures. Rock-bag samplers were installed at one (1) sample site approximately 490-feet downstream of the dam on August 9, 2019; samplers were retrieved on September 13, 2019.

The invertebrate community sampled downstream of the Lowell Tannery dam was abundant, moderately rich, and well-populated with stress sensitive taxa indicating good water quality. The community structure and function found below the Lowell Tannery dam indicates a generally healthy community with evidence of natural, biological enrichment. It is the professional opinion of Moody Mountain Environmental, a qualified invertebrate specialist, that the macroinvertebrate community downstream of the Lowell Tannery dam on the Passadumkeag River is naturally occurring, does not show excessive stress as a result of project operation, and attains Class A aquatic life standards. In addition, the data was submitted to MDEP for analysis using a linear discriminant water quality model to determine the water quality class attainment of aquatic macroinvertebrate communities. MDEP determined that sufficient information has been provided to demonstrate the community met Class A and AA aquatic life water standards.

4.8.2 Environmental Effects

4.8.2.1 Proposed Action

KEI (USA) is proposing to continue to operate the Lowell Tannery Project as run-of-river where natural inflow to the dam is equal to the outflow and there is no water storage in the reservoir for generation. Water quality monitoring completed throughout the Lowell Tannery Project area in 2019 and 2020 demonstrated that at the deep spot in the impoundment, DO levels occasionally decrease below the Class A/AA standards and that these low levels can be transported downstream during generation. The 2020 study showed that the low DO levels in the impoundment may be influenced by low DO in inflowing water to the impoundment or by biological processes in the impoundment and are not the result of project operations. In a September 16, 2021 letter providing comments on the DLA, MDEP stated inflowing waters to the impoundment contributed to the low DO values observed in the impoundment and tailwater and that sufficient DO data has been collected at the Lowell Tannery Project. Half of the total phosphorus samples collected in the impoundment were above the Class A/AA standard. Chlorophyll-a, Secchi disk, and pH were in attainment with the standards throughout the study period. The benthic macroinvertebrate monitoring downstream of the Lowell Tannery dam demonstrated that the aquatic community attains Class A aquatic life standards. Overall, the results of the 2019 and 2020 water quality studies indicate that operation of the Lowell Tannery Project does not have an adverse impact on water resources in the Passadumkeag River and is not expected to have new adverse effects on existing water resources.

4.8.2.2 No Action Alternative

Under the current operating regime, the Passadumkeag River at the Lowell Tannery Project attains applicable water quality standards and meets the designated uses of "recreation in and on the water" and "habitat for fish and other aquatic life." Continued run-of-river operation of the Lowell Tannery Project is not expected to alter the water quality of the impoundment or tailrace and will continue to maintain the resident fish and aquatic organism community.

4.8.2.3 Unavoidable Adverse Effects

Current operation of the Lowell Tannery Project does not adversely affect the water resources in the Passadumkeag River. KEI (USA) may need to temporarily alter water levels in the impoundment or tailrace for routine maintenance or repairs.

4.8.3 References

Davies, S.P. and L. Tsomides. 2014 Revised. Methods for biological sampling and analysis of Maine's rivers and streams. ME Dept. of Env. Prot. Augusta, ME.31p.

Dudley, R.W., 2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine (ver. 1.1, December 21, 2015): U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p., http://dx.doi.org/10.3133/sir20155151.

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4.9 Fish and Aquatic Resources

4.9.1 Affected Environment

The Lowell Tannery Project is on the Passadumkeag River, a 48-mile-long tributary of the Penobscot River in northern Maine. The Passadumkeag River originates at Weir Pond and Number Three Pond in Twombly Township near Lee and Burlington, Maine. The river flows south-southwest through forests and wetlands to converge with the Penobscot River in Passadumkeag, Maine. The Lowell Tannery Project is located approximately 13 river miles upstream from the confluence of the Penobscot River and the Passadumkeag River; the confluence of the Penobscot River and Passadumkeag River is approximately 57 river miles from Penobscot Bay (Figure 4.13). The drainage area of the Passadumkeag River is approximately 397 square miles and the drainage area at the Lowell Tannery Project is approximately 297 square miles (USGS 2021).

KEI (USA) operates the Lowell Tannery Project as a run-of-river facility, which is protective of aquatic resources, as stable headpond and river flows are maintained. The Lowell Tannery Project is the only impoundment on the Passadumkeag River. Aquatic habitat within the Project area includes the reaches of the Passadumkeag River upstream and downstream of the dam. Lentic (i.e., impounded) habitat extends approximately 3.75 river miles upstream from the dam to the outlet of Saponac Pond. The impoundment is generally narrow and shallow with extensive amounts of woody debris, snags, and aquatic vegetation beds along the shoreline (Photo 4.1). The depth immediately upstream of the dam is approximately 20 feet, and the surface area of the reservoir is 341 acres. The Project boundary also includes the tailwater, which encompasses approximately 250-feet of the Passadumkeag River downstream of the dam. The tailwater area is shallow and narrow with bedrock or large boulder substrates. The Passadumkeag River immediately downstream of the Lowell Tannery Project includes typical low-gradient stream features such as riffle, run, and pool habitats (Photo 4.2 and Photo 4.3).

Figure 4.13 Passadumkeag River Watershed and Project Location

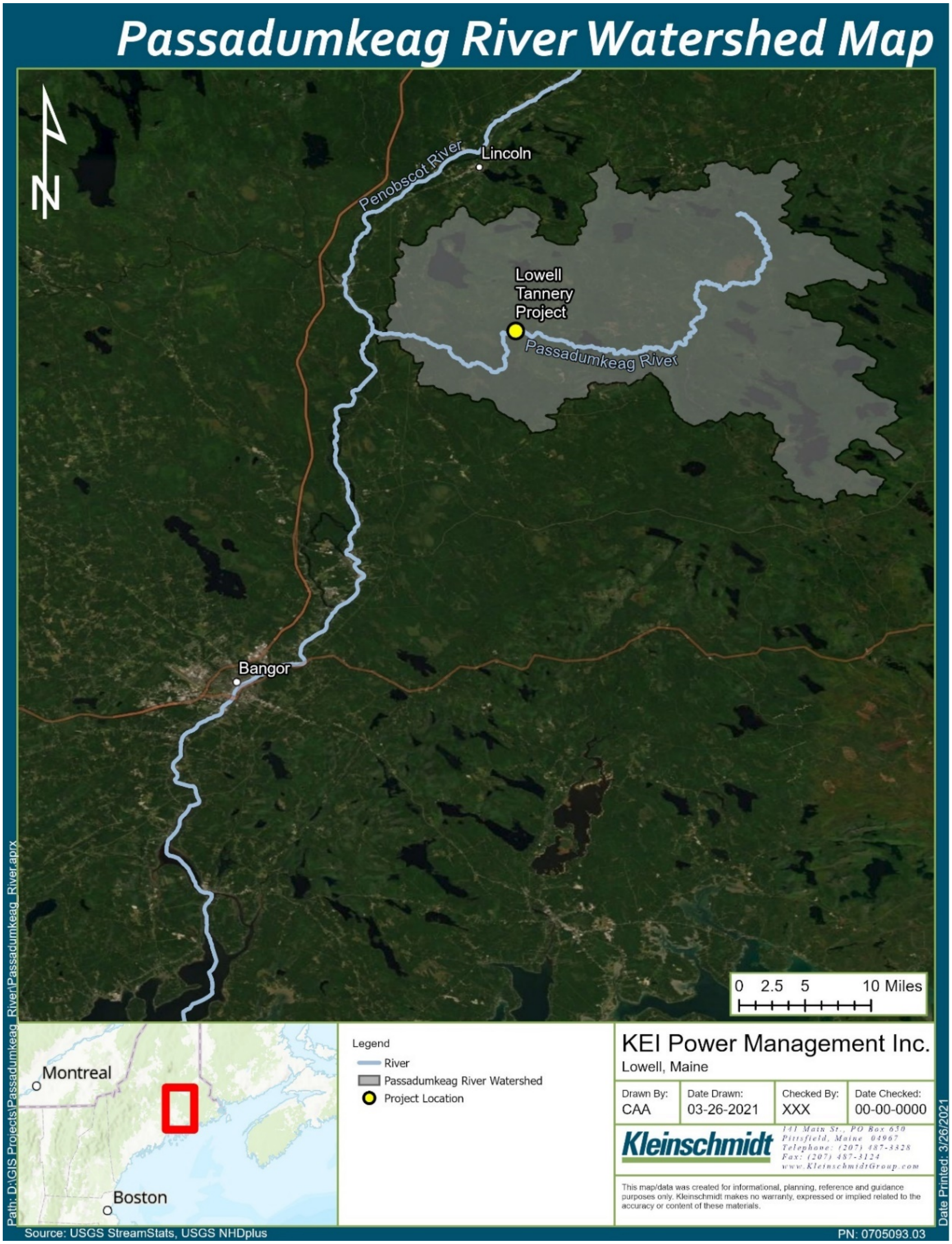

Photo 4.1 View of the Lowell Tannery Project Impoundment

Photo 4.2 View of the Lowell Tannery Project Tailwater

Photo 4.3 View of River Reach Downstream of the Lowell Tannery Project Tailrace.

4.9.1.1 Fishery Resources

The Midwest Biodiversity Institute (MBI) used boat electrofishing techniques to sample fish assemblages on the Passadumkeag River during 2004 and 2009. Sampling was conducted near river mile 7, approximately halfway between the Lowell Tannery Project and the confluence with the Penobscot River. Eleven common, resident, coldwater and warmwater game and non-game fish species were documented during both sampling efforts (Table 4.10). Common shiner and white sucker were the most abundant species, and comprised almost half of the species composition. Three diadromous fish species were also collected: one juvenile Atlantic salmon, 1 juvenile sea lamprey, and 10 American eels (Table 4.10).

Table 4.10 Fish species Collected by MBI during 2004 and 2009 Electrofishing Efforts on the Passadumkeag River

Common Name	No. Collected	Percent Catch	Batch Weight (grams)	Percent by Weight
Common shiner	158	26.4%	222	1.03%
White sucker	130	21.7%	9563	44.38%
Fallfish	72	12.0%	518	2.40%
Brown bullhead	63	10.5%	3382	15.70%
Golden shiner	42	7.0%	179	0.83%
Redbreast sunfish	35	5.8%	948	4.40%
Yellow perch	33	5.5%	1570	7.29%
Chain pickerel	29	4.8%	350	1.62%
Smallmouth bass	16	2.7%	2072	9.62%
American eel	10	1.7%	2320	10.77%
Burbot	6	1.0%	190	0.88%
Pumpkinseed sunfish	3	0.5%	220	1.02%
Sea lamprey	1	0.2%	10	0.05%
Atlantic salmon	1	0.2%	4	0.02%
Total	**599**	**100.0%**	**21,548**	**100.00%**

Source: MBI 2009

The MDIFW stocks the Passadumkeag River with brook trout annually to support a put-grow-take fishery. The MDIFW stocked 20,000 brook trout and 778 6-inch-long landlocked salmon approximately 12 river miles upstream of the Lowell Tannery Project near the Grand Falls Township in 2020. The MDIFW also stocked 10,000 brook trout and 389 landlocked salmon in the Passadumkeag River in Lowell, Maine, in 2020 (MDIFW 2020). The MDIFW also stocks multiple reaches of Cold Stream and Cold Stream Pond annually to support fisheries for brook trout and landlocked salmon. Cold Stream is a tributary to the Passadumkeag River, located approximately 11 river miles downstream. KEI (USA) provides access to the impoundment from a small, unpaved boat launch at the dam. Additionally, KEI (USA) maintains a parking area and canoe portage from the impoundment access area to a put-in location near the bridge on Tannery Road.

4.9.1.2 Fish Passage and Diadromous Fish Species

The Lowell Tannery Project is approximately 32 river miles upstream of the Milford Project, which is the first hydropower project on the Penobscot River. The Milford Project is equipped with a fish-lift system, and is known to pass multiple diadromous fish species including Atlantic salmon, American shad, American eel, river herring (blueback herring and sea-run alewife), and sea lamprey. The range of other diadromous fish that occur in the Penobscot River, including striped bass, Atlantic tomcod, rainbow smelt, shortnose sturgeon, and Atlantic sturgeon, is limited to the lower part of the watershed downstream of the Milford Project. Milford Falls was the historical upstream limit to these species (NOAA 2016).

Brookfield Black Bear Hydro, licensee for the Milford Project, has passed thousands of American shad and millions of river herring since operation of the fish lift began in 2014. Historically, the Penobscot River supported major runs of Atlantic salmon; in 2020, approximately 1,600 adult salmon returned to the Penobscot River. The number of returning Atlantic salmon has increased in recent years likely as a result, at least in part, of major river restoration, fish passage, and dam removal projects (e.g., removal of Great Works and Veazie dams; installation of state-of-the-art fish lifts). Atlantic salmon are a federally endangered species with protection under the Endangered Species Act (ESA); recovery of the species is supported by a conservation hatchery program led by the USFWS (NOAA 2016). Adult salmon returning to the Penobscot River are collected at the Milford fish lift and used for broodstock and hatchery programs. Very few salmon, other than escapees or immature adults, are passed upstream of the Milford Project. KEI (USA) initially consulted NMFS in 2014 to begin Section 7 consultation but NMFS ultimately recommended waiting until relicensing to reinitiate consultation. KEI (USA) has developed a draft biological assessment (BA) and species protection plan (SPP).

4.9.1.3 Existing Fish Passage Measures

The Lowell Tannery Project is equipped with upstream and downstream fish passage systems, including a Denil fish ladder and a dedicated downstream fishway at the intake (Photo 4.4). KEI (USA) operates the upstream fishway annually from May 15 through November 10; 40 cfs of attraction and conveyance water is discharged near the base of the powerhouse through the fishway. The downstream fishway is adjacent to the eastern side of the intake racks (Photo 4.4); a bypass gate in the forebay leads to an 18-inch pipe, which discharges into a plunge pool next to the tailrace. The intake racks are equipped with 1.5-inch clear space vertical bars angled at 45 degrees. KEI (USA) provides 20 cfs through the downstream bypass through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (USA) operates the downstream fishway in the spring from ice-out through early June to pass Atlantic salmon smolts, should they migrate downstream through the Passadumkeag River. Downstream passage for Atlantic salmon kelts (i.e., post-spawned adults) is provided through the downstream fishway from November 1 to ice-in.

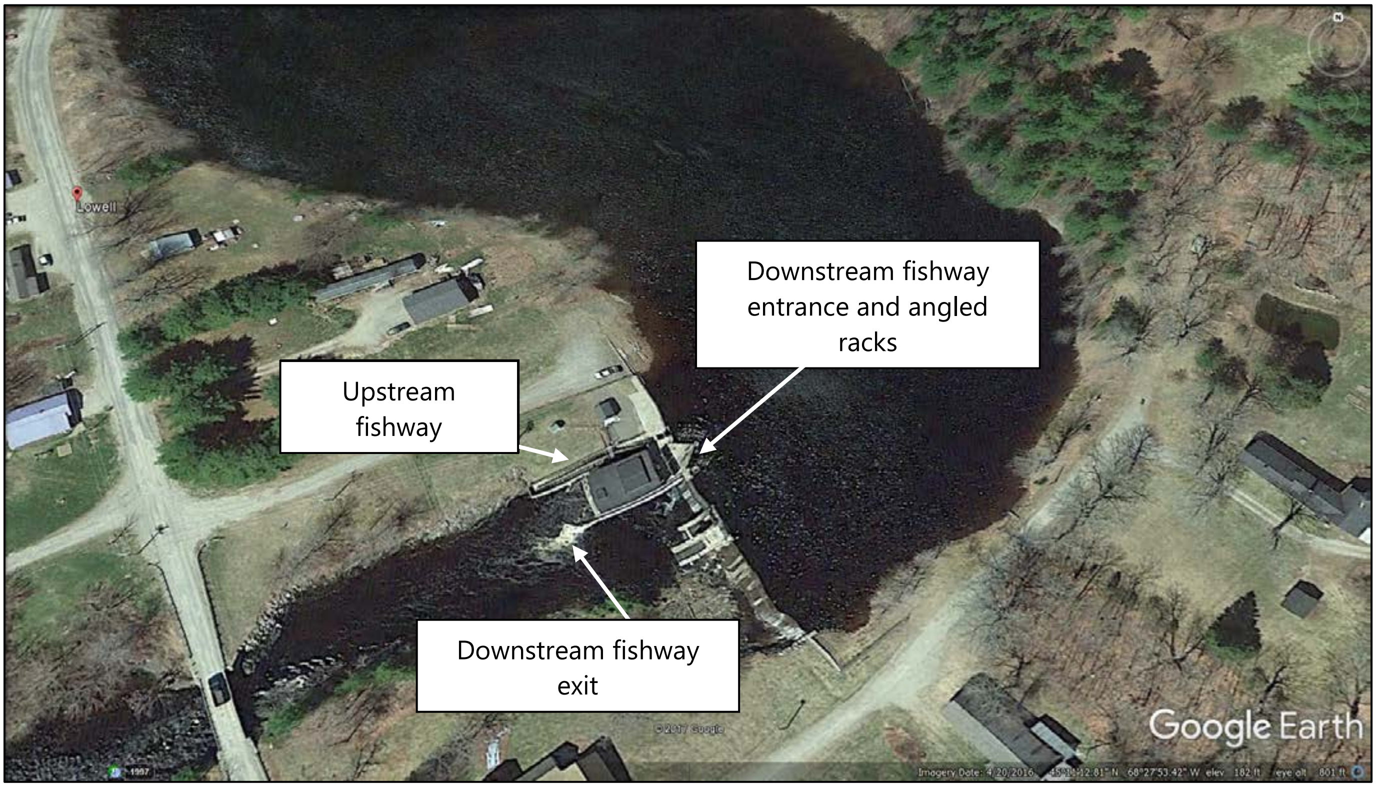

Photo 4.4 Aerial imagery showing location of upstream fishway, downstream fishway, and angled intake racks at Lowell Tannery Project.

KEI (USA) completed several studies of diadromous fish at the Lowell Tannery Project, including upstream American eel monitoring, upstream fish passage effectiveness studies for river herring (completed in 2020 and 2021), and a desktop entrainment and downstream passage survival study as part of the relicensing effort. Study reports are described below and provided in Appendix B and Appendix C.

American Eel

The American eel is the only catadromous species that occurs in Maine. Spawning is believed to occur in the Sargasso Sea, in the waters east of the Bahamas and South of Bermuda. Eggs hatch into larvae and ride currents that distribute them across North America. Larvae grow to over 2 inches during this timeframe, and enter the glass eel lifestage as they enter coastal areas. Glass eels develop pigmentation once they enter estuary habitats, and grow in elvers. Migration of glass eels and elvers towards coastal habitats and into estuaries generally occurs during April-July in Maine, although some movement continues into the early fall. Older juveniles migrate upstream, and enter the yellow eel lifestage over the course of several years. Yellow eels can spend decades in upstream riverine habitats, and some individuals may remain in more downstream habitats. A majority of yellow eels in higher latitudes, including Maine, are female. A larger proportion of adult American eels in lower latitudes are male. Yellow eels enter a sexually mature silver eel lifestage prior to outmigration from freshwater habitats. Most silver eels in Maine move downstream in the fall at night with rain events. Spawning only occurs once for each fish, as individuals die after spawning occurs (GOM 2007).

KEI (USA) conducted nighttime visual surveys at the Lowell Tannery Project during the summer of 2020 to assess whether juvenile American eels attempt to migrate upstream or congregate at the base of the dam. Nighttime surveys were completed on seven nights from June 4 to August 20; additional surveys were not feasible because spill conditions at the dam prevented researchers from observing the dam and spillway areas. Juvenile eels were documented during all surveys at the base of the dam. Most eels were observed along a horizontal sill of concrete at the toe of the dam, or in the transitional area between the dam face and a concrete abutment (Figure 4.14). Approximately 5,000 to 8,000 American eels were observed in total, with the largest congregation of eels on the sill. Some individuals attempted to move up wetted surfaces of the dam.

Figure 4.14 Aerial Showing Areas of Eel Congregations at the Lowell Tannery Dam

<u>River Herring</u>

River herring includes blueback herring and sea-run alewives, although alewives are more common in Maine and in the Penobscot River basin (MDMR 2021). Adults of both species at northern latitudes, including Maine, enter rivers during early May and into June to spawn. Spawning often occurs at water temperatures of 13 to 16°C. Blueback herring spawn from Nova Scotia to Florida, but are more abundant at lower latitudes (i.e., at and below Virginia). Out migration generally occurs in the late summer and early fall in Maine. Alewives are a commercially important species, as they are preferred bait for Maine's spring lobster fishery. Additionally, alewives provide an alternative prey source for marine predators and birds of prey during the time that Atlantic salmon are also outmigrating (MDMR 2021).

The licensee has worked with researchers from the University of Maine (UMaine) to evaluate upstream fish passage effectiveness at the Lowell Tannery Project since 2011. Passive integrated tagging (PIT) equipment installed at the entrance and the exit of the fishway is used to monitor movements of tagged adult sea-run alewives and Atlantic salmon through the fishway. Data for adult sea-run alewives collected by the University of Maine at the Lowell Tannery Project have demonstrated fishway effectiveness values ranging from 2.7 to 57.6 percent. Effectiveness values for Atlantic salmon are described below in the Atlantic salmon section. Table 4.11 provides a summary of fishway passage data from 2011 – 2020 for the Lowell Tannery Project.

Of the 33 tagged alewives detected in 2020 at the entrance of the fishway, 19 were repeat spawners tagged in 2018 or 2019. Of the 14 alewives tagged in 2020 that migrated to the Lowell Tannery fishway, average time to reach the Lowell Tannery Project's fishway from the Milford Project was 3.9 days (range 1.6 to 12.5); the Milford fish lift, where tagging occurs, is approximately 32 river miles downstream from the Lowell Tannery Project. All of the 2020 fish that reached the Lowell Tannery Project were tagged in early June, arriving at the site in early to mid-June. Prior to the 2020 study, KEI (USA) ensured that the fishway was operated as the original design. Data from 2020 suggest that returning the fishway to an original design positively influenced fishway effectiveness for sea-run alewives, as there was a notable increase in fishway effectiveness as compared to previous years; fishway effectiveness in 2020 (57.6 percent) was considerably higher than in all previous years of monitoring. KEI (USA) and UMaine conducted a follow-up study utilizing radio telemetry, as required by the Commission, in 2021 (see report in Appendix C). Due to timing and duration of the upstream migration in 2021 and how quickly the alewife run ended, UMaine was only able to capture 80 of the targeted 105 fish. Of the those, only 40 fish approached the Project and the remainder dropped back downstream. Two of the 40 fish found the ladder entrance but did not pass upstream. Based upon 2021 study results that indicate upstream migrants are not sufficiently attracted to the ladder entrance, and discussion with UMaine, KEI (USA) proposes to modify the discharge location of the downstream fish passage pipe to an area adjacent to the upstream ladder entrance and re-conduct the 2021 telemetry study in 2022.

Table 4.11 Summary of Fishway Effectiveness Study Results for sea-run alewives, 2011-2021 at the Lowell Tannery Project.

Sea-run Alewives			
Year	Approached Fishway	Passed Fishway	Fishway Effectiveness
2015	73	12	16.4%
2016	37	1	2.7%
2017	-	-	NA
2018	160	31	19.4%
2019	185	15	8.1%
2020	33	19	57.6%
2021	40	0	0%

American Shad

American shad are the largest member of the herring family and are indigenous to the western Atlantic Ocean and the east coast of Canada. Specifically, this anadromous species has a historical range that extends from southeastern Canada to central Florida. Adult American shad begin upstream movements into rivers during May or June at northern latitudes, and peak spawning occurs around 18.5°C. Spawning generally occurs at night, beginning at sundown and continuing until after midnight. After hatching, young American shad move downstream during the fall, and form schools during outmigration. Adult females generally reach lengths of approximately 24 inches, and adults males reach sizes of approximately 20 inches. In northern rivers, American shad spawn after spending several years at sea, and individuals can sometimes spawn multiple times. More southern populations generally die after spawning (USFWS 2021). American shad numbers in the Penobscot River basin are lower than some other anadromous species (i.e., river herring), although thousands of American shad have been passed at the downstream Milford Project since fish lift operation began in 2014. No upstream passage studies are planned for American shad at the Lowell Tannery Project, given their low numbers in the Passadumkeag River system.

Atlantic Salmon

Atlantic salmon are an anadromous species that live in freshwater as juveniles for one to three years before outmigrating to saltwater. Spawning generally occurs at water temperatures of 7.2 to 10°C. Atlantic salmon experience strong homing tendencies, with adult fish returning to their natal rivers to spawn. Spawning reaches in rivers and streams generally include well oxygenated water and gravel bottomed riffles located upstream of pools. Peak spawning occurs during the fall months (e.g., October through November), and eggs generally hatch in late March or April. Fry emerge in mid-May, largely during nighttime hours. The diet for young Atlantic salmon largely consists of aquatic insect larvae. As they grow in size, terrestrial insects are also targeted as prey items. Young Atlantic salmon outmigrate at sizes of 12.5 to 15 centimeters (e.g., 2-3 years). Small Atlantic salmon begin feeding on euphausiids, amphipods, and small fish after entering saltwater habitats. Larger Atlantic salmon transition to a diet of larger fishes, including smelt, herring, and alewife (Fuller et al. 2021).

Atlantic salmon in the Passadumkeag River are part of the Gulf of Main distinct population segment (USFWS 2019). Additional life history and federal listing information regarding

Atlantic salmon is described in Section 4.11 (Rare, Threatened and Endangered Species). Downstream passage for Atlantic salmon at the Lowell Tannery Project includes a downstream fishway for Atlantic salmon smolts during ice-out to early June, and passage for kelts (i.e., post-spawned adults) during November 1 to ice-in.

Stocking efforts led by the USFWS are conducted annually. This includes stocking of juvenile salmon in the upstream reaches of rivers. Few salmon are passed upstream at the downstream Milford Project, and those that are collected at the fishway are used as broodstock for hatchery programs. Brookfield has passed more than 1,000 adult salmon annually at the Milford Project over 2 to 3 years. Few Atlantic salmon are passed upstream annually at the Lowell Tannery Project. Since 2014, 16 Atlantic salmon have been tagged and tracked at the fishway entrance. Six of these individuals passed the fishway and moved upstream. Atlantic salmon effectiveness values at the Lowell Tannery Project ranged from 0 to 75 percent from 2011-2020 (Table 4.12). No upstream passage studies are planned in the near future for Atlantic salmon at the Lowell Tannery Project, given the low numbers that return to the Passadumkeag River.

Table 4.12 Summary of Fishway Effectiveness Study Results for Atlantic Salmon, 2011-2020 at the Lowell Tannery Project.

Atlantic Salmon			
Year	Approached Fishway	Passed Fishway	Fishway Effectiveness
2011	120	45	37.5%
2012	13	8	61.5%
2013	-	-	-
2014	0	0	NA
2015	3	2	66.7%
2016	4	3	75.0%
2017	0	0	NA
2018	4	1	25.0%
2019	1	0	0.0%
2020	4	0	0.0%

4.9.1.4 Desktop Turbine Passage and Survival Study

KEI (USA) 's 2020 desktop entrainment study assessed the risk of entrainment (i.e., involuntary passage through a turbine) and impingement (i.e., involuntary entrapment against the upstream face of the trash rack), turbine passage survival, and whole station survival of target migratory species. Risk of entrainment was determined based on project parameters (intake velocities and trash rack spacing), and was compared to target fish species characteristics (swim speeds and body widths). Modeling based on the USFWS' turbine blade strike analysis model (Towler and Pica 2018) was conducted to assess survival of fish that have the potential to be entrained, pass thru the fishway, or pass via spill.

KEI (USA) modeled 27 scenarios that assessed turbine passage survival and whole station survival of juvenile Alosines, adult alewives, adult American eel, and Atlantic salmon smolts. The analysis was completed at three flow thresholds to represent low, moderate, and high water conditions, and two downstream fishway efficiencies of 50 percent and 25 percent. An initial desktop study report was provided to the resource agencies in March of 2020; the analysis was subsequently updated to reflect comments received from NMFS, the USFWS, and MDMR on the initial study report. The following adjustments to the model were made:

Fish length standard deviation – increased the standard deviation from 0.5-inches to 1.0-inch to provide a wider range of size classes for the analysis.

Spillway survival – adjusted spillway survival from 100 percent to 97 percent.

Fish bypass survival – lowered bypass survival to account for some injury or mortality to occur. We expect that survival through a designed fishway would be higher than survival via passage over the spillway; therefore, we adjusted bypass survival from 100 percent to 98 percent.

Fish bypass efficiency – added another scenario in the model for all species that assigns a bypass efficiency of 25 percent.

Runner Diameter – changed from 4.6 to 7.2 feet based on updated information.

Although the resource agencies provided additional technical comments on the desktop study, KEI (USA) respectfully did not adopt some of these requests in the revised analysis because additional, detailed analysis of the existing downstream fishway is not warranted. The revised desktop study results described below are sufficient to describe the effects of the Lowell Tannery Project on downstream fish passage survival. Agencies provided additional comments on the desktop entrainment study and MDMR states the "DLA was filed before the full suite of downstream studies were completed…" This comment neglects to acknowledge the Director's finding of February 10, 2021 that "KEI Power's desktop study should be sufficient to describe the project's effects on downstream fish passage and to develop potential mitigation measures."

Results of the desktop study demonstrated that juvenile Alosines (shad, alewives, and blueback herring), adult American eel, and Atlantic salmon smolts may fit through the angled, 1.5-inch trash racks and pass downstream via the turbine. Adult salmon and adult American shad are likely excluded from entrainment based on their body widths as compared to trash rack widths. Body width for 18-inch-long and 20-inch-long adult American shad is expected to range from 2.5 to 2.7 inches based on recent fish size data from the Penobscot River[4] (Table 4.13). Adult salmon are expected to be approximately 29-inches-long and have body widths in excess of the 1.5-inch racks as well. As such, adult salmon and adult American shad are excluded from the turbine by the trash rack bars. Additionally, impingement risk is low across life stages, based on expected swim speeds that exceed intake velocities; most fish are capable of swimming away from the trashracks.

Specifically, approach velocity ranges from 0.0 to 0.49 fps (low water year), 0.0 to 1.23 fps (median water years), and from 1.36 to 2.51 fps during high water years during peak migratory periods (e.g., May, June, July, September, and October) (Table 4.14). Based on prolonged swim speeds and expected water velocity in front of the intake during peak migratory periods, the risk of involuntary entrainment to the turbine or impingement against the trash racks is low. The maximum, normal approach velocity during times when the Lowell Tannery Project is fully operational (i.e., during high flow conditions) is estimated to be 2.5 fps, which is near reported prolonged swim speeds for Atlantic salmon smolts, adult herring, adult shad, and adult American eel. At other times of the year or during low or median water years, approach velocity is expected to be less than 2.51 fps (e.g., 0.00 to 1.23 fps), thereby reducing the likelihood of involuntary entrainment or impingement for all species and lifestages, including juvenile herring and American shad. The most risk for impingement or involuntary entrainment is during times when the turbine may be fully operational during the fall outmigration of juveniles Alosines and American eels. Installation of seasonal rack overlays and siphons will reduce potential entrainment of these species and provide a means to bypass the project.

Results of turbine blade strike modeling suggest that whole station survival is likely low to moderate for large-bodied American eels, moderate to high for adult river herring, high

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[4] Personal communication, MDMR staff, January 2020.

for juvenile Alosines, and moderate to high for Atlantic salmon smolts. Mean turbine survival estimates by species and lifestage are described in Table 4.15 and Table 4.16. In summary, the analysis demonstrated that:

- Mean turbine passage survival of adult river herring ranged from 86.2 to 91.1 percent.
- Whole station survival of adult river herring ranged from 90.1 to 97.8 percent.
- Mean turbine passage survival of juvenile Alosines was 95 percent.
- Whole station survival of juvenile Alosines ranged from 96.6 to 98.3 percent.
- Mean turbine passage survival of adult American eels using a lambda[5] of 0.20 ranged from 31.6 to 67.0 percent.
- Whole station survival adult American eels using a lambda of 0.20 ranged from 48.6 to 98.0 percent (high survival when there is not enough water to generate power).
- Mean turbine passage survival of adult American eels using a lambda of 0.15 ranged from 49.2 to 74.0 percent.
- Whole station survival adult American eels using a lambda of 0.15 ranged from 60.9 to 98.3 percent (high survival when there is not enough water to generate power).
- Mean turbine passage survival of Atlantic salmon smolts ranged from 88.4 to 95.3 percent.
- Whole station survival of Atlantic salmon smolts ranged from 90.4 to 96.1 percent.

Table 4.13 Body Length and Width Estimate for Adult American Shad

Fish Sex	Total Length*	Standard Length	Body Width**
Male	18 inches	15 inches	2.5 inches
Female	20 inches	16.6 inches	2.7 inches

* MDMR data from the Penobscot River

** Body width is reported as 16.4 percent of standard length (Smith 1986).

[5] Lambda is a coefficient in the blade strike equation that takes into consideration fish orientation during passage, the difference in the impact of a strike relative to the fish's body (i.e., a strike to the anterior region is more detrimental that a strike to the posterior region), and hydraulic characteristics near the leading edge of the blade tip.

Table 4.14 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/ Life Stage	Peak Migration	Low Flow (cfs)	Approach Velocity (fps)	Median Flow (cfs)	Approach Velocity (fps)	High Flow (cfs)	Approach Velocity (fps)
Atlantic Salmon Smolts	May	178	***0.49***	443	***1.23***	905	**2.51**
Adult River Herring	June	135	***0.38***	381	***1.05***	905	**2.51**
Juvenile Alosines	September	21	***0.00***	88	***0.00***	490	**1.36**
Adult American Shad	July	60	***0.00***	160	***0.44***	811	**2.25**
Adult American Eel	October	28	***0.00***	165	***0.46***	905	**2.51**

Table 4.15 Summary of Turbine Passage and Whole Station Survival Estimates

	Adult River Herring	Juvenile Alosines	Adult Eel (0.20)	Adult Eel (0.15)	Atlantic Salmon Smolts
Turbine Passage Survival (Low)	86.2%	94.9%	31.6%	49.2%	88.4%
Turbine Passage Survival (High)	91.1%	95.0%	67.0%	74.0%	95.3%
Whole Station Survival (Low)	90.1%	96.6%	48.6%	60.9%	90.4%
Whole Station Survival (High)	97.8%	98.3%	98.0%	98.3%	96.1%

Table 4.16 Calculated turbine and whole station survival estimates for diadromous fish species, Lowell Tannery Project.

Scenario	Species	Length*	Turbine Flow	Percent Fish to Unit	Percent Fish to Spill	Percent Fish to Bypass	Mean Turbine Survival	Mean Whole-Station Survival
1	Adult alewife	10.5	905	0.314	0.372	0.314	91.1%	95.7%
2	Adult alewife	10.5	905	0.471	0.372	0.157	89.1%	93.7%
3	Adult alewife	10.5	381	0.500	0.000	0.500	86.2%	92.2%

Scenario	Species	Length*	Turbine Flow	Percent Fish to Unit	Percent Fish to Spill	Percent Fish to Bypass	Mean Turbine Survival	Mean Whole-Station Survival
4	Adult alewife	10.5	381	0.750	0.000	0.250	86.8%	90.1%
5	Adult alewife	10.5	135	0.000	0.500	0.500	***NA***	97.8%
6	Juvenile Alosines	4.0	490	0.500	0.000	0.500	95.0%	96.6%
7	Juvenile Alosines	4.0	490	0.750	0.000	0.250	94.9%	96.6%
8	Juvenile Alosines	4.0	88	0.000	0.500	0.500	***NA***	97.5%
9	Juvenile Alosines	4.0	88	0.000	0.500	0.500	***NA***	98.3%
10	Juvenile Alosines	4.0	21	0.000	0.500	0.500	***NA***	98.0%
11	Adult eel (0.20)	33.0	905	0.429	0.141	0.429	67.0%	83.6%
12	Adult eel (0.20)	33.0	905	0.644	0.141	0.215	64.3%	71.9%
13	Adult eel (0.20)	33.0	165	0.500	0.000	0.500	31.9%	63.9%
14	Adult eel (0.20)	33.0	165	0.750	0.000	0.250	31.6%	48.6%
15	Adult eel (0.20)	33.0	28	0.000	0.500	0.500	***NA***	98.0%
16	Adult eel (0.15)	33.0	905	0.429	0.141	0.429	73.1%	86.1%
17	Adult eel (0.15)	33.0	905	0.644	0.141	0.215	74.0%	81.6%
18	Adult eel (0.15)	33.0	165	0.500	0.000	0.500	50.3%	74.3%
19	Adult eel (0.15)	33.0	165	0.750	0.000	0.250	49.2%	60.9%
20	Adult eel (0.15)	33.0	28	0.000	0.500	0.500	***NA***	98.3%
21	Salmon smolts	7.5	905	0.332	0.337	0.332	95.3%	96.1%
22	Salmon smolts	7.5	905	0.497	0.337	0.166	94.1%	95.8%
23	Salmon smolts	7.5	443	0.500	0.000	0.500	90.9%	94.3%
24	Salmon smolts	7.5	443	0.750	0.000	0.250	91.4%	93.8%
25	Salmon smolts	7.5	178	0.500	0.000	0.500	89.0%	93.2%
26	Salmon smolts	7.5	178	0.750	0.000	0.250	88.4%	90.4%
27	Salmon smolts**	7.5	905	0.497	0.337	0.166	94.3%	96.0%

* Standard deviation of 1.0 inches
** Sample size = 10,000 (run for comparison; limited difference in results documented as compared to a sample size of 4,000)
NA = not enough water to generate

4.9.1.5 Proposed Fishway Measures

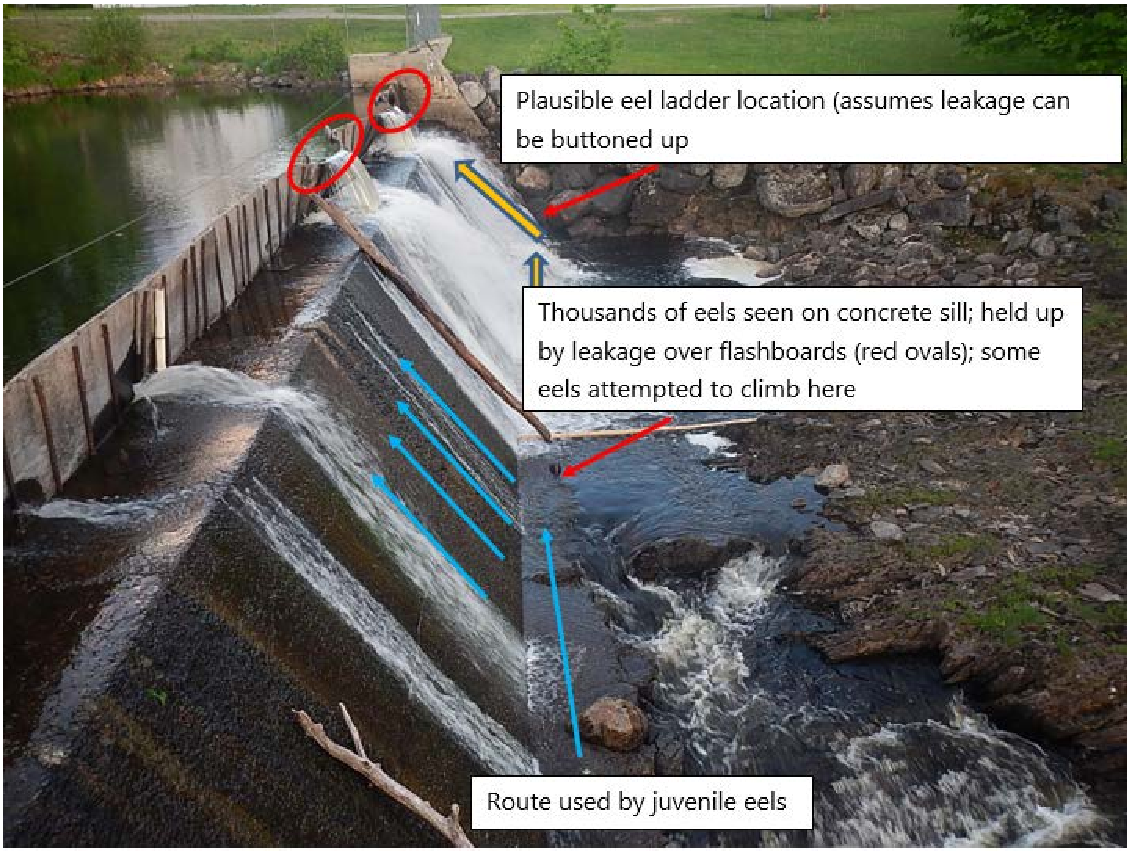
KEI (USA) proposes to continue operating the existing fishways annually according to the following schedule:

- Operate the upstream fishway from May 1 through November 15.
- Operate the downstream fishway from April 1 (or ice-out, whichever happens last) to December 31 (or ice-in, whichever happens first).

A total of 40 cfs of attraction and conveyance water will continue to be discharged near the base of the powerhouse through the fishway during this timeframe. The downstream fishway will continue to be operated annually with 20 cfs attraction and conveyance flow but will be modified to discharge adjacent to the upstream ladder entrance. KEI (USA) has developed a draft SPP as part of this relicensing proceeding to formalize protection measures for Atlantic salmon at the Lowell Tannery Project. The draft SPP is provided with this Final License Application. KEI (USA) anticipates that NMFS will provide comments and recommended modifications to the SPP.

Researchers documented a potential eel ladder location in 2020 (Figure 4.15). KEI (USA) anticipates designing an upstream eel passage ladder in consultation with the resource agencies as part of post-license compliance activities. KEI (USA) proposes to install downstream eel passage consisting of two siphon style passage systems, similar to the system recently implemented at KEI (USA)'s American Tissue Project (FERC No. 2809) located at the east and west downstream extents of the intake rack structure. KEI (USA) also proposes to install full depth seasonal intake rack overlays consisting of 7/8-inch hole diameter punch plate. Due to results of the 2021 upstream radio telemetry study for alewives, KEI (USA) proposes to modify the discharge location for the existing downstream fish passage pipe to discharge adjacent to the existing upstream fish ladder entrance. KEI (USA) will make this modification prior to the 2022 upstream migration season for alewives and re-conduct the 2021 telemetry study to assess whether this modification improves effectiveness of the upstream fish ladder.

Figure 4.15 Photo Showing Location of Potential Eel Ladder



4.9.1.6 Essential Fish Habitat

NMFS identifies essential fish habitat (EFH) for fish species that are commercially-managed under the Magnuson-Stevens Fishery Conservation and Management Act. EFH is defined as the "habitat necessary for managed fish species to complete their life cycle such that the fishery can be harvested sustainably." According to NMFS (1998):

Atlantic salmon EFH includes all aquatic habitats in the watersheds of the identified rivers, including all tributaries, to the extent that they are currently or were historically accessible for salmon migration.

Based on NMFS's habitat mapper[6] of EFH for salmon, the Passadumkeag River is EFH. Additional information about critical habitat for the recovery of Atlantic salmon is provided in Section 4.11 *Rare, Threatened, and Endangered Species*.

[6] https://www.habitat.noaa.gov/application/efhmapper/atlanticSalmonEFH.pdf

4.9.1.7 Benthic Macroinvertebrates and Freshwater Mussels

Section 4.8 provides information about 2016 BMI sampling completed by MDEP in the Passadumkeag River near Grand Falls Township in 2016 (see Photo 4.4 (Water Quality section) for sampling locations). MDEP's monitoring demonstrated that Class A water quality standards were met, and that EPT and HBI indices were indicative of excellent water quality (MDEP 2021) (See Section 4.8.1.1). KEI (USA) conducted additional benthic macroinvertebrate studies during 2019 to determine if aquatic life (i.e., the macroinvertebrate community) attained Class A standards for water quality. Macroinvertebrates were sampled downstream of the Lowell Tannery Project, and the macroinvertebrate community was abundant, moderately rich, and well populated with sensitive taxa. Results indicated that Class A aquatic life standards were attained in downstream of the Lowell Tannery dam. The Water Quality section of this exhibit provides additional detail about the 2019 and 2020 monitoring and a full study report is provided as Appendix B.

There are ten native freshwater mussel species known to occur in Maine, all of which have been observed in the Passadumkeag River (Nedeau et al., 2000; Table 4.17). Yellow lampmussel, tidewater mucket, and the brook floater are listed by the state of Maine as threatened species; the creeper is listed as a species of special concern (MDIFW 2021). No studies of freshwater mussels were requested as part of this relicensing effort.

Table 4.17 Freshwater mussels known to occur in the Passadumkeag River

Common Name	Scientific Name
Eastern pearlshell	*Margaritifera*
Brook floater	*Alasmidonta varicosa*
Triangle floater	*Alasmidonta undulata*
Creeper	*Strophitus undulatus*
Eastern floater	*Pyganodon cataracta*
Alewife floater	*Anodonta implicata*
Eastern elliptio	*Elliptio complanata*
Tidewater mucket	*Leptodea ochracea*
Yellow lampmussel	*Lampsili cariosa*
Eastern lampmussel	*Lampsilis radiata*

Source: Nedeau et al., 2000

4.9.2 Environmental Effects

4.9.2.1 Proposed Action

The Licensee is proposing no changes to operations, and will continue to operate the Lowell Tannery Project in a run-of-river mode. Proposed run-of-river operations are expected to provide and maintain riverine and impounded aquatic habitat for resident fish, diadromous fish, freshwater mussels, and aquatic macroinvertebrates. Class A aquatic life standards, which are currently met under existing operations, would be maintained. Continued operation of the Lowell Tannery Project as proposed is not expected to have new, significant adverse effects on existing aquatic habitat, and will maintain existing habitat in the downstream reach of the Passadumkeag River through minimum flows and run-of-river operations. Appendix E contains impoundment water level and operations data for the past three years.

The licensee proposes to provide upstream and downstream passage through the existing fishway for Atlantic salmon, river herring, and other migratory species. The proposed dates of operations encompass typical migratory period for diadromous species. KEI (USA) proposes to install downstream eel passage consisting of two siphon style passage systems, similar to the system recently implemented at KEI (USA)'s American Tissue Project (FERC No. 2809), located at the east and west downstream extents of the intake rack structure. KEI (USA) also proposes to install full depth seasonal intake rack overlays consisting of 7/8-inch hole diameter punch plate. Due to results of the 2021 upstream radio telemetry study for alewives, KEI (USA) proposes to modify the discharge location for the existing downstream fish passage pipe to discharge adjacent to the existing upstream fish ladder entrance. KEI (USA) will make this modification prior to the 2022 upstream migration season for alewives and re-conduct the 2021 telemetry study to assess whether this modification improves effectiveness of the upstream fish ladder.

Continued operation of the downstream fishway is expected to provide safe and effective downstream fish passage for anadromous species such as salmon and river herring. As described in the desktop entrainment study report, turbine passage survival for all species and lifestages was high for smaller, migratory fish species including salmon smolts, adult river herring, and juvenile river herring. The existing trash rack bars exclude larger-bodied adult salmon and adult shad from entrainment and approach velocities are low enough such that fish can swim away from the intake volitionally. Implementation of downstream eel siphons and seasonal rack overlays will provide for safer downstream passage for adult American eel through prevention of entrainment and bypass around the project.

4.9.2.2 No-Action Alternative

Under the no action alternative, the Licensee would continue to operate the Lowell Tannery Project under the existing license requirements. Existing aquatic habitats would remain unchanged, and existing fish passage measures would remain. Additional fish passage measures (i.e., American eel passage) would not be implemented, which would adversely affect American eel by restricting passage at the dam.

4.9.2.3 Unavoidable Adverse Effects

KEI (USA) may infrequently modify water levels in the impoundment for maintenance and repairs. Such modifications may expose normally inundated fish habitat and restrict fish assemblages to a smaller area than normal for short periods of time. KEI (USA) would procure necessary approvals from state or federal regulatory agencies prior to completing these types of maintenance activities, as needed.

KEI (USA) anticipates that a determination of potential effects of the Project on Atlantic salmon will be made by NMFS under the ESA.

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4.10 Terrestrial Resources

4.10.1 Affected Environment

The Lowell Tannery Project is located in the Eastern Interior Biophysical Region of Maine (MFIGP 2016). This region of Maine is 98 percent forested, and 44 percent of the total area is comprised of spruce-fir forest types, as well as habitat types ranging from intolerant communities to semi-rich hardwoods (MFIGP 2016 and MDC 2009). This region also contains the largest concentration of peatlands, marches, and swamps in the state (MDC 2009). The dominant land cover classes in the Passadumkeag River watershed are evergreen forest (28.4 percent), mixed forest (25.3 percent), woody wetlands (17.1 percent), deciduous forest (14.2 percent), and open water (7.8 percent) (MRLC 2011). The land cover in and around the project impoundment and downstream of the project consists of forest and woodland. Specifically, forested habitat around the Project is largely comprised of northern mesic hardwood and conifer forest. Additional wetland areas include northern and central swamp forest, northern central floodplain forest and scrub, and north American boreal swamp forest (USGS 2021). There is minimal area around the Project that is classified as Urban and suburban (i.e., percent cover of roads, buildings, and impervious surfaces is greater than vegetative cover). The only area in and immediately around the Project boundary with this classification includes the dam, powerhouse, driveway, parking lot, bridge, and Tannery Road.

4.10.1.1 Vegetation

Vegetation in the Project area is present in both riparian habitats and in wetlands. Wetland vegetation is described in Section 4.10.1.3 (Wetlands). Riparian habitat is the specialized zone of vegetation that serves as the interface between the upland vegetation community and the riverine environment. This zone provides valuable environmental functions including maintaining streambank stability, sediment filtration, and floodplain processes. Littoral zone habitat is the shallow water area along the perimeter of the impoundment, and includes the shoreline zone located between deep and shallow water habitats.

The banks of the Passadumkeag River in the vicinity of the Project provide riparian and littoral habitat to a variety of plant species. Common plant species expected to be present in riparian areas at the Project include silver maple, green ash, red maple, speckled alder, and willow (Kuhns 2009). Overall, shoreline habitats at the project are limited to the immediate riparian and littoral zones and a narrow band of upland mixed forest. The narrow band of upland mixed forest includes both coniferous and deciduous tree species.

There is minimal littoral habitat due to the Project impoundment's riverine features, however, and the transition zone between the Passadumkeag River and the adjacent land is minimal.

4.10.1.2 Invasive Plants

A total 125 non-native terrestrial plant species are known to occur, or may occur in Maine. These include widespread invasive species, localized invasive species, and invasive species that have not been detected but may potentially be present in low numbers. Widespread invasive plant species that may potentially occur in the Passadumkeag watershed are described in Table 4.18 (MDACF 2021) (Table 4.18), and several of these species could be expected to occur near the Project. Widespread invasive plant species that may occur near the Project include garlic mustard, honeysuckle, purple loosestrife, and wood blue grass. Multiple invasive aquatic plant species have been documented in Maine, but these species are not likely to occur in open water habitats at the Project based on their preferred habitat characteristics. Aquatic invasive species have not been documented at the Project to date.

Table 4.18 Invasive Plants Potentially Occurring within the Project

Common Name	Scientific Name
Asiatic bittersweet	*Celastrus orbiculatus*
Autumn olive	*Elaeagnus umbellata*
Bittersweet or climbing nightshade	*Solanum dulcamara*
Black locust	*Robinia pseudoacacia*
Black swallowwort	*Cynanchum louiseae*
Brown knapweed	*Centaurea jacea*
Bull thistle	*Cirsium vulgare*
Canada bluegrass, flat-stemmed bluegrass	*Poa compressa*
Canada thistle	*Cirsium arvense*
Coltsfoot	*Tussilago farfara*
Common barberry	*Berberis vulgaris*
Common buckthorn	*Rhamnus cathartica*
Common mugwort	*Artemisia vulgaris*
Common reed	*Phragmites australis*
Common valerian	*Valeriana officinalis*
Creeping buttercup	*Ranunculus repens*
Creeping jenny	*Lysimachia nummularia*
Cypress spurge	*Euphorbia cyparissias*
Dame's rocket	*Hesperis matronalis*

Common Name	Scientific Name
False spiraea	*Sorbaria sorbifolia*
February daphne; paradise plant	*Daphne mezereum*
Fine-leaved sheep fescue	*Festuca filiformis*
Garlic mustard	*Alliaria petiolata*
Glossy buckthorn	*Frangula alnus*
Goutweed	*Aegopodium podagraria*
Japanese barberry	*Berberis thunbergii*
Japanese knotweed	*Fallopia japonica*
Morrow's honeysuckle	*Lonicera morrowii*
Multiflora rose	*Rosa multiflora*
Norway maple	*Acer platanoides*
Ornamental jewelweed	*Impatiens glandulifera*
Purple loosestrife	*Lythrum salicaria*
Reed canary grass	*Phalaris arundinacea*
Rugosa rose	*Rosa rugosa*
Spotted knapweed	*Centaurea stoebe*
Tartarian honeysuckle	*Lonicera tatarica*
Water forget-me-not	*Myosotis scorpioides*
Western lupine	*Lupinus polyphyllus*
White poplar	*Populus alba*
White Sweet Clover	*Melilotus albus*
Wild parsnip	*Pastinaca sativa*
Wild thyme	*Thymus pulegioides*
Winged euonymous	*Euonymus alatus*
Wood blue grass	*Poa nemoralis*
Yellow iris	*Iris pseudacorus*

Source: MDACF 2021

4.10.1.3 Wetlands

A majority of wetlands in the Project area are classified by the National Wetlands Inventory (NWI) as R2UBH, PSS1E, PSS1F, and PFO1E freshwater forested/shrub wetland (Figure 4.16).

R2UBH describes riverine, lower perennial, unconsolidated bottom, permanently flooded wetland habitat. This wetland type is defined as low, slow flowing water where substrate consists mainly of sand and mud (USFWS 2021b). Unconsolidated bottoms include wetland habitats with at least 25 percent cover of particles smaller than stones and a vegetative cover less than 30 percent (USFWS 2021b).

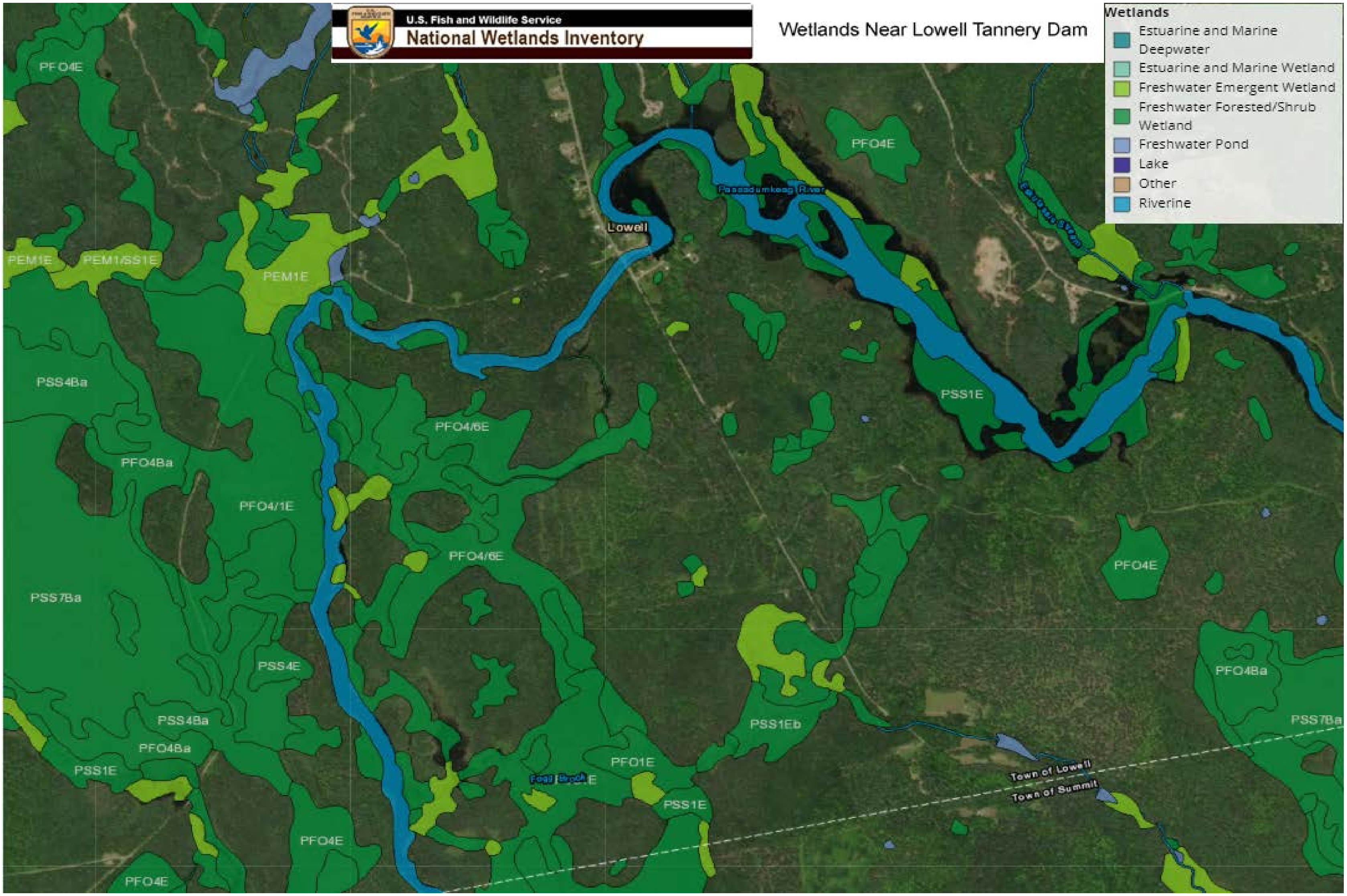
PSS1E, or palustrine scrub-shrub wetland, is defined as all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, including areas dominated by woody vegetation less than 6 meters (20 feet) tall. These areas have surface water present for parts of the growing season, where they can be seasonally flooded and saturated (USFWS 2021c).

PSS1F, or palustrine scrub-shrub wetland, is defined as all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, including areas dominated by woody vegetation less than 6 meters (20 feet) tall. These areas have surface water persisting throughout the growing season in most years, and are semi-permanently flooded (USFWS 2021d).

PFO1E, or palustrine forested wetland, is defined as all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, including woody vegetation that is 6 meters (20 feet) tall or taller, as well as deciduous trees and shrubs. This wetland type has surface water persisting throughout the growing season in most years, and is semi-permanently flooded (USFWS 2021e).

Some of the wildlife species that are commonly found in freshwater wetlands and may be found in the wetlands near the Project include wood ducks, snapping and painted turtles, dragonflies, damselflies, and multiple songbird species (MDEP 2018).

Figure 4.16 Wetlands in the Vicinity of the Project



Source: USFWS 2021a

4.10.1.4 Wildlife Resources

The Project provides wildlife habitat within the impoundment and areas of forest and wetlands within and surrounding the Project Boundary. The area immediately surrounding the Project includes a narrow band of riparian forest, surrounded by extensive forest and wetlands. A list of potential wildlife species that may occur at the Project is included as Appendix C. There are 58 mammalian species found in Maine that are not associated with marine environments (MDIFW 2021a). Mammal species that would be expected to occur at the Project include habitat generalists. Specific species that may be present include eastern chipmunk, gray squirrel, red squirrel, and house mouse. The close proximity of riparian forest and the river likely also provides habitat for bat species including the little brown myotis, silver haired bat, and big brown bat (DeGraaf and Yamasaki 2001).

At least 292 bird species are found in Maine during at least part of the year (MDIFW 2021b). Bird species that could be expected to utilize habitat types that are present throughout the Project area include the black-capped chickadee, white-breasted nuthatch, bluejay, and wild turkey. Raptor species likely present at the Project would likely include those that utilize water bodies and wetlands for part of their life histories. This would include osprey and bald eagle. Shorebirds could include the spotted sandpiper, and wading birds such as great blue heron and American bittern (DeGraaf and Yamasaki 2001). Migratory waterfowl species, including Canada goose, mallard, and wood duck would be expected to occupy the Project area during breeding season and the winter months. Similarly, neotropical avian species such as various flycatchers and warblers likely occupy lands surrounding the Project during the spring, summer, and fall before returning to the tropics of Central and South American during the winter season (DeGraaf and Yamasaki 2001). Many species of passerines found in Maine make their homes in the abundant conifer-dominated forests of the state. Passerine species also inhabit the shrubland habitats in the state, including regenerating forests, utility right-of-ways, roadsides, and railroads such as those in proximity of the Project. Additionally, as mentioned above, many other avian species make their homes in the littoral zones that are found throughout the state (DeGraaf and Yamasaki 2001).

Maine is home to at least 39 species and subspecies of reptiles and amphibians (MDIFW 2021c). Sixteen common amphibian species and six common aquatic reptiles are known to occur in the region and have life history requirements that could result in their use of the riverine or lacustrine habitat found within the Lowell Tannery Project area (Table 4.19). Seven species of salamander (blue-spotted salamander, spotted salamander, eastern newt, northern dusky salamander, northern redback, four-toed salamander, and northern two-lined salamander) inhabit both aquatic and terrestrial habitat. Nine species of frogs and toads may occur and require use of aquatic habitat (Table 4.19). Aquatic or semi-aquatic reptilian species likely to be found in the Project area include the snapping turtle, painted turtle, and the wood turtle. Four species of snake (northern redbelly, common garter, and northern ringneck snake) may make limited use of riparian areas for shelter and feeding (DeGraaf and Yamasaki 2001, Hunter et al., 1999).

Species with commercial, recreational, or cultural value would not generally be expected to use the Project Area and immediate surrounding lands as permanent habitat. Spatial and temporal distribution of wildlife species within the Project area can be inferred based on known life-history characteristics of species and taxa groups. Several terrestrial species common to the area are habitat generalists, and are therefore likely found in a variety of habitats throughout the Project area. Additionally, several species with more specialized habitat needs, such as wetlands for breeding, water resources for feeding, and hardwood/conifer forests for shelter, could also be found in the Project area. These species include the American bittern, green heron, red-shouldered hawk, water shrew, muskrat, and mink (DeGraaf and Yamasaki 2001).

Table 4.19 Amphibian and aquatic reptile species with the potential to occur in vicinity of the Lowell Tannery Project.

Common Name	Scientific Name
Amphibians	
Blue-spotted salamander	*Ambystoma laterale*
Spotted salamander	*Ambystoma maculatum*
Eastern newt	*Notophthalmus v. viridescens*
Northern dusky salamander	*Desmognathus fuscus*
Northern redback salamander	*Plethodon cinereus*
Four-toed salamander	*Hemidactylium scutatum*
Northern two-lined salamander	*Eurycea bislineata*
Eastern American toad	*Bufo americanus*
Eastern Spring peeper	*Pseudacris crucifer*
Gray treefrog	*Hyla versicolor*
Bullfrog	*Rana catesbeiana*
Green frog	*Rana clamitans*
Mink frog	*Rana septentrionalis*
Pickerel frog	*Rana palustris*
Wood frog	*Rana sylvatica*

Common Name	Scientific Name
Northern leopard frog	*Rana pipiens*
Reptiles	
Painted turtle	*Chrysemys picta*
Snapping turtle	*Chelydra serpentine*
Wood turtle	*Clemmys insculpta*
Northern ringneck snake	*Diadophis punctatus*
Northern redbelly snake	*Storeria occipitomaculatum*
Common garter snake	*Thamnophis sirtalis*

Source: Degraaf and Yamasaki 2001, Hunter et al. 1999

4.10.1.5 Invasive Wildlife Species

Multiple exotic or invasive wildlife species are known to occur in Maine, including bird species (European starling and house sparrow) and mammal species (house mouse and Norway rat). The invasive Gypsy month may also have the potential to occur in the Project area, as they have been documented throughout central and southern Maine and prefer habitats that include hardwoods (i.e. oak, aspen, and birch) (USFS 2021).

4.10.2 Environmental Effects

4.10.2.1 Proposed Action

The proposed action (i.e., continued run-of-river operations) is expected to have no adverse effects on wildlife species. Riparian, aquatic, and terrestrial habitats will be maintained during the term of a new license, providing a variety of habitats for terrestrial and aquatic wildlife species. Operations of the Lowell Tannery Project will result in infrequent, short-duration drawdowns for maintenance or safety activities, in coordination with resource agencies, maintaining stable water levels within the impoundment or in downstream river reaches, and will have no adverse effects on surrounding terrestrial wildlife or habitats.

KEI (USA) is proposing to continue to operate the Project in a run-of-river mode. As continued operation of the Lowell Tannery Project is not anticipated to have a significant effect on wildlife resources. No PME measures are proposed given that operation of the Lowell Tannery Project is not expected to negatively affect terrestrial species or associated habitats.

4.10.2.2 No-Action Alternative

Under the no action alternative, the Project would continue to operate in run-of-river mode, having no adverse effects on wildlife or botanical resources.

4.10.2.3 Unavoidable Adverse Effects

The impoundment water levels may be temporarily modified, if required, by operating emergencies, or maintenance. If major drawdowns were to occur in the Project impoundment for maintenance, they would be short-term and infrequent, resulting in limited impacts to wildlife species that prefer littoral habitats and large bodies of water, including waterfowl and wading bird species. Because these scenarios are very temporary and infrequent situations for the Lowell Tannery Project, there are no anticipated significant adverse long term environmental effects to the local terrestrial wildlife inhabiting the Project area. Any major drawdowns needed for maintenance over the term of the license would be permitted in advance with the necessary state and federal agencies.

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4.11 Rare, Threatened, and Endangered Species

4.11.1 Affected Environment

The Licensee performed an initial assessment in 2018 for the potential occurrence of rare, threated, and endangered (RTE) species with the Lowell Tannery Project area by reviewing information provided by the MDIFW and USFWS.

As part of KEI (USA)'s assessment, the Licensee has requested an updated official species list from the USFWS on May 2, 2021, to address additional species or changes in status of the species that were identified in 2018. Based on the new species list, there are no new species listed for the project area.

A review of the Maine list of threatened and endangered species was completed. Based on the available habitat and ranges of the species listed, there are six Maine state listed species identified as potentially occurring within the Project, this includes the Tomah mayfly that was identified by the MDIFW in their March 8, 2019 comment letter (MDIFW 2019). In addition, there are seventeen species listed as Species of Special Concern that may occur in the Project (Table 4.20) (MDIFW, 2018).

Table 4.20 Endangered, Threatened, and Species of Special Concern that May Occur in the Project or in the Project Vicinity.

Species Common Name	Endangered	Threatened	Special Concern
Amphibian			
Blue-spotted salamander			X
Northern leopard frog			X
Bird			
Great blue heron			X
Bald eagle			X
Northern Harrier			X
Barn owl			X
Whip-poor-will			X
Barn swallow			X
Northern rough-winged swallow			X

Species Common Name	Endangered	Threatened	Special Concern
Veery			X
Rusty blackbird			X
Fish			
American eel			X
Mammal			
Little brown bat	X		
Northern long-eared bat	X		X
Red bat			X
Hoary bat			X
Silver-haired bat			X
Eastern pipistrelle			X
Reptile			
Northern ribbon snake			X
Mussel			
Brook floater		X	
Tidewater mucket		X	
Yellow lampmussel		X	
Insects			
Tomah mayfly		X	

Source: MDIFW 2018, 2019

The Licensee's determination of the potential for a species to occur was based on species known distribution in the vicinity of the Lowell Tannery Project. The Licensee has identified five rare, threated, or endangered species that have the potential to occur in the Lowell Tannery Project area (Table 4.21).

Table 4.21 Rare, Threatened, and Endangered Species That May Occur in the Lowell Tannery Project Area.

Common Name	Scientific Name	Status
Atlantic salmon	*Salmo salar*	Federally Endangered
Northern long eared bat	*Myotis septentrionalis*	Federally Threatened
Little brown bat	*Myotis lucifugus*	State Endangered

Common Name	Scientific Name	Status
Tomah mayfly	*Siphlonisca aerodromia*	State Threatened
Brook floater	*Siphlonisca aerodromia*	State Threatened
Tidewater mucket	Leptodea ochracea	State Threatened
Yellow lampmussel	Lampsilis cariosa	State Threatened

Source: USFWS 2021, MDIFW 2018, 2019

4.11.1.1 Threatened and Endangered Wildlife Species Distribution and Life History Information and Consultation

Atlantic Salmon

Atlantic salmon are an anadromous fish species with a complex life history. Individuals spend the majority of their adult life in marine environments but return to freshwater rivers and streams to spawn (Fay et al. 2006). Atlantic salmon are native to the North Atlantic Ocean and have been found worldwide as far south as Portugal in the eastern Atlantic and the Connecticut and Housatonic Rivers in the western Atlantic, and north to Ungava Bay in Quebec as well as the Nastapoka River in Hudson Bay (Morin 1991). Atlantic salmon were initially listed as endangered on November 17, 2000, on eight coastal Maine watersheds by the NMFS and the USFWS (65 FR 69459). NMFS and the USFWS expanded the listing to include Atlantic salmon that inhabit large Maine rivers (Androscoggin, Kennebec, and Penobscot) that were partially or wholly excluded in the initial listing (74 FR 29344; June 19, 2009). NMFS determined that Atlantic salmon that inhabit the Gulf of Maine watersheds from the Androscoggin River eastward to the Dennys River are a distinct population segment (i.e., GOM DPS) and thus should be listed as a "species."

Currently, the GOM DPS includes Atlantic salmon that occupy freshwater from the Androscoggin River to the Dennys River, as well as anywhere Atlantic salmon occur in the estuarine and marine environments. The historical upstream limits of the species freshwater range are primarily determined by impassable falls in the Penobscot River watershed, including Big Niagara Falls on Nesowadnehunk Stream in Township 3 Range 10, Grand Pitch Falls on Webster Brook in Trout Brook Township, and Grand Falls on the Passadumkeag River (74 FR 9344; June 19, 2009). Additionally, conservation hatchery populations maintained by Green Lake National Fish Hatchery and Craig Brook National Fish Hatchery are included in the GOM DPS. Landlocked and commercially raised salmon are excluded from the listing (74 FR 29344; June 19, 2009).

Section (5)(A) of the Endangered Species Act defines "critical habitat'' for a threatened or endangered species as:

(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species.

Coincident with the June 19, 2009, Atlantic salmon listing, NMFS designated critical (74 FR 29300; June 19, 2009). The final rule was revised on August 10, 2009, (74 FR 39003; August 10, 2009) in which designated critical habitat for the Atlantic salmon was revised to exclude trust and fee holdings of the Penobscot Indian Nation. The Passadumkeag River is not classified as critical habitat for species recovery (74 FR 29300; June 19, 2009).

KEI (USA) informally consulted with NMFS prior to the relicensing process and developed a draft BA and SPP. The draft BA and SPP is provided with this Final License Application.

Bats

The northern long-eared bat (NLEB) is listed as a federally threatened species and is listed as Endangered at the state level. The silver-haired bat is a species of special concern in the state of Maine. The NLEB was listed as threatened on April 2, 2015, with a final rule published in the Federal Register on January 14, 2016. On April 27, 2016, the USFWS determined that the designation of critical habitat for the species was not prudent; therefore, no critical habitat is established for the NLEB (USFWS, 2020b).

The northern long-eared bat feeds on invertebrates and is known to glean prey from vegetation and water surfaces. The NLEB winters in underground caves and cave like structures, but summers singly or in small colonies in cavities, under bark, or in hollows of live and dead trees typically greater than 3 in. in diameter. Suitable roosting trees also include exfoliating bark, cavities, or cracks (USFWS, 2020b). The silver-haired bat is a summer resident of Maine and inhabits clear-cuts, coniferous forest, and mixed forest. The silver-haired bat also feeds primarily on insects, often over ponds, streams, and forest clearings (DeGraaf, 2001).

While the Project falls within the range of the NLEB it is unlikely that the overwintering or summer roosting occurs with the Project, although feeding may occur over the impoundment. This is also true for the little brown bat. Based on their known distribution, these bat species could occur in the Lowell Tannery Project area. The stakeholders requested no bat studies of as part of the relicensing.

Brook Floater

The Brook Floater is listed as threatened under Maine's Endangered Species Act. The brook floater is found in creeks and small rivers where it is found among rocks in gravel substrates and in sandy shoals, the brook floater inhabits flowing-water habitats only. It occurs in running water and although typically found in riffles and moderate rapids with sandy shoals or riffles with gravel bottoms, it can also be found in a range of flow conditions (NatureServe 2017b).

Although little is known about the feeding habitats of the species, stomach content analysis indicates freshwater mussels generally feed on mud, desmids, diatoms, rotifers, flagellates, and other unicellular organisms (NatureServe 2017b).

Glochidia (larval form) of freshwater mussels are typically parasitic on fish. Historically in Maine, the species may have used the Atlantic salmon as a host species to transport larva. The brook floater is a long-term brooder. Like most species of freshwater mussels, the brook floater is long-lived and can live between 30 to 70 years (NatureServe 2017b).

Tidewater Mucket

The tidewater mucket (TWM) is listed as threatened under Maine's Endangered Species Act. The TWM inhabits ponds, canals, and slow-moving sections of rivers; including artificial impoundments, using substrates such as silt, sand, gravel, cobble, and occasionally clay (NatureServe 2017c).

This species is a long-term brooder as eggs are fertilized in late summer and glochidia are released the following spring. The only confirmed fish host for this species is white perch (NatureServe 2017c).

Yellow Lampmussel

The yellow lampmussel (YLM) is listed as threatened under Maine's Endangered Species Act. The YLM occurs in larger streams and rivers, typically found in sand and gravel where good current exists, but has also been seen to inhabit ponds in northern portions of range, but generally prefers flowing water (NatureServe 2017d).

Dispersal of the species occurs with the glochidia attaching its self to the host fish. Adult mussels may have passive movement downstream (NatureServe 2017d). Glochidia of the YLM are parasitic on fish while the adult mussels are filter filters.

This species is a long-term brooder where eggs are fertilized in late summer and glochidia are released the following spring (Nedeau et al. 2000).

Tomah mayfly

As stated in the MDIFW March 8, 2019 letter, the Tomah Mayfly is a State-Threatened species and has been documented downstream of the Project. This rare species of mayfly occurs much lower in the river in association with expansive, adjacent sedge floodplain wetlands in the vicinity of Ayers Brook. Based on our assessment of the habitat in the impoundment and immediately downstream of the dam, it appears that suitable habitat for this species limiting or not present. Given that changes in Project operations are not being proposed, minimal, if any, impacts to this species are anticipated.

Migratory Birds

The protection of birds is regulated by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)).

Bald eagles are no longer listed under the ESA, but maintain federal protection under the Bald and Golden Eagle Protection Act. Bald eagles typically nest within 0.25 to 1 mile of large bodies of open water, such as lakes and large rivers. Eagles nest in large, super-canopy trees or snags often in late-successional forest. They prefer a nest site at the edge of the forest, near foraging areas, unobstructed views, and with little human disturbance. Most eagles forage primarily on fish, with lesser quantities of waterfowl, carrion, and small mammals. The bald eagle often winters along large interior or coastal bodies of water that remain free of ice.

The evening grosbeak (Coccothraustes vespertinus), a bird of conservation concern was identified in the May 2021 review of migratory birds. The breeding season for this species is between May and August. Based on the habitat requirements, it is no likely that the proposed operations or existing operations would affect the species. The evening grosbeak habitat includes conifer forests, box elders and other maples, as well as fruiting shrubs (Audubon 2021).

4.11.1.2 Essential Fish Habitat

Pursuant to the amended Magnuson-Stevens Fishery Conservation and Management Act (Act), Congress mandated that habitats essential to federally managed commercial fish species be identified, and that measures be taken to conserve and enhance habitat. In the amended Act, Congress defined EFH for federally managed fish species as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (PFMC, 2021). As previously noted, based on NMFS’s habitat mapper of EFH for salmon, the Passadumkeag River in the Project area is EFH.

4.11.2 Environmental Effects

4.11.2.1 Proposed Action

KEI (USA) proposes to continue to operate the Project in run-of-river mode such that water levels will continue to be similar as under current operation, and therefore would continue to sustain current availability and quality of habitat.

4.11.2.2 No-Action Alternative

Any flows and water levels caused by passing inflows at the Project will continue to occur. As discussed above, this operating regime would continue to sustain current availability and quality of wetland habitat and the wildlife species, include RTE, that utilized the existing habitat. The no-action alternative would also maintain existing downstream minimum flows.

4.11.2.3 Unavoidable Adverse Effects

No unavoidable impacts to the above mentioned species and habitat are anticipated to occur, as minimum flow, ground impact, and roosting habitat will not be affected by the proposed action (i.e., no tree clearing is proposed). Bat foraging may take place over the reservoir and along the shoreline; however, the run-of-river operation of the Project will not affect the ability of the bats to access foraging habitat or limit potential prey species (e.g., invertebrates). KEI (USA) anticipates that a determination of potential effects of the Project on Atlantic salmon will be made by NMFS under the ESA.

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4.12 Recreation and Land Use

4.12.1 Affected Environment

4.12.1.1 Regional Recreation Opportunities

The Lowell Tannery Project is within the Maine Highlands tourism region as defined by the Maine Office of Tourism (MOT) (MTA 2021). The Maine Highlands provides opportunities for several passive and active outdoor recreational activities. The 200,000 acre Baxter State Park is approximately 50 miles northwest of the Lowell Tannery Project and provides over 200 miles of hiking trails, over 300 campsites, and amenities for boating, kayaking, canoeing, picnicking, biking, swimming, fishing, and scenic and wildlife viewing (BSP 2021). Maine's tallest mountain, Mount Katahdin, is in Baxter State Park. Maine's 100-mile wilderness is a popular destination for hikers and extends from Monson, Maine, to Baxter State Park; this area contains the northern section of the Appalachian Trail. The Appalachian Trail is a designated National Scenic Trail (NPS 2021a). The Gulf Hagas area is part of the Appalachian Trail and contains a 400-foot-deep gorge on the west branch of the Pleasant River (MOT 2021). Gulf Hagas is a National Natural Landmark and provides 7.5 miles of hiking trails and scenic viewing (NPS 2021b).

The Katahdin Woods and Waters is an 87,500-acre national monument in the western section of the Maine Highlands (MDOT 2021). Katahdin Woods and Waters provides opportunities for boating, canoeing, kayaking, camping, fishing, scenic viewing, hiking, visiting historical landmarks, picnicking, whitewater rafting, wildlife viewing, snowmobiling, and skiing. The Katahdin Woods and Waters Maine Scenic Byway provides views of the east and west branches of the Penobscot River, Mount Katahdin, several lakes, and other mountains within the Appalachian chain. Katahdin Iron Works is approximately 40 miles northwest of the Lowell Tannery Project and offers historical landmarks to visit, hiking trails and scenic and wildlife viewing (MDACF 2021a).

A portion of the Downeast and Acadia tourism region is in the eastern section of the Passadumkeag River watershed, including the Duck Lake public reserved land unit which contains over 27,000 acres of forest land approximately 20 miles east of the Lowell Tannery Project. The Duck Lake area provides opportunities for hiking, boating, canoeing, swimming, and camping, as well as snowmobile and ATV trails (MDC 2009; MDACF 2021b).

Two state parks are within the Maine Highlands tourism region. The 925-acre Lily Bay State Park near Greenville, Maine, is approximately 60 miles northwest of the Lowell Tannery Project on Moosehead Lake, which is Maine's largest lake. The park provides amenities for snowmobiling, cross country skiing, fishing, scenic and wildlife viewing, camping, boating, canoeing, hiking, picnicking, swimming, and a 2-mile walking trail (MDACF 2021c). Peaks-Kenny State Park is 839-acres and approximately 40 miles west of the Project on Sebec Lake near Dover-Foxcroft, Maine. The park provides amenities for swimming, camping, boating, canoeing, kayaking, 10-miles of hiking trails, fishing, picnicking, wildlife viewing, and scenic viewing (MDACF 2021d).

The Passadumkeag River was listed in the Nationwide River Inventory in 1982 because of outstanding geologic and botanical resource values (NPS 2018c). The Passadumkeag River was also listed on the Final Category C List of the Maine Rivers Study because of unique and significant geologic, hydrologic, anadromous fishery, undeveloped, and canoe touring resource values (Grand Falls Rapids) (MDC 1982). The Enfield horseback esker and the Saponac esker are unique examples of glacial geology. The Passadumkeag Marsh and boglands is a National Natural Landmark (NPS 2021d). Rivers in Category C possess a composite natural and recreational resource value with state-wide significance (MDC 1982).

4.12.1.2 County and Municipal Recreation Areas

Within the vicinity of the Lowell Tannery Project, there are a number of recreational areas. The town of Lowell, Maine, is in the southern portion of the Lincoln Lakes Region which contains woodlands, forests, 25 lakes, and the Penobscot, Passadumkeag, Mattawamkeag, and Piscataquis Rivers (LLRCC 2017). The Passadumkeag River provides opportunities for fishing, canoeing, kayaking, and whitewater rafting. MDIFW stocks the Passadumkeag River in Lowell and Grand Falls Township with brook trout and landlocked salmon each year; other locations stocked each year in the Passadumkeag River watershed include Cold Stream, Cold Stream Pond, and Trout Pond (MDIFW 2021). The Saponac to Upper Lord Brook section of the Passadumkeag River (approximately 12 river miles upstream of the Lowell Tannery Project) is a 0.8-mile-long Class V whitewater section (AWW 2021).

Boat access to the Passadumkeag River is available from a trailer accessible launch on the Penobscot River just upstream of the confluence with the Passadumkeag River; from a ramp on the river left[7] shore next to the Goulds Ridge Road bridge approximately 11 river miles downstream of the Lowell Tannery dam; and from a hand carry launch site near the northwest corner of Saponac Pond approximately 5 river miles upstream of the Project (MDACF 2021e). Trailer-accessible boat launches are also available at several lakes throughout the Lincoln Lakes Region, including at Cold Stream Pond, Upper Cold Stream Pond, Mattanawcook Pond, Folsom Pond, Long Pond, and Silver Lake (MDACF 2021e). Additional recreation opportunities within the Lincoln Lakes Region include camping, walking and hiking trails, biking, and skiing.

4.12.1.3 Existing Project Recreation Opportunities and Use

KEI (USA) provides access to the impoundment from a hand carry boat access area on the north side of the dam, a parking area, and a canoe portage from the impoundment access area to a location near the bridge on Fogg Brook Road (Photo 4.5). These recreation facilities were recommended in the 1983 license for the Project (FERC 1983). FERC granted an exemption from filing the Licensed Hydropower Development Recreation Report (Form 80) to the Lowell Tannery Project in 2001 because the Project received low recreational use (FERC 2001).

[7] From the perspective of an observer looking downstream.

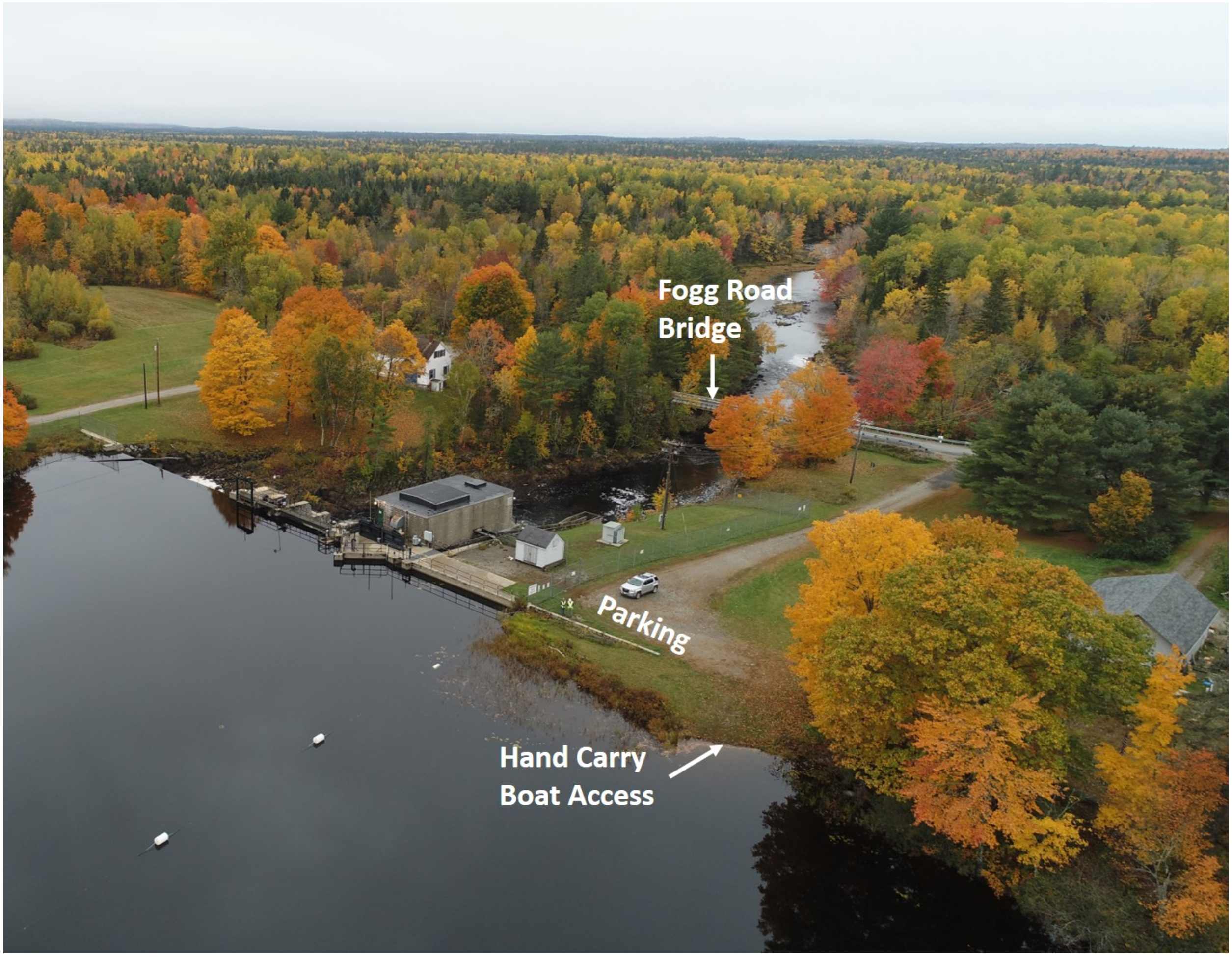


Photo 4.5 Recreation sites at the Lowell Tannery Project.

4.12.1.4 Land Uses and Management Within the Project Vicinity

Overview of Land Use

The Lowell Tannery Project is within the Eastern Interior Management Plan area of the state of Maine. The land surrounding the Lowell Tannery Project is not public reserved land or a special protection or management area (MDC 2009). Portions of the Duck Lake public reserved land unit and Nicatous Lake easement area are approximately 20 miles east of the Lowell Tannery Project.

The Lowell Tannery Project is in the rural town of Lowell, Maine. The Passadumkeag River watershed has an area of approximately 397 square miles and is within Penobscot and Hancock counties. The dominant land cover class in the Passadumkeag River watershed is forest (evergreen, deciduous and mixed) (67.0 percent) followed by woody wetlands (17.1 percent) and open water (7.9 percent) (Table 4.22). Developed, barren, shrub/scrub, herbaceous, hay/pasture/ cultivated crops, woody wetlands, and emergent herbaceous wetlands each constitute 2.8 percent or less of the land cover (Table 4.22).

Table 4.22 Land Cover in the Passadumkeag River Watershed

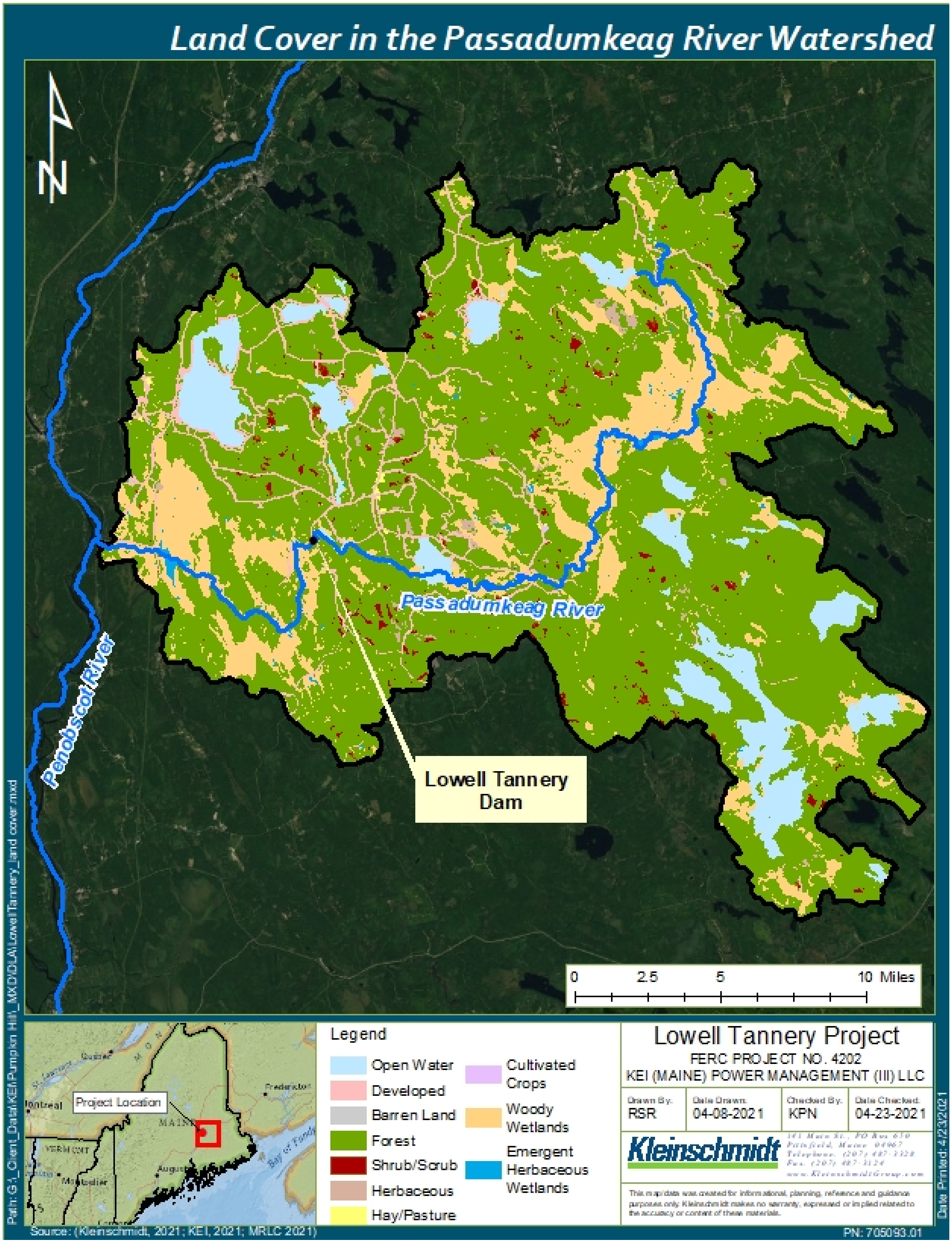
Land Use	Square Miles	PERCENT
Open Water	31.2	7.9%
Developed	7.2	1.8%
Barren Land	0.2	0.1%
Forest	266.0	67.0%
Shrub/Scrub	11.2	2.8%
Herbaceous	7.3	1.8%
Hay/Pasture	1.0	0.3%
Cultivated Crops	0.2	0.1%
Woody Wetlands	68.0	17.1%
Emergent Herbaceous Wetlands	4.7	1.2%
Total	397	100.0%

Source: MRLC 2016

4.12.1.5 Land Use and Management of Project Lands

Project operations and maintenance are the primary activities that occur on project lands. There are no formal public recreation facilities at the Project and access to the dam is blocked to unauthorized vehicles or pedestrians.

Figure 4.17 Passadumkeag River Land Cover



4.12.2 Environmental Effects

4.12.2.1 Proposed Action

KEI (USA) is proposing to continue operating the Lowell Tannery Project under the current regime and to continue providing access to the informal recreation areas at the Project. KEI (USA) is not proposing to add new recreational facilities but to continue to maintain the existing hand carry access and portage.

4.12.2.2 No-Action Alternative

The no-action alternative will have the same effect on recreation and land use as the proposed action.

4.12.2.3 Unavoidable Adverse Effects

KEI (USA) may need to temporarily alter water levels in the impoundment or tailrace for routine maintenance or repairs. This may result in limited, short-term periods of reduced access to project waters for recreation.

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4.13 Aesthetic Resources

4.13.1 Affected Environment

The Lowell Tannery Project is on the Passadumkeag River in Penobscot County, Maine. Approximately 75 percent of the land area of Penobscot County is forested, 23 percent is agricultural or open space, and 2 percent is classified as urban (PCEMA 2016). The Passadumkeag River originates at Weir Pond and Number Three Pond in Twombly Township near Lee and Burlington, Maine (Figure 4.2). The Passadumkeag River then flows south-southwest through forest and wetlands to converge with the Penobscot River in Passadumkeag, Maine. The area around the project is heavily forested with sporadic residential development; approximately two-thirds (68 percent) of the Passadumkeag River watershed is forested (Figure 4.5).

4.13.1.1 Visual Character of Project Lands and Waters

Project facilities include a concrete gravity dam and powerhouse; an outlet gate; a log sluice section; a Denil ladder upstream fishway; a downstream fishway, a tailrace channel; a 341-acre reservoir at full pond elevation of 187.5 feet msl; a generator; a transformer; 200-foot-long transmission lines; and appurtenant facilities (Photo 4.6., Photo 4.7, Photo 4.8). A short gravel road leads to the powerhouse and dam. The right and left banks downstream of the dam have a moderate slope with boulders and vegetation (Photo 4.8). The impoundment extends upstream approximately 4 river miles and is bordered by forest and wetlands.

Photo 4.6 View of powerhouse, dam, fishways, and spillway.

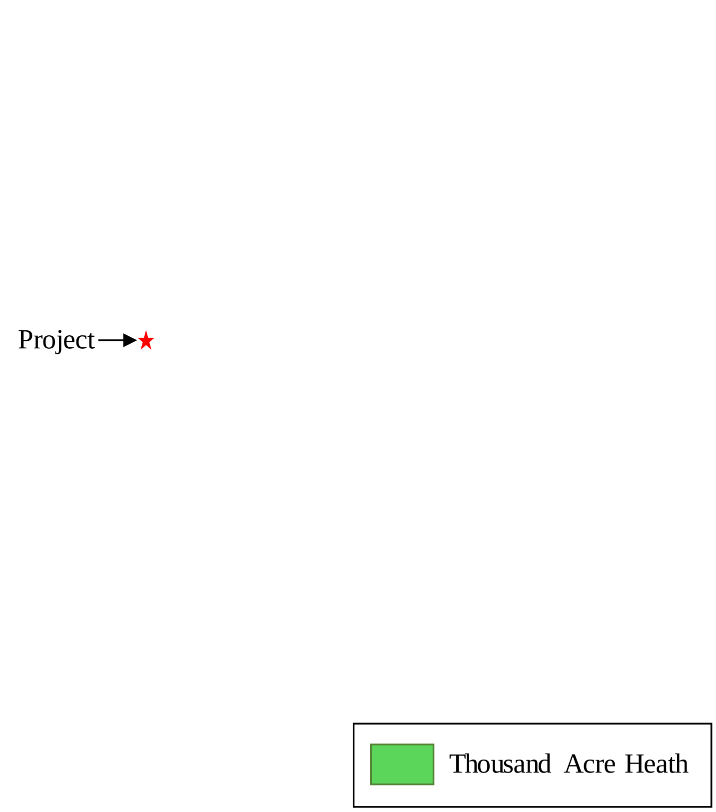
Photo 4.7 Lowell Tannery Powerhouse and Gates

Photo 4.8 View of the Lowell Tannery Project Impoundment.

4.13.1.2 Nearby Scenic Attractions

The Lowell Tannery Project is within the Maine Highlands region which is known for natural and undeveloped landscapes, mountains, lakes, rivers, woodlands, and waterfalls. The Passadumkeag River watershed contains several natural areas of state and national significance. The Lowell Tannery Project is within the Thousand Acre Heath which is a focus area of statewide ecological significance because of unique plant and animal communities, high value wildlife habitat, intact natural landscapes, and undeveloped habitat (Figure 4.18) (MDACF 2018). The Lowell Tannery Project is also adjacent to the Passadumkeag Marsh and Boglands which was designated as a National Natural Landmark in 1973 (NPS 2016). The town of Lowell, Maine, is in the southern portion of the Lincoln Lakes Region which contains woodlands, forests, 25 lakes, and the Penobscot, Passadumkeag, Mattawamkeag, and Piscataquis Rivers (LLRCC 2017). The Duck Lake Ecological Reserve is in the eastern portion of the watershed and contains unique wildlife habitat and natural communities including bogs, wetlands, hemlock forests, red pine forests, and an unpatterned fen ecosystem (MDC 2009).

Figure 4.18 Location of the Lowell Tannery Project within the Thousand Acre Heath.



4.13.2 Environmental Effects

4.13.2.1 Proposed Action

KEI (USA) is not proposing any measures anticipated to affect aesthetic resources.

4.13.2.2 No-Action Alternative

The no-action alternative will have the same effect on aesthetic as the proposed action.

4.13.2.3 Unavoidable Adverse Effects

KEI (USA) may need to temporarily alter water levels in the impoundment, bypassed reach, or tailrace for routine maintenance or repairs. This may result in temporary, short-term periods of effects on aesthetic views associated with areas that are dewatered.

4.13.3 References

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Penobscot County Emergency Management Agency (PCEMA). 2016. Penobscot County Hazard Mitigation Plan 2016. [Online] URL: http://static1.1.sqspcdn.com/static/f/547079/27442155/1486577218533/Penobscot+County+HM+Plan2016+Update.pdf?token=5js36CwAd%2BAxYO%2FaLAdD60zVuyo%3D. Accessed March 23, 2018.

4.14 Cultural Resources

4.14.1 Affected Environment

4.14.1.1 Area of Potential Effect

The Advisory Council on Historic Preservation (Advisory Council) defines an Area of Potential Effect (APE) as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. KEI (USA) has delineated the APE for the Lowell Tannery Hydroelectric Project and defines it as all lands within the FERC Project Boundary, including the powerhouse, tailrace, dam, and extends upstream approximately 4 miles upstream of the Lowell Tannery Project. No improvements or enhancements are proposed beyond this line.

Identification of Historic and Archeological Sites in the Project Vicinity

There are three places in the Project vicinity that are on the National Register, primarily located in Passadumkeag, Brooklin, and Burlington, Maine (NPS 2014):

- District No. 2 School located at Southeast Corner of Junction of Pleasant Street and Caribou Road, Passadumkeag, Maine. The structure was built between 1834 and 1849. The building was also used as a town meeting place.
- Beth Eden Chapel located on the East side of Naskeag Point Road, .05 miles North of junction with Naskeag Loop Road, Brooklin, Maine. The chapel was completed in 1900, representing the first religious facility erected in the Naskeag area of what is presently the town of Brooklin.
- The Old Tavern located on Main Route 188 and Old Dam Road, Burlington, Maine. The two-story building was built around 1844. The build served as an Inn and tavern.

Prior Cultural Resource Investigations

KEI (USA) is not aware of prior cultural resources investigation in the project boundary. Based upon requests from the Maine Historic Preservation Commission (MHPC), KEI (USA) is currently developing a scope for the Phase 1 cultural resource survey and National Register eligibility assessment of project structures in 2021. Results will be submitted to MHPC and FERC when the surveys are completed.

4.14.2 Environmental Effects

4.14.2.1 Proposed Action

The proposed action will not result in changes or be likely to affect cultural resources based on the run-of-rive mode of operations. KEI (USA) will consult with SHPO prior to any construction activities as part of state and federal permitting requirement (i.e., MDEP and USACE permitting) in accordance with Section 106 of the NHPA.

4.14.2.2 No-Action Alternative

Under the no-action alternative, the Project would continue to operate as required by the current Project license (i.e., there would be no change to the existing environment). KEI (USA) would continue to comply with Section 106 through MHPC consultation, as needed, on a case-by-case basis.

4.14.2.3 Unavoidable Adverse Effects

KEI (USA) has proposed no changes to the operations or the facilities of the Lowell Tannery Project that will have unavoidable adverse effects on cultural resources. The project operates in run-of-river mode and will continue to operate as such. Installation of upstream eel passage facilities would require consultation with MHPC through state permitting process.

4.14.3 References

National Park Service (NPS). 2014. National Register of Historic Places Program: Research. Map. [Online] https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466. Accessed March 21, 2018.

4.15 Tribal Resources

4.15.1 Affected Environment

There are no Native American lands, known Native American traditional cultural properties or religious properties, or National Register-eligible or -listed sites associated with Native American Nations within the Project boundary to KEI's knowledge.

The Project is operated in run-of-river mode, which more closely matches the natural hydrologic regime of the River. As such, project operations are not expected to affect any resources that may impact cultural or economic interests.

4.15.1.1 Identification and Consultation with Tribes

The Commission extended an invitation to the Aroostook Band of Micmacs, Houlton Band of Maliseet Indians, Passamaquoddy Tribe at Motahkmkuk, Passamaquoddy Tribe at Sipayik, and the Penobscot Indian Nation (PIN) on November 2, 2017, in anticipation of the start of the relicensing process. The FERC docket does not identify whether any addition discussion occurred from this initiation.

On September 26, 2018, the NOI and PAD for the Lowell Tannery Project was filed and distributed to the four tribes addressed above.

One comment letter has been received, that of the PIN on April 9, 2019, providing its support and concurrence for the comments and study requests filed by the NMFS on March 9, 2019. No comments on the DLA were received from the PIN.

4.15.2 Environmental Effects

4.15.2.1 Proposed Action

There are no known tribal resources in lands proposed to be removed from the Project boundary. Therefore, the proposed action will not likely negatively affect tribal resources.

4.15.2.2 No-Action Alternative

Continued operation of the Project under the no-action alternative is unlikely to affect Tribal resources; the licensee would address any tribal resources, should they be discovered, on a case-by-case basis.

4.15.3 Unavoidable Adverse Effects

The licensee has not identified any unavoidable adverse effects on tribal resources.

4.15.4 References

Federal Energy Regulatory Commission (FERC). 2017. Consultation with Tribes for the Lowell Tannery Project No. 4202.

KEI (USA) Power Management Inc. 2018. Lowell Tannery Hydroelectric Project (FERC No. 4202) -Filing of Notice of Intent and Pre-Application Document.

Penobscot Nation. 2019. Lowell Tannery Hydroelectric Project (FERC #4202).

5.0 ECONOMIC ANALYSIS

Project economics are provided in detail in Exhibit A of this application.

APPENDIX A

SUMMARY OF CONSULTATION

Commenting Entity	Document Section	Comment	Response
USFWS and MDMR	Exhibit A 2.1 Project Facilities	KEI states that the top of flashboards heigh is at elevation 182.3 feet. According to the Service's records and parts of the DLA, normal headpond is at 187.5 Clarify what the existing flashboard height is at the project as well as the normal headpond elevation and fix the inconsistency.	Discrepancy has been corrected. Top of boards/normal headpond is 187.5' and the dam crest is 184.05'.
MDMR	Exhibit A 2.1 Project Facilities	KEI states, "The project reservoir is approximately 314 acres at elevation 187.5 feet mean sea level," but in table 2.1 of the DLA states that the project reservoir is 341 acres. MDMR request KEI clarify the correct impoundment elevation and the correct headpond surface area.	Discrepancy has been corrected to 341 acres.
MDMR	Exhibit E 2.1.1 Existing Project Description	MDMR requests that KEI include a description of the status of the attraction water system.	There are two attraction water systems, one is operational to provide 20 cfs. A secondary system is in place but is not in use due to past conflicting opinions from state and federal fisheries agencies whether it would potentially provide too much flow.
MDMR	Exhibit E 2.1.1 Existing Project Description	KEI states, "When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam." MDMR requests that KEI describe the receiving area below the spill areas.	This section has been updated to include a photo of the pools at the toe of the dam during spill conditions.
USFWS and MDMR	Exhibit E 2.4 Proposed Project Facilities	The Service recommends that KEI operate the Project in instantaneous run-of-river mode, whereby inflow to the Project equals outflow from the Project at all times and water levels above the dam are not drawn down for the purpose of generating power. KEI should develop an operations and compliance monitoring plan in consultation with the agencies that describes mechanisms and structures that will be used, including level of manual and automatic operation, methods used for recording data, the protocol for providing data to the agencies, and an implementation schedule. At a minimum, headpond elevation and station generation should be recorded hourly, with records maintained digitially for the term of any new license issued for the Project. There should be no fluctuation of headpond. Instantaneous run-of-river operations may be temporarily modified if required by operating emergencies beyond the control of the Applicant or for short periods upon mutual agreement from the Service and other agencies. MDMR supports the recommendation of the USFWS.	KEI (USA) does not draw the impoundment for the purposes of generating power. Pond level data is already collected on 10 minute intervals and electronically stored. Generation is logged on an hourly basis.
USFWS	Exhibit E 4.1 General Description of the River Basin	Restoration activities upstream of the Project is not included in the DLA. Previous comments filed by the USFWS stated that there are ongoing collaborative efforts to restore river herring to the Passadumkeag River. This is guided by the State of Maine's diadromous fish restoration plan for the Penobscot River. This plan identifies lakes in the Passadumkeag River watershed that would or should be considered for restoration by 2050 when all three phases of this plan are completed. Phase 3 includes six lakes with a total potential alewife run size of about 2,759,000 fish. The Service estimates that the minimum alewife run size moving past the Project will be approximately 845,000 fish within the next ten years.	It is not for KEI to assess whether the cited projections are accurate. However, KEI notes that trap count data over the past four years at the Orono Project on the mainstem Penobscot River have only average less than 20% of the Service's estimated 845,000 that will pass the Project, on a tributary to the mainstem, in the next 10 years.
MDMR	Exhibit E 4.1.2 Major Water Uses	MDMR is collaborating with MDIFW, USFWS, the Atlantic Salmon Federation, and others to restore river herring to the Passdumkeag River guided by the State of Maine's diadromous fish restoration plan for the Penobscot watershed. Upon completion of phase 2 in 2021, MDMR anticipates adult returns of alewives to Phase 1 and Phase 2 habitats to be 1.35 million annually. Additional restoration activities are planned to occur by 2050, which will increase adult returns to the Passdumkeag Watershed to 4.3 million annually.	See prior response.
MDMR	Exhibit E 4.1.2 Major Water Uses	MDMR recommends that the statement "The West Branch of the river is known for its landlock salmon fishing and the East Branch is very well known for its small mouth bass fisheries (TMH 2018)," as TMH is not a primary source and the statement does not reflect the management plan of the agencies that oversee the watershed.	Statement and reference have been removed.
Maine DEP	Exhibit E 4.8 Water Resources	2019 Impoundment Water Quality Monitoring - The March 2020 ISR and DLA indicate some impairments to impoundment water quality. Project study results indicated nutrient concentrations (phosphorous and chlorophyll-a) in the Lowell Tannery impoundment exceed generally acceptable concentrations for Class A waters. A single Secchi disk measurement was less than the two-meter threshold demonstrating attainment of Class AA/A water quality standards, however color values are high (85-100 PCU) in the Passadumkeag River at this location, which prevents conclusions from being drawn from the Secchi disk transparency measurements.	Not response needed, but comment acknowledged.
Maine DEP	Exhibit E 4.8 Water Resources	2019 Impoundment Trophic State Study - In 2019, DO concentrations in the impoundment failed to meet the 7 ppm concentration to attain Maine Water Quality Standards. The Applicant conducted an additional DO monitoring study in 2020.	Not response needed, but comment acknowledged.
Maine DEP	Exhibit E 4.8 Water Resources (p. 4-35 and 4-36)	2020 Water Quality Monitoring/Dissolved Oxygen Studies - The Applicant provided the max, min, and average values for DO concentration, percent saturation, and water temperature from the 2020 DO Study in the DLA. The Department requests that the Applicant submit the raw data in excel format from the 2020 DO studies for analysis.	Raw data will be provided to MDEP directly.
Maine DEP	Exhibit E 4.8 Water Resources	Dissolved Oxygen Studies - Based on the 2019 and 2020 DO data provided in the DLA, the Department is able to conclude that inflowing waters to the impoundment contributed to the low DO values in the impoundment and in the tailwater that were observed in 2019. The Department concludes that sufficient data has been collected related to DO at the Project and, pending the submission of the 2020 DO and temperature data set, the Department will be able to make a determination of whether the Project causes or contributes to the failure of the water body to meet the Class A standard for DO.	Not response needed, but comment acknowledged.
Maine DEP	Exhibit E 4.8 Water Resources	Habitat Studies - To demonstrate run-of-river operations, flow and water level data were requested. These data were nc reported in the DLA. The Department requests that the Applicant submit three years of impoundment elevation and inflow/outflow data.	Three Years of operations data is Appended to Exhibit E of the FLA.

Maine DEP	Exhibit E 4.8 Water Resources	Flow and water level data were not reported in the ISR or the DLA, so the Department must analyze the Project based on operations. With run-of-river operations and all inflow delivered to the outlet stream and no appreciable bypass reach, the Department expects that the downstream reach of the Project to provide sufficient aquatic habitat to meet the State's aquatic life and habitat standards. Further, when reviewed with the findings of the Benthic Macroinvertebrate Study, the Department believes that ROR operations do not negatively affect the quality of habitat downstream of the Lowell Tannery Dam.	See prior response.
Maine DEP	Exhibit E 4.8 Water Resources	Benthic Macroinvertebrate Monitoring - Based on the results of this study, the Department concludes that KEI has provided sufficient information to demonstrate that the benthic macroinvertebrate community in the vicinity of the Lowell Tannery Hydroelectric Project meets Class A and Class AA aquatic life standards under current and proposed flow conditions.	Not response needed, but comment acknowledged.
MDMR	Exhibit E 4.9 Fish and Aquatic Resources	KEI states the surface area of the reservoir is 68.5 acres. MDMR recommends KEI clarify the correct surface area of the reservoir.	This has been corrected to 341 acres.
USFWS	Exhibit E 4.9 Fish and Aquatic Resources	KEI states in the DLA that 40 cfs of attraction and conveyance water is discharged through the fishway. The fishway only conveys 20 cfs which would be augmented by 20 cfs from an auxiliary water supply (AWS). However, the AWS has not been functional for over a decade. This information should be included in the FLA.	There are two attraction water systems, one is operational to provide 20 cfs. A secondary system is in place but is not in use due to past conflicting opinions from state and federal fisheries agencies whether it would potentially provide too much flow.
MDMR	Exhibit E 4.9 Fish and Aquatic Resources	MDMR recommends the Applicant refer to the annual reports of the U.S. Atlantic Salmon Assessment Committee for accurate information regarding the returns and escapement of adult Atlantic salmon to the Penobscot River.	Not response needed, but comment acknowledged.
USFWS	Exhibit E 4.9 Fish and Aquatic Resources	Previous data shows that the current fishway at the Project is not effective at passing river herring and is undersized and cannot meet the future watershed goals for river herring. Pending the 2020/2021 study with the University of Maine related to fishway effectiveness, KEI should include robust and appropriate PME measures that will ensure safe, timely, and effective passage of river herring past the dam in its FLA.	Results of the 2021 study are summarized in Exhibit E. While KEI does not agree with a foregone conclusion that the existing upstream fish passage is undersized, KEI has proposed some modifications and additional study in 2022.
MDMR	Exhibit E 4.9 Fish and Aquatic Resources	MDMR stated that the current fishway is undersized and cannot meet the capacity requirements for watershed goals for river herring and that the 2021 effectiveness study results have not been reported. MDMR recommends KEI include PME measures in the FLA that will ensure safe, timely, and effective passage of river herring. These measures should be mindful that Atlantic salmon, American Shad, and Sea lamprey will also make use of the upstream fish passage facilities at the project.	See prior response.
MDMR	Exhibit E 4.9 Fish and Aquatic Resources	MDMR recommends KEI corrects the errors in the Desktop Turbine Passage and Survival Study by performing the analysis using a lambda value of 0.2 for salmonid and alosine species and 0.4 for adult American eel. Additionally, the report included passage route proportions that are disproportionate to flow at the project. Update estimates should be included in the FLA.	KEI disagrees that the desktop analysis is erroneous. FERC concluded that the study is sufficient to assess downstream fish passage at the project.
USFWS	Exhibit E 4.9 Fish and Aquatic Resources	The Service is unable to provide comprehensive comments at this point in the licensing process due to the lack of substantive information regarding downstream passage in the DLA. The Service had previously requested parameter adjustments to the Desktop Turbine Passage and Survival Study that were not completed. The Service also has not been provided details about the feasibility study and passage alternatives study of downstream eel passage alternatives and they have not to date been consulted on study details.	KEI disagrees that the desktop analysis is erroneous. FERC concluded that the study is sufficient to assess downstream fish passage at the project. Downstream eel passage measures are proposed in the FLA.
MDMR	Exhibit E 4.9 Fish and Aquatic Resources	MDMR recommends KEI consult with the agencies about the methodologies and approach for the downstream eel passage feasibility study and the passage alternatives study to ensure appropriate alternatives are being included.	Downstream eel passage measures are proposed in the FLA, which would be designed in consultation with agencies.
USFWS	Exhibit E Environmental Effects - Proposed Action	Upstream and downstream eel passage and protection measures at the Project are warranted. Upstream and downstream fish passage structures at Lowell Tannery should provide safe, timely, and effective passage and be designed in consultation with, and require approval by, the Service. The designs should be consistent with the Service's 2019 Fish Passage Engineering Design Criteria Manual.	Upstream and Downstream eel passage measures are proposed in the FLA, which would be designed in consultation with agencies.
Maine DEP	Exhibit E Appendix B 2020 Study Reports	Maine DEP requests that the Applicant submit the raw bathymetry data collected in 2020 in excel format for analysis. The Applicant presented a figure showing the bathymetry of the Project impoundment, demonstrating that this data was collected, but did not report the raw data collected during 2020.	Raw data will be provided to MDEP directly.
MHPC		MHPC requested a Phase 1 archaeological study and historic structures evaluation by hardcopy letter to KEI in October 2018 that was overlooked. By letter dated June 29, 2021 to Kleinschmidt, MHPC reiterated the study request. KEI is currently evaluating the work scope with a qualified consultant to conduct the study as soon as is practical.	

CONSULTATION DOCUMENTATION

Following is a summary of key consultation conducted during the Lowell Tannery relicensing proceeding. The Distribution List is provided as attachment to the cover letter to the Final License Application filing. Consultation documentation is provided as part of the Traditional Licensing Process (TLP) record.

Date	From	To	Description
11/2/2017	Federal Energy Regulatory Commission (FERC)	Aroostook Band of Micmacs, Houlton Band of Maliseet Indians, Passamaquoddy Tribe at Motahkmikuk, Passamaquoddy Tribe at Sipayik, Penobscot Nation	Letter Inviting Aroostook Band of Micmacs et al to Participate in the Licensing Process for the Existing Lowell Tannery Project under P-4202.
9/26/2018	KEI (USA) Power Management Inc. (KEI (USA))	Distribution List and FERC	Notice of Intent, Pre-Application Document (PAD) for the Lowell Tannery Project of KEI (USA) under P-4202, and request to use the Traditional Licensing Process (TLP).
9/27/2018	KEI (USA)	Distribution List and FERC	Newspaper Notice Proof of Filing
11/23/2018	FERC	KEI (USA)	Notice of Intent to File License Application, Filing of Pre-Application Document, and Approving Use of the Traditional Licensing Process re KEI (USA) under P-4202.
12/27/2018	KEI (USA)	Distribution List and FERC	Joint Agency and Public Meeting Notice
1/11/2019	KEI (USA)	Maine Department of Environmental Protection (MDEP), Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Department of Marine Resources (MDMR)	Joint Agency and Public Meeting
1/22/2019	KEI (USA)	Distribution List and FERC	Joint Agency Meeting Transcript
3/6/2019	KEI (USA)	Distribution List and FERC	Issued Initial Study Report

Date	From	To	Description
3/8/2019	MDIFW	KEI (USA) and FERC	PAD Comments and Study Requests
3/9/2019	National Marine Fisheries Service (NMFS)	KEI (USA) and FERC	PAD Comments and Study Requests
3/11/2019	MDMR	KEI (USA) and FERC	PAD Comments and Study Requests
3/12/2019	MDEP	KEI (USA) and FERC	PAD Comments and Study Requests
3/14/2019	U.S. Fish and Wildlife Service (USFWS)	KEI (USA) and FERC	PAD Comments and Study Requests
3/15/2019	Maine Trout Unlimited Council	KEI (USA) and FERC	PAD Comments and Study Requests
4/9/2019	Penobscot Indian Nation	KEI (USA) and FERC	PAD Comments and Study Requests
3/24/2020	KEI (USA)	Distribution List and FERC	Issued Draft Study Plan
4/17/2020	MDEP	KEI (USA) and FERC	Comments on the Initial Study Report (ISR)
4/27/2020	USFWS	KEI (USA) and FERC	Comments on the ISR and 2020 Draft Study Plan
5/12/2020	NMFS	KEI (USA) and FERC	Comments on the ISR
10/15/2020	NMFS	KEI (USA) and FERC	Request for Dispute Resolution for the Conduct of Studies
10/30/2020	KEI (USA)	NMFS and FERC	Response to the National Marine Fisheries Service Request for Dispute Resolution for the Conduct of Studies
12/8/2020	FERC	KEI (USA) and Public	Public Notices for Conference Call with KEI (USA)
12/18/2020	FERC	KEI (USA), NMFS, USFWS, MDEP, MDMR, Penobscot Nation, University of Maine Cooperative Fish and Wildlife Research Unit	Conference Call to Discuss the National Marine Fisheries Service Request for Dispute Resolution for the Conduct of Studies
12/21/2020	USFWS	FERC	Response to Request for Additional Information of National Marine Fisheries Service
1/11/2021	FERC	KEI (USA) and Distribution List	Memo Providing Conference Call Minutes with Applicant and Resource Agencies Held 12/18/2020
2/10/2021	FERC	KEI (USA) and NMFS	Letter to KEI (USA) Discussing the Study Dispute for the Lowell Tannery Hydroelectric Project
3/24/2021	KEI (USA)	Distribution List	Study Plan for Upstream Fishway Effectiveness

Date	From	To	Description
3/24/2021	NMFS	KEI (USA)	Informal Email Comments Regarding the Issued Draft Study Plan
3/26/2021	MDMR	KEI (USA)	Informal Email Comments Regarding the Issued Draft Study Plan
4/1/2021	USFWS	KEI (USA)	Informal Email Comments Regarding the Issued Draft Study Plan
4/1/2021	MDEP	KEI (USA)	Informal Email Comments Regarding the Issued Draft Study Plan
5/30/2021	KEI (USA)	Distribution List and FERC	Filing of Draft License Application (DLA)
6/29/2021	Maine State Historic Preservation Office	KEI (USA)	DLA Comments
7/19/2021	Houlton Band of Maliseets	KEI (USA)	Informal Email DLA Comments
9/14/2021	USFWS	KEI (USA) and FERC	DLA Comments
9/15/2021	MDMR	KEI (USA) and FERC	DLA Comments
9/15/2021	NMFS	KEI (USA) and FERC	DLA Comments and Study Report Comments
9/16/2021	MDEP	KEI (USA) and FERC	DLA Comments

KEI (USA) Power Management Inc.
423 Brunswick Avenue
Gardiner, ME 04345
Tel.: (207) 203-3026

September 26, 2018

VIA E-FILING

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Lowell Tannery Hydroelectric Project (FERC No. 4202)
Filing of Notice of Intent and Pre-Application Document

Dear Secretary Bose:

KEI (USA) Power Management Inc. [KEI (USA)] or Applicant] on behalf of KEI (Maine) Power Management (II) LLC filing with the Federal Energy Regulatory Commission (FERC or Commission) its Notification of Intent (NOI) to relicense and the required Pre-Application Document (PAD) for the 1000 kW Lowell Tannery Hydroelectric Project (FERC No. 4202) (Project) (also known as the Pumpkin Hill Project). The Project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine. KEI (USA) hereby electronically files with the Federal Energy Regulatory Commission (FERC or Commission) the Notice of Intent to File a License Application (NOI) and accompanying Pre-Application Document (PAD) for the Project. These documents are being filed pursuant to 18 CFR §5.5 and §5.6 of the Commission's regulations and are being simultaneously distributed to agencies and stakeholders listed in the attached Distribution List.

We are also utilizing this cover letter and as identified in the NOI, to request designation as the non-federal representative under Section 7 of the Endangered Species Act and under Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, request the authority to initiate consultation pursuant to Section 106 of the National Historic Preservation Act, and request to use the Traditional Licensing Process (TLP) for the Project.

DOCUMENT DISTRIBUTION

In accordance with 18 CFR §5.5 and §16.8 of the Commission's regulations, we are transmitting this letter and the referenced attachments (excluding Appendix B of the PAD containing Critical Energy Infrastructure Information (CEII) and filed under separately with the FERC) to relevant and known resource agencies, Tribes, non-governmental organizations and stakeholders that we believe may have an interest in the Project (see attached Distribution List). All materials related to the current license as well as other materials related to this NOI and PAD are available for inspection at the office of KEI (USA) operations office at 423 Brunswick Avenue, Gardiner, ME 04345, by appointment. We have also published notice of this filing in the Bangor Daily Newspaper, a newspaper in general circulation of the project.

Also in accordance with 18 CFR §5.5, we are providing a courtesy copy (in hardcopy and CD) of the NOI, PAD (Volume I and Volume II), this cover letter and the proof of electronic filing of these documents to the FERC Office of Energy Projects (Room 61-02) and the FERC Office of General Counsel - Energy Projects (Room 101-56). We are also providing a courtesy copy of these documents in hardcopy and CD to the FERC New York Regional Office.

NON FEDERAL REPRESENTATIVE

In accordance with 18 CFR §5.5(e) and in order to identify potential issues earlier in the process so that they can be addressed prior to filing of the license application with the Commission, KEI (USA) hereby requests that the Commission designate KEI (USA) as a non-federal representative under Section 7 of the Endangered Species Act and the joint agency regulation there under 50 CFR §402 to undertake formal consultation with applicable federal and state agencies regarding federally threatened and endangered species that may be impacted by the Project.

CONSULTATION AUTHORITY

KEI (USA) requests that it be granted authority to initiate consultation with the Maine State Historic Preservation Officer (SHPO), appropriate federally-recognized Tribes and other consulting parties pursuant to 36 CFR §800.2(c)(4) of the regulations implementing Section 106 of the National Historic Preservation Act.

