LOW-IMPACT HYDROPOWER POWER INSTITUTE CERTIFICATION APPLICATION

LAWRENCE HYDROELECTRIC PROJECT
(FERC No. 2800)

Prepared for:

Essex Company, LLC
Subsidiary of Central Rivers Power, LLC

Central Rivers Power

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1.0 FACILITY DESCRIPTION

The Lawrence Hydroelectric Project (Lawrence Project), Federal Energy Regulatory Commission (FERC) No. 2800, is owned and operated by Essex Company, LLC (Essex), a subsidiary of Central Rivers Power US, LLC. The Lawrence Project is located at river mile (RM) 29 along the Merrimack River in the city of Lawrence, Massachusetts. From its source in Franklin, New Hampshire, the Merrimack River flows generally south through New Hampshire and then northeast in Massachusetts towards the town of Newburyport, where it empties into the Atlantic Ocean. The Merrimack River is approximately 117 miles long and has a drainage area of approximately 5,015 square miles. Numerous hydroelectric plants are located along the entire length of the Merrimack River.

1.1 PROJECT DESCRIPTION

The Lawrence Project consists of the following major features: (1) the Essex Dam, a 33-foot high, 900-foot-long dam of rubble masonry construction with a five-foot-high pneumatic crest gate system; (2) a 9-mile-long reservoir having a surface area of 655 acres at normal high water elevation 44.2 feet mean sea level (msl) and a maximum storage capacity of approximately 6,000 acre-feet; (3) the South Canal approximately 35 feet wide and 10 feet deep, originating at the south abutment of the Essex Dam and generally paralleling the Merrimack River bed, below the Essex Dam, for a distance of approximately 2,750 feet; (4) the North Canal, approximately 95 feet wide and 15 feet deep, originating at the north abutment of the dam and paralleling the Merrimack River below the dam for a distance of approximately 5,300 feet; (5) fish passage facilities including a fish elevator installed at the powerhouse, a downstream fish bypass and an eel ladder; (6) a powerhouse containing two 8.4 MW hydroelectric generating units and a tailrace channel extending into the Merrimack River; and (7) appurtenant facilities.

On August 31, 2020, Essex filed a non-capacity license amendment application with FERC to remove the North Canal and South Canal from the Project. As of this writing, the amendment application is still pending before the FERC.

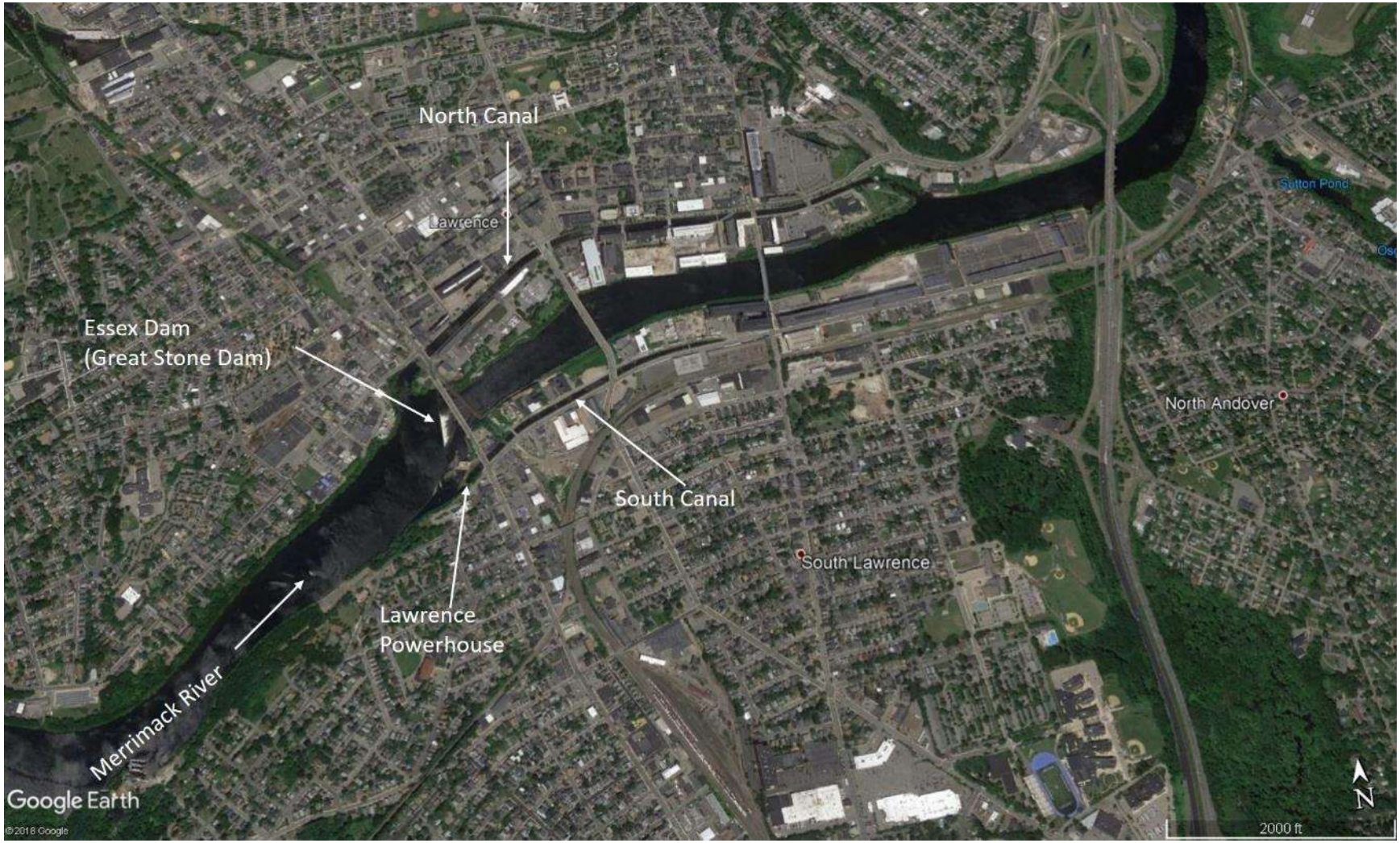

FIGURE 1 Overview of Lawrence Hydroelectric Project Location.

1.2 PROJECT OPERATIONS

The Lawrence Project is operated year-round in a run-of-river mode through use of an automatic pond level control system. The upstream fish passage operation typically begins annually in late April and continues through mid-July, with final operation schedule determined in consultation with resource agencies. Upstream fish passage lifts generally occur between 8:00 a.m. to 4:00 p.m. daily during the operational periods and maintains operations up to river flows of 25,000 cfs with a 120 cfs attraction flow provided for the fish elevator system. In addition, upstream eel passage occurs from mid September through October. The downstream fish passage bypass operation typically begins annually on April 1 and continues through mid-July and from September 1 through November 15, with final operation schedule determined in consultation with resource agencies.

The Lawrence Project's dam is equipped with a pneumatic crest gate system, deployed on the spillway crest in three 300-foot-long zones. The system utilizes air pressure to adjust the crest gate height to maintain normal headpond elevation at the Project based on the river user needs, flow and weather conditions. The installation of the system eliminated the need for impoundment drawdowns required for flashboard replacement, enhanced river debris management with reduced debris build up near the dam, enhanced high flow condition management and reduced false fish attraction away from the fish passage facilities often caused by board leakage and partial board loss.

The North and South Canals receive flow only to the extent necessary to maintain canal levels and are not needed for Project operations. There are no hydroelectric facilities on either canal. On August 31, 2020, Essex filed a non-capacity amendment application with FERC to remove the North and South Canals from the Project.

1.3 REGULATORY AND COMPLIANCE HISTORY

Since issuance of the 2015 LIHI Certification for the Lawrence Project, Essex was required to meet two conditions: (1) *Applicant will obtain a final letter from Massachusetts Department of Fish and Wildlife (or other agency recommended by MDFW) that confirms the facility and facility operations have no negative impact on the existence of Bald Eagle in the area, by August 1, 2015;* and *(2) Applicant will work with MDFW to improve effectiveness of eel passage at the site by July 15, 2016. This includes keeping elvers off dam by eliminating or rerouting leakage. Applicant will obtain letter from MDFW by July 15, 2016 that confirms passage measures are adequate*.

- By an email dated July 19th 2016, Misty-Anne Marold of the Massachusetts Division of Fisheries and Wildlife informed Essex that that the Lawrence facility and its operations have no negative impacts on the existence of bald eagle in the area (Appendix E).
- By an email dated July 7th 2016, Caleb Slater of the Massachusetts Division of Fisheries and Wildlife informed Essex that the eelway, and improvements to it, constructed at the Essex Dam in Lawrence does in fact meet the LIHI certification condition to improve juvenile eel passage at the facility (Appendix E). Essex is currently in the process of planning for the installment an eel elevator at the dam's left (northern) abutment, in consultation with the fishery agencies. Along with the existing eel ramp at the right abutment, elver passage will be provided at both ends of the dam.

1.4 LAWRENCE FACILITY DESCRIPTION INFORMATION (LIHI CERTIFICATE #121)

TABLE 1. FACILITY DESCRIPTION INFORMATION FOR LAWRENCE HYDROELECTRIC PROJECT (LIHI #121)

Information Type	*Variable Description*	*Response (and reference to further details)*
Name of the Facility	Facility name (use FERC project name if possible)	Lawrence Hydroelectric Project (FERC No. 2800)
Location	River name (USGS proper name)	Merrimack River
	River basin name	Merrimack River Drainage Basin
	Nearest town, county, and state	Lawrence, Essex County, MA
	River mile of dam	29
	Geographic latitude	42.7003 N
	Geographic longitude	71.1660 W
Facility Owner	Application contact names:	Kevin Webb Licensing Manager Central Rivers Power, LLC 670 N. Commercial St. Manchester, NH 03101
	Facility owner (individual and company names)	Essex Company, LLC, a subsidiary of Central Rivers Power, LLC, is the owner and operator of the Facility.
	Operating affiliate (if different from owner)	N/A
	Representative in LIHI certification	Jot Splenda WSP 1001 Wade Ave., Suite 400, Raleigh, NC 27605
Regulatory Status	FERC Project Number, issuance and expiration dates	Project No. 2800 Issued: 12/04/1978 Expires: 11/30/2028
	FERC license type or special classification	Major
	Water Quality Certificate identifier and issuance date, plus source agency name	A Water Quality Certificate was issued by the Massachusetts Division of Water Pollution Control (now Department of Environmental Protection) on July 5, 1978 (Appendix C).

Information Type	*Variable Description*	*Response (and reference to further details)*
	Hyperlinks to key electronic records on FERC e-library website (e.g., most recent Commission Orders, WQC, ESA documents, etc.)	1978 FERC License Order Other major orders are linked below where cited.
Power Plant Character-istics	Date of initial operation (past or future for operational applications)	The Lawrence Project was licensed by FERC on December 4, 1978 and went into operation on July 14, 1981.
	Total name-plate capacity (MW)	16.8 MW
	Average annual generation (GWh)	64.6 GWh
	Number, type, and size of turbines, including maximum and minimum hydraulic capacity of each unit	Number of units: 2 Unit type: horizontal Kaplan bulb units Unit capacity (each): 8.4 MW Min hydraulic capacity (each): 600 cfs Max hydraulic capacity (each): 4,000 cfs
	Trashrack clear spacing (inches) for each trashrack	7 inches
	Modes of operation (run-of-river, peaking, pulsing, seasonal storage, etc.)	Run-of-river using automatic pond level control
	Dates and types of major equipment upgrades	The license was amended on June 19, 2007[1] to replace the wooden flashboard system with a pneumatic crest gate system.
	Dates, purpose, and type of any recent operational changes	No major operational changes have occurred at the Project.
	Plans, authorization, and regulatory activities for any facility upgrades	No major facility upgrades are planned in the near future, other than the installation of the eel elevator at the dam's left abutment, as noted above.
Character-istics of Dam,	Date of construction	Essex Dam and canals: 1845 – 1848 Powerhouse, fish lift etc. commissioned July 1981
	Dam height	33-feet high, with 5-foot high pneumatic crest gate system

[1] 20070619-3021

Information Type	*Variable Description*	*Response (and reference to further details)*
Diversion, or Conduit	Spillway Elevation and Hydraulic Capacity	900-feet-long; crest elevation of 44.2 feet mean sea level (msl) at top of crest gates (normal pond elevation); spillway capacity approx. 128,000 cfs.
	Tailwater elevation	13 to 20 feet msl
	Length and type of all penstocks and water conveyance structures between reservoir and powerhouse	None; the intake and powerhouse are located directly adjacent to the dam.
	Dates and types of major, generation- related infrastructure improvements	In 2009 and 2010 Essex replaced the original 5-foot-high wooden flashboards on the spillway crest with an Obermeyer crest gate system, which provides a number of environmental and operational benefits, including more efficient use of the available river flow. In 2008 FERC granted the Licensee a Production Tax Credit for the resulting increase in energy production.[2]
	Designated facility purposes	The purpose of this facility is to generate power to be supplied to the local grid.
	Water source	Merrimack River
	Water discharge location or facility	Water utilized by the Lawrence Project discharges directly into the waters of the Merrimack River directly downstream of the powerhouse. The North and South Canals are not used for Project operation and only receive flow to the extent necessary to manage water levels in the canals.
Characte-ristics of Reservoir and Watershed	Authorized maximum and minimum water surface elevations	Minimum 39.2 feet msl (spillway crest) Normal maximum 45.2 feet msl (1 foot above crest gate crest), per the Crest Gate System Operation Plan.[3] Water level will rise higher once the crest gate is fully lowered, at inflows above ±52,000 cfs.
	Normal operating elevations and normal fluctuation range	44.2 feet msl
	Gross storage volume and surface area at full pool	Estimated gross storage approx. 6,000 acre-feet Surface area approx. 655 acres, excluding canals

[2] 20081107-4003
[3] 20081014-0266

Information Type	*Variable Description*	*Response (and reference to further details)*	
	Usable storage volume and surface area	N/A – the Lawrence Project is operated in a run-of-river mode and as such has no net useable storage capacity.	
	Describe requirements related to impoundment inflow, outflow, ramping and refill rate.	Article 32 of the license requires the Licensee to maintain a continuous minimum flow of 951 cfs unless and until the reservoir water surface elevation is drawn below the crest of the dam; thereupon the minimum release must equal inflow. The project meets and exceeds this requirement by operating ROR.	
	Upstream dam(s) by name, ownership, FERC number (if applicable), and river mile	Upstream Dam: Pawtucket Dam (Lowell Hydroelectric Project) Owner: Boott Hydropower, LLC FERC No.: 2790 River Mile (RM): 40	
	Downstream dam(s) by name, ownership, FERC number (if applicable), and river mile	Downstream Dam: None	
	Operating agreements with upstream or downstream reservoirs that affect water availability, if any, and facility operation	Essex's parent company, Central Rivers Power, LLC (CRP) owns all the hydropower facilities on the Merrimack and Pemigewasset Rivers, which allows CRP to fully coordinate operations on the river. Lawrence and the other hydroelectric projects in the Merrimack River basin pay annual Headwater Benefits charges to FERC, which offset the cost of operation of the US Army Corps of Engineers' flood control projects in the Merrimack River basin.	
	Area inside FERC project boundary, where appropriate	Approximately 680 acres	
Hydrologic Setting	Average annual flow at the dam (prorated for dam location)	8,419 cfs (for the period 1924 through 2019)	
	Average monthly flows of Merrimack River at Lowell, MA USGS Gage 01100000	Annual Monthly Mean for the period 1924 through 2019:	January – 7,510 cfs February – 7,600 cfs March – 12,900 cfs April – 19,400 cfs May – 11,700 cfs June – 6,680 cfs July – 3,740 cfs

Information Type	*Variable Description*	*Response (and reference to further details)*	
			August – 3,080 cfs September – 3,140 cfs October – 4,660 cfs November – 7,120 cfs December – 8,190 cfs
	Location and name of relevant stream gauging stations above and below the facility	USGS Gage 01100000 is located at: Lat 42°38'45", long 71°17'56" Middlesex County, MA, Hydrologic Unit 01070002, downstream of the Concord River tributary, approximately 9.4 miles upstream of the Essex Dam.	
	Watershed area at the dam	4,672 square miles	
Designated Zones of Effect	Number of zones of effect (Upstream to Downstream)	Impoundment ZOE Downstream ZOE North Canal ZOE[4] South Canal ZOE See Appendix A for a depiction of Project ZOEs.	
	Upstream and downstream locations by river miles	Zone 1 Impoundment ZOE: RM 38 (upstream extent of impoundment and Project Boundary) to RM 29 (Essex Dam) Zone 2 Downstream ZOE: RM 29 (Lawrence Project) to RM 0 (Atlantic Ocean) Zone 3 North Canal ZOE: RM 29 (Essex Dam) to RM 28 Zone 4 South Canal ZOE: RM 29 (Essex Dam) to RM 28.4	
	Type of waterbody (river, impoundment, by-passed reach, etc.)	According to the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory[5], the Impoundment ZOEs are classified as lake areas, and the downstream ZOE is classified as a	

[4] The North and South Canals are proposed for removal from the FERC Project as described in the Lawrence Non-Capacity Amendment Application filed with FERC on August 31, 2020 (Ascension number 20200831-5299)

[5] https://www.fws.gov/wetlands/

Information Type	***Variable Description***	***Response (and reference to further details)***
		riverine area.
	Delimiting structures	Impoundment ZOE: RM 38 (upstream end of impoundment near "Hunts Falls" and Project Boundary) to RM 29 (Essex Dam) Downstream ZOE: RM 29 (Essex Dam) to RM 0 (Atlantic Ocean) North Canal ZOE: RM 29 (Essex Dam) to RM 28 (outflow of North Canal into Spicket River) South Canal ZOE: RM 29 (Essex Dam) to RM 28.4 (outflow of South Canal at South Canal Wasteway)
	Designated uses by state water quality agency	Massachusetts Department of Environmental Protection designates waters in the Merrimack River near the Lawrence Project as Class B. Class B waters of Massachusetts are designated as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.[6]
Additional Contact Information	Names, addresses, phone numbers, and e-mail for local state and federal resource agencies	Please see section 4.0 for the Project Contacts Form
	Names, addresses, phone numbers, and e-mail for local non-governmental stakeholders	Please see section 4.0 for the Project Contacts Form

[6] https://www.mass.gov/files/documents/2017/10/18/314cmr4.pdf

Information Type	*Variable Description*	*Response (and reference to further details)*
Photographs and Maps	Photographs of key features of the facility and each of the designated zones of effect	Please see Appendix A for photographs of key features of the facility and identification of each designated ZOE, and for project drawings.
	Maps, aerial photos, and/or plan view diagrams of facility area and river basin	Please see Appendix B for aerial photos of facility area and river basin.

2.0 STANDARDS MATRICES

Impoundment ZOE

Criterion		Alternative Standards				
		1	**2**	**3**	**4**	**Plus**
A.	**Ecological Flow Regimes**	**X**				
B.	**Water Quality**		**X**			
C.	**Upstream Fish Passage**	**X**				
D.	**Downstream Fish Passage**		**X**			
E.	**Watershed and Shoreline Protection**	**X**				
F.	**Threatened and Endangered Species Protection**		**X**			
G.	**Cultural and Historic Resources Protection**		**X**			
H.	**Recreational Resources**		**X**			

Downstream ZOE

Criterion		Alternative Standards				
		1	**2**	**3**	**4**	**Plus**
A.	**Ecological Flow Regimes**		**X**			
B.	**Water Quality**		**X**			
C.	**Upstream Fish Passage**		**X**			**X**
D.	**Downstream Fish Passage**	**X**				
E.	**Watershed and Shoreline Protection**	**X**				
F.	**Threatened and Endangered Species Protection**		**X**			
G.	**Cultural and Historic Resources Protection**	**X**				
H.	**Recreational Resources**		**X**			

North Canal ZOE

Criterion		Alternative Standards				
		1	2	3	4	Plus
A.	**Ecological Flow Regimes**	X				
B.	**Water Quality**	X				
C.	**Upstream Fish Passage**	X				
D.	**Downstream Fish Passage**	X				
E.	**Watershed and Shoreline Protection**	X				
F.	**Threatened and Endangered Species Protection**		X			
G.	**Cultural and Historic Resources Protection**		X			
H.	**Recreational Resources**		X			

South Canal ZOE

Criterion		Alternative Standards				
		1	2	3	4	Plus
A.	**Ecological Flow Regimes**	X				
B.	**Water Quality**	X				
C.	**Upstream Fish Passage**	X				
D.	**Downstream Fish Passage**	X				
E.	**Watershed and Shoreline Protection**	X				
F.	**Threatened and Endangered Species Protection**		X			
G.	**Cultural and Historic Resources Protection**		X			
H.	**Recreational Resources**		X			

3.0 SUPPORTING INFORMATION

3.1 – Ecological Flow

Impoundment, South Canal and North Canal ZoEs

Criterion	Standard	
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. • If Run-of-River operation, provide details on how flows, water levels, and operation are monitored to ensure such an operational mode is maintained. • In a conduit project, identify the water source and discharge points for the conduit system within which the hydropower plant is located. • 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 Project powerhouse is located directly adjacent to the dam and forms its right abutment. There is no bypassed reach at the Project.
- Article 32 of the license requires the Licensee to maintain a continuous minimum flow of 951 cfs unless and until the reservoir water surface elevation is drawn below the crest of the dam; thereupon the minimum release must equal inflow. Essex meets and exceeds this requirement by operating the Lawrence Project in a run-of-river mode through use of an automatic pond level control system.
- There are no flow related requirements for the Project impoundment or canal ZoEs. The North and South Canals receive flow only to the extent necessary to manage canal water levels. Fish and wildlife habitat in the impoundment zone is maintained by the stable impoundment water levels inherent in run-of-river operations.

Downstream ZoE

Criterion	Standard	
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 protective). • 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. • Explain how the recommendation relates to agency management goals and objectives for fish and wildlife. • 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).

- Article 32 of the license requires the Licensee to maintain a continuous minimum flow of 951 cfs unless and until the reservoir water surface elevation is drawn below the crest of the dam; thereupon the minimum release must equal inflow. Essex meets and exceeds this requirement by operating the Lawrence Project in a run-of-river mode through use of an automatic pond level control system.
- The Licensee's "Report on Flows to be Released from Project Works" pursuant to license Article 32 was filed on Dec. 3, 1979 and was approved by FERC on April 1, 1980 (Appendix H). Notably, the plan pointed out the inherent conflict between maintaining the downstream minimum flow requirement of 951 cfs,[7] the ability to meet the Licensee's contractual water right for the former Merrimac Paper hydro projects on the South Canal,[8] and the flow requirements for fish passage operations. During the mid 1980's there were discussions among the Licensee, FERC and the resource agencies regarding the modification of or "waiver" from Article 32 to allow run-of-river operations, which

[7] The minimum flow requirement is the 7Q10 flow at the Project and was required under the Project's Water Quality Certification to ensure attainment of water quality standards downstream of the Lawrence wastewater treatment facility located downstream of the Project.

[8] Merrimac Paper Company went bankrupt and ceased operating the Aquamac Project (FERC No. 2927) and Merrimac Project (No. 2928) about ten years ago. FERC terminated both licenses by implied surrender on July 26, 2012. As a result, the need to meet the water right demand for these projects is no longer a factor in managing flows at the Lawrence Project.

the USFWS supported by letter dated Jun 2, 1987 (Appendix H). For unknown reasons the license amendment or Article 32 waiver was never pursued further, however since that time Essex Company has taken the position that run-of-river operation of the Project meets and exceeds the requirements of Article 32. In 1998 FERC initiated an investigation of the Licensee's compliance with Article 32, in response to which the Licensee demonstrated that the project meets the requirements of Article 32 by operating in a run-of-river mode. FERC concluded that "the Project was operated in a manner consistent with the minimum flow requirements of article 32."[9] Interestingly, the FERC record of this investigation includes a Privileged internal FERC memorandum described in eLibrary as "Submits memo dtd 980824 re non-compliance matter of Article 32 to be ambiguos [*sic*] re Lawrence Proj-2800"[10], a statement which reflects the Licensee's conclusions regarding the clarity of Article 32.

