Central Rivers Power

Boott Hydropower, LLC

Subsidiary of Central Rivers Power US, LLC
670 N. Commercial Street, Suite 204
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Via eFiling

December 1, 2021

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

Re: **Lowell Hydroelectric Project (FERC No. 2790-074); Updated Study Report Meeting Summary**

Dear Secretary Bose:

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20-megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5. In accordance with the ILP, the Commission issued a Study Plan Determination (SPD) for the Project on March 13, 2019. The SPD directed Boott to conduct 13 studies in support of relicensing the Project.

On June 12, 2020, the Commission issued a Revised Process Plan and Schedule and Determination on Requests for Study Modifications for the Lowell Hydroelectric Project (Revised PPS). In accordance with the Revised PPS, Boott filed the Revised ISR with the Commission on September 30, 2020, which contained the results of the following studies: Recreation and Aesthetics Study; Downstream American Eel Passage Assessment; Juvenile Alosine Downstream Passage Assessment; Upstream and Downstream Adult Alosine Passage Assessment; and the Fish Assemblage Study. Boott held the Revised ISR Meeting with relicensing participants and FERC staff on October 15, 2020 by video conferencing call. FERC issued the Director's Determination on Disputes/Amendments on February 2, 2021.

In accordance with the Revised PPS, on February 25, 2021, Boott filed a second Revised ISR containing the following studies: Three-Dimensional Computational Fluid Dynamics Modeling Study; Fish Passage Survival Study; Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach; Resources, Ownership, Boundaries, and Land Rights Study; Historically Significant Waterpower Equipment Study; and Operation Analysis of the Lowell Canal Study. Boott also filed an updated Recreation and Aesthetics Report as requested in FERC's February 2, 2021 Determination. On March 5, 2021, Boott filed the Water Level and Flow Effects on Historic Resources Study. Boott held the Revised ISR Meeting with relicensing participants and FERC staff on March 11, 2021 by video conferencing call and filed the summary of the Revised ISR Meeting per regulations at 18 C.F.R. § 5.15(c)(3).

On June 23, 2021, FERC issued a Determination on Requests for Study Modifications for the Lowell Hydroelectric Project (June 2021 Study letter). This letter recommended that Boott file an Updated Study Report (USR) for all completed studies, and to file the initial Whitewater Boating and Access Study. In accordance with the June 2021 Study Letter, Boott filed a USR

for the following studies: Downstream American Eel Passage Assessment; Juvenile Alosine Downstream Passage Assessment; Upstream and Downstream Adult Alosine Passage Assessment; Fish Passage Survival Study; Fish Assemblage Study; Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach; Resources, Ownership, Boundaries, and Land Rights Study; Water Level and Flow Effects on Historic Resources Study; Historically Significant Waterpower Equipment Study; Recreation and Aesthetics Study; Operation Analysis of the Lowell Canal Study; and the 3-D CFD Study.

Boott held a Study Report Meeting from 1:00 p.m. to 5:00 p.m. on November 16, 2021. Pursuant to 18 C.F.R. § 5.15(c)(3) and the June 2021 Study letter, Boott is filing this USR Meeting Summary with the Commission on or before December 1, 2021. Within 30 days of the filing of the USR Meeting Summary (i.e., December 31, 2021), stakeholders may file a disagreement with the summary and/or any proposals to modify ongoing studies with the Commission.

1.0 Meeting Purpose and List of Participants

1.1 Purpose

During the USR Meeting, Boott presented information regarding the USR filed on November 1, 2021. A copy of the USR Meeting presentation is included as Attachment A to this USR Meeting Summary.

1.2 Participants

Concurrent with the USR filed on November 1, 2021, resource agencies, tribes, non-governmental organizations, and other interested parties were invited to participate in the USR Meeting. The USR meeting was hosted by video conference call with an established agenda; thus, certain participants only attended/called into certain portions of the meeting. Representatives from the following organizations called into the meeting:

- FERC
- Boott
- Massachusetts Division of Fisheries and Wildlife (MADFW)
- National Marine Fisheries Service (NMFS)
- United States Fish and Wildlife Service (USFWS)
- Massachusetts Department of Environmental Protection (MADEP)
- Massachusetts Department of Conservation and Recreation (MADCR)
- National Park Service (NPS)
- American Whitewater (AW)
- Normandeau Associates, and
- HDR, Inc.

2.0 SUMMARY OF THE INITIAL STUDY REPORT MEETING

2.1 Introduction

Kevin Webb (Boott) and HDR introduced the meeting, including the introduction of meeting participants and Boott's relicensing team, the purpose of the meeting, an overview of the relicensing process, study completed to date, and ILP milestones.

2.2 Fish Passage Survival Study

Drew Trested (Normandeau) presented the goals, objectives, methods, and results of the Fish Passage Survival Study.

- FERC and Normandeau discussed that the turbine blade strike analysis (TBSA) tool provides an overall prediction of survival when the population is routed through all potential routes, including proportion passing through the turbines. TBSA gives the predicted losses of fish and what component were lost by each route.

2.3 Three-Dimensional Computational Fluid Dynamics Modeling Study

HDR presented the goals, objectives, methods, and results of the Three-Dimensional Computational Fluid Dynamics Modeling Study.

- HDR stated they would confirm/update Table 3-1 in the report.

- HDR clarified that the model run of the fish ladder was based on field measurements (not based on water elevations).

2.4 Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach

Normandeau presented the goals, objectives, methods, and the results of the Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach.