REQUEST TO UTILIZE THE TRADITIONAL LICENSING PROCESS

The following sections outline how use of the TLP will: a) comply with the criteria outlined in 18 CFR Section 5.3 (C)(1)(ii)(A-F); b) benefit the participants to the process, and c) provide FERC with the information it needs to complete its licensing obligations.

- *Likelihood of on-time license issuance (§5.3A)*
  The Lowell Tannery Project is a small run of river hydroelectric project located on the Passadumkeag River in the east-central region of Maine. The project consists of a 68.5-acre impoundment with negligible storage capacity, an existing dam and powerhouse containing two turbine-generators with a total capacity of 1000 kW. The Licensee is not proposing to change the existing mode of operation or to change the existing project facilities which have provided a reliable source of energy for local customers. The resource agencies that will be involved in the relicensing process for the Project have substantial knowledge of the Penobscot basin (the basin of which the Passadumkeag River is part) with the project involvement with the Stillwater and Milford Projects downstream on the Penobscot River. Therefore, the agencies and Licensee are well aware of the issues that are likely to be raised at the Project. In addition, the agencies' familiarity with the process and informational needs should allow for the timely issuance of the project license on or before the expiration date of the existing license.

- *Complexity of the Resource Issues (§5.3B)*
  Based upon past experience with resource agencies and stakeholders during consultation efforts the following issues may need to be addressed in some fashion during the relicensing process:
  - Water quality sampling above and below the Project
  - RTE species and habitat
  - Fish passage during the term of the license
  - Recreation access
  - Cultural resources at the Project

  These issues have been addressed at other projects that have undergone relicensing in the basin and are common to hydroelectric projects in the state of Maine. KEI (USA)'s proposed data gathering and study efforts are summarized in Section 6.0 of the PAD. The primary issues specific to the project is fish passage for Atlantic salmon, for which KEI (USA) has actively been consulting with NOAA Fisheries to address for the past several years and has developed a draft Species Protection Plan. NOAA Fisheries has reviewed the draft plan and recommended that final consultation efforts be coordinated under the relicensing process.

- *Level of Anticipated Controversy (§5.3C)*
  As noted above, the Licensee has already begun the process of working with NOAA Fisheries on fisheries issues that will be considered during the process. To date, the cooperative relationship between the Licensee and the agency has been generally positive. Given the low complexity of issues already identified at the Project, it is not currently anticipated that the project will result in any significant controversy that cannot be overcome through a cooperative TLP process.

- *Relative cost of the Traditional Licensing Process compared to the Integrated Licensing Process (§5.3D)*
  KEI (USA)'s request to use the TLP is based upon the desire to time some relicensing and scoping efforts concurrent, to the extent possible, with the relicensing of KEI (USA)'s Lower Barker Hydroelectric Project (FERC No. 4202), the NOI and PAD for which was filed in August 2018. Concurrent licensing efforts for these two projects is expected to result in some efficiencies for KEI (USA) and agencies and interested parties that will be active participants in the licensing process for both Projects.

- *The amount of available information and potential for significant disputes over studies (§5.3E)*
  As indicated in the attached PAD, baseline information exists for environmental resources in the Penobscot River basin. Within the project area, KEI (USA) and the resource agencies have identified existing information and data sources. KEI (USA) will work with the resources agencies and stakeholders on sufficient data collection efforts to address resource concerns associated with the Project. Should a significant dispute arise during the process, KEI (USA) would initiate FERC's dispute resolution process outlined in 18CFR §16.8 (b)(6)(i).

- *Other Factors*
  KEI (USA) has published notice of our Intent to Use the TLP in the September 24, 2018 edition of Bangor Daily News, the newspaper having local distribution. That notice requests that any comments in response to this request be filed with the Commission **by October 26, 2018.**

  By copy of the is letter, KEI (USA) also requests that agencies and interested parties to which the request has been distributed (see attached distribution list) provided comments on the request to the Commission **within 30 days, by October 26, 2018.** Please note that comments on the PAD and study request will then be required after KEI (USA)'s Scoping Meeting later this year, pending FERC approval of the TLP.

KEI (USA) hereby respectfully requests that the Commission notice the filing of KEI (USA)'s NOI, approve the filing of its PAD, grant non-federal representative status and consultation authority to KEI (USA) and grant the request to use the TLP.

If there are any questions or comments related to the NOI, PAD or any of the other information presented above, please contact me at (207) 203-3025 or by email at Lewis.Loon@kruger.com.

Sincerely,

Lewis C. Loon, General Manager
Operations and Maintenance – USA/QC
Lewis.Loon@kruger.com
Direct Line: (207) 203-3027

Kleinschmidt

September 27, 2018

VIA ELECTRONIC FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code DLC, HL-11.2
888 First Street, NE Room 1A
Washington, DC 20426

Pre-Application Document Proof of Publication
Lowell Tannery (FERC No. 4202-000)

Dear Secretary Bose:

Pursuant to the Commission's regulations at 18 CFR § 5.3 (d)(2), Kleinschmidt, on behalf of KEI (USA) Power Management LLC, hereby encloses proof of publication of public notice in connection with the Licensees' Application for Subsequent License for the Lowell Tannery Project (FERC No. 4202) and request to use the traditional process filed with the Commission on September 26, 2018. The notice was published in *Bangor Daily News*, a daily newspaper published in Penobscot County on September 24, 2018.

Please let me know if there are any questions or concerns.

Sincerely,

KLEINSCHMIDT ASSOCIATES

Kayla A. Easler

Kayla A. Easler
Regulatory Coordinator

KAE:TMJ
Enclosure: Proof of Publication

J:\705\093\Docs\Newspaper\705093_CVTL_Notice of Filing with the FERC.docx

Legal Notices

NOTICE OF FILING WITH THE FEDERAL ENERGY REGULATORY COMMISSION
KEI (USA) POWER MANAGEMENT INC.
LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

KEI (USA) Power Management (II) LLC [KEI (USA)], as required by the Federal Energy Regulatory Commission (FERC or Commission), hereby gives notice of its intent to seek the relicensing of the Lowell Tannery Project, FERC No. 4202. The Project is a hydroelectric generating facility, located on the Passadumkeag River in the Town of Lowell in Penobscot County, Maine. The Applicant's address is 423 Brunswick Avenue, Gardiner, Maine 04345; phone number is 207-203-3025.

On or about September 26, 2018, KEI (USA) will file with the FERC its Notification of Intent (NOI) to seek a new license, a Pre-Application Document (PAD), and a request for Authorization to Use the Traditional Licensing Process (TLP) under Part 4 of the Commission's Regulations for the Project. The NOI provides notice of KEI (USA)'s intent to file a license application for the Project. The PAD summarizes relevant and available information regarding the Project's description and operation along with discussions of the potential operational effects on environmental and cultural resources.

KEI (USA) invites resource agencies, Indian tribes, and members of the public likely to be interested in the proceedings to participate in the licensing and to comment on this notice and related matters. The PAD and NOI and associated reference materials are available for inspection and reproduction on line at http://www.ferc.gov/docs-filings/elibrary.asp. They are also available for inspection during regular business hours at the KEI (USA) operations office at 423 Brunswick Avenue, Gardiner, Maine 04345.

KEI (USA)'s request to use the TLP is based upon prior and ongoing consultation associated with the Lowell Tannery Project and the Browns Mill Project (FERC No. 5613) for fish passage issues. Because the Project has a limited physical footprint and KEI (USA) is requesting no changes to existing operations, environmental issues are generally known and not expected to be extensive in comparison to other hydro relicensings. KEI (USA) believes that granting the request to use the TLP will not infringe on the ability for agencies or the public to provide comments on the project, nor on KEI (USA)'s ability to address such comments.

Comments on the request to use the TLP are due to the Commission no later than 30 days following the filing date of this request or not later than October 26, 2018. All responses must reference the Lowell Tannery FERC project number (FERC No. 4202). Comments should address, as appropriate to the circumstances of the request, the (A) likelihood of timely license issuance; (B) complexity of the resource issues; (C) level of anticipated controversy; (D) relative cost of the traditional process compared to the integrated process; (E) the amount of available information and potential for significant disputes over studies; and (F) other factors the commenter believes pertinent. Commenters must submit an electronic filing via FERC's website (http://www.ferc.gov/docs-filing/ferconline.asp) pursuant to 18 CFR§ 385.2003(c) or an original and eight copies of their comments to the Office of the Secretary, Federal Energy Regulatory Commission, 888 First Street NE, Washington, DC 20426.

Sept. 24, 2018

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

KEI (Maine) Power Management (II) LLC Project No. 4202-024

NOTICE OF INTENT TO FILE LICENSE APPLICATION, FILING OF PRE-APPLICATION DOCUMENT, AND APPROVING USE OF THE TRADITIONAL LICENSING PROCESS

(November 23, 2018)

a. Type of Filing: Notice of Intent to File License Application and Request to Use the Traditional Licensing Process.

b. Project No.: 4202-024

c. Date Filed: September 26, 2018

d. Submitted By: KEI (Maine) Power Management (II) LLC (KEI Power)

e. Name of Project: Lowell Tannery Hydroelectric Project

f. Location: On the Passadumkeag River, in Penobscot County, Maine. No federal lands are occupied by the project works or located within the project boundary.

g. Filed Pursuant to: 18 CFR 5.3 and 5.5 of the Commission's regulations.

h. Potential Applicant Contact: Lewis C. Loon, KEI (USA) Power Management Inc., 423 Brunswick Avenue, Gardiner, Maine 04345; (207) 203-3027; e-mail – Lewis.Loon@kruger.com.

i. FERC Contact: Dr. Nicholas Palso at (202) 502-8854; or e-mail at nicholas.palso@ferc.gov.

j. KEI Power filed its request to use the Traditional Licensing Process on September 26, 2018. KEI Power provided public notice of its request on September 24, 2018. In a letter dated November 23, 2018, the Director of the Division of Hydropower Licensing approved KEI Power's request to use the Traditional Licensing Process.

k. With this notice, we are initiating informal consultation with the U.S. Fish and Wildlife Service and/or NOAA Fisheries under section 7 of the Endangered Species Act and the joint agency regulations thereunder at 50 CFR Part 402; and

NOAA Fisheries under section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations at 50 CFR 600.920. We are also initiating consultation with the Maine State Historic Preservation Officer, as required by section 106 of the National Historic Preservation Act, and the implementing regulations of the Advisory Council on Historic Preservation at 36 CFR 800.2.

l. With this notice, we are designating KEI Power as the Commission's non-federal representative for carrying out informal consultation pursuant to section 7 of the Endangered Species Act and section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act; and consultation pursuant to section 106 of the National Historic Preservation Act.

m. KEI Power filed a Pre-Application Document (PAD; including a proposed process plan and schedule) with the Commission, pursuant to 18 CFR 5.6 of the Commission's regulations.

n. A copy of the PAD is available for review at the Commission in the Public Reference Room or may be viewed on the Commission's website (http://www.ferc.gov), using the "eLibrary" link. Enter the docket number, excluding the last three digits in the docket number field to access the document. For assistance, contact FERC Online Support at FERCOnlineSupport@ferc.gov, (866) 208-3676 (toll free), or (202) 502-8659 (TTY). A copy is also available for inspection and reproduction at the address in paragraph h.

o. The licensee states its unequivocal intent to submit an application for a subsequent license for Project No. 4202. Pursuant to 18 CFR 16.20, each application for a subsequent license and any competing license applications must be filed with the Commission at least 24 months prior to the expiration of the existing license. All applications for license for this project must be filed by September 30, 2021.

p. Register online at http://www.ferc.gov/docs-filing/esubscription.asp to be notified via e-mail of new filings and issuances related to this or other pending projects. For assistance, contact FERC Online Support.

Kimberly D. Bose,
Secretary.

Kleinschmidt

December 27, 2018

VIA E-FILING

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Lowell Tannery Hydroelectric Project (FERC No. 4202)
Joint Agency and Public Meeting

Dear Secretary Bose:

On September 26, 2018, KEI (USA) Power Management Inc. [KEI (USA)] filed the Pre-Application Document (PAD) for the Lowell Tannery Hydroelectric Project (FERC No. 4202) with the Commission. The Lowell Tannery Hydroelectric Project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine. On November 23, 2018, the Commission granted the use of the Traditional Licensing Process (TLP) for the Lowell Tannery Project.

This letter is to notify the Commission that KEI (USA) will host the Joint Agency and Public Meeting (JAM) for the Project on Friday, January 11, 2019 at 10:00 a.m. at the Black Bear Inn, 4 Godfrey Drive, Orono, Maine 04473. A site visit will follow the meeting.

Attached is a copy proof publication for the public notice for the meeting, which was published in the Bangor Daily Newspaper on December 17, 2018 and was distributed to the resource agencies and interested parties listed in the attached Distribution List, in accordance with FERC regulations, on December 27, 2018.

Section 6.0 of the PAD lists issues that may need to be addressed to meet licensing requirements stipulated in 18 CFR §4.51. Pursuant to 18 CFR §16.8(b)(4) written comments and requests for studies will be required within 60 days of the JAM. The proposed meeting agenda is:

a) Introduction to Project Licensing Team Members

b) Project Description

c) Overview of Licensing Process

d) Pre-Application Document (PAD)

e) Discussion of Identified Issues

f) Comments and Questions

If you have any questions about the meeting, please contact me at (207) 416-1271 or by email at kayla.easler@kleinschmidtgroup.com.

Sincerely,

KLEINSCHMIDT ASSOCIATES

Kayla A. Easler

Kayla A. Easler
Regulatory Coordinator

KAE:TMJ
Enclosure: Public Notice
Proof of Publication
Email & Certified Mailing
cc: Andy Qua, Kleinschmidt
Lewis Loon, Sherri Loon, KEI (USA)

PUBLIC NOTICE

NOTICE
JOINT AGENCY AND PUBLIC MEETING
KEI (USA) POWER MANAGEMENT INC.
LOWELL TANNERY HYDROELECTRIC PROJECT
(FERC NO. 4202)

KEI (USA) Power Management Inc. [KEI (USA)], will host a Joint Agency and Public Meeting and site visit on **Friday, January 11, 2019**, to discuss the Federal Energy Regulatory Commission (FERC) relicensing of the Lowell Tannery Hydroelectric Project (Project). The Project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine. The purpose of the meeting is to: 1) provide information about the Project and licensing process; 2) solicit information regarding the existing environmental resources associated with the Project and data that may need to be obtained; and 3) obtain agency and stakeholder opinions regarding the Project and its potential effect on existing resources.

The meeting will be held at 10 a.m. at the Black Bear Inn located at, 4 Godfrey Drive, Orono, ME 04473. This meeting is open to the public but is primarily focused on issues and concerns of the state and federal resource agencies. A tour of the Project facilities will be held following the meeting.

The proposed meeting agenda is:

a) Introduction to Project Licensing Team Members
b) Project Description
c) Overview of Licensing Process
d) Pre-Application Document (PAD)
e) Discussion of Identified Issues
f) Comments and Questions

Please note that the PAD is available for public inspection and reproduction at the KEI (USA)'s office at 423 Brunswick Avenue, Gardiner, Maine 04345, by appointment, and will be available for review at the meeting. Public sections of these documents are also accessible on the web at http://www.ferc.gov/docs-filings/elibrary.asp. Comments on the PAD are due within 60 days after the meeting.

For additional information, questions regarding this meeting, or the Lowell Tannery Hydroelectric Project license process, please contact:

Kayla A. Easler
207-416-1271
Kayla.Easler@kleinschmidtgroup.com

PROOF OF PUBLICATION

BDN

Todd McLeod | Print Sales Manager

December 17, 2018

AFFIDAVIT OF PUBLICATION

This is to certify the advertising

OF: Kleinschmidt Associates

RE: KEI (USA) Power Management Inc.

ON: December 17, 2018

Signed: [signature]

Todd McLeod
Print Sales Manager

Then personally appeared the above named Todd McLeod, Print Sales Manager, and acknowledged the foregoing instrument to be his free act and deed in his said capacity and the free act and deed of said corporation.

Before me,

[signature]

Barbara G. Mower
Notary Public
My commission expires November 9, 2024

Legal Notices

NOTICE
JOINT AGENCY AND PUBLIC MEETING
KEI (USA) POWER MANAGEMENT INC.
LOWELL TANNERY HYDROELECTRIC PROJECT
(FERC NO. 4202)

KEI (USA) Power Management Inc. [KEI (USA)], will host a Joint Agency and Public Meeting and site visit on Friday, January 11, 2019, to discuss the Federal Energy Regulatory Commission (FERC) relicensing of the Lowell Tannery Hydroelectric Project (Project). The Project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine. The purpose of the meeting is to: 1) provide information about the Project and licensing process; 2) solicit information regarding the existing environmental resources associated with the Project and data that may need to be obtained; and 3) obtain agency and stakeholder opinions regarding the Project and its potential effect on existing resources.

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The proposed meeting agenda is:

a) Introduction to Project Licensing Team Members
b) Project Description
c) Overview of Licensing Process
d) Pre-Application Document (PAD)
e) Discussion of Identified Issues
f) Comments and Questions

Please note that the PAD is available for public inspection and reproduction at the KEI (USA)'s office at 423 Brunswick Avenue, Gardiner, Maine 04345, by appointment, and will be available for review at the meeting. Public sections of these documents are also accessible on the web at http://www.ferc.gov/docs-filings/elibrary.asp. Comments on the PAD are due within 60 days after the meeting.

For additional information, questions regarding this meeting, or the Lowell Tannery Hydroelectric Project license process, please contact:

Kayla A. Easler
207-416-1271
Kayla.Easler@kleinschmidtgroup.com

Dec. 17, 2018

BARBARA G. MOWER
NOTARY PUBLIC
State of Maine
My Commission Expires
November 9, 2024

EMAIL & CERTIFIED MAILING

From:	Kayla Easler
To:	"nicholas.palso@ferc.gov"; "john.spain@ferc.gov"; "achp@achp.gov"; "harold.peterson@bia.gov"; "jeff.murphy@noaa.gov"; "donald.dow@noaa.gov"; "sean.mcdermott@noaa.gov"; "jay.l.clement@usace.army.mil"; "abele.ralph@epa.gov"; "nstasuli@usgs.gov"; "Andrew_Raddant@ios.doi.gov"; "steven_shepard@fws.gov"; "kevin_mendik@nps.gov"; "jim.vogel@maine.gov"; "kathleen.leyden@maine.gov"; "eric.sroka@maine.gov"; "kathy.howatt@maine.gov"; "john.perry@maine.gov"; "casey.clark@maine.gov"; "Megan.M.Rideout@maine.gov"; "gstewart@usgs.gov"; "sean.ledwin@maine.gov"; "Gordon.Kramer@maine.gov"; "Mark.Caron@maine.gov"; "kevin.dunham@maine.gov"; "jpictou@micmac-nsn.gov"; "kirk.francis@penobscotnation.org"; "chris.sockalexis@penobscotnation.org"; "envplanner@maliseets.com"; "governorsocobasin@gmail.com"; "nbennett@nrcm.org"; "bgraber@americanrivers.org"; "john@asf.comcastbiz.net"; "landis@mainerivers.org"; "kevin@americanwhitewater.org"; "bmayo@old-town.org"
Cc:	"Loon, Sherri"; Loon, Lewis; Andy Qua
Subject:	Lowell Tannery
Date:	Thursday, December 27, 2018 11:06:00 AM
Attachments:	705093_Public Notice_JAM.docx image001.png

KEI (USA) Power Management Inc. will be hosting a Joint Agency and Public Meeting for the Lowell Tannery Relicensing, on January 11, 2019 at 10:00 am. The meeting will be held at the Black Bear Inn, 4 Godfrey Drive, Orono, ME 04473, which will be followed by a site visit at the Project. We request that individuals RSVP by 01/05 and bring personal protection equipment (PPE) if you plan to attend the site visit.

Please see the attached notice for more information.

If you have questions, please feel free to contact me at 207-416-1271

Kayla A. Easler
Regulatory Coordinator
Kleinschmidt
Direct: (207) 416-1271
www.KleinschmidtGroup.com
*Providing **practical** solutions for **complex** problems affecting energy, water, and the environment*

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FERC
Office of General Council
Energy Projects
(Rm 61-02)
888 First Street, NE
Washington, DC 20426

Kleinschmidt

January 21, 2019

VIA E-FILING

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 1st Street NE
Washington, DC 20426

Lowell Tannery Hydroelectric Project (P-4202) Meeting Transcript

Dear Secretary Bose:

On January 11, 2019, KEI (USA) Power Management Inc. [KEI (USA)] hosted a Joint Agency and Public Meeting (JAM) to discuss the relicensing of the Lowell Tannery Hydroelectric Project (FERC No. 4202) (Project). KEI (USA) published notice of the JAM in Bangor Daily News on December 17, 2019.

A stenographer was present at the JAM to transcribe the meeting. The transcript of the JAM is enclosed.

If you have any questions pertaining to this filing, please contact me at (207) 416-1271 or by email at Kayla.Easler@KleinschmidtGroup.com.

Sincerely,

KLEINSCHMIDT ASSOCIATES

Kayla A. Easler

Kayla A. Easler
Regulatory Coordinator

KAE:TMJ
Enclosure: JAM Transcript
cc: Andy Qua, Kleinschmidt
Lewis Loon, KEI (USA)

J:\705\093\Docs\JAM\705093_Transcript CLT.docx

KEI (USA) POWER MANAGEMENT, INC.

PUBLIC HEARING

IN RE: Joint Agency and Public Meeting
Lowell Tannery Hydroelectric Project
FERC No. 4202

Black Bear Inn

4 Godfrey Drive

Orono, Maine

January 11, 2019

10:00 a.m.

PRESENTED BY:

Kayla A. Easler, Regulatory Coordinator
Kleinschmidt

Reported by: Tammy M. Smith

TRANSCRIPT OF PROCEEDINGS

* * * * * *

MS. EASLER: Good morning, everybody. Thanks for coming today. We're going to, I think, start off here. We'll go around the room and introduce ourselves so Tammy can take everybody's name down. We'll start with me. My name's Kayla Easler. I'm with Kleinschmidt Associates.

MR. QUA: Andy Qua, Kleinschmidt Associates.

MS. LOON: Sherri Loon with Kruger Energy.

MR. LOON: Lewis Loon with Kruger Energy.

MS. HOWATT: Kathy Howatt, DEP.

MR. PERRY: John Perry with Inland Fisheries and Wildlife.

MR. DUNHAM: Kevin Dunham, Inland Fisheries and Wildlife.

MR. CARON: Mark Caron, Fish and Wildlife.

MR. CLARK: Casey Clark, Maine DMR.

MS. EASLER: All right. Thank you. Welcome, everybody. We'll start -- I guess we'll start right in. And welcome to the agency -- joint agency and public meeting for the Lowell Tannery Project.

We're just going to go through our project overview, a little bit of description for you. We'll go through the FERC licensing process. We'll talk a little bit about what we have for the PAD, any issues that have come up. We'll kind of wrap up with comments and questions for you guys. We do plan on having a site visit, if you would like to go to the site afterwards; but we also have some drone footage from the project looking at the project itself and the impoundment.

So here you get an overview of the Penobscot River basin. Our project is located in Lowell, Maine, on the Passadumkeag River. It's approximately 13 miles upstream from where the Passadumkeag River and Penobscot River meet.

So a little overview of the project. The impound is approximately 68 and a half acres. The project runs for the run-of-river operation and has both upstream and downstream fish passage. I took these snapshots from the footage of the drone just to give you a little idea. This is upstream from the project itself. Right around the first bend that goes up into the river shows the islands there. This second photo is just a little bit of the first area for wetlands and marshes. It'll give you a little idea of what the impoundment looks like.

Project facilities contain a 230-foot dam. The dam has two spillway parts to it. It has a 30-foot long primary section, and then an 89-foot secondary spillway section. It has a seven-foot-wide ****** and a ten-foot-wide Tainter gate, which bypass loads go through. It also has upstream/downstream fish passage. And it has -- within the powerhouse itself, it has a single unit turban generator with a rated capacity of 1,000 kilowatts.

So like I said before, there is upstream and downstream fish passage here at the project. The upstream passage is a Denil ladder. It is approximately three feet wide, and it has three runs and two switchbacks. There is downstream passage. The downstream passage is located on the eastern side of the intake racks. There's a surface bypass gate here near the intake racks. And that goes into an eight-inch bypass pipe, and that discharges into the plunge pool next to the tailrace.

So again, the project is a run-of-river river project. It has an overall minimum flow requirement of 150 CFS. There's a -- one turban generator rated at 12,000 kilowatts. And there's a 200-foot 12.5 kilovolt transmission line.

MS. HOWATT: Kayla, how do you deliver the minimum flow when the impoundment level is down, say, in late summer?

MR. LOON: Well, basically what it does is in the summer, when we have no flows -- you know, it's inflow equals outflow. So any of that 150 is actually spilled over the dam.

MS. HOWATT: Okay.

MR. LOON: Spilled over the dam and down through the pie bypass pipe. And depending on the time of year, you know. There's some flow running through the fish bypass, the downstream ladder.

MR. QUA: So if flows are low, you shut down?

MR. LOON: What's that.

MR. QUA: If flows are low, you shut down?

MR. LOON: Yeah, absolutely. What works

well with this particular site, that min flow is really the hydraulic capacity of that unit, because we actually need a little bit more than the inflow to actually operate. So we're running the site at its minimum, which is around (indiscernible due to back ground noise).

THE REPORTER: Can I shut this door?

MS. EASLER: Sure.

MR. LOON: So typically, we'll shut it down when it gets around 100 KW, which hydraulic capacity is roughly, I believe, a little north of 160. So we shut it down, and you have instantaneous spill.

MS. HOWATT: Thank you.

MS. EASLER: Continuing the operations from May 15th to November 10th, KEI provides 40 CFS for the -- traction flow for the upstream fish passage. There's a 20 CFS provided through the downstream fish passage. This operates from ice-out to early June, and then for Kelt passage is from November 1 to ice-in.

So we'll go through a little bit of the FERC overview. FERC is an independent federal agency that regulates hydroelectric projects and other energy projects through the authorization of the Federal Power Act of 1920. FERC authorizes hydroelectric projects usually before October 2017. It was with a default license of 30 years, or a license could be from 30 years to 50 years for a term. After October 2017, there was a default of 40 years of a license term.

So when it comes to re-licensing a project, the licensee has the opportunity or chance to use any of the three licensing processes. The first process is the integrated licensing process. This is the default licensing process for FERC. It's heavily driven by predetermined and predictable schedule. It's ideal for projects that are complex or have multiple resource issues.

The traditional licensing process is -- needs to be approved by FERC. It's known for its flexible timeline, and it's great for smaller projects with license issues with them.

There's also the alternative licensing process. This also has to be approved by FERC. And it's known for also having a flexible timeline, but it's more used for projects that have a higher involvement from stakeholders or may need a potential for a settlement agreement.

So each one of these processes, they all pretty much have the same parts. They all have a public process. They have a portion with where you need to find available information for each, and then this information helps FERC decide if they have enough information to prescribe a license.

So no matter what type of process you choose, there's an overall -- the overall process is the same based on these four steps here. So there's the preliminary information part. This is the pre-application document that we -- that KEI, provided in September. You go to the consulting stage with the stakeholders. This is the agency meeting that we have today. That will be the PAD comment period and additional consultation efforts that are needed. Any information here -- if there needs to be more information than what is already existing, studies can be done for the project. And then there's the last stage, where you prepare the application for FERC and file with FERC.

So again, FERC regulates hydroelectric projects through the operation of the Federal Power Act. They cannot prescribe a license term longer than 50 years. And there's three options for FERC for a license when it expires. The Commission can issue a new license through re-licensing. There's -- the federal government could take over the project, or the project could be decommissioned.

These are some dates that we're going to for for the Lowell Tannery Project. Like I said, the license expires September 30th of 2023. And a prior -- five years prior to expiration, the PAD is due. So KEI provided that PAD in September of 2018. We'll go back into these a little bit in the next slide.

So there's three stages of the licensing process. The first stage is the initial consultations. This is where the applicant submits the pre-application document. Usually, it's typically five years prior to the expiration date. KEI provided this on September 26, 2018. Today we're having the agency consultation meeting. And for this, the

PAD comment period ends 60 days after this meeting, which is going to be March 12th of 2019.

The second stage of the process includes the studies and the draft license application. KEI is proposing to submit the draft license application in September of 2020, and there will be another comment period for that, which will be due November of 2020.

And the final stage is the final license application. This needs to be submitted to FERC two years prior to the expiration date, which we'll be planning on submitting this September of 2021.

So again, here are some of the dates. KEI provided the PAD, the NOI, and their request to use the TLP on September 26, 2018. FERC approved the TLP process on November 23rd, 2018. So while we were going through the PAD process and looking at existing information that we could find, recent applicable studies that we did come up with was that there's an electrofishing study done in 2004 and 2009 by Midwest Biodiversity Institute. This study was located approximately six miles downstream from the project area. They looked at collecting information for fish assemblage in the lower part of the Passadumkeag River. From this study, they found that the lower Passadumkeag River has -- consists of at least 11 species. These species also contain three diadromous species. There was one Atlantic salmon found, one juvenile lamprey, and ten American eels.

So this just repeats what I just said. So from there, KEI proposes to continue the run-of-river operations. It proposes to still continue the minimum flow requirements of an overall 150 CFS, including the 40 CFS for upstream passage and 20 CFS for downstream passage. And it will also continue providing seasonal fish passage.

So we've gone through the initial steps. KEI has provided the PAD. We're going through the meeting right now. So the next step is the public comment period. This comment period will be due 60 days from this meeting, which is about March 3rd of this year, March 12th, yes, sorry. If you're interested in following the project, you can e-scribe to the FERC website. If you want to provide comments, those can either be hardcopy or electronic. Also, during this comment period, there's also study requests that can be submitted as well. If you decide to submit, FERC does have specific guidelines for this information and how it should be requested. It essentially talked about the study and how it's relevant to the re-licensing of the project. This layout can be found in the PAD under Section 2.2.4. You should have all of our e-mails, but here's our project contact information. You can contact any of us if you have additional information.

Before we get into questions and comments, I want to let you know that we do have drone footage of the project that we can -- I have a couple videos that we can show of the project facility and part of the impoundment. And we also are set up to have a site visit afterwards as well, whoever wants to brave the temperatures out there. But at this time, are there any questions or comments?

MR. CLARK: I had a question about trash guard spacing.

MS. EASLER: It's one and a half inches.

MR. CLARK: And are they full depth?

MR. LOON: Full depth.
MR. CLARK: Okay.
MS. EASLER: Anybody else?
MR. DUNHAM: I am curious, how much the 150 minimum flow is going through the fishway. Is there a minimum fishway?
MS. EASLER: There's the 40 CFS for going up, for the upstream traction, and then 20 CFS for the downstream 18-inch pipe.
Kathy, you have a question?
MS. HOWATT: The PAD does not include -- I'm Kathy Howatt with DEP. The PAD did not include a list of proposed studies. At least I didn't find one in there. So the Department will request studies for -- just the regular list that we also request. But in particular, we also would want to ask for bathymetry. And so we're going to ask for that, and that's a little departure from the regular; but if you're able to find that information elsewhere, then that will be fine. We just don't have that. So in order to look at the habitat characteristics in the impoundment, we would want to look at that.
MR. CLARK: Following on that statement,

we did not find any information on fish passage efficiencies for the current fish passage projects. So if any of those are available, we would love to see if they've been tested. And if not, we'll be asking for the same.

MS. EASLER: Well, I can show the video.

MR. LOON: What species are you in particularly looking at?

MR. CLARK: We're looking for eels, Atlantic salmon, alewives, shad, and lamprey. Are you all considering brook trout as well?

MR. DUNHAM: It will fall under those species.

MS. EASLER: Did you say brook trout?

MR. CLARK: Brook trout, as well, yes.

MR. CARON: I just have a quick -- Mark Caron, Fish and Wildlife. Just the routine maintenance, are there -- does it have a history of regular drawdowns for maintenance, things like that?

MR. LOON: Actually, it does not. We've really -- never really done -- since I've been operating the facility, done a drawdown at that site. At one particular time, that site was -- when we first took it over, you had to -- in the license you had the ability to actually fluctuate that. It actually had three feet of storage. A few years back, we actually give that up and actually give up our fluctuation of three feet to become run-of-river. So that was the only fluctuation we ever had in the past is that three feet at the top from the flashboards to the crest of the dam.

MR. CARON: So it's not a particular site where you have periodical drawdowns for maintenance?

MR. LOON: No, it's not. Not to say that it won't happen. You know, it is a 40-year project and --

MR. CARON: Stuff happens.

MR. LOON: Stuff happens. We try to use, you know, divers most of the time to do any inspection work. Right now, the dam is in pretty good condition, what's below the waterline. We don't foresee any major drawdowns in the near future, if that answers your question.

MR. CARON: Yeah. And then it would be a whole mechanism if there was one contact, agencies or contact, et cetera, et cetera?

MR. LOON: Absolutely.
MS. LOON: That's usually in the water quality, isn't it?
MS. HOWATT: Yes, indeed.
MS. LOON: So we'd have to follow the procedures.
MR. PERRY: John Perry, Inland Fisheries and Wildlife. So as you mentioned, the PAD, I mean, this is one of the premiere rivers in the state, actually, for freshwater mussels. We have -- all ten species of mussels is pretty rare in one river system. All three of our state-listed species, brook floater, yellow lampmussel, and tidewater mucket, they're all listed as state threatened. So any time there's a scheduled drawdown or any time you think you'd be going below the minimum flow for maintenance, you know, we would appreciate that call. We'd probably initiate some sort of relocation effort.
MR. LOON: Absolutely. And we do have those in that river system?
MR. PERRY: Yes.
MR. LOON: Yep.
MR. PERRY: Yeah. So for brook floater,

which is actually being considered, I believe, for federal listing, it's one of our premier rivers.

So things seem to be going fine, and we don't have any study requests at this time. Again, if there's ever a need for a drawdown or maintenance activity, we would like to have that notification.

MR. LOON: Okay.

MS. EASLER: Do you want to view the videos? They're pretty short.

MS. LOON: Does anybody want to do a site visit?

MR. DUNHAM: I don't believe it's necessary.

MS. LOON: Not necessary, okay. Would you like to see the drone footage?

MR. DUNHAM: Oh, definitely.

MR. CARON: I'd be curious, too, just as a side comment, how much you use drones now that they're a technology. Do you use them a lot?

MR. LOON: We've actually -- Kruger actually just started using drones, and we actually use them at our wind farms as well. But in the U.S., you know, our regional manager has a drone. In the Virginia region, I have a drone as well for, you know, the Maine region. So, yeah, we have started using them.

MS. LOON: And Kleinschmidt actually just started.

MR. QUA: We're starting to use them for re-licensings for this initial phase because it can really -- they show you a lot more than just going and standing on the shoreline.

MR. CARON: State agencies always bring up the rare with this kind of stuff, technologies. But I hope we get into it as well. I was just curious.

MR. LOON: Just to come back to the drone footage, we were re-licensing Lower Barker, and we actually did the -- one of the recreation studies was we did a test of the canoe board agent and, you know, the canoes and white water below the dam. And I put that drone up pretty high so I could actually capture it all, and it was pretty neat to see that.

MR. QUA: We actually have one of our engineers who went through the license procedure to got licensed, because it's a commercial --

MR. LOON: Right.
MR. DUNHAM: -- we use for dam inspections and most everything. It's pretty amazing.
MS. EASLER: So I was able to go out with Jesse this fall, and I was just like, Wow, this is amazing. You can see everything.
MR. QUA: Good timing with the fall colors.
MS. EASLER: It really was. You'll see it was crystal clear, and it was beautiful. But we'll start it here.
(At this time, a video was shown.)
MR. QUA: Is this the one with the herring?
MS. EASLER: It is. You'll see a blue herring fly off here. I was supposed to look out for birds.
MS. LOON: Chuck almost got his taken by a hawk at home, an osprey. He had to bring her down quick.
MR. LOON: He was circling it.
MR. CLARK: Will this video be made available?
MR. QUA: It's up to you guys. I don't see why not.

MR. CLARK: That would be great.

MS. LOON: I have it, actually, at work.

MR. LOON: Could you e-mail that?

MS. LOON: Yeah.

MR. CLARK: Yeah, that would be great. Thank you.

MR. QUA: We might have to do a download link. These files are --

MS. HOWATT: Because they're so big?

MS. EASLER: Yeah.

MR. LOON: Well, we could thumb drive it, too, and mail it to you.

MR. QUA: Your mussels are right there, John.

MR. LOON: How is the brook trout in this river system?

MR. DUNHAM: Below the dam, it's fairly popular. Warm-water species are more popular. But above the dam, it's more warm species. Although, we occasionally do get trout and land-locked salmon in Saponac Pond.

MR. LOON: Is Saponac Pond the one with the dam?

MR. DUNHAM: Not that I'm aware of.

MR. CARON: That's the big pond upriver,

the next one up, the next big body of water.

MS. EASLER: So we weren't able to go extremely far upriver in the impoundment, but I think we were able to go at least up and around the first bend with the first couple of islands.

MS. HOWATT: How far upstream does the impoundment stretch?

MR. QUA: Maybe a mile, give or take.

MR. LOON: I know it's fairly shallow. I took off out of there in a boat with one of my operators in the front, and we thought we had it made until we hit a log; and I about lost him right out of the front of the boat. All right, we'll turn back.

The only problem we ever really had at this facility, we had a neighbor tell us she was getting electrocuted by the hydro. And, you know, she made some big complaints. So we had to go up and investigate, but I literally went to her house. And she told me she's laying in bed and she's electrocuted every time we turn that thing on. I'm thinking, God, this is pretty bad. So we've got to go see what's going on. Her husband came out, and looked he at me and said, She's crazy. But they weren't even on, and she was getting electrocuted. So it kind of all went away.

MS. LOON: I remember that.

MR. PERRY: So seeing some of that footage there -- John Perry, Maine Inland Fisheries and Wildlife -- there are some -- several (indiscernible) and water fowl, bird habitats. We also have state-threatened Tomah mayfly located downstream in some of the sedge wetlands associated with some of the tributaries. So again, those would be habitats and species of concern, again, if there was a drawdown. But I don't have, really, any concerns, as long as the project continues to be operated as run-of-river.

(Indiscernible cross-talk.)

(The reporter asked that one person speak at a time.)

MS. EASLER: This is just going back up and around.

MR. CARON: Mark Caron, again, with Maine Fish and Wildlife. When was the dam built?

MR. LOON: Eighty-eight, eighty-nine, rebuilt. The dam was there.

MR. CARON: Okay.

MR. LOON: You know, it's an old dam, but it was powered by consolidated hydro back in the late '80s.

MR. CARON: Okay. So before my time in the region anyway. I'm assuming they did some kind of studies back then as well, the usual requested studies as part of the process.

MR. LOON: Yeah. And, obviously, to have fish passage put in, there was some studies done.

MR. CARON: Is there a document that's available somewhere? We may have it stuffed away. It may be up in our attic for all I know.

MS. LOON: We can look through our files.

MR. CARON: I'm just curious what was done back then initially for wildlife studies. But again, I don't have a lot of concerns at this point anyway. That was just more background information really.

MR. QUA: Mark, we can check our files that we used to pull together the initial document. If there's anything there that looks useful, we can send it on.

MR. CARON: Yeah. That might be interesting. I mean, a lot of that, too, wasn't digital at the time, too. So I'm sure it's a document in a box sitting somewhere.

MS. HOWATT: Kathy Howatt, DEP. Mark, so the original license was in 1983, and the types of the studies that would have been requested at that time are not what we would request at this time. We didn't have the regulations for water quality that we have now at that time. So there may or may not be a lot of background there. But we also, the Department, can pull together whatever we may have on that river and get copies of that to you.

MR. CARON: Right. I mean, NRPA and a lot of the (indiscernible) stuff and TR, it's come a long way, obviously. I was just curious from the beginning what we had done.

(End of video.)

MS. EASLER: Those were the videos. We can get those to you, like Sherri said. Is there any additional comments or questions at this time?

MR. PERRY: Just a quick question. Maybe we don't know the answer. John Perry, Maine

Fish and Wildlife. As far as the influence of the main stem of the Penobscot back up into the Passadumkeag, do we know that?

MR. QUA: I don't know.

MR. PERRY: Okay.

MR. CLARK: Casey Clark again, Maine DMR. I was planning on a site visit. I appreciate the videos, and so I think for today, I won't require everyone to go out there if I'm the only one who really wants to see. But I guess I kind of assumed that federal folks, when they come back on, would also like to a have site visit. So we can postpone it maybe.

MR. QUA: Yeah. When they come back on, we're going to offer that to them. I know at least some of them have been going up annually for inspection of the fishways. So they may or may not want to, but we'll certainly let you know if they are.

MR. LOON: If you want to schedule a time when the actual fish passage is actually fully operational, that might be a good time to come up and take a look as well.

MR. CLARK: I think that's a good idea.

MS. HOWATT: Usually, Casey, there's a

week in May, usually maybe the second week in May, sometimes the fist, that Don Dow with NOAA arranges for these fishway inspections. And so you might want to contact Don and make sure you're on his list to accompany him on that round, at least for the dams that you'd be interested in looking at.

MR. CLARK: Thanks, Kathy.

MR. QUA: And he can tell you a lot of the details about how to operates, too. Not that Trevor couldn't, but Donny's pretty intimately familiar with this.

MR. DUNHAM: Are there still any PIT tagger rays in the fishway, do you know?

MR. LOON: There is. There is. And actually, we've got a lot of data. You know, the University of Maine has been coming to these sites. And I think last year was one of the many years that they didn't do anything. But they've been there every year with -- you know, PIT tagging those fishways.

MR. DUNHAM: It seems like DMR, Randy Spencer, had a project going one time.

MR. LOON: He did. He did.

MR. DUNHAM: I know the University did as well.

MS. HOWATT: You said that you had lamprey. Do you have American eel at this site as well?

MS. EASLER: Yeah. They had, in that study, ten American eel found.

MS. HOWATT: And is there a dedicated eelway here, or is that -- or they just go up over the, what we're looking at, the right side, I would guess? That just looks like it's more ledgy over there. Like, maybe that's where they might go.

MR. LOON: Yes. And, yeah, there is no dedicated upstream eelway as of yet. We can see that will be coming.

MS. HOWATT: Yeah, you might be thinking about that.

MR. LOON: I just think at this site this is very, very easy, very easy.

MR. CLARK: All right. I'm move not going out here as we're looking at the picture here. Do you know if there's any places there might be an impoundment issue in those rocky ledges on what we see in the right in the picture?

MR. LOON: Upstream or downstream?

MR. CLARK: Downstream.
MR. LOON: No. There's pretty good flow there. You're talking for upstream passage for eels?
MR. CLARK: I'm talking for downstream, getting stuck in a pool.
MS. HOWATT: So if they come over the spillway, is there anywhere that they kind of get hung up or stranded?
MR. CLARK: Yeah.
MR. LOON: That's a possibility. We'll need to look into that.
MR. CLARK: Okay.
MR. LOON: It's pretty stepped. You know, the pools are pretty stepped down through there.
MR. CLARK: Is it concrete, or was there blasting? Is that all bedrock?
MR. LOON: That's all bedrock.
MR. CLARK: Okay.
MS. EASLER: It seems like in through here, that comes down.
MR. CLARK: Okay. Thank you.
MS. HOWATT: And, Chuck, your flashboards are how high there?

MR. LOON: Three and a half feet.
MS. HOWATT: Three and a half feet. How flashy is this river? Do you lose the boards frequently, or is that -- is the flow pretty steady.
MR. LOON: We actually do not. It's actually not all that flashy, because I believe -- you know, the impoundment up above and all the streams that come in up above it, it's very slow. You know, you get to rain, and it's a slow rise, but lasts forever. You know, it lasts forever. So, no. We barely lose the flashboards at this facility. We barely lose them. There's been several years that it's the same flashboards, unlike some of the other facilities, you know, you lose them two or three times a year. So it's a real low maintenance site.
MR. CLARK: What about debris or anything else that gets caught up at the trash racks or the intake from the downstream passage?
MR. LOON: Once again, very little debris. Like I said, very low maintenance. And what debris we get, the operator actually stacks it up at the facility, and we haul it off. He

hauls it off to the local landfill.

MR. CLARK: I was just thinking about in contrast to Upper Barker.

MR. LOON: No. Totally different. You know, you're right. Unlike Brown's Mill, down the road, it's pulp truck loads during some flashing events.

MS. EASLER: That's it. We thank you for coming today.

MS. LOON: Thank you very much. We didn't think anybody would show up. You never know.

(The proceeding ended at 10:45 a.m.)

CERTIFICATE

I, Tammy M. Smith, a Notary Public in and for the State of Maine, hereby certify that the foregoing is a correct transcription of my stenographic notes in the matter of the above-entitled cause.

IN WITNESS WHEREOF, I subscribe my hand and affix my seal this 17th day of January, 2019.

Tammy M. Smith
Notary Public/Court Reporter

My Commission Expires: January 12, 2026

INITIAL STUDY REPORT

LOWELL TANNERY HYDROELECTRIC PROJECT

FERC No. 4202

Prepared for:

KEI (Maine) Power Management (III) LLC

Prepared by:

Kleinschmidt Associates

March 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF ATTACHMENTS

J:\705\093\Docs\2019 Studies\705093_001RP Lowell Tannery Project 2019 Study Report March 6 2020.docx

1.0 INTRODUCTION

The Lowell Tannery Hydroelectric Project (Lowell Tannery Project) is on the Passadumkeag River, in Lowell, Maine, approximately 13 river miles upstream of the confluence with the Penobscot River (Figure 1). KEI (Maine) Power Management (III) LLC [KEI (Maine)] operates one hydroelectric turbine-generator unit at the Lowell Tannery Project, which can produce up to approximately 1,000 kilowatts[1] of renewable, hydroelectric energy. KEI (Maine) operates the Lowell Tannery Project in run-of-river mode so that outflow at the powerhouse matches natural river inflow. After water passes through the turbine unit, it discharges back into the Passadumkeag River from a small powerhouse that is integral to the dam.

KEI (Maine) filed a Notice of Intent and Pre-Application Document (PAD) on September 26, 2018, to initiate the relicensing of the Lowell Tannery Project using the Traditional Licensing Process. The PAD and subsequent scoping identified potential environmental issues associated with the operation of the Lowell Tannery Project for which the existing, relevant, and reasonably available information was insufficient. Comments on the PAD and study requests were received from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Maine Department of Environmental Protection (MDEP), Trout Unlimited (TU), and the Penobscot Indian Nation (PIN).

This study report presents the results of studies completed by KEI (Maine) and Kleinschmidt Associates (Kleinschmidt) in 2019. In 2019, KEI (Maine) monitored water quality at the Lowell Tannery Project and completed a desktop fish entrainment and turbine survival analysis using methods based on the USFWS's Turbine Blade Strike Analysis (Towler and Pica 2018). The water quality study was performed in accordance with MDEP protocols; the desktop study estimated turbine passage and whole station survival for adult and juvenile sea run alewives, adult and juvenile American shad, adult American eel, and Atlantic salmon smolts.

KEI (Maine) is preparing a study plan for the 2020 field season that will be submitted to the stakeholders separately.

[1] Approximate maximum instantaneous generation capacity.

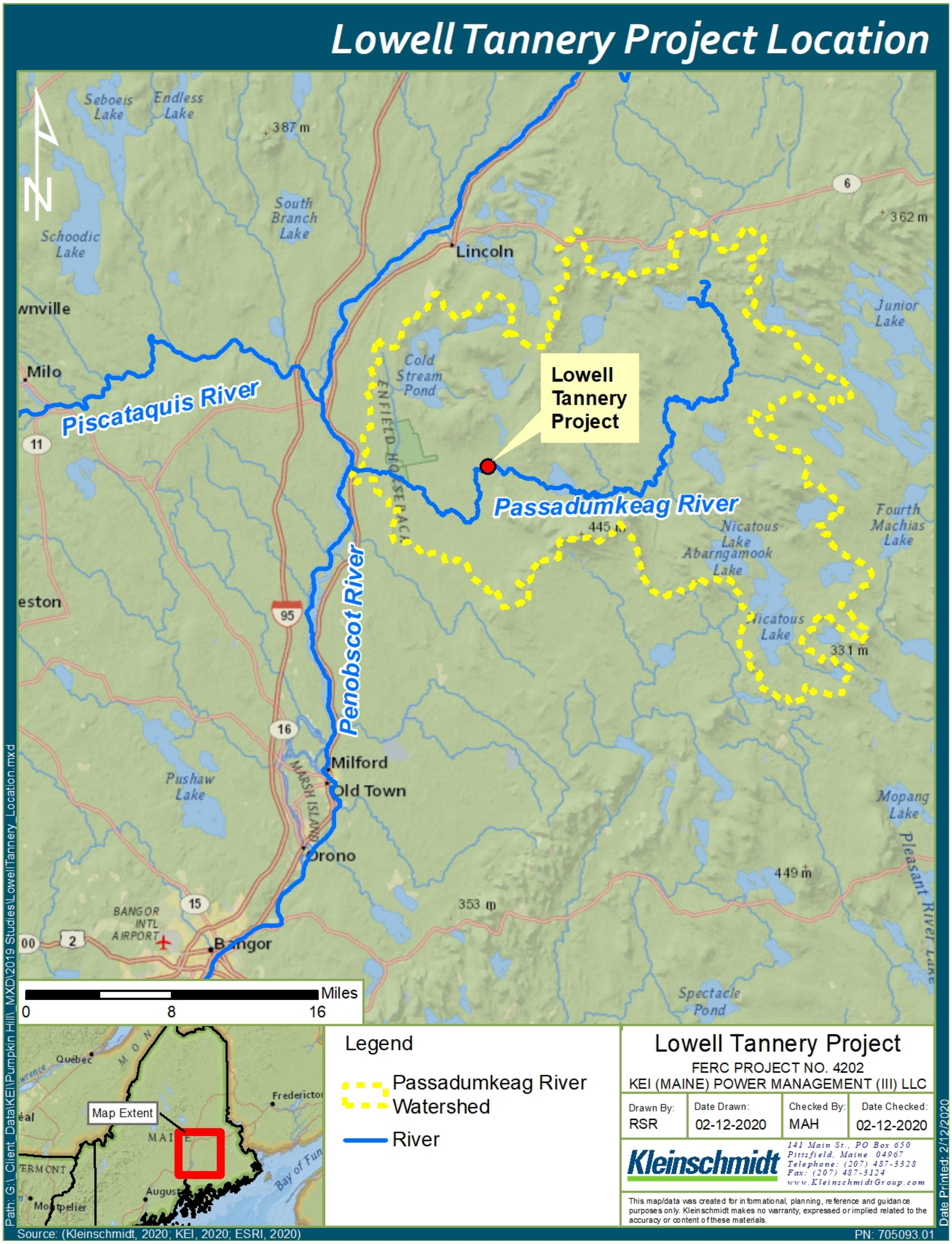

Figure 1 Lowell Tannery Project Location

2.0 WATER QUALITY

KEI (Maine) studies water quality to collect information about the potential effects of project operations on water quality and benthic macroinvertebrates. The water quality studies included lake trophic monitoring, tailwater dissolved oxygen (DO) and water temperature monitoring, and benthic macroinvertebrate sampling. The studies were completed in accordance with MDEP protocols (MDEP 2018a), During study plan development, KEI (Maine) clarified with MDEP that because the Lowell Tannery Project is operated in a run-of-river mode, the impoundment habitat study and downstream habitat study initially requested by MDEP were not necessary (personal communication, Kathy Howatt, MDEP, with Jesse Wechsler, Kleinschmidt Associates, May 21, 2019; Attachment A).

Maine Statute 38 MRSA §464-470 establishes the state of Maine's classification system for surface waters. The Passadumkeag River from the Lowell Tannery dam to the confluence with the Penobscot River is Class AA; the Passadumkeag River upstream of the Lowell Tannery dam is Class A (MRS 1989a). Class AA waters are the highest classification in the state of Maine and are "*applied to waters which are outstanding natural resources which should be preserved because of their ecological, social, scenic or recreational importance*" (MRS 1989b). The quality of Class AA waters must support the designated uses of drinking water supply after disinfection, fishing, agriculture, recreation in and on the water, navigation, and habitat for fish and other aquatic life; aquatic life, DO and bacteria content shall be as naturally occurs. Class A waters are the second highest classification and must be of such quality to support the designated uses of drinking water after disinfection, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and habitat for fish and other aquatic life (MRS 1989b). The state of Maine has Class AA and Class A water quality standards for several parameters (Table 1).

Table 1 Maine Water Quality Standards for Select Parameters

Parameter	Criteria	Water Classification
Dissolved Oxygen[a]	>7 mg/L or 75% saturation	Class A
	As naturally occurs	Class AA
Iron[b]	1000 µg/L or 1 mg/L	Statewide
Chloride[b]	230,000 µg/L or 230 mg/L	Statewide
Aluminum[b]	87 µg/L or 0.087 mg/L	Statewide
Total Phosphorus[c]	≤ 18 µg/L (0.018 mg/L)	Class AA/A
Water Column Chlorophyll-a[c]	≤ 3.5 µg/L (0.0035 mg/L)	Class AA/A
Secchi Disk Depth[c]	≥ 2.0 meters	Class AA/A
pH[c]	6.0 – 8.5	Class AA/A

[a]MRS 1989b; [b]MDEP 2012a; [c]MDEP 2012b
Notes: milligrams per liter (mg/L); micrograms per lier (µg/L)

2.1 Methods

2.1.1 Lake Trophic Study

KEI (Maine) completed a reconnaissance-level bathymetry survey prior to collecting the first lake trophic sample to identify the deepest, safely accessible spot in the lower impoundment (i.e., upstream of the boat barrier). The deepest spot was approximately 20-feet-deep and 250-feet upstream of the dam (Figure 2). MDEP approved of the sampling location via e-mail dated June 25, 2019 (Attachment A). KEI (Maine) installed a temporary buoy to mark the sample location (Photo 1). Lake trophic sampling was conducted twice per month for five consecutive months from June through October 2019 primarily between 11:00 and 15:00.

Sample parameters included Secchi disk transparency, water temperature and DO profiles (1-meter intervals), and epilimnetic core[2] samples of total phosphorus, Chlorophyll-a, color, pH, and total alkalinity. Additional nutrient and dissolved metal samples were collected during the late summer sampling event on August 15, 2019. The additional late

[2] The epilimnetic zone is determined by establishing a temperature profile at 1-meter increments to define the epilimnion as the upper layer where the change in temperature per meter of depth is less than 1-degree C ($\Delta T/m < 1^{\circ}C$).

summer sample parameters included nitrate, dissolved organic carbon (DOC), total iron, total dissolved aluminum, total calcium, total magnesium, total sodium, total potassium, specific conductance, chloride, and sulfate. The late season sample was collected from an integrated epilimnetic core because the water column was not thermally stratified (i.e., change in water temperature T ≥ 1°C/meter) (Section 2.2.2). KEI (Maine) delivered the water samples on ice to the state of Maine's Health and Environmental Testing Lab (HETL) in Augusta within 24 hours of sampling. Appropriate chain-of-custody and sample collection techniques were followed.

Photo 1 Lowell Tannery Impoundment Lake Trophic Sample Site

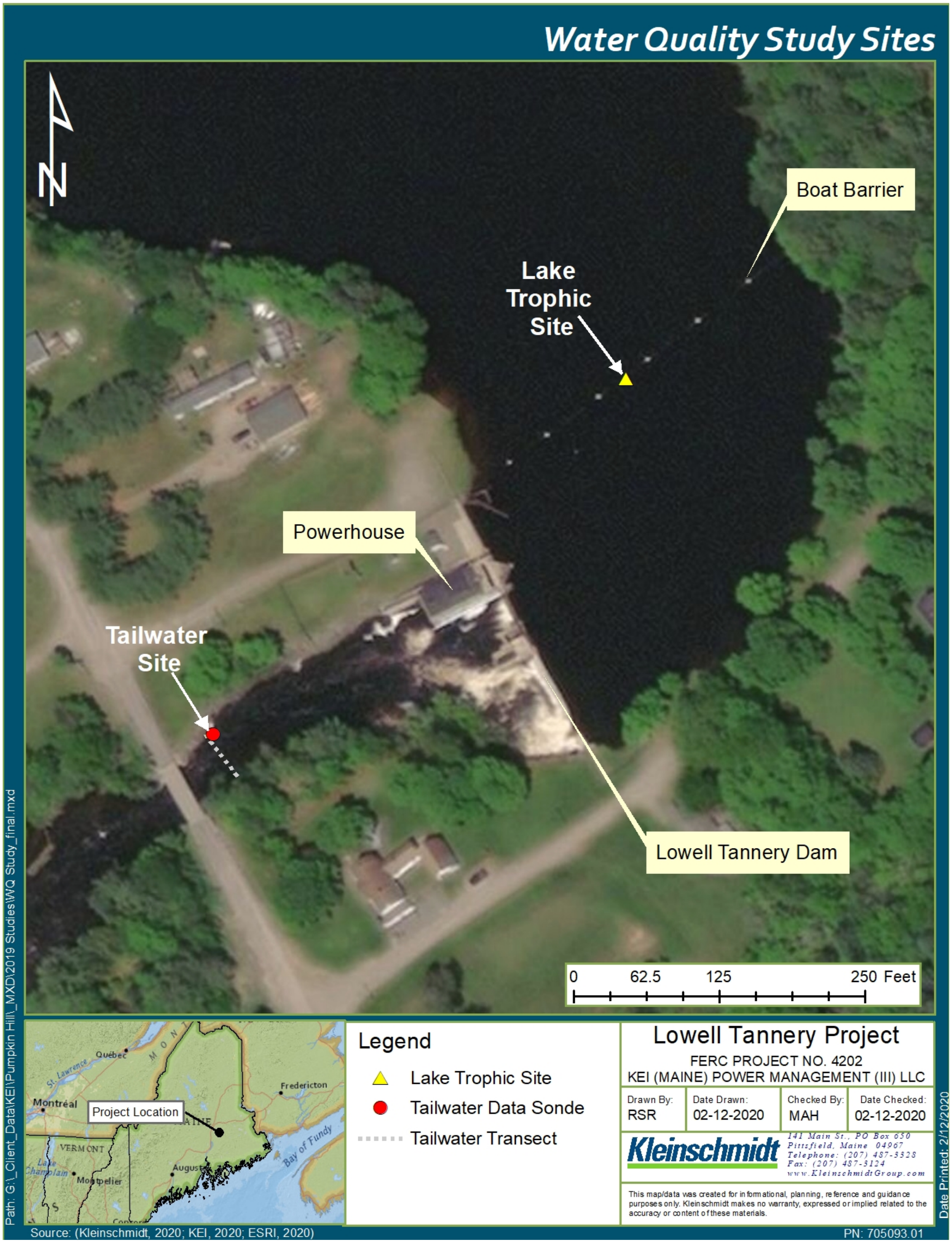

Figure 2 Lowell Tannery Water Quality and Benthic Macroinvertebrate Sampling Sites

2.1.2 Riverine Dissolved Oxygen and Water Temperature Monitoring

KEI (Maine) monitored DO and water temperature at a single location approximately 200-feet downstream of the tailrace using an Onset Hobo U26-001 data logger (Figure 2, Photo 1). Prior to installing the datalogger, KEI (Maine) measured DO at quarterly increments across the river channel to determine if there were any significant variations in DO levels; the data logger was installed near the river right bank, near the quarterly increment that had the lowest DO measurement (Table 2).

The data logger was enclosed in a 2-inch-diameter perforated poly vinyl chloride (PVC) pipe, attached with a cable, and anchored to tree trunks and riprap along the shoreline. The water depth at the sensor was approximately 2 to 3 feet depending on river flow and unit operations. The data logger was equipped with a biofouling guard and calibrated according to the manufacturer's specifications. The logger was programmed to record water temperature and DO concentration (mg/L) at 1-hour intervals from June 25 to September 17, 2019, during the summer low flow, high temperature period. A barometer was installed nearby to measure real-time air pressure data which was used to calculate DO percent saturation.

Data downloads and equipment checks were performed at 2-week intervals during the monitoring period. During each download, KEI (Maine) measured water temperature and DO with a handheld YSI ProODO meter to compare to measurements of the Onset data logger and to assess whether the data logger needed additional calibration. The calibration of the YSI ProODO meter was checked in the field prior to each sampling event.

Table 2 Quarterly Incremental Dissolved Oxygen, June 25, 2019

Location	Water Temperature (°C)	DO (mg/L)	DO (Percent Saturation)
River Right	21.4	8.12	91.7
Center	21.5	8.24	93.2
River Left	21.7	8.51	96.9

Photo 2 Location of Data Logger Downstream of Lowell Tannery Project

2.2 Results

2.2.1 Lake Trophic State

Trophic state describes the ability of a water body to produce algae or other aquatic vegetation (i.e., biological productivity) and depends on the nutrient content of the water (LSM 2018; MDEP 1996). A brief description of the trophic state indicators monitored in this study and the results are provided below.

Total Phosphorus - Total phosphorus is an indicator of nutrient levels. It is an important nutrient required for plant growth and is often a limiting nutrient; however, too much phosphorus can lead to algal blooms. Total phosphorus in the Lowell Tannery impoundment ranged from 15 µg/L to 33 µg/L with an average of 20 µg/L (Table 3). Five of the samples had total phosphorus levels above the standards for Class A/AA waters (18 µg/L).

Color - Color is an indicator of water clarity and is a measure of the amount of dissolved organic acids and suspended matter in the water. Water with a color value greater than 25 platinum cobalt units (PCU) is colored and may have a reduced Secchi disk transparency. Color ranged from 85 PCU to 180 PCU with an average of 136 PCU (Table 3).

Chlorophyll-a - Chlorophyll-a is a photosynthetic pigment found in algae and plants and is an indicator of algal levels and biological productivity in the water. Large concentrations of chlorophyll-a can be an indication of eutrophication (i.e., excessive nutrient inputs leading to algal blooms). Chlorophyll-a ranged from 0.0020 mg/L to 0.0050 mg/L with an average of 0.0031 mg/L (Table 3). The samples collected on June 25 and August 26, 2019 had values of 0.004 mg/L, and the sample collected on August 15, 2019 was 0.005 mg/L; the Class A/AA standard is 0.0035 mg/L.

Total Alkalinity - Alkalinity (i.e., buffering capacity) is an indicator of the water's capacity to neutralize acids or buffer against changes in pH; water bodies with alkalinity values less than 10 mg/L are considered poorly buffered. Sources of alkalinity include rocks, soil, salts, and algal activity. In the Lowell Tannery impoundment, total alkalinity ranged from 6 mg/L to 8 mg/L with an average of 7.3 mg/L (Table 3).

pH - pH is a measure of the acidity of water and regulates the biological processes that may occur in a water body. pH ranged from 6.4 to 7.1 with an average of 6.6 (Table 3). All samples were within the range for Class A/AA waters (6.0 to 8.5).

Secchi Disk - Secchi disk transparency is a measure of the clarity of water and is the distance that visible light penetrates through the water column. Transparency in a water column is influenced by suspended particles (e.g., algae, zooplankton, and silt); water color is an indirect measure of algal growth. The Secchi disk depth at the deep spot in the Lowell Tannery impoundment ranged from 1.9 meters to 2.9 meters with an average of 2.3 meters (Table 3). All measurements, except for the October 2, 2019 Secchi Disk reading (1.9 meters), were above the 2-meter Class A/AA water quality standard.

Late Summer Sample - Results from the late summer lake trophic sample (collected on August 15, 2019 at 13:30) are shown in Table 4. Iron and chloride met the established standards. Aluminum and dissolved aluminum were 0.18 mg/L and 0.15 mg/L, respectively. Conductivity in the Lowell Tannery impoundment was 29.9 microsiemens /cm (Table 4).

Table 3 Lowell Tannery Impoundment Lake Trophic Monitoring Results

Date/Time	Alkalinity (mg/L)	Chlorophyll-a (mg/L)	Color (PCU)	pH	Total Phosphorus (µg/L)	Secchi Disk (m)
6/18/19 14:15	7	0.003	85	6.9	33	2.5
6/25/19 13:30	8	0.004	100	6.5	22	2.4
7/16/19 13:00	8	0.003	140	6.6	20	2.2
7/29/19 15:00	8	0.003	95	6.7	19	2.9
8/15/19 13:45	7	0.005	150	6.5	18	2.3
8/26/19 11:45	7	0.004	170	6.4	18	2.1
9/6/19 11:15	7	0.003	160	6.6	17	2.1
9/19/19 11:45	8	0.002	120	6.6	15	2.6
10/2/19 12:15	6	0.002	180	6.4	21	1.9
10/16/19	7	0.002	160	7.1	16	2.2
Average	**7.3**	**0.003**	**136**	**6.6**	**19.9**	**2.3**
Minimum	**6.0**	**0.002**	**85**	**6.4**	**15.0**	**1.9**
Maximum	**8.0**	**0.005**	**180**	**7.1**	**33.0**	**2.9**

Table 4 Dissolved Ion and Metal Concentrations from 2019 Summer Lake Trophic Sample

Parameter	Value
Conductivity (µS/cm)	29.9
Aluminum (mg/L)	0.18
Calcium (mg/L)	3.6
Iron (mg/L)	0.36
Magnesium (mg/L)	0.56
Potassium (mg/L)	0.57
Sodium (mg/L)	1.9
Sulfate (mg/L)	1
Chloride (mg/L)	1
Nitrate Nitrogen (mg/L)	<0.01
Dissolved Aluminum (mg/L)	0.15
Dissolved Organic Carbon (mg/L)	16

Trophic State - Total phosphorus, chlorophyll-a, and Secchi disk transparency are often used as indicators of trophic state, or the biological productivity in a water body, particularly a lake (MDEP 2018b). An oligotrophic lake is characterized as having low productivity, a mesotrophic lake has medium productivity, and a eutrophic lake is highly productive. Table 5 lists the criteria used to classify the trophic state of lakes in Maine (MDEP 2018b).

Table 5 Criteria for Classifying the Trophic State of Lakes in Maine

Trophic State	Chlorophyll-a (mg/l)	Total Phosphorus (ug/l)	Secchi Disk (m)	Trophic State Index
Oligotrophic	< 0.0015	< 4.5	> 8	0-25
Mesotrophic	0.0015 - 0.007	4.5 - 20	4 - 8	25-60
Eutrophic	> 0.007	> 20	< 4	>60 and/or repeated algal

The Maine Trophic State Index (TSI) for lakes can be calculated as (MDEP 1996):

TSI = 70*log (mean chlorophyll-a + 0.7)

Using the average chlorophyll-a concentration for the entire sampling period (0.003 mg/L), the TSI for the Lowell Tannery impoundment is 40.6, which is categorized as mesotrophic.

2.2.2 Impoundment Dissolved Oxygen and Water Temperature Profiles

The results of the water temperature and DO profiles collected at the deep spot in the Lowell Tannery impoundment are presented in Table 6, Table 7, and Table 8. The water temperature was highest near the surface and decreased with increasing depth; the impoundment was not stratified on any sampling occasion. The average water column water temperature was approximately 21°C to 22°C in June 2019 and increased to the highest water column average (25.3°C) on July 29, 2019 (Table 6). The water temperature decreased in each subsequent profile to an average of 12.4°C on October 16, 2019 (Table 6).

In all profiles, the DO concentration was uniform throughout the water column (Table 7). The water column average DO concentration was 8.1 mg/L on June 18, 2019 and 7.9 mg/L on June 25, 2019 (Table 7). In the July and August 2019 profiles, DO ranged from 6.3 mg/L to 7.3 mg/L with averages of 6.5 mg/L to 6.8 mg/L. DO generally increased in the remaining profiles collected in September and October 2019 (range 7.1 mg/L to 9.2 mg/L); the water column average was 9.0 mg/L in the last profile on October 16, 2019 (Table 7).

The DO percent saturation profiles were highest in the two June 2019 profiles with a range of 87.4 percent to 98.5 percent (Table 8). In the two July 2019 profiles and the August 15, 2019 profile, the DO percent saturation ranged from 75.2 percent to 91.0 percent (water column averages of 79.3 percent to 81.8 percent). The DO percent saturation was lowest on August 26, 2019 (range 72.1 percent to 75.1 percent, average 73.3 percent). In the September and October 2019 profiles, the DO percent saturation ranged from 76.6 percent to 86.9 percent (Table 8). Except for the August 26, 2019 profile, all DO percent saturation measurements were above the standard for Class A waters (75 percent saturation).

Table 6 Lowell Tannery Impoundment Water Temperature

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	24.1	22.1	24.8	26.9	24.2	21.3	19.9	17.2	15.0	13.2
1	22.7	21.6	24.2	26.6	23.3	21.2	19.5	16.5	15.0	12.6
2	21.8	21.5	23.8	25.6	23.1	21.2	19.4	16.3	15.0	12.3
3	21.3	21.4	23.7	24.9	22.9	21.2	19.4	16.2	15.0	12.2
4	21.2	21.4	23.6	24.5	22.9	21.1	19.3	16.1	15.0	12.2
5	20.9	21.0	23.6	24.4	22.8	21.1	19.3	16.0	15.0	12.1
6	20.9	20.9	23.3	24.3	22.7	21.1	19.3	16.0	15.0	12.1
7	-	-	-	-	-	21.1	19.3	-	-	-
Average	21.8	21.4	23.9	25.3	23.1	21.2	19.4	16.3	15.0	12.4
Minimum	20.9	20.9	23.3	24.3	22.7	21.1	19.3	16.0	15.0	12.1
Maximum	24.1	22.1	24.8	26.9	24.2	21.3	19.9	17.2	15.0	13.2

Table 7 Lowell Tannery Impoundment Dissolved Oxygen Concentration Profiles

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	8.3	8.0	6.9	7.3	7.0	6.7	7.3	8.3	8.0	9.2
1	8.2	8.0	6.8	7.3	6.8	6.6	7.2	8.3	7.9	9.0
2	8.2	7.9	6.7	6.9	6.8	6.5	7.2	8.3	7.9	9.0
3	8.1	7.9	6.7	6.6	6.8	6.5	7.1	8.3	7.9	9.0
4	8.1	7.9	6.7	6.4	6.8	6.5	7.1	8.3	7.9	8.9
5	8.0	7.9	6.7	6.3	6.7	6.5	7.1	8.2	7.8	8.9
6	8.0	7.8	6.6	6.3	6.7	6.4	7.1	8.2	7.8	8.9
7	-	-	-	-	-	6.4	7.1	-	-	-
Average	8.1	7.9	6.7	6.7	6.8	6.5	7.1	8.3	7.9	9.0
Minimum	8.0	7.8	6.6	6.3	6.7	6.4	7.1	8.2	7.8	8.9
Maximum	8.3	8.0	6.9	7.3	7.0	6.7	7.3	8.3	8.0	9.2

Table 8 Lowell Tannery Impoundment Dissolved Oxygen Percent Saturation

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	98.5	92.0	82.9	91.0	83.2	75.1	79.8	86.4	78.9	86.9
1	94.7	90.7	81.2	90.5	79.7	74.3	78.3	84.8	78.5	84.9
2	92.8	89.9	79.7	84.8	79.2	73.6	77.8	84.4	78.2	83.9
3	90.9	89.7	79.0	79.6	78.7	73.3	77.4	84.2	78.1	83.5
4	90.4	89.4	78.8	76.2	78.5	73.0	77.1	84.0	77.8	83.1
5	89.5	88.4	78.6	75.4	77.8	72.6	76.9	83.1	77.5	82.6
6	89.3	87.4	76.8	75.2	77.7	72.3	76.7	82.7	77.0	82.3
7	-	-	-	-	-	72.1	76.6	-	-	-
Average	92.3	89.6	79.6	81.8	79.3	73.3	77.6	84.2	78.0	83.9
Minimum	89.3	87.4	76.8	75.2	77.7	72.1	76.6	82.7	77.0	82.3
Maximum	98.5	92	82.9	91	83.2	75.1	79.8	86.4	78.9	86.9

2.2.3 Tailwater Water Temperature and Dissolved Oxygen

In late June 2019, water temperatures downstream of the Lowell Tannery dam ranged from 16.0ºC to 21.9ºC (Table 9, Figure 3) and in July 2019, the temperatures ranged from 20.4ºC to 26.6ºC. The water temperature gradually increased from late June 2019 through early August 2019 reaching a maximum of 26.8ºC on August 1, 2019 (Figure 3). The temperature decreased from approximately 25.7ºC on August 6, 2019 to 21.5º C on August 12, 2019 and then decreased more gradually through mid-September 2019 when the temperature ranged from 17ºC to 18.4ºC.

In late June 2019, the DO concentration and percent saturation ranged from 7.6 mg/L to 10.0 mg/L and 81.8 percent to 103.1 percent (Table 9, Figure 4). The DO concentration ranged from 6.2 mg/L to 9.1 mg/L, and the percent saturation ranged from 70.9 percent to 104.5 percent in July and August 2019. In September 2019, the DO concentration ranged from 7.7 mg/L to 9.8 mg/L, and the DO percent saturation ranged from 79.5 percent to 101.5 percent (Table 9). The DO percent saturation was above the Class A standard (75 percent saturation) throughout the monitoring season except for four relatively short periods: from July 12 at 22:00 to July 13, 2019 at 12:00; July 14 at 10:00; August 17, 2019 from 04:00 to 16:00; and from August 17 at 23:00 to August 19, 2019 at 10:00 (Figure 4). These four periods represented approximately 3 percent of the total number of hourly measurements.

The rapid increases and decreases in DO corresponded to times when the Lowell Tannery Project began and stopped generating (Figure 4). When generation stopped, DO levels downstream of the dam increased as a result of spill reflecting increased aeration and mixing (for example on August 3 and August 19, 2019). During times when the project was generating, the water temperature and DO measured downstream of the dam reflected the levels in the impoundment as demonstrated by comparing levels downstream to the impoundment profiles on June 25, July 16, July 29, and August 16, 2019.

Table 9 Monthly Water Temperature and DO Statistic Downstream of Lowell Tannery Dam

Statistic	Water Temperature (°C)	DO (mg/L)	DO (percent)
June 25-30			
Average	20.5	8.1	90.2
Median	20.6	8.1	90.8
Minimum	16.0	7.6	81.8
Maximum	21.9	10.0	103.1
July 1-31			
Average	24.1	7.4	88.0
Median	24.1	7.1	86.7
Minimum	20.4	6.3	72.9
Maximum	26.6	9.1	104.5
August 1-31			
Average	22.9	7.8	91.1
Median	22.5	8.1	97.8
Minimum	20.5	6.2	70.9
Maximum	26.8	9.0	101.9
September 1-17			
Average	18.5	8.8	93.8
Median	18.1	9.0	99.0
Minimum	16.7	7.7	79.5
Maximum	21.2	9.8	101.5

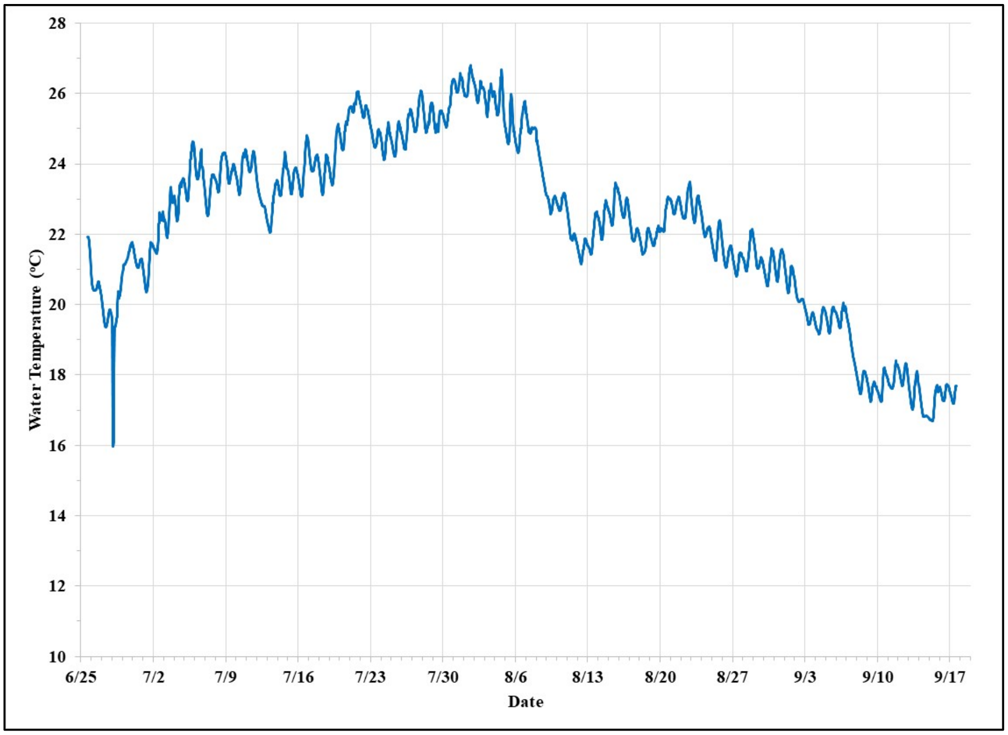

Figure 3 Lowell Tannery Tailrace Hourly Water Temperature Time (June 25 to September 17, 2019)

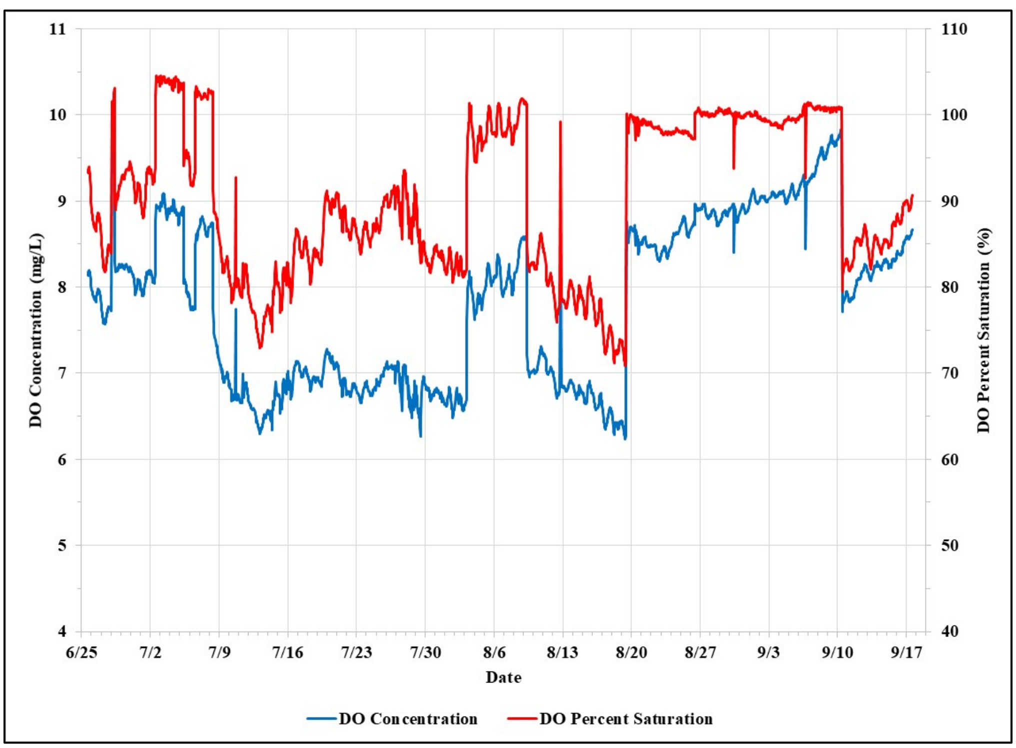

Figure 4 Lowell Tannery Tailrace Hourly DO Concentration and Percent Saturation Time Series (June 25 to September 17, 2019)

2.3 Summary

KEI (Maine) completed lake trophic and riverine water quality monitoring at the Lowell Tannery Project between June and October 2019. Secchi Disk (average 2.3 meters), chlorophyll-a (average 0.0031 mg/L), and pH (average 6.6) measurements collected in the impoundment complied with Class A/AA water quality standards. Half of the total phosphorus samples exceeded the Class A/AA standard. Water temperature and DO displayed uniform vertical profiles indicating that the Lowell Tannery impoundment did not stratify.

Water temperature in the impoundment and tailwater displayed the typical seasonal variation of ranging from approximately 20ºC to 22ºC in June 2019, increasing to a peak of 25ºC to 27ºC in late July/early August 2019 and then steadily decreasing through the end of the study period. During some of the times when the Lowell Tannery Project was generating in July and August 2019, the tailwater DO concentration decreased below the Class A water quality standard (7 mg/L). The DO percent saturation exceeded the Class A standard in approximately 97 percent of the measurements. DO levels in the Project area may be reflective of conditions in the watershed and/or a result of elevated biological productivity that increases DO consumption during decay.

3.0 BENTHIC MACROINVERTEBRATE STUDY - SUMMARY

MDEP requested that KEI (Maine) perform an aquatic life criteria study (i.e., benthic macroinvertebrate sampling) to assess whether the Passadumkeag River attains Class A water quality standards and the designated use of “habitat for fish and other aquatic life” at the Lowell Tannery Project. With respect to designated uses, the Maine Water Quality Law requires that “Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; 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.” In addition, for Class A waters, “The habitat must be characterized as natural.” ((38 M.R.S.A. § 465(4)(A)). The term “Natural” is defined as “means living in, or as if in, a state of nature not measurably affected by human activity.” ((38 M.R.S.A. § 466(9)).

The objective of the macroinvertebrate sampling study was to determine if the aquatic life, in this case the macroinvertebrate community, attained these Class A standards. The MDEP "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 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 invertebrate community sampled below the Lowell Tannery dam was abundant, moderately rich, and well-populated with stress sensitive taxa. The community structure and function found below the Lowell Tannery dam indicates a generally healthy community with evidence of natural, biological enrichment. It is the professional opinion of Moody Mountain Environmental, a qualified invertebrate specialist, that based on the 2019 data that the macroinvertebrate community downstream of the Lowell Tannery dam on the Passadumkeag River is naturally occurring, does not show excessive stress as a result of the project operation, and attains Class A aquatic life standards.

The MDEP uses a linear discriminant water quality model (LDM) and professional judgment to determine water quality class attainment of aquatic macroinvertebrate communities. The LDM results are percentages indicating the probability of a site attaining water quality Classes A, and AA (the biocriteria requirements are the same), B, or C. The LDM numeric criteria results can be supplanted by professional judgment if conditions are such that the data sets are unsuitable for LDM analysis. The MDEP determined that the Benthic Macroinvertebrate (BMI) community met Class A water quality standards.

Attachment A provides the 2019 Benthic Macroinvertebrate study report and the MDEP determination.

4.0 DESKTOP TURBINE BLADE STRIKE AND WHOLE STATION SURVIVAL STUDY

KEI (Maine) performed a desktop study to assess the risk of entrainment (i.e., involuntary passage through the turbine), impingement (i.e., involuntary entrapment against the upstream face of the trash rack), turbine passage survival, and whole-station survival of target migratory fish species that are known to have occurred historically in the Passadumkeag River. Whole-station survival was classified as successful downstream passage via multiple routes including fishways, spill, and turbine passage. Target fish species included adult American eel, adult and juvenile sea-run alewives (used also as a surrogate for similarly sized blueback herring), adult and juvenile American shad, and Atlantic salmon.

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam. KEI (Maine) provides 40 cubic feet per second (cfs) of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. Downstream fish passage is provided through a dedicated fish bypass that is adjacent to the eastern side of the intake racks. A fishway gate leads to an 18-inch bypass pipe that discharges into a plunge pool next to the tailrace. KEI (Maine) provides a fishway flow of 20 cfs through the downstream bypass. The Lowell Tannery Project has two angled trash racks (V-shape) with bars spaced at 1.5-inch clear. Both trash racks are 15-feet-deep by 12-feet-wide resulting in a total surface area of 360 square feet.

The Lowell Tannery Project has one vertical Kaplan hydroelectric turbine that can generate with up to 905 cfs and a minimum capacity of 90 cfs. The turbine has four fixed blades with a rotational speed up to 190 revolutions per minute. Table 9 provides a description of pertinent turbine and project characteristics applicable to this study.

Table 9 Turbine and Fish Characteristics used for Turbine Blade Strike and Whole Station Survival Analysis

Number of Turbines	1
Turbine Style	Vertical Kaplan
Project Head for Generation (Net Head)	20 feet
Number of Turbine Blades	4 (adjustable)
Runner Diameter (diameter of the turbine hub and turbine blades)	4.6 feet
Max. Turbine Runner Rotational Speed	190 revolutions per minute
Maximum Hydraulic Capacity	905 cfs
Minimum Hydraulic Capacity	90 cfs
Discharge at Optimum Efficiency	886 cfs (92.3%)
Turbine Efficiency	0.67 (assigned)

4.1 Methods

4.1.1 Risk of Entrainment and Impingement

To evaluate the risk of impingement, KEI (Maine) calculated the expected approach velocities at the turbine intake and compared them to typical prolonged swim speeds of target fish species. Approach velocities at the intake were determined by dividing the hydraulic capacity of the turbine on a seasonal basis (i.e., when migratory fish typically move downstream) by the size of the intake area (USFWS 2019). The intake area has a surface area of 360-square-feet (15-feet-tall by 12-feet-wide for each rack). For example, at the full station capacity of 905 cfs, the approach velocity was calculated as:

905 cfs (water flow to turbine) / 360 square feet (intake area) = 2.5 feet per second (approach velocity)

Burst swim speed is the swimming speed that a fish can maintain for approximately 20 seconds (Beamish 1978). This enables a fish to escape predation or traverse through high-velocity areas in the water column (Beamish 1978). Prolonged swim speeds are typically maintainable for 20 seconds to 200 minutes (Alden 2004). Table 10 provides a list of prolonged swim speeds used during the analysis.

Table 10 Prolonged Swim Speeds Used to Evaluate Risk of Entrainment and Impingement at the Lowell Tannery Project

Species/Lifestage	Reported Swim Speed (fps)	Literature Source
Atlantic salmon smolts	3.2	Hvas and Oppedal 2017
Adult alewife	6.0	USFWS 2019
Juvenile alewife	1.4 to 1.75	Alden 2004
Adult blueback herring	6.0	USFWS 2019
Juvenile blueback herring	0.75 to 1.14	Alden 2004
Adult American shad	5.0	FishXING 2006
Juvenile American shad	2.15	FishXING 2006
Adult American eel	2.15	Qunitella et. al 2010

To evaluate the risk of entrainment to the turbine, KEI (Maine) compared trash rack spacing to fish size and morphology. Fish with a body thickness less than 1.5 inches (i.e., trash rack open spacing) were classified as "at risk of entrainment" through the trash racks. Fish with swim speeds less than 1.5 feet per second were considered "at risk for impingement" at the trash rack face based on typical USFWS's criteria. Fish morphology information (body width and length) were obtained from literature or field data from fisheries studies in the region. Body width for adult American shad was estimated based on the proportion of body width to standard length (Smith 1986) for fishes collected by the MDMR at the Milford Hydroelectric Project on the Penobscot River in Maine from 2017 to 2019.

4.1.2 Turbine Blade Strike and Whole Station Survival Analysis

KEI (Maine) used STRYKE,[3] a Python-based[4] desktop model, to quantitatively estimate the probability of turbine blade strike survival and whole station survival via a combination of available downstream passage routes (e.g., turbine, spill, and fish bypass) for each target fish species and lifestage. STRYKE uses the turbine blade strike equations from Franke et al. (1997) and is based on the USFWS's Turbine Blade Strike Analysis desktop model (Towler and Pica 2018). Model variables included fish length, number of fish, and turbine characteristics (e.g., runner diameter, turbine type, turbine efficiency, hydraulic capacity, runner speed, and head) (Table 9).

The survival analysis was completed at three flow thresholds to provide a range of possible turbine survival and whole-station survival estimates depending on river flow conditions. Hydrologic conditions were determined from Flow Duration Curves for the Passadumkeag River for low-flow condition (90 percent exceedance), median flow condition (50 percent exceedance), and high flow condition (10 percent exceedance) during times of the year when each species or lifestage is most likely to be outmigrating (Table 13). These thresholds were selected to represent high, median, and low water year conditions.

Three other critical factors require input by the user: fish length; the proportion of fish passing through each available route of passage (spill, fish bypass, or turbine); and the strike mortality correlation factor (lambda).

4.1.2.1 Strike Mortality Coefficient

The strike mortality correlation factor is built into the model to account for differences in actual turbine mortality derived from field tests as compared to predicted model output (Franke et al. 1997). Three variables are built into the strike mortality correlation factor: the position of the fish relative to the plane of the turbine revolution (i.e., fish orientation during passage), the difference in the impact of a strike relative to the fish's body (i.e., a

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[3] Developed by Kleinschmidt Associates (Kleinschmidt).

[4] Python is an open source, object oriented, extendable programming language with packages that support scientific and advanced numerical computing.

strike to the anterior region is more detrimental that a strike to the posterior region), and hydraulic characteristics near the leading edge of the blade tip, which may carry a fish around the leading edge, reducing the likelihood of blade strike (Franke et al. 1997). Franke et al. (1997) suggests using a lambda value of 0.10 to 0.20 for Kaplan turbines based on results of field studies compared to model predictability. Model iterations for the Lowell Tannery Project were run using lambda values of 0.15.

4.1.2.2 Routing of Fish Through the Lowell Tannery Project

Bypass efficiency (i.e., number of fish using the fish bypass to pass downstream) was assumed to be 50 percent for most model runs; for American eels, a second scenario was run with a bypass efficiency of 25 percent because there is not a dedicated downstream bypass. The number of fish routed to the spillway to pass downstream was based on ratio of river flow to turbine capacity. For example, if river flow was 1,250 cfs, approximately 25 percent of fish would be routed to spill because 25 percent of river flow would spill, and 75 percent would be used to generate power. If river flow was less than the maximum capacity of the turbine, 0 percent of fish were routed to spill. When river flow was less than approximately 125 cfs (minimum capacity of the turbine), 0 cfs was routed to the turbine to replicate periods of time when the turbine is not operational. In this instance, all fish were routed through the fish bypass or spill.

4.1.2.3 Fish Length

Turbine passage survival and blade strike probability is influenced more by fish size than species; therefore, the equations do not differentiate between species but only consider fish size (Franke et al. 1997). STRYKE allows the user to enter fish length plus a standard deviation factor to account for variability in fish length; fish length is assumed to be normally distributed (Towler and Pica 2018). Fish length information for the target species was obtained from published reports, field data from regional studies, and other literature sources. Table 12 provides the size ranges for target fish species evaluated for the Lowell Tannery Project. A standard deviation of 0.5 inches was used for all fish species. Adult American eel have a unique body shape that allows them to contort into irregular shapes. As such, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

The STRYKE model was run 20 times sequentially to estimate mean turbine and whole-station survival, calculate a standard deviation, and determine the 95 percent confidence interval. Sample size (# of fish) was set at 200 for each model run. The accuracy of the STRYKE model was verified by running the same scenarios (e.g., same fish length and same turbine characteristics) in the USFWS's model to determine if survival estimates fell within in the 95 percent CI range produced by the STRYKE model.

Table 11 Fish Lengths for the Lowell Tannery Turbine Blade Strike and Whole Station Survival Analysis

Species/Life Stage	Total Length (inches/millimeters)	Data Source
Atlantic Salmon Smolts	7.5 inches (190.5 mm)	Baum 1997
Atlantic Salmon Adults	29 inches (737 mm)	Baum 1997
Adult Alewives	10.5 (267 mm)	MDMR 2020
Juvenile Alewives	4 inches (101 mm)	Pardue 1983
Adult American Shad	19 inches (560 mm)	MDMR 2020
Juvenile American Shad	4 inches (101 mm)	Talbot and Sykes 1958
Adult American Eel	33.5 inches (851 mm)	Kleinschmidt 2012 and 2013

Table 12 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/Life Stage	Peak Outmigration (Month)	Low Flow Threshold (cfs; 90%)	Median Flow Threshold (cfs; 50%)	High Flow Threshold (cfs; 10%)
Atlantic Salmon Smolts	May	178	443	1,365
Adult Alewives	June	135	381	1,441
Juvenile Alewives	September	21*	88*	490
Adult American Shad	July	60*	160	811
Juvenile American Shad	September	21*	88*	490
Adult American Eel	October	28*	165	1,054

* Blue cells indicate turbine unit inoperable because of low water conditions (less or close to 90s); turbine-strike equal to 0.00 and whole-station survival assumed 100 percent.

4.2 Results

4.2.1 Risk of Entrainment or Impingement

4.2.1.1 Trash Rack Exclusion

Juvenile alosines (shad, alewives, and blueback herring), adult American eel, and Atlantic salmon smolts may fit through the 1.5-inch trash racks and pass downstream via the turbine given their smaller body size and morphology. Body width for 18-inch-long and 20-inch-long adult American shad is expected to range from 2.5 to 2.7 inches based on recent fish size data from the Penobscot River[5] (Table 14). Adult salmon are expected to be approximately 29-inches-long. As such, adult salmon and adult American shad are excluded from the turbine by the trash rack bars.

Table 13 Body Length and Width Estimate for Adult American Shad

Fish Sex	Total Length*	Standard Length	Body Width**
Male	18 inches	15 inches	2.5 inches
Female	20 inches	16.6 inches	2.7 inches

* MDMR data from the Penobscot River

** Body width is reported as 16.4 percent of standard length (Smith 1986).

4.2.1.2 Approach Velocity and Impingement

Approach velocity ranges from 0.0 to 0.49 fps (low water year), 0.0 to 1.23 fps (median water years), and from 1.36 to 2.51 fps during high water years during peak migratory periods (e.g., May, June, July, September, and October) (Table 15).

[5] Personal communication, MDMR staff, January 2020.

Table 14 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/ Life Stage	Peak Migration	Low Flow (cfs)	Approach Velocity (fps)	Median Flow (cfs)	Approach Velocity (fps)	High Flow (cfs)	Approach Velocity (fps)
Atlantic Salmon Smolts	May	178	***0.49***	443	***1.23***	905	**2.51**
Adult River Herring	June	135	***0.38***	381	***1.05***	905	**2.51**
Juvenile Alosines	September	21	***0.00***	88	***0.00***	490	**1.36**
Adult American Shad	July	60	***0.00***	160	***0.44***	811	**2.25**
Adult American Eel	October	28	***0.00***	165	***0.46***	905	**2.51**

Based on prolonged swim speeds and expected water velocity in front of the intake during peak migratory periods, the risk of involuntary entrainment to the turbine or impingement against the trash racks is low. The maximum, normal approach velocity during times when the Lowell Tannery Project is fully operational (i.e., during high flow conditions) is estimated to be 2.5 fps, which is near reported prolonged swim speeds for Atlantic salmon smolts, adult herring, adult shad, and adult American eel. At other times of the year or during low or median water years, approach velocity is expected to be less than 2.51 fps (e.g., 0.00 to 1.23 fps), thereby reducing the likelihood of involuntary entrainment or impingement for all species and lifestages, including juvenile herring and American shad. The most risk for impingement or involuntary entrainment is during times when the turbine may be fully operational during the fall outmigration of juveniles alosines and American eels or the outmigration of American shad.

4.2.2 Turbine Passage and Whole Station Survival

4.2.2.1 Adult Sea-Run Alewives and Juvenile Alewives/American Shad

Mean turbine passage survival at the Lowell Tannery Project for 10.5-inch-long adult sea-run alewives ranged from 87 to 95 percent depending on hydrologic conditions in June (e.g., high, median, or low water year); mean whole project survival estimates ranged from 93 to 99 percent (Table 16).

Table 15 Turbine Blade Strike and Whole Station Survival Estimate for Adult Sea-Run Alewives at Lowell Tannery Project

Variable	Flow Condition and Survival Estimates		
Flow Condition	High (1,441 cfs)	Median (381 cfs)	Low (135 cfs)
Turbine Capacity	905	381	135
Percent to Turbine	31.4	50	50
Percent to Spill	37.2	0	0
Percent to Bypass	31.4	50	50
Strike Coefficient	0.15	0.15	0.15
RPM	190	190	190
Mean Turbine Survival	**95%**	**90%**	**87%**
Standard Deviation	3%	4%	5%
Turbine Passage Survival 95% CI (Low)	90%	83%	77%
Turbine Passage Survival 95% CI (High)	98%	97%	95%
Mean Whole Project Survival	**99%**	**95%**	**93%**
Standard Deviation	1%	2%	3%
Whole Project Survival 95% CI (Low)	97%	91%	89%
Whole Project Survival 95% CI (High)	99%	99%	98%

Mean turbine passage survival at the Lowell Tannery Project for 4-inch-long juvenile alosines (e.g., American shad and sea run alewives) ranged from 97.0 to 100 percent depending on hydrologic conditions in September (e.g., high, median, or low water year); mean whole project survival estimates ranged from 98 to 100 percent (Table 17). The Lowell Tannery Project turbine would not be operable at the median or low flow condition in September; therefore, whole-station survival is expected to be 100 percent (Table 17)

Table 16 Turbine Blade Strike and Whole Station Survival Estimate for Juvenile Alosine Species

Variable	Flow Condition and Survival Estimates		
Flow Condition	High (490 cfs)	Median (88 cfs)	Low (21 cfs)
Turbine Capacity	490	0	0
Percent to Turbine	50	0	0
Percent to Spill	0	50	50
Percent to Bypass	50	50	50
Strike Coefficient	0.15	-	-
RPM	190	-	-
Mean Turbine Survival	**97%**	**100%**	**100%**
Standard Deviation	2%	-	-
Turbine Passage Survival 95% CI (Low)	94%	100%	100%
Turbine Passage Survival 95% CI (High)	100%	100%	100%
Mean Whole Project Survival	**98%**	**100%**	**100%**
Standard Deviation	1%	-	-
Whole Project Survival 95% CI (Low)	97%	100%	100%
Whole Project Survival 95% CI (High)	100%	100%	100%

4.2.2.2 Atlantic Salmon Smolts

Mean turbine passage survival at the Lowell Tannery Project for 7.5-inch-long Atlantic salmon smolts ranged from 91 to 96 percent depending on hydrologic conditions in May (e.g., high, median, or low water year); mean whole project survival estimates ranged from 95 to 98 percent (Table 18).

Table 17 Turbine Blade Strike and Whole Station Survival Estimate for Atlantic Salmon Smolts

Variable	Flow Condition and Survival Estimates		
Flow Condition	High (1,365 cfs)	Median (443) cfs	Low (178) cfs
Turbine Capacity	905	443	178
Percent to Turbine	33	50	50
Percent to Spill	34	0	0
Percent to Bypass	33	50	50
Strike Coefficient	0.15	0.15	0.15
RPM	190	190	190
Mean Turbine Survival	**96%**	**95%**	**91%**
Standard Deviation	2%	3%	3%
Turbine Passage Survival 95% CI (Low)	90%	89%	84%
Turbine Passage Survival 95% CI (High)	99%	99%	95%
Mean Whole Project Survival	**98%**	**97%**	**95%**
Standard Deviation	1%	2%	2%
Whole Project Survival 95% CI (Low)	96%	94%	92%
Whole Project Survival 95% CI (High)	99%	99%	97%

4.2.2.3 Adult American Eel

Mean turbine passage survival at the Lowell Tannery Project for 33-inch-long adult American eel ranged from 60 to 100 percent depending on hydrologic conditions in October (e.g., high, median, or low water year); mean whole project survival estimates ranged from 71 to 100 percent (Table 19).

Table 18 Turbine Blade Strike and Whole Station Survival Estimate for Adult American Eel

Variable	Flow Condition and Survival Estimates				
Flow Condition	High (905 cfs; 50% Bypass)	High (905 cfs; 25% Bypass)	Median (165 cfs; 50% Bypass)	Median (165 cfs; 25% Bypass)	Low (28 cfs)
Turbine Capacity	905	905	165	165	0
Percent to Turbine	43	65	50	75	0
Percent to Spill	14	14	0	0	50
Percent to Bypass	43	21	50	25	50
Strike Coefficient	0.15	0.15	0.15	0.15	-
RPM	190	190	190	190	-
Mean Turbine Survival	**84%**	**84%**	**60%**	**61%**	**100%**
Standard Deviation	4%	4%	5%	4%	-
Turbine Passage Survival 95% CI (Low)	77%	77%	50%	53%	100%
Turbine Passage Survival 95% CI (High)	91%	90%	68%	68%	100%
Mean Whole Project Survival	**93%**	**90%**	**81%**	**71%**	**100%**
Standard Deviation	2%	2%	3%	3%	-
Whole Project Survival 95% CI (Low)	89%	86%	74%	65%	100%
Whole Project Survival 95% CI (High)	97%	93%	84%	77%	100%

4.2.2.4 Adult American Shad and Atlantic Salmon

Adult salmon and American shad are expected to pass downstream via spill or through the downstream fish bypass, therefore turbine blade strike and whole-passage survival estimates were not calculated, and survival was assumed to be 100 percent.

4.3 Summary

Kleinschmidt's turbine blade strike and whole station survival model provided an automated method to run multiple iterations of turbine and whole station survival estimates for multiple species and lifestages of migratory fish under varying flow conditions. The narrowly spaced, full depth trash rack bars and relatively low approach velocities reduce the likelihood of entrainment and prohibit larger-bodied fish (e.g., adult Atlantic salmon or adult American shad) from becoming entrained. The characteristics of the turbine at the Lowell Tannery Project (i.e., Kaplan with relatively low RPMs, low head) and the relatively small size of fish that may be entrained increases the probability for high turbine passage survival and high whole-station survival of migratory fish species. Large-bodied American eel are at the highest risk of turbine-strike and mortality, during median flow conditions; however, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

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ATTACHMENT A

MDEP CONSULTATION RECORD

From:	Howatt, Kathy
To:	Jesse Wechsler; Rachel Russo; Sherri.Loon@kruger.com
Subject:	Lowell Tannery PSP
Date:	Tuesday, May 21, 2019 7:34:34 AM

Jesse and Rachel,

I conferred with Barry M., and on confirmation that operating conditions are ROR (no drawdown, fluctuations of up to one foot allowed) and the powerhouse integral to the dam with no bypass reach, an impoundment habitat study and downstream habitat study will not be required. The applicant, in its DLA and FLA, needs to present all available information and make the case that the water quality standards for habitat designated uses are met, despite lack of data demonstrating such. Let me know if you have any questions,

Kathy

Kathy Davis Howatt
Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection
Phone: 207-446-2642
www.maine.gov/dep

ATTACHMENT B

MOODY MOUNTAIN AQUATIC INVERTEBRATE REPORT
LOWELL TANNERY

2019

Macroinvertebrate Sampling Study

Downstream

of the

Lowell Tannery Dam

Lowell Maine

FERC NO. 4202

Submitted by:

Paul C. Leeper

Moody Mountain Environmental

137 Diamond Str

Searsmont Maine 04973

Submitted to:

Jesse Wechler

Kleinschmidt Group

141 Main Street

Pittsfield, ME 04967

Date: February 18, 2020

Introduction

This macroinvertebrate sampling study was conducted in support of the relicensing of the Lowell Tannery Hydroelectric Project (Project or Lowell Tannery Project), Federal Energy Regulatory Commission (FERC) Project No. 4202. This report details 2019 study efforts as part of the Water Quality Sampling Study.

Study Objectives

The goal of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Passadumkeag River downstream of the Lowell Tannery Dam and assess this community in terms of Maine's Aquatic Life Standards.

Study Area

In 2019 we placed samples at one (1) site approximately 490 ft below the Lowell Tannery Dam in the Passadumkeag River to study aquatic macroinvertebrates (Figure 1).

Water Classification

The Passadumkeag River downstream of the Lowell Tannery Dam is classified Class A ((38 M.R.S.A § 467(4) (18)(A)(1))). With respect to designated uses, the Maine Water Quality Law requires that "Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; 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." In addition, for Class A waters, "The habitat must be characterized as natural." (38 M.R.S.A. § 465(4)(A). The term "Natural" is defined as "means living in, or as if in, a state of nature not measurably affected by human activity." ((38 M.R.S.A. § 466(9)).

Figure 1. Location of aquatic macroinvertebrate sampling site downstream of the Lowell Tannery Dam. Passadumkeag River, August, September 2019.

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 A 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 site; samplers are typically left in the river for approximately 28 days (± 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) from each site were sorted, identified, and enumerated.

The Maine Department of Environmental Protection (DEP), Division of Environmental Assessment (DEA) uses a linear discriminant water quality model (LDM) and professional judgment to determine water quality class attainment of aquatic macroinvertebrate communities. The LDM results are percentages indicating the probability of a site attaining water quality Classes A, and AA (the biocriteria requirements are the same), B, or C. The LDM numeric criteria results can be supplanted by professional judgment if conditions are such that the data sets are unsuitable for LDM analysis.

The Method outlines a number of conditions that can trigger the use of professional judgment to analyze data. Among these are:

1. Minimum Provisions - if the sample Mean Total Abundance is less than 50 individuals or Generic Richness is less than 15 genera.
2. Atypical Conditions - where atypical conditions could result in uncharacteristic findings, professional judgment can be used to make adjustments. Examples of these atypical conditions are:

    a. - Habitat Factors

        Lake Outlets
        Impounded Waters
        Substrate Characteristics
        Tidal Waters

    b. - Sampling Factors

        Disturbed Samples
        Unusual Taxa Assemblages
        Human Error in Sampling

    c. - Analytical Factors

        Subsample versus Whole Sample analysis
        Human Error in Processing

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In cases where professional judgment is used the Method outlines a process by which adjustments should occur. These are:

a. **Resample** the site if specific sampling factors may have influenced the results

b. **Raise the Finding** of the LDM from non-attainment to indeterminant or attainment of Class C;

c. **Raise the Finding** of the LDM from one class to the next higher class;

d. **Lower the Finding** of the LDM to indeterminant or the next lower class. This would be based on evidence that the narrative aquatic life criteria for the assigned class are not met;

e. **Determination of Non-Attainment**: Minimum Provisions not met by samples for which no evidence exists of atypical conditions.

f. **Determination of Attainment**: Minimum Provisions not met by samples for which there is evidence of factors that could result in minimum provisions not being met, professional judgment may be used to make a professional finding of attainment of the aquatic life criteria for any class. Such decisions will be provisional until appropriate resampling is carried out.

Typically, the process for analyzing community data using the LDM and making adjustments is the responsibility of the DEP; however, in this report professional judgment is used, taking into account these same factors.

Results

The samplers were placed in the river on August 6, 2019. Due to high flows in the river the samplers could not safely be retrieved until September 13, 2019. This interval is outside the 28 days (± 4 days) window called for in DEP methods. Habitat measurements for are shown in Table 1. Photos of the areas around the sample site are included below.

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Table 1. Habitat measurements in the Passadumkeag River downstream of Lowell Tannery Dam for aquatic macroinvertebrate sampling. August-September 2019

Macroinvertebrate Field Data Sheet

Log ________	Directions	Type of Sampler **RB**
Station Number	________	Date Deployed **8/6/19**
Waterbody **Passadumkeag R.**	________	Number Deployed **3**
River Basin **Passadumkeag R.**	Lat-Long Coordinates	Date Retrieved **9/13/19**
Town **Lowell**	**45°11'9.31"N**	Number Retrieved **3**
Stream Order **6**	**68°27'59.04"W**	Collector(s) **P Leeper MME**

1. **Land Use** (surrounding watershed)		2. **Terrain**	3. **Canopy Cover**
☐ Urban	**X** Upland conifer	☐ Flat	☐Dense (75-100% shaded)
☐ Cultivated	☐ Swamp hardwood	**X** Rolling	☐Partly open (25-75% shaded)
☐ Pasture	☐ Swamp conifer	☐ Hilly	**X** Open (0-25% shaded)
X Upland hardwood	☐ Marsh	☐ Mountains	(% daily direct sun) ________

4. **Physical Characteristics of Bottom** estimate % over 12 m stretch

[10]	Bedrock	[50]	Cobble (2.5" – 10")	[]	Sand (<1/8")	[ ]	Clay
[40]	Boulders (>10")	[ ]	Gravel (1/8" – 2.5")	[	Silt	[ ]	Muck

5. **Habitat Characteristics** (immediate area)		Temp. Probe #	7. **Water Samples**
Time **1125h**	Time **1125h**	☐ deployed	☐ Standard
Wetted Width	Wetted Width (m) **80m**	6. **Observations**	☐ Other
Bank Fl Width	Bank Full Width **80m**		Lab Number
Depth **65cm**	Depth		8. **Photograph**
Velocity	Velocity 103 cm/s		Put-In **Yes**
Diss. O_2 (ppm)	Diss. O_2 (ppm) 8.4		Take-Out **Yes**
Temp (C)	Temp (C) 17.4		
Turbidity	Turbidity		
DO Meter #______Cal? /	DO Meter # YSI Pro 1 Cal? **Y** /		

Photo 1. Sample Site view northeast (upstream). Passadumkeag R. 8-6-19

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Photo 2. Sample Site 1 view southeast (crosstream). Passadumkeag R. 8-6-19

Photo 3. Sample Site 1 view southwest (downstream). Passadumkeag R. 7-29-19

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Photo 4. Typical substrate in the Passadumkeag River downstream of Lowell Tannery Dam. August-September 2019

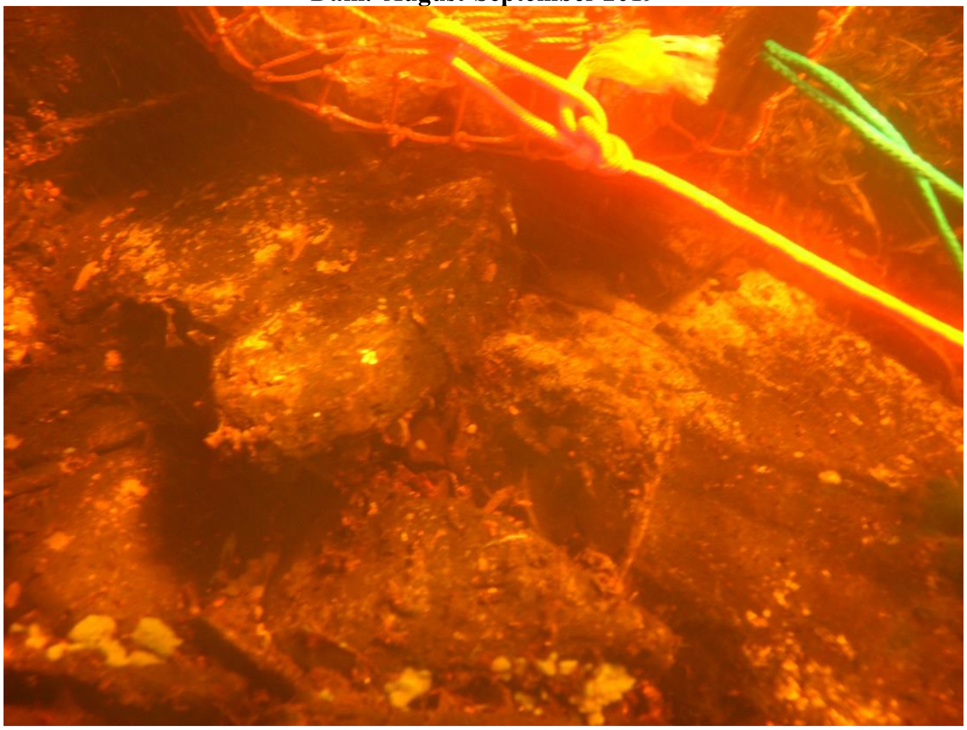
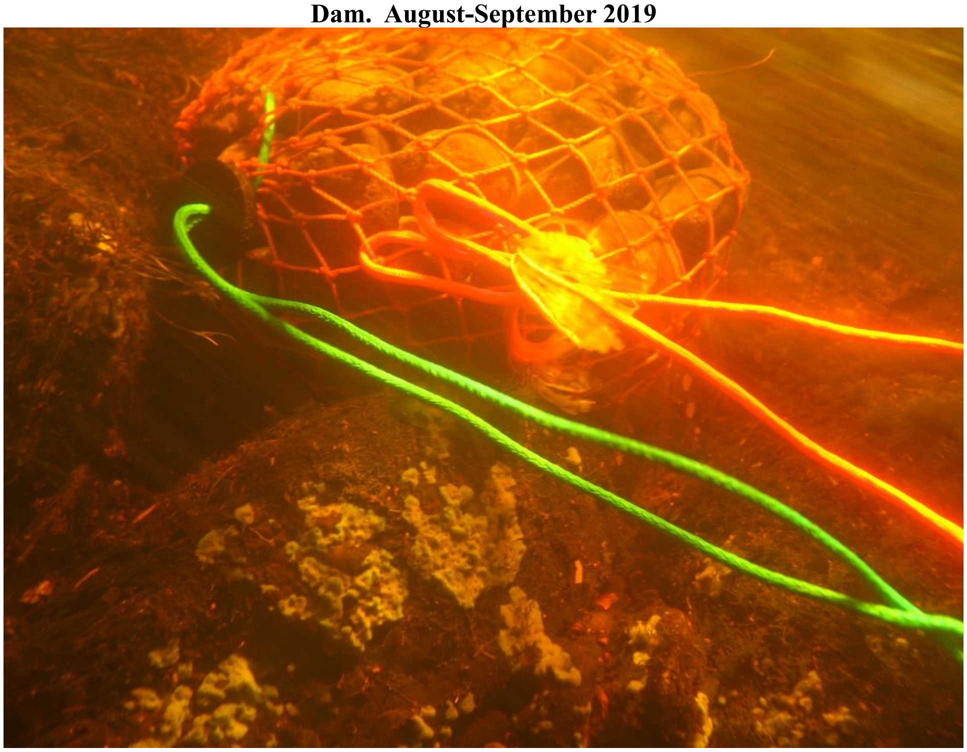


Photo 5. Typical substrate in the Passadumkeag River downstream of Lowell Tannery Dam. August-September 2019



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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. The model results indicate that the community was in attainment of Aquatic Life Class B Standards. However, the DEP used Best Professional Judgement to raise the finding to A "*because of impoundment acting like a natural lake outlet. The sample has a lot of filter feeding organisms. Further upstream, Saponac Pond is a shallow, natrually (*sic*)mesotrophic lake*."

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 the Passadumkeag River in Auburn Maine downstream of the Lowell Tannery Dam in 2019. 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	1%*	73%	100%	0%

- Best Professional Judgement used to raise finding to Class A

Community Analysis

The macroinvertebrate communities sampled downstream of the Lowell Tannery Dam were abundant and moderately rich in taxa (Appendix 1). The community was populated with 17 different taxa with a Mean Total Abundance of 856. Filter-feeding caddisflies were numerous, representing over 50% 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 Lowell Tannery Dam. Passadumkeag River, August-September 2019.

Site	Tot. Abund.	Taxa Richness	S-W Div.	Hils. Biotic Index (HBI)	Water Quality indication from HBI	Mayfly, Stonefly, Caddisfly (EPT) Richness	Mayfly, Stonefly (EP)		Midge	
							Rich	% Ab	Rich	% Ab
Site 1	856.3	17	2.14	4.11	Very Good	10	5	4	2	5

Indexes measuring the communities' tolerance to poor water quality conditions indicated

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good water quality. Sensitive mayfly and stonefly taxa were well represented (5 taxa). The Hilsenhoff Biotic Index value, 4.11 indicated very good water quality (Hilsenhoff 1987).

Dominant organisms (representing over 5% of the Total Abundance) in the community are shown in Table 3 arranged from the most sensitive organisms to the organisms most tolerant of poor water quality conditions. The community had 2 taxa, sensitive caddisflies *Hydropsyche* and tolerant blackflies *Simulium*, that made up 79% of the total abundance.

Table 4. Dominant aquatic invertebrate organisms downstream of the Lowell Tannery Dam. Passadumkeag River, July- August 2019.

Sensitivity to Poor Water Quality	Dominant Organism	% of Community
Sensitive	Caddisfly *Hydropsyche*	44%
Intermediate		
Tolerant	Blackfly *Simulium*	35%

The community structure and function found downstream of the Lowell Tannery Dam on the Passadumkeag River indicates some evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983). However, the presence in the community of sensitive stoneflies and mayflies indicates there has been no loss of genera or excessive dominance by any group.


Blackfly larvae Source:http:// www.sciencepartners.info/

Caddisfly:Cheumatopsyche www.waterbugkey.vcsu.ed

Enrichment and caddisfly dominance downstream of lake outlets and dam outlets is a common phenomenon that has long been reported in the literature. Illies (1956 in Spence and Hynes 1970) reported an increase in the number of filter-feeding Trichoptera below a lake when compared to upstream communities. He attributed this to an increase in food availability. Filter-feeding organisms (the blackfly *Simulium* is also a filter-feeder)

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are often the dominant organisms in streams and rivers (Hynes 1970) and frequently are very abundant at lake outlets (Carlsson et al. 1977; Valett and Stanford 1987). The density or biomass of these filter-feeders typically decline the farther one looks downstream (Osgood 1979). This blossoming and decline of the aquatic community may be in response to a gradient in the quantity and/or quality of the food resources. High quality lake seston (the particulate matter in the water), typically made up of algal cells, is processed by the filter-feeders near the outlet and may be transformed to lower quality detritus (Benke and Wallace 1980, Valett and Stanford 1987).

Hydropsychidae and filter-feeding net
Photo by: J Montem

This phenomenon has also been long observed at impoundment outlets. Spence and Hynes (1971) reported increased numbers of Hydropsychidae (the caddisfly *Hydropsyche* is a genus in the family Hydropsychidae) and other organisms downstream of an impoundment and stated that the downstream differences were comparable to mild organic enrichment. Parker and Voshell (1983) reported production of filter-feeding Trichoptera to be the highest at a site closest to the dam when compared to sites farther downstream and sites on free-flowing rivers. They concluded that, not only the amount of high quality food, but the specific size of the seston, contributed to the ability of the caddisflies to occupy this niche.

Hydropsychidae and net
© David H. Funk

The community sampled from the Passadumkeag River exhibited the typical community enrichment seen below natural lake and impoundment outlets. The Lowell Tannery Dam operates in a similar manner to a natural lake outlet and enriches the aquatic community downstream. The community sampled close to the dam is influenced by a high quality food resource exiting the impoundment. This resource allows the aquatic filter feeders to flourish. The community downstream of the dam is responding as expected within their habitats.

It is my professional opinion that the macroinvertebrate community downstream of Lowell Tannery Dam on the Passadumkeag River is naturally occurring, does not show excessive stress

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as a result of the project operation, and attains Class A aquatic life standards. Specifically, it is my opinion that the aquatic life in the Passadumkeag River downstream of Lowell Tannery Dam is as naturally occurs.

Summary

1. The objective of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Passadumkeag River downstream of the Lowell Tannery Dam and assess this community in terms of Maine's Aquatic Life Standards. The Passadumkeag River downstream of the dam is classified Class A.

2. The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2014) were used as the basis of the field and laboratory procedures in this study.

3. Samplers were retrieved from one (1) sample site approximately 490 ft downstream of the dam on September 13, 2019 due to earlier high flows. This was outside the normal colonization time frame.

4. The LDM biocriteria results indicate that the community is in attainment of Class A Aquatic Life Standards using best Professional Judgement.

5. The invertebrate community sampled below the Lowell Tannery Dam was abundant, moderately rich, and well-populated with stress sensitive taxa.

6. The community structure and function found below the Lowell Tannery Dam indicates a generally healthy community with evidence of natural, biological enrichment.

7. It is my professional opinion that the macroinvertebrate community downstream of the Lowell Tannery Dam on the Passadumkeag River is naturally occurring, does not show excessive stress as a result of the project operation, and attains Class A aquatic life standards.

References

Benke, A.C. and J.B. Wallace. 1980. Trophic basis of production among net-spinning caddisflies in a southern Appalachian stream. Ecology 61: 108-118.

Carlsson, M., L.M. Nilsson, Bj. Svensson, and S. Ulfstrand, 1977. Lacustrine seston and other factors influencing blackflies (Diptera: Simuliidae) inhabiting lake outlets in Swedish Lapland. Oikos 29: 229-238.

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Osgood, M.W. 1979. Abundance patterns of filter-feeding caddisflies (Trichoptera: Hydropsychidae) and seston in a Montana (U.S.A.) lake outlet. Hydrobiologia Vol. 63 (2):177-183.

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Valett, H.M. and A. Stanford. 1987. Food quality and Hydropsychidae caddisfly density in a lake outlet stream in Glacier National Park, Montana, U.S.A. Can. J. Fish Aquat. Sci. 44: 77-82.

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Appendix 1

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

Station Information

Station Number:	**S-1173**	River Basin:	
Waterbody:	Passadumkeag River - Station 1173	HUC8 Name:	
Town:	Lowell	Latitude:	
Directions:	RIVER CENTER APPROX. 500 FT DOWNSTREAM OF DAM, JUST DOWNSTREAM OF RIVER RIGHT VEGETATED LEDGE	Longitude:	
		Stream Order:	

Sample Information

Log Number:	**2793**	Type of Sample:	ROCK BAG	Date Deployed:	8/6/2019
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	9/13/2019

Classification Attainment

Statutory Class:	**AA**	**Final Determination:**	**A**	Date:	2/18/2020
Model Result with P≥0.6:	B	**Reason for Determination:**	**Best Professional Judgement**		
Date Last Calculated:	2/14/2020	Comments:	Class B raised to Class A because of impoundment acting like a natural lake outlet. The sample has a lot of filter feeding organisms. Further upstream, Saponac Pond is a shallow, natrually mesotrophic lake.		

