
**HANOVER POND DAM HYDROELECTRIC PROJECT
(FERC #P-14550)**

**9 Cutlery Ave, Meriden, New Haven County, CT
Quinnipiac River**

July 22, 2019

Application for Low Impact Hydropower Institute (LIHI) Certification



Submitted To:

Low Impact Hydropower Institute
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Submitted By:



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1. Introduction

New England Hydropower Company, LLC (NEHC), on behalf of Hanover Pond Hydro, LLC, submits this Application for Certification by the Low Impact Hydropower Institute (LIHI) for the Hanover Pond Dam Hydroelectric Project (Facility) located on the Quinnipiac River (River) in Meriden, CT. The Hanover Pond Dam (Dam) has not been used to power machinery since the late 1920s and no Federal Energy Regulatory Commission (FERC) license has previously been issued for power generation at the Dam. On May 19, 2016, FERC issued the Facility an Exemption from Licensing (<10 MW) under Docket Number P-14550 (Exemption) for the Facility.

The Facility is owned by Hanover Pond Hydro, LLC and was created as the first in the nation hydroelectric facility to employ the Archimedes Screw Turbine (AST) for power generation. The AST uses the head of an existing, previously non-powered dam to produce electricity through a slowly turning screw attached to a variable speed gear box and generator, which distributes the electricity produced out to the grid. The AST is known for its ability to pass fish safely downstream and has been chosen for installation at this location because of this attribute. Please see Figures 4, 5 and 6 for photographs of the AST and Facility.

This application is laid out in the following format:

Sections 2 and 3, following, discuss the Facility and LIHI Standards respectively. Section 4, Supporting Information, is broken into two subsections, each discussing one of the two Zones of Effect (ZoE).

Section 4.1 discusses all applicable standards for criteria in ZoE 1, the impoundment above the Dam.

Section 4.2 discusses all applicable standards for criteria in ZoE 2, the downstream area below the Dam. The bypassed reach is approximately 65 feet and is discussed in this section where appropriate.

Figures 1 and 2 show the two ZoEs.

2. Facility Description

The Facility operates in a true run-of-river manner, and water levels do not change as a result of Facility operation. Agreed upon minimum flows pass over the low-flow notch in the Dam, seasonally through the existing fishway, and then are allocated to the AST. The intake of water to the AST is controlled by a hydraulically powered sluice gate. This system maintains true run-of-river flow consumption by continuous remote monitoring of a head pond water level gage upstream of the intake, and automatically adjusts the height of the sluice gate to maintain a pre-set flow level. This system, along with the fixed spillway, maintains the current Pond elevation. If insufficient flows exist after satisfying the needs of the low-flow notch and seasonally operated fishway, the AST automatically ceases operation until flows increase. Figure 3 shows an aerial photograph of the Facility layout. Figures 7 and 8 show the flows schematic, and the Facility's Human-Machine Interface allowing for instantaneous monitoring.

The Facility consists of an intake, located in the bank, just upstream of the Dam face, a powerhouse sitting atop the earthen section of the Dam, the AST housed in a concrete trough sloping down the downstream face of the earthen section of the Dam, and the short tailrace immediately emptying into the River below the Dam.

The generator, gearbox, electrics and other controls are located inside the powerhouse. The entire Facility is adjacent to an existing fishway installed by the City of Meriden when the Dam was reconstructed in 2005.

Table 2-1 Facility Description Information for the Hanover Pond Hydroelectric Facility

Information Type	Variable Description	Response (and reference to further details)
Name of the Facility	Facility name (use FERC Facility name if possible)	Hanover Pond Dam Hydroelectric Facility, FERC Facility No. 14550
Location	River name (USGS proper name)	Quinnipiac River Main Stem
	River basin name	Quinnipiac River Watershed
	Nearest town, county, and state	Meriden, New Haven County, CT
	River mile of dam above next major river	River mile at Hanover Pond Dam = approximately 22.5
	Geographic latitude	41.519996
	Geographic longitude	-72.826537
Facility Owner	Application contact names (IMPORTANT: you must also complete the Facilities Contact Form)	Glendon Barnes Carol Wasserman
	- Facility owner (individual and company names)	Hanover Pond Hydro LLC
	- Operating affiliate (if different from owner)	NEHC
	- Representative in LIHI certification	Carol Wasserman
Regulatory Status	FERC Facility Number (e.g., P-xxxxx), issuance and expiration dates	FERC Facility No. P-14550 FERC Exemption Issued May 19, 2016 (Perpetual)
	FERC license type or special classification (e.g., "qualified conduit")	Exemption from Licensing (10 MW or Less)
	Water Quality Certificate identifier and issuance date, plus source agency name	Section 401 Water Quality Certification No. WQC-201506301 Issued by CT DEEP on April 16, 2016

Information Type	Variable Description	Response (and reference to further details)
	<p>Hyperlinks to key electronic records on FERC e-library website (e.g., most recent Commission Orders, WQC, ESA documents, etc.)</p>	<p>FERC Project P-14550 - Significant documents in these records are:</p> <p>Agency Determination on T&E species: (note the submittal says “northern long-eared owl” but should say “northern long-eared bat”) https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14176330</p> <p>City of Meriden Wetlands Approval: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14210606</p> <p>Water Quality Certification: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14206230</p> <p>Order granting the Exemption: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14251954</p> <p>Transfer of WQC to Hanover Pond Hydro: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14360404</p> <p>Notice of Commercial Generation: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14502118</p> <p>Order approving Fish Channel Plan: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14552356</p> <p>Preliminary Fish Injury and Mortality Report: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14632951</p> <p>Fishway Utilization Report: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14683916</p> <p>Letter granting extension of time to perform studies: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=14964832</p>

Information Type	Variable Description	Response (and reference to further details)
		Water Quality Monitoring Report: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=15212375 Eel Mortality study with agency comments: https://elibrary.ferc.gov/idmws/common/open.nat.asp?fileID=15185281
Power Plant Characteristics	Date of initial operation (past or future for operational applications)	February 23, 2017
	Total name-plate capacity (MW)	220kW
	Average annual generation (MWh)	900 MWh
	Number, type, and size of turbines, including maximum and minimum hydraulic capacity of each unit	One Archimedes Screw Turbine (AST), 46.5 ft long, 11.65 foot diameter, min:10cfs, max: 194cfs
	Modes of operation (run-of-river, peaking, pulsing, seasonal storage, etc.)	Run-of-River
	Dates and types of major equipment upgrades	No power plants of any kind have existed at this dam since it was reconstructed in 2005. Facility with AST is new construction in 2017. Dam was non-powered until installation of this generating unit in 2017.
	Dates, purpose, and type of any recent operational changes	New power plant construction, no changes
	Plans, authorization, and regulatory activities for any facility upgrades	None
Characteristics of Dam, Diversion, or Conduit	Date of construction	Dam was completely rebuilt in 2005 by the owner, the City of Meriden, and a fishway was installed at that time.
	Dam height	25 ft
	Spillway elevation and hydraulic capacity	A 247-foot-long concrete spillway composed of five sections, including: (1) a 40-foot-long portion with an ogee crest elevation of 87.3 feet National Geodetic Vertical Datum 1929 (NGVD 29), (2) a 147-foot-long portion with a broad crest elevation of 87.3 feet NGVD 29, (3) a 40-foot-long portion with an ogee crest elevation of