2.5 Resources, Ownership, Boundaries, and Land Rights Study Report

HDR presented the goals, objectives, methods, and results for the Resources, Ownership, Boundaries, and Land Rights Study Report.

- HDR discussed updates to the Resources, Ownership, Boundaries and Land Rights Study Report, particularly to the publicly-accessible database. HDR and NPS discussed what structures were and were not included in the database.

2.6 Water Level and Flow Effects on Historic Resources Study

HDR presented the goals, objectives, methods, and results of the Water Level and Flow Effects on Historic Resources Study. The primary update to this study is the inclusion of the Great Wall Visual Assessment.

2.7 Historically Significant Waterpower Equipment Study

HDR presented the goals, objectives, methods, and results of the Historically Significant Waterpower Equipment Study.

2.8 Whitewater Boating and Access Study

HDR and Boott provided an update on the Whitewater Boating and Access Study.

- Boott conducted in-person site reconnaissance of the bypassed reach during lower flows. During this site visit, Boott noted safety concerns related to debris in the bypassed reach, primarily rebar, that needs to be further evaluated and considered in the Safety Plan. The rebar was not previously noticeable under higher flows In the Quarter 2 2021 Progress Report, Boott included photos of the rebar found in the bypassed reach, and a map showing the main area of concern that needs to be further evaluated with AW. Boott is currently working with AW to evaluate safety concerns associated with rebar in the bypassed reach, as well as monitoring the National Weather Service's Advanced Hydrologic Prediction Service for the Merrimack River at Lowell to evaluate if predicted river flows are adequate to perform the study. Boott will continue to monitor flow forecasts and will execute the study as soon as possible.
- Additionally, FERC was notified in August that the Project was off-line following an electrical fault in the transmission cable to the grid. With the Project offline, Boott did not have control of the river and would not have been able to allocate the various flow levels necessary to complete the study in Q4.
- AW expressed their frustrations that the study was not completed by the November 1, 2021 filing.
- FERC noted it would be helpful if Boott filed more information about the rebar and what solutions are being considered by Boott. Boott agreed to file additional information after a more extensive evaluation of the rebar issue.

2.9 Other Studies

- FERC asked questions relating to the final detection locations for the 18 radio-tagged juveniles identified as having not passed downstream during the juvenile assessment. This information is provided in Attachment B as Request #1.

- FERC asked for the frequency distribution for number of passage attempts prior to successful downstream passage of adult shad, adult river herring, juvenile alosines, and eels and for upstream passage of adult shad and adult river herring. This information is provided in Attachment B as Request #2.

3.0 Conclusion

Boott is filing this USR Meeting Summary in accordance with 18 C.F.R. § 5.15(c)(3) of the

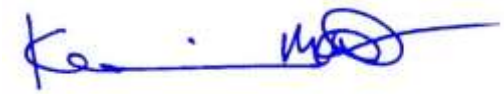
Commission's regulations. At this time, Boott is not proposing any new studies. After review of the USR Meeting Summary, stakeholders may file disagreements with the meeting summary, request modifications to ongoing studies, or request new studies. Disagreements with the USR Meeting Summary and any requests to amend the study plan to include new or modified studies must be filed with the Commission no later than December 31, 2021. In requesting modifications to ongoing studies or new studies, stakeholders must follow the Commission's Criteria for Modification of Approved Study (18 C.F.R. 5.15(d)) or Criteria for New Study (18 C.F.R. 5.15(e)).

Boott will have 30 days to respond to any disagreements or requests to amend the study plan, and the Commission's Director of the Office of Energy Projects will resolve any disagreement and amend the approved study plan, as appropriate, within 30 days of the due date for Boott's response.

Please do not hesitate to contact me at (978) 935-6039 or kwebb@centralriverspower.com if you have any questions concerning this filing.

Sincerely,

Boott Hydropower, LLC



Kevin M. Webb
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Cc: Lowell Hydroelectric Project (FERC No. 2790) Distribution List

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ATTACHMENT A

Lowell Hydroelectric Project (FERC No. 2790)

Study Report Meeting

Agenda for Study Report Meeting

- 1:00 – 1:30 p.m.: Fish Passage Survival Study
- 1:30 – 2:00 p.m.: 3-D CFD Study
- 2:00 – 2:30 p.m.: Instream Flow Study and Zone of Passage Assessment in the Bypassed Reach
- 2:30 – 3:00 p.m.: Resources, Ownership, Boundaries, and Land Rights Study
- 3:00 – 3:30 p.m.: Historically Significant Waterpower Equipment Study
- 3:30 – 4:00 p.m.: Water Level and Flow Effects on Historic Resources Study
- 4:00 - 5:00 p.m. – Other Project Studies (Downstream American Eel Passage Assessment; Juvenile Alosine Downstream Passage Assessment; Upstream and Downstream Adult Alosine Passage Assessment; Fish Assemblage Study; Recreation and Aesthetics Study; Operation Analysis of the Lowell Canal Study; Whitewater Boating and Access Study)

Study Report Meeting Objectives

- Pursuant to the ILP, Boott filed Updated Study Reports (USR) on November 1, 2021 with FERC.
  - The USR presented new results of the following studies:
    - Three-Dimensional Computational Fluid Dynamics Modeling Study (3D CFD);
    - Fish Passage Survival Study;
    - Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach;
    - Resources, Ownership, Boundaries, and Land Rights Study;
    - Historically Significant Waterpower Equipment Study;
    - Water Level and Flow Effects on Historic Resources Study

  - The Commission's regulations at 18 C.F.R. § 5.15(c) requires Boott to hold today's Study Report Meeting within 15 days of filing the USR.