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.11	Class C	0.19	Class A, B, or C	1.00
Class B	0.69	NA	0.00	Non-Attainment	0.00
B or Better Model				**A Model**	
Class A or B			0.73	Class A	0.01
Class C or Non-Attainment			0.27	Class B or C or Non-Attainment	0.99

Model Variables

01 Total Mean Abundance	856.33	18 Relative Abundance Ephemeroptera	0.04
02 Generic Richness	17.00	19 EPT Generic Richness	10.00
03 Plecoptera Mean Abundance	9.33	21 Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	0.00
04 Ephemeroptera Mean Abundance	35.33	23 Relative Generic Richness- Plecoptera	0.12
05 Shannon-Wiener Generic Diversity	2.14	25 Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	41.00
06 Hilsenhoff Biotic Index	4.11	26 Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	28.00
07 Relative Abundance - Chironomidae	0.05	28 EP Generic Richness/14	0.36
08 Relative Generic Richness Diptera	0.24	30 Presence of Class A Indicator Taxa/7	0.00
09 *Hydropsyche* Abundance	377.67		
11 *Cheumatopsyche* Abundance	41.00		
12 EPT Generic Richness/ Diptera Generic Richness	2.50		
13 Relative Abundance - Oligochaeta	0.00		
15 Perlidae Mean Abundance (Family Functional Group)	9.33		
16 Tanypodinae Mean Abundance (Family Functional Group)	0.00		
17 Chironomini Abundance (Family Functional Group)	0.00		

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Hydropsyche*	44.10
2	*Simulium*	34.72
3	*Cheumatopsyche*	4.79
4	*Chimarra*	4.55
5	*Eukiefferiella*	4.28

Report Printed: 2/18/2020 Contact: biome@maine.gov or (207)287-7688 Page 1

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

Station Number: S-1173	Town: Lowell		Date Deployed: 8/6/2019
Log Number: 2793	Waterbody: Passadumkeag River - Station 1173		Date Retrieved: 9/13/2019

Sample Collection and Processing Information

Sampling Organization: PCL

Taxonomist: PAUL LEEPER (MOODY MOUNTAIN ENVIRONMENTAL)

Waterbody Information - Deployment		Waterbody Information - Retrieval	
Temperature:		Temperature:	17.4 deg C
Dissolved Oxygen:		Dissolved Oxygen:	8.4 mg/l
Dissolved Oxygen Saturation:		Dissolved Oxygen Saturation:	
Specific Conductance:		Specific Conductance:	
Velocity:		Velocity:	103 cm/s
pH:		pH:	
Wetted Width:	80 m	Wetted Width:	80 m
Bankfull Width:	80 m	Bankfull Width:	80 m
Depth:		Depth:	

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain	
Upland Conifer	Open	Rolling	
Upland Hardwood			

Potential Stressor	Location	Substrate	
Regulated Flows	Below Dam	Bedrock	10 %
		Boulder	40 %
		Rubble/Cobble	50 %

Landcover Summary - 2004 Data

Sample Comments

WATER UP, OUT OFTIMIE WINDOW

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

Station Number: S-1173 Waterbody: Passadumkeag River - Station 1173 Town: Lowell

Log Number: 2793 Subsample Factor: X1 Replicates: 3 Calculated: 2/14/2020

Taxon	Maine Taxonomic Code	Count (Mean of Samplers) Actual	Adjusted	Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance % Actual	Adjusted
Planariidae	03010101	1.33	1.33		--	0.2	0.2
Beloneuria	09020209044	2.67	2.67		--	0.3	0.3
Agnetina	09020209050	6.67	6.67	2	PR	0.8	0.8
Baetidae	09020401	3.33	3.33		--	0.4	0.4
Stenonema	09020402016	28.00	28.00	4	SC	3.3	3.3
Isonychia	09020404018	4.00	4.00	2	CF	0.5	0.5
Chimarra	09020601003	39.00	39.00	2	CF	4.6	4.6
Cheumatopsyche	09020604015	41.00	41.00	5	CF	4.8	4.8
Hydropsyche	09020604016	377.67	377.67	4	CF	44.1	44.1
Macrostemum	09020604018	0.33	0.33	3	CF	0.0	0.0
Mystacides	09020618075	1.33	1.33	4	CG	0.2	0.2
Nigronia	09020701003	0.33	0.33	0	PR	0.0	0.0
Sialis	09020702004	1.33	1.33	4	PR	0.2	0.2
Eukiefferiella	09021011041	36.67	36.67	8	CG	4.3	4.3
Rheotanytarsus	09021011072	8.67	8.67	6	CF	1.0	1.0
Simulium	09021012047	297.33	297.33	4	CF	34.7	34.7
Atherix	09021015055	6.67	6.67	2	PR	0.8	0.8

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JANET T. MILLS
GOVERNOR

STATE OF MAINE
DEPARTMENT OF
INLAND FISHERIES & WILDLIFE
284 STATE STREET
41 STATE HOUSE STATION
AUGUSTA ME 04333-0041

JUDITH CAMUSO
COMMISSIONER

VIA ELECTRONIC FILING

March 8, 2018

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Subject: **Comments on KEI (USA) Power Management Inc. Pre-Application Document for the Lowell Tannery Hydroelectric Project (P-4202)**

Dear Secretary Bose:

The Maine Department of Inland Fisheries and Wildlife (MDIFW) received a Notification of Intent (NOI) to relicense and the required Pre-Application Document (PAD) for the 1000 kW Lowell Tannery Hydroelectric Project (FERC No. 4202). The Project is located on the Passadumkeag River in the town of Lowell in Penobscot County, Maine.

MDIFW is a cabinet level agency of the State of Maine, and under Maine State Law (12 MRSA, §10051) MDIFW's mandate is "*…to preserve, protect, and enhance the inland fisheries and wildlife resources of the State; to encourage the wise use of these resources; to ensure coordinated planning for the future use and preservation of these resources; and to provide for effective management of these resources*." The MDIFW is concerned with the Project's impacts to resident fishery resources and public use of those resources. Based on our statutory responsibility we have prepared the following comments and recommendations.

<u>Aquatic Resources</u>

As stated in the PAD, all ten of Maine's native freshwater mussel species have been documented in the Passadumkeag River, both downstream and upstream of the Project. Of these, the yellow lampmussel, tidewater mucket, and brook floater are listed as State-Threatened Species in Maine. The Brook Floater is also under review by the U.S. Fish & Wildlife Service (USFWS) to determine if Federal listing status is warranted. As Project operations are expected to remain the same, our Agency does not have concerns for the listed mussel species. However, maintenance activities which require an alternation of normal flows or impoundment drawdowns could have deleterious effects and result in the Take of one or more listed species, as evidenced by a 5-foot drawdown at the Project in the 1990's which resulted in a large mussel kill.

As a condition of the new license for this Project, we will be recommending that both MDIFW and the US Fish and Wildlife Service be given advanced notification in situations requiring impoundment drawdowns, or lowering of downstream flows outside the normal flow regime. The advanced notification should allow adequate time for the Licensee to develop a mussel relocation plan in conjunction with, and to be approved by, both MDIFW and USFWS.

Tomah Mayfly

The Tomah Mayfly, a State-Threatened species, has been documented downstream of the Project. This rare species of mayfly occurs much lower in the river in association with expansive, adjacent sedge floodplain wetlands in the vicinity of Ayers Brook. Based on our assessment of the habitat in the impoundment and immediately downstream of the dam, it appears that suitable habitat for this species is limiting or not present. Given that changes in Project operations are not being proposed, minimal, if any, impacts to this species are anticipated.

Proposed Studies

Our Agency is not proposing studies at this time.

Thank you for the opportunity to comment on the Lowell Tannery Hydroelectric Project. To help ensure that our Agency responds in a timely manner, all future general electronic correspondence should be sent to IFWEnvironmentalreview@maine.gov. Alternatively, though not preferred, mailings and notifications can be sent to:

Environmental Review Coordinator
Maine Department of Inland Fisheries and Wildlife
284 State Street, 41 SHS
Augusta, ME 04333-0041

If you have any specific questions, please feel free to contact me directly by phone at 207-287-5254 or by email at john.perry@maine.gov.

Best regards,

John Perry
Environmental Review Coordinator

Cc: Kevin Dunham, Mark Caron, MDIFW Region E
Casey Clark, MDMR
Kathy Howatt, MDEP
Steven Shepard, USFWS

Document Content(s)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

MAR - 9 2019

Kimberly D. Bose, Secretary
Federal Energy Regulatory Division
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the KEI (Maine) Pre-Application Document and Study Requests for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

Dear Secretary Bose:

On November 23, 2018, you issued a Notice of Intent to file license application, filing of Pre-Application Document (PAD), and approving use of the Traditional License Process for the Lowell Tannery Project (FERC No. 4202). The PAD contains information about the Lowell Tannery Project itself and the environmental resources that are affected by the Project. As part of the Traditional License Process, we have an opportunity to comment on the PAD and to submit study requests.

Attached for filing, please find our comments regarding the PAD as well as a request for three studies. Should you have any questions or need additional information, please contact Jeff Murphy (jeff.murphy@noaa.gov or 207-866-7379). We look forward to continuing to work with you and your staff during the relicensing process.

Sincerely,

Julia E. Crocker
Endangered Fish Branch Chief

cc: Service List
Steven Shepard, USFWS
Casey Clark, USFWS
John Perry, MEDIFW
Kathy Howatt, MEDEP
Sherri Loon, KEI (Maine)

National Marine Fisheries Service's Comments and Study Requests on KEI (Maine) Pre-Application Document for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

March, 2019

1 Project Background

The Lowell Tannery Hydroelectric Project is located on the Passadumkeag River in the Town of Lowell, Maine. The Passadumkeag River is a tributary to the Penobscot River. The Project consists of a dam, spillway, fish passage facilities, a 1,000 kilowatt (kw) powerhouse, and ancillary equipment. The Project has a drainage area of 301 square miles, and at normal pool elevation of 182.3 feet, has a reservoir surface area of 68.5 acres with no usable storage.

2 Federal Statutory Requirements

We have a long-term interest in the relicensing of the Project and the measures to protect and enhance fisheries resources that will be included as elements of the federal license. Our responsibilities in this matter are codified under our authorities pursuant to: the Fish and Wildlife Coordination Act (16 U.S.C. §661 et seq.), which requires that the federal action agency give great weight to the comments of federal and state resource agencies; the ESA (16 U.S.C. §1531 et seq.) of 1973 as amended, which requires Federal agencies to ensure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of any listed species or adversely modify designated critical habitat; the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600.920), which requires consultation between the federal action agency and us for Projects that affect essential fish habitat; and the Federal Power Act 16 U.S.C. §803 and 811, for the protection of anadromous fish resources and their habitat affected by the licensing, operation and maintenance of hydroelectric Projects.

3 NOAA Trust Resources

NOAA's National Marine Fisheries Service (NMFS) is a trustee for coastal and living marine resources, including commercial and recreational fisheries, anadromous species, marine mammals, and marine, estuarine and coastal habitat systems. Estuary and coastal riverine habitat systems, including rivers flowing into Penobscot Bay, provide an integral component of significant ecological functions for the larger marine environment. Estuaries and coastal rivers support many living marine resources. Many species including alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), and American eel (*Anguilla rostrata*) rely on these coastal systems for refuge, spawning, rearing and nursery habitat.

Our work is guided by two core mandates: to ensure the productivity and sustainability of fisheries and fishing communities through science-based decision-making and compliance with regulations, and to recover and conserve protected resources through the use of sound natural and social sciences and compliance with regulations.

4 PROTECTED SPECIES IN THE PROJECT AREA

We are obligated to manage, conserve, and rebuild populations of marine mammals and endangered and threatened marine and anadromous species in rivers, bays, estuaries and marine waters of the United States. Through management, conservation and recovery efforts, and public outreach and education under the Marine Mammal Protection Act and Endangered Species Act (ESA), we strive to ensure the survival of the protected marine species in the Northeast United States for future generations. There are no marine mammals in the project area.

Endangered Atlantic salmon occur in the Lowell Tannery Project area. The Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon is listed as endangered under the ESA (65 FR 69459 and 74 FR 29344). The GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River. Included are all associated conservation hatchery populations used to supplement these natural populations. The Lowell Tannery Project is located within the GOM DPS of Atlantic salmon; thus, project operations may affect the species. The overarching goals of NMFS and the U.S. Fish and Wildlife Service (USFWS) with respect to endangered Atlantic salmon are to recover the species and conserve the ecosystem on which they depend. While adult returns are currently low throughout the DPS, active recovery programs, including raising of fish in hatcheries and stocking, are ongoing and we fully expect that Atlantic salmon will continue be present in the Passadumkeag River during the term of any new license issued by the Federal Energy Regulatory Commission (FERC). As such, potential Project effects to listed Atlantic salmon during the term of the new license must be addressed within the context of this licensing proceeding.

Critical habitat has been designated for listed Atlantic salmon pursuant to section 4 of the ESA (74 FR 29300 and 74 FR 39003). The critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon at the time of listing. The critical habitat designation includes approximately 19,571 kilometers of perennial river, stream, and estuary habitat and 799 square kilometers of lake habitat within the range of the GOM DPS and in which are found the physical and biological features essential to the conservation of the species. The entire occupied range of the GOM DPS in which critical habitat is designated is within the State of Maine. The Passadumkeag River is not located within designated critical habitat for Atlantic salmon.[1]

In February 2019, we jointly issued a Final Recovery Plan for the GOM DPS of Atlantic salmon (NMFS/USFWS 2019) with the U.S. FWS. The Final Recovery Plan includes: 1) a description of site-specific management actions necessary to conserve the species; 2) objective, measurable criteria that, when met, will allow the species to be removed from the endangered and threatened species list; and, 3) estimates of the time and funding required to achieve the plan's goals. The plan presents a recovery strategy based on the biological and ecological needs of the species as

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[1] In the critical habitat analysis, we analyzed the entire Penobscot, Androscoggin, Kennebec, and Downeast Coastal Basins. All of the HUC 10 watersheds outside the historic range were determined to have no biological value to Atlantic salmon and were subsequently not evaluated for critical habitat with the exception of the Passadumkeag watershed (HUC code 0102000503) in the Penobscot River watershed. The Passadumkeag watershed was determined to be occupied up to Grand Falls in Grand Falls Township, though it was assigned a biological value of "1" because of biological quality and habitat quantity. In the ESA section 4(b)(2) exclusion analysis, the Passadumkeag was excluded from designation because it was assigned an economic score of "2", subsequently qualifying this watershed for exclusion.

well as current threats and conservation accomplishments that affect its long-term viability. Our comments and study requests for this project are intended to support the licensing process and facilitate our goals to protect and recover the GOM DPS of Atlantic salmon pursuant to our authorities under the ESA and to ensure FERC meets its obligations under Sections 7(a)(l) and 7(a)(2) of the ESA.

5 NOAA Comments on the Pre-Application Document (PAD)

The pre-application document (PAD) contains information about the Project's structure and operations and affected environmental resources. We offer the following comments based on our review of the PAD.

5.1 PAD Section 4.0 Project Location, Facilities, and Operations

The PAD states that the Lowell Tannery Project is a small run of river hydroelectric dam. The PAD also states the Project has a 68.5-acre reservoir with no usable storage capacity at elevation 187.5 feet mean sea level (msl).

NMFS Comment
Please provide daily reservoir and tailwater elevation data collected at the Project since run of river operations commenced at the Lowell Tannery Project in 2016. This data can be presented graphically and is needed to evaluate operations of the Project.

Upstream passage for anadromous fish is provided by a Denil ladder that is located at the dam. KEI (Maine) provides 40 cubic feet per second (cfs) of attraction flow and conveyance water through the fishway from May 15 through November 10 annually.

NMFS Comment
Please provide the quantity of river herring and American shad that the fishway is designed to pass during the operational period described above. The quantity of fish that the fishway can safely, timely, and effectively convey over a barrier in a given time period is referred to as the fishway (or biological) capacity (USFWS 2017). This information is important to our understanding of the effectiveness of the existing fishway.

5.2 PAD Section 5.2.6 Available Reservoir Information

The applicant states that the Project reservoir has a usable storage capacity of 100-acre feet at elevation 187.5 msl.

NMFS comment
We understand that the Project is currently licensed as run of river and therefore, the Project is not authorized for any storage. In light of this, please clarify the statement regarding usable storage capacity.

5.3 PAD Section 5.3.1 Existing Fish and Aquatic Communities

The PAD states "today, approximately 500 adult salmon return to the Penobscot River". The Applicant also states that "very few salmon, other than escapes or immature adults, are passed upstream of the Milford Project."

NMFS Comment
Please note that over the last twenty years, documented returns of Atlantic salmon in the Penobscot River have ranged from 261 adults (2014) to 3,125 adults (2011)(USASC). As such, the number of adult salmon passed upstream of the Milford Project can vary in any given year. Regardless of these numbers, Atlantic salmon occur in the Project area.

The PAD states that three anadromous fish species (Atlantic salmon, sea lamprey, and American eel) have been documented in the Passadumkeag River.

NMFS Comment
The PAD fails to acknowledge that the Passadumkeag River historically supported abundant runs of anadromous species of river herring (blueback herring and alewives). American shad were also known to migrate upstream of the Lowell Tannery Project (American Shad Working Group 2001). The PAD also fails to acknowledge that aquatic habitat within and upstream of the Lowell Tannery Project is currently used by river herring and that the habitat is suitable for these species. The Passadumkeag River upstream of the Lowell Tannery Project is currently capable of supporting over 1 million alewives (MDMR 2008).

The Maine Department of Marine Resources (MDMR) has developed plans to restore alewives and American shad in the Passadumkeag River including upstream of Lowell Tannery Project (MDMR/MDIFW 2008; MDMR/MDIFW 2009). The MDMR has stocked river herring upstream of the Lowell Tannery Project in Saponac Pond annually in 2011 to 2014 (unpublished data, Maine DMR). Adult and juvenile river herring (alewives and/or blueback herring) have been documented in the Lowell Tannery Project area, including within the upstream fishway (personal communication, February 14, 2010, Peter Ruksznis, Fisheries Biologist, MDMR). Although American shad presently occur in the Penobscot River upstream to the confluence of the Passadumkeag River, it is not presently known if the species occurs in the Lowell Tannery Project area.

5.4 PAD Section 5.6 Threatened and Endangered Species

The PAD states that there is no documentation of Atlantic salmon presently occurring in the Passadumkeag River.

NMFS Comment
This statement is incorrect. Atlantic salmon have been documented in the Lowell Tannery Project nearly annually since 2011. PIT tags studies conducted at the Lowell Tannery Project since 2002 have documented 140 adult salmon using the Project's upstream fishway (unpublished data, University of Maine at Orono). We note that the Licensee has collaborated on these PIT tag studies since their inception. In April 2012, over a dozen post-spawned Atlantic salmon were documented in the Lowell Tannery Project headpond. Based upon on-site observations by NMFS and MDMR staff, these adult fish were unable to find a safe downstream route pass the Lowell Tannery Project. KEI (Maine) staff were aware of this issue in 2012. Also, Atlantic salmon parr were stocked in the lower Passadumkeag River annually from 1989 - 2001(USASC 2018).

PAD Section 6.0 Preliminary Listing of Potential Issues

The PAD states that the Project will continue to operate run of river thereby limiting effects to aquatic habitat.

NMFS Comment

The PAD fails to acknowledge that under existing conditions, the Project will continue to impact passage of upstream and downstream anadromous species including Atlantic salmon and river herring. The impacts to passage of these species negatively impacts the ability of state and federal resource agencies to achieve their goals to restore anadromous species to the Passadumkeag River. Stich et al (2018) documented that high upstream and downstream passage rates are necessary at dams in the Penobscot River to achieve the State of Maine's restoration goals for anadromous American shad. High upstream and downstream survival rates at dams in the Penobscot River are also necessary to recover Atlantic salmon (Nieland et al 2013).

6 Study Requests

We recommend the following studies be conducted during the study phase of the relicensing activity. Each study is supported using the Commission's study plan criteria 18 CFR 5.9(b). Information derived from each of these studies will inform the decision process during this licensing action.

Study 1: Anadromous Fish Upstream Passage Efficiency Study

Endangered Atlantic salmon and river herring occur within the Project area. American shad could occur in the project area, however, numbers are expected to be too low for conducting passage studies. Therefore, the Project area is part of the migratory corridor for upstream pre-spawn adult salmon and river herring. For restoration and recovery of these species to occur, adult pre-spawn anadromous fish should be able to pass the Project when they are biologically and physically ready, and the full run including early- and late-arrival fish should have access to passage to support genetic diversity and resilience within the stock. Anadromous fish should not experience undue harm or stress, and structures should not induce a negative effect on migrants. The lack of effective upstream passage would impact state and federal goals for restoring anadromous species to the Passadumkeag River. Presently, there is no quantitative data concerning the effectiveness of the upstream fishway is passing upstream anadromous species at the Lowell Tannery Project.

As such, we request a study to understand upstream passage efficiency for anadromous fish (i.e., alewife, blueback herring, and Atlantic salmon) at the Lowell Tannery Project, as well as the movement and behavior of these species immediately downstream of the Project. Data from this study will provide important information for evaluating whether the existing fishway meets the overall goals of safe, timely, and effective passage for these species. KEI (Maine) should establish rigorous criteria for the study in consultation with the resource agencies. Consultation with the resource agencies will be necessary regarding any potential modification to fish passage designs prior to filing with the Commission.

Study Plan Criteria

1. The goal of the study is to evaluate whether the existing upstream fishway provides safe, timely and effective passage for river herring and ESA-listed Atlantic salmon. The objectives of this study are to: 1) describe the passage effectiveness, and the extent of injury and mortality that occur during passage, and 2) assess the extent of delay migrating fish may experience due to Project operations.
2. The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Resource management goals and plans are codified in our regulatory statutes. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.
3. The requestor, NMFS, is a federal resource agency.
4. Although both Atlantic salmon and river herring have been documented using the upstream fishway at the Lowell Tannery Project, no quantitative studies concerning fishway effectiveness have been conducted to date. Results of this study request will provide information to determine if the fishway operations meet the overall goals for safe, timely and effective passage that are necessary to achieve state and federal restoration goals for the watershed.
5. Anadromous fish use flow to orient their migratory path. Project operations affect flow fields surrounding the Project. Evaluating the response of migratory fish to the flow fields surrounding the Project during the study phase will assist in the consultation process for evaluating existing fish passage facilities. These data will also contribute to the development of an administrative record in support of potential Section 18 fishway prescriptions or 10(j) recommendations as well as the ESA consultation concerning the relicensing of the project.
6. There are a variety of observational, field, and desktop methods that could be used to evaluate effectiveness, delay, injury, and mortality associated with passage at the Lowell Tannery Project. For species that are available in sufficient numbers (i.e., river herring), we request that a radio-telemetry study be conducted. Radio telemetry studies are a commonly accepted field method for assessing in-stream behavior of migratory fish. A well-executed radio telemetry study can track the location of fish within the river. At a minimum, arrays should be placed to detect fish that might be attracted to flow from the tailrace, gates, spillway and downstream of the entire Project. Fish can be captured, tagged, and released directly downstream of the Project. A minimum of 100 river herring should be used to ensure a sufficient sample size for this study. Seining, dip nets, cast nets, and electrofishing have been used to successfully capture river herring for studies.

   Atlantic salmon are currently at very low abundance within the Passadumkeag River; it is unlikely that they will occur in sufficient numbers to conduct a telemetry study. Therefore, we request that KEI (Maine) continue to collaborate with the University of Maine on PIT tag studies for adult salmon at the Lowell Tannery Project.
7. The telemetry studies could be completed in one migration season with potential for a second season depending on success of the implementation and seasonal conditions. The

level of effort and cost is commensurate with a Project size of the Lowell Tannery facility and the likely license term. No alternatives have been proposed.

Study 2: Downstream Fish Passage Effectiveness and Survival: Behavior, Entrainment and Impingement at the Intake.

Atlantic salmon adults (pre and post-spawned) have been documented in the Lowell Tannery Project area. Given pre-spawn Atlantic salmon occur upstream of the Project, we must assume that some level of natural reproduction is occurring upstream of the project. This means that downstream migrating Atlantic salmon, including smolts and kelts, will be present at the Project and need to pass downstream of the project to complete their lifecycle. Therefore, Atlantic salmon smolts and kelts require safe and effective downstream passage at the Project.

As indicated above, MDMR is actively engaged in the restoration of anadromous alewife, blueback herring, and American shad in the Penobscot River including the river upstream and downstream of the Lowell Tannery Project. In 2011, MDMR initiated stocking of river herring upstream of the Lowell Tannery Project. The MDMR's 2009 Operational Plan for the Restoration of Anadromous Fishes to the Penobscot River details goals for restoring river herring to the Passadumkeag River.

According to the PAD, downstream fish passage at Lowell Tannery is provided through a dedicated fish bypass adjacent to the eastern side of the intake racks. The bypass consists of a downstream surface bypass gate that leads to an 18- inch bypass pipe, which discharges into a plunge pool next to the tailrace. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (Maine) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts (i.e., post-spawned adults) is provided through the downstream fishway from November 1 to ice-in. The effectiveness of the downstream passage facility for anadromous fish has never been evaluated. The survival of fish through the Project's turbines is not known. Furthermore, the overall survival of anadromous fish passing downstream through all potential routes of passage (turbine, spillway, downstream fishway) of the Project is not known. Hydroelectric facilities impact fisheries resources through migratory delay, increased predation, and injury or death through intake entrainment and impingement. The delay, death and injury of river herring and Atlantic salmon at the Project must be determined to assess the Project's effects on our trust resources within the Passadumkeag River.

We recommend KEI (Maine) conduct a study to assess the effectiveness of the existing downstream fishway in passing river herring and Atlantic salmon. The study must also assess the survival of both species using the downstream fishway and other passage routes at the Project (turbines and spillway) including survival through the project reservoir. Information collected during this study will serve to determine the adequacy of existing passage facilities at the Project for restoring these species to the Passadumkeag River.

Study Plan Criteria

1. The goal of the study is to evaluate: 1) behavior of outmigrating juvenile and adult river herring and juvenile Atlantic salmon at the Project intakes; 2) the potential level of

entrainment and impingement of the species/lifestages at the Project intakes; 3) the survival of these species and lifestages that pass through the downstream fish bypass, turbines, and spillway; and, 4) delays in downstream passage at the Project for these species and lifestages. The study should also determine the physical characteristics of the both intake structures including their location and dimensions, the velocity distribution in front of the intake structures and the need for additional measures to minimize and mitigate potential impacts associated with Project operations.

2. NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Resource management goals and plans are codified in our regulatory statutes. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not readily available. This study is an appropriate request for the pre-application period.
3. The requestor, NMFS, is a federal resource agency.
4. Information in the PAD was not sufficient to evaluate the potential for Project induced entrainment or impingement of anadromous fish at the Project's powerhouse intakes. Results of this study will provide information regarding fish behavior at the intakes, entrainment and impingement impacts at the Project intakes and inform the consultation process for developing appropriate downstream fish passage and protection measures.
5. Downstream migrating fish are susceptible to impingement on trash racks or entrainment through turbines when the Project is operating. This is a direct project related impact. The PAD does not include data or a discussion evaluating the potential extent of those impacts. Evaluation of the fish behavior and potential for entrainment and impingement impacts is needed to inform the Commission's licensing decision on the need for downstream fish passage and protection measures and contribute to an administrative record for potential Section 18 fishway prescriptions. The use of desktop analysis to estimate survival of fishes have been demonstrated to be vastly inaccurate and therefore is not an appropriate method to collect this information (see Ellsworth Project, FERC No. 2727)[2].
6. Field studies involving both radio telemetry and direct turbine injection studies should be performed at the Project to determine routes of passage, effectiveness of existing downstream fishways, and survival through Project turbines, spillway, and other routes of passage. Radio telemetry has been successfully used at many FERC-licensed hydro Projects throughout New England, including the State of Maine, to collect this information (see representative list of studies below). We expect that Atlantic salmon smolts will be available for the study from the USFWS's Green Lake National Fish Hatchery. Adult river herring for the study can be readily obtained immediately downstream of the Lowell Tannery Project. Juvenile river herring can be obtained at a downstream collection facility located on Sabattus Lake in Maine. The study must utilize an adequate sample size of test fish to obtain statistically valid results. We recommend downstream telemetry studies involving at least 100 adult river herring and 100 juvenile river herring and 100 Atlantic salmon smolts (300 total fish).
7. Field work would be required to collect data on juvenile and adult river herring and

[2] FERC Accession Numbers 20130904-3002 and 20141230-3032

Atlantic salmon that are being impinged and entrained, survival of fish using other passage routes (spill, downstream fishway), delay of passage, the behavior of fish at the intake, and obtaining water velocity data. This seasonal nature of this study will require at least one full year to complete. The level of effort and cost of the recommended study is commensurate with a project the size of the Lowell Tannery Project and the likely license term. No alternatives (e.g., desktop studies) can accurate provide this necessary information.

Methods References

Normandeau Associates, Inc. (Normandeau). 2014. Assessment of Upstream Passage of Adult American Shad at the Spring Island and Bradbury Fish Locks, Cataract Project, Saco River, Maine. Report Prepared for Brookfield White Pine Hydro. Report date December 2014. [Upstream adult shad]

Normandeau Associates, Inc. (Normandeau). 2015. Assessment for Entrance Siting and Fish Passage Location, West Buxton Project, Saco River, Maine. Report Prepared for Brookfield White Pine Hydro. Report date January 2016. [Upstream adult river herring]

Normandeau Associates, Inc. (Normandeau). 2015. Assessment of Upstream American Shad Passage, Lockwood Project, Kennebec River, Maine. Report Prepared for Merimil Limited Partnership. Report date March 2016. [Upstream adult shad]

Normandeau Associates, Inc. (Normandeau). 2016. Radio-telemetry Evaluation for Upstream Fish Passage Entrance Placement, Shawmut Project, Kennebec River, Maine. Report Prepared for Brookfield White Pine Hydro. Report date September 2016. [Upstream adult river herring]

Normandeau Associates, Inc. (Normandeau). 2016. Upstream and downstream passage of adult American shad at the Holyoke Hydroelectric Project. Report Prepared for Holyoke Gas and Electric. [Upstream and Downstream adult shad]

Normandeau Associates, Inc. (Normandeau). 2015. ILP Study 21 American Shad Telemetry Study – Final Study Report. Report Prepared for TransCanada Hydro Northeast, Inc. Report date February 2017. [Upstream and Downstream adult shad]

Normandeau Associates, Inc. (Normandeau). 2016. Radio-telemetry evaluation of downstream passage and survival of adult river herring, Hydro Kennebec, Kennebec River, Maine. Report Prepared for Hydro Kennebec LLC. Report date March 2017. [Downstream adult river herring]

Normandeau Associates, Inc. (Normandeau). 2015. Evaluation of downstream passage for adult and juvenile river herring, Lockwood Project, Kennebec River, Maine. Report Prepared for Merimil Limited Partnership. Report date January 2016. [Downstream adult river herring; tank evaluation of juvenile tagging]

Normandeau Associates, Inc. (Normandeau). 2017. Assessment of adult American shad outmigration at the Milford, Stillwater and Orono Projects, Penobscot River, Maine. DRAFT Report – in client review now [Downstream – Adult Shad]

Normandeau Associates, Inc. (Normandeau). 2016. Downstream passage of juvenile American shad at the Holyoke Hydroelectric Project. Report Prepared for Holyoke Gas and Electric. [Downstream juvenile alosines]

Normandeau Associates, Inc. (Normandeau). 2015. Garvins Falls Juvenile Clupeid Downstream Passage Telemetry Assessment, Merrimack River, New Hampshire. Report Prepared for Eversource Energy. Report date January 2016. [Downstream juvenile alosines]

Study 3: Downstream Fish Entrainment and Impingement at the Intake.

Hydroelectric facilities are known to impact fisheries resources through migratory delay, increased predation, and injury or death through intake entrainment and impingement. We recommend the licensee conduct a study to assess turbine entrainment and impingement potential at the Lowell Tannery Project. This study is intended to evaluate the existing downstream passage method (trashracks and surface weir) and determine the need for enhancements to protect downstream migrating juvenile and adult diadromous fish. Information collected during this study will also serve to develop actions for recovering Atlantic salmon and Alosines in the project area.

Study Plan Criteria

1. The goal of the study is to evaluate: 1) the potential level of entrainment and impingement at the Project intake; and, 2) and the effects on the quality of fisheries resources in the Lowell Tannery Project. The objectives of this study are to describe: 1) the physical characteristics of the intake structure including its location and dimensions, the velocity distribution in front of the intake structure; the presence of any trashracks or screens, and if present, the size of the clear spacing between bars; 2) assess the relative abundance, age and size, timing, and species composition of fishes potentially entrained, impinged, or otherwise affected by the intake structure based upon swim speeds; 3) describe the effects of Project induced entrainment or impingement on the fish resources (injury and mortality); and, 4) evaluate the need for measures to minimize and mitigate potential impacts associated with Project operations.
2. The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Resource management goals and plans are codified in our regulatory statutes and outlined in the 2011-2014 CFMP. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not readily available. This study is an appropriate request for the pre-application period.
3. The requestor, NMFS, is a federal resource agency.
4. Information in the PAD was not sufficient to evaluate the potential for Project induced entrainment or impingement of fish at the Project's intake and any associated effects on the quality of the Lowell Tannery impoundment fishery resource. Results of this study will provide information regarding fish behavior at the intakes, potential entrainment and impingement impacts at the Project intakes and inform the consultation process for developing appropriate downstream fish passage and protection measures.

5. Fish that occupy the Lowell Tannery impoundment, including diadromous species, are susceptible to impingement on Project trashracks or entrainment through the Project's turbine when the Project is operating. This is a direct project related impact. The PAD does not include data or a discussion evaluating the potential extent of those impacts. Evaluation of the fish behavior and potential for entrainment and impingement impacts is needed to inform a decision on the need for downstream fish passage and protection measures in the license and contribute to an administrative record for potential Section 18 fishway prescriptions.
6. A number of different field methods could be used to survey velocities at the intake structure. These methods are well-established. Measurements of single point velocities on a two foot by two-foot grid measured six inches upstream and across the front of trashracks should be taken with a portable velocity meter or acoustic doppler current profiler or comparable method. The velocities should then be compared to published swim speeds of fish expected to be in the project area and assess their potential for becoming impinged or entrained.
7. Field work would be required to collect data on water velocity data. This seasonal nature of this study will require at least one full year to complete. The level of effort and cost of the recommended study is commensurate with a project the size of the Lowell Tannery facility and the likely license term. No alternatives have been proposed.

7 Literature Cited

American Shad Working Group. 2001. A Strategic Plan to Restore American Shad (*Alosa sapidissima*) to the Penobscot River, Maine. Prepared by the U.S. Fish and Wildlife Service, Penobscot Indian Nation, Maine Department of Marine Resources, and Maine Department of Inland Fisheries and Wildlife

Maine Dept. of Marine Resources and Maine Dept. of Inland Fisheries and Wildlife. 2008. Strategic Plan for the Restoration of Diadromous Fishes to the Penobscot River

Maine Dept. of Marine Resources and Maine Dept. of Inland Fisheries and Wildlife. 2009. Operational Plan for the Restoration of Anadromous Fishes to the Penobscot River.

Nieland, J.L., Sheehan, T.F., Saunders, R., Murphy, J.S., Trinko Lake, T.R. and Stevens, J.R., 2013. Dam impact analysis model for Atlantic salmon in the Penobscot River, Maine.

Stich, Daniel S., Timothy F. Sheehan, and Joseph D. Zydlewski. "A dam passage performance standard model for American shad." Canadian Journal of Fisheries and Aquatic Sciences 999 (2018): 1-18.

U.S. Atlantic Salmon Assessment Committee. 2017 Activities. Report No. 30 – 2017. Portland, Maine.

USFWS (U.S. Fish and Wildlife Service). 2017. Fish Passage Engineering Design Criteria.
USFWS, Northeast Region R5, Hadley, Massachusetts.

USFWS and NMFS. 2018. Final recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (Salmo salar). 75 pp.

Document Content(s)

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

JANET T. MILLS
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

March 11, 2019

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Lowell Tannery Hydroelectric Project (P-4202)

Dear Secretary Bose:

The Maine Department of Marine Resources (MDMR) is writing in response to the November 23, 2018 Notice of Intent to file license application, filing of Pre-Application Document (PAD), and approving use of the Traditional License Process for the Lowell Tannery Project (FERC No. 4202).

Below you will find our comments regarding the PAD, as well as a request for two additional studies. If you have any questions or need additional information, please contact (casey.clark@maine.gov) or (207) 624-6594.

Sincerely,

Patrick C. Keliher, Commissioner

cc: Sean Ledwin, Gail Wippelhauser, Casey Clark, DMR
John Perry, DIFW
Kathy Howatt, DEP
Steven Shepard, USFWS
Sean McDermott, Jeff Murphy, NOAA

Background

The Lowell Tannery Hydroelectric Project is located on the Passadumkeag River in the Town of Lowell, Maine. The Passadumkeag River is a tributary to the Penobscot River. The Project consists of a dam, spillway, fish passage facilities, a 1,000 kw powerhouse, and ancillary equipment. The Project has a drainage area of 301 square miles, and at normal pool elevation of 182.3 feet, has a reservoir surface area of 68.5 acres with no usable storage.

1. Comments on the Pre-Application Document (PAD)

MDMR appreciates the Licensees' effort to prepare the PAD, which provides existing and relevant information intended to enable participants in the relicensing proceeding to identify issues and related information needs and to develop study requests. We provide the following specific comments:

3.1 Overview

River flow data for the Lowell Tannery Project was generated from United States Geological Survey (USGS) gage No. 01031500 (Piscataquis River at Dover-Foxcroft, Maine) for the period January 1987 to December 2017. Data from the gage were adjusted using seasonal proration factors to the Lowell Tannery Project. The mean, median, minimum, and maximum annual river flows of the Passadumkeag River at the Lowell Tannery Project are estimated to be 545 cfs, 270 cfs, 5 cfs, and 6,980 cfs, respectively (Table 5-3). The maximum monthly average flow typically occurs in April, and the minimum monthly average flow is typically in August-September. Annual and monthly flow duration curves for the Lowell Tannery Project are presented in Appendix E.

MDMR Comment: The Piscataquis is a separate drainage. Flow conditions are unique to the habitat and associated restrictions of a given drainage are not transferable between drainages. If the Piscataquis drainage is used as a surrogate, language needs to be added to the PAD to the effect of the above. In addition, licensee needs to thoroughly describe what is meant by "data from the gage were adjusted using seasonal proration factors". Please describe the prorations that were used and justify that those prorations are appropriate.

3.3 Major Water Uses

The Penobscot River is also utilized for recreational purposes; the majority of which are fishing and boating. Some of the best fishing can be found along the shores of the Penobscot River. The West Branch of the river is known for its landlock salmon fishing and the East Branch is very well known for its Smallmouthed Bass Fisheries (TMH 2018).

MDMR Comment: TMH is not a primary source and the statement above from the PAD does not reflect the management plan of the agencies that oversee the watershed. For accurate information on the Penobscot river, please refer to the management plans provided below.

- Strategic Plan for the Restoration of Diadromous Fishes to the Penobscot River
- Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River

4.1 Existing Project Facilities

The PAD states "The project has a 68.5-acre reservoir with no usable storage capacity at 187.5 feet mean sea level (MSL)."

MDMR Comment: In the description of the project submitted by Civil Engineering Services on May 25, 1982 the project reservoir is described as: "The existing water surface encompasses some 38.6 acres. At peak impoundment levels an additional 29.9 acres will be inundated, resulting in an impoundment surface area of 68.5 acres." In 1988, Maine Dept. of Environmental Protection stated that "Subsequent field inspections have revealed that the impoundment extends further upstream than originally anticipated." As a result MDEP ordered clearing of trees in addition to the original clearing plan of 29.9 acres (dated May 17, 1984). Analysis of satellite images shows a much larger area impacted by the project impoundment, which is likely due to outdated project boundary mapping. The project boundary map included in the 1982 filing shows the project boundary continuing up to the point where the Passadumkeag River is directly adjacent to Woodman Hill Road (45.18499, -68.44279), approximately 2.9 km upstream of the project. The project reservoir map including in the current PAD shows the project boundary only continuing 1.25 km upstream of the project. This should be corrected to accurately reflect the entire impacted area. Geographic coordinates for each corner of the impoundment, an updated map clearing showing the project boundaries, and the updated total area of the impoundment should be included in the PAD. A survey will likely need to be done to assess this boundary.

4.4 Existing Project Operations

The PAD states "KEI (USA) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for Kelts is provided through the downstream fishway from November 1 to ice-in."

MDMR Comments: Juvenile alewives move downstream starting in early August. The current project operations do not appear to provide downstream passage for juvenile alewives during the peak of downstream migration. MDMR requests that the PAD include a description of any other current operations at the Project that provide downstream passage.

4.5 Proposed Project Operations

The PAD states "KEI (USA) is not currently proposing any changed to the existing Project operations."

MDMR Comments: A letter received from Maine Live Fish, Inc received by MDMR November 4th, 1987 documented a drastic decrease in the number of American eels captured at weir on the Passadumkeag River as a result of the Lowell Tannery Project. The Licensee should anticipate that upstream passage at the Lowell Tannery Project for American eels will be required during relicensing. MDMR requests that proposed facilities and operations for upstream passage of American Eel be included in the PAD.

5.3.1 Existing Fish and Aquatic Communities

The PAD states "today, approximately 500 adult salmon return to the Penobscot River". The Applicant also states that "very few salmon, other than escapes or immature adults, are passed upstream of the Milford Project.

MDMR Comment: Recovery of self-sustaining populations of Atlantic Salmon is central to the mission of MDMR. Natural spawning is fundamental to recovery, genetic viability, and long-term persistence of self-sustaining populations. In recent years, low returns to the Penobscot River have necessitated that a higher proportion of total returns be taken to federal hatcheries for broodstock. However, the drivers of low adult returns (e.g. low marine survival) are not static. In addition, the method for collection of broodstock is subject to change and would result in release of salmon above the Milford project. MDMR requests that the PAD reflect that the number of salmon passed upstream of Milford project can vary in any given year.

PAD Section 5.6 Threatened and Endangered Species

The PAD states that there is no documentation of Atlantic salmon presently occurring in the Passadumkeag River.

MDMR Comment: Atlantic salmon have been documented within the Lowell Tannery Project boundaries nearly annually for the last ten years. The Licensee collaborated on PIT tag studies at the Project that were conducted by University of Maine Orono (2002). In addition post-spawn adults were documented in the Project headpond on April, 2012. Based upon on-site observations by NMFS and MDMR staff, these adult fish were unable to find a safe downstream route pass the Lowell Tannery Project. KEI (Maine) staff were aware of this issue in 2012. Also, Atlantic salmon parr were stocked in the lower Passadumkeag River annually from 1989 - 2001(USASC 2018).

2. Study Requests

MDMR requests three studies that are relevant to upstream and downstream passage of diadromous fish species at the Project:

1. Eel passage facility and design siting;
2. Effectiveness testing of existing upstream passage efficiency and survival;
3. Effectiveness testing of existing downstream passage and associated entrainment and survival.

Study 1. Eel Passage Facility Design and Siting

1. Goals and objectives

The goal of the study is to determine appropriate designs and locations for upstream and downstream eel passage facilities, and to determine their operating criteria for the Lowell Tannery Project.

2. Relevant resource management goals

MDMR is a cabinet level agency of the State of Maine. MDMR was established to regulate, conserve, and develop marine, estuarine, and diadromous fish resources; to conduct and sponsor scientific research; to promote and develop marine coastal industries; to advise and cooperate with state, local, and federal officials concerning activities in coastal waters; and to implement, administer, and enforce the laws and regulations necessary for these purposes. MDMR is the lead state agency in the restoration and management of diadromous (anadromous and catadromous) species of fishes.

MDMR's management goal is restore alewife, blueback herring, American shad, American eel, and Atlantic salmon to their historic habitat in the Passadumkeag River watershed, MDMR has been actively restoring alewife to their historic range in the Passadumkeag River since 2011 by stocking pre-spawning adults into historic habitat. Atlantic salmon have been documented within the Project boundaries. Upstream and downstream passage for American eel has been provided at the hydropower facilities downstream of the Passadumkeag River.

3. Existing information

MDMR is not aware of any existing information regarding the timing of downstream eel migration, size distribution of eels or the behavior of migrants at the Project.

4. Nexus between project operations and effects

The Lowell Tannery blocks or inhibits the upstream movement of American eel. Passage facilities are needed to reestablish the connection between American eel growth and spawning habitats.

5. Study methods

A phased approach is appropriate for the design and implementation of American eel passage. An initial field study of eel abundance, size distribution, and behavior at the downstream face of the powerhouse and spillway will be conducted to inform fishway location and design decisions. This would be a nighttime survey and should be conducted during the upstream migration season for American eels (June1 to September 15). This would be followed by upstream fishway final design and construction. Finally, an adaptive approach would be developed to monitor and refine the facilities and their operation. Downstream passage will be informed by Study 3.

6. Level of effort and cost and consideration of alternative studies

Field work would be required to inform the fishway design and location. This would be a low level of effort that may span one or two field seasons, depending on eel abundance.

Study 2. Effectiveness testing of existing upstream passage efficiency and survival

1. Goals and objectives

The goal of this study is to evaluate whether the existing upstream fishway provides safe, timely and effective passage from river ESA-listed Atlantic Salmon and river herring. Specific objectives are to 1) describe the passage effectiveness, and the extent of injury and mortality that occur during passage, and 2) assess the extent of delay migrating fish may experience due to Project operations.

2. Relevant resource management goals

See description in Study 1.

3. Existing information

It is our understanding that the effectiveness of this upstream passage facility has never been tested using quantitative studies.

4. Nexus between project operations and effects

Fish that migrate upstream past the Lowell Tannery Project are subjected to potential delays, injury, and stress in the upstream fish passage facilities at the Project. Evaluation of the effectiveness of this passage is necessary if the Licensee proposes to continue using it to pass upstream migrants.

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5. Study methods

MDMR requests the use of radio-telemetry to evaluate upstream passage route and project survival, respectively, for adult alewife. At a minimum, an array of stationary radio-telemetry receivers will be placed prior to the peak upstream migration for adult alewife in the Passadumkeag River. Telemetry receivers will be placed above and below the Project to assess passage and monitor passage through the fishway. A statistically significant number of telemetered fish will be released downstream of the Project impoundment, throughout the migration season, and releases should encompass various flow conditions and operating conditions. Throughout the study, the Licensee will record river flows and project operations. Atlantic salmon are currently at very low abundance within the Passadumkeag River; it is unlikely that they will occur in sufficient numbers to conduct a telemetry study. We request that KEI (Maine) continue to collaborate with the University of Maine on PIT tag studies for adult salmon at the Lowell Tannery Project.

6. Level of effort and cost and consideration of alternative studies

There is a moderate to high level of effort and cost associated with this type of study. Field work would be required to collect data on the species studying the behavior of fish below the Project and within the fishway. Depending on outcome of the first year of the study and sampling size, an additional year of data collection may be necessary. No alternatives are proposed.

Study 3. Downstream fish passage effectiveness

1. Goals and objectives

The goal of this study is to determine the effectiveness of the existing downstream fish passage facility for adult alewife and adult American eel during the appropriate migration season under a range of flows with particular attention to high flow conditions and routes of passage. Specific objectives are to 1) determine the proportion of fish that utilize the existing routes of downstream passage (I.e. powerhouse, fish passage facility, spillway); 2) estimate the survival for each route of passage; 3) estimate transit time through the headpond, past the project, and through defined reaches downstream.

2. Relevant resource management goals

See description in Study 1.

3. Existing information

It is our understanding that the effectiveness of this downstream passage facility has never been tested and therefore the only existing information to inform downstream project routing, potential for delay in passage, or whole project survival is a fish stranding event that was recorded by MDMR in July 1993.

4. Nexus between project operations and effects

Fish that migrate downstream past the Lowell Tannery Project are susceptible to impingement on trash racks and/or entrainment through the powerhouse when the Project is operating. Evaluation of the effectiveness of this passage is necessary if the Licensee proposes to continue using it to pass downstream migrants.

5. Study methods

MDMR proposes the use of a combination of radio-telemetry and balloon tagging to evaluate downstream passage route and project survival, respectively, for adult alewife and adult American eel. To determine downstream passage route, an array of stationary radio-telemetry receivers will be placed prior to the peak downstream migration for adult alewife and adult eel in the Little Androscoggin River. Telemetry receivers will be placed above and below the Project to assess passage and monitor passage over the dam, entrance into the powerhouse turbine, and entrance into each of the bypass pipes. A statistically significant number of telemetered fish will be released upstream of the Project impoundment, throughout the migration season, for each fish and releases should encompass various flow conditions and operating conditions. Throughout the study, the Licensee will record river flows and project operations.

A HI-Z Turb'n Tag approach will be used to determine direct injury and project survival of adult alewife and adult American eel passed through the powerhouse turbine, downstream fish passage, and spillway of the Lowell Tannery Project facilities. This tag allows for immediate recapture of fish after passage through specific routes (turbines, spillways, etc.) in order to assess fish condition and determine the extent and type of any injuries that may occur. A sufficient sample size of fish to be released through each passage route to obtain a statistically significant result. Due to the potential for low survival and high injury rates for fish passed through the powerhouse turbine, a high sample size may be required for testing this portion of Project facilities. After passage through specified routes, fish will be held and injury and relative survival will be assessed at 1 hour and 48 hours. The general protocol for this study design should be similar to the protocol outlined by Normandeau Associates, Inc to assess the Ellsworth Project Dam (FERC No. 2727; 2017)[1].

6. Level of effort and cost and consideration of alternative studies

There is a moderate to high level of effort and cost associated with this type of study. Field work would be required to collect data on the species that may be entrained, studying the behavior of fish at the intake, and obtaining water velocity data. Depending on outcome of the first year of the study and sampling size, an additional year of data collection may be necessary. No alternatives are proposed.

[1] "Evaluation of Survival and Injury Occurrence Associated with Downstream Passage for Juvenile Salmonids". Ellsworth Project, FERC No. 2727. Prepared by Normandeau Associates, Inc. November 2017.

Document Content(s)

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

PAUL MERCER
COMMISSIONER

VIA ELECTRONIC FILING

March 12, 2019

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Pre-Application Document and Study Requests for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

Dear Secretary Bose:

The Maine Department of Environmental Protection (Department or DEP) received and reviewed a Pre-Application Document (PAD), submitted on September 26, 2018 by Kruger Energy, KEI (USA) Power Management Inc. (applicant), for the Lowell Tannery Hydroelectric Project (Project) (FERC No. 4202). Department staff attended the joint agency meeting on January 11, 2019, and reviewed appropriate Project documents to prepare the following comments and study requests.

The proposed relicensing of the Lowell Tannery Project is subject to water quality certification provisions of Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act). By Executive Order of the Governor of the State of Maine, the Department is the certifying agency for projects located wholly or partially in organized towns and cities, and as such has jurisdiction over the Project.

The existing Lowell Tannery Project consists of a 230-foot-long, 27-foot-high concrete gravity dam with a crest elevation of approximately 178.8 feet[1] topped with 3.5-foot-high flashboards (for a total of 182.3 feet normal pond elevation), with a principal spillway of 30 feet and an auxiliary spillway of 89 feet, a seven-foot-wide log sluice and a 10-foot-wide tainter gate. The dam impounds a reservoir with a surface area of approximately 68.5 acres at a normal pond elevation. The dam contains a 3-foot-wide Denil fish passage facility and a dedicated downstream fish bypass pipe. A powerhouse integral to the dam contains a single turbine-generator unit with a total generating capacity of 1 MW and an average annual generation of approximately 4,095 MWh. The Lowell Tannery Project operates in a run-of-river mode where upstream water flowing into the project impoundment approximately equals water flowing downstream from the project.

[1] Elevations are provided in feet above mean sea level.

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The Department understands that there are no proposed changes in facilities or operations of the Rollinsford Project at this time.

Comments on the Pre-Application Document (PAD)

The Department appreciates the effort of the applicant to prepare the PAD. The PAD provides an understanding of the Project facilities, the surrounding resources, and current and proposed project operations. The PAD also provides information from which issues related to relicensing can be readily identified. After review of the available documents, the Department has the following comments on the PAD:

1. **Section 4.0 (p. 4-2)** describes current Project facilities; however, it is unclear whether the normal full pond water elevation is 187.5 feet (listed in the description of the Project Structures, in the description of the Project Reservoir, and in section 4.4, Existing Project Operations) or 182.3 feet (listed as full pond on table 4-1 and in the description of the Dam). The applicant should clarify this.

2. **Section 5.2.9 (p. 5-18 through 5-20)** summarizes existing water quality data collected in the vicinity of the Lowell Tannery Project, however the PAD does not include a proposal for water quality studies (at section 6.2.2) to demonstrate attainment of Maine's water quality standards. Water quality studies are necessary to assess whether the project, under current operation, meets Maine's water quality standards, because Kruger is not proposing changes to its operations under a new license for the Project.

3. **Section 5.2.10 (p. 5-21)** summarizes benthic macroinvertebrate data collected by the Department in 2016, which indicated that sensitive species were present and that the Passadumkeag Stream attains Class A water quality standards for aquatic life and habitat downstream of the Project. However, the Passadumkeag River is Class AA downstream of the Lowell Tannery dam, therefore a Benthic Macroinvertebrate Study may be necessary to ensure that Maine's classification standards are met.

4. Under **Section 6.2.2 (p. 6-3)**, the applicant does not propose any water quality studies. As discussed below in the Water Quality Certification Data Requirements Section, the Department will require several studies to be completed by the applicant to demonstrate attainment of Maine Water Quality Standards in the project area.

Water Quality Classifications and Standards

Water quality standards and the water quality classifications of all surface waters of the State have been established by Maine Legislature (Title 38 M.R.S.A. §§ 464-468). The following classification applies to the waters affected by the Lowell Tannery Project:

"Passadumkeag River and its tributaries – Class A, unless otherwise specified.

(a) Pasadumkeag River from the Pumpkinhill[2] Dam to its confluence with the Penobscot River - Class AA"[3]

Class AA waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; fishing; agriculture; recreation in and on the water; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as free-flowing and natural.

The aquatic life, dissolved oxygen, and bacteria content of Class AA waters shall be as naturally occurs.

Except as provided in statute, there may be no direct discharge of pollutants to Class AA waters.[4]

Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; 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 natural.

The dissolved oxygen content of Class A water shall not be less than 7 parts per million or 75% of saturation, whichever is higher. The aquatic life and bacteria content of Class A water shall be as naturally occurs.

Except as provided in statute[5], direct discharges to these waters licensed after January 1, 1986 are permitted only if, in addition to satisfying all the requirements of this article, the discharged effluent will be equal to or better than the existing water quality of the receiving waters.

Antidegradation

The State's antidegradation policy provides that water quality certification may be approved only if the applicable standards of classification of the affected water body are met and existing in-stream uses and the level of water quality necessary to protect those existing uses are maintained and protected. The policy also provides that, where the actual quality of any classified water exceeds the minimum standards of the next highest classification, that higher water quality classification shall be maintained and protected.[6]

Water Quality Certification Data Requirements

The applicant does not propose any water quality studies for the relicensing of the Lowell Tannery Project; however, water quality studies in the impoundment and tailrace reaches are

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[2] Lowell Tannery facility is also known as Pumpkinhill.
[3] Title 38 M.R.S. §467 (7)(F)(6)
[4] 38 M.R.S. § 465 (1)(C)
[5] Title 38 M.R.S. §465 (2)(C)
[6] See Title 38 M.R.S.A §464(4)(F)

typically required to evaluate compliance with Maine Water Quality Standards before the Department issues a water quality certification for a hydropower project.

It has been the Department's practice to determine the metrics, methods, timing, and duration of water quality monitoring necessary to ensure that the water quality studies meet data quality objectives. The Department requests that the applicant conduct water quality studies that include the following parameters and adhere to the Department's established sampling protocols in support of water quality certification. Formal study requests following FERC's Integrated Licensing Process (ILP) criteria are attached to this comment letter.

Impoundment Trophic State Study – Water quality data presented in the PAD for the Lowell Tannery Project is insufficient to demonstrate that the impoundment exhibits a steady or improving trophic state; therefore the Department is requesting that an impoundment Trophic State Study be conducted to determine if Maine's water quality standards are met. A Trophic State Study should be conducted in accordance with the protocols established in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018), provided with this comment letter.

Impoundment Aquatic Habitat Study – The purpose of this study is to determine the character of the impoundment's littoral zone and the ability of the impoundment to support fish and other aquatic life. The Lowell Tannery Project is operated as a run-of-river facility; therefore, normal operations should not greatly affect the littoral zone. However, bathymetric data is not available for the impoundment and no measurements of the littoral zone have been made. The applicant will need to establish a bathymetric profile of the impoundment and conduct the impoundment aquatic habitat study following the "Habitat Study" protocol under "Lakes, Ponds, and Impoundments" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018), which is provided with this comment letter.

Downstream Temperature and Dissolved Oxygen Study – Temperature and dissolved oxygen must be monitored downstream of the Lowell Tannery dam to verify compliance with Maine dissolved oxygen criteria. Data must be collected in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018), which is attached to this comment letter. As noted in the protocol, the applicant must consult with the Department to verify representative sampling locations as the study plan is developed.

Benthic Macroinvertebrate Monitoring – Assessment of the benthic macroinvertebrate community is required in order to determine whether current in-stream flow releases are affecting attainment of habitat and aquatic life criteria in the river below the Lowell Tannery dam. As noted above, The Department completed a Benthic Macroinvertebrate Study in the Passadumkeag River in 2016, establishing that the Project meets Class A water quality standards. However, the classification standard downstream of the Lowell Tannery dam is Class AA. Therefore, a Benthic Macroinvertebrate Study is necessary and should be developed in accordance with the DEP METHODS FOR BIOLOGICAL SAMPLING AND ANALYSIS OF MAINE'S RIVERS AND STREAMS (2002, revised April 2014), which is attached to this comment letter. The applicant must consult with the Department to determine the sampling location as the study plan is developed.

Aquatic Habitat Cross-Section Flow Study - This study evaluates whether current in-stream flow releases are affecting attainment of habitat criteria for fish and other aquatic life in the Passadumkeag River downstream of the Lowell Tannery dam. It is the Department's position that there must be both sufficient quality and quantity of habitat for aquatic organisms to meet habitat and aquatic life criteria. The applicant must demonstrate attainment of habitat and aquatic life criteria by conducting an Aquatic Habitat Cross-Section Flow Study following the "Habitat and Aquatic Life Studies" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018), which is attached to this comment letter. This study is required in the tailrace reach. The applicant should consult with the resource agencies when establishing the transects for the flow study. All depth, velocity, and wetted width data for each transect should be submitted to the resource agencies and included in any study reports.

Thank you for the opportunity to comment on the Pre-Application Document (PAD) and submit study requests for the Lowell Tannery Project. Please direct any questions regarding these comments and study requests to Kathy.Howatt@maine.gov or 207-446-2642.

Sincerely,

Kathy Davis Howatt
Hydropower Coordinator
Maine Department of Environmental Protection

Encl: Impoundment Trophic State and Aquatic Habitat Study Request
Downstream Temperature and Dissolved Oxygen Study Request
Benthic Macroinvertebrate Study Request
Aquatic Habitat Cross-Section Flow Study Request
DEP Sampling Protocol for Hydropower Studies (June 2018)
Methods for Biological Sampling and Analysis of Maine's Rivers and Streams (August 2002)

cc: Lewis Loon, KEI
Sherri Loon, KEI (email only)
Andy Qua, Kleinschmidt Associates (email only)

Maine Department of Environmental Protection
Study Request
Lowell Tannery Hydropower Project (FERC No. 4202)

Impoundment Trophic State and Aquatic Habitat Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Trophic state and aquatic habitat are important indicators of water quality within the impoundment. Assessment of these criteria provides information to evaluate the health of the impoundment and the impact of the dam structure and operation on the river. The objective of this study proposal is to determine if the project impoundment meets Maine Water Quality Standards including habitat and aquatic life criteria, dissolved oxygen criteria, and the designated use of recreation in and on the water. Data collected will be used to determine if the impounded water satisfy aquatic life criteria.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   Agency file review indicates there is no data in support of these criteria for impounded water upstream of the Lowell Tannery dam. The PAD does not reference a study of this nature, although the height of the dam indicates that stratification may occur in the impoundment. If stratification does occur, it should be identified and its effects quantified.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will identify trophic state and may identify stratification effects on the impounded water and habitat. Information will be used to evaluate whether the Project meets Maine designated uses, habitat and aquatic life criteria, and dissolved oxygen criteria, which will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (June 2018) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.** Trophic state samples are collected twice each month for five consecutive months during open water season. If required, an impoundment aquatic habitat study can be completed in one field season. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lowell Tannery Hydropower Project (FERC No. 4202)

Downstream Temperature and Dissolved Oxygen Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Temperature and dissolved oxygen (DO) are important indicators of water quality to ensure that discharges from the hydropower project are sufficient to maintain the resident biologic community downstream of the Lowell Tannery dam. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower project meets Maine Water Quality Standards including Class C DO criteria.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   Dissolved oxygen concentrations downstream of the Lowell Tannery dam must meet Maine water quality criteria for Class AA waters. Agency file review indicates temperature and dissolved oxygen data is insufficient to assess attainment of these criteria. The PAD does not indicate that a study of this nature is planned for the project.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will be used to evaluate project effects on water temperature and DO concentrations in the Passadumkeag River downstream of the Lowell Tannery dam. Information will be used to evaluate whether the project meets Maine DO criteria for Class AA waters and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
   The DEP Sampling Protocol for Hydropower Studies (June 2018) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
The DEP Sampling Protocol for Hydropower Studies (June 2018) offers two options for the temperature and DO study that can be completed in one field season. Temperature and DO samples can be collected one day per week for at least 10 weeks or measured hourly using data sondes placed at designated locations during summer low flow, high water temperature conditions (e.g. July and August). The Department prefers the second method. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lowell Tannery Hydropower Project (FERC No. 4202)

Benthic Macroinvertebrate Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Assessment of the benthic macroinvertebrate community is critical to determine whether current in-stream flow releases affect attainment of Maine habitat and aquatic life criteria for Class AA waters in the Passadumkeag River below the Lowell Tannery dam. The assessment provides biological data to evaluate potential impacts caused by project operations.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   The Passadumkeag River must meet Maine aquatic life criteria in the vicinity of the Lowell Tannery Project. Agency file review indicates data is insufficient to evaluate the current aquatic community in the tailrace reach downstream of the Lowell Tannery dam. The PAD does not indicate that a study of this nature is planned for the project.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will be used to evaluate the benthic macroinvertebrate community in the tailrace reach downstream of the Lowell Tannery dam. Information will be used to evaluate whether the project meets Maine aquatic life criteria and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
   The DEP <u>Methods for Biological Sampling and Analysis of Maine's Rivers and Streams</u> (August 2002, revised April 2014) was established by Department staff and has been

used successfully throughout the state by DEP and others since 1983. A copy of the Department manual is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.** Replicate benthic macroinvertebrate sample collectors (rock baskets or cones) are deployed for a 28-day study period in the tailrace reach of the hydropower project during low flow, high temperature conditions. Samples must be collected by a professional aquatic biologist and evaluated by a professional freshwater macroinvertebrate taxonomist. Methods are documented in the DEP manual Methods for Biological Sampling and Analysis of Maine's River and Streams (August 2002, revised April 2014). Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lowell Tannery Hydropower Project (FERC No. 4202)

Aquatic Habitat Cross-Section Flow Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
Assessment of aquatic habitat downstream of the Lowell Tannery dam is required to determine whether current in-stream flow releases meet Maine habitat and aquatic life criteria. An aquatic habitat cross-section flow study measures depth, velocity, and wetted width along established transects at various discharges to determine flows where at least 75% of the stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. Data will be evaluated to determine if the downstream waters provide sufficient quantity of water to maintain riverine aquatic habitat in the bypass and tailrace reaches.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
The Passadumkeag River downstream of the Lowell Tannery dam must meet Maine habitat and aquatic life criteria. Agency file review indicates data is insufficient in the tailrace reach of the Lowell Tannery Project to assess attainment of these criteria. The PAD does not indicate that a study of this nature is planned for the project.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
Data collected will be used to evaluate aquatic habitat in the Passadumkeag River downstream of the Lowell Tannery dam. Information will be used to evaluate whether the project meets Maine habitat and aquatic life criteria and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
   The DEP Sampling Protocol for Hydropower Studies (June 2018) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
   A cross-section flow study measures depth, velocity, and wetted width along established transects in the bypass and tailrace reaches at various discharges to determine flows where at least 75% of the stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. This type of study can typically be accomplished in one or two days. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

DEP SAMPLING PROTOCOL FOR HYDROPOWER STUDIES June 2018

LAKES, PONDS, AND IMPOUNDMENTS

Trophic State Study

Sampling personnel must be certified annually for this sampling protocol by DEP's Division of Environmental Assessment Lakes Section.

Each basin shall be sampled at the deepest location twice each month for at least five consecutive months during one open water season as follows.

Parameter	Sampling method	Detection limits
Secchi disk transparency	water scope	0.1 meter
Temperature	profile[1]	0.1 C
Dissolved oxygen	profile[1]	0.1 mg/l
Total phosphorus	integrated core[2]	0.001 mg/L
Chlorophyll a	integrated core[2]	0.001 mg/L (trichromatic)
Color	integrated core[2]	1.0 SPU
pH	integrated core[2]	0.1 SU
Total alkalinity	integrated core[2]	1.0 mg/l

[1]Profiles shall consist of temperature and dissolved oxygen measurements taken every meter up to 15 meters, every other meter to 25 meters, then every 5 meters thereafter.

[2]Integrated core samples should be obtained 1) in thermally stratified ($\Delta T \geq 1°C/m$ at any depth below the top 3 m depth) waters from an epilimnetic core, unless there is a spike in dissolved oxygen concentration deeper, in which case the core depth should be extended to capture the dissolved oxygen spike, or 2) in non-thermally stratified waters, to twice the Secchi disk depth, 1 m from the bottom, or 10 m, whichever is less.

In addition, during late summer (mid to late August depending on latitude and weather conditions), water samples shall be collected and analyzed from up to three depths in the water column for the parameters below except Chlorophyll *a*. If the waterbody is thermally stratified samples will be collected from an epilimnetic core, at the top of the hypolimnion, and at one meter above the sediment. If the waterbody is not thermally stratified, only one integrated core sample is needed from the surface to two times the Secchi disk depth, to 1 m from the bottom, or 10 m, whichever is less.

Parameter	Detection limit
Total phosphorus	0.001 mg/l
Nitrate	0.01 mg/l
Chlorophyll a (uncorrected)	0.001 mg/l (trichromatic determination)
Color	1.0 SPU
DOC	0.25 mg/l
pH	0.1 SU
Total alkalinity	1.0 mg/l
Total iron `	0.005 mg/l
Total & dissolved aluminum	0.010 mg/l
Total calcium	1.0 mg/l
Total magnesium	0.1 mg/l

Total sodium	0.05 mg/l
Total potassium	0.05 mg/l
Total silica	0.05 mg/l
Specific conductance	1 ms/cm
Chloride	1.0 mg/l
Sulfate	0.5 mg/l

Additional sampling may be required due to the hydraulic or physical characteristics of a given waterbody or to the presence of significant water quality problems.

Habitat Study

For lakes, ponds, and riverine impoundments, determination of attainment of the designated use 'habitat for fish and other aquatic life' will be determined as follows. Using a depth of twice the mean summer Secchi disk transparency, determined from the Trophic State Study or historic DEP data, as the bottom of the littoral zone, the volume and surface area dewatered by the drawdown will be calculated to determine if at least 75% of the littoral zone remains watered at all times. Alternatively, studies of fish and other aquatic life communities, including freshwater mussels, may be conducted to demonstrate that the project maintains 'structure and function of the resident biological community' despite a drawdown that results in less than 75% of the littoral zone remaining watered at all times.

Fishing (Mercury Contamination) Study

To ensure that the project does not contribute to the Statewide Fish Consumption Advisory due to mercury, projects with excessive drawdowns (generally >10 feet) may be required to analyze sport fish from the project waterbody and one or more reference waters for mercury. Contact DEP for specific requirements for each project.

RIVERS AND STREAMS

Temperature and Dissolved Oxygen Study

Applicability

This rivers and streams sampling protocol shall apply to tailwater areas that are not impoundments where existing data are insufficient to determine existing and future water quality.

Sampling Stations

Sampling shall occur in the tailwater downstream from the turbine/gate outlet or dam at a location representative of downstream flow as agreed by DEP on a case by case basis. Initially, measurements of temperature and dissolved oxygen should be made along a transect across the stream at the first, second and third quarter points across the width. If there is no violation of dissolved oxygen criteria and no significant (<0.4 mg/l) difference in concentrations among the quarter points, subsequent measurements may be made at the location shown to be representative of the main flow. Otherwise, measurements should be made at the location of the lowest concentration and the location of the main flow. Sampling should also occur in any bypassed segment of the river created by the project. Additional sampling stations may be required in the upstream or downstream areas where significant point or nonpoint sources exist or where slow moving or deep water occurs. The number and spacing of any additional stations will be determined by DEP on a case-by-case basis.

Parameters

Temperature and dissolved oxygen shall be sampled at mid-depth in rivers less than 2 m deep or in a profile of 1 meter increments of depth in rivers greater than 2 m deep. In rivers where it is already known that attainment of required statutory dissolved oxygen criteria is questionable, sampling for additional parameters (e.g. BOD, nitrogen, phosphorus) may be necessary.

Frequency and Timing

Sampling should be conducted during the summer low flow high temperature period, with the ideal conditions being the 7Q10 flow (the 7 day average low flow with a 10 year recurrence interval) combined with daily average water temperatures exceeding 24 ^{o}C. Measurements of temperature and dissolved oxygen shall be made every hour with a datasonde in remote unattended mode continuously during July and August, unless high flows well above seasonal median flows occur.

Alternatively, with concurrence by DEP, sampling could be undertaken one day per week for a minimum of ten weeks throughout the summer low flow, high temperature period. Each discrete grab sampling event for temperature and dissolved oxygen would consist of a minimum of two daily runs, the first of which should occur before 7 AM and the second of which should occur after 2 PM. Sampling results will not be considered complete unless a minimum of 5 sampling days meets the following conditions: The product of the water temperature (^{o}C) and the flow duration (the percentage of the time a given flow is statistically exceeded) at the time of sampling exceeds 1500. For cycling hydropower projects, in addition to twice daily monitoring, continuous monitoring may be required at some locations for a duration equivalent to the period of one cycle of the storage and the release of flow.

For either method, a summer in which low flows and high temperatures are not experienced may result in additional sampling requirements for the next summer. Low flow conditions may occur naturally, as an unregulated river or may be artificially induced, as in the case of upstream flow regulation or flows downstream from a cycling or peaking power project or in the case of a bypassed segment which receives flow only by spillage, leakage or specific releases.

Available Data

The use of data already available is encouraged provided that adequate QA/QC procedures have been followed. Old data may not be acceptable for considerations of meeting minimum sampling requirements, but could still provide useful information. Acceptance/rejection of data will be determined on a case by case basis, but generally data more than 10 years old may be rejected.

Habitat and Aquatic Life Studies

For rivers and streams, determination of attainment of the designated use 'habitat for fish and other aquatic life' will be determined as follows. A Cross-Section Flow Study is required that measures width and depth at various flows to determine the flow at which at least 75% of the bank full cross-sectional area of the river or stream is continuously watered. At least three cross-sections representative of the river or stream must be measured. Alternately, a combination of ambient measurements in one cross-section, flow data from existing flow gages, and/or modelling may be approved by DEP.

In addition, to determine if the project 'attains the aquatic life criteria, i.e. 'maintains the structure and function of the resident biological community', biological monitoring of the benthic macroinvertebrate community must be conducted following DEP's standard protocol in Methods for Biological Sampling and Analysis of Maine's Rivers and Streams, DEP LW0387-B2002.
A copy can be found at www.maine.gov/dep/water/monitoring/biomonitoring/material.html

Methods for Biological Sampling and Analysis of Maine's Rivers and Streams

Susan P. Davies
Leonidas Tsomides




DEP LW0387-C2014
Revised April, 2014

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

METHODS

FOR

BIOLOGICAL SAMPLING AND ANALYSIS OF

MAINE'S RIVERS AND STREAMS

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Bureau of Land and Water Quality
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CONTENTS

APPENDICES

FOREWORD

This manual describes the field, laboratory and data preparation methods required by the Maine Department of Environmental Protection to collect and analyze benthic macroinvertebrate samples for the River and Stream Biological Monitoring Program. The biological classification of Maine's inland waters was authorized by the Maine State Legislature with the passage of Public Law 1985 Chapter 698 - The Classification System for Maine Waters. This law states that it is the State's objective "to restore and maintain the chemical, physical and biological integrity" of its waters, and establishes a water quality classification system to enable the State to manage its waters so as to protect their quality. The classification system further establishes minimum standards for each class, which are based on designated uses, and related characteristics of those uses, for each class of water.

Each water quality class contains standards that, among other things, describe the minimum condition of the aquatic life necessary to attain that class. The Maine Department of Environmental Protection (the Department) has developed numeric criteria in support of the narrative aquatic life standards in the Water Quality Classification Law. The Department has collected a large, standardized database consisting of benthic macroinvertebrate samples from above and below all significant licensed discharges in the State, from areas impacted by non-point sources, as well as from relatively unperturbed areas. These sampling locations were chosen to represent the range of water quality conditions in the State. This information has been used to develop numeric criteria which are specific to the natural biotic community potential of the State of Maine (see Davies et al., 1995 and 1999 for a description of the development and application of numeric criteria) and is established in DEP regulation Chapter 579 : Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

Standardization of data collection and analytical methods is fundamental to the consistent, unbiased and scientifically sound evaluation of aquatic life impacts. This manual sets forth the standardized practices and procedures used by the Department to acquire or accept benthic macroinvertebrate data for use in regulation, assessment or program development.

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I GENERAL METHODS FOR RIVER AND STREAM AQUATIC LIFE CLASSIFICATION ATTAINMENT EVALUATION

Each water quality class is defined by standards that describe the minimum condition of the aquatic community necessary to attain that class. The benthic macroinvertebrate community is used as an indicator community of the general state of the aquatic life in flowing waters for the purpose of assessment of classification attainment. Standardized sampling techniques and sample analysis are required for assessment of biological attainment of stream water quality classification. This manual presents the standard practices and procedures that have been adopted by the Department to acquire benthic macroinvertebrate data for purposes of aquatic life classification attainment evaluation.

Purpose:

To determine the water quality class attained by a particular river or stream reach in terms of the aquatic life standards set forth in 38 MRSA Sec. 465 (The Classification System for Maine Waters).

Requirements:

All samples of aquatic life that are collected for purposes of classification attainment evaluation, whether collected by the Department or by any party required to make collections by the Department, must be collected, processed and identified in conformance with the standardized methods outlined in this manual. Selection of appropriate sampling sites and micro-habitat to sample, as well as procedures for quantitative analysis of the sample must conform to methods set forth in this manual. Data submitted by any party required to make collections by the Department must be accompanied by a Quality Assurance Plan, approved by the Commissioner.

1. <u>Qualifications of Sampling Personnel</u>

Biological sampling must be performed by a professional aquatic biologist or by qualified personnel under the supervision of a professional aquatic biologist. The professional aquatic biologist must have, as a minimum, a Bachelor of Science degree in biological sciences with aquatic entomology, invertebrate zoology, fisheries or closely related specialization, and greater than 6 months experience working with macroinvertebrate sampling methods and taxonomy. (See also Qualifications of Laboratory Personnel, Sec. II-1.)

2. Apparatus, Equipment, Supplies, Instruments

(1) Sampling devices

a) Rock-filled wire basket introduced substrate

Use: flowing wadeable, eroded, mineral-based bottom rivers and streams.

Description: cylindrical plastic coated or chrome wire, baskets with at least 1.5 cm spaces between wires, a hinged opening, and secure closure (Klemm, D.J. et al, 1990).

Substrate material: clean, washed, bank-run cobble, graded to uniform diameter range of 3.8 to 7.6 cm (1.5 to 3 inches) in size (#2 roofing stone).

Baskets must be filled to 7.25 +/- 0.5 kg (16 lbs +/-1 lb) of substrate material.

b) Rock-filled mesh bag introduced substrate

Use: small flowing streams, too shallow for rock baskets to be fully submerged.

Description: mesh bags of sufficient size to hold 7.25 +/- 0.5 kg of cobble substrate as described above, with at least 2.54 cm aperture mesh, and secure closures.

c) Closing introduced substrate cone

Use: deep, non-wadeable rivers having sufficient flow to have an eroded, mineral based bottom.

Description: cone shaped wire, or plastic coated wire basket filled with substrate material and closed by means of an inverted, weighted funnel (Courtemanch, 1984).

Substrate material: (see above Rock-filled wire basket substrate material).

(2) Sieves, sieve buckets, nets

Samples are concentrated on sieves having a mesh size between 500 - 600 microns (USA Standard Testing Sieve ASTM-E-11 Specification size No. 30 or No. 35).

(3) Optical equipment

a) Binocular microscope: Magnification range from 10x or less to 30x or greater.

b) Compound microscope: Magnification range from 10x to at least 400x; 100x with oil immersion lens is advisable.

3. Sampling Season, Sampler Exposure Period, Placement and Retrieval

(1) Sampling season

The standard sampling season upon which all macroinvertebrate classification criteria are based is the late summer, low flow period (July 1 to September 30). All baseline data for the biological classification program has been collected during this time period. This period often presents conditions of maximal stress to the biological community due to decreased dilution of pollutional material and increased stream water temperatures. Furthermore, because the composition of the benthic macroinvertebrate community changes with season, due to natural life history features, this period defines a standardized seasonal community.

As noted, the Department's linear discriminant models define biological classification criteria derived from a macroinvertebrate community defined by the specific sampling methods and index season under which they were collected. Samples collected at other times of year may yield valuable water quality related information, however classification attainment may not be assigned solely on the basis of results of the linear discriminant models for these non-standard samples.

(2) Exposure period

Standard methods require that substrate samplers be exposed in the water body for a period of 28 days +/- four days within the above-specified sampling season. However, extended exposure periods may be necessary to allow for adequate colonization in the case of assessments of low velocity or impounded habitats. If such conditions exist a 56 days +/- four days exposure period may be used.

(3) Sampler placement

Rock Baskets/Bags

The actual sampler location should be approached so as to avoid any disturbance in, or upstream of, the sampled site. Position baskets in locations of similar habitat characteristics. Orient baskets with the long axis parallel to stream flow. Provide for relocation of baskets by flagging trees in the vicinity and/or by drawing a diagram with appropriate landmarks indicated.

Cones

Cone samplers should be marked with individual marker buoys (milk jugs or other suitable float) leaving about 5 extra feet of line to allow for water level changes and to provide for easy retrieval. They should be placed on the substrate with a minimum of disturbance, in an apex-up position, and located in the approximate middle fifty percent of the channel. (Note however, care should be taken not to create an obstruction to boat traffic.) In areas subject to vandalism, or in rivers having extensive macrophyte beds, it may be necessary to attach the sampler lines to a common anchor and thence to one unobtrusive surface float. Retrieval funnels will not properly close when lines are fouled with drifting macrophytes.

(4) Sampler retrieval

Rock Baskets/ Bags

Baskets are approached from downstream. Excessive accumulations of macrophytes, algae or debris clinging to the outside of the basket should be carefully removed, taking care to avoid jarring the basket itself. An aquatic net or drift net (mesh size 500 - 600 microns) is positioned against the substrate immediately downstream of the basket which is then quickly lifted into the net. The contents of the basket and all net washings are emptied into a sieve bucket (500 - 600 microns); the basket wires are carefully cleaned first, then rocks are hand washed and inspected and returned to the basket. All sieve bucket contents are placed in sample jars. A small amount of stream water and 95% ethyl alcohol is added to yield an approximately 70% solution of alcohol. Especially dense samples should be re-preserved in the laboratory, with fresh 70% ethyl alcohol. Rock baskets should be thoroughly cleaned and allowed to desiccate prior to re-use.

Cones

Cone samplers should be retrieved with the boat anchored directly upstream of the samplers. Once the float is retrieved and removed, the line should be held as vertically as possible while the weighted funnel is released down the line to enclose the cone. Cone and funnel should be retrieved quickly and smoothly from the bottom, and released directly into a sieve bucket or tub. Field processing should then proceed as described above for rock baskets.

4. Site Selection Criteria

Classification criteria apply to a strictly defined sample of the benthic macroinvertebrate community. Habitat type from which the community is obtained is a significant determinant of the make-up of the target community. Benthic macroinvertebrate communities of flowing streams and rivers having a hard, eroded substrate comprise the majority of samples in the baseline data set. This habitat is characteristic of the majority of the river and stream waters of the State. Exceptions to these conditions may require special consideration and the exercise of professional judgment. (Note: See Section III-2. (3) "Classification attainment evaluation of waters subjected to flow regulation" page 13, for procedures relating to the assessment of regulated flow sites.) While it is useful to obtain both an upstream and downstream sample to evaluate the effect of a pollution source, classification attainment evaluation does not require data from a matched reference site in order to arrive at a determination of aquatic life class. Analytical methods for classification attainment evaluation are described in Section III.

(1) Site attributes

a) The area selected should be generally representative of the habitat of the stream reach as a whole;
b) Where there is alternating riffle/pool habitat, the riffle/run is the habitat of choice;
c) A location should be selected where there is a high degree of certainty that the rock basket samples will remain fully submerged even if the water level drops significantly.

(2) Precautions

a) Avoid atypical influences such as bridges, entering culverts, channelized areas such as road crossings, culverts, or obstructions to flow;
b) Avoid bank effects: samplers should be located in the middle 50% of the bank to bank width, or in an area with a flow regime typical of the overall character of the stream segment;
c) Avoid slackwater areas and eddies immediately upstream or downstream of large rocks or debris.

(3) Matching reference and effluent impacted sites

If possible both stream reaches should be viewed prior to selection of sampling sites. Efforts should be made to sample habitats which are comparable in the following characteristics:

a) Water velocity;
b) Substrate composition (i.e., size ranges and proportions of particles making up the substrate);
c) Canopy coverage;
d) Depth;
e) Other upstream influences except the pollution source in question (for example, use caution when one site is just below a lake outfall and the other is not).

(4) Factors to be considered in site selection below point sources

The area of initial dilution of an effluent should be determined by visual observation of the plume pattern; by observations of biotic effects attributable to the plume, if evident (periphyton growth, die-off patterns); and by transects of specific conductance measurements from the outfall, in a downstream direction. The site selected should be in an area where reasonable opportunity for mixing of the effluent has occurred. If a mixing zone has been defined in a license, sampling should occur immediately downstream of it. In cases where the effluent plume channels down one bank for great distances (>1 km), or where localized effluent impact is expected to be severe for a distance beyond the zone of initial dilution, it is advisable to have a sampling site upstream of the source, one or more in the plume, and at least two farther downstream. One downstream site should be located at the point of presumed bank to bank mixing and subsequent sites should be located to assess the extent of impact downstream.

5. Sample Size

The biological community is evaluated on the basis of benthic macroinvertebrates obtained from at least three samplers which yield an average of at least 50 organisms per sampler. Matched upstream and downstream sites must be sampled using identical methods and level of effort, preferably by the same personnel.

Subsampling may be performed on samples if the mean number of organisms in a sampler exceeds 500 and subsampling will yield at least 100 organisms per rock/cone sampler. All samplers in a site should be treated consistently. Subsampling methods are described in Section II-5. Note: Subsampling will reduce sample richness by an indeterminate amount. This may affect the outcome of linear discriminant analysis. See Section III-2. (2).

6. Physical Habitat Evaluation

A field data sheet (Appendix A) is to be completed at the time of sampler placement. This form records site specific information concerning natural variables that may affect community structure. Items addressed include exact site location (latitude and longitude, narrative description of the mapped location and/or a topographic map with site indicated); substrate composition; canopy coverage; land use and terrain characteristics; water velocity, temperature, dates of exposure and investigator name. The form is to be completed by observation as well as instrument measurement of water velocity, specific conductance, dissolved oxygen, global positioning device, temperature, etc.

II LABORATORY METHODS

1. Qualifications of Laboratory Personnel

Sample processing and taxonomy in the laboratory must be performed or supervised by a professional freshwater macroinvertebrate taxonomist who is certified by the Society of Freshwater Science in the identification of eastern US taxa. Certification must include Genus level categories, such as Ephemeroptera, Plecoptera and Trichoptera (EPT), General Arthropods and Chironomidae taxa. Taxonomic data will not be accepted without verification that the supervising laboratory taxonomist has been certified in relevant categories.

2. Sample Preservation, Sorting

All sample material collected in the field, as described in Section I, is preserved in 70% ethyl alcohol. Samples are stored in airtight containers until sorted. Sorting of macroinvertebrates from detritus and debris should follow methods described in Appendix B. One out of every ten samples is evaluated by a biologist for sorting completeness.

After sorting, recommended storage for macroinvertebrates is in 70% ethyl alcohol with 5% glycerin, in vials sealed with tightly fitting rubber stoppers.

3. Sample Labeling

All samples are labeled in the field immediately upon collection. The label must include the following information:

Date of sample retrieval
Waterbody
Town or target discharge
Whether above or below the discharge (if applicable)
Replicate number

4. Sample Log Book

In the laboratory, the samples from each sampled site are to be assigned a sample log number, written on all items generated by the sample (e.g., sample vials, slides, records, count sheets, etc.). Log numbers are sequentially recorded in a master log book. The log book shall also contain site identification, date of placement and retrieval, investigator name, sampler type and any comments regarding sampler retrieval or data quality.

5. Subsampling

(1) Methods

If it is determined that a sample should be subsampled (see criteria in Section I-5 Sample Size) methods of Wrona et al, (1982) are followed. These are summarized below:

a) Fit a plastic or glass Imhoff-type settling cone with an aquarium air stone sealed in the bottom and connected to a compressed air supply.

b) Place the sorted macroinvertebrate sample in the cone and fill the apparatus with water to a total volume of one liter.

c) Agitate gently for 2 to 5 minutes with the air stone.

d) Remove 25% of the sample in 5 aliquots with a wide-mouth 50 ml dipper and combine into one sample vial. The dipper should be submerged and withdrawn over a five second interval.

e) Ascertain whether or not the required 100 organisms have been obtained in the subsample.

f) Indicate clearly on the sample label and on the data sheet the fraction of the sample that the subsample represents.

(2) Precautions

a) Especially large or dense organisms such as crayfish, molluscs or caddisflies with stone cases, which do not suspend randomly in the sample, should not be included in the subsample. They should be counted separately.

b) When removing aliquots, the subsampler should be careful to avoid biased capture of organisms in the cone. Avoid watching the cone as the dipper is withdrawn.

This method has been tested by the Department and has been found to randomly distribute the sample. The five separate counts conform to a Poisson series and thus can be combined into one sample (Elliott, 1979).

(3) Chironomidae subsampling

A subsampling plan for Chironomidae shall be approved by the Department. A Department recommended subsampling plan follows the following criteria:

a) For samples having less than 100 midges, all midges will be identified to genus/species level.

b) For samples having 100 to 199 midges, a subsample of one half (0.5) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

c) For samples having 200 to 499 midges, a subsample of one quarter (0.25) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

d) For samples having 500 or more midges, midges will be grouped by genus for those for which it is possible to confidently identify them to genus level without mounting. For remaining midges not grouped by genus, a subsample of 100 specimens will be randomly selected and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

e) Reporting of the subsample of the sample will be as follows. Numbers reported on the Excel spreadsheet will be converted to reflect the sample total. Any round-off errors between the subsample total and the sample total will be equalized by adding or deducting the difference from the most numerous taxon. If unusual or rare specimens are removed from the sample following the subsample removal, the conversion of the subsample total to a "partial" sample total will be based on the sample total minus the number of unusual or rare specimens. Following this procedure, the number of unusual or rare specimens will be added to the "partial" sample total to bring it back to the sample total.

6. Sample Taxonomy

All taxonomic data submitted to the Department must be accompanied by the name(s) of the individual(s) actually performing the identifications. A list of taxonomic references used, and a reference collection of organisms must also be submitted (see below).

(1) Taxonomic resolution

Macroinvertebrate organisms are identified to genus in all cases where possible. If generic keys are not available or taxonomic expertise is lacking for a taxon it should be identified to the lowest level possible. Identification of organisms to species is highly recommended whenever possible. Although quantitative analysis of benthic macroinvertebrate samples by the Department is based on counts adjusted to the generic level of resolution, species designations are recorded in the Department database and can contribute to the final stage of data analysis, Professional Judgment Evaluation of the model outcome. This is especially important for Class Insecta. Taxonomists submitting data for use by the Department must use current taxonomic references.

(2) Identification of Chironomidae

Specimens of chironomid midges are identified from slide mounts of the cleared head capsule and body parts. Euparol or Berlese mounting medium is recommended for preparation of slides. CMCP-9 is recommended for the preparation of permanent slide mounts of reference material, for voucher specimens or for permanent collections. These slides should be prepared under a fume hood. Instructions for preparation and slide mounting may be found in Wiederholm, (1983). In samples in which a given taxon is represented by a large number of individuals, the identification to genus may be made from slide mounts of a sufficient proportion of the individuals to give a high degree of certainty that they are all the same (10-50% depending on the distinctiveness of the taxon visible under binocular microscope). A subsampling plan for Chironomidae is described in Section II-5. Each permanent slide mount is to be fully labeled or coded in a manner which positively associates the slide with the sample from which it originated.

(3) Quality control

All organisms and records from any sampling event intended to serve regulatory purposes must be preserved for a period of at least ten years. In the course of identifying taxa collected as part of the Department's biological monitoring program, or in other collection activities, a special reference collection of separate taxa is established. This collection allows subsequent identifications of the same taxon to be confirmed and thus serves to standardize taxonomy for the program.

Each contracted taxonomist, working for the Department or working for anyone submitting data to the Department, will be required to submit a reference collection of taxa identified, as well as a list of the taxonomic references used in the identifications. Organism identifications will be checked against the Department's collection by a Department taxonomist.

III ANALYTICAL METHODS

In general, it is the responsibility of the Department, or its agents, to conduct sampling for the purpose of making decisions on the attainment of water quality classification. Under certain conditions, sampling may be required of applicants for waste discharge licenses, or applicants requiring Section 401 Water Quality Certification. Sampling may be performed by corporations, businesses, organizations or individuals who can demonstrate their qualifications and ability to carry out the Department's sampling and analytical protocol, described in this manual. Such monitoring will be conducted according to a quality assurance plan provided to the Department and approved by the Commissioner.

Classification attainment evaluation is established in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. Davies et al, 1995 details the conceptual and technical basis for the State’s application of linear discriminant analysis to assess attainment of aquatic life standards. A synopsis of Chapter 579 follows in this section.

1. Minimum Provisions

Properly collected and analyzed samples that fail to achieve the following criteria are unsuitable for further analysis through the numeric criteria statistical models:

- Total Mean Abundance must be at least *50* individuals (average per basket/bag/cone);
- Generic Richness for three replicate basket/bag/cone samplers must be at least *15*.

Samples not attaining these criteria shall be evaluated by Professional Judgment. A determination will be made whether the affected community requires re-sampling or whether the community demonstrates non-attainment of minimum provisions of the aquatic life standards.

2. Aquatic Life Statistical Decision Models

The four statistical decision models consist of linear discriminant functions developed to use quantitative ecological attributes of the macroinvertebrate community (Appendix C-1) to determine the strength of the association of a test community to any of the water quality classes (Appendix D). The coefficients or weights are calculated using a linear optimization algorithm to minimize the distance, in multivariate space, between sites within a class, and to maximize the distance between sites between classes.

(1) Linear discriminant models

The discriminant function has the form:

$$Z = C + W_1X_1 + W_2X_2 + ...W_nX_n$$

Where: Z = discriminant score
C = constant
W_i = the coefficients or weights
X_i = the predictor variable values

Association values are computed, using variable values from a test sample, for each classification using one four-way model and three two-way models. The four-way model uses nine variables pertinent to the evaluation of all classes and provides four initial probabilities that a given site attains one of three classes (A, B, or C), or is in non-attainment (NA) of the minimum criteria for any class. These probabilities have a possible range from 0.0 to 1.0, and are used, after transformation, as variables in each of the three subsequent final decision models. The final decision models (the three, two-way models) are designed to distinguish between a given class and any higher classes as one group and any lower classes as the other group (i.e., Classes A+B+C vs. NA; Classes A+B vs. Class C+NA; Class A vs. Classes B+C+NA). The equations for the final decision models use the predictor variables relevant to the class being tested (Appendix E). The process of determining attainment class using association values is outlined in Appendix F.

(2) Application of professional judgment

Where there is documented evidence of conditions which could result in uncharacteristic findings, allowances may be made to account for those situations by adjusting the classification attainment decision through use of professional judgment as provided in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. The Department may make adjustments to the classification attainment decision based on analytical, biological, and habitat information or may require that additional monitoring of affected waters be conducted prior to issuing a classification attainment decision.

Professional Judgment may be utilized when conditions are found that are atypical to the derivation of the linear discriminant model. Factors that may allow adjustments to the model outcome include but are not limited to:

a) Habitat factors
- Lake outlets
- Impounded waters
- Substrate characteristics
- Tidal waters

b) Sampling factors
- Disturbed samples
- Unusual taxa assemblages
- Human error in sampling

c) Analytical factors
- Subsample vs. whole sample analysis
- Human error in processing

(3) Classification attainment evaluation of waters subjected to flow regulation

The Maine State Legislature, in 38 MRSA Article 4-A Sec. 464 (9)-(10), *The Water Classification Program*, acknowledges that changes to aquatic life and habitat occur as the result of the impoundment of riverine waters and has modified the standards of waters so affected. The habitat and aquatic life criteria of riverine impounded waters of Class A, Class B or Class C are deemed to be met if the impoundment attains the standards of Class C (e.g., maintenance of structure and function of the resident biological community). Impoundments managed as Great Ponds must also attain Class C aquatic life standards. If the actual water quality attains any more stringent characteristic or criterion than the Class C standards dictate, then the waterbody must be managed so as to protect those higher characteristics. Class C standards also apply to the *downstream* waters below certain specified riverine impoundments on the Kennebec River and the Saco River (Wyman Dam, Moosehead East Outlet Dam, West Buxton Dam and Skelton Dam) that are classified as A or B. All other waters subjected to flow regulation are managed according to standards of the water quality classification assigned by the Legislature.

(4) Adjustments of a decision

It is the responsibility of the Department to decide if adjustments of a decision should occur. The following adjustments may be made to correct for these conditions:

a) Resample
The Department may require that additional monitoring of the test community be done before a determination of class attainment can be made, based on documented evidence of specific sampling factors that may have influenced the results.

b) Raise the finding
   i. The Department may raise the classification attainment outcome predicted by the model from non-attainment of any class to indeterminate or to attainment of Class C, based on documented evidence of specific conditions, as defined above.

   ii. The Department may raise the classification attainment outcome predicted by the model from attainment in one class to attainment in the next higher class, based on documented evidence of specific conditions, as defined above.

c) Lower the finding
The Department may decide to lower the classification attainment finding, on the basis of documented, substantive evidence that the narrative aquatic life criteria for the assigned class are not met.

d) Determination of non-attainment: minimum provisions not met
Samples having any of the ecological attributes not attaining the minimum provisions, and where there is no evidence of conditions which could result in uncharacteristic findings, as defined above, must be determined to be in non-attainment of the minimum provisions of the aquatic life criteria for any class.

e) Determination of attainment: minimum provisions not met
Where there is evidence of factors that could result in minimum provisions not being met, professional judgment may be used to make a professional finding of attainment of the aquatic life criteria for any class. Such decisions will be provisional until appropriate resampling is carried out.

(5) Sampling procedures do not conform

For classification attainment evaluation of test communities that do not conform to criteria provided in Section I General Methods, or Section III-1, Minimum Provisions, of this manual, and are therefore not suitable to be run through the linear discriminant models, the Department may make an assessment of classification attainment or aquatic life impact in accordance with the following procedures:

a) Approved assessment plan
A quantitative sampling and data analysis plan must be developed in accordance with methods established in the scientific literature on water pollution biology, and shall be approved by the department.

b) Determination of sampling methods
Sampling methods are determined on a site-specific basis, based on habitat conditions of the sampling site, and the season sampled:

i. Soft-bottomed substrates shall, whenever ecologically appropriate and practical, be sampled by core or dredge of known dimension or volume.

ii. The preferred method for sampling hard-bottomed substrates shall be the rock basket/cone/bag as described in Section I-2.

iii. Other methods may be used where ecologically appropriate and practical.

c) Classification attainment decisions
Classification attainment decisions may be based on a determination of the degree to which the sampled site conforms to the narrative aquatic life classification criteria provided in 38 MRSA Section 465 and found in Appendix D. The decision is based on established principles of water pollution biology and must be fully documented.

d) Site-specific impact decisions
Site-specific impact decisions may rely on established methods of analysis of comparative data between a test community and an approved reference community.

e) Determination of detrimental impact
A determination of detrimental impact to aquatic life of a test community without an approved reference community may be made if it can be documented, based on established methods of the interpretation of macroinvertebrate data, and based on established principles of water pollution biology, that the community fails to demonstrate the ecological attributes of its designated class as defined by the narrative aquatic life standards in the water quality classification law.

Appendix A

Maine DEP Biological Monitoring Unit
Stream Macroinvertebrate Field Data Sheet

Log Number ______________________
Station Number______________________
Waterbody______________________
River Basin______________________
Municipality______________________
Stream Order______________________

Directions______________________
____
____
Lat-Long Coordinates (WGS84, meters)
Latitude______________________
Longitude______________________

Type of Sample______________________
Date Deployed______________________
Number Deployed______________________
Date Retrieved______________________
Number Retrieved______________________
Agency/Collector(s)______________________

1. **Land Use** (500 m radius upstream)		2. **Terrain** (500 m radius upstream)	3. **Canopy Cover** (upstream view)
☐ Urban	☐ Upland conifer	☐ Flat	☐ Dense (75-100% shaded)
☐ Cultivated	☐ Swamp hardwood	☐ Rolling	☐ Partly open (25-75% shaded)
☐ Pasture	☐ Swamp conifer	☐ Hilly	☐ Open (0-25% shaded)
☐ Upland hardwood	☐ Marsh	☐ Mountains	(% daily direct sun) ____________

4. Physical Characteristics of Bottom (estimate % of each component over 12 m stretch of site; total = 100%)

[ ] Bedrock	[ ] Rubble (3" – 10")	[ ] Sand (<1/8")	
[ ] Boulders (<10")	[ ] Gravel (1/8" – 3")	[ ] Silt-clay-muck	[ ] Detritus

5. Habitat Characteristics (immediate area)

Time __________AM PM	Time __________AM PM
Width (m) __________	Width (m) __________
Depth (cm) __________	Depth (cm) __________
Flow (cm/s) __________	Flow (cm/s) __________
Diss. O_2 (ppm)__________	Diss. O_2 (ppm)__________
Temp (°C) __________	Temp (°C) __________
pH __________	pH __________
SPC (µS/cm) __________	SPC (µS/cm) __________
TDS (ppm) __________	TDS (ppm) __________

Temperature Probe # ______________

☐ deployed ☐ retrieved

6. Observations (describe)
Fish______________________
Algae______________________
Macrophytes______________________
Habitat quality______________________
Dams/impoundments______________________
Discharges______________________
Nonpoint stressors ______________________

7. Water Samples
☐ Standard
☐ Metals
☐ Pesticides

Lab Number

8. Photographs

9. Landmarks of Sampler Placement (illustrate or describe landmarks to be used for relocation)

Appendix B

Instructions for Macroinvertebrate Sorters

1. Pick the sample **in small portions** (1-2 TBS of material) at a time.

2. Pick all organisms you can see. If in doubt it's usually best to include it.

3. Some types of samples can be easily floated by adding a saturated solution of Epsom salt or sugar to the water. Maintain the saturated solution for the lab by adding enough salt or sugar to water to maintain a thick layer of crystals on the bottom of the storage jar. Use the supernatant solution for picking. Large numbers of organisms can be removed with a sieve spoon from the water surface. After the floaters have been removed, proceed to pick the rest of the sample as usual. A significant portion of the sample will not float and must be picked out with forceps.

4. The sample can be considered done when a careful 45 second search, after swirling the sample, yields no further organisms.

5. The samples are picked in water but should not remain unpreserved for more than 8 hours. Be certain that the final sample vial is preserved with 70% alcohol and 5% glycerin solution when done.

6. Return the detrital material to the original sample jar and preserve with 70% alcohol.

7. Write on the sample jar label "Picked X1 (your initials)".

8. Include in the vial of organisms a slip of index card label in hard pencil (No. 2) including **all information appearing on the original jar label**:

   Log Number — River
   Date - month/day/year — Location (Town or industry name)
   whether above or below
   Basket or Cone number
   Vial number if more than 1 vial is needed per basket

   ex. Log 621 Sandy R. 9/5/97
   Below Farmington (disturbed)
   Basket 2 vial #1 of 2

9. Complete all samples from one log number before beginning a new log number.

10. Keep a record of samples picked including log number

    Basket number — Time spent per basket
    Your name — Date

Appendix C-1

Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models

Variable
Number

1 **Total Mean Abundance**

Count all individuals in all replicate samples from one site and divide by the number of replicates to yield mean number of individuals per sample.

2 **Generic Richness**

Count the number of different genera found in all replicates from one site.

Counting rules for Generic Richness:

a) All population counts at the species level will be aggregated to the generic level.

b) A family level identification which includes no more than one taxon identified to the generic level is counted as a separate taxon in generic richness counts.

c) A family level identification with more than one taxon identified to generic level is not counted towards generic richness. Counts are to be divided proportionately among the genera that are present.

d) Higher level taxonomic identifications (Phylum, Class, Order) are not counted toward generic richness unless they are the only representative.

e) Pupae are ignored in all calculations.

3 **Plecoptera Mean Abundance**

Count all individuals from the order Plecoptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Plecopteran individuals per sampler.

4 **Ephemeroptera Mean Abundance**

Count all individuals from the order Ephemeroptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Ephemeropteran individuals per sampler.

5 **Shannon-Wiener Generic Diversity (Shannon and Weaver, 1963)**

After adjusting all counts to genus following counting rules in Variable 2:

$$\bar{d} = \frac{c}{N}\left(N \log_{10} N - \sum n_i \log_{10} n_i\right)$$

where: $\bar{d}$ = Shannon-Wiener Diversity
c = 3.321928 (converts base 10 log to base 2)
N = Total abundance of individuals
n_i = Total abundance of individuals in the i^{th} taxon

6 **Hilsenhoff Biotic Index (Hilsenhoff, 1987)**

$$HBI = \sum \frac{n_i a_i}{N}$$

where: HBI = Hilsenhoff Biotic Index
n_i = number of individuals in the i^{th} taxon
a_i = tolerance value assigned to that taxon
N = total number of individuals in sample with tolerance values.

7 **Relative Chironomidae Abundance**

Calculate the mean number of individuals of the family Chironomidae, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).

8 **Relative Diptera Richness**

Count the number of different genera from the Order Diptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).

9 ***Hydropsyche* Mean Abundance**

Count all individuals from the genus *Hydropsyche* in all replicate samplers from one site, and divide by the number of replicates to yield mean number of *Hydropsyche* individuals per sampler.

10 **Probability (A + B + C) from First Stage Model**

Sum of probabilities for Classes A, B, and C from First Stage Model.

11 ***Cheumatopsyche* Mean Abundance**

Count all individuals from the genus *Cheumatopsyche* in all replicate samplers from one site and divide by the number of replicates to yield mean number of *Cheumatopsyche* individuals per sampler.

12 **EPT - Diptera Richness Ratio**

EPT Generic Richness (Variable 19) divided by the number of genera from the order Diptera, following counting rules in Variable 2. If the number of genera of Diptera in the sample is 0, a value of 1 is assigned to the denominator.

13 **Relative Oligochaeta Abundance**

Calculate the mean number of individuals from the Order Oligochaeta, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).

14 **Probability (A + B) from First Stage Model**

Sum of probabilities for Classes A and B from First Stage Model.

15 **Perlidae Mean Abundance (Family Functional Group)**

Count all individuals from the family Perlidae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Perlidae per sampler.

16 **Tanypodinae Mean Abundance (Family Functional Group)**

Count all individuals from the subfamily Tanypodinae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Tanypodinae per sampler.

17 **Chironomini Mean Abundance (Family Functional Group)**

Count all individuals from the tribe Chironomini (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Chironomini per sampler.

18 **Relative Ephemeroptera Abundance**

Variable 4 divided by Variable 1.

19 **EPT Generic Richness**

Count the number of different genera from the Order Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) in all replicate samplers, according to counting rules in Variable 2, generic richness.

20 **Variable Reserved**

21 **Sum of Mean Abundances of**: ***Dicrotendipes, Micropsectra, Parachironomus*** **and** ***Helobdella***

Sum the abundance of the 4 genera and divide by the number of replicates (as performed in Variable 4).

22 **Probability of Class A from First Stage Model**

Probability of Class A from First Stage Model.

23 **Relative Plecoptera Richness**

Count number of genera of Order Plecoptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).

24 **Variable Reserved**

25 **Sum of Mean Abundances of *Cheumatopsyche, Cricotopus, Tanytarsus* and *Ablabesmyia***

Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).

26 **Sum of Mean Abundances of *Acroneuria* and *Stenonema***

Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).

27 **Variable Reserved**

28 **Ratio of EP Generic Richness**

Count the number of different genera from the order Ephemeroptera (E), and Plecoptera (P) in all replicate samplers, following counting rules in Variable 2, and divide by 14 (maximum expected for Class A).

29 **Variable Reserved**

30 **Ratio of Class A Indicator Taxa**

Count the number of Class A indicator taxa as listed in Appendix C-2 that are present in the community and divide by 7 (total possible number).

Appendix C-2

Indicator Taxa: Class A

Brachycentrus (Trichoptera: Brachycentridae)
Serratella (Ephemeroptera: Ephemerellidae)
Leucrocuta (Ephemeroptera: Heptageniidae)
Glossosoma (Trichoptera: Glossosomatidae)
Paragnetina (Plecoptera: Perlidae)
Eurylophella (Ephemeroptera: Ephemerellidae)
Psilotreta (Trichoptera: Odontoceridae)

Appendix C-3

Family Functional Groups

PLECOPTERA

Perlidae
Acroneuria
Attaneuria
Beloneuria
Eccoptura
Perlesta
Perlinella
Neoperla
Paragnetina
Agnetina

CHIRONOMIDAE

Tanypodinae
Ablabesmyia
Clinotanypus
Coelotanypus
Conchapelopia
Djalmabatista
Guttipelopia
Hudsonimyia
Labrundinia
Larsia
Meropelopia
Natarsia
Nilotanypus
Paramerina
Pentaneura
Procladius
Psectrotanypus
Rheopelopia
Tanypus
Telopelopia
Thienemannimyia
Trissopelopia
Zavrelimyia

Appendix C-3

Family Functional Group (continued)

Chironomini
Pseudochironomus
Axarus
Chironomus
Cladopelma
Cryptochironomus
Cryptotendipes
Demicryptochironomus
Dicrotendipes
Einfeldia
Endochironomus
Glyptotendipes
Goeldichironomus
Harnischia
Kiefferulus
Lauterborniella
Microchironomus
Microtendipes
Nilothauma
Pagastiella
Parachironomus
Paracladopelma
Paralauterborniella
Paratendipes
Phaenopsectra
Polypedilum
Robackia
Stelechomyia
Stenochironomus
Stictochironomus
Tribelos
Xenochironomus

Appendix D

MRSA 38, 4-A Sec 464-465

Aquatic Life Standards for the State of Maine

Classification	Biological Standards
AA	No direct discharge of pollutants; aquatic life shall be as naturally occurs.
A	Natural habitat for aquatic life; aquatic life shall be as naturally occurs.
B	Unimpaired habitat for aquatic life; discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.
C	Habitat for aquatic life; discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

Appendix E

Process of Calculating Model Variables and Association Values Using Linear Discriminant Models

Computer calculates model variables (*Var1 – Var30*) using taxa counts from a sample event using procedures described in Appendix C-1.

↓

FIRST STAGE LINEAR DISCRIMINANT MODEL (LDM)
(4-way model: A vs. B vs. C vs. NA)

1. Model calculates Discriminant Score[1] using *Var1 – Var9*.
2. Model uses Discriminant Score to calculate Association Values[1].

Example Results:

probability Class AA/A (*pA1*)	=	0.27
probability Class B (*pB1*)	=	0.70
probability Class C (*pC1*)	=	0.03
probability Non-Attainment (*pNA1*)	=	0.00

↓

SECOND STAGE LDM
(2-way model: C or better vs. NA)

1. Model calculates Discriminant Score[1] using *Var10 (pA1+pB1+pC1)* and *Var11 – Var13*.
2. Model uses Discriminant Score to calculate Association Values[1].

Example Results:
probability C or better (*pABC*) = 1.00
probability NA (*pNA*) = 0.00

SECOND STAGE LDM
(2-way model: B or better vs. C, NA)

1. Model calculates Discriminant Score[1] using *Var14 (pA1+pB1)* and *Var15 – Var21*.
2. Model uses Discriminant Score to calculate Association Values[1].

Example Results:
probability B or better (*pAB*) = 1.00
probability C or NA (*pCNA*) = 0.00

SECOND STAGE LDM
(2-way model: A vs. B, C, or NA)

1. Model calculates Discriminant Score[1] using *Var22 (pA1)* and *Var23 – Var30.*
2. Model uses Discriminant Score to calculate Association Values[1].

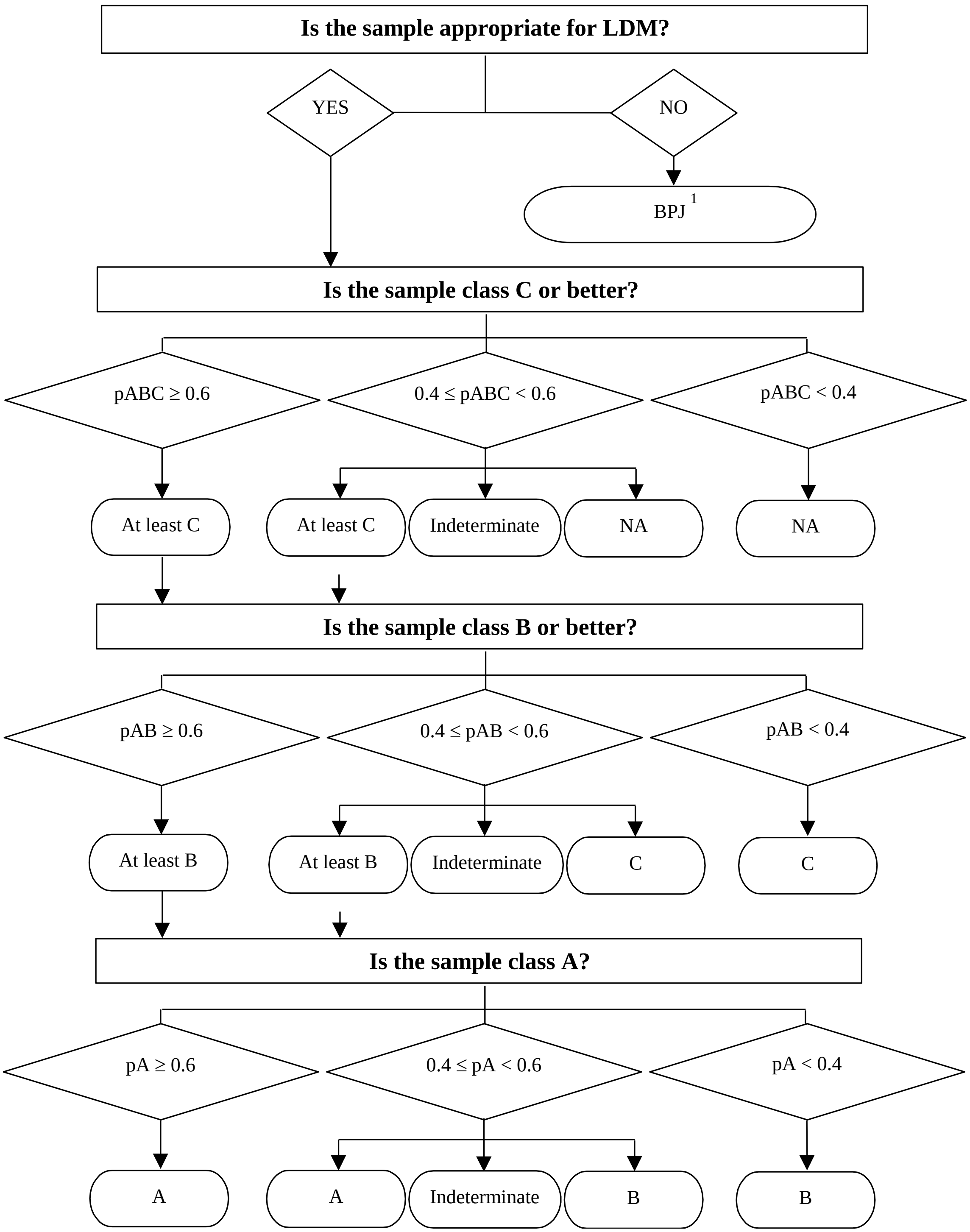
Example Results:
probability AA/A (*pA*) = 0.07
probability B, C, or NA (*pBCNA*) = 0.93

[1] Discriminant Score and Association Values are defined in Section III-2.(1).

Chart by Thomas J. Danielson

Appendix F

Process for Determining Attainment Class Using Association Values



[1] Best Professional Judgment (BPJ) is defined in Section III-2. (2), (4), and (5)

Chart by Thomas J. Danielson

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Maine DEP Biological Monitoring Unit
Stream Macroinvertebrate Field Data Sheet

Location: ______________________________

____

Potential Stressor: ______________________

____

Log Number ________________________
Station Number______________________
Waterbody____________________________
River Basin___________________________
Town_________________________________
Stream Order__________________________

Directions_____________________________
____
____
Lat-Long Coordinates (WGS84, meters)
Latitude_______________________________
Longitude_____________________________

Type of Sampler________________________
Date Deployed__________________________
Number Deployed_______________________
Date Retrieved_________________________
Number Retrieved_______________________
Agency/Collector(s) Put-In:
Take-Out:

1. Land Use (surrounding watershed)	**2. Terrain** (surrounding watershed)	**3. Canopy Cover** (surrounding view)
☐ Urban ☐ Upland conifer	☐ Flat	☐ Dense (75-100% shaded)
☐ Cultivated ☐ Swamp hardwood	☐ Rolling	☐ Partly open (25-75% shaded)
☐ Pasture ☐ Swamp conifer	☐ Hilly	☐ Open (0-25% shaded)
☐ Upland hardwood ☐ Marsh	☐ Mountains	(% daily direct sun) _______________

4. Physical Characteristics of Bottom (estimate % of each component over 12 m stretch of site; total = 100%)

[ ] Bedrock [ ] Cobble (2.5" – 10") [ ] Sand (<1/8") [ ] Clay
[ ] Boulders (>10") [ ] Gravel (1/8" – 2.5") [ ] Silt [ ] Muck [ ] Detritus

5. Habitat Characteristics (immediate area)

Flag location where measured

Time ___________ AM PM	Time ___________ AM PM
Wetted Width (m)_______	Wetted Width (m) _______
Bank Full Width (m) _____	Bank Full Width (m) _____
Depth (cm) ____________	Depth (cm) ____________
Velocity (cm/s) _________	Velocity (cm/s) _________
Diss. O_2 ___ (ppm) ___ (%)	Diss. O_2 ___ (ppm) ___ (%)
Temp (°C) _____________	Temp (°C) _____________
SPC (µS/cm) ___________	SPC (µS/cm) ___________
pH ____________________	pH ____________________
DO Meter #_______ Cal? Y / N	DO Meter #_______ Cal? Y / N
SPC Meter # ______ Cal? Y / N	SPC Meter # ______ Cal? Y / N

Temperature Probe # _________________
☐ deployed ☐ retrieved

6. Observations (describe, note date)

7. Water Samples
☐ Standard
☐ Other
Lab Number:

8. Photograph #
Put-In
Up
Down
Take-Out
Up
Down

9. Landmarks of Sampler Placement (illustrate or describe landmarks to be used for relocation)

Options for Potential Stressor:

Agricultural Runoff
Altered Habitat
Altered Hydrology
BOD (Low DO)
Bog Headwaters
Chlorine
Gravel Pit
Impounded
Inorganic Solids
Lake Outlet
Logging
Low Gradient
Low pH
Metals
NPS Pollution
Nutrients
Organic Solids
Pesticides
Regulated Flows
Sedimentation
Superfund Site
Thermal
Tidal/Estuary
Toxic Organics
Urban Runoff

Options for 6. Observations:

Fish
Algae
Macrophytes
Habitat quality
Dams/impoundments
Discharges
Nonpoint stressors

Options for Location:

Above Road Crossing
Below Road Crossing
Above Town
Below Town
Above Fish Hatchery
Below Fish Hatchery
Above POTW
Below POTW
Above Landfill
Below Landfill
Below Airport
Below In-Place Contamination
Above In-Place Contamination
Above Point Source
Below Point Source
Above Urban NPS
Below Urban NPS
Above Agriculture NPS
Below Agriculture NPS
Above Forestry NPS
Below Forestry NPS
Above Dam
Below Dam
Impoundment
Lake Outlet
Main Stem (only for larger systems)
Above Confluence
Below Confluence
Below Falls
Pristine Landscape
Designated Ecoreserve
Minimally Disturbed

Document Content(s)

March 15, 2019

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Pre-Application Document (PAD) for Hydropower License for the Lowell Tannery Hydroelectric Project, FERC Project No. 4202

Dear Secretary Bose,

The Maine Council of Trout Unlimited respectfully submits the following comments on the Commission's Pre-Application Document (PAD) for Hydropower License for the Lowell Tannery Hydroelectric Project (P-4202) located on the Passadumkeag River in Lowell, Maine.

The mission of Trout Unlimited is to "Conserve, protect and restore North America's coldwater fisheries and its watersheds." This is the first dam upstream of the river's confluence with the Penobscot River and we are especially concerned with how this project impacts access of Atlantic salmon to critical habitat in the entire Passadumkeag Watershed. While a fishway has been installed and maintained at the Lowell Tannery Dam, its performance has not been scientifically verified.

The engineering science that underlies fishway design is non-linear: "…change of the output is not proportional to the change of the input... Nonlinear dynamical systems, describing changes in variables over time, may appear chaotic, unpredictable, or counterintuitive, contrasting with much simpler linear systems." [1] Studies comparing fishway performance show that it varies greatly from fishway to fishway.[2]

Obtaining good fish passage data is also problematic: fish may enter a fishway but not ascend it. The use of radio-telemetry to ensure that fish actually transit the fishway is the best science available.[3]

National Environmental Protection Act (NEPA) analyses must use the ''best available science'' [4] and radio-telemetry is certainly that for both fisheries assemblage and fish passage studies, and we reason that if this technology is not applied, the Commission and the Applicant risk having to deal with the outcomes associated with an invalid Environmental Assessment (EA).

---

[1] Wikipedia "Nonlinear system" https://en.wikipedia.org/wiki/Nonlinear_system

[2] A quantitative assessment of fish passage efficiency. Noonan et al. FISH and FISHERIES, 2012, 13, 450–464

[3] Adaptive fishway design: a framework and rationale for effective evaluations. Castro-Santos. Bundesanstalt für Gewässerkunde Veranstaltungen. 7/2012

[4] Federal Register / Vol. 73, No. 200 / Wednesday, October 15, 2008 / Rules and Regulations 61299 https://www.fws.gov/habitatconservation/DOI_NEPA_Regs.pdf

Accordingly, we support the three studies requested by the National Marine Fisheries Service (NMFS)[5] as being absolutely essential to a valid EA for relicensing of the Lowell Tannery Dam:

Study 1: Anadromous Fish Upstream Passage Efficiency Study

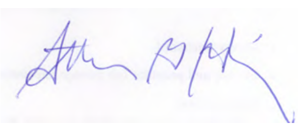
Study 2: Downstream Fish Passage Effectiveness and Survival: Behavior, Entrainment and Impingement at the Intake.

Study 3: Downstream Fish Entrainment and Impingement at the Intake.

Thank you for your time and consideration of the above comments.

Respectfully submitted this 15th day of March 2019,

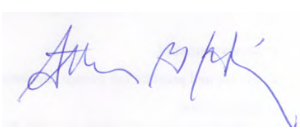
C. E. McGinley
Maine TU Council Chair



Stephen G. Heinz
Maine TU Council

on behalf of himself and the above.

CERTIFICATE OF SERVICE:
I hereby certify that I have this 15th day of March 2019 caused the foregoing document to be electronically served on each person/entity on the Commission's official service list as compiled by the Secretary in this proceeding.



Attachments:

A quantitative assessment of fish passage efficiency. Michael J Noonan, James W A Grant & Christopher D Jackson. FISH and FISHERIES, 2012, 13, 450–464

Adaptive fishway design: a framework and rationale for effective evaluations. Theodore Castro-Santos. Bundesanstalt für Gewässerkunde Veranstaltungen. 7/2012

[5] NMFS Comments on the KEI (Maine) Pre-Application Document and Study Requests for the Lowell Tannery Hydroelectric Project (FERC No. 4202) dated March 9, 2019

FISH and FISHERIES

FISH and FISHERIES, 2012, **13**, 450–464

A quantitative assessment of fish passage efficiency

Michael J Noonan, James W A Grant & Christopher D Jackson

Department of Biology, Concordia University, 7141 Sherbrooke Street West, Montreal, QC H4B 1R6, Canada

Abstract

In an attempt to restore the connectivity of fragmented river habitats, a variety of passage facilities have been installed at river barriers. Despite the cost of building these structures, there has been no quantitative evaluation of their overall success at restoring fish passage. We reviewed articles from 1960 to 2011, extracted data from 65 papers on fish passage efficiency, size and species of fish, and fishway characteristics to determine the best predictors of fishway efficiency. Because data were scarce for fishes other than salmonids (order Salmoniformes), we combined data for all non-salmonids for our analysis. On average, downstream passage efficiency was 68.5%, slightly higher than upstream passage efficiency of 41.7%, and neither differed across the geographical regions of study. Salmonids were more successful than non-salmonids in passing upstream (61.7 vs. 21.1%) and downstream (74.6 vs. 39.6%) through fish passage facilities. Passage efficiency differed significantly between types of fishways; pool and weir, pool and slot and natural fishways had the highest efficiencies, whereas Denil and fish locks/elevators had the lowest. Upstream passage efficiency decreased significantly with fishway slope, but increased with fishway length, and water velocity. An information-theoretic analysis indicated that the best predictors of fish passage efficiency were order of fish (i.e. salmonids > non-salmonids), type of fishway and length of fishway. Overall, the low efficiency of passage facilities indicated that most need to be improved to sufficiently mitigate habitat fragmentation for the complete fish community across a range of environmental conditions.

Keywords Conservation, dams, fishways, habitat fragmentation, migration, passage efficiency

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Introduction

Habitat loss and fragmentation are the major threats to both terrestrial and aquatic biodiversity, including freshwater fishes (Andrén 1994; Fahrig 2003; Larinier 2001). Given the linear nature of freshwater habitats, dams and weirs act as anthropogenic barriers that fragment the river, obstructing the movement of organisms and nutrients, and reducing the amount of available habitat for fishes (Poff and Hart 2002; Sheer and Steel 2006). More than half of the world's largest river systems are currently negatively affected by dams (Nilsson *et al.* 2005). These barriers have frequently been implicated in the decline of resident and anadromous fish populations because of their negative effects on upstream adult migration (Caudill *et al.* 2007) and downstream migration by juveniles and adults (Wertheimer and Evans 2005; Arnekleiv *et al.* 2007). Indeed, habitat loss is the most important threat to endangered freshwater fishes in Canada, and infrastructure such as dams and impoundments is the most important human activity causing the loss of habitat (Venter *et al.* 2006). Even when upstream passage has been satisfactory, other negative effects of dams include a delay in migration in a wide variety of fish species (Haro and Kynard 1997; Lucas and Frear 1997; Moser *et al.* 2000, 2002a,b; Karppinen *et al.* 2002; Keefer *et al.* 2004; Zigler *et al.* 2004; Hasler *et al.* 2011), higher energetic expenditures during migration (Tiffan *et al.* 2010) and a failure to reach the spawning grounds (Gowans *et al.* 2003).