Information Type	Variable Description	Response (and reference to further details)
		87.0 feet NGVD 29, (4) a 6-foot-long portion (i.e., low-flow notch) with an ogee crest elevation of 86.3 feet NGVD 29, and (5) a 14-foot-long portion with an ogee crest elevation of 88.3 feet NGVD 29. A maximum flow of 5,962cfs occurred at Hanover Pond Dam in 1982. As reconstructed in 2005-2006, the Dam is intended to withstand this capacity.
	Tailwater elevation	71.29 feet NGVD
	Length and type of all penstocks and water conveyance structures between reservoir and powerhouse	78 foot long, 12 foot wide, 8 foot deep buried concrete penstock channel
	Dates and types of major, generation-related infrastructure improvements	February 1-2, 2017: new transformer and power poles installed by Connecticut Light & Power d/b/a/ Eversource Energy.
	Designated facility purposes (e.g., power, navigation, flood control, water supply, etc.)	Power generation, flood control, downstream fish passage
	Water source	Hanover Pond created by the Hanover Pond Dam impounding the Quinnipiac River
	Water discharge location or facility	Water used to operate the AST is taken from the upstream side of Hanover Pond Dam and discharged approximately 65 feet downstream. Remaining water passes through fishway (seasonally) and over Dam crest and low flow spillways directly to the river below.
Characteristics of Reservoir and Watershed	Gross volume and surface area at full pool	Storage Capacity of Pond: 1,800 acre-feet (according to NID records) Surface area: 71 acres
	Maximum water surface elevation (ft. MSL)	Normal surface elevation is 87.3 ft NGVD29 subject to seasonal variation. FEMA Base Flood Elevation is 91 ft NGVD29. Maximum water surface elevation is not available but can be inferred to be between the two elevations.

Information Type	Variable Description	Response (and reference to further details)
	Maximum and minimum volume and water surface elevations for designated power pool, if available	Not applicable, Run-of-River operations
	Upstream dam(s) by name, ownership, FERC number (if applicable), and river mile	No upstream dams. Carpenter's Dam in Meriden and Clarks Brothers Dam in Southington have both been removed.
	Downstream dam(s) by name, ownership, FERC number (if applicable), and river mile	Wallace Dam in Wallingford, owned by the Town of Wallingford, CT, CT ID# 14823; river mile 16.6 Britannia Spoon Dam in Wallingford, was located approximate river mile 19.5. No current information available, breached.
	Operating agreements with upstream or downstream reservoirs that affect water availability, if any, and facility operation	Not applicable. No upstream or downstream reservoirs.
	Area inside FERC Facility boundary, where appropriate	The area inside the FERC Facility boundary includes the Hanover Pond, approximately 71 acres. In addition, approximately 0.9 acres is upland where the powerhouse and access road are located.
Hydrologic Setting	Average annual flow at the dam	185 cfs (from 1930-2013)
	Average monthly flows	Approximated average monthly flows at Hanover Pond Dam derived from closest USGS gage at Wallingford - from 1930-2016 Jan. 215 cfs Feb. 225 cfs Mar. 317 cfs Apr. 297 cfs May 207 cfs June 165 cfs July 100 cfs Aug. 94 cfs Sept. 99 cfs Oct. 122 cfs Nov. 159 cfs Dec. 203 cfs
	Location and name of relevant stream gauging stations above and below the facility	There are no relevant/operational upstream gages.

Information Type	Variable Description	Response (and reference to further details)
		The Wallingford gage (No. 01196500) is located downstream of the facility
	Watershed area at the dam	95 sq mi
Designated Zones of Effect	Number of zones of effect	2: upstream impoundment and downstream of Facility and Dam Small bypassed reach is included in downstream ZoE
	Upstream and downstream locations by river miles	1. Impoundment upstream of the Dam. 2. Approximately 65 feet downstream of the Dam where the water discharges from the AST tailrace, back into the river. River miles are not applicable.
	Type of waterbody (river, impoundment, bypassed reach, etc.)	1. Impoundment created by Dam 2. River where tailrace water rejoins
	Delimiting structures	Hanover Pond Dam
	Designated uses by state water quality agency	Habitat for fish and other aquatic life Wildlife habitat Recreation Industrial and/or agricultural supply Navigation
Additional Contact Information	Names, addresses, phone numbers, and e-mail for local state and federal resource agencies	See Attachment B
	Names, addresses, phone numbers, and e-mail for local non-governmental stakeholders	See Attachment B
Photographs and Maps	Photographs of key features of the facility and each of the designated zones of effect	See Figures section following text. Figures are referenced where appropriate in text.
	Maps, aerial photos, and/or plan view diagrams of facility area and river basin	See Figures section following text, Figures are referenced where appropriate in text.

3. Standards Matrices

As mentioned above, two Zones of Effect (ZoE) exist for the Facility at the Hanover Pond Dam. The first ZoE (ZoE 1) is Hanover Pond, an impoundment created by the Hanover Pond Dam, fed by the inflow from the

Quinnipiac River. The second ZoE (ZoE 2) is downstream of the Dam and where water passing through the AST rejoins the River. A bypassed reach has been identified as being approximately 65 feet in length, however as approximately 46.5 feet of this length is the turbine itself, the bypassed reach is extremely short. As a result, any discussion of it has been included in the discussion of ZoE 2.

Facility Name: Hanover Pond Dam Hydropower Facility Zone of Effect 1: Impoundment

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				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		X

Facility Name: Hanover Pond Dam Hydropower Facility Zone of Effect 2: Downstream of Dam

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				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		X

4. Supporting Information

Below is the supporting information for each criterion. The Alternative Standards are listed individually and grouped by Zone of Effect. Bulleted, italicized text represents the instructions listed in the LIHI Certification Handbook 2nd Edition. Applicant’s response follows each instruction in standard text.

