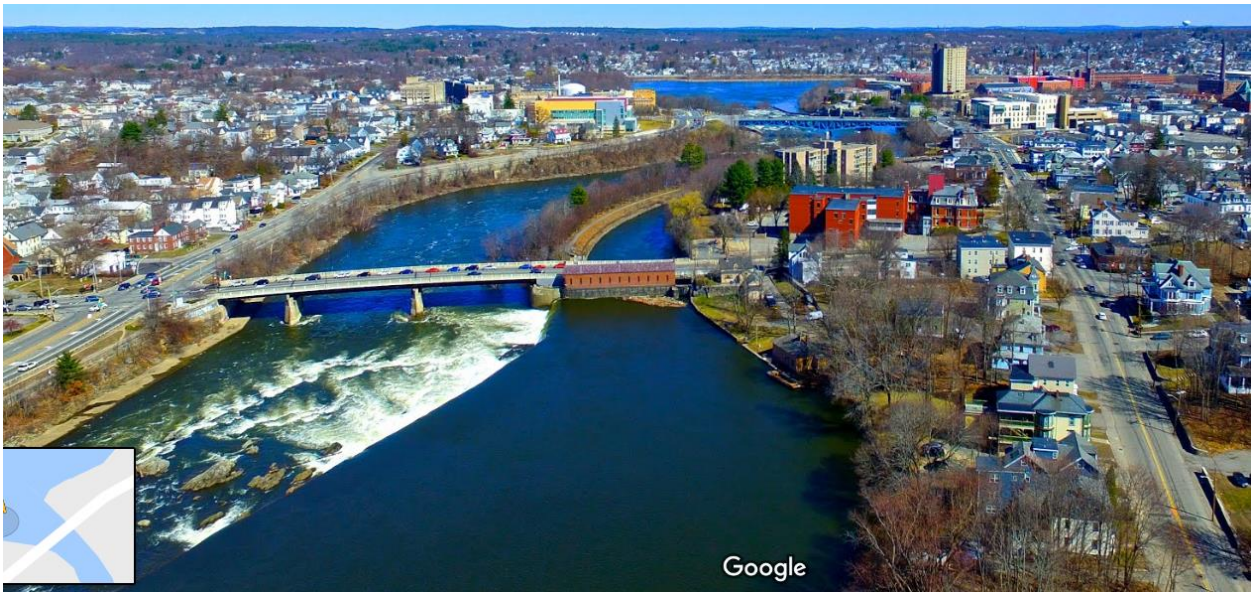
FULL APPLICATION

Lowell Hydroelectric Facility

Certification Application to the Low Impact Hydropower Institute

FERC Project No. 2790



Prepared by
Peter Drown, President
Cleantech Analytics LLC
In Support of
Boott Hydropower, LLC
Subsidiary of
Enel Green Power North America, Inc.

July 26, 2017

TABLE OF CONTENTS

INTRODUCTION 3
PART I. FACILITY DESCRIPTION 4
PART II. STANDARDS SELECTION 11
PART III. SUPPORTING INFORMATION 15
PART IV. SWORN STATEMENT AND WAIVER 44
PART V. CONTACTS 45
Appendix A. Turbine/Generator Data 47
Appendix B. Lowell Project Canal Schematic 49
Appendix C. Supporting Documentation by Criterion 50

TABLE OF FIGURES

Figure 1 - Lowell Facility Primary Structures (excl. Canal System) 3
Figure 2 - Merrimack Watershed 4
Figure 3 - Pawtucket Dam (pre-crest gate, viewing South-East to North-West) 5
Figure 4 - ELF Powerhouse (side view) 5
Figure 5 - ELF Powerhouse Intake 6
Figure 6 - Pawtucket Dam 8
Figure 7 - Fish lift at EL Field Powerhouse 8
Figure 8 - Fish ladder at Pawtucket Dam 8
Table 1 - Facility Description Information for Lowell Hydroelectric Facility 9
Table 2 - Zone of Effect Selection 11
Figure 9 – Zones 2 and 3 (immediate project vicinity) 12
Figure 10 - Zone of Effect Approximate Delineation Map 12
Table 3 - LIHI Standards for Zone of Effect No. 1 13
Table 4 - LIHI Standards for Zone of Effect No. 2 13
Table 5 - LIHI Standards for Zone of Effect No. 3 13
Table 6 - LIHI Standards for Zone of Effect No. 4 14
Figure 11 - Lowell Crest Gate Operational Protocol 20
Table 8 - MA84A-01 Impairment Data (EPA Waterbody Quality Assessment Report) 22
Table III-4. Information Required to Support Water Quality Standards 23
Table 9 - MA84A-02 Impairment Data (EPA Waterbody Quality Assessment Report 23
Table 10 - MA84A-29 Impairment Data (EPA Waterbody Quality Assessment Report) 25
Figure 12 - OLIVER Mapping of Lowell Project (PH1321 = Bald Eagle) 38

INTRODUCTION

This is an application to the Low Impact Hydropower Institute (LIHI) for certification of the Lowell Hydroelectric Facility ("Facility") owned by Boott Hydropower, LLC, a subsidiary of Enel Green Power North America, Inc. (EGPNA), an owner and operator of renewable energy projects. This 24.8 MW, run-of-river Facility is located on the Merrimack River in the City of Lowell, Massachusetts. The Facility includes a 1,093 foot-long, 15 foot-high stone-masonry gravity dam that impounds a 720 acre reservoir and maintains a normal maximum water surface elevation of 92.2 ft NVGD 1929. The project includes a primary powerhouse and four power stations in mill buildings along the downtown canal system. The Facility received its FERC License (#2790) on April 13, 1983, and commenced operations in 1986. Upstream and downstream fish passage facilities include a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam. All fish passage facilities were designed in consultation with the U.S. Fish and Wildlife Service. Passage operations are supervised by the state and federal fishery agencies. The project maintains a minimum flow of 1,990 cfs by operating the project in ROR mode using pond level control at the ELF powerhouse. Flow control and habitat enhancement are provided by a pneumatic crest gate which is due to be completed by the end of 2017.

Boott Hydropower has consistently engaged with resource agencies to improve the environmental performance of the Facility. In support of this LIHI application, Boott engaged Massachusetts Department of Fish and Wildlife (MDFW) and United States Fish and Wildlife Service (USFWS) to develop a plan to improve fish passage at the site. As a result, USFWS and MDFW have both drafted letters supporting this application with the commitment to provide additional enhancements provided in that plan. We believe the Lowell Hydroelectric Facility meets LIHI criteria and represents a strong addition to the Low Impact Hydropower portfolio of projects.

Figure 1 - Lowell Facility Primary Structures (excl. Canal System)

PART I. FACILITY DESCRIPTION

The Lowell Hydroelectric Facility ("Facility") consists of a run-of-river hydropower project located on the Merrimack River in Lowell, Massachusetts, and is intended to fully develop, conserve, and utilize the water resource of the Merrimack River at the Pawtucket Dam. The Project operates in a run-of-river mode and has no useable storage capacity. The primary features include: (1) the 1093-foot-long stone-masonry gravity Pawtucket Dam, topped by a 5-foot-high pneumatic crest gate system[1]; (2) the 17.3 MW E.L. Field powerhouse containing two 8.6 MW horizontal Kaplan turbine-generator units; a fish lift system at the powerhouse, (3) a fish ladder adjacent to the Pawtucket Dam and (4) a canal system in downtown Lowell which provides flow to four smaller power stations. Hydroelectric and hydromechanical power was historically generated at several other mill buildings along the canal system, however many of these the units have been either decommissioned or inoperable for some time and are not included in the Lowell Project. A detailed description of the Lowell Project follows:

Watershed Characteristics

The Lowell project is in a heavily urban area in downtown Lowell, MA, on the Merrimack River. The Merrimack River has supported a wide variety of industrial and anthropogenic uses, including waste assimilation, drinking water (second largest surface drinking water source in New England) hydropower production, recreation, etc. The Project is located approximately 11 miles upstream of the Lawrence Project and approximately 30 miles downstream of the Amoskeag Dam in New Hampshire. The 116-mile-long River begins at the confluence of the Winnipesaukee and Pemigewasset rivers in Franklin, New Hampshire, flows southward into Massachusetts, and then travels northeast until it discharges into the Atlantic Ocean. Several other rivers feed into the Merrimack throughout its course (see Figure 1.) The river drains a 5,010 square mile watershed throughout New Hampshire and north-eastern Massachusetts (comprising the largest watershed in New Hampshire.)

Figure 2 - Merrimack Watershed

Pawtucket Dam

The existing dam is of dressed masonry gravity construction with a length of 1,092.5 feet, a spillway crest length of 982.5 ft and an average height of 15 feet. The pond formed by the Pawtucket Dam extends approximately 23 miles upstream to Moore's Falls in Litchfield and Merrimack, New Hampshire. At the normal pond elevation of El 92.2 ft NGVD 1929, the surface area of the pond is reported to encompass an area of about 720 acres. Original drawings show the masonry was ashlar, laid dry with a mortared masonry upstream face at a 1:1 slope, a two-foot-thick capstone, and the bed course laid in mortar. It was built in two sections in 1847 and 1875, the latter being grouted during construction. The dam foundation rests on bedrock, except for a short section on hardpan. A fishway is located at the left dam abutment, and the intake structure for the Northern Canal is at the right abutment.

[1] On April 3, 2013 the FERC issued an Order Amending License which approved replacement of the existing 5-foot-high wooden flashboards on the Pawtucket Dam with an Obermeyer crest gate system (143 FERC ¶ 61,048). The crest gate system is currently under construction and is expected to be completed and commissioned by the end of 2017.

A pneumatically-operated crest gate system (currently under construction, see footnote on pg. 4) is mounted on the spillway crest to maintain the headpond at its normal level of 92.2 feet NGVD 1929. The pneumatic crest gate system consists of 20 ft long hinged steel panels supported on their downstream side by tubular rubber air bladders. The crest gate system is installed in five independently-controllable zones. Air compressors, which supply system inflation and deflation pressure, and the crest gate control system are housed in a building located near the fish ladder and the left (northerly) abutment of the dam.

Figure 3 - Pawtucket Dam (pre-crest gate, viewing South-East to North-West)

E.L. Field Powerhouse

The powerhouse incorporates a separate conventional intake structure for each of the station's two identical horizontal Kaplan turbine-generator units. Each intake is equipped with trashracks; intake and draft tube gate slots with permanent or bulkhead style gates for emergency shutdown and dewatering purposes are also provided. The powerhouse is equipped with a traversing trash rake to remove debris at the intake. Both mobile and on-site cranes are used for heavy equipment movement at the facility. A surge gate upstream of the powerhouse alleviates Northern Canal elevation changes caused by sudden flow fluctuations. The surge gate can be operated in manual or automatic mode. A 1,000-foot-long tailrace channel was excavated in bedrock in the river. The channel excavation is approximately 60 feet wide by 20 feet deep. The tailrace is protected from high river flows by a five-foot-high concrete training wall, which directs bypassed river flows away from the tailrace

Figure 4 - ELF Powerhouse (side view)

Figure 5 - ELF Powerhouse Intake

Canal Network & Power Units

The Lowell Project includes a two-tiered network of man-made canals, totaling some 5.5 miles in length, which run throughout downtown Lowell. Flow enters the canal system upstream of the Pawtucket Dam via the Pawtucket Canal and is controlled by the Guard Lock and Gates Facility (labeled "Old Guard Locks" in Appendix B). The nominal flow capacity of the downtown canal system via the Pawtucket Canal and the Guard Lock and Gates Facility is approximately 2,000 cfs.