In an attempt to counteract the negative effects of habitat fragmentation, a wide variety of devices have been installed at river barriers to restore connectivity and aid with both upstream and downstream fish migration (Clay 1995). Two of the most common devices to assist upstream migration are fishways, structures that allow fish to swim upstream under their own effort, and fish locks/elevators, devices that lift the fish over obstructions (Clay 1995). Downstream devices include physical screens, angled bar racks and surface bypasses, intended to divert juveniles from passing downstream via the turbines (Larinier 2001). The design of these fishways and lifts has largely focused on economically important, anadromous species, and as a result, many non-target species are not able to fully ascend the structure (Office of Technology Assessment 1995). Even well-designed facilities will vary in their effectiveness depending on inter-individual differences in swimming behaviour (Hinch and Bratty 2000; Castro-Santos 2005) and physiological condition of the fish (Pon *et al.* 2009; Hasler *et al.* 2011). In addition, a large number of fishways still prevent or delay the migration of target species (Gowans *et al.* 2003; Boggs *et al.* 2004; Keefer *et al.* 2004) because of the lack of sufficient flow to attract fish to the entrance (hereafter, attraction flow), unsuitable entrance location, inadequate maintenance and/or poor hydraulic conditions, which are not designed to aid the target species (Larinier 2001). Therefore, the presence of a fishway may not fully mitigate the fragmentation induced by a river barrier (Roscoe and Hinch 2010).

Evaluating a fishway's efficiency after construction is crucial to ensure the structure is serving its purpose and to make necessary adjustments (Clay 1995; Roscoe and Hinch 2010). Numerous summaries on how to design an effective fishway exist (e.g. Clay 1995; Odeh 1999; Larinier 2002), but there has only been one qualitative analysis of the effectiveness of fishways (Roscoe and Hinch 2010). Roscoe and Hinch (2010) identified the major questions addressed concerning fishway design, including the efficiency with which individuals were able to pass a fishway, as well as the biological, environmental or structural mechanisms affecting passage. In addition, they described trends in fishway publications and concluded that the focus of research has not changed significantly over time. The purpose of our study was to complement their analysis by quantifying the efficiency of fishways at providing upstream and downstream passage for fishes. Specifically, we quantified the passage efficiency of different species and sizes of fish in relation to the type of passage facility and its specific design characteristics, including its height, gradient, length and water velocity through the structure.

Methods

Literature search

An extensive literature search for articles using the search terms 'fishway', 'fishpass', 'fish bypass', 'fish', 'dam' and 'passage' was previously conducted by Roscoe and Hinch (2010) via the ISI Web of Knowledge, and Aquatic Sciences and Fisheries Abstracts (for more details, see Roscoe and Hinch (2010)). The 96 peer-reviewed articles identified by their search criteria were used for this study, supplemented with 26 articles published since June 2008, obtained using the same search terms and the ISI Web of Knowledge. These articles encompassed both up- and downstream movement of fish through dedicated passage facilities across 61 dams/obstructions found in 20 countries from North America (30 dams/obstructions), Europe (24 dams/obstructions), South America (three dams/obstructions) and Australia (four dams/obstructions) (see references with asterisks). Included were articles from 1964 to 1 January 2011.

For each study, we recorded the following information, when available: migration direction, river, dam/obstruction of study, fishway type (see below), technical characteristics of the fishway, including length, width, height, mean water depth, slope, and mean water velocity of the fishway, sample size (i.e. number of fish) and mean length of all fishes recorded in the study. While it is clear that hydraulic characteristics vary markedly within a fish passage facility (e.g. Hinch and Bratty 2000), detailed information was unavailable for most facilities. These values were compared against the species, life-stage, migration time, attraction, entrance, passage efficiencies, fallback percentage, and passage times of their respective studies. For the purpose of this study, attraction efficiency was defined as the percentage of potential migrants that was able to locate the fishway entrance (Aarestrup *et al.* 2003), whereas entrance efficiency was the percentage at the fishway entrance, which enters a fishway (Evans *et al.* 2008). Passage efficiency was defined as the percentage of fish present which entered and successfully moved through a fishway (Larinier 2001) and encompassed both attraction and entrance efficiency. Passage time was defined as the time elapsed since first detection within the vicinity of the tailraces of a dam to the moment of successful fishway exit (Caudill *et al.* 2007). Fallback was defined as the percentage of fish that pass back downstream via spillways, turbine intakes or other means, after the successful ascension of a fishway (Boggs *et al.* 2004).

Data analysis

To avoid the overrepresentation of studies with a large amount of data, or of highly studied dams, one data point per facility, per study was recorded. If a particular study had multiple data points for a single facility, a weighted average was recorded. In the case of cross-study comparisons of a single facility, the median value for the facility was used as a datum in our analysis. In a few cases, efficiency values were reported as being <0 or >100. In these cases, the values were adjusted to 0 and 100%, respectively. When sample sizes permitted, further analyses were conducted to determine whether order of fish (see below), diel differences, geographical location, fishway type, as well as the technical characteristics of a fishway, affected fishway efficiency. When a study reported data on the passage efficiency of several species, one data point per species was used to evaluate the effect of fish size on passage efficiency. Fork length was converted to total length using species-specific conversion factors (Fishbase 2010).

We first grouped fish by family and order for statistical analysis. Because data were scarce for all orders except for salmonids (Salmoniformes), we divided all fish into two groups: salmonids and non-salmonids. While this division is clearly arbitrary, it was useful because salmonids have higher swimming speeds than other fishes (Webb 1975), and many fishways are designed specifically for economically important salmonid species (Larinier 2001). When a study reported a significant difference in the time of day during which a species used a fishway, the preferred time of passage was recorded. Following Roscoe and Hinch (2010), we divided the studies into three geographical locations: North America, Europe and Australia/South America.

Fish passage facilities designed for upstream passage were grouped into five categories: pool and weir, pool and slot, natural, Denil and a combination of fish lift/lock and trap and truck. Pool and weir fishways were constructed as a series of small pools in steps and required fish to swim over dividers from pool to pool (Clay 1995). Pool and slot fishways were constructed as a series of small pools in steps with openings that allowed fish to swim through dividers between pools (Clay 1995). Fishways built to resemble a natural channel, with suitable substrate, water flows, morphology and slopes, were categorized as natural fishways (Calles and Greenberg 2005). Denil fishways included those designed as a steep flume with vanes installed to dissipate the flow and decrease velocity (Clay 1995). Fish lift/lock systems collected fish in an enclosed lock and then raised the water level to the top of the dam by the addition of water (Ziliukas and Ziliukiene 2002). Trap and truck installations included some form of attraction/collection system, followed by the transportation of collected fish upstream via appropriate vehicles (Schilt 2007). If a structure contained a combination of fishway types, or the types were not explicitly stated in the article, they were excluded from analyses of efficiency vs. type of fishway.

Statistical analysis

We could not conduct a formal meta-analysis because most studies reported the percentage of fish passing successfully through a facility without an estimate of variance (see Harrison 2011). We used analyses of variance (ANOVA), covariance (ANCOVA), Pearson's correlations and Sign tests ($\alpha = 0.05$) in an initial descriptive analysis of the data. The efficiency values were subjected to angular transformations for all statistical analyses. We then used an information-theoretic approach (Burnham *et al.* 2010), using Akaike's information criterion adjusted for small sample sizes (AICc) to identify the model that best explained the observed upstream passage efficiencies. Although statistical analyses were performed on transformed data, for visual purposes, we used the untransformed data in all figures.

Results

Data were scarce for fishes other than salmonids (Table 1). Hence, we first analysed upstream passage efficiency for all non-salmonid orders, including estimates for complete fish communities (Fig. 1). Because the mean upstream passage efficiency did not differ significantly for non-salmonid orders ($F_{4,35} = 0.554$, $P = 0.697$), we combined the data for all non-salmonids in subsequent analyses.

Mean passage efficiency did not differ significantly between upstream ($\bar{x} = 41.7\%$, SE = 4.4, $n = 61$) and downstream ($\bar{x} = 68.5\%$, SE = 6.4, $n = 17$) directions (two-way ANOVA: $F_{1,74} = 3.07$, $P = 0.084$), but was higher for salmonids (downstream: $\bar{x} = 74.6\%$, SE = 6.4, $n = 14$; upstream: $\bar{x} = 61.7\%$, SE = 5.9, $n = 31$) than non-salmonids (downstream: $\bar{x} = 39.6\%$, SE = 10.7, $n = 3$; upstream: $\bar{x} = 21.1\%$, SE = 3.7, $n = 30$) (two-way ANOVA: $F_{1,74} = 15.4$, $P < 0.0005$) (Fig. 2). Upstream migrating salmonids used the fishways primarily during the day in 16 of 17 studies (Sign test: $P < 0.0005$), whereas non-salmonids showed no preference (five during the day vs. five at night; Sign test: $P = 1.00$). Furthermore, upstream passage efficiency did not differ significantly between continents (data not shown; two-way ANOVA:

Table 1 The taxonomic distribution of upstream and downstream passage efficiency data. One datum was used per facility per family of fish, per study.

Family	Order	Upstream (*N*)	Downstream (*N*)
Salmonidae	Salmoniformes	31	14
Entire community	–	9	–
Clupeidae	Clupeiformes	8	2
Percidae	Perciformes	6	–
Cyprinidae	Cypriniformes	6	–
Petromyzontidae	Petromyzontiformes	5	–
Catostomidae	Cypriniformes	3	–
Cottidae	Scorpaeniformes	3	–
Percichthyidae	Perciformes	3	–
Centrarchidae	Perciformes	2	–
Acipenseridae	Acipenseriformes	1	–
Esocidae	Esociformes	1	–
Lotidae	Gadiformes	1	–
Balitoridae	Cypriniformes	1	–
Cobitidae	Cypriniformes	1	–
Retropinnidae	Osmeriformes	1	–
Galaxiidae	Osmeriformes	1	–
Characidae	Characiformes	1	–
Anostomidae	Characiformes	1	–
Prochilodontidae	Characiformes	1	–
Loricariidae	Siluriformes	1	–
Terapontidae	Perciformes	1	–
Anguillidae	Anguilliformes	–	1

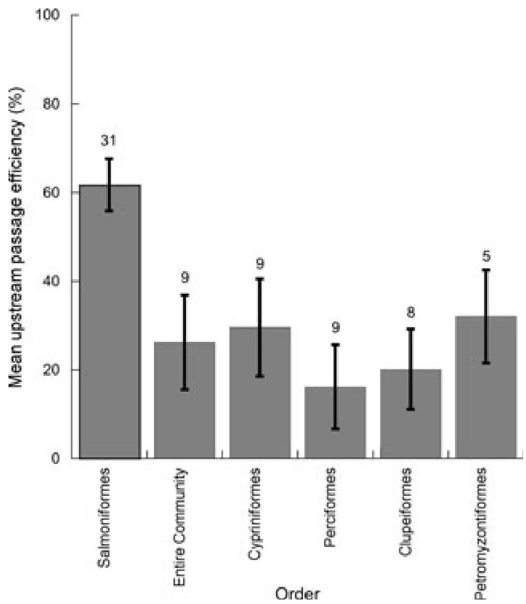

Figure 1 Mean (±SE) upstream passage efficiency for all orders of fishes with $N \geq 5$. Entire community refers to studies that measured the entire non-salmonid community with no distinction between orders. In all figures, numerals above the bars represent sample sizes.

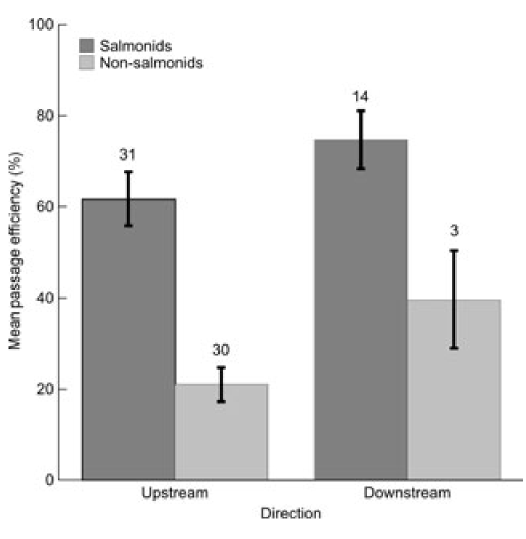

Figure 2 Mean (±SE) passage efficiencies for up- and downstream migration at fish passage facilities for salmonid and non-salmonid fishes in North America, Europe and South America/Australia.

$F_{2,50} = 0.50$, $P = 0.608$), but did differ significantly between salmonids and non-salmonids (see below; two-way ANOVA: $F_{1,50} = 11.31$, $P = 0.002$).

The type of fishway had a significant effect on passage efficiency (two-way ANOVA: $F_{4,63} = 4.781$, $P = 0.002$) (Fig. 3), as did order of fish (two-way ANOVA: $F_{1,63} = 13.496$, $P < 0.0005$), with salmonids having a higher efficiency than non-salmonids; there was no significant interaction between species of fish and type of fishway (two-way ANOVA: $F_{4,63} = 0.445$, $P = 0.776$). Pool and weir fishways did not differ significantly from pool and slot, or natural fishways (Tukey *post hoc* test, all *P*-values > 0.14), but had higher passage efficiency than Denil fishways and fish locks/elevators (Tukey *post hoc* test, all *P*-values < 0.0005); no other comparisons differed significantly from one another.

Because fish locks/elevators differ fundamentally from the other types, in that they do not require fish to swim upstream under their own effort (Clay 1995), they were excluded from further analysis of the effects of technical characteristics. To determine how pool and weir, pool and slot, natural and Denil fishways differed, one-way ANOVAs were used to compare three basic technical characteristics: length, slope and velocity (Table 2). Total fishway length differed significantly between types ($F_{3,25} = 6.347$, $P < 0.0005$), as did the slope ($F_{3,26} = 12.279$, $P < 0.0005$) and water velocity ($F_{3,16} = 4.091$, $P = 0.025$). For all three characteristics, pool and weir, pool and slot and natural fishways did not differ significantly (Tukey *post hoc* test: all *P*-values > 0.086), but all three differed significantly from Denil fishways (Tukey *post hoc* test: all *P*-values < 0.046), except for water velocity between natural and Denil fishways ($P = 0.250$)

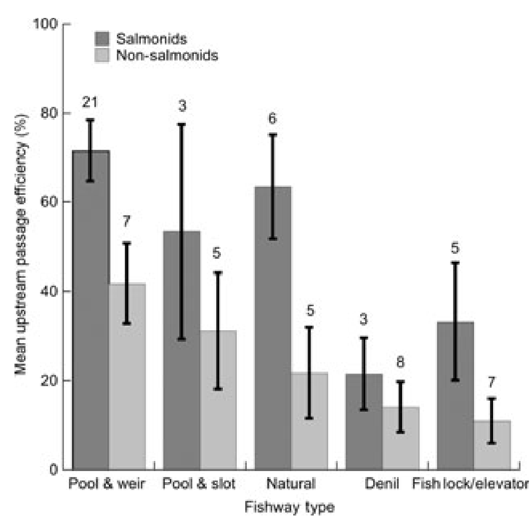

Figure 3 Mean (±SE) upstream passage efficiency for migration at five types of fish passage facility, for salmonid and non-salmonid fishes.

Table 2 (a) Mean values of the primary technical characteristics for four types of fish passage facility and (b) Pearson's correlation coefficients (*N*) between the three characteristics.

(a)

Type of fishway	Length (m)	SE	*n*	Slope (%)	SE	*n*	Velocity (m s^{-1})	SE	*n*
Pool and weir	190.3	±71.4	7	8.1	±0.75	11	1.78	±0.18	9
Pool and slot	175.6	±101.8	5	6.3	±2.42	3	2.07	±0.33	3
Natural	202.9	±41.4	10	4.2	±1.11	9	1.80	±0.50	2
Denil	14.2	±5.3	8	14.5	±1.47	10	0.89	±0.21	7

(b)

	Length (m)	Velocity (m s^{-1})
Slope (%)	−0.703** (23)	−0.474 (13)
Velocity (m s^{-1})	0.594* (13)	

*$P < 0.05$; **$P < 0.01$.

and length between pool and slot and Denil fishways ($P = 0.234$). Fishway slope was negatively correlated with fishway length and velocity, whereas fishway length was positively correlated with velocity (Table 2b).

For all fishways that required fish to swim upstream under their own effort, upstream passage efficiency decreased as the slope increased (ANCOVA: $F_{1,34} = 6.45$, $P = 0.016$; Fig. 4a) and increased with the length (ANCOVA: $F_{1,38} = 4.79$, $P = 0.035$; Fig. 4b), and the water velocity through the fishway (ANCOVA: $F_{1,24} = 6.47$, $P = 0.018$; Fig. 4c). In all cases, efficiency was higher for salmonids than non-salmonids (length: ANCOVA, $F_{1,34} = 12.34$, $P = 0.001$; slope: ANCOVA, $F_{1,38} = 6.01$, $P = 0.019$; water velocity: ANCOVA, $F_{1,24} = 4.17$, $P = 0.052$). Upstream passage efficiency also increased with total fish length for salmonids (Pearson's correlation: $r = 0.737$, $n = 19$, $P < 0.0005$), but not for non-salmonids (Pearson's correlation: $r = 0.092$, $n = 17$, $P = 0.724$, Fig. 4d). Species of salmonid was not related to passage efficiency once fish length was included in the model (ANCOVA: $F_{7,10} = 0.87$, $P = 0.56$). Total fish length was not significantly related to downstream passage efficiency for salmonids (Pearson's correlation: $r = -0.321$, $n = 9$, $P = 0.400$), and there were insufficient data ($n = 1$) to analyse the non-salmonids.

Passage time differed significantly between orders of fish (one-way ANOVA: $F_{1,15} = 46.353$, $P < 0.0005$) and was longer for non-salmonids ($\bar{x} = 5.52$ days, SE = 1.61, $n = 3$) than for salmonids ($\bar{x} = 0.87$ days, SE = 0.10, $n = 14$). However, fallback after successful upstream passage did not differ significantly between salmonid species (one-way ANOVA: $F_{3,26} = 0.80$, $P = 0.505$) (Fig. 5).

Mean attraction efficiency ($\bar{x} = 65.1\%$, SE = 7.6, $n = 12$) was significantly higher than entrance efficiency ($\bar{x} = 39.6\%$, SE = 8.1, $n = 11$) (one-way ANOVA: $F_{1,21} = 5.60$, $P = 0.028$), but there were insufficient data to perform any further statistical analysis on species-specific trends. Attraction and entrance efficiency were negatively related to the slope of the fishway, (ANCOVA: $F_{1,13} = 5.48$, $P = 0.036$, Fig. 6a), and positively, but not significantly, related to the length of the fishway (ANCOVA: $F_{1,16} = 2.345$, $P = 0.145$, Fig. 6b). In both cases, attraction efficiency was higher than entrance efficiency (ANCOVA: $F_{1,13} = 9.99$, $P = 0.008$; $F_{1,16} = 8.13$, $P = 0.012$, respectively). There were insufficient data to study the effects of water velocity on attraction and/or entrance efficiency ($n = 4$, and 3, respectively).

To determine the best predictors of fish passage efficiency, we used an information-theoretic approach (Burnham *et al.* 2010) to select the best model. Of the models analysed using the complete data set, three had AICc values within 2 of the best model (Table 3a). However, the only single-factor model in this group included order of fish (i.e. salmonids vs. non-salmonids) as the best predictor of upstream passage efficiency (Table 3a). Type of fishway alone was not supported; however, models that included species and type were also well

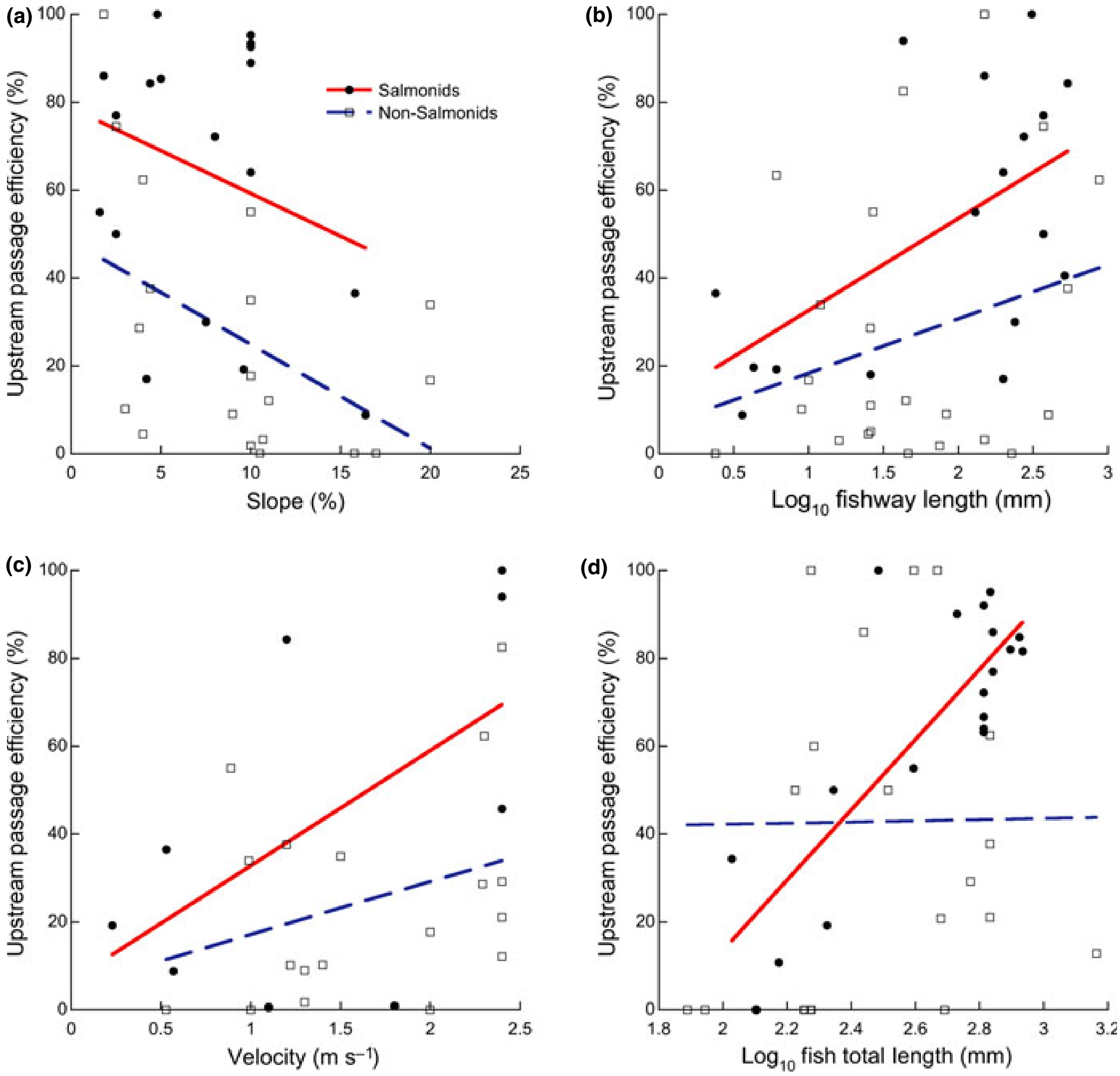

Figure 4 Upstream passage efficiency, for salmonid and non-salmonid fishes in relation to (a) fishway slope, (b) fishway length, (c) water velocity through the fishway and (d) total fish length. Lines represent least-squares regressions.

supported. In the reduced data set that included technical characteristics of the fishway, three models emerged with AICc values within 2 of the best model. The only single-factor model in this group included length of the fishway as the best predictor of passage efficiency. However, models that also included order of fish and type of fishway could not be ignored (Table 3b).

Discussion

To mitigate habitat fragmentation caused by anthropogenic barriers, upstream passage facilities should allow 90–100% of migrating adult fish to pass in a safe and rapid manner (Ferguson *et al.* 2002; Lucas and Baras 2001). Our analysis indicated that the mean upstream passage efficiency of only 41.7% was well below this desired goal. While many studies reported passage efficiencies at facilities within the desired ranges, many more reported much lower efficiencies, including several facilities with 0% passage efficiency (Laine *et al.* 1998; Bunt *et al.* 2000; Knaepkens *et al.* 2006; Mallen-Cooper and Stuart 2007). Even though the average downstream passage efficiency of 68.5% was slightly higher than upstream, it was clear that current fishways are not achieving their primary conservation goal of restoring the connectivity of freshwater ecosystems.

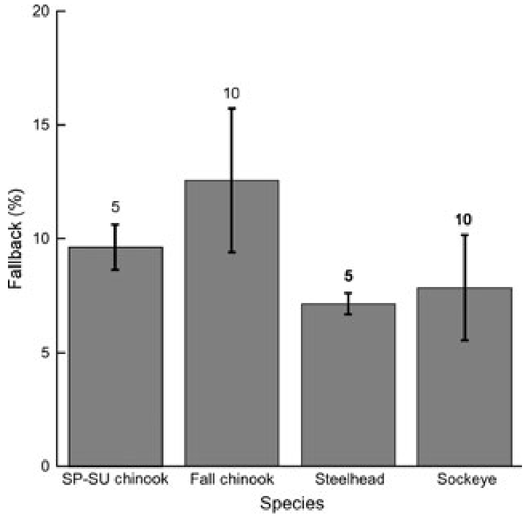

Figure 5 Mean (±SE) percentage of fish that fell back at fishways, defined as the percentage of fish that passed back downstream via spillways or turbine intakes, after the successful ascension of a fishway, for four different species of salmonids. SP-SU chinook are spring-summer running chinook, fall chinook are fall running chinook.

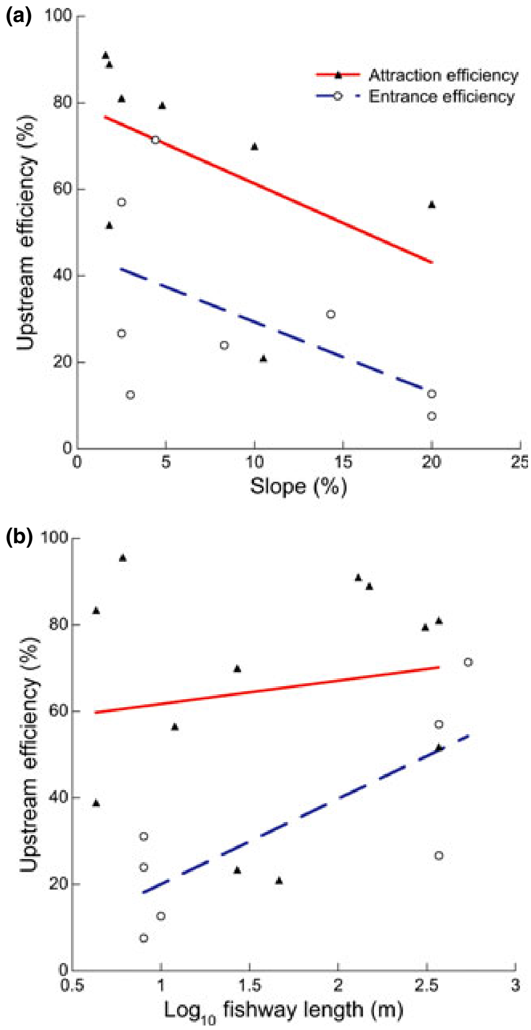

Figure 6 Upstream attraction and entrance efficiencies in relation to (a) fishway slope and (b) fishway length for all fish species. Lines represent least-squares regressions.

Regardless of fishway type, salmonids were more successful than non-salmonids at bypassing barriers. Indeed, order of fish was the best overall predictor of upstream passage efficiency in the complete data set and was included in the best supported models in the reduced data set. The relative success of salmonids is likely related to their strong swimming ability (Webb 1975) and to the design of fishways, which often target adults of commercially important species, such as anadromous salmonids (Larinier 2001; Calles and Greenberg 2005; Parsley *et al.* 2007; Schilt 2007). For example, in the Columbia and Snake Rivers, fishways are well designed for passing anadromous salmonids, whereas non-salmonids are unable to use the fishways effectively (Moser *et al.* 2002a,b). As the goal of conservation activities shifts from a maximum-sustainable-yield to a biodiversity-protection approach, it will be increasingly important to consider the swimming abilities and behaviour of the complete fish community (Oldani *et al.* 2007). Given this new conservation perspective, our analysis highlights the need for more research on non-salmonid species.

Our results indicate that the type of fishway was an important parameter in most well-supported models predicting passage efficiency. Pool-type fishways had the highest efficiency, followed closely by natural fishways, whereas fish locks/elevators and Denil fishways were less efficient. When a reduced data set was analysed, longer fishways had higher passage efficiency. All else being equal, a longer fishway would increase the energy expenditure of the migrating fish and thus decrease passage efficiency. However, energy expenditure may be more related to fishway steepness than length (Mallen-Cooper and Stuart 2007), and fishway length and slope were negatively correlated. Hence, our findings were in agreement with those showing that fish passage decreases with the slope of the fishway (Mallen-Cooper and Stuart 2007). The poor success of Denil fishways may be related to the shortness ($\bar{x}$ = 14.2 m) and steepness ($\bar{x}$ = 14.5%) of these structures.

Table 3 Model selection using Akaike's information criterion adjusted for small sample sizes (AICc) to assess variation in upstream passage efficiency using (a) the complete data set and (b) a reduced data set incorporating technical characteristics of the fishway (length and slope).

	AICc	Δ_i	w_i
(a) Complete data set (*n* = 47)			
Order†	53.39	0.00	0.53
Order + Type	55.04	1.65	0.23
Order*Type	55.27	1.88	0.21
Intercept	58.64	5.25	0.038
Type	58.83	5.44	0.035
(b) Reduced data set (*n* = 26)			
Length + Order*Type†	25.45	0.00	0.29
Order*Type	26.26	0.81	0.19
Order + Length	27.01	1.55	0.13
Length	27.53	2.08	0.10
Order + Type + Length	28.69	3.23	0.058
Slope + Order*Type	28.84	3.39	0.054
Length + Slope + Order*Type	29.12	3.67	0.047
Type + Length	29.32	3.87	0.042
Order + Type	30.87	5.42	0.019
Order	31.89	6.44	0.012
Type	32.12	6.67	0.010
Order + Slope	32.32	6.86	0.0094
Slope	32.75	7.30	0.0076
Order + Type + Length + Slope	33.09	7.64	0.0064
Intercept	34.00	8.55	0.0041
Order + Type + Slope	34.11	8.66	0.0039
Type + Slope	34.36	8.91	0.0034

Order denotes salmoniformes vs. all other orders, whereas type refers to pool and weir, pool and slot, natural and Denil fishways.
†The selected model.

Water velocity through the fishway was positively correlated with upstream passage efficiency, but too few data were available for further analyses. Although the energy expenditure of migrating fish increases with swimming speed and water velocity (Webb 1975), higher water velocities attract more fish to the fishway (Weaver 1963). The inability of fish to locate fishway entrances results from the numerous sources of water discharge in the dam tailrace, such as undesirable eddies, boils and upwellings that act as directional stimuli and confuse salmon (Clay 1995; Brown *et al.* 2006). While fishways require a constant flow of water through their structure, resulting in lost production of hydroelectric power, the loss is typically a fraction of the annual capital cost of the fishway (see below; Clay 1995). Denil fishways also had the lowest mean water velocities, likely resulting in poorer attraction of potential migrants.

Our findings may have implications for the assessment of infrastructure development in countries with strict environmental policies. For example, in Canada, the Fisheries Act requires proponents of new projects to achieve 'No Net Loss' of the productive capacity of habitats for fisheries (Quigley and Harper 2006). As such, the construction of an effective passage facility may be required whenever a dam or barrier is constructed. A free-standing, concrete-reinforced, pool-type fishway that takes no advantage of natural contours costs about \$2600 m^{-3} (2011 U.S. dollars), with annual expenses of about 1–2% of the capital cost (Clay 1995). A fishway that can take advantage of any natural contours will reduce these costs accordingly. Denil fishways, often the cheapest option (Clay 1995), cost about \$124 000 (2011 U.S. dollars) per vertical metre (Erkan 2002) with minimal maintenance and operation costs (Clay 1995). Fish locks and elevators cost roughly \$2.4 million (2011 U.S. dollars) to install, with annual maintenance charges of 5% of the capital cost (Clay 1995). While Denil fishways are generally the most economical option, they also had the lowest mean passage efficiency, approximately 16%. Our analysis suggests that the more expensive pool and natural fishways were also the most effective. However, only the very best designed fishways are approaching 100% success, which would satisfy Canada's 'No Net Loss' policy. Indeed, the average fishway in our data set allowed only 62% of salmonids and 21% of non-salmonids to pass upstream. Application of the precautionary principle would imply that the average barrier equipped with a fishway reduced the productive capacity of the ecosystem by about 50%.

The design of a fishway is highly relevant to the efficiency of its performance, affecting its use by fish, and the species that it may pass (Agostinho *et al.* 2002). Many currently installed fishways have technical characteristics that are poorly matched to the ichthyofauna present, exemplified by undesirably low mean passage efficiencies. These characteristics need to be measured and reported more frequently, particularly in Canada (see Hatry *et al.* 2011), if we are to develop more effective fish passage facilities.

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Adaptive fishway design: a framework and rationale for effective evaluations

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Introduction

Scientific understanding of the effects of dams on fish and other aquatic organisms has been advancing rapidly in recent years (AGOSTINHO et al. 2005; MORITA & YAMAMOTO 2002; WAPLES et al. 2008). Humans have been building dams for millenia, and the first attempts to mitigate these effects date back centuries. It is only recently, however, that tools have become available to help us understand the extent to which dams and other anthropogenic barriers restrict movements, and the effects of these barriers on populations and ecosystems. This paper reviews developments in techniques of fishway evaluations and offers some suggestions for standardized evaluation methods that can direct modifications and improvements to future designs.

During the 20th century several factors arose that led to advances in fishway development and evaluations. The development of efficient hydro-turbines at the end of the 19th century created an incentive to build ever-larger and taller dams. This led to a dramatic increase in construction of large dams during the first half of the 20th century. Soon after, laws and treaties providing protection for migratory fish species were put into effect. This created a mandate to develop more effective fishways. At the same time, advances in hydraulic engineering made it possible to dissipate the head associated with high dams in ways that were shown to improve passability. Hydraulic engineers working in Europe and North America made important advances to fishway designs during this period (British Institution of Civil Engineers 1942; DENIL 1909, 1937; MCLEOD & NEMENYI 1940).

Biological understanding of the requirements of fishway design lagged behind these engineering advances. Early studies of fishway performance were largely restricted to determining whether individuals of a given species could pass a short section of fishway (MCLEOD & NEMENYI 1940), and to largely qualitative descriptions of swimming and leaping performance (DOW 1962; STRINGHAM 1924). Laboratory methods were eventually developed for quantifying swimming performance that provided the first theoretical rationale for fishway design (BRETT 1962, 1964, 1967). By this time, however, many fundamentals of fishway design had already been established, with some empirical (mostly laboratory-based) performance data to support them (COLLINS 1962; COLLINS & ELLING 1960; GAULEY & THOMPSON 1962; ORSBORN 1987). To a large extent, the effect of these developments in biology was to establish or confirm existing design thresholds. These thresholds largely consisted of criteria meant to ensure that flow velocities within fishways were below what a limited number of target fish species were able to traverse.

Quantifying performance

Since the mid-20th century, advances in monitoring technologies and movement theory have provided a more nuanced view of the need for and purpose of fishways. Most recently fishways have come to be employed as a tool in the greater effort to restore ecological connectivity in riverine systems that have become highly fragmented and otherwise altered (BLOCH 1999). To do this, fishways are expected to pass a range of taxa, including many species of vertebrates, as well as some invertebrates. Regardless of taxon, however, the goal of fish passage is the same: to expedite passage for native species.

In order to expedite passage, three processes have to be optimized, each occurring in a different location relative to the fishway: Fish must first find the fishway entrance ('Approach zone', for upstream passage this might be the tailrace of a dam); then they must enter the fishway ('Entry zone', an area near the fishway entrance where the entrance can be detected using hydraulic and other cues); finally, they must ascend (or descend) and exit the fishway ('Passage zone', within the fishway itself; Figure 1). The processes are sequential, and each can be completely quantified as time-dependent rates:

$$\Pr(Advancing) \times dt^{-1} \qquad (1)$$

Where Pr(*Advancing*) is proportion of the available population moving into the next process in the sequence, and *dt* refers to a change in unit time. For each process, a countervening rate occurs as fish abandon the Entry zone, fishway, etc:

$$\Pr(Retreating) \times dt^{-1} \qquad (2)$$

Where Pr(*Retreating*) is the proportion reversing direction or otherwise departing a given zone. Here, each proportion refers to movement from one zone to the next. As such, the units of Equations 1 and 2 can be thought of as representing distance time^{-1}, the appropriate units for movement rate.

This differs from a strict measurement of velocity, however, because the distance units refer to transition between zones (Approach, Entry, etc.). The scale at which distance and time are important will vary depending on context (open river movements vs. fishway passage vs. turbine passage). Also, these two rates should be thought of as competing with each other for a mutually exclusive outcome – a fish that advances is no longer available to retreat, and one that retreats can no longer advance. Each individual has the potential to realize either fate so long as they are present within a particular zone. This is referred to as a 'competing risks' scenario in the survival analysis literature, and has important implications for quantification of movement patterns (ALLISON 1995; CASTRO-SANTOS & HARO 2003; CASTRO-SANTOS & PERRY 2012; See 'Data Analysis Methods' below).

When evaluating passage within a fishway, it may be more useful to characterize passage explicitly in terms of distance:

$$\Pr(Passing) \times dD^{-1} \qquad (3)$$

Where *dD* is the distance traversed or height ascended.

It is important to understand, though, that the physiological and behavioral processes that lead to forward or backward movement are time-dependent, and distance of ascent is the result of rates of forward movement (Equation 1) and failure (Equation 2). Ultimately the goal of fishways is to maximize the first rate while minimizing the second. We must understand the roles of each of these rates if we hope to improve passage.

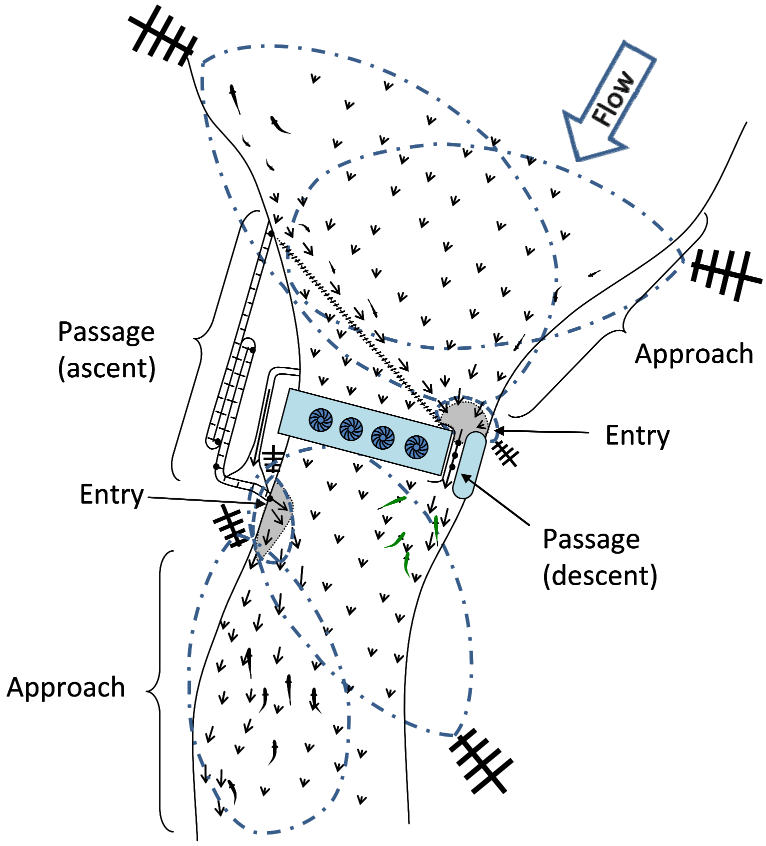

Figure 1: Schematic of typical upstream and downstream fishways at a hydro plant. Zones of Approach, Entry, and Passage are marked. Entry zones are depicted as shaded areas at fishway entrances. Thin arrows indicate flow vectors (length corresponds to velocity). Note attraction flow provided for upstream guidance to left of powerhouse and angled bar racks for downstream guidance upstream of the powerhouse. Antenna arrays are also depicted showing how radio telemetry can be used to identify when individual fish enter and exit each zone (aerials are represented in bold black, ovoids are detection zones with dash-dot monitoring Approach zones and short dashes monitoring Entry zones). Black dots depict PIT antennas deployed for monitoring upstream and downstream Entry and Passage.

Common practices for evaluating fishways

Evidence of passage

In the 19th century (and in many cases even today) managers viewed fishways as successful if they saw evidence of spawning upstream of the structure (PRINCE 1914; ROGERS 1892). The assumption was that if even a few individuals can pass a structure, then the structure must be passable to all individuals of that population. Evidence for this mindset can be seen today in fish passage design manuals, where specifications are provided for species and size classes, with little if any consideration of individual variability in swimming performance or migratory motivation (BELL 1991; LARINIER 2002).

Managers should not be criticized too harshly for this perspective: often the only evaluation tool available to them was surveys of upstream habitat – they had no way to monitor movements of fish through the structures. Moreover, the objective for building these structures was to provide access to habitat, and if there was evidence that that was occurring then it was not unreasonable to consider that structure a success.

Counts

Probably the most common method for evaluating fishways today is to count numbers of fish passing a structure. Various methods can be used to provide visual counts: many fishways are equipped with monitoring windows staffed with live counters. Video is also often used, and recent advances in image processing technology allow counters to view only those clips where fish are present. Hydroacoustics (SONAR and DIDSON) can also be effective for enumerating targets, sometimes even allowing automated species assignment (ENZENHOFER et al. 1998). Hydroacoustic techniques are of greatest value for downstream passage, where deep, quiescent forebay environments make it possible to monitor movements and quantify passage routes (SKALSKI et al. 1996; STEIG & JOHNSTON 1996). The shallow depth and highly air-entrained environments of many fishways, however, largely precludes the use of hydroacoustics in the vicinity of these structures (THORNE 1998; TREVORROW 1998).The use of visual counts and their acoustic analogues holds an intuitive appeal – the better a fishway performs the more fish it should pass. There is an important logical flaw in this thinking, however: the number of individuals passing a structure is a function of both the number trying to pass and the passage rate. In order for fish counts to be an adequate measure of fishway performance the following criteria must be met: 1) the number attempting to pass must be known; 2) arrival timing for the population passing must be known; 3) individuals can only be counted once – fallback must be negligible. A corollary of criterion 3 is that movement must either be unidirectional, or the observer must be able to account for both upstream and downstream movements of individuals. Without the aid of tagging technology these three criteria cannot be met except perhaps for very small, closed populations.

Where sequential fishways exist on river systems it may be possible to satisfy the first 2 criteria for all but the first fishway. Without being able to identify individuals, however, the third criterion cannot be met. This may be acceptable if each fishway in a sequence rapidly passes the entire population of available fish. Such fishways might be deemed fully successful with no further monitoring required. Examples of this are rare, however, even among salmonid populations for which fishways are broadly thought to be effective. Also, the performance of the first fishway in the sequence cannot be known: even if estimates of populations below the dam are available (e. g. as might be provided with hydroacoustics), the duration of exposures and identity of individuals is typically not estimable. At best, video and acoustic monitoring should be thought of as a screening test: if the criteria can be met and passage meets management goals then video can be a sufficient evaluation tool. If either the criteria or management goals are not met, however, other methods must be employed to evaluate passage.

In addition to evaluating performance, fishway counts are also often used as population indices of migratory fish. This may be the greatest value of fishway counts, and many long-term datasets are available that document runs, especially of anadromous fish species. Although widely used, these indices should also be viewed with caution because they only indicate how many fish passed the structure, not how many were available to pass. If passage performance were constant across years, then this would be a reliable index. Performance can vary widely, however, with environmental conditions (temperature, discharge), hydroelectric facility operations, and physiological state of migrants (SULLIVAN 2004; ZABEL et al. 2008). Thus fishway counts are of greatest value for long-term monitoring and trends, but in order to understand annual variability in performance more reliable methods are required.

Mark-Recapture

Mark-recapture techniques are one of the best-established ways to estimate population size, and can be a very effective tool for measuring passage performance. Techniques of mark-recapture include visual marks (e. g. external marking or tagging), biological marks (e. g., genetic identifiers, otolith marking, etc), and telemetry. Visual and biological marks can be useful, especially for batch marking large numbers of individuals. However they typically require that individuals be physically re-captured and handled, which can affect their behavior. More importantly, although successful fish can be easily captured in fishways, this may require obstructing passage of large numbers of untagged individuals. Finally, these methods do not provide ready estimates of how many tagged fish even approach the fishway. Telemetry, in contrast, allows monitors to detect fish as they approach and pass each structure, and so offers a far more appropriate set of tools for fishway evaluations. The following subsection describes the three most common forms of telemetry and describes their application to fishway performance monitoring and evaluation.

Radio and Acoustic telemetry

The past two decades have seen dramatic advances in the field of wildlife telemetry, with many of the advances being developed specifically to address questions of fish passage. Both radio and acoustic telemetry allow users to tag individual fish and monitor their movements over a range of scales. Tags can be coded to transmit unique identifiers; some systems are able to discriminate among several hundreds of codes on a single frequency. A particularly useful feature of radio telemetry is that radio antennas and receivers can be tuned to manage detection range. This allows users to quickly and effectively identify movements among Approach, Entry, and Passage zones (Figure 1). A recent book documents details of the development of this technology and offers many specifics on application (ADAMS et al. 2012).

Radio telemetry tags fall into two broad categories: active and PIT (for passive integrated transponders). Active tags carry a battery and can be programmed to transmit their codes at user-specified rates. Signals from these tags can be detected over very large distances (even by orbiting satellites in some cases); range is correlated with power consumption, though, and to maximize battery life most transmitters have a maximum working range of < 1 km through air. One concern common to all telemetry methods is that when multiple tags are present within a detection range it is possible for signals to collide, causing missed reads. This can be avoided with tags and receivers that operate on more than one frequency. Some receivers are able to simultaneously monitor all frequencies within a fairly broad band (e. g. 1 MHz). Most receivers have to scan among frequencies, however, which means that detection efficiency decreases with increasing frequency number.

PIT tags do not carry batteries; instead they are built with induction coils that are charged when the tag passes near or through an antenna. These tags are typically small (1 x 8 mm - 3 x 32 mm) and hermetically sealed in glass or plastic capsules, which offers the advantage of nearly unlimited functional life. PIT detectors operate at very high rates (tens of reads per second). The tags only function over short ranges however: in most cases tags must be < 1 m of an antenna to be detected. Antennas themselves can be larger, however, and can be easily constructed to span slots and weirs of dimensions common to fishways; in some cases they can even span small rivers (FRANKLIN et al. 2012). This makes them ideal for documenting entry into and passage through fishways (CASTRO-SANTOS et al. 1996; SULLIVAN et al. 2001; FRANKLIN et al. 2012; Figure 1). Moreover, their short detection range precludes detection outside the fishway, where signals from active tags can often penetrate through solid structures providing a false impression of entry. Also, the rapid read rate means that PIT detectors can monitor brief passage events, such as sprinting through a slot or downstream passage at a sluiceway. Active tags fire slowly, and have larger but typically less precise read range. While this makes them less effective for monitoring brief passage events, they are more effective at monitoring longer events, like Approach and Entry. Thus these two forms of radio telemetry complement each other and make an excellent combination for evaluating fish passage.

One limitation of PIT and active radio telemetry is that both types are sensitive to radio-frequency (RF) noise and interference. Interfering signals can be conducted along power cables and can be transmitted through air. With increasing use of radio bandwidths for communications this issue promises to become an increasing problem. Those planning monitoring programs and experiments will do well to first survey the bandwidths in their study area. Tags can then be built that transmit on those bands with the least amount of noise for that location.

A second important limitation for radio telemetry is that transmissions are rapidly attenuated in water. This problem is most severe in saltwater, where attenuation is almost complete even in very shallow depths. Attenuation is not a problem in riverine applications where fish swim within a few meters of the surface. Where fish swim near the bottom of deep rivers or lakes, radio may still be useful over short distances (10's of meters), especially if receiving antennas can be placed below the water surface. This technique can also help eliminate problems of transmitted RF noise. Where long detection distances are required for fish moving at depth, however, radio telemetry may not be an effective tool for monitoring movements.

Acoustic telemetry can work well in those very environments where radio is ineffective. Similar to radio, acoustic tags can transmit unique codes. Some systems are able to detect signals over multiple frequencies. Under optimal conditions, acoustic tags can be detected over a range of 100's of meters – appropriate distances for broad-scale monitoring of movements. Some manufacturers have developed methods for triangulating position of tags based on the different arrival times of signals to hydrophones arranged in carefully designed arrays. In some cases the position of the tag can be resolved to within a few centimeters. This ability helps to counter a significant weakness of acoustic systems: sensitivity and detection range can vary widely at a given location depending on water chemistry, turbidity, and presence of acoustic noise (e. g. from wind, currents, boat traffic, etc.). In the absence of multiple redundant receivers that can triangulate position or similar methods, precision of these instruments can be poor, limiting the value of the data they provide.

Where fine-scale positioning is possible, significant time investments are typically necessary to ensure that only reliable transmissions are used. The data this method provides can be used to characterize approach, and even entry into fishways, although these metrics really do not require the level of resolution that can be achieved, and most of the information provided by acoustic triangulation falls outside the scope of quantifying passage performance. Also, acoustic telemetry does not work in confined spaces with high amounts of entrained air, such as is found within fishways. These issues limit the value of acoustic telemetry technology for monitoring fish passage.

Perhaps the greatest promise of acoustic telemetry (and the same can be said for fine-scale radio applications) lies in the ability to couple detailed movement data with information on hydrodynamics and how complex flow patterns influence orientation and navigation. Fish possess highly specialized mechanosensory structures that allow some species to detect small fluctuations in flow. How fish respond to these fluctuations and how this relates to other sensory and environmental stimuli (e. g. vision, smell, etc.) remains poorly understood and represents one of the greatest research needs in understanding how to best to locate and design fishways relative to dams, powerhouses, and riverbed morphology. Predictive models developed coupling computational fluid dynamics models (CFD) with acoustic and other forms of telemetry and hydroacoustics suggests that this may provide a very powerful tool for improving both upstream and downstream passage (GOODWIN et al. 2006; NESTLER et al. 2008).

Data analysis methods

The fact that fish may either advance or retreat from a given zone (Equations 1 and 2) complicates analysis of telemetry data. When presence in a given zone can terminate in more than one way the researcher must calculate rates based on those individuals that are present and available to advance or retreat, regardless of which event terminates that presence. Once the individual leaves the zone, however, it must no longer contribute to rate calculations. A set of statistical tools developed for clinical trials, actuarial applications, and materials testing (collectively called 'survival analysis') is well-suited to accommodate this feature (see CASTRO-SANTOS 2004, 2011; CASTRO-SANTOS & HARO 2003; and ZABEL et al. 2008 for details on these techniques and their application to fish passage). These tools allow researchers to measure competing rates of advance and retreat, while eliminating the bias caused by the fact that both rates are acting on individuals simultaneously. Importantly, these methods allow for calculation of effects of covariates (velocity, turbulence, temperature) on those rates, thereby allowing managers and researchers to identify specific conditions that act to limit or enhance passage.

Where detailed movement studies are available, they indicate that existing and widespread standards of fishway design are far from optimal for passage of a range of species, and that much more work is needed if we hope to provide passage for the multitude of aquatic organisms that use rivers as movement corridors.

Case studies

Recent work has called into question the effectiveness of fish passage and other river restoration techniques. Perhaps more troubling is the fact that post-construction monitoring and evaluation are the rare exception, rather than the rule. This is true of river restoration programs generally (BERNHARDT et al. 2005), and also for fishways in particular. A recent meta-analysis combed the peer-reviewed and gray literature to determine whether certain fishway types are more effective than others (BUNT et al. 2011). The authors identified more than 100 published studies purporting to evaluate fishways, but only 19 of these provided enough information to determine what proportion of fish entered and passed the respective fishways. Among those fishways that had received this minimal level of evaluation performance ranged widely, both within and among fishway types and species groups. The variability in performance was so great that the authors concluded that no compelling evidence yet exists to support any one fishway design; worse, those designs in common use cannot be expected to reliably pass any species (Figure 2).

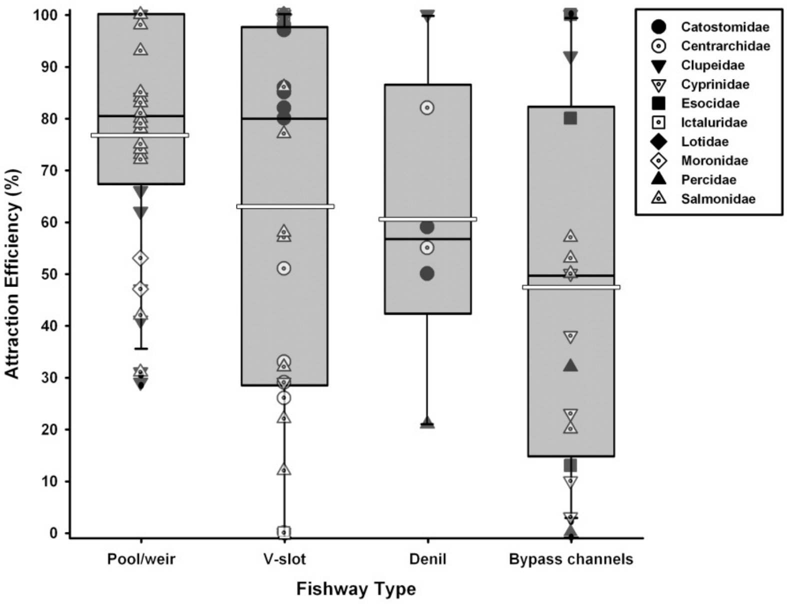

Figure 2a: Percent attraction (approach x entry) by fishway type. Reprinted with permission from BUNT et al. (2011)

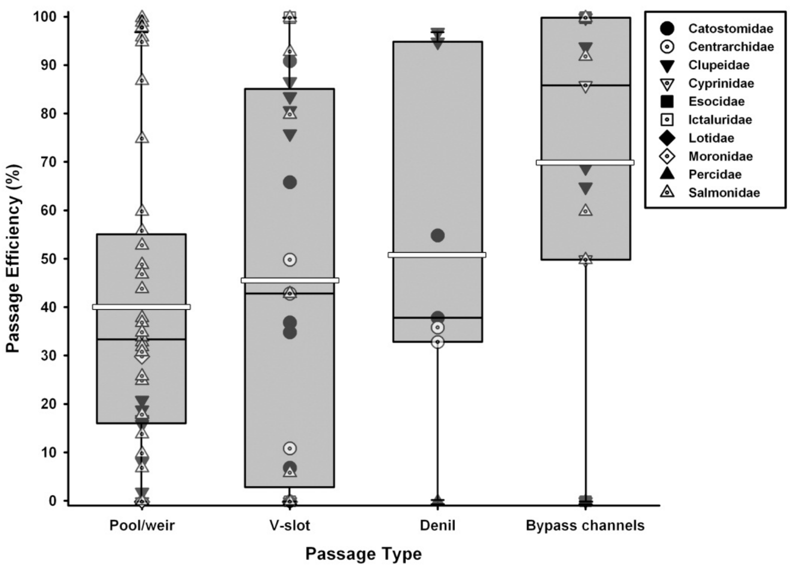

Figure 2b: Percent passage by fishway type. Note the broad variability in performance both here and in Figure 2a. Redrawn with permission from BUNT et al. (2011).

The work by BUNT et al. (2011) required that fishway evaluations separate out passage for fish that enter fishways from the proportion entering. As stated above, however, there are two steps that must occur before fish even enter the fishway: they must first approach and locate the fishway entrance, and then they must actually enter the structure (Figure 1).

Work that colleagues and I have performed at fishways on the Connecticut River has illustrated the importance of including all three steps in evaluations (CASTRO-SANTOS & HARO 2010; CASTRO-SANTOS & LETCHER 2010; SULLIVAN et al. 2001). The Turners Falls dam and fishway complex (Connecticut River, USA, RKm 194) creates a serious barrier to passage of American shad (*Alosa sapidissima*). Because they have passed tens of thousands of American shad in some years, these fishways have been widely hailed as models of effective shad passage (LARINIER & TRAVADE 2002; MOFFITT et al. 1982; RIDEOUT et al. 1985). Those claims of effectiveness were entirely based on numbers of individuals passing, however. As dicussed earlier, this approach overlooks the important question of how many fish are actually entering the fishway. We began our evaluations of passage at Turners Falls using PIT telemetry in 1999, later we coupled PIT and active radio telemetry, and that work continues today. In the case of Cabot Ladder – the first fishway in the system, and once thought to be a highly effective fishway – passage proportions range from 3 - 17 %. This failure was manifest in the distance that fish are able to ascend the ladder (Figures 3 and 4). The mechanism of the failure, though, can be better understood by considering the competing rates of success and failure: shad abandon the ladder at greater rate than they ascend (Figure 5), which produces a consistently low passage rate.

Figure 3: Cabot fishway, RKm 194 on the Connecticut River, Massachusetts USA. Constructed in 1980, this fishway has probably never passed shad effectively.

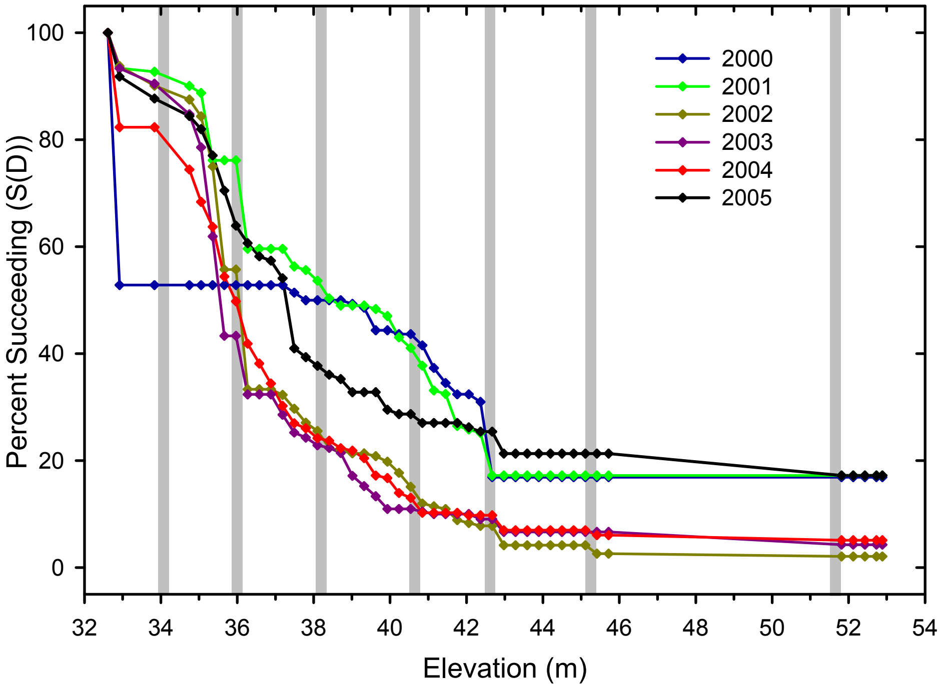

Figure 4: Results of 6 years of PIT telemetry at Cabot Ladder (Figure 3). Gray bars indicate turnpools, dots indicate individual PIT antenna locations and percent arriving to each antenna.

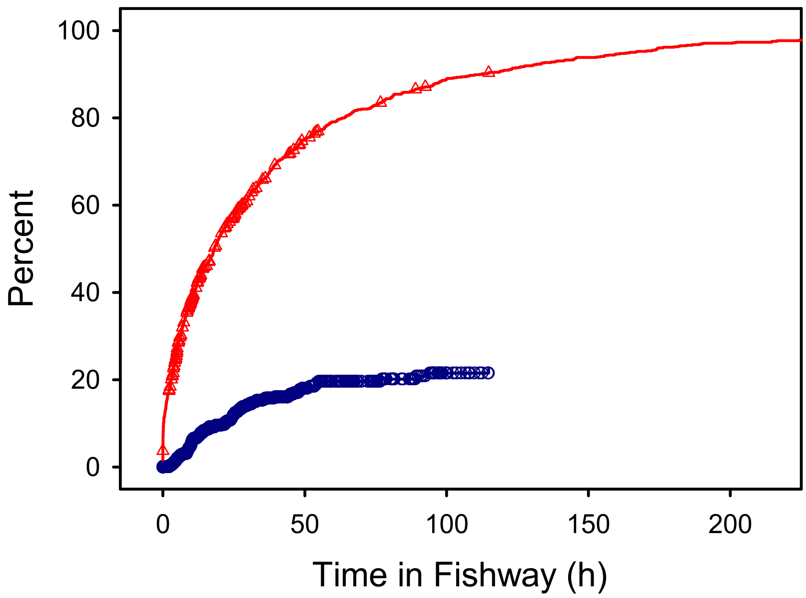

Figure 5: Time to pass (blue) vs. time to fail (red) of American shad in the Cabot fishway. Lines are modified Kaplan-Meier curves (KAPLAN & MEIER 1958) and are least-biased estimates of cumulative distribution functions that would be expected if only one endpoint were available. Circles and triangles represent censored observations, i. e. for the passage curve they represent residence times for individuals that did not pass and for the failure curve they represent passage times of successful passers. Note that failure rate always much greater than passage rate – this is the cause of the poor passage success shown in Figure 2a.

Despite multiple changes to this fishway improvements have been marginal, and plans are underway to replace it with a fishlift. This is an important lesson of the importance of performing evaluations as part of fishway design: the fishway was completed in 1980 at a cost of about $10 million and operated for almost 20 years before its poor performance was documented in a way that managers could act on. Now it must be replaced at even greater cost. Mounting evidence suggests that poor performance at this and other fishways in the system have contributed to declines in the very populations they were intended to enhance (CASTRO-SANTOS & LETCHER 2010).

Although passage through Cabot Ladder is poor, approach and entry appear to be satisfactory (about half of the shad passed at the next dam downstream enter the fishway (SULLIVAN 2004)). Other fishways in the complex have the opposite problem, however. At the uppermost fishway in the system (Gatehouse Ladder) shad pass at in comparatively high proportions (about 60 % of shad that enter successfully pass). However fewer than half the shad that attempt to pass Gatehouse Ladder ever encounter the original fishway entrance (low approach rate), and those that do often fail to enter (low entry rate). A series of modifications begun in 2007 has yielded a greater than 4-fold improvement in passage rate at Gatehouse Ladder, and work is ongoing to improve this further. Thus at the Turners Falls we have examples of failure in each of the three steps: Approach, Entry, and Passage. Successful resolution of these problems is now being realized, but only because we were able to differentiate among the sources of failure.

Conclusions

Fishways are expected to restore ecological connectivity to fragmented riverine systems by expediting passage for a range of taxa. Several factors will determine the effectiveness of these structures. These factors include biomechanics (locomotion) and physiology (endurance, motivation), as well as behavior (orientation, optimization; swimming, climbing, etc.). Limitations to any one of these factors can preclude successful fishway performance, and there is a pressing need to advance our understanding of all three factors with respect to fish passage.

Expeditious passage requires that fish be able to pass a structure with a minimum of delay, stress, injury, or exposure to direct or indirect anthropogenic influences. In short, it means that fishways should eliminate the impediments to movement caused by dams and impoundments. Ultimately, any organism for which passage is provided must complete the three steps of fishway passage: Approach, Entry, and Passage. Biologists and engineers must collaborate to understand how well fishways are performing, and what solutions are likely to improve passage where problems occur. Available evidence has shown that existing designs cannot be expected to reliably expedite passage. Even so-called nature-like fishways have largely failed to deliver on their promise to expedite passage for a broad range of taxa (BUNT et al. 2011). Given that passage provisions remain a priority worldwide, it is all the more important that managers and engineers adopt an adaptive management approach to the design and construction of fishways. With widespread application of evaluations that measure performance standards with clear biological relevance it may become possible to better understand the relationship between design and performance – a relationship that at the moment continues to elude us.

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1992 – 1993

Field Biologist, RMC Environmental Services (now Normandeau Associates), Brattleboro, VT

1993 – 1995

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Since 1995

Research Ecologist, S.O. Conte Anadromous Fish Research Center (U.S. Geological Survey-Biological Resources Division), Turner Falls, MA

Experience in biomechanics and swimming performance of migratory fishes, migratory behavior and survival, and numerical methods for describing effectiveness of fishways.

Document Content(s)

PENOBSCOT NATION

DEPARTMENT OF
NATURAL RESOURCES

JOHN S. BANKS, DIRECTOR

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4/9/2019

Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Lowell Tannery Hydroelectric Project (FERC # 4202)

Dear Secretary Bose,

The Penobscot Indian Nation (PIN) has inhabited the Penobscot River watershed since time immemorial. The PIN continues to be unable to exercise its Treaty Reserved Sustenance Fishing rights on the Penobscot River because of the low abundances of 13 species of sea-run fish. These culturally significant species are at historic low levels because of the hydroelectric development of the river, and the lack of efficient fishways. (Saunders et al, 2006)

The Passadumkeag River offers significant diverse habitats for multiple sea-run fish species, and the transparency of the Lowell Tannery project to those fishes is paramount to their recovery.

The Penobscot Indian Nation has taken the opportunity to review the Pre-Application document (PAD) and the Notice of Intent to File (NOI) filed November 23, 2018. The PIN has also has consulted with our federal partners at the National Marine Fisheries Service (NMFS) and reviewed their comments and study requests, filed with the FERC on March 9, 2019.

The PIN would like to express its complete support and concurrence for the comments and study requests filed by the NMFS on March 9th, 2019.

If the Secretary has any questions, please reach out at your nearest convenience.

Sincerely,

4/9/19

Daniel McCaw

Penobscot Indian Nation

Fisheries Program Manager

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Document Content(s)

DRAFT 2020 STUDY PLAN

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

Prepared for:

KEI (Maine) Power Management (III) LLC

Prepared by:

Kleinschmidt Associates

March 2020

Kleinschmidt

TABLE OF CONTENTS

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1.0 INTRODUCTION

The Lowell Tannery Hydroelectric Project (Lowell Tannery Project)[1] is on the Passadumkeag River, in Lowell, Maine, approximately 13 river miles upstream of the confluence with the Penobscot River. KEI (Maine) Power Management (III) LLC [KEI (Maine)] operates one hydroelectric turbine-generator unit at the Lowell Tannery Project, which can produce up to approximately 1,000 kilowatts[2] of renewable, hydroelectric energy. KEI (Maine) operates the Lowell Tannery Project in run-of-river mode so that outflow at the powerhouse matches natural river inflow. After water passes through the turbine unit, it discharges back into the Passadumkeag River from a small powerhouse that is integral to the dam. The Penobscot River watershed supports diadromous fish species such as Atlantic salmon, American eel, American shad, and river herring.

The existing license for the Lowell Tannery Project issued by the Federal Energy Regulatory Commission (FERC) license (FERC No. 4202) expires on September 30, 2023. KEI (Maine) must file an Application for Subsequent License (License Application) with FERC on or before September 30, 2021. KEI (Maine) filed a Notice of Intent and Pre-Application Document (PAD) on September 26, 2018, to initiate the relicensing of the Lowell Tannery Project using the Traditional Licensing Process. The PAD provided a description of the Lowell Tannery Project, including its structures, operations, and potential resource issues. By letter order dated November 23, 2018, FERC granted KEI (Maine) approval to use the Traditional Licensing Process (TLP).

KEI (Maine) distributed the PAD to federal and state resource agencies, local governments, Native American tribes, and others thought to be interested in the relicensing proceeding. The PAD and subsequent scoping identified potential environmental issues associated with the operation of the Lowell Tannery Project for which the existing, relevant, and reasonably available information was insufficient. Comments on the PAD and study requests were received from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Maine Department of Environmental Protection (MDEP), Trout Unlimited (TU), and the Penobscot Indian Nation (PIN).

[1] Also known as the Pumpkin Hill Project.
[2] Approximate maximum instantaneous generation capacity.

In 2019, KEI (Maine) contracted Kleinschmidt Associates (Kleinschmidt) to complete a water quality study in the impoundment, a dissolved oxygen study in the tailwater, benthic macroinvertebrate sampling in the tailwater, and a desktop turbine passage survival and whole station survival analysis. The 2019 study report was provided to the resource agencies on March XX, 2020. KEI (Maine) is planning to complete three additional studies in 2020:

- a radio telemetry and PIT-tag[3] study with the University of Maine, Orono (UMO) to evaluate upstream passage of adult Atlantic salmon and adult sea-run alewives;
- an upstream American eel passage study; and
- and a feasibility study to evaluate potential ways to provide downstream passage for adult American eels.

Studies requested by agencies thus far in the process are not of insignificant costs, thus KEI (Maine) is carefully considering the appropriateness of the scope and timing of the fish passage studies recommended by the stakeholders. As described in the 2019 Initial Study Report, the desktop entrainment study demonstrated that turbine passage survival for all species and lifestages was generally high and that the existing trash rack bars exclude larger-bodied fish from entrainment. The study showed that project operations may affect adult American eel migrating downstream the most. Therefore, KEI (Maine) is proposing to conduct a feasibility study of downstream eel passage alternatives in 2020. KEI (Maine) is not providing a formal study plan for the feasibility assessment but a summary of alternatives evaluated will be provided in a follow-on report for 2020 study efforts.

[3] Passive Integrated Transponder tags.

2.0 UPSTREAM PASSAGE STUDY FOR ANADROMOUS FISH

2.1 Study Objectives

To evaluate whether the existing upstream Denil fishway provides safe, effective, and timely passage for adult Atlantic salmon and river herring.

2.2 Known Resource Management Goals

NMFS, MDMR, and the USFWS have management objective that include the restoration and protection of anadromous fish stocks in the Penobscot River basin.

2.3 Background and Existing Information

KEI (Maine) operates a Denil fishway at the Lowell Tannery Project to pass migratory fish species upstream. Atlantic salmon and sea-run alewives are known to arrive at the Lowell Tannery Project each year during their upstream migration. KEI (Maine) plans to collaborate with the University of Maine to study Atlantic salmon, American shad, and river herring at the Lowell Tannery Project in 2020. Researchers from UMO, with the support of KEI (Maine), studied the upstream passage of Atlantic salmon and sea-run alewives using PIT-tags equipment at the Lowell Tannery project in 2018 and 2019. In 2019, one tagged Atlantic salmon and 185 tagged river herring attempted to migrate upstream at the Lowell Tannery Project. UMO researchers documented passage of 15 river herring (8.1 percent) through the Lowell Tannery fishway; the individual tagged salmon that arrived at the site did not pass through the fishway but was detected at the entrance. In 2018, UMO documented passage rates of 20 percent (river herring) and 25 percent (Atlantic salmon) through the Lowell Tannery fishway.

KEI (Maine) plans to modify the Denil fishway in 2020 based on recommendations by the USFWS' fish passage engineer following a monthly fish passage planning meeting in January 2020. The following modifications are planned prior to the planned study:

- Dewater and clean the fishway;
- Replace any damaged baffles according to the original design drawings;
- Install all baffles according to the original design;
- Ensure all baffles are constructed according to the original design drawings; and
- Once all baffle modifications have been made, and while it is still dewatered, allow resource agencies to inspect, should they opt to.

2.4 Project Nexus

Operation of the Lowell Tannery Project may affect the upstream passage of anadromous fish.

2.5 Methods

UMO researchers plan to install full-duplex PIT-tag antennas in the fishway at the entrance and exit to monitor the behavior and upstream passage of tagged diadromous fish at the Lowell Tannery Project. UMO researchers also plan to install a radio-telemetry receiver near the entrance to the fishway or in the tailwater area to monitor tagged fish that approach the facility. UMO plans to work with the Maine Department of Marine Resources (MDMR) to tag fish at the Milford fish lift, which is the Penobscot River, approximately 19 river miles downstream of the Lowell Tannery Project. In 2019, MDMR and UMO tagged over 4,000 sea-run alewives and almost 1,200 adult Atlantic salmon with PIT-tags, plus 50 Atlantic salmon were radio-tagged. KEI (Maine) anticipates that a similar number of fish will be tagged and released at Milford in 2020.

Lotek and Biomark (or similar) tags and receivers will be used during the study. Data will be offloaded from PIT-tag and telemetry receivers weekly and archived. Fishway effectiveness will be calculated by comparing the number of fish detected at the fishway entrance to the number of fish detected at the fishway exit. Telemetry data will be used to determine how many Atlantic salmon arrive in the tailwater area. Information about transit time through the fishway, delay, and the effectiveness of the fishway in attracting fish will be evaluated. Data associated with normal project operations will be reviewed to determine if changes to operations influence upstream passage rates and effectiveness.

2.6 Consistency with Generally Accepted Scientific Practice

Researchers regularly use PIT-tagging and telemetry studies to evaluate upstream passage at hydroelectric projects.

2.7 Deliverables and Schedule

The 2020 upstream passage study would take place from approximately May 1 – November 1, 2020. This would encompass the upstream migration period of Atlantic salmon and sea-run alewives. A summary of research findings will be provided in an Updated Study Report by approximately March 1, 2021.

3.0 AMERICAN EEL UPSTREAM PASSAGE FACILITY DESIGN AND SITING STUDY

3.1 Study Objectives

The objective of this study is to determine if juvenile American eels pass upstream or congregate at the Lowell Tannery Project dam or tailwater. If juvenile American eels are observed at the dam, tailwater, or near gates, KEI (Maine) will consult with NMFS, USFWS, and MDMR to determine the need for, timing, and design of a seasonal upstream eelway to facilitate upstream American eel passage during post-license compliance activities.

3.2 Known Resource Management Goals

NMFS, MDMR, and the USFWS have management objective that include the restoration and protection of diadromous fish stocks.

3.3 Background and Existing Information

There is limited information that describes the behavior of American eels at the Lowell Tannery Project. The study will provide background information to be used to assist in decision-making and environmental analyses during the relicensing period.

3.4 Project Nexus

Operation of the Lowell Tannery Project may affect the migration of juvenile American eels in the Passadumkeag River.

3.5 Methods

The licensee proposes to monitor the distribution and abundance of juvenile eels at the Lowell Tannery Project during the peak upstream migration period in 2020. Most juvenile eels in Maine move upstream in June, July, and August, typically at night under cloud cover or in the rain. The licensee plans to conduct up to 12 nighttime surveys once a week from June 1 to August 28. Surveys will be completed during non-spill conditions to increase the likelihood of locating juvenile eels along or near the dam face. If a wet summer or operational conditions results in sustained spill over the dam, the licensee may only be able to perform some of the proposed monitoring.

Researchers plan to survey from safe, accessible areas at or below the dam to identify where eels may congregate or move upstream. The survey area will include the tailrace area immediately downstream of the powerhouse, along gates at the dam, and accessible and visible portions of the spillway and bedrock outcrops between the dam and the powerhouse. Surveys will be timed to coincide with precipitation and different lunar phases, as possible. Each survey will begin at or near sunset and will last up to 1.5 hours, depending on the number of eels observed. During each survey, the field crew will (1) identify each area where eels congregate or ascend past the Lowell Tannery Project; (2) record the date, start time, end time, and survey conditions; (3) count the approximate number of eels at each location; (4) observe and note behavior and migratory patterns; (5) and estimate the size range of observed eels. The surveys will be completed with spotlights and binoculars.

3.6 Consistency with Generally Accepted Scientific Practice

This study will employ widely accepted methods for evaluating upstream eel passage at hydroelectric projects in Maine. The proposed monitoring plan is like previous efforts undertaken at other hydroelectric projects in Maine in recent years (e.g., American Tissue Project, Lower Barker Project, Williams Project). These efforts have resulted in the successful identification of areas where eels congregate or pass upstream at hydroelectric dams, allowing the licensee to design and install upstream passage systems to facilitate the movements of juvenile eels.

3.7 Deliverables and Schedule

The field work will be conducted between June 1 and August 28 (2020). Data analysis and technical reporting will begin after the completion of the monitoring. A summary of research findings will be provided in an Updated Study Report by approximately March 1, 2021.

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

JANET T. MILLS
GOVERNOR

GERALD D. REID
COMMISSIONER

April 17, 2019

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Initial Study Report for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

Dear Secretary Bose:

The Maine Department of Environmental Protection (Department or DEP) reviewed a Pre-Application Document (PAD), submitted on September 26, 2018, and filed comments and study requests on March 12, 2019. The Department also reviewed a Water Quality Study Plan dated June 2019 and attended a Study Plan Meeting on March 27, 2020, organized by Kruger Energy, KEI (USA) Power Management Inc. (Applicant), for the Lowell Tannery Hydroelectric Project (Project) (FERC No. 4202) that detailed the results of those water quality studies and discussed additional studies for the upcoming 2020 field season. Department staff reviewed appropriate Project documents to prepare the following comments and study requests.

As previously noted, the proposed relicensing of the Lowell Tannery Project is subject to water quality certification provisions of Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act). By Executive Order of the Governor of the State of Maine, the Department is the certifying agency for projects located wholly or partially in organized towns and cities, and as such has jurisdiction over the Project.

The existing Lowell Tannery Project consists of a 230-foot-long, 27-foot-high concrete gravity dam with a crest elevation of approximately 178.8 feet[1] topped with 3.5-foot-high flashboards (for a total of 182.3 feet normal pond elevation), with a principal spillway of 30 feet and an auxiliary spillway of 89 feet, a seven-foot-wide log sluice and a 10-foot-wide tainter gate. The dam impounds a reservoir with a surface area of approximately 68.5 acres at a normal pond elevation. The dam contains a 3-foot-wide Denil fish passage facility and a dedicated downstream fish bypass pipe. A powerhouse integral to the dam contains a single turbine-generator unit with a total generating capacity of 1 MW and an average annual generation of approximately 4,095 MWh. The Lowell Tannery Project operates in a run-of-river mode where upstream water flowing into the project impoundment approximately equals water flowing downstream from the project.

[1] Elevations are provided in feet above mean sea level.

The Department understands that there are no proposed changes in facilities or operations of the Rollinsford Project at this time.

Comments on the Initial Study Report

The Department appreciates the effort of the Applicant to prepare the Initial Study Report. After review of the available documents, the Department has the following comments on the Initial Study Report:

1. The ISR presents data for three water quality studies, including an Impoundment Trophic State Study, Tailwater Dissolved Oxygen and Water Temperature Study, and a Tailwater Benthic Macroinvertebrate Study, and for a desktop Turbine Blade Strike and Whole Station Survival Study. The Department confines its comments to the water quality studies and defers commentary on the Turbine Blade Strike and Whole Station Survival Study to the fish resource agencies with the expertise and experience to provide meaningful comment.

2. In its comments on the Pre-Application Document for the Lowell Tannery Project, the Department also requested an Aquatic Habitat Cross-Section Flow Study and an Impoundment Aquatic Habitat Study which were not conducted by the Applicant. In lieu of conducting the requested studies, the Department requests the Applicant submit three years of water level and flow data to demonstrate run-of-river operations (ROR), wherein inflow is equal to outflow and impoundment water level fluctuations are limited to one foot. Making a demonstration of ROR operations, along with the impoundment bathymetry measurements requested will provide the data necessary to calculate the impoundment littoral zone and the % wetted area and volume, demonstrating extent of habitat for fish and other aquatic life in the impoundment. Submission of the flow data is expected to demonstrate maintenance of consistent flow and the associated maintenance of the riverine aquatic habitat for fish and other aquatic life downstream of the dam.

3. The ISR does not present impoundment bathymetric data, as request by the Department in its comments on the PAD. Bathymetric data is critical to evaluation of impoundment littoral habitat in lieu of conducting an Impoundment Aquatic Habitat Study, and is again requested, along with water level and flow data to demonstrate attainment of the designated use of habitat for fish and other aquatic life.

4. 2019 Macroinvertebrate Sampling Study. Table 2 of the report appears to contain errors, referring to the location of Passadumkeag Sream in Auburn, Maine. Please review this information as well as the rest of the table and revise as necessary.

Water Quality Studies

Impoundment Trophic State Study – Water quality data was collected at the Lowell Tannery Project between June and October 2019, in accordance with the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018). Nutrient concentration exceeding those determined by the Department to be acceptable can cause negative environmental impacts to surface waters, such as algal blooms, low dissolved oxygen concentrations, excessive growths of filamentous algae or bacteria, generation of cyanotoxins or affecting the resident biological community. Project study results indicate nutrient concentrations (phosphorus and chlorophyll-a in the Lowell Tannery impoundment exceed generally acceptable concentrations for Class A waters. Secchi disk transparency measurements ranged from 1.9-2.9 meters; measurements less than two meters can indicate algal growth, especially in the presence of excessive nutrients A single Secchi disk measurement, collected on October 2, 2019, was less than the two-meter threshold demonstrating attainment of Class AA/A water quality standards, however color values are high (85-100 PCU) in the Passadumkeag River at this location, which prevents conclusions being drawn from the Secchi disk transparency measurements or the total phosphorus data. It is important to note that the Department does not apply averaged measurements in determining whether Secchi disk transparency measurements at any project attains or does not attain the threshold criteria. Color values in the range measured at the Lowell Tannery Project interfere with water transparency, and the humic acids responsible for the color can bind with phosphorus, making it biologically unavailable. Humic acids can also contribute to oxygen depression because the reactions that occur when sunlight breaks down these molecules consume oxygen. Dissolved oxygen concentrations in the impoundment failed to attain Maine Water Quality Standards, specifically the minimum criteria of 7 ppm, on 4 of 10 sampling dates (40% of the sampling period).

Impoundment Aquatic Habitat Study – The purpose of this study is to determine the character of the impoundment's littoral zone and the ability of the impoundment to support fish and other aquatic life. The Lowell Tannery Project is operated as a run-of-river facility; therefore, normal operations should not greatly affect the littoral zone. The Department requested that the Applicant establish a bathymetric profile of the impoundment and conduct the impoundment aquatic habitat study following the "Habitat Study" protocol under "Lakes, Ponds, and Impoundments" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018); however, as noted in its comments, above, submission of three years of impoundment water level data will demonstrate the ROR character of the Lowell Tannery operations, and coupled with the requested bathymetric measurements can be used to calculate the % wetted area and volume of the littoral zone and may demonstrate attainment of the designated use of habitat for fish and other aquatic life. The Department again requests bathymetric measurements in the impoundment and three years of impoundment water level and flow data in demonstration of attainment of the designated use of habitat for fish and other aquatic life.

Downstream Temperature and Dissolved Oxygen Study – Temperature and dissolved oxygen monitoring downstream of the Lowell Tannery Dam was requested to demonstrate compliance with Maine's Class AA/A minimum dissolved oxygen criteria of 7 parts per million and 75% saturation. A Dissolved Oxygen and Temperature Study was conducted by the Applicant between June and October 2019, in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018). The Department notes that the photo presented in the ISR shows the Hobo data logger near the bank river right, instead of at the quarter point location determined to have the lowest DO measurement, which would have more accurately represented conditions in the river. The Initial Study Report presents the DO monitoring values as well as minimums, maximums, medians and averages for each sample month; results ranged from 6.2 mg/L to 10 mg/L, with percent saturation ranging between 70.9%

and 104.5%. The Study notes that DO concentrations appear to track the concentrations measured in the impoundment during generation, and generally increase when generation stops. The Department requests the Applicant submit an excel spreadsheet of the temperature and DO data to assist its interpretation of Project results.

To show whether the cause is upstream or arises in the impoundment, the Applicant could sample DO above, within, and below the impoundment twice each day (before 8:00am and again in mid-afternoon at each, following the Department's sampling protocol referenced above. The Department must review and approve any such study plan before monitoring begins.

Benthic Macroinvertebrate Monitoring – Assessment of the benthic macroinvertebrate community is critical to determining whether Project operations affect attainment of habitat and aquatic life criteria in the river below the Lowell Tannery dam. As noted above, The Department completed a Benthic Macroinvertebrate Study in the Passadumkeag River in 2016, establishing that the River meets Class A water quality standards upstream of the Lowell Tannery Project. However, a Benthic Macroinvertebrate Study downstream of the dam is necessary to demonstrate that Project operations do not negatively impact habitat and aquatic life. A Benthic Macroinvertebrate Study was conducted in accordance with the DEP METHODS FOR BIOLOGICAL SAMPLING AND ANALYSIS OF MAINE'S RIVERS AND STREAMS (2002, revised April 2014). The study was conducted between August 6 and September 13, 2019; results indicate that the macroinvertebrate community in the vicinity of the Lowell Tannery Dam attains Class A water quality standards after raising an initial finding of Class B, based on lake outlet effect. The report notes, however, that sample retrieval was delayed, and the sampling interval is outside the 28 days (+/- 4 days) prescribed by the Department's sampling protocol. And lastly, the Department notes that the 2019 macroinvertebrate study plan incorrectly states that the statutory class of the Passadumkeag River downstream of the Lowell Tannery Dam is Class A, rather than Class AA. While Class AA and Class A macroinvertebrate criteria are the same, it's important to understand and acknowledge the correct classification standard, in order to interpret sampling results.

Aquatic Habitat Cross-Section Flow Study - This study evaluates whether current in-stream flow releases are affecting attainment of habitat criteria for fish and other aquatic life in the Passadumkeag River downstream of the Lowell Tannery dam. It is the Department's position that there must be both sufficient quality and quantity of habitat for aquatic organisms to meet habitat and aquatic life criteria. The Applicant may demonstrate attainment of habitat and aquatic life criteria at the Project by conducting an Aquatic Habitat Cross-Section Flow Study following the "Habitat and Aquatic Life Studies" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018) or, in this case, may submit three years of flow data to demonstrate that ROR conditions, where inflow is equal to outflow, are maintained, demonstrating that Project operations do not adversely impact the volume of water discharged from the Project, and thus maintain riverine aquatic habitat downstream of the Lowell Tannery dam.

Thank you for the opportunity to comment on the Initial Study Report for the Lowell Tannery Project. Please direct any questions regarding these comments to Kathy.Howatt@maine.gov or 207-446-2642.

Sincerely,

Kathy Davis Howatt
Hydropower Coordinator
Maine Department of Environmental Protection

cc: Lewis Loon, KEI (Maine) LLC
Sherri Loon, KEI (Maine) LLC
Andy Qua, Kleinschmidt Associates

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

May 12, 2020

Mr. Lewis Loon
KEI (USA) Power Management Inc.
423 Brunswick Ave.
Gardiner, ME 04345

RE: Comments on the Initial Study Report and 2020 Draft Study Plan for the Lowell Tannery Hydroelectric Project (FERC No. 4202).

Dear Mr. Loon:

On March 26, 2020, you provided us with the Initial Study Report for the Lowell Tannery Hydroelectric Project (FERC No. 4202). The outcomes of these studies are intended to inform the licensing process. The quality of the study design, implementation, and analysis are critical to informing future license requirements for mitigating project related impacts. With that perspective, we provide the attached comments and recommendations for the improvement of the Desktop Entrainment, Impingement, and Turbine Passage Evaluation.

We are also in receipt of your 2020 draft study plan for the Lowell Tannery Project. The 2020 draft plan does not propose a downstream anadromous fish passage effectiveness and survival study at the project. We specifically requested this study in our March 9, 2019, letter commenting on the Pre-Application Document for the Project. Furthermore, you also do not present any rationale for not implementing our recommended study. Conducting studies to quantitatively identify direct project impacts on aquatic resources, and to inform appropriate mitigation is consistent with the requirements of the National Environmental Policy Act and the Federal Power Act regulations. Your final 2020 study plan for the Lowell Tannery Project must include a plan to conduct a downstream anadromous fish passage effectiveness and survival study.

In the 2020 draft study plan for the Lowell Tannery Project, you propose to conduct an upstream passage study for anadromous fish at the Lowell Tannery Project. We requested an upstream passage study for anadromous species in our March 9, 2019, letter to FERC. However, as currently proposed, the 2020 draft study plan is not sufficient to evaluate whether the existing upstream Denil fishway provides safe, effective, and timely passage for adult Atlantic salmon and river herring. In the draft 2020 study plan, you assume that other organizations, including the Maine Department of Marine Resources and the University of Maine, will PIT tag anadromous fish at the Milford Project on the mainstem of the Penobscot River to evaluate fish passage at the Lowell Tannery Project on the Passadumkeag River. You further assume that some of these tagged fish will migrate to the Lowell Tannery Project for upstream passage evaluation. In our March 9, 2019, comments on the Lowell Tannery Project Pre-Application Document, we specifically requested that KEI capture and tag at least 100 river herring in the Passadumkeag River to assess upstream passage effectiveness at the Lowell Tannery Project. It is not appropriate to rely on PIT tag fish in the lower Penobscot River to evaluate fish passage at the Lowell Tannery Project since it cannot be determined whether these fish are actually migrating to the Passadumkeag River. Therefore, it is not reasonable to rely on any tagging studies that may or may not be done at the Milford project to inform an evaluation of upstream passage at the Lowell Tannery Project. Your final 2020 study plan for the Lowell Tannery Project must include a plan to tag and release at least 100 river herring downstream of the Lowell Tannery Project. If we are not able to come to an agreement for these two studies in the next 30 days, we will seek study plan dispute resolution with the Commission pursuant to 18 CFR 16.8(b)(6).

As indicated in our March 9, 2019, comments on the pre-application document, endangered Gulf of Maine distinct population segment (GOM DPS) Atlantic salmon occur in the Lowell Tannery Project area and project operations may affect the species. As such, we anticipate that a consultation, pursuant to section 7 of the Endangered Species Act (ESA) will be necessary to ensure that any licensing action proposed by the Federal Energy Regulatory Commission is not likely to jeopardize the continued existence of this species. Our study requests for this project are intended to support the licensing process and facilitate our goals to protect and recover the GOM DPS of Atlantic salmon pursuant to our authorities under the Endangered Species Act and the Federal Power Act. The requested studies are necessary for a complete understanding of the effects of the project and are critical to informing the ESA section 7 consultation process. Data collected from these studies will also contribute to the development of an administrative record in support of potential Federal Power Act Section 18 fishway prescriptions or 10(j) recommendations.

Thank you for the opportunity to provide comments on the ISR and 2020 proposed study plan for the Lowell Tannery Project. If you have any questions, please contact Jeff Murphy (Jeff.Murphy@noaa.gov/207-866-7379).

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

cc: Service List

National Marine Fisheries Service's Comments on KEI (USA) Power Management's Initial Study Report for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

On March 26, 2020, KEI provided an Initial Study Report summarizing the progress of relicensing studies at the Lowell Tannery Project. We provide the following comments on the Desktop Entrainment, Impingement, and Turbine Passage Survival Evaluation.

Existing Downstream Bypass Design

The flow of 20 cubic feet per second (cfs) (2.2% of maximum hydraulic capacity), or inflow, whichever is less, through the existing downstream passage does not meet contemporary guidelines for downstream bypass systems. The U.S. Fish and Wildlife Service's (USFWS) current guidelines state that a downstream bypass entrance should produce gradually accelerating flow with an opening that is at least 3 feet wide and 2 feet deep resulting in flows of at least 25 cfs (USFWS 2019). In addition, USFWS's current guidelines state that the conveyance should be at least 48 cfs based on the 5% station hydraulic capacity guideline. Both of these fishway attributes are necessary to properly attract and pass downstream migrants though fishways. We support the U.S. Fish and Wildlife's guidelines for downstream fish passage at this facility.

Section 4.1.1 Risk of Entrainment and Impingement

The approach velocity of 2.5 feet per second (fps) exceeds the reported prolonged swim speeds of juvenile river herring and matches that of juvenile American shad and adult American eel, thus creating a risk of impingement and entrainment. The available data indicates that it is more likely for juvenile alewife to entrain through the turbines than pass safely through the downstream bypass once in the vicinity of the project intake. The remainder of the target species have sufficient swim speeds to avoid entrainment if there are no blockages on the trashracks that would increase approach velocities. If timely egress is not available, at some point juvenile alosines and adult eels will fatigue and either get entrained or become impinged on the racks. The reported approach velocities support the need to upgrade the downstream passage facilities to reduce the risk of entrainment of juvenile alosines and adult American eel.

Section 4.1.2 Turbine Blade Strike and Whole-station Survival Analysis

We appreciate the ability of the Python-based STRYKE model to produce statistics from the turbine blade strike model. However, the report does not provide a justification for the sample size and the number of iterations that produce the statistics; therefore, it is not possible to assess the validity of the results.

Recommendation: We recommend you provide the basis for choosing 20 iterations of each simulation as well as the chosen sample size of 200 fish.

We appreciate the effort to evaluate the project survival by incorporating the flow duration curve to estimate a low, normal, and high water year. However, the duration of time the project spills and operates has a differential overlap with the presence of different species and life stages. Therefore, we recommend the study analyze each target species and lifestage separately unless their migratory periods are similar (e.g., alewife and blueback herring).

Section 4.1.2.1 Strike Mortality Coefficient
Recommendation: The strike mortality coefficient (λ) of 0.15 should be justified by turbine specifics and project-specific data. Smaller changes in the coefficient value used may make a difference at the project survival level and will be significant at a cumulative impacts level (i.e., multiple projects in the watershed).

Section 4.1.2.2 Routing of Fish through Lowell Tannery Project
The bypass efficiency is a crucial parameter in this desktop modeling exercise. You do not provide justification for the selection of a value of 50 percent bypass efficiency in the interim study report. However, based on a downstream passage study we commissioned on the Penobscot River, the value is a good approximation of a facility with 1.5 inch rack spacing (Alden Research Laboratory 2012). In that same report, the minimum and maximum bypass efficiency of the seven projects evaluated with trashrack clear spacing of 1.5 inches (like the Lowell Tannery project) were 17 and 73 percent. Therefore, the actual bypass efficiency at the Lowell Tannery project may be 50 percent or it could be higher or lower. We cannot determine what the appropriate value is without a routing study. If a routing study is not completed, we would have to use the conservative, lower efficiency values as supported by past studies of projects with designs that are similar to the Lowell Tannery facility.

Absent site-specific route passage data, the model assumes that downstream migrants pass in proportion to flow at the project. Site-specific telemetry data is needed to verify this assumption. Alewife and blueback herring, can pass through the turbines, the downstream bypass, or via spillage if available. However, at low flow, the likelihood that herring will pass via the spillway depends on the volume of spill over the flashboards. For instance, herring would not likely pass over the spillway under a thin veil of spillage (i.e., water depths less than 6 inches). At lower river flows with less water depth over the flashboards and no turbine flow, most downstream migrants would likely use the existing downstream passage facility. Given the above uncertainties, a site-specific routing study needs to be conducted at the project.

Section 4.1.2.3 Fish Length
Recommendation: Please adjust the standard deviation to reflect the species and life stage. A single standard deviation of 0.5 inches for all fish species is not appropriate to represent to various species and lifestages of fish that occur in the Lowell Tannery Project area. As an example of an acceptable approach, at the Holyoke project on the Connecticut River in Massachusetts, Holyoke Gas and Electric provided mean body length and standard deviation in their FERC filed report (Table 1).

Table 1. Mean body length and standard deviation (in inches) for adult male and female American shad. Source: Accession # 20180131-5174, page 7.

	MALE	**FEMALE**
Mean	16.1	17.7
SD	0.8	0.6

Section 4.2.1.1 Trashrack Exclusion
Recommendation: This analysis should be modified to include consideration of adult river

herring. Adult river herring are not excluded from 1.5-inch clear spaced trashracks. In fact, adult river herring can pass 1-1/8 inch clear spaced trashracks similar to swim through gates installed at the Milford fishway on the Penobscot River.

Section 4.2.1.2 Approach Velocity
Recommendation: A flow duration curve needs to be calculated to adequately estimate the effects of approach velocity on entrainment and impingement for each species and life stage.

Recommendation: You should determine the threshold generation value for each species (e.g., maximum generation is the threshold for American eel and juvenile American shad at 2.15 fps). Blockage of the trashrack will create velocity hot spots that will affect the potential for entrainment and impingement. In the project survival analysis, you should consider the effect of debris on the approach velocity and account for occlusion.

Section 4.2.2.1 Adult Sea-Run Alewives and Juvenile Alosines
In Table 15 of the interim study report, the three designated flow regimes are calculated for only the month of June. The downstream passage season is from June 1 to July 31.

Recommendation: We recommend development of a flow duration curve that considers the entirety of the downstream passage season to inform the whole project survival analysis.

Recommendation: We recommend you determine the appropriate flow thresholds for key parameters for the strike model and calculate the whole project survival estimate by integrating the area underneath the flow duration curve to improve model predictions. For example:

- Some percent of the time the project will be generating with insufficient spill to be conducive for spillway passage; therefore, downstream migrants can either pass via the turbine or via the downstream bypass system;
- Some percent of the time the project will be generating with sufficient spill to be conducive for spillway passage; therefore, downstream migrants can either pass via the turbine, spillway, or downstream bypass system.
- Some percent of the time the project will not be generating; therefore, downstream migrants can pass via the downstream bypass system or spillage (provided sufficient water depths over the spillway).

The whole project survival estimate will then be calculated by summing the weighted survival estimates for each flow regime, where S_B is the bypass survival estimate, S_{B+T} is the bypass and turbine survival estimate, S_{B+T+S} is the bypass, turbine and spillway survival estimate, and S_L is a literature based estimate of indirect survival.

$$Project\ Survival = \{[0.13 * S_B] + [(0.81 + 0.01) * S_{B+T}] + [0.05 * S_{B+T+S}]\} * S_L$$

Section 4.2.2.1 Adult Sea-Run Alewives and Juvenile Alosines
In table 4.8 of the interim study report, the flow duration curve is only for September for juvenile alosine species when the migratory period is July 15 to November 30. The project survival analysis needs to be estimated using the flow duration curve for the full migratory period.

Recommendation: We recommend development of a more appropriate flow duration curve that reflects the entirety of the July 15 to November 30 migratory period, to conduct the whole project survival analysis.

Bypass efficiency will vary depending on generation. For example, juvenile blueback herring have a prolonged swim speed of 0.75 fps, which corresponds with a specific generation flow. At some river flows (turbine plus bypass flow) the bypass efficiency will be higher. Conversely, at higher river flows, the bypass efficiency will be lower.

Recommendation: The thresholds based on approach velocity and swimming capabilities of each species need to be incorporated into the analysis by modifying the bypass efficiency while the project is generating. These variations in bypass efficiency should be justified with published data on other projects or professional judgment, and clearly described in the final study report.

Section 4.2.2.2 Atlantic Salmon Smolts

Recommendation: We recommend completing the analysis as described using the full migratory period for Atlantic salmon smolts (May through June).

Section 4.2.2.3 Adult American Eel

The methods used to estimate project survival for anadromous species is not appropriate for adult American eel. Therefore, we do not consider the results for American eel presented in the interim study report to be appropriate or reliable.

Recommendation: We recommend you complete a telemetry study for silver eel. In lieu of a field study, multiple linear regression models have been used at other hydroelectric facilities to determine project survival of American eel (Amaral 2017) and that approach should be considered in the absence of a telemetry study.

2.13 Section 4.2.2.4 Adult American Shad and Atlantic Salmon

The assumption that project spill and the downstream bypass facility have 100 percent survival may not be valid for all species and lifestages (Alden 2012). The spillway passage at the Lowell Tannery project is likely to have a high survival rate, but highly unlikely to have 100 percent survival for all downstream migrants. An often used estimate for spillway survival is 97 percent with a range from 76 to 100 percent derived from the massive data set from the Columbia River Power System (Alden Research Laboratory 2012). Site-specific data is needed to support this assumption.

Recommendation: We recommend you provide the technical specifications for the downstream bypass system (e.g., drawings and hydraulic calculations) and conduct a downstream passage routing and survival study for alosines and Atlantic salmon at the Lowell Tannery Project.

References

Alden Research Laboratory. 2012. Atlantic Salmon Survival Estimates at Mainstem Hydroelectric Projects on the Penobscot River. Phase 3 Final Report. Prepared for The National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Holden, MA.

Amaral, S. 2017. Theoretical Assessment of Downstream Passage Survival of American Eel at s Small Hydro Project.

U.S. Fish & Wildlife Service. 2019. Fish Passage Engineering Design Criteria. *Edited by* D.o.t. Interior. Northeast Region R5, Hadley, Massachusetts. p. 248.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

October 14, 2020

Terry Turpin, Director
Office of Energy Projects
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Request for dispute resolution for the conduct of studies; Lowell Tannery Hydroelectric Project (FERC No. 4202).

Dear Mr. Turpin:

My office is participating in the relicensing of KEI (USA) Power Management's (KEI) Lowell Tannery Hydroelectric Project (P-4202) on the Passadumkeag River, Maine. Our responsibilities in this matter are codified under our authorities pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. §661 et seq.), which requires that the federal action agency give full consideration to the comments of federal and state resource agencies; the Endangered Species Act (ESA) (16 U.S.C. §1531 et seq.) of 1973 as amended, which requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or destroy or adversely modify designated critical habitat; the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600.920), which requires consultation between the federal action agency and the National Marine Fisheries Service for projects that affect essential fish habitat; and the Federal Power Act at 16 U.S.C. §803(j) and §811, which provides for the protection of anadromous fish resources affected by the licensing, operation and maintenance of hydroelectric projects.

We have been fully engaged throughout the ongoing relicensing of the Lowell Tannery Project to ensure the public trust resources under our jurisdiction are given proper consideration and to develop an administrative record that informs the development of any new license. We hereby request resolution of dispute regarding studies not conducted in this proceeding pursuant to 18 CFR 16.8(b)(6). We are unable to resolve a disagreement with KEI as to the need to conduct a study or gather information in this proceeding. On March 9, 2019, in response to the pre-application document, we requested KEI conduct three studies: 1) Anadromous Fish Upstream Passage Efficiency Study; 2) Downstream Fish Passage Effectiveness and Survival: Behavior, Entrainment and Impingement at the Intake; and 3) Desktop Downstream Fish Entrainment and Impingement at the Intake Study. Each study request followed the criteria identified in 18 CFR section 16.8(b)(5), including identifying goals and objectives, recommended methodologies, and project nexus. To date, KEI has only conducted one of our requested studies (Study Request #3, Desktop Entrainment and Impingement Study). We note that KEI stated in their September 26, 2018, request to use the Traditional License Process that "should a significant dispute arise during the process, KEI would initiate FERC's dispute resolution process outlined in 18CFR §16.8 (b)(6)(i)." Thus, our request for resolution of dispute for studies is consistent with KEI's proposal filed the FERC.

We provided our proposed study plan comments on March 9, 2019. In an email sent to the Licensee on August 21, 2019 (attached), we expressed concern that the Licensee was not making appropriate progress towards conducting requested studies at the Lowell Tannery Project (attached). Beginning in January 2020, a series of meetings were established by the U.S. Fish and Wildlife Service to promote coordination among the agencies and KEI regarding actions at their hydropower projects. These meetings were informative; however, KEI did not provide any additional information regarding studies or the relicensing process at the Lowell Tannery Project until March 26, 2020. Despite our efforts, we could not reach resolution.

KEI provided the results of a desktop entrainment analysis in their March 26, 2020, Initial Study Report (attached). We submitted comments on the desktop entrainment analysis to KEI on May 12, 2020 (attached). As indicated in our comments, the desktop analysis is inadequate for quantifying impacts of downstream passage at the project on anadromous fish including endangered Atlantic salmon, river herring, and American eel in the Passadumkeag River. The method used by KEI is based on unsupported assumptions (e.g., 50% downstream passage efficiency) and outdated engineering guidelines for downstream fishways (e.g., inadequate passage flows and high approach velocities). Absent site-specific data, the desktop analysis is unreliable and unverified for the decision making process regarding the protection of anadromous fish. A desktop entrainment study largely only assess the likelihood of a blade strike on individual fish passing through the turbines. Desktop entrainment studies do not assess injury severity or rates, delay, or latent morality. Desktop studies are limited in their ability to accurately determine project related impacts including route of passage especially given the unique nature of each hydroelectric project. Field based studies provide data to support desktop analysis, including route of passage, extent of delay, and rate of injury and mortality via each passage route. KEI's desktop analysis for the Lowell Tannery Project relies on a blade strike model that provides a mortality estimate for fish that are entrained and encounter the turbine blades. However, it does not assess the full scope of survival past the project, and therefore does not provide the information needed to assess the full scope of project effects on Atlantic salmon. We estimate that the costs of conducting the requested downstream passage studies to range from $100,000 to $150,000 based the following cost estimates: 1) $60,000 for 300 radio tags @$200/tag; 2) $25,000 to tag fish and set up monitoring equipment; 3) $25,000 for data analysis and reporting.

On March 26, 2020, KEI also provided us with a draft 2020 study plan for the Lowell Tannery Project (attached). The 2020 draft plan does not include a study of the behavior, entrainment, or impingement of anadromous fish including endangered Atlantic salmon at the Lowell Tannery Project. We specifically requested that KEI conduct radio telemetry studies involving adult and juvenile river herring and Atlantic salmon smolts to quantify the effects of operating the Lowell Tannery Project on the downstream migrations of these species (Study Request #2). This information is needed by FERC to properly and fully evaluate the effects of operating the project on migratory delay, predation, injuries, and latent mortality pursuant to your obligations under the ESA, FPA, and National Environmental Policy Act (NEPA).

Furthermore, the 2020 draft plan for upstream passage studies is not sufficient to evaluate whether the existing upstream fishway provides safe, effective, and timely passage for river herring. We specifically requested an upstream passage study for river herring in our March 9, 2019, letter to FERC. Data from this study is needed to evaluate whether the existing fishway meets the overall goals of safe, timely, and effective passage for river herring. The lack of effective upstream passage at the Lowell Tannery Project would impact state and federal goals for restoring anadromous species to the Passadumkeag River. Presently, there is no quantitative data concerning the effectiveness of the upstream fishway at passing river herring at the Lowell Tannery Project. In their proposed 2020 draft study plan, KEI does not plan to tag any fish as part of the study. Rather, KEI assumes that other entities, including the Maine Department of Marine Resources and the University of Maine will PIT tag river herring at the Milford Hydroelectric Project on the mainstem of the Penobscot River and some of those tagged fish will migrate to the Lowell Tannery Project for upstream passage evaluation. In our March 9, 2019, comments on the Lowell Tannery Project Pre-Application Document, we specifically requested that KEI capture and tag at least 100 river herring in the Passadumkeag River to assess upstream passage effectiveness at the Lowell Tannery Project. It is not appropriate to PIT tag river herring in the lower Penobscot River to evaluate fish passage at the Lowell Tannery Project since it cannot be determined whether these fish are actually migrating to the Passadumkeag River. Thus, any reliance on tagging of river herring at other hydroelectric projects is not reasonable nor expected to provide any meaningful results for the Lowell Tannery Project. Absent this information, FERC will not be able to fully assess the effects of operating the Lowell Tannery Project on river herring in accordance with the FPA.

Anadromous fish are an important public trust resource that support valuable commercial and recreational fisheries across our region, and are integral to a healthy, sustainable ecosystem. The impacts on migrating anadromous fish at hydropower facilities are well documented in the FERC docket. Our requested upstream and downstream passage studies met FERC's study plan criteria as described in 18 CFR 4.38(b)(4) and would inform the licensing process by defining project related impacts on fisheries and habitat using generally accepted methods. Those data would inform the development of license articles appropriate for protecting public trust resources. Further, those study results would inform the decision process to ensure the project is best adapted to comprehensive plans and give equal consideration to development and non-development values under Sections 10(a) and 4(e) of the Federal Power Act, respectively. These data will also contribute to the development of an administrative record in support of potential FPA Section 18 fishway prescriptions or 10(j) recommendations as well as the ESA consultation concerning the relicensing of the project.

Pursuant to FERC's regulations under 18 CFR 16.8(b)(6), any decision by the Commission on disputed studies will be made on the basis of two criteria: 1) whether the requested study is reasonable and necessary in relation to the resource goals and management objectives of the resource agencies, and 2) whether it is generally accepted practice to use the study method requested by the agency or tribe. Our March 9, 2019 study request and information contained in this letter clearly demonstrate that the Commission must determine that both of these criteria have been met.

As indicated in our March 9, 2019, comments on the pre-application document, endangered Atlantic salmon occur in the Lowell Tannery Project area. Since no upstream or downstream fishway is ever 100 percent effective at passing migratory fish, we expect that project operations are affecting the species. Based on the information we have about this project, we expect that it results in the death, injury, delay, and predation of Atlantic salmon attempting to pass upstream and downstream of the Lowell Tannery Project. Our study requests for this project are intended to support the licensing process and facilitate our goals to protect and recover the GOM DPS of Atlantic salmon pursuant to our authorities under the ESA. The requested studies are necessary to inform any actions we take under section 18 of the FPA and will help ensure that the required ESA section 7 consultation is based on the best available scientific information.

In addition, during formal ESA section 7 consultation, a Federal agency is required to provide us the best scientific and commercial data available or *which can be obtained during the consultation* (emphasis added) for an adequate review of the effects that an action may have upon listed species or critical habitat (50 CFR§402.14). Please understand that absent reliable, site-specific data on which to base our analysis, we will be required to make assumptions, giving the benefit of the doubt to the species, based on effects to species at other similar projects.

In American Rivers v FERC the issue of the value of field studies (in the NEPA context) was squarely addressed by the Court (895 F. 3d 32, 51; D.C. Cir. 2018). Specifically, the court held that FERC's reliance on the applicant's estimates of project related mortality without any up to date site specific studies was flawed and "unreasoned." Likewise, in the ESA context, field studies are equally invaluable in providing information related to the effects of project operations on Atlantic salmon and other anadromous species. With the inclusion of the data from the requested studies, the information needed to assess project effects would facilitate the formal section 7 consultation process and support the timely issuance of any new license.

As discussed above, we have consulted with KEI on several occasions to address our concerns and provide justification for reasonable studies to inform the licensing process. To date, we have not succeeded in coming to resolution on two of our study requests. Through this dispute resolution process, we request you require the following two studies. The study request details are provided in our March 9, 2019, filing.

- Study Request 1: Anadromous Fish Upstream Passage Efficiency Study
- Study Request 2: Downstream Fish Passage Effectiveness and Survival: Behavior, Entrainment and Impingement at the Intake

We look forward to hearing from you on next steps regarding this request. If you have any questions, please contact Jeff Murphy (Jeff.Murphy@noaa.gov) or 207-866-7379).

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

cc: Service List

Attachments:

- NMFS email to KEI dated August 21, 2019

- Initial Study Report for the Lowell Tannery Project (P-4202). KEI(Maine) Power Management III, LLC
- NMFS May 12, 2020 Comments on the Lowell Tannery Project (P-4202) Initial Study Report
- Draft 2020 Lowell Tannery Study Plan. KEI Power Management III, LLC

Jeff Murphy - NOAA Federal <jeff.murphy@noaa.gov>

Re: Lowell Tannery

1 message

Jeff Murphy - NOAA Federal <jeff.murphy@noaa.gov> Thu, Aug 22, 2019 at 9:35 AM
To: "Loon, Sherri" <Sherri.Loon@kruger.com>
Cc: "Loon, Lewis" <LewisC.Loon@kruger.com>, "nicholas.palso@ferc.gov" <nicholas.palso@ferc.gov>, "john.spain@ferc.gov" <john.spain@ferc.gov>, "achp@achp.gov" <achp@achp.gov>, "harold.peterson@bia.gov" <harold.peterson@bia.gov>, "donald.dow@noaa.gov" <donald.dow@noaa.gov>, "sean.mcdermott@noaa.gov" <sean.mcdermott@noaa.gov>, "jay.l.clement@usace.army.mil" <jay.l.clement@usace.army.mil>, "abele.ralph@epa.gov" <abele.ralph@epa.gov>, "nstasuli@usgs.gov" <nstasuli@usgs.gov>, "Andrew_Raddant@ios.doi.gov" <Andrew_Raddant@ios.doi.gov>, Kayla Easler <Kayla.Easler@kleinschmidtgroup.com>, "kevin_mendik@nps.gov" <kevin_mendik@nps.gov>, "jim.vogel@maine.gov" <jim.vogel@maine.gov>, "kathleen.leyden@maine.gov" <kathleen.leyden@maine.gov>, "eric.sroka@maine.gov" <eric.sroka@maine.gov>, "kathy.howatt@maine.gov" <kathy.howatt@maine.gov>, "john.perry@maine.gov" <john.perry@maine.gov>, "casey.clark@maine.gov" <casey.clark@maine.gov>, "Megan.M.Rideout@maine.gov" <Megan.M.Rideout@maine.gov>, "gstewart@usgs.gov" <gstewart@usgs.gov>, "sean.ledwin@maine.gov" <sean.ledwin@maine.gov>, "Gordon.Kramer@maine.gov" <Gordon.Kramer@maine.gov>, "Mark.Caron@maine.gov" <Mark.Caron@maine.gov>, "kevin.dunham@maine.gov" <kevin.dunham@maine.gov>, "jpictou@micmac-nsn.gov" <jpictou@micmac-nsn.gov>, "kirk.francis@penobscotnation.org" <kirk.francis@penobscotnation.org>, "chris.sockalexis@penobscotnation.org" <chris.sockalexis@penobscotnation.org>, "envplanner@maliseets.com" <envplanner@maliseets.com>, "governorsocobasin@gmail.com" <governorsocobasin@gmail.com>, "nbennett@nrcm.org" <nbennett@nrcm.org>, "bgraber@americanrivers.org" <bgraber@americanrivers.org>, "john@asf.comcastbiz.net" <john@asf.comcastbiz.net>, "landis@mainerivers.org" <landis@mainerivers.org>, "kevin@americanwhitewater.org" <kevin@americanwhitewater.org>, "bmayo@old-town.org" <bmayo@old-town.org>, Andy Qua <Andy.Qua@kleinschmidtgroup.com>, Teta Jungels <Teta.Jungels@kleinschmidtgroup.com>, Antonio Bentivoglio <Antonio_Bentivoglio@fws.gov>, Bryan Sojkowski <Bryan_Sojkowski@fws.gov>

Thank you Sherri for the prompt response. We look forward to reviewing the plans. We would also be available to meet with you and go over the draft study plans at your convenience. Jeff.

On Thu, Aug 22, 2019 at 9:13 AM Loon, Sherri <Sherri.Loon@kruger.com> wrote:

> Good morning Jeff –
>
> KEI (USA) will distribute study plans for comments in late September, we did consult with MDEP for their requested water quality study which is being completed this month and we plan to compile requested intake information, including collection of velocity data this fall and conduct fisheries studies in 2020. We met with Joe Z. of UMaine earlier in the year and understood he had planned to capture and tag alewife for release in the Project tailwater but he has informed us that did not occur. We will be meeting with him when he returns from China to review the data he collected from mainstem Penobscot and at Browns Mill and plans for coordination for his studies next year.
>
> Should further studies be necessary in 2021 we will either include that information in the final license application at the end of September 2021 or file a supplement to the application shortly thereafter.
>
> If you have any further questions please feel free to contact me. Thank you
>
> *Sherri*

Sherri L. Loon

Coordinator - Operations USA

Kruger Energy

423 Brunswick Avenue, Gardiner, ME 04345

T. 207-203-3026 / F 207-582-0094 / C 207-458-1524 /
Sherri.Loon@kruger.com

From: Jeff Murphy - NOAA Federal [mailto:jeff.murphy@noaa.gov]
Sent: Wednesday, August 21, 2019 9:50 AM
To: Loon, Lewis <LewisC.Loon@kruger.com>; Loon, Sherri <Sherri.Loon@kruger.com>
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Subject: Re: Lowell Tannery

Hello Chuck and Sherri - I was wondering if you had any updates concerning the preparation of draft study plans for the Lowell Tannery Project? I recognize that the federal shut-down caused significant delays (~6 weeks) in the submission of federal agency comments and study requests on the PAD, but the schedule proposed in the PAD (below) seems to have slipped well beyond the period affected by the shutdown. Also, how might this affect the 2 years of study seasons typically afforded by the Traditional License Process? Thank you, Jeff.

TLP Schedule	Duration	Start	Finish
File NOI/PAD and Request TLP		9/29/18	9/29/2018
FERC Issues Notice NOI and Comments on TLP	60	9/29/18	11/28/2018
STAGE 1			
TLP Approved	30	11/28/18	12/28/2018
Joint Agency Meeting (JAM)	30	12/28/18	1/27/2019
Comments on PAD/Study Request	60	1/27/19	3/28/2019
Issue Draft Study Plan	60	1/27/19	3/28/2019
Comments on Draft Study Plan	30	3/28/19	4/27/2019
Finalize Study Plan	30	3/28/19	4/27/2019
STAGE 2			
Conduct Studies	400	4/27/19	5/31/2020
Issue Draft Study Report	30	5/31/20	6/30/2020
2nd Year Studies	75	12/27/20	3/12/2021
Develop Draft Application	120	12/27/20	4/26/2021
Issue Draft Application, Study Results and Proposal	5	4/26/21	5/1/2021
Comments on Draft Application	90	5/1/21	7/30/2021
STAGE 3			
Final Application Due	5	9/29/21	9/29/21
License Expiration		9/30/23	9/30/23

chu

On Fri, Jan 11, 2019 at 2:24 PM Kayla Easler <Kayla.Easler@kleinschmidtgroup.com> wrote:

Good afternoon,

Thank you to those who attended the JAM this morning, per request please find the presentation and a copy of the attendance sheet. We also will be following up with a link to the drone footage shown during the meeting.

Thank you,

Kayla A. Easler

Regulatory Coordinator

Kleinschmidt

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From: Kayla Easler
Sent: Thursday, December 27, 2018 11:06 AM
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Cc: 'Loon, Sherri' <Sherri.Loon@kruger.com>; Loon, Lewis <LewisC.Loon@kruger.com>; Andy Qua <Andy.Qua@KleinschmidtGroup.com>
Subject: Lowell Tannery

KEI (USA) Power Management Inc. will be hosting a Joint Agency and Public Meeting for the Lowell Tannery Relicensing, on January 11, 2019 at 10:00 am. The meeting will be held at the Black Bear Inn, 4 Godfrey Drive, Orono, ME 04473, which will be followed by a site visit at the Project. We request that individuals RSVP by 01/05 and bring personal protection equipment (PPE) if you plan to attend the site visit.

Please see the attached notice for more information.

If you have questions, please feel free to contact me at 207-416-1271

Kayla A. Easler

Regulatory Coordinator

Kleinschmidt

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*Providing **practical** solutions for **complex** problems affecting energy, water, and the environment*

> --
>
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INITIAL STUDY REPORT

LOWELL TANNERY HYDROELECTRIC PROJECT

FERC No. 4202

Prepared for:

KEI (Maine) Power Management (III) LLC

Prepared by:

Kleinschmidt Associates

Kleinschmidt

March 2020

www.kleinschmidtgroup.com

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF ATTACHMENTS

J:\705\093\Docs\2019 Studies\705093_001RP Lowell Tannery Project 2019 Study Report March 6 2020.docx

1.0 INTRODUCTION

The Lowell Tannery Hydroelectric Project (Lowell Tannery Project) is on the Passadumkeag River, in Lowell, Maine, approximately 13 river miles upstream of the confluence with the Penobscot River (Figure 1). KEI (Maine) Power Management (III) LLC [KEI (Maine)] operates one hydroelectric turbine-generator unit at the Lowell Tannery Project, which can produce up to approximately 1,000 kilowatts[1] of renewable, hydroelectric energy. KEI (Maine) operates the Lowell Tannery Project in run-of-river mode so that outflow at the powerhouse matches natural river inflow. After water passes through the turbine unit, it discharges back into the Passadumkeag River from a small powerhouse that is integral to the dam.

KEI (Maine) filed a Notice of Intent and Pre-Application Document (PAD) on September 26, 2018, to initiate the relicensing of the Lowell Tannery Project using the Traditional Licensing Process. The PAD and subsequent scoping identified potential environmental issues associated with the operation of the Lowell Tannery Project for which the existing, relevant, and reasonably available information was insufficient. Comments on the PAD and study requests were received from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Maine Department of Environmental Protection (MDEP), Trout Unlimited (TU), and the Penobscot Indian Nation (PIN).

This study report presents the results of studies completed by KEI (Maine) and Kleinschmidt Associates (Kleinschmidt) in 2019. In 2019, KEI (Maine) monitored water quality at the Lowell Tannery Project and completed a desktop fish entrainment and turbine survival analysis using methods based on the USFWS's Turbine Blade Strike Analysis (Towler and Pica 2018). The water quality study was performed in accordance with MDEP protocols; the desktop study estimated turbine passage and whole station survival for adult and juvenile sea run alewives, adult and juvenile American shad, adult American eel, and Atlantic salmon smolts.

KEI (Maine) is preparing a study plan for the 2020 field season that will be submitted to the stakeholders separately.

[1] Approximate maximum instantaneous generation capacity.