4.1. Zone of Effect 1: Impoundment Upstream of Facility

This area includes the Hanover Pond upstream of the Dam which is created by the inflow of the Quinnipiac River from the northwest corner of the Pond. This man-made waterbody has a surface area of approximately 71 acres, a maximum depth of approximately 7.0 feet, and an estimated mean depth of 2.5 feet. According to the United States Geological Survey (USGS), the average hydraulic residence time is 0.5 days.

4.1.1. Ecological Flow Regimes

The Facility satisfies Standard A-1 for ecological flow regimes.

Criterion	Standard	Instructions
A	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • 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 Facility, 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.

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.*

The powerhouse is located adjacent to the Dam on the western side of the River. Using the LIHI Handbook diagrams depicting bypassed reaches, which appears to be the distance from dam to the powerhouse or the dam to the tailrace, there is no bypassed reach for ZoE 1 (see p.6, and the diagrams at pp.18 – 19 of the LIHI Handbook 2nd Edition – Rev. 2.03). The short bypassed reach, which appears to be almost completely the turbine itself, is included in ZoE 2 discussed in section 4.2. Please see Figures 1 – 4 for photographs of the Facility and site.

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

The Facility is operated in run-of-river mode, and therefore does not change the surface elevations of Hanover Pond. All incoming flows pass through the AST, down the fishway, over the low flow notch and over the main spillway based on seasonal flows. No flow is retained in the impoundment greater than pre-Facility conditions. Please see Figure 7 for a diagram of flow distribution. See also the Facility flow monitoring plan located at:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14777991>

The intake from Hanover Pond is controlled by a hydraulically powered sluice gate. This system maintains true run-of-river flow by continuous remote monitoring of a head pond water level gage upstream of the intake, and automatically adjusts the height of the sluice gate to maintain a pre-set river level. This system, along with the fixed spillway, maintains the current elevation in Hanover Pond.

Operation of all components is carried out by a Programmable Logic Controller system (PLC) with input through a touch screen Human-Machine Interface (HMI). The PLC holds adjustable set points

which dictate how the system starts, stops and reacts to changing flow conditions in the River and water levels in the impoundment.

The PLC takes data from various system sensors, and inputs them to control the sluice gate and variable frequency drive (VFD). This ensures the system only takes the water flows available from the River and no more, maintaining the level of the impoundment upstream. The reserve flow over the low flow notch and flow through the fish pass structures are also maintained through the settings established in the PLC.

As part of the Terms and Conditions of granting an Exemption from Licensing, FERC, the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the Connecticut Department of Energy and Environmental Protection (CT DEEP) assisted NEHC in drafting and implementing an approved flow monitoring plan. Please see the Flow Monitoring Plan link provided above. The Plan is intended to ensure all the correct safeguards are set in place and the system is configured in a way to provide not only clean, renewable energy, but also maintain the prescribed flows and fish habitat protection.

The Exemption requires a reserve flow of 30 cfs to pass partially over the low flow spillway, seasonally through the fishway, and for the downstream fish passage channel to be wetted to a depth of two feet. These amounts were based on a sound understanding of aquatic habitat and ecological flow needs.

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

This is not applicable as the Facility is not located within a conduit.

- *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 impoundment is owned by the City of Meriden, and wildlife habitat within the impoundment zone is not actively evaluated or managed by the City. Hanover Pond is generally managed as a recreational resource, not as wildlife habitat. Regardless, the Pond attracts various bird species. In addition, the CT DEEP annually stocks Hanover Pond with trout for recreational fishing. Installed fish passage at the Hanover Pond Dam, as well as at the Wallace Dam downstream of the Facility, help pass some migratory fish species. No additional dams exist upstream of the Facility, allowing any migrants passing up the fish passage the ability to travel approximately 16 additional miles to the headwaters of the Quinnipiac River.

To establish a baseline for freshwater mussels and invasive species, NEHC has conducted a freshwater mussel survey:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14292342>

and drafted an invasive species monitoring and control plan:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14510038>.

4.1.2. Water Quality

The Facility satisfies Standard B-3 for water quality in both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
B	3	<p><u>Site-Specific Monitoring Studies:</u></p> <ul style="list-style-type: none"> • 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. • Document consultation with appropriate water quality agency to determine what water quality parameters and sampling methods are required. • Present recent water quality data from the facility or from other sources in the vicinity of the facility (e.g., data collected from the state, watershed associations, or others who collected data under generally accepted sampling protocols and quality assurance procedures) and explain and demonstrate how it satisfies current applicable water quality standards including designated uses, or provide a letter from the appropriate state or other regulatory agency accepting the data.

STANDARD B-3. Site-Specific Monitoring Studies

- *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.*

The 2010, 2014, and 2016 State of Connecticut Integrated Water Quality Reports include Hanover Pond on its list of impaired waterbodies for which total maximum daily loads (TMDLs) are necessary to address unacceptable loading of Enterococcus Bacteria, Nutrient/Eutrophication Biological Indicators, Polychlorinated Biphenyls (PCBs) and Sediment/Siltation. This report states Hanover Pond, in addition to the TMDL Assessment and Recommendations, is also impaired for Fish Consumption, Fish Habitat, and Recreation. For reference, the 2010, 2014, and 2016 reports can be found here:

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/ctiwqr10final.pdf

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2014_iwqr_305b_303d_final.pdf

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2016_iwqr_final.pdf

As the above listed water quality assessment findings were published prior to initiation of construction and commencement of operation of the Facility in February 2017, the Facility cannot be the cause of such water quality limitation.

- *Document consultation with appropriate water quality agency to determine what water quality parameters and sampling methods are required.*

NEHC has been aware of the water quality issues in the Quinnipiac River and Hanover Pond since the inception of the Project. Prior to construction, NEHC drafted a Standard Operating Procedure for low-flow water quality sampling, which was reviewed and approved by CT DEEP. Water quality sampling commenced to establish baseline data at three locations around Hanover Pond Dam (one upstream of the Dam and two downstream of the Dam) for dissolved oxygen (DO) and water temperature, during the 2014 and 2015 low flow season (July through September), when DO levels are typically lowest and temperatures are typically highest.

Following this baseline data collection, NEHC coordinated with CT DEEP to draft a post-construction water sampling plan which would continue with the water sampling as it had begun in the years prior to construction.

The protocol was submitted to and approved by CT DEEP and FERC. Please see:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14692474>

Links to the data collected and reports drafted can be found below.