- In response to ordering paragraph (E) of the 2007 license amendment approving installation of the spillway crest gate system, the Licensee submitted a Crest Gate Operations Plan on October 10, 2008.[11] The plan established an operations protocol to maintain stable impoundment water levels. Under normal operations the crest gate control system would work in concert with the powerhouse pond level control system to maintain the impoundment water level within 1 foot of the crest gate crest (i.e., between 44.2 and 45.2 feet msl). At flows above approximately 52,000 cfs, the crest gates would be fully lowered and the upstream water level would rise in accordance with the spillway rating curve.
- Since the Project was last LIHI certified in 2015 there have been no deviations from the minimum flow or run-of-river operational requirements.
- On June 7, 2017, the City of Lawrence and other stakeholders filed a complaint against the Licensee alleging multiple violations of its FERC license, including violations of its minimum flow requirements[12]. On May 16, 2019 FERC's Division of Hydropower Administration & Compliance (DHAC) conducted a site visit to, in part, evaluate the complaint. On August 8, 2019, DHAC issued a Response to Complaint finding no violation of the license as alleged in the complaint[13]. On September 9, 2019 Complainants filed a Request for Rehearing[14]. On March 19, 2020 FERC issued an Order Denying Rehearing[15] which dismissed all aspects of the complainants' Request for Rehearing.

[9] 19981221-0458
[10] 19980903-0256
[11] 20081014-0266
[12] 20170607-5160
[13] 20190808-3037
[14] 20190909-5134
[15] 20200319-3043

3.2 – Water Quality

Impoundment and Downstream ZoEs

Criterion	Standard	
B	2	Agency Recommendation: • If facility is located on a Water Quality Limited river reach, provide a link to the state's most recent impaired waters list and indicate the page(s) therein that apply to facility waters. If possible, provide an agency letter stating that the facility is not a cause of such limitation. • Provide a copy of the most recent Water Quality Certificate and any subsequent amendments, including the date(s) of issuance. If more than 10 years old, provide documentation that the certification terms and conditions remain valid and in effect for the facility (e.g., a letter from the agency). • Identify any other agency recommendations related to water quality and explain their scientific or technical basis. • Describe all compliance activities related to water quality and any agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations

- As stated above, the Project received a Water Quality Certification (WQC) on July 5, 1978 (Appendix C), which provided a minimum flow release (951 cfs) adequate to maintain the status of the class "B" designation. Class B waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation[16]. Applicable water quality standards associated with Class B waters are shown in table 2.

[16] https://www.mass.gov/files/documents/2017/10/18/314cmr4.pdf

Table 2. Applicable water quality standards for Class B waters of Massachusetts (Massachusetts Divisions of Water Pollutions Control, 2019).

Water Quality Parameter	Description of Standard
Dissolved Oxygen (mg/L)	Shall not be less than 6.0 mg/L in cold water fisheries and not less than 5.0 mg/L in warm water fisheries.
Temperature	Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven-day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries.
pH	Shall be in the range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the natural background range.
Bacteria	The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml.
Solids	Waters shall be free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
Color and Turbidity	These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.
Oil and Grease	Waters shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life.
Taste and Oder	None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this Class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.

- Provisional continuous (15-minute interval) water quality data collected from the lower Merrimack River in Lawrence, MA for the periods of January 1, 2018 through November 6, 2018 and from June 19, 2019 through October 7, 2019 is available on the EPA's website.[17] Water temperature exceeded the 28.3°C standard for a warm water fishery in 0.39 percent of the samples with an average sample temperature of 18.2°C. pH values

[17] https://www.epa.gov/merrimackriver/live-water-quality-data-lower-merrimack-river

were outside the range of 6.5 to 8.3 in 3.5 percent of samples collected. Dissolved oxygen exceeded the 5.0 mg/L standard for a warm water fishery in 2 percent of samples collected and exceeded the 6.0 mg/L standard for a cold water fishery in 12.8 percent of samples collected.

- "Qualifiers", which indicate special considerations and uses applicable to the segment that may affect the application of criteria or antidegradation provisions, associated with the class "B" designation of the Merrimack River in the impoundment and downstream ZoE include warm water, treated water supply, and combined sewer overflows. The City of Lawrence has been heavily developed for industrial uses since the late 1800's and as a result faces many environmental challenges. Based on the EPA's website on Environmental Challenges for the Merrimack River[18] reducing high levels of bacteria in the river is a top priority and are primarily due to illicit sewage discharges into storm drain systems, combined sewer overflows, and urban stormwater. Other challenges include nutrient challenges (phosphorus), stormwater challenges, and litter.
- The impoundment and downstream ZoE areas are listed as impaired in the MA DEP's 2014 Integrated List of Waters[19] and its 2016 Integrated List of Waters[20] for *Escherichia coli* (*E. coli)*, mercury in in fish tissue, PCB in fish tissue, and total phosphorous. MA DEP stated in its email response dated July 15, 2020 (Appendix C) that the existence or operation of the Lawrence Project does cause or contribute to these listed impairments.

North Canal and South Canal ZoEs

Criterion	Standard	
B	1	<u>Not Applicable / De Minimis Effect</u>: • If facility is located on a Water Quality Limited river reach, provide a link to the state's most recent impaired waters list and indicate the page(s) therein that apply to facility waters. If possible, provide an agency letter stating that the facility is not a cause of such limitation. • Explain the rationale for why the facility does not alter water quality characteristics below, around, and above the facility.

- Waters of the North and South Canal ZoEs are not listed on the Massachusetts 303(d) list, and there are no water quality related requirements for these ZoEs in the FERC Project license or water quality certification.

[18] https://www.epa.gov/merrimackriver/environmental-challenges-merrimack-river#BC
[19] https://www.mass.gov/files/documents/2016/08/sa/14list2_0.pdf
[20] https://www.mass.gov/files/documents/2020/01/07/16ilwplist.pdf

3.3 – Upstream Fish Passage

Merrimack River fish species in the vicinity of the Lawrence Project include a mix of warm water, cold water, and anadromous species. Anadromous fish, specifically Atlantic salmon, American shad and river herring, are managed by the Technical Committee for the Restoration of Anadromous Fish to the Merrimack River ("Technical Committee") which is comprised of the Massachusetts Division of Marine Fisheries, Massachusetts Division of Fisheries and Wildlife, New Hampshire Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service and U. S. Forest Service[21].

Impoundment, North Canal, and South Canal ZoEs

Criterion	Standard	
C	1	Not Applicable / De Minimis Effect: • Explain why the facility does not impose a barrier to upstream fish passage in the designated zone. Typically, impoundment zones will qualify for this standard since once above a dam and in an impoundment, there is no facility barrier to further upstream movement. • Document available fish distribution data and the lack of migratory fish species in the vicinity. • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this

- There are no barriers to upstream passage within the impoundment ZoE and therefore the Upstream Fish Passage Criteria are not applicable.

- Upstream or downstream fish passage facilities are not necessary in the North or South Canal ZOEs because anadromous species cannot enter the canal systems. At the downstream end of the South Canal ZoE is an underground wasteway which is normally closed. It is highly unlikely that fish would attempt to ascend through this dark tunnel in the rare instances that the wasteway is open during fish passage season. At the downstream end of the North Canal there are no ladders or any means by which fish could use to access the canal. The North and South Canals receive flow only to the extent necessary to maintain canal water levels. As previously stated, the Licensee has filed a license amendment application to remove the North and South Canals from the project boundary. levels.

[21] https://www.mass.gov/files/documents/2016/08/rb/tr18-anad-p4-merrimack.pdf

- All anadromous species in the Merrimack River are in the mainstem of the river and can pass upstream via the fish lift and eel ladder located at the Lawrence Powerhouse. As mentioned previously, NMFS, FWS, and other members of the Technical Committee annually monitor the effectiveness of the fish passage facilities and work with the Licensee to continually improve upstream and downstream passage.

Downstream ZoE

Criterion	Standard	
C	2	<u>Agency Recommendation:</u> • 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 protective). • 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. • Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- The Essex Dam is the first barrier to anadromous species of the Merrimack River. Articles 15 and 16, 31 and 33 of the FERC license for the Lawrence Hydroelectric Project relate to fish and fish passage facilities. Articles 15 and 16 provide for the installation of additional fish passage facilities should they become necessary. Special Article 31 requires the Licensee to conduct operational studies and to file a final report to the Commission on the effectiveness of the fish passage facilities. Special Article 33 provides for monitoring of the fish passage facilities for determining the presence of threatened or endangered species and implementing any measures necessary to protect and conserve such species.
- The upstream fish passage facility consists of a fish lift with a trap and counting facility. Fish are released directly to the project's impoundment. In addition, several thousand fish are typically hand-dipped from the lift hopper and transported via stocking truck for release in upstream areas within the Merrimack River basin, or to other coastal drainages in New Hampshire. The Licensee's personnel operate the fish passage facility and estimate numbers of fish in each lift cycle.[22] More recently, Essex has implemented a digital video counting system to confirm fish counts. The upstream fish lift is typically

[22] Historically the MA Division of Marine Fisheries performed all fish counts, as provided in the FERC approved Comprehensive Fish Passage Plan. However, due to state budget cuts Essex has agreed to assume this responsibility.

operated from mid- to late April through mid- to late-July, annually, as determined by the Technical Committee.

- The fish lift began operating in 1983 in consultation with the relevant resource agencies.
- Fish passage operations at the project have been adaptively managed under the framework of a Comprehensive Fish Passage Plan (CFPP) jointly developed by the Licensee in consultation with the Technical Committee and filed pursuant to license Article 31.[23] The CFPP was approved by FERC on July 20, 2000[24] and a revision of the CFPP was approved on June 29, 2001.[25] Under the terms of the CFPP the Licensee has worked cooperatively with the Technical Committee to monitor fish passage operations and success, identify system maintenance and improvement needs, and to conduct additional studies.
- The Central New England Fish and Wildlife Conservation Office maintains a list of anadromous fish returns in the Merrimack River[26]. Tables 3 and 4 show the fish counts for 2019 by species and the returns for river herring, American shad, and Atlantic salmon from 1991 to 2018. The Atlantic salmon restoration program for the Merrimack River was terminated in 2013.
- NMFS and FWS perform annual inspections of the upstream fish passage facilities at the Project. The inspections offer an opportunity for members of the Technical Committee for the Restoration of Anadromous Fish to the Merrimack River (Technical Committee) and the Licensee to observe, review, and recommend improvements to the fish passage facilities. Since the previous LIHI Certification in 2015, some of the issues observed by the Technical Committee and addressed by the Licensee include improvements to the camera system for more accurate counts, installation of finer mesh on the crowder screen to reduce impingement, and repairs to the entrance gate transducer. Table 5 provides a detailed summary of the agency recommendations made during annual inspections of the fish passage facilities (upstream and downstream passage facilities) from 2015 through 2019, as well as the Applicant's responses.

[23] 20000309-0019
[24] 20000721-0149
[25] 20010703-0219
[26] https://www.fws.gov/northeast/cnefro/returns.html

Table 3. 2019 annual fish counts at the Essex Dam in Lawrence, Massachusetts.[27]

Species	**Returns**
Atlantic Salmon	14
American Shad	18,653
River Herring*	143,541
Striped Bass	272
Sea Lamprey	8,897
American Eel	44
Gizzard Shad	0

* River herring refers collectively to two fish species: blueback herring and alewife

Table 4. Annual fish counts at the Essex Dam in Lawrence, Massachusetts, from 1991 through 2018.[28]

Year	River Herring*	American Shad	Atlantic Salmon
1991	379,588	16,098	332
1992	102,166	20,796	199
1993	14,027	8,599	61
1994	88,913	4,349	21
1995	33,425	13,861	34
1996	51	11,322	76
1997	403	22,661	71
1998	1,362	27,891	123
1999	7,898	56,461	185
2000	19,405	72,800	82
2001	1,550	76,717	83
2002	526	54,586	56
2003	10,866	55,620	147
2004	15,051	36,593	129
2005	99	6,382	34
2006	1,257	1,205	91
2007	1,169	15,876	74
2008	108	25,116	119
2009	1,456	23,199	81
2010	518	10,442	85
2011	740	13,835	402
2012	8,992	21,396	137
2013	17,359	37,149	22
2014	57,213	38,107	75
2015	128,692	89,467	13

[27] Source: FWS. 2019. Central New England Fish & Wildlife Conservation Office Anadromous Fish Returns – Merrimack River. Available at: https://www.fws.gov/northeast/cnefro/returns.html. Accessed December 22, 2019.
[28] Source: FWS. 2019. Central New England Fish & Wildlife Conservation Office Anadromous Fish Returns – Merrimack River. Available at: https://www.fws.gov/northeast/cnefro/returns.html. Accessed December 22, 2019

Year	River Herring*	American Shad	Atlantic Salmon
2016	417,240	67,528	6
2017	91,616	62,846	5
2018	449,356	29,060	10
TOTAL	**1,851,046**	**919,962**	**2,753**

All counts were taken at the Essex Dam Fish Lift in Lawrence, Massachusetts

* River herring refers collectively to two fish species: blueback herring and alewife

Table 5. Agency recommendations made during annual inspections of the Lawrence fish passage facilities and Central River Power responses.

Year	Agency Recommendations	Applicable Fishways	Central Rivers Power's Responses
2015	(1) Install a flow meter at the entrance of the fish lift to accurately account record entrance flow rates. (2) Maintain spare parts associated with the eel ladder (i.e. substrate, cover, etc.) on hand so that repairs may be made in a timely manner. (3) Install a sill on the attraction water pipe to reduce the risk of trapping eels in the corner of the dam. (4) Provide proper equipment to clean fish counting window (5) Restore function to fish trap at window	Fish lift and eel ladder	(1) Essex will evaluate and respond to the Tech Committee by the annual winter meeting (2016) on the feasibility, and if feasible, any plans to provide continuous or spot checks of fishway flow in 2016. (2) Spare components are available on site, including FWS-specified substrate panels, water piping and miscellaneous hardware. (3) A temporary sill was placed by FWS in July 2015 and Essex will attempt to install a permanent sill by the 2016 eel passage season. (4) Essex will ensure that proper equipment is available in 2016 to clean the count window at all times during passage season. (5) Essex will ensure that the fish trap features, and function are fully available at start of and throughout the passage season.
2016	(1) Prior to the 2017 migratory season correct the excessive level of noise and vibration occurring at the fish lift that may result in elevated stress levels in fish. (2) Clean and maintain the exit of the downstream bypass flume daily to ensure there is no risk to downstream migrating fish.	Fish lift and downstream bypass flume	(1) Essex will evaluate hopper travel (noise and vibration) remedy. (2) Essex will ensure downstream bypass clear of debris.
2017	(1) Bulk heads should be off site prior to the start of the season in order to provide access to the transport truck. (2) Annual cleaning of the AWS chamber and screen should be conducted to ensure upwelling/aeration does not occur during the season. (3) A transducer should be integrated into the entrance gate in order to track the true elevation of the lip of the gate (4) work with the Merrimack Technical Committee to define the operational range of the eel ladder (5) Add a finer mesh screen on the crowder to	Fish lift and eel ladder	(1) Was likely a one-time event and Essex will take fish transport needs into account during future maintenance planning. (2) Essex agrees to close the attraction water system vent and clean any debris from the entire fishway system prior to 2018 season. (4) Essex will obtain and provide the requested information prior to the 2018 fish passage season. (5) Essex added a smaller mesh screen to the crowder to avoid fish injury.

Year	Agency Recommendations	Applicable Fishways	Central Rivers Power's Responses
	avoid fish injury		
2018	(1) Install a finer mesh screen on the crowder to avoid and minimize impingement. (2) Work with the agency team to develop a more robust design for the eel ladder that will withstand the forces put on the structure during high flows. (3) Maintain an on-site inventory of critical eel ladder elements (e.g., substrate) to facilitate efficient repair and replacement without significant downtime. (4) Eliminate the existing gap in the fishway entrance gallery and inspect salmon trap. (5) Leave the exit gate of the exit channel open at night so any fish still in the exit channel could exit upstream. (6) Develop an O&M plan for review such that it is ready well before the 2019 migratory season and can be reviewed by the agency team. (7) Take measurements with the entrance gate transducer throughout the full operational period of the fishway in future years. (8) Monitor and eventually seal the exit flume leakage to prevent fish impingement inside the exit flume and/or damage to the fishway.	All fishways	(1) Suitable finer-mesh screen will be installed on the Lawrence crowder system before the spring 2019 passage season. (2) Essex are open to any design revision suggestions from FWS (3) A compete on-site inventory of eel ladder replacement parts will be established by the spring 2019 passage season. (4) Essex will close identified and potential gaps within the fishway prior to the spring 2019 upstream passage season. (5) Essex will keep the trap gate open nightly. (6) Essex agreed to provide all O&M Plans to the agencies for review by February 1, 2019 and implement the plans prior to the 2019 passage season. (7) Essex will ensure that the complete season-long data record is available from this transducer for 2019 and beyond. (8) Any necessary repairs will be completed prior to the mid-April start of 2019 season.
2019	(1) Check the transducer to ensure it is operational and accurate prior to the start of the 2020 fish passage season. (2) Finalize the O&M plan prior to the annual post-season meeting with the agencies. (3) Work with the agency team to develop a more robust design for the eel ladder that will withstand the forces put on the structure during high flows. (4) Fix the de-watering gate such that the static crowder can be assessed in a de-watered state and fixed prior to the start of the 2020 migratory season.	Fish lift and eel ladder	Pending

Sources: 20150427-5399, 20150827-5057, 20151014-5322, 20151209-3074, 20161104-5054, 20170217-5072, 20170419-5190, 20170919-5123, 20180206-5062, 20180216-5148, 20180530-3019, 20180920-5078, 20190102-5054, 20191107-5016

Criterion	Standard	
C	Plus	Bonus Activities: • If advanced technology has been or will be deployed, explain how it will increase fish passage success relative to other options. • If a basin-scale redevelopment strategy is being pursued, explain how it will increase the abundance and sustainability of migratory fish species in the river system. • If adaptive management is being applied, describe the management objectives, the monitoring program pursuant to evaluating performance against those objectives, and the management actions that will be taken in response to monitoring results.

- The CFPP has been implemented in an adaptive management approach and includes provisions for future facility monitoring and facility improvements. As outlined in the CFPP, the Technical Committee was responsible for monitoring fish passage, performing fish counts, and collection of fish data (length, weight, sex, and scale samples). However, financial constraints have since prevented members of the Technical Committed to continue these duties. To ensure the agreement was maintained and fish passage measures remained in plan, Essex assumed responsibility of these duties and associated costs. Fish counts are performed both by visual estimation at the count window and by video computer software.
- Plans for an eel passage system began in 2009 and after further consultation and study, the passage system began operating in 2013. Located at the toe of the Essex Dam adjacent to the powerhouse, the eel passage system consists of an eel ladder and a collection box. The eel passage system operates from May 1 through September 30 each year. Essex is currently working toward installation of an eel elevator system at the dam's left (northern) abutment, in consultation with the Technical Committee. This is a good example of the cooperative and adaptive management of the Project's fish passage facilities.
- In addition to the CFPP, the Licensee has more recently developed a Fishway Operations and Management Plan (FOMP, Appendix G) in consultation with the Technical Committee, which updates and partially replaces the CFPP, however the FOMP has not been formally filed with the FERC under Article 31. Compared to the CFPP, the FOMP contains more details regarding the operation and maintenance of each fish passage facility including detailed off-season maintenance procedures and detailed in-season operational and maintenance procedures. Unlike the CFPP, the FOMP also contains detailed descriptions and operation and maintenance procedures for the Lawrence south permeant eelway and the Lawrence north interim eelway. The FOMP outlines provisions for fish and eel passage reporting that includes weekly distribution of

collected data to the Technical Committee and annual meetings with the Technical Committee in the spring and fall, where recently completed fish passage/eel passage activities will be reviewed and the scope of monitoring and evaluations for next season will be developed, as well as reviews of details and expectations for the upcoming passage season. The FOMP has been developed as a "living document" and will be updated on an as-needed basis to reflect modifications to fishway operations that may be implemented following future consultations with the Technical Committee.

- As of late January, 2020 all of the hydroelectric facilities on the Merrimack River are now under common ownership by Essex Company's parent company, Central Rivers Power, LLC. This allows for better coordination of fish passage operations for all projects both within CRP's operations and regulatory departments, as well as between CRP and the Technical Committee. CRP has had informal discussions with the Technical Committee regarding better coordination of passage operations and attainment of restoration goals, and anticipates that these discussions will continue into the foreseeable future.

3.4 – Downstream Fish Passage and Protection

Impoundment ZoE

Criterion	Standard	
D	2	<u>Agency Recommendation</u>: • 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 protective). • 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. • Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

- Downstream migrating fish are transported from the project forebay into the tailrace by way of a concrete bypass chute. The downstream fish passage facility is typically operated from April 1 through July 15 and from September 1 through November 15, annually. The Project trashrack has 7 inch clear spacing between the bars. The

downstream passage facility was designed in consultation with the Technical Committee, and was approved by FERC in 1992[29] and completed in 1993, and has been operating since. During consultation, FWS, NMFS, and Massachusetts DFW state that the trashrack spacing and passage design incorporated previously required modifications, and thus endorsed construction.

- The operation and maintenance of the fish bypass chute are managed via the CFPP.
- As with upstream passage, NMFS and FWS perform annual inspections of the downstream fish passage facilities at the Project. Since the previous LIHI Certification in 2015, some of the issues observed by the Technical Committee and addressed by the Licensee include ensuring that the downstream fish bypass is clear of debris. See Table 5 for a detailed summary of agency recommendations made during the annual fishway inspections.

Downstream, North Canal, and South Canal ZoEs

Criterion	Standard	
D	1	Not Applicable/ De Minimis Effect: • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone. Typically, tailwater/downstream zones will qualify for this standard since once below a dam and powerhouse there is no facility barrier to further downstream movement. • For riverine fish populations that are known to move downstream, explain why the facility does not contribute adversely to the sustainability of these populations or to their access to habitat necessary for successful completion of their life cycle. • Document available fish distribution data and the lack of migratory fish species in the vicinity. • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

- There are no facilities in the downstream ZoE that act as a barrier to downstream fish passage. Once fish cross over the Essex Dam with use of the downstream passage facilities, they do not have any further impediments to passage through the downstream ZOE.

[29] 19921029-0289 (Document is only available on microfilm from FERC. Copy can be provided on request.)

- The only obligatory catadromous species in the vicinity of the Lawrence Project is the American eel, which encounters no barriers to downstream migration in the downstream ZoE.
- There is no longer any significant flow passed into either the North Canal or South Canal, other than for canal water level maintenance. Therefore, there is little or no opportunity for diadromous fish to enter either canal.
- The Project's CFPP includes a provision for seasonally closing off the South Canal during outmigration periods for Atlantic salmon smolts and juvenile clupeids. This "South Canal Closure Plan" was required to protect outmigrating fish from two other hydroelectric projects, Aquamac and Merrimac (P-2927 and P-2928, respectively) which were formerly located on the South Canal. However, the owner of the projects, Merrimack Paper Company, went bankrupt and the projects ceased operation. In 2012 FERC terminated both licenses by implied surrender.[30] Thus the South Canal Closure Plan is moot and is no longer implemented

3.5 – Shoreline and Watershed Protection

All ZoEs

Criterion	Standard	
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 FERC project or facility boundary). • Document that there have been no Shoreline Management Plans or similar protection requirements for the facility.

- The Licensee does not own any property along the impoundment outside of the immediate vicinity of the project works and North and South Canals, which is entirely urban lands of little ecological value. The Massachusetts Shoreline Protection Act specifically excludes man-made canals, such as the canals in Lawrence, from its provisions.[31] The project boundary around the project impoundment is defined as the contour elevation at the normal impoundment water level at the crest gate crest (figure 11).
- The original license did not require the development of a shoreline management plan. Article 35 of the license requires the Licensee to ensure that authorized usage of Project lands are consistent with shoreline aesthetics, are maintained in good condition and

[30] 20120726-3019 and 20120726-3020
[31] 310 CMR (2)(a)1.g.

comply with state and local regulations. The project is located in a heavily developed industrial area in downtown Lawrence, MA.