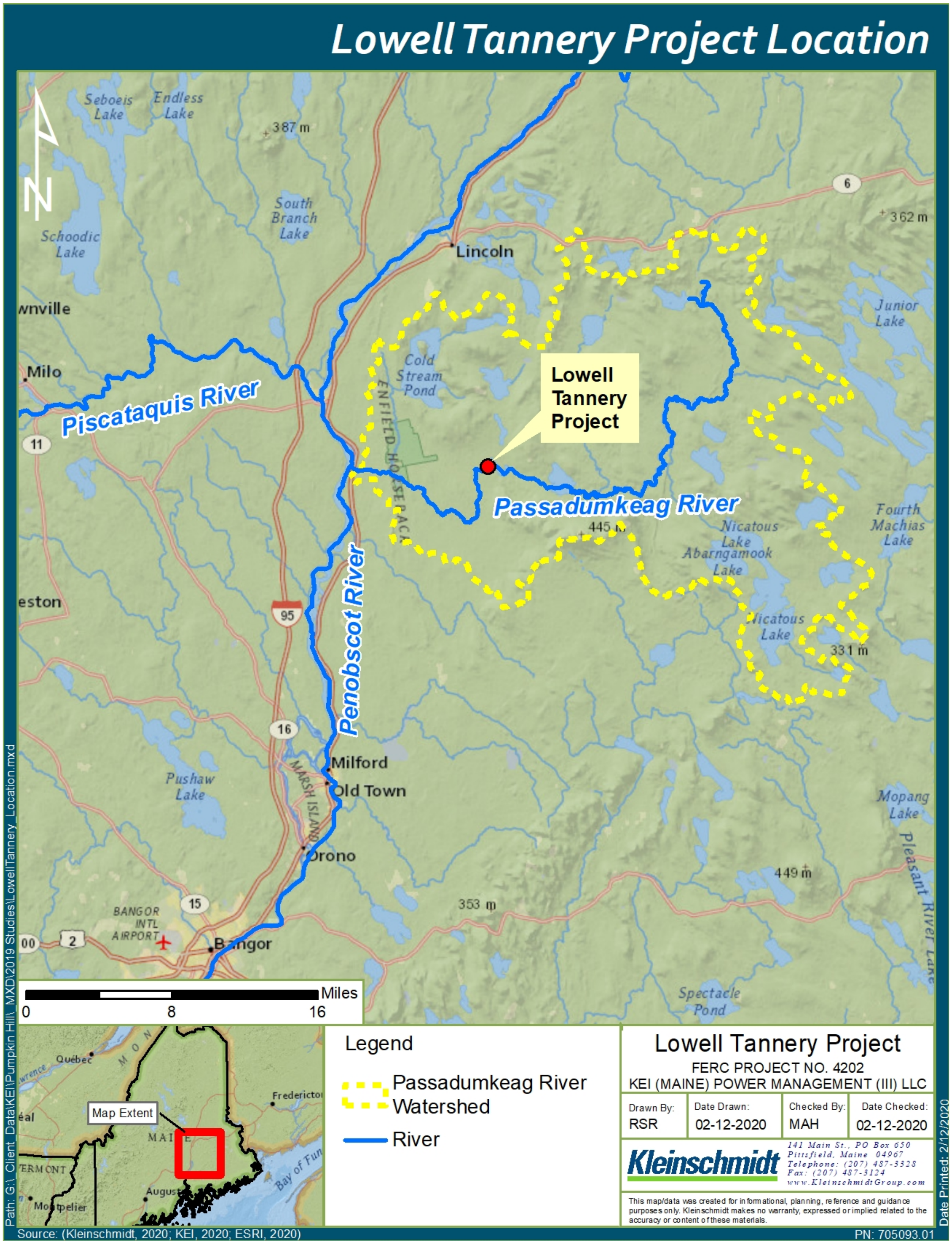

Figure 1 Lowell Tannery Project Location

2.0 WATER QUALITY

KEI (Maine) studies water quality to collect information about the potential effects of project operations on water quality and benthic macroinvertebrates. The water quality studies included lake trophic monitoring, tailwater dissolved oxygen (DO) and water temperature monitoring, and benthic macroinvertebrate sampling. The studies were completed in accordance with MDEP protocols (MDEP 2018a), During study plan development, KEI (Maine) clarified with MDEP that because the Lowell Tannery Project is operated in a run-of-river mode, the impoundment habitat study and downstream habitat study initially requested by MDEP were not necessary (personal communication, Kathy Howatt, MDEP, with Jesse Wechsler, Kleinschmidt Associates, May 21, 2019; Attachment A).

Maine Statute 38 MRSA §464-470 establishes the state of Maine's classification system for surface waters. The Passadumkeag River from the Lowell Tannery dam to the confluence with the Penobscot River is Class AA; the Passadumkeag River upstream of the Lowell Tannery dam is Class A (MRS 1989a). Class AA waters are the highest classification in the state of Maine and are "*applied to waters which are outstanding natural resources which should be preserved because of their ecological, social, scenic or recreational importance*" (MRS 1989b). The quality of Class AA waters must support the designated uses of drinking water supply after disinfection, fishing, agriculture, recreation in and on the water, navigation, and habitat for fish and other aquatic life; aquatic life, DO and bacteria content shall be as naturally occurs. Class A waters are the second highest classification and must be of such quality to support the designated uses of drinking water after disinfection, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and habitat for fish and other aquatic life (MRS 1989b). The state of Maine has Class AA and Class A water quality standards for several parameters (Table 1).

Table 1 Maine Water Quality Standards for Select Parameters

Parameter	Criteria	Water Classification
Dissolved Oxygen[a]	>7 mg/L or 75% saturation	Class A
	As naturally occurs	Class AA
Iron[b]	1000 µg/L or 1 mg/L	Statewide
Chloride[b]	230,000 µg/L or 230 mg/L	Statewide
Aluminum[b]	87 µg/L or 0.087 mg/L	Statewide
Total Phosphorus[c]	≤ 18 µg/L (0.018 mg/L)	Class AA/A
Water Column Chlorophyll-a[c]	≤ 3.5 µg/L (0.0035 mg/L)	Class AA/A
Secchi Disk Depth[c]	≥ 2.0 meters	Class AA/A
pH[c]	6.0 – 8.5	Class AA/A

[a]MRS 1989b; [b]MDEP 2012a; [c]MDEP 2012b
Notes: milligrams per liter (mg/L); micrograms per lier (µg/L)

2.1 Methods

2.1.1 Lake Trophic Study

KEI (Maine) completed a reconnaissance-level bathymetry survey prior to collecting the first lake trophic sample to identify the deepest, safely accessible spot in the lower impoundment (i.e., upstream of the boat barrier). The deepest spot was approximately 20-feet-deep and 250-feet upstream of the dam (Figure 2). MDEP approved of the sampling location via e-mail dated June 25, 2019 (Attachment A). KEI (Maine) installed a temporary buoy to mark the sample location (Photo 1). Lake trophic sampling was conducted twice per month for five consecutive months from June through October 2019 primarily between 11:00 and 15:00.

Sample parameters included Secchi disk transparency, water temperature and DO profiles (1-meter intervals), and epilimnetic core[2] samples of total phosphorus, Chlorophyll-a, color, pH, and total alkalinity. Additional nutrient and dissolved metal samples were collected during the late summer sampling event on August 15, 2019. The additional late

[2] The epilimnetic zone is determined by establishing a temperature profile at 1-meter increments to define the epilimnion as the upper layer where the change in temperature per meter of depth is less than 1-degree C ($\Delta T/m < 1°C$).

summer sample parameters included nitrate, dissolved organic carbon (DOC), total iron, total dissolved aluminum, total calcium, total magnesium, total sodium, total potassium, specific conductance, chloride, and sulfate. The late season sample was collected from an integrated epilimnetic core because the water column was not thermally stratified (i.e., change in water temperature T ≥ 1°C/meter) (Section 2.2.2). KEI (Maine) delivered the water samples on ice to the state of Maine's Health and Environmental Testing Lab (HETL) in Augusta within 24 hours of sampling. Appropriate chain-of-custody and sample collection techniques were followed.

Photo 1 Lowell Tannery Impoundment Lake Trophic Sample Site

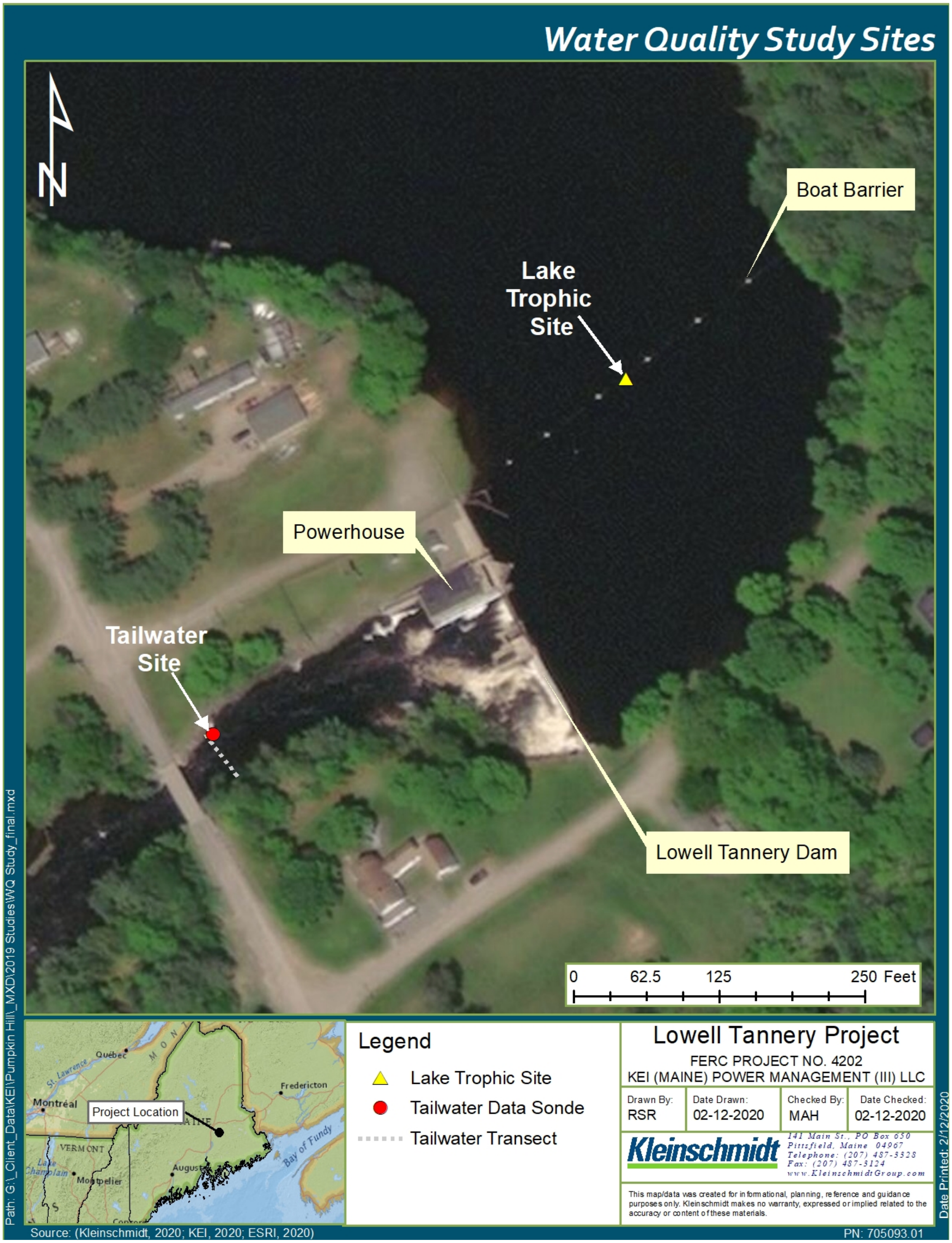

Figure 2 Lowell Tannery Water Quality and Benthic Macroinvertebrate Sampling Sites

2.1.2 Riverine Dissolved Oxygen and Water Temperature Monitoring

KEI (Maine) monitored DO and water temperature at a single location approximately 200-feet downstream of the tailrace using an Onset Hobo U26-001 data logger (Figure 2, Photo 1). Prior to installing the datalogger, KEI (Maine) measured DO at quarterly increments across the river channel to determine if there were any significant variations in DO levels; the data logger was installed near the river right bank, near the quarterly increment that had the lowest DO measurement (Table 2).

The data logger was enclosed in a 2-inch-diameter perforated poly vinyl chloride (PVC) pipe, attached with a cable, and anchored to tree trunks and riprap along the shoreline. The water depth at the sensor was approximately 2 to 3 feet depending on river flow and unit operations. The data logger was equipped with a biofouling guard and calibrated according to the manufacturer's specifications. The logger was programmed to record water temperature and DO concentration (mg/L) at 1-hour intervals from June 25 to September 17, 2019, during the summer low flow, high temperature period. A barometer was installed nearby to measure real-time air pressure data which was used to calculate DO percent saturation.

Data downloads and equipment checks were performed at 2-week intervals during the monitoring period. During each download, KEI (Maine) measured water temperature and DO with a handheld YSI ProODO meter to compare to measurements of the Onset data logger and to assess whether the data logger needed additional calibration. The calibration of the YSI ProODO meter was checked in the field prior to each sampling event.

Table 2 Quarterly Incremental Dissolved Oxygen, June 25, 2019

Location	Water Temperature (°C)	DO (mg/L)	DO (Percent Saturation)
River Right	21.4	8.12	91.7
Center	21.5	8.24	93.2
River Left	21.7	8.51	96.9

Photo 2 Location of Data Logger Downstream of Lowell Tannery Project

2.2 Results

2.2.1 Lake Trophic State

Trophic state describes the ability of a water body to produce algae or other aquatic vegetation (i.e., biological productivity) and depends on the nutrient content of the water (LSM 2018; MDEP 1996). A brief description of the trophic state indicators monitored in this study and the results are provided below.

Total Phosphorus - Total phosphorus is an indicator of nutrient levels. It is an important nutrient required for plant growth and is often a limiting nutrient; however, too much phosphorus can lead to algal blooms. Total phosphorus in the Lowell Tannery impoundment ranged from 15 µg/L to 33 µg/L with an average of 20 µg/L (Table 3). Five of the samples had total phosphorus levels above the standards for Class A/AA waters (18 µg/L).

Color - Color is an indicator of water clarity and is a measure of the amount of dissolved organic acids and suspended matter in the water. Water with a color value greater than 25 platinum cobalt units (PCU) is colored and may have a reduced Secchi disk transparency. Color ranged from 85 PCU to 180 PCU with an average of 136 PCU (Table 3).

Chlorophyll-a - Chlorophyll-a is a photosynthetic pigment found in algae and plants and is an indicator of algal levels and biological productivity in the water. Large concentrations of chlorophyll-a can be an indication of eutrophication (i.e., excessive nutrient inputs leading to algal blooms). Chlorophyll-a ranged from 0.0020 mg/L to 0.0050 mg/L with an average of 0.0031 mg/L (Table 3). The samples collected on June 25 and August 26, 2019 had values of 0.004 mg/L, and the sample collected on August 15, 2019 was 0.005 mg/L; the Class A/AA standard is 0.0035 mg/L.

Total Alkalinity - Alkalinity (i.e., buffering capacity) is an indicator of the water's capacity to neutralize acids or buffer against changes in pH; water bodies with alkalinity values less than 10 mg/L are considered poorly buffered. Sources of alkalinity include rocks, soil, salts, and algal activity. In the Lowell Tannery impoundment, total alkalinity ranged from 6 mg/L to 8 mg/L with an average of 7.3 mg/L (Table 3).

pH - pH is a measure of the acidity of water and regulates the biological processes that may occur in a water body. pH ranged from 6.4 to 7.1 with an average of 6.6 (Table 3). All samples were within the range for Class A/AA waters (6.0 to 8.5).

Secchi Disk - Secchi disk transparency is a measure of the clarity of water and is the distance that visible light penetrates through the water column. Transparency in a water column is influenced by suspended particles (e.g., algae, zooplankton, and silt); water color is an indirect measure of algal growth. The Secchi disk depth at the deep spot in the Lowell Tannery impoundment ranged from 1.9 meters to 2.9 meters with an average of 2.3 meters (Table 3). All measurements, except for the October 2, 2019 Secchi Disk reading (1.9 meters), were above the 2-meter Class A/AA water quality standard.

Late Summer Sample - Results from the late summer lake trophic sample (collected on August 15, 2019 at 13:30) are shown in Table 4. Iron and chloride met the established standards. Aluminum and dissolved aluminum were 0.18 mg/L and 0.15 mg/L, respectively. Conductivity in the Lowell Tannery impoundment was 29.9 microsiemens /cm (Table 4).

Table 3 Lowell Tannery Impoundment Lake Trophic Monitoring Results

Date/Time	Alkalinity (mg/L)	Chlorophyll-a (mg/L)	Color (PCU)	pH	Total Phosphorus (µg/L)	Secchi Disk (m)
6/18/19 14:15	7	0.003	85	6.9	33	2.5
6/25/19 13:30	8	0.004	100	6.5	22	2.4
7/16/19 13:00	8	0.003	140	6.6	20	2.2
7/29/19 15:00	8	0.003	95	6.7	19	2.9
8/15/19 13:45	7	0.005	150	6.5	18	2.3
8/26/19 11:45	7	0.004	170	6.4	18	2.1
9/6/19 11:15	7	0.003	160	6.6	17	2.1
9/19/19 11:45	8	0.002	120	6.6	15	2.6
10/2/19 12:15	6	0.002	180	6.4	21	1.9
10/16/19	7	0.002	160	7.1	16	2.2
Average	**7.3**	**0.003**	**136**	**6.6**	**19.9**	**2.3**
Minimum	**6.0**	**0.002**	**85**	**6.4**	**15.0**	**1.9**
Maximum	**8.0**	**0.005**	**180**	**7.1**	**33.0**	**2.9**

Table 4 Dissolved Ion and Metal Concentrations from 2019 Summer Lake Trophic Sample

Parameter	Value
Conductivity (µS/cm)	29.9
Aluminum (mg/L)	0.18
Calcium (mg/L)	3.6
Iron (mg/L)	0.36
Magnesium (mg/L)	0.56
Potassium (mg/L)	0.57
Sodium (mg/L)	1.9
Sulfate (mg/L)	1
Chloride (mg/L)	1
Nitrate Nitrogen (mg/L)	<0.01
Dissolved Aluminum (mg/L)	0.15
Dissolved Organic Carbon (mg/L)	16

Trophic State - Total phosphorus, chlorophyll-a, and Secchi disk transparency are often used as indicators of trophic state, or the biological productivity in a water body, particularly a lake (MDEP 2018b). An oligotrophic lake is characterized as having low productivity, a mesotrophic lake has medium productivity, and a eutrophic lake is highly productive. Table 5 lists the criteria used to classify the trophic state of lakes in Maine (MDEP 2018b).

Table 5 Criteria for Classifying the Trophic State of Lakes in Maine

Trophic State	Chlorophyll-a (mg/l)	Total Phosphorus (ug/l)	Secchi Disk (m)	Trophic State Index
Oligotrophic	< 0.0015	< 4.5	> 8	0-25
Mesotrophic	0.0015 - 0.007	4.5 - 20	4 - 8	25-60
Eutrophic	> 0.007	> 20	< 4	>60 and/or repeated algal

The Maine Trophic State Index (TSI) for lakes can be calculated as (MDEP 1996):

$$\textbf{TSI} = 70 * \log(\text{mean chlorophyll-a} + 0.7)$$

Using the average chlorophyll-a concentration for the entire sampling period (0.003 mg/L), the TSI for the Lowell Tannery impoundment is 40.6, which is categorized as mesotrophic.

2.2.2 Impoundment Dissolved Oxygen and Water Temperature Profiles

The results of the water temperature and DO profiles collected at the deep spot in the Lowell Tannery impoundment are presented in Table 6, Table 7, and Table 8. The water temperature was highest near the surface and decreased with increasing depth; the impoundment was not stratified on any sampling occasion. The average water column water temperature was approximately 21ºC to 22ºC in June 2019 and increased to the highest water column average (25.3ºC) on July 29, 2019 (Table 6). The water temperature decreased in each subsequent profile to an average of 12.4ºC on October 16, 2019 (Table 6).

In all profiles, the DO concentration was uniform throughout the water column (Table 7). The water column average DO concentration was 8.1 mg/L on June 18, 2019 and 7.9 mg/L on June 25, 2019 (Table 7). In the July and August 2019 profiles, DO ranged from 6.3 mg/L to 7.3 mg/L with averages of 6.5 mg/L to 6.8 mg/L. DO generally increased in the remaining profiles collected in September and October 2019 (range 7.1 mg/L to 9.2 mg/L); the water column average was 9.0 mg/L in the last profile on October 16, 2019 (Table 7).

The DO percent saturation profiles were highest in the two June 2019 profiles with a range of 87.4 percent to 98.5 percent (Table 8). In the two July 2019 profiles and the August 15, 2019 profile, the DO percent saturation ranged from 75.2 percent to 91.0 percent (water column averages of 79.3 percent to 81.8 percent). The DO percent saturation was lowest on August 26, 2019 (range 72.1 percent to 75.1 percent, average 73.3 percent). In the September and October 2019 profiles, the DO percent saturation ranged from 76.6 percent to 86.9 percent (Table 8). Except for the August 26, 2019 profile, all DO percent saturation measurements were above the standard for Class A waters (75 percent saturation).

Table 6 Lowell Tannery Impoundment Water Temperature

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	24.1	22.1	24.8	26.9	24.2	21.3	19.9	17.2	15.0	13.2
1	22.7	21.6	24.2	26.6	23.3	21.2	19.5	16.5	15.0	12.6
2	21.8	21.5	23.8	25.6	23.1	21.2	19.4	16.3	15.0	12.3
3	21.3	21.4	23.7	24.9	22.9	21.2	19.4	16.2	15.0	12.2
4	21.2	21.4	23.6	24.5	22.9	21.1	19.3	16.1	15.0	12.2
5	20.9	21.0	23.6	24.4	22.8	21.1	19.3	16.0	15.0	12.1
6	20.9	20.9	23.3	24.3	22.7	21.1	19.3	16.0	15.0	12.1
7	-	-	-	-	-	21.1	19.3	-	-	-
Average	21.8	21.4	23.9	25.3	23.1	21.2	19.4	16.3	15.0	12.4
Minimum	20.9	20.9	23.3	24.3	22.7	21.1	19.3	16.0	15.0	12.1
Maximum	24.1	22.1	24.8	26.9	24.2	21.3	19.9	17.2	15.0	13.2

Table 7 Lowell Tannery Impoundment Dissolved Oxygen Concentration Profiles

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	8.3	8.0	6.9	7.3	7.0	6.7	7.3	8.3	8.0	9.2
1	8.2	8.0	6.8	7.3	6.8	6.6	7.2	8.3	7.9	9.0
2	8.2	7.9	6.7	6.9	6.8	6.5	7.2	8.3	7.9	9.0
3	8.1	7.9	6.7	6.6	6.8	6.5	7.1	8.3	7.9	9.0
4	8.1	7.9	6.7	6.4	6.8	6.5	7.1	8.3	7.9	8.9
5	8.0	7.9	6.7	6.3	6.7	6.5	7.1	8.2	7.8	8.9
6	8.0	7.8	6.6	6.3	6.7	6.4	7.1	8.2	7.8	8.9
7	-	-	-	-	-	6.4	7.1	-	-	-
Average	8.1	7.9	6.7	6.7	6.8	6.5	7.1	8.3	7.9	9.0
Minimum	8.0	7.8	6.6	6.3	6.7	6.4	7.1	8.2	7.8	8.9
Maximum	8.3	8.0	6.9	7.3	7.0	6.7	7.3	8.3	8.0	9.2

Table 8 Lowell Tannery Impoundment Dissolved Oxygen Percent Saturation

Depth (m)	6/18/2019 14:00	6/25/2019 13:25	7/16/2019 12:40	7/29/2019 14:45	8/15/2019 13:30	8/26/2019 11:30	9/6/2019 11:00	9/19/2019 11:30	10/2/2019 12:10	10/16/2019 12:50
0.25	98.5	92.0	82.9	91.0	83.2	75.1	79.8	86.4	78.9	86.9
1	94.7	90.7	81.2	90.5	79.7	74.3	78.3	84.8	78.5	84.9
2	92.8	89.9	79.7	84.8	79.2	73.6	77.8	84.4	78.2	83.9
3	90.9	89.7	79.0	79.6	78.7	73.3	77.4	84.2	78.1	83.5
4	90.4	89.4	78.8	76.2	78.5	73.0	77.1	84.0	77.8	83.1
5	89.5	88.4	78.6	75.4	77.8	72.6	76.9	83.1	77.5	82.6
6	89.3	87.4	76.8	75.2	77.7	72.3	76.7	82.7	77.0	82.3
7	-	-	-	-	-	72.1	76.6	-	-	-
Average	92.3	89.6	79.6	81.8	79.3	73.3	77.6	84.2	78.0	83.9
Minimum	89.3	87.4	76.8	75.2	77.7	72.1	76.6	82.7	77.0	82.3
Maximum	98.5	92	82.9	91	83.2	75.1	79.8	86.4	78.9	86.9

2.2.3 Tailwater Water Temperature and Dissolved Oxygen

In late June 2019, water temperatures downstream of the Lowell Tannery dam ranged from 16.0ºC to 21.9ºC (Table 9, Figure 3) and in July 2019, the temperatures ranged from 20.4ºC to 26.6ºC. The water temperature gradually increased from late June 2019 through early August 2019 reaching a maximum of 26.8ºC on August 1, 2019 (Figure 3). The temperature decreased from approximately 25.7ºC on August 6, 2019 to 21.5º C on August 12, 2019 and then decreased more gradually through mid-September 2019 when the temperature ranged from 17ºC to 18.4ºC.

In late June 2019, the DO concentration and percent saturation ranged from 7.6 mg/L to 10.0 mg/L and 81.8 percent to 103.1 percent (Table 9, Figure 4). The DO concentration ranged from 6.2 mg/L to 9.1 mg/L, and the percent saturation ranged from 70.9 percent to 104.5 percent in July and August 2019. In September 2019, the DO concentration ranged from 7.7 mg/L to 9.8 mg/L, and the DO percent saturation ranged from 79.5 percent to 101.5 percent (Table 9). The DO percent saturation was above the Class A standard (75 percent saturation) throughout the monitoring season except for four relatively short periods: from July 12 at 22:00 to July 13, 2019 at 12:00; July 14 at 10:00; August 17, 2019 from 04:00 to 16:00; and from August 17 at 23:00 to August 19, 2019 at 10:00 (Figure 4). These four periods represented approximately 3 percent of the total number of hourly measurements.

The rapid increases and decreases in DO corresponded to times when the Lowell Tannery Project began and stopped generating (Figure 4). When generation stopped, DO levels downstream of the dam increased as a result of spill reflecting increased aeration and mixing (for example on August 3 and August 19, 2019). During times when the project was generating, the water temperature and DO measured downstream of the dam reflected the levels in the impoundment as demonstrated by comparing levels downstream to the impoundment profiles on June 25, July 16, July 29, and August 16, 2019.

Table 9 Monthly Water Temperature and DO Statistic Downstream of Lowell Tannery Dam

Statistic	Water Temperature (ºC)	DO (mg/L)	DO (percent)
June 25-30			
Average	20.5	8.1	90.2
Median	20.6	8.1	90.8
Minimum	16.0	7.6	81.8
Maximum	21.9	10.0	103.1
July 1-31			
Average	24.1	7.4	88.0
Median	24.1	7.1	86.7
Minimum	20.4	6.3	72.9
Maximum	26.6	9.1	104.5
August 1-31			
Average	22.9	7.8	91.1
Median	22.5	8.1	97.8
Minimum	20.5	6.2	70.9
Maximum	26.8	9.0	101.9
September 1-17			
Average	18.5	8.8	93.8
Median	18.1	9.0	99.0
Minimum	16.7	7.7	79.5
Maximum	21.2	9.8	101.5

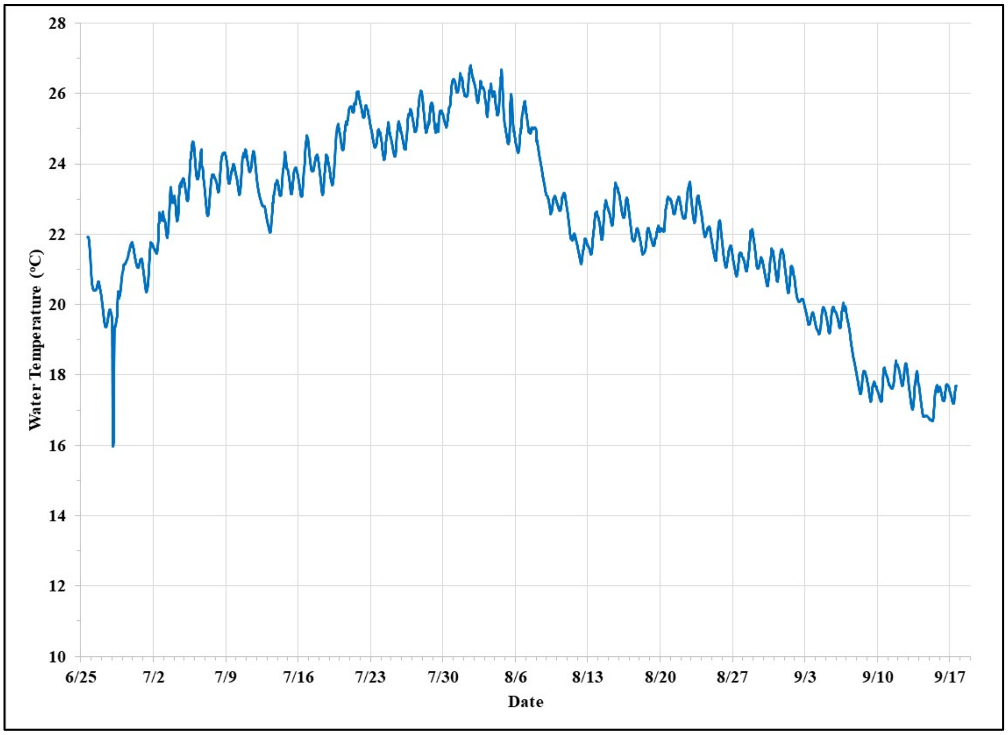

Figure 3 Lowell Tannery Tailrace Hourly Water Temperature Time (June 25 to September 17, 2019)

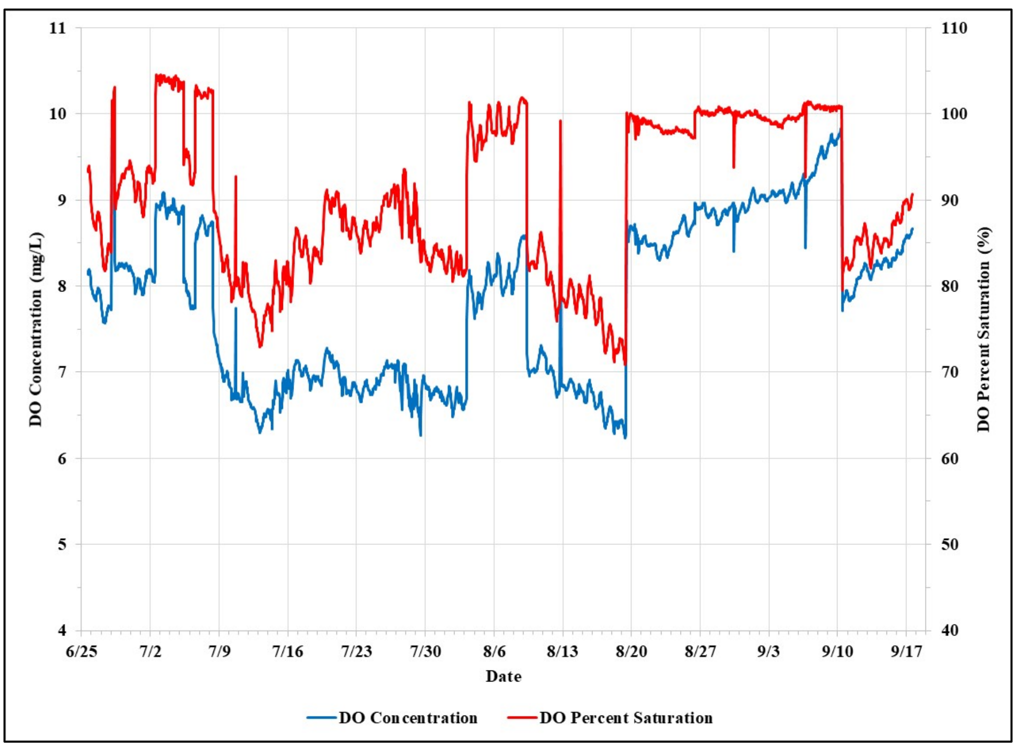

Figure 4 Lowell Tannery Tailrace Hourly DO Concentration and Percent Saturation Time Series (June 25 to September 17, 2019)

2.3 Summary

KEI (Maine) completed lake trophic and riverine water quality monitoring at the Lowell Tannery Project between June and October 2019. Secchi Disk (average 2.3 meters), chlorophyll-a (average 0.0031 mg/L), and pH (average 6.6) measurements collected in the impoundment complied with Class A/AA water quality standards. Half of the total phosphorus samples exceeded the Class A/AA standard. Water temperature and DO displayed uniform vertical profiles indicating that the Lowell Tannery impoundment did not stratify.

Water temperature in the impoundment and tailwater displayed the typical seasonal variation of ranging from approximately 20ºC to 22ºC in June 2019, increasing to a peak of 25ºC to 27ºC in late July/early August 2019 and then steadily decreasing through the end of the study period. During some of the times when the Lowell Tannery Project was generating in July and August 2019, the tailwater DO concentration decreased below the Class A water quality standard (7 mg/L). The DO percent saturation exceeded the Class A standard in approximately 97 percent of the measurements. DO levels in the Project area may be reflective of conditions in the watershed and/or a result of elevated biological productivity that increases DO consumption during decay.

3.0 BENTHIC MACROINVERTEBRATE STUDY - SUMMARY

MDEP requested that KEI (Maine) perform an aquatic life criteria study (i.e., benthic macroinvertebrate sampling) to assess whether the Passadumkeag River attains Class A water quality standards and the designated use of “habitat for fish and other aquatic life” at the Lowell Tannery Project. With respect to designated uses, the Maine Water Quality Law requires that “Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; 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.” In addition, for Class A waters, “The habitat must be characterized as natural.” ((38 M.R.S.A. § 465(4)(A)). The term “Natural” is defined as “means living in, or as if in, a state of nature not measurably affected by human activity.” ((38 M.R.S.A. § 466(9)).

The objective of the macroinvertebrate sampling study was to determine if the aquatic life, in this case the macroinvertebrate community, attained these Class A standards. The MDEP "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 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 invertebrate community sampled below the Lowell Tannery dam was abundant, moderately rich, and well-populated with stress sensitive taxa. The community structure and function found below the Lowell Tannery dam indicates a generally healthy community with evidence of natural, biological enrichment. It is the professional opinion of Moody Mountain Environmental, a qualified invertebrate specialist, that based on the 2019 data that the macroinvertebrate community downstream of the Lowell Tannery dam on the Passadumkeag River is naturally occurring, does not show excessive stress as a result of the project operation, and attains Class A aquatic life standards.

The MDEP uses a linear discriminant water quality model (LDM) and professional judgment to determine water quality class attainment of aquatic macroinvertebrate communities. The LDM results are percentages indicating the probability of a site attaining water quality Classes A, and AA (the biocriteria requirements are the same), B, or C. The LDM numeric criteria results can be supplanted by professional judgment if conditions are such that the data sets are unsuitable for LDM analysis. The MDEP determined that the Benthic Macroinvertebrate (BMI) community met Class A water quality standards.

Attachment A provides the 2019 Benthic Macroinvertebrate study report and the MDEP determination.

4.0 DESKTOP TURBINE BLADE STRIKE AND WHOLE STATION SURVIVAL STUDY

KEI (Maine) performed a desktop study to assess the risk of entrainment (i.e., involuntary passage through the turbine), impingement (i.e., involuntary entrapment against the upstream face of the trash rack), turbine passage survival, and whole-station survival of target migratory fish species that are known to have occurred historically in the Passadumkeag River. Whole-station survival was classified as successful downstream passage via multiple routes including fishways, spill, and turbine passage. Target fish species included adult American eel, adult and juvenile sea-run alewives (used also as a surrogate for similarly sized blueback herring), adult and juvenile American shad, and Atlantic salmon.

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam. KEI (Maine) provides 40 cubic feet per second (cfs) of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. Downstream fish passage is provided through a dedicated fish bypass that is adjacent to the eastern side of the intake racks. A fishway gate leads to an 18-inch bypass pipe that discharges into a plunge pool next to the tailrace. KEI (Maine) provides a fishway flow of 20 cfs through the downstream bypass. The Lowell Tannery Project has two angled trash racks (V-shape) with bars spaced at 1.5-inch clear. Both trash racks are 15-feet-deep by 12-feet-wide resulting in a total surface area of 360 square feet.

The Lowell Tannery Project has one vertical Kaplan hydroelectric turbine that can generate with up to 905 cfs and a minimum capacity of 90 cfs. The turbine has four fixed blades with a rotational speed up to 190 revolutions per minute. Table 9 provides a description of pertinent turbine and project characteristics applicable to this study.

Table 9 Turbine and Fish Characteristics used for Turbine Blade Strike and Whole Station Survival Analysis

Number of Turbines	1
Turbine Style	Vertical Kaplan
Project Head for Generation (Net Head)	20 feet
Number of Turbine Blades	4 (adjustable)
Runner Diameter (diameter of the turbine hub and turbine blades)	4.6 feet
Max. Turbine Runner Rotational Speed	190 revolutions per minute
Maximum Hydraulic Capacity	905 cfs
Minimum Hydraulic Capacity	90 cfs
Discharge at Optimum Efficiency	886 cfs (92.3%)
Turbine Efficiency	0.67 (assigned)

4.1 Methods

4.1.1 Risk of Entrainment and Impingement

To evaluate the risk of impingement, KEI (Maine) calculated the expected approach velocities at the turbine intake and compared them to typical prolonged swim speeds of target fish species. Approach velocities at the intake were determined by dividing the hydraulic capacity of the turbine on a seasonal basis (i.e., when migratory fish typically move downstream) by the size of the intake area (USFWS 2019). The intake area has a surface area of 360-square-feet (15-feet-tall by 12-feet-wide for each rack). For example, at the full station capacity of 905 cfs, the approach velocity was calculated as:

905 cfs (water flow to turbine) / 360 square feet (intake area) = 2.5 feet per second (approach velocity)

Burst swim speed is the swimming speed that a fish can maintain for approximately 20 seconds (Beamish 1978). This enables a fish to escape predation or traverse through high-velocity areas in the water column (Beamish 1978). Prolonged swim speeds are typically maintainable for 20 seconds to 200 minutes (Alden 2004). Table 10 provides a list of prolonged swim speeds used during the analysis.

Table 10 Prolonged Swim Speeds Used to Evaluate Risk of Entrainment and Impingement at the Lowell Tannery Project

Species/Lifestage	Reported Swim Speed (fps)	Literature Source
Atlantic salmon smolts	3.2	Hvas and Oppedal 2017
Adult alewife	6.0	USFWS 2019
Juvenile alewife	1.4 to 1.75	Alden 2004
Adult blueback herring	6.0	USFWS 2019
Juvenile blueback herring	0.75 to 1.14	Alden 2004
Adult American shad	5.0	FishXING 2006
Juvenile American shad	2.15	FishXING 2006
Adult American eel	2.15	Qunitella et. al 2010

To evaluate the risk of entrainment to the turbine, KEI (Maine) compared trash rack spacing to fish size and morphology. Fish with a body thickness less than 1.5 inches (i.e., trash rack open spacing) were classified as “at risk of entrainment” through the trash racks. Fish with swim speeds less than 1.5 feet per second were considered “at risk for impingement” at the trash rack face based on typical USFWS’s criteria. Fish morphology information (body width and length) were obtained from literature or field data from fisheries studies in the region. Body width for adult American shad was estimated based on the proportion of body width to standard length (Smith 1986) for fishes collected by the MDMR at the Milford Hydroelectric Project on the Penobscot River in Maine from 2017 to 2019.

4.1.2 Turbine Blade Strike and Whole Station Survival Analysis

KEI (Maine) used STRYKE,[3] a Python-based[4] desktop model, to quantitatively estimate the probability of turbine blade strike survival and whole station survival via a combination of available downstream passage routes (e.g., turbine, spill, and fish bypass) for each target fish species and lifestage. STRYKE uses the turbine blade strike equations from Franke et al. (1997) and is based on the USFWS's Turbine Blade Strike Analysis desktop model (Towler and Pica 2018). Model variables included fish length, number of fish, and turbine characteristics (e.g., runner diameter, turbine type, turbine efficiency, hydraulic capacity, runner speed, and head) (Table 9).

The survival analysis was completed at three flow thresholds to provide a range of possible turbine survival and whole-station survival estimates depending on river flow conditions. Hydrologic conditions were determined from Flow Duration Curves for the Passadumkeag River for low-flow condition (90 percent exceedance), median flow condition (50 percent exceedance), and high flow condition (10 percent exceedance) during times of the year when each species or lifestage is most likely to be outmigrating (Table 13). These thresholds were selected to represent high, median, and low water year conditions.

Three other critical factors require input by the user: fish length; the proportion of fish passing through each available route of passage (spill, fish bypass, or turbine); and the strike mortality correlation factor (lambda).

4.1.2.1 Strike Mortality Coefficient

The strike mortality correlation factor is built into the model to account for differences in actual turbine mortality derived from field tests as compared to predicted model output (Franke et al. 1997). Three variables are built into the strike mortality correlation factor: the position of the fish relative to the plane of the turbine revolution (i.e., fish orientation during passage), the difference in the impact of a strike relative to the fish's body (i.e., a

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[3] Developed by Kleinschmidt Associates (Kleinschmidt).

[4] Python is an open source, object oriented, extendable programming language with packages that support scientific and advanced numerical computing.

strike to the anterior region is more detrimental that a strike to the posterior region), and hydraulic characteristics near the leading edge of the blade tip, which may carry a fish around the leading edge, reducing the likelihood of blade strike (Franke et al. 1997). Franke et al. (1997) suggests using a lambda value of 0.10 to 0.20 for Kaplan turbines based on results of field studies compared to model predictability. Model iterations for the Lowell Tannery Project were run using lambda values of 0.15.

4.1.2.2 Routing of Fish Through the Lowell Tannery Project

Bypass efficiency (i.e., number of fish using the fish bypass to pass downstream) was assumed to be 50 percent for most model runs; for American eels, a second scenario was run with a bypass efficiency of 25 percent because there is not a dedicated downstream bypass. The number of fish routed to the spillway to pass downstream was based on ratio of river flow to turbine capacity. For example, if river flow was 1,250 cfs, approximately 25 percent of fish would be routed to spill because 25 percent of river flow would spill, and 75 percent would be used to generate power. If river flow was less than the maximum capacity of the turbine, 0 percent of fish were routed to spill. When river flow was less than approximately 125 cfs (minimum capacity of the turbine), 0 cfs was routed to the turbine to replicate periods of time when the turbine is not operational. In this instance, all fish were routed through the fish bypass or spill.

4.1.2.3 Fish Length

Turbine passage survival and blade strike probability is influenced more by fish size than species; therefore, the equations do not differentiate between species but only consider fish size (Franke et al. 1997). STRYKE allows the user to enter fish length plus a standard deviation factor to account for variability in fish length; fish length is assumed to be normally distributed (Towler and Pica 2018). Fish length information for the target species was obtained from published reports, field data from regional studies, and other literature sources. Table 12 provides the size ranges for target fish species evaluated for the Lowell Tannery Project. A standard deviation of 0.5 inches was used for all fish species. Adult American eel have a unique body shape that allows them to contort into irregular shapes. As such, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

The STRYKE model was run 20 times sequentially to estimate mean turbine and whole-station survival, calculate a standard deviation, and determine the 95 percent confidence interval. Sample size (# of fish) was set at 200 for each model run. The accuracy of the STRYKE model was verified by running the same scenarios (e.g., same fish length and same turbine characteristics) in the USFWS's model to determine if survival estimates fell within in the 95 percent CI range produced by the STRYKE model.

Table 11 Fish Lengths for the Lowell Tannery Turbine Blade Strike and Whole Station Survival Analysis

Species/Life Stage	Total Length (inches/millimeters)	Data Source
Atlantic Salmon Smolts	7.5 inches (190.5 mm)	Baum 1997
Atlantic Salmon Adults	29 inches (737 mm)	Baum 1997
Adult Alewives	10.5 (267 mm)	MDMR 2020
Juvenile Alewives	4 inches (101 mm)	Pardue 1983
Adult American Shad	19 inches (560 mm)	MDMR 2020
Juvenile American Shad	4 inches (101 mm)	Talbot and Sykes 1958
Adult American Eel	33.5 inches (851 mm)	Kleinschmidt 2012 and 2013

Table 12 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/Life Stage	Peak Outmigration (Month)	Low Flow Threshold (cfs; 90%)	Median Flow Threshold (cfs; 50%)	High Flow Threshold (cfs; 10%)
Atlantic Salmon Smolts	May	178	443	1,365
Adult Alewives	June	135	381	1,441
Juvenile Alewives	September	21*	88*	490
Adult American Shad	July	60*	160	811
Juvenile American Shad	September	21*	88*	490
Adult American Eel	October	28*	165	1,054

* Blue cells indicate turbine unit inoperable because of low water conditions (less or close to 90s); turbine-strike equal to 0.00 and whole-station survival assumed 100 percent.

4.2 Results

4.2.1 Risk of Entrainment or Impingement

4.2.1.1 Trash Rack Exclusion

Juvenile alosines (shad, alewives, and blueback herring), adult American eel, and Atlantic salmon smolts may fit through the 1.5-inch trash racks and pass downstream via the turbine given their smaller body size and morphology. Body width for 18-inch-long and 20-inch-long adult American shad is expected to range from 2.5 to 2.7 inches based on recent fish size data from the Penobscot River[5] (Table 14). Adult salmon are expected to be approximately 29-inches-long. As such, adult salmon and adult American shad are excluded from the turbine by the trash rack bars.

Table 13 Body Length and Width Estimate for Adult American Shad

Fish Sex	Total Length*	Standard Length	Body Width**
Male	18 inches	15 inches	2.5 inches
Female	20 inches	16.6 inches	2.7 inches

* MDMR data from the Penobscot River

** Body width is reported as 16.4 percent of standard length (Smith 1986).

4.2.1.2 Approach Velocity and Impingement

Approach velocity ranges from 0.0 to 0.49 fps (low water year), 0.0 to 1.23 fps (median water years), and from 1.36 to 2.51 fps during high water years during peak migratory periods (e.g., May, June, July, September, and October) (Table 15).

[5] Personal communication, MDMR staff, January 2020.

Table 14 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/ Life Stage	Peak Migration	Low Flow (cfs)	Approach Velocity (fps)	Median Flow (cfs)	Approach Velocity (fps)	High Flow (cfs)	Approach Velocity (fps)
Atlantic Salmon Smolts	May	178	***0.49***	443	***1.23***	905	**2.51**
Adult River Herring	June	135	***0.38***	381	***1.05***	905	**2.51**
Juvenile Alosines	September	21	***0.00***	88	***0.00***	490	**1.36**
Adult American Shad	July	60	***0.00***	160	***0.44***	811	**2.25**
Adult American Eel	October	28	***0.00***	165	***0.46***	905	**2.51**

Based on prolonged swim speeds and expected water velocity in front of the intake during peak migratory periods, the risk of involuntary entrainment to the turbine or impingement against the trash racks is low. The maximum, normal approach velocity during times when the Lowell Tannery Project is fully operational (i.e., during high flow conditions) is estimated to be 2.5 fps, which is near reported prolonged swim speeds for Atlantic salmon smolts, adult herring, adult shad, and adult American eel. At other times of the year or during low or median water years, approach velocity is expected to be less than 2.51 fps (e.g., 0.00 to 1.23 fps), thereby reducing the likelihood of involuntary entrainment or impingement for all species and lifestages, including juvenile herring and American shad. The most risk for impingement or involuntary entrainment is during times when the turbine may be fully operational during the fall outmigration of juveniles alosines and American eels or the outmigration of American shad.

4.2.2 Turbine Passage and Whole Station Survival

4.2.2.1 Adult Sea-Run Alewives and Juvenile Alewives/American Shad

Mean turbine passage survival at the Lowell Tannery Project for 10.5-inch-long adult sea-run alewives ranged from 87 to 95 percent depending on hydrologic conditions in June (e.g., high, median, or low water year); mean whole project survival estimates ranged from 93 to 99 percent (Table 16).

Table 15 Turbine Blade Strike and Whole Station Survival Estimate for Adult Sea-Run Alewives at Lowell Tannery Project

Variable	Flow Condition and Survival Estimates		
Flow Condition	High (1,441 cfs)	Median (381 cfs)	Low (135 cfs)
Turbine Capacity	905	381	135
Percent to Turbine	31.4	50	50
Percent to Spill	37.2	0	0
Percent to Bypass	31.4	50	50
Strike Coefficient	0.15	0.15	0.15
RPM	190	190	190
Mean Turbine Survival	**95%**	**90%**	**87%**
Standard Deviation	3%	4%	5%
Turbine Passage Survival 95% CI (Low)	90%	83%	77%
Turbine Passage Survival 95% CI (High)	98%	97%	95%
Mean Whole Project Survival	**99%**	**95%**	**93%**
Standard Deviation	1%	2%	3%
Whole Project Survival 95% CI (Low)	97%	91%	89%
Whole Project Survival 95% CI (High)	99%	99%	98%

Mean turbine passage survival at the Lowell Tannery Project for 4-inch-long juvenile alosines (e.g., American shad and sea run alewives) ranged from 97.0 to 100 percent depending on hydrologic conditions in September (e.g., high, median, or low water year); mean whole project survival estimates ranged from 98 to 100 percent (Table 17). The Lowell Tannery Project turbine would not be operable at the median or low flow condition in September; therefore, whole-station survival is expected to be 100 percent (Table 17)

Table 16 Turbine Blade Strike and Whole Station Survival Estimate for Juvenile Alosine Species

Variable	**Flow Condition and Survival Estimates**		
Flow Condition	High (490 cfs)	Median (88 cfs)	Low (21 cfs)
Turbine Capacity	490	0	0
Percent to Turbine	50	0	0
Percent to Spill	0	50	50
Percent to Bypass	50	50	50
Strike Coefficient	0.15	-	-
RPM	190	-	-
Mean Turbine Survival	**97%**	**100%**	**100%**
Standard Deviation	2%	-	-
Turbine Passage Survival 95% CI (Low)	94%	100%	100%
Turbine Passage Survival 95% CI (High)	100%	100%	100%
Mean Whole Project Survival	**98%**	**100%**	**100%**
Standard Deviation	1%	-	-
Whole Project Survival 95% CI (Low)	97%	100%	100%
Whole Project Survival 95% CI (High)	100%	100%	100%

4.2.2.2 Atlantic Salmon Smolts

Mean turbine passage survival at the Lowell Tannery Project for 7.5-inch-long Atlantic salmon smolts ranged from 91 to 96 percent depending on hydrologic conditions in May (e.g., high, median, or low water year); mean whole project survival estimates ranged from 95 to 98 percent (Table 18).

Table 17 Turbine Blade Strike and Whole Station Survival Estimate for Atlantic Salmon Smolts

Variable	Flow Condition and Survival Estimates		
Flow Condition	High (1,365 cfs)	Median (443) cfs	Low (178) cfs
Turbine Capacity	905	443	178
Percent to Turbine	33	50	50
Percent to Spill	34	0	0
Percent to Bypass	33	50	50
Strike Coefficient	0.15	0.15	0.15
RPM	190	190	190
Mean Turbine Survival	**96%**	**95%**	**91%**
Standard Deviation	2%	3%	3%
Turbine Passage Survival 95% CI (Low)	90%	89%	84%
Turbine Passage Survival 95% CI (High)	99%	99%	95%
Mean Whole Project Survival	**98%**	**97%**	**95%**
Standard Deviation	1%	2%	2%
Whole Project Survival 95% CI (Low)	96%	94%	92%
Whole Project Survival 95% CI (High)	99%	99%	97%

4.2.2.3 Adult American Eel

Mean turbine passage survival at the Lowell Tannery Project for 33-inch-long adult American eel ranged from 60 to 100 percent depending on hydrologic conditions in October (e.g., high, median, or low water year); mean whole project survival estimates ranged from 71 to 100 percent (Table 19).

Table 18 Turbine Blade Strike and Whole Station Survival Estimate for Adult American Eel

Variable	Flow Condition and Survival Estimates				
Flow Condition	High (905 cfs; 50% Bypass)	High (905 cfs; 25% Bypass)	Median (165 cfs; 50% Bypass)	Median (165 cfs; 25% Bypass)	Low (28 cfs)
Turbine Capacity	905	905	165	165	0
Percent to Turbine	43	65	50	75	0
Percent to Spill	14	14	0	0	50
Percent to Bypass	43	21	50	25	50
Strike Coefficient	0.15	0.15	0.15	0.15	-
RPM	190	190	190	190	-
Mean Turbine Survival	**84%**	**84%**	**60%**	**61%**	**100%**
Standard Deviation	4%	4%	5%	4%	-
Turbine Passage Survival 95% CI (Low)	77%	77%	50%	53%	100%
Turbine Passage Survival 95% CI (High)	91%	90%	68%	68%	100%
Mean Whole Project Survival	**93%**	**90%**	**81%**	**71%**	**100%**
Standard Deviation	2%	2%	3%	3%	-
Whole Project Survival 95% CI (Low)	89%	86%	74%	65%	100%
Whole Project Survival 95% CI (High)	97%	93%	84%	77%	100%

4.2.2.4 Adult American Shad and Atlantic Salmon

Adult salmon and American shad are expected to pass downstream via spill or through the downstream fish bypass, therefore turbine blade strike and whole-passage survival estimates were not calculated, and survival was assumed to be 100 percent.

4.3 Summary

Kleinschmidt's turbine blade strike and whole station survival model provided an automated method to run multiple iterations of turbine and whole station survival estimates for multiple species and lifestages of migratory fish under varying flow conditions. The narrowly spaced, full depth trash rack bars and relatively low approach velocities reduce the likelihood of entrainment and prohibit larger-bodied fish (e.g., adult Atlantic salmon or adult American shad) from becoming entrained. The characteristics of the turbine at the Lowell Tannery Project (i.e., Kaplan with relatively low RPMs, low head) and the relatively small size of fish that may be entrained increases the probability for high turbine passage survival and high whole-station survival of migratory fish species. Large-bodied American eel are at the highest risk of turbine-strike and mortality, during median flow conditions; however, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

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ATTACHMENT A

MDEP CONSULTATION RECORD

From:	Howatt, Kathy
To:	Jesse Wechsler; Rachel Russo; Sherri.Loon@kruger.com
Subject:	Lowell Tannery PSP
Date:	Tuesday, May 21, 2019 7:34:34 AM

Jesse and Rachel,

I conferred with Barry M., and on confirmation that operating conditions are ROR (no drawdown, fluctuations of up to one foot allowed) and the powerhouse integral to the dam with no bypass reach, an impoundment habitat study and downstream habitat study will not be required. The applicant, in its DLA and FLA, needs to present all available information and make the case that the water quality standards for habitat designated uses are met, despite lack of data demonstrating such. Let me know if you have any questions,

Kathy

Kathy Davis Howatt
Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection
Phone: 207-446-2642
www.maine.gov/dep

ATTACHMENT B

MOODY MOUNTAIN AQUATIC INVERTEBRATE REPORT
LOWELL TANNERY

2019

Macroinvertebrate Sampling Study

Downstream

of the

Lowell Tannery Dam

Lowell Maine

FERC NO. 4202

Submitted by:

Paul C. Leeper

Moody Mountain Environmental

137 Diamond Str

Searsmont Maine 04973

Submitted to:

Jesse Wechler

Kleinschmidt Group

141 Main Street

Pittsfield, ME 04967

Date: February 18, 2020

Introduction

This macroinvertebrate sampling study was conducted in support of the relicensing of the Lowell Tannery Hydroelectric Project (Project or Lowell Tannery Project), Federal Energy Regulatory Commission (FERC) Project No. 4202. This report details 2019 study efforts as part of the Water Quality Sampling Study.

Study Objectives

The goal of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Passadumkeag River downstream of the Lowell Tannery Dam and assess this community in terms of Maine's Aquatic Life Standards.

Study Area

In 2019 we placed samples at one (1) site approximately 490 ft below the Lowell Tannery Dam in the Passadumkeag River to study aquatic macroinvertebrates (Figure 1).

Water Classification

The Passadumkeag River downstream of the Lowell Tannery Dam is classified Class A ((38 M.R.S.A § 467(4) (18)(A)(1))). With respect to designated uses, the Maine Water Quality Law requires that "Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; 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." In addition, for Class A waters, "The habitat must be characterized as natural." (38 M.R.S.A. § 465(4)(A). The term "Natural" is defined as "means living in, or as if in, a state of nature not measurably affected by human activity." ((38 M.R.S.A. § 466(9)).

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Figure 1. Location of aquatic macroinvertebrate sampling site downstream of the Lowell Tannery Dam. Passadumkeag River, August, September 2019.

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 A 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 site; samplers are typically left in the river for approximately 28 days (± 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) from each site were sorted, identified, and enumerated.

The Maine Department of Environmental Protection (DEP), Division of Environmental Assessment (DEA) uses a linear discriminant water quality model (LDM) and professional judgment to determine water quality class attainment of aquatic macroinvertebrate communities. The LDM results are percentages indicating the probability of a site attaining water quality Classes A, and AA (the biocriteria requirements are the same), B, or C. The LDM numeric criteria results can be supplanted by professional judgment if conditions are such that the data sets are unsuitable for LDM analysis.

The Method outlines a number of conditions that can trigger the use of professional judgment to analyze data. Among these are:

1. Minimum Provisions - if the sample Mean Total Abundance is less than 50 individuals or Generic Richness is less than 15 genera.
2. Atypical Conditions - where atypical conditions could result in uncharacteristic findings, professional judgment can be used to make adjustments. Examples of these atypical conditions are:

   a. - <u>Habitat Factors</u>

      Lake Outlets
      Impounded Waters
      Substrate Characteristics
      Tidal Waters

   b. - <u>Sampling Factors</u>

      Disturbed Samples
      Unusual Taxa Assemblages
      Human Error in Sampling

   c. - <u>Analytical Factors</u>

      Subsample versus Whole Sample analysis
      Human Error in Processing

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In cases where professional judgment is used the Method outlines a process by which adjustments should occur. These are:

a. **Resample** the site if specific sampling factors may have influenced the results

b. **Raise the Finding** of the LDM from non-attainment to indeterminant or attainment of Class C;

c. **Raise the Finding** of the LDM from one class to the next higher class;

d. **Lower the Finding** of the LDM to indeterminant or the next lower class. This would be based on evidence that the narrative aquatic life criteria for the assigned class are not met;

e. **Determination of Non-Attainment**: Minimum Provisions not met by samples for which no evidence exists of atypical conditions.

f. **Determination of Attainment**: Minimum Provisions not met by samples for which there is evidence of factors that could result in minimum provisions not being met, professional judgment may be used to make a professional finding of attainment of the aquatic life criteria for any class. Such decisions will be provisional until appropriate resampling is carried out.

Typically, the process for analyzing community data using the LDM and making adjustments is the responsibility of the DEP; however, in this report professional judgment is used, taking into account these same factors.

Results

The samplers were placed in the river on August 6, 2019. Due to high flows in the river the samplers could not safely be retrieved until September 13, 2019. This interval is outside the 28 days (± 4 days) window called for in DEP methods. Habitat measurements for are shown in Table 1. Photos of the areas around the sample site are included below.

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Table 1. Habitat measurements in the Passadumkeag River downstream of Lowell Tannery Dam for aquatic macroinvertebrate sampling. August-September 2019

Macroinvertebrate Field Data Sheet

Log ______	Directions	Type of Sampler **RB**
Station Number	______	Date Deployed **8/6/19**
Waterbody **Passadumkeag R.**	______	Number Deployed **3**
River Basin **Passadumkeag R.**	Lat-Long Coordinates	Date Retrieved **9/13/19**
Town **Lowell**	**45°11'9.31"N**	Number Retrieved **3**
Stream Order **6**	**68°27'59.04"W**	Collector(s) **P Leeper MME**

1. **Land Use** (surrounding watershed)		2. **Terrain**	3. **Canopy Cover**
☐ Urban	**X** Upland conifer	☐ Flat	☐Dense (75-100% shaded)
☐ Cultivated	☐ Swamp hardwood	**X** Rolling	☐Partly open (25-75% shaded)
☐ Pasture	☐ Swamp conifer	☐ Hilly	**X** Open (0-25% shaded)
X Upland hardwood	☐ Marsh	☐ Mountains	(% daily direct sun) ______

4. **Physical Characteristics of Bottom** estimate % over 12 m stretch			
[**10**] Bedrock	[**50**] Cobble (2.5" – 10")	[] Sand (<1/8")	[ ] Clay
[**40**] Boulders (>10")	[ ] Gravel (1/8" – 2.5")	[Silt	[ ] Muck

5. **Habitat Characteristics** (immediate area)		Temp. Probe #	7. **Water Samples**
Time **1125h**	Time **1125h**	☐ deployed	☐ Standard
Wetted Width	Wetted Width (m) **80m**	6. **Observations**	☐ Other
Bank Fl Width	Bank Full Width **80m**		Lab Number
Depth **65cm**	Depth		8. **Photograph**
Velocity	Velocity 103 cm/s		Put-In **Yes**
Diss. O_2 (ppm)	Diss. O_2 (ppm) 8.4		Take-Out **Yes**
Temp (C)	Temp (C) 17.4		
Turbidity	Turbidity		
DO Meter #______Cal? /	DO Meter # YSI Pro 1 Cal? **Y** /		

Photo 1. Sample Site view northeast (upstream). Passadumkeag R. 8-6-19

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Photo 2. Sample Site 1 view southeast (crosstream). Passadumkeag R. 8-6-19

Photo 3. Sample Site 1 view southwest (downstream). Passadumkeag R. 7-29-19

Photo 4. Typical substrate in the Passadumkeag River downstream of Lowell Tannery Dam. August-September 2019

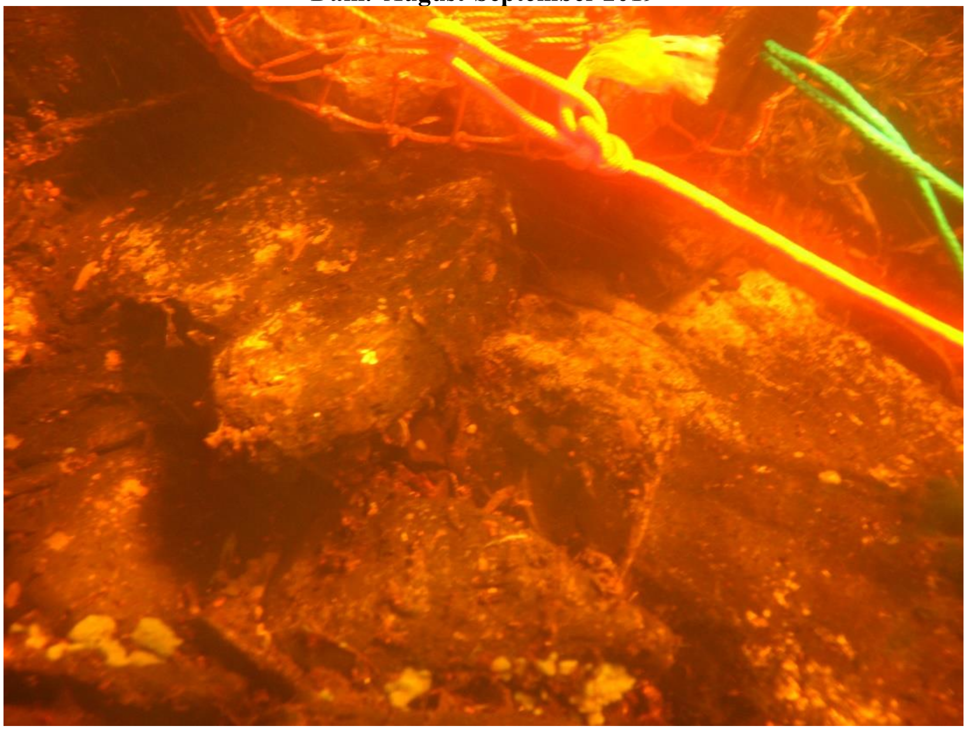
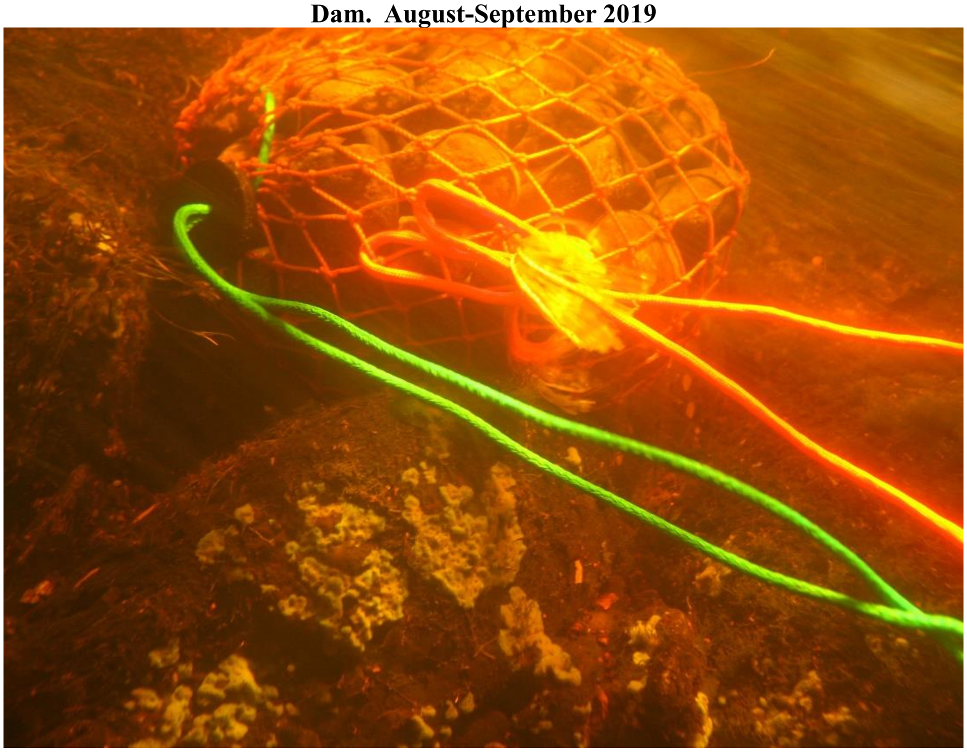


Photo 5. Typical substrate in the Passadumkeag River downstream of Lowell Tannery Dam. August-September 2019



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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. The model results indicate that the community was in attainment of Aquatic Life Class B Standards. However, the DEP used Best Professional Judgement to raise the finding to A "*because of impoundment acting like a natural lake outlet. The sample has a lot of filter feeding organisms. Further upstream, Saponac Pond is a shallow, natrually (*sic*)mesotrophic lake*."

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 the Passadumkeag River in Auburn Maine downstream of the Lowell Tannery Dam in 2019. 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	1%*	73%	100%	0%

- Best Professional Judgement used to raise finding to Class A

Community Analysis

The macroinvertebrate communities sampled downstream of the Lowell Tannery Dam were abundant and moderately rich in taxa (Appendix 1). The community was populated with 17 different taxa with a Mean Total Abundance of 856. Filter-feeding caddisflies were numerous, representing over 50% 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 Lowell Tannery Dam. Passadumkeag River, August-September 2019.

Site	Tot. Abund.	Taxa Richness	S-W Div.	Hils. Biotic Index (HBI)	Water Quality indication from HBI	Mayfly, Stonefly, Caddisfly (EPT) Richness	Mayfly, Stonefly (EP)		Midge	
							Rich	% Ab	Rich	% Ab
Site 1	856.3	17	2.14	4.11	Very Good	10	5	4	2	5

Indexes measuring the communities' tolerance to poor water quality conditions indicated

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good water quality. Sensitive mayfly and stonefly taxa were well represented (5 taxa). The Hilsenhoff Biotic Index value, 4.11 indicated very good water quality (Hilsenhoff 1987).

Dominant organisms (representing over 5% of the Total Abundance) in the community are shown in Table 3 arranged from the most sensitive organisms to the organisms most tolerant of poor water quality conditions. The community had 2 taxa, sensitive caddisflies *Hydropsyche* and tolerant blackflies *Simulium*, that made up 79% of the total abundance.

Table 4. Dominant aquatic invertebrate organisms downstream of the Lowell Tannery Dam. Passadumkeag River, July- August 2019.

Sensitivity to Poor Water Quality	**Dominant Organism**	**% of Community**
Sensitive	Caddisfly *Hydropsyche*	44%
Intermediate		
Tolerant	Blackfly *Simulium*	35%

The community structure and function found downstream of the Lowell Tannery Dam on the Passadumkeag River indicates some evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983). However, the presence in the community of sensitive stoneflies and mayflies indicates there has been no loss of genera or excessive dominance by any group.

Enrichment and caddisfly dominance downstream of lake outlets and dam outlets is a common phenomenon that has long been reported in the literature. Illies (1956 in Spence and Hynes 1970) reported an increase in the number of filter-feeding Trichoptera below a lake when compared to upstream communities. He attributed this to an increase in food availability. Filter-feeding organisms (the blackfly *Simulium* is also a filter-feeder)

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are often the dominant organisms in streams and rivers (Hynes 1970) and frequently are very abundant at lake outlets (Carlsson et al. 1977; Valett and Stanford 1987). The density or biomass of these filter-feeders typically decline the farther one looks downstream (Osgood 1979). This blossoming and decline of the aquatic community may be in response to a gradient in the quantity and/or quality of the food resources. High quality lake seston (the particulate matter in the water), typically made up of algal cells, is processed by the filter-feeders near the outlet and may be transformed to lower quality detritus (Benke and Wallace 1980, Valett and Stanford 1987).

This phenomenon has also been long observed at impoundment outlets. Spence and Hynes (1971) reported increased numbers of Hydropsychidae (the caddisfly *Hydropsyche* is a genus in the family Hydropsychidae) and other organisms downstream of an impoundment and stated that the downstream differences were comparable to mild organic enrichment. Parker and Voshell (1983) reported production of filter-feeding Trichoptera to be the highest at a site closest to the dam when compared to sites farther downstream and sites on free-flowing rivers. They concluded that, not only the amount of high quality food, but the specific size of the seston, contributed to the ability of the caddisflies to occupy this niche.

The community sampled from the Passadumkeag River exhibited the typical community enrichment seen below natural lake and impoundment outlets. The Lowell Tannery Dam operates in a similar manner to a natural lake outlet and enriches the aquatic community downstream. The community sampled close to the dam is influenced by a high quality food resource exiting the impoundment. This resource allows the aquatic filter feeders to flourish. The community downstream of the dam is responding as expected within their habitats.

It is my professional opinion that the macroinvertebrate community downstream of Lowell Tannery Dam on the Passadumkeag River is naturally occurring, does not show excessive stress

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as a result of the project operation, and attains Class A aquatic life standards. Specifically, it is my opinion that the aquatic life in the Passadumkeag River downstream of Lowell Tannery Dam is as naturally occurs.

Summary

1. The objective of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Passadumkeag River downstream of the Lowell Tannery Dam and assess this community in terms of Maine's Aquatic Life Standards. The Passadumkeag River downstream of the dam is classified Class A.

2. The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2014) were used as the basis of the field and laboratory procedures in this study.

3. Samplers were retrieved from one (1) sample site approximately 490 ft downstream of the dam on September 13, 2019 due to earlier high flows. This was outside the normal colonization time frame.

4. The LDM biocriteria results indicate that the community is in attainment of Class A Aquatic Life Standards using best Professional Judgement.

5. The invertebrate community sampled below the Lowell Tannery Dam was abundant, moderately rich, and well-populated with stress sensitive taxa.

6. The community structure and function found below the Lowell Tannery Dam indicates a generally healthy community with evidence of natural, biological enrichment.

7. It is my professional opinion that the macroinvertebrate community downstream of the Lowell Tannery Dam on the Passadumkeag River is naturally occurring, does not show excessive stress as a result of the project operation, and attains Class A aquatic life standards.

References

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Appendix 1

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

Station Information

Station Number:	**S-1173**	River Basin:	
Waterbody:	Passadumkeag River - Station 1173	HUC8 Name:	
Town:	Lowell	Latitude:	
Directions:	RIVER CENTER APPROX. 500 FT DOWNSTREAM OF DAM, JUST DOWNSTREAM OF RIVER RIGHT VEGETATED LEDGE	Longitude:	
		Stream Order:	

Sample Information

Log Number:	**2793**	Type of Sample:	ROCK BAG	Date Deployed:	8/6/2019
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	9/13/2019

Classification Attainment

Statutory Class:	**AA**	**Final Determination:**	**A**	Date:	2/18/2020
Model Result with P≥0.6:	B	**Reason for Determination:**	**Best Professional Judgement**		
Date Last Calculated:	2/14/2020	Comments:	Class B raised to Class A because of impoundment acting like a natural lake outlet. The sample has a lot of filter feeding organisms. Further upstream, Saponac Pond is a shallow, natrually mesotrophic lake.		

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.11	Class C	0.19	Class A, B, or C	1.00
Class B	0.69	NA	0.00	Non-Attainment	0.00
B or Better Model				**A Model**	
Class A or B			0.73	Class A	0.01
Class C or Non-Attainment			0.27	Class B or C or Non-Attainment	0.99

Model Variables

01 Total Mean Abundance	856.33	18 Relative Abundance Ephemeroptera	0.04
02 Generic Richness	17.00	19 EPT Generic Richness	10.00
03 Plecoptera Mean Abundance	9.33	21 Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	0.00
04 Ephemeroptera Mean Abundance	35.33	23 Relative Generic Richness- Plecoptera	0.12
05 Shannon-Wiener Generic Diversity	2.14	25 Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	41.00
06 Hilsenhoff Biotic Index	4.11	26 Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	28.00
07 Relative Abundance - Chironomidae	0.05	28 EP Generic Richness/14	0.36
08 Relative Generic Richness Diptera	0.24	30 Presence of Class A Indicator Taxa/7	0.00
09 *Hydropsyche* Abundance	377.67		
11 *Cheumatopsyche* Abundance	41.00		
12 EPT Generic Richness/ Diptera Generic Richness	2.50		
13 Relative Abundance - Oligochaeta	0.00		
15 Perlidae Mean Abundance (Family Functional Group)	9.33		
16 Tanypodinae Mean Abundance (Family Functional Group)	0.00		
17 Chironomini Abundance (Family Functional Group)	0.00		

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Hydropsyche*	44.10
2	*Simulium*	34.72
3	*Cheumatopsyche*	4.79
4	*Chimarra*	4.55
5	*Eukiefferiella*	4.28

Report Printed: 2/18/2020 Contact: biome@maine.gov or (207)287-7688 Page 1

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

Station Number: S-1173	Town: Lowell		Date Deployed: 8/6/2019
Log Number: 2793	Waterbody: Passadumkeag River - Station 1173		Date Retrieved: 9/13/2019

Sample Collection and Processing Information

Sampling Organization: PCL

Taxonomist: PAUL LEEPER (MOODY MOUNTAIN ENVIRONMENTAL)

Waterbody Information - Deployment		**Waterbody Information - Retrieval**	
Temperature:		Temperature:	17.4 deg C
Dissolved Oxygen:		Dissolved Oxygen:	8.4 mg/l
Dissolved Oxygen Saturation:		Dissolved Oxygen Saturation:	
Specific Conductance:		Specific Conductance:	
Velocity:		Velocity:	103 cm/s
pH:		pH:	
Wetted Width:	80 m	Wetted Width:	80 m
Bankfull Width:	80 m	Bankfull Width:	80 m
Depth:		Depth:	

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain	
Upland Conifer	Open	Rolling	
Upland Hardwood			

Potential Stressor	Location	Substrate	
Regulated Flows	Below Dam	Bedrock	10 %
		Boulder	40 %
		Rubble/Cobble	50 %

Landcover Summary - 2004 Data

Sample Comments

WATER UP, OUT OFTIMIE WINDOW

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

Station Number: S-1173 Waterbody: Passadumkeag River - Station 1173 Town: Lowell

Log Number: 2793 Subsample Factor: X1 Replicates: 3 Calculated: 2/14/2020

Taxon	Maine Taxonomic Code	Count (Mean of Samplers)		Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance %	
		Actual	Adjusted			Actual	Adjusted
Planariidae	03010101	1.33	1.33		--	0.2	0.2
Beloneuria	09020209044	2.67	2.67		--	0.3	0.3
Agnetina	09020209050	6.67	6.67	2	PR	0.8	0.8
Baetidae	09020401	3.33	3.33		--	0.4	0.4
Stenonema	09020402016	28.00	28.00	4	SC	3.3	3.3
Isonychia	09020404018	4.00	4.00	2	CF	0.5	0.5
Chimarra	09020601003	39.00	39.00	2	CF	4.6	4.6
Cheumatopsyche	09020604015	41.00	41.00	5	CF	4.8	4.8
Hydropsyche	09020604016	377.67	377.67	4	CF	44.1	44.1
Macrostemum	09020604018	0.33	0.33	3	CF	0.0	0.0
Mystacides	09020618075	1.33	1.33	4	CG	0.2	0.2
Nigronia	09020701003	0.33	0.33	0	PR	0.0	0.0
Sialis	09020702004	1.33	1.33	4	PR	0.2	0.2
Eukiefferiella	09021011041	36.67	36.67	8	CG	4.3	4.3
Rheotanytarsus	09021011072	8.67	8.67	6	CF	1.0	1.0
Simulium	09021012047	297.33	297.33	4	CF	34.7	34.7
Atherix	09021015055	6.67	6.67	2	PR	0.8	0.8

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

May 12, 2020

Mr. Lewis Loon
KEI (USA) Power Management Inc.
423 Brunswick Ave.
Gardiner, ME 04345

RE: Comments on the Initial Study Report and 2020 Draft Study Plan for the Lowell Tannery Hydroelectric Project (FERC No. 4202).

Dear Mr. Loon:

On March 26, 2020, you provided us with the Initial Study Report for the Lowell Tannery Hydroelectric Project (FERC No. 4202). The outcomes of these studies are intended to inform the licensing process. The quality of the study design, implementation, and analysis are critical to informing future license requirements for mitigating project related impacts. With that perspective, we provide the attached comments and recommendations for the improvement of the Desktop Entrainment, Impingement, and Turbine Passage Evaluation.

We are also in receipt of your 2020 draft study plan for the Lowell Tannery Project. The 2020 draft plan does not propose a downstream anadromous fish passage effectiveness and survival study at the project. We specifically requested this study in our March 9, 2019, letter commenting on the Pre-Application Document for the Project. Furthermore, you also do not present any rationale for not implementing our recommended study. Conducting studies to quantitatively identify direct project impacts on aquatic resources, and to inform appropriate mitigation is consistent with the requirements of the National Environmental Policy Act and the Federal Power Act regulations. Your final 2020 study plan for the Lowell Tannery Project must include a plan to conduct a downstream anadromous fish passage effectiveness and survival study.

In the 2020 draft study plan for the Lowell Tannery Project, you propose to conduct an upstream passage study for anadromous fish at the Lowell Tannery Project. We requested an upstream passage study for anadromous species in our March 9, 2019, letter to FERC. However, as currently proposed, the 2020 draft study plan is not sufficient to evaluate whether the existing upstream Denil fishway provides safe, effective, and timely passage for adult Atlantic salmon and river herring. In the draft 2020 study plan, you assume that other organizations, including the Maine Department of Marine Resources and the University of Maine, will PIT tag anadromous fish at the Milford Project on the mainstem of the Penobscot River to evaluate fish passage at the Lowell Tannery Project on the Passadumkeag River. You further assume that some of these tagged fish will migrate to the Lowell Tannery Project for upstream passage evaluation. In our March 9, 2019, comments on the Lowell Tannery Project Pre-Application Document, we specifically requested that KEI capture and tag at least 100 river herring in the Passadumkeag River to assess upstream passage effectiveness at the Lowell Tannery Project. It is not appropriate to rely on PIT tag fish in the lower Penobscot River to evaluate fish passage at the Lowell Tannery Project since it cannot be determined whether these fish are actually migrating to the Passadumkeag River. Therefore, it is not reasonable to rely on any tagging studies that may or may not be done at the Milford project to inform an evaluation of upstream passage at the Lowell Tannery Project. Your final 2020 study plan for the Lowell Tannery Project must include a plan to tag and release at least 100 river herring downstream of the Lowell Tannery Project. If we are not able to come to an agreement for these two studies in the next 30 days, we will seek study plan dispute resolution with the Commission pursuant to 18 CFR 16.8(b)(6).

As indicated in our March 9, 2019, comments on the pre-application document, endangered Gulf of Maine distinct population segment (GOM DPS) Atlantic salmon occur in the Lowell Tannery Project area and project operations may affect the species. As such, we anticipate that a consultation, pursuant to section 7 of the Endangered Species Act (ESA) will be necessary to ensure that any licensing action proposed by the Federal Energy Regulatory Commission is not likely to jeopardize the continued existence of this species. Our study requests for this project are intended to support the licensing process and facilitate our goals to protect and recover the GOM DPS of Atlantic salmon pursuant to our authorities under the Endangered Species Act and the Federal Power Act. The requested studies are necessary for a complete understanding of the effects of the project and are critical to informing the ESA section 7 consultation process. Data collected from these studies will also contribute to the development of an administrative record in support of potential Federal Power Act Section 18 fishway prescriptions or 10(j) recommendations.

Thank you for the opportunity to provide comments on the ISR and 2020 proposed study plan for the Lowell Tannery Project. If you have any questions, please contact Jeff Murphy (Jeff.Murphy@noaa.gov/207-866-7379).

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

cc: Service List

National Marine Fisheries Service's Comments on KEI (USA) Power Management's Initial Study Report for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

On March 26, 2020, KEI provided an Initial Study Report summarizing the progress of relicensing studies at the Lowell Tannery Project. We provide the following comments on the Desktop Entrainment, Impingement, and Turbine Passage Survival Evaluation.

Existing Downstream Bypass Design

The flow of 20 cubic feet per second (cfs) (2.2% of maximum hydraulic capacity), or inflow, whichever is less, through the existing downstream passage does not meet contemporary guidelines for downstream bypass systems. The U.S. Fish and Wildlife Service's (USFWS) current guidelines state that a downstream bypass entrance should produce gradually accelerating flow with an opening that is at least 3 feet wide and 2 feet deep resulting in flows of at least 25 cfs (USFWS 2019). In addition, USFWS's current guidelines state that the conveyance should be at least 48 cfs based on the 5% station hydraulic capacity guideline. Both of these fishway attributes are necessary to properly attract and pass downstream migrants though fishways. We support the U.S. Fish and Wildlife's guidelines for downstream fish passage at this facility.

Section 4.1.1 Risk of Entrainment and Impingement

The approach velocity of 2.5 feet per second (fps) exceeds the reported prolonged swim speeds of juvenile river herring and matches that of juvenile American shad and adult American eel, thus creating a risk of impingement and entrainment. The available data indicates that it is more likely for juvenile alewife to entrain through the turbines than pass safely through the downstream bypass once in the vicinity of the project intake. The remainder of the target species have sufficient swim speeds to avoid entrainment if there are no blockages on the trashracks that would increase approach velocities. If timely egress is not available, at some point juvenile alosines and adult eels will fatigue and either get entrained or become impinged on the racks. The reported approach velocities support the need to upgrade the downstream passage facilities to reduce the risk of entrainment of juvenile alosines and adult American eel.

Section 4.1.2 Turbine Blade Strike and Whole-station Survival Analysis

We appreciate the ability of the Python-based STRYKE model to produce statistics from the turbine blade strike model. However, the report does not provide a justification for the sample size and the number of iterations that produce the statistics; therefore, it is not possible to assess the validity of the results.

Recommendation: We recommend you provide the basis for choosing 20 iterations of each simulation as well as the chosen sample size of 200 fish.

We appreciate the effort to evaluate the project survival by incorporating the flow duration curve to estimate a low, normal, and high water year. However, the duration of time the project spills and operates has a differential overlap with the presence of different species and life stages. Therefore, we recommend the study analyze each target species and lifestage separately unless their migratory periods are similar (e.g., alewife and blueback herring).

Section 4.1.2.1 Strike Mortality Coefficient
Recommendation: The strike mortality coefficient (λ) of 0.15 should be justified by turbine specifics and project-specific data. Smaller changes in the coefficient value used may make a difference at the project survival level and will be significant at a cumulative impacts level (i.e., multiple projects in the watershed).

Section 4.1.2.2 Routing of Fish through Lowell Tannery Project
The bypass efficiency is a crucial parameter in this desktop modeling exercise. You do not provide justification for the selection of a value of 50 percent bypass efficiency in the interim study report. However, based on a downstream passage study we commissioned on the Penobscot River, the value is a good approximation of a facility with 1.5 inch rack spacing (Alden Research Laboratory 2012). In that same report, the minimum and maximum bypass efficiency of the seven projects evaluated with trashrack clear spacing of 1.5 inches (like the Lowell Tannery project) were 17 and 73 percent. Therefore, the actual bypass efficiency at the Lowell Tannery project may be 50 percent or it could be higher or lower. We cannot determine what the appropriate value is without a routing study. If a routing study is not completed, we would have to use the conservative, lower efficiency values as supported by past studies of projects with designs that are similar to the Lowell Tannery facility.

Absent site-specific route passage data, the model assumes that downstream migrants pass in proportion to flow at the project. Site-specific telemetry data is needed to verify this assumption. Alewife and blueback herring, can pass through the turbines, the downstream bypass, or via spillage if available. However, at low flow, the likelihood that herring will pass via the spillway depends on the volume of spill over the flashboards. For instance, herring would not likely pass over the spillway under a thin veil of spillage (i.e., water depths less than 6 inches). At lower river flows with less water depth over the flashboards and no turbine flow, most downstream migrants would likely use the existing downstream passage facility. Given the above uncertainties, a site-specific routing study needs to be conducted at the project.

Section 4.1.2.3 Fish Length
Recommendation: Please adjust the standard deviation to reflect the species and life stage. A single standard deviation of 0.5 inches for all fish species is not appropriate to represent to various species and lifestages of fish that occur in the Lowell Tannery Project area. As an example of an acceptable approach, at the Holyoke project on the Connecticut River in Massachusetts, Holyoke Gas and Electric provided mean body length and standard deviation in their FERC filed report (Table 1).

Table 1. Mean body length and standard deviation (in inches) for adult male and female American shad. Source: Accession # 20180131-5174, page 7.

	MALE	**FEMALE**
Mean	16.1	17.7
SD	0.8	0.6

Section 4.2.1.1 Trashrack Exclusion
Recommendation: This analysis should be modified to include consideration of adult river

herring. Adult river herring are not excluded from 1.5-inch clear spaced trashracks. In fact, adult river herring can pass 1-1/8 inch clear spaced trashracks similar to swim through gates installed at the Milford fishway on the Penobscot River.

Section 4.2.1.2 Approach Velocity
Recommendation: A flow duration curve needs to be calculated to adequately estimate the effects of approach velocity on entrainment and impingement for each species and life stage.

Recommendation: You should determine the threshold generation value for each species (e.g., maximum generation is the threshold for American eel and juvenile American shad at 2.15 fps). Blockage of the trashrack will create velocity hot spots that will affect the potential for entrainment and impingement. In the project survival analysis, you should consider the effect of debris on the approach velocity and account for occlusion.

Section 4.2.2.1 Adult Sea-Run Alewives and Juvenile Alosines
In Table 15 of the interim study report, the three designated flow regimes are calculated for only the month of June. The downstream passage season is from June 1 to July 31.

Recommendation: We recommend development of a flow duration curve that considers the entirety of the downstream passage season to inform the whole project survival analysis.

Recommendation: We recommend you determine the appropriate flow thresholds for key parameters for the strike model and calculate the whole project survival estimate by integrating the area underneath the flow duration curve to improve model predictions. For example:

- Some percent of the time the project will be generating with insufficient spill to be conducive for spillway passage; therefore, downstream migrants can either pass via the turbine or via the downstream bypass system;
- Some percent of the time the project will be generating with sufficient spill to be conducive for spillway passage; therefore, downstream migrants can either pass via the turbine, spillway, or downstream bypass system.
- Some percent of the time the project will not be generating; therefore, downstream migrants can pass via the downstream bypass system or spillage (provided sufficient water depths over the spillway).

The whole project survival estimate will then be calculated by summing the weighted survival estimates for each flow regime, where S_B is the bypass survival estimate, S_{B+T} is the bypass and turbine survival estimate, S_{B+T+S} is the bypass, turbine and spillway survival estimate, and S_L is a literature based estimate of indirect survival.

$$Project\ Survival = \{[0.13 * S_B] + [(0.81 + 0.01) * S_{B+T}] + [0.05 * S_{B+T+S}]\} * S_L$$

Section 4.2.2.1 Adult Sea-Run Alewives and Juvenile Alosines
In table 4.8 of the interim study report, the flow duration curve is only for September for juvenile alosine species when the migratory period is July 15 to November 30. The project survival analysis needs to be estimated using the flow duration curve for the full migratory period.

Recommendation: We recommend development of a more appropriate flow duration curve that reflects the entirety of the July 15 to November 30 migratory period, to conduct the whole project survival analysis.

Bypass efficiency will vary depending on generation. For example, juvenile blueback herring have a prolonged swim speed of 0.75 fps, which corresponds with a specific generation flow. At some river flows (turbine plus bypass flow) the bypass efficiency will be higher. Conversely, at higher river flows, the bypass efficiency will be lower.

Recommendation: The thresholds based on approach velocity and swimming capabilities of each species need to be incorporated into the analysis by modifying the bypass efficiency while the project is generating. These variations in bypass efficiency should be justified with published data on other projects or professional judgment, and clearly described in the final study report.

Section 4.2.2.2 Atlantic Salmon Smolts

Recommendation: We recommend completing the analysis as described using the full migratory period for Atlantic salmon smolts (May through June).

Section 4.2.2.3 Adult American Eel

The methods used to estimate project survival for anadromous species is not appropriate for adult American eel. Therefore, we do not consider the results for American eel presented in the interim study report to be appropriate or reliable.

Recommendation: We recommend you complete a telemetry study for silver eel. In lieu of a field study, multiple linear regression models have been used at other hydroelectric facilities to determine project survival of American eel (Amaral 2017) and that approach should be considered in the absence of a telemetry study.

2.13 Section 4.2.2.4 Adult American Shad and Atlantic Salmon

The assumption that project spill and the downstream bypass facility have 100 percent survival may not be valid for all species and lifestages (Alden 2012). The spillway passage at the Lowell Tannery project is likely to have a high survival rate, but highly unlikely to have 100 percent survival for all downstream migrants. An often used estimate for spillway survival is 97 percent with a range from 76 to 100 percent derived from the massive data set from the Columbia River Power System (Alden Research Laboratory 2012). Site-specific data is needed to support this assumption.

Recommendation: We recommend you provide the technical specifications for the downstream bypass system (e.g., drawings and hydraulic calculations) and conduct a downstream passage routing and survival study for alosines and Atlantic salmon at the Lowell Tannery Project.

References

Alden Research Laboratory. 2012. Atlantic Salmon Survival Estimates at Mainstem Hydroelectric Projects on the Penobscot River. Phase 3 Final Report. Prepared for The National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Holden, MA.

Amaral, S. 2017. Theoretical Assessment of Downstream Passage Survival of American Eel at s Small Hydro Project.

U.S. Fish & Wildlife Service. 2019. Fish Passage Engineering Design Criteria. *Edited by* D.o.t. Interior. Northeast Region R5, Hadley, Massachusetts. p. 248.

DRAFT 2020 STUDY PLAN

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

Prepared for:

KEI (Maine) Power Management (III) LLC

Prepared by:

Kleinschmidt Associates

March 2020

Kleinschmidt

TABLE OF CONTENTS

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1.0 INTRODUCTION

The Lowell Tannery Hydroelectric Project (Lowell Tannery Project)[1] is on the Passadumkeag River, in Lowell, Maine, approximately 13 river miles upstream of the confluence with the Penobscot River. KEI (Maine) Power Management (III) LLC [KEI (Maine)] operates one hydroelectric turbine-generator unit at the Lowell Tannery Project, which can produce up to approximately 1,000 kilowatts[2] of renewable, hydroelectric energy. KEI (Maine) operates the Lowell Tannery Project in run-of-river mode so that outflow at the powerhouse matches natural river inflow. After water passes through the turbine unit, it discharges back into the Passadumkeag River from a small powerhouse that is integral to the dam. The Penobscot River watershed supports diadromous fish species such as Atlantic salmon, American eel, American shad, and river herring.

The existing license for the Lowell Tannery Project issued by the Federal Energy Regulatory Commission (FERC) license (FERC No. 4202) expires on September 30, 2023. KEI (Maine) must file an Application for Subsequent License (License Application) with FERC on or before September 30, 2021. KEI (Maine) filed a Notice of Intent and Pre-Application Document (PAD) on September 26, 2018, to initiate the relicensing of the Lowell Tannery Project using the Traditional Licensing Process. The PAD provided a description of the Lowell Tannery Project, including its structures, operations, and potential resource issues. By letter order dated November 23, 2018, FERC granted KEI (Maine) approval to use the Traditional Licensing Process (TLP).

KEI (Maine) distributed the PAD to federal and state resource agencies, local governments, Native American tribes, and others thought to be interested in the relicensing proceeding. The PAD and subsequent scoping identified potential environmental issues associated with the operation of the Lowell Tannery Project for which the existing, relevant, and reasonably available information was insufficient. Comments on the PAD and study requests were received from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Maine Department of Environmental Protection (MDEP), Trout Unlimited (TU), and the Penobscot Indian Nation (PIN).

[1] Also known as the Pumpkin Hill Project.
[2] Approximate maximum instantaneous generation capacity.

In 2019, KEI (Maine) contracted Kleinschmidt Associates (Kleinschmidt) to complete a water quality study in the impoundment, a dissolved oxygen study in the tailwater, benthic macroinvertebrate sampling in the tailwater, and a desktop turbine passage survival and whole station survival analysis. The 2019 study report was provided to the resource agencies on March XX, 2020. KEI (Maine) is planning to complete three additional studies in 2020:

- a radio telemetry and PIT-tag[3] study with the University of Maine, Orono (UMO) to evaluate upstream passage of adult Atlantic salmon and adult sea-run alewives;
- an upstream American eel passage study; and
- and a feasibility study to evaluate potential ways to provide downstream passage for adult American eels.

Studies requested by agencies thus far in the process are not of insignificant costs, thus KEI (Maine) is carefully considering the appropriateness of the scope and timing of the fish passage studies recommended by the stakeholders. As described in the 2019 Initial Study Report, the desktop entrainment study demonstrated that turbine passage survival for all species and lifestages was generally high and that the existing trash rack bars exclude larger-bodied fish from entrainment. The study showed that project operations may affect adult American eel migrating downstream the most. Therefore, KEI (Maine) is proposing to conduct a feasibility study of downstream eel passage alternatives in 2020. KEI (Maine) is not providing a formal study plan for the feasibility assessment but a summary of alternatives evaluated will be provided in a follow-on report for 2020 study efforts.

[3] Passive Integrated Transponder tags.

2.0 UPSTREAM PASSAGE STUDY FOR ANADROMOUS FISH

2.1 Study Objectives

To evaluate whether the existing upstream Denil fishway provides safe, effective, and timely passage for adult Atlantic salmon and river herring.

2.2 Known Resource Management Goals

NMFS, MDMR, and the USFWS have management objective that include the restoration and protection of anadromous fish stocks in the Penobscot River basin.

2.3 Background and Existing Information

KEI (Maine) operates a Denil fishway at the Lowell Tannery Project to pass migratory fish species upstream. Atlantic salmon and sea-run alewives are known to arrive at the Lowell Tannery Project each year during their upstream migration. KEI (Maine) plans to collaborate with the University of Maine to study Atlantic salmon, American shad, and river herring at the Lowell Tannery Project in 2020. Researchers from UMO, with the support of KEI (Maine), studied the upstream passage of Atlantic salmon and sea-run alewives using PIT-tags equipment at the Lowell Tannery project in 2018 and 2019. In 2019, one tagged Atlantic salmon and 185 tagged river herring attempted to migrate upstream at the Lowell Tannery Project. UMO researchers documented passage of 15 river herring (8.1 percent) through the Lowell Tannery fishway; the individual tagged salmon that arrived at the site did not pass through the fishway but was detected at the entrance. In 2018, UMO documented passage rates of 20 percent (river herring) and 25 percent (Atlantic salmon) through the Lowell Tannery fishway.

KEI (Maine) plans to modify the Denil fishway in 2020 based on recommendations by the USFWS' fish passage engineer following a monthly fish passage planning meeting in January 2020. The following modifications are planned prior to the planned study:

- Dewater and clean the fishway;
- Replace any damaged baffles according to the original design drawings;
- Install all baffles according to the original design;
- Ensure all baffles are constructed according to the original design drawings; and
- Once all baffle modifications have been made, and while it is still dewatered, allow resource agencies to inspect, should they opt to.

2.4 Project Nexus

Operation of the Lowell Tannery Project may affect the upstream passage of anadromous fish.

2.5 Methods

UMO researchers plan to install full-duplex PIT-tag antennas in the fishway at the entrance and exit to monitor the behavior and upstream passage of tagged diadromous fish at the Lowell Tannery Project. UMO researchers also plan to install a radio-telemetry receiver near the entrance to the fishway or in the tailwater area to monitor tagged fish that approach the facility. UMO plans to work with the Maine Department of Marine Resources (MDMR) to tag fish at the Milford fish lift, which is the Penobscot River, approximately 19 river miles downstream of the Lowell Tannery Project. In 2019, MDMR and UMO tagged over 4,000 sea-run alewives and almost 1,200 adult Atlantic salmon with PIT-tags, plus 50 Atlantic salmon were radio-tagged. KEI (Maine) anticipates that a similar number of fish will be tagged and released at Milford in 2020.

Lotek and Biomark (or similar) tags and receivers will be used during the study. Data will be offloaded from PIT-tag and telemetry receivers weekly and archived. Fishway effectiveness will be calculated by comparing the number of fish detected at the fishway entrance to the number of fish detected at the fishway exit. Telemetry data will be used to determine how many Atlantic salmon arrive in the tailwater area. Information about transit time through the fishway, delay, and the effectiveness of the fishway in attracting fish will be evaluated. Data associated with normal project operations will be reviewed to determine if changes to operations influence upstream passage rates and effectiveness.

2.6 Consistency with Generally Accepted Scientific Practice

Researchers regularly use PIT-tagging and telemetry studies to evaluate upstream passage at hydroelectric projects.

2.7 Deliverables and Schedule

The 2020 upstream passage study would take place from approximately May 1 – November 1, 2020. This would encompass the upstream migration period of Atlantic salmon and sea-run alewives. A summary of research findings will be provided in an Updated Study Report by approximately March 1, 2021.

3.0 AMERICAN EEL UPSTREAM PASSAGE FACILITY DESIGN AND SITING STUDY

3.1 Study Objectives

The objective of this study is to determine if juvenile American eels pass upstream or congregate at the Lowell Tannery Project dam or tailwater. If juvenile American eels are observed at the dam, tailwater, or near gates, KEI (Maine) will consult with NMFS, USFWS, and MDMR to determine the need for, timing, and design of a seasonal upstream eelway to facilitate upstream American eel passage during post-license compliance activities.

3.2 Known Resource Management Goals

NMFS, MDMR, and the USFWS have management objective that include the restoration and protection of diadromous fish stocks.

3.3 Background and Existing Information

There is limited information that describes the behavior of American eels at the Lowell Tannery Project. The study will provide background information to be used to assist in decision-making and environmental analyses during the relicensing period.

3.4 Project Nexus

Operation of the Lowell Tannery Project may affect the migration of juvenile American eels in the Passadumkeag River.

3.5 Methods

The licensee proposes to monitor the distribution and abundance of juvenile eels at the Lowell Tannery Project during the peak upstream migration period in 2020. Most juvenile eels in Maine move upstream in June, July, and August, typically at night under cloud cover or in the rain. The licensee plans to conduct up to 12 nighttime surveys once a week from June 1 to August 28. Surveys will be completed during non-spill conditions to increase the likelihood of locating juvenile eels along or near the dam face. If a wet summer or operational conditions results in sustained spill over the dam, the licensee may only be able to perform some of the proposed monitoring.

Researchers plan to survey from safe, accessible areas at or below the dam to identify where eels may congregate or move upstream. The survey area will include the tailrace area immediately downstream of the powerhouse, along gates at the dam, and accessible and visible portions of the spillway and bedrock outcrops between the dam and the powerhouse. Surveys will be timed to coincide with precipitation and different lunar phases, as possible. Each survey will begin at or near sunset and will last up to 1.5 hours, depending on the number of eels observed. During each survey, the field crew will (1) identify each area where eels congregate or ascend past the Lowell Tannery Project; (2) record the date, start time, end time, and survey conditions; (3) count the approximate number of eels at each location; (4) observe and note behavior and migratory patterns; (5) and estimate the size range of observed eels. The surveys will be completed with spotlights and binoculars.

3.6 Consistency with Generally Accepted Scientific Practice

This study will employ widely accepted methods for evaluating upstream eel passage at hydroelectric projects in Maine. The proposed monitoring plan is like previous efforts undertaken at other hydroelectric projects in Maine in recent years (e.g., American Tissue Project, Lower Barker Project, Williams Project). These efforts have resulted in the successful identification of areas where eels congregate or pass upstream at hydroelectric dams, allowing the licensee to design and install upstream passage systems to facilitate the movements of juvenile eels.

3.7 Deliverables and Schedule

The field work will be conducted between June 1 and August 28 (2020). Data analysis and technical reporting will begin after the completion of the monitoring. A summary of research findings will be provided in an Updated Study Report by approximately March 1, 2021.

KEI (USA) Power Management Inc.
423 Brunswick Avenue
Gardiner, ME 04345
Tel.: (207) 203-3026

October 29, 2020

Terry Turpin, Director
Office of Energy Projects
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Response of KEI (Maine) Power Management (II) LLC to National Marine Fisheries Request for Dispute Resolution for the Conduct of Studies;
Lowell Tannery (Pumpkin Hill) Hydroelectric Project (P-4202-024)

Dear Mr. Turpin,

By letter dated October 14, 2020 and filed with the Federal Energy Regulatory Commission (FERC) on October 15, 2020, National Marine Fisheries Service (NMFS) filed a request[1] for dispute resolution for the conduct of studies for the Lowell Tannery Hydroelectric Project (Project) relicensing pursuant to 18 CFR §16.8(b)(6) and §16.8(c)(2). The Project license is held by KEI (Maine) Power Management (II) LLC (KEI (Maine)). The NMFS filing also included KEI (Maine)'s March 2020 Initial Study Report on relicensing studies conducted thus far and the Draft 2020 Study Plan. NMFS requests resolution of two study requests: (1) anadromous fish passage upstream passage efficiency study; and (2) downstream fish passage effectiveness and survival: behavior, entrainment and impingement at the intake.

BACKGROUND INFORMATION AND CURRENT PROJECT STATUS

The Lowell Tannery Hydroelectric Project (P-4202) is in the Penobscot River Basin and is the first dam on the Passadumkeag River, approximately thirteen miles from the confluence with the Penobscot River. To reach the Lowell Tannery Project, anadromous fish pass the Milford Project and enter the Passadumkeag River, rather than continue up the Penobscot River. The University of Maine has been conducting studies of anadromous fish species on the Penobscot River and tributaries for several years. KEI (Maine) has worked cooperatively with the University to accommodate installation and maintenance of tracking/monitoring equipment at the Project's upstream fish ladder for tagged river herring and Atlantic salmon to provide data for relicensing. The University of Maine conducted PIT-tagging and monitoring during the 2018-2020 upstream passage seasons. In 2019/2020 KEI (Maine) conducted water quality and benthic macroinvertebrate field studies, and a desktop entrainment study. Study results were reported to agencies in March 2020. In 2020, KEI (Maine) conducted additional water quality monitoring and an upstream eel passage facility design and siting study and intends to provide a report on results near the end of 2020 or as part of the draft license application that will be distributed 2021.

DISPUTE RE: UPSTREAM PASSAGE EFFICIENCY STUDY

KEI (Maine) understands and acknowledges NMFS's statutory and regulatory responsibilities for fishery resources under the Federal Power Act, Endangered Species Act, and other programs identified in its October 14 dispute resolution request. NMFS states that "requested studies are necessary to inform any

[1] https://elibrary.ferc.gov/eLibrary/docinfo?document_id=14900418

actions we take under section 18 of the FPA and will help ensure that the required ESA section 7 consultation is based on the best available scientific information."[2] By letter dated March 9, 2019 and filed with FERC on March 11, 2019[3], NMFS requested the KEI (Maine) conduct "a study to understand upstream fish passage efficiency for anadromous fish (i.e., alewife, blueback herring, and Atlantic salmon)…as well as the movement and behavior of these species immediately downstream of the Project."[4] The recommended study methods include use of radio telemetry to capture, tag, and release a minimum of 100 fish directly downstream of the Project. NMFS stated that given the low abundance of Atlantic salmon in the Passadumkeag River, KEI (Maine) should continue to collaborate with the University of Maine on PIT tag studies for adult salmon at the Project. In its dispute request, NMFS neglects to acknowledge that KEI (Maine) proposed to collaborate with the University of Maine in 2020 on the larger scale Penobscot River Basin study of upstream fish passage for Atlantic salmon and alewives, which is a continuation of the same study conducted by the University in 2018 and 2019. In 2019, this study included tagging of over 4,000 sea-run alewives, nearly 1,200 adult Atlantic salmon, and monitoring of the Lowell Tannery fishway with a PIT-tag array[5]. Of those fish, approximately 185 tagged river herring were documented at the Lowell Tannery project.

NMFS dispute request also neglects to acknowledge that, based on recommendations from the U.S. Fish and Wildlife Service, KEI (Maine) actively made modifications to the fish ladder to restore the facilities to original design conditions prior to conduct of the University of Maine study in 2020. In NMFS May 12, 2020 comments on the 2020 Draft Study Plan (also attached to NMFS October 15th filing) the agency criticizes KEI (Maine) of assuming the University of Maine would again tag fish on the mainstem Penobscot River in 2020. However, KEI (Maine) consulted with the University of Maine in preparing the 2020 study plan and methods and was in regular communication with the University of Maine leading up to the 2020 upstream migration season, to confirm the study would indeed be conducted despite COVID-19 concerns at the time. NMFS May 12th comments state that "is not appropriate to rely on PIT tag fish in the lower Penobscot River to evaluate fish passage at the Lowell Tannery Project since it cannot be determined whether these fish are actually migrating to the Passadumkeag River." Yet NMFS neglects to acknowledge that in 2019 the University of Maine documented 185 of the river herring tagged on the Penobscot River at the Lowell Tannery Project, which is nearly twice as many as the sample size recommended by NMFS and which volitionally migrated from Milford to the project.

While preliminary results have not yet formally been reported from the University of Maine's 2020 tagging and monitoring efforts, KEI (Maine) understands that approximately 1,300 alewives were tagged and released at Milford and 57.6% of fish detected at Lowell Tannery migrated up the ladder (J. Zydlewski, personal communication, October 27, 2020). Atlantic salmon tracking is still being conducted. Considering that 2018 and 2019 data indicated that about 20% and 8%, respectively, of river herring detected at the ladder passed upstream, modification to the ladder in 2020 appear to have greatly improved passage efficiency. KEI (Maine) believes it would be much more productive to assess with agencies, whether additional modification to the ladder or its operations are necessary than to invest time and money to conduct the disputed study which is unlikely to further inform decision making.

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[2] *Id.* at 4.

[3] https://elibrary.ferc.gov/eLibrary/docinfo?document_id=14750833

[4] *Id.* at 6.

[5] Draft 2020 Study Plan. Lowell Tannery Hydroelectric Project, appended to NMFS October 15, 2020 filing with FERC.

DISPUTE RE: DOWNSTREAM FISH PASSAGE EFFECTIVENESS AND SURVIVAL

Downstream fish passage at the Lowell Tannery Hydroelectric Project has operated to pass anadromous fish for approximately 30 years. At the request of NMFS and USFWS at the beginning of smolt migration, typically opens the exit for the upstream fish passage to provide an additional downstream route of passage.

NMFS requests telemetry studies for adult and juvenile river herring and Atlantic salmon to assess routes of passage, effectiveness of existing passage facilities, and survival via various passage routes. In the dispute request filing of October 15 (2020), NMFS contends that "the desktop analysis is inadequate for quantifying impacts of downstream passage at the project on anadromous fish including endangered Atlantic salmon, river herring, and American eel." In its original study requests from March 2019, NMFS makes no acknowledgement of level of costs for the requested studies. At KEI (Maine)'s Upper Barker Project[6], NMFS has stated[7] similar requested studies would need to be conducted for two years (telemetry) and cost $200,000 ($100,000 per year). NMFS estimated a survival study to cost $100,000 at a project, like that of Lowell Tannery, has FERC approved downstream fish passage facilities that have been in successful operation for 30 years. KEI (Maine) views these costly studies as unnecessary to assess project effects because consistent with conclusions in FERC (1995)[8], impacts are expected to be "low relative to the costs of entrainment studies or protective measures". FERC reached the same conclusion at Upper Barker.[9]

Desktop entrainment and mortality models are a generally accepted substitute for the much more labor intensive and expensive downstream telemetry and project survival studies requested by NMFS. While NMFS has provided extensive comments regarding the desktop entrainment results that may or may not be reasonable and appropriate to incorporate, the model results demonstrate both high turbine survival (>90 % for all species analyzed (except for adult American eel under certain flow conditions) and total Project survival (95% or better for alosines and Atlantic salmon). The results of the desktop entrainment and survival study confirm the project's actual operating results, and support KEI (Maine)'s position that project impacts are "low relative to the costs of entrainment studies or protective measures".

As noted above, NMFS has identified several issues and recommendations to modify the desktop analysis. KEI (Maine) plans to address the comments and make appropriate model refinements and provide the agencies with updated results. However, such changes are not expected to significantly alter the model results and cannot negate the long term, successful operating history of the existing facilities.

If there are any questions or comments related to this filing, please contact me at (207) 203-3027 or by email at Lewis.Loon@kruger.com.

Sincerely,

Lewis C. Loon, General Manager
Operations and Maintenance – US

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[6] FERC docket number P-3562-025.

[7] https://elibrary.ferc.gov/eLibrary/docinfo?document_id=14859361

[8] Federal Energy Regulatory Commission (FERC). 1995. Preliminary assessment of fish entrainment at hydropower projects – volume 1 (Paper No. DPR-10). Office of Hydropower Licensing, FERC, Washington, DC.

[9] https://elibrary.ferc.gov/eLibrary/filelist?document_id=14868427

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

KEI (Maine) Power Management (II) LLC — Project No. 4202-024

NOTICE OF CONFERENCE CALL

(December 8, 2020)

a. Date and Time of Meeting: December 18, 2020 at 1:00 p.m. Eastern Standard Time

b. FERC Contact: Steve Kartalia at stephen.kartalia@ferc.gov or (202) 502-6131

c. Purpose of Meeting: On October 15, 2020, the National Marine Fisheries Service (NMFS) requested that, pursuant to section 16.8(b)(6) of the Commission's regulations, the Director of the Office of Energy Projects resolve a dispute with KEI (Maine) Power Management (II) LLC (KEI Power), regarding two studies NMFS requested during the first stage of consultation for the proposed relicensing of the Lowell Tannery Hydroelectric Project No. 4202 (project). NMFS's dispute involves two studies: an upstream fish passage effectiveness study, and a downstream fish passage effectiveness and survival study. Commission staff need additional information to provide a recommendation on the dispute involving upstream fish passage.

Commission staff is meeting with KEI Power, NMFS, the U.S. Fish and Wildlife Service, and other interested participants, via conference call, to discuss the project's upstream fish passage facility, project operation, and existing information about the project's effects on upstream fish passage.

d. Proposed Agenda: (1) Introduction of participants; (2) FERC staff explain purpose of meeting and gather information about upstream passage at the project; (3) Participants discuss upstream passage at the project; and (4) Meeting conclusion.

e. A summary of the meeting will be prepared and filed in the Commission's public file for the project.

f. All local, state, and federal agencies, Indian tribes, and other interested parties are invited to participate by phone. If interested, please contact Steve Kartalia at stephen.kartalia@ferc.gov or (202) 502-6131, by December 16, 2020, to receive the conference call number and access code.

Kimberly D. Bose,
Secretary.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Maine - New Hampshire Fish and Wildlife Service Complex
306 Hatchery Road
East Orland, Maine 04431
207/469-7300 Fax: 207/902-1588

December 21, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Response to Request for Additional Information; Lowell Tannery Hydroelectric Project P-4202-024.

Dear Secretary Bose:

On December 18, 2020, the Federal Energy Regulatory Commission (Commission) hosted a teleconference[1] to discuss the National Marine Fisheries Service's (NMFS) October 15, 2020 Request for Dispute Resolution for the Conduct of Studies (dispute) at the Lowell Tannery Hydroelectric Project P-4202-024 (Project).[2] During the teleconference, Commission staff requested the U.S. Fish and Wildlife Service (Service) provide the results of any fishway inspections conducted by Service staff at the Project. Per that request, we are providing a Summary of Notes prepared in response to a series of hydroelectric project fishway inspections conducted in May 2016, and a March 2018 Inspection Report (Report) for the July 18, 2017 survey of the Lowell Tannery Project's existing upstream fishway.[3] The attached Report includes two recommendations for potential enhancements to improve river herring passage at the Project.[4] While we believe the enhancements for recommendation 1 have been implemented, we are not aware of the implementation of any additional upstream fish passage enhancements at the Project.

[1] Noticed on December 8, 2020, Accession Number 20201208-3063.
[2] Accession Number: 20201015-5017.
[3] We note that the Report makes reference to 2016 video footage taken by Service personnel; however, that footage is not available for upload due to constraints of the Commission's electronic filing system.
[4] It is important to note these recommendations do not consider potential effects to or enhancements for, the passage of the federally listed Atlantic salmon (*Salmo salar*).

We appreciated the Commission's review of this dispute and look forward to its resolution. If you have any questions regarding this letter, or need additional information to inform the study dispute resolution process, please contact Julianne Rosset at Julianne_Rosset@FWS.gov.

Sincerely,

PETER LAMOTHE

Digitally signed by PETER LAMOTHE
Date: 2020.12.21 12:04:01 -05'00'

Peter Lamothe
Complex Manager
Maine Field Office
Maine-NH Fish and Wildlife Service Complex

Attached: Summary of Notes ME DPS site inspections conducted May 2016
March 2018 MEMORANDUM, Lowell Tannery (P-04202) Baffle Assessment.

Summary of notes

ME DPS site inspections conducted May 23rd to May 26th, 2016

Bryan Sojkowski, P.E., Regional Fish Passage Engineer

Brunswick

- Hydraulics within the pools are not ideal (upwelling occurring along the wall) due to the 12" drop per pool and 10% slope.
- There is potential to create more conducive hydraulics by reducing the amount of flow through the fishway. Currently the fishway flow is approximately 30 cfs but fluctuates based on the headpond elevation. The flow through the fishway is controlled via the headgate which closes from above. Unfortunately, as the gate closes in this manner, orifice conditions (water flows under the gate) are created which prevents Brookfield from minimizing the flow more than a few cfs. It is the intent of USFWS engineering to perform a flow test via addition of a weir to control the flow before the start of the 2017 migratory season.
- The hydraulics through the section of the fishway that was manipulated in 1991-1992 (removal of stub walls) is not conducive for fish passage (velocities are too high). It is recommended that the stub walls are put back in as this site has not seen a significant improvement in fish passage numbers post the alterations.
- Dead river herring were found along the angled rack that leads the fish to the exit channel. This should be covered with chicken wire during the entirety of the fish passage season.

Pejepscot

- Fish passage operations in order
- Counting is not performed at this site but if work will be conducted at the Lower Barker site, should we be obtaining this data?

Worumbo

- The entrance jet on the tailrace side was weak, only protruding from the entrance approximately 10 ft before being turned back towards the powerhouse. This was due to the river left unit being the only unit on which caused a reverse eddy (circulating towards the powerhouse) that created velocities along the tailrace side wall to point in the wrong direction (towards the powerhouse versus downstream). An operational protocol should be developed with NOAA and USFWS engineering to ensure this type of hydraulic does not occur during the migratory season.

Lockwood

- Same old story…
- Witnessed river herring within a shallow pool in the bypass

Shawmut

- Should consider a tailrace bypass fishway like the one at Burnham to ensure fish that move into the tailrace have an exit route. The flow from the downstream bypass creates non-conducive hydraulics (excessive turbulence and aeration) where the bypass would exit and therefore should be shut off. Implementing the angled bar rack at the headgates so that fish are excluded from the location of the intake racks would allow the bypass to be shut off. This flow could be moved to the spillway in order to increase the far-field attraction to the new fishway.

Weston

- No comment

Hydro-Kennebec

- Construction just starting, trucks on site.

Benton Falls

- So many herring!
- Dave and Nate described alterations they conducted on the v-trap just upstream of the PVC counting tubes. They were getting downstream migrants coming through the v-trap in excessive numbers that would cloud the viewing window. They changed the shape from a v to what they called, “a modified t-position” which has proven to make a significant benefit and almost completely prevented fish from coming through the v-trap area. It is the intent of USFWS engineering to research this method to determine if it should be implemented elsewhere.

Burnham

- Tailrace bypass working very well, stacking up of fish within the tailrace did not occur this year (past operations forced them to shut the units off to let the fish fall back).

Orono

- Overwhelmed by river herring, well over the capacity of the trap and truck operation.
- I made the suggestion that the entrance be set with a 2 ft drop to prevent herring from utilizing the fishway and allow for ATS.

Stillwater A&B

- Eelways to be checked at a later date

Milford

- Discussed floor diffuser and bubble issues (to be addressed during the 2 week shutdown in August)

- Data collection has been implemented, Andy has sent comments and edits to the program that will be implemented for the 2017 season.
- Sorting facility is non-efficient. During the visit there were 2 ATS in the exit channel. A fishway operator had to sit and wait at the crowder for the ATS to pass which sometimes is a matter of days not hours. River herring and shad were witnessed at the viewing window by the crowder and the fish seemed stressed as they would move upstream and then fall back multiple times. This is a behavior that is non-typical of other facilities with viewing windows and crowders.

West Enfield

- Hydraulics through the fishway looks good.
- Entrance conditions at the bankside (river left) looked conducive and fish were witnessed utilizing the entrance whereas the middle entrance was overwhelmed (attraction jet not clear) by the downstream bypass flow that was being passed through the tainter gate.

Howland

- Witnessed fish within the bypass
- The Denil was not completely shut down and approximately 20-30 sea lampreys were stranded

Weldon

- Witnessed river herring at the entrance of the fishway
- Downstream bypass pipe still leaking (this was witnessed last year) and vibrating in a manner that may cause injury to fish. The vibrations may be due to the fact the pipe makes multiple bends within a short length near the exit which can induce too much of a headloss within the pipe rather than dissipating the energy within a plunge pool, which is preferable for safe downstream fish passage.
- The current fishway is not conducive for river herring and American shad passage as the drops per pool are approximately 1 ft and flow plunges into each pool (streaming is preferred for Alosines). During the visit the drops per pool were not consistent. It was brought to my attention that there is an orifice under each weir. This may be the cause for the inconsistent drops as they tend to get clogged with debris. The fishway should be inspected for debris and inverts of each weir should be surveyed to ensure that a consistent drop is maintained.

Browns Mill

- Downstream bypass did not seem to have enough water (only a couple of inches of depth over the weir). This may have been due to the flashboards being down but should they be down during the season?
- The exit of the downstream bypass is located just downstream of the dam and then flows over multiple weirs cut into the ledge. Fish (brook trout) were witnessed in the pool just downstream of the bypass pipe. River herring were not witnesses at the site but there is risk of fish becoming stranded just below the dam. This should be prevented possibly by a concrete pour.

- The Pike Dike was installed and at the time was producing a drop in excess of 2 ft (not measured). This will completely prevent river herring and shad from moving upstream and would also be difficult for ATS as a Denil resting pool does not provide enough volume for an ATS to gather the momentum needed to make the leap.
- There seems to be too much water down the Denil. At the low operating flow a Denil should have only 2ft of depth at the exit. This depth was exceeded (not measured on site but clearly greater than 2 ft) and the flashboards were down. The operators explained that the flow is controlled during the season by utilizing the headgate which is downward opening. This is not how the flow down a Denil should be controlled as it produces orifice flow and velocities that are outside of USFWS criteria within the exit channel. Flow reducing baffles should be investigated at this site.

Moosehead

- John Trube currently working on a downstream bypass design
- Not enough depth over the existing downstream bypass, it looked like a board could be pulled
- Last baffle had too much of a drop and aeration. The cause seemed to be the telemetry equipment was directly in the flow path near the v-notch of the baffle. This should be looked at and moved.
- This Denil is same design as Browns Mill and therefore had a headgate which controlled the flow through the fishway. This fishway should be investigated for implementation of flow reducing baffles or an alternate way to control the flow.

Guilford

- Excessive drop over the baffle near the exit of the fishway causing the upper leg to not be conducive for fish passage. Baffles should be pulled and checked dimensionally.
- Same downward gate at the exit…

Lowell Tannery

- Lots of river herring stacked up below the fishway entrance. It was obvious that fish were struggling to ascend the ladder (video was taken).
- Another Denil that seems to have too much water and the slope seemed steep, possibly 1:6 (was not checked as design plans were not located on site) which is too much for river herring (USFWS engineering recommends a minimum of 1:8 for river herring and shad)
- The fishway was dewatered and there was an excessive amount of debris throughout the entirety of the fishway which can have a significantly negative impact on the effectiveness of the fishway. The fishway should be free of debris during the entirety of the migratory season which may require daily maintenance to be performed.
- Looked like lowermost baffle was not in place. This design plans need to be investigated for this site and potential alterations discussed.

Ellsworth

- Lots of herring in the tailrace. Lots of fish being lifted even though the drop at the entrance seemed very high (roughly 2 ft, not measured)
- Downstream pipe shoots back at the dam which may cause injury of fish as they may bounce off the dam and over the training walls. The angle should be changed to be in line with the training walls. The height of the training walls may need to be increased to ensure that the water does not spill over the sides.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

300 Westgate Center Drive
Hadley, MA 01035-9589

March - 2018

MEMORANDUM

To: Maine Fish and Wildlife Service Complex, East Orland, ME
Attention: Anna Harris, ES Project Leader
Stephen Shepard, Fish & Wildlife Biologist

From: Bryan Sojkowski, P.E., Hydraulic Engineer, Fish Passage (USFWS)

Subject: Lowell Tannery (P-04202) Baffle Assessment

The purpose of this memorandum is to provide the results and associated recommendations following a survey of the existing fishway at the Lowell Tannery (P-04202) site located on the Passadumkeag River in Maine. A total station survey was conducted on 7/18/2017 by United Sates Fish and Wildlife (USFWS), National Oceanic and Atmospheric Administration (NOAA), and the Maine Department of Marine Resources (MEDMR) personnel. The intent of the survey was to collect elevations throughout the entirety of the fishway in order to ensure that the critical elements of the fishway (e.g., baffle notches, flashboards) were in the appropriate positions per the original design plans (dated October 11, 1985). This effort stemmed from observations of river herring struggling to traverse the fishway in 2016 (video footage taken by USFWS personnel) as well as information provided by the University of Maine (Joseph Zydlewski) which demonstrated that in 2015 and 2016 river herring efficiencies (fish that successfully negotiated the Lowell Tannery fishway) ranged from 3-15% (based on a total number of roughly 90 test fish).

Background

The existing fishway at the Lowell Tannery site is a 3 ft wide Denil with a slope of 1V:8H (7.1%). Denil fishways utilize baffles as roughness elements with the purpose of dissipating the kinetic energy of the flow and providing a zone through the baffles that are within the swimming capabilities of the target species. The location and elevation of the notch of the baffle (see Figure 1) is critical to the proper operation of the fishway. The elevation of the notch of the uppermost baffle (located within the exit channel) is especially important in that it controls the amount of flow through the fishway.