- *Present recent water quality data from the facility or from other sources in the vicinity of the facility (e.g., data collected from the state, watershed associations, or others who collected data under generally accepted sampling protocols and quality assurance procedures) and explain and demonstrate how it satisfies current applicable water quality standards including designated uses, or provide a letter from the appropriate state or other regulatory agency accepting the data..*

In accordance with the Terms and Conditions set forth in the FERC Exemption, NEHC has performed, and will continue to perform water quality sampling at the Facility. Water feeding the AST travels through a fixed intake structure and therefore the AST does not disturb sediments in the impoundment. The turbine structure itself sits in a trough attached to, and immediately downstream of, the powerhouse and therefore has no effect on the water quality in the impoundment. Post construction water quality sampling in low flow seasons commenced in 2017 and will conclude in 2020.

Based on a comparison of the results of low-flow water quality sampling for pre-operation years 2014 – 2016 and post-operation years 2017 - 2018, the Project has not affected water quality at the impoundment. NEHC will continue to sample and to monitor DO and temperature during the low-flow seasons for the years 2019, and 2020. The water quality results will continue to be provided in an annual report submitted to the USFWS, CT DEEP and FERC.

2017 NEHC Water Quality Sampling Report:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14773252>

2018 NEHC Water Quality Sampling Report:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=15212375>

4.1.3. Upstream Fish Passage

The Facility satisfies Standard C-1.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
C	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to upstream fish passage in the designated zone. • 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.

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.*

ZoE 1 is the impoundment above the Dam known as Hanover Pond. There are no additional known obstructions or dams on the Quinnipiac River upstream of the Hanover Pond Dam and the Facility. This allows fish the ability to swim from ZoE 1 to the headwaters of the Quinnipiac River. In addition, the Facility was constructed completely within the earthen section of the existing Hanover Pond Dam. It was not constructed in a location where fish could previously pass. The Facility was carefully sited adjacent to an existing Denil fish pass, the exit to which is located in ZoE 1. The exit of the fishway is, in no way, blocked by the Facility. Please see Figures 3 and 4 for photographs of the site and location of fishway. Please see also section 4.2.3 below, which discusses the fishway, located in ZoE 2, in further detail.

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

CT DEEP has identified the Quinnipiac River as a high priority for anadromous fish restoration, particularly for Alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), and Blueback herring (*Alosa aestivalis*). As part of CT DEEP’s anadromous populations restoration, fish and American eel passage have been constructed at both the downstream Wallace Dam and the Hanover Pond Dam. Very few fish species are known to regularly inhabit Hanover Pond. As mentioned previously, CT DEEP stocks the Pond annually with trout for recreational fishing. Some migrants are known to utilize the fishway and exit into ZoE 1, though they are not monitored once they reach the Pond. The following fish have been documented within the Quinnipiac River Watershed and may be present in ZoE 1.

**Table 4.1.3.1
Quinnipiac River Watershed Fish Species**

Popular Name	Scientific Name	Popular Name	Scientific Name
American eel	<i>Anguilla rostrata</i>	Sea lamprey	<i>Petromyzon marinus</i>
Banded killifish	<i>Fundulus diaphanous</i>	Spottail shiner	<i>Notropis hudsonius</i>
Blacknose dace	<i>Rhinichthys atrarulus</i>	Striped bass	<i>Morone saxatilis</i>
Brook trout	<i>Salvelinus fontinalis</i>	Tessellated darter	<i>Etheostoma olmstedi</i>
Brown bullhead	<i>Ameiurus nebulosus</i>	Tomcod	<i>Microgadus tomcod</i>
Brown trout	<i>Salmo trutta</i>	White perch	<i>Morone americana</i>
Fathead minnow	<i>Pimephales promelas</i>	White Sucker	<i>Catostomus commersonii</i>
Gizzard shad	<i>Dorosoma cepedianum</i>	Yellow bullhead	<i>Ameiurus natalis</i>
Golden shiner	<i>Notemigonus crysoleucas</i>	Yellow perch	<i>Perca flavescens</i>
Longnose dace	<i>Rhinichthys cataractae</i>	Black crappie	<i>Promoxis nigromaculatus</i>
Minnow	<i>Cyprinidae spp.</i>	Bluegill sunfish	<i>Lepomis macrochirus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>	Carp	<i>Family: Cyprinidae</i>
Redbreast sunfish	<i>Lepomis auritus</i>	Rainbow trout	<i>Oncorhynchus mykiss</i>
Redfin pickerel	<i>Esox americanus</i>		

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

Historically, over 100 Industrial Revolution-era dams existed on the Quinnipiac River. All of these dams existed prior to the creation of fishways and few fish made it past the larger ones. In addition, many of the dams powered industrial facilities which discharged pollutants and wastes directly into the River. With the removal of all but two actively used dams, both of which have installed fishways, the once infrequent passage of migratory species has slowly begun to rebound.

As Facility operation commenced in February 2017, long after the prolific industrial damming of the Quinnipiac River, it could not be a cause of migratory fish species extirpation.

4.1.4. Downstream Fish Passage

The Facility satisfies Standard D-1 and qualifies for the Plus Standard for downstream fish passage for both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
D	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). • 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

Criterion	Standard	Instructions
		<p>necessary for successful completion of their life cycles.</p> <ul style="list-style-type: none"> • 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.

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, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines).*

Somewhere around 250 B.C. the Archimedes Screw was invented for the simple purpose of raising water from a lower level to a higher one. Modern uses of Archimedes Screw pumps have been deployed in Europe, the United Kingdom and North America specifically as a safe means to transport fish (and of course, water) in an upward manner for various purposes. Fish hatcheries have employed this technology to transfer fish from tank to truck and it has been used as an active fish lift in some locations, replacing a passive fishway. Only in the past 20 years has the Archimedes Screw pump been turned around to generate electricity. That has not diminished its ability to pass fish safely. Earlier models once contained pinch points and other properties that could harm some fish, but current models have bumpers installed on the flights as well as design changes to eliminate pinch points. Some companies in Europe offer Archimedes Screws in both pump and turbine operations so both can be deployed simultaneously where appropriate. Please see Attachment D for additional resources. See also Figure 11 demonstrating the upstream and downstream transit of fish in the Archimedes Screw pump and Turbine.