Upcoming ILP Milestones

- Based on FERC's June 2021 *Revised Process Plan and Schedule and Determination on Requests for Study Modifications for the Lowell Hydroelectric Project*

Milestone	Responsible Party	Date
Study Report Meeting on All Studies	**All stakeholders**	**November 16, 2021**
Revised Initial Study Report Meeting Summary	Boott	December 1, 2021
Any Disputes/Requests to Amend Study Plan Due	**All stakeholders**	**December 31, 2021**
Responses to Disputes/Amendment Requests Due	**All stakeholders**	**January 30, 2022**
Director's Determination on Disputes/Amendments	FERC	March 2, 2022

Any Disputes/Requests to Amend Study (18 C.F.R. § 5.15(d))

- *Criteria for modification of approved study.* Any proposal to modify an ongoing study must be accompanied by a showing of good cause why the proposal should be approved, and must include, as appropriate to the facts of the case, a demonstration that:
  - (1) Approved studies were not conducted as provided for in the approved study plan; or
  - (2) The study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.

- If requesting new studies, stakeholders must consider FERC's Criteria (18 C.F.R. § 5.15(e)).

- www.LowellProjectRelicensing.com
- FERC eLibrary Docket Number (P-2790)

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Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

- Fish Passage Survival Study report was filed with FERC on February 25, 2021
  - Goal: Assess the potential survival of fish passing downstream through the E.L. Field turbines and to inform estimates of Project passage survival for emigrating diadromous fish species (adult and juvenile American shad, river herring, and American eel)
  - Objectives:
    - Assess the potential for impingement for the target species and life stages;
    - Assess the potential for entrainment for target species and life stages;
    - Conduct a desktop survival analysis to estimate passage survival of target species and life stages for each active turbine type; and
    - Assess total Project survival for the target species and life stages.

Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

- FERC issued a *Determination on Requests for Study Modifications* for the Lowell Project on June 23, 2021
  - Specific to the Fish Passage Survival Study, FERC indicated Boott should "*rerun the model for adult eels, adult alosines, and juvenile alosines for low, medium, and high flow conditions (i.e., 75, 50, and 25 percent exceedance flows), using the calibrated lambda values discussed above, with the assumption that fish routing will occur in proportion to flows*".

- Boott filed Updated Study Reports for the Project on November 1, 2021
  - Included was a Normandeau technical memo prepared to address the Commissions request for additional analyses

Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

- To address the FERC request the following items were assembled:
  - Mean body length and associated standard deviation for anticipated outmigrating populations of adult river herring, adult American shad, juvenile alosines, and adult American eels;
  - Lowell inflow for the downstream passage season for spring (i.e., May to June) and fall (i.e., October to November) migrants for the 75%, 50%, and 25% exceedance conditions;
  - Set of physical parameter values and estimates for characterizing the two Kaplan turbine units housed in the E.L. Field powerhouse;
  - Calibrated values of lambda for use in the new downstream passage models for adult alosines and adult eels (calibration to be informed using estimated turbine survival rates obtained during 2019-2020 field studies for adult eels and alosines);
  - Proportional distribution among available downstream passage routes; and
  - Non-turbine route-specific survival estimates.

Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

Body Size Information

Species	Minimum (inches)	Maximum (inches)	Average (inches)	Std. Dev.
River herring (Adult)	9	13	11	0. 7
American shad (Adult)	15	23	19	1.3
Juvenile Alosine	2	6	4	0.7
American Eel	25	41	33	2. 7

Seasonal Inflow Information

Percent Exceedance	Spring (cfs)	Fall (cfs)
25	11,239	8,835
50	6,755	4,989
75	4,129	3,038

Turbine Information

Turbine Type	Kaplan
Runner Diameter (ft)	12.7
Number of Blades	5
Turbine Discharge (cfs)	3,300
Discharge at Optimum Efficiency (%)	81.3%
Net Head (ft)	39
Speed (rpm)	120
Turbine Efficiency (%)	92.8

Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

Lambda Calibration

Fish Species (life stage)	Field-derived Turbine Survival Rate	Correlation Factor (λ)	Resulting TBSA Turbine Survival Rate
River herring (Adult)	73.9% (75% CI = 68.8%-79.1%)	0.7	73.9%
American shad (Adult)	35.5% (75% CI = 25.8%-45.2%)	1	34.6%
Juvenile Alosine	-	0.2*	-
American Eel	75.0% (75% CI = 70.6%-79.4%)	0.2	75.0%

*As no field-derived estimate of juvenile alosine survival was available, the standard USFWS value of λ =0.2 was used

Route Partitioning

Condition	Inflow (cfs)	Discharge (cfs)			Distribution (%)		
		Turbine	Bypass	Spill	Turbine	Bypass	Spill
Spring - 25% Exceedance	11,239	6,600	132	4,507	59%	1%	40%
Spring - 50% Exceedance	6,755	6,600	132	23	98%	2%	0%
Spring - 75% Exceedance	4,129	4,046	83	0	98%	2%	0%
Fall - 25% Exceedance	8,835	6,600	132	2,103	75%	1%	24%
Fall - 50% Exceedance	4,989	4,889	100	0	98%	2%	0%
Fall - 75% Exceedance	3,038	2,977	61	0	98%	2%	0%