Presently, the Lowell Project includes four power stations located within mill buildings along the downtown canal system. Together, these canal stations contain a total of 19 hydroelectric units currently authorized under the project license. The Hamilton Power Station contains 5 units totaling 1,180 kW capacity and draws water from the Hamilton Canal in the upper canal system and discharges into the Lower Pawtucket Canal in the lower canal system at a head of approximately 13 feet. The Assets Power Station contains 3 units totaling 795 kW capacity and draws water from the Merrimack Canal in the upper canal system and discharges into the Lower Pawtucket Canal in the lower canal system at a head of approximately 13 feet. In the lower canal system, the Bridge Street and John Street Power Stations each draw water from the Eastern Canal and discharge to the Merrimack River or the Concord River, at a head of approximately 21 feet. The John Street Power Station contains 4 units totaling 2,100 kW capacity and discharges into the Merrimack River. The Bridge Street Power Station has 3 units totaling 1,080 kW capacity (also known as "Section 8") which discharge into the Concord River, and another 4 units totaling 2,360 kW capacity (also known as "Main Power") which discharge to the Merrimack River. For a detailed map of the Canal Network and associated Power Stations, see Appendix B.

Operations Description

The project is normally operated in a run-of-river mode using the automatic pond level control capability of the E.L. Field Powerhouse. Boott Hydropower normally operates the project to maximize flow through the available units at the E.L. Field, then routes any additional flows through the Pawtucket Canal system. The EL Field turbine-generator units are more efficient and operate at a higher head than the older canal units, and are therefore the priority first-on,

last off units in the project operations scheme. When river flows exceeds the hydraulic capacity of the available EL Field units (approximately 4000 cfs per unit or 8000 for both units) excess flows of up to approximately 2000 cfs are routed through the downtown canal system and to the canal units. Any flows in excess of approximately 10,000 cfs (8,000 cfs EL Field plus 2,000 cfs via canals) are passed over the Pawtucket Dam spillway.

Fish Passage Facilities

Upstream and downstream fish passage facilities include a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam. All fish passage facilities were designed in consultation with the U.S. Fish and Wildlife Service. Passage operations are supervised by the state and federal fishery agencies.

The reinforced concrete fish ladder at the Pawtucket Dam is designed to allow for controlled fish passage at river flows up to 25,000 cfs. The fishway operates at 500 cfs, including attraction flow. The fish ladder is a vertical slot design with 13-foot-wide by 10-foot-long pools. A counting station and fish trap area is provided. The Pawtucket Dam has been modified by removing ashlar masonry to allow the exit channel to penetrate the dam. Figure 6 and 7 show the location and design of the ladder.

The upstream fishway at the powerhouse is of the elevator type. A fish collection gallery with two entrances the downstream wall of the powerhouse to collect fish migrating through the tailrace channel. The total design discharge capacity is 200 cfs out of both entrances, however the Owner reached agreement with agencies to close the street side entrance to prevent fish from traveling in one entrance and out of the other. Currently, only the river side entrance is used, and passes a maximum of 120 cfs. The fish are attracted into the 30-foot crowding pool, trapped, and crowded. From the crowding pool, they enter the elevator and are lifted in a hopper to the exit channel. From the elevator area, the fish enter a holding pool 10 feet wide by 50 feet long. Fish next enter the fish trap area where they can be counted. A 10-foot by 12-foot fish counting station is provided. Passage of fish through the trap area allows fish to enter the exit channel, passing into the Northern Canal and then upriver.

The downstream fishway at the powerhouse consists of an adjustable-flow sluiceway and bypass adjacent to the intake headwall. Downstream migrants entering the bypass are quickly sluiced into an enlarged and deepened plunge pool located in the bypassed river reach next to the powerhouse. Natural channel braids in the riverbed allow emigrants to move downstream to the mainstem river, at the confluence of the river reach and tailrace.

In support of LIHI certification, USFWS and MDFW requested that the Owner make certain enhancements to the design and operation of the fish lift system and spillway fish ladder. These include tailrace rock excavation, American Eel passage improvements, and operation of the fish ladder for the entire duration of the anadromous fish upstream passage season. USFWS and MDFW both noted in their comment letters that with these commitments, they support this application for LIHI Certification of the Lowell Facility.

Figure 6 - Pawtucket Dam (Fish ladder in northwest abutment; weirs in river channel direct fish to ladder)

Figure 8 - Fish ladder at Pawtucket Dam

Figure 7 - Fish lift at EL Field Powerhouse

Table 1 - Facility Description Information for Lowell Hydroelectric Facility

Information	***Facility Description***
Facility Name:	• Lowell Hydroelectric Project
Location:	• Merrimack River • Merrimack River Watershed • Lowell, Massachusetts • River mile of dam: 40.8 • Latitude:42.649585° • Longitude:-71.330795°
Facility Owner:	• Boott Hydropower, LLC, subsidiary of Enel Green Power North America, Inc. • Randald Bartlett, Northeast Operations Manager
Regulatory Status:	• FERC License #2790 (issued 04/13/83, expires 04/30/2023[2]) • WQC (issued 07/26/82 and revised 7/27/1983) • See Appendix C for FERC hyperlinks by criteria

Characteristics of the Power Plant:	• Commercial Operation Date: 1986
	• Total Authorized Capacity: currently 24.823 MW; 22.463 MW following approval of pending amendment application
	• Average annual generation: 88,530 MWh (10 year average)
	• Number, type and size of turbines, including maximum and minimum hydraulic capacity of each unit:
	  • The maximum combined hydraulic capacity of E.L. Field and the canal system is approximately 10,000 cfs, but may be restricted by unit availability, debris accumulation at the Northern Canal Gatehouse, high tailwater conditions, and other factors.
	  • Please see Appendix A for unit-by-unit hydraulic capacity
	• Mode of operation: Run-of-River (see “Flows” criterion)
	• Dates/types of major equipment upgrades: pneumatic crest gate installation (2016-2017)
	• Dates, purpose and type of recent operational changes: see fish passage enhancements in Appendix C
	• Plans, authorization and regulatory activities for any facility upgrades: None

Characteristics of the Dam or Diversion:	• Date of Construction: Two sections constructed in 1845 and 1875, canal infrastructure late 18th/ 19th centuries • Dam Height: 15 feet (average) • Spillway Elevation and hydraulic capacity: 92.2 ft. NGVD at normal pond level • Tailwater elevation: ~57 ft. NGVD measured downstream of E.L. Field powerhouse • Length and type of all penstocks and water conveyance structures between reservoir and powerhouse: ~0.5m between gatehouse and EL Field Powerhouse; canal system is ~5m long total • Dates & types of major, generation-related infrastructure improvements: None

[2] Boott Hydropower will likely utilize the Integrated Licensing Process (ILP) to re-license this facility. Specific studies and pre-application activities will proceed per schedule established through the ILP.

<table>
<tr><th>Information</th><th>Facility Description</th></tr>
<tr><td>Characteristics of Reservoir and Watershed:</td><td>

Gross volume and surface area at full pool: 720 acres surface area
Max and min volume and water surface elevations for designated power pool, if available: n/a
Upstream dams by name, ownership and river mile: Amoskeag Dam, Public Service Company of New Hampshire, RM 74
Operating agreements with upstream or downstream reservoirs that affect water availability, if any, and facility operation: none, although the Owner does pay annual charges to support upstream Army Corps flood storage reservoirs
Area inside FERC project boundary, where appropriate: ~760 acres

</td></tr>
<tr><td>Hydrologic Setting:</td><td>

Average annual flow at dam: 7110 cfs

<table>
<tr><th>JAN</th><th>FEB</th><th>MAR</th><th>APR</th><th>MAY</th><th>JUN</th></tr>
<tr><td>6,664</td><td>6,773</td><td>11,665</td><td>17,394</td><td>10,443</td><td>5,984</td></tr>
<tr><th>JUL</th><th>AUG</th><th>SEP</th><th>OCT</th><th>NOV</th><th>DEC</th></tr>
<tr><td>3,343</td><td>2,733</td><td>2,797</td><td>4,172</td><td>6,246</td><td>7,332</td></tr>
</table>

Location and name of relevant stream gauging stations above and below facility:

Above: USGS 01092000 Merrimack R near Goffs Falls, below Manchester, NH
Below: USGS 01100000, right bank at Lowell, 1,100 ft downstream from Concord River

Watershed area at the dam: 3979 mi^2

</td></tr>
<tr><td>Designated Zones of Effect:</td><td>

4 Zones of Effect (see Part II below)

</td></tr>
<tr><td>Agency Contacts:</td><td>

List names, addresses, phone numbers and email for local resource agencies and non-governmental stakeholders: See Part V

</td></tr>
<tr><td>Photographs of the Facility</td><td>

Photographs of key features of the facility and each of the designated zones of effect: Included above

</td></tr>
</table>

PART II. STANDARDS SELECTION

	Zone 1	Zone 2	Zone 3	Zone 4
Upstream and downstream locations by river mile	54 - 41	41 - 40.3	40.3 - 38	n/a (canals)
Type of waterbody	Impoundment	Bypass reach on Merrimack	Downstream Reach	Canal System
Delimiting structures	Nashua River confluence in Nashua, NH to Pawtucket Dam	Pawtucket Dam to ELF Powerhouse	Tailrace of ELF Powerhouse to Duck Island Wastewater Treatment Outfall	Francis Gate Guard Locks & Pawtucket Gatehouse to Merrimack River
Designated uses by state water quality agency	Impaired for fish consumption, primary contact recreation	Impaired for fish consumption, fish, other aquatic life and wildlife, and primary contact recreation	Impaired for fish consumption, fish, other aquatic life and wildlife, and primary contact recreation	Impaired for aquatic life harvesting

Justification for Zone 2 and 3 Selection (in response to Intake Review comments)

Hydro units in the canal system only operate when flows exceed the capacity of the EL Field powerhouse (~8,000 cfs.) The discharge of these canal powerhouses is minimal, and therefore the primary bypassed reach is only the 0.7 mile segment from the top of the Pawtucket Dam to the ELF powerhouse tailrace. Flows immediately downstream of the powerhouse are negligibly impacted by any flows discharged from the canal system. The LIHI definition of Zones states that zone delineation accounts for the fact that the environmental effects of hydropower operate differently in different parts of a river system. The segment we designate as Zone 3, downstream of the powerhouse to the wastewater treatment outfall, behaves very differently than the 0.7 mile bypassed reach and more like a free-flowing river. For these four reasons, we would suggest ZOE2 is accurately portrayed as-is.