The AST has now been tested at the Hanover Pond Facility to the satisfaction of CT DEEP staff and the studies performed by NEHC have been accepted by FERC. In accordance with the Terms and Conditions of the Exemption, NEHC drafted an Injury and Mortality assessment to be carried out once the AST became operational. NEHC performed this assessment with the assistance of CT DEEP staff in the spring of 2017. Alewives and American shad (both target species) were released into the AST in two separate tests and their condition was documented upon exiting the screw. No injuries or fatalities were reported as a result of transiting through the screw. The report can be found here: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14632951>

CT DEEP staff decided additional testing (using additional species) was not necessary and determined that the AST is considered safe for downstream fish passage. A similar study using American eels (*Anguilla rostrata*) was also conducted and the report can be found here: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=15185281>

As the design of the AST provides for large, slow moving pockets of water to travel downstream, any fish entering the AST, enter at the top and be deposited at the base of the screw without injury. The AST itself provides for safe downstream passage of fish, but other design elements were incorporated to accommodate fish specifically targeted for restoration by CT DEEP. The design of the Facility was

completed with input from CT DEEP fisheries staff to ensure fish-safe features were included. Nine-inch clear bar spacing of the trash rack was specifically designed to allow shad, a species targeted for restoration, ample space to enter the AST without impingement on the trash rack, while still providing a safety barrier for people and trapping large debris such as logs. Sharp edges and pinch-points have been designed out to avoid any damage to fish and the bottom end bearing of the AST sits on a reinforced concrete block in the center of the flow, faired to allow smooth passage of water and fish around it.

- *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 cycles.*

Unlike most conventional hydropower facilities which either impinge downstream migrants against a fine mesh trash rack or prove fatal to fish upon entrance to the turbine itself, the AST is specifically designed to allow fish access to the screw through generously spaced trash rack bars and transport them downstream in a safer manner than plunging over the low flow notch in the Dam. The installation of the AST will not contribute adversely to the sustainability of populations migrating downstream to complete their life cycles. Instead, the AST will allow a second, more benign, method of transiting fish to migrate downstream.

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

CT DEEP has identified the Quinnipiac River as a high priority for anadromous fish restoration, particularly for Alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), and Blueback herring (*Alosa aestivalis*). As part of CT DEEP's anadromous populations restoration, fish and American eel passage have been constructed at both the downstream Wallace Dam and the Hanover Pond Dam.

Please see Table 4.1.3.1 above for fish species present in the Quinnipiac River watershed.

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

Historically, over 100 Industrial Revolution-era dams were constructed on the Quinnipiac River, all of which existed long before the construction or operation of the Facility. These dams, along with the pollution they created, prohibited the safe downstream migration of most fish once native to the River. All but two of the dams once installed on the River have been breached or removed and both active dams now have fishways, allowing for upstream migration. Those that head back downstream will encounter almost no barriers along the Quinnipiac since the installation of a low flow notch at the Hanover Pond Dam and the low head height of the Wallace Dam. In addition, since the commencement of Facility operation, the AST has been proven as a safe mode of downstream transit for migrating fish and provides a second, safer mode of downstream passage.

As Facility operation commenced in February 2017, long after the prolific industrial damming of the Quinnipiac River, it could not be a cause of migratory fish species extirpation. On the contrary, the

Facility will encourage the return of once extirpated species as they will now be able to fully complete their migratory life cycles.

Criterion	Standard	Instructions
D	PLUS	<p><u>Bonus Activities:</u></p> <ul style="list-style-type: none"> • 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.

STANDARD D-PLUS:

- *If advanced technology has been or will be deployed, explain how it will increase fish passage success relative to other options.*

The use of the AST itself in a hydroelectric facility is a form of advanced technology that will increase fish passage success as it will offer a safe, alternative downstream passage. Prior to construction and operation of the Facility, the only downstream passage for fish was directly over the Dam spillway or through the low flow notch. Now fish can safely travel the height of the Dam in a slow-moving pocket of water. In addition, 9-inch clear bar spacing was used on the trashrack to allow fish to easily enter the AST and use it as a means to pass safely downstream.

- *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.*

The state of Connecticut with assistance of several interest groups has undertaken a basin-wide dam removal initiative along the Quinnipiac River. As of the writing of this application only two dams still exist on the River. Both are actively in use and have monitored fishways.

CT DEEP has listed specific species targeted for restoration as American shad (*Alosa sapidissima*), Alewife (*Alosa pseudoharengus*), Blueback herring (*Alosa aestivalis*), Sea lamprey (*Petromyzon marinus*), and American eel (*Anguilla rostrata*). In addition, resident brown trout (*Salmo trutta*) are regularly stocked in various locations along the Quinnipiac River to support recreational fishing.

Removal or breach of all but the two remaining, active dams, in combination with installation of monitored fishways will help increase the abundance and sustainability of migratory fish species in the River.

- *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.*

No adaptive management plans above what has been agreed to in the Terms and Conditions of the Exemption have been implemented.

4.1.5. Watershed and Shoreline Protection

The Facility satisfies Standard E-1 for watershed and shoreline protection in both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
E	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • 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 Facility boundary). • Document that there have been no Shoreline Management Plans or similar protection requirements for the facility.

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 Facility boundary).*

The Facility is located on the south side of Hanover Pond in the southwestern section of the City of Meriden. In both ZoE 1 and ZoE 2, the lands occupied and utilized by the Facility are leased to the applicant by the City of Meriden. The City retains ownership of the Dam as well as the fishway. The land surrounding the Facility Site consists of single and multi-family residential housing to the east and west, a commercial automotive facility to the south at 33 Main Street, other small commercial establishments and restaurants along Main Street, and the City-owned Habershon Field recreational complex to the northwest along Hanover Pond. Developed land surrounding Hanover Pond consists of predominantly single-family residences and recreational areas. Zoning within the Facility boundary include: C2- General Commercial, R1- Single Family Residence, R2- Two and Three Family Residence and NCDD- Neighborhood Commercial Design District.

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

Searches of the City of Meriden’s publicly available documents yielded reference to a downtown master plan, a flood plan for Harbor Brook and revitalization initiatives. No Shoreline Management Plan has been issued or drafted for anywhere within the Facility boundary, including the impoundment of Hanover Pond and was not required for construction or operation of the Facility. In order to construct the Facility, a soil erosion and sediment control plan to protect Hanover Pond and the Quinnipiac River was drafted and filed with FERC.

Soil Erosion and Sediment Control Plan for the Facility can be found here:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14296619>

The FERC order approving the Soil Erosion and Sediment Control Plan can be found here:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14325806>

In addition, an invasive species survey, originally scheduled for the summer of 2018 will be performed in the summer of 2019. The reason for the postponement was the unscheduled maintenance of the Facility requiring the AST remain inoperable for several months and the ground disturbance this maintenance caused. It was decided no plant species, native or invasive would re-establish in the upland area prior to the summer of 2019. The order can be read here: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14964832>

4.1.6. Threatened and Endangered Species Protection

The Facility Satisfies Standard F-1 for threatened and endangered species protection in both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
F	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Document that there are no listed species in the facility area or affected riverine zones downstream of the facility. • If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species. • If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken.