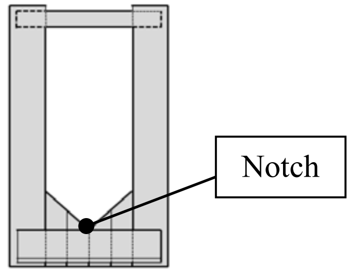

Figure 1 – Notch Location on a Typical Baffle

The design plans provided by the licensee (assumed to be final) showed that the fishway was intended to have a total of 82 baffles (based on the stated spacing), with the uppermost baffle notch elevation being 184.78 ft (relative to the datum used within the design plans). A layout of the baffle positions (section views) was created within AutoCAD based on the information provided within the design plans as shown in Figure 2.

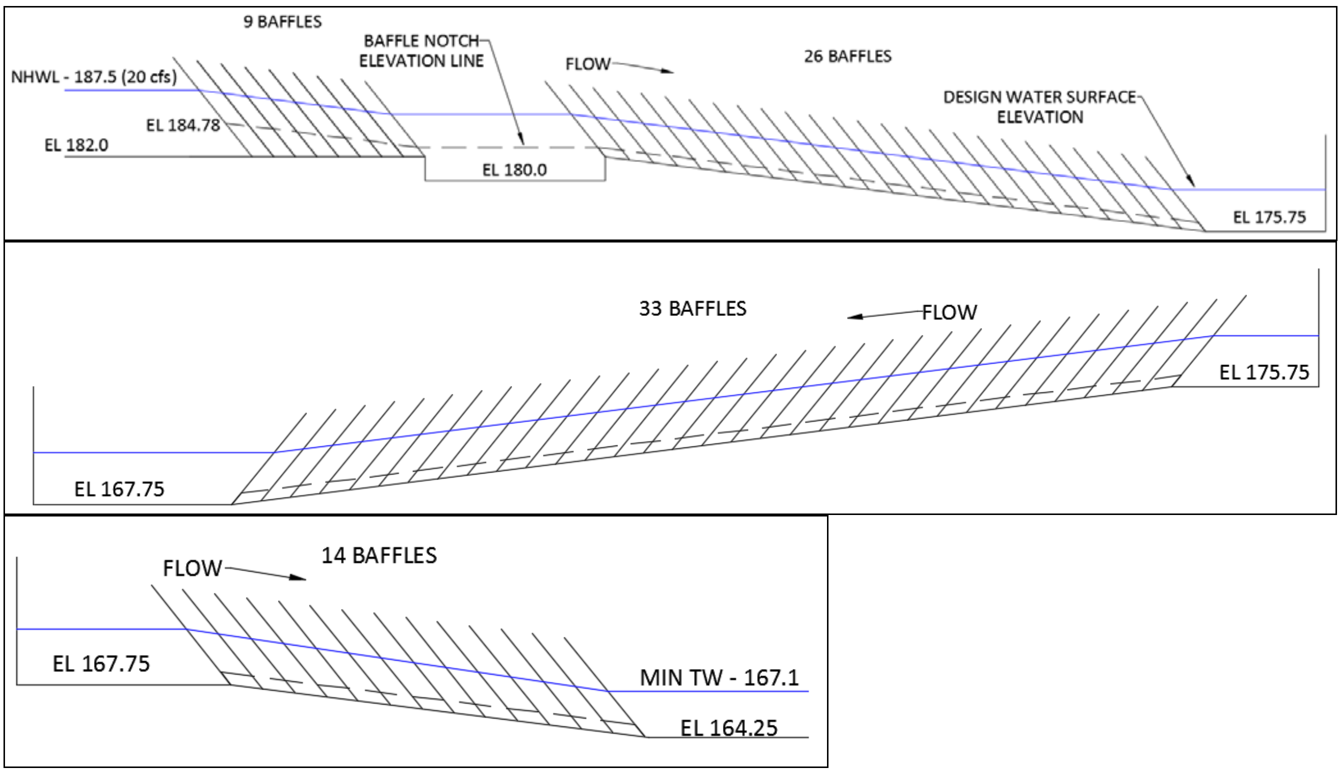

Figure 2 – Section Views of Baffle Locations (Top: Upper Leg and Exit Channel; Middle: Middle Leg; Bottom: Lower Leg and Entrance Channel)

As shown in Figure 2, the design called for 9 baffles within the exit channel of the fishway, followed by a sloped leg with 26 baffles, a middle leg with 33 baffles, and a lower leg leading into the entrance channel with 14 baffles. The dashed line represents the baffle notch elevations which are critical to the proper operation of the fishway. At the normal headpond water level of 187.5 ft (per design plans) and the uppermost notch elevation of 184.78 ft, an anticipated flow of 20 cfs would flow through the fishway. Also represented on Figure 2 are the floor elevations of exit and entrance channels as well as turn pools. The minimum tailwater level labeled within the design plans is 167.1 ft (the associated river flow is unknown).

Results

Seventy four out of the 82 baffle notches were surveyed as part of the 7/18/2017 total station survey. Several of the baffle notches within the turnpool (with floor elevation of 167.75 ft) could not be obtained due to lack of a line of sight. Baffle notch elevations within the entirety of the upper leg were obtained and labeled "B1" through "B31" with "B1" representing the uppermost baffle. All the surveyed baffle notch elevations were analyzed to investigate if there were notches in the improper position, which can create hydraulics that may hinder upstream passage performance. It must be noted that there is an inherent error in measuring the notch elevations in that the surveying rod may not be perfectly level and the baffle is angled and therefore the exact position of the notch may be difficult to obtain. Therefore only baffle notches with an error (difference from design elevation) greater than 0.2 ft (~2 in) were flagged as a potential issue (see Appendix I for raw data). A summary of the key findings are listed below:

1. All survey points taken at the floor of the fishway, top of wall, and top of flashboards matched the design elevations. The water surface in the headpond was measured at 187.76 ft which is in line with the normal headpond level within the design plans (187.75 ft). These measurements validated that the survey was conducted in an accurate manner.
2. The uppermost baffle notch had an elevation of 184.4 ft, approximately 4.8 inches lower than the design elevation. This difference in elevation provides an additional flow of approximately 8 cfs (total of 28 cfs) through the fishway.
3. Baffle "B9" resides just upstream of a resting pool. The next baffle ("B10"), assumed to be just downstream of the resting pool should have the same notch elevation in order to ensure that the water surface does not change within the pool (i.e., maintains a backwatered zone where the energy of the flow is dissipated). It was found that baffle notch "B10" was approximately 10 inches lower than baffle notch "B9". This condition creates a sloped water surface within the resting pool and does not allow the energy of the flow to be properly dissipated. Comparing the horizontal position of the baffle (along the centerline of the fishway) to the design plans revealed that baffle "B10" was located along the slope of the fishway rather than just downstream of the resting pool as shown in Figure 3. Baffle "B31" represented the baffle just upstream of the turnpool and therefore only 22 baffles resided within the sloped leg rather than the 26 baffles as designed. This condition was further validated when looking at photos (taken by USFWS personnel) from a 2016 site inspection in that the resting pool contained excessive aeration and turbulence as shown in Figure 4.

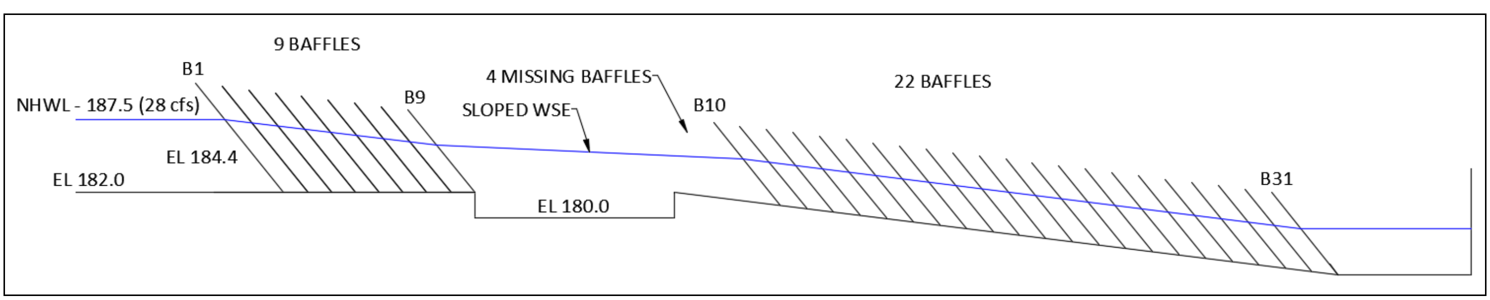

Figure 3 – Upper Leg Surveyed Baffle Positions

Figure 4 – Turbulent Resting Pool Downstream of Baffle "B9"

4. Out of the 9 baffles located within the exit channel, 4 of them exceeded the aforementioned error threshold. As stated above, baffle notch "B1" was close to 5 inches too low. Additionally baffle notch "B2" was 2.4 inches too low, and both baffle notches "B4" and "B5" were 2.5 and 3 inches, respectively, too high.
5. Baffle notches "B15" through "B25" were all greater than 2 inches higher than their associated design values with baffle notch "B20" close to 5 inches too high.
6. Baffle notch "B31" is located just upstream of the first turnpool (with floor elevation of 175.75 ft). Baffle notch "B32" should therefore reside at the same elevation in order to produce hydraulics within the turnpool that warrant resting. Instead, baffle notch "B32" was 3.8 inches lower than "B31", again producing a sloped water surface profile and not properly dissipating the energy of the flow.
7. Baffle notches "B37" through "B61" were all lower than the design values by more than 2 inches with baffle notches "B43" and "B45" greater than 6 inches.
8. The lowermost baffle notch ("B74"), located within the entrance channel was found to be 2.5 inches higher than design.

Discussion

It is imperative that all the baffles are located in the appropriate positions and reside at the design elevations in order to ensure that the fishway operates under uniform (non-changing) conditions. The results above demonstrate that many of the baffles are seated too high or too low which will cause an unintended change in hydraulics between baffles that could have a negative effect on upstream fish passage. Anscillary to this, the resting pools are critical areas to allow target species to rest prior to traversing the next leg of the fishway. The resting pool and turn pool that was able to be analyzed both had baffles that were outside of design values causing sloped water surface profiles and increased velocities.

The original design plans had the fishway operating at a flow of approximately 20 cfs at the normal headpond level of 187.75 ft. Utilizing the empirical equations developed by (Odeh, 2003) with a head of 4.1 ft (derived via the surveyed notch elevation of 184.4) at normal headpond, and the geometry of the baffles yields an average velocity through the baffles of 5.4 ft/s and an average velocity within the fishway channel (i.e., resting pools) of 2.5 ft/s. Note that the existing resting pools may exceed 2.5 ft/s due to the lack of proper backwatering and sloped water surface profiles. Also note that the existing fishway operates at a flow of approximately 28 cfs due to the improper positioning of the upper most baffle. Current fish passage criteria (USFWS, 2017) for river herring recommends that the baffle velocity be kept at or below 4 ft/s. Reducing the head to 2.8 ft (reduction of 1.3 ft from existing conditions or approximately 1 ft from original design) would result in velocities within the 4 ft/s threshold and would reduce resting pool velocities to an average of 1.6 ft/s.

Recommendations

1. A large percentage (~60%) of the baffle notches were found to be in the improper position (greater than 2 inches from design). This can be due to a multitude of factors including the age of the baffles, debris, improperly seated within the existing angle iron supports, or damaged baffles. It is recommended that all of the baffles within the entirety of the fishway are replaced (including the 4 that were found to be missing upstream of baffle "B10") prior to the 2018 migratory season in order to ensure that the fishway maintains uniform hydraulic conditions during the migratory season.
2. The amount of flow through the fishway under the normal headpond level produces velocities outside acceptable levels for river herring. Reducing the amount of head by 1 ft (from the original design) is necessary to provide hydraulics that meet current fish passage criteria. This reduction in head would result in a reduction of fishway flow from 20 cfs to approximately 11 cfs. It is recommended that the reduction in head be done in one of the following two ways:

    A. Lower the existing flashboard height by 1 ft to an elevation of 186.5 ft during the migratory season.
    B. Transform the section with 9 baffles and the section with 26 baffles into one continuous sloped section with 37 baffles via utilizing the resting pool (with floor elevation of 180.0) as shown in Figure 5.

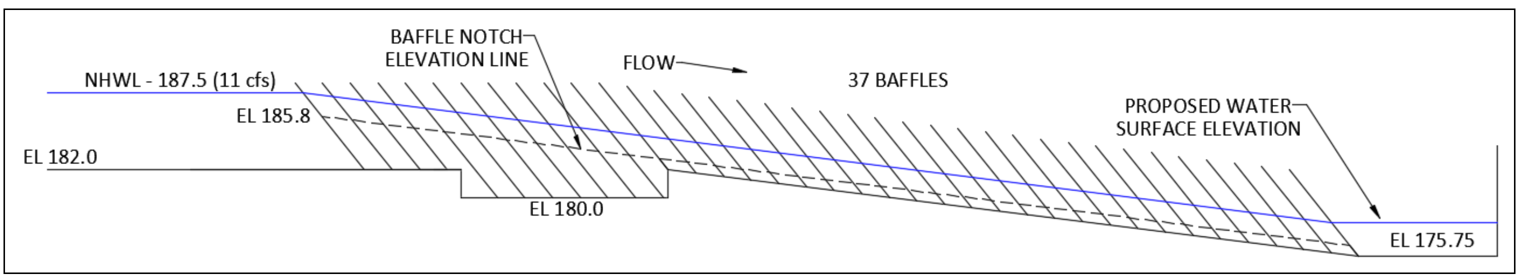

Figure 5 – Transformed Upper Leg to Accommodate a Reduction in Head of 1 ft

Note that recommendation 2 may alter the necessary changes recommended in item 1 and therefore should be decided prior to the replacement of any baffles. If option B described above is not feasible to complete prior to the 2018 migratory season it is recommended to prioritize option A which can be done to prove the option B concept.

3. It is recommended that the licensee collaborate with USFWS, NOAA, and MEDMR personnel to investigate the alterations described within this memorandum in order to improve upstream fish passage for the 2018 migratory season.

CC: Fred Seavey, USFWS
Don Dow, NOAA
Peter Ruksznis, MEDMR

References:

Odeh M. 2003. Discharge Rating Equation and Hydraulic Characteristics of Standard Denil Fishways. *Journal of Hydraulic Engineering. ASCE/May 2003*

USFWS.2017. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

APPENDIX I

Comparison of surveyed baffle notch elevations to design elevations (design plans dated Oct 11, 1985) for the Lowell Tannery site on the Passadumkeag River in Maine

Baffle # Baffle number given to each of the surveyed baffles
EL, ft Surveyed elevation of the baffle notch in feet
Design EL, ft Design elevation of the baffle notch in feet
Error, ft Difference between surveyed and design notch elevations in feet
Error, in Difference between surveyed and design notch elevations in inches
Design Baffle # Baffle number given to each of the baffles based on design plans

*** NOTE - Baffle "B1" and "1" represent the upstream most baffle ***

Baffle #	EL, ft	Design EL, ft	Error, ft	Error, in	Design Baffle #
B1	184.3769	184.78	0.4031	4.8372	1
B2	184.3294	184.53	0.2006	2.4072	2
B3	184.1077	184.28	0.1723	2.0676	3
B4	184.2370	184.03	-0.2070	-2.4840	4
B5	184.0249	183.78	-0.2449	-2.9388	5
B6	183.5079	183.53	0.0221	0.2652	6
B7	183.2377	183.28	0.0423	0.5076	7
B8	183.0281	183.03	0.0019	0.0228	8
B9	182.7341	182.78	0.0459	0.5508	9
MISSING		182.78	MISSING	N/A	10
MISSING		182.53	MISSING	N/A	11
MISSING		182.28	MISSING	N/A	12
MISSING		182.03	MISSING	N/A	13
B10	181.913	181.78	-0.1330	-1.5960	14
B11	181.6689	181.53	-0.1389	-1.6668	15
B12	181.4779	181.28	-0.1979	-2.3748	16
B13	181.148	181.03	-0.1180	-1.4160	17
B14	180.9044	180.78	-0.1244	-1.4928	18
B15	180.7109	180.53	-0.1809	-2.1708	19
B16	180.4571	180.28	-0.1771	-2.1252	20
B17	180.282	180.03	-0.2520	-3.0240	21
B18	180.0977	179.78	-0.3177	-3.8124	22
B19	179.7999	179.53	-0.2699	-3.2388	23
B20	179.6695	179.28	-0.3895	-4.6740	24
B21	179.3986	179.03	-0.3686	-4.4232	25
B22	179.1262	178.78	-0.3462	-4.1544	26
B23	178.7982	178.53	-0.2682	-3.2184	27
B24	178.4738	178.28	-0.1938	-2.3256	28
B25	178.2085	178.03	-0.1785	-2.1420	29
B26	177.7898	177.78	-0.0098	-0.1176	30
B27	177.6341	177.53	-0.1041	-1.2492	31
B28	177.4213	177.28	-0.1413	-1.6956	32
B29	177.1084	177.03	-0.0784	-0.9408	33
B30	176.7728	176.78	0.0072	0.0864	34
B31	176.4924	176.53	0.0376	0.4512	35

B32	176.2119	176.53	0.3181	3.8172	36
B33	176.1548	176.28	0.1252	1.5024	37
B34	175.8559	176.03	0.1741	2.0892	38
B35	175.6632	175.78	0.1168	1.4016	39
B36	175.3926	175.53	0.1374	1.6488	40
B37	175.0382	175.28	0.2418	2.9016	41
B38	NS	175.03		NS	42
B39	174.471	174.78	0.3090	3.7080	43
B40	174.1896	174.53	0.3404	4.0848	44
B41	173.907	174.28	0.3730	4.4760	45
B42	173.6696	174.03	0.3604	4.3248	46
B43	173.2541	173.78	0.5259	6.3108	47
B44	173.1541	173.53	0.3759	4.5108	48
B45	172.7355	173.28	0.5445	6.5340	49
B46	172.7672	173.03	0.2628	3.1536	50
BSC?	NS	172.78		NS	51
B48	172.2056	172.53	0.3244	3.8928	52
B49	171.9599	172.28	0.3201	3.8412	53
B50	171.8303	172.03	0.1997	2.3964	54
B51	171.4498	171.78	0.3302	3.9624	55
B52	171.2476	171.53	0.2824	3.3888	56
B53	170.9024	171.28	0.3776	4.5312	57
B54	170.756	171.03	0.2740	3.2880	58
B55	170.5053	170.78	0.2747	3.2964	59
B56	170.2214	170.53	0.3086	3.7032	60
B57	169.9863	170.28	0.2937	3.5244	61
B58	169.6552	170.03	0.3748	4.4976	62
B59	169.4232	169.78	0.3568	4.2816	63
B60	169.2573	169.53	0.2727	3.2724	64
B61	168.9958	169.28	0.2842	3.4104	65
NOT SURVEYED		169.03	NOT SURVEYED	NOT SURVEYED	66
		168.78			67
		168.53			68
		168.53			69
		168.28			70
		168.03			71
		167.78			72
B65	167.5869	167.53	-0.0569	-0.6828	73
B66	167.211	167.28	0.0690	0.8280	74
B67	167.0676	167.03	-0.0376	-0.4512	75
B68	166.7802	166.78	-0.0002	-0.0024	76
B69	166.7051	166.53	-0.1751	-2.1012	77
B70	166.3973	166.28	-0.1173	-1.4076	78
B71	166.1176	166.03	-0.0876	-1.0512	79
B72	165.8126	165.78	-0.0326	-0.3912	80
B73	165.5042	165.53	0.0258	0.3096	81
B74	165.4858	165.28	-0.2058	-2.4696	82

(yellow)	Denotes a resting pool
(red)	Denotes a baffle notch that is outside of design by > 2 inches
NS	Not Surveyed

Document Content(s)

FEDERAL ENERGY REGULATORY COMMISSION

MEMORANDUM

DATE: January 11, 2021

FROM: Bill Connelly
New England Branch
Division of Hydropower Licensing
Office of Energy Projects

TO: Public Files for the Lowell Tannery Hydroelectric Project
(FERC Project No. 4202-024)

SUBJECT: Conference Call Minutes with Applicant and Resource Agencies held December 18, 2020

On October 15, 2020, the National Marine Fisheries Service (NMFS) requested that, pursuant to section 16.8(b)(6) of the Commission's regulations, the Director of the Office of Energy Projects resolve a dispute with KEI (Maine) Power Management (II) LLC (KEI Power), regarding two studies that NMFS requested during the first stage of consultation for the proposed relicensing of the Lowell Tannery Hydroelectric Project No. 4202 (project). NMFS's dispute involves two studies: an upstream fish passage effectiveness study, and a downstream fish passage effectiveness and survival study.

On December 18, 2020, Commission staff participated in a conference call with KEI Power, NMFS, the U.S. Fish and Wildlife Service (FWS), the Maine Department of Environmental Protection (Maine DEP), the Maine Department of Marine Resources (Maine DMR), the Penobscot Nation (Penobscot), and other interested participants to discuss the project's upstream fish passage facility, project operation, and existing information about the project's effects on upstream fish passage.

Conference call agenda and minutes are as follows: (1) introduction of participants; (2) FERC staff explain purpose of meeting and gather information about upstream passage at the project; (3) participants discuss upstream passage at the project; and (4) meeting conclusion.

Participants:

KEI (Maine) Power Management (II) LLC (KEI Power, or applicant)

- Lewis Loon

- Sherri Loon

Kleinschmidt Associates (Kleinschmidt)

- Andy Qua
- Jesse Wechsler

National Marine Fisheries Service (NMFS)

- Matt Buhyoff
- Don Dow
- Jeff Murphy

U.S. Fish and Wildlife Service (FWS)

- Ken Hogan
- Julianne Rossett
- Bryan Sojkowski

Maine Department of Environmental Protection (Maine DEP)

- Kathy Howatt
- Christopher Sferra

Maine Department of Marine Resources (Maine DMR)

- Casey Clark
- Mitch Simpson

Penobscot Nation (Penobscot)

- Dan McCaw

University of Maine Cooperative Fish and Wildlife Research Unit (University of Maine)

- Joe Zydlewski

Federal Energy Regulatory Commission (Commission) staff

- Nick Jayjack
- Nick Tackett
- Steve Kartalia
- Arash Jalali Barsari
- Bill Connelly

Minutes

- Steve Kartalia (Commission staff) began the meeting with introductions, background about the disputed studies, purpose of the meeting, and background about the disputed studies.
- Steve Kartalia (Commission staff) asked if there are any interim, draft, or final upstream alewife passage reports available from the University of Maine 2018, 2019, or 2020 seasons that could be filed on the record. He stated that staff are particularly interested in the study methodology and the study results from any of those years.
- Joe Zydlewski (University of Maine) stated that some data from a graduate student's dissertation study are available and can be shared with the Commission. He stressed that they are unpublished and not peer-reviewed and stated any data would need to be uploaded with a disclaimer indicating that the data are preliminary and not peer-reviewed.
- Steve Kartalia (Commission staff) asked the meeting participants to describe the methodology used to evaluate upstream alewife passage. He also asked if Passive Integrated Transponder (PIT) tag readers were installed only at the entrance and exit of the fishway
- Joe Zydlewski (University of Maine) stated that the available data consist of PIT tag data, which are records of fish physically inside the fishway. He said the PIT tag readers are installed at the entrance and exit of the fishway and are deployed from April through November.
- Steve Kartalia (Commission staff) asked if there is a radio receiver downstream of the fishway to detect Atlantic salmon and whether that receiver was just there for the 2020 study period.
- Joe Zydlewski (University of Maine) stated that the radio receiver was installed near the entrance of the fishway and pointed downstream. The receiver has a range of 1,300 to 2,000 feet, depending on weather and the depth of fish.
- Jesse Wechsler (Kleinschmidt) asked if the salmon study involved PIT tagging and radio tagging.
- Joe Zydlewski (University of Maine) stated that was correct.
- Jesse Wechsler (Kleinschmidt) asked if it was possible to tell if salmon were approaching the fishway but not entering.
- Joe Zydlewski (University of Maine) said yes.
- Joe Zydlewski (University of Maine) stated that a greater number of salmon were tagged in 2020 than in previous years. He said that radio receivers can detect fish from a greater distance, and the PIT tag reader detects fish in the fishway.
- Steve Kartalia (Commission staff) asked if there are plans to continue the University of Maine study in 2021.

- Joe Zydlewski (University of Maine) said that there are no funds for salmon or alewife in 2021, but funding can be fluid. He said there are no plans at this time for radio tagging Atlantic salmon. However, he said PIT tag readers will be installed in 2021 to detect any salmon PIT-tagged by Maine DMR.
- Mitch Simpson (Maine DMR) said that, the last he heard, it was uncertain if PIT tags readers were going to be operated in 2021. He asked if staff will be available to oversee the study.
- Joe Zydlewski (University of Maine) said that a reduced PIT tag reader array will be deployed in 2021, and there will be staff to monitor readers at Brownsville, West Enfield, and Lowell Tannery. He said the intent was to continue collecting data.
- Steve Kartalia (Commission staff) asked what the cost of the study was for KEI Power.
- Sherri Loon (KEI Power) said she was not sur e of the cost but could provide the information.
- Steve Kartalia (Commission staff) asked if the information could be filed in the FERC record.
- Andy Qua (Kleinschmidt) asked if staff want KEI to file the cost information.
- Steve Kartalia (Commission staff) said yes.
- Steve Kartalia (Commission staff) asked if there any known observations or documentation of river herring schooling/milling in locations other than near the entrance of the fishway, such as downstream of the powerhouse discharge or the spillway that is adjacent to the powerhouse. He asked where milling occurs and under what operational conditions.
- Bryan Sojkowski (FWS) said there is obvious delay occurring. He said he has underwater video of fish “stacked up” from the fishway to the Tannery Road Bridge, which is approximately 240 feet downstream. He said a lot of fallback occurs at the fishway entrance.
- Jesse Wechsler (Kleinschimt) asked if this observation was part of a study or from the fishway inspections.
- Bryan Sojkowski (FWS) said it was from visual inspection during the inspections. He said there was a report from 2018 that was shared, and it included recommendations for the fishway.
- Steve Kartalia (Commission staff) asked if these are the same recommendations KEI Power refers to.
- Bryan Sojkowski (FWS) said yes.
- Sherri Loon (KEI Power) said that at the beginning of the 2020 season, KEI Power put the fishway back to original specs at the request of the agencies. She

said previous changes had been made at the request of the agencies, but now the fishway was put back to original specs.

- Don Dow (NMFS) said NMFS did not make that request.
- Sherri Loon (KEI Power) said Don Dow (NMFS) did not make that request, somebody else did.
- Bryan Sojkowski (FWS) said there are flow reducing baffles in the exit channel of the fishway. In 2018, water elevations were off from design specs. Without those baffles, too much flow went down the fishway. He wanted to get it back to the original design. He thought it was done in 2019. He said he was on site to look at baffles.
- Jesse Wechsler (Kleinschmidt) said he thought it was done in spring of 2020.
- Don Dow (NMFS) said he was definitely there after the changes were made, and it was not 2020.
- Lewis Loon (KEI Power) said the changes were made in 2019. He said he verified it early this spring. He said it was done in late 2019, and they were in place for the 2020 run.
- Jesse Wechsler (Kleinschmidt) said there was an increase in fishway use in 2020 over 2019, according to Joe Zydlewski's (University of Maine) data.
- Casey Clark (Maine DMR) said fewer fish approached the fishway in 2020 than in recent years.
- Steve Kartalia (Commission staff) asked if FWS could file the 2018 report with FERC.
- Ken Hogan (FWS) said yes, and they might be able to file the videos if they are under 50 megabytes.
- Nick Tackett (Commission staff) said it would be helpful to have a description of the project operating conditions when FWS observed fish stacked up at the fishway.
- Bryan Sojkowski (FWS) said he would assume normal operating conditions, but did not know for sure.
- Ken Hogan (FWS) said KEI Power might be able to provide generation records for those dates, and he would communicate those dates with KEI Power.
- Bill Connelly (Commission staff) asked where river herring spawn upstream of the project dam.
- Casey Clark (Maine DMR) said the recovered population size would be 1.5 to 2 million on habitat that is currently accessible or will be accessible with additional passage. He said he could update staff about those projects, but most projects upstream of Lowell Tannery are already accessible. He said the information should be in the pre-application document, but he could provide more information.

- Steve Kartalia (Commission staff) said KEI Power stated, in its March 2020 study plan, that it would evaluate information about upstream passage effectiveness, along with data on project operation, to determine if changes to project operation influence upstream passage rates and effectiveness. He asked if KEI Power could describe the analyses that it intends to conduct to assess passage rates and effectiveness.
- Jesse Wechsler (Kleinschmidt) said the study would largely draw on data from the 2020 study, but there are multiple years of study of the fishway. He said he would work with Lewis and Sherri Loon (KEI Power) to tease out operation and environmental conditions that could be used to understand the situation.
- Steve Kartalia (Commission staff) asked if it would be possible to understand when peak effectiveness occurs with regard to project operation.
- Casey Clark (Maine DMR) said it would depend upon the specific data from the University of Maine about the timing of passage. He said PIT tag data are easy to track against operation because the data are time-stamped. He said it should be a straightforward analysis assuming Joe Zydlewski (University of Maine) can provide the raw data files.
- Joe Zydlewski (University of Maine) said he can definitely share the data to make those assessments.
- Jesse Wechsler (Kleinschmidt) said they can use the detection data from the entrance and exit PIT readers to determine how long it takes fish to move through the fishway.
- Casey Clark (Maine DMR) said that the PIT tag data provides information about internal efficiency, not delay.
- Joe Zydlewski (University of Maine) said fish passage is carved up into different components, and different tools give different pieces of puzzle. He said PIT tags provide information for fish successfully attracted into fishway. He said the PIT tag data provide the success of that subgroup. The PIT tag data would not include fish that approach, but do not enter, the fishway.
- Casey Clark (Maine DMR) said Maine DMR requested a radio telemetry study for a complete picture of delay and greater impacts. He said PIT tag data only provide information about the internal efficiency of the fishway.
- Sherri Loon (KEI Power) said she found an email from Antonio Bentivoglio (FWS) from 2020, requesting that the fishway be put back to original specs.
- Don Dow (NMFS) said he had an email from Steve Shepard (FWS) that the fishway was returned to original specs in 2018.
- Sherri Loon (KEI Power) said the baffles were repaired and replaced in 2018.
- Steve Kartalia (Commission staff) asked if KEI Power would file that information in the record.

- Sherri Loon (KEI Power) said yes.
- Nick Tackett (Commission staff) asked if the raw data from the University of Maine study would be released sometime in 2021, or at a potentially uncertain time in the future.
- Joe Zydlewski (University of Maine) said his student is likely finishing her degree next December. He said meetings with KEI Power have been collaborative in nature, and they have discussed what information is needed. He said if there are specific needs, he can make the data available for independent analysis as long as his student can complete her analysis as well. He said, based on that timeline, the data could be available in January 2021.
- Nick Jayjack (Commission staff) said staff, when reviewing the dispute and different cases, will look from a standpoint of incremental increase of information versus incremental cost. He said observations indicate that fish are getting to the fishway entrance but stacking up for several hundred feet downstream.
- Ken Hogan (FWS) said we all can agree the PIT tags will address internal efficiency of the fishway. He said sample size is a concern. As indicated by Brian Sojkowski (FWS), fish are collecting below the dam, and it is unknown how readily they are passing. He said there have been two rounds of revisions to the ladder, but the effect of those revisions is unknown. He said that the question is whether the ladder is functioning as intended and whether the project is creating delay cannot be answered with just PIT tag data. He said KEI also conducted an eel entrainment study, and FWS has new information for a desktop study, which will be filed. He said he did not think the downstream salmon study is adequate for delay assessment.
- Casey Clark (Maine DMR) agreed with Ken Hogan (FWS) and said, from an agency's perspective, will the project pass alewives with more salmon approaching the project? He said it is important to see that the project passes fish, and he is expecting salmon numbers to increase.
- Andy Qua (Kleinschmidt) notes that there's an existing fishway, and nobody disagrees that it does not work as desired. He said KEI Power is concerned about spending money on studies versus spending on resolving the problems.
- Nick Tackett (Commission staff) asked if the fundaments issue is whether the project is causing delay or what is causing the delay.
- Casey Clark (Maine DMR) said there is not enough information to know what operational measures are causing delay. He said KEI Power cannot make an operational change to improve movement because current information does not include fish that do not make it to the fishway.
- Ken Hogan (FWS) agreed and said, with just PIT tag data, we do not know if fish are being falsely attracted to the tailrace. He said radio telemetry would tell us

that. He asked how the problem can be fixed if we don't know what the problem is. He said a key component is to identify the problems, then provide a solution to address the problem. He asked how KEI Power can fix the problem without data.

- Jeff Murphy (NMFS) asked for a resolution of the downstream study. He said FERC probably has enough information to make a decision. He said naturally produced salmon smolts are likely impacted by the project. He asked how a desktop study could provide sufficient information to do an Endangered Species Act analysis. He asked that his comments be added to the meeting minutes.
- Nick Tackett (Commission staff) said NMFS's study request focused on radio telemetry. He asked if NMFS has a cost estimate for a telemetry study. He also asked if NMFS looked at other study methodology to get the same information, such as a computational fluid dynamics (CFD) modeling study.
- Jeff Murphy (NMFS) said NMFS did provide a ballpark cost estimate in its October 16, 2020 letter. He said it is outside of NMFS's expertise to cost out the study, and the applicant probably has a better estimate. He said that he thought the original request was well laid out, and that radio telemetry is the preferred methodology. He said radio telemetry is more informative about fish movements and concentrations, and that information cannot be obtained with CFD modeling.
- Bryan Sojkowski (FWS) said CFD modeling may indicate where potential issues could set up, but fish behavior information is needed for reliable results.
- Ken Hogan (FWS) said CFD data is typically paired with telemetry data to understand how fish respond to different currents. Then, we can run operational scenarios to anticipate response of fish to the scenarios.
- Casey Clark (Maine DMR) asked why the downstream passage study request is not being discussed. He asked if there would be another meeting to discuss the downstream study request.
- Steve Kartalia (Commission staff) said staff do not intend to have another conference call because staff feel there is enough information to address that request. Staff only needed information about the upstream passage study.
- Steve Kartalia (Commission staff) subsequently concluded the meeting.

Document Content(s)

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426
February 10, 2021

OFFICE OF ENERGY PROJECTS

Project No. 4202-024 – Maine
Lowell Tannery Hydroelectric Project
KEI (Maine) Power Management (II) LLC

VIA Electronic Mail

Jennifer Anderson
National Marine Fisheries Service
United States Department of Commerce
Jennifer.Anderson@noaa.gov

Lewis C. Loon
KEI (Maine) Power Management (III) LLC
Lewis.Loon@kruger.com

Reference: Request for Study Dispute Resolution

Dear Ms. Anderson and Mr. Loon:

In a letter filed October 15, 2020, the National Marine Fisheries Service (NMFS) requested, pursuant to section 16.8(b)(6) of the Commission's regulations, that the Director, Office of Energy Projects (OEP Director) resolve a dispute with KEI (Maine) Power Management (II) LLC (KEI Power), regarding two studies NMFS requested during the first stage of consultation for the proposed relicensing of the Lowell Tannery Hydroelectric Project No. 4202 (Lowell Tannery Project or project).

Background

On November 23, 2018, the Commission approved KEI Power's request to use the Traditional Licensing Process (TLP) to prepare an application to relicense the project. On January 11, 2019, KEI Power held the required joint agency meeting to discuss the project and study requests. On March 11, 2019, NMFS filed a request for KEI Power to conduct, in part: (1) an upstream fish passage study using radio telemetry to determine the effectiveness of the fishway at the project; and (2) a study of downstream fish passage effectiveness and survival, using radio telemetry and turbine injection to determine passage behavior, entrainment, and impingement at the project intake.

On March 26, 2020, KEI Power provided a draft study plan to NMFS and other stakeholders that included proposed upstream passage studies for anadromous fish and American eel.[1] KEI Power stated that researchers from the University of Maine studied the upstream passage of Atlantic salmon and sea-run alewives at the Lowell Tannery Project in 2018 and 2019, with the support of KEI Power. In its study plan, KEI Power proposed to continue coordinating with the University of Maine to study the upstream passage of anadromous fish in 2020. KEI Power also provided the results of a desktop study that assessed the potential for project-related entrainment, impingement, turbine passage survival, and whole-station survival for downstream-migrating fish species. KEI Power believes that the desktop analysis is sufficient for assessing downstream fish passage and that no further study is necessary.

In a May 12, 2020 letter, NMFS provided comments to KEI Power on the draft study plan,[2] and reiterated its request for the upstream fish passage effectiveness study. In its comments, NMFS explained that the study described in KEI Power's draft study plan would not be sufficient for determining the project's effects on upstream fish passage. The letter also identified concerns with the assumptions used in KEI Power's downstream fish passage desktop analysis, recommended modifications to the analysis, and reiterated the request for a downstream fish passage effectiveness and survival study.

On October 15, 2020, NMFS filed a letter requesting formal dispute resolution concerning its recommendation for the upstream and downstream passage studies. On October 30, 2020, KEI Power and the U.S. Fish and Wildlife Service (FWS) each filed a response to NMFS's request for study dispute resolution.

On December 18, 2020, Commission staff held a conference call with KEI Power, Kleinschmidt Associates, NMFS, FWS, the Penobscot Indian Nation, Maine

[1] KEI Power's study results and study plan are included as attachments to NMFS's October 15, 2020 filing.

[2] NMFS's letter to KEI Power is included as an attachment to NMFS's October 15, 2020 filing.

Department of Marine Resources, Maine Department of Environmental Protection, and the University of Maine, to discuss the upstream fish passage facility, project operation, and the project's effects on upstream fish passage.[3] FWS filed additional information on December 21, 2020, pertaining to prior fishway inspections at the project.

Study Dispute Determination

As discussed in the Appendix, the upstream fish passage study described in KEI Power's draft study plan would not be sufficient to describe the project's effects on upstream fish passage and develop potential mitigation measures. While it would provide information on the number of fish that enter and successfully pass through the upstream fishway at the project, it would not provide information on passage delay or false attraction to other sources of outflow at the project. Therefore, KEI Power is required to conduct NMFS's requested upstream passage effectiveness study.

KEI Power's desktop study should be sufficient to describe the project's effects on downstream fish passage and to develop potential mitigation measures. Therefore, NMFS's requested downstream passage effectiveness and survival study is unnecessary and KEI Power is not required to conduct the study. However, KEI Power must address NMFS's concerns with the desktop study in its draft license application as required by section 16.8(c)(4)(i)(B) of the Commission's regulations.

If you have any questions, please contact Bill Connelly at (202) 502-8587 or William.Connelly@ferc.gov.

Sincerely,

Terry L. Turpin
Director
Office of Energy Projects

[3] *See* Commission staff's January 11, 2021 Memorandum on Conference Call Minutes with Applicant and Resource Agencies.

Project No. 4202-024

APPENDIX

STAFF'S RECOMMENDATIONS ON REQUESTED STUDIES

Anadromous Fish Upstream Passage Efficiency Study

Background

The Lowell Tannery Project is located on the Passadumkeag River in Maine, approximately 13 miles upstream of its confluence with the Penobscot River. The project includes an upstream fish passage facility that consists of a 3-foot-wide Denil ladder located at the dam (Figure 1). Diadromous fish at the project include Atlantic salmon, American eel, and alosines. According to KEI Power's September 26, 2018 Pre-application Document (PAD), KEI Power provides 40 cubic feet per second (cfs) of water through the upstream fishway from May 15 through November 10 to attract upstream migrating fish. The flow is discharged from the fishway near the base of the powerhouse.

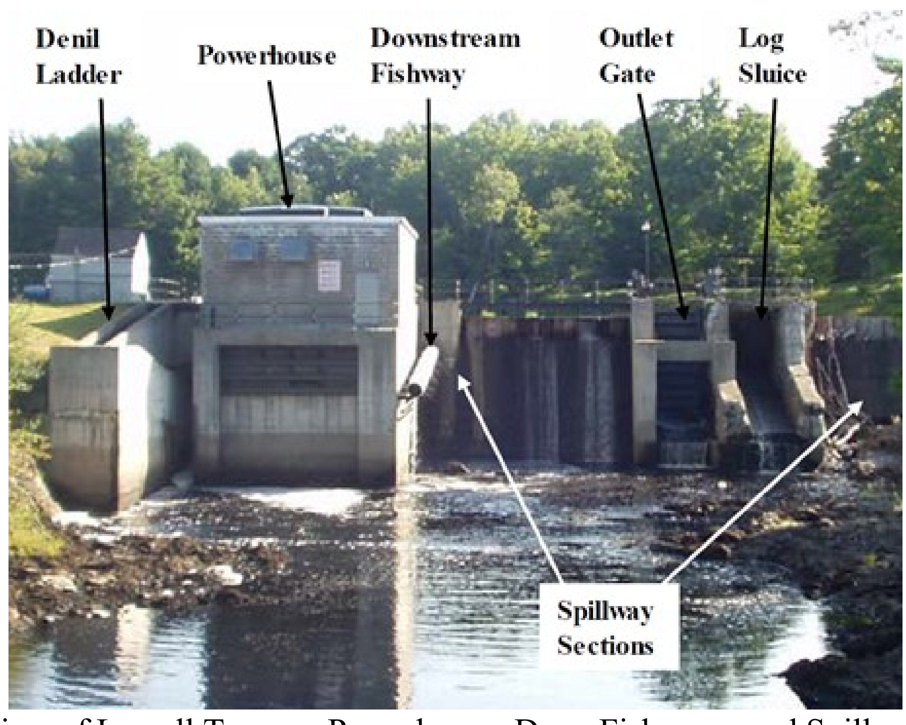

Figure 1: View of Lowell Tannery Powerhouse, Dam, Fishways, and Spillway. (Source: PAD)

Upstream Fish Passage Studies at the Lowell Tannery Project

In its draft study plan,[4] KEI Power stated that researchers from the University of Maine, with the support of KEI Power, studied the upstream passage of Atlantic salmon and sea-run alewives at the project in 2018 and 2019, using PIT tag[5] equipment. In the draft study plan, KEI Power stated that it planned to collaborate with the University of Maine in 2020 to continue this study effort and evaluate whether the upstream fishway provides "safe, effective, and timely" passage for adult Atlantic salmon and river herring.

According to the draft study plan, the University of Maine and the Maine Department of Marine Resources planned to tag fish in the spring of 2020, at the Milford Project No. 2534 on the Penobscot River, approximately 32 river miles downstream of the Lowell Tannery Project. From May 1 to November 1, 2020, researchers from the University of Maine planned to install PIT tag receivers at the Lowell Tannery Project to detect river herring and salmon that were tagged and released at the Milford Project.

The draft study plan stated that KEI Power would assess the effectiveness of the fishway in 2020 by comparing the number of fish detected at the Lowell Tannery Project's fishway entrance to the number of fish detected at the fishway exit. KEI Power stated that it would evaluate information about transit time through the fishway, passage delay, and upstream passage effectiveness, along with data on project operation, to determine if changes to project operation influence upstream passage rates and effectiveness. KEI Power stated that it would provide a study report to the resource agencies by March 1, 2021.

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[4] KEI Power did not file the March 2020 study plan with the Commission. The study plan is attached to NMFS's October 15, 2020 filing.

[5] Passive integrated transponder (PIT) tags are rice-sized tags injected into the pelvic fin area of the body cavity of the fish, providing each individual study fish with its own barcode that can be detected without handling the fish after initial implantation.

NMFS's Study Dispute and Request

In its October 15, 2020 dispute resolution request, NMFS states that there is no quantitative data concerning the effectiveness of the project's upstream fishway at passing river herring. NMFS states that it is not appropriate to PIT tag river herring at the Milford Project in the lower Penobscot River in order to evaluate fish passage at the Lowell Tannery Project. NMFS states that "it cannot be determined whether these fish are migrating to the Passadumkeag River," and that "any reliance on tagging of river herring at other hydroelectric projects is not reasonable nor expected to provide any meaningful results for the Lowell Tannery Project." NMFS states that KEI Power should conduct the Anadromous Fish Upstream Passage Efficiency Study that NMFS requested on March 11, 2019.

The goal of NMFS's Anadromous Fish Upstream Passage Efficiency Study is to evaluate whether the existing upstream fishway provides "safe, timely, and effective" passage for river herring and Atlantic salmon. The objectives of the study are to determine the effectiveness of the fishway, the extent of injury and mortality, and the extent of migration delay at the project.

As it pertains to river herring, NMFS requests that at least 100 test fish be collected, tagged, and released directly downstream of the project during the migration season. NMFS states that radio telemetry should be used to assess the in-stream behavior of the river herring, and that radio telemetry receivers should be placed in specific locations at the project to detect whether fish are "attracted to flow from the tailrace, gates, spillway and downstream of the entire Project."

As to Atlantic salmon, NMFS explains that because adult salmon abundance is likely too low in the Passadumkeag River to conduct a radio telemetry study, KEI Power should "continue to collaborate with the University of Maine on PIT tag studies for adult salmon at the Lowell Tannery Project."

Comments on the Requested and Proposed Studies

In its October 30, 2020 filing, KEI Power notes that of the 4,000 river herring tagged at the Milford Project in 2019, 185 were detected by the PIT tag receivers at the Lowell Tannery Project. KEI states that this number of fish is almost twice the sample size requested by NMFS. While results have not been formally reported from the

University of Maine's 2020 study efforts, KEI Power states that approximately 1,300 alewives were tagged and released at the Milford Project, and 57.6 percent of river herring detected at the Lowell Tannery Project migrated upstream through the existing fishway. During the conference call on December 18, 2020, the University of Maine provided a table summarizing the results of the PIT tagging study for the years 2009 through 2020, and corroborating KEI Power's account of the 2020 study results (Figure 2).

Pumpkin Hill/Lowell Tannery

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
American shad												
Approached	NA*	NA	NA	NA**	NA	0	0	0	0	0	0	NA
Passed	NA	NA	NA	NA	NA	0	0	0	0	0	0	NA
Total Pass	NA	NA	NA	NA	NA	-	-	-	-	-	-	NA
Atlantic salmon												
Approached	NA	NA	120	13	NA***	0	3	4	0	4	1	3 or 4
Passed	NA	NA	45	8	NA	0	2	3	0	1	0	0
Total Pass	NA	NA	37.5%	61.5%	NA	-	66.7%	75.0%	-	25.0%	0.0%	0%
River herring												
Approached	NA	NA	NA****	NA	0	0	73	37	NA	160	185	33
Passed	NA	NA	NA	NA	0	0	12	1	NA	31	15	19
Total Pass	NA	NA	NA	NA	-	-	16.4%	2.7%	NA	19.4%	8.1%	57.6%
Sea lamprey*****												
Approached	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	0
Passed	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	0
Total Pass	NA	NA	NA	NA	-	NA	NA	NA	NA	NA	NA	-

*Pumpkin Hill had a PIT array beginning in 2011
**No shad tagged in 2012-13
***No info on tagged salmon from 2013
****River herring not tagged 2011-12
*****Sea lamprey tagged in 2013 and 2020 only

Figure 2: Summary of University of Maine PIT Tag Study Results from 2009 through 2020 (Source: Joseph Zydlewski, University of Maine).

On December 21, 2020, FWS provided documentation of fishway inspections, assessments, and recommended modifications, including regular debris removal, changes to flow through the fishway, and replacement/adjustment of fishway baffles. KEI Power states that it made modifications to the fishway in 2020, in response to the recommendations it received from the FWS, and that these modifications have improved the effectiveness of the upstream passage facility relative to previous study seasons. KEI Power states that it would be more productive to consult with the agencies on whether additional modifications to the ladder or fishway operation are necessary, rather than conducting NMFS's requested radio telemetry study.

In its October 30, 2020 filing, FWS states that the 2020 study conducted by the University of Maine only provides information on the effectiveness of the project's fishway, not on the effects of the project as a whole. FWS states that the 2020 study provides passage information on fish that enter the upstream fishway, but does not provide information about whether fish are effectively finding the fishway entrance, being falsely attracted to competing flows at the project, or otherwise being delayed in their upstream migration as a result of the project's presence and operation. Accordingly, FWS supports NMFS's requested study.

On December 21, 2020, FWS filed documentation of river herring "stacked up" downstream of the project fishway entrance. During the conference call on December 18, 2020, a representative of FWS stated that upstream migrating fish were backed up from the fishway entrance to the Tannery Road bridge, a distance of approximately 240 feet.

Discussion and Recommendation

This discussion and staff recommendation pertains to NMFS's request to study upstream river herring passage at the project, not Atlantic salmon passage. In its March 11, 2019 study request, NMFS stated that KEI Power should "continue to collaborate with the University of Maine on PIT tag studies for adult salmon at the Lowell Tannery Project." Based on the record, it appears that KEI Power is doing so, and therefore, NMFS's March 11, 2019 study request on upstream salmon passage is not in dispute.

Information presented during the conference call and filed by FWS on December 21, 2020, indicates that river herring are being delayed at the project. Prior study results also indicate a low river herring passage rate through the fishway itself and that river herring detected at the entrance of the fishway did not pass through the fishway.

The University of Maine PIT tag study provides information on the number of river herring tagged at the Milford Project that eventually enter the Lowell Tannery Project fishway and, of those, how many successfully ascend and exit the fishway. Thus, contrary to NMFS's assertions, the PIT tag study provides quantitative data on the effectiveness of the project's upstream fishway at passing river herring, and demonstrates that some river herring tagged at the Milford Project are migrating to the Lowell Tannery Project on the Passadumkeag River.

The University of Maine study also provides information on how long it takes river herring to pass through the fishway because entrance and exit times are recorded by the PIT tag readers. Therefore, the PIT tag study is likely to be helpful in determining whether the fishway itself is operating as intended once river herring gain access to the fishway.

However, as FWS explains, KEI Power's draft study plan does not describe how KEI Power would use the PIT tag study results to evaluate: (1) whether river herring are able to effectively locate the fishway in the first place; (2) the extent of passage delay at the project; or (3) potential sources of false attraction flow under varying flow and operation conditions. Although KEI Power states that it will use the PIT tag study results to evaluate information about upstream river herring passage delay and the effectiveness of the fishway, KEI Power's draft study plan states that PIT-tag antennas for river herring detection will only be installed in the entrance and exit of the fishway. Figure 1 shows multiple potential sources of false attraction flow for upstream-migrating river herring, including releases from the powerhouse, spillways, outlet gate, and/or log sluice. It is clear that PIT tag readers at the entrance/exit of the fishway could not be used to determine whether river herring are locating the fishway entrance in the first place, or whether upstream river herring passage is delayed by competing attraction flows at the project.

In order to assess the project's effects on upstream river herring passage and develop any needed license conditions, Commission staff will need to understand the extent to which project operation is delaying or preventing upstream migrating river herring from entering the existing fishway. Radio telemetry is a generally accepted study methodology that could be used to track movements of river herring as they approach the project, as they locate or fail to locate the fishway entrance, and within the fishway itself. Therefore, NMFS's requested study could be used to determine the project-related causes of river herring delay as river herring approach the dam and search for a means of passage upstream, including whether river herring are able to successfully locate, access, and pass through the existing fishway, and whether any passage delay is caused by competing attraction flows from other releases at the project.

NMFS does not estimate the cost of its radio telemetry study. However, a similar radio telemetry study using 100 test fish at the West Enfield Project No. 2600 on the Penobscot River was estimated to cost approximately $100,000. The cost of NMFS's requested study is justified because the study would provide the information

Commission staff needs for an environmental analysis that assesses: (1) how long it takes river herring to find the fishway entrance upon approaching the dam; (2) which project outflows delay or prevent river herring from finding the fishway entrance; and (3) whether operational or structural changes to the project and fishway could be implemented to mitigate any such project effects. KEI Power should conduct the upstream fishway study using the radio telemetry methods requested by NMFS on March 11, 2019, during the 2021 upstream migration season (approximately May 15 to June 15) for river herring.

Downstream Fish Passage Effectiveness and Survival Study

Background

The project passes fish downstream via a gated, 18-inch bypass pipe at the dam that discharges into a plunge pool next to the tailrace (Figure 1). The entrance gate for the bypass pipe is adjacent to the turbine intake, which is fitted with a trashrack that has a clear bar spacing of 1.5 inches. According to the PAD, KEI Power provides a flow of 20 cfs through the bypass pipe. When river flow exceeds the 905-cfs maximum hydraulic capacity of the turbine, KEI Power states that fish may pass downstream with spill over the dam.

KEI Power's Desktop Turbine Blade Strike and Whole Station Survival Study

KEI Power conducted a desktop analysis to assess the risk of entrainment, impingement, turbine passage survival, and whole station survival (*i.e.*, survival through the turbine, spillway, and fish bypass) for adult American eel, juvenile and adult alewives, juvenile and adult American shad, and Atlantic salmon.[6] Specifically, KEI Power: (1) evaluated the risk of impingement by calculating the expected approach velocities at the turbine intake and comparing them to the prolonged swim speeds of target fish species; (2) evaluated the risk of entrainment into the turbine by comparing trashrack spacing to fish size and morphology; and (3) used the STRYKE[7] desktop

[6] KEI Power did not file its March 2020 study report with the Commission. The study report is attached to NMFS's October 15, 2020 study dispute letter.

[7] The STRYKE model uses the turbine blade strike equations from Franke *et. al.* (1997) and is based on the FWS's Turbine Blade Strike Analysis desktop model. Model

model to quantitatively estimate the probability of turbine blade strike survival and whole-station survival using a combination of available downstream passage routes (*e.g.*, turbine, spill, and fish bypass) for each target fish species and life stage.

NMFS's Study Dispute and Request

In its October 15, 2020 study dispute, NMFS argues that KEI Power's desktop study is inadequate because it lacks a site-specific evaluation of downstream fish passage behavior and survival necessary to determine direct project impacts on diadromous fish. NMFS asserts that the desktop analysis conducted by KEI Power is based on unsupported assumptions and thus, the data and analyses are unreliable.

NMFS states that KEI Power should conduct the Downstream Fish Passage Effectiveness and Survival Study that NMFS requested on March 11, 2019. Specifically, NMFS requests that KEI Power conduct a downstream passage radio telemetry study that includes tagging 100 each of adult and juvenile river herring and juvenile Atlantic salmon (300 total fish) and releasing the test fish upstream of the project. The goals of the study are to evaluate route selection, rates of entrainment and impingement, survival, and delay of downstream migrating fish. NMFS expects the study would require at least one year of field data collection. NMFS states that this information would be used to better understand the effects of the project and to determine measures and recommendations to increase fish survival and improve fish passage at the project.

In addition, NMFS requests that KEI Power conduct a "direct turbine injection" study of the same species and life stages to determine survival through the turbine. NMFS does not specify the sample sizes for the direct turbine injection portion of the study.

Although NMFS did not estimate a cost of the study in its March 11, 2020 study request, in the October 15, 2020 letter, NMFS estimates that the requested study would cost between $100,000 and $150,000.

---

variables included fish length, number of fish, and turbine characteristics (*e.g.*, runner diameter, turbine type, turbine efficiency, and hydraulic capacity, runner speed, and head).

NMFS argues that its study request follows generally accepted practices that are common to projects in the Northeast, its costs are commensurate with the potential for impacts on "public trust resources," and that it has taken steps to address fish passage and restoration of diadromous species throughout the Passadumkeag River, as well as at the mainstem dams of the Penobscot River. Consequently, NMFS believes that conducting its requested study at this phase in the Lowell Tannery Project relicensing process is necessary to quantitatively identify project impacts on aquatic resources, and to inform decisions on the need for mitigation.

Comments on the Requested and Proposed Studies

In its October 30, 2020 filing, KEI Power opposes NMFS's requested telemetry and project survival study based on cost and effort. KEI Power states that desktop entrainment and mortality models are a generally accepted substitute for the much more labor intensive and costly downstream telemetry and project survival study requested by NMFS. KEI Power states that the results of its desktop analysis confirm the project's actual operating results and support its position that project impacts are low relative to the costs of entrainment studies or protective measures. KEI Power states that it intends to address NMFS's comments and recommendations on its desktop analysis and provide the agencies with the updated results.

Discussion and Recommendations

KEI Power's desktop analysis is consistent with generally accepted methods for estimating fish entrainment, impingement, turbine passage survival, and whole station survival at hydropower projects. KEI Power is proposing to address NMFS's comments and recommendations on the desktop analysis (regarding certain model inputs and assumptions), which should improve the analysis and at least partially address NMFS's concerns about the available data. While the field methods sought by NMFS could also be used to assess downstream passage routes and the potential for fish mortality, there is already a substantial amount of existing information on the effects of entrainment, impingement, and turbine mortality at similar hydroelectric projects in the Northeast to corroborate the findings of the desktop analysis. The desktop analysis and existing information should be sufficient to describe the project's effects on downstream fish passage and develop potential mitigation measures at a lower cost than the field-based studies recommended by NMFS, which it estimates would cost between $100,000 and

$150,000. Therefore, no basis has been established for requiring KEI Power to conduct the field-based telemetry and project survival studies requested by NMFS.

As a reminder, Section 16.8(c)(4)(i)(B) of the Commission's regulations requires that KEI Power respond to comments and recommendations made by resource agencies and Indian tribes during the first stage of consultation in preparing its draft license application. Therefore, KEI Power should include in its draft license application information that addresses agency concerns with the assumptions and analysis used in the STRYKE model in its draft license application.

Document Content(s)

From:	Jeff Murphy - NOAA Federal
To:	Jesse Wechsler
Cc:	Wippelhauser, Gail; donald.dow@noaa.gov; Sferra, Christopher; Howatt, Kathy; Sojkowski, Bryan; Rosset, Julianne; Hilling, Corbin D; casey.clark@maine.gov; Andy Qua; Joseph Zydlewski; Sherri.Loon@kruger.com
Subject:	Re: study plan for Lowell Tannery - Upstream Fishway Effectiveness
Date:	Wednesday, March 24, 2021 4:00:26 PM

Thanks Jesse. Do you have a map depicting approximate PIT and radio telemetry receiver coverage? Thanks, Jeff.

On Wed, Mar 24, 2021 at 3:13 PM Jesse Wechsler <Jesse.Wechsler@kleinschmidtgroup.com> wrote:

> Good afternoon all,
>
> KEI (Maine) will be working again this year with the University of Maine to complete an upstream fishway effectiveness study at the Lowell Tannery Hydro Project on the Passadumkeag River. The study methods will employ radio telemetry and PIT tagging and are based on NMFS' original study recommendations. The study plan is attached for your records.
>
> If you have comments, please provide them at your next opportunity, as we anticipate starting the study this spring.
>
> Thank you!
>
> Jesse
>
> **Jesse Wechsler**
>
> **Senior Environmental Scientist and Project Manager**
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> **Office: 207-416-1278**
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> www.KleinschmidtGroup.com
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> *Providing* **practical** *solutions for* **complex** *problems affecting energy, water, and the environment*

From:	Rosset, Julianne
To:	Clark, Casey; Jesse Wechsler; jeff.murphy; Wippelhauser, Gail; donald.dow; Sferra, Christopher; Howatt, Kathy; Sojkowski, Bryan
Cc:	Andy Qua; Joseph Zydlewski; Sherri.Loon@kruger.com
Subject:	Re: [EXTERNAL] RE: study plan for Lowell Tannery - Upstream Fishway Effectiveness
Date:	Thursday, April 1, 2021 9:40:26 AM

Hi Jesse -

The United States Fish and Wildlife Service (Service) is in receipt of the Lowell Tannery (FERC No. 4202) Upstream Fishway Effectiveness draft study plan, which was emailed to the resource agencies on March 24, 2021. The Service agrees with, and supports, the comments provided by the Maine Department of Marine Resources on March 26, 2021 and has no additional comments to offer at this time.

Thank you for this opportunity to comment.
Julianne

Julianne Rosset
Hydropower Coordinator | Maine Field Office
United States Fish and Wildlife Service
306 Hatchery Road, East Orland, ME 04431
cell: 603-309-4842
fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Clark, Casey <Casey.Clark@maine.gov>
Sent: Friday, March 26, 2021 2:59 PM
To: Jesse Wechsler <Jesse.Wechsler@KleinschmidtGroup.com>; jeff.murphy <jeff.murphy@noaa.gov>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; donald.dow <Donald.Dow@noaa.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Rosset, Julianne <julianne_rosset@fws.gov>; Hilling, Corbin D <corbin_hilling@fws.gov>
Cc: Andy Qua <Andy.Qua@KleinschmidtGroup.com>; Joseph Zydlewski <josephz@maine.edu>; Sherri.Loon@kruger.com <Sherri.Loon@kruger.com>
Subject: [EXTERNAL] RE: study plan for Lowell Tannery - Upstream Fishway Effectiveness

Hello Jesse,

Thank you for sharing the study plan for us to review. DMR has reviewed the study plans and has the following comments:

- Please provide a map that depicts the location and estimated range of the telemetry receivers for the study

- KEI (Maine) states that, “Researchers will collect study fish from the tailwater area or from the fishway…” and that “Fish will be captured, tagged, and released directly back into the water.” Please include a map that depicts the proposed capture and release locations for the release groups.
- If KEI (Maine) plans to collect fish from the fishway, please add a description of how KEI (Maine) plans to transport those fish downstream. If fish are released at the fishway or in the tailrace directly below the project, they study will not be able to access attraction to the fishway entrance. DMR requests that all fish released for the study, be released at a downstream location identified by KEI (Maine).
- KEI (Maine) has proposed to use a combination of methods to collect fish including, angling, dip netting, cast netting, or seining, and potentially electrofishing. Some of these methods are more likely to impact alewives post release and alewives are known for being sensitive to handling. Given both of these factors, it is safe to assume that approximately 30% of the released fish could fail to approach the Project. DMR recommends that KEI (Maine) increase the number of tagged alewives to 150 to ensure that a reasonable sample size approaches the project and enters the fishway. DMR also recommends that KEI (Maine) increase the number of release events to ensure that number of tagged alewives that approach the project does not overwhelm the receivers. We recommend limiting release sizes to no more than 40 tagged fish per day.
- We appreciate the inclusion of data collection and analysis of “Operational aspects, including river flow, and project operation (generation and amount of spill).” DMR recommends that KEI (Maine) collect as detailed of information on operation of the project as possible. We also request that the location of spill be added to this list of data collected.

Thank you for the opportunity to review this study plan.

-Casey

Casey Clark
Resource Management Coordinator
Maine Department of Marine Resources
Office: (207) 624-6594 (currently forwarding)
Cell: (207) 350-9791
Email: casey.clark@maine.gov

From: Jesse Wechsler <Jesse.Wechsler@KleinschmidtGroup.com>
Sent: Wednesday, March 24, 2021 3:12 PM
To: jeff.murphy <jeff.murphy@noaa.gov>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; donald.dow <Donald.Dow@noaa.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Rosset, Julianne <julianne_rosset@fws.gov>; Hilling, Corbin D <corbin_hilling@fws.gov>; Clark, Casey <Casey.Clark@maine.gov>
Cc: Andy Qua <Andy.Qua@KleinschmidtGroup.com>; Joseph Zydlewski <josephz@maine.edu>; Sherri.Loon@kruger.com

From:	Howatt, Kathy
To:	Jesse Wechsler; jeff.murphy; Wippelhauser, Gail; donald.dow; Sferra, Christopher; Sojkowski, Bryan; Rosset, Julianne; Hilling, Corbin D; Clark, Casey
Cc:	Andy Qua; Joseph Zydlewski; Sherri.Loon@kruger.com
Subject:	RE: study plan for Lowell Tannery - Upstream Fishway Effectiveness
Date:	Thursday, April 1, 2021 10:00:26 AM

Good morning Jesse,

Department staff reviewed the Study Pan for Lowell Tannery Upstream Fishway Effectiveness and comments from other resource agencies. We have the following comments on the study.

1. KEI (Maine) has proposed to use a combination of methods to collect fish including, angling, dip netting, cast netting, or seining, and potentially electrofishing. Literature exists which demonstrates that electroshocking can disorient fish and that several hours is often required for resident fish to resume normal behavior. If electroshocking is used as a collection method, shocking methods should be alewife specific (pulse strength should be appropriate) and there should be an approximate 3 hour resting time given to alewives so that they can resume normal behavior before approaching the fishway. Please see below comments for release groups and delaying fish.

2. MDEP concurs with the comments submitted by MDMR that some of these methods (electrofishing) are more likely to impact alewives post release. MDEP agrees that KEI (Maine) should:
   a. provide details concerning the downstream release location to assess attraction of the fishway entrance.
   b. increase the number of tagged alewives to ensure that a reasonable sample size approaches the project and enters the fishway.
   c. Provide details concerning the release groups based on the comments of MDMR, including the size, timing, and the methods by which the groups will be held and released at a later time.

3. The Department supports comments from other state and federal resource agencies. A request was made for a figure depicting the location and reach of antenna arrays at the project for this study; the Department echoes the request in order to better understand the limitations of the study area and the eventual study results.

Thanks for the opportunity to review the study design and to provide comments.

Kathy

Kathy Davis Howatt

Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection
Phone: 207-446-2642
www.maine.gov/dep

From: Jesse Wechsler <Jesse.Wechsler@KleinschmidtGroup.com>
Sent: Wednesday, March 24, 2021 3:12 PM
To: jeff.murphy <jeff.murphy@noaa.gov>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; donald.dow <Donald.Dow@noaa.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Rosset, Julianne <julianne_rosset@fws.gov>; Hilling, Corbin D <corbin_hilling@fws.gov>; Clark, Casey <Casey.Clark@maine.gov>
Cc: Andy Qua <Andy.Qua@KleinschmidtGroup.com>; Joseph Zydlewski <josephz@maine.edu>; Sherri.Loon@kruger.com
Subject: study plan for Lowell Tannery - Upstream Fishway Effectiveness

Good afternoon all,

KEI (Maine) will be working again this year with the University of Maine to complete an upstream fishway effectiveness study at the Lowell Tannery Hydro Project on the Passadumkeag River. The study methods will employ radio telemetry and PIT tagging and are based on NMFS' original study recommendations. The study plan is attached for your records.

If you have comments, please provide them at your next opportunity, as we anticipate starting the study this spring.

Thank you!
Jesse

Jesse Wechsler
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JANET T. MILLS
GOVERNOR

KIRK F. MOHNEY
DIRECTOR

June 29, 2021

Ms. Kayla A. Hopkins
Kleinschmidt
PO Box 650
Pittsfield, ME 04967

Project: MHPC #1094-21 (CR 1357-18) Lowell Tannery Hydroelectric Project; FERC #4202
Draft License Application
Town: Lowell, ME

Dear Ms. Hopkins:

In response to your recent request, I have reviewed the information received June 21, 2021 to continue consultation on the above referenced project in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended.

Information concerning above-ground/architectural properties in the draft license application is incorrect. Our office sent a letter requesting architectural survey for the impoundment area in October 2018. Please see enclosed.

Information about the presence of archaeological sites and need for archaeological survey associated with this project dam and impoundment is misrepresented on pp 4-98 and 4-99 of the [filing]. There is one known prehistoric archaeological site associated with the impoundment shore, and one historic archaeological site. Phase I and possibly other archaeological survey work is necessary on this project to avoid possible adverse effect, as we pointed out in letter dated October 10, 2018.

Both architectural and archaeological survey is necessary in order for our office to continue Section 106 consultation.

Please contact Megan M. Rideout of our staff at 287-2992 or megan.m.rideout@maine.gov if you have any questions regarding above ground resources.

Sincerely,

Kirk F. Mohney

Kirk F. Mohney
State Historic Preservation Officer

RECEIVED
JUL 06 2021
KLEINSCHMIDT
ASSOCIATES

MAINE HISTORIC PRESERVATION COMMISSION
55 CAPITOL STREET
65 STATE HOUSE STATION
AUGUSTA, MAINE
04333

PAUL R. LEPAGE
GOVERNOR

KIRK F. MOHNEY
DIRECTOR

October 10, 2018

Mr. Lewis C. Loon
Kruger Energy
KEI (USA) Power Management Inc
423 Brunswick Ave
Gardiner, ME 04345

Project: MHPC #1357-18 KEI Maine Power Management; FERC 4202; Lowell Tannery Project
Filing of Notice of Intent and Pre-Application Document
Town: Lowell, ME

Dear Mr. Loon:

In response to your recent request, I have reviewed the information received October 1, 2018 to initiate consultation on the above referenced project in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended.

An architectural survey is recommended to identify and record information on all resources within the area of potential effect (APE) that are at least 50 years old. Survey must be completed according to our "Revised Above Ground Cultural Resource Survey Manual Project Review Specific." All surveys must be submitted electronically via our on-line CARMA database. See our website for more information: http://www.maine.gov/mhpc/architectural_survey/survey-guidelines.html.

A list of historic preservation consultants who are qualified to conduct architectural survey and have been trained in the use of the CARMA database may be found at the following page of our website: http://www.maine.gov/mhpc/project_review/consultants/carma_trained_consultants.shtml

With regards to archaeological resources, a Phase I archaeological survey for potentially significant historic and prehistoric archaeological sites is recommended for the impoundment margin of the Lowell Tannery project. A sawmill was present on what is now the project location, as well as other structures, shown on the 1859 county map. Prehistoric archaeological survey should focus on a 30 m wide area around the impoundment margin.

A list of qualified prehistoric archaeologists has been can be found on our website: http://www.maine.gov/mhpc/project_review/consultants/prehistoric_archaeology.shtml.

If you have any questions regarding archaeology, please contact Dr. Arthur Spiess of this office at Arthur.Spiess@maine.gov.

Please contact Megan M. Hopkin of our staff at 287-2992 or megan.m.hopkin@maine.gov if you have any questions regarding above ground resources.

Sincerely,

Kirk F. Mohney
State Historic Preservation Officer

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Maine-New Hampshire Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A
306 Hatchery Road
East Orland, Maine 04431
207/469-7300 Fax: 207/902-1588

September 14, 2021

Lewis C. Loon, General Manager
KEI (USA) Power Management Inc.
423 Brunswick Avenue
Gardiner, ME 04345

RE: Comments on Draft License Application for the Lowell Tannery Hydroelectric Project (FERC No. 4202-024)

Dear Mr. Loon,

This is the United States Fish and Wildlife Service's (Service) response to the Draft License Application (DLA) submitted by KEI (USA) Power Management (II) LLC (KEI; Applicant) on June 18, 2021, as part of the licensing proceeding for the Lowell Tannery Hydroelectric Project (Project), located on the Passadumkeag River in Penobscot County, Maine. The Service has reviewed the DLA and offers the following comments.

BACKGROUND

KEI issued a Pre-Application Document (PAD) on September 26, 2018, and on November 23, 2018, received permission from the Federal Energy Regulatory Commission (FERC) to use the Traditional Licensing Process. The Service provided comments on the PAD by letter dated March 14, 2019[1] and submitted two study requests: an American eel (*Anguilla rostrata*) passage facility design and siting study and a fish behavior, entrainment, and impingement study. On March 6, 2020 KEI provided an Initial Study Report (ISR) to the resource agencies for review and comment and, on March 26, 2020, submitted a draft study plan (2020 plan). On April 27,

[1] Accession No. 20190314-5136

2020, the Service provided comments on the ISR and 2020 plan.[2] On October 15, 2020 the National Marine Fisheries Service (NMFS) submitted a Request for Dispute Resolution for the Conduct of Studies (dispute).[3] On December 18, 2020, FERC hosted a teleconference to discuss the dispute.[4] During the teleconference, FERC staff requested the Service submit all fishway inspection reports related to the Project. On December 21, 2020, the Service provided the requested information to FERC.[5] On February 10, 2021, FERC issued its dispute determination, requiring KEI to conduct the upstream passage effectiveness study requested by NMFS.[6]

PROJECT DESCRIPTION AND PROPOSAL

The Project consists of a 27-foot-high, 230-foot-long, concrete dam with 30-foot-long and 89-foot-long spillway sections topped by 3.5-foot-high flashboards, a powerhouse containing one vertical Kaplan turbine unit with a rotational speed of up to 190 revolutions per minute and a total generating capacity of 1,000 kilowatts. Per FERC's order dated June 23, 2014, the Project is operated in a run-of-river mode.[7]

KEI proposes no changes to the current project configuration or facilities. Protection, mitigation, and enhancement (PME) measures proposed by KEI include continuing to operate in a run-of-river mode, continuing to operate the existing upstream fishway, continuing to operate the existing downstream fishway, and installation of upstream eel passage facilities.

COMMENTS

General

In the DLA, the Applicant states "KEI (USA) is not aware the Project affects any Native American tribe. There are no Native American lands, known Native American traditional cultural properties or religious properties, or National Register-eligible or -listed sites associated with Native American Nations within the Project boundary to KEI's knowledge." However, the Penobscot Indian Nation (PIN) and the Passamaquoddy Tribe own tribal trust lands upstream of the project. According to the PIN, "Inefficient fishways, lack of turbine exclusion for migrants, and the disruption of sediment flows through the system continue to negatively impact the Tribal trust lands upstream of the project and eliminate the ability for PIN members to exercise their Treaty-Reserved sustenance fishing rights in the Penobscot River."

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[2] Accession No. 20200427-5283
[3] Accession No. 20201015-5017
[4] Accession No. 20201208-3063
[5] Accession No. 20201221-5274
[6] Accession No. 20210210-3039
[7] Article 19 of the Lowell Tannery Project license was revised in 2014 to read as follows: The licensee shall operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River. These flows may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods for fishery management purposes upon mutual agreement between the licensee and the Maine Department of Inland Fisheries and Wildlife.

2.1 Project Facilities

KEI states, "The top of flashboards height (normal pond) is at elevation 182.3 feet." According to the Service's records, and parts of the DLA, the normal headpond is 187.5, not 182.3. The Service recommends KEI clarify what the existing flashboard height is at the Project, as well as the normal headpond elevation.

2.4. Proposed Project Facilities

KEI proposes to continue to operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River "…while maintaining the headpond within one foot of elevation 187.5 feet." The Service recommends KEI operate the Project in instantaneous run-of-river mode, whereby inflow to the Project equals outflow from the Project at all times and water levels above the dam are not drawn down for the purpose of generating power. In order to ensure this operational regime is followed for the duration of the new license, KEI should develop an operations and compliance monitoring plan in consultation with the agencies. The plan should describe mechanisms and structures that will be used, including level of manual and automatic operation, methods used for recording data, the protocol for providing data to the agencies, and an implementation schedule. At a minimum, headpond elevation and station generation should be recorded hourly, with records maintained digitally for the term of any new license issued for the Project. Since KEI proposes to eliminate its downstream minimum flow requirement of 150 cfs because "…inflows and out flows from that project should be equal and maintain aquatic habitat conditions downstream" there should be no fluctuation of the headpond. Instantaneous run of river operation may be temporarily modified if required by operating emergencies beyond the control of the Applicant or for short periods upon mutual agreement from the Service and the other agencies.

4.1 General Description of the River Basin

Lowell Tannery is the only dam located on the Passadumkeag River, 13 miles upstream from the confluence of the Penobscot River and approximately 30 miles from the Milford Hydroelectric project (FERC No. 2534). While KEI states, "There are two dams located on upstream tributaries of the Project, one on Eskutassis River at Gristmill Pond approximately 3 miles away and one at the outlet of Nicatous Lake (Figure 4.3)" information regarding restoration activities upstream of the Project, including removal of barriers, is not included in the DLA. As stated in our PAD and ISR comment letters, the Service is working closely with the Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Atlantic Salmon Federation, and other agencies, to restore alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), collectively referred to as river herring, to the Passadumkeag River.[8] This effort is guided by the State of Maine's diadromous fish restoration plan (Plan) for the Penobscot River (MDIFW 2009)[9] which is a comprehensive plan under Section 803 (a)(2)(A) of the Federal Power Act.

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[8] This includes lakes within the watershed. For example, Eskutassis Lake and Gristmill Pond

[9] MDMR and MDIFW. 2009. Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River. Augusta, Maine. 358 pp.

The Plan is separated into three phases and identifies lakes in the Passadumkeag River watershed that would be restored, or should be considered for restoration, by 2050.[10] Phase 1 of the Plan is complete, with alewife stocked into Saponac and Madagascal Ponds. Phase 2 is currently underway and includes Eskutassis (Eskutassis, Little Eskutassis and Gristmill Ponds) and Number Three Pond, which will support a run of about 434,000 fish. Phase 2 will be finished by 2023. Phase 3 includes opening habitat upstream of Grand Falls, which has been documented to be passable by Atlantic salmon (*Salmo salar*) and may be passable to alewife by 2050. Phase 3 includes six lakes with a total potential alewife run size of about 2,759,000 fish.

The Service estimates that the minimum alewife run size moving past the Project will be approximately 845,000 fish within the next ten years.

4.9 Fish and Aquatic Resources

<u>Existing Fish Passage Measures</u>

In the DLA, KEI states "…40 cfs of attraction and conveyance water is discharged near the base of the powerhouse through the fishway." However, as stated in our ISR comment letter, the fishway only conveys 20 cfs (two percent of the hydraulic capacity of 905 cfs) which would be augmented by 20 cfs from an auxiliary water supply (AWS) if it were functional. However, the AWS hasn't been operational for over a decade. The Applicant should include this information in the Final License Application (FLA).

<u>River Herring</u>

Based on data collected from 2011 to 2020, the Project's fishway has a demonstrated effectiveness ranging from 2.7 to 57.6 percent. While KEI is working with the University of Maine to conduct an additional year of study related to the fishways effectiveness, data collected to date shows that the current, three-foot-wide Denil, at the Project (1) is not effective at passing river herring; and (2) is undersized and cannot meet the future watershed goals for river herring.[11] Pending the 2020/2021 study the Applicant is working on with the University of Maine, KEI should, in its FLA, include, robust and appropriate PME measures that will ensure the safe, timely, and effective passage of river herring past the dam.

<u>Desktop Turbine Passage and Survival Study</u>

In lieu of a downstream telemetry study requested by the agencies, KEI performed a *Desktop Turbine Passage and Survival Study* and submitted the study results to the agencies on March 6, 2020.[12] In response, the Service asked KEI to adjust several of the parameters used, and

[10] 14,740 acres of alewife habitat, all of which are upstream of the Project, are identified in the Plan.
[11] According to the Service's Fish Passage Engineering Design Criteria manual, the rule of thumb is 200,000 adult river herring as an annual capacity for a four-foot wide denil.
[12] Desktop entrainment analyses are useful tools but do not provide true estimates of downstream passage survival. Without data from telemetry studies to inform inputs, such as bypass efficiency values, analysts and reviewers must speculate on inputs to estimate passage survival at hydroelectric dams. Consequently, desktop analyses create challenges in assessing which modeled scenarios are most representative of actual project characteristics and how

assumptions made, in the study. However, as stated in the DLA, "…KEI (USA) respectfully did not adopt some of these requests in the revised analysis because additional, detailed analysis of the existing downstream fishway is not warranted." It is unclear why modifying certain parameters, so they are consistent with Service guidance, is not warranted. Of particular concern is the need to adjust the strike mortality correlation factor, or lambda, in the existing model. Per the Service's guidance (Attachment A), the desktop analysis should be performed using a lambda value of 0.2 for salmonid and alosine fishes and 0.4 for adult American eel.

Based on the results of the existing desktop study, KEI states "…turbine and whole station survival is low for larger-bodied adult American eel. Therefore, KEI (USA) is conducting a feasibility study of downstream eel passage alternatives. These alternatives will be provided in the FLA." To date, details about the feasibility study and passage alternatives study have not been provided to the agencies, and we have not been consulted on key study details including but not limited to methodology and alternatives being considered.

Given that the DLA was filed before the full suite of downstream studies were completed, KEI's analysis of potential project effects does not fully benefit from the results of the relicensing studies. As such, the Applicant has not proposed any operational changes and has not proposed any new PME measures to protect downstream migrating eel. Therefore, due to the lack of substantive information regarding downstream passage in the DLA, the Service is unable to provide comprehensive comments at this point in the licensing process.

Environmental Effects – Proposed Action

Seven nighttime eel surveys were performed from June 4 to August 20, 2020 and "Approximately 5,000 to 8,000 American eels were observed in total, with the largest congregation of eels on the sill." In the DLA, KEI states, "Researchers documented a potential eel ladder location in 2020 (Figure 4.15). KEI (USA) anticipates designing an upstream eel passage ladder in consultation with the resource agencies as part of post-license compliance activities. KEI (USA) also anticipates development of downstream passage measures for American eel as a post-license compliance measure, contingent on timing of providing upstream passage facilities."

Based on data collected by the Applicant to date, upstream and downstream eel passage and protection measures at the Project are warranted. Dedicated upstream eel passage is necessary to provide access to rearing habitat upstream of the Project, throughout the migratory eel passage season. Similarly, eels and alosines need to be protected as they attempt to move downstream past the Project. Upstream and downstream fish passage structures at Lowell Tannery should provide safe, timely, and effective passage and be designed in consultation with, and require approval by, the Service. The designs should be consistent with the Service's 2019 Fish Passage Engineering Design Criteria Manual (USFWS 2019) or updated versions as they become available.

Thank you for this opportunity to comment. Please direct any questions to Julianne Rosset at

---

downstream migratory fish interact with a particular project. Moreover, desktop analyses do not provide information regarding passage delays, injuries, or latent mortality.

julianne_rosset@fws.gov.

Sincerely,

AMANDA CROSS Digitally signed by AMANDA CROSS
Date: 2021.09.14 08:39:30 -04'00'

Amanda S. Cross, Ph.D.
Project Leader
Maine Field Office
Maine-New Hampshire
Fish and Wildlife Service Complex

cc: PIN, Dan McCaw
NMFS, Jeff Murphy
MEDEP, Christopher Sferra
MEDMR, Casey Clark
MEDIFW, John Perry
RO/Fisheries, Brian Sojkowski
ES: JRosset:9-14-21:(603)309-4842

LITERATURE CITED

USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts

ATTACHMENT A

United States Department of the Interior

FISH AND WILDLIFE SERVICE

300 Westgate Center Drive
Hadley, MA 01035-9589

December 8, 2020

MEMORANDUM

To: Hydropower Program, Ecological Services, North Atlantic - Appalachian Region

From: Brett Towler, Regional Fish Passage Engineer, FAC, Regional Office
Jessica Pica, Regional Fish Passage Engineer, FAC, Regional Office

Subject: TBSA strike mortality correlation factor for eels in Kaplan turbines

On March 16, 2019, Fish Passage Engineering (Engineering) released an updated version of the entrainment model, Turbine Blade Strike Analysis or TBSA (Towler and Pica, 2019). This package is an Excel-based Visual Basic for Applications (VBA) implementation of the blade strike equations described in "Development of Environmentally Advanced Hydropower Turbine Systems Design Concepts" by Franke et al., 1997. That development provides for the adjustment of modeled results to empirical data through a strike mortality correlation factor, λ. Accordingly, lambda (λ) integrates the effects of typically secondary injury mechanisms and other influences on turbine-related mortality. Based on numerous studies primarily conducted on salmonids, Franke et al. (1997) recommends a factor in the range: $0.1 \leq \lambda \leq 0.2$. This range is reasonably extrapolated to species of similar body form and locomotion style (e.g., American shad, alewife, trout). Since the predictive results are sensitive to lambda, Engineering recommends using a conservative value of $\lambda = 0.2$ when modeling salmonid and alosine entrainment with the TBSA package.

The American eel is also impacted by turbine entrainment at hydroelectric facilities. In contrast to salmonids and alosines, the eel is characterized by a catadromous life cycle and an anguilliform body shape and locomotion style. These characteristics may contribute to a distinct response when eels are subjected to turbine entrainment. Indeed, there is evidence that eel mortality may be higher in Kaplan turbines than in Francis turbines (GSE, 2012). While Franke et al. (1997) asserts that "no effect of species is observed for fish survival through Kaplan turbines", this finding appears to be based on only 2 anguillid studies. Given the ecological significance of the American eel, a further examination of lambda for eel entrainment is warranted.

Recently, Engineering performed an analysis on a published data set of European eel mortality rates through Kaplan turbines. TBSA models were created for all 74 turbine tests from 17 sites reported in Gomes and Larinier (2008). All units were 3-to-6 blade Kaplan turbines with diameters and rotational speeds ranging from 4.3 – 21 feet and 68 – 375 rpm, respectively. Mortality rates were reported for adult eels ranging in tail lengths of 11.8 to 40.2 inches. Turbine efficiencies (a required TBSA input) were not reported in the study. Kaplan turbines are typified by near-flat efficiency curve over a relatively wide range of fractional hydraulic capacities. Therefore, a uniform efficiency of 90% was assumed for all turbines operating at 70% gate or greater; this reduced the number of models to 49. In each of these TBSA models, lambda (λ) was set so that model predictions matched the empirical results. In this way, each model's λ was calibrated. The overall results are described by the following:

Measure :	Mean	Median	SD
lambda (λ)	0.402	0.401	0.134

The symmetrical distribution of lambda (λ) supports the data's overall correlation with the Franke et al. (1997) equations upon which TBSA is based. While significant variability in lambda was observed (see attached), the variance appears to be of lesser magnitude than similar calibrations performed by Franke et al. (1997).

In summary, Engineering's analysis of the Gomes and Larinier (2008) data suggest a greater value of lambda (λ) is warranted when modeling adult eel entrainment in Kaplan turbines. However, these results are preliminary and future analyses of additional data sets are planned. In the interim, Engineering recommends a lambda value of λ =0.4 for TBSA models of adult eel entrainment through Kaplan and propeller turbines.

Please contact Brett Towler at brett_towler@fws.gov or Jessica Pica at jessica_pica@fws.gov if you have any questions or concerns.

Attachment

cc: K. Sprankle, CTR FWCO, FAC
S. Eyler, Mid-Atlantic FWCO, FAC

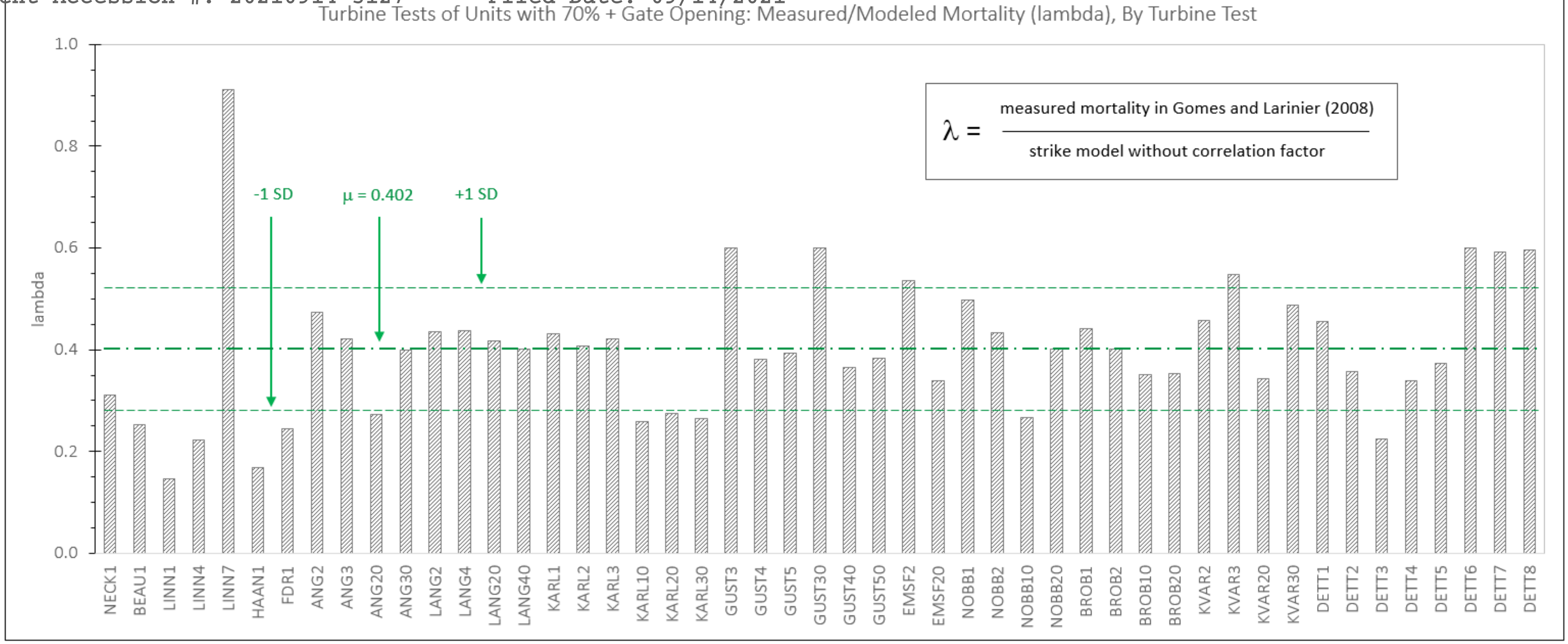
Citations:

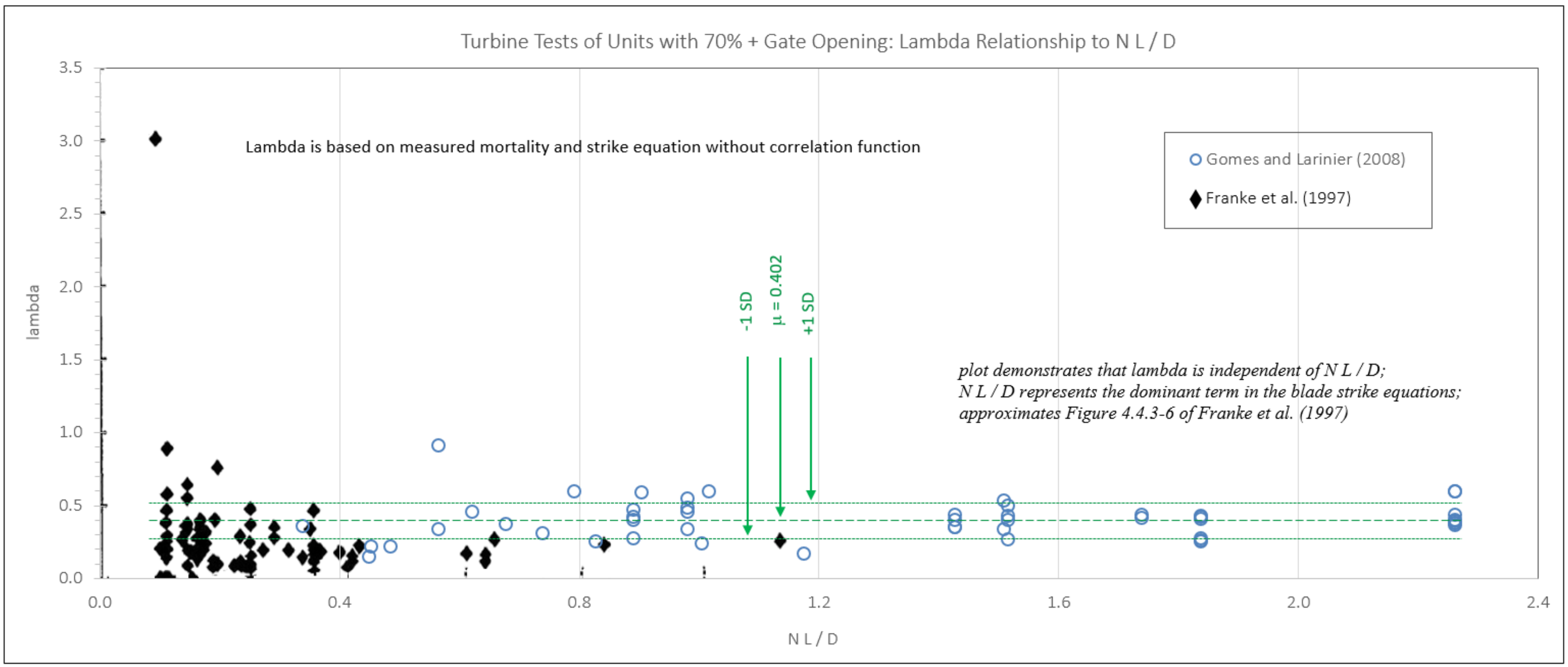
Franke, G. F., Webb, D. R., Fisher, R. K. Jr., Mathur, D., Hopping, P. N., March, P. A., Headrick, M. R., Laczo, I. T., Ventikos, Y., Sotiropoulos, F., 1997. Development of Environmentally Advanced Hydropower Turbine System Design Concepts. Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID 83415.

Gomes P., Larinier M., 2008. Dommages subis par les anguilles lors de leur passage au travers des turbines Kaplan. Établissement de formules prédictives. Rapport GHAAPPE RA 08.05, 75 p.

Gomez and Sullivan Engineers, P.C., 2012, Final Study Report Biological and Engineering Studies of American Eel, RSP 3.3, Conowingo Hydroelectric Project, FERC Project Number 405. Prepared for Exelon. August 2012.

Towler, B. Pica, J., 2019. Oral Presentation: "Turbine blade strike analysis model: A desktop tool for estimating mortality of fish entrained in hydroelectric turbines." Connecticut River Atlantic Salmon Commission (CRASC) Research Forum, March 19, 2019, Hadley, Massachusetts.


Turbine Tests of Units with 70% + Gate Opening: Measured/Modeled Mortality (lambda), By Turbine Test
λ = measured mortality in Gomes and Larinier (2008) / strike model without correlation factor
-1 SD
μ = 0.402
+1 SD
lambda
NECK1 BEAU1 LINN1 LINN4 LINN7 HAAN1 FDR1 ANG2 ANG3 ANG20 ANG30 LANG2 LANG4 LANG20 LANG40 KARL1 KARL2 KARL3 KARL10 KARL20 KARL30 GUST3 GUST4 GUST5 GUST30 GUST40 GUST50 EMSF2 EMSF20 NOBB1 NOBB2 NOBB10 NOBB20 BROB1 BROB2 BROB10 BROB20 KVAR2 KVAR3 KVAR20 KVAR30 DETT1 DETT2 DETT3 DETT4 DETT5 DETT6 DETT7 DETT8


Turbine Tests of Units with 70% + Gate Opening: Lambda Relationship to N L / D
Lambda is based on measured mortality and strike equation without correlation function
Gomes and Larinier (2008)
Franke et al. (1997)
-1 SD
μ = 0.402
+1 SD
plot demonstrates that lambda is independent of N L / D;
N L / D represents the dominant term in the blade strike equations;
approximates Figure 4.4.3-6 of Franke et al. (1997)
lambda
N L / D

Document Content(s)

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

September 17, 2021

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Lowell Tannery Hydroelectric Project (P-4202)

Dear Secretary Bose:

The Maine Department of Marine Resources (MDMR) is writing in response to Draft License Application (DLA) submitted by KEI (USA) Power Management (II) LLC (KEI; Applicant) on June 18, 2021 as part of the Traditional License Process for the Lowell Tannery Hydroelectric Project (FERC No. 4202), located on the Passadumkeag River in Penobscot County, Maine. MDMR has reviewed the DLA and includes our comments in the attached document.

If you have any questions or need additional information, please contact (casey.clark@maine.gov) or (207) 624-6594.

Sincerely,

Patrick C. Keliher, Commissioner

cc: Sean Ledwin, Gail Wippelhauser, Casey Clark, DMR
John Perry, DIFW
Kathy Howatt, DEP
Amanda Cross, Julianne Rosset, USFWS
Jeff Murphy, NOAA
Dan McCaw, PIN

Background

The Lowell Tannery Hydroelectric Project is located on the Passadumkeag River in the Town of Lowell, Maine. The Passadumkeag River is a tributary to the Penobscot River. The Project consists of a dam, spillway, fish passage facilities, a 1,000 kw powerhouse, and ancillary equipment. The Project has a drainage area of 301 square miles, and at a normal pool elevation of 182.3 feet, has a reservoir surface area of 68.5 acres.

KEI issued a Pre-Application Document (PAD) on September 26, 2018. MDMR filed comments on the PAD on March 11, 2019 and requested three studies: an American eel upstream passage facility design and siting study, an upstream passage effectiveness and survival study for Atlantic salmon and river herring, and a downstream passage effectiveness and survival study using adult river herring and adult American eel. KEI did not submit a Proposed Study Plan (PSP) prior to the 2019 study season. On March 6, 2020 KEI provided the Initial Study Report (ISR) for review and comment, and on the same date KEI submitted a draft study plan for the 2020 study season. On October 15, 2020 the National Marine Fisheries Service (NMFS) submitted a Request for Dispute Resolution for the Conduct of Studies (dispute). On February 10, 2021, FERC issued its dispute determination, requiring KEI to conduct the upstream passage effectiveness study requested by NMFS in the 2021 season. No study report for the 2021 study season has been filed.

Exhibit A

2.1 Project Facilities

KEI states, "The top of flashboards height (normal pond) is at elevation 182.3 feet." According to the description of the Project in the PAD and parts of the DLA, the normal headpond is 187.5, not 182.3. MDMR requests that KEI correct this inconsistency and clarify what the existing flashboard height is at the Project, as well as the normal headpond elevation.

In addition, KEI states, "The project reservoir is approximately 314 acres at elevation 187.5 feet mean sea level." Although in table 2.1 of the DLA the project reservoir is stated to be 341 acres. As the headpond elevation determines the surface acres of the impoundment, MDMR requests KEI clarify the correct impoundment elevation and the correct headpond surface area.

KEI is not proposing any changes to the existing Project facilities.

Exhibit E

1.2.2 Endangered Species Act

KEI states, "Critical habitat has been designated for the Atlantic salmon within the Penobscot River however, the Passadumkeag River is not classified as critical habitat for species recovery (74 FR 29300; June 19, 2009) (i.e., critical to the recovery of the species)." While the Passadumkeag River is not critical habitat for the GOM DPS of Atlantic salmon, the listed salmon occupy habitat above and below the Project and have been documented in the vicinity of the Project. KEI collaborated on PIT tag studies of salmon at the Project that were conducted by University of Maine Orono in recent years. In addition, post-spawn adults were documented at in the Project headpond in April 2012. Based upon on-site observations by NMFS and MDMR staff, these adult fish were unable to find a safe downstream route pass the Lowell Tannery Project. KEI staff were aware of this issue in 2012. Also, Atlantic salmon parr were stocked in the lower Passadumkeag River annually from 1989 - 2001(USASC 2018).

2.1.1 Existing Project Description

KEI states, "KEI (USA) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse." The attraction water system has been inoperable for several years and MDMR has no record of the attraction water system being repaired. With the attraction water system inoperable, the conveyance water through the fishway, which is 20 cfs, is the only water provided for the upstream fishway facility. MDMR requests that KEI include a description of the status of the attraction water system.

KEI states, "When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam." Similar to the "plunge pool" description for the downstream fishway, MDMR requests that the Applicant describe the receiving area below the spill areas. Adequate water depth below spill areas is needed to ensure safe downstream passage for Atlantic salmon and other diadromous species.

2.4.1 Proposed Project Operations

KEI is not proposing any changes to the existing Project facilities.

2.4.1 Proposed Project Operations

KEI proposes to continue to operate in run-of-river mode such that inflow to the reservoir is equal to outflow for the purpose of protecting and enhancing aquatic resources in the Passadumkeag River "…while maintaining the headpond within one foot of elevation 187.5 feet." MDMR supports the recommendation of the U.S. Fish and Wildlife Service (USFWS) that KEI operated the Project in instantaneous run-of-river mode to include the following:

- Inflow to the Project equal outflow from the Project at all times and water levels above the dam are not drawn down for the purpose of generating power.
- Development an operations and compliance monitoring plan in consultation with the agencies. The plan should describe mechanisms and structures that will be used, including level of manual and automatic operation, methods used for recording data, the protocol for providing data to the agencies, and an implementation schedule.
- Headpond elevation and station generation should be recorded hourly, with records maintained digitally for the term of any new license issued for the Project.
- Instantaneous run of river operation may be temporarily modified if required by operating emergencies beyond the control of the Applicant or for short periods upon mutual agreement from MDMR and the other resource agencies.

4.1.2 Major Water Uses

KEI states, "The Project is the only dam located on the Passadumkeag River approximately 13-miles upstream from the confluence of the Penobscot River. There are two dams located on upstream tributaries of the Project, one on Eskutassis River at Gristmill Pond approximately 3 miles away and one on Craig Brook, Cold Stream Pond, owned by the State of Maine Department of Inland Fisheries and Wildlife, approximately 6 miles northwest (USACE, 2018)." The Lowell Tannery Project is the only hydropower project in the Passadumkeag watershed. The two dams referred to in the DLA are small, historic dams that are identified under Phase 2 for restoration of passage for diadromous species in the comprehensive plan for the Penobscot Watershed (Plan)[1]. MDMR is collaborating with the Maine Department of Inland Fisheries and Wildlife, USFWS, the Atlantic Salmon Federation, and others to restore Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*), collectively referred to as river herring, to the Passadumkeag River. Namely, passage into Eskutassis (Eskutassis, Little Eskutassis, and Gristmill Ponds) is in the design phase and should be implemented by 2023. Once passage into Eskutassis is complete, all of the Phase 1 and Phase 2 alewife habitats in the Passadumkeag Watershed will be accessible. MDMR anticipates adult returns of alewives to Phase 1 and Phase 2 habitats to be 1.35 million annually (range of 0.8 million to 2.8 million)[2]. Additional restoration activities are planned to occur by 2050 under Phase 3 of the Plan. Completion of assess to Phase 3 habitats will increase adult returns to the Passadumkeag Watershed to 4.3 million annually (range of 2.6 million to 9.3 million).

KEI states, "The West Branch of the river is known for its landlock salmon fishing and the East Branch is very well known for its small mouth bass fisheries (TMH 2018)." TMH is not a primary source and the statement above from the DLA does not reflect the management plan of the agencies that oversee the watershed. MDMR recommends this statement be removed from the FLA. For accurate information on the Penobscot river, please refer to the comprehensive management plans for the Penobscot River[3].

4.9 Fish and Aquatic Resources

KEI states, "The depth immediately upstream of the dam is 20 feet, and the surface area of the reservoir is 68.5 acres." MDMR recommends KEI clarify the correct surface area of the reservoir.

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[1] MDMR and MDIFW. 2009. Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River. Augusta, Maine. 358 pp.

[2] Estimates of alewife production are based on 1) average productivity is 397 adults per acre (average productivity for harvested Maine ponds); 2) minimum productivity is 235 adults per acre (ASMFC 2017 River Herring Stock Assessment); 3) maximum productivity is 841 adults per acre (Gibson et al. 2017).

[3] MDMR and MDIFW. 2009. Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River. Augusta, Maine. 358 pp.

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4.9.1.2 Fish Passage and Diadromous Fish Species

KEI states, "Very few salmon, other than escapees or immature adults, are passed upstream of the Milford Project." This statement does not accurately summarize the returns and escapement of adult Atlantic salmon to the Penobscot River. MDMR recommends the Applicant refer to the annual reports of the U.S. Atlantic Salmon Assessment Committee for accurate information

River Herring

Data on fish passage effectiveness of the Project's Denil fishway has been collected from 2011 to 2020 in different forms. This data has demonstrated effectiveness ranging from 2.7 to 57.6 percent[4]. As required by FERC, KEI contracted with the University of Maine to conduct a project specific upstream passage effectiveness study in 2021. The results of the 2021 study have not been reported. The data that has been reported has shown that the current Denil fishway is not effective at passing river herring. In addition, the current three-foot wide Denil at the project is undersized and cannot meet the capacity requirements for watershed goals for river herring. According to the USFWS's Fish Passage Engineering Design Criteria Manual, a four-foot wide Denil is capable of effectively passing 200,000 river herring annually.[5] MDMR recommends KEI include PME measures in the FLA that will ensure safe, timely, and effective passage of river herring. These measures should be mindful that Atlantic salmon, American Shad, and Sea lamprey will also make use of the upstream fish passage facilities at the project.

Desktop Turbine Passage and Survival Study

While the agencies requested downstream telemetry and survival studies for river herring and American eel, KEI performed only a desktop modeling study. KEI submitted the study report on March 6, 2020. The study report demonstrated an inappropriate use of inputs to the desktop entrainment model. Per USFWS' guidance, the desktop analysis should be performed using a lambda value of 0.2 for salmonid and alosine species and 0.4 for adult American eel. In addition, the report included passage route proportions that are disproportionate to flow at the project.[6] MDMR recommends KEI correct the errors in this study and include updated estimates in the FLA.

Even with overly optimistic input values for the desktop study, KEI found ""…turbine and whole station survival is low for larger-bodied adult American eel. Therefore, KEI (USA) is conducting a feasibility study of downstream eel passage alternatives. These alternatives will be provided in the FLA." As of this filing, no details about the feasibility study nor the passage

[4] Data collected in some years included only internal fishway effectiveness and did not include project approach effectiveness or false attraction.
[5] USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts
[6] As no project specific data is available, the route of passage for downstream migrating fish should be assumed to be equal to the proportion of flow through the passage routes.

alternatives study have been provided to the resource agencies. MDMR recommends KEI consult with the agencies about the methodologies and approach for these studies to ensure appropriate alternatives are being included in the studies.

As the DLA was filed before the full suite of downstream studies were completed, KEI's analysis of potential project effects is lacking information from the relicensing studies and therefore is not based on the best available information of the Project. As such, MDMR is unable to provide comprehensive comments at this point in the relicensing process.

Environmental Effects – Proposed Action

KEI states, "Researchers documented a potential eel ladder location in 2020 (Figure 4.15). KEI (USA) anticipates designing an upstream eel passage ladder in consultation with the resource agencies as part of post-license compliance activities. KEI (USA) also anticipates development of downstream passage measures for American eel as a post-license compliance measure, contingent on timing of providing upstream passage facilities." In addition, KEI states, "Approximately 5,000 to 8,000 American eels were observed in total, with the largest congregation of eels on the sill." These observations were from seven nighttime eel surveys that were performed during the 2020 study season.

On the basis of data collected by the Licensee to date, MDMR has determined that safe, timely, and effective upstream and downstream passage for diadromous species and protection measures at the Project are warranted. The existing upstream anadromous passage facility does not effectively pass river herring and is undersized for the expected number of returning adults. Dedicated upstream passage for American eel that is operated throughout the migration period is necessary to provide access to growth habitat upstream of the Project. The effectiveness of the existing downstream passage facility for adult American eel, juvenile Atlantic salmon, and adult and juvenile river herring was estimated from a desk-top analysis – no field studies were conducted. The study showed that turbine and whole station survival was low for larger-bodied adult American eel. KEI (USA) states that it is conducting a feasibility study of downstream eel passage alternatives, and the alternatives will be provided in the FLA. Upstream and downstream fish passage structures at the project should be designed in consultation with the agencies, and the designs should be consistent with the Service's 2019 Fish Passage Engineering Design Criteria Manual (USFWS 2019, entire) or updated version.

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Document Content(s)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

September 15, 2021

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E
Washington, DC 20426

RE: Comments on the Lowell Tannery Hydroelectric Project (FERC No. 4202) Draft License Application and Study Report

Dear Secretary Bose:

On June 18, 2021, KEI (USA) Power Management Inc. (KEI (USA)) provided us with a copy of the Draft License Application (DLA) and Study Report for the relicensing of the Lowell Tannery Project on the Passadumkeag River in Maine. KEI (USA) requested written comments on the DLA and Study Report within 90 days of the date the documents were transmitted (i.e., September 17, 2021). Pursuant to the Commission's regulations at 18 CFR §385.2008 and as detailed below, we request an extension to file written comments on the DLA and Study Report.

On February 10, 2021, in response to our request for formal dispute resolution concerning the conduct of upstream and downstream passage studies during the relicensing of the Lowell Tannery Project, the Commission required KEI (USA) to conduct an upstream passage study of adult alosines using radio telemetry techniques at the project in the spring of 2021. Although the study was completed in the spring of 2021, neither the June 18, 2021 DLA or Study Report presented the results of the study. In the DLA, KEI (USA) acknowledges this ongoing study and states that "KEI (USA) and UMaine are currently (2021) conducting a follow-up study utilizing radio telemetry, as required by the Commission by letter."

The 2021 upstream passage study will provide the only empirical data collected by the Licensee over the course of this entire relicensing concerning the overall effects of project operations, including delay and false attraction, on the upstream passage of alosines. Since the DLA was filed before the study results were available, the Licensee's analysis omits potential project effects that the Commission determined were necessary to study and consider in order to form potential license conditions. We note that KEI (USA) has not proposed any operational changes and has not proposed any new protection, mitigation, or enhancement measures for upstream passage at the project despite the fact that previous studies conducted by UMaine using Passive Integrated Transponders have documented significant issues with internal passage efficiency at the project for alosines. We also note that internal passage efficiency is just one component of a fishway's effectiveness and the 2021 telemetry study will provide a comprehensive evaluation of near-field and far-field attraction as well as delay. We anticipate that the 2021 study results will demonstrate the need for additional measures to improve upstream passage at the project. As the 2021 study results are critical to our understanding of the effects of project operations on our trust resources and to evaluate the need for potential license articles, we are unable to provide comprehensive comments at this point in the licensing process. For these reasons and under good cause as provided at 18 CFR §385.2008 (Extensions of time, Rule 2008), we request a 90-day extension to submit written comments to KEI (USA) on the DLA and Study Report, with this 90 day period to begin upon our receipt of the 2021 upstream passage study report.

We appreciate this opportunity to comment and look forward to continued consultation and collaboration on appropriate protection, mitigation, and enhancement measures for the licensing of the Lowell Tannery Project. If you have any questions regarding this letter, please contact Jeff Murphy of this office at jeff.murphy@noaa.gov.

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

cc: Service List

Document Content(s)

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

JANET T. MILLS
GOVERNOR

GERALD D. REID
COMMISSIONER

September 16, 2021

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Draft Licensing Application for the Lowell Tannery Hydroelectric Project (FERC No. 4202)

Dear Secretary Bose:

The Maine Department of Environmental Protection (Department or DEP) reviewed a Pre-Application Document (PAD), submitted on September 26, 2018, a Water Quality Study Plan dated June 2019, and the 2019 Initial Study Report (ISR) issued March 26, 2020. The Department also attended a Initial Study Report Meeting on March 27, 2020, organized by Kruger Energy, KEI (USA) Power Management Inc. (Applicant), for the Lowell Tannery Hydroelectric Project (LTHP, Project) (FERC No. 4202) that detailed the results of those water quality studies and discussed additional studies for the (then) upcoming field season. Department staff submitted comments to the ISR on April 17, 2020 and have reviewed the Draft License Application (DLA), submitted for review on June 18, 2021.

As previously noted, the proposed relicensing of the LTHP is subject to water quality certification provisions of Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act). By Executive Order of the Governor of the State of Maine, the Department is the certifying agency for projects located wholly or partially in organized towns and cities, and as such has jurisdiction over the Project.

Background

Water quality studies requested by the Department to be conducted pursuant to the Project study plan included studies intended to demonstrate whether water quality in the vicinity of the Project meets Maine's water quality standards for Class A waters (upstream of the Project) and Class AA waters (downstream of the project dam) [1] and to assess whether current instream flow releases and project operations are affecting attainment of classification standards.

The existing LTHP consists of a 230-foot-long, 27-foot-high concrete gravity dam with a crest elevation of approximately 184.0 feet[2] topped with 3.5-foot-high flashboards (for a total of 187.5 feet normal pond elevation), with a principal spillway of 30 feet and an auxiliary spillway of 89

[1] 38 M.R.S. Section 467(7)(F)(6)(a)
[2] Elevations are provided in feet above mean sea level.

feet, a seven-foot-wide log sluice and a 10-foot-wide tainter gate. The dam impounds a reservoir with a surface area of approximately 68.5 acres at a normal pond elevation. The dam contains a 3-foot-wide Denil fish passage facility and a dedicated downstream fish bypass pipe. A powerhouse integral to the dam contains a single turbine-generator unit with a total generating capacity of 1 MW and an average annual generation of approximately 4,095 MWh. The Lowell Tannery Project operates in a run of river mode where upstream water flowing into the project impoundment approximately equals water flowing downstream from the project.

The Department understands that there are no proposed changes in facilities or operations of the LTHP at this time.

The Department has reviewed the DLA materials and has the following comments:

Water Quality Studies

Impoundment Trophic State Study – The purpose of trophic state study is to determine, if the Project impoundment has a steady or decreasing trophic state subject only to natural fluctuations and is free of algal blooms that impair the impoundment use or enjoyment. The Department requested the Impoundment Trophic State Study in their March 2019 PAD comments.

This study was conducted by the Applicant between June and October 2019, in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018).

The March 2020 ISR and DLA indicate some impairments to impoundment water quality. Nutrient concentration exceeding those determined by the Department to be acceptable can cause negative environmental impacts to surface waters, such as algal blooms, low dissolved oxygen concentrations, excessive growths of filamentous algae or bacteria, generation of cyanotoxins or affecting the resident biological community. Project study results indicated nutrient concentrations (phosphorus and chlorophyll-a) in the Lowell Tannery impoundment exceed generally acceptable concentrations for Class A waters. Secchi disk transparency measurements ranged from 1.9-2.9 meters; measurements less than two meters can indicate algal growth, especially in the presence of excessive nutrients. A single Secchi disk measurement, collected on October 2, 2019, was less than the two-meter threshold demonstrating attainment of Class AA/A water quality standards, however color values are high (85-100 PCU) in the Passadumkeag River at this location, which prevents conclusions being drawn from the Secchi disk transparency measurements.

DO concentrations in the impoundment failed to attain Maine Water Quality Standards, specifically the minimum criteria of 7 ppm, on 4 of 10 sampling dates (40% of the sampling period). As summarized below the Applicant conducted an additional DO monitoring study in 2020. The Department provides its evaluation of the DO data collected in 2019 and 2020 in the comment section below.

Downstream Temperature and Dissolved Oxygen Study – Temperature and DO were monitored downstream of the Lowell Tannery Dam to demonstrate whether the Project meets Maine's DO numeric criteria downstream of the Project.

This study was conducted by the Applicant between June and October 2019, in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018). This study was conducted with Maine's Class AA/A minimum dissolved oxygen criteria of 7 parts per million and 75% saturation.

The March 2020 ISR and DLA indicated some impairment to tailwater DO. DO results ranged from 6.2 mg/L to 10 mg/L, with percent saturation ranging between 70.9% and 104.5%. Dissolved oxygen concentrations in the tailwater failed to attain Maine Water Quality Standards, specifically the minimum criteria of 7 ppm. The Study notes that DO concentrations appear to track the concentrations measured in the impoundment during generation, and generally increase when generation stops.

As discussed above, the results of both studies conducted in 2019 indicated that DO did not meet the 7 parts per million (PPM) concentration for Class A criteria in the impoundment or the 7 PPM concentration for Class AA criteria in the tailwater of the Project. MDEP stated these water quality deficiencies to the Applicant and to FERC in their April 2020 comments to the ISR. Further, the Department stated that, to aid in determining whether the cause of low DO is upstream or arises in the impoundment, the Applicant could sample DO above, within, and below the impoundment twice each day (before 8:00am and again in mid-afternoon at each), following the DEP SAMPING PROTOCOL FOR HYDROPOWER STUDIES (June 2018). The Applicant and its consultant, in consultation with MDEP on May 26, 2020, coordinated an additional study on DO during the 2020 field season.

Comments to Dissolved Oxygen Studies

The Applicant monitored DO and water temperature throughout the Lowell Tannery project area in July and August 2020 to evaluate whether upstream waters (i.e., impounded waters or inflowing waters to the impoundment) may have contributed to the low DO values in the impoundment and in the tailwater that were observed in 2019. KEI (USA) installed Onset Hobo U-26 dataloggers in the Passadumkeag River at four locations, which were approved by the MDEP, and recorded hourly DO and water temperature data between July 15 and August 24, 2020.

- Site 1 Upstream - approximately 3.8 river miles upstream from the dam at the transitional point between river and impounded habitat;

- Site 2 Impoundment- at the deepest location within the impoundment, where 2019 water quality samples were collected (approximately 250 feet upstream of dam, water depth approximately 20 feet);

- Site 3 Tailwater – in the tailwater directly downstream of the dam; and

• Site 4 Downstream - one mile downstream of the dam.

Figure 4.12 and Table 10 of the DLA demonstrate that waters upstream of the Project impoundment did have DO concentrations and percent saturation levels below the Class A/AA standards. The DO concentrations at the deep spot in the impoundment were consistently between 6.0 mg/L and 7.5 mg/L and 60 percent to 90 percent saturation and were below the standard. In the tailwater and downstream of the dam, the DO concentration and percent saturation were above the Class AA standards throughout the monitoring period. The Applicant provided discussions of the data on p. 4-35 and 4-36 of the DLA. This reporting only shows the max, min and average values for DO concentration, % saturation and water temperature from the 2020 DO Study. The Department requests that the Applicant submit the raw data in excel format from the 2020 DO studies for analysis.

The summary of the DO data presented in the DLA appears to show that DO numeric criteria for Class A waters was not met downstream of the Project during the sampling in 2019, but was met during the sampling in 2020. The data additionally shows that DO numeric criteria was not met in the impoundment in either 2019 or 2020, however, the 2020 sampling demonstrated that the 7 ppm numeric criteria for Class A waters was also not met at the sampling station upstream of the impoundment.

Based on the 2019 and 2020 DO data provided in the DLA, the Department is able to conclude that inflowing waters to the impoundment contributed to the low DO values in the impoundment and in the tailwater that were observed in 2019. Therefore, the Department concludes that sufficient data has been collected related to DO at the Project and, pending the submission of the 2020 DO and temperature data set, the Department will be able to make a determination of whether the Project causes of contributes to the failure of the water body to meet the Class A standard for DO.

Habitat Studies

Impoundment Aquatic Habitat Study - For water quality certification the Applicant must demonstrate that the Lowell Tannery impoundment, as a Class A water, is suitable as habitat for fish and other aquatic life; further, the habitat must be characterized as natural.

In its March 2019 PAD comments for the Lowell Tannery Project, the Department requested the Impoundment Aquatic Habitat Study, or in lieu of conducting the requested study, the Applicant was requested to submit three years of water level and flow data and impoundment bathymetry data to demonstrate run-of-river operations (ROR), wherein inflow is equal to outflow and impoundment water level fluctuations are limited to one foot.

These data were not reported or submitted in the March 2020 ISR, and the Department reiterated in their April 2020 ISR comments that this data must be submitted in order for the Department to make a determination concerning ROR operations and assess habitat in the Project impoundment. The flow and water level data were also not reported in the DLA. The Applicant presented a figure showing the bathymetry of the Project impoundment, demonstrating that this data was collected, but did not report the raw data collected during 2020. Bathymetric data is critical to the evaluation of impoundment littoral habitat and the Department requests that the raw bathymetric data be submitted (see below).

In 2014 KEI (Maine)'s WQC and FERC license for the Lowell Tannery Hydroelectric Project were amended to eliminate store and release drawdowns and establish ROR operations, with drawdowns limited to specified maintenance or emergency operations. Therefore, the Lowell Tannery Project is reported to be a ROR facility wherein inflow is generally equal to outflow, and the water level elevation does not fluctuate more than one foot from its normal full pond elevation of 187.5 feet. Under a ROR operating regime, flows are not managed for the purpose of hydropower generation. As a ROR Project, impoundment water levels at the Lowell Tannery Project must be stable and as naturally occur, generally subject only to natural variations related to precipitation events, and Project operations do not cause the water level to fluctuate.

Therefore, at least 3/4ths of the cross-sectional area of the riverine impoundment is expected to be maintained and the impoundment is expected to be suitable as habitat for fish and other aquatic life.

Aquatic Habitat Cross-Section Flow Study - The Class AA waters downstream of the Project Dam must be found suitable as habitat for fish and other aquatic life and must be free-flowing and natural. As discussed above, the Project is believed to operate in ROR mode, where inflow is generally equal to outflow. As such, all water flowing into the Project impoundment is discharged to the Class AA river below the dam, which flows freely for approximately 13 miles to its confluence with the Penobscot River. The powerhouse is aligned with the dam with no bypass reach and operates in a band of flows between 90 cfs and 905 cfs. All flows are discharged through the powerhouse, through the fishway, or over the dam as spill directly downstream to the Passadumkeag River.

In its March 2019 PAD comments, the Department requested the Applicant conduct an Aquatic Habitat Cross-Section Flow Study to demonstrate attainment of habitat and aquatic life criteria, however the study was not conducted. As stated above the flow and water level data were not reported in the ISR or the DLA.

Therefore, the Department must analyze the Project based on operations. As discussed above, ROR operations, by definition, require inflow to be equal to outflow. With all inflow delivered to the outlet stream and with no appreciable bypass reach, the Department concludes that 3/4ths of the cross-sectional area of the Passadumkeag River below the Project Dam remains wetted at all times, and is expected to provide sufficient aquatic habitat to meet the State's aquatic life and habitat standards. Further, when reviewed with the findings of the Benthic Macroinvertebrate Study (see below) the Department believes that ROR operations do not negatively affect the quality of aquatic habitat downstream of the Lowell Tannery Dam and that the habitat found there can be characterized as natural because it met Class A habitat and life criteria.

Comments to Habitat Studies

The Applicant asserts in the DLA that the Project is ROR, however, the Applicant has yet to demonstrate that the LTHP operates as ROR and has not submitted the requested inflow/outflow and water level data. In Figure 4 of the DLA, the Applicant includes a map of the impoundment bathymetry, however, no detailed bathymetry data was presented in the DLA and no data has been submitted to the Department at this time. MDEP requests that the Applicant submit the raw bathymetry data collected in 2020 in excel format for analysis.

While ROR conditions are not demonstrated by the Applicant, based on the licensed operating regime, the Department believes that at least 3/4ths of the littoral habitat remains wetted during normal Project operations and if so, in accordance with the Department's water level and flow policy, the Project meets the aquatic life and habitat standard. The Applicant can confirm the Department's understanding by submission of the requested bathymetry data and three years of water level and flow data.

Based on the information reviewed by the Department, and also based on its professional judgement, the Department believes that the outlet stream habitat meets Class AA water quality standards. Here, the Department again requests that the Applicant demonstrate the extent of habitat for fish and other aquatic life in the impoundment by submitting three years of impoundment elevation and inflow/outflow data.

Benthic Macroinvertebrate Monitoring – Assessment of the benthic macroinvertebrate community is critical to determining whether Project operations affect attainment of habitat and aquatic life criteria in the river below the Lowell Tannery dam.

KEI conducted a benthic macroinvertebrate study between August 6 and September 13, 2019 in the Class AA waters immediately downstream of the Lowell Tannery dam, in accordance with the Department's "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2014). KEI reports that three replicate rock bags were installed at one sample site in representative aquatic habitat located approximately 490 feet downstream of the dam on August 6 and were retrieved on September 13[3]. Habitat measurements, including substrate type, depth, and temperature, were collected at the time of sample retrieval.