- On June 7, 2017, complaints were filed against the Licensees alleging multiple violations of its FERC license for its hydroelectric facility in Lawrence, including violations of its minimum flow requirements. On May 16, 2019 FERC's Division of Hydropower Administration & Compliance ("DHAC") conducted a site visit to, in part, evaluate the complaint. On August 8, 2019, DHAC issued a Response to Complaint finding no violation of the license as alleged in the complaint. On September 9, 2019 Complainants filed a Request for Rehearing. On March 19, 2020 FERC issued an Order Denying Rehearing[32] which dismissed all aspects of the complainants' Request for Rehearing.
- Land cover units in the vicinity of the Lawrence Project are almost exclusively "Developed" and of either medium or high intensity according to the 2016 National Land Cover Database[33] (Table 6).

TABLE 6. Project Area Land Cover and Classified by the National Land Cover Database 2016.

Class/Value	***Classification Description***
23	**Developed, Medium Intensity** -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	**Developed High Intensity**-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

[32] 20200319-3043
[33] https://www.mrlc.gov/viewer/

3.6 – Threatened and Endangered Species Protection

All ZoEs

Criterion	Standard	
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. • 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.

- In the 1978 FERC License Order FERC noted that FWS, NMFS, and MA Division of Fisheries and Wildlife all concluded that no adverse effects from the Project are expected on listed species.
- On July 17, 2020, outreach was made to U.S. Fish and Wildlife Service regarding the potential for the continued operation of the Lawrence Project to affect listed species (Appendix E). No response has been received. A U.S. Fish and Wildlife Information for Planning and Conservation (IPaC) Trust Resources Report was generated December 19, 2019 for the Essex County (Appendix E). The IPaC Report identified one endangered species, the Roseate Tern (*Sterna Dougallii dougallii*) and four threatened species, Northern Long-eared Bat (*Myotis septentrionalis*), piping plover (*Charadrius melodus*), red knot (*Calidris canutus rufa),* and small whorled pogonia (*Isotria medeoloides).* Critical habitat has only been designated for the piping plover but is outside of the Lawrence Project location.
- On July 18, 2020, outreach was made to the MA DFW regarding the potential for the continued operation of the Lawrence Project to affect state-listed species (Appendix E). MA DFW responded that in order to provide a letter, the project will have to file for a formal MESA Review. A list of Massachusetts State Endangered, Threatened, and Species of Concern in Lawrence, MA was generated on December 19, 2019 from the Massachusetts Natural Heritage and Endangered Species Program website (Table 7). The Peregrine Falcon is the only state listed species that has been observed in recent years and according to the Massachusetts Natural Heritage and Endangered Species Program website, buildings that have consistent peregrine falcon nests can be found in Lawrence Massachusetts. A review of the Project Record on FERC's eLibrary did not document any project impacts to or observations of peregrine falcon at project facilities. The likely absence of the species listed in Table 7 is due to the urban nature of the Project location. Continued operation of the Lawrence Project as its currently licensed and operated is unlikely to have an effect on species listed in Table 7.

Table. 7. Massachusetts State Endangered, Threatened, and Species of Concern in Lawrence, MA.[34]

Taxonomic Group	Scientific Name	Common Name	MESA Status	Most Recent Observation
Vascular Plant	*Carex typhina*	Cat-tail Sedge	T	1879
Vascular Plant	*Gentiana andrewsii*	Andrews' Bottle Gentian	E	1885
Vascular Plant	*Juncus filiformis*	Thread Rush	E	1903
Vascular Plant	*Ranunculus pensylvanicus*	Bristly Buttercup	SC	1879
Vascular Plant	*Sabatia kennedyana*	Plymouth Gentian	SC	2011
Mussel	*Alasmidonta varicosa*	Brook Floater (Swollen Wedgemussel)	E	Historic
Beetle	*Cicindela purpurea*	Cow Path Tiger Beetle	SC	1923
Bird	*Falco peregrinus*	Peregrine Falcon	T	2018

3.7 – Cultural and Historic Resource Protection
Impoundment, North Canal, and South Canal ZoEs

Criterion	Standard	
G	2	Approved Plan: • Provide documentation of all approved state, federal, and recognized tribal plans for the protection, enhancement, and mitigation of impacts to cultural and historic resources affected by the facility. • Document that the facility is in compliance with all such plans

- The Essex Dam (a.k.a. "Great Stone Dam"), the North Canal and the associated gatehouse are listed in the National Register of Historic Places. The project's South Canal and associated gatehouse are eligible for listing in the National Register.
- Throughout the license term, Essex has revised its recreational facilities plan, which included the historic gatehouses[35], and amended its license[36] to install an Obermeyer crest gate system on the spillway crest of the historic Essex Dam. During these processes, the Massachusetts Historical Commission was consulted on each proposed action and made "no adverse effect" determinations.
- On June 7, 2017, the City of Lawrence and other stakeholders filed a complaint against the Licensee alleging multiple violations of its FERC license for its hydroelectric facility in Lawrence, including Article 29 which requires Licensee "*to avoid any adverse impact on identified historical structures of the Project*." The complainants stated, in part, that the Licensee has maintained very low water levels in both canals which causes the wood structures to slowly rot, even to the point that most of the headgate, penstocks, and

[34] https://www.mass.gov/service-details/rare-species-viewer
[35] 19950804-0020
[36] 20070619-3021

related canal infrastructure are in moderate to extreme despair and leading to flooding and potential structural damage of adjacent buildings On May 16, 2019 FERC's Division of Hydropower Administration & Compliance ("DHAC") conducted a site visit to, in part, evaluate the complaint. On August 8, 2019, DHAC issued a Response to Complaint finding no violation of the license as alleged in the complaint. Separately, DHAC issued a letter[37] directing the Licensee to complete follow-up actions arising from the May 16, 2019 site visit, including repairs to the walkways across the historic North Canal Gatehouse and at the terminal dam at the downstream end of the North Canal. On September 9, 2019 Complainants filed a Request for Rehearing. On March 19, 2020 FERC issued an Order Denying Rehearing[38] which dismissed all aspects of the complainants' Request for Rehearing.

Downstream ZoE

Criterion	Standard	
G	1	Not Applicable / De Minimis Effect: • Document that there are no cultural or historic resource located on the facility lands that can be affected by construction or operations of the facility. • Document that the facility construction and operation have not in the past, nor currently adversely affect any cultural or historic resources that are present on facility lands

- There are no cultural or historic resources in the downstream ZoE. A review of the National Register of Historic Places' list of Listed properties[39] did not find any Listed properties or structures in the downstream ZoE.

[37] 20190808-3037
[38] 20200319-3043
[39] https://www.nps.gov/subjects/nationalregister/upload/national_register_listed_20200108.xlsx

3.8 – Recreational Resources

All ZoEs

Criterion	Standard	
H	2	Agency Recommandation: • Document any comprehensive resource agency recommendations and enforceable recreation plan that is in place for recreational access or accommodations. • Document that the facility is in compliance with all such recommendations and plans.

- The Licensee's Recreation Plan was approved with the 1978 License Order and then amended by Commission Orders on August 1, 1995[40], and on August 9, 1995[41] removing the requirements for the picnic area, the moving of the South Canal Gatehouse, and the portable fence, and adding painted markings on the paved walkway and directional signage to the North Canal carriage house. Recreational facilities owned and operated by the Licensee include the restored gatekeeper's Carriage House on the North Canal that includes a visitor center with a concrete parking area, new video displays, lighting, seating display panels and other interactive exhibits. The facility is used to illustrate the history of the region, the operation of the hydroelectric facilities, and the operation of the fish passage facilities. Until September 11, 2001, tours were given of the powerhouse area and the fish passage facilities, but these tours have been terminated for security reasons. Other recreational facilities not owned and operated by the Licensee but within the impoundment and downstream ZoE's include a boat launch with a large parking area upstream of the project owned and maintained by the State of Massachusetts and a fishing area and boat ramp downstream of the project that is owned and maintained by the City of Lawrence.
- On August 14, 1980[42], the Licensee accepted a proposed amendment from FERC by adding a new license article 43 that permitted the Licensee to grant permission for certain uses of project lands and waters and to convey certain interest in project lands without prior Commission approval, if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. The new article has since become a standard article included in all licenses by FERC. This article requires the Licensee to allow the public free access, to a reasonable extent, to project waters and adjacent project lands owned by the Licensee for the purpose of full public utilization of such lands and waters for navigation and for outdoor recreational purposes, including fishing and hunting; provided, that the Licensee may reserve from public access such portions of the project

[40] 19950804-0020
[41] 19950915-0022
[42] 19800820-0001

waters, adjacent lands, and project facilities as may be necessary for the protection of life, health, and property.

- The 2017 FERC Environmental Inspection Report[43] only noted a missing Part 8 sign as a non-compliance/follow-up issue for Recreational Resources. By a letter dated June 20, 2017[44], the licensee informed the Commission that a new Part 8 sign was being made and would be installed by September 15, 2017. In a letter order dated July 20, 2017[45], the Commission accepted the Licensee's proposed course of action outlined in its June 20, 2017 letter. Essex installed the new Part 8 sign in late June 2020 and will file documentation of this installation with the FERC in the near future.
- On June 7, 2017, a complaint was filed against the Licensee alleging multiple violations of its FERC license for the Lawrence Project, including violations of its approved Recreation Plan. The complainants stated that the Licensee needs to improve recreation at the Carriage House and needs to enhance recreation at the project in general, due to increasing recreational demand in the project area. On May 16, 2019 DHAC conducted a site visit to, in part, to evaluate the complaints. On August 8, 2019, DHAC issued a Response to Complaint finding no violation of the license as alleged in the complaint. Separately, DHAC issued a letter[46] directing the Licensee to complete follow-up actions arising from the May 16, 2019 site visit, including an update to the Project's Public Safety Plan, a trash removal plan for the canals, and improved signage for tours at the Carriage House. On September 9, 2019 the complainants filed a Request for Rehearing. On March 19, 2020 FERC issued an Order Denying Rehearing[47] which dismissed all aspects of the complainants' Request for Rehearing.

[43] 20170620-3058
[44] 20170620-5068
[45] 20170720-3002
[46] 20190808-3037
[47] 20200319-3043

4.0 CONTACTS FORMS

Project Owner:	
Name and Title	Matt Stanley, Vice President and General Manager, Central Rivers Power, LLC
Company	Essex Company, LLC
Phone	
Email Address	
Mailing Address	670 N. Commercial Street, Suite 204, Manchester, NH 03101
Consulting Firm / Agent for LIHI Program (if different from above):	
Name and Title	Jot Splenda
Company	WSP
Phone	(919) 866-4417
Email Address	Jot.splenda@wsp.com
Mailing Address	1001 Wade Ave; Suite 400; Raleigh, NC 27615
Compliance Contact (responsible for LIHI Program requirements):	
Name and Title	Kevin Webb, Licensing Manager
Company	Central Rivers Power US, LLC
Phone	1-978-935-6039
Email Address	kwebb@centralriverspower.com
Mailing Address	670 N. Commercial Street, Suite 204, Manchester, NH 03101
Party responsible for accounts payable:	
Name and Title	Torie Massero
Company	Central Rivers Power US, LLC
Phone	(603) 300-6621
Email Address	tmassero@centralriverspower.com
Mailing Address	670 N. Commercial Street, Suite 204, Manchester, NH 03101

Agency Contact (Check area of responsibility: Flows_X_, Water Quality _X_, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation _X_):	
Agency Name	Massachusetts Department of Environmental Protection
Name and Title	Robert Kubit, Environmental Engineer
Phone	508-767-2854
Email address	Robert.Kubit@mass.gov
Mailing Address	8 New Bond St, Worcester, MA 01606

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	Massachusetts Division of Fisheries and Wildlife
Name and Title	Caleb Slater, Anadromous Fish Project Leader
Phone	508-389-6331
Email address	Caleb.Slater@mass.gov
Mailing Address	1 Rabbit Hill Road, Westborough, MA 01581

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	Massachusetts Division of Marine Fisheries
Name and Title	Ben Gahagan, Diadromous Fish Biologist
Phone	617-626-1520
Email address	Ben.Gahagan@mass.gov
Mailing Address	251 Causeway Street, Suite 400, Boston, MA 02114

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	U.S. Fish and Wildlife Service
Name and Title	Thomas Chapman, Supervisor New England Field Office
Phone	603-227-6410
Email address	Tom_Chapman@fws.gov
Mailing Address	70 Commercial St., Suite 300 Concord, NH 03301

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	U.S. Fish and Wildlife Service
Name and Title	Mike Bailey, Assistant Project Leader
Phone	603-595-0957

Email address	Michael_Bailey@fws.gov
Mailing Address	151 Broad Street Nashua, NH 03603

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	U.S. Fish and Wildlife Service
Name and Title	Bryan Sojkowski, Fish Passage Engineering
Phone	413-253-8645
Email address	Bryan_sojkowski@fws.gov
Mailing Address	300 Westgate Center Drive Hadley, MA 01035

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __)	
Agency Name	National Oceanic and Atmospheric Administration · NMFS Greater Atlantic Regional Habitat and Ecosystem Service Division
Name and Title	Susan Tuxbury, BOEM Activities/Hydropower
Phone	978-281-9176
Email address	Susan.tuxbury@NOAA.gov
Mailing Address	55 Great Republic Dr, Gloucester, MA 01930

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __)	
Agency Name	National Oceanic and Atmospheric Administration · NMFS Greater Atlantic Regional Fisheries Office
Name and Title	Bjorn Lake, Fish Passage Engineer
Phone	978-281-9252 ex 6252
Email address	Bjorn.Lake@NOAA.gov
Mailing Address	55 Great Republic Dr, Gloucester, MA 01930

Agency Contact (Check area of responsibility: Flows_X_, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	New Hampshire Fish and Game Department
Name and Title	Matt Carpenter, Fisheries Biologist
Phone	603-271-2612
Email address	Matthew.Carpenter@wildlife.nh.gov
Mailing Address	11 Hazen Drive Concord, NH 03301

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	Massachusetts Diversion of Fisheries and Wildlife
Name and Title	Misty-Anne Marold, Senior Endangered Species Review Biologist, Natural Heritage & Endangered Species Program
Phone	508-389-6356
Email address	Mist-Anne.Marold@mass.gov
Mailing Address	1 Rabbit Hill Road, Westborough, MA 01581

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources _X_, Recreation __):	
Agency Name	Massachusetts Historical Commission
Name and Title	Brona Simon, State Historic Preservation Officer and Executive Director
Phone	617-727-8470
Email address	Brona.Simon@state.ma.us
Mailing Address	220 Morrissey Boulevard Boston, MA 02125

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources _ _, Recreation __):	
Agency Name	City of Lawrence
Name and Title	Dan McCarthy, Land Use Planner
Phone	(978) 620-3505
Email address	DMcCarthy@cityoflawrence.com
Mailing Address	200 Common Street, Lawrence, MA 01840

5.0 SWORN STATEMENT

Sworn Statement and Waiver Form

All applications for LIHI Certification must include the following sworn statement before they can be reviewed by LIHI:

SWORN STATEMENT

As an Authorized Representative of _Essex Company, 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 LIHI Certification of the applying facility is granted, the LIHI Certification Mark License Agreement must be executed prior to marketing the electricity product as LIHI Certified®.

The Undersigned 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.

FOR PRE-OPERATIONAL CERTIFICATIONS:

The Undersigned acknowledges that LIHI may suspend or revoke the LIHI Certification should the impacts of the facility, once operational, fail to comply with the LIHI program requirements.

Company Name: Essex Company, LLC

Authorized Representative:

Name: Kevin M. Webb

Title: Licensing Manager

Authorized Signature: 

Date: December 15, 2020

APPENDIX A
PROJECT ZOES, PHOTOS, & DRAWINGS

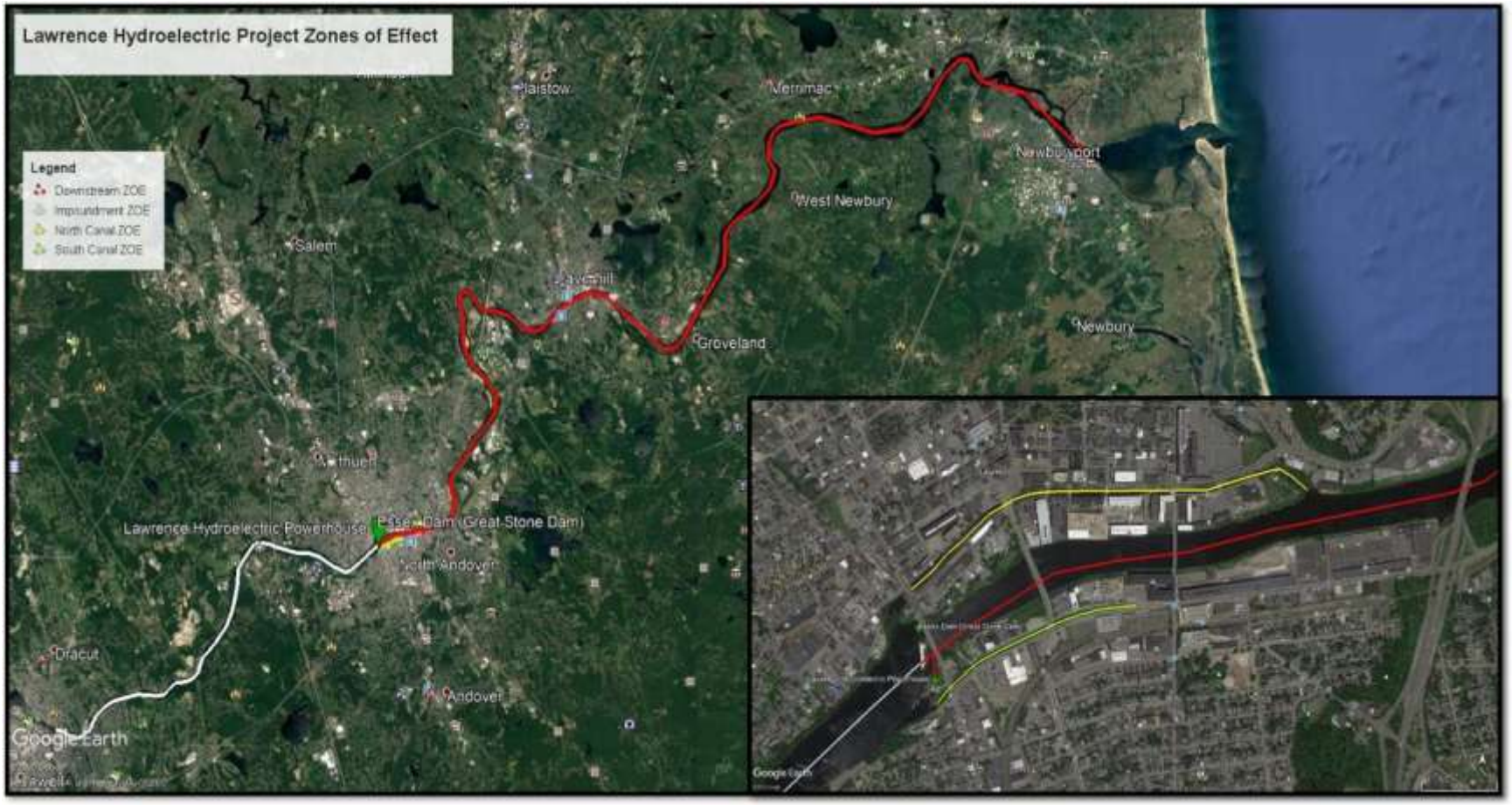

Figure 2. Overview Map of the Lawrence Hydroelectric Project Zones of Effect.

APPENDIX B
AERIAL PHOTOS OF FACILITY AREA AND RIVER BASIN

FIGURE 3: Merrimack River Drainage Basin

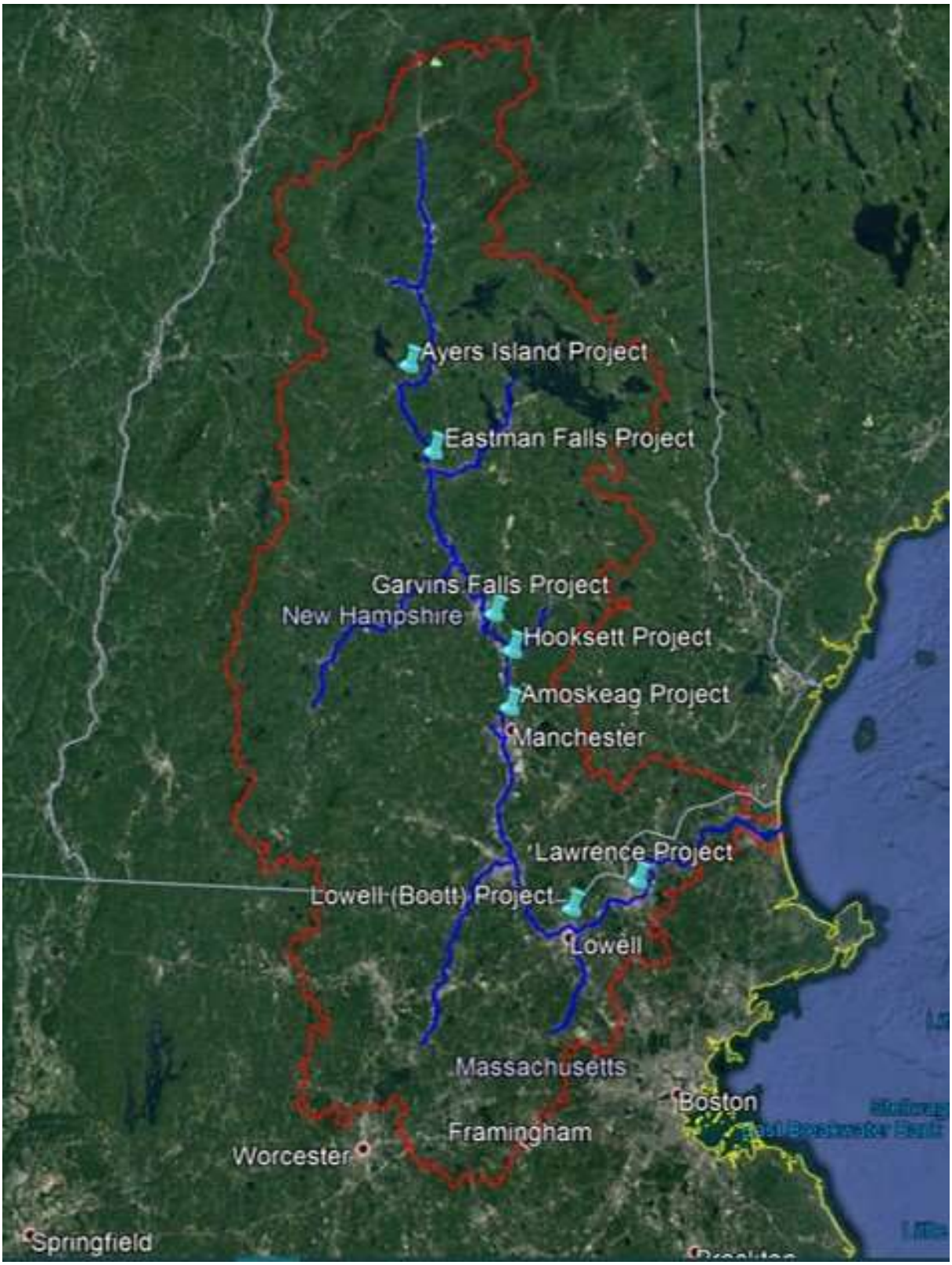

FIGURE 4: Merrimack River Hydroelectric Projects owned and operated by Central Rivers Power.

FIGURE 5: Lawrence Project impoundment, Essex Dam with the five-foot-high pneumatic crest gate system, the impoundment and downstream reach, and the North Canal Gatehouse in the background.

FIGURE 6: Lawrence Project tailrace and exit channel of the downstream fish passage facility.

FIGURE 7: View of the eel collection tank that is part of the upstream eel passage system at the Lawrence Project.