STANDARD F-1. Not Applicable/De Minimis Effect

- *Document that there are no listed species in the facility area or affected riverine zones downstream of the facility.*

NEHC obtained an official USFWS species list for the Facility boundary stating there were no listed species within the area. A copy of this letter can be found at Attachment C.

NEHC contacted CT DEEP and requested a review of State Threatened and Endangered Species and Species of State Concern. A copy of the response can be found at Attachment C. CT DEEP stated the box turtle and wood turtle are both listed as State Species of Special Concern and could be found within the Facility site. CT DEEP also stated a historic sedge had once been in the Facility area as well. Mitigation measures were proposed for the turtle species based on suggestions from CT DEEP. No further action was required by CT DEEP for the sedge.

- *If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species.*

NEHC consulted with the USFWS and CT DEEP regarding Threatened and Endangered species and State Listed Species of Concern in 2015, prior to the construction and operation of the Facility. NEHC received notice that there were no federally listed threatened or endangered species in the Facility area. CT DEEP stated two extant turtle species and a historic sedge were listed as species of concern. The mitigation measures NEHC proposed were adequate for protection of the existing turtle species

and the historic record of the sedge did not require any protection considerations, according to CT DEEP staff. Please see Attachment C for copies of correspondence from both agencies.

Since consultation with the above listed agencies took place, the northern long-eared bat has been listed in CT. As the Facility is constructed and landscaped, no trees are planned to be cut. No known hibernaculum nor any roost trees exist anywhere at the Facility site. In addition, the operation of the Facility will have no affect on the northern long-eared bat.

- *If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken.*

There are no significant efforts to reintroduce extirpated species.

4.1.7. Cultural and Historic Resource Protection

The Facility satisfies Standard G-1 for cultural and historic resources in both ZoE 1 and ZoE 2.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
G	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Document that there are no cultural or historic resources located on 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 adversely affected any cultural or historic resources that are present on facility lands.

STANDARD G-1. Not Applicable/De Minimis Effect

- *Document that there are no cultural or historic resources located on facility lands that can be affected by construction or operations of the facility.*

A dam was originally built at the approximate location of the existing Dam in the 1850s and Hanover Pond was impounded to provide hydropower to the former Meriden Cutlery Factory. The factory buildings were located downstream and south of the Facility Site. All buildings associated with the factory, which closed in the 1920s, were demolished in the 1930s.

The only known portions of the factory complex on the Facility Site were the original timber crib dam (now demolished and fully rebuilt) and a former north-south oriented water intake canal that once traversed the western portion of the Facility Site (abandoned and filled sometime between 1934 and 1951). No Facility excavations occurred at the location of the former intake canal.

Significant ground disturbance occurred during the reconstruction of the Dam in 2005-2006 across the approximately 2.7-acre Facility Site.

The CT State Historic Preservation Officer indicated no impacts would result to cultural or historic resources as a result of Facility construction. Please see Attachment D for correspondence.

- Document that the facility construction and operation have not in the past adversely affected any cultural or historic resources that are present on facility lands.

The Facility was constructed between September, 2016 and February, 2017. It became operational in late February, 2017. As no cultural or historic resources were present prior to the construction and operation of the Facility, none were adversely affected. Please see above for complete description of area.

4.1.8. Recreational Resources

The Facility satisfies Standard H-3 and Plus Standard for recreational resources in both ZoE 1 and ZoE 2.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
H	3	<p><u>Assured Accessibility:</u></p> <ul style="list-style-type: none"> • In lieu of existing recommendations and plans for recreational uses, document the facility’s current and future commitment to accommodate reasonable requests from recreation interests for adequate public access for recreational use of lands and waters of the facility, including appropriate recreational water flows and levels, without fees or charges.

STANDARD H-3. Assured Accessibility:

- *In lieu of existing recommendations and plans for recreational uses, document the facility’s current and future commitment to accommodate reasonable requests from recreation interests for adequate public access for recreational use of lands and waters of the facility, including appropriate recreational water flows and levels, without fees or charges*

Hanover Pond is owned and managed by the City of Meriden. Despite the USEPA Assessment and Recommendations regarding TMDL¹ development for the Quinnipiac Mainstem, the City allows recreational activities such as fishing and boating, and the Facility’s installation and operation has not impacted those recreational activities.

Prior to the construction of the Facility, most recreational boaters portaged around the Hanover Pond Dam through tall grass anywhere along the earthen portion of the Dam. Informal take-out and put-in locations existed in the form of patches of eroded and compacted shoreline. As part of the construction of the Facility NEHC has installed signage upstream and downstream of the Facility to indicate appropriate take-out and put-in locations for non-motorized boats desiring to portage around the Dam and Facility. The Facility also has well landscaped, clean grounds surrounding it and warning signs of the Facility’s intake and outflow. To keep boaters a safe distance from the Dam’s

¹ Water quality is not meeting the designated uses, including habitat for fish, other aquatic life, wildlife habitat; and recreation. In 2008, a TMDL for indicator bacteria was adopted by CT DEEP.

spillway and low flow notch, a floating safety boom was strung across the River, just upstream of the Dam.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
H	PLUS	<u>Bonus Activities:</u> <ul style="list-style-type: none"> Document any new public recreational opportunities that have been created on facility lands or waters beyond those required by agencies (e.g., campgrounds, whitewater parks, boating access facilities and trails). Document that such new recreational opportunities did not create unmitigated impacts to other resources.

As mentioned above, the grounds around Facility have been upgraded with a more formal, maintained portage location. The Facility itself is fenced for safety, but the portage trail is located on a gentler slope of the earthen portion of the Dam. Gravel put-in and take-out locations have been installed for easy identification of portage landings, and the landings are located safely away from the Facility's intake and outflow.

Allowing for safer, more identified access to portage around the Dam has not created unmitigated impacts to other resources. The site is simply more accessible and clearly marked. Activities that took place at the site prior to the construction of the Facility have been formally recognized and provided for.

4.2. Zone of Effect 2: Downstream of the Dam

The second ZoE (ZoE 2) is located at the outflow of the water from the Dam and tailrace of the AST, below the Dam. Where information provided for ZoE 2 is identical to that of ZoE 1 above, it is noted.