Non-turbine Survival

Fish Species (life stage)	Bypass	Spill	Notes
River herring (Adult)	12.2%	10.8%	Spill was limited to 1 individual; used rate for adult shad as a surrogate
American shad (Adult)	17.4%	10.8%	
Juvenile Alosine	12.0%	11.0%	Used adult alosine rates as a surrogate
American Eel	0.0%	0.0%	Spill based on 4 individuals; bypass assumed to be equivalent

Fish Passage Survival Study
Lowell Hydroelectric Project (FERC No. 2790)

- Turbine Blade Strike Analysis Tool (TBSA) used to generate estimates of passage survival for adult river herring, adult American shad, juvenile alosines and adult American eels
  - Model runs for high, moderate, and low flow conditions

Adult Herring

Condition	Turbine Strikes	Bypass Failures	Survival
Spring - 25% Exceedance	14.7%	6.5%	78.8%
Spring - 50% Exceedance	24.2%	0.0%	75.8%
Spring - 75% Exceedance	35.8%	0.0%	64.2%

Adult Shad

Condition	Turbine Strikes	Bypass Failures	Survival
Spring - 25% Exceedance	42.2%	2.7%	55.1%
Spring - 50% Exceedance	64.5%	0.6%	34.9%
Spring - 75% Exceedance	79.4%	0.3%	20.3%

Juvenile Alosines

Condition	Turbine Strikes	Bypass Failures	Survival
Fall - 25% Exceedance	1.1%	2.8%	96.1%
Fall - 50% Exceedance	3.2%	0.7%	96.1%
Fall - 75% Exceedance	3.9%	0.2%	95.9%

Adult Eels

Condition	Turbine Strikes	Bypass Failures	Survival
Fall - 25% Exceedance	16.7%	0.0%	83.3%
Fall - 50% Exceedance	27.2%	0.0%	72.8%
Fall - 75% Exceedance	33.9%	0.0%	66.1%

Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)

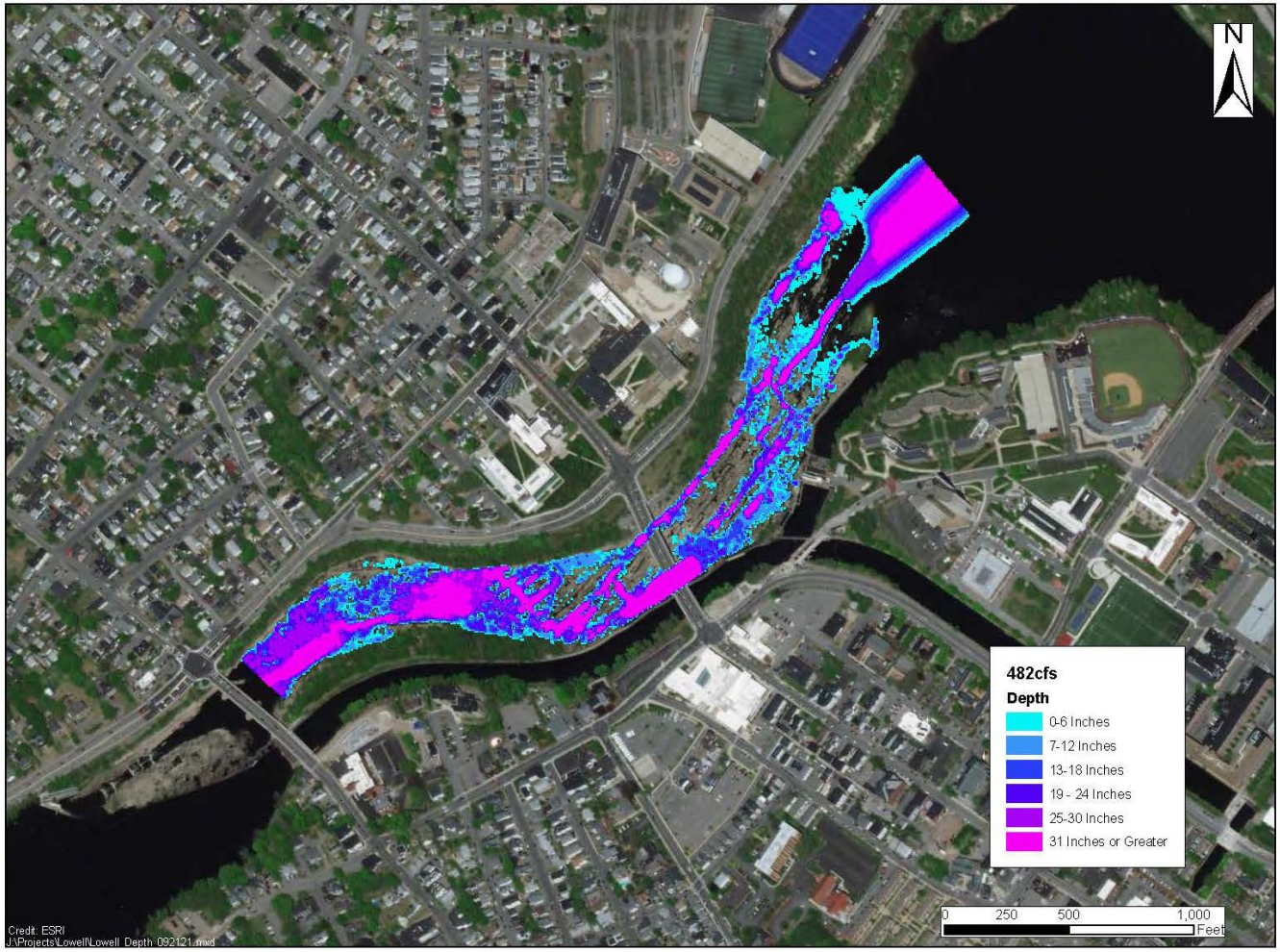
- Instream Flow Habitat Assessment and Zone of Passage report was filed with FERC on February 25, 2021
  - February Study Report addressed to separate study request elements:
    - o Bypass Zone of Passage Assessment: determine flows which facilitate fish passage through the bypass reach through the use of detailed elevation and bathymetry data and two-dimensional (2D) modeling techniques;
    - o Instream Flow Habitat Assessment: determine impacts of a range of Project flows on wetted area and habitat for key aquatic species by conducting an instream flow study based on the Instream Flow Incremental Methodology (IFIM) process and one-dimensional (1D) modeling techniques.

Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)

- FERC issued a *Determination on Requests for Study Modifications* for the Lowell Project on June 23, 2021
  - Specific to the Instream Flow and Zone of Passage Study, FERC indicated Boott should "*show water depth in 6-inch, color-coded increments from 6 inches to 2.5 feet for each flow. For the velocity maps, we recommend that Boott show four color-coded, 1-fps velocity increments above the maximum velocity recommended for each species by FWS's Design Criteria Manual*".

- Boott filed Updated Study Reports for the Project on November 1, 2021
  - Included a series of ArcGIS shapefiles to provide the requested water depth and velocity information for the range of modeled flows from 250 to 14,000 cfs to address the Commissions request above.

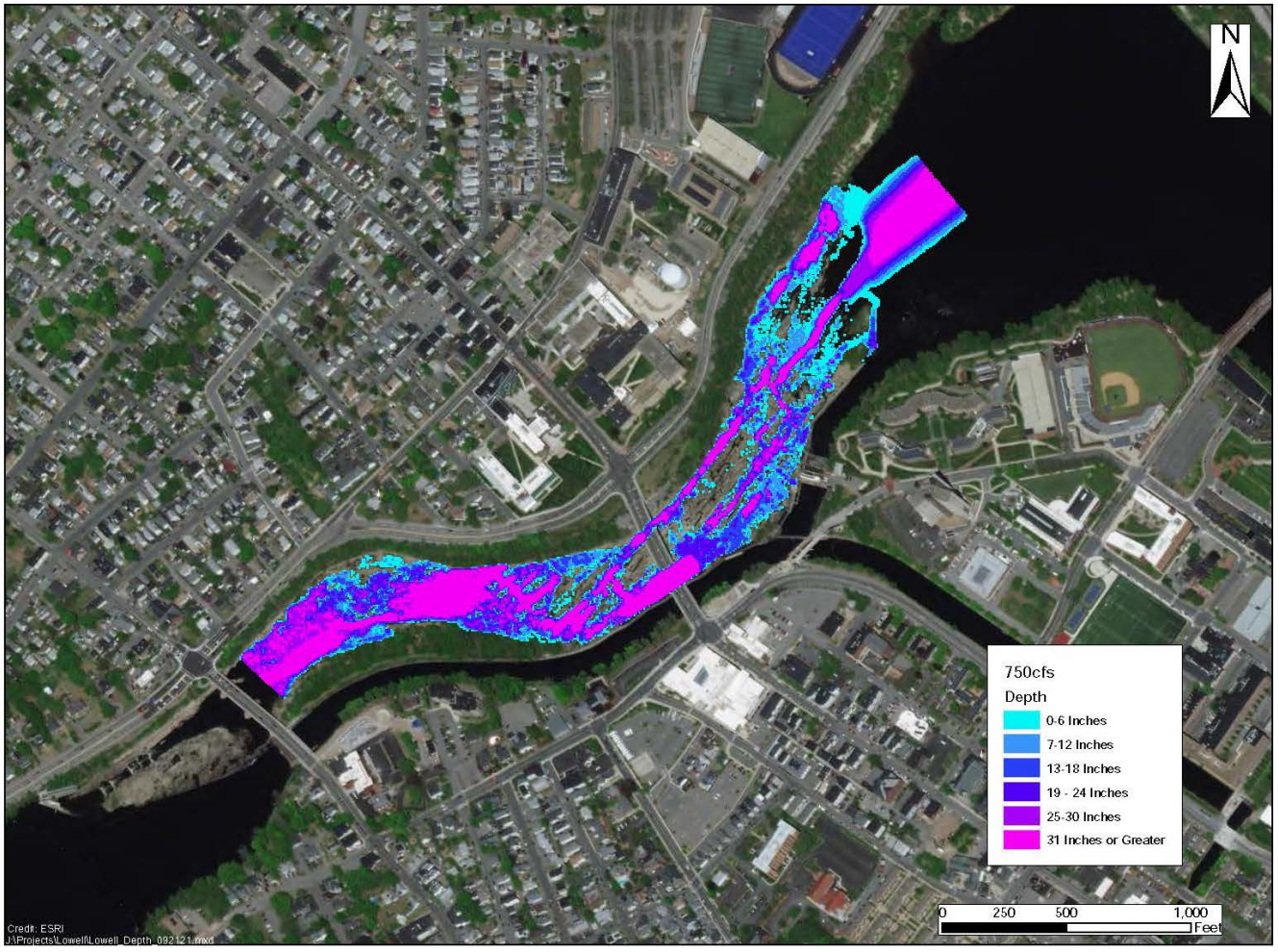
Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)