The Applicant's consultant reports that the community structure and function downstream of the Lowell Tannery dam is generally healthy with evidence of natural biological enrichment that does not show signs of excessive stress as a result of Project operations. The Department analyzed the samples using its linear discriminant model and professional judgement to determine that while the model predicted attainment of Class B aquatic life standards, the final determination is Class A[4], based on lake outlet effect, where the impoundment discharge acts like a natural lake outlet.

[3] The Applicant's contractor was unable to retrieve the samplers within the 28 day =/- 4 day window due to high river flows.
[4] The aquatic life criteria for classes A and AA are the same. Therefore, a determination that the waters meet Class A aquatic habitat and life criteria also demonstrate attainment of Class AA. Email from the Department's Biological Monitoring Program Manager, dated March 27, 2020.

Based on the results of the BMI study, the Department concludes that KEI (Maine) has provided sufficient information to demonstrate that the benthic macroinvertebrate community in the Passadumkeag River in the vicinity of the LTHP meets Class A and Class AA aquatic life standards under current and proposed flow conditions.

Thank you for the opportunity to comment on the DLA for the Lowell Tannery Project. Please direct any questions regarding these comments to Christopher.Sferra@maine.gov (207) 446 - 1619.

Sincerely,

Christopher O. Sferra
Project Manager
Maine Department of Environmental Protection

cc: Lewis Loon, KEI (Maine) LLC
Sherri Loon, KEI (Maine) LLC
Andy Qua, Kleinschmidt Associates

Document Content(s)

From:	Isaac St. John
To:	Kayla Hopkins
Subject:	RE: Lowell Tannery Draft License Application (FERC No. 4202)
Date:	Monday, July 19, 2021 7:19:26 AM
Attachments:	image001.png

Good Morning,

We do not have an immediate concern with your project or project site, and do not currently have the resources to fully investigate same. Should any human remains, archaeological properties or other items of historical importance be unearthed while working on this project, we recommend that you stop your project and report your findings to the appropriate authorities including the Houlton Band of Maliseet Indians.

Thank you,

Isaac St. John
Tribal Historic Preservation Officer
Houlton Band of Maliseet Indians
88 Bell Road
Littleton, ME 04730

From: Kayla Hopkins [mailto:Kayla.Hopkins@KleinschmidtGroup.com]
Sent: Friday, June 18, 2021 6:05 PM
To: achp@achp.gov; harold.peterson@bia.gov; jeff.murphy@noaa.gov; donald.dow@noaa.gov; jay.l.clement@usace.army.mil; nstasuli@usgs.gov; kevin_mendik@nps.gov; timmermann.timothy@epa.gov; jim.vogel@maine.gov; kathleen.leyden@maine.gov; Howatt, Kathy <kathy.howatt@maine.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; john.perry@maine.gov; casey.clark@maine.gov; Megan.M.Rideout@maine.gov; Gordon.Kramer@maine.gov; Mark.Caron@maine.gov; kevin.dunham@maine.gov; Rosset, Julianne <julianne_rosset@fws.gov>; Hilling, Corbin D <corbin_hilling@fws.gov>; jpictou@micmac-nsn.gov; kirk.francis@penobscotnation.org; chris.sockalexis@penobscotnation.org; governorsocobasin@gmail.com; john.banks@penobscotnation.org; dan.mccaw@penobscotnation.org; csabattis@maliseets.com; istjohn@maliseets.com; Soctomah@gmail.com; heinz@maine.rr.com; nbennett@nrcm.org; bgraber@americanrivers.org; john@asf.comcastbiz.net; landis@mainerivers.org; kevin@americanwhitewater.org; bmayo@old-town.org
Cc: Andy Qua <Andy.Qua@KleinschmidtGroup.com>; Sherri.Loon@kruger.com; Teta Jungels <Teta.Jungels@KleinschmidtGroup.com>
Subject: Lowell Tannery Draft License Application (FERC No. 4202)

Good evening,

On behalf of our client KEI (USA) Power Management Inc (KEI (USA)), Kleinschmidt herein submits to agencies and interested parties the Draft License Application (DLA) and Study Report (2020) for the relicensing of the Lowell Tannery Hydroelectric Project (FERC No. 4202). The 1,000-kilowatt project is located on the Passadumkeag River in the town of Lowell, Penobscot County, Maine. The current license, issued by the Commission on October 31, 1983, expires on September 30, 2023.

Written comments are due within 90 days of the date of this email distribution (**comments due September 17, 2021**).

If there are any questions, please contact Sherri Loon at (207) 203-3026 or by email at Sherri.Loon@kruger.com.

Thank you,

Kayla A. Hopkins
Regulatory Coordinator
Kleinschmidt
Direct: (207) 416-1271
www.KleinschmidtGroup.com
*Providing **practical** solutions for **complex** problems affecting energy, water, and the environment*

September 28, 2021

VIA CERTIFIED MAIL

Lowell Tannery Hydroelectric Project (FERC No. 4202-024)
Final License Application

Dear Recipient:

KEI (USA) Power Management Inc. (KEI (USA) or Licensee), Licensee for the Lowell Tannery Hydroelectric Project (Project) is applying to the Federal Energy Regulatory Commission (FERC) for a subsequent License pursuant to the Federal Power Act to continue operation of the Lowell Tannery Hydroelectric Project located on the Passadumkeag River in the Town of Lowell, Penobscot County, Maine.

The License Application is being filed with FERC no later than September 30, 2021, and will be available for public inspection at 423 Brunswick Avenue, Gardiner, Maine 04345 or by request to Lewis Loon at (207) 203-3025. The License Application will also be available for inspection online at https://elibrary.ferc.gov/elibrary under docket number P-4202. A Project location map is attached for your reference. The FERC application process requires that affected landowners, Tribes, and nearest municipalities be notified of the application, which is why you are receiving this letter.

If there are any questions regarding the FERC application, please contact me by email at Jessica.Antonez@KleinschmidtGroup.com or by phone at (207) 416-1214.

Sincerely,

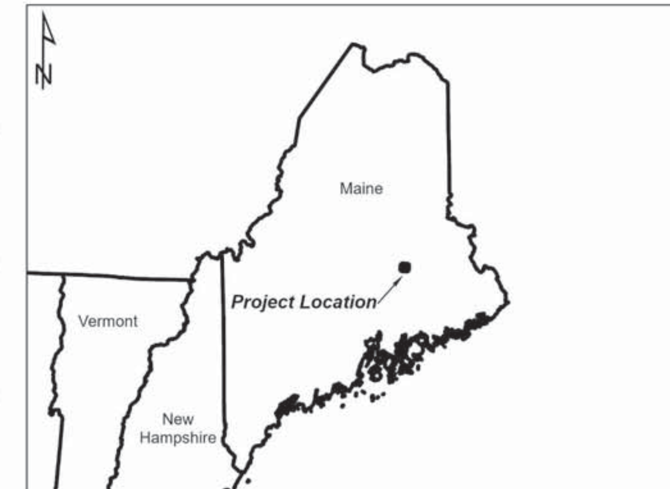
Kleinschmidt Associates

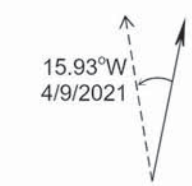
Jessica Antonez

Jessica Antonez
Associate Licensing Coordinator

Enc.: Exhibit G Project location map

PROJECT BOUNDARY MAP





- Project Boundary
- Roads
- Streams
- Waterbody
- Features
- Municipal Boundary

Map notes:
1. The Lowell Tannery Project is located in the State of Maine in Penobscot County.
2. Reference Point coordinates are shown in NAD 1983 2011 StatePlane Maine East FIPS 1801 Ft US.
3. Elevations shown are referenced to NAVD 88, where MSL = NAVD88 + 0 ft. Conversion factor was determined from NOAA tidal benchmark at Pettegrove Point, Dochet Island ME, Station ID 8410834.
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5. There are no federal lands within the Project boundary.
6. The Project boundary description, as required by 18 CFR 4.41, is represented here by a grid of Northings and Eastings around, and graticules within, the map frame. Any position in Northings and Eastings along the Project boundary can be determined using these references.
7. The Project boundary, in part, was digitized from contour elevations derived from USGS ME LiDAR data (USGS 2017, USGS 2019).

SURVEYORS STATEMENT

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STATE OF MAINE STEPHEN W. EVERETT 2161 PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

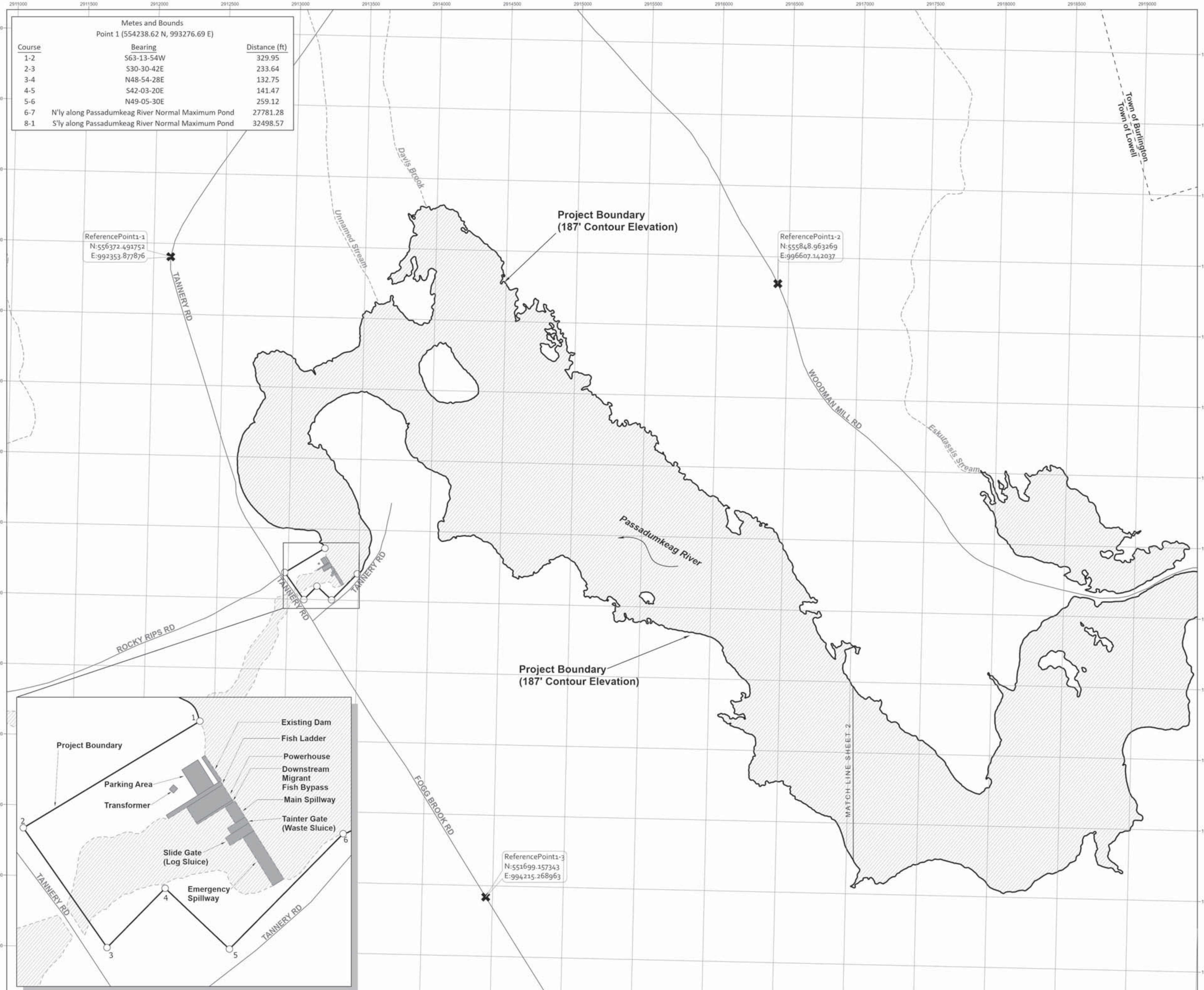
EXHIBIT G — SCALE: 1" = 720' — SHEET NO. 1 OF 4

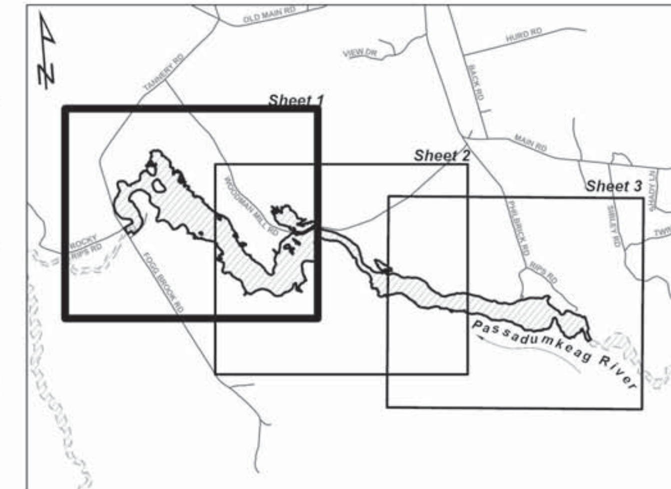
0 500 1,000 2,000 3,000 4,000 Feet

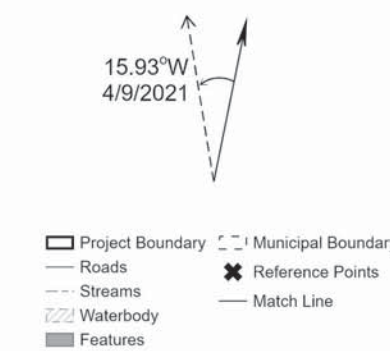
FERC DWG. NO. 4202-

Metes and Bounds
Point 1 (554238.62 N, 993276.69 E)

Course	Bearing	Distance (ft)
1-2	S63-13-54W	329.95
2-3	S30-30-42E	233.64
3-4	N48-54-28E	132.75
4-5	S42-03-20E	141.47
5-6	N49-05-30E	259.12
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57







Map notes:
1. The Lowell Tannery Project is located in the State of Maine in Penobscot County.
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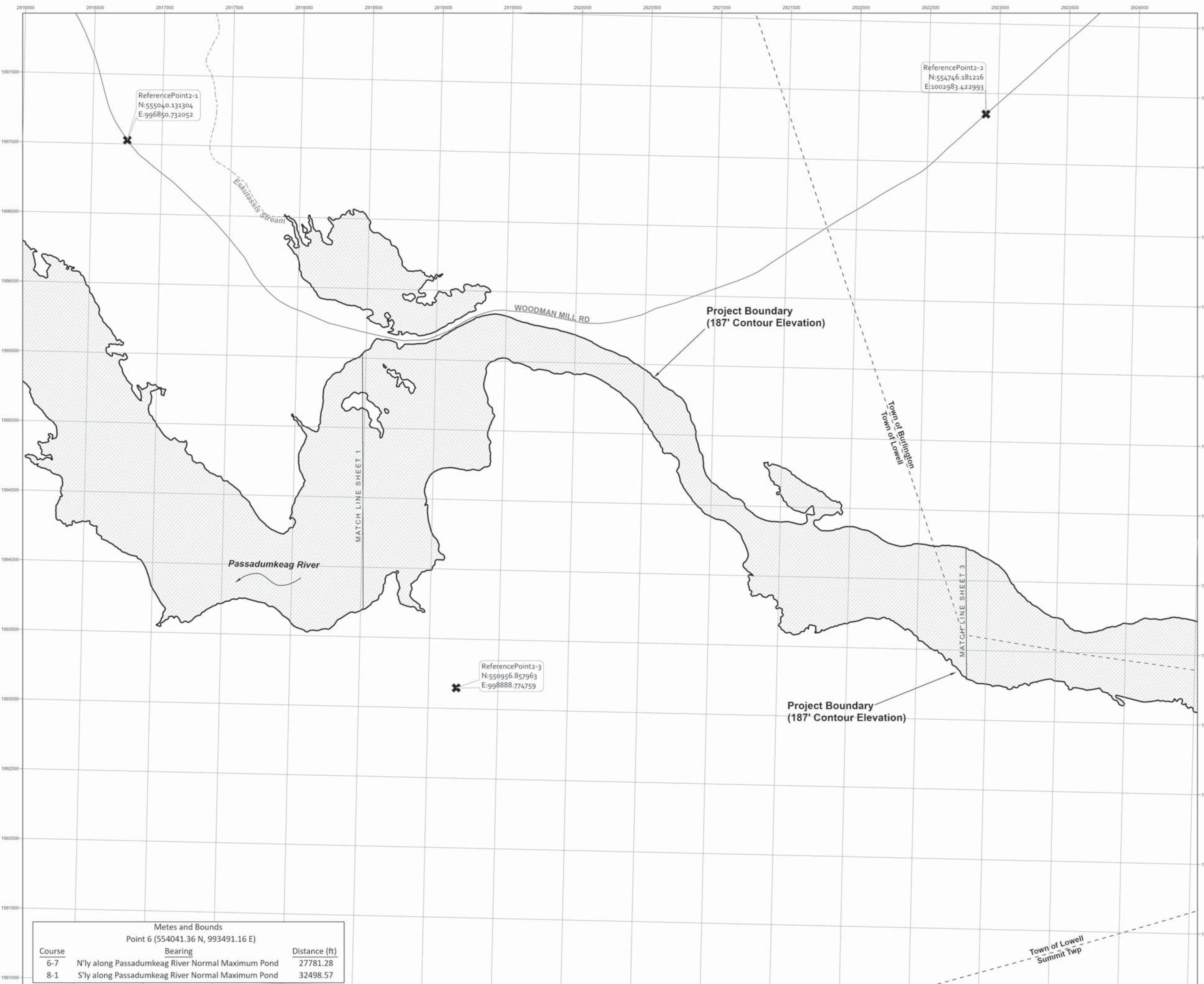
KEI (USA) POWER MANAGEMENT INC.

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

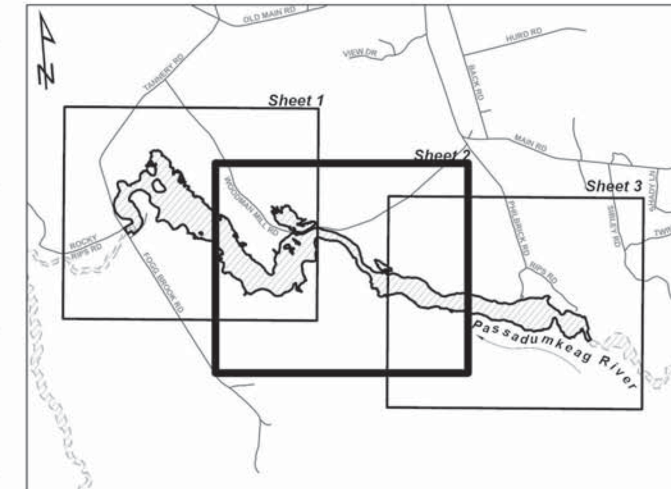
EXHIBIT G — SCALE: 1" = 333' — SHEET NO. 2 OF 4

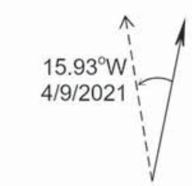


Metes and Bounds

Point 6 (554041.36 N, 993491.16 E)

Course	Bearing	Distance (ft)
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57





Project Boundary
Roads
Streams
Waterbody
Features
Municipal Boundary
Reference Points
Match Line

Map notes:
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STATE OF MAINE
STEPHEN W. EVERETT
2161
PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

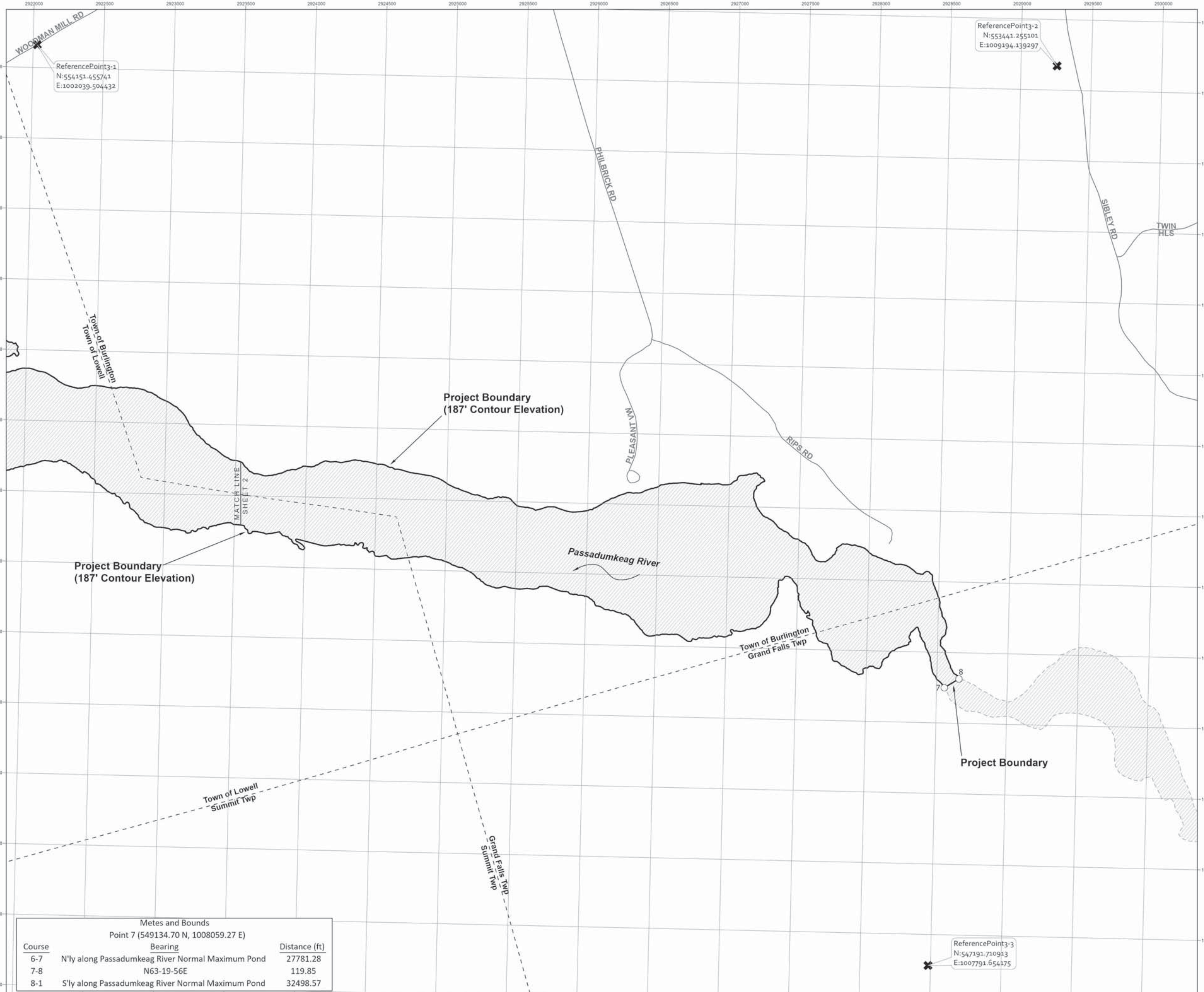
LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

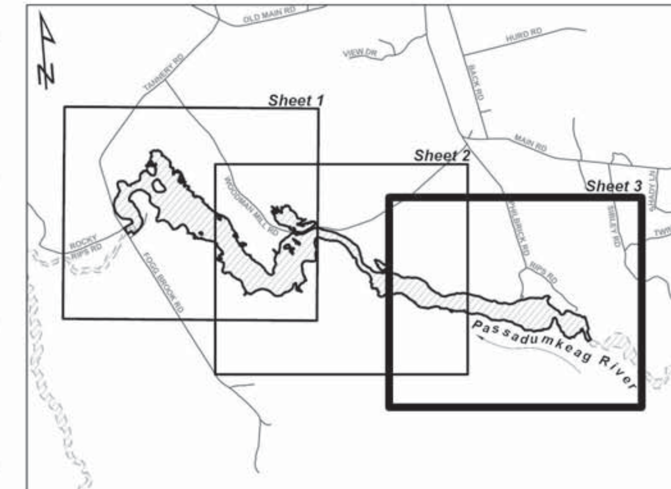
EXHIBIT G | SCALE: 1" = 333' | SHEET NO. 3 OF 4

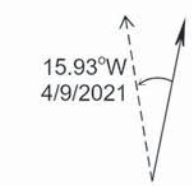
0 250 500 1,000 1,500 2,000 Feet

FERC DWG. NO. 4202-



Metes and Bounds		
Point 7 (549134.70 N, 1008059.27 E)		
Course	Bearing	Distance (ft)
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
7-8	N63-19-56E	119.85
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57





- Project Boundary
- Roads
- Streams
- Waterbody
- Features
- Municipal Boundary
- Reference Points
- Match Line

Map notes:
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STATE OF MAINE
STEPHEN W. EVERETT 2161
PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

EXHIBIT G | SCALE: 1" = 333' | SHEET NO. 4 OF 4

0 250 500 1,000 1,500 2,000 Feet

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City, State: Lowell, ME 04493

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City, State,: Lincoln ME 04457-0338

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Street anc: 96 Tannery Road

City, State: Lowell ME 04493

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Sent To: Garfiled Michael

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City, Sta: Lowell ME 04493

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Street and
City, State

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Wales MA 01081

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Street and
City, State

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Lincoln ME 04457

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City, State

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PO Box 1616
Bangor ME 04402

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- ☐ Adult Signature Required $
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- ☐ Adult Signature Required $
- ☐ Adult Signature Restricted Delivery $

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Total Postage and Fees $ 5.31

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City, State, ZIP+4®: Burlington, ME 04417

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APPENDIX B

2020 LOWELL TANNERY STUDY REPORT

2020 Study Report

Lowell Tannery Hydroelectric Project

FERC No. 4202

Prepared for:

KEI (Maine) Power Management (III) LLC

Prepared by:

Kleinschmidt Associates

March 2021

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

\\kleinschmidtusa.com\Condor\Jobs\705\093\Docs\Studies\
2020 Study Report\Lowell Tannery Project 2020 Study Report.docx

1.0 INTRODUCTION

This report presents the results of studies and monitoring completed in 2020 at the Lowell Tannery Project, which is on the Passadumkeag River, in Lowell, Maine, approximately 13 river miles upstream of the confluence with the Penobscot River (Figure 1). KEI (Maine) Power Management (III) LLC [KEI (Maine)] operates one hydroelectric turbine-generator unit at the Lowell Tannery Project, which can produce up to approximately 1,000 kilowatts of renewable, hydroelectric energy. KEI (Maine) operates the Lowell Tannery Project in run-of-river mode so that outflow at the powerhouse matches natural river inflow. After water passes through the turbine unit, it discharges back into the Passadumkeag River from a small powerhouse that is integral to the dam. KEI (Maine) operates upstream and downstream fishways species at the Lowell Tannery Project annually to pass migratory fish.

KEI (Maine) filed a Notice of Intent and Pre-Application Document (PAD) on September 26, 2018, to initiate the relicensing of the Lowell Tannery Project using the Traditional Licensing Process. The PAD and subsequent scoping identified potential environmental issues associated with the operation of the Lowell Tannery Project for which the existing, relevant, and reasonably available information was insufficient. Comments on the PAD and study requests were received from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fish and Wildlife (MDIFW), the Maine Department of Environmental Protection (MDEP), Trout Unlimited (TU), and the Penobscot Indian Nation (PIN).

KEI (Maine) completed water quality monitoring, benthic macroinvertebrate monitoring, and a desktop fish entrainment and turbine survival analysis in 2019. The water quality study and benthic macroinvertebrate studies were performed in accordance with MDEP protocols; the desktop study estimated turbine passage and whole station survival for adult and juvenile sea run alewives, adult and juvenile American shad, adult American eel, and Atlantic salmon smolts. The results of these studies were presented to the stakeholders on March 27, 2020 during a conference call.

KEI (Maine) prepared a study plan for the 2020 field season that was submitted to the stakeholders on March 26, 2020. In 2020, KEI (Maine):

- Monitored upstream eel passage at the Lowell dam to determine if juveniles attempt to migrate upstream and to inform the need for and location of an upstream eel ladder.
- Completed an upstream fish passage effectiveness study of Atlantic salmon and adult alewives working with University of Maine researchers.
- Monitored dissolved oxygen in the Project area as a follow up to the study completed in 2019.
- Updated the desktop entrainment study of downstream passage survival to address several comments received from the agencies on the initial report in 2020; the updated desktop entrainment study report is provided in Section 2.3.

Per FERC's February 10, 2021, dispute resolution letter, KEI (Maine) is planning to complete a radio-telemetry study to assess the effectiveness of passing river herring upstream at the Lowell Tannery Project; results of that study will be presented in the Final License Application, which is due to FERC by September 30, 2021.

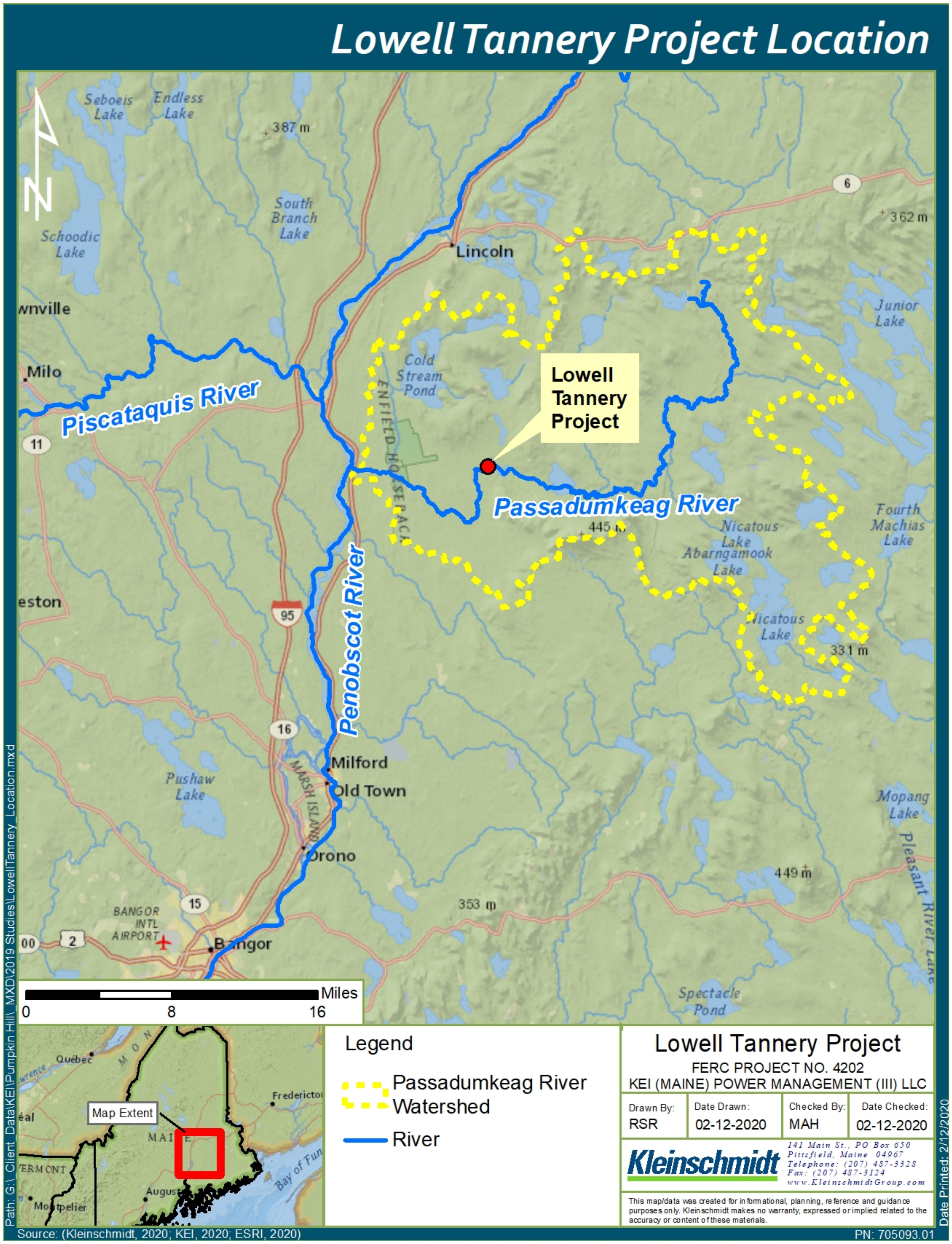

Figure 1 Lowell Tannery Project Location

2.0 INDIVIDUAL STUDY REPORTS

2.1 Upstream Eel Passage Monitoring

Researchers performed nighttime visual surveys at the Lowell Tannery Project during the summer of 2020 to assess whether juvenile American eels attempt to migrate upstream or congregate at the base of the dam. Nighttime surveys were completed on June 4, June 11, June 25, July 7, July 24, August 6, and August 20. Additional surveys were not possible because there was too much water spilling over the dam. During each survey, biologists scanned the face of the dam, concrete structures around gates, and the tailwater area using binoculars and spotlights to document the presence of juvenile American eels. The location, approximate size, and the approximate number of juvenile American eels were monitored. Surveys lasted approximately 1 hour and started at or near dusk.

Juvenile American eels were documented at the Lowell Tannery Project during all surveys in 2020. During each survey, the overwhelming majority of juvenile eels were observed about ½ way across the toe of the dam, along a horizontal sill of concrete (Figure 2) or in the transitional area between the dam face and a concrete abutment (Figure 3). In total, researchers observed approximately 5,000 to 8,000 juvenile American eels at or near the toe of the dam. Most eels were approximately 6 to 8 inches long. Once eels encountered too much water on the sill from leakage through the flashboards, they attempted to climb the concrete, roughened dam. A few hundred eels were seen on the dam face during the study, but most were congregated on the sill. Fallback of American eels climbing the dam was observed.

Figure 3 provides a potential location for a seasonal eel ladder. Positioning a ladder on the river left side (as one is looking downstream) would allow eels to traverse the sill of the dam until they find the ladder entrance which will facilitate upstream passage into the head pond. The flashboard system would need to be maintained in a way that reduces large volumes of leaking water for eels to traverse the sill of the dam.

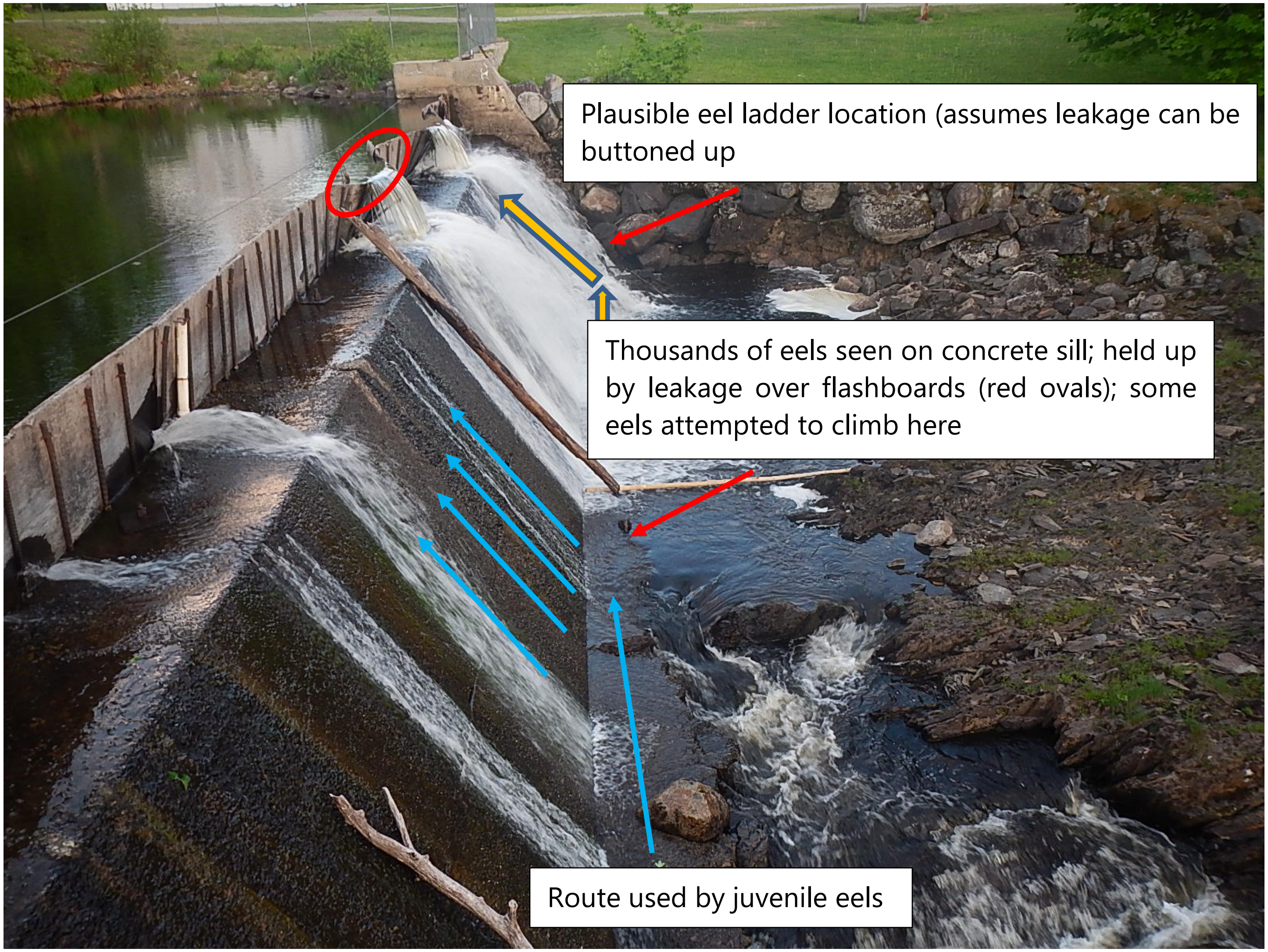

Figure 2 Photo Showing Location of Observed Eels and Potential Ladder Location

Figure 3 Aerial Showing Areas of Eel Congregations at the Lowell Tannery Dam

2.2 Upstream Passage Effectiveness Study

KEI (Maine) has been working collaboratively with researchers from the University of Maine to evaluate upstream fish passage effectiveness at the Lowell Tannery Project since 2011. Researchers have installed passive integrated tagging (PIT) equipment at the entrance and exit of the fishway annually to monitor movements of tagged adult sea-run alewives and adult Atlantic salmon through the Lowell Tannery fishway. Approximately 4,000 alewives have been tagged at the Milford Hydroelectric Project fishway in recent years so that their movements in the watershed can be monitored. For the 2020 study, the Lowell Tannery fishway was returned to its original design, and all fishway baffles were replaced or repaired prior to monitoring.

Data for adult sea-run alewives collected by the University of Maine at the Lowell Tannery Project have demonstrated fishway effectiveness values ranging from 2.7 to 57.6 percent for sea-run alewives and 0 to 75 percent for adult Atlantic salmon (data source – Dr. Joe Zydlewski, University of Maine). Table 1 provides a summary of fishway passage data from 2011 – 2020 for the Lowell Tannery Project.

Table 1 Summary of Fishway Effectiveness Study Results, 2011-2020 at the Lowell Tannery Project.

Atlantic Salmon			
Year	Approached Fishway	Passed Fishway	Fishway Effectiveness
2011	120	45	37.5%
2012	13	8	61.5%
2013	-	-	-
2014	0	0	NA
2015	3	2	66.7%
2016	4	3	75.0%
2017	0	0	NA
2018	4	1	25.0%
2019	1	0	0.0%
2020	4	0	0.0%

Sea-run Alewives			
Year	Approached Fishway	Passed Fishway	Fishway Effectiveness
2015	73	12	16.4%
2016	37	1	2.7%
2017	-	-	NA
2018	160	31	19.4%
2019	185	15	8.1%
2020	33	19	57.6%

Of the 33 fish detected in 2020 at the entrance of the fishway, 19 were repeat spawners tagged in 2018 or 2019. Of the 14 fish tagged in 2020 that migrated to the Lowell Tannery fishway, average time to reach the Lowell Tannery Project's fishway from the Milford Project was 3.9 days (range 1.6 to 12.5); the Milford fish lift, where tagging occurs, is approximately 32 river miles downstream from the Lowell Tannery Project. All of the 2020 fish that reached the Lowell Project were tagged in early June, arriving at the site in early to mid-June. Data from 2020 suggest that returning the fishway to its original design positively influenced fishway effectiveness for sea-run alewives as there was a notable increase in fishway effectiveness as compared to previous years; fishway effectiveness in 2020 (57.6 percent) was considerably higher than in all previous years of monitoring.

Per the study dispute resolution letter issued by FERC in February 2020, KEI (Maine) plans to work with University of Maine researchers again in 2021 to study the upstream passage of adult sea-run alewives (considered representative of river herring passage) at the Lowell Tannery Project. The study in 2021 will rely on radio telemetry; a study plan was provided to state and federal resource agencies on March 24, 2021. No adult salmon passage studies are planned given the low number of Atlantic salmon returning to the Passadumkeag River.

2.3 Desktop Turbine Blade Strike and Whole Station Survival Study

KEI (Maine) performed a desktop study to assess the risk of entrainment (i.e., involuntary passage through the turbine), impingement (i.e., involuntary entrapment against the upstream face of the trash rack), turbine passage survival, and whole-station survival of target migratory fish species that are known to have occurred historically in the Passadumkeag River. Whole-station survival was classified as successful downstream passage via multiple routes including fishways, spill, and turbine passage. Target fish species included adult American eel, adult and juvenile sea-run alewives (used also as a surrogate for similarly sized blueback herring), adult and juvenile American shad, and Atlantic salmon.

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam. KEI (Maine) provides 40 cubic feet per second (cfs) of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse. Downstream fish passage is provided through a dedicated fish bypass that is adjacent to the eastern side of the intake racks. A fishway gate leads to an 18-inch bypass pipe that discharges into a plunge pool next to the tailrace. KEI (Maine) provides a fishway flow of 20 cfs through the downstream bypass. The Lowell Tannery Project has two angled trash racks (V-shape) with bars spaced at 1.5-inch clear. Both trash racks are 15-feet-deep by 12-feet-wide resulting in a total surface area of 360 square feet.

The Lowell Tannery Project has one vertical Kaplan hydroelectric turbine that can generate with up to 905 cfs and a minimum capacity of 90 cfs. The turbine has four fixed blades with a rotational speed up to 190 revolutions per minute. Table 2 provides a description of pertinent turbine and project characteristics applicable to this study.

Table 2 Turbine and Fish Characteristics used for Turbine Blade Strike and Whole Station Survival Analysis

Number of Turbines	1
Turbine Style	Vertical Kaplan
Project Head for Generation (Net Head)	20 feet
Number of Turbine Blades	4 (adjustable)
Runner Diameter (diameter of the turbine hub and turbine blades)	7.2 feet
Max. Turbine Runner Rotational Speed	190 revolutions per minute
Maximum Hydraulic Capacity	905 cfs
Minimum Hydraulic Capacity	90 cfs
Discharge at Optimum Efficiency	606 cfs (67 percent)
Turbine Efficiency	92.3 percent

The objectives of this study were to evaluate the risk of entrainment, risk of impingement, and quantitatively estimate turbine passage and whole station survival of migratory fish at the Lowell Tannery Project. KEI (Maine) updated the desktop study in 2021 to reflect comments received from NMFS, the USFWS, and MDMR on the Initial Study Report in 2020. The following adjustments to the model were made:

- **Fish length standard deviation** – increased the standard deviation from 0.5-inches to 1.0-inch to provide a wider range of size classes for the analysis.
- **Spillway survival** – adjusted spillway survival from 100 percent to 97 percent.
- **Fish bypass survival** – lowered bypass survival to account for some injury or mortality to occur. We expect that survival through a designed fishway would be higher than survival via passage over the spillway; therefore, we adjusted bypass survival from 100 percent to 98 percent.

- **Fish bypass efficiency** – added another scenario in the model for all species that assigns a bypass efficiency of 25 percent.

KEI (Maine) notes that the original description of the turbine runner diameter was incorrectly set at 4.6 feet. The actual runner diameter is 7.2-feet; therefore, the original scenarios were run with the updated turbine diameter information.

Although the resource agencies provided additional technical comments on the desktop study, KEI (Maine) has respectfully not adopted some of these requests in this analysis. KEI (Maine) is of the opinion that additional, detailed analysis of the existing downstream fishway is not warranted. The revised desktop study results described below are sufficient to describe the effects of the Lowell Tannery Project on downstream fish passage survival.

2.3.1 Methods

2.3.1.1 Risk of Entrainment and Impingement

To evaluate the risk of impingement, KEI (Maine) calculated the expected approach velocities at the turbine intake and compared them to typical prolonged swim speeds of target fish species. Approach velocities at the intake were determined by dividing the hydraulic capacity of the turbine on a seasonal basis (i.e., when migratory fish typically move downstream) by the size of the intake area (USFWS 2019). The intake area has a surface area of 360-square-feet (15-feet-tall by 12-feet-wide for each rack). For example, at the full station capacity of 905 cfs, the approach velocity was calculated as:

905 cfs (water flow to turbine) / 360 square feet (intake area) =
2.5 feet per second (approach velocity)

Burst swim speed is the swimming speed that a fish can maintain for approximately 20 seconds (Beamish 1978). This enables a fish to escape predation or traverse through high-velocity areas in the water column (Beamish 1978). Prolonged swim speeds are typically maintainable for 20 seconds to 200 minutes (Alden 2004). Table 3 provides a list of prolonged swim speeds used during the analysis.

Table 3 Prolonged Swim Speeds Used to Evaluate Risk of Entrainment and Impingement at the Lowell Tannery Project

Species/Lifestage	Reported Swim Speed (fps)	Literature Source
Atlantic salmon smolts	3.2	Hvas and Oppedal
Adult alewife	6.0	USFWS 2019
Juvenile alewife	1.4 to 1.75	Alden 2004

Species/Lifestage	Reported Swim Speed (fps)	Literature Source
Adult blueback herring	6.0	USFWS 2019
Juvenile blueback herring	0.75 to 1.14	Alden 2004
Adult American shad	5.0	FishXING 2006
Juvenile American shad	1.5	FishXING 2006
Adult American eel	2.15	Qunitella et. al

To evaluate the risk of entrainment to the turbine, KEI (Maine) compared trash rack spacing to fish size and morphology. Fish with a body thickness less than 1.5 inches (i.e., trash rack open spacing) were classified as "at risk of entrainment" through the trash racks. Fish with swim speeds less than 1.5 feet per second were considered "at risk for impingement" at the trash rack face based on typical USFWS's criteria. Fish morphology information (body width and length) were obtained from literature or field data from fisheries studies in the region. Body width for adult American shad was estimated based on the proportion of body width to standard length (Smith 1986) for fishes collected by the MDMR at the Milford Hydroelectric Project on the Penobscot River in Maine from 2017 to 2019.

2.3.1.2 Turbine Blade Strike and Whole Station Survival Analysis

KEI (Maine) used STRYKE,[1] a Python-based[2] desktop model, to quantitatively estimate the probability of turbine blade strike survival and whole station survival via a combination of available downstream passage routes (e.g., turbine, spill, and fish bypass) for each target fish species and lifestage. STRYKE uses the turbine blade strike equations from Franke et al. (1997) and is based on the USFWS's Turbine Blade Strike Analysis desktop model (Towler and Pica 2018). Model variables included fish length, number of fish, and turbine characteristics (e.g., runner diameter, turbine type, turbine efficiency, hydraulic capacity, runner speed, and head) (Table 2).

The survival analysis was completed at three flow thresholds to provide a range of possible turbine survival and whole-station survival estimates depending on river flow conditions. Hydrologic conditions were determined from Flow Duration Curves for the Passadumkeag River for low-flow condition (90 percent exceedance), median flow condition (50 percent exceedance), and high flow condition (10 percent exceedance)

[1] Developed by Kleinschmidt Associates (Kleinschmidt).
[2] Python is an open source, object oriented, extendable programming language with packages that support scientific and advanced numerical computing.

during times of the year when each species or lifestage is most likely to be outmigrating (Table 5). These thresholds were selected to represent high, median, and low water year conditions.

Three other critical factors require input by the user: fish length; the proportion of fish passing through each available route of passage (spill, fish bypass, or turbine); and the strike mortality correlation factor (lambda).

2.3.1.3 Strike Mortality Coefficient

The strike mortality correlation factor is built into the model to account for differences in actual turbine mortality derived from field tests as compared to predicted model output (Franke et al. 1997). Three variables are built into the strike mortality correlation factor: the position of the fish relative to the plane of the turbine revolution (i.e., fish orientation during passage), the difference in the impact of a strike relative to the fish's body (i.e., a strike to the anterior region is more detrimental that a strike to the posterior region), and hydraulic characteristics near the leading edge of the blade tip, which may carry a fish around the leading edge, reducing the likelihood of blade strike (Franke et al. 1997). Franke et al. (1997) suggests using a lambda value of 0.10 to 0.20 for Kaplan turbines based on results of field studies compared to model predictability. Model iterations for the Lowell Tannery Project were run using an intermediate lambda value of 0.15. For adult American eel, the model was also run with a lambda value of 0.20 to account for ell morphology; values derived from the model with a 0.20 lambda value are considered to be representative of worst-case conditions (i.e., lower survival through the turbines).

2.3.1.4 Routing of Fish Through the Lowell Tannery Project

Bypass efficiency (i.e., number of fish using the fish bypass to pass downstream) was assumed to be 25 percent or 50 percent for all model runs. The number of fish routed to the spillway to pass downstream was based on ratio of river flow to turbine capacity. For example, if river flow was 1,250 cfs, approximately 25 percent of fish would be routed to spill because 25 percent of river flow would spill. The remaining 75 percent were routed to the fish bypass and the turbine to represent two scenarios: 50 percent and 25 percent fishway efficiency. If river flow was less than the maximum capacity of the turbine, no fish were routed to spill. When river flow was less than approximately 90 cfs (minimum capacity of the turbine), no fish were routed to the turbine to replicate periods of time when the turbine is not operational. In this instance, all fish were routed through the fish bypass or spill. Spillway survival was assumed to be 97 percent (Alden 2012) and bypass survival was assumed to be 98 percent.

2.3.1.5 Fish Length

Turbine passage survival and blade strike probability is influenced more by fish size than species; therefore, the equations do not differentiate between species but only consider fish size (Franke et al. 1997). STRYKE allows the user to enter fish length plus a standard deviation factor to account for variability in fish length; fish length is assumed to be normally distributed (Towler and Pica 2018). Fish length information for the target species was obtained from published reports, field data from regional studies, and other literature sources. Table 4 provides the size ranges for target fish species evaluated for the Lowell Tannery Project. A standard deviation of 1.0 inches was used for all fish species. Adult American eel have a unique body shape that allows them to contort into irregular shapes. As such, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

The STRYKE model was run 20 times sequentially to estimate mean turbine and whole-station survival, calculate a standard deviation, and determine the 95 percent confidence interval. Sample size (# of fish) was set at 200 for each model run for a total sample size of 4,000 per model run. The accuracy of the STRYKE model was verified by running the same scenarios (e.g., same fish length and same turbine characteristics) in the USFWS's model to determine if survival estimates fell within in the 95 percent CI range produced by the STRYKE model. The selected sample size of 4,000 was compared to a larger sample size of 10,000 with little difference in results.

Table 4 Fish Lengths for the Lowell Tannery Turbine Blade Strike and Whole Station Survival Analysis

Species/Life Stage	Total Length (inches/millimeters)	Data Source
Atlantic Salmon Smolts	7.5 inches (190.5 mm)	Baum 1997
Atlantic Salmon Adults	29 inches (737 mm)	Baum 1997
Adult Alewives	10.5 (267 mm)	MDMR 2020
Juvenile Alewives	4 inches (101 mm)	Pardue 1983
Adult American Shad	19 inches (560 mm)	MDMR 2020
Juvenile American Shad	4 inches (101 mm)	Talbot and Sykes 1958
Adult American Eel	33.5 inches (851 mm)	Kleinschmidt 2012 and 2013

Table 5 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/Life Stage	Peak Outmigration (Month)	Low Flow Threshold (cfs; 90%)	Median Flow Threshold (cfs; 50%)	High Flow Threshold (cfs; 10%)
Atlantic Salmon Smolts	May	178	443	1,365
Adult Alewives	June	135	381	1,441
Juvenile Alewives	September	21*	88*	490
Adult American Shad	July	60*	160	811
Juvenile American Shad	September	21*	88*	490
Adult American Eel	October	28*	165	1,054

* Blue cells indicate turbine unit inoperable because of low water conditions (less or close to 90 cfs); turbine-strike equal to 0.00 and whole-station survival assumed 100 percent.

2.3.2 Results

2.3.2.1 Risk of Entrainment or Impingement

2.3.2.1.1 Trash Rack Exclusion

Juvenile Alosines (shad, alewives, and blueback herring), adult American eel, and Atlantic salmon smolts may fit through the 1.5-inch trash racks and pass downstream via the turbine given their smaller body size and morphology. Body width for 18-inch-long and 20-inch-long adult American shad is expected to range from 2.5 to 2.7 inches based on recent fish size data from the Penobscot River[3] (Table 6). Adult salmon are expected to be approximately 29-inches-long. As such, adult salmon and adult American shad are excluded from the turbine by the trash rack bars.

Table 6 Body Length and Width Estimate for Adult American Shad

Fish Sex	Total Length*	Standard Length	Body Width**
Male	18 inches	15 inches	2.5 inches
Female	20 inches	16.6 inches	2.7 inches

* MDMR data from the Penobscot River

** Body width is reported as 16.4 percent of standard length (Smith 1986).

[3] Personal communication, MDMR staff, January 2020.

2.3.2.1.2 Approach Velocity and Impingement

Approach velocity ranges from 0.0 to 0.49 fps (low water year), 0.0 to 1.23 fps (median water years), and from 1.36 to 2.51 fps during high water years during peak migratory periods (e.g., May, June, July, September, and October) (Table 7).

Table 7 Peak Seasonal Outmigration Periods and Hydrologic Conditions Evaluated

Species/ Life Stage	Peak Migration	Low Flow (cfs)	Approach Velocity (fps)	Median Flow (cfs)	Approach Velocity (fps)	High Flow (cfs)	Approach Velocity (fps)
Atlantic Salmon Smolts	May	178	***0.49***	443	***1.23***	905	**2.51**
Adult River Herring	June	135	***0.38***	381	***1.05***	905	**2.51**
Juvenile Alosines	September	21	***0.00***	88	***0.00***	490	**1.36**
Adult American Shad	July	60	***0.00***	160	***0.44***	811	**2.25**
Adult American Eel	October	28	***0.00***	165	***0.46***	905	**2.51**

Based on prolonged swim speeds and expected water velocity in front of the intake during peak migratory periods, the risk of involuntary entrainment to the turbine or impingement against the trash racks is low. The maximum, normal approach velocity during times when the Lowell Tannery Project is fully operational (i.e., during high flow conditions) is estimated to be 2.5 fps, which is near reported prolonged swim speeds for Atlantic salmon smolts, adult herring, adult shad, and adult American eel. At other times of the year or during low or median water years, approach velocity is expected to be less than 2.51 fps (e.g., 0.00 to 1.23 fps), thereby reducing the likelihood of involuntary entrainment or impingement for all species and lifestages, including juvenile herring and American shad. The most risk for impingement or involuntary entrainment is during times when the turbine may be fully operational during the fall outmigration of juveniles alosines and American eels or the outmigration of American shad.

2.3.2.2 Turbine Passage and Whole Station Survival

Table 8 and Table 9 provide tabular results. In summary, the analysis demonstrated that:

- Mean turbine passage survival of adult river herring ranged from 86.2 to 91.1 percent.
- Whole station survival of adult river herring ranged from 90.1 to 97.8 percent.
- Mean turbine passage survival of juvenile Alosines was 95 percent.
- Whole station survival of juvenile Alosines ranged from 96.6 to 98.3 percent.
- Mean turbine passage survival of adult American eels using a lambda of 0.20 ranged from 31.6 to 67.0 percent.
- Whole station survival adult American eels using a lambda of 0.20 ranged from 48.6 to 98.0 percent (high survival when there is not enough water to generate power).
- Mean turbine passage survival of adult American eels using a lambda of 0.15 ranged from 49.2 to 74.0 percent.
- Whole station survival adult American eels using a lambda of 0.15 ranged from 60.9 to 98.3 percent (high survival when there is not enough water to generate power).
- Mean turbine passage survival of Atlantic salmon smolts ranged from 88.4 to 95.3 percent.
- Whole station survival of Atlantic salmon smolts ranged from 90.4 to 96.1 percent.

Table 8 Summary of Turbine Passage and Whole Station Survival Estimates

	Adult River Herring	Juvenile Alosines	Adult Eel (0.20)	Adult Eel (0.15)	Atlantic Salmon Smolts
Turbine Passage Survival (Low)	86.2%	94.9%	31.6%	49.2%	88.4%
Turbine Passage Survival (High)	91.1%	95.0%	67.0%	74.0%	95.3%
Whole Station Survival (Low)	90.1%	96.6%	48.6%	60.9%	90.4%
Whole Station Survival (High)	97.8%	98.3%	98.0%	98.3%	96.1%

Table 9 Summary of Turbine Blade Strike Analysis and Whole Station Survival for the Lowell Tannery Project

Scenario	Species	Length*	Turbine Flow	% Fish to Unit	% Fish to Spill	% Fish to Bypass	Mean Turbine Survival	Mean Whole-Station Survival
1	Adult alewife	10.5	905	0.314	0.372	0.314	91.1%	95.7%
2	Adult alewife	10.5	905	0.471	0.372	0.157	89.1%	93.7%
3	Adult alewife	10.5	381	0.500	0.000	0.500	86.2%	92.2%
4	Adult alewife	10.5	381	0.750	0.000	0.250	86.8%	90.1%
5	Adult alewife	10.5	135	0.000	0.500	0.500	***NA***	97.8%
6	Juvenile Alosines	4.0	490	0.500	0.000	0.500	95.0%	96.6%
7	Juvenile Alosines	4.0	490	0.750	0.000	0.250	94.9%	96.6%
8	Juvenile Alosines	4.0	88	0.000	0.500	0.500	***NA***	97.5%
9	Juvenile Alosines	4.0	88	0.000	0.500	0.500	***NA***	98.3%
10	Juvenile Alosines	4.0	21	0.000	0.500	0.500	***NA***	98.0%
11	Adult eel (0.20)	33.0	905	0.429	0.141	0.429	67.0%	83.6%
12	Adult eel (0.20)	33.0	905	0.644	0.141	0.215	64.3%	71.9%
13	Adult eel (0.20)	33.0	165	0.500	0.000	0.500	31.9%	63.9%
14	Adult eel (0.20)	33.0	165	0.750	0.000	0.250	31.6%	48.6%
15	Adult eel (0.20)	33.0	28	0.000	0.500	0.500	***NA***	98.0%
16	Adult eel (0.15)	33.0	905	0.429	0.141	0.429	73.1%	86.1%
17	Adult eel (0.15)	33.0	905	0.644	0.141	0.215	74.0%	81.6%
18	Adult eel (0.15)	33.0	165	0.500	0.000	0.500	50.3%	74.3%
19	Adult eel (0.15)	33.0	165	0.750	0.000	0.250	49.2%	60.9%
20	Adult eel (0.15)	33.0	28	0.000	0.500	0.500	***NA***	98.3%
21	Salmon smolts	7.5	905	0.332	0.337	0.332	95.3%	96.1%
22	Salmon smolts	7.5	905	0.497	0.337	0.166	94.1%	95.8%
23	Salmon smolts	7.5	443	0.500	0.000	0.500	90.9%	94.3%
24	Salmon smolts	7.5	443	0.750	0.000	0.250	91.4%	93.8%
25	Salmon smolts	7.5	178	0.500	0.000	0.500	89.0%	93.2%
26	Salmon smolts	7.5	178	0.750	0.000	0.250	88.4%	90.4%
27	Salmon smolts**	7.5	905	0.497	0.337	0.166	94.3%	96.0%

*** Standard deviation of 1.0 inch**
**** Sample size of 10,000 for comparison**
NA = not enough water to generate

2.3.3 Summary

Across all scenarios evaluated, the desktop analysis demonstrates that turbine passage survival and whole station survival is expected to be moderate to high for adult river herring (86 to 98 percent), high for juvenile Alosines (95 to 98 percent), and moderate to high for Atlantic salmon smolts (88 to 96 percent) based on their small size and the characteristics of the turbine (e.g., low RPMs, Kaplan type, four blades). Turbine passage survival and whole station survival is expected to be low to moderate for large-bodied American eels when the project is operational (31.6 to 73.1 percent); however, researchers have noted that the traditional blade strike equations may overestimate strike probability and mortality for American eels (Alden 2018).

Kleinschmidt's turbine blade strike and whole station survival model provided an automated method to run multiple iterations of turbine and whole station survival estimates for multiple species and lifestages of migratory fish under varying flow conditions. The narrowly spaced, full depth, angled trash rack bar system and low approach velocities reduce the likelihood of impingement and entrainment, and prohibit larger-bodied fish (e.g., adult Atlantic salmon or adult American shad) from becoming entrained. The characteristics of the turbine at the Lowell Tannery Project (i.e., Kaplan with relatively low RPMs, low head) and the relatively small size of fish that may be entrained increases the probability for high turbine passage survival and high whole station survival of migratory fish species. American eels are the most susceptible to entrainment and injury from turbine passage given their large size.

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2.4 2020 Water Quality Monitoring and Bathymetry Survey

2.5 Introduction

In accordance with recommendations from the Maine Department of Environmental Protection (MDEP) received on April 17, 2020, and the 2020 study approach developed in consultation with MDEP, KEI (Maine) monitored dissolved oxygen (DO) and water temperature in 2020 to evaluate whether upstream waters (i.e., impounded waters or inflowing waters to the impoundment) contributed to low DO values near the dam and in the tailwater that were observed in 2019. The 2019 study demonstrated that DO values in the impoundment and tailwater were occasionally less than the 7.0 mg/L and 75 percent saturation standard for Class A and Class AA surface waters in Maine. The Passadumkeag River from the Lowell Tannery dam to the confluence with the Penobscot River is Class AA; the Passadumkeag River upstream of the Lowell Tannery dam is Class A.

2.5.1 Methods

KEI (Maine) installed four Onset Hobo U-26 dataloggers in the Passadumkeag River at the following locations (Figure 5):

- **Site 1** – approximately river 3.8 miles upstream from the dam at the transitional point between river and impounded habitat,
- **Site 2** – at the deepest spot within the impoundment (approximately 250 feet upstream of dam, water depth approximately 20 feet),
- **Site 3** – in the tailwater directly downstream of the dam,
- **Site 4** – a mile downstream of the dam.

Monitoring at Sites 2, 3, and 4 occurred from July 15 through August 24, 2020. Monitoring at Site 4 occurred from July 20 through August 24, 2020. DO and water temperature were monitored at hourly intervals. A barologger was installed at the dam to monitor barometric pressure, which was used to calculate DO percent saturation.

Per MDEP's request, KEI (Maine) performed a bathymetry survey in the impoundment (Figure 4) to characterize water depths so that MDEP could determine if operations of the Lowell Tannery Project affect the littoral zone (i.e., that portion of the impoundment where there is enough ambient sunlight to promote plant growth). KEI (Maine) operates the Lowell Tannery Project as run of river, meaning that there are no changes in water surface elevation during normal operations. Due to low river flows in 2020, KEI (Maine) was not able to generate power during the monitoring period in 2020. All water was passed through the fishways or over the dam. However, the goal of the 2020 monitoring was to determine if inflowing water have low DO concentrations, not to assess the effects of project operations.

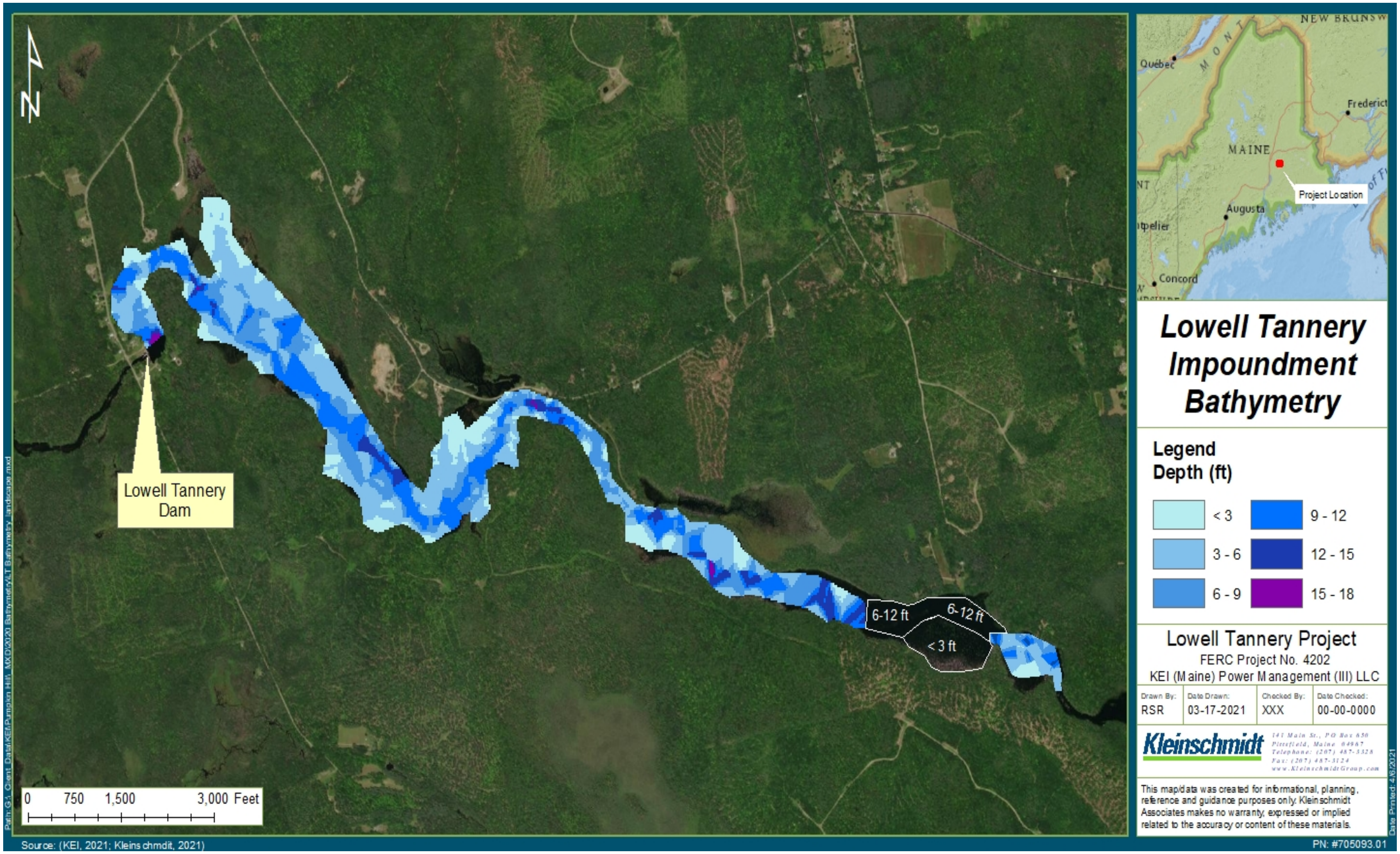

Figure 4 Lowell Tannery Bathymetry

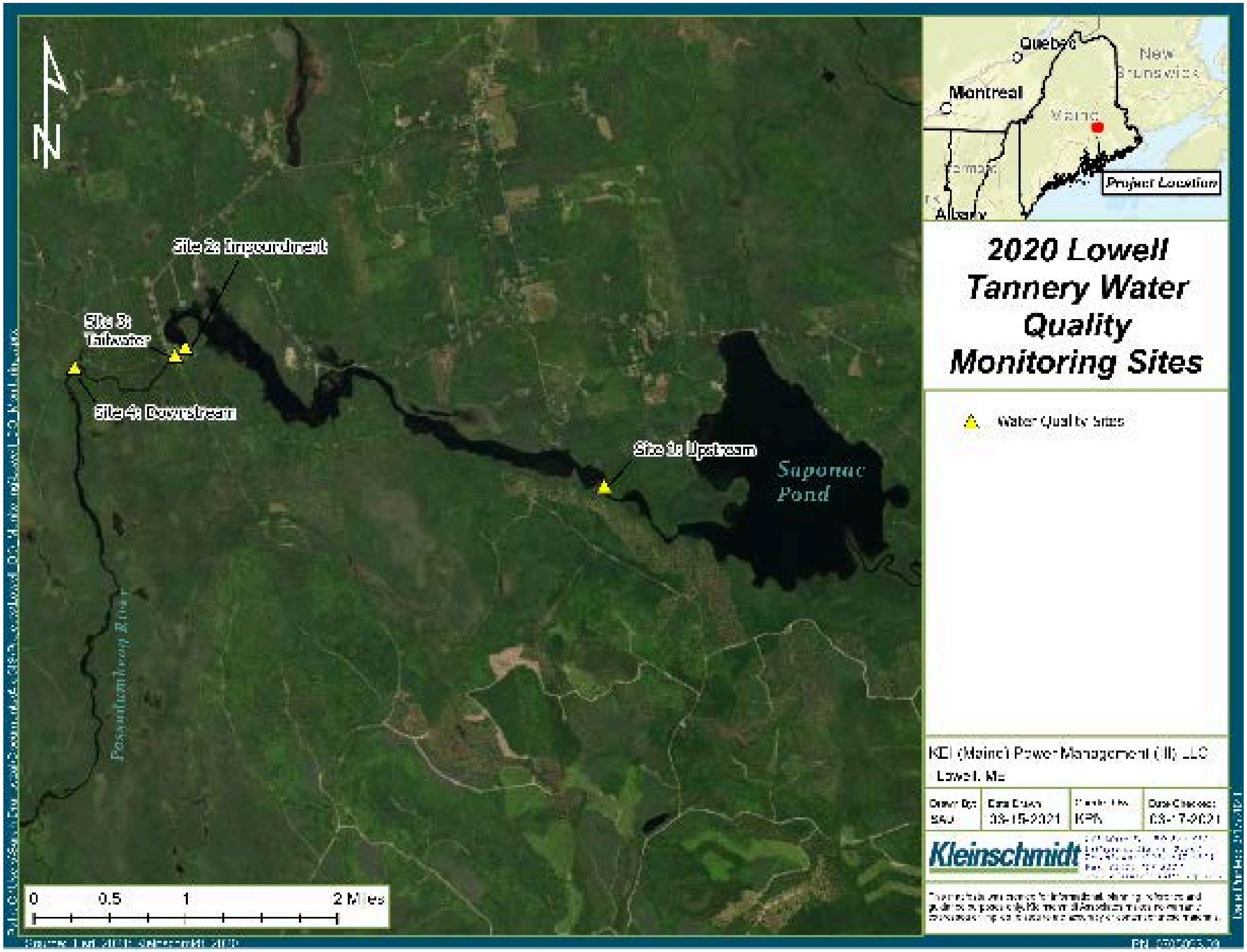

Figure 5 Location of datasondes in 2020 at the Lowell Tannery Project

2.5.2 Results

In summary, the data collected in 2020 demonstrated that:

- DO values in the inflowing water to the impoundment were regularly below 7.0 mg/L and 75 percent saturation (Figure 6, Figure 7).
- DO values in the impoundment near the dam were consistently between 6 mg/L and 7.5 mg/L (Figure 6); percent saturation was generally between 60 percent and 90 percent (Figure 7).
- DO values in the tailwater were uniform between 8.0 mg/L to 8.8 mg/L and 97.8 percent and 105.3 percent and were above the standards during the entire monitoring period (Table 10, Figure 6, Figure 7).
- DO values 1-mile downstream of the Lowell Tannery Project were consistently above 7 mg/L and 88 percent saturation during the entire monitoring period (Table 10, Figure 6, Figure 7).

The data collected in 2020 demonstrate that low DO values observed at the Lowell Tannery Project may result from several factors, including inflowing water to the impoundment that does not meet Class A standards for surface water quality. Anecdotal information suggests that water quality in the Passadumkeag River has been poor historically due to an intrusion of saw dust from past logging practices near Saponac Pond,[4] which is just upstream of the Lowell Tannery project; the logger at Site 1 was approximately 0.7 river miles downstream of Saponac Pond. Entrainment of saw dust over time may have affected DO consumption and balance within the Passadumkeag River at the Lowell Tannery Project.

Researchers noted in 2020 that the Lowell Tannery impoundment is shallow and productive with an abundance of dead and decaying tree root wads and snags (Photo 1 and Photo 2), wetland habitats, and submerged aquatic vegetation, which may contribute to lower overall DO values through decomposition of detritus and decaying plant matter.

The 2020 data also demonstrated that low DO conditions were ameliorated in the tailwater and within 1 mile of the Lowell Tannery Project; DO downstream of the dam was above the Class A standard during the entire monitoring period.

[4] https://www.maine.gov/ifw/docs/lake-survey-maps/penobscot/saponac_pond.pdf

Photo 1 Photo of Decaying Snags – Lowell Tannery Impoundment

Photo 2 Photo of Decaying Root Wads – Lowell Tannery Impoundment

Table 10 DO concentration (mg/L), DO percent saturation (%), and water temperature (°C) statistics throughout the Lowell Tannery project area, July 15-August 24, 2020

Statistic	DO (mg/L)	DO Percent Saturation (%)	Water Temperature (°C)
*Upstream**			
Minimum	0.7	8.6	21.4
Maximum	8.9	114.5	28.2
Average	7.2	87.3	25.0
Impoundment			
Minimum	4.8	58.6	21.8
Maximum	7.9	97.2	26.6
Average	6.5	77.8	24.3
Tailwater			
Minimum	8.0	97.8	22.1
Maximum	8.8	105.3	28.2
Average	8.4	101.9	25.0
Downstream			
Minimum	7.2	87.9	21.4
Maximum	9.6	113.5	29.1
Average	8.2	98.7	25.0

*July 20-August 24 only

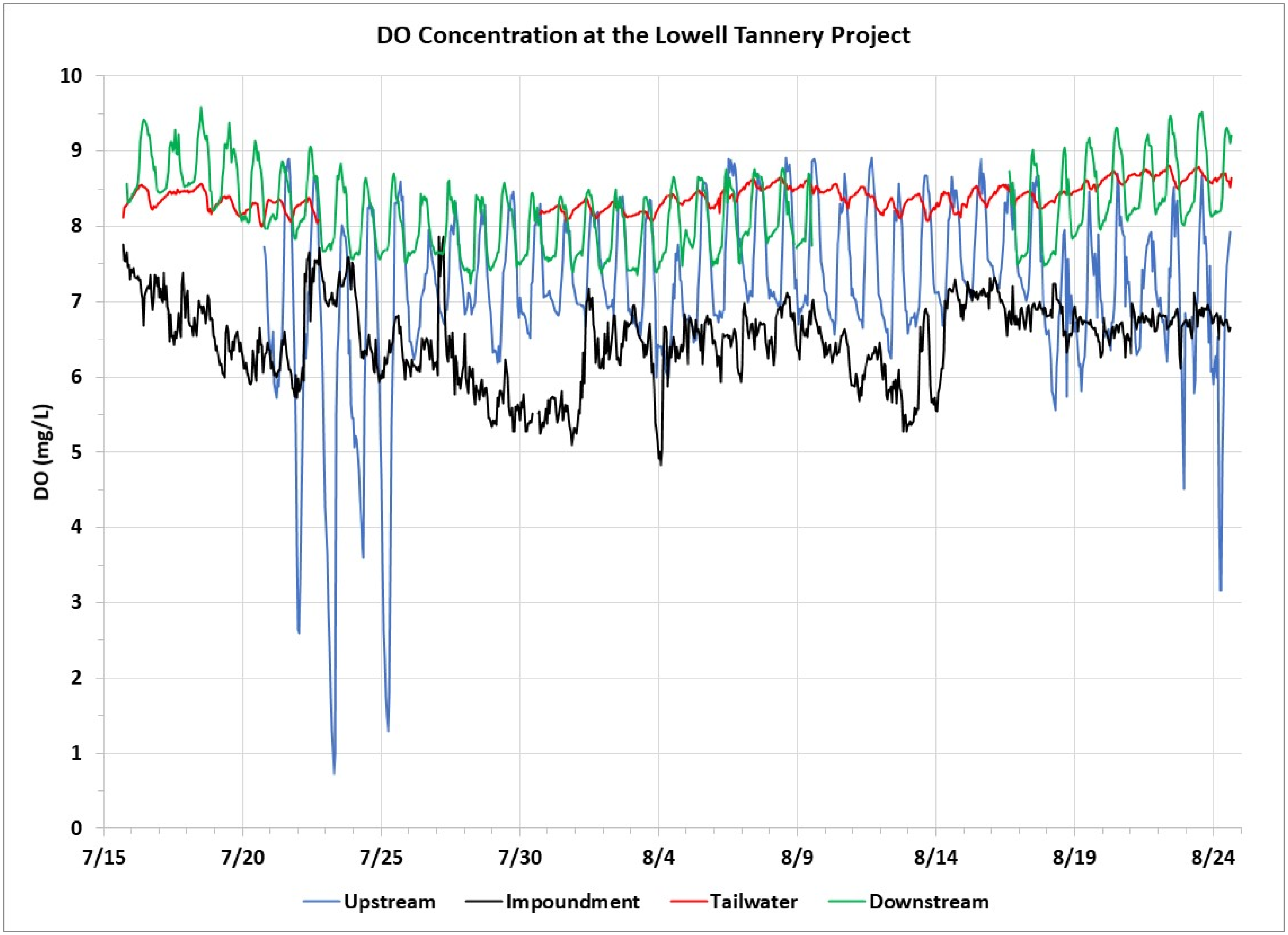

Figure 6 Time Series of Dissolved Oxygen Concentration Data

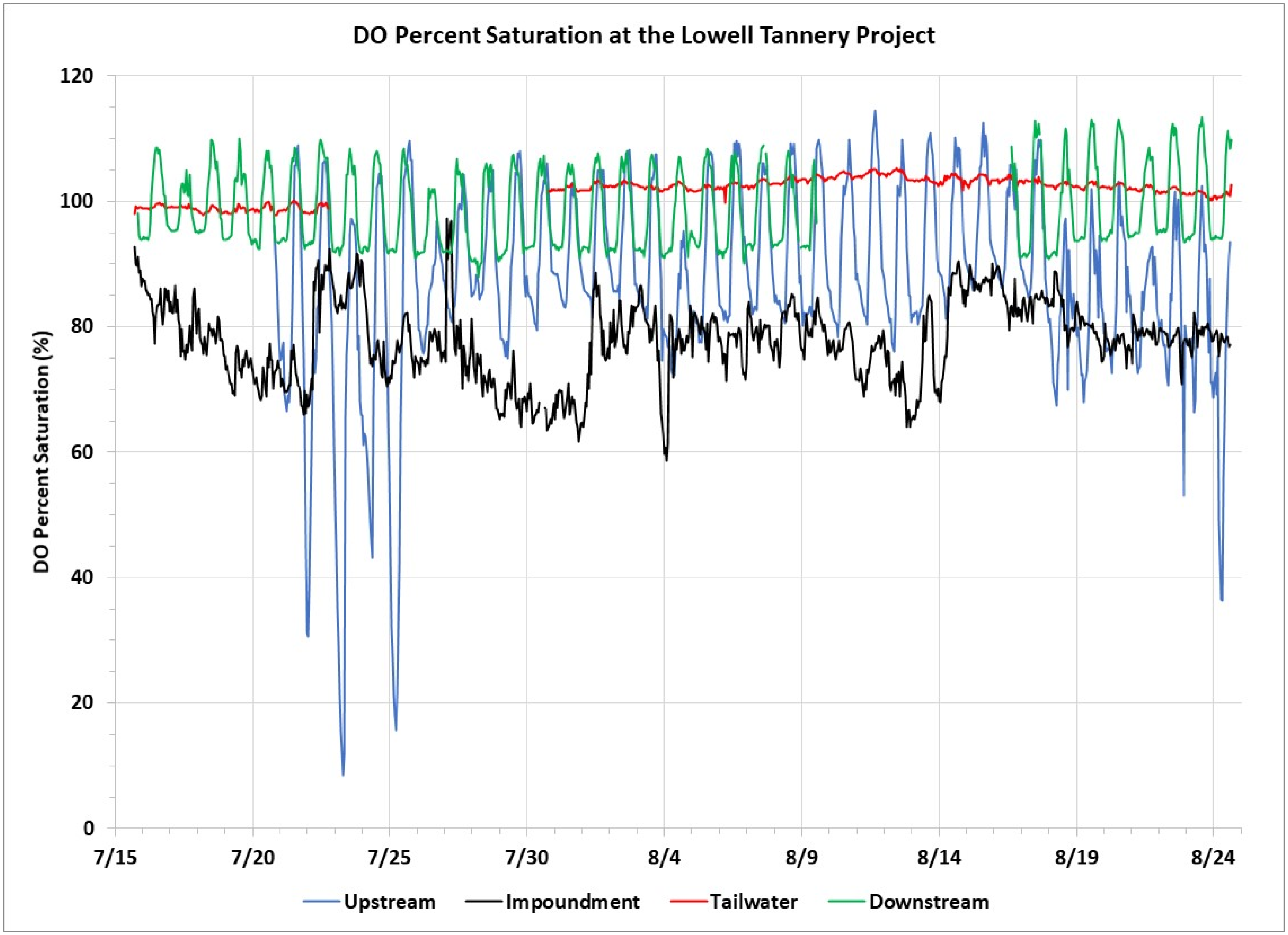

Figure 7 Time Series of Dissolved Oxygen Percent Saturation Data

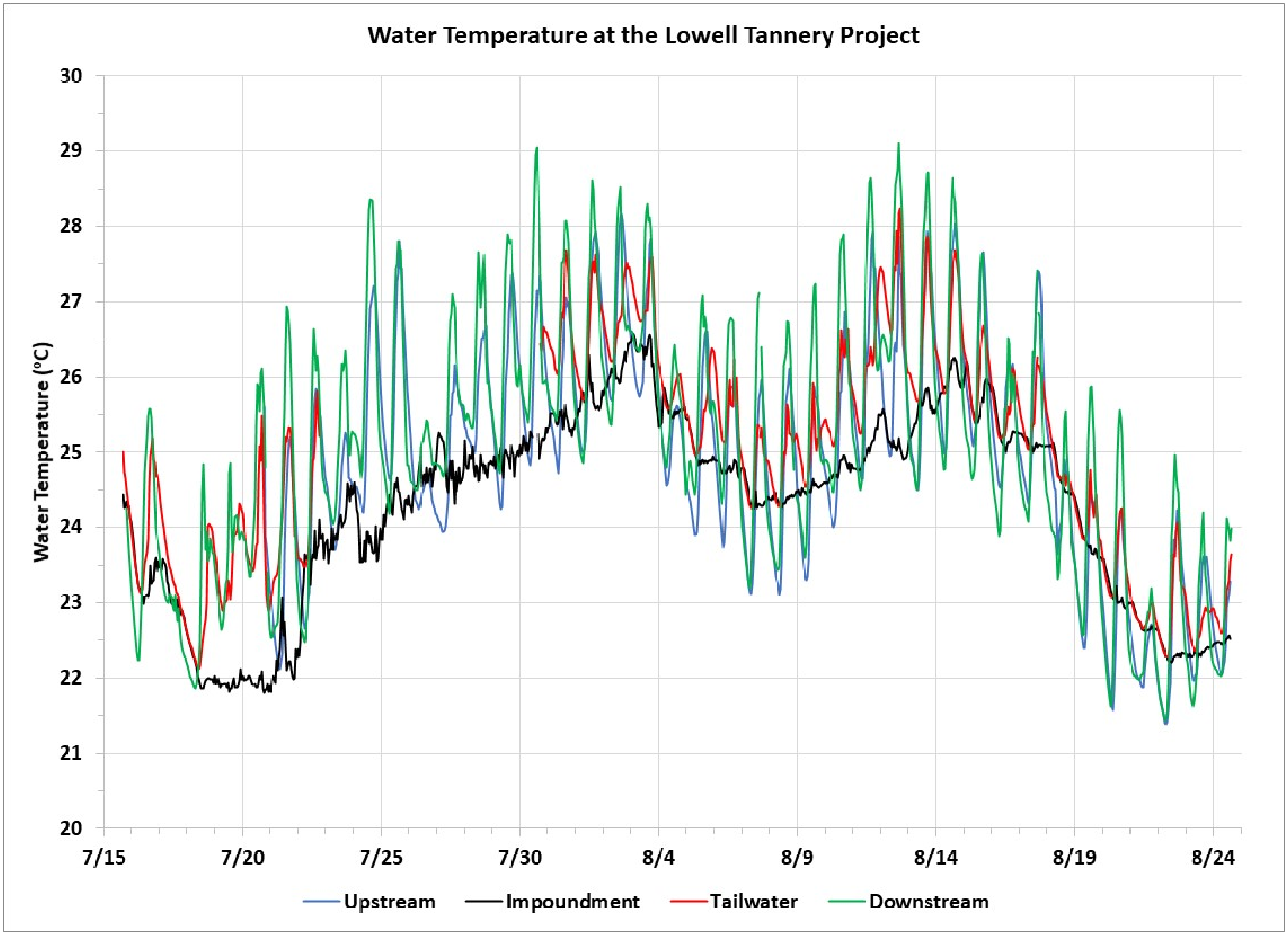

Figure 8 Time Series of Water Temperature Data

Appendix C

2021 Lowell Tannery Telemetry Report

2021 Lowell Tannery Fish Passage Assessment

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Methodology

Radio Telemetry Array

Six radio antennas were distributed along the length of the Lowell Tannery Dam (Figure 1). Four of these antennas (labelled as 3, 4, 5, and 6, respectively) pointed downstream of the dam to observe the approach of fish toward the dam. One antenna was pointed upstream of the dam, and one was pointed downward into the exit of the fishway (labelled as 1 and 2, respectively). These two antennas together acted as the final confirmation of successful passage over the dam. A seventh antenna was installed north of Tannery Road Bridge to observe fish that were exiting the study area. Each array was comprised of a Lotek receivers, powered with two deep cycle batteries and housed in a water resistant sealed case. The antennas were four element Yagi style antennas that provide a moderate level of directionality (compared to a dipole).

This study was afforded access to the extensive radio telemetry and PIT arrays on the main stem of the Penobscot River (including upstream and downstream main-stem locations, West Enfield Dam, Howland Dam and bypass). This allows for further description of the movement of these fish after they left the study area in order to account for tagging outcomes.

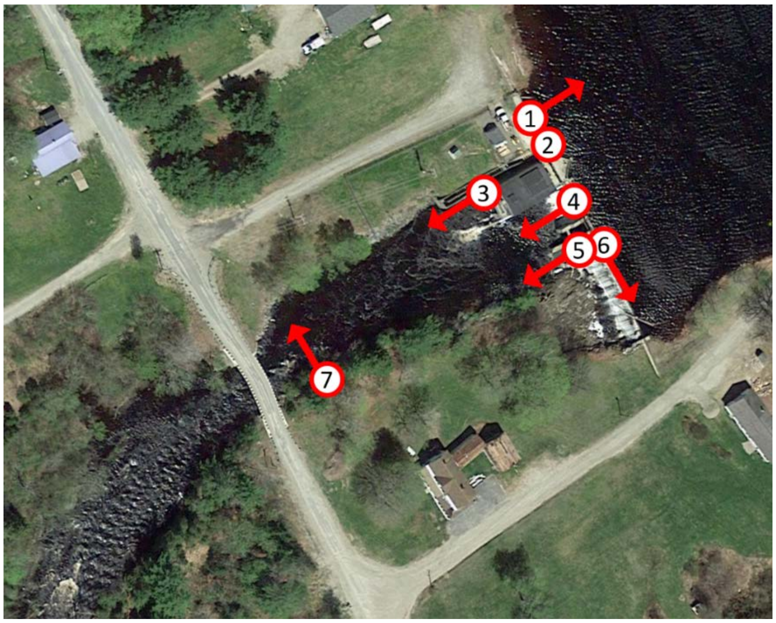


Figure. 1: Map of the radio antennas and the direction in which they were pointed. Antennas 1 and 2 monitor upstream movement and the exit of the fishway. Antennas 3, 4, 5, and 6 monitor movement below the dam. Antenna 7 monitors movement at the exit of the study area, around Tannery Road Bridge.

PIT Array

As an ancillary method of detection, we made use of three PIT antennas installed in the fishway of the dam to assess passage. One antenna was placed at the entrance of the fishway, one in the middle, and one at the exit. While radio antennas can detect if a tagged fish is in the general vicinity of the fishway, PIT antennas can describe where exactly in the fishway the fish was at a given moment. In order to pass the dam, a fish must pass the PIT antennas at the entrance and exit of the fishway, and the antennas can record precisely when that occurs. The middle antenna was new this year, and it failed shortly after water was reinstalled to the fishway (May 13). It is not feasible to repair it with water in the fishway, so the antenna remains in place but not operational.

Array Maintenance

The array was visited every 2-3 days between May 10 and July 7 for battery changes and data downloads. There were no events where data was not successfully retrieved and the array remained functional for the entirety of the study. By July 7, it became apparent that fish were no longer approaching the dam and visits to check equipment and retrieve data were reduced to once weekly. The radio array was dismantled on July 24, after having gone six weeks without new detections. The PIT array remains in the fishway to provide data for other ongoing studies.

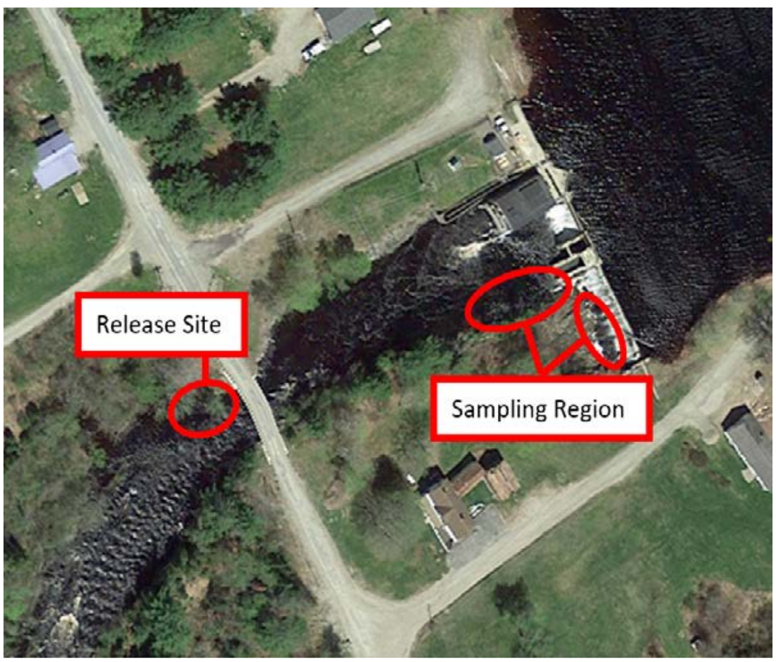


Figure. 2: Map highlighting regions where fish were captured and released.

Fish Capture

Alewife were captured directly below the dam to ensure that all sampled fish had demonstrated intent to approach the dam. On each sampling day, the study area was surveyed to locate potential capture sites based on where the fish were pooling. Consistently, this was on the northeast side of the river below the spillway. Fish were gathered here every day, which allowed for easy sampling. Alewife were captured using a 1.5 m cast nets. Captured fish were stored in a large tank with aeration in the back of a truck until they were tagged. Following tagging, fish were released in order to observe their movement around the dam (Figure 2).

Fish Tagging

Species was confirmed through morphology upon tagging. Lotek Freshwater Nanotags (NTF-6-1) were used for all fish in this study. Tagging initiation was determined by the delivery of the tags. Radio tags arrived on May 10 and were promptly activated and had Biomark APT12 PIT tags glued on so that both the radio and PIT arrays could be used. Sampling began on May 13 and also occurred on May 17, 21, 25, and 28. The proposed study design outlined three sampling events of 33 fish. The first two sampling events resulted in the successful tagging of ~33 fish, however the migration timing of alewife was sharply curtailed in the following week. After a day of lackluster sampling on May 25, Milford Dam was consulted for updated trap counts. DMR reported 600,000 new river herring passing Milford Dam in that most recent week, so we remained optimistic that the fish would turn up at Lowell Tannery after a few days and continued to try to capture fish. In the following days, however, it became clear that the alewife run had transitioned to the blueback herring run. Several additional alewife were tagged, but with water temperatures were rising rapidly (and presumptive blueback herring passing Milford Dam were dwindling as well) we shifted the focus to tracking. The blueback herring that were often bycatch of the sampling efforts in the last few days were briefly considered for use in the study, but (aside from being the wrong species) these fish were much smaller and below our cutoff size for radio tagging (24 cm).

By May 10, in anticipation of dummy-tagged fish, a 150-gallon circular tank had been filled with water and set up with aeration, a water pump, and a net covering. The pump brought in cool water and kept the tank's water moving while the aerator kept the water oxygenated. This tank was disassembled the week after the conclusion of tagging when it was determined that there would not be enough fish for this portion of the study.

Mobile Tracking

In addition to the stationary radio and PIT arrays, a portable radio receiver was utilized to monitor fish movement beyond the reach of the stationary receivers. During regular visits for battery changes and data downloads, the river was patrolled following Fire Lane 28 with a portable receiver and Yagi antenna for at least two km below the Tannery Road Bridge (Figure 3). Once each week, this patrol was expanded to include various logging roads and trails that extended the range by an additional five km. From July 7 to July 24, to assess if any fish had passed upstream, a handful of tracking events included following the Passadumkeag north to Saponac Pond and beyond, expanding the range by 15 km upstream of the dam.

One tracking event (July 2) was a canoe trip of the entirety of the Passadumkeag River downstream of the dam until it intercepted the Penobscot River (~20 km). By this date, there were no fish approaching the dam, so the goal was to determine if they were still in the river, if any tags had been dropped, or if there was any evidence of fish mortality. No alewife were detected.

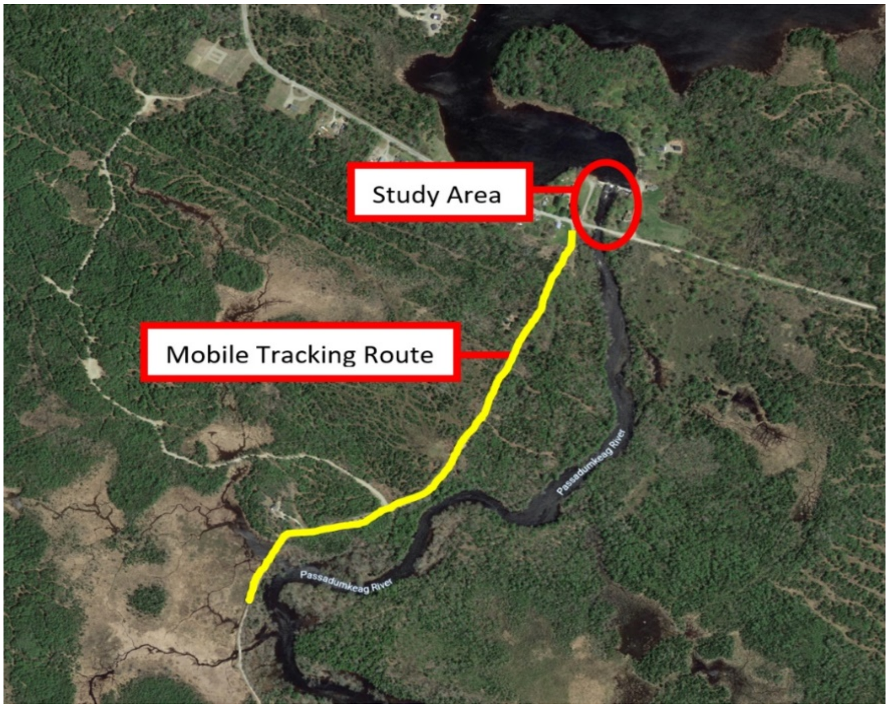


Figure 3: Map of the regular mobile tracking route (2 km) in relation to the study area.

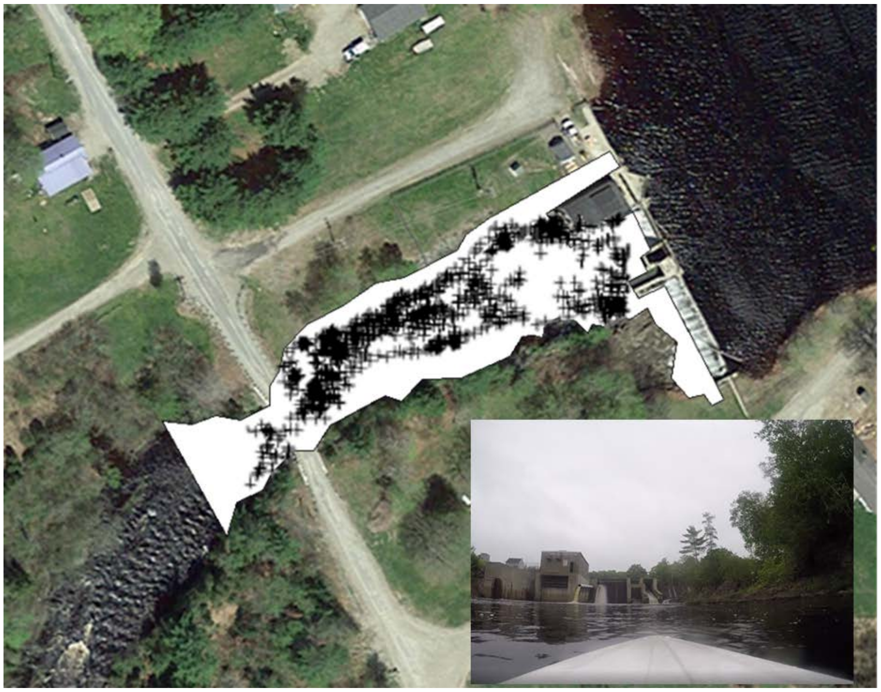


Figure 4: A map of the study area, overlaid with the GPS points that paired with radio array detections collected from the remote-controlled boat. Gaps typically indicate shallow or rocky areas that the boat could not safely access. Data for these points were interpolated from the nearest neighboring points. Inset is view from radio controlled boat approaching dam.

Mapping of Fish Movements

To precisely assess where fish were spending time below the dam, we needed to relate the strength of the radio detections to a physical location below the dam. This required data that paired a signal strength with a known location. To obtain this data we operated a remote-controlled boat below the dam. Inside this boat was a test tag (pings every 5 seconds, as opposed to 30 seconds on live tags) and a GPS unit. The boat was driven for 2 hours and collected GPS data for the entire study area (Figure 4).

We were able to obtain known locations and known detection powers by relating the time of the detections that occurred during this testing to the time of the GPS points. This was done in R using the "*lubridate*," "*sp*," and "*raster*" packages (R Core Team 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/).

The known locations and powers were split by the antennas that detected them. Nearest-neighbor (Delauny triangulation) calculations were performed using the "*dismo*" and "*deldir*" packages in R to create Voronoi plots that interpolate detection powers based on the points near a given point. Raster objects were created from these Voronoi plots using the "raster" package in R. The Voronoi plots were fitted to a shapefile that described the study area (Figure 5).

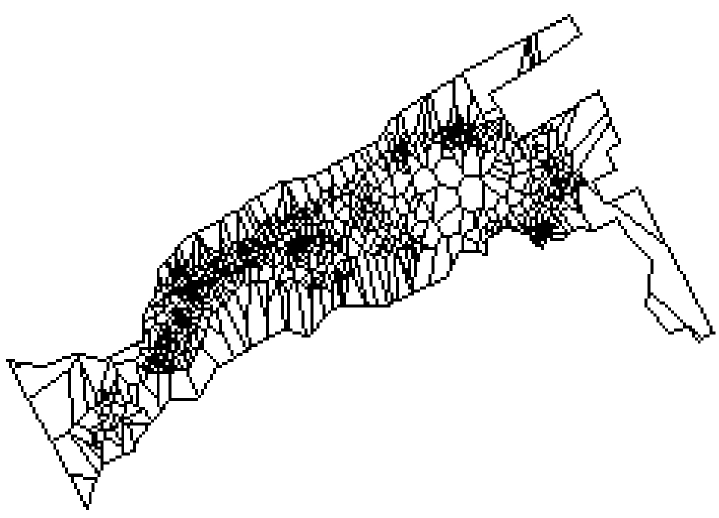


Figure 5. The Voronoi plot for one antenna fitted to the study area. Each polygon forms the basis of the raster object that acts as the grid system for the rest of the analysis.

The raster object acts as a grid with cells of known or interpolated (*predicted*) power values for each antenna. Each of the detections on each antenna had a power value (*observed*) that could then be compared against this grid for. Thus each detection's reported power (between 1 and 255) was compared against the predicted observed powers recorded on each of the six antennas. An index value was calculated that determined how well each cell (*x,y*) in each raster object described the detection. This allows us to report an index (I) of probability that for a given detection, a fish is likely to be in one area and not another. The equation for the index value is

Equation 1

$$I_{Fish(x,y)} = \frac{\sum_{detect=1}^{k} \frac{\sum_{Ant=1}^{6} \sqrt{(Observed_{Ant} - Predicted_{Ant(x,y)})^2}}{(6)(255)}}{k}$$

Where $I_{Fish(x,y)}$ is index of location likelihood that a given fish is in a given pixel based on all detections (k). The denominator of 6 and 255 convert the index to a value between 0 and 1, where 255 is the maximum possible detection strength and 6 is the number of antennas used for this calculation. An index consolidating the data from all 40 fish that approached the dam is given by:

Equation 2

$$I_{T(x,y)} = \frac{\sum_{Fish=1}^{40} I_{Fish(x,y)}}{40}$$

The graphic presentations of these indices shown in Equations 1 and 2 represent high (low values) versus low (high values) spatial probability of time spent near the dam.

Results

Fish Observation:

On each sampling day, the fish were pooling in four reaches below the dam (Figure 6): in the pool created by the spillway, the southeast side of the river below the spillway, by the Tannery Road Bridge, and on the southeast side of the river halfway between the bridge and the spillway. These were the only four regions below the dam where the fish appeared to gather in this manner. Fish were never observed pooling on the northwest side of the river, though greater depth likely makes this observation more difficult. An adult Atlantic salmon was also observed resting on the southeastern shore.

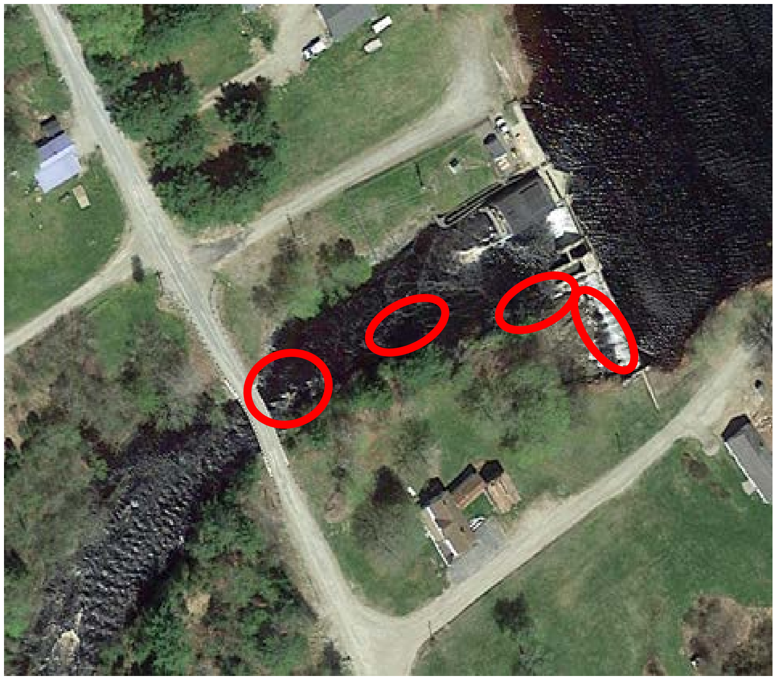


Figure 6: A visualization of where fish were observed pooling below the dam. Though fish were not seen in every pool every day, these were the most common areas to find them. Fish were consistently in the pools just below the spillway.

Fish Tagging

Tagging occurred on May 13, 17, 21, 25, and 28. On these days respectively, there were 31, 34, 8, 0, and 7 fish successfully tagged for a total of 80 fish (Figure 7). This is fewer than the target of 105 fish due to how quickly the alewife run ended.

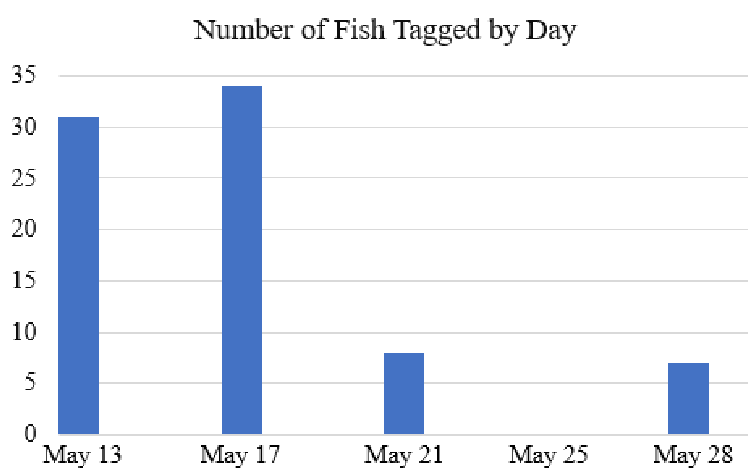


Figure 7: A graph of how many fish were captured at each sampling event. Though the first two events were very successful, sampling success quickly dropped until it was not worthwhile to continue sampling efforts.

Radio Telemetry

Of the 80 fish that were sampled, 40 approached the dam after sampling. Figure 8 describes the amount of time each of these fish spent below the dam before exiting the study area.

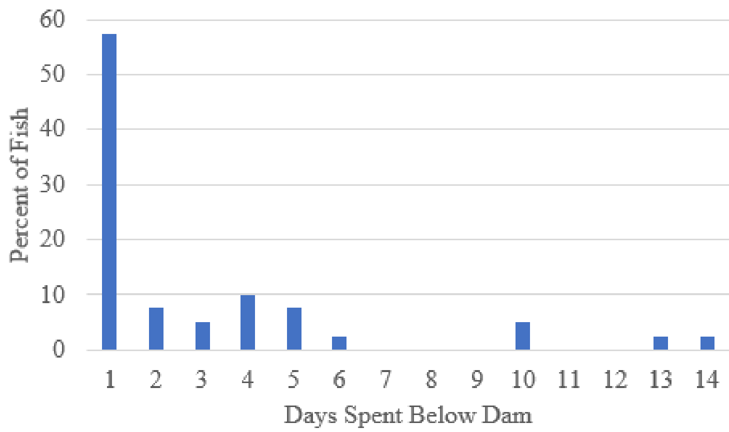


Figure . 8: How much time fish were spending below the dam before leaving the study area. Nearly 60% of fish spent only one day below the dam before leaving the study area. Almost 10% of fish were searching for passage for 10 or more days.

No tagged fish passed the dam, we sought to explain where they could have gone.

Analysis of the radio array on the main stem of the Penobscot revealed 13 fish moving through the river (Table 2).

PIT Array Detections

In addition to returning to the study area, two fish also attempted to use the fishway. The PIT antenna at the bottom of the fishway detected two radio tagged fish entering the fishway, but they were not detected on the PIT antenna at the top of the ladder nor were they detected on the antennas that point into the headpond.

Table 2: Detections of fish on the Penobscot main stem. Note that Milford Dam is located at river kilometer (RKM) 62.

TagID	Detections	FirstTimestamp	LastTimestamp	avgPower	RKM	Location
12	6	5/25/2021 3:26	5/25/2021 18:06	146.83	53.2	Bradley
18	3	5/27/2021 14:27	5/27/2021 17:40	28.33	150.2	Matawamkeag
18	2	6/3/2021 0:00	6/3/2021 0:00	38.5	60.7	MilfordMobile
19	6	5/24/2021 14:54	5/28/2021 14:15	24.5	150.2	Matawamkeag
19	10	6/3/2021 0:00	7/7/2021 0:00	101.5	61.2	MilfordMobile
20	1	5/24/2021 20:06	5/24/2021 20:06	137	53.2	Bradley
21	1	6/3/2021 22:52	6/3/2021 22:52	103	64.8	MilfordUpstream
21	4	6/4/2021 0:00	6/4/2021 0:00	77.5	60.7	MilfordMobile
22	2	5/27/2021 2:51	5/27/2021 2:53	108	64.8	MilfordUpstream
34	2	5/29/2021 19:02	5/29/2021 19:04	96.5	64.8	MilfordUpstream
61	1	5/28/2021 0:33	5/28/2021 0:33	105	64.8	MilfordUpstream
61	3	5/28/2021 23:07	5/29/2021 2:41	89.25	45.8	Eddington
66	10	5/27/2021 2:59	5/27/2021 7:47	119.4	64.8	MilfordUpstream
93	3	5/30/2021 1:27	5/30/2021 1:31	150.6	64.8	MilfordUpstream
96	24	5/30/2021 0:00	7/6/2021 0:00	81.08	61.2	MilfordMobile
97	1	5/25/2021 20:00	5/25/2021 20:00	101	64.8	MilfordUpstream
102	3	5/24/2021 18:08	5/24/2021 18:16	145	53.2	Bradley

Table 3: PIT Detections for the two fish that attempted to use the fishway and the time they spent below the dam (since tagging) before finding the fishway

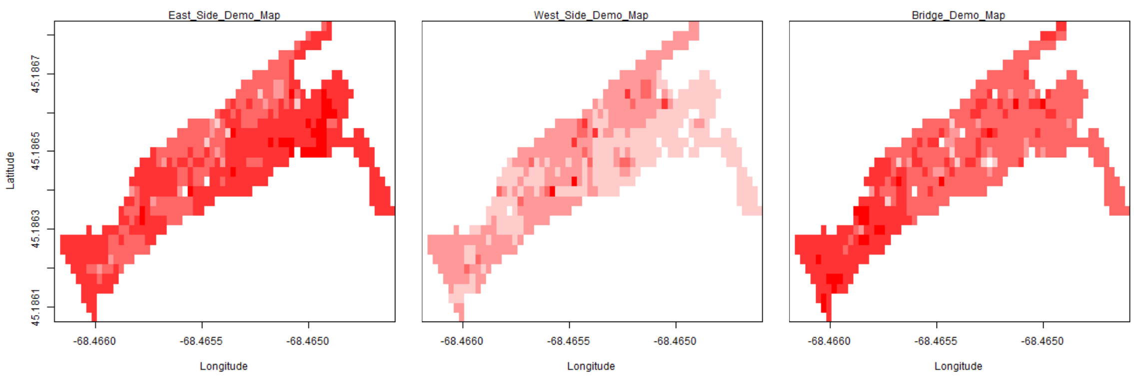
FishID	PITID	Detections	Detection Timestamp	Release Date	Days btw Release and Detection
18	3DD.003D9922E4	1	5/18/2021 15:22	5/13/2021	5
33	3DD.003D9922D7	1	5/18/2021 13:26	5/17/2021	1

Mobile Tracking

No fish were detected along Fire Lane 28 at any point during the study. No fish from this study were detected via a canoe assessment of the entire river. Detection of another fish (sea lamprey) from another study a few kilometers from the confluence with the Penobscot confirmed our ability to detect these tags.

Fish Movement Near the Lowell Tannery Dam

Figure 10 are hypothetical data demonstrating what a map looks like when a fish is detected with high power (150 Power) in one part of the study area and not another. For example, the “East Side Demo” map is only using data from the antennas on the southeast side of the river, and likewise for the other maps.



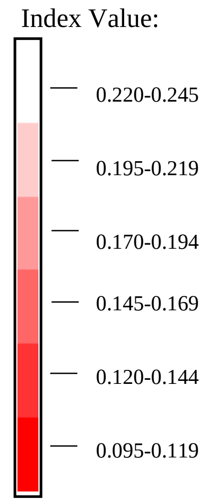
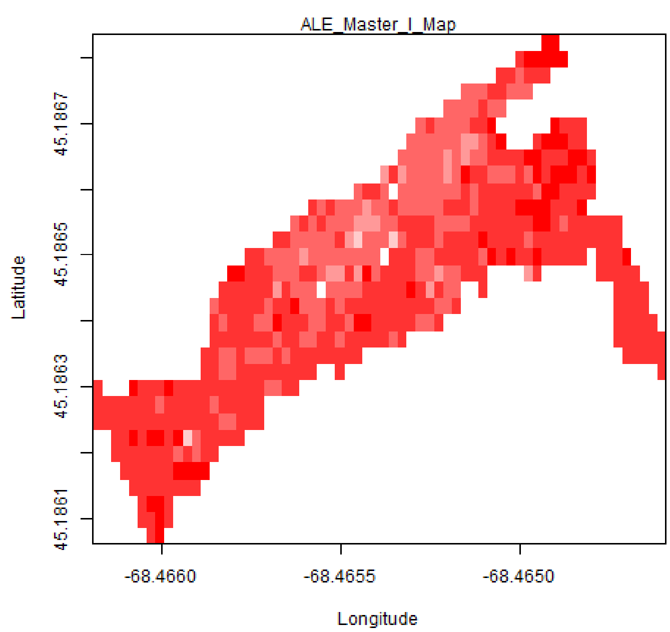


Figure 10: Demonstrations of detections in each region of the study area. If a hypothetical fish was detected at 150 Power on the eastern antennas, it is a darker shade of red on that side of the map. The same can be said for high-power detections in the other regions and their respective maps.



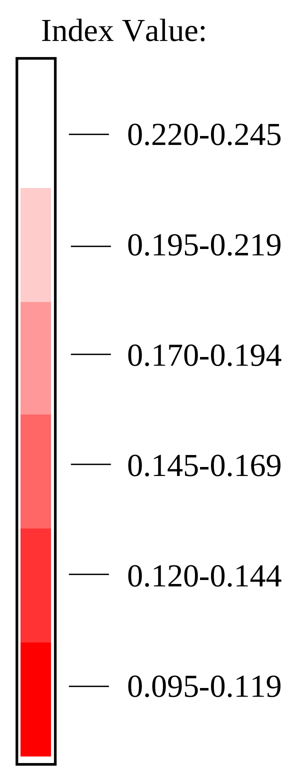


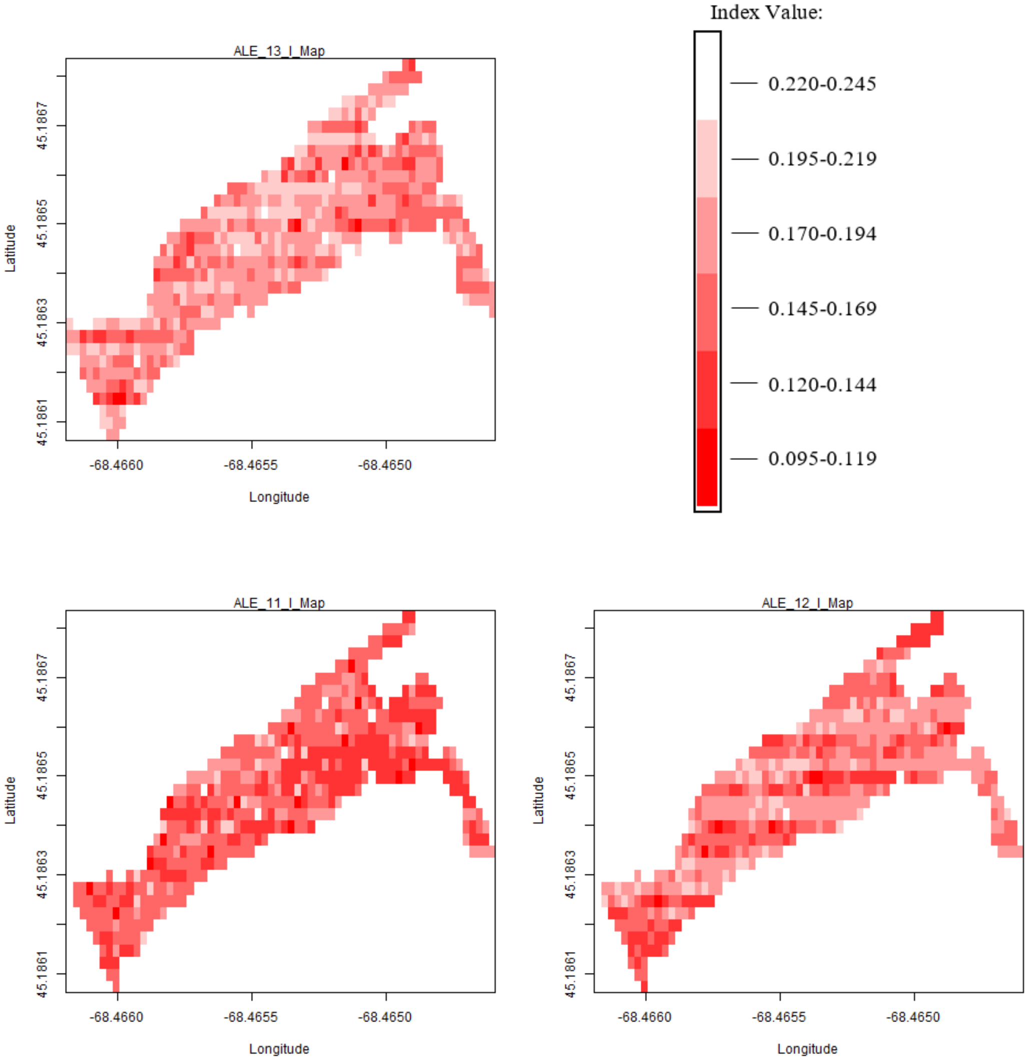
Figure 11: A plot if the index of occupancy probability index (I) averaged across all fish that approached the dam (n=40). The darker colors on the southern side of the dam indicates greater time spent away from the fishway.

The aggregate data for all 40 returning fish is detailed in Figure 11. The map shows overall higher index values on the southeastern side of the study area and near Tannery Road Bridge. This suggests that fish were tending to spend more time in the fast-moving water below the spillway. These maps were created in R using the packages "*raster*" and "*sp*" and incorporates the maps of all returning fish (see Appendix I for individual maps).