4.2.1. Ecological Flow Regimes

The Facility satisfies Standard A-2 for ecological flows.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
A	2	<u>Agency Recommendation:</u> <ul style="list-style-type: none"> 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).

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.*

As part of the Terms and Conditions drafted through consultation with USFWS, NMFS, CT DEEP and NEHC, the Facility is to operate in run-of-river mode. These Terms and Conditions were incorporated into the FERC License (Exemption) for the Facility issued on May 19, 2016. The Facility has the ability to regulate flows through the turbine via a gage linked to the automatically adjusting sluice gate. Reserve flows remain at 30cfs at all times, subject to River flow. This flow is to satisfy the fishway (seasonally) with the remainder flowing over the low level spillway. Above this flow, the sluice gate will allow any additional flow into the AST. Delegating a minimum flow to the fishway and the low level spillway prior to taking any flow for Facility operation ensures protection of the River resources. Please see the Order granting exemption:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14251954>

In addition, the Plan for monitoring bypass flows can be read here:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14777991>

- *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.*

Gage data was compiled from the gage at Wallingford as well as data from StreamStats² to aid in the proper understanding of an appropriate minimum flow. The minimum flow amount was agreed upon through basic understanding of River flow at the site, agency knowledge of flows needed to operate the fishway and appropriate flow over the low flow spillway to protect downstream resources.

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

Agency goals include short term maintenance and long term improvement of current conditions. The Facility contributes to the long term goals of the agencies by assisting in ecological flow management. The river levels downstream are monitored and maintained at a designated depth subject to inflow during regular operation.

Flows sufficient to pass fish upstream through the fishway as well as sufficient for ecological maintenance of the downstream area help further the agencies' goals of re-establishing habitat for state species of concerns.

² https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools?qt-science_center_objects=0#qt-science_center_objects

- *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).*

As part of the Terms and Conditions of granting an Exemption from Licensing, FERC, the USFWS, NMFS, and CT DEEP required NEHC to draft and implement a flow monitoring plan. The Plan is referenced above and helps to ensure all the correct safeguards are in place and the system is configured in a way to provide not only clean, renewable energy, but also the prescribed flows for fish habitat protection.

The Exemption requires a reserve flow of 30 cfs to pass partially over the low flow spillway, seasonally through the fishway and for the fish passage channel at the base of the Dam to be wetted to a depth of two feet. This amount was based on a sound understanding of aquatic habitat and ecological flow needs.

If through data collection, the agreed upon 30-cfs minimum flow does not provide the required two feet of water in the fish passage channel, allow for operation of the existing fishway, and provide adequate flow through the low-flow notch, NEHC will increase the minimum flow, with the assistance and collaboration of USFWS and CT DEEP, to the appropriate amount. If NEHC finds that the PLC is not maintaining the required depth of 2 feet when operating in fully automatic mode, the parameters in the PLC will be altered to achieve the necessary water depth in the fish channel.

4.2.2. Water Quality

The Facility satisfies Standard B-3 for water quality.

Criterion	Standard	Instructions
B	3	<p><u>Site-Specific Monitoring Studies:</u></p> <ul style="list-style-type: none"> • If facility is located on a <u>Water Quality Limited</u> 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. • Document consultation with appropriate water quality agency to determine what water quality parameters and sampling methods are required. • Present recent water quality data from the facility or from other sources in the vicinity of the facility (e.g., data collected from the state, watershed associations, or others who collected data under generally accepted sampling protocols and quality assurance procedures) and explain and demonstrate how it satisfies current applicable water quality standards including designated uses, or provide a letter from the appropriate state or other regulatory agency accepting the data.

STANDARD B-3. Site-Specific Monitoring Studies

- *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.*

The 2010, 2014, and 2016 State of Connecticut Integrated Water Quality Reports include Hanover Pond on its list of impaired waterbodies for which total maximum daily loads (TMDLs) are necessary to address unacceptable loading of Enterococcus Bacteria, Nutrient/Eutrophication Biological Indicators, Polychlorinated Biphenyls (PCBs) and Sediment/Siltation. This report states Hanover Pond, in addition to the TMDL Assessment and Recommendations, is also impaired for Fish Consumption, Fish Habitat, and Recreation. For reference, the 2010, 2014, and 2016 reports can be found here:

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/ctiwqr10final.pdf

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2014_iwqr_305b_303d_final.pdf

http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2016_iwqr_final.pdf

As the above listed water quality assessment findings were published prior to initiation of construction and commencement of operation of the Facility in February 2017, the Facility cannot be the cause of such water quality limitation.

- *Document consultation with appropriate water quality agency to determine what water quality parameters and sampling methods are required.*

NEHC has been aware of the water quality issues in the Quinnipiac River and Hanover Pond since the inception of the Project. Prior to construction, NEHC drafted a Standard Operating Procedure for low-flow water quality sampling, which was reviewed and approved by CT DEEP. Water quality sampling commenced to establish baseline data at three locations around Hanover Pond Dam (one upstream of the Dam and two downstream of the Dam) for dissolved oxygen (DO) and water temperature, during the 2014 and 2015 low flow season (July through September), when DO levels are typically lowest and temperatures are typically highest.

Following this baseline data collection, NEHC coordinated with CT DEEP to draft a post-construction water sampling plan which would continue with the water sampling as it had begun in the years prior to construction.

The protocol was submitted to and approved by CT DEEP and FERC. Please see:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14692474>

Links to the data collected and reports drafted can be found below.

- *Present recent water quality data from the facility or from other sources in the vicinity of the facility (e.g., data collected from the state, watershed associations, or others who collected data under generally accepted sampling protocols and quality assurance procedures) and explain and demonstrate how it*

satisfies current applicable water quality standards including designated uses, or provide a letter from the appropriate state or other regulatory agency accepting the data.

In accordance with the Terms and Conditions set forth in the FERC Exemption, NEHC has performed, and will continue to perform water quality sampling at the Facility. Water flowing from the AST tailrace is churned and may, under certain conditions, provide additional DO in ZoE 2. Generally, the impoundment is subject to supersaturation from algal blooms and has shown higher concentrations of DO than downstream locations. So far, the monitoring has shown this to be the case. Post construction water quality sampling in low flow seasons commenced in 2017 and will conclude in 2020.

Based on a comparison of the results of low-flow water quality sampling for pre-operation years 2014 – 2016 and post-operation years 2017 - 2018, the Project has not affected water quality downstream of the Dam. NEHC will continue to sample and to monitor DO and temperature during the low-flow seasons for the years 2019, and 2020. The water quality results will continue to be provided in an annual report submitted to the USFWS, CT DEEP and FERC.