Depth Example
482 cfs

6 inch bins
0-2.5 ft

Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)



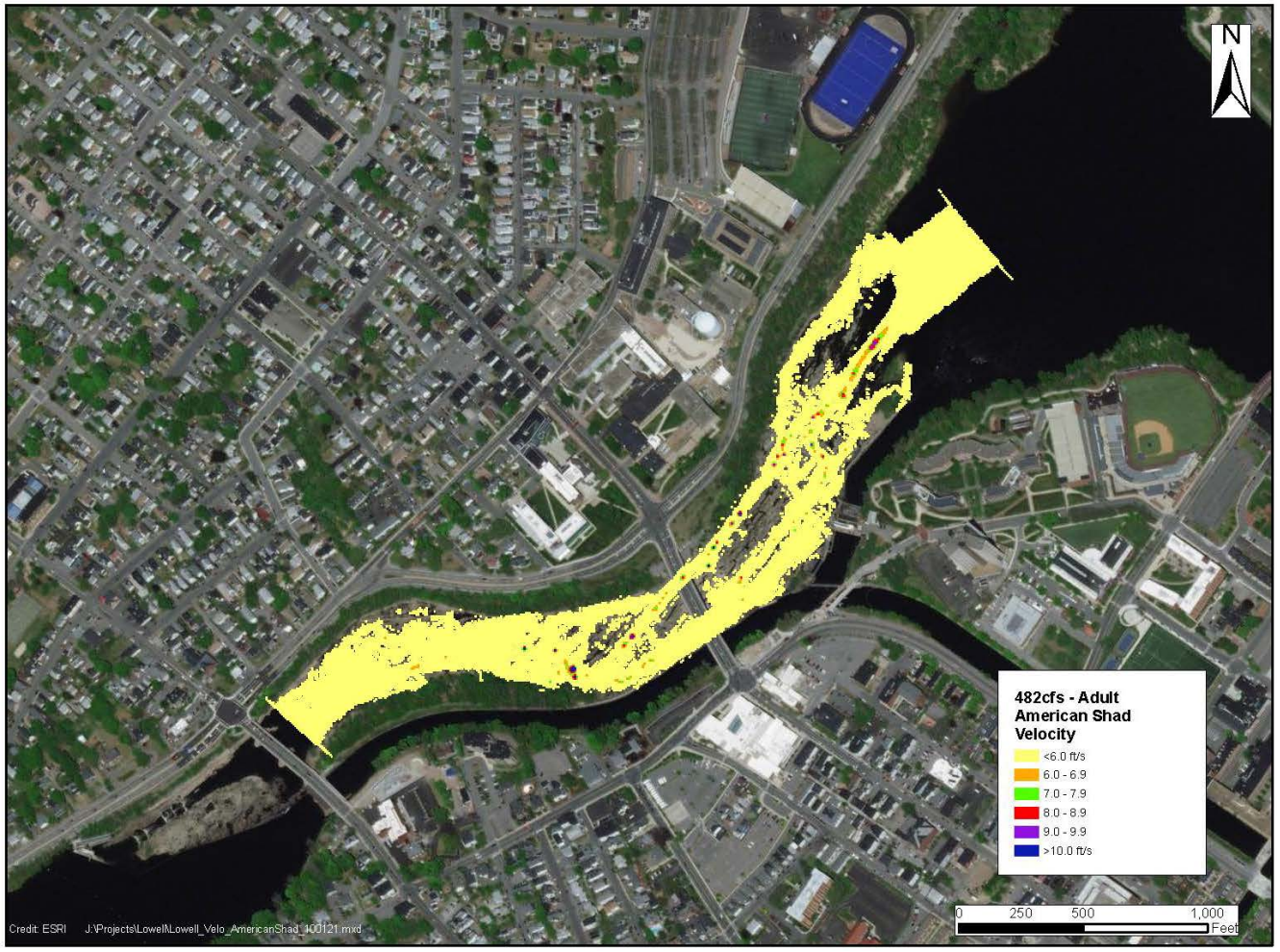
Depth Example
750 cfs

6 inch bins
0-2.5 ft

Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)