Table 2 - Zone of Effect Selection

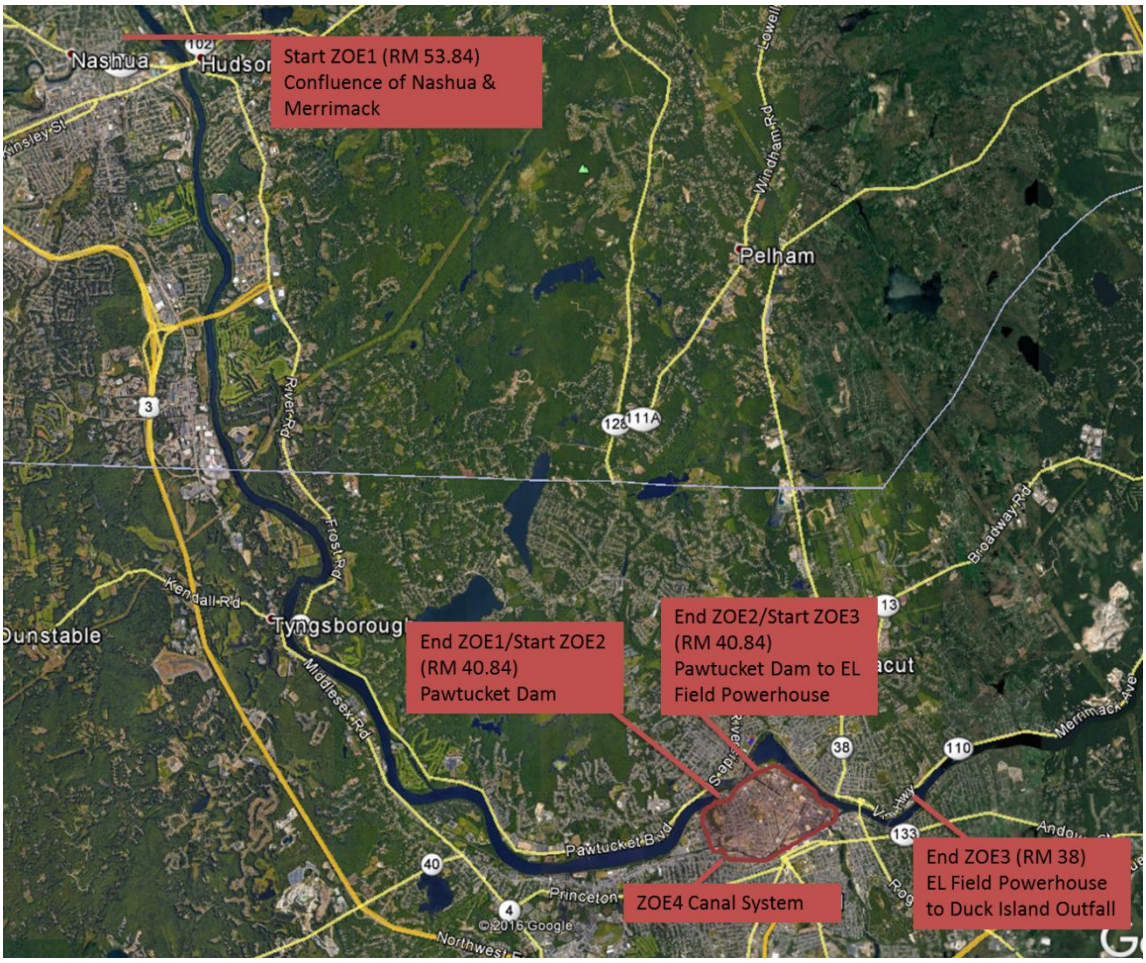


Figure 10 - Zone of Effect Approximate Delineation Map

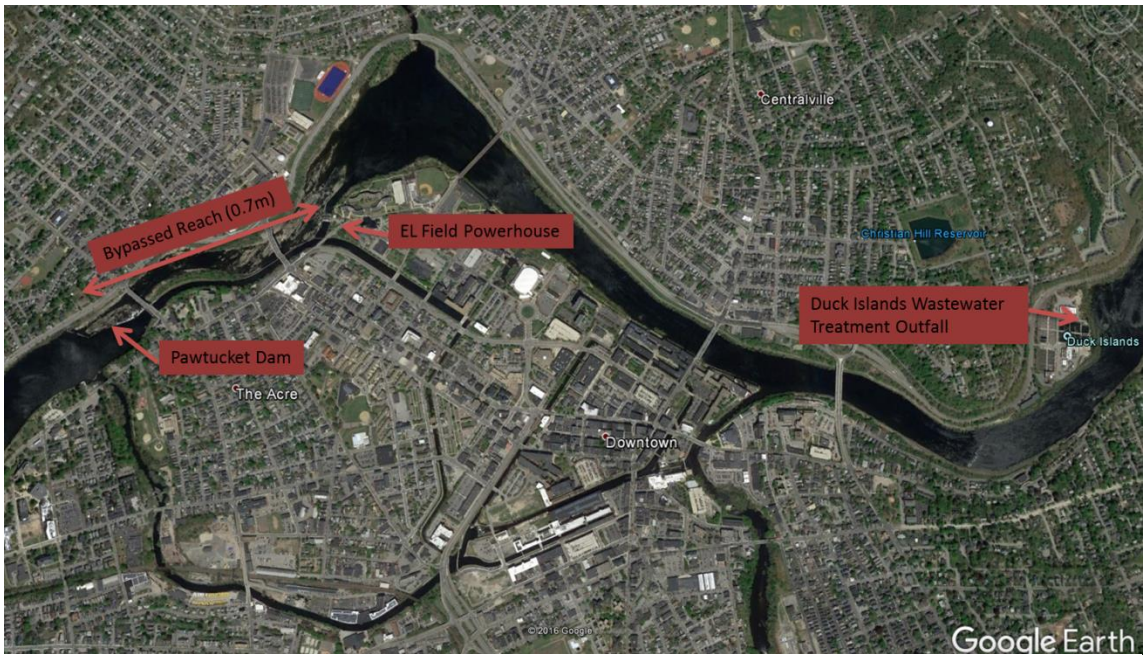


Figure 9 – Zones 2 and 3 (immediate project vicinity)

Table 3 - LIHI Standards for Zone of Effect No. 1

	Criterion	Alternative Standards					
		1	2	3	4	5	PLUS
A	Ecological Flows and Water Levels	X					
B	Water Quality		X				
C	Upstream Fish Passage	X					
D	Downstream Fish Passage and Protection		X				
E	Watershed Protection		X				
F	Threatened/Endangered Species		X				
G	Cultural Resources		X				
H	Recreational Resources		X				

Table 4 - LIHI Standards for Zone of Effect No. 2

	Criterion	Alternative Standards					
		1	2	3	4	5	PLUS
A	Ecological Flows and Water Levels		X				
B	Water Quality		X				
C	Upstream Fish Passage		X				
D	Downstream Fish Passage and Protection		X				
E	Watershed Protection	X					
F	Threatened/Endangered Species		X				
G	Cultural Resources		X				
H	Recreational Resources		X				

Table 5 - LIHI Standards for Zone of Effect No. 3

	Criterion	Alternative Standards					
		1	2	3	4	5	PLUS
A	Ecological Flows and Water Levels		X				
B	Water Quality		X				
C	Upstream Fish Passage		X				
D	Downstream Fish Passage and Protection	X					
E	Watershed Protection	X					
F	Threatened/Endangered Species		X				
G	Cultural Resources		X				
H	Recreational Resources		X				

Table 6 - LIHI Standards for Zone of Effect No. 4

	Criterion	Alternative Standards					
		1	2	3	4	5	PLUS
A	Ecological Flows and Water Levels	X					
B	Water Quality						
C	Upstream Fish Passage	X					
D	Downstream Fish Passage and Protection	X					
E	Watershed Protection	X					
F	Threatened/Endangered Species		X				
G	Cultural Resources		X				
H	Recreational Resources		X				

PART III. SUPPORTING INFORMATION

This section contains information that explains and justifies the standards selected to pass the LIHI certification criteria (see Part II for selections).

III.A.1 Ecological Flow Standard for Zone 1

The installation of an inflatable crest gate system on the Pawtucket Dam significantly stabilizes the pond level of the reservoir in Zone 1. This system alleviates water level fluctuation effects in the impoundment Zone, and provides significant advantages to fish and wildlife habitat as noted by the resource agencies who strongly endorsed the proposal.

Table III-1. Information Required to Support Ecological Flows Standards

Criterion	*Standard*	*Instructions*
A	1	Not Applicable / De Minimis Effect

Confirm the location of the powerhouse relative to other dam/diversion structures to establish that there are no bypassed reaches at the facility.

- Bypassed reach is included in Zone 2. Criterion A-1 was selected due to LIHI instructions: "All impoundment zones can apply Criterion A-1 to pass this criterion."

If Run-of-River operation, provide details on how flows, water levels, and operation are monitored to ensure such an operational mode is maintained.

- A pneumatically-operated crest gate system is currently being installed on the spillway crest to maintain the headpond at its normal level of 92.2 feet NGVD 1929. This system alleviates water level fluctuation effects in the impoundment Zone, and backwater analysis and technical evaluation found the system would enhance project operational control and generation and would provide significant advantages for other resources that are dependent on water levels, including flood control, recreation, and fish passage. The proposal was strongly endorsed by the Massachusetts Department of Fisheries and Wildlife, and the National Marine Fisheries Service, who both noted the project's beneficial effect on fish habitat and movement within the project area.

*For impoundment zones only, explain how fish and wildlife habitat within the zone is evaluated and managed – **NOTE:** this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion.*

- The Environmental Assessment completed prior to the crest gate installation noted up to 46 miles of shoreline aquatic habitat could benefit from installing the crest gate:
  "The proposed pneumatic crest gate system likely would reduce the false attraction for upstream migrating fish by reducing the amount of leakage from the dam and would improve upstream passage efficiencies. Resident fish upstream of the project would benefit from the reduced frequency of sudden and extended drawdowns because the river would behave more like an unregulated river and nearshore spawning and nursery habitat would remain submerged."

III.A.2 Ecological Flow Standard for Zone 2 (Bypassed Reach)

The project maintains a minimum flow of 1,990 cfs released from the project, or inflow, whichever is less. In addition, the fish ladder at the Pawtucket Dam maintains a total operating flow of 500 cfs, including attraction flow. In support of LIHI certification, the USFWS and MDFW concurred that this ladder should operate for the entire duration of the fish passage season (see Fish Passage Criteria for further information.)

Table III-2. Information Required to Support Ecological Flows Standards

Criterion	*Standard*	*Instructions*
A	2	Agency Recommendation

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- The original Agency Recommendation impacting flow at the dam itself (this Zone) is contained in the Comprehensive Fish Passage Plan, approved by FERC by order issued November 28, 2000. This Plan required operations of a fish ladder at the Pawtucket Dam. The fish ladder has a total operating flow of 500 cfs including attraction flow. This is the primary source of flow in the bypassed reach, other than spillage over the Pawtucket Dam spillway. The fish lift system at ELF has a total flow capacity of 200 cfs, however it presently operates at 100-120 cfs since the Owner shut down the "street side" entrance many years ago with agency concurrence.
- The Crest Gate Operational Plan constitutes another recent agency recommendation impact flows in the bypassed reach. Previously, frequent failure of the wooden flashboards led to false attraction flows and stranded pools within this Zone. This Crest Gate system stabilizes impoundment levels and allows the owner to control flows below the project, eliminating false attraction flows and improving aquatic habitat as noted by the agencies who supported installation of this system (see below.) The Crest Gate impacts this Zone by lowering to pass flows into this Zone in accordance with the plan described in Zone 3, below.

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- A pneumatically-operated crest gate system is currently being mounted on the spillway crest to maintain the headpond at its normal level of 92.2 feet NGVD 1929. This system is installed to prevent flooding in the impoundment Zone, after backwater analysis and technical evaluation found the system would enhance project operational control and generation and would provide significant advantages for other resources that are dependent on water levels, including flood control, recreation, and fish passage. The proposal was strongly endorsed by the Massachusetts Department of Fisheries and Wildlife, and the National Marine Fisheries Service, who both noted the project's beneficial effect on fish habitat and movement within the project area. The installation of

these systems has demonstrated positive impacts on fish passage in similar environments, including the downstream Lawrence project. In a U.S. Circuit Court ruling supporting the installation, the Court summarized the scientific and technical basis for the agency recommendations:

"…the record supports FERC's conclusion that, as compared to the flashboards, the pneumatic crest gate will result in more steady water levels, increased fish passage, increased power generation, and a safer working environment for those working on the Dam, and thus is a better option from a hydroelectric engineering standpoint. These factual findings -- based on the 2004-2007 project operation review, the Boott backwater analysis report, the technical assessment report, the Environmental Assessment, and discussions between FERC, Boott, and numerous interest groups -- go almost entirely unchallenged in the record, and thus clearly satisfy the substantial evidence standard." (U.S. Court of Appeals, First Circuit, No. 13-2439, filed 02/02/15)

Explain how the recommendation provides fish and wildlife protection, mitigation and enhancement (including in-stream flows, ramping and peaking rate conditions, and seasonal and episodic instream flow variations).