2017 NEHC Water Quality Sampling Report:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14773252>

2018 NEHC Water Quality Sampling Report:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=15212375>

4.2.3. Upstream Fish Passage

The Facility satisfies Standard C-2 and qualifies for the Plus Standard for upstream fish passage.

Criterion	Standard	Instructions
C	2	<p><u>Agency Recommendation:</u></p> <ul style="list-style-type: none"> 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.

STANDARD C-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).*

As part of the Terms and Conditions drafted through consultation with USFWS, NMFS, CT DEEP and NEHC, the Facility has monitored and reported on the upstream use of the existing fishway and

installed and operated an eel trap. The Terms and Conditions were incorporated into the FERC License (Exemption) for the Facility issued on May 19, 2016. Please see the Order granting exemption <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14251954>

In addition, as outlined in the Terms and Conditions of the Exemption, an eel trap was constructed at the base of the Facility tailrace. Eels would be collected in the trap, counted, and manually transported to Hanover Pond. The eel trap report can be found here:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=15107120>

- *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*

Since the installation of the fishway, no agency had monitored it to know its efficacy. NEHC designed a system for CT DEEP that includes a custom built fish crowder, underwater camera and SalmonSoft counting software installed in a laptop. The camera captures the images of fish as they exit the fishway into the Pond. Post processing images by the SalmonSoft software allows for an accurate accounting of the migratory species utilizing the fishway.

Similarly, no accounting of eels had ever been undertaken at the site and no eel trap or eel pass existed prior to construction of the Facility. American eels now are monitored for upstream passage at this location.

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

As mentioned above, a custom built monitoring station was developed for the existing fishway at the Facility. The Terms and Conditions of the Exemption required monitoring pre- and post-construction to determine if the Facility had any impact on the migration of species or the use of the fishway. The baseline data is available for one year prior to construction of the Facility and will be available for three years following construction. The 2018 fishway utilization report can be found here: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14999771>

In addition, as part of the construction process and as a requirement outlined in the Terms and Conditions of the Exemption, NEHC installed a fish passage channel at the base of the Dam. This channel is intended to provide a steady stream of water, when flows allow, to encourage upstream migrants to navigate towards the entrance of the fishway. The fish channel can be seen as a row of boulders at the bottom center of the photograph at Figure 3. The Order approving fish channel plan can be found here: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14552356>

As mentioned above, eels have also been monitored since the construction of the Facility and the Eel Trap Report is referenced and linked above.

4.2.4. Downstream Fish Passage

The Facility satisfies Standard D-1 for downstream fish passage.

Criterion	Standard	Instructions
D	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). • 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 cycles. • 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.

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, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines).*

As mentioned in Section 4.1.4 above, the AST provides safe downstream passage by allowing downstream migrants who enter the intake from the impoundment a slow downstream transport within the pockets of water formed between the blades of the AST. Should any downstream migrants not access the AST for downstream travel, there is still a low-flow notch with a plunge pool at the base of the Dam that migrants can use to gain access to the River below the Dam. The low flow notch has a minimum reserve flow, subject to River flow, to ensure downstream migrants this form of passage.

- *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 cycles.*

As mentioned above, any downstream migrants now have two means of downstream passage whereas prior to construction of the Facility, they had only one. The Facility actually increased the ability of migrant species to travel safely downstream. Recognizing that some species may not enter the intake of the AST, the low flow notch retains a minimum flow.

In addition, mortality studies have been performed in the UK as well as at the Facility. The UK studies can be accessed at Attachment D. The studies performed in collaboration with CT DEEP at the Facility can be accessed here:

Downstream eel mortality report:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=15153826>

Fish Injury and Mortality Study:

<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14632951>

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

The documented fish in the Quinnipiac River Watershed can be found in Table 4.1.3.1. In addition, the fishway utilization report referenced above contains data collected on species using the fishway at the Facility.

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

Historically, over 100 Industrial Revolution-era dams existed on the Quinnipiac River, all of which existed long before the construction or operation of the Facility. These dams, along with the pollution they created prohibited the safe downstream migration of most fish once native to the River. All but two of the dams once installed on the River have been breached or removed and both active dams now have fishways, allowing for upstream migration. Those that head back downstream will encounter almost no barriers along the Quinnipiac since the installation of a low flow notch at the Hanover Pond Dam and the low head height of the Wallace Dam. In addition, since the commencement of Facility operation, the AST has been proven as safe mode of downstream transit for migrating fish and provides a second, safer mode of downstream passage.

As Facility operation commenced in February 2017, long after the prolific industrial damming of the Quinnipiac River, it could not be a cause of migratory fish species extirpation. On the contrary, the Facility will encourage the return of once extirpated species as they will now be able to fully complete their migratory life cycles.

4.2.5. Watershed and Shoreline Protection

The Facility satisfies Standard E-1 for watershed and shoreline protection for both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
E	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • 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 Facility boundary). • Document that there have been no Shoreline Management Plans or similar protection requirements for the facility.

Please see the discussion in Section 4.1.5, ZoE 1.

4.2.6. Threatened and Endangered Species Protection

The Facility Satisfies Standard F.1 for threatened and endangered species protection in both ZoE 1 and ZoE 2.

Criterion	Standard	Instructions
F	1	<u>Not Applicable / De Minimis Effect:</u>

		<ul style="list-style-type: none"> • Document that there are no listed species in the facility area or affected riverine zones downstream of the facility. • If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species. • If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken.
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Please see the discussion in Section 4.1.6, ZoE 1.

4.2.7. Cultural and Historic Resource Protection

The Facility satisfies Standard G.1 for cultural and historic resources.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
G	1	<u>Not Applicable / De Minimis Effect:</u> <ul style="list-style-type: none"> • Document that there are no cultural or historic resources located on 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 adversely affected any cultural or historic resources that are present on facility lands.

Please see the discussion in Section 4.1.7, ZoE 1.

4.2.8. Recreational Resources

The Facility satisfies Standard H-3 for recreational resources in both ZoE 1 and ZoE 2.

<i>Criterion</i>	<i>Standard</i>	<i>Instructions</i>
H	3	<u>Assured Accessibility:</u> <ul style="list-style-type: none"> • In lieu of existing recommendations and plans for recreational uses, document the facility's current and future commitment to accommodate reasonable requests from recreation interests for adequate public access for recreational use of lands and waters of the facility, including appropriate recreational water flows and levels, without fees or charges.

Please see the discussion in Section 4.1.8, ZoE 1.