Velocity Example
482 cfs

1 foot velocity bins over 6 fps



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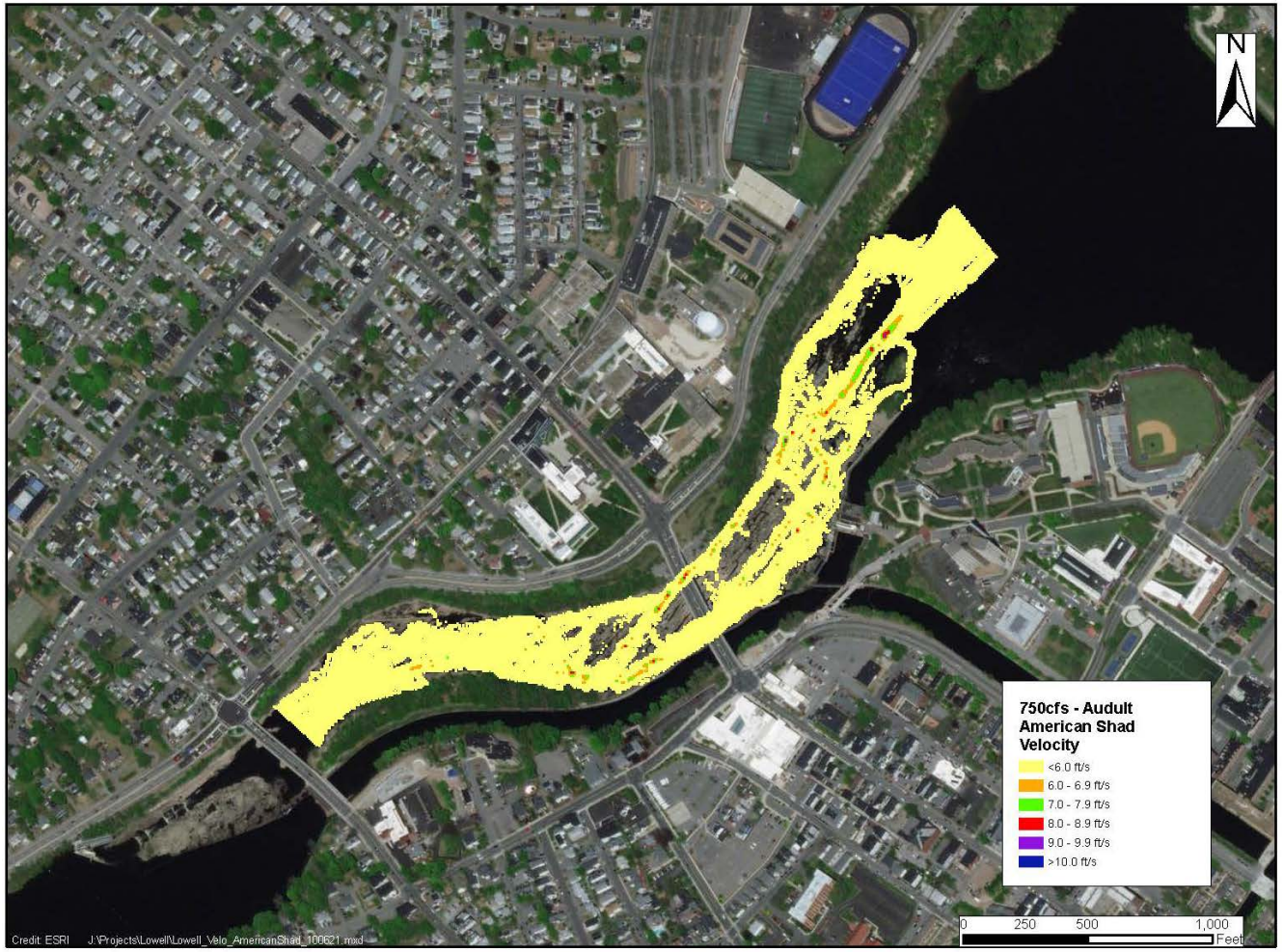
Instream Flow and Zone of Passage Study
Lowell Hydroelectric Project (FERC No. 2790)

Velocity Example
750 cfs

1 foot velocity bins over 6 fps



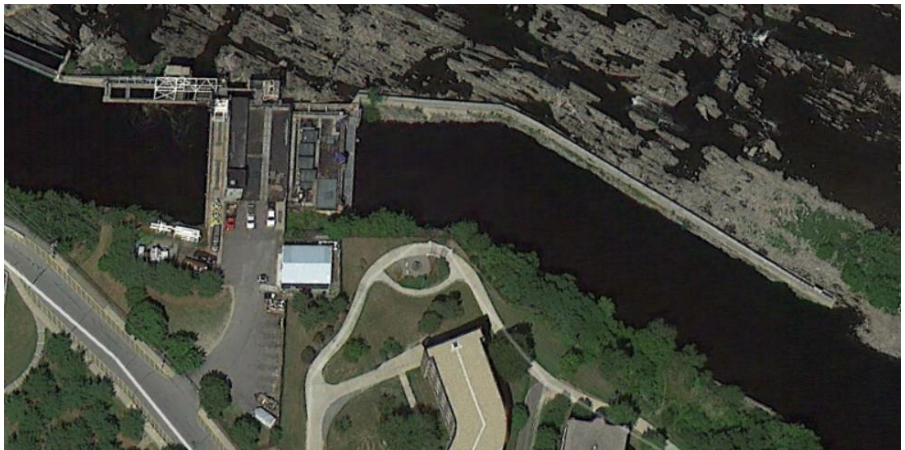
Three-Dimensional Computational Fluid Dynamics (CFD) Modeling