- See above. Inflatable flashboard systems offer superior fish and aquatic habitat protection, and are often recommended by state and federal fishery agencies as a proven method of improving environmental performance of hydroelectric projects.

Explain how the recommendation relates to agency management goals and objectives for fish and wildlife.

- During the license amendment process for the Crest Gate installation, multiple fishery agencies reviewed and endorsed the proposal, in support of the agency's goal of protecting and improving anadromous fish passage on the Merrimack River:

  May 14, 2010: *"The proposed system would allow different sections of the dam crest to be lowered as river flows change. This type of system also allows rapid re-inflation after periods of high river flows, thereby avoiding delays to upstream fish passage posed by lost or damaged sections of wooden flashboards… the Division strongly endorses Enel's proposal to replace the existing wooden flashboards at the Lowell project with an inflatable crest-gate system."* (Caleb Slater, Massachusetts Division of Fisheries and Wildlife)

  June 22, 2010: *"Installation of the proposed crest gate system would maintain more consistent water levels, reduce water leakage from the dam, and minimize the need for impoundment drawdowns, all contributing to improved fish passage to their spawning habitat."* (Paul Diodati, Massachusetts Division of Marine Fisheries)

III.A.2 Ecological Flow Standard for Zone 3 (Downstream Reach)

Table III-2. Information Required to Support Ecological Flows Standards

Criterion	*Standard*	*Instructions*
A	2	Agency Recommendation

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- License articles 36 and 37 originally required an interim minimum flow of 905 cfs, and to conduct further studies to determine optimal flow to protect fish and aquatic resources. Following a Study Plan License Amendment issued November 27, 1984, the Owner reached agreement with MDFW, USFWS, and NMFS to release from the project a minimum flow of 1,990 cfs, or inflow, whichever is less. Boott now maintains this project minimum flow requirement by operating the project in ROR mode using pond level control at the ELF powerhouse. The recommended flow was based on the USFWS's "Aquatic Base Flow" interim policy in effect at the time, amounting to 0.5 cfs per square mile of upstream drainage basin (0.5 cfsm).
- Following flooding events in 2006 and 2007, FERC required the Owner to develop alternative strategies to alleviate backwater impacts from the operation of the existing wooden flashboards. The Owner developed several alternatives, one of which was a pneumatically-operated crest gate system. Following several analyses and environmental assessment, this was determined to be the most optimal course of action. The Crest Gate Operational Plan currently represents the most recent agency recommendation affecting flows at Lowell.
- (Note: the Reviewer requested whether additional flow studies will be required during relicensing. We do not know the answer to that until we have submitted the pre-application document next year.)

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- A pneumatically-operated crest gate system is mounted on the spillway crest to maintain the headpond at its normal level of 92.2 feet NGVD 1929. This system was installed to prevent flooding in the impoundment Zone, after backwater analysis and technical evaluation found the system would enhance project operational control and generation and would provide significant advantages for other resources that are dependent on water levels, including flood control, recreation, and fish passage. The proposal was strongly endorsed by the Massachusetts Department of Fisheries and Wildlife, and the National Marine Fisheries Service, who both noted the project's beneficial effect on fish habitat and movement within the project area. The installation of these systems has demonstrated positive impacts on fish passage in similar environments, including the downstream Lawrence project. In a U.S. Circuit Court ruling supporting the installation, the Court summarized the scientific and technical basis for the agency

recommendations:

> *"…the record supports FERC's conclusion that, as compared to the flashboards, the pneumatic crest gate will result in more steady water levels, increased fish passage, increased power generation, and a safer working environment for those working on the Dam, and thus is a better option from a hydroelectric engineering standpoint. These factual findings -- based on the 2004-2007 project operation review, the Boott backwater analysis report, the technical assessment report, the Environmental Assessment, and discussions between FERC, Boott, and numerous interest groups -- go almost entirely unchallenged in the record, and thus clearly satisfy the substantial evidence standard."* (U.S. Court of Appeals, First Circuit, No. 13-2439, filed 02/02/15)

Explain how the recommendation provides fish and wildlife protection, mitigation and enhancement (including in-stream flows, ramping and peaking rate conditions, and seasonal and episodic instream flow variations).

- The Aquatic Base Flow was selected by the U.S. Fish and Wildlife Service as appropriate for this site in lieu of a more detailed instream flow study. A FERC Order issued November 27, 1984 states: "the Licensee has reached an agreement with the MDFW, the FWS, and the NMFS to release from the powerhouse a flow of 1,990 cfs, or inflows, whichever is less, until such time as the Flow Study is conducted. Further, if the Licensee chooses not to perform the study, the Commission would be notified by the Licensee that the release of 1,990 cfs would be made indefinitely. The FWS recommends that if the Flow Study is postponed indefinitely beyond 1985, Article 37 should be changed to require an instantaneous flow release of 1,990 cfs." FERC ordered this change in Article 37.
- The USFWS offers the following explanation of the ecological underpinnings of ABF in a report cited below: "The ABF method relies on the natural ecological-hydrological system to serve as a baseline or reference condition from which stream flow conditions suitable for the protection and propagation of aquatic life could be identified. Aquatic life in natural stream systems is subject to an inherently complex array of imperfectly understood relationships and conditions that serve to limit or promote life in lotic environments. The Service concluded that aquatic life in free flowing New England streams have evolved and adapted to naturally occurring chemical, physical and biological conditions, and that if these environmental conditions could be emulated, aquatic life would be sustained at a level commensurate with populations existing under similar natural environmental regimes."[3]
- Inflatable flashboard systems offer superior fish and aquatic habitat protection, and are often recommended by state and federal fishery agencies as a proven method of improving environmental performance of hydroelectric projects.
- The Crest Gate operational plan is depicted below:

[3] For a detailed description of Aquatic Base Flow in New England, please visit the following link: https://www.fws.gov/newengland/pdfs/Flowpolicy.pdf

Approx. Spillway Flow (cfs) †	Crest Gate Status	Target Pond Level (ft NGVD)	Unit Operation
0	Full elevation	92.2 ft (Normal pond)	Pond level control maintained at E. L. Field Powerhouse; additional flow passed through downtown canal system as necessary
0 - 3,250	Full elevation	Rising to ±93.2 ft	Full available output
3,250 – ±23,000 (est.)	Automatic pond level control	±93.2 ft	Full available output
±23,000 (est.) – 35,000 ††	Automatic pond level control if High Water Operations Protocol is not triggered.	±93.2 ft	Full available output
	Fully lowered if High Water Operations Protocol is triggered.	Pond level follows spillway rating curve based on spillway flow	Full available output
> 35,000	Fully lowered	Rises above 93.2 ft as spillway discharge increases	Full available output

Figure 11 - Lowell Crest Gate Operational Protocol

- Although the Owner is not required to operate in a strict run-of-river fashion, this operational mode likely ensures that the project meet's LIHI's definition of "true run-of-river:" *Outflow is within reasonable measurable accuracy (+/- 10%) of inflow, as measured on an hourly basis.* However, since a bypassed reach exists at the project and this Zone also contains other Agency Recommendations, we cannot qualify under A1 Not Applicable/De Minimis for this Standard, and A2 is used instead, with the most recent recommendation being the Crest Gate Operational Plan and the 1,990 cfs minimum flow requirement.

Explain how the recommendation relates to agency management goals and objectives for fish and wildlife.

- During the license amendment process for the Crest Gate installation, multiple fishery agencies reviewed and endorsed the proposal, in support of the agency's goal of protecting and improving anadromous fish passage on the Merrimack River:

  May 14, 2010: *"The proposed system would allow different sections of the dam crest to be lowered as river flows change. This type of system also allows rapid re-inflation after periods of high river flows, thereby avoiding delays to upstream fish passage posed by lost or damaged sections of wooden flashboards… the Division strongly endorses Enel's proposal to replace the existing wooden flashboards at the Lowell project with an inflatable crest-gate system."* (Caleb Slater, Massachusetts Division of Fisheries and Wildlife)

  June 22, 2010: *"Installation of the proposed crest gate system would maintain more consistent water levels, reduce water leakage from the dam, and minimize the need for impoundment drawdowns, all contributing to improved fish passage to their spawning habitat."* (Paul Diodati, Massachusetts Division of Marine Fisheries)

III.A.2 Ecological Flow Standard for Zone 4 (Canal System)

Table III-2. Information Required to Support Ecological Flows Standards

Criterion	*Standard*	*Instructions*
A	1	Not Applicable/De Minimis

Confirm the location of the powerhouse relative to other dam/diversion structures to establish that there are no bypassed reaches at the facility.

- See "Canal Description" on Page 5, and Canal Schematic in Appendix B. There are no bypassed reaches for any of the powerhouses.

If Run-of-River operation, provide details on how flows, water levels, and operation are monitored to ensure such an operational mode is maintained.

- There are no flow requirements for this portion of the project, which is essentially a conduit system. However, the Owner maintains an operating agreement with the NPS to allow tour boat operations to navigate the canal system. The Owner agreed to lower canal water levels approximately 6 inches during the May 15 to October 15 recreational season. Operations are maintained through a series of locks and gatehouses along the Canal System (see Appendix B.)
- There are no protocols or restrictions on maintenance work necessitating drawing down water levels in the canal system; however, the Owner has adopted the best management practice of notifying all impacted parties in advance of any planned canal drops.

In a conduit project, identify the water source and discharge points for the conduit system within which the hydropower plant is located.

- See Canal Schematic in Appendix B. The Assets, Bridge Street, John Street, and Hamilton power stations are housed within large nineteenth-century mill buildings sited along the 5.5-mile canal system. The Hamilton and Assets Power Stations draw water from the upper canal system and discharge to the lower canal system, whereas the Bridge Street and John Street Power Stations draw water from the lower canal system and discharge to the Merrimack River or the Concord River. The Hamilton Power Station draws water from the Hamilton Canal and discharges into the Lower Pawtucket Canal. The Assets Power Station draws water through an intake structure at the Merrimack Canal and discharges into the Lower Pawtucket Canal. The Bridge Street Power Station (also known as "Section 8") draws water from the Eastern Canal and discharges into the Concord River. The John Street Power Station also draws water from the Eastern Canal and discharges into the Merrimack River.

*For impoundment zones only, explain how fish and wildlife habitat within the zone is evaluated and managed – **NOTE:** this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion.*

- N/A – not an impoundment zone

III.B.1 Water Quality Standard for Zone 1 (Impoundment Zone)

Table III-3. Information Required to Support Water Quality Standards

Criterion	*Standard*	*Instructions*
B	2	Agency Recommendation

If facility is located on a Water Quality Limited river reach, provide an agency letter stating that the facility is not a cause of such limitation.

- This section of the Merrimack River (MA84A-01) is listed as impaired for Fish Consumption and Primary Contact Recreation. The 2014 Water Quality Assessment Status attributes this to atmospheric depositions, municipal discharge and urban-related runoff. The hydropower facility is not listed as a cause of this limitation.

Table 7 - MA84A-01 Impairment Data (EPA Waterbody Quality Assessment Report)

Designated Use Impairment	Cause of Impairment	Probable Source
Fish Consumption	Mercury in Fish Tissue	Atmospheric Deposition – Toxics Source Unknown
Primary Contact Recreation	Fecal Coliform	Combined Sewer Overflows Unspecified Urban Stormwater

Provide a copy of the most recent Water Quality Certificate, including the date of issuance

- The Water Quality Certificate was issued July 26, 1982 and per LIHI evaluation standards, is no longer relevant.

Identify any other agency recommendations related to water quality and explain their scientific or technical basis

- See responses for Flow Criteria in III(a), above.

Describe all compliance activities related to the water quality related agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations.