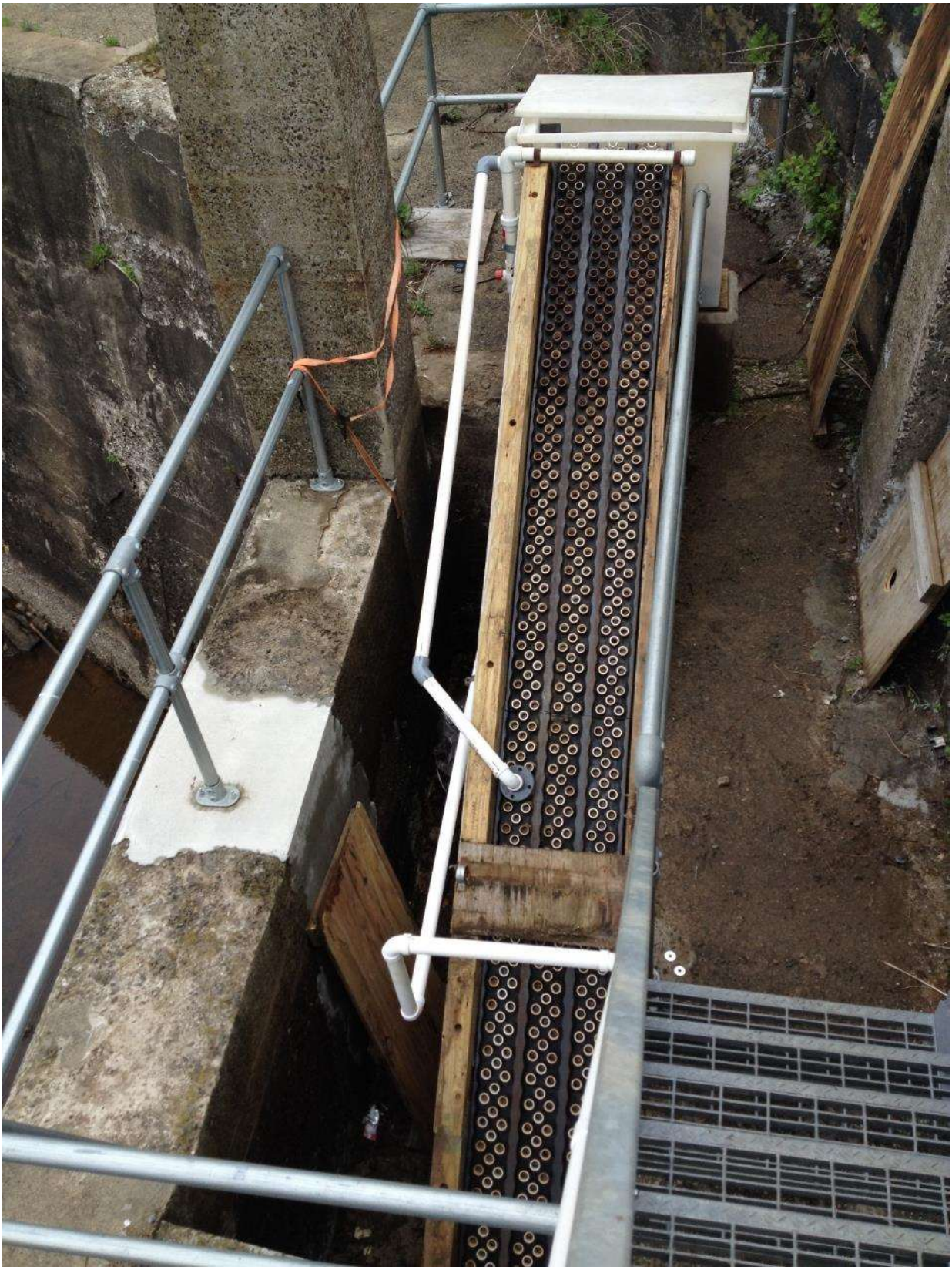

FIGURE 8: View of the upstream eel ladder at the Lawrence Project.

FIGURE 9: View of the North Canal Gatehouse.

FIGURE 10: View of the South Canal Gatehouse.

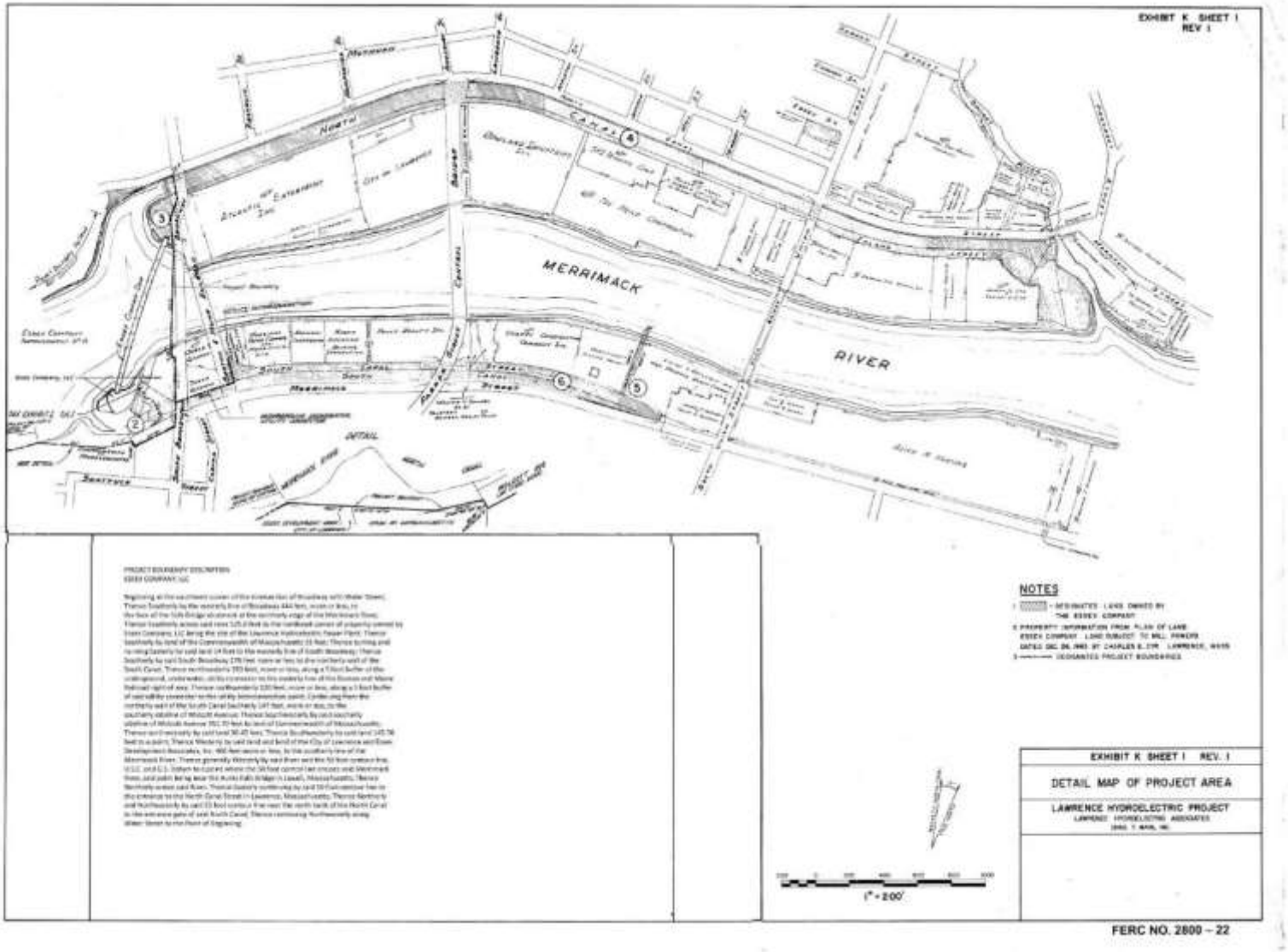

FIGURE 11: Exhibit K Detailed Map of the Project Area.

APPENDIX C
WATER QUALITY CERTIFICATE

40M-1-77-129302

402.2

THE COMMONWEALTH OF MASSACHUSETTS

WATER RESOURCES COMMISSION

DIVISION OF WATER POLLUTION CONTROL

110 TREMONT STREET, BOSTON 02108

OFFICE OF THE DIRECTOR

July 5, 1978

Dr. Kenneth Plumb, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street
Washington, D.C. 20426

Re: Water Quality Certification
Lawrence Hydroelectric Project
FERC License Application P-2800
Lawrence, Mass.

Dear Dr. Plumb:

This letter is written at the request of Lawrence Hydroelectric Associates, developers of a proposed 14.1 Megawatt generating station on the Merrimack River at Lawrence, Mass. The Associates have requested a letter from this Division as to the effect of the operation of the proposed facility on the water quality of the Merrimack River below the project.

The proposed development will be located at the existing Essex Dam in Lawrence, approximately two miles upstream of the outfall from the recently-completed Greater Lawrence Sanitary District Wastewater Treatment Plant. This plant was designed to produce an effluent of such quality and characteristics that, with a 7-day, 10-year low flow on the Merrimack River at the outfall, the assigned "B" classification of the river would be attained. The Division was concerned lest the regimen of the river would be so changed through the operation of the proposed facility that the Class B standard would be violated.

Staff of this Division have had numerous meetings and correspondence with staff of the developers. As a result, this Division has now received reasonable assurances from the applicant that the proposed project will be operated in a manner which will not cause a violation of applicable water quality standards adopted by this Division under authority of Section 27 (5) of Chapter 21 of the Massachusetts General Laws.

Therefore, based on these assurances and our own investigations, this Division hereby issues this Water Quality Certification relative to this project, in accordance with the provisions of Section 401 of the Federal Water Pollution Control Act as amended (Public Law 95-217), subject to the following conditions:

1. A minimum flow of 951 c.f.s. (equivalent to approximately 1,000 c.f.s. at the Greater Lawrence Sanitary District Wastewater Treatment Plant outfall) shall be continuously released from the impoundment behind the Essex Dam by whatever means or combination of means necessary to accomplish this release, unless or until the pool elevation behind the dam is so drawn down that it reaches the crest of the dam.

2. At such times, outflow released from the dam shall be equal to inflow as recorded at the U.S.G.S. Lowell, gage, during the period the flow is less than 951 c.f.s. When the flow exceeds 951 c.f.s., the excess flow over 951 c.f.s. may be utilized to refill the impoundment to the top of flashboards, whereupon Condition 1 above will again go into effect.

Should any violation of the water quality standards or the terms of this Certification occur as a result of the proposed activity, the Division will direct that the condition be corrected. Non-compliance on the part of the permittee will be cause for this Division to recommend the revocation of the permit(s) issued therefor or to take such other action as is authorized by the General Laws of the Commonwealth.

Very truly yours,

Thomas C. McMahon
Director

TCM/WAS/rew

cc: Gordon A. Marker, Lawrence Hydroelectric Associates, 8 Arlington Street, Boston 02116
David Standley, Commissioner, Department of Environmental Quality Engineering, 100 Cambridge Street, Boston 02202
Barbara Ingle, Deputy Commissioner, Department of Environmental Quality Engineering, 100 Cambridge Street, Boston 02202
Morgan Rees, Chief, Permits Branch, Corps of Engineers, 424 Trapelo Road, Waltham 02154
John J. Hannon, Director, Division of Land & Water Use, Department of Environmental Quality Engineering, 100 Nashua Street, Boston 02114
Matthew Connelly, Director, Division of Fisheries & Wildlife, 100 Cambridge Street, Boston 02202

APPENDIX D
WATER QUALITY CERTIFICATE CORRESPONDENCE

From: Kubit, Robert (DEP) [mailto:robert.kubit@state.ma.us]
Sent: Monday, January 6, 2020 1:52 PM
To: Anderson, Elise (Enel North America - USA) <elise.anderson@enel.com>
Cc: Wong, David W (DEP) <david.w.wong@state.ma.us>
Subject: Lawrence Hydro - WQC (FERC No. 2800)

Hi Elise,

In support of your pending application to the Low Impact Hydropower Certification Institute, the Massachusetts Department of Environmental Protection verifies the attached Water Quality Certification terms and conditions for the Lawrence Hydroelectric Project remain valid and in effect for the facility. If I can provide any further information, please let me know.

Bob

Robert Kubit, P.E.
Bureau of Water Resources
Division of Wetlands and Waterways
8 New Bond Street
Worcester MA 01606
(508) 767-2854
Robert.kubit@state.ma.us

From: Kubit, Robert (DEP) <robert.kubit@state.ma.us>
Sent: Wednesday, July 15, 2020 9:58 AM
To: Byrne, Stephen
Subject: RE: LIHI recertification of the Lawrence Project, FERC No. 2800, LIHI Certification No. 121

Good morning Steve,

The Massachusetts Department of Environmental Protection does not believe the operation or existence of the Lawrence Hydroelectric Project located at the Essex Dam on the Merrimack River causes or contributes to water quality impairments of E. coli, PCBs in fish tissue, mercury or total phosphorous either upstream or downstream of the dam.

Bob

Robert Kubit, P.E.
MA Department of Environmental Protection
Bureau of Resource Protection
Division of Wetlands and Waterways
8 New Bond Street, Worcester MA 01606
(508)767-2854; Robert.kubit@mass.gov

From: Byrne, Stephen <stephen.byrne@wsp.com>
Sent: Monday, July 13, 2020 4:49 PM
To: Kubit, Robert (DEP) <robert.kubit@mass.gov>
Cc: Splenda, Jot <jot.splenda@wsp.com>; Kevin Webb <kwebb@centralriverspower.com>
Subject: LIHI recertification of the Lawrence Project, FERC No. 2800, LIHI Certification No. 121

Mr. Kubit,

On behalf of Central Rivers Power, I am reaching out to you regarding the continued operation of the Lawrence Hydroelectric Project, located in Lawrence, MA, and Massachusetts Department of Environmental Protection's listing of the Merrimack River in the vicinity of the Project as impaired.

It is my understanding that the portion of the Merrimack River immediately upstream of the Essex Dam (segment ID MA84A-03) is currently listed as Impaired due to exceeding concentrations of E. coli, mercury and PCBs in fish tissue, and total phosphorous, and that the river immediately downstream of the dam (segment ID MA84A-04) is currently listed as Impaired due to exceeding concentrations of E. coli, PCBs in fish tissue, and total phosphorous. To the best of your knowledge, is the existence and operation of the Lawrence Hydroelectric Project the cause of these impairments upstream or downstream of the Project?

Thank you and please let me know if you need any additional information.

Steve

Stephen Byrne
Fisheries Biologist

Email: stephen.byrne@wsp.com

APPENDIX E
THREATENED AND ENDANGERED SPECIES IPaC REPORT

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Essex County, Massachusetts

Local office

New England Ecological Services Field Office

(603) 223-2541
(603) 223-0104

70 Commercial Street, Suite 300

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS

Northern Long-eared Bat Myotis septentrionalis No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Piping Plover Charadrius melodus There is final critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot Calidris canutus rufa No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1864	Threatened
Roseate Tern Sterna dougallii dougallii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2083	Endangered

Flowering Plants

NAME	STATUS
Small Whorled Pogonia Isotria medeoloides No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1890	Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

MIGRATORY BIRD INFORMATION IS NOT AVAILABLE AT THIS TIME

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
Parker River National Wildlife Refuge (978) 465-5753 (978) 465-2807 6 Plum Island Turnpike Newburyport, MA 01950-4315 https://www.fws.gov/refuges/profiles/index.cfm?id=53550	4,581.38 acres
Thacher Island National Wildlife Refuge (978) 465-5753 (978) 465-2807 C/o Parker River Nwr 6 Plum Island Turnpike Newburyport, MA 01950-4315 https://www.fws.gov/refuges/profiles/index.cfm?id=53554	17.09 acres

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX F
CORRESPONDENCE WITH MA DFW ON COMPLIANCE WITH LIHI CERTIFICATION CONDITIONS

Essex Company, LLC
A Subsidiary of Enel Green Power North America, Inc.

One Tech Drive, Suite 220 – Andover, MA 01810 – USA
T +1 978 681 1900 – F +1 978 681 7727

Via eMail

July 27, 2016

Dana Hall
Deputy Director
Low Impact Hydropower Institute
P.O. Box 194
Harrington Park, NJ 07640
dhall@lowimpacthydro.org

Re: Lawrence Hydroelectric Project (FERC No. 2800-MA);
LIHI Certificate No. 121 Condition Compliance.

Dear Ms. Hall:

Please find attached two email statements from the MA Department of Fish and Wildlife in response to Conditions 1 and 2 of the LIHI Certificate for the Lawrence Hydroelectric Project:

> **Condition 1.** Applicant will obtain a final letter from Massachusetts Department of Fish and Wildlife (or other agency recommended by MDFW) that confirms the facility and facility operations have no negative impact on the existence of Bald Eagle in the area, by August 1, 2015.
>
> **Condition 2.** Applicant will work with MDFW to improve effectiveness of eel passage at the site by July 15, 2016. This includes keeping elvers off dam by eliminating or rerouting leakage. Applicant will obtain letter from MDFW by July 15, 2016 that confirms passage measures are adequate.

We trust that the attached statements are sufficient to satisfy the requirements of these two conditions. According to our records the Annual Compliance Statement was emailed to you by Mr. Randald Bartlett on March 22, 2016.

Please do not hesitate to contact me at (978) 935-6039 if you have any questions concerning this matter.

Sincerely,
Essex Company, LLC

Kevin M. Webb
Hydro Licensing Manager

cc: R. Bartlett, EGPNA

From: Marold, Misty-Anne (FWE)
To: Webb, Kevin (EGP North America)
Cc: Giorgino, Lauren (FWE)
Subject: RE: LIHI Certification requirements for Lawrence
Date: Tuesday, July 19, 2016 2:43:05 PM
Attachments: image002.png

RE: NHESP No. 15-34520, Essex Dam, Lawrence Hydroelectric Project, FERC No. 2800-MA

Kevin,

The Massachusetts Division of Fisheries and Wildlife (Division) is the agency responsible for the protection and management of the fish and wildlife resources of the Commonwealth. The Division is also responsible for the regulatory protection of imperiled species and their habitats as codified under the Massachusetts Endangered Species Act (M.G.L. c.131A; 321 CMR 10.00). This email is to confirm that the Division is satisfied that the facility and facility operations have no negative impact on the existence of Bald Eagle in the area.

The Division conducts annual nesting Bald Eagles surveys. Feel free to periodically contact us to determine if we have discovered any nesting pairs in and around the facility. Each year, we detect a few totally new nests with new pairs, and some existing pairs move their preferred nesting location. In such a circumstance, we work with operators to implement best managements practices to avoid impacting any trees used for nesting.

Best, Misty-Anne

Misty-Anne R. Marold, Senior Endangered Species Review Biologist
Massachusetts Division of Fisheries & Wildlife
Natural Heritage & Endangered Species Program
1 North Drive, Rabbit Hill Road
Westborough, MA 01581
Direct: 508-389-6356| Fax: 508-389-7891

From: Slater, Caleb (MISC) [mailto:caleb.slater@state.ma.us]
Sent: Thursday, July 07, 2016 3:31 PM
To: Webb, Kevin (EGP North America)
Subject: RE: LIHI Certification requirements for Lawrence

Kevin,

This email is to confirm that the Division is satisfied that the eelway, and improvements to it, constructed at the Essex Dam in Lawrence does in fact meet the LIHI certification condition to improve juvenile eel passage at the facility. I look forward to working with you in the future as we strive to further improve juvenile eel passage at the facility.

Caleb Slater

Caleb Slater, PhD
Anadromous Fish Project Leader
Massachusetts Division of Fisheries and Wildlife
1 Rabbit Hill Road

Westborough, MA 01581
508-389-6331
www.mass.gov/masswildlife

From: Webb, Kevin (EGP North America) [mailto:Kevin.Webb@enel.com]
Sent: Thursday, July 07, 2016 11:27 AM
To: Slater, Caleb (FWE)
Subject: LIHI Certification requirements for Lawrence

Caleb:

As you & I discussed following the Tech Committee meeting here in Andover, we will need a couple of brief letters from you relative to our LIHI certificate compliance conditions for Lawrence. We will need a letter or letters addressing the following conditions:

> **Condition 1.** Applicant will obtain a final letter from Massachusetts Department of Fish and Wildlife (or other agency recommended by MDFW) that confirms the facility and facility operations have no negative impact on the existence of Bald Eagle in the area, by August 1, 2015.
>
> **Condition 2.** Applicant will work with MDFW to improve effectiveness of eel passage at the site by July 15, 2016. This includes keeping elvers off dam by eliminating or rerouting leakage. Applicant will obtain letter from MDFW by July 15, 2016 that confirms passage measures are adequate.

Please don't hesitate to contact me if you have any questions or concerns about either of these conditions – note my new phone number below. Thanks again for your assistance with this.

Kevin

Kevin Webb
Hydro Licensing Manager
O&M: Environmental Compliance & Regulatory Services

Green Power

Enel Green Power North America, Inc.
One Tech Drive, Suite 220 – Andover, MA – USA
T +01 978-935-6039
Kevin.Webb@enel.com

APPENDIX G
FISHWAYS OPERATION AND MAINTENANCE PLAN

Fishways Operation and Maintenance Plan

Lawrence Hydroelectric Project (FERC No. 2800-MA)

Prepared For
Essex Company, LLC
100 Brickstone Square, Suite 300
Andover, Massachusetts 01810

Prepared By
Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110
www.normandeau.com

October 17, 2019

RECORD OF CHANGES

Revision ID	Date of Issue	Modifications
Revision 1	Jan. 31, 2019	Initial draft
Revision 2	May 16, 2019	Incorporates responses to initial USFWS comments provided to Enel on March 11, 2019
Revision 3	June 7, 2019	Incorporates additional information from Enel based on USFWS comments
Revision 4	October 17, 2019	Provides post-season and updated content revision from agency review, on-site post-season inspection

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1 Introduction

This Fishway Operations and Management Plan (FOMP, Plan) details the operations, maintenance, and record keeping required to operate the fish passage facilities at the Lawrence Project (FERC No. 2800) owned by Essex Company, LLC (Essex; a subsidiary of ENEL Green Power North America, Inc.). This Plan describes the existing upstream fish passage facility located at the Lawrence Project (Project), the period in which the facility will be operated, pre and post season checks and maintenance, annual start-up and shut-down procedures, operating procedures and guidelines, and established maintenance/safety guidelines. In addition to the above described procedures and guidelines, pertinent contact information will also be included. This FOMP has been developed as a "living document" and will be updated on an as needed basis to reflect modifications to fishway operations that may be implemented following future consultations with the resource agencies comprising the Merrimack River Technical Committee (Technical Committee)[1].

2 Project Facilities and Structures

The Lawrence Project is located on the Merrimack River in the city of Lawrence, Essex County, Massachusetts. The Project works (Figure 2-1) consist of: (1) a 33-foot high, 900-foot-long dam of rubble masonry construction with five-foot-high inflatable flashboard system; (2) a 9.8-mile-long reservoir having a surface area of 655 acres at normal high water elevation 44.17 feet mean sea level (msl) and a maximum storage capacity of approximately 19,900 acre-feet; (3) the existing South Canal, approximately 35 feet wide and 10 feet deep, originating at the south abutment of the Essex Dam and generally paralleling the Merrimack River bed, below the Essex Dam, for a distance of approximately 2,750 feet; (4) the existing North Canal, approximately 95 feet wide and 15 feet deep, originating at the north abutment of the dam and paralleling the Merrimack River below the dam for a distance of approximately 5,300 feet; (5) fish passage facilities including a fish elevator installed at the dam, a downstream fish bypass and an eel ladder; (6) a powerhouse containing two identical (horizontal, double-regulated, 128.6 rpm Kaplan bulb turbines manufactured by Allis-Chalmers) hydroelectric generating units with a combined hydraulic capacity of ~8,000 cfs and a tailrace channel extending into the Merrimack River; and (7) appurtenant facilities.