Summary

- PIT and Radio observations suggest that no tagged fish successfully passed the dam.
- Analysis of the signal strength data from the 40 fish that approached the dam indicate low attraction to the fishway entrance compared with the southeastern side of the tailrace. This is consistent with observations of fish schooling in this area.
- Only 2 tagged fish found the fishway entrance. One tagged fish found the fishway after 1 day (by which point 60-70% of fish have already fallen back away from the dam). A second fish found the fishway after 90% of fish have fallen back.
- There was significant fallback of tagged fish, with half approaching the dam and half leaving the immediate area. No fish were detected along Fire Lane 28 at any points during the study. This may indicate that once fish decided to leave the study area, they left the Passadumkeag entirely and quickly. This is likely as 13 fish were detected elsewhere in the Penobscot River.
- The continued upstream movement of alewives in the main stem Penobscot indicates continued searching for upstream habitat that could not be accessed in the Passadumkeag River but confirms the utility of those fish that did return.
- Our post assessment survey detected no tags either "shed" or from mortalities

Appendix



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0.195-0.219
0.170-0.194
0.145-0.169
0.120-0.144
0.095-0.119
ALE_13_I_Map
ALE_11_I_Map
ALE_12_I_Map
Latitude
Longitude
45.1861
45.1863
45.1865
45.1867
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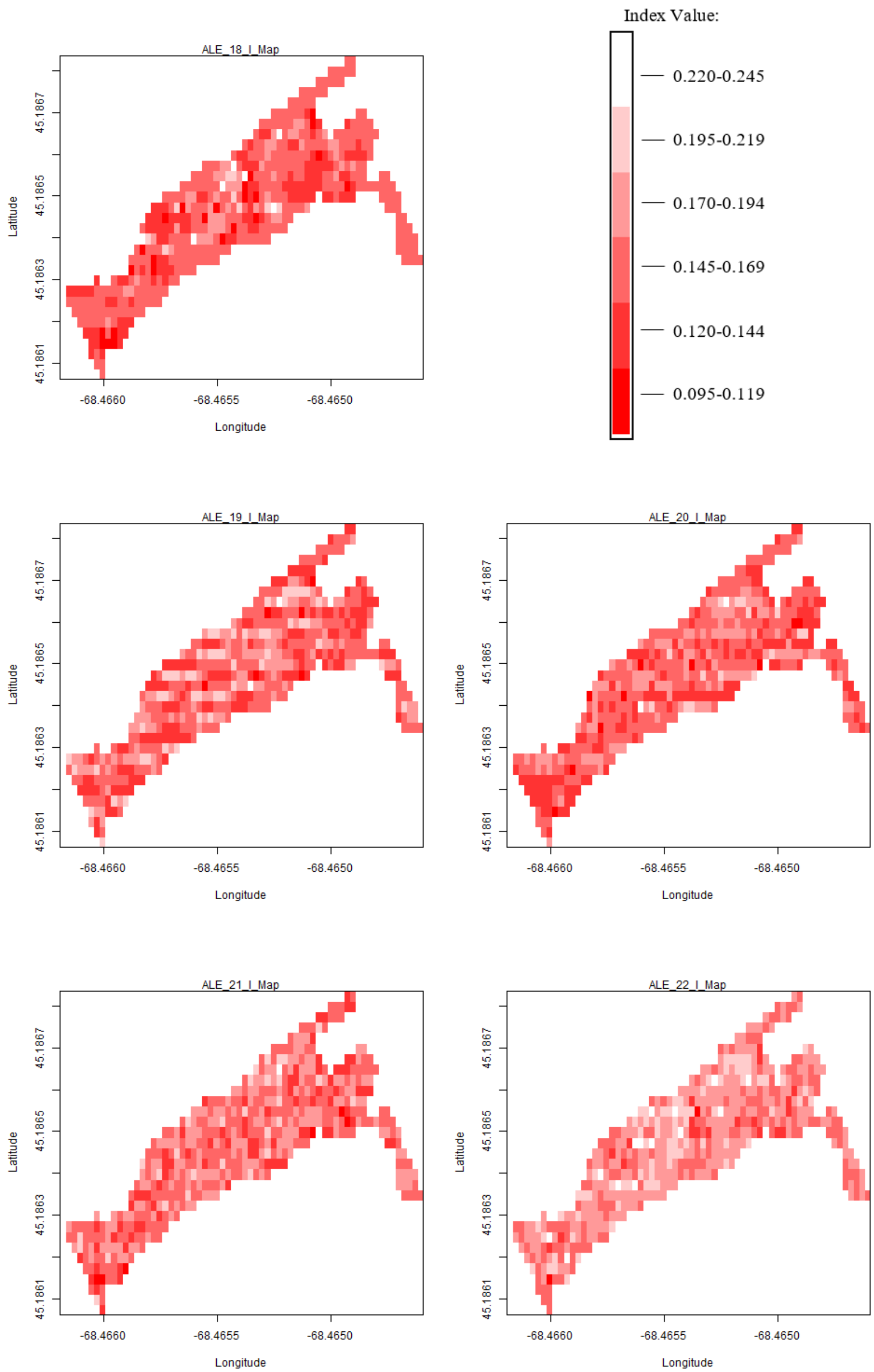
-68.4655
-68.4650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0.220-0.245
0.195-0.219
0.170-0.194
0.145-0.169
0.120-0.144
0.095-0.119
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ALE_19_I_Map
ALE_20_I_Map
ALE_21_I_Map
ALE_22_I_Map
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Longitude
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45.1863
45.1865
45.1867
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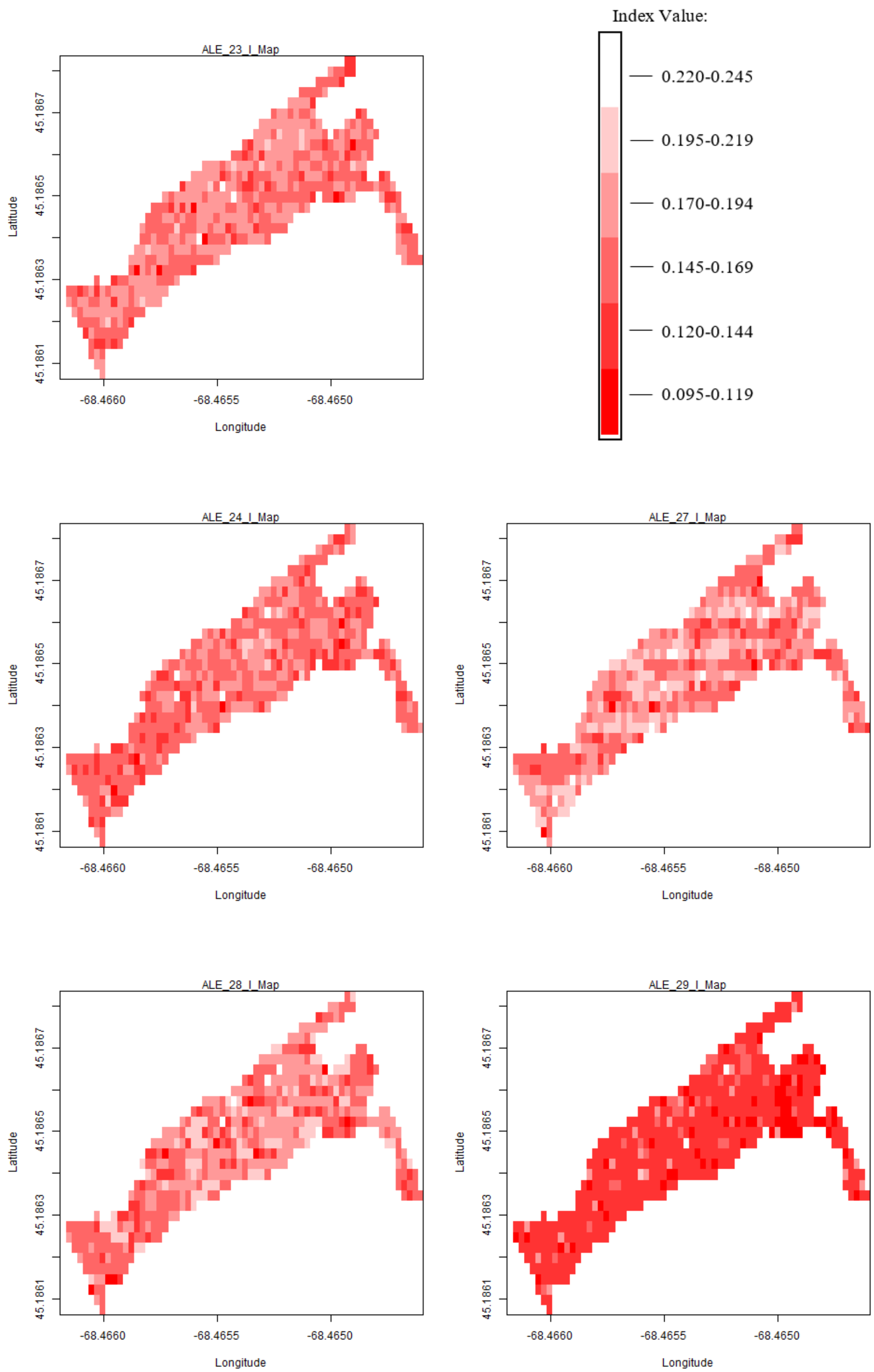
-68.4650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0.170-0.194
0.145-0.169
0.120-0.144
0.095-0.119
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ALE_24_I_Map
ALE_27_I_Map
ALE_28_I_Map
ALE_29_I_Map
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Longitude
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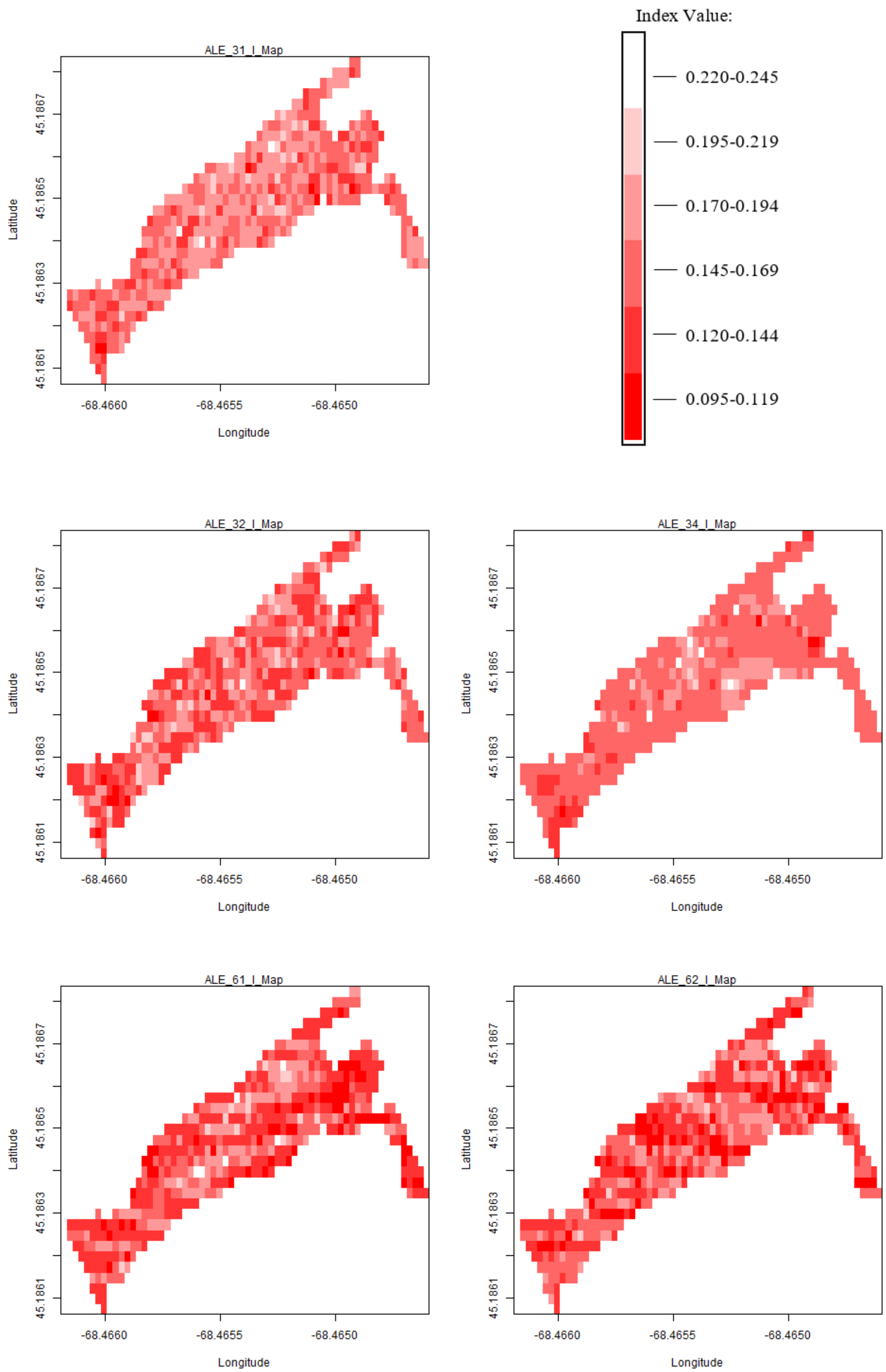
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ALE_32_I_Map
ALE_34_I_Map
ALE_61_I_Map
ALE_62_I_Map
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Longitude
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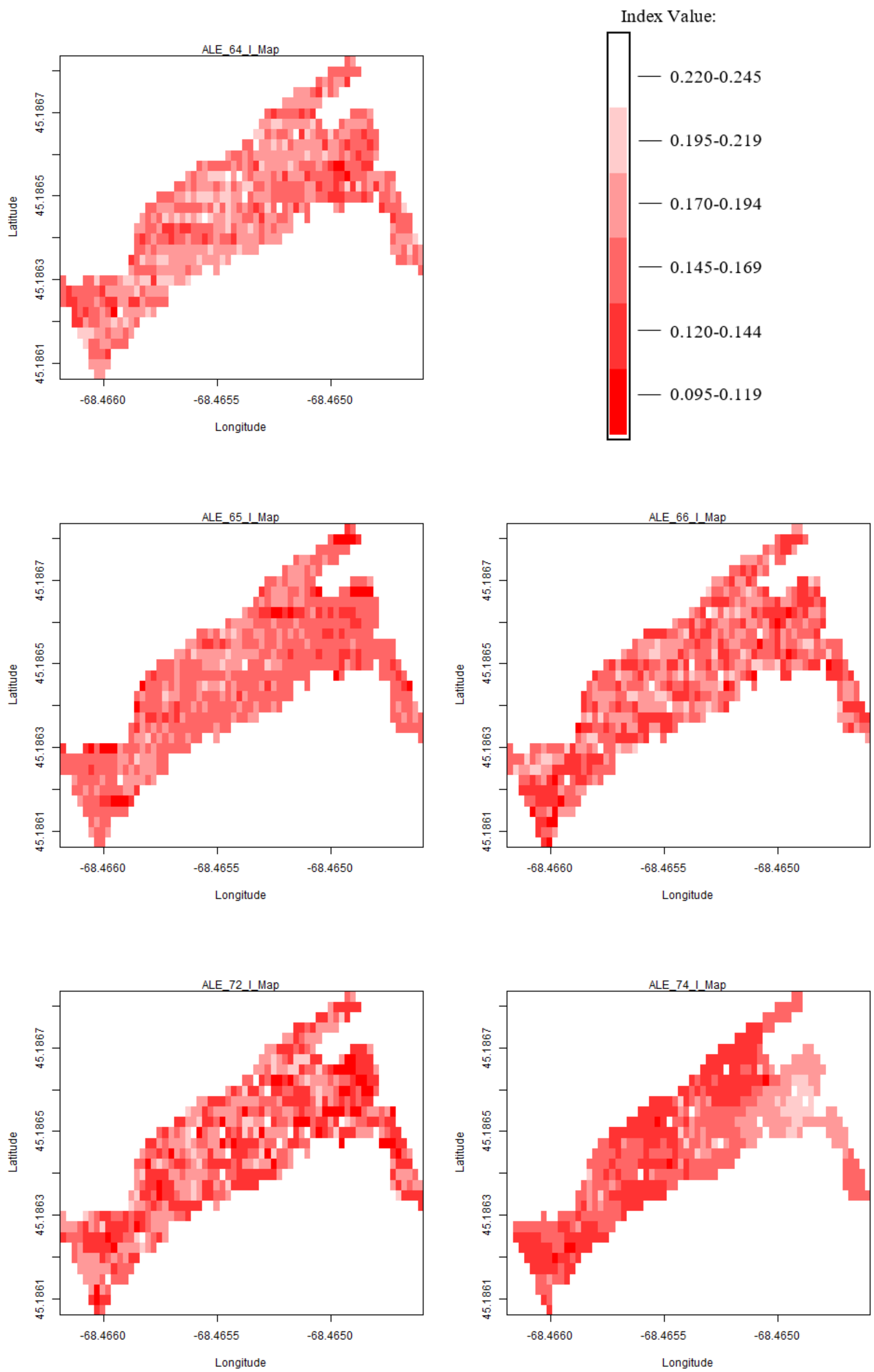
-68.4655
-68.4650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ALE_65_I_Map
ALE_66_I_Map
ALE_72_I_Map
ALE_74_I_Map
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45.1865
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Longitude
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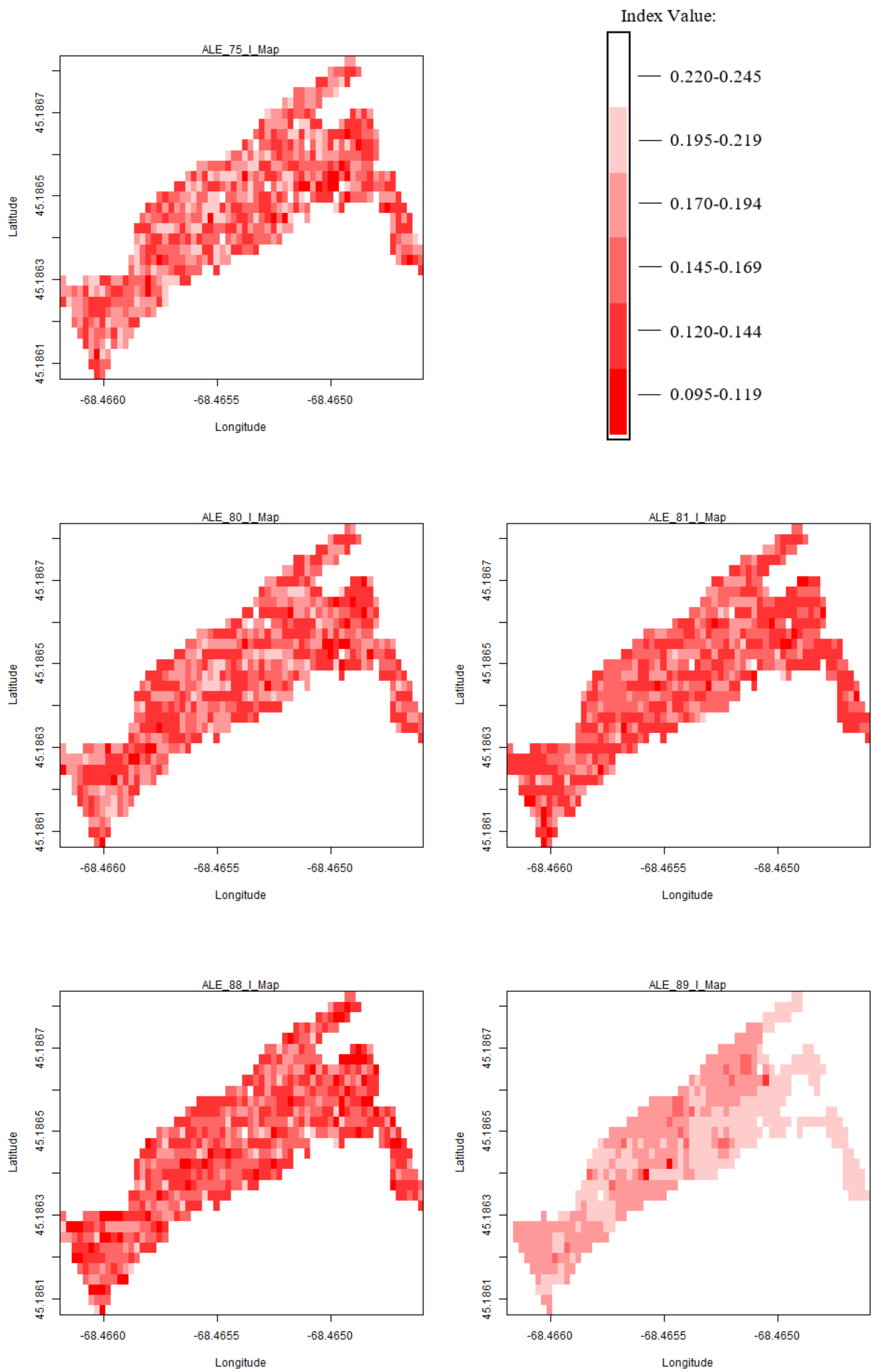

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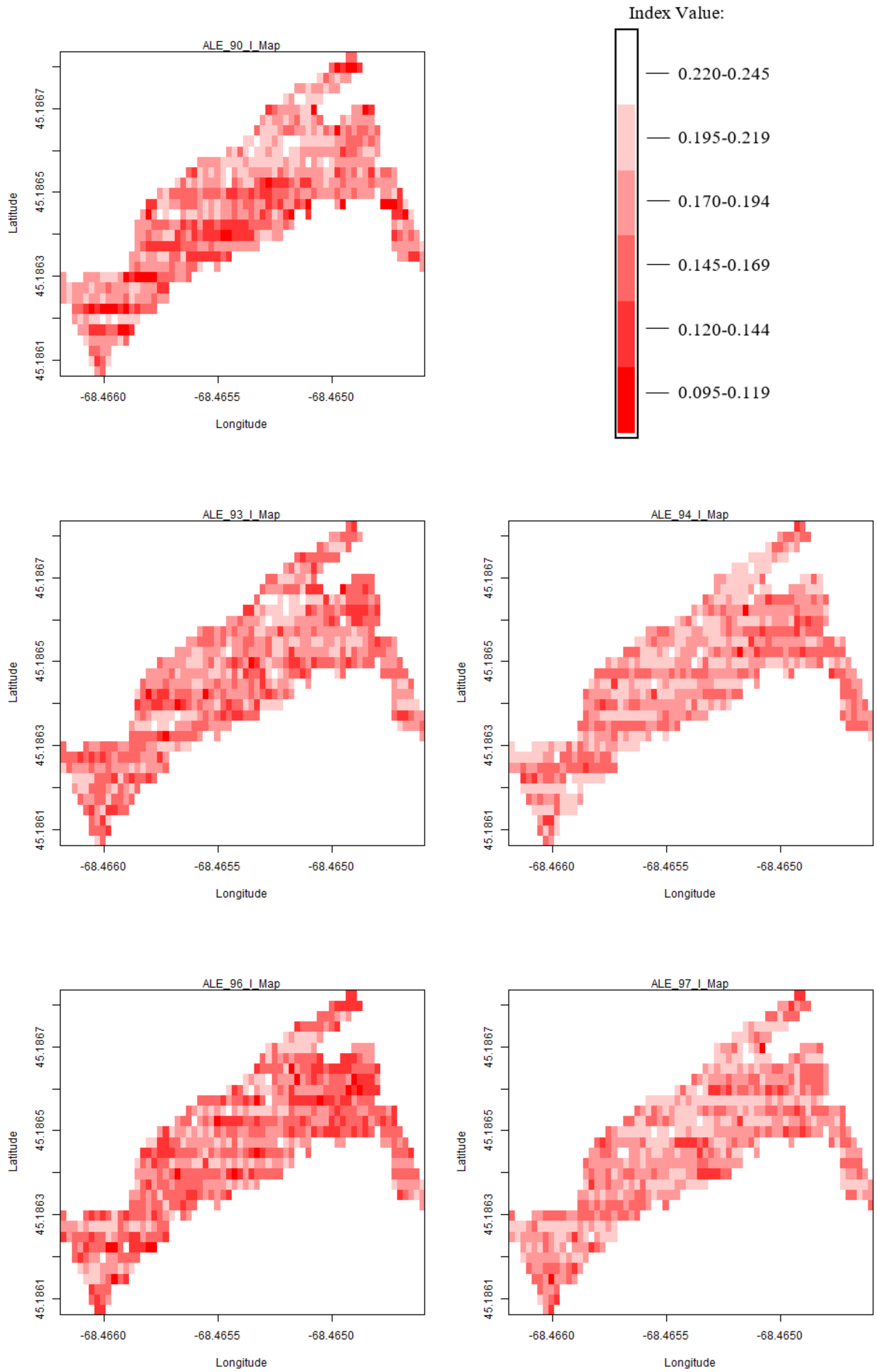
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0.170-0.194
0.145-0.169
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0.095-0.119
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ALE_93_I_Map
ALE_94_I_Map
ALE_96_I_Map
ALE_97_I_Map
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45.1863
45.1865
45.1867
Longitude
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-68.4655
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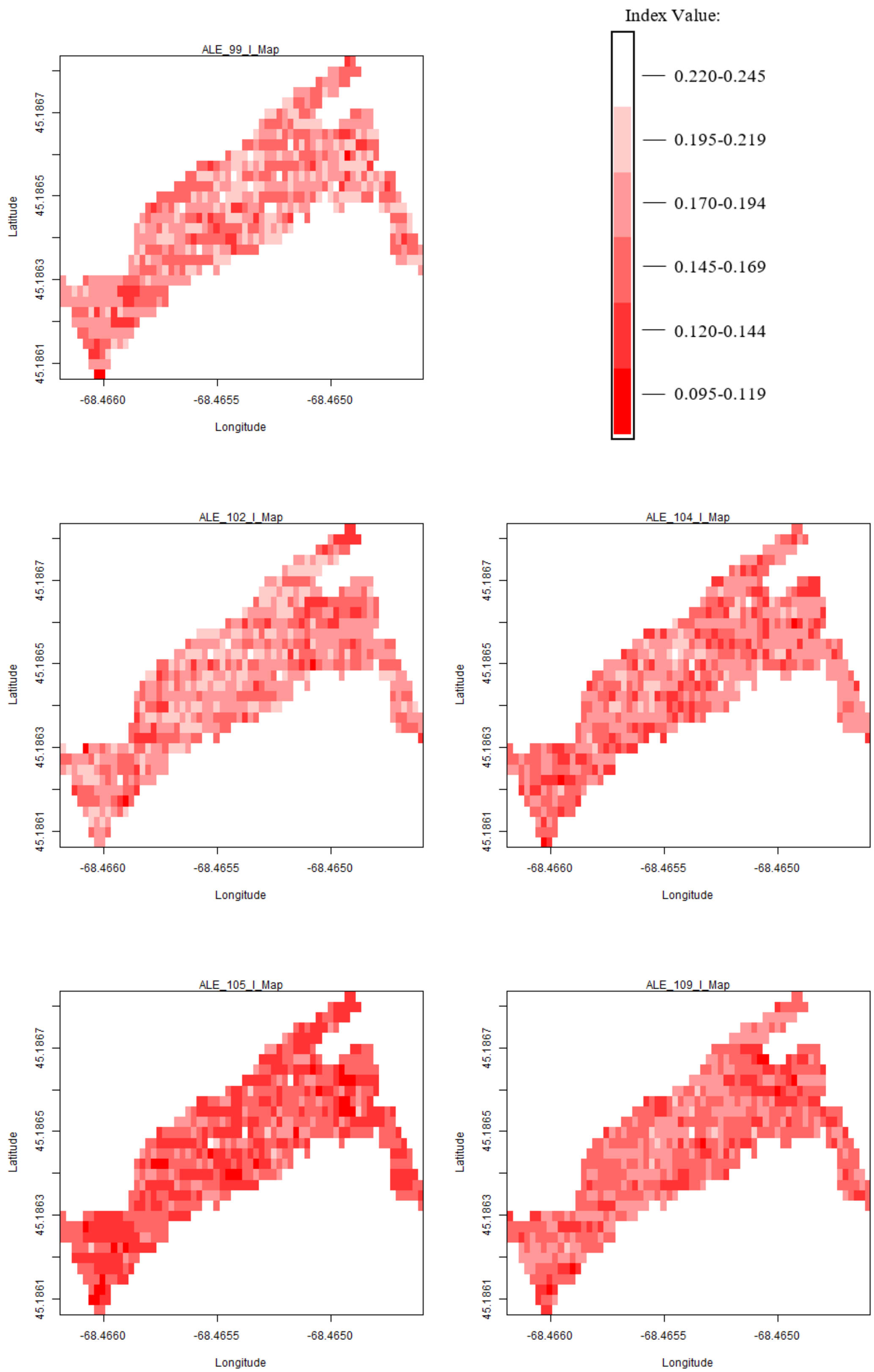
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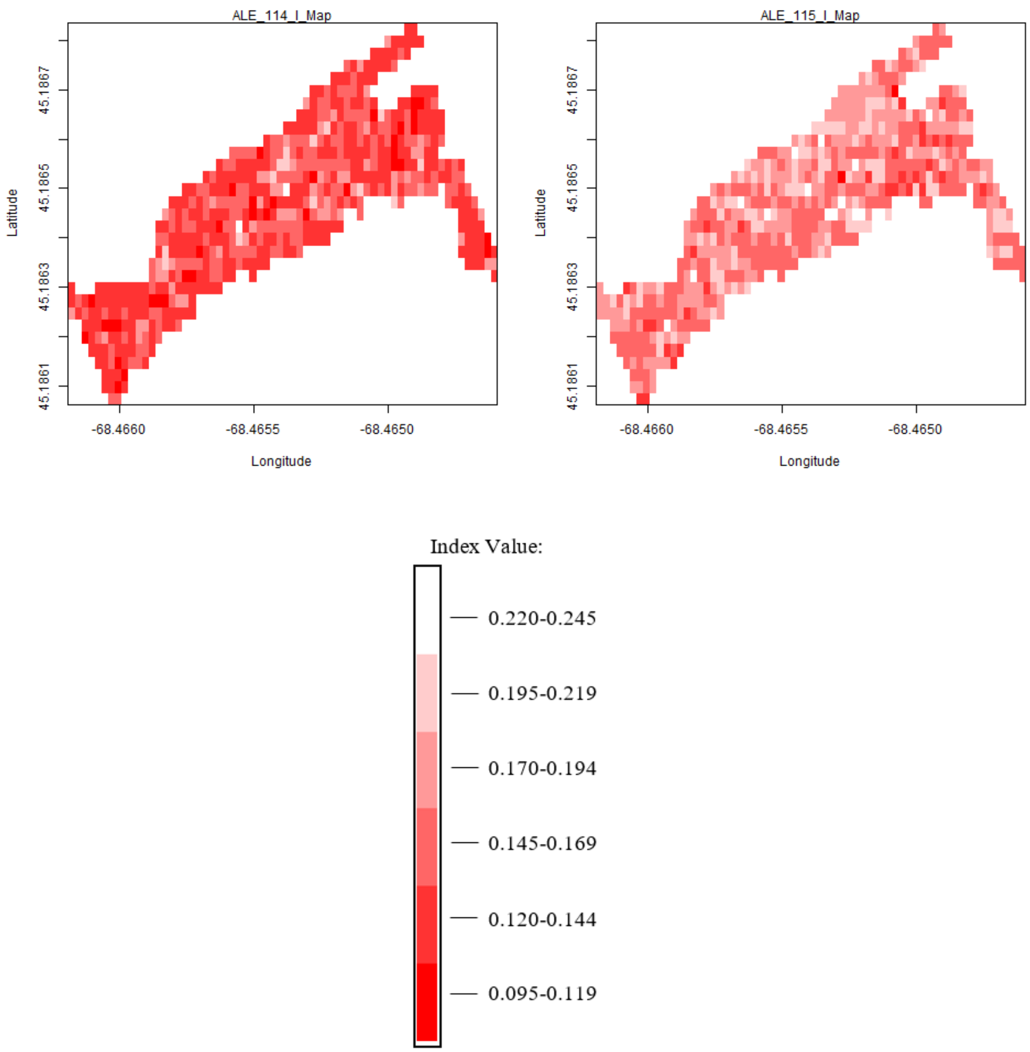
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-68.4655
-68.4650
Longitude
Index Value:
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0.195-0.219
0.170-0.194
0.145-0.169
0.120-0.144
0.095-0.119

APPENDIX D

A LIST OF POTENTIAL WILDLIFE SPECIES THAT MAY OCCUR AT THE PROJECT

COMMON NAME	**SCIENTIFIC NAME**
BIRDS	
Alder Flycatcher	Empidonax alnorum
American Bittern	Botaurus lentiginosus
American Black Duck	Anas rubripes
American Crow	Corvus brachyrhynchos
American Robin	Turdus migratorius
Bald Eagle	Haliaeetus leucocephalus
Barn Swallow	Hirundo rustica
Barred Owl	Strix varia
Belted Kingfisher	Megaceryle alcyon
Black-capped Chickadee	Poecile atricapillus
Blue Jay	Cyanocitta cristata
Boreal Owl	Aegolius funereus
Broad-winged Hawk	Buteo platypterus
Canada Goose	Branta canadensis
Canada Warbler	Cardellina canadensis
Cerulean Warbler	Setophaga cerulea
Common Goldeneye	Bucephala clangula
Common Merganser	Mergus merganser
Common Raven	Corvus corax
Common Snipe	Gallinago gallinago
Common Yellowthroat	Geothlypis trichas
Gray Jay	Perisoreus canadensis
Great Blue Heron	Ardea herodias
Great Horned Owl	Bubo virginianus
Green Heron	Butorides virescens
Green-winged Teal	Anas carolinensis
Hooded Merganser	Lophodytes cucullatus
Lincoln’s Sparrow	Melospiza lincolnii
Long-eared Owl	Asio otus
Mallard	Anas platyrhynchos
Mourning Dove	Zenaida macroura
Northern Harrier	Circus hudsonius
Northern Parula	Setophaga americana
Northern Rough-winged Swallow	Stelgidopteryx serripennis
Northern Saw-whet Owl	Aegolius acadicus
Northern Waterthrush	Parkesia noveboracensis
Osprey	Pandion haliaetus
Pileated Woodpecker	Dryocopus pileatus
Red-Shouldered Hawk	Buteo lineatus
Red-Tailed Hawk	Buteo jamaicensis
Red-wing Blackbird	Agelaius phoeniceus

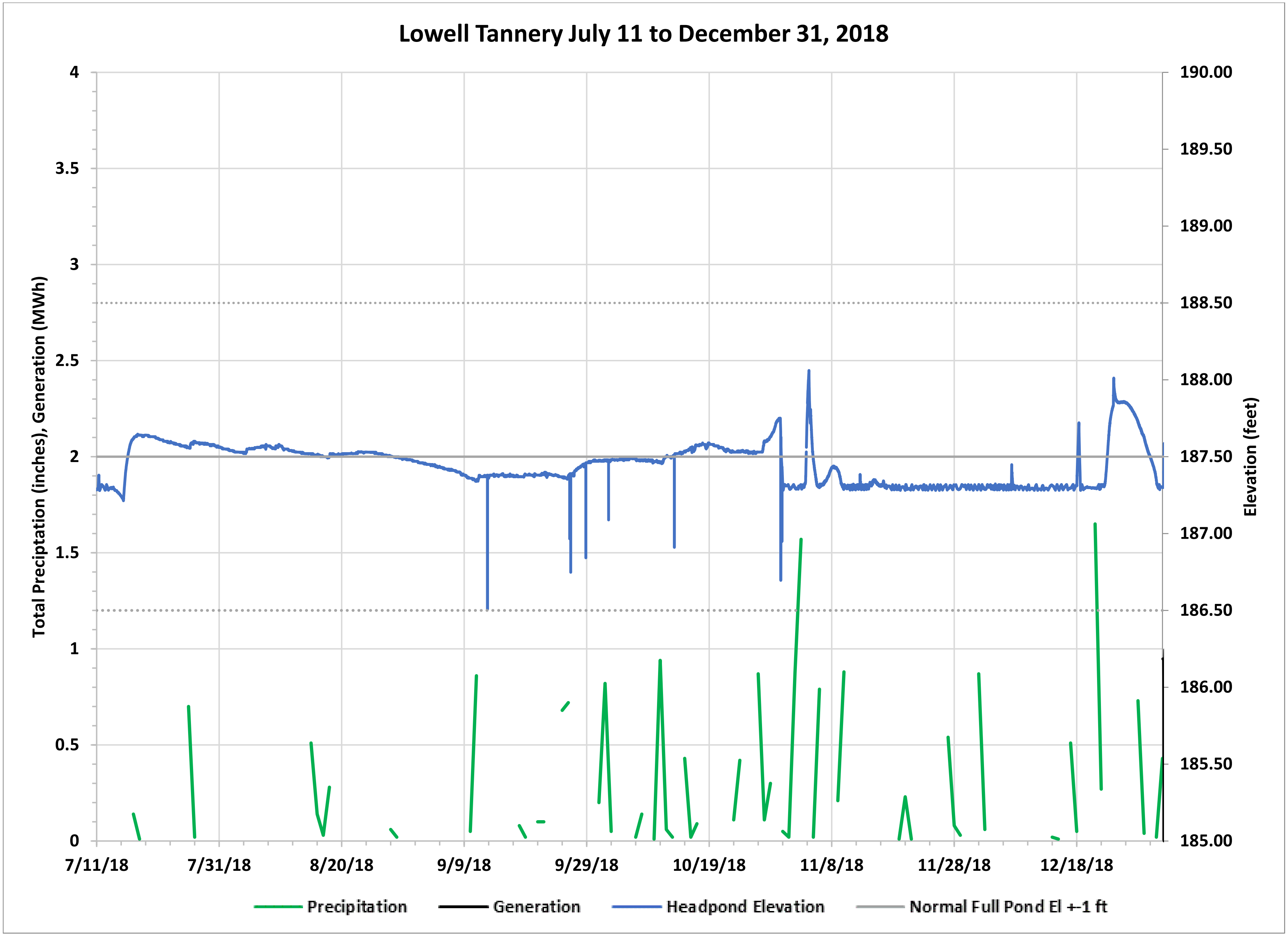
COMMON NAME	SCIENTIFIC NAME
Ring-necked Duck	Aythya collaris
Ruby-crowned Kinglet	Regulus calendula
Rusty Blackbird	Euphagus carolinus
Sharp-Shinned Hawk	Accipiter striatus
Short-eared Owl	Asio flammeus
Song Sparrow	Melospiza melodia
Sora	Porzana carolina
Spotted Sandpiper	Actitis macularius
Swamp Sparrow	Melospiza georgiana
Veery	Catharus fuscescens
Virginia Rail	Rallus limicola
Whip-poor-will	Caprimulgus vociferus
White-breasted Nuthatch	Sitta carolinensis
Wild Turkey	Meleagris gallopavo
Wilson's Warbler	Cardellina pusilla
Winter Wren	Troglodytes hiemalis
Wood Duck	Aix sponsa
Yellow Warbler	Dendroica petechia
Yellow-bellied Flycatcher	Empidonax flaviventris
MAMMALS	
American Water Shrew	Sorex palustris
Beaver	Castor canadensis
Big Brown Bat	Eptesicus fuscus
Black Bear	Ursus americanus
Eastern Chipmunk	Tamias striatus
Eastern Pipistrelle	Perimyotis subflavus
Ermine	Mustela erminea
Fisher	Martes pennanti
Gray Squirrel	Sciurus carolinensis
Hoary Bat	Lasiurus cinereus
House Mouse	Mus musculus
Little Brown Bat	Myotis lucifugus
Meadow Vole	Microtus pennsylvanicus
Mink	Neovison vison
Moose	Alces alces
Muskrat	Ondatra zibethicus
Northern Long-eared Bat	Myotis septentrionalis
Northern Short-tailed Shrew	Blarina brevicauda
Norway Rat	Rattus norvegicus
Raccoon	Procyon lotor
Red Bat	Lasiurus borealis
Red Squirrel	Sciurus vulgaris
Silver-haired Bat	Lasionycteris noctivagans

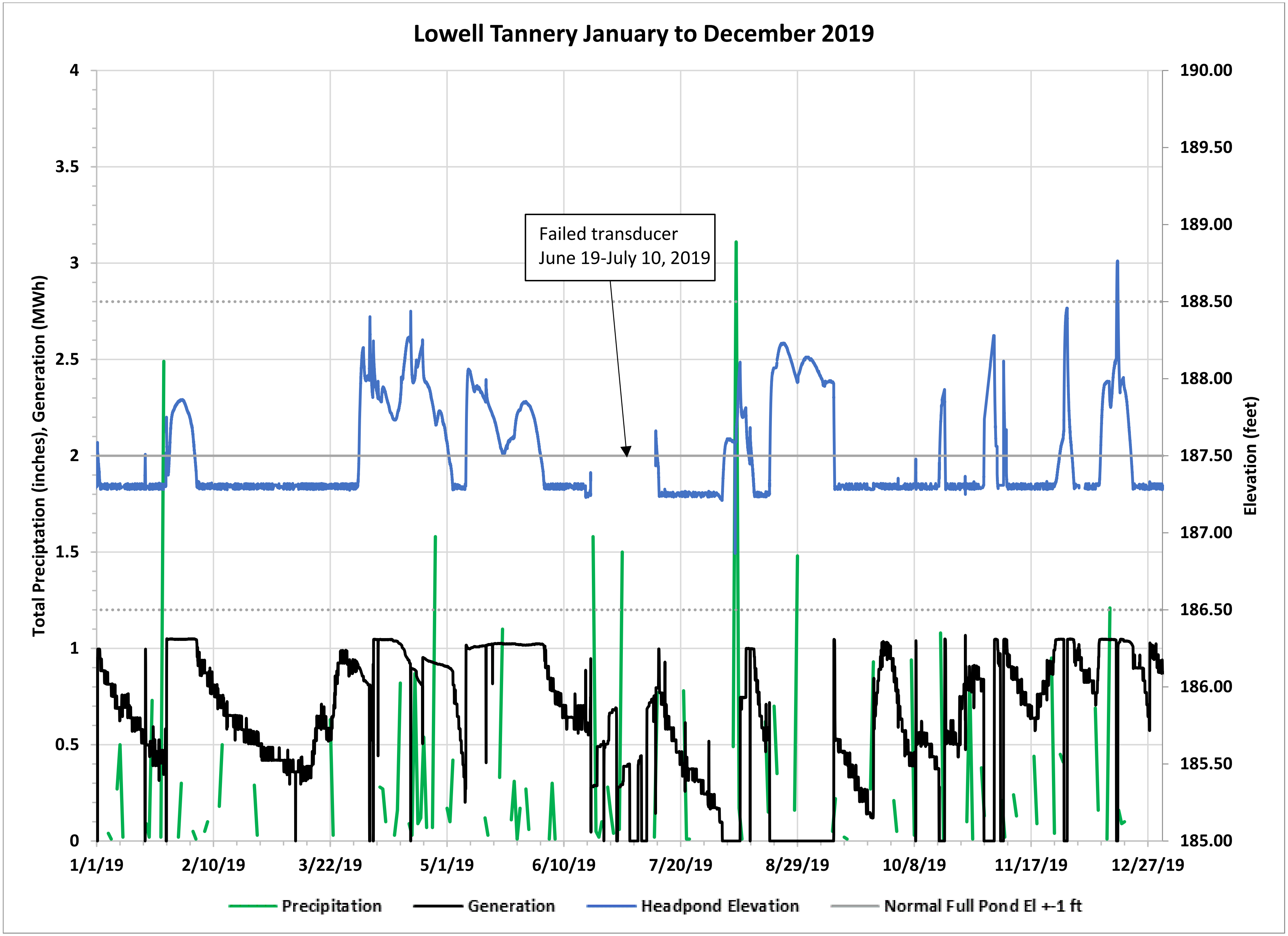
COMMON NAME	SCIENTIFIC NAME
Snowshoe Hare	Lepus americanus
Star-nosed Mole	Condylura cristata
White-tailed Deer	Odocoileus virginianus
Woodland Jumping Mouse	Napaeozapus insignis

Source: DeGraff and Yamasaki 2001

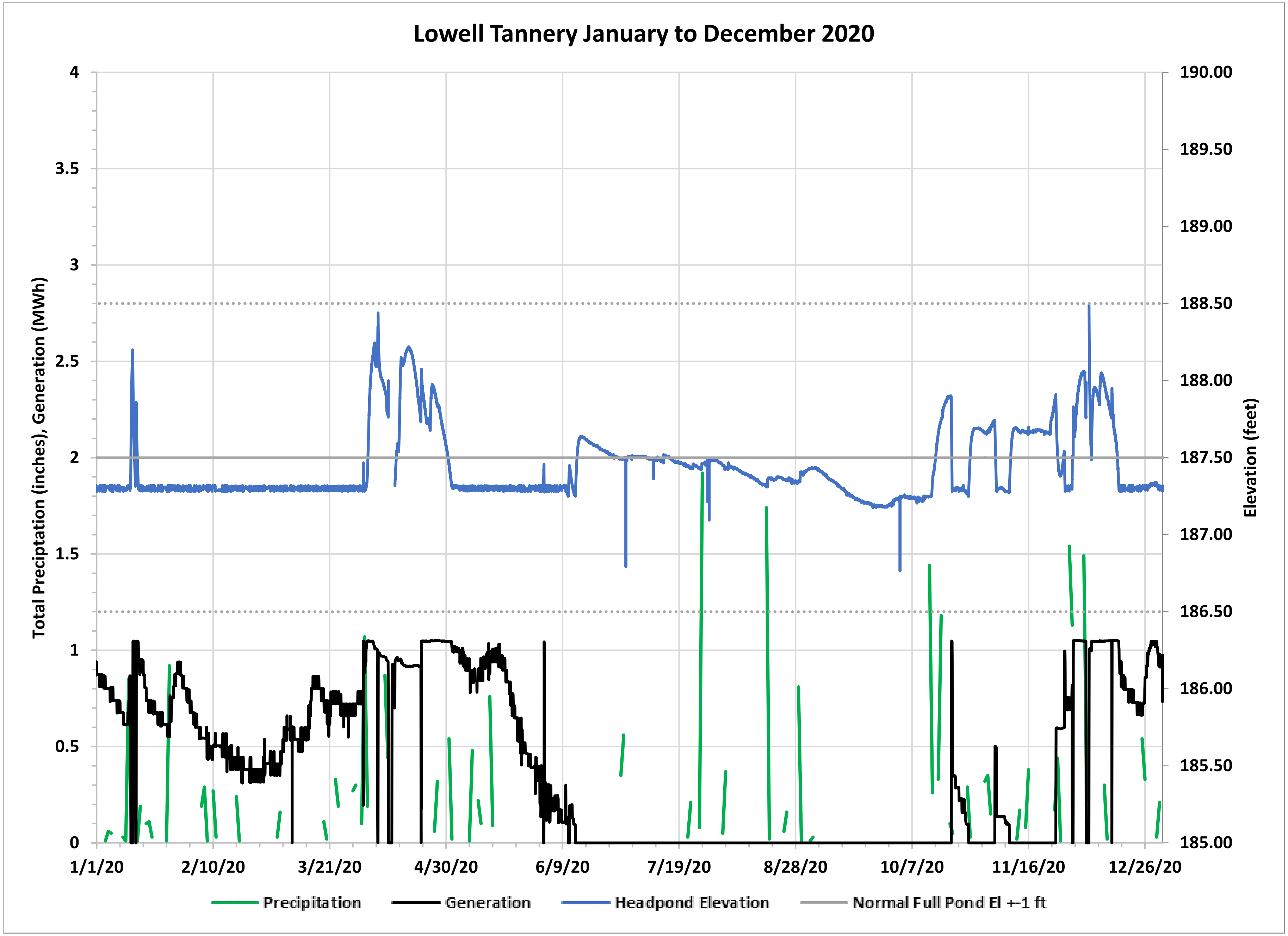
APPENDIX E

IMPOUNDMENT LEVEL AND OPERATIONS CHARTS

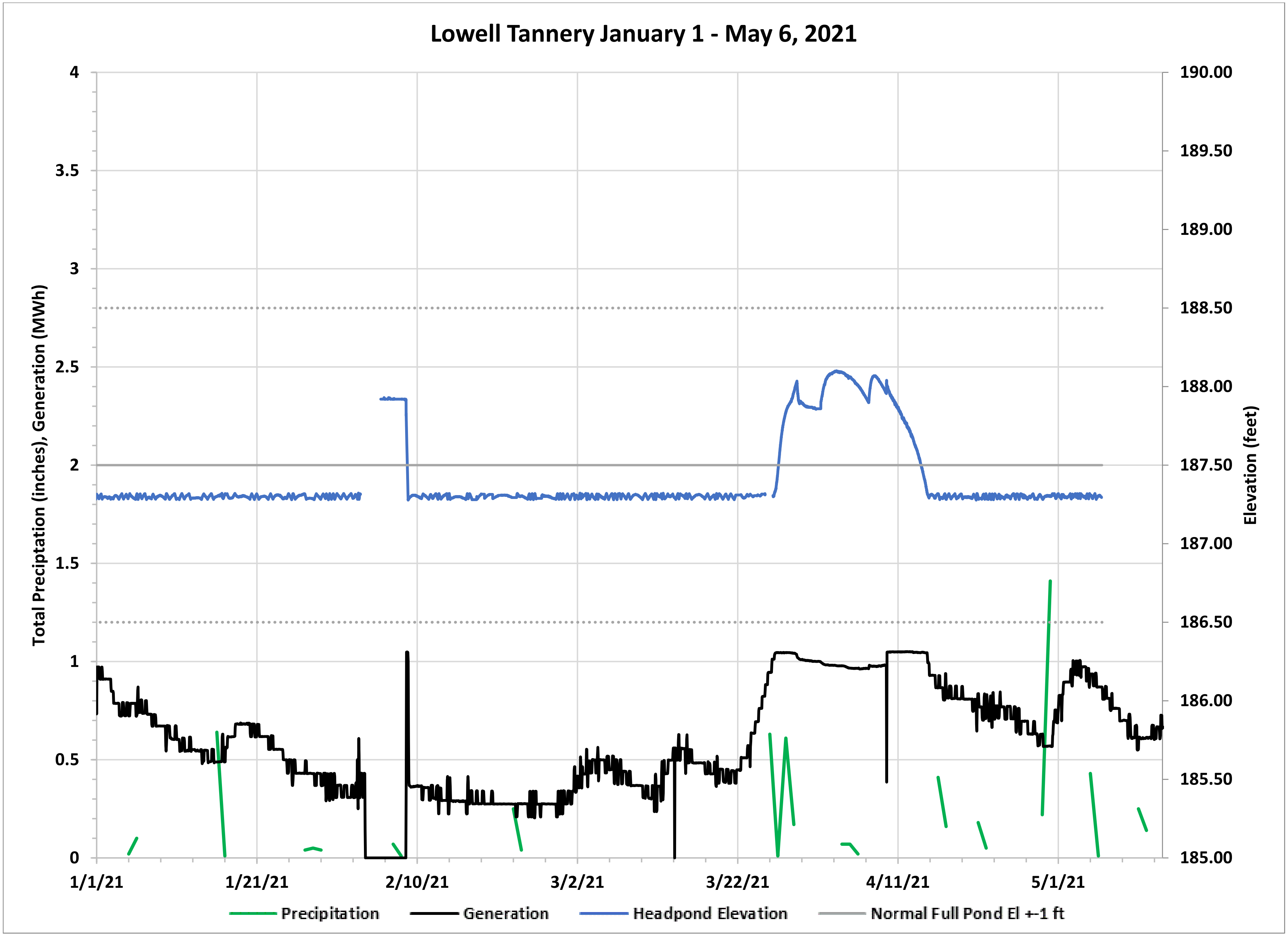

Lowell Tannery July 11 to December 31, 2018
Total Precipitation (inches), Generation (MWh)
Elevation (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
190.00
189.50
189.00
188.50
188.00
187.50
187.00
186.50
186.00
185.50
185.00
7/11/18
7/31/18
8/20/18
9/9/18
9/29/18
10/19/18
11/8/18
11/28/18
12/18/18
Precipitation
Generation
Headpond Elevation
Normal Full Pond El +-1 ft



Lowell Tannery January to December 2019
Failed transducer
June 19-July 10, 2019
Total Preciptation (inches), Generation (MWh)
Elevation (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
190.00
189.50
189.00
188.50
188.00
187.50
187.00
186.50
186.00
185.50
185.00
1/1/19
2/10/19
3/22/19
5/1/19
6/10/19
7/20/19
8/29/19
10/8/19
11/17/19
12/27/19
Precipitation
Generation
Headpond Elevation
Normal Full Pond El +-1 ft



Lowell Tannery January to December 2020
Total Preciptation (inches), Generation (MWh)
Elevation (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
190.00
189.50
189.00
188.50
188.00
187.50
187.00
186.50
186.00
185.50
185.00
1/1/20
2/10/20
3/21/20
4/30/20
6/9/20
7/19/20
8/28/20
10/7/20
11/16/20
12/26/20
Precipitation
Generation
Headpond Elevation
Normal Full Pond El +-1 ft



Lowell Tannery January 1 - May 6, 2021
Total Precipitation (inches), Generation (MWh)
Elevation (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
190.00
189.50
189.00
188.50
188.00
187.50
187.00
186.50
186.00
185.50
185.00
1/1/21
1/21/21
2/10/21
3/2/21
3/22/21
4/11/21
5/1/21
Precipitation
Generation
Headpond Elevation
Normal Full Pond El +-1 ft

Appendix F

Draft Biological Assessment

DRAFT BIOLOGICAL ASSESSMENT

PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

Prepared for:

KEI (Maine) Power Management (II) LLC
Lewiston, Maine

Prepared by:

Kleinschmidt

Pittsfield, Maine
www.KleinschmidtGroup.com

April 2018

DRAFT BIOLOGICAL ASSESSMENT

PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

Prepared for:

KEI (Maine) Power Management (II) LLC
Lewiston, Maine

Prepared by:

Kleinschmidt

Pittsfield, Maine
www.KleinschmidtGroup.com

April 2018

DRAFT BIOLOGICAL ASSESSMENT
PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS

BA	biological assessment
cfs	cubic feet a second
CPUE	Catch per Unit Effort
DPS	Distinct Population Segment
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
ft	feet
GOM DPS	Gulf of Maine Distinct Population Segment
kVA	kilovolt-amp
kW	kilowatt
MDIFW	Maine Department of Inland Fisheries and Wildlife
MDMR	Maine Department of Marine Resources
mm	millimeter
MW	megawatt
NMFS	National Marine Fisheries Service
PCE	Primary Constituent Elements
rpm	revolutions per minute
RST	Rotary Screw Traps
SHRU	Salmon Habitat Recovery Unit
SPP	Species Protection Plan
USASAC	United States Atlantic Salmon Assessment Committee
USFWS	U.S. Fish and Wildlife Service

DRAFT BIOLOGICAL ASSESSMENT
PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

1.0 INTRODUCTION

The Pumpkin Hill Hydroelectric Project (Pumpkin Hill Project)[1] is on the Passadumkeag River, approximately 13 river miles upstream from its confluence with the Penobscot River. Atlantic salmon (*Salmo salar*), which is listed as an endangered species pursuant to the Endangered Species Act (ESA), occurred in the Passadumkeag River historically. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) expanded the listing of Atlantic salmon in 2009 to include the Androscoggin, Kennebec, and Penobscot rivers (and tributaries) that were partially or wholly excluded when salmon were first listed in 2000 (74 FR 29344; June 19, 2009). Records from survey work completed by the Maine Department of Marine Resources indicate that the species does not presently occur in the river system (2017 personal communication, Peter Ruksznis, Marine Scientist, MDMR).

The purpose of this biological assessment (BA) is to assess how the Pumpkin Hill Project may affect the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon. In addition, this BA evaluates KEI (Maine)'s proposed Species Protection Plan (SPP) (Attachment A), which was developed in 2017 to further avoid and minimize the potential adverse effects of project operations on Atlantic salmon. KEI (Maine), on behalf of the Federal Energy Regulatory Commission (FERC), is being proactive by developing an SPP and a BA ahead of any pending federal action (e.g., an amendment to the current license).[2] On March, 3, 2014, FERC designated KEI (Maine) as its designated non-federal representative for informal ESA Section 7 consultation to assess the effects of the proposed SPP on Atlantic salmon at the Pumpkin Hill Project. This BA, prepared as required under Section 7 of the ESA (16 U.S.C. 1536[c]), follows the standards set forth in FERC's National Environmental Policy Act guidance.

[1] Owned and operated by KEI (Maine) Power Management (II), LLC.
[2] The Federal Energy Regulatory Commission (FERC) issued a license for the Pumpkin Hill Project in 1983 for a term of 40 years.

The ESA prohibits the take of endangered species. Take is defined by the ESA as "to harass, harm, pursue, ban, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Exemptions to the prohibitions of take can be provided by the NMFS or the USFWS through Section 10 or Section 7 of the ESA. Under ESA Section 10(a)(1)(B), permits may be issued for take that is incidental to the purposes of an otherwise lawful activity (incidental take permits). Under ESA Section 7(a)(2), incidental take statements may be issued to exempt any take anticipated as an incidental result of an activity conducted, permitted, or funded by a federal agency provided it would not be likely to result in jeopardy to the species or destruction of its critical habitat. Section 7 of the ESA mandates that all federal agencies consult with the Secretaries of Commerce (through NMFS) or Interior (through USFWS) to determine whether a proposed action is likely to be categorized, with respect to listed species and designated critical habitat, as follows:

- ***No Effect***: No effects to the species and its critical habitat from the proposed action either positive or negative are expected.
- ***May Affect, Not Likely to Adversely Affect***: All effects of the proposed action to the species and its critical habitat are beneficial, insignificant, or discountable. Beneficial effects have positive effects to the species or its critical habitat. Insignificant effects relate to the size of the effect and should not reach the scale where incidental or unintentional take (harming or killing) occurs. Discountable effects are those that are extremely unlikely to occur. Determinations of "may affect, not likely to adversely affect" require written concurrence from the USFWS or NMFS
- ***May Affect, Likely to Adversely Affect***: The action would have an adverse effect on the species or its critical habitat. Any action that would result in take of an endangered species is considered an adverse effect. A combination of beneficial and adverse effects is still considered "likely to adversely affect" even if the net effect is neutral or positive. An effect that can be detected in any way is not insignificant and is considered an adverse effect. Adverse effects are not considered discountable because they are expected to occur. This determination requires formal consultation with the USFWS or NMFS.

2.0 CONSULTATION RECORD

KEI (Maine) held informal discussions with NMFS starting in 2014 about the BA, SPP, and to identify ways to minimize the risk for take of endangered Atlantic salmon. KEI (Maine) provided a draft BA and SPP to NMFS on August 26, 2016. NMFS provided informal comments via email on November 30, 2016. KEI (Maine) addressed comments and monitored water temperature in the spring of 2017 to provide information relative to the proposed measures in the SPP.

3.0 PROJECT DESCRIPTION

3.1 PROJECT FACILITIES

The Pumpkin Hill Project is located on the Passadumkeag River in Lowell, Maine (Figure 1). The site has a contributing drainage area of approximately 301 square miles. The Passadumkeag River confluence with the Penobscot River is approximately 13 river miles downstream of the Pumpkin Hill dam. KEI (Maine) operates the Pumpkin Hill Project in a run-of-the-river mode (i.e., river inflow at the intake is approximately equivalent to river outflow at the powerhouse), with excess flows (i.e., spill) passing over the top of the flashboards. The facility began commercial operation in 1987 and has a nameplate capacity of 0.99 megawatts (MW). Project features include (a) a concrete gravity dam, with spillway sections topped by 3.5-foot-high flashboards; (b) a low level outlet gate and log sluice section; (c) a 68.5-acre reservoir with a usable storage capacity of 100 acre-feet at elevation 187.5 feet mean sea level with a 3-foot drawdown; (d) a powerhouse located near the north dam abutment containing a generator and vertical Kaplan turbine; (e) upstream and downstream fishways located adjacent to the powerhouse; and (f) a tailrace channel. The intake bar racks at the Pumpkin Hill Project have 1.5-inch clear spacing and are set at a 45-degree angle to the flow of the river.

3.2 MINIMUM FLOW

KEI (Maine) releases a minimum flow of 150 cubic feet a second (cfs) (or inflow to the dam, whichever is less) from the powerhouse to downstream reaches of the Passadumkeag River. This instream flow release was developed during the original licensing proceedings to protect fish and aquatic resources in the project area downstream of the dam (FERC 1983).

3.3 FISH PASSAGE FACILITIES

Upstream passage for diadromous fish is provided by a Denil ladder that is located at the dam (Photo 1). KEI (Maine) provides 40 cfs of attraction and conveyance water through the fishway from May 15 through November 10 annually; the fishway attraction flow is discharged near the base of the powerhouse (Photo 1).

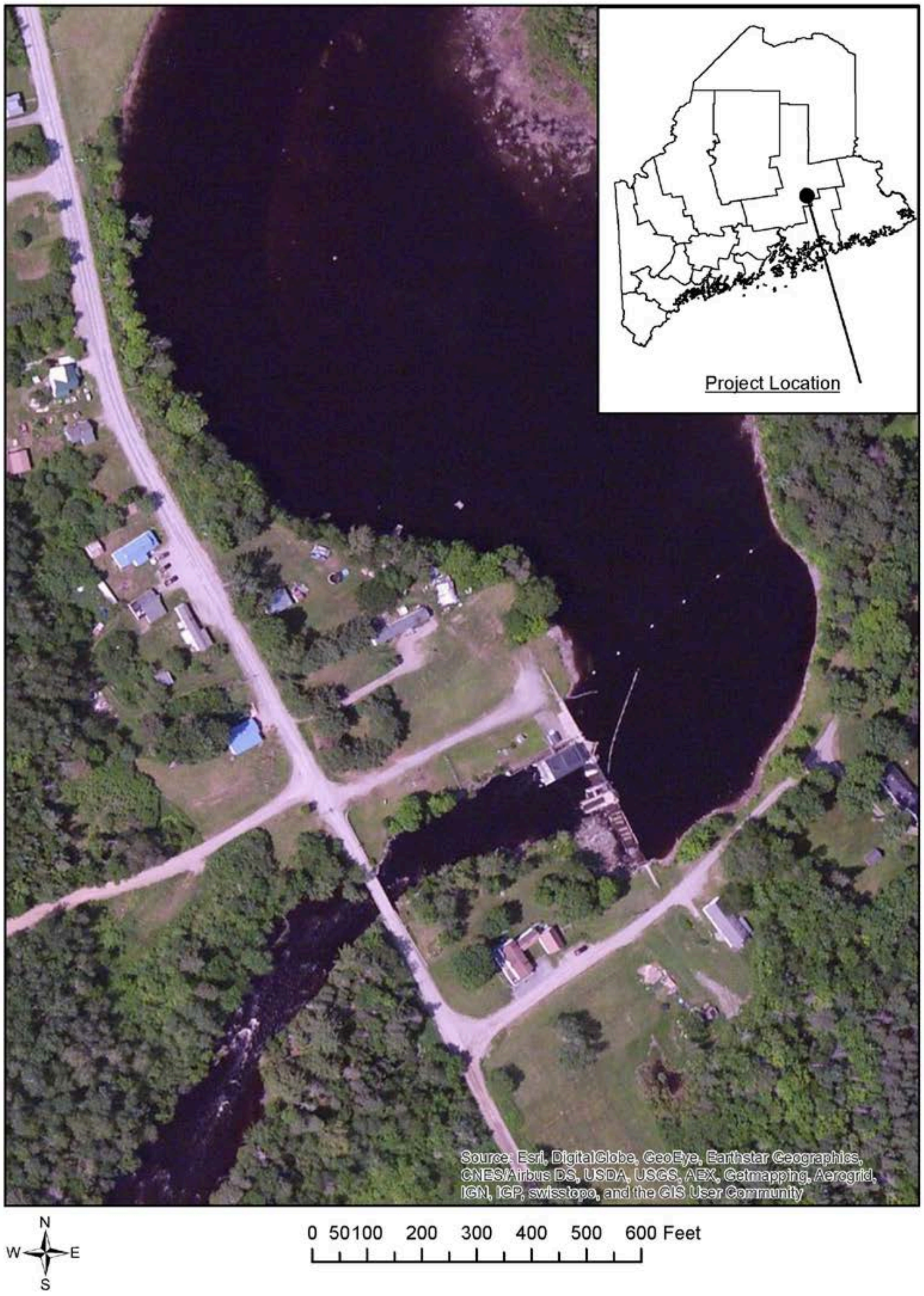


FIGURE 1 PUMPKIN HILL PROJECT

Downstream fish passage is provided through a dedicated fish bypass (Photo 1). Adjacent to the eastern side of the intake racks, there is a downstream surface bypass gate that leads to an 18-inch bypass pipe, which discharges into a plunge pool next to the tailrace. KEI (Maine) provides a fishway flow of 20 cfs through the downstream bypass, which is provided through the stop log slot at the entrance. When river flow exceeds the powerhouse capacity, fish may pass with spill over the dam. KEI (Maine) operates the downstream fish passage in the spring from ice-out through early June. Downstream passage for kelts is provide through the downstream fishway from November 1 to ice-in.

PHOTO 1. AERIAL IMAGERY SHOWING LOCATION OF UPSTREAM AND DOWNSTREAM FISHWAYS, ANGLED INTAKE RACKS, AND POWER CANAL AT THE PUMPKIN HILL PROJECT.

3.4 PROPOSED SPECIES PROTECTION PLAN

As described above, the Pumpkin Hill Project includes several protection and enhancement measures for Atlantic salmon, including upstream and downstream fish passage systems, narrowly-spaced full depth trash racks (1.5-inch clear space between vertical bars) angled at 45 degrees at the intake, run-of-river operations, and the provision of instream flows; the existing license order requires KEI (Maine) to provide 150 cubic feet a second (cfs) from the Pumpkin Hill Project to the Passadumkeag River.

To further minimize the potential adverse effects of operations on Atlantic salmon at the Pumpkin Hill Project in the future, KEI (Maine) proposes to implement an SPP for Atlantic salmon (Attachment A). Pursuant to the SPP, KEI (Maine) would continue operating the existing upstream and downstream fishways, operate in a run-of-river mode, and, in addition to these measures, cease generation at night from 8:00 PM to 4:00 AM for two weeks (i.e., 14 nights) during the last part of April or the first few weeks in May annually, when water temperature is between 10°C (50°F) and 15°C (59°F). The peak outmigration of Atlantic salmon smolts is expected during this timeframe and under these conditions.[3] Nighttime turbine shutdowns in Maine have been shown to be an effective means to pass smolts downstream in the spring (Stich et al., 2015).

Because Atlantic salmon do not presently occur in the Passadumkeag River near or above the Pumpkin Hill Project, KEI (Maine) would initiate annual nighttime shutdowns upon receiving notification from the NMFS that a viable population has been established or sustained annual stocking of Atlantic salmon has occurred in the Passadumkeag River system above the Pumpkin Hill dam. At that point, KEI (Maine) would monitor hourly water temperature annually from mid-April through May 31 annually to align the actual two-week window for nighttime shutdowns directly to water temperature. KEI (Maine) will cease generation at night (8:00 PM to 4:00 AM) once water temperature reaches 10°C. If water temperature drops below 10°C, generation may be reinstated until water temperature reaches 10°C again. Once generation has been curtailed for 14 nights with water temperatures ranging from 10°C (50°F) and 15°C (59°F), KEI (Maine) would return to its normal operating procedures. The downstream fishway would be operated during the nighttime shutdowns and water will be spilled over the dam.

As part of the SPP, KEI (Maine) also plans to complete upstream salmon passage monitoring upon receiving notification from NMFS that enough study fish are available for monitoring purposes (i.e., dependent on stock availability). Initiation of salmon passage studies would be required if more than 40 adult salmon are passed upstream in any two subsequent years. KEI

[3] From annual smolt trap counts completed by the Maine Department of Marine Resources.

(Maine) may opt to work collaboratively with researchers from the University of Maine or other dam owners in the watershed to evaluate the upstream passage of salmon at the site. A study plan would be developed in consultation with NMFS.

KEI (Maine) will retain the ability to transition to protective measures such as seasonal overlays, narrower trashracks, and provision of spill in the future, should they opt to pursue other options in the future for passing and protecting salmon in lieu of nighttime shutdowns.

4.0 ACTION AREA

The action area for this BA includes areas that could be directly or indirectly affected by the proposed action [50 CFR §402.02]. The action area encompasses areas where both the direct and indirect effects of the proposed action could affect listed species and critical habitat. KEI (Maine) operates the Pumpkin Hill Project as a run-of-river facility; therefore, the extent of any operational influences on aquatic habitat or individual salmon is limited to the immediate project area. The action area includes the FERC-designated project boundary, which includes the dam, powerhouse, fishways, impoundment, and other appurtenant features.

5.0 DESCRIPTION OF ATLANTIC SALMON AND CRITICAL HABITAT

5.1 SPECIES DESCRIPTION AND LISTING

Atlantic salmon are an anadromous fish species with a complex life history. Individuals spend most of their adult life in marine environments but return to freshwater rivers and streams to spawn (Fay et al. 2006). Atlantic salmon are native to the North Atlantic Ocean and have been found worldwide as far south as Portugal in the eastern Atlantic and the Connecticut and Housatonic Rivers in the western Atlantic, and north to Ungava Bay in Quebec as well as the Nastapoka River in Hudson Bay (Morin 1991). Atlantic salmon were initially listed as endangered on November 17, 2000, on eight coastal Maine watersheds by the NMFS and the USFWS (65 FR 69459). NMFS and the USFWS expanded the listing to include Atlantic salmon that inhabit large Maine rivers (Androscoggin, Kennebec, and Penobscot) that were partially or wholly excluded in the initial listing (74 FR 29344; June 19, 2009). NMFS determined that Atlantic salmon that inhabit the Gulf of Maine watersheds from the Androscoggin River eastward to the Dennys River are a distinct population segment (i.e., GOM DPS) and thus should be listed as a "species."

Currently, the GOM DPS includes Atlantic salmon that occupy freshwater from the Androscoggin River to the Dennys River, as well as anywhere Atlantic salmon occur in the estuarine and marine environments. The historical upstream limits of the species freshwater range are primarily determined by impassable falls in the Penobscot River watershed, including Big Niagara Falls on Nesowadnehunk Stream in Township 3 Range 10, Grand Pitch Falls on Webster Brook in Trout Brook Township, and Grand Falls on the Passadumkeag River (74 FR 29344; June 19, 2009). Additionally, conservation hatchery populations maintained by Green Lake National Fish Hatchery and Craig Brook National Fish Hatchery are included in the GOM DPS. Landlocked and commercially raised salmon are excluded from the listing (74 FR 29344; June 19, 2009).

5.2 LIFE HISTORY OF THE ATLANTIC SALMON

Anadromous Atlantic salmon have a complex life cycle and go through several distinct phases which are accompanied by changes in behavior, physiology, morphology, and habitat requirements. While spawning by adult Atlantic salmon does not occur until fall, upstream migration begins in the spring. In Maine, most Atlantic salmon begin to ascend rivers from May to mid-July, but migration may continue until the fall (Meister 1958). As soon as fish enter freshwater, they stop feeding and darken in coloration. Salmon that return in the early spring may spend up to 5 months in the river before spawning. These fish spend the summer months in cool water refuges such as deep pools, springs, and mouths of cold-water tributaries (Fay et al. 2006). In either the fall or the following spring, post-spawned adults (i.e., "kelts") migrate downstream after spawning and resume feeding once reaching the marine environment. A small percentage may return to spawn 1 to 2 years later.

Spawning typically takes place from late October through November when water temperatures are around 7°C to 10°C (45°F to 50°F). Preferred spawning sites consist of gravel substrate within flowing water (Peterson 1978), with water depth ranging from 30 to 61 centimeters (11.8 to 24 inches) and water velocities averaging 60 centimeters a second (2.0 feet a second) (Beland 1984). Eggs are deposited in a series of nests (i.e., redds) scoured from the gravel by the female. As they are deposited in the redd, one or more males will fertilize the eggs. A returning female can produce approximately 7,500 eggs (Fay et al. 2006).

In late March or April, salmon eggs hatch as alevin (or sac fry). Alevin remain in the redd for approximately 6 weeks nourished by their yolk sac. In mid-May, alevins emerge from the gravel and begin to actively feed, at which point they are called fry. Salmon fry enter the parr stage within days of emerging. This stage is indicated by vertical bars (i.e., "parr marks") which appear on their sides. Sites preferred by parr include areas with sufficient cover, water depths from roughly 10 to 60 centimeters (4.0 to 23.6 inches), water velocities between 30 and 92 centimeters a second (0.9 to 3.0 feet a second), and water temperatures around 16°C (60.8°F) (Fay et al. 2006). The diet of juvenile salmon includes aquatic invertebrates such as the larvae of mayflies, stoneflies, chironomids, caddisflies, aquatic annelids, and mollusks, as well as a variety of terrestrial invertebrates that fall into the river (Fay et al. 2006). In the fall, parr will seek shelter in the substrate as water flows increase and temperature and day length decrease (Fay et al. 2006).

Parr will remain in freshwater for 1 to 3 years before undergoing smoltification, which is a series of physiological, morphological, and behavioral changes that prepare the salmon to move from freshwater to marine environments. In the Penobscot River watershed, smolts migrate back to the marine environment between late April and early June with a peak movement in early May (Fay et al. 2006). After returning to sea, Atlantic salmon commence long migrations from their natal rivers. During this time, Atlantic salmon experience a period of rapid growth. Once they reach maturity, they return to their natal river (Fay et al. 2006). Atlantic salmon may spend up to 3 years in the marine environment before returning to their natal freshwater streams to spawn (Fay et al. 2006).

5.3 STATUS AND TREND OF ATLANTIC SALMON IN THE GULF OF MAINE DISTINCT POPULATION SEGMENT

The overall abundance of Atlantic salmon has been declining since the 1800s (Fay et al. 2006). Although comprehensive data on adult abundance are not available until after 1967, current abundance levels of Atlantic salmon are significantly lower than historical estimates (Figure 2). Whereas Foster and Adkins (1869) estimated that approximately 100,000 adult Atlantic salmon returned to the Penobscot Rivers historically, since 1967 it has been uncommon for adult returns for the entire Gulf of Maine DPS to exceed 5,000 individuals (Fay et al. 2006, USASAC 2014). Adult returns have remained low since 2011; only 376 individuals returned to the Gulf of Maine area in 2014, a 24 percent decrease from 2013 (USASAC 2014). In 2016, 626 adult salmon returned to USA rivers; of these, 616 returned to the Gulf of Maine (USASAC 2017).

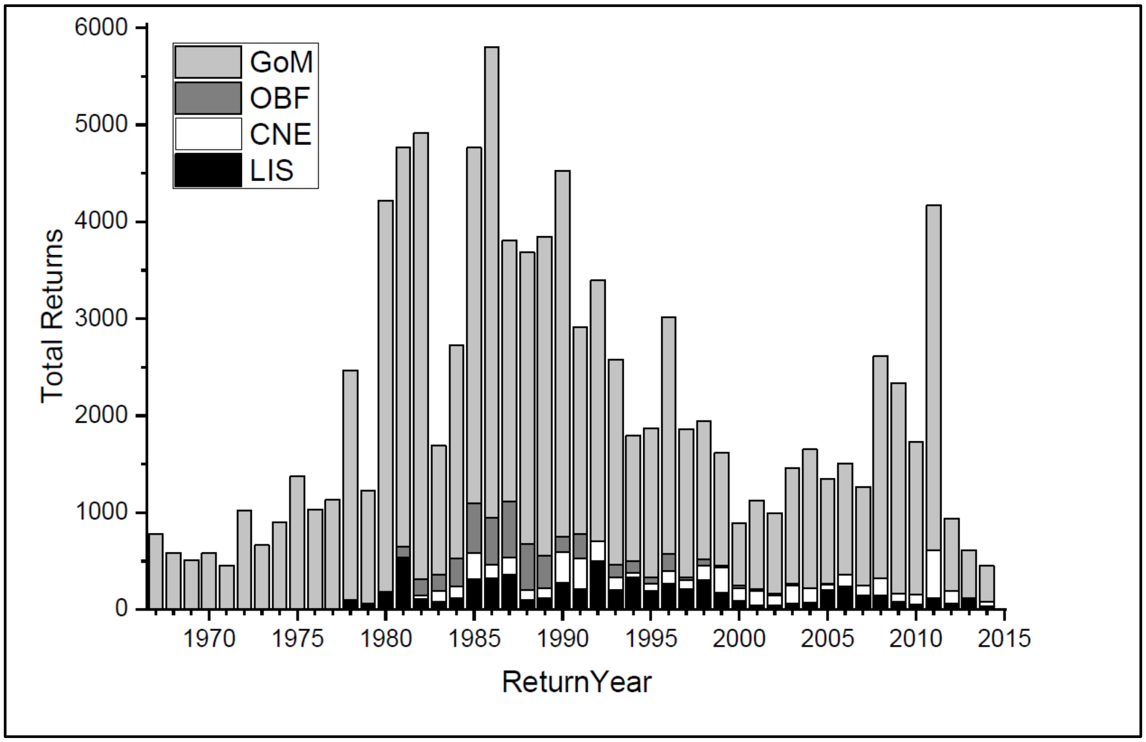


FIGURE 2 ESTIMATED TOTAL RETURNS TO NEW ENGLAND FOR OUTER BAY OF FUNDY (OBF), GOM DPS, CENTRAL NEW ENGLAND COMPLEX (CNE), AND LONG ISLAND SOUND (LIS) COMPLEX FROM 1967 TO 2014

5.4 STATUS AND DISTRIBUTION OF ATLANTIC SALMON – PASSADUMKEAG RIVER

Although the species occurred historically in the Passadumkeag river system, there has been no documentation that the species presently occurs in or uses the Passadumkeag River seasonally (i.e., for spawning, rearing, or for migration). Records from MDMR survey work in the watershed indicate that the species does not presently occur in the river system (personal communication, Peter Ruksznis, Marine Scientist, MDMR).

5.5 CRITICAL HABITAT FOR ATLANTIC SALMON IN THE GULF OF MAINE DISTINCT POPULATION SEGMENT

Section (5)(A) of the Endangered Species Act defines “critical habitat’’ for a threatened or endangered species as

> *(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or*

protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species.

Coincident with the June 19, 2009, Atlantic salmon listing, NMFS designated critical (74 FR 29300; June 19, 2009). The final rule was revised on August 10, 2009, (74 FR 39003; August 10, 2009) in which designated critical habitat for the Atlantic salmon was revised to exclude trust and fee holdings of the Penobscot Indian Nation. The Passadumkeag River is not classified as critical habitat for species recovery (74 FR 29300; June 19, 2009).

6.0 EFFECTS ANALYSIS

The following sections discuss the potential effects of the operation of the Pumpkin Hill Project on Atlantic salmon. This discussion focuses on how the Pumpkin Hill Project may affect connectivity (i.e., upstream and downstream passage of adult and juvenile salmon) and habitat suitability. In addition, we evaluated the effects of implementing the proposed SPP (Attachment A), which has been developed to further minimize the potential effects of operations of the Pumpkin Hill Project on Atlantic salmon.

Little information is available about Atlantic salmon habitat use in the Passadumkeag River. Currently, Atlantic salmon are not known to occur in waters near or upstream of the Pumpkin Hill Project. In the future, the main stem of the Passadumkeag River may serve as a migration corridor for fish that may incidentally explore the tributary while migrating throughout the Penobscot basin. Life stages of Atlantic salmon that may be affected by the Pumpkin Hill Project in the future include adults, kelts, and smolts. However, the effects of the Pumpkin Hill Project on migrating salmon will largely already be ameliorated because KEI (Maine) operates the facility in a run-of-river mode and provides for upstream and downstream passage.

6.1 UPSTREAM AND DOWNSTREAM PASSAGE

Migrating salmon can reach the Passadumkeag River because of dam removals and fish passage systems in place on the main stem of the Penobscot River. There are two dams on the main stem Passadumkeag River downstream of the Pumpkin Hill Project that are deteriorated enough so that salmon may be able to pass upstream and downstream. Upstream passage behavior has been well studied on the Penobscot River, and Atlantic salmon are known to successfully utilize upstream fishways. However, the effectiveness of upstream passage at the Pumpkin Hill Project is currently unknown.

In many instances, Atlantic salmon have been documented using upstream fishways (Power and McCleave 1980, Shepard 1991, Shepard 1993, Shepard 1995, Kleinschmidt 2016, Izzo et al. 2016). Some of these studies have documented consistent migratory behaviors that may contribute to migration delays, including upstream and downstream forays to and away from the dam, extended holding in fast water, seeking thermal refuge in tributaries, attraction to spillage at dams, reduced migratory behavior in late summer, and inhibited movement at temperature above 23°C (Power and McCleave 1980, Shepard 1991, Shepard 1993, Shepard 1995, Kleinschmidt 2016, Izzo et al. 2016).

The presence of dams can also result in downstream migration delays or entrainment of smolts or kelts into the turbines. Amaral et al. (2012) predicted turbine passage survival and blade strike probability for Atlantic salmon smolts and kelts at the Pumpkin Hill Project based on turbine design, operational information, and other standard aspects of turbine survival estimates (e.g., ratio of fish length to blade thickness, mortality coefficient) (Table 1). When fish length (approach angle) and the strike mortality coefficient (*K*) were examined independently and together, there were moderate to large variations in strike probabilities ranging from approximately 28 to 81 percent with a predicted survival ranging from approximately 81 to 92 percent for salmon smolts 160 millimeters or longer (Table 2). Given their large body size, strike probability for kelts was assumed 100 percent for both the baseline and modified angles. However, Amaral et al. estimated 100 percent of kelts are excluded from turbine entrainment because of the full depth, narrowly spaced trashracks.

Amaral et al. (2012) assumed a bypass efficiency for smolts of 25 percent (i.e., 25 percent of approaching smolts would pass via the fishway and 75 percent would pass via the turbines). We note that the Amaral model is based on trashrack spacing of 2-inches; however, the spacing between vertical bars is 1.5 inches, meaning that a higher percentage of smolts are likely excluded from the intake, especially given that the trashracks are oriented at a 45-degree angle to river flow. Regardless, Amaral et al. predicted that total project survival for Atlantic salmon smolts ranges from 84.7 to 94.9 percent (mean survival of 88.7 percent) across the range of river flows that could occur in May (i.e., during the peak smolt outmigration period). Total project survival for kelts ranged from 92.7 to 94.1 percent over the range of expected monthly average flows (Amaral et al. 2012). Downstream spillway passage survival for smolts and kelts was estimated to be 97 percent (Amaral et al. 2012).

Barriers can affect the timing of or delay smolt migration. Migrating fish that do not reach the sea within the physiological smolt window may revert to the parr condition (Hoar 1988; Nielsen et al. 2001; Shrimpton et al. 2000). Thus, substantial delay may result in fish either abandoning migration, or reaching the estuary in sub-optimal physiological condition (McCormick et al. 1999; Shrimpton et al 2000). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration (McCormick et al. 1999). The onset of the smolt migration has often been linked to a thermal threshold of 10ºC although the rate of increase may be more important. Naturally reared and wild smolts in Maine typically enter the sea during May to begin their ocean migration (Fay et al. 2006). In the Penobscot River smolts migrate between late April and early June with a peak migration in early May (Fay et al. 2006). The peak of movement shifts from year to year in response to environmental conditions (Bakshtansky et al. 1976, Jonsson and Ruud-Hansen 1985). Smolt migratory movement is a combination of passive entrainment with flow, particularly in areas of high water velocity, and active swimming (Ruggles 1980).

TABLE 1 PERTINENT DESIGN AND OPERATIONAL PARAMETERS USED TO ESTIMATE TURBINE PASSAGE SURVIVAL OF SMOLTS AND KELTS AT THE PUMPKIN HILL PROJECT

PARAMETERS	DATA ACQUIRED/ESTIMATED
Turbine Type	Kaplan
Flow (cfs)	800
Runner Diameter (ft)	7.2
Hub Diameter (ft)	1.7
Turbine Speed (rpm)	189
Number Blades	4
Flow Angle (degree)	32
Leading Edge Blade Thickness (mm)	17.6[1]

[1] Parameter was estimated. Source: (Amaral et al. 2012)

TABLE 2 TURBINE SURVIVAL ESTIMATES FOR ATLANTIC SALMON SMOLTS AT THE PUMPKIN HILL PROJECT

FISH LENGTH (MM)	BASELINE PREDICTIONS		MODIFIED RADIAL FISH LENGTH[1]				TURBINE PASSAGE SURVIVAL FOR MODIFIED *K*[2]		COMPOUNDED TURBINE PASSAGE SURVIVAL ESTIMATE[3]	
			+10° FISH APPROACH ANGLE		-10° FISH APPROACH ANGLE					
	STRIKE PROBABILITY	TURBINE PASSAGE SURVIVAL	STRIKE PROBABILITY	TURBINE PASSAGE SURVIVAL	STRIKE PROBABILITY	TURBINE PASSAGE SURVIVAL	20% HIGHER *K*	20% LOWER *K*	20% HIGHER *K*; +10° FISH APPROACH ANGLE	20% LOWER *K*; -10° FISH APPROACH ANGLE
130	0.399	0.902	0.502	0.876	0.284	0.930	0.882	0.918	0.852	0.942
140	0.430	0.891	0.541	0.863	0.306	0.922	0.869	0.909	0.836	0.935
150	0.461	0.880	0.580	0.849	0.328	0.915	0.856	0.900	0.819	0.929
160	0.492	0.869	0.618	0.836	0.350	0.907	0.843	0.891	0.803	0.922
170	0.522	0.858	0.657	0.821	0.372	0.899	0.830	0.882	0.786	0.916
180	0.553	0.847	0.696	0.807	0.394	0.891	0.816	0.872	0.769	0.909
190	0.584	0.835	0.734	0.793	0.416	0.883	0.802	0.863	0.751	0.902
200	0.615	0.823	0.773	0.778	0.438	0.874	0.788	0.853	0.733	0.895
210	0.645	0.811	0.812	0.763	0.459	0.866	0.774	0.843	0.715	0.888

[1] Modifications to radial fish length result in changes to strike probability and turbine passage survival.

[2] Modifications to *K* result in changes to turbine passage survival, but not strike probability (i.e., strike probability is the same as the baseline).

[3] The compounded turbine passage survival estimates are based on the strike probabilities for the modified radial length.

Source: (Amaral et al. 2012)

TABLE 3 TURBINE SURVIVAL ESTIMATES FOR ATLANTIC SALMON KELTS AT THE PUMPKIN HILL PROJECT

Fish Length (mm)	Baseline Predictions		Modified Radial Fish Length [1]				Turbine Passage Survival for Modified *K* [2]		Compounded Turbine Passage Survival Estimate [3]	
			+10° Fish Approach Angle		-10° Fish Approach Angle					
	Strike Probability	Turbine Passage Survival	Strike Probability	Turbine Passage Survival	Strike Probability	Turbine Passage Survival	20% Higher *K*	20% Lower *K*	20% Higher *K*; +10° Fish Approach Angle	20% Lower *K*; -10° Fish Approach Angle
650	1.000	0.599	1.000	0.599	1.000	0.599	0.519	0.666	0.519	0.666
675	1.000	0.595	1.000	0.595	1.000	0.595	0.514	0.663	0.514	0.663
700	1.000	0.592	1.000	0.592	1.000	0.592	0.510	0.660	0.510	0.660
725	1.000	0.589	1.000	0.589	1.000	0.589	0.506	0.657	0.506	0.657
750	1.000	0.585	1.000	0.585	1.000	0.585	0.502	0.654	0.502	0.654
775	1.000	0.582	1.000	0.582	1.000	0.582	0.499	0.652	0.499	0.652
800	1.000	0.579	1.000	0.579	1.000	0.579	0.495	0.649	0.495	0.649

[1] Modifications to radial fish length result in changes to strike probability and turbine passage survival.

[2] Modifications to K result in changes to turbine passage survival, but not strike probability (i.e., strike probability is the same as the baseline).

[3] The compounded turbine passage survival estimates are based on the strike probabilities for the modified radial length.

Source: (Amaral et al. 2012)

6.2 Critical habitat

The Passadumkeag River is not critical habitat for salmon recovery purposes, and it is approximately 13 river miles upstream of the main stem of the Penobscot River. The Pumpkin Hill Project is operated in a run-of-river mode. KEI (Maine) releases a minimum flow of 150 cfs (or inflow to the dam, whichever is less) from the powerhouse to downstream reaches of the Passadumkeag River. This instream flow release was developed during the original licensing proceedings to protect fish and aquatic resources in the project area downstream of the dam (FERC 1983). Therefore, the operations of the Pumpkin Hill Project are not expected to affect Atlantic salmon critical habitat that occurs in the Penobscot River.

Dams inundate free-flowing reaches of river and can increase stream temperatures upstream and downstream of the structure (Fay et al. 2006). In general, dam impoundments increase water depth, increase the water retention time (flushing rate) within a given river reach, and dampen daily fluctuations in water temperatures (FERC 1997). Large reservoirs with deep water that stratifies in summer may release water that is warmer or colder than ambient inflows, depending on the depth of withdrawal in relation to depth of the thermocline, whereas run-of-the-river impoundments, such as the Pumpkin Hill Project, are typically shallow and have little effect on temperature (McCully 1996).

6.3 Water Temperature

Observations and anecdotes of the thermal tolerance of adult salmon have been reported in literature. Shepard (1995) hypothesized that adult Atlantic salmon thermal tolerance may be about 3.4°C lower than juvenile salmon tolerance, based on thermal tolerance studies of adult and juvenile Pacific salmon (Coutant 1970). Based on in-situ observations and experimental data, adult Atlantic salmon mortalities may occur at daily maxima of 27°C or prolonged periods with daily mean temperatures above 23°C. Maine Department of Marine Resources (MDMR) measured water temperature monitoring in the Passadumkeag River in the Pumpkin Hill Project fishway in 2004 using a continuous data logger that recorded temperature once per hour from June to October (Figure 3). Although water temperature exceeded 23°C for small periods during the summer of 2004, there is no indication that operation of the Pumpkin Hill Project results in water temperatures that are higher than other areas within the watershed. Water temperature did not exceed 27°C in 2004 (Figure 3).[4]

During the development of the SPP, KEI (Maine) installed two water temperature loggers near the Pumpkin Hill Project (upstream and downstream of the dam) to evaluate water temperature during the smolt outmigration period, which is typically in late-April and May in Maine. Water temperature at the Pumpkin Hill Project ranged from 4°C (38.8 °F) to 18.3°C (65 °F) from mid-April to the end of May in 2017 (Figure 4). KEI (Maine) will continue to collect water temperature annually to align the actual two-week window for the proposed nighttime shutdowns directly to water temperature monitoring performed at the site.

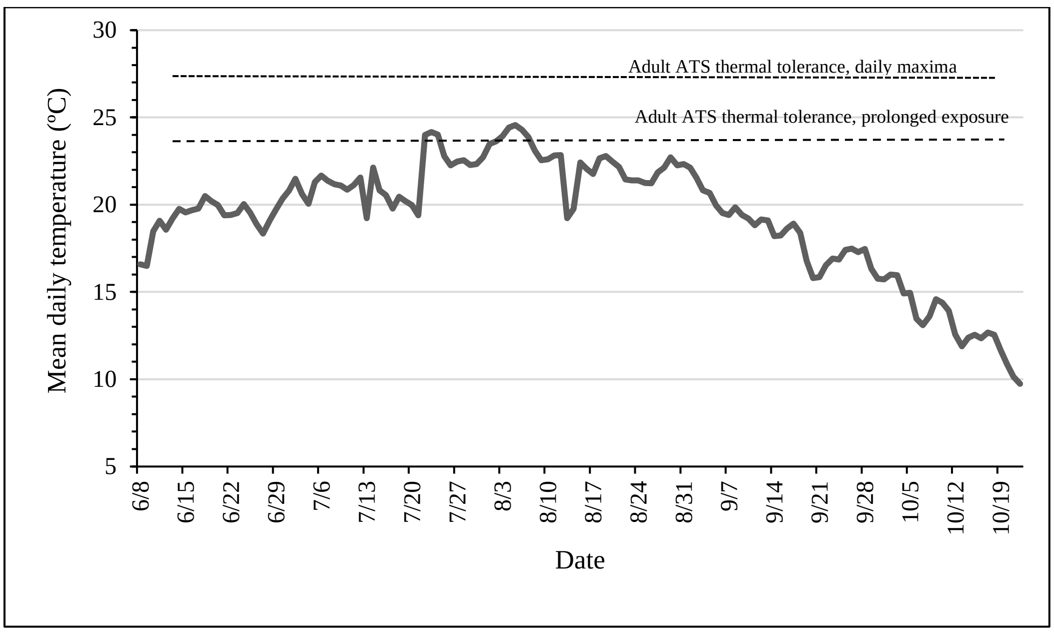


FIGURE 3 MEAN DAILY TEMPERATURE AT THE PUMPKIN HILL PROJECT FISHWAY, JUNE – OCTOBER 2004

[4] Source: MDMR Unpublished Data

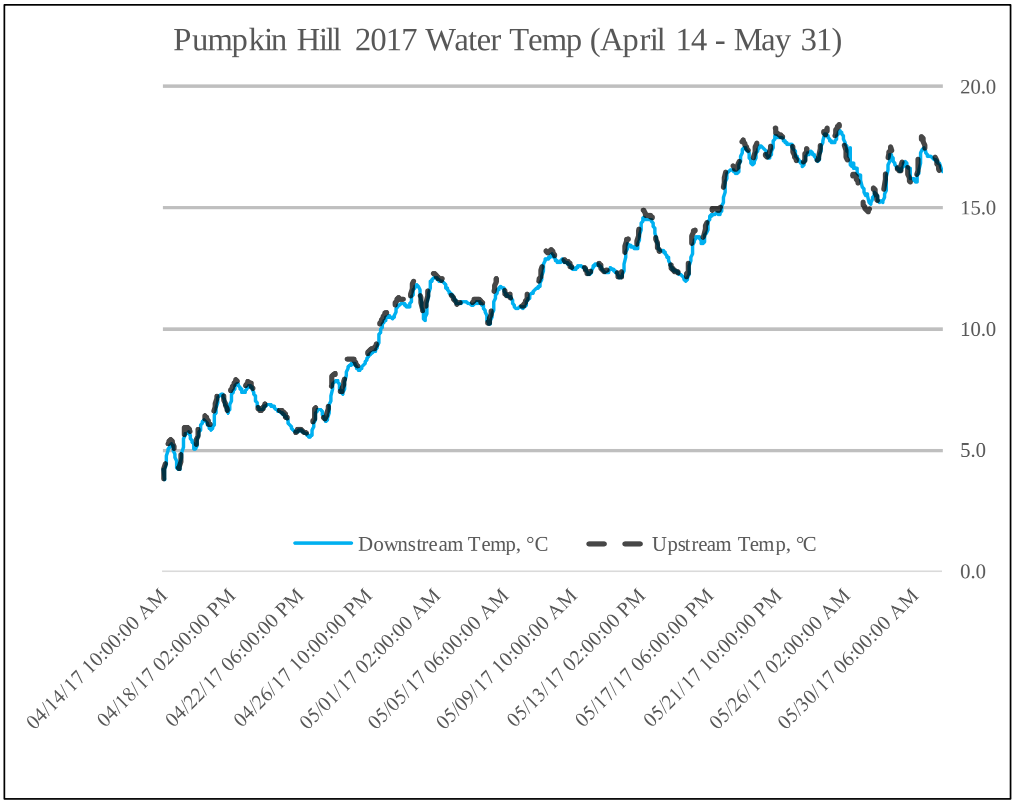


FIGURE 4 HOURLY WATER TEMPERATURE DATA COLLECTED BY KEI (MAINE) AT THE PUMPKIN HILL PROJECT FROM APRIL 14 TO MAY 31, 2017.

6.4 COLD WATER REFUGE

There are several tributaries to the Passadumkeag River downstream of the Pumpkin Hill dam that can provide coldwater refugia and habitat for salmon if they inhabit the river system seasonally. These include but are not limited to: Onemile Brook, Cold Stream,[5] Little Cold Stream, Ayers Brook, Buck Brook, Mountain Brook, Lord Brook, and Hodgson Brook.

6.5 PREDATION

Atlantic salmon smolts face predation risk during their migration from freshwater to estuarine and marine environments. Anthropogenic factors (e.g., dams) may contribute to conditions that are suitable for known predators of Atlantic salmon such as chain pickerel, smallmouth bass, and avian predators (Fay et al., 2006). Dams may increase predation risk due to smolt disorientation, injuries, congregating behavior, and decreased abundance of other diadromous fishes that

[5] Cold Stream is the water source for the Enfield Fish Hatchery, operated by the state of Maine to produce brook trout and landlocked salmon.

historically acted as a prey buffer by providing a robust alternative food source for predators (Northeast Salmon Team 2011). Dam passage may also affect predator detection and avoidance by salmonids (Raymond 1979, Mesa 1994). Adult salmon may also be susceptible to predation when attempting to locate and pass an upstream passage facility at a dam when stressed by higher summer temperatures (Power and McCleave 1980). Non-native fishes stocked throughout the range of the GOM DPS include rainbow and brown trout (NMFS and USFWS 2005, Fay et al. 2006, Gingerich 2008). These species may compete with native Atlantic salmon for habitat resources, forage, or spawning areas.

The range of smallmouth bass now extends through north-central Maine and well into New Brunswick including the project area. Smallmouth bass will feed on salmon fry and parr. Smallmouth bass are predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993). Chain pickerel, which occur in the Passadumkeag River, feed upon fry, parr, and smolts (Van den Ende 1993). Smolts were the most common item in the diet of chain pickerel observed by Barr (1962) and Van den Ende (1993).

Mergansers, belted kingfisher, bald eagles, ospreys, double-crested cormorants, gulls, and gannets will prey upon Atlantic salmon throughout their life cycle (Fay et al. 2006). The USFWS concluded that avian predation poses a high-level threat to the survival and recovery of the GOM DPS (NMFS and USFWS 2005). Blackwell and Krohn (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. Smolts were consumed by resident and migratory (Blackwell 1996; Blackwell and Krohn 1997). Another study found Atlantic salmon comprised 26 percent of cormorant diet during the smolt run (Hatch and Weseloh 1999). Meister and Gramlich (1967) documented that cormorants consumed an estimated 8,000 tagged hatchery smolts during the period 1966-1967 in the Machias River. Predation rates on migrating hatchery-reared salmon smolts were found to be as high as 13.4 percent in the Machias River (Meister and Gramlich 1967).

The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the effects of cormorant predation on the GOM DPS (Northeast Salmon Team 2011).

Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon fry and parr in freshwater environments (Fay *et al.* 2006). Studies conducted in Canada found mergansers consumed more juvenile Atlantic salmon than cormorants (NMFS and USFWS 2005). These birds are common across Maine (Cornell Lab of Ornithology 2011). There is limited information regarding abundance and distribution of these predatory species in the action area; however, some impoundment mortality of juvenile salmon from predation may occur.

6.6 IMPLEMENTATION OF THE SPECIES PROTECTION PLAN

Implementation of the SPP (Attachment A) is expected to further reduce the potential for the operations of the Pumpkin Hill Project to affect Atlantic salmon. The SPP includes continuing fishway operations, shutting down the turbines and providing spill during key migratory periods to pass smolts downstream, assessing upstream passage effectiveness, protecting habitat by maintaining run-of-river operations, and providing annual updates to NMFS. Shutting the turbine units down during the peak of the smolt outmigration will provide a safe route-of-passage downstream for salmon, thereby preventing turbine entrainment.

6.7 CUMULATIVE EFFECTS

Cumulative effects are the effects of future state and private activates that are reasonably certain to occur with the action area (50 C.F.R § 402.02). Cumulative effects do not include federal or federally authorized actions, which would be subject to future ESA section 7(a)(2) consultations. The effects of non-federal activities on Atlantic salmon are largely unknown in the Passadumkeag River. It is possible that occasional recreational fishing may result in incidental takes of Atlantic salmon. Stream barriers such as small dams or culverts may prevent juvenile Atlantic salmon from reaching summer refugia. There is no information to suggest that the effects of future activities in the action area will be any different from effects of current activities and those that have occurred in the past. The cumulative effects from forestry and agricultural practices will continue to occur in the watershed area, potentially affecting water quality, spawning and rearing habitat, reducing habitat complexity and connectivity, and altering water temperatures. These practices can also decrease the amount of large woody debris in the river system, increase sedimentation, and increase pollutant levels resulting from increased runoff, use of pesticides, and grazing in riparian areas (Fay et al. 2006).

7.0 DETERMINATION OF EFFECT

Operation of the Pumpkin Hill Project "may affect, and is likely to adversely affect Atlantic salmon." This conclusion is based on an assessment of existing conditions, operations of the Pumpkin Hill Project, implementation of the SPP, the distribution of the species in the watershed currently, and the biological and habitat requirements of the species in the Passadumkeag River. The operation of the Pumpkin Hill Project is not expected to affect Atlantic salmon critical habitat because it does not occur in the Passadumkeag River and operations do not affect critical habitat in the main stem of the Penobscot River. As such, KEI (Maine) concludes that designated critical habitat for Atlantic salmon will not be adversely modified or destroyed through implementation of the SPP or operation of the Pumpkin Hill Project.

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Attachment A

Species Protection Plan

Pumpkin Hill Project

DRAFT SPECIES PROTECTION PLAN

FOR ATLANTIC SALMON

PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

Prepared for:

KEI (Maine) Power Management (II) LLC
Lewiston, Maine

Prepared by:

Kleinschmidt

Pittsfield, Maine
www.KleinschmidtGroup.com

April 2018

DRAFT SPECIES PROTECTION PLAN FOR ATLANTIC SALMON
PUMPKIN HILL HYDROELECTRIC PROJECT
(FERC NO. 4202)

TABLE OF CONTENTS

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1.0 INTRODUCTION

KEI (Maine) Power Management (II) LLC owns and operates the Pumpkin Hill Project (FERC No. 4202), which is on the Passadumkeag River. The Passadumkeag River is a tributary to the Penobscot River, discharging into the main stem near Passadumkeag, Maine. The Federal Energy Regulatory Commission (FERC) issued a license order for the Pumpkin Hill Project on October 31, 1983. The FERC license for the Pumpkin Hill Project expires in 2023. Atlantic salmon, a federally protected species, occur in the Penobscot River. The Passadumkeag River is part of the Penobscot River Salmon Habitat Recovery Unit; however, it is not classified as critical habitat for the recovery of the species (74 FR 29300; June 19, 2009). Records from survey work completed by the Maine Department of Marine Resources (MDMR) indicate that the species does not presently occur in the river system (personal communication, Peter Ruksznis, Marine Scientist, MDMR).

Section 7 of the Endangered Species Act (ESA) requires that federal agencies consult with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS) to determine whether a proposed action is likely to adversely affect listed species or designated critical habitat. NMFS is the lead action agency for ESA consultations on Atlantic salmon that involve hydroelectric operations in the northeastern United States. FERC designated KEI (Maine) as its non-federal representative for informal consultation under Section 7 of the ESA regarding federally listed Atlantic salmon at the Pumpkin Hill Project on March 3, 2014.

KEI (Maine) developed this Species Protection Plan (SPP) to avoid and minimize potential adverse effects of operation of the Pumpkin Hill Project on Atlantic salmon.

The Pumpkin Hill Project includes several protection and enhancement measures for Atlantic salmon, including upstream and downstream fish passage systems, narrowly-spaced full depth trash racks (1.5-inch clear space between vertical bars) at the intake angled at 45 degrees, run-of-river operations, and the provision of instream flows; the existing license order requires KEI

(Maine) to provide 150 cubic feet a second (cfs) from the Pumpkin Hill Project to the Passadumkeag River. KEI (Maine) will continue implementing existing measures, plus additional protective measures as described in Section 2.0.

2.0 PROPOSED PROTECTION MEASURES

To further minimize potential adverse effects of operations on Atlantic salmon at the Pumpkin Hill Project, upon receiving notification from the MDMR or NMFS that Atlantic salmon have been documented in the Passadumkeag River system above the Pumpkin Hill dam, KEI (Maine) proposes to cease generation annually at night from 8:00 PM to 4:00 AM for two weeks (i.e., 14 nights) during the last part of April or the first few weeks in May when water temperature is between 10°C (50°F) and 15°C (59°F). The peak outmigration of Atlantic salmon smolts is expected during this timeframe when water temperature is between 10°C (50°F) and 15°C (59°F).[1] Nighttime turbine shutdowns in Maine in the spring have been shown to be an effective means to pass smolts downstream in the spring (Stich et al., 2015).

KEI (Maine) collected hourly water temperature data upstream and downstream of the dam in 2017 at the Pumpkin Hill Project to determine the anticipated timeframe for shutting down the turbine units to protect outmigrating smolts (i.e.,14 nights when water temperature is between 10°C (50°F) and 15°C (59°F)). KEI (Maine) expects to cease generation between late April and mid to late May based on water temperature data collected at the site in 2017 (Figure 1).

KEI (Maine) will continue to collect water temperature data annually to align the actual two-week window for nighttime shutdowns directly to water temperature. KEI (Maine) will collect hourly water temperature data from mid-April through May 31 annually. KEI (Maine) will cease generation at night (8:00 PM to 4:00 AM) once water temperature reaches 10°C. If water temperature drops below 10°C, generation may be reinstated until water temperature reaches 10°C again. KEI (Maine) will return to its normal operating procedures once generation has been curtailed for 14 nights with water temperatures ranging from 10°C (50°F) and 15°C (59°F). The downstream fishway will be operated during the nighttime shutdowns and water will be spilled over the dam.

[1] From annual smolt trap counts completed by the Maine Department of Marine Resources in Downeast Maine.

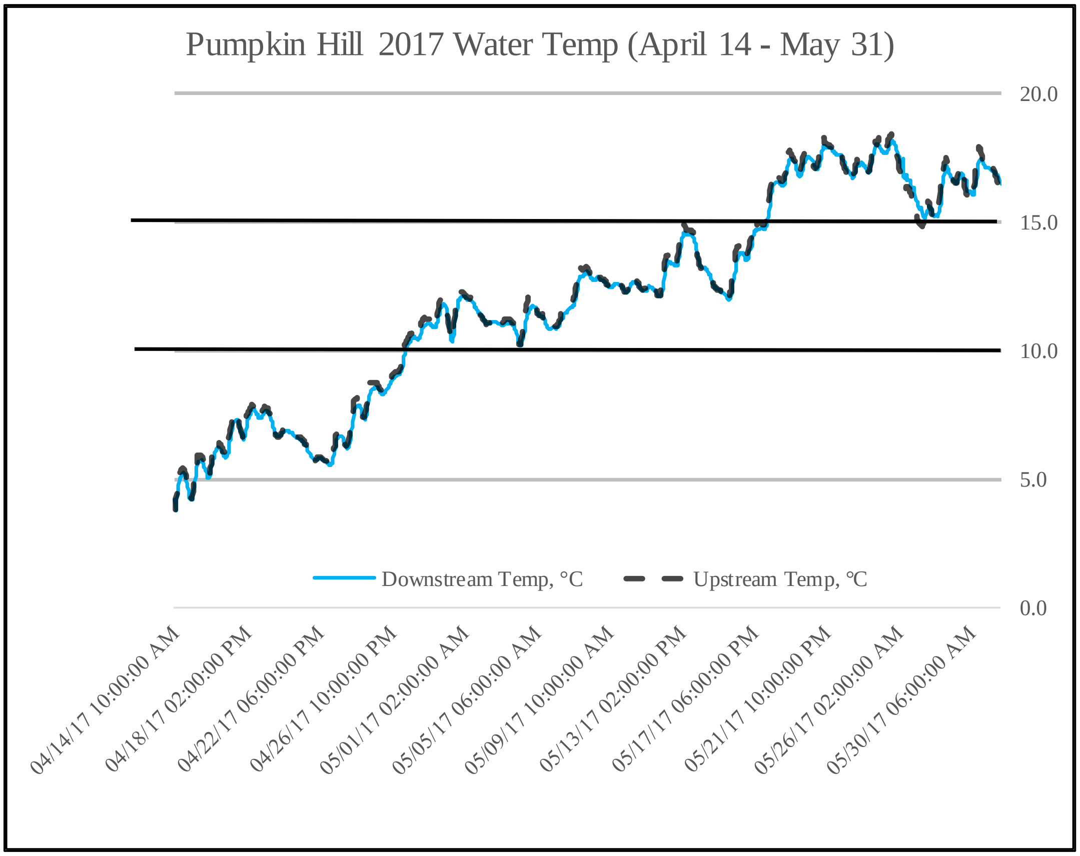


FIGURE 1 HOURLY WATER TEMPERATURE DATA COLLECTED BY KEI (MAINE) FROM APRIL 14 TO MAY 31, 2017.

KEI (Maine) also plans to complete upstream salmon passage studies within two years of receiving notification from NMFS that enough study fish are available for monitoring purposes (i.e., dependent on stock availability) and that an upstream salmon passage study for the Passadumkeag River is warranted. Initiation of salmon passage studies would be required if more than 40 adult salmon are passed upstream in any two subsequent years. KEI (Maine) may opt to work collaboratively with researchers from the University of Maine or other dam owners in the watershed to evaluate upstream salmon passage at the site. The study plan would be developed in consultation with NMFS.

KEI (Maine) will retain the ability to install protective measures such as seasonal overlays, narrower trashracks, and provision of spill, should they opt to pursue other options in the future for passing and protecting outmigrating salmon in lieu of nighttime shutdowns.

3.0 IMPLEMENTATION PROVISIONS

3.1 EFFECTIVE DATE AND SCHEDULE

The proposed SPP will be implemented following NMFS's issuance of a Biological Opinion and Incidental Take Statement and once KEI (Maine) has been notified that Atlantic salmon inhabit the Passadumkeag River.

3.2 REPORTING

KEI (Maine) will provide an annual report by December 31 each year describing accomplishments and plans for the upcoming year. KEI (Maine) will notify NMFS of any observed salmon take within 24 hours of discovering any salmon affected by operations.

4.0 REFERENCES

Stich, D.S., Bailey, M.W., Holbrook, C.M., Kinnsion, M.T., and Zydlewski, J.D. 2015. Catchment-wide survival of wild- and hatchery-reared Atlantic salmon smolts in a changing system. Canadian Journal of Fish and Aquatic Science. 72:1-14.

Exhibit F

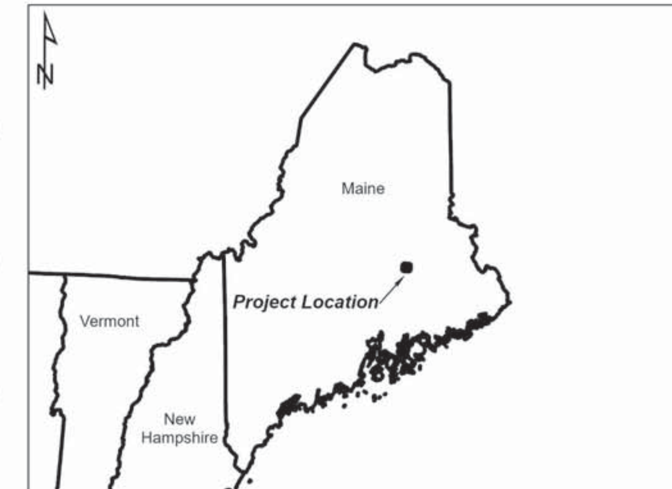
General Design Drawings

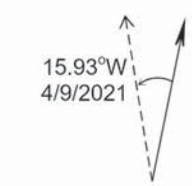
18 CFR §4.41 requires that a Supporting Design Report be filed with the license application. KEI (Maine) does not have historic documentation related to supporting design information. Therefore, KEI (Maine) is developing stability information of project water retaining structures which will be filed as a supplement to the License Application by December 1, 2021.

Exhibit F drawings are provided for federal use only and are not included for public review of this license application. This material is considered Critical Energy Infrastructure Information (CEII) particularly with regard to proposed project structures, the incapacity or destruction of which would affect security, economic security, public health, or safety. Members of the public may obtain non-public or privileged information by submitting a Freedom of Information Act (FOIA) request. See www.ferc.gov/legal/ceii-foia.asp for more information.

Exhibit G

Project boundary map





- Project Boundary
- Roads
- Streams
- Waterbody
- Features
- Municipal Boundary

Map notes:
1. The Lowell Tannery Project is located in the State of Maine in Penobscot County.
2. Reference Point coordinates are shown in NAD 1983 2011 StatePlane Maine East FIPS 1801 Ft US.
3. Elevations shown are referenced to NAVD 88, where MSL = NAVD88 + 0 ft. Conversion factor was determined from NOAA tidal benchmark at Pettegrove Point, Dochet Island ME, Station ID 8410834.
4. Licensee has acquired all flowage rights and title in fee or the right to use in perpetuity all lands necessary or appropriate for the construction, maintenance, and operation of the Project. All property records are kept on file with the licensee.
5. There are no federal lands within the Project boundary.
6. The Project boundary description, as required by 18 CFR 4.41, is represented here by a grid of Northings and Eastings around, and graticules within, the map frame. Any position in Northings and Eastings along the Project boundary can be determined using these references.
7. The Project boundary, in part, was digitized from contour elevations derived from USGS ME LiDAR data (USGS 2017, USGS 2019).

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

STATE OF MAINE
STEPHEN W. EVERETT 2161
PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

EXHIBIT G | SCALE: 1" = 720' | SHEET NO. 1 OF 4

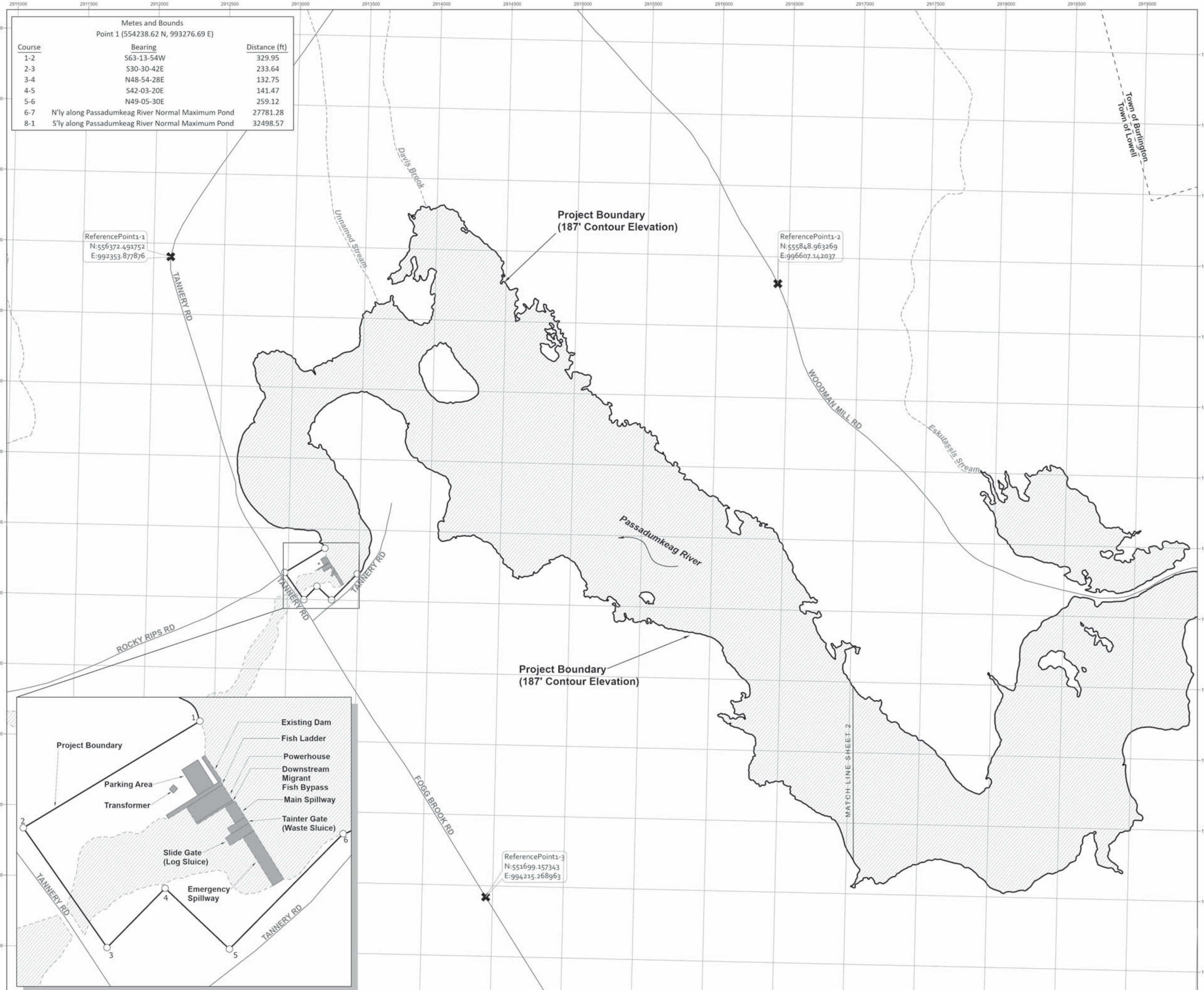
0 500 1,000 2,000 3,000 4,000 Feet

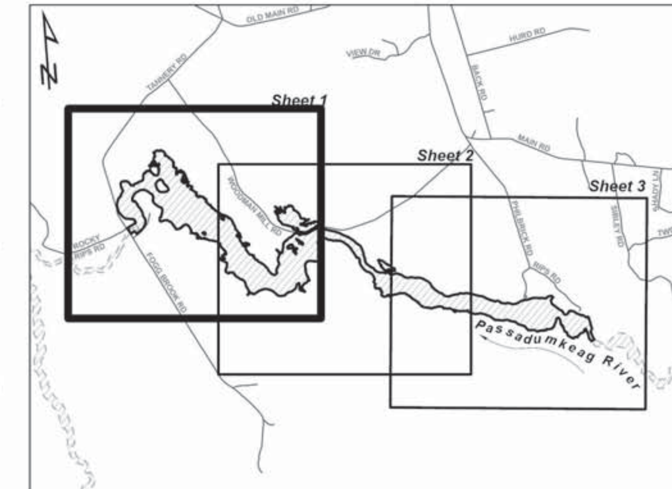
FERC DWG. NO. 4202-

Metes and Bounds

Point 1 (554238.62 N, 993276.69 E)

Course	Bearing	Distance (ft)
1-2	S63-13-54W	329.95
2-3	S30-30-42E	233.64
3-4	N48-54-28E	132.75
4-5	S42-03-20E	141.47
5-6	N49-05-30E	259.12
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57





15.93°W
4/9/2021

- Project Boundary
- Roads
- Streams
- Waterbody
- Features
- Municipal Boundary
- Reference Points
- Match Line

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STATE OF MAINE STEPHEN W. EVERETT 2161 PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

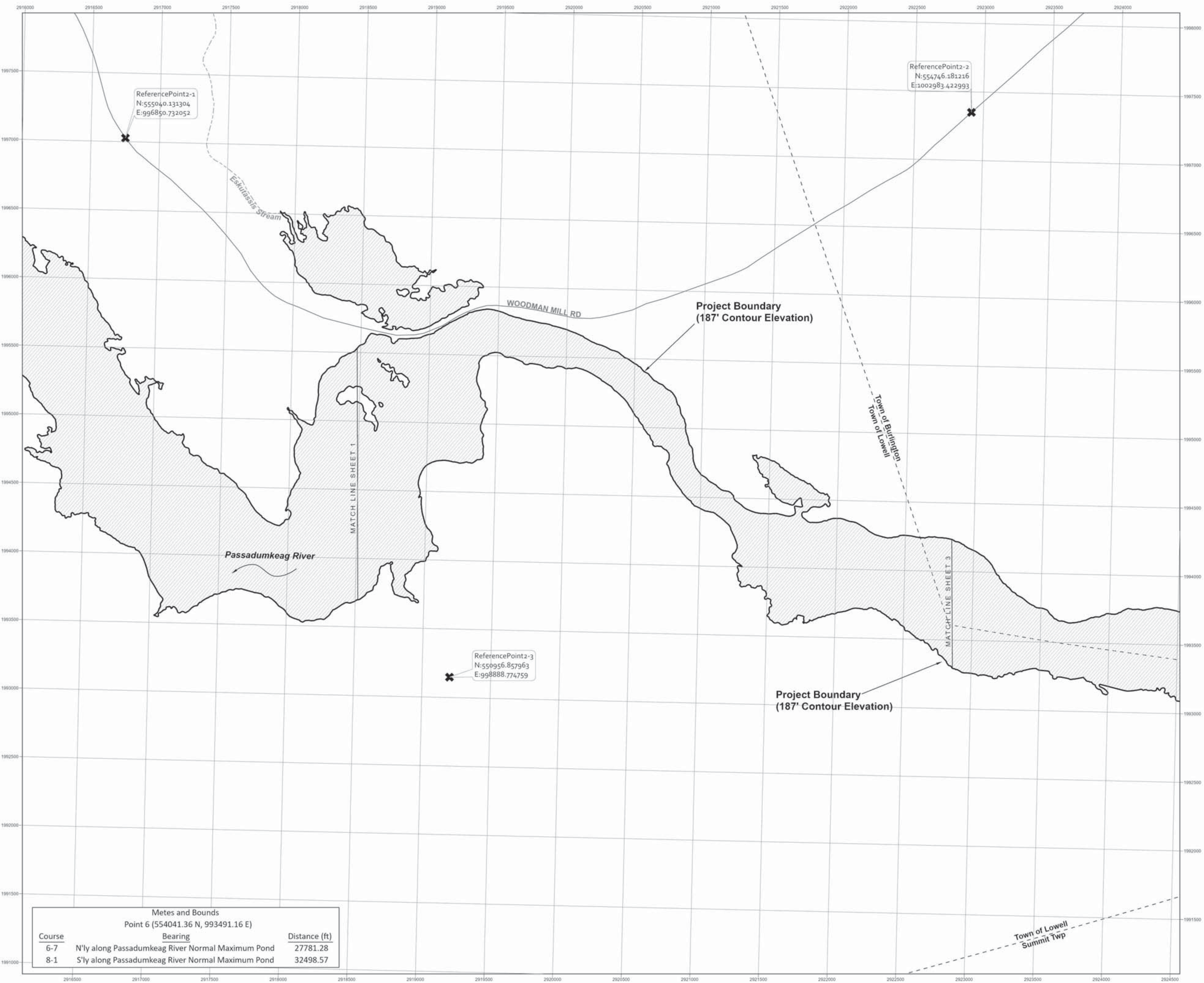
LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

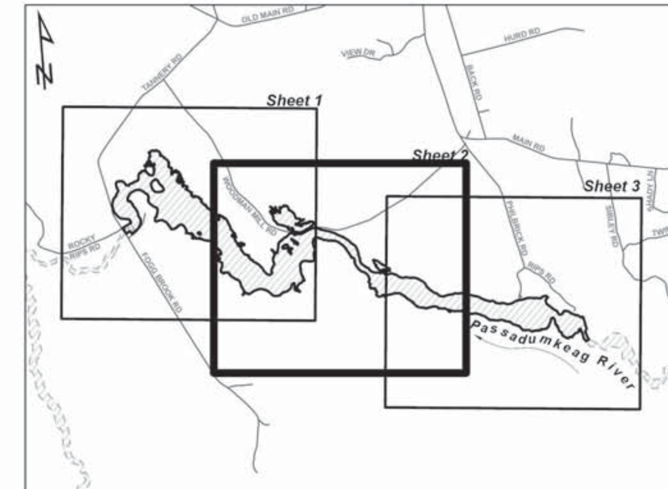
EXHIBIT G | SCALE: 1" = 333' | SHEET NO. 2 OF 4

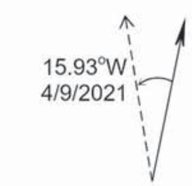
0 250 500 1,000 1,500 2,000 Feet

FERC DWG. NO. 4202-



Metes and Bounds		
Point 6 (554041.36 N, 993491.16 E)		
Course	Bearing	Distance (ft)
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57





Project Boundary
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STATE OF MAINE
STEPHEN W. EVERETT 2161
PROFESSIONAL LAND SURVEYOR

KEI (USA) POWER MANAGEMENT INC.

LOWELL TANNERY HYDROELECTRIC PROJECT
FERC NO. 4202

PROJECT BOUNDARY MAP

EXHIBIT G   SCALE: 1" = 333'   SHEET NO. 3 OF 4

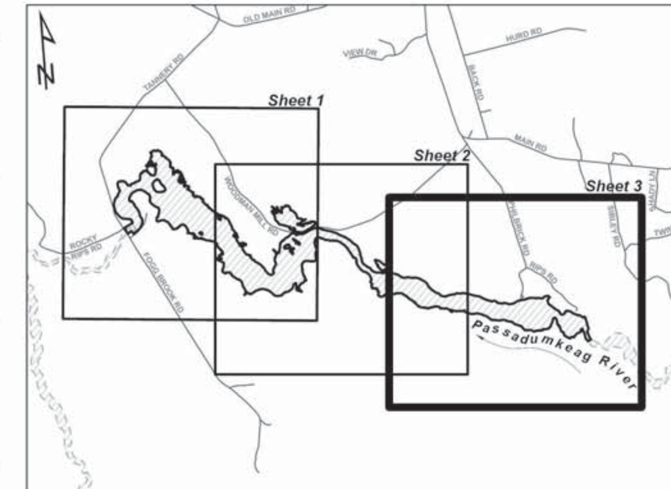
0 250 500 1,000 1,500 2,000 Feet

FERC DWG. NO. 4202-

Metes and Bounds

Point 7 (549134.70 N, 1008059.27 E)

Course	Bearing	Distance (ft)
6-7	N'ly along Passadumkeag River Normal Maximum Pond	27781.28
7-8	N63-19-56E	119.85
8-1	S'ly along Passadumkeag River Normal Maximum Pond	32498.57



15.93°W
4/9/2021

Project Boundary
Municipal Boundary
Roads
Reference Points
Streams
Match Line
Waterbody
Features

Map notes:
1. The Lowell Tannery Project is located in the State of Maine in Penobscot County.
2. Reference Point coordinates are shown in NAD 1983 2011 StatePlane Maine East FIPS 1801 Ft US.
3. Elevations shown are referenced to NAVD 88, where MSL = NAVD88 + 0 ft. Conversion factor was determined from NOAA tidal benchmark at Pettegrove Point, Dochet Island ME, Station ID 8410834.
4. Licensee has acquired all flowage rights and title in fee or the right to use in perpetuity all lands necessary or appropriate for the construction, maintenance, and operation of the Project. All property records are kept on file with the licensee.
5. There are no federal lands within the Project boundary.
6. The Project boundary description, as required by 18 CFR 4.41, is represented here by a grid of Northings and Eastings around, and graticules within, the map frame. Any position in Northings and Eastings along the Project boundary can be determined using these references.
7. The Project boundary, in part, was digitized from contour elevations derived from USGS ME LiDAR data (USGS 2017, USGS 2019).

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

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Lowell Tannery Hydroelectric Project

(FERC No. 4202)

Exhibit H

Description of Project Management and Need for Project Power

This exhibit it is not applicable based on the Lowell Tannery Project being defined as minor project under 1.5 megawatts, seeking a subsequent license.