- There are no existing water quality related agency recommendations for the facility, other than the Flow requirements in III(a), above.

III.B.2 Water Quality Standard for Zones 2 (Bypassed Reach) and 3 (Downstream Reach)

On the EPA Water Quality Assessment Report, Zones 2 and 3 are assessed as one river reach from the Pawtucket Dam to the Duck Islands Wastewater Utility Outfall (MA84A-02). Although this section of the river does include "Hydromodification" as a probable source of impairment, MDEP confirmed the additional flow requirements agreed to by the USFWS and MDFW (see Appendix C,) should provide for adequate mitigation for this reach.

Table III-4. Information Required to Support Water Quality Standards

Criterion	*Standard*	*Instructions*
B	2	Agency Recommendation

If facility is located on a Water Quality Limited river reach, provide an agency letter stating that the facility is not a cause of such limitation.

- This section of the Merrimack River (MA84A-02) is listed as impaired for Fish Consumption, Primary Contact Recreation and Fish, Other Aquatic Life and Wildlife.

Table 8 - MA84A-02 Impairment Data (EPA Waterbody Quality Assessment Report

Designated Use Impairment	Cause of Impairment	Probable Source
Fish Consumption	Mercury in Fish Tissue	Atmospheric Deposition – Toxics Source Unknown
Primary Contact Recreation	Escherichia Coli (E. Coli)	Wet Weather Discharges (Municipal discharges/sewage)
Fish, Other Aquatic Life and Wildlife	Phosphorus, Total Low Flow Alterations	Municipal Point Source Discharges Unspecified Urban Stormwater Hydromodification

- As part of this LIHI Application, the Owner has agreed to fish passage enhancements which will provide increased flows into the bypassed reach Zone. MDEP provided a letter of support on March 27, 2017 stating that "*measures to enhance fish passage, such as those proposed for the Lowell Hydroelectric project, including fish lift and ladder improvements and operation of the passage facilities for increased lengths of time, will certainly be advantageous and are consistent with the goals of the Clean Water Act.*"
- We discussed the reviewer comments with Arthur Johnson from MDEP on May 31, 2017. He reiterated that, in his judgement, this gap measure will improve water quality and aquatic habitat by providing additional flow in the bypassed reach during passage season. Any additional site-specific studies and new measures will be considered during re-licensing. The existing impairment listing is due to an assessment completed in 1999, and removing this from the reported list of impairments would require a guarantee that a specific depth and amount of flow were provided into the bypassed reach, based on site-specific studies. In the meantime, he would defer to the fishery agencies on how this project impacts aquatic habitat. In this case, both USFWS and MDFW have agreed that this passage protocol will be sufficient to promote fish passage at the site in this interim

period, and that appears to satisfy MDEP as well.

Provide a copy of the most recent Water Quality Certificate, including the date of issuance

- The Water Quality Certificate was issued July 26, 1982 and amended July 27, 1983.

Identify any other agency recommendations related to water quality and explain their scientific or technical basis

- See responses for Flow Criteria in III(a), above.

Describe all compliance activities related to the water quality related agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations.

- There are no existing water quality related agency recommendations for the facility, other than the Flow requirements in III(a), above.

III.B.2 Water Quality Standard for Zone 4 (Canal System)

On the EPA Water Quality Assessment Report, Zones 4 is impaired for Fish Consumption. No probable sources of impairments are attributable to the existence of the hydropower facility.

Table III-4. Information Required to Support Water Quality Standards

Criterion	*Standard*	*Instructions*
B	2	Agency Recommendation

If facility is located on a Water Quality Limited river reach, provide an agency letter stating that the facility is not a cause of such limitation.

- This section of the Merrimack River (MA84A-29) is listed as impaired for Fish Consumption, Primary Contact Recreation and Fish, Other Aquatic Life and Wildlife. No causes of this impairment are attributed to the hydropower facility.

Table 9 - MA84A-29 Impairment Data (EPA Waterbody Quality Assessment Report)

Designated Use Impairment	Cause of Impairment	Probable Source
Fish Consumption	DDT Lead Mercury in Fish Tissue PCB(s) in Fish Tissue	Atmospheric Deposition – Toxics Source Unknown

Provide a copy of the most recent Water Quality Certificate, including the date of issuance

- The revised Water Quality Certificate was issued July 27, 1983 and per LIHI evaluation standards, is no longer relevant.

Identify any other agency recommendations related to water quality and explain their scientific or technical basis

- None

Describe all compliance activities related to the water quality related agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations.

- There are no existing water quality related agency recommendations for the facility, other than the Flow requirements in III(a), above.

III.C.1 Upstream Fish Passage Standard for Zone 1

Table III-5. Information Required to Support Upstream Fish Passage

Criterion	*Standard*	*Instructions*
C	1	Not Applicable/ De Minimis Effect

Explain why the facility does not impose a barrier to upstream fish passage in the designated zone.

- There are no upstream fish passage requirements as this is an impoundment Zone; see Zone 2 for upstream fish passage requirements at the dam and powerhouse.

Document available fish distribution data and the lack of migratory fish species in the vicinity.

- Diadromous fish species present in the Merrimack River include Atlantic salmon, American shad, river herring and American eel. Management of these species and efforts to restore populations is the responsibility of the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin ("Technical Committee"), an interagency committee. Efforts to restore Atlantic salmon were abandoned in 2013 for the Merrimack River, after consistently low return numbers were observed. Efforts shifted towards the restoration of the remaining fish species, notably herring and shad. In 2016, record number of herring (since the establishment of the restoration efforts,) were observed at the Amoskeag Dam, upstream of the Lowell project. The returns have been so successful that efforts to bring herring over the fish ladder at the Amoskeag Dam overwhelmed the trap and truck operation in 2016[4].

If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

- N/A – impoundment zone. See Zones 2-3 for further information.

[4] http://www.concordmonitor.com/fish-stocking-2127105

III.C.2 Upstream Fish Passage Standard for Zone 2 (Bypassed Reach)

Table III-6. Information Required to Support Upstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
C	2	Agency Recommendations

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- The most recent agency recommendation is provided in Appendix C of this Application. In support of LIHI certification, USFWS and MDFW requested that the Owner make certain enhancements to the design and operation of the fish lift system and spillway fish ladder. These include tailrace rock excavation, American Eel passage improvements, and operation of the fish ladder for the entire duration of the anadromous fish upstream passage season. USFWS and MDFW both noted in their comment letters that with these commitments, they support this application for LIHI Certification of the Lowell Facility.
    - Design of the tailrace rock excavation leading to fishway entrance is to occur in 2016 with ledge removal in summer 2017, ready for the 2018 passage season. In the interim period, three 12' diversion/guidance panels (40' LOA with attachment panel) were installed in the Lowell tailrace to guide fish into the lift system entrance. The panels will be discontinued when excavation is complete or upon concurrence of the Technical Committee.
- Fish passage operations are coordinated with the Technical Committee. Boott has made significant improvements to the upstream fish passage system to increase effectiveness over the past 10 years. All fish passage facilities were designed in consultation with the U.S. Fish and Wildlife Service. Passage operations are supervised by the Technical Committee.
- Upstream and downstream fish passage facilities include a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam.
- The reinforced concrete fish ladder at the Pawtucket Dam is designed to allow for controlled fish passage at river flows up to 25,000 cfs. The fishway operates at 500 cfs, including attraction flow. The fish ladder is a vertical slot design with 13-foot-wide by 10-foot-long pools. A counting station and fish trap area is provided. The Pawtucket Dam has been modified by removing ashlar masonry to allow the exit channel to penetrate the dam.

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- Fish passage operations are coordinated with the Technical Committee. All fish passage facilities were designed in consultation with the U.S. Fish and Wildlife Service. Passage operations are supervised by the state and federal fishery agencies. Throughout the project's history, agency recommendations and the basis for those decisions have evolved. The most recent recommendations and technical basis can be found in the annual Post-Season Updates. Additional studies completed pertaining to fish passage at the site include:

- Comprehensive Fish Passage Plan (March 10, 2000) – This plan includes details of operational measures to be undertaken by the Owner to protect upstream and downstream migrating anadromous fish. In summary, the Owner is required to operate both the fish ladder and the fish lift daily during spring of each year when a cumulative of 50 American Shad or 200 River Herring are passed at the downstream Lawrence Project. In addition, the Owner is required to operate the downstream bypass facility from April 1 through July 15 and from September 1 through November 15. FERC noted in their Order approving the CFPP (November 28, 2000):

  "The plan is based on studies conducted and experience gained at the project since the installation of the project's fish lift and fish bypass facilities. The plan was developed in consultation with the resource agencies, and many of the agencies' recommendations have been incorporated into the plan."

- Downstream Smolt Passage Study Report (November 27, 2001) – The 2001 study assessed the survival for smolts during downstream migration, and indicated that smolt bypass usage during downstream migration averaged 32% over three flow settings tested, and overall survival for all smolts choosing turbine passage could approach 100%.

Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- The Owner is required to provide annual Post-Season Updates to the Technical Committee – a link to the most recent report (2016) is included in Appendix C.
- The Owner supports upstream and downstream eel passage studies, working with USFWS and the University of Massachusetts, Amherst. In 2016, the Owner purchased a new telemetry receiver for additional USFWS monitoring, and three sites are currently being monitored to assess downstream eel passage.
- During the ladder operating period arranged with the Technical Committee, Boott Hydropower staff installed a SalmonSoft camera recording system at the Lowell ladder. Because it was the only count estimate for this location, records from this camera were processed as a priority, with the assistance of USFWS. A draft report of ladder count results was prepared by USFWS and distributed on August 31, 2016. A major, recurring problem with camera use at the ladder in 2016 was missing data, almost entirely caused by power interruptions. The solar power source will be replaced with full AC power supply as part of the crest gate installation, scheduled for completion in 2017. The AC power supply and data accessibility (through internet or other) are expected to yield much better reliability and count assessment of passage at the ladder.

III.C.2 Upstream Fish Passage Standard for Zone 3 (Downstream Reach)

Table III-6. Information Required to Support Upstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
C	2	Agency Recommendations

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- All answers are substantially the same as Zone 2 – Bypassed Reach

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- All answers are substantially the same as Zone 2 – Bypassed Reach

Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- All answers are substantially the same as Zone 2 – Bypassed Reach

III.C.2 Upstream Fish Passage Standard for Zone 4 (Canal System)

Table III-6. Information Required to Support Upstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
C	1	Not Applicable – De Minimis

Explain why the facility does not impose a barrier to upstream fish passage in the designated zone.

- N/A – No Resource Agency Recommendations for fish passage were made related to the canal system. Fish are capable of bypassing the entire canal system via the Merrimack River and use the existing upstream and downstream fish passage facilities at the Pawtucket Dam and EL Field Powerhouse.

Document available fish distribution data and the lack of migratory fish species in the vicinity.

- There is no available fish distribution data for the canal system.

If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

- N/A

III.D.1 Downstream Fish Passage and Protection Standards for Zone 1 (Impoundment)

Table III-7. Information Required to Support Downstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
D	2	Agency Recommendation

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- Downstream fish passage facilities consist of the downstream fish bypass at the E.L. Field powerhouse, which operates seasonally during passage season each year.
- Fish passage operations are coordinated with the Technical Committee. All fish passage facilities were designed in consultation with the U.S. Fish and Wildlife Service. Passage operations are supervised by the state and federal fishery agencies. Throughout the project's history, agency recommendations and the basis for those decisions have evolved. The most recent recommendations and technical basis can be found in the annual Post-Season Updates. Additional studies completed pertaining to fish passage at the site include:
- Comprehensive Fish Passage Plan (March 10, 2000) – This plan includes details of operational measures to be undertaken by the Owner to protect upstream and downstream migrating anadromous fish. In summary, the Owner is required to operate both the fish ladder and the fish lift daily during spring of each year when a cumulative of 50 American Shad or 200 River Herring are passed at the downstream Lawrence Project. In addition, the Owner is required to operate the downstream bypass facility from April 1 through July 15 and from September 1 through November 15. FERC noted in their Order approving the CFPP (November 28, 2000):

  "The plan is based on studies conducted and experience gained at the project since the installation of the project's fish lift and fish bypass facilities. The plan was developed in consultation with the resource agencies, and many of the agencies' recommendations have been incorporated into the plan."