The Project is operated in a run-of-river mode through use of an automatic pond level control system (PLC). The upstream fish passage season typically begins annually in late April and continues through mid-July and from mid-September through October, with final operation schedule determined in consultation with resource agencies. Upstream fish passage lifts generally occur between 8:00am to 4:00pm daily during the operational period and at river flows up to 25,000 cfs with a 120 cfs attraction flow provided for the fish elevator system. The downstream fish passage bypass operation typically begins annually on April 1 and continues

[1] The Merrimack River Technical Committee is comprised of representatives from the U.S. Fish and Wildlife Service, Massachusetts Division of Fish and Wildlife, Massachusetts Division of Marine Fisheries, New Hampshire Fish and Game Department, and the National Marine Fisheries Service.

through mid-July and from September 1 through November 15, with final operation schedule determined in consultation with resource agencies.

The Lawrence Project's dam is equipped with an inflatable crest gate system. The system varies air pressure to adjust gate height to maintain normal headpond elevation at the Project based on river user needs, flow and weather conditions. The installation of the system eliminated the need for impoundment drawdowns required for flashboard replacement, enhanced river debris management with reduced debris build up near the dam, enhanced high flow condition management and reduced false fish attraction away from the fish passage facilities often caused by board leakage and partial board loss.

2.1 Fish Passage Facilities

Fish passage facilities at Lawrence include a fish lift, a downstream bypass, a permanent eelway on the south side and an interim eelway on the north side of Essex Dam (Figure 2-1).

2.1.1 Lawrence Fish Lift

The upstream facility at Lawrence is an elevator type lift with a designed total operational flow (both entrances) of 200 cfs with 50 cfs supplied through the upper fishway channel and the remaining 150 cfs supplied through floor diffusers in the lower fishway attraction channel (Appendix A). The collection gallery has a pair of entrances located in the powerhouse tailrace (i.e., weir 1 and weir 2). At present the lift system is operated with weir 1 only. Following an evaluation of internal efficiency (Normandeau 1996), entrance weir 2 was closed and a cut-off wall was installed at the junction of the two entrance channels. Attraction flow run with the single entrance open is ~100 cfs, but is varied according to USFWS-developed operating guidelines. Fish are attracted into the crowding channel and trapped by a set of pneumatic weir gates that crowd the fish into the elevator bay. Fish are then lifted by the hopper and released into the holding channel and are counted as they pass through the fish trap and counting station. From the fish trap/counting station, fish are able to volitionally exit the facility and have access to the reach of the Merrimack River extending upstream towards Lowell. Monitoring of fish passage is performed by Massachusetts Division of Fisheries and Wildlife (and/or Division of Marine Fisheries) staff, supplemented at the exit flume counting window by video recording (SalmonSoft).

2.1.2 Lawrence Downstream Bypass

The downstream bypass at Lawrence is located at the powerhouse on the south side of the river. The bypass gate is mechanically-driven and operates to provide surface spill from the adjacent forebay, providing 2% of turbine flow, typically adjusted daily.

2.1.3 Lawrence South Permanent Eelway

A concrete eel ladder was constructed at the south toe of the Essex dam in 2012, per agreement with the Technical Committee for the Restoration of Anadromous Fish to the Merrimack River and per the project's approved Comprehensive Fish Passage Plan. The eel ladder consists of 4 switch backed concrete ramp section of various lengths that total

approximately 40-feet in length with a slope that does not exceed 40°. Ladder sections are fitted with 18-inch milieu plastic elver substrate (1-inch stud spacing) on all ramp surfaces. The ladder terminates at a 120-gallon flow-through plastic collection tank. The ladder water supply, including attraction water, is supplied by a 300-gallon per minute submersible pump located in the headpond. A distribution valve system allows flow balancing between the tank and ladder attraction water. An enclosed attraction flow pipe is available for use if high flows damage the ladder or regular flow pipe. The installed eel ramp is depicted in drawings in Appendix A.

2.1.4 Lawrence North Interim Eelway

A temporary structure is planned for installation along the Northern toe of Essex dam in 2019. The current plan is to establish a basic ramp and trap style eelway similar to the interim structure established by USFWS in 2018. The eelway will be supplied with water from the headpond.

2.2 Operational Period

2.2.1 Lawrence Fish Lift

The FERC-approved Comprehensive Fish Passage Plan (CFPP; revised March 2000) for the Project requires that operation of the fish lift commence as reasonably requested by the Technical Committee on or about May 1 of each year. However, based on downriver observations, river conditions (flow and temperatures), or other appropriate information, the Lawrence fish lift may begin operation at an earlier or later date. To the extent safely possible, the fishway will be operational when river flows at Lawrence range from 500 cfs up to 25,000 cfs. The typical daily lift operation period occurs from 0800-1600 on an hourly basis, although during high passage periods lifting can occur at more frequent intervals, and from 0700-2000 if necessary. Termination of the upstream passage season is determined in consultation with the Technical Committee and usually occurs in mid-July. The lift is operational up to Merrimack River flows of 25,000 cfs (based on USGS gage 01100000 Merrimack River below Concord River at Lowell, MA).

2.2.2 Lawrence Downstream Bypass

The downstream bypass is operated on a 24-hour basis from April 1 through July 15, and from September 1 to November 15. Modifications to this schedule (in terms of dates and hours of operation) may be made upon mutual agreement with the MTC or by FERC order.

2.2.3 Lawrence South Permanent Eelway

The designated start date for the permanent eelway is May 1 although the actual start date can be dependent on river conditions during the spring set up period. The eelway operates through September 30.

2.2.4 Lawrence North Interim Eelway

This eelway is proposed to operate between July 15 and September 30. The actual start date will vary based on the ability to safely access the toe of Essex Dam.

2.3 Attraction Flow

2.3.1 Lawrence Fish Lift

Fish enter the tailrace and are attracted to the lift by approximately 100 cfs of attraction flow (3% of station capacity) supplied from the powerhouse forebay, using operating condition guidelines established and provided by USFWS (USFWS operating guidelines, Table 4-1). Attraction water to the Lawrence fish lift is supplied to the entrance via two intakes, both of which are located in the floor of the exit channel. The "water circulation pipe" is designed to draw 50 cfs through the intake grating that is located at the most downstream end of the exit channel. A slide gate at the entrance of the pipe is used to regulate the flow. This circulation flow is discharged to a diffusion chamber located just upstream of the hopper pit and then flows through the crowder channel to the entrance gates. The 50 cfs circulation water is left on continuously during the fish passage season to help reduce the accumulation of debris at the lift entrance. The major AWS component at Lawrence supplies up to 150 cfs through the intake grating that is located just upstream of the counting window, controlled via an orifice located in stilling basin. Downstream of the control basin, the attraction water pipe supplies the flow to the diffusion chamber located below the entrance channel floor elevation on the downstream end of the river-side entrance channel, where it then flows up through grating to the entrance channel. The 150 cfs attraction water is turned on daily at 0600 and shut down after the final lift of the day. Actual daily attraction water flow settings are adjusted per USFWS-supplied 'operating guidelines' and consider tailwater elevation and fishway differential, overall fishway flow, turbulence, etc. to establish best passage conditions (Table 4-1, USFWS 2017).

2.3.2 Lawrence Downstream Bypass

There is no additional attraction flow associated with the downstream bypass system.

2.3.3 Lawrence South Permanent Eelway

Attraction flow to the permanent eelway at Lawrence is provided by a 300 gpm submersible pump. The flow to the ladder and tank is field-adjusted, with the remainder bypassed to the entrance of the ladder as attraction flow.

2.3.4 Lawrence North Interim Eelway

Similar to the permanent eel passage structure on the south side, the interim eelway has attraction water and tank/ramp supply water provided by submersible pump (in this case, two ½ hp pumps). Attraction and eelway flow are monitored and adjusted by valves and a manifold to provide optimal flow to the interim ladder.

2.4 Unit Prioritization

At present, Essex operates the Lawrence turbines in a balanced load fashion across both units during the upstream fish passage season. For various mechanical or electrical reasons, it is sometimes necessary to operate or prioritize a single unit. Currently there is no official priority given to unit sequencing associated with upstream fish passage.

Figure 2–1. Major features of the Lawrence Hydroelectric Project.

3 Fish Passage Training and Safety

3.1 Staffing

Staffing for the Lawrence fish lift is provided by Essex, while Massachusetts and other Technical Committee agencies conduct counting, trap and transport and scientific tasks related to passage. Three seasonal employees under the supervision of the permanent Essex operations staff are hired and retained at Lawrence for the duration of the fish passage season. Two staff members from the Massachusetts Division of Fish and Wildlife (and/or Division of Marine Fisheries) are on site daily during the fish passage season. Because passage conditions and priorities can change quickly, these individuals are responsible for determining the daily duration and frequency of fish lifts at Lawrence.

3.2 Training

Each seasonal staff member receives the same general safety and operations training consistent with that provided to permanent Essex employees. In addition they receive site-specific training necessary to safely perform the duties required to operate the Lawrence fish lift. Additional training, offered by USFWS, is available annually for Essex's seasonal staff if they are available to attend on the scheduled date and time.

3.3 Safety

Safety training for temporary staff is the responsibility of Essex. The following guidelines refer specifically to staff working on site and agency or other visitors at all Lawrence fishways and should be used in conjunction with the training and rules applicable to all Enel sites.

3.3.1 On-site Safety and Personal Protective Equipment

- Hardhats: A Type I Class E is to be worn at all times on site by personnel (excluding in the counting room).
- Safety Glasses: Safety glasses meeting ANSI Z87.1 standard (or approved prescription glasses with side shields) will be worn at all times on site
- Clothing:
    - Long pants and long/short sleeve shirts are required, short pants and tank tops are not acceptable
    - ASTM F 2413 (or ANSI Z41) rated, I/C protective-toe, EH designated boots with a minimum 6-inch ankle height must be worn on site
- Hoists: All hoist operation is to be conducted by Essex operations staff only.
- All incidents are to be reported to Essex host immediately.
- Agency personnel are permitted in established work areas only and are required to have the appropriate clothing and PPE to be on-site.

- Initial site safety review to counting personnel will be provided, including work area review, site protocols and access, unusual conditions, personal protective equipment, etc. Notify Essex host if any new personnel are to be brought onsite that have not received site safety review.
- A daily Job Hazard Analysis form discussing the daily work to be conducted and the potential hazards/safety measures that will be present is to be read and discussed by staff prior to initiating daily work.

3.3.2 Fish Rescue and Restricted Areas Access

- Restricted areas are considered to be any area other than working deck, counting room, hopper dump area, or control room. Restricted areas include, but are not limited to:
  - The dam toe
  - Retaining walls
  - Interior of fish ladder
  - Tailrace walls
- Access is limited to agency personnel pre-approved by Essex Project staff. Approval from on-site Project staff must be obtained for each access event.
- Personnel must be equipped with appropriate safety gear in addition to standard PPE if required for specific tasks or accessing certain areas. Additional safety items may include:
  - Life vest
  - Safety harness
- Spotters are required for all fish rescue and restricted area access as well as during the backing up of tank trucks on site.
- Established exclusion barriers will be clearly identified and must be respected at all times.

3.3.3 Scheduling and Communication

- Lift timing and duration requests beyond the 0800-1600 hour time frame are to be conveyed clearly to staff as soon as determined.
- Any items or plan modifications must be noted to Project staff as appropriate.

3.3.4 Volunteers or Visitors

- No photos or video footage without prior authorization from Essex.
- All visitors must be approved by Essex.
- Essex 'Release and Waiver' executed by ALL non-agency personnel prior to entering the property for any site activities.
- Essex 'Release and Waiver' execution rests entirely with volunteer/visitor

- Site access log (sign in/out) to be completed by all personnel.
- Visitor badge may be required of all visitors, obtained when completing the site access log and must be worn in a visible location at all times on-site.
- Failure to comply with indemnification, access log and badge requirements will result in ejection from the site, at the Project's discretion.
- All volunteers and other visitors may be subject to background checks.

3.3.5 Agency Personnel

- Verifiable agency ID may be requested of agency personnel.
- Responsibility for 'Release and Waiver' execution rests entirely with agency personnel.
- Site access log (sign in/out) to be completed by all agency personnel.
- Visitor badge may be required of all agency personnel, obtained when completing the site access log and must be worn at all times on-site.

4 Operations and Maintenance

4.1 Lawrence Fish Lift

4.1.1 Off-Season Maintenance

In general, the Lawrence fish lift is dewatered and then visually inspected for damage and necessary repairs, after the close of each upstream passage season. Debris is removed and all critical components are serviced as necessary (e.g. grease/lube/clean/inspect/test). Common deficiencies to be inspected, include but are not limited to, concrete cracking and deterioration, surface defects, rust, displacement, deformation, leakage and seepage, erosion, insufficient drainage, overgrown vegetation, debris, sedimentation, and vandalism. At all locations where grating or brailles are present, sections will be visually inspected to ensure good condition and that all fasteners are intact and secure. Inspection and maintenance performed prior to the fish passage season is recorded on an inspection checklist (Appendix B) with notes added for areas requiring additional servicing or to confirm maintenance (e.g. part replacement). In addition to annual maintenance tasks listed here, Essex will address all items listed on any Agency provided inspection list prior to the season (targeted date of April 15).

4.1.2 Off-Season Maintenance Procedures

The following off-season procedures are necessary to maintain the Lawrence fish lift in working condition.

- Address all items listed on agency-provided inspection list
- Grease all gears and gearboxes (including hoist boxes), bearings and chains including: attraction water gates, crowder, separation gate, hopper hoist and chain, hopper door,

fish trapping equipment at counting station, gate stems, and attraction water inlet gate operators.

- Test run all motors for entrance gates, crowder, fish hopper, separation gate, upper weir gate, repair as necessary.
- Check all hoists operation and limit switches. Have all hoists inspected by MA Crane and Hoist (or other reputable company). Follow any recommendations.
- Acquire necessary seasonal visitor safety equipment (e.g. safety glasses, hard hats, boots, etc.).
- Perform and document overall safety check on: rails, fencing, and on electrical, tripping hazards.
- De-water upper fishway:
    - Remove debris from upper fishway.
    - Check and ensure all fishway gratings are in good condition, in their proper place, and fastened securely in place.
    - Inspect air system piping to counting room.
    - Check all fishway fencing.
    - Replace wood planks at hopper dump area (as necessary).
    - 50 cfs slide gate: clean, lubricate, and check operational status.
    - 150 cfs attraction water valve system/valve chamber: Clean, operate and assess working condition of the 150 cfs valve and piping for use during fish passage season.
    - 50 and 150 cfs intake grating: inspect grating to verify it is intact, fish cannot pass through any openings and that grating is firmly attached.
    - Trapping station: install diversion grating as necessary to divert fish to window and prevent debris into hopper and lower fishway, ensure grating is properly secured and gaps do not exist between the structure and the concrete for fish passage season.
    - Exit gate: check lubrication, note equipment condition, test functionality.
    - Viewing window: clean both sides, note damage, and provide access to long handled cleaning brush.
    - Clean or replace panel opposite count room window.
    - Clean off fish trap brailles opposite counting window.
    - Counting room: clean and prep for fish passage season (Operate and perform maintenance on trapping gates and air supply, test heaters, test vent system, test sump pump).

- Install surface trash boom at fish way exit and suspended grating to reduce fishway debris (SPRING ONLY).
- Check and clean/reroute supplemental water pump and piping, verify operation.

- De-water lower fishway (should occur AFTER work on upper channel):
  - Ensure dewatering pump is available and functioning, clear debris from lower fishway.
  - Inspect crowder rubber flaps for any tears, etc. and repair or replace as necessary.
  - 50 cfs discharge grating: inspect grating to verify it is intact, fish cannot pass through any openings and that grating is firmly attached. Remove enough grating at exit of 50 cfs tube to allow for visual inspection or to remove any trapped debris. Inspect and clean/repair/secure as necessary.
  - 150 cfs discharge grating: Check fishway grating to ensure it is in good condition and securely fastened with hardware in good condition, check and secure blinding plates, check and secure diffuser grating. Inspect flow vanes and clean/repair as necessary. Provide photographic documentation to verify all systems are appropriately clean and ready for fish passage season.
  - Inspect structural steel and fasteners, repair or replace as required.
  - Evaluate condition, clean, lubricate and run the fishway to ensure it operates properly prior to fish passage season. Assess and repair/replace crowder air lines. Correct any drag or binding of the crowder doors.
  - Inspect entrance gate seals. Tighten bolts as required. Clean any debris from below elevator. Run elevator to full lowered position. Check that top of elevator is below concrete that crowder runs on.
  - Inspect plates and grating in crowder floor, tighten or replace fasteners as necessary.
  - Lower separation gate to lower limit, check that gate is flush with concrete floor, adjust limit switch as necessary. Lubricate and ensure working.
  - Repair or replace separation gate bars as necessary to exclude fish.
  - Place crowder in fully "fished" position, adjust limit if clearance is greater than 8 inches.
  - Inspect screening on crowder (full depth). Repair or replace screen (screen type ¾" #9 expanded metal) as necessary to avoid gap sizes capable of gilling passing fish.
  - Inspect fish hopper door seal in actual operation, repair or replace seal if necessary. Clean and paint fish hopper, check /replace door wheels and pins, test hoist, check compressor, lines, routing and attachment for hopper.

- Ensure the hole that was plugged within the entrance channel is still plugged, a 2017-noted corrective measure
- Inspect cut-off screen within entrance gallery for gaps between concrete

- Calibrate differential gages at fishway entrance (SPRING ONLY).
- Install and test video recording system at counting window (SPRING ONLY).

4.1.3 Spare Parts List

Mechanical:

- Master links for crowder chain
- Master links for main hopper chain
- Hopper wheels
- Spare limit switch parts
- 2 rail bearing for crowder arms
- Air hose
- Grating
- Mesh screening for crowder (3/4" #9 expanded metal).
- Expanded metal and sheet rubber for crowder/hopper repairs

Electrical

- Main hoist
  - Brake contactor
  - Control transformer
  - Rectifier bridge
- Small hoists
  - Trolley contactor
  - Hoist contactor
  - Control transformer
  - Main contactor
  - Push-button switch
  - Spare contact sets
  - Overload heaters
  - Rectifier bridge

- Limit switches

4.1.4 In-Season Operations & Maintenance

The following section describes the daily operational steps that will occur at the Lawrence fish lift. The General, Debris Management, and Fish Count sections are a daily occurrence while other steps (Crest Gate/Spill Protocol, Outage Protocols, Sections 5, 6) are conducted as necessary (e.g. lift break down, river flow exceeding station capacity). Throughout any given day of operations at the Lawrence fish lift it is important to maintain communications with Boott personnel at Lowell. Operations at Lowell (i.e., increase/decrease in flows) can impact Lawrence soon after initiation upstream. Knowledge of potential changes occurring in the river is essential for maintaining fishway differentials as well as operational safety.

4.1.5 Operational Procedures

Prior to the first fish lift of the day, the following items must be addressed:

- At 0600, attraction water (150 cfs) is turned on.
- Proceed to the 150 intake valves and inspect the discharge grate of the 150 pit for upwelling or other signs of debris build up. If build up is present then inform Essex personnel and preparations will be taken to remove when feasible (photo documentation should be included to verify debris free system).
    - Open each valve (4 total) approximately 1 foot to fill chamber and send flow down to the lower fishway. Water will rise up through the floor below the crowder system.
    - Check tailwater elevation and adjust 150 cfs AWS as described in Section 4.1.8.
- Open the entrance gate control panel and check differential gage.
- Check status of entrance gate and that water is flowing over the gate and that differential is appropriate (Section 4.1.8).
- Adjust entrance gate so that differential is between 0.5-1.2 feet measured at the entrance gate differential meter located in the control box at the top of the control room stairs, or as shown on project PLC screen.
- Confirm crowder is in the fishing position (i.e., all the way downstream and gates open approximately 2.0 feet).
- Separation gate is up and in fishing position.
- Fish hopper is down.
- Check the exit grating barrier for debris.
- Inspect and ensure that 50 cfs AWS slide gate is in the open position. This should be on continuously during the fish passage season.
- Inspect the 50 intake/hopper dumping door area.

- Counting window is clean and camera is operating
- Counting gate is normally open

Unless otherwise arranged, the first lift of the day is scheduled for 0800. Lift operations will typically be performed hourly up until 1600. During the peak of the fish passage season, lift events may begin as early as 0700 and extend beyond 1600 up until conditions are no longer safe to do so (i.e., darkness). Daily duration and frequency of fish lifts at Lawrence will be determined by the fishery agency personnel on site, responsible for counting fish and collecting data. Seasonal Essex employees or operations staff should collect the data necessary to complete the Lawrence Fish Lift Daily Inspection Form (Appendix C-1).

Fish lift operations will occur using the following steps:

- Close crowder doors by turning and holding the close switch for the separation gate in the control panel.
- Once doors are closed, drive the crowder to the trap position (i.e., all the way up to the separation gate) by pressing the upstream button on the fish crowder controls in the main control panel.
- Lower the separation gate by pressing and holding the lower button for the separation gate in the main control panel.
- Raise the hopper by pressing the start button and then press and hold the raise button in the control panel (*watch and listen to hoist, chains, and hopper to ensure nothing is malfunctioning*).
- When hopper is raised to the point when it starts to become no longer visible and meets the concrete wall, stop and use the 50 cfs control area control station.
- At the 50 cfs control area continue to raise the hopper by switching the hand/auto switch to manual then press and hold the raise button located at the 50 cfs control box. The hopper door will ride up and over the dumping door ramps allowing the bucket to empty
- When the door falls open, release the raise bucket switch.
- Be prepared to turn on additional flow pump(s) to help assist any fish in the bucket as well as rinse the bucket of any sand.
    - Shut off additional flow pump once hopper is empty and rinsed.
- From the 50 cfs control box, begin to lower the hopper by depressing the lower button. (*Watch dumping door wheels and make sure they pass smoothly through the track flaps and the hopper returns to its original position so operations from above can be completed*).
- Return the hand/auto switch to auto, close box door and head up to the main control panel.

- Continue to lower the hopper door down to the lower limit, stopping and allowing the hopper to fill when it reaches the water line.
    - NOTE – the bucket will float and slowly sink as it takes on water. During this time the chains become slack and it is important to minimize hopper "floating". If too much slack occurs bucket can sink rapidly and jam. Once hopper is ~95% lowered it will go into slow speed for remainder of lowering distance.
- Retract the fish crowder by pressing and holding the downstream button on the fish crowder controls in the main control panel. – This step should take place at the same time that the hopper is raised (bullet 4)
    - It is safe to open the crowder doors to the 18-24 inch mark when the crowder red line matches the red line on the wall approximately 10 feet downstream.
    - If doors are opened too soon they will impact the separation gate and may cause damage.
    - Continue reversing the crowder all the way to the downstream fishing position limit – watching to ensure the crowder and crowder hose do not get hung up or over travel.
- Raise separation gate to the upper limit out of the water or until the red marks line up.
    - Bottom of gate must be above water level and is accomplished by pressing and holding the raise button for the separation gate located in the main control panel.
- Confirm entrance gate differential is still the normal range of 0.5-1.2 feet (adjust if needed).

Prior to the final lift of the day, relevant data (i.e., river flow (cfs), generator output (kW), forebay and tailrace elevations, gate opening settings for the 50 and 150 cfs attraction water, entrance differential (ft)) should be collected by lift staff prior to completion of the lift. Following the last lift Essex will ensure:

- Close the (4) 150 valves located at the upstream end of the fishway which will drain the 150 chamber and reduce flow out the entrance gate.
- Close and lock the main control panel and the entrance gate panel.
- The 50 cfs attraction flow is left on overnight for debris management.
- Ensure that the crowder gate (near the counting window) is in its open position such that any fish that have not exited the exit channel has the opportunity to exit during the evening

Any truck and transport operations scheduled are the responsibility of the agency personnel in charge. Essex seasonal employees will provide assistance when possible but must continue to adhere to the on-site safety procedures outlined in Section 3.

4.1.6 Debris Management

In addition to debris removal from the lift conducted prior to the start of the passage season, debris should be removed from the upper and lower lift areas, the hopper, the downstream bypass, and any entrance or exit areas at the onset of each day and prior to the first lift. Any debris attached to grating (near the counting window, attraction water, etc.) should be removed before lifts are initiated.

Maintenance of the following structures will help prevent debris accrual within the lift:

- Ensure trash rack system upstream of exit gate is maintained at a proper height (extending above the water surface).
- The 50 cfs AWS should remain on during the fish passage season.