- Downstream Smolt Passage Study Report (November 27, 2001) – The 2001 study assessed the survival for smolts during downstream migration, and indicated that smolt bypass usage during downstream migration averaged 32% over three flow settings tested, and overall survival for all smolts choosing turbine passage could approach 100%.

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- Significant studies were conducted in preparation of the Comprehensive Fish Passage Plan and subsequent recommendations, including:
- *Passage of Radio-Tagged American Shad Through the Northern Canal Headgate Structure Lowell Hydroelectric Project, Lowell, Massachusetts* (RMC Environmental Services, November 1988)
- *An Assessment of the Effectiveness of a Bypass Sluiceway for passing Downstream Migrating Atlantic Salmon Smolts and Estimated Survival for Salmon Smolts Passed*

Through the 8.6-MW Kaplan Turbines at the E.L. Field Powerhouse, Lowell, Massachusetts (NAI, March 1991)

- *Downstream Passage Routes of Radio-Tagged Adult American Shad at the Lowell Hydroelectric Project on the Merrimack River, Lowell, Massachusetts* (NAI, March 1991)
- *An Assessment of the Effectiveness of a Fish Bypass for Passing Juvenile Alewives at the Lowell Hydroelectric Project, Lowell, Massachusetts* (NAI, April 1991)
- *Use of the Fish Bypass at the Lowell Hydroelectric Facility During Fall 1993* (NAI, September 1994)
- *Use of the Fish Bypass by Juvenile Clupeids at the Lowell Hydroelectric Project During Fall 1994* (NAI, December 1995)
- *Downstream Passage Routes of Radio-Tagged Atlantic Salmon Smolts at the Lowell and Lawrence Hydroelectric Projects on the Merrimack River* (NAI, February 1996)

Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- Boott Hydropower is required to provide annual Post-Season Updates to the Technical Committee – a link to the most recent report (2016) is included in Appendix C.
- The Owner supports upstream and downstream eel passage studies, working with USFWS and the University of Massachusetts, Amherst. In 2016, the Owner purchased a new telemetry receiver for additional USFWS monitoring, and three sites are currently being monitored to assess downstream eel passage.

III.D.2 Downstream Fish Passage and Protection Standards for Zone 2 (Bypassed Reach)

Table III-8. Information Required to Support Downstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
D	2	Agency Recommendations

Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).

- All answers are substantially the same as Zone 1 – Impoundment

Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.

- All answers are substantially the same as Zone 1 – Impoundment

Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- All answers are substantially the same as Zone 1 – Impoundment

III.D.2 Downstream Fish Passage and Protection Standards for Zone 3 (Downstream Reach)

Table III-8. Information Required to Support Downstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
D	1	Not Applicable/De Minimis

Explain why the facility does not impose a barrier to downstream fish passage in the designated zone.

- N/A – downstream reach zone. The next barrier to downstream fish passage is the Lawrence Hydroelectric Facility (LIHI #121), which also has downstream fish passage

Document available fish distribution data and the lack of migratory fish species in the vicinity.

- N/A – downstream reach zone

If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

- N/A – downstream reach zone

III.D.2 Downstream Fish Passage and Protection Standards for Zone 4 (Canal System)

Table III-8. Information Required to Support Downstream Fish Passage Standards

Criterion	*Standard*	*Instructions*
D	1	Not Applicable/ De Minimis Effect

Explain why the facility does not impose a barrier to downstream fish passage in the designated zone.

- N/A – No Resource Agency Recommendations for fish passage were made related to the canal system. Fish are capable of bypassing the entire canal system via the Merrimack River and use the existing upstream and downstream fish passage facilities at the Pawtucket Dam and EL Field Powerhouse. There are no exclusionary measures at the entrance of the canal system.
- In the Comprehensive Fish Passage Plan, the Owner includes an operational protocol to pass additional flows through the canal system in the rare instance where the Northern Canal needs to be dewatered to conduct repairs or maintenance on the main powerhouse during downstream fish passage season.

Document available fish distribution data and the lack of migratory fish species in the vicinity.

- There is no available fish distribution data for the canal system.

If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

- N/A

III.E.1 Shoreline and Watershed Protection Standards for Zone 1 (Impoundment)

At Normal Pool, there are 36 shoreline miles for the reservoir impounded by the Pawtucket Dam. 13% of this shoreline is available for public use. The project does not own this land, nor are there any existing requirements for Shoreline and Watershed Protection other than Standard Article 41 to remove dead trees on the periphery of the project.

Per reviewer request, we are attaching FERC Exhibit G – Project Area, with this submission.

Table III-9. Information Required to Support Shoreline and Watershed Protection Standards

Criterion	*Standard*	*Instructions*
E	2[5]	Agency Recommendation

Provide copies or links to any agency recommendations or management plans that are in effect related to protection, mitigation, or enhancement of shoreline surrounding the facility.

- Article 41 requires the Licensee to clear and keep clear lands along open conduits and dispose of material unnecessary for the purpose of the project which results from project operations. Also, all trees along periphery of project reservoirs that die during operations of the project are required to be removed. This is the only existing agency recommendation pertaining to the Shoreline and Watershed Protection Standard.

Provide documentation that indicates the facility is in full compliance with any agency recommendations or management plans that are in effect.

- The Owner frequently provides volunteer services to help clean up parks and playgrounds around the Merrimack Valley. For example, on October 16, 2016 more than 160 EGPNA employees volunteered with Groundwork Lawrence and other community groups to clean up the Lowell National Historic Park and remove debris from the Merrimack River.

[5] The Reviewer suggested this could be changed to Standard 1 – Not applicable/De Minimis. However, since it is difficult to quantify the ecological value of the extensive shoreline area around the impoundment, we do not feel this is appropriate here.

III.E.2 Shoreline and Watershed Protection Standards for Zone 2 (Bypassed Reach), Zone 3 (Downstream Reach), and Zone 4 (Canal System)

Zones 2, 3 and 4 are located in a heavily urban area in downtown Lowell, MA. There is limited ecological value associated with this land, and the only requirement pertinent to this Criterion is Standard Article 41, as described in Zone 1 above.

Table III-10. Information Required to Support Shoreline and Watershed Protection Standards

Criterion	*Standard*	*Instructions*
E	1	Not Applicable/De Minimis Effect

If there are no lands with significant ecological value associated with the facility, document and justify this (e.g., describe the land use and land cover within the project boundary)

- Zones 2-4 are located in a densely urban setting that runs through downtown Lowell, Massachusetts – see Canal schematic in Appendix B.

Document that there have been no Shoreline Management Plans or similar protection requirements for the facility

- There are no Shoreline Management Plans for these Zones.

III.F.1. Threatened and Endangered Species Standards for all Zones

In all cases, the applicant shall identify all listed species in the facility area based on current data from the appropriate state and federal natural resource management agencies.

Table III-11. Information Required to Support Threatened and Endangered Species Standards

Criterion	*Standard*	*Instructions*
F	2	Finding of No Negative Effects

Identify all listed species in the facility area based on current data from the appropriate state and federal natural resource management agencies.

- The project was mapped on OLIVER, the Massachusetts Natural Heritage and Endangered Species Program GIS software to determine any locations of threatened or endangered species. The program returned identical results for Priority Habitat (Code PH 1321, Bald Eagle) for the downstream Lawrence Hydroelectric Facility. We therefore rely on the same determination for this project.
- The Bald Eagle is a Threatened Species in Massachusetts, based on the most recent listing on MDFW[6].
- Northern Long-eared Bat is a Federally-listed Species that occurs in Massachusetts.

Provide documentation of a finding of no negative effect of the facility on any listed species in the area from an appropriate natural resource management agency

Based off previous conversations with resource agency officials, the ongoing operation of a hydropower project does not pose any likely threat to the existence of the Bald Eagle or Northern Long-eared Bat, as long as no new habitat modification/tree-cutting is planned. No new work is planned that could disrupt habitat. No tree cutting occurs in the reservoir or downstream reach.

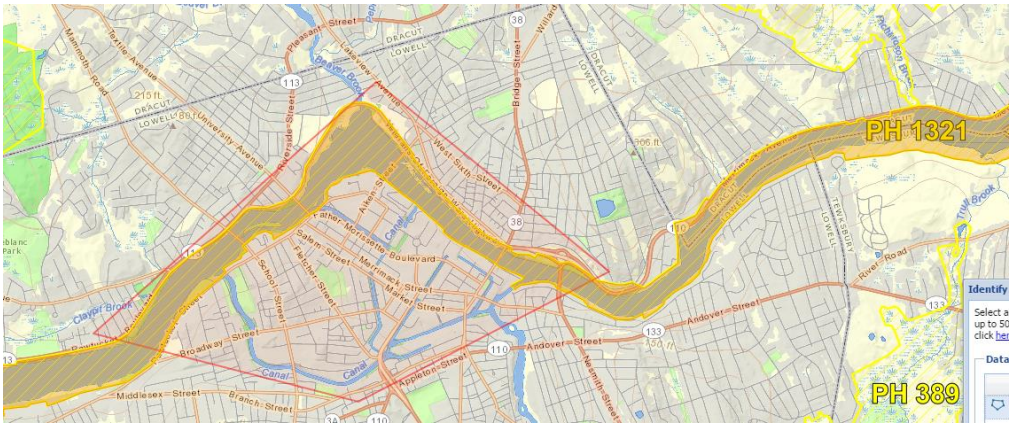


Figure 12 - OLIVER Mapping of Lowell Project (PH1321 = Bald Eagle)

[6] http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/haliaeetus-leucocephalus.pdf

III.G.1 Cultural and Historic Resources Standards for Zones 1, 2, and 3 (identical response applies to all zones)

The Lowell Hydroelectric Facility is located in downtown Lowell, with several historic features that symbolize the early Industrial Revolution. In 1978, Congress passed the Lowell Act, which recognized the historical value of this area and established the Lowell Park and Lowell Historic Preservation District. In Zones 1-3, the primary historic features impacted by this project pertain to the Pawtucket Dam and the Northern Canal.

Table III-13. Information Required to Support Cultural and Historic Resources Standards

Criterion	Standard	Instructions
G	2	Approved Plan

Provide documentation of all approved state, provincial, federal, and recognized tribal plans for the protection, enhancement, and mitigation of impacts to cultural and historic resources affected by the facility.

- The Lowell Act, passed by Congress in 1978. According to the Lowell Act:
- *"No Federal entity may issue any license or permit to any person to conduct an activity within the park or preservation district unless such entity determines that the proposed activity . . . will not have an adverse effect on the resources of the park or preservation district."*

Document that the facility is in compliance with all such plans.

- During Licensing, the New Hampshire State Historic Preservation Officer determined the proposed project would not affect significant historic and archeological resources located on upstream portions of the Merrimack River in New Hampshire.
- Following extensive consultations with the Massachusetts State Historic Preservation Office and the National Park Service, numerous changes to the project plans were made to avoid destroying historic Waste Gates on the Northern Canal and to fund repairs to the Northern Canal Gates to restore them to their original condition. The proposed powerhouse was relocated, and fish passage facilities were modified to avoid any impacts to the Northern Canal Gatehouse. In addition, the Owner constructed a new set of locks in the Northern Canal to provide boat passage, to avoid any loss of historic use of the canal system. Furthermore, additional mitigative measures were undertaken by the Owner to minimize impacts of new structures introduced into the historic district. These included historic and engineering research and data collection, physical modifications, including reconstructed walkways along the Northern Canal, landscaping treatments to revegetate disturbed areas with native plants, and placement of transmission lines in inconspicuous or underground locations. Massachusetts SHPO concluded the proposed would result in no adverse effect on the Historic District provided their continued involvement in design and implementation of the project.
- As noted in Flows Criterion above, the Lowell Project's pneumatic crest gates alleviate backwater effects in the impoundment Zone, and enhance project operational control and generation. FERC found the installation would provide significant advantages for other resources that are dependent on water levels, including flood control, recreation,

and fish passage, and the fishery agencies endorsed the proposal. The National Park Service opposed the installation, citing the Lowell Act and stating the proposal would result in an adverse effect on the Dam by removing a feature of the Dam (the pre-existing flashboards,) which they believed to be an integral part of the Dam's historic engineering and structure. The Owner modified its proposal to mitigate these impacts, and over the course of the next three years consulted with the local authorities and federal resource agencies to arrive at an acceptable solution. During this time, FERC conducted an analysis of the project and issued an Environmental Assessment on December 19, 2011, which found the proposed amendment would result in long-term beneficial effects of the project. On April 18, 2013, FERC granted the proposed amendment, citing the proposed installation would:

  - provide the most reliable and complete attenuation of the backwater effect that results from high flows;
  - increase worker safety since workers would no longer have to approach the dam in boats, often during high flow periods in order to replace the flashboards;
  - improve fish passage at the site;
  - help maintain a consistent impoundment level that would benefit two utilities that use the impoundment as a source for water supply;
  - allow the project to generate more clean energy because the gates could be reinflated relatively soon after high flows as opposed to waiting for the flashboards to be replaced through a process that took months; and
  - provide a more stable reservoir elevation

- FERC furthermore cited that the proposed installation would not have an adverse effect on the Dam, and thus not violate the Lowell Act, and that the proposal would not be inconsistent with Lowell Park's Preservation Standards. Specifically, FERC stated: "the proposed action would not adversely affect the dam and the Historic District." This is for two primary reasons:
  - The flashboards that were to be replaced were not part of the "original" dam design. They were added to the dam well after construction and had been modified repeatedly over time, as a temporary crest control structure.
  - The required alterations to the crest gate to mimic the appearance of the original flashboards along with interpretive exhibits explaining the original flashboard system and the modern pneumatic crest gate system would mitigate any negative effects of replacing the flashboards. FERC noted that this same approach was taken (and agreed to by Department of Interior,) when a fishway was placed with a modern fish ladder in the 1980s.
- DOI petitioned for this decision to be reviewed on November 18, 2013. In a comprehensive Circuit Court Ruling issued February 12, 2015,, the First Circuit Court of Appeals confirmed FERC's decision and determined that the DOI had incorrectly applied the Lowell Act[7].

[7] Petition Denied; United States Court of Appeals for the First Circuit, U.S. Department of the Interior v. Federal Energy Regulatory Commission, Case No. 13-2439 (February 12, 2015)

- Given both FERC's decision and the Circuit Court Ruling, it is clear that the installation of the pneumatic crest gate is in compliance with plans that protect the cultural and historic resources in the area, specifically the Lowell Act of 1978 and the National Historic Preservation Act of 1966.

III.G.1 Cultural and Historic Resources Standards for Zone 4 (Canal System)

The Pawtucket Canal System was initially constructed in 1796, as a system to bypass the Pawtucket Falls and facilitate the transportation of timber and agricultural products from New Hampshire to the Atlantic Ocean. As the textile industry emerged in the early 1800s, the canal system was expanded and numerous mills were constructed along the canal system, harnessing the flow of water to provide electrical and mechanical power for operations. The National Park Service currently offers historical boat tours of the canal system, and the Owner facilitates this through an operating agreement.

Table III-13. Information Required to Support Cultural and Historic Resources Standards

Criterion	Standard	Instructions
G	2	

Provide documentation of all approved state, provincial, federal, and recognized tribal plans for the protection, enhancement, and mitigation of impacts to cultural and historic resources affected by the facility.

- The Lowell Act, passed by Congress in 1978. According to the Lowell Act:

  "No Federal entity may issue any license or permit to any person to conduct an activity within the park or preservation district unless such entity determines that the proposed activity . . . will not have an adverse effect on the resources of the park or preservation district."

Document that the facility is in compliance with all such plans

- FERC determined both during original construction and subsequent modifications that the facility has "no adverse effect on the Locks and Canals Historic District." License Article 33 includes specific mitigative measures agreed to by the Massachusetts SHPO and the Advisory Council on Historic Preservation.

III.H.2 Recreational Resources Standards for all Zones

During FERC Licensing, the Owner was required to provide numerous recreational enhancements to the project site, as described below.) The urban downtown location of the powerhouse and canal system draws many visitors per year, and the Owner is in full compliance with all recreational requirements in the FERC license, in addition to reporting requirements for non-project facilities in the annual Form 80.

Table B-16. Information Required to Support Recreational Resources Standards

Criterion	Standard	Instructions
H	2	Agency Recommendation

Document any comprehensive resource agency recommendations and enforceable recreation plan that is in place for recreational access or accommodations.

- Article 38 requires the Owner to file a revised Report on Recreational Resources containing functional plans, site development costs and schedules for the following recreational facilities at the site: (1) a navigation lock at the Northern Canal control structure; (2) a visitor facility at the powerhouse; (3) restoration of portions of the Northern Canal Walkway near the powerhouse; and (4) repair the Northern Canal gates. The report also included a canal system water elevation maintenance plan to allow the NPS to operate tour bouts to navigate the lower canal system. The Owner agreed to lower canal water levels approximately 6 inches during the May 15 to October 15 recreational season.

Document that the facility is in compliance with all such recommendations and plans.

- The above plan was filed on April 16, 1984 and approved on September 10, 1984 (see Appendix)
- The installation of the crest gate system improves recreational access to the impoundment waters upstream of the Pawtucket Dam. In particular, one shallow stretch of the Merrimack River in the vicinity of Nashua, NH risked boats running aground or otherwise damaging their motors when the reservoir was previously drawn down for flashboard repairs. The new crest gate is operated in accordance with a plan developed with the Town of Lowell, resource agencies and FERC to promote a stable reservoir level.
- The Owner files FERC 80 Recreation Reports for activity in the project area. This includes monitoring the following recreational areas: (1) Bank fishing area on the outside of the river bend downstream of ELF; (2) Lowell Boat Club (private boat club on right bank adjacent to the entrance to the Pawtucket Canal); Sheehy Park next to boat club; Lowell Heritage State Park / U. Lowell boat house (left bank upstream of dam) and the Visitors' Center. In 2014 reporting year, these facilities included 43,687 visitors.

PART IV. SWORN STATEMENT AND WAIVER

As an Authorized Representative of Boott Hydropower, LLC, the Undersigned attests that the material presented in the application is true and complete.

The Undersigned acknowledges that the primary goal of the Low Impact Hydropower Institute's Certification Program is public benefit, and that the LIHI Governing Board and its agents are not responsible for financial or other private consequences of its certification decisions.

The undersigned further acknowledges that if certification of the applying facility is issued, the LIHI Certification Mark License Agreement must be executed prior to marketing the electricity product as LIHI Certified.

The undersigned Applicant further agrees to hold the Low Impact Hydropower Institute, the Governing Board and its agents harmless for any decision rendered on this or other applications, from any consequences of disclosing or publishing any submitted certification application materials to the public, or on any other action pursuant to the Low Impact Hydropower Institute's Certification Program.

Company Name: Boott Hydropower, LLC

Authorized Representative

Name: _____

Title _____

State of _____)

County of _____)

On this, the_____day of _____, 20____, before me a notary public, the undersigned officer, personally appeared_____, known to me (or satisfactorily proven) to be the person whose name is subscribed to the within instrument, and acknowledged that he executed the same for the purposes therein contained. In witness hereof, I hereunto set my hand and official seal.

Notary Public _____

PART V. CONTACTS

1. Facility Contacts

Project Owner:	
Name and Title	Randald Bartlett, Northeast Operations Manager
Company	Boott Hydropower, LLC
Phone	352-812-1984
Email Address	Randald.Bartlett@Enel.com
Mailing Address	100 Brickstone Square, Suite 300, Andover, MA 01810
Project Operator (if different from Owner):	
Name and Title	
Company	
Phone	
Email Address	
Mailing Address	
Consulting Firm / Agent for LIHI Program (if different from above):	
Name and Title	Peter Drown, President
Company	Cleantech Analytics LLC
Phone	(207) 951-3042
Email Address	Peter.drown@cleantechanalytics.com
Mailing Address	6717 Cub Run Court, Centreville, VA 20121
Compliance Contact (responsible for LIHI Program requirements):	
Name and Title	Kevin Webb, Hydro Licensing Manager
Company	Boott Hydropower, LLC
Phone	978-935-6039
Email Address	Kevin.Webb@Enel.com
Mailing Address	100 Brickstone Square, Suite 300, Andover, MA 01810
Party responsible for accounts payable:	
Name and Title	Accounts Payable
Company	Enel Green Power North America, Inc.
Phone	978-681-1900
Email Address	Accounts.Payable@enel.com
Mailing Address	100 Brickstone Square, Suite 300, Andover, MA 01810

2. Current state, federal, provincial, and tribal resource agency contacts.

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	U.S. Fish and Wildlife Service
Name and Title	John Warner
Phone	Assistant Supervisor Federal Activities
Email address	John_Warner@fws.gov
Mailing Address	

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	Massachusetts Department of Fish and Wildlife
Name and Title	Caleb Slater, Anadromous Fish Project Leader
Phone	(508) 389-6331
Email address	Caleb.Slater@state.ma.us
Mailing Address	

Agency Contact (Check area of responsibility: Flows__, Water Quality _X_, Fish/Wildlife Resources __, Watersheds _X_, T/E Spp. ____, Cultural/Historic Resources __, Recreation __):	
Agency Name	Massachusetts Department of Environmental Protection
Name and Title	Arthur Johnson, Environmental Monitoring
Phone	(508) 767-2873
Email address	Arthur.johnson@state.ma.us
Mailing Address	

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	
Name and Title	
Phone	
Email address	
Mailing Address	

Appendix A. Turbine/Generator Data[8]

Turbine

Powerhouse	Unit #	Type	Size Inches	Speed RPM	Net Head Feet	Flow Rate cfs	Power HP
E. L. Field	1	Fuji Horizontal Full Kaplan	152.4	120	39	3,300	11,540 †
E. L. Field	2	Fuji Horizontal Full Kaplan	152.4	120	39	3,300	11,540 †
Assets	1	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444
Assets	2	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444
Assets	3	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444
Bridge Street	4	Hercules Type D Single Runner	42	138.5	22	333	655
Bridge Street	5	Hercules Type D Single Runner	42	138.5	22	333	655
Bridge Street	6	Hercules Type D Single Runner	42	138.5	22	333	655
Hamilton	1	Leffel Type Z Single Runner	45	120	13	374	459
Hamilton	2	Leffel Type Z Single Runner	39	133	13	279	341
Hamilton	3	Leffel Type Z Single Runner	36	150	13	237	287
Hamilton	4	Leffel Type Z Single Runner	45	120	13	374	459
Hamilton	5	Leffel Type Z Single Runner	45	120	13	374	459
John Street	3	Leffel Single Runner	33	200	21	250	482
John Street	4	Leffel Single Runner	33	200	21	250	482
John Street	5	Leffel Single Runner	33	200	21	250	482
John Street	6	Allis Chalmers Single Runner	72	100	21	1,000	1,925

Generator

Powerhouse	Unit #	Type	Power kW	Voltage Volts	Speed RPM
E.L. Field	1	Fuji Electric	7,506 ††	4,160	120
E.L. Field	2	Fuji Electric	7,506 ††	4,160	120
Assets	1	General Electric Type ATB 48-332-150	265	600	150
Assets	2	General Electric Type ATB 48-332-150	265	600	150
Assets	3	General Electric Type ATB 48-332-150	265	600	150
Bridge Street	4	General Electric Co. Type ATB	360	600	138.5
Bridge Street	5	General Electric Co. Type ATB	360	600	138.5
Bridge Street	6	General Electric Co. Type ATB	360	600	138.5
Hamilton	1	Westinghouse Electric Co.	280	600	120
Hamilton	2	Electric Machinery Co.	190	600	133
Hamilton	3	Electric Machinery Co.	160	600	150
Hamilton	4	Electric Machinery Corporation	280	600	120
Hamilton	5	Electric Machinery Corporation	280	600	120
John Street	3	General Electric Co. Type ATI	300	600	200
John Street	4	General Electric Co. Type ATI	300	600	200
John Street	5	General Electric Co. Type ATI	300	600	200
John Street	6	Allis-Chalmers Type AV	1,200	600	100

[8] On March 16, 2017 Boott Hydropower filed an Application for Amendment of License seeking the removal of four non-operational units at the Bridge Street powerhouse from the project license. The application is still pending before the FERC. The table above reflects the project status after FERC approves Boott Hydropower's application.