4.1.7 Fish Counts

Visual Counts

Visual count estimates of the species and number of individuals will be provided for each lift in accordance with the guidelines supplied by the MTC (Appendix C-2). Counts and pertinent Project and river conditions at the time of each lift are recorded and an example is provided in Appendix C-2. In general, agency staff on hand are responsible for counts and data records. However, all Essex staff should be prepared to assist in this process. An example of hourly records required for each lift are shown in Appendix C-2 and include the following items:

- Date and time of lift operation
- Name of lift operator
- Headpond and tailwater elevation (ft)
- River temperature (°C) and flow (cfs)
- 50 valve setting (inches)
- 150 valve setting (ft. elevation)
- AWS (cfs)
- % Hydraulic discharge – this value is calculated by the program and does not need to be recorded
- Amount of spill (cfs)

- Unit 1 flow (cfs)
- Unit 2 flow (cfs)
- Entrance gate setting (ft)
- Entrance gate drop (ft)
- V-trap opening (inches)
- Fish counts (by species)

Beginning in 2018-19, trap operation protocol at the count window has included leaving the trapping gates open continuously, during the lift day, and overnight.

Video Recorded Counts

In addition to count estimates, recorded visually, at the count window (from Massachusetts agencies) for each fish lift event, seasonal fish counts at the Lawrence fish lift are recorded by SalmonSoft video software. Prior to the onset of the fish passage season, system components will be inspected to ensure working condition, installed and tested. Equipment and supplies necessary for installation of fish monitoring equipment include:

- Computer with enough processing power to continuously run Salmonsoft fish counting software for multiple months,
- Tripod or similar device for mounting camera,
- Digital video camera preferably with built-in infrared light,
- Dazzle Video Capture USB v1.0 digital video converter,
- Uninterruptable Power source (UPS device for backup power during outages),,
- External hard drive or USB flash drive with 64+ GB of space,
- Extension cords,
- Zip Ties,
- Electrical tape.

Installation of the video recording hardware will occur in the following order:

- Plug in UPS and ensure that the backup battery is charged or charging.
- Plug in (to UPS) and power on computer (pre-loaded with SalmonSoft software).
- Plug Dazzle digital video converter into USB port on computer.
    - Confirm that the blue light on the video converter illuminates.
- Plug in external memory device to a USB port on the computer.
- Open SalmonSoft "FishCap".
    - Click "Change Parameters".
    - Select "Dazzle" from "Capture Driver" drop down menu.

- Mount camera to desired mounting device and plug camera's power adapter into UPS.
- Plug camera's video cable into Dazzle video converter.
- If camera and video converter are plugged in and powered on properly, you should now see the live video feed in the open Salmonsoft window on the computer.
- Use the video feed as reference to adjust the camera so that the fish ladder window is adequately framed.
- Use zip ties and/or electrical tape to solidify pieces of the installation to prevent equipment from becoming unplugged or moved between system checks.
- Navigate through the parameters menu to input the prescribed settings for the project, and to select the desired saving location.

Prior to the start of each lift day, the counting system will be maintained by:

- Cleaning the window and board to ensure optimal viewing of fish as they passing counting room.
- Check angle and view of camera on screen to ensure it is optimally covering the viewing window and has not be moved or altered to a non-optimal position.
- Check and verify that the video system (SalmonSoft) is actively working, recording and has enough drive space available to continue operating throughout the passage day.

Detailed instruction on how to check and verify that the video counting system is on and working are presented in Appendix D.

4.1.8 Attraction Flow and Entrance Differential Adjustment Procedures

Attraction water systems and entrance differentials should be maintained based on the recommendation table 4-1 below. Attraction water and weir gate setting recommendations are based on tailwater elevation to provide appropriate flows and a fishlift/tailwater height differential that falls between the minimum and maximum identified.

Table 4–1. Recommended weir gate setting (ft) and target attraction flow setting (cfs) values at Lawrence fish lift, recommended by USFWS to achieve a target differential of 0.5-1.2 ft and entrance velocity of 4-6 fps based on tailwater elevation (ft).

TARGET AWS (cfs)	Tailwater Elevation (ft)	Recommended Gate Setting (ft above entrance invert)	Estimated Differential (ft)	Estimated Entrance Velocity (fps)
	13			
	13.25			
	13.5			
	13.75			
	14			
	14.25			
	14.5			
	14.75			
	15			
	15.25			
	15.5			
	15.75			
	16			
	16.25			
	16.5			
	16.75			
	17			
	17.25			
	17.5			
	17.75			
	18			
	18.25			
	18.5			
	18.75			
	19			

While the 50 cfs AWS should remain in the 'on' position during the entirety of the fish passage season, the means of operating each of the AWS systems is described below. Adjustment of the 150 cfs AWS based on tailwater elevation set forth by USFWS in table 4.1 should be checked and conducted prior to initiating lifts. In general, AWS should be maximized while keeping differential within acceptable range. Additionally, the steps used to evaluate and adjust the entrance differential are provided below.

150 AWS

The major AWS component at Lawrence supplies up to 150 cfs through the intake grating that is located just upstream of the counting window, controlled via an orifice located in stilling basin. As the stem inlets to the stilling basin are opened, attraction water is carried via piping into the lower fishway. The attraction water pipe supplies the flow to the diffusion chamber located below the entrance channel floor elevation on the downstream end of the river-side entrance channel, where it then flows up through grating to the entrance channel. The 150 cfs attraction water is turned on daily at 0600 and shut down after the final lift of the day. Actual daily attraction water flow settings are adjusted per USFWS-supplied 'operating guidelines' (Table 4-1) and consider tailwater elevation and fishway differential, overall fishway flow, turbulence, etc. to establish best passage conditions (USFWS 2017).

Field-derived discharge values are presented along with calculated values based on the use of the sharp-crested weir formula are presented in Appendix E. These values are used to determine how far to open the controlling stem valves. Steps to operate and adjust the 150 AWS are:

- The valves operating the 150 cfs attraction flow is located upstream of the counting window, and provide flow to a stilling basin, which exits into the screened 150 cfs-pipe inlet..
- Turning the valves to the left increases the amount of water allowed through the pipe while turning it to the right decreases the amount. In terms of turns per inches opened:
    - 20 turns = 3 inches
    - 30 turns = 4.25 inches
    - 50 turns =7.25 inches
- As shown in Appendix E, discharge can be estimated based on the valve setting (% open). These estimates can be used to adjust the flow to fit within the recommendation (Table 4-1).

50 AWS

The "water circulation pipe" is designed to draw 50 cfs through the intake grating that is located at the most downstream end of the exit channel. A stem driven gate at the entrance of the pipe is used to regulate the flow. This circulation flow is discharged to a diffusion chamber located just upstream of the hopper pit and then flows through the crowder channel to the

entrance gates. The 50 cfs circulation water is used during the fish passage season to attract fish towards the hopper and ensure velocities within the holding pool are maintained at 1-1.5 fps. The 50 cfs remains on during the entirety of the fish passage season to help reduce the accumulation of debris at the lift entrance.

Field-derived discharge values are presented along with calculated values based on the use of the sharp-crested weir formula are presented in Appendix E. These values are used to determine how far to open the controlling stem gate. Steps to operate and adjust the 50 AWS are:

- The valve operating the 50 cfs attraction flow is located at the hopper dump station control level.
- Turning the valve to the left increases the amount of water allowed through the pipe while turning it to the right decreases the flow, through gear-driven gate operation of manual handwheel.
- As shown in Appendix E, discharge can be estimated based on the valve setting (% open).
- Currently, this valve is opened at the beginning of the fish passage season and remains on until the lift is discontinued in mid-July.

Weir Entrance Gate

The differential between the water in the lift system and the tailrace is established by a weir gate located at the entrance of the fish lift. In the event that it is necessary to adjust the weir gate to fall within the USFWS specified differential of 0.5 to 1.2 feet the following steps should be used:

- The elevation of the tailwater is determined by a differential gate, the reading of which can be found at control panel of the weir gate or on the PLC screen.
- The height of the water in the lower fishway can be identified by using the staff gate located at the entrance.
- If the difference between the entrance height and the tailrace elevation exceeds or is less than the recommended levels (0.5-1.2 feet), the weir gate must be adjusted.
- Weir gate settings controls are locate at the top of the control room stairs.
- Operation of the weir gate is conducted by pushbutton operation of the hoist from the top of stairs into the powerhouse. Backup operation can be accomplished at the hoist location itself, with proper protective equipment. Differential check, and subsequent weir adjustment as necessary, should occur at the start of each lift day and as often as needed to ensure acceptable differential conditions throughout the lift day.

- Record new weir gate settings and time of adjustment along with other pertinent settings.

- The tailrace and fish lift entrance elevations should be checked multiple times during the day to ensure they remain within the specified differential.

4.2 Lawrence Downstream Bypass

4.2.1 Off-Season Maintenance

Off-season maintenance and preparation is also necessary to ensure the downstream bypass is operable and reliable during the entire passage period. Inspection and maintenance prior to the fish passage season of the fish lift and bypass are recorded on an inspection checklist (Appendix B) with notes added for areas requiring additional servicing or to confirm maintenance (e.g. part replacement). In addition to annual maintenance tasks listed here, Essex should address all items listed on any Agency provided inspection lists prior to the season. Listed deficiencies or items able to be completed post-season (typically fall) should be identified and addressed; as this timeframe is typically better than the immediate spring pre-season period for major work. The following bullet points are specific to off season maintenance for the downstream bypass.

- Address all items listed on agency-provided inspection list
- Grease all gears and gearboxes (including hoist boxes).
- Test run all motors, repair as necessary.
- Have all hoists inspected by MA Crane and Hoist (or other reputable company). Follow any recommendations.
- Inspect downstream passage stop logs, replace as necessary.
- Clear downstream bypass plunge pool and exit channel of debris.

4.2.2 In-Season Operations & Maintenance

4.2.3 Operational Procedures

The bypass gate is adjusted to reflect units' flow each morning and afternoon. If major unit flow fluctuations are anticipated during the day (planned repairs or adjustements, headpond fluctuations, variable inflows, etc.) the bypass is set to provide the most flow, or accommodate the widest range of conditions anticipated during the period. See attached 'bypass flow chart' in Appendix E.

4.2.4 Debris Management

There is no active debris management control procedure in place for the downstream bypass; debris is removed as necessary.

4.3 Lawrence South Permanent Eelway

4.3.1 Off-Season Maintenance

- Pre-Installation
  - Visually inspect all concrete ladder components, Milieu substrate, and plywood covers. Repair any sections that appear to have been damaged.
  - Inspect and install holding tank, water supply, pump, and attraction water components. Repair or replace any parts that appear damaged or worn.
  - Start pump and add water to ladder without plywood covers on. Ensure:
    - Water flows over all substrate sections and does not run underneath substrate
    - There is no excessive leakage from any of the ladder above the entrance
    - Water flows evenly over the substrate and does not concentrate to one side.
    - Drains and valves work freely and function properly
  - Install plywood covers
  - Install mussel spat/chain matrix and predator cover in space between entrance and the river.
- Winterization
  - Shut down pump and allow water to drain from system (ladder, hoses, tanks)
  - Remove and visually inspect concrete ladder components, Milieu substrate, and plywood covers.
  - Note/conduct any repairs that can be made prior to winter
  - Remove all mussel spat/chain matrix, dry and store
  - Break down, inspect, dry and store all hoses, tanks, and water distribution manifold parts
  - Note and replace any parts that appear worn or not working properly

4.3.2 Spare Parts List

Spare Parts to be held on hand for the permanent eelway during fish passage season include:

- 1-inch Milieu sections
- Additional plywood for covers
- Eel spat
- Submersible Pump
- Spray bar/manifold parts
- Attraction water hose
- Cordless drill

- Fall protection harness

4.3.3 *In-Season Operations & Maintenance*

4.3.4 *Operational Procedures*

At approach, conduct a visual assessment of the ladder and is operational status. Visual assessments will be made by LHA staff and recorded on a site eelway data collection form (Appendix C-3) and device conditions checklist (Appendix C-4).

  - Is the pump supplying water to the holding tank
  - Are there any obvious leaks or water flow outside of the ladder system
  - Is the attraction flow functioning
  - Special attention to ladder condition and function will be given following dam spill events (entire dam or over zone 1 [closest to eel ladder]) during the operating period, and repairs will be given high priority.
- After inspection of the ladder for general function, LHA will collect eels from the holding tank and transfer them into 5-gallon containers for transport.
- During collection, the necessary data will be transferred onto the appropriate data sheet (see Appendix C-3):
- Releases will occur at alternating locations (by day) upstream of the dam:
  - Upper fishway
  - Nose pier or near the South end of Essex Dam

4.3.5 *Debris Management*

Debris management for the permanent eelway should be minimal based on the location of the pump in the headpond and the relatively small sized water outlets. Maintenance that should be conducted to avoid debris issues include:

- Periodically shutting down submersible pump and removing any debris that has accumulated on the screening.
- Check and ensure that no debris has built up at the base of the ladder, especially after any high water events where spill may have deposited larger debris at the base of the dam.
- All safety procedures outlined in Section 3.3.2 must be followed when working at the base of the dam.

Periodically during the season, general maintenance should be conducted to ensure that the ladder water supply manifold and the attraction water manifold are operating correctly and free of debris. This maintenance should include:

- Examination of exposed ladder areas and removal of any material that could cause clogging or prevent upstream movement
- Cleaning of screens and drains to ensure tank does not overflow
- Examination and cleaning of water supply manifold parts to clear any blockages that may have built up over time.

4.3.6 Fish Counts

Daily eel capture data is recorded onto the form shown in Appendix C-3. For the date on which the trap is checked the following information should be recorded:

- Total quantity of eels captured
- Quantity of large eels captured (>12").
- Enel personnel checking trap
- Any comments including:
  - Environmental or Project conditions that may be influencing trap performance
  - Mechanical issues that require attention
  - Improvement or changes to eelway
  - Alterations of in-eelway flows or attraction water
  - Outages or malfunctions that cause a shutdown of the eelway

4.3.7 Attraction Flow and Entrance Differential Adjustment Procedures

The supply for attraction water supply, tank water supply, and ramp water supply will be drawn by a submersible pump supplying 300 gpm, located in the headpond. While the guidelines for flow distribution (attraction, ramp, and tank) vary depending on the size, component parts and location of the eelway, the following flow procedures should be maintained and periodically checked to ensure no changes have occurred due to pump or manifold clogging.

- In general, it is recommended to provide as much attraction water as possible without overwhelming the entrance and preventing eels from identifying and entering the ramp (ASMFC 2013).
  - After an adequate amount of flow has been allocated to the trap and ramp, the remaining water (as reasonable) should be used for attraction.
- Tank flow should provide enough water to allow for adequate turnover to maintain ambient water temperatures and appropriate dissolved oxygen levels (ASMFC 2013).
  - Care should be taken during any increase in tank water supply to ensure that it does not overwhelm the drain system.

- Ramp water supply generally requires just enough water to provide a few millimeters of coverage on the ramp floor, not a few millimeters above the upper extent of the substrate (i.e. the top of a raised node or bristle).
    - While the amount of water required is site specific, in general, a level of 3-10 liters/minute (0.79-2.64 gallons/minute) has been cited for other mid-sized or larger ramps (ASMFC 2013).
    - Rough estimates of the volume/minute, to ensure that flows are in an adequate range, can be measured by determining the amount of time required to fill a 5 gallon pail or other known volume container.

4.3.8 Lamprey Deterrence at Dam Toe

Lamprey seeking upstream passage can ascend the south ledges of the Essex Dam, typically in flows from the operating eel ramp. Although the occurrence is brief in duration, the route and area is not a feasible, effective passage route for lamprey. In any season, a record of conditions and events associated with lamprey accumulation on the ledges should be made in the fish lift daily logs. To deter lamprey from the ledge area nearest the powerhouse, the following measures will be implemented as needed:

- During periods of known or suspected high lamprey presence, reduce most eel ramp attraction flows (the majority of eel AWS) during daylight, fish-lift hours;
- Should lamprey successfully ascend in numbers onto the ledges, "flush" the aggregated fish off the ledge by brief operation of crest gate Zone 1;
- More complex and less certain deterrent measures could involve: release of ground/sectioned sacrificed lamprey onto the ledges, lighting, chemical or electric deterrents, etc.

4.4 Lawrence North Temporary Eelway

4.4.1 Off-Season Maintenance

It is anticipated for the near future that this ladder will remain as an interim ladder. As such, it will be necessary for this system to be light-weight, movable, and adaptable enough to be placed in different locations depending on performance and operational or environmental conditions.

- All component parts (design likely to be ramp and tank) should be inspected and run at an on-site location to ensure all aspects are working.
- Site location should be chosen that best accommodates:
    - LHA employee safety

  - Equipment security
  - Eel capture
  - Optimal operation
- Upon set up, the ladder should be run and flows adjusted to provide the best ladder and attraction flow combination from the manifold.

4.4.2 Spare Parts List

Due to the exposed nature of this ladder, an entire second set of equipment is recommended in the event that high water or vandalism results in total loss. At a minimum, the following equipment should be kept on hand for replacement of worn or damaged parts prior to set-up:

- Additional water hose
- Attraction and tank water control manifold parts
- Mussel spat and chain
- Plywood (for construction/replacement of ramp)
- Holding tank
- Life jacket
- Submersible pump

4.4.3 In-Season Operations & Maintenance

At approach, conduct a visual assessment of the ladder and its operational status. Visual assessments will be made by LHA staff and recorded on a site eelway data collection form (Appendix C-3) and device conditions checklist (Appendix C-4).

  - Is the pump supplying water to the holding tank
  - Are there any obvious leaks or water flow outside of the ladder system
  - Is the attraction flow functioning
  - Special attention to ladder condition and function will be given following dam spill events (entire dam or over zone 1 [closest to eel ladder]) during the operating period, and repairs will be given high priority.
- After inspection of the ladder for general function, LHA will collect eels from the holding tank and transfer them into 5-gallon containers for transport.
- During collection, the necessary data will be transferred onto the appropriate data sheet (see Appendix C-3):
- Releases will occur at alternating locations (by day) upstream of the dam:
  - Upper fishway
  - Nose pier or near the South end of Essex Dam.

4.4.4 *Debris Management*

Debris management for the temporary eelway should be minimal based on the location of the pump in the headpond and the relatively small sized water outlets. Maintenance that should be conducted to avoid debris issues include:

- Periodically shutting down submersible pump and removing any debris that has accumulated on the screening.
- Check and ensure that no debris has built up at the base of the ladder, especially after any high water events where spill may have deposited larger debris at the base of the dam.
- All safety procedures outlined in Section 3.3.2

Periodically during the season, general maintenance should be conducted to ensure that the ladder water supply manifold and the attraction water manifold are operating correctly and free of debris. This maintenance should include:

- Examination of exposed ladder areas and removal of any material that could cause clogging or prevent upstream movement
- Cleaning of screens and drains to ensure tank does not overflow
- Examination and cleaning of water supply manifold parts to clear any blockages that may have built up over time.

4.4.5 *Fish Counts*

Daily eel capture data is recorded onto the form shown in Appendix C-3. For the date on which the trap is checked the following information should be recorded:

- Total quantity of eels captured
- Quantity of large eels captured (>12").
- Enel personnel checking trap
- Any comments including:
    - Environmental or Project conditions that may be influencing trap performance
    - Mechanical issues that require attention
    - Improvement or changes to eelway
    - Alterations of in-eelway flows or attraction water
    - Outages or malfunctions that cause a shutdown of the eelway

4.4.6 *Attraction Flow and Entrance Differential Adjustment Procedures*

The supply for attraction water supply, tank water supply, and ramp water supply will be drawn by two ½ hp submersible pumps rated at 70 gpm located in the headpond. While the

guidelines for flow distribution (attraction, ramp, and tank) vary depending on the size and location of the eelway, the following flow procedures should be maintained and periodically checked to ensure no changes have occurred due to pump or manifold clogging.

- In general, it is recommended to provide as much attraction water as possible without overwhelming the entrance and preventing eels from identifying and entering the ramp (ASMFC 2013).
    - After an adequate amount of flow has been allocated to the trap and ramp, the remaining water (as reasonable) should be used for attraction.
- Tank flow should provide enough water to allow for adequate turnover to maintain ambient water temperatures and adequate dissolved oxygen levels (ASMFC 2013).
    - Care should be taken during any increase in tank water supply to ensure that it does not overwhelm the drain system.
- Ramp water supply generally requires just enough water to provide a few millimeters of coverage on the ramp floor, not a few millimeters above the upper extent of the substrate (i.e. the top of a raised node or bristle).
    - While the amount of water required is site specific, in general, a level of 1-2 liters/minute (0.26-0.53 gallons/minute) has been cited for several other small ramps (ASMFC 2013).
    - Rough estimates of the volume/minute, to ensure that flows are in an adequate range, can be measured by determining the amount of time required to fill a 5 gallon pail.

5 Outage Protocols

In the event that environmental conditions (e.g. flows in excess of 25,000 cfs) or mechanical (e.g. broken hoist) result in a partial or complete condition affecting passage, the following protocols will be initiated:

- The Lawrence Project supervisor(s) will be alerted as to the outage and provided with the time of shut down.
    - Lawrence Site Supervisor
    - Regional Manager
    - Enel passage compliance specialist
- Essex operations staff or, if necessary, third party contractors will be contacted to assess the problem and establish the safest and most efficient way to repair and return the damaged lift/ladder to operation.
- The Merrimack River Technical Committee will be alerted as the outage (date/time), the problem (if known), and the proposed means of repair and estimate of time until returning to operations (If possible).
    - Massachusetts Division of Fisheries & Wildlife representative;
    - USFWS-designated representative

While it is understood that Essex will maintain a standing stock of materials necessary to perform basic repairs and part replacements, it may be necessary to order some parts. Off-season inspections of the ladder and lift are intended to prevent any major equipment malfunctions from occurring during the fish passage season.

6 Crest Gate Operations

An Obermeyer pneumatic crest gate system is installed on the Essex Dam, having three independently-controlled zones. Each zone is 300 feet long and consists of fifteen 20-foot long hinged steel panel sections supported by tubular rubber air bladders. The crest gate system is designed for one foot of overtopping in the raised position and can be operated in both a fully and partially raised position for extended periods of overtopping without experiencing significant oscillation, adverse flow conditions, or wear. The crest gate system is operated by an automatic control system capable of maintaining a constant operator-input upstream water elevation. Normal pond elevation is maintained at 44.2 ft NGVD and remains at this point until water inflow exceeds unit capacity. When inflows begin to exceed the capacity of the available units, the crest gate control system automatically adjusts the gates to maintain the impoundment elevation no higher than El. 45.2 ft NGVD, or one foot above the normal pond elevation. When under automatic control the crest gates are fully lowered at spillway flows of approximately 52,000 cfs and above, and the headpond level will rise above El. 45.2 ft following the spillway rating curve. The three crest gate zones are independently controllable, allowing zones to be prioritized in the pond level control scheme.

Based on prior field assessment with the MTC, the middle crest gate zone is prioritized in the control system (or in manual operation) to deflate first when Merrimack River flows result in spill, to provide supplemental attraction flow toward the fish ladder entrance (Table 6-1).

Table 6–1. The crest gate status, target headpond level (ft NGVD), and unit operation at approximate spillway flows at Essex Dam, Lawrence MA.

Approximate Spillway Flow (cfs)[1,2]	Crest Gate Status	Target Pond Level (ft NGVD)	Unit Operation
0-8,000	Full Elevation	44.2 ft (Normal pond)	Pond level control
8,001-12,500	Full Elevation	Rising to ± 45.2 ft	Full output
12,501-52,000	Crest gate lowers as flow over the spillway increases, maintaining water level at 1 foot above normal pond	± 54.2 ft	Full output
>52,000	Fully Lowered	Rises above 45.2 ft as flows over spillway increase.	Full output

1 - Table reproduced from 'Lawrence Hydroelectric Project (FERC No. 2800-MA); Crest Gate System Operation Plan' Dated October 10, 2008.

2 - The combined hydraulic capacity of the Lawrence Project turbines is approximately 8,000 cfs.