Appendix B. Lowell Project Canal Schematic

Appendix C. Supporting Documentation by Criterion

Criterion A – Flows

FERC Order Approving Crest Gate Operations Plan (03/30/2015)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13819726

Lowell Officials Strike Deal on Pawtucket Dam Gate (04/24/2014)

http://www.lowellsun.com/todaysheadlines/ci_25620047/lowell-officials-strike-deal-pawtucket-dam-gate

Crest Gate Operations Plan (07/30/2014)https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13604588FERC Order Approving Crest Gate Installation (03/30/2015)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13819726FERC Order Approving New Minimum Flows (11/27/1984)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13719603

FERC Original License (04/13/1983)

https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13583777

Criterion B Water Quality

See 'Flows' Criterion links above

Zone 1 Waterbody Quality Assessment Report

https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=MA84A-01&p_list_id=MA84A-01&p_cycle=2014

Zone 2 Waterbody Quality Assessment Report

https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=MA84A-02&p_list_id=MA84A-02&p_cycle=2014

Zone 3 Waterbody Quality Assessment Report

https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=MA84A-02&p_list_id=MA84A-02&p_cycle=2014

Zone 4 Waterbody Quality Assessment Report

https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=MA84A-29&p_list_id=MA84A-29&p_cycle=2014

MDEP Letter on Water Quality Impacts of Fish Passage Enhancements (03/27/2017)

See Next Page

Gmail **Peter Drown <peter.drown@gmail.com>**

F&W Letter for concurrence

Johnson, Arthur (DEP) <Arthur.Johnson@massmail.state.ma.us> Mon, Mar 27, 2017 at 3:38 PM
To: Peter Drown <peter.drown@cleantechanalytics.com>
Cc: "Kubit, Robert (DEP)" <robert.kubit@state.ma.us>, "Groff, Kimberly (DEP)" <kimberly.groff@state.ma.us>

Hi Peter – Thank you for the opportunity to discuss with you the proposed enhancement of fish passage at the Boott Hydro facility at Pawtucket Dam in Lowell, MA. As I indicated to you on the phone, a segment of the Merrimack River directly downstream from Pawtucket Falls has been listed on the Massachusetts Integrated List of Waters as impaired by low-flow alterations since 2002. This was in response to MADEP's 1999 water quality assessment of the Merrimack River Watershed which found that a 0.7-mile bypass reach of the Merrimack River (Pawtucket Falls) is periodically dewatered during low-flow conditions. Therefore, measures to enhance fish passage, such as those proposed for the Lowell Hydroelectric project, including fish lift and ladder improvements and operation of the passage facilities for increased lengths of time, will certainly be advantageous and are consistent with the goals of the Clean Water Act. Please let me know if you have any questions. Thank you for the opportunity to comment on this project.

Art Johnson

Arthur S. Johnson

Massachusetts Department of Environmental Protection

DWM Environmental Monitoring Program

8 New Bond Street

Worcester, MA 01606

Phone: (508) 767-2873

FAX: (508) 791-4131

arthur.johnson@state.ma.us

Criterion C & D – Upstream and Downstream Fish Passage

2016 Fish Passage Post-Season Update (11/30/2016)

https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14392108

Order Modifying and Approving Fish Passage Plan (11/28/2000)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=8020994

Comprehensive Fish Passage Plan (03/09/2000)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=8082870

USFWS and MDFW Letters Supporting LIHI Certification (see next page)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
http://www.fws.gov/newengland

REF: Lowell Hydroelectric Project - FERC No. 2790 March 24, 2017

Mr. Randald Bartlett, P.E.
ENEL Green Power North America, Inc.
100 Brickstone Square, Suite 300
Andover, MA 01810

Dear Mr. Bartlett:

This letter refers to upstream fish passage at your Lowell Hydroelectric Project, located on the Merrimack River in Lowell, Massachusetts.

The Fish and Wildlife Service (Service) has been working with ENEL Green Power, North America (ENEL), parent company of the project licensee, Boott Hydro, for many years to address upstream fish passage performance at the Lowell Project. ENEL has made significant efforts in recent years to address passage questions and problems. Progress has been made on improved fish lift operations protocols, fish lift entrance evaluations, and fish ladder repairs and maintenance. However, the Service and other fisheries agencies have indicated in prior meetings and correspondence that additional measures are necessary at both the tailrace fish lift and spillway fish ladder in order to achieve adequate American shad and river herring passage effectiveness.

In a telephone conversation on January 27, 2017 with John Warner of my staff, you indicated that Boott Hydropower is seeking a Low Impact Hydropower Institute (LIHI) Certification for the Lowell Project. As part of the application for LIHI Certification, Boott Hydro is proposing to commit to implementing additional fish passage measures at the project to address agency concerns.

In addition to ENEL's current commitments to evaluations of and modifications to the fish lift system, including tailrace rock excavation and American eel passage improvements, outlined in letters from ENEL dated March 21, 2016 and November 3, 2016, and minutes of an October 20, 2016 interagency meeting dated October 26, 2016, Boott Hydro is also proposing to operate the fish ladder located at the Pawtucket Dam for the entire duration of the anadromous fish upstream passage season, consistent with the operating timeframes defined for the powerhouse fish lift in the project's FERC-approved Comprehensive Fish Passage Plan.

For spring 2017, Boott Hydro agrees to operate and maintain the fish ladder for the entire season with the same in-ladder and attraction flow release protocols followed in 2016. Upon receiving LIHI Certification, Boott Hydro will similarly continue full season ladder operation in 2018 and each year thereafter until issuance of a new FERC license for the project.

With full season ladder operation until relicensing and the other commitments to continue consultations on and implementation of improvements to the passage facilities and operations, we support Boott Hydro's application for LIHI Certification for the Lowell Project.

We look forward to continued cooperation to address fish passage at the project. Please contact Mr. Warner at 603-227-6420, or via e-mail at john_warner@fws.gov, if you have any questions or need assistance.

Sincerely yours,

Thomas R. Chapman
Supervisor
New England Field Office

MASSWILDLIFE

DIVISION OF
FISHERIES & WILDLIFE
1 Rabbit Hill Road, Westborough, MA 01581
p: (508) 389-6300 | f: (508) 389-7890
MASS.GOV/MASSWILDLIFE
Jack Buckley, *Director*

REF: Lowell Hydroelectric Project - FERC No. 2790 March 16, 2017

Mr. Randald Bartlett, P.E.
ENEL Green Power North America, Inc.
100 Brickstone Square, Suite 300
Andover, MA 01810

Dear Mr. Bartlett:

This letter refers to upstream fish passage at your Lowell Hydroelectric Project, located on the Merrimack River in Lowell, Massachusetts.

The Massachusetts Division of Fisheries and Wildlife (MassWildlife) has been working with ENEL Green Power, North America (ENEL), parent company of the project licensee, Boott Hydro, for many years to address upstream fish passage performance at the Lowell Project. ENEL has made efforts in recent years to address passage questions and problems, although the Service and other fisheries agencies have indicated in prior meetings and correspondence that additional measures are necessary at both the tailrace fish lift and spillway fish ladder.

In a telephone conversation on January 27, 2017, you indicated that Boott Hydropower is seeking a Low Impact Hydropower Institute (LIHI) Certification for the Lowell Project. As part of the application for LIHI Certification, Boott Hydro is proposing to commit to implementing additional fish passage measures at the project to address agency concerns.

In addition to ENEL's current commitments to evaluations of, and modifications to, the fish lift system, including tailrace rock excavation and American Eel passage improvements, outlined in letters from ENEL dated March 21, 2016 and November 3, 2016, and minutes of an October 20, 2016 interagency meeting dated October 26, 2016, Boott Hydro is also proposing to operate the fish ladder located at the Pawtucket Dam for the entire duration of the anadromous fish upstream passage season, consistent with the operating timeframes defined for the powerhouse fish lift in the project's FERC-approved Comprehensive Fish Passage Plan.

For spring 2017, Boott Hydro agrees to operate and maintain the fish ladder for the entire season with the same in-ladder and attraction flow release protocols followed in 2016. Upon receiving LIHI Certification, Boott Hydro will similarly continue full season ladder operation in 2018 and each year thereafter until issuance of a new FERC license for the project.

With full season ladder operation until relicensing and the other commitments to continue consultations on and implementation of improvements to the passage facilities and operations, MassWildlife supports Boott Hydro's application for LIHI Certification for the Lowell Project.

We look forward to continued cooperation to address fish passage at the project. Please contact me if you have any questions or need assistance.

Sincerely,

Caleb Slater
Anadromous Fish Project Leader
Massachusetts Division of Fisheries and Wildlife

cc: CNEFRO–Joe McKeon, Mike Bailey (via email)
RO/Fisheries - Bryan Sojkowski (via email)
NHFGD–Matt Carpenter (via email)
USFWS-John Warner (via email)
MDMF-Gloucester–Ben Gahagan (via email
NMFS–Sue Tuxbury, Bjorn Lake (via email)
FERC-Div. of Hydropower Administration and Compliance

MASSWILDLIFE

Criterion D Watershed Protection

FERC License (04/13/1983) – See Article 41

https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13583777

News Article describing EGPNA's volunteer activity to support watershed

http://www.eagletribune.com/business/enel-green-power-pitches-in-to-clean-up-river-parks/article_b68232e6-5447-51bc-ba70-a68d252e5f69.html

Soil Erosion and Sediment Control Plan for the Lowell Hydroelectric Project (07/31/2015)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13974619

Criterion E Threatened and Endangered Species

See Lawrence Hydroelectric Facility's LIHI Reviewer Report (pp. 16, 19):

http://lowimpacthydro.org/wp-content/uploads/2015/07/Lawrence-Certification-Report_Revised.pdf

Bald Eagle Status in Massachusetts

http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/haliaeetus-leucocephalus.pdf

Criterion F Cultural and Historical

Order Revising Crest Gate Mitigation Measures (05/08/2016)

https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14266808

National Park Service Waiving of Mitigation Measures (02/02/2016)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14199220

FERC Order Approving Crest Gate Installation (04/18/2013)

https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13237384

Criterion G Recreational

DCR comments on Crest Gate Installation (09/10/2010)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=12435038

Revised Report on Recreational Resources (pursuant to Articles 20 and 38) (04/16/1984)

https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13720246