7 Reporting Requirements

The following sections detail the reporting procedure that will be followed for fish passage at Lawrence Project.

7.1 Fish Passage Reporting

Essex will provide a weekly summary of fish counts for the fish lift and fishway conditions to the Merrimack River Technical Committee. Weekly counts will be based on the visual estimates of passage numbers made at the Lawrence Powerhouse fish lift and incorporated into a spreadsheet developed in consultation with USFWS. Seasonal SalmonSoft counts for passage at the lift will be provided by Boott after the completion of the passage season.

Essex will host a minimum of two annual meetings with the Merrimack River Technical Committee, typically in conjunction with similar passage topics for the Lawrence Project:

- Fall Season: review recently completed fish passage activities and develop scope of monitoring and evaluations for next season.
- Spring Season: review details and expectations for the upcoming passage season.

In addition, Essex will accommodate the annual fishway inspections conducted by the Merrimack River Technical Committee and consider recommendations made as part of that process.

7.2 Eel Passage Reporting

Essex will provide a weekly summary of eel counts, size class distribution, and eel ladder conditions to the Merrimack River Technical Committee. Weekly counts will be based on the visual estimates of passage numbers made and recorded by LHA staff. Seasonal passage counts at each ladder will be provided by Essex after the completion of the passage season.

Essex will host a minimum of two annual meetings with the Merrimack River Technical Committee:

- Fall Season: review recently completed fish passage/eel passage activities and develop scope of monitoring and evaluations for next season.
- Spring Season: review details and expectations for the upcoming fish and eel passage season.

In addition, Essex will participate in annual fishway inspections conducted by the Merrimack River Technical Committee and consider recommendations made as part of that process.

8 Literature Cited

Gomez and Sullivan 2016. Analysis of upstream fish passage facilities and operation; Boott Hydroelectric Project (FERC # P-2790-MA). Prepared for ENEL Green Power, North America. Prepared by Gomez and Sullivan Engineers, D.P.C. March, 2016.

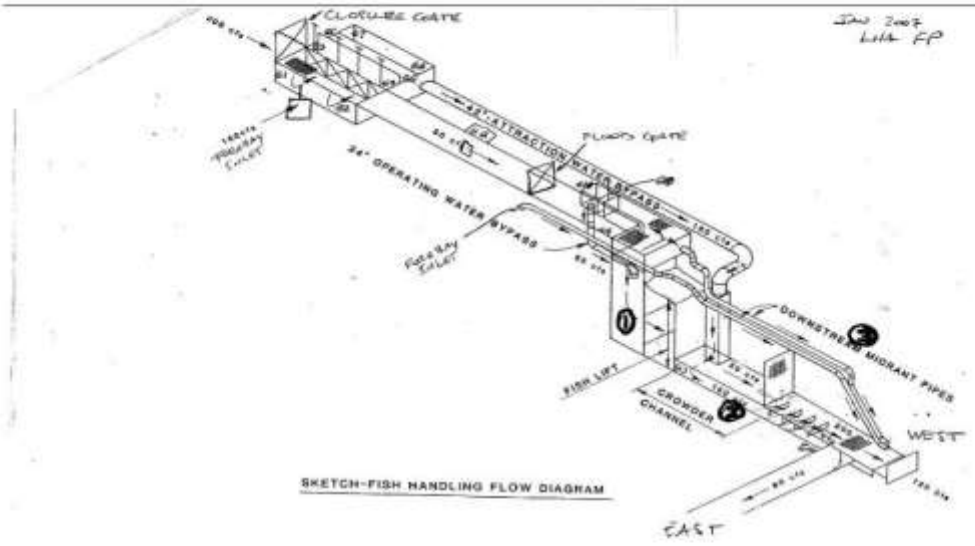
Normandeau (Normandeau Associates, Inc.) 1997. Lowell Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program, Spring 1996. Report prepared for Consolidated Hydro Inc.

USFWS (U.S. Fish and Wildlife Service). 2017. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

9 Appendices

Appendix A

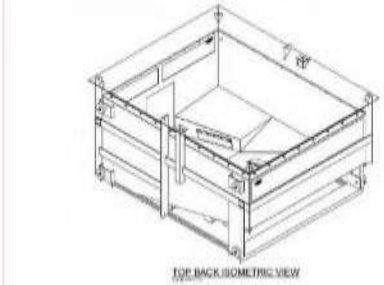
A-1

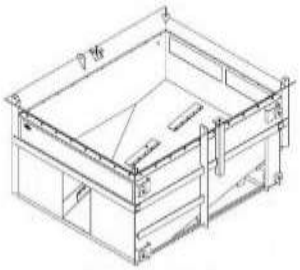


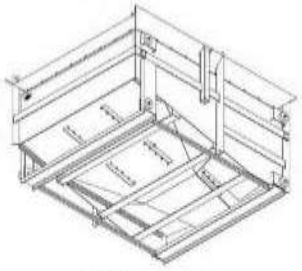
SKETCH-FISH HANDLING FLOW DIAGRAM

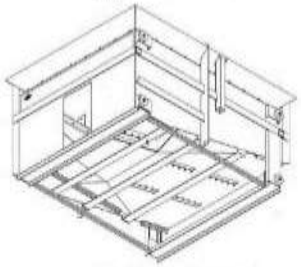
① = "50" supply
② = "150" supply
③ = Forebay FBy supply

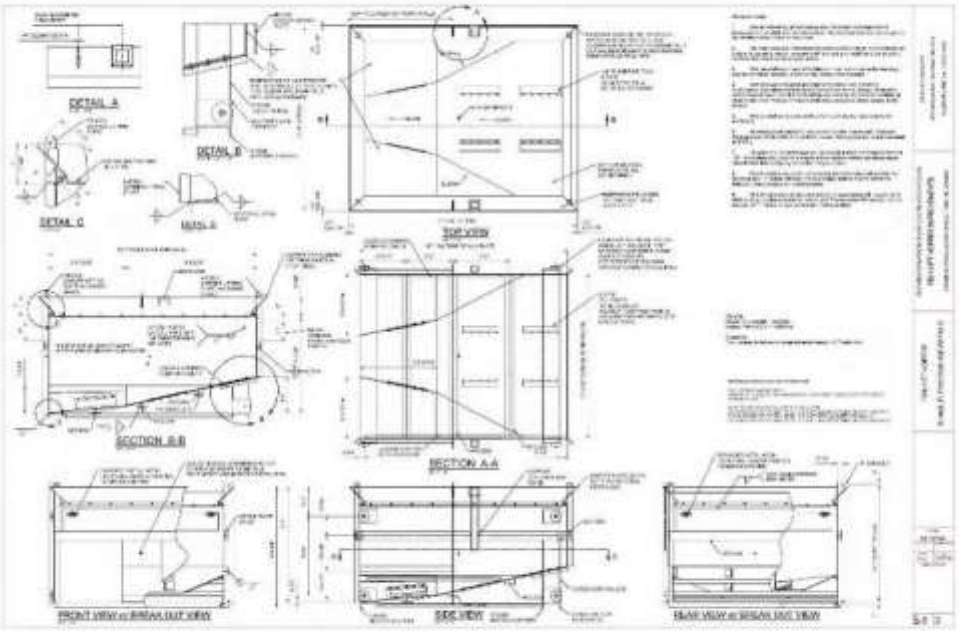
A-2

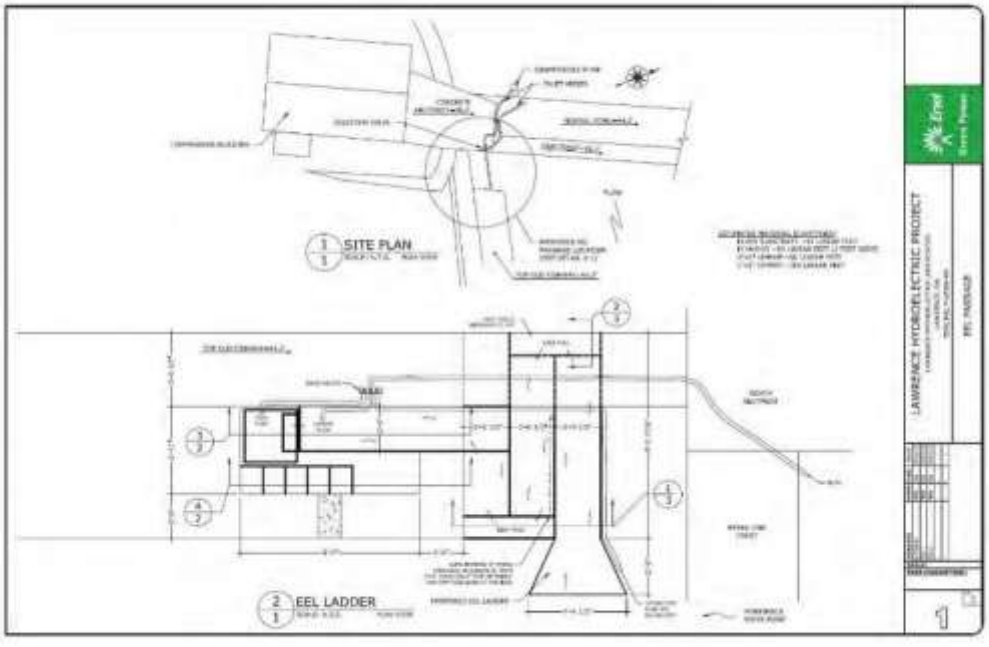

TOP BACK ISOMETRIC VIEW

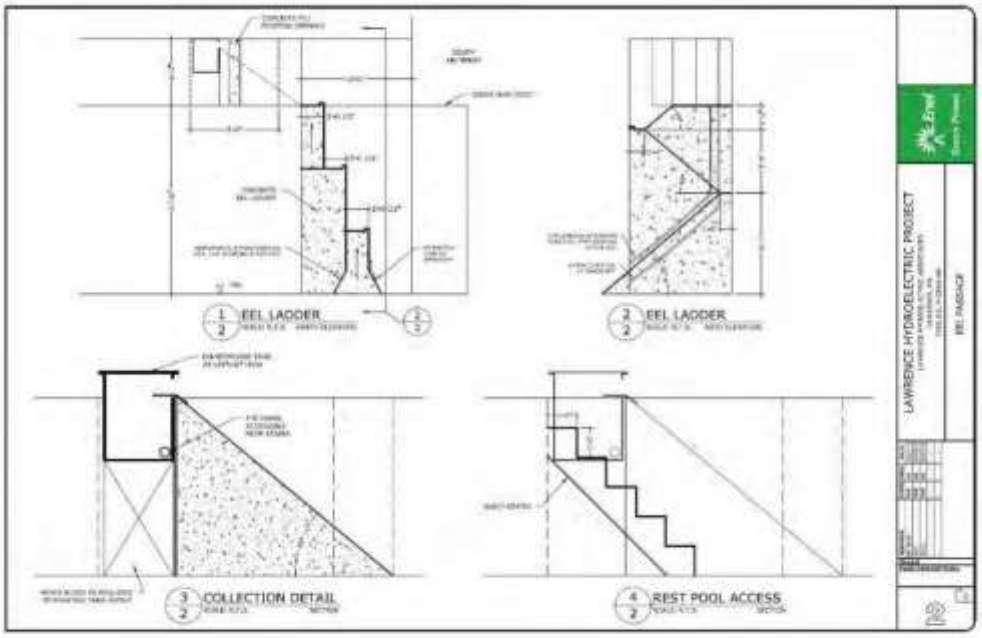

TOP FRONT ISOMETRIC VIEW

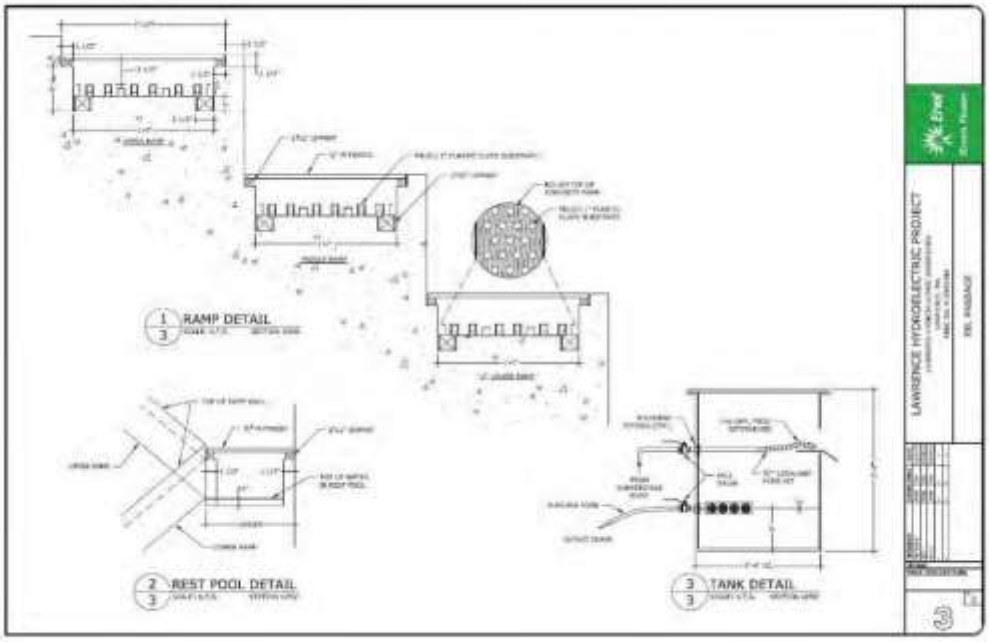

BOTTOM BACK ISOMETRIC VIEW


BOTTOM FRONT ISOMETRIC VIEW


A-3
DETAIL A
DETAIL B
DETAIL C
SECTION B-B
SECTION A-A
FRONT VIEW
SIDE VIEW
REAR VIEW


1 SITE PLAN
2 EEL LADDER
LAWRENCE HYDROELECTRIC PROJECT


EEL LADDER
EEL LADDER
COLLECTION DETAIL
REST POOL ACCESS
LAWRENCE HYDROELECTRIC PROJECT
EEL PASSAGE


RAMP DETAIL
REST POOL DETAIL
TANK DETAIL
LAWRENCE HYDROELECTRIC PROJECT
EEL PASSAGE

Appendix B

LAWRENCE PRE-SEASON CHECKLIST

Inspector/Owner Representative:

_____

Weather/Site Conditions:

_____

Headpond Level (ft): _____ Tailwater Level (ft): _____

River Flow (cfs): _____ Powerhouse Flow (cfs): _____

Checklist Instructions Dewater the fishway and visually inspect and maintain (e.g., grease/lube/clean) each of the critical components of the fishway below. After inspecting and maintaining a checklist item, water the fishway and operate each component. Place a √ or *X* next to that components name once confirmed to operate as designed. Add notes in the areas provided as necessary for each component. Note location and dimensions of deficiencies with a sketch or photograph. Additional observations may be added to the *Other* item located at the end of the checklist.

Common deficiencies to be inspected, but not limited to, include concrete cracking and deterioration, surface defects, rust, displacement, deformation, leakage and seepage, erosion, insufficient drainage, overgrown vegetation, debris, sedimentation, and vandalism.

___ Entrance Gate

- Physical Condition:
- Hoist and Lifting Sling:
- Transducer:
- Staff Gauges:

___ Holding Pool

- Physical Condition:
- Sedimentation:

___ Crowder

- Grating Condition:
- Drive Chain:
- Guide Wheels and Rail:
- Actuator:

___ Closure Gate

- Grating Condition:
- Hoist and Lifting Sling:

___ Hopper

- Paint:
- Guide Wheels:
- Chain:
- Hoist:
- Discharge Gate:
- Fill Ports:

___ Exit Flume

- Physical Condition:
- Crowder Grating:
- Viewing Window:
- Viewing Backboard:
- Counting Room:

___ Exit Gate

- Physical Condition:
- Actuator:
- Trash Racks/Boom:

___ Auxiliary Water Supply

- Intake grating:
- Intake Chamber:
- Auxiliary Water Pump:
- Valves:
- Diffusion Chamber:
- Flow Baffles:
- Diffusion Grating:

___ Downstream Fishway

- Entrance:
- Flume:
- Exit:

___ Other

- Item 1:
- Item 2:
- Changes from Prior Inspections:

Additional Notes:

Appendix C

C-1

LAWRENCE FISH LIFT DAILY INSPECTION FORM	
GENERAL	
DATE	
TIME	
INSPECTOR	

RIVER CONDITIONS	
HEADPOND EL, ft	
TAILWATER EL, ft	
RIVER FLOW, cfs	
RIVER TEMP, °C	

FLOW ALLOCATION	
50 CFS VALVE SETTING, in	
150 CFS VALVE SETTING, ft EL	
Total AWS, CFS	
SPILLWAY FLOW, cfs	

UNIT CONDITIONS	
UNIT 1, CFS	
UNIT 2, CFS	

FISHWAY CONDITIONS	
ENTRANCE GATE SETTING, ft	
ENTRANCE DROP, ft	
V-TRAP OPENING, in	

FISH COUNTS	
AMERICAN SHAD	
RIVER HERRING	
ATLANTIC SALMON	
SEA LAMPREY	
AMERICAN EEL (LIFT)	
AMERICAN EEL (LADDER)	

GENERAL COMMENTS

*Please fill out this inspection form once/lift and enter all data into the data collection program once/day to provide to agencies. Contact Bryan Sojkowski with any questions (413-253-8645).

C-2

LAWRENCE LOG OF DAILY INSPECTION FORM DATA												
GENERAL			RIVER CONDITIONS				FLOW ALLOCATION					
Date	Time	Inspector	HP, ft	TW, ft	River Flow, cfs	River Temp, °C	50 Valve, in	150 Valve, %	AWS (curve), cfs	AWS (meter), cfs	% Hydraulic Discharge	Amount of Spill, cfs

Continued.										
UNIT CONDITIONS		FISHWAY CONDITIONS			FISH COUNTS					
Unit 1 Flow, cfs	Unit 2 Flow, cfs	ENT Gate Setting, ft	ENT Drop, ft	v-trap opening, in	American shad	Atlantic Salmon	River Herring	Sea Lamprey	American Eel (Lift)	American Eel (Ladder)

Continued.					
"No Fish Data" Reason	Comments	Conditions Outside of Range?	Comment	Recommendation	Ladder Differential

C-3

Lawrence Eel Ramp - Data Sheet

Date	TOTAL QTY	QTY large	Ramp Eels	Lift Eels	North Ramp	Comments
	0	0	0	1		
	0	0	0	0		
	0	0	0	0		
	0	0	0	1		
	0	0	0	5		
	0	0	0	0		
	0	0	0	2		
	0	0	0	1		
	0	0	0	1		

C-4

Daily Eel Ramp Checklist

South/North ramp device DATE:_____

- Cover(s) attached, intact?
- Primary AWS pump working, intake clear?
- All flow paths working: tank, drain, supplemental?
- Drain screened & clean?
- Diffusion/spray bars functional, not clogged?
- Collected eels active, viable, no mortalities?
- Any spill flow damage apparent?
- Any predation on migrating eels noted?
- Spat rope/attractant installed, intact?
- Collect & transport all eels to headpond!

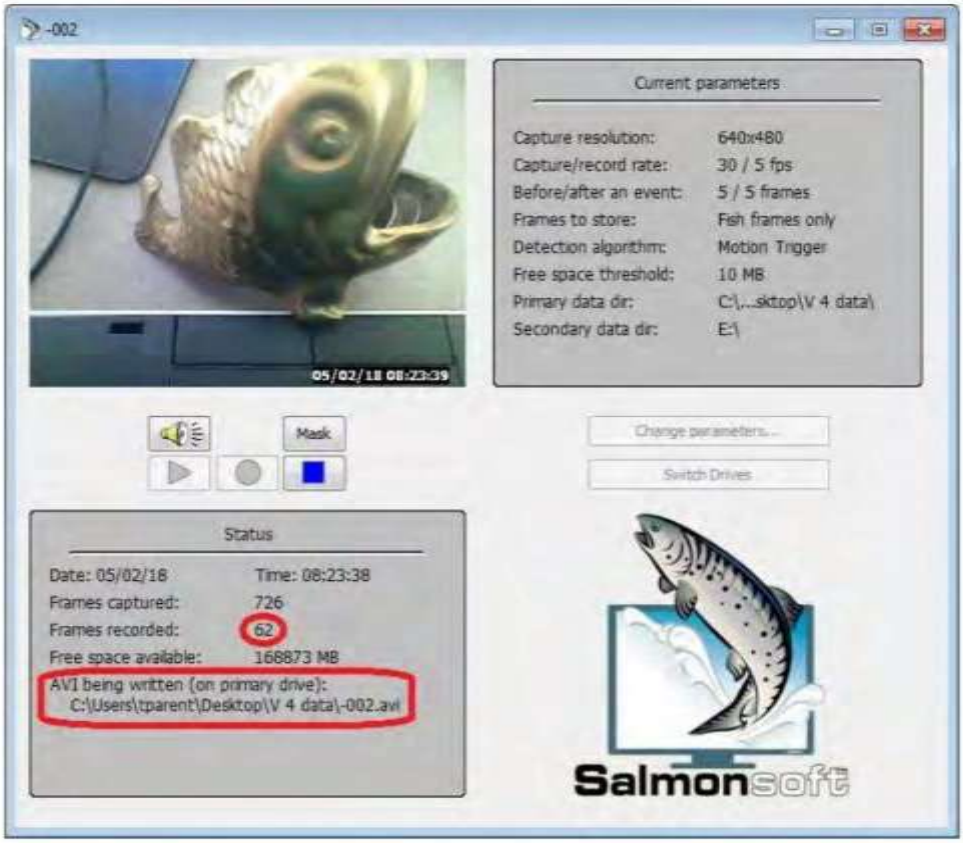
Appendix D

Upon arriving at the video capture computer, the screen will likely be off but after moving the mouse just a little, the screen should illuminate to reveal that a program called, "FishCap" is already open. To confirm that the system is filming as it should there are a couple of onscreen cues to check.

-Wave your hand in front of the camera and confirm that you can see your hand on the viewing window in the top left of the program.

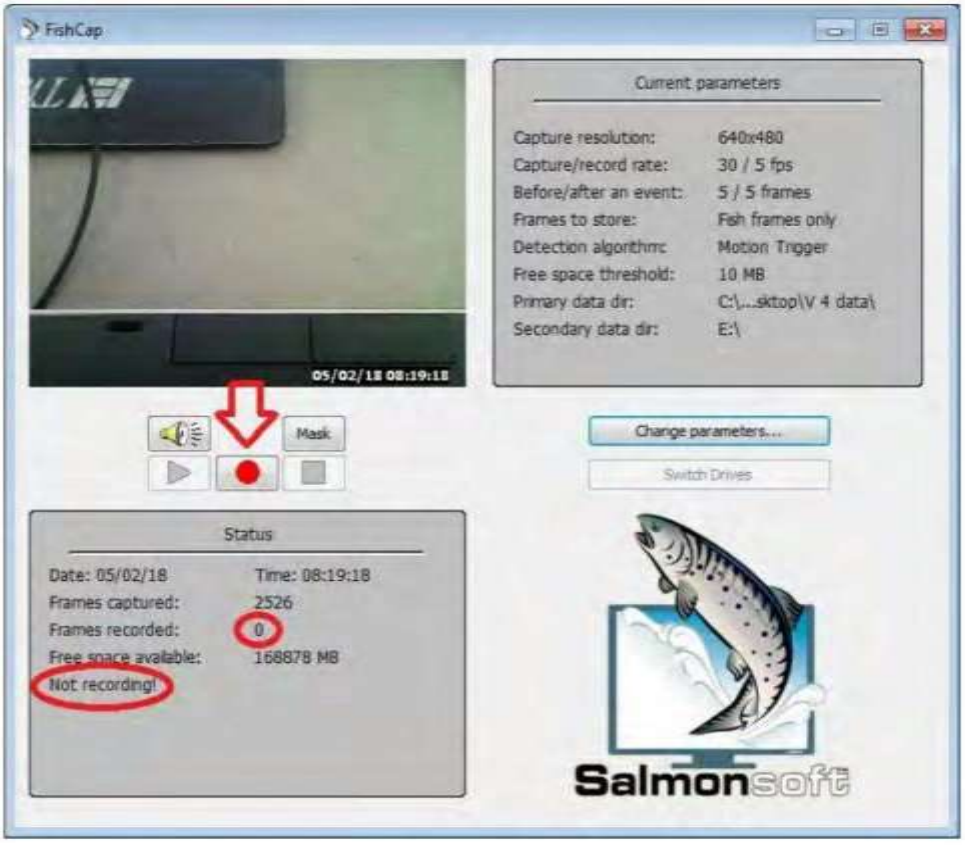
-Next confirm that the number of frames recorded (62 in the screenshot below) is getting larger when you wave your hand in front of the camera. Note: Frames captured should always be growing, even if there is no motion in front of the camera.

-Finally, Confirm that at the bottom of the gray window below the video feed, the program shows, "AVI being written……." This will confirm that it is actively creating a new file.



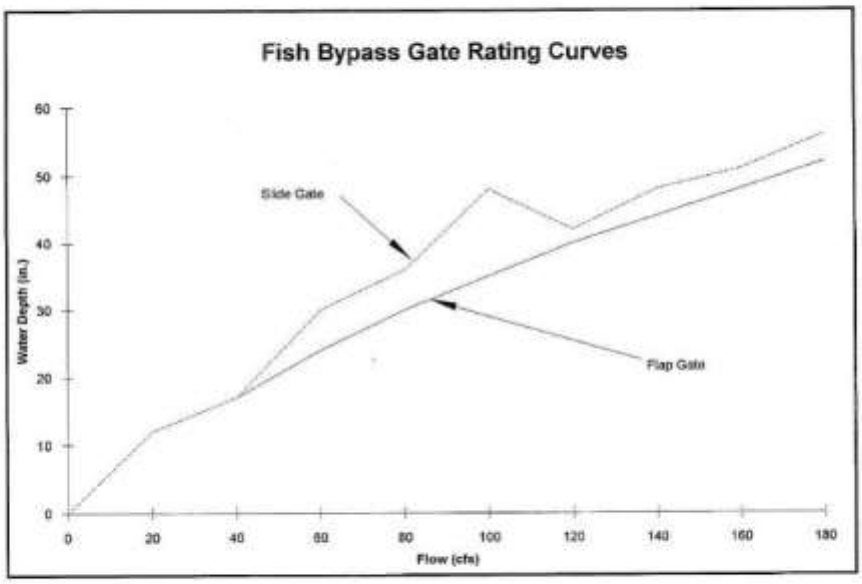
Below is a screenshot of an open FishCap window that is not recording. You should never see the record button illuminated (Red circle). This means that the system is waiting for someone to push record. Additionally, you will notice that frames recorded = 0, and at the bottom of the gray area it says, "Not recording!".

If this is what you find when checking the computer, simply press the record button (red circle) and confirm the steps from the previous page of checks to ensure that the system is now recording properly.



If FishCap is not running for some reason, open FishCap, (it is on the desktop) and then press record (red circle) to resume recording.

Appendix E


Fish Bypass Gate Rating Curves
Water Depth (in.)
Flow (cfs)
Slide Gate
Flap Gate
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180

NORMANDEAU ASSOCIATES
Environmental Consultants

April 28, 2016

Mr. Skip Medford
Enel Green Power North America, Inc.
One Tech Drive, Suite 220
Andover, MA 01810

Re: Lawrence Rating Curve Development

Dear Mr. Medford:

Normandeau Associates, Inc. (Normandeau) collected field measurements required for the preparation of a flow rating curve for the weir gate of the upstream fish passage facility at the Lawrence Hydroelectric Project in Lawrence, Massachusetts on April 14, 2016. Attraction water at the upstream passage facility is provided by two conduits with separate control points. The smaller "50" control is a stem driven gate whereas the larger "150" control is provided via a stilling basin. As the stem inlets to the "150" stilling basin are opened, attraction water is carried via piping into the lower fishway, across the entrance gate and into the tailrace. Normandeau collected depth and velocity information to calculate the true attraction water discharge under a range of settings for both the "50" and "150" devices. The two were tested independently of one another. The collection technique and results for the April 14th field effort are provided in this letter. Field-derived discharge values are presented along with calculated values based on use of the sharp-crested weir formula.

The forebay and tailwater elevations at the time of measurements were recorded as 44.95' and 18.7' MSL, respectively. The weir gate was set with a top elevation of 18.98' MSL for all tests. The elevation of the upper grate over the fishway sits at 29.12' and the bottom of the fishway channel sits at 10.65' MSL.

Enel staff opened the "50" gate through a series of three settings ranging from 4 to 12 inches (Table 1). Following stabilization of flows at each valve setting, Normandeau measured the lower fishway water surface elevation as the difference (in feet) below the upper grate of the fishway (i.e., 29.12' MSL) and water level in lower fishway determined by the valve setting being evaluated. Water depth over the weir gate at each setting was calculated as the difference between the lower fishway elevation (as described above) and the pre-set top elevation of the entrance weir gate (i.e., 18.98' MSL). A series of water velocities (ft/s) were collected at the quarter points of the weir gate using a Marsh McBierney Flowmate digital flow meter. As fluid dynamics around the sensor electrodes of the flow meter can cause the readings to fluctuate, values were stabilized by setting the unit to use a 10 second fixed point averaging function. This essentially provided an average velocity value for multiple readings collected at one second increments during the 10 second time period. This process was repeated three times at each measurement location.

30 International Drive, Suite 6, Pease International Tradeport · Portsmouth, NH 03801 · (603) 319-5300

Corporate Office: Normandeau Associates, Inc. · 25 Nashua Road · Bedford, NH 03110 · (603) 472-5191
www.normandeau.com

NORMANDEAU ASSOCIATES
Environmental Consultants

During the evaluation of the "150" supply, the weir gate setting was maintained at 18.98' MSL. Enel staff opened the "150" valve through a series of three settings ranging from 3-7.25" opening of the controlling stem valve [3](Table 1). Normandeau obtained the lower fishway elevation, overflow depth and representative velocities in the same manner as described above for the "50" valve.

Field-Derived Discharge Determination, Velocity Measurement

Discharge estimates (Q) for the various settings of the "50" and "150" were calculated as the average cross-weir velocity multiplied by the area and using the formula:

$$Q = WDV$$

Where: Q = discharge (cfs)
W = width of weir gate channel (i.e., 6 ft)
D = depth of water over weir gate (i.e., (lower fishway elevation) – (weir crest elevation))
V = average velocity (ft/s)

Sharp-crested Weir Discharge Determination

Field derived discharge estimates were cross-checked using a crested-weir formula:

$$Q = CW(D^{3/2})$$

Where: Q = discharge (cfs)
C = weir coefficient (i.e., 3.3)
W = width of weir gate channel (i.e., 6 ft)
D = depth of water over weir gate (i.e., (lower fishway elevation) – (weir crest elevation))

The field-derived and weir-calculated discharge values for each setting examined for the "50" and "150" devices are presented in tabular format in Table 1 and graphical format in Figures 1 and 2.

[3] 3 inch stem valve opening equivalent to 20 turns; 4.25 inch stem valve opening equivalent to 30 turns; 7.25 inch stem valve opening equivalent to 50 turns

NORMANDEAU ASSOCIATES
Environmental Consultants

Table 1. Attraction flow settings and resulting depth and velocity values for the "50" and "150" conduits at the Lawrence Hydroelectric Project, with corresponding discharge over the weir gate.

Valve	Valve Setting	Forebay Elevation (MSL)	Tailrace Elevation (MSL)	Fishway WS Elevation (MSL)	Water Depth over Weir (ft)	Mean Column Velocity (ft/s)	Discharge (cfs)	
							Field-Derived	Calculated
50	4"	44.95	18.7	20.04	1.34	0.34	16.1	26.0
	8"	44.95	18.7	20.69	1.99	0.82	41.7	47.1
	12"	44.95	18.7	20.97	2.27	1.09	57.2	57.4
150	3"	44.95	18.7	21.23	2.53	1.71	92.0	67.5
	4.25"	44.95	18.7	21.69	2.99	2.00	112.1	86.7
	7.25"	44.95	18.7	21.94	3.24	2.19	125.4	97.8

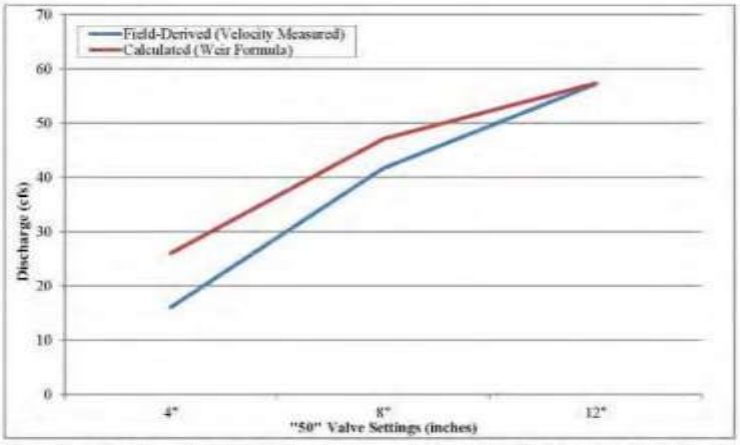


Figure 1. Rating curve showing "50" supply settings and resulting discharge over the entrance weir crest at the Lawrence Hydroelectric Project.

NORMANDEAU ASSOCIATES
Environmental Consultants

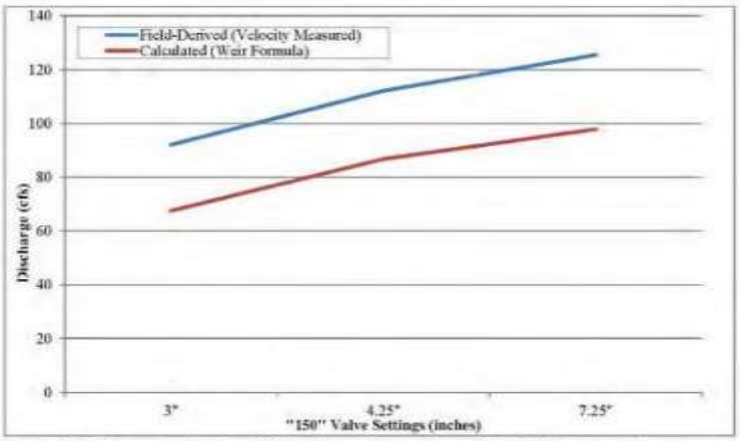


Figure 2. Rating curve showing "150" valve settings and resulting discharge over the entrance weir crest at the Lawrence Hydroelectric Project.

Measured discharges ranged between 16.1 cfs and 57.2 cfs for the "50" and between 92.0 cfs and 125.4 cfs for the "150" valve.

Should you have any further questions related to these measurements please do not hesitate to contact me (dtrested@normandeau.com).

Sincerely,

Drew Trested
Fisheries Biologist
Normandeau Associates, Inc.

APPENDIX H
REPORT ON FLOWS TO BE RELEASED FROM PROJECT WORKS

401.1.3
Art. 32

LAWRENCE HYDROELECTRIC PROJECT
PROJECT NO. 2800
REPORT ON FLOWS TO BE RELEASED
FROM PROJECT WORKS
ARTICLE 32 OF LICENSE

As required by Article 32 of the FERC license issued December 4, 1978 to Lawrence Hydroelectric Associates (LHA) and the Essex Company, LHA has prepared this report on the minimum flow requirements of the U.S. Department of Interior, Fish and Wildlife Service; the U.S. Department of Commerce, National Marine Fisheries Service; the Commonwealth of Massachusetts, Department of Environmental Quality and Engineering Division of Water Pollution Control; and the Massachusetts Department of Fisheries Wildlife and Recreational Vehicles.

As required by the Massachusetts Department of Environmental Quality and Engineering Division of Water Pollution Control Water Quality Permit and Article 32 of the FERC license for the Lawrence Hydroelectric Project, LHA and the Essex Company will maintain a continuous flow of 951 CFS below the Essex Company dam unless and until the reservoir surface elevation is reduced below the crest of the dam; thereupon the minimum flow shall be equal to the inflow to the reservoir as measured by the U.S.G.S. gaging station which is located at Hunts Falls in Lowell, Massachusetts.

This flow of 951 CFS is required to maintain the present water quality of the river below the Essex Company dam. The Essex Company uses its Lower Rocks river gage to continuously monitor river flows downstream of the Dam. (See Figure 2).

LHA and the Essex Company has been consulting with the various federal and state agencies that are concerned with minimum flow required for upstream migration of anadromous fish (200 CFS at the power plant discharge) and the water quality below the dam.

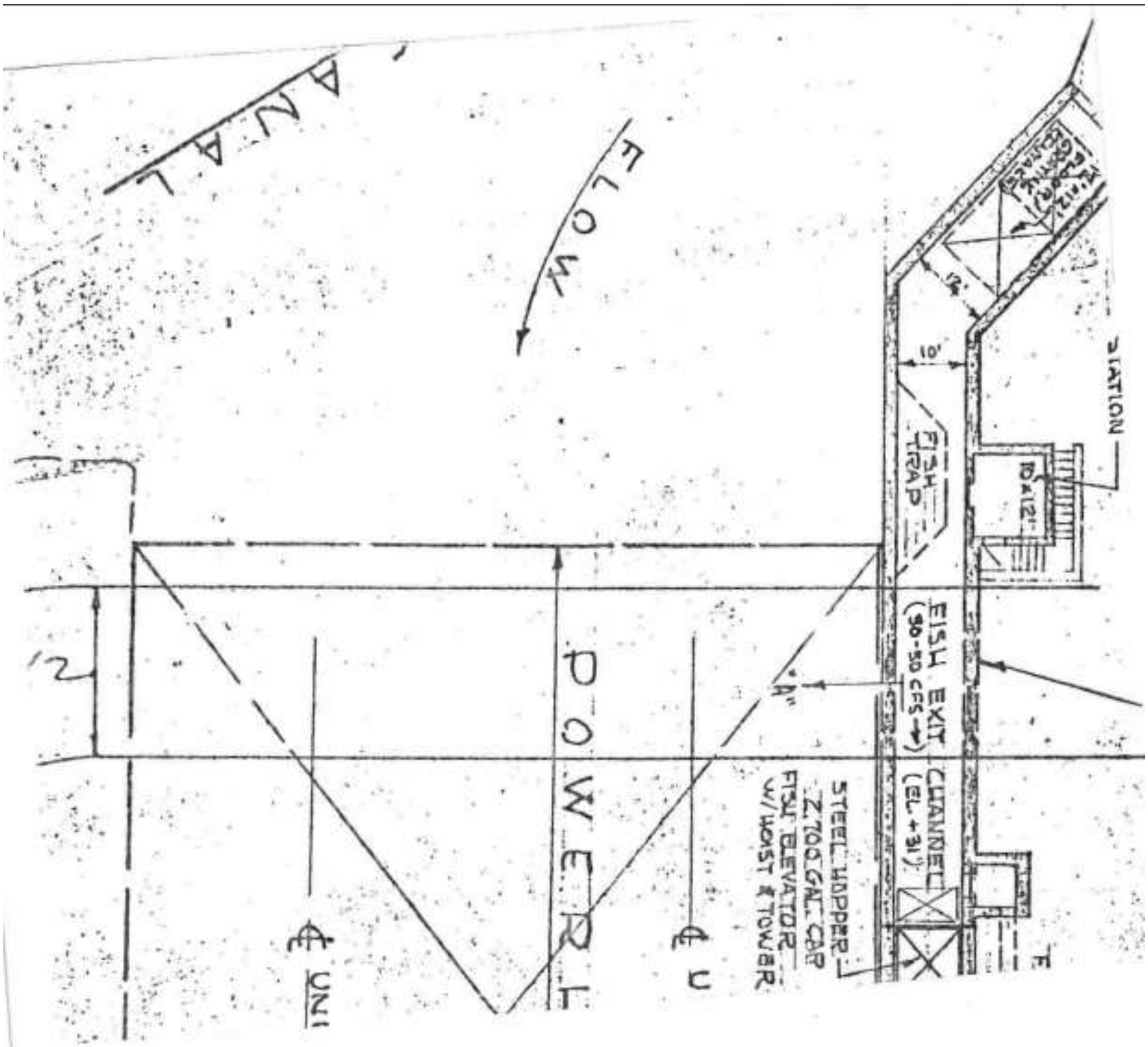
Status of Minimum Discharge Requirements

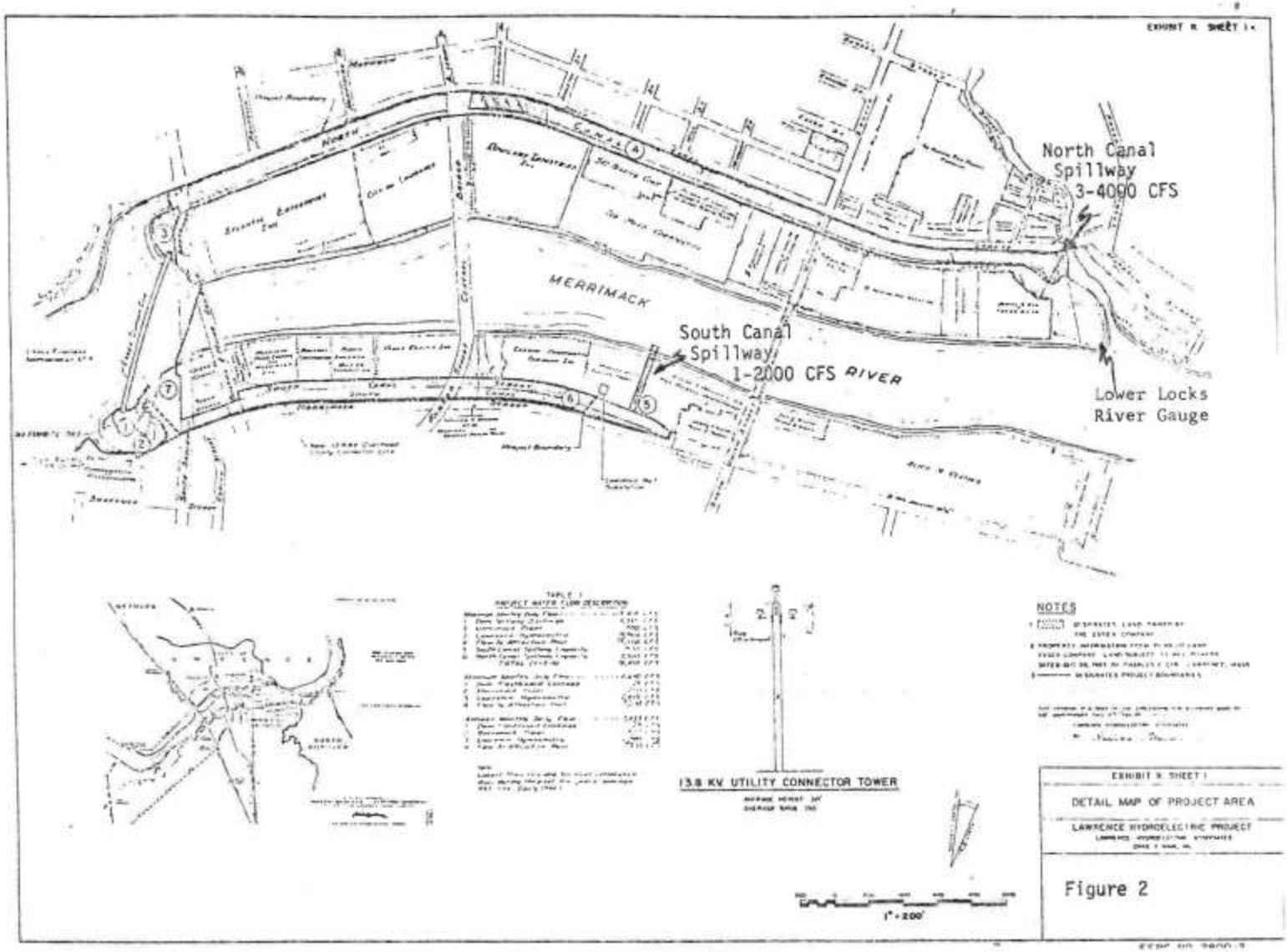
As of the date of this report there are no known additional requirements with respect to minimum flows from project works from any state or federal agencies.

The Lawrence Hydroelectric Project is still under construction and will not be in operation until mid 1981. The general contractor and LHA have ongoing discussions with the state and federal agencies concerned with the design and construction of the fish elevator facilities that will be installed adjacent to the power house (see Figure 1).

Under a low flow situation when no turbines are operating, the fish elevator facilities will be able to pass 250 CF (200 CFS attraction flow plus 50 CFS thru the downstream migration conduit). Also during a low flow condition the Essex Company is required to supply 715 CFS to Merrimack Paper and Aquamac Corporation to meet their power generation requirements.

The total downstream flow below the Essex Company Dam is 965 CFS from these two sources and does not include flashboard leakage estimated at be 25 CFS. As a result LHA feels that the required 951 CFS can be maintained by normal system operations. However in the event that both of these release sources are inoperative during a low flow condition the Essex Company north and south canal spillways located at the end of the north and south canals have ample capacity to meet the total 951 CFS requirement (see Figure 2).


FLOW
POWER
FISH TRAP
10'
12'
10x12'
STATION
FISH EXIT CHANNEL
(30-50 CFS→) (EL +31')
"A"
STEEL HOPPER
2,700 GAL CAP
FISH ELEVATOR
W/HOIST & TOWER


North Canal
Spillway
3-4000 CFS
MERRIMACK
South Canal
Spillway
1-2000 CFS
RIVER
Lower Locks
River Gauge
NOTES
138 KV UTILITY CONNECTOR TOWER
EXHIBIT R SHEET 1
DETAIL MAP OF PROJECT AREA
LAWRENCE HYDROELECTRIC PROJECT
Figure 2

U.S. FISH AND WILDLIFE SERVICE'S JUNE 2, 1987 LETTER SUPPORTING WAIVER OF ARTICLE 32 MINIMUM FLOW REQUIREMENTS

United States Department of the Interior

FILE
401.1.3
Art. 32
JUN 9 RECD

FISH AND WILDLIFE SERVICE
400 RALPH PILL MARKETPLACE
22 BRIDGE STREET
CONCORD, NEW HAMPSHIRE 03301-4901

REF: FERC #2800

Mr. Fred Springer, Acting Director
Office of Hydropower Licensing
Federal Energy Regulatory Commission
825 Capitol Street
Washington, DC 20426

JUN 0 2 1987

Dear Mr. Springer:

This letter is in reference to the request to you by Consolidated Hydro, Inc. (Licensee) for a waiver of the minimum flow required in Article 32 of the license for the Lawrence Hydroelectric Project, located on the Merrimack River in Lawrence, Massachusetts (see enclosure). The Licensee must presently maintain a minimum flow of 951 cfs (0.2 cfsm) under Article 32, but requested the waiver to provide for operation of the project in a run-of-river mode.

We do not object to FERC deleting the requirement for a minimum flow of 951 cfs. However, in order to be consistent with the discharge required at the Lowell Project, FERC No. 2790 (1,990 cfs; 0.5 cfsm) located upstream from the Lawrence Project, Article 32 should be amended to specify an instantaneous discharge of 2,340 cfs (0.5 cfsm) or inflow to the project area, whichever is less.

We suggest the following wording for an amended Article 32:

> Licensee shall maintain a continuous minimum flow of 2,340 cfs or inflow to the project area, whichever is less for the protection and enhancement of fish, wildlife, and aquatic resources in the Merrimack River below the project. The Licensee shall at all times minimize the fluctuation of the reservoir surface elevation by ensuring that reservoir water levels are at an elevation that is equal to, or over the crest of the dam, and/or flashboards when they are in place. This flow may be temporarily modified if required by operating emergencies beyond the control of the Licensee, and for short periods upon mutual agreement between the Licensee and the Massachusetts Division of Fisheries and Wildlife, National Marine Fisheries Service, and the U.S. Fish and Wildlife Service.

If FERC would prefer alternative wording of our recommended License article, we request an opportunity to review the proposed text before it is finalized. Should this be the case, or if you have any questions, please contact Joseph F. McKeon at FTS 834-4411.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Area

Enclosure