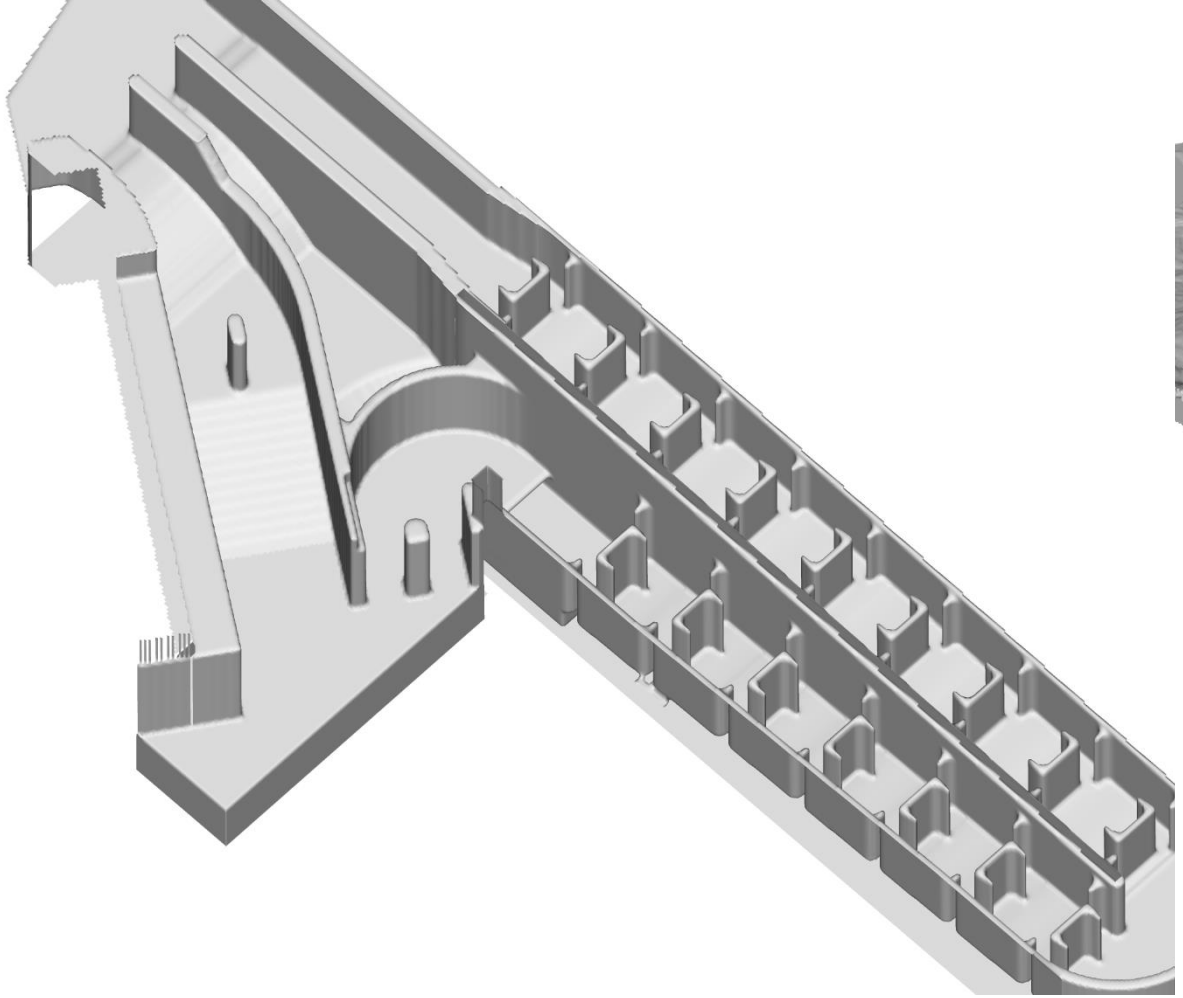
November 16, 2021

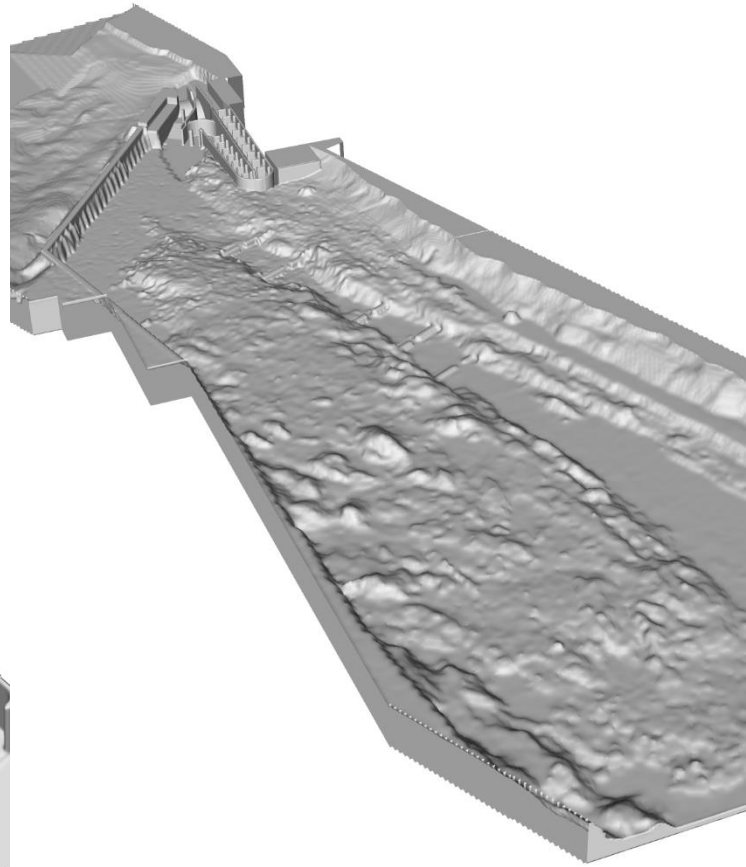
CFD Model Study

Comment Response and Updates

- Fish Ladder
  - Measure and update ladder flow rate
  - Add baffles to ladder
  - Update stop logs in bypass weirs
- E.L Forebay
  - Prepare additional images with velocity magnitude and vectors
- E.L Tailrace
  - No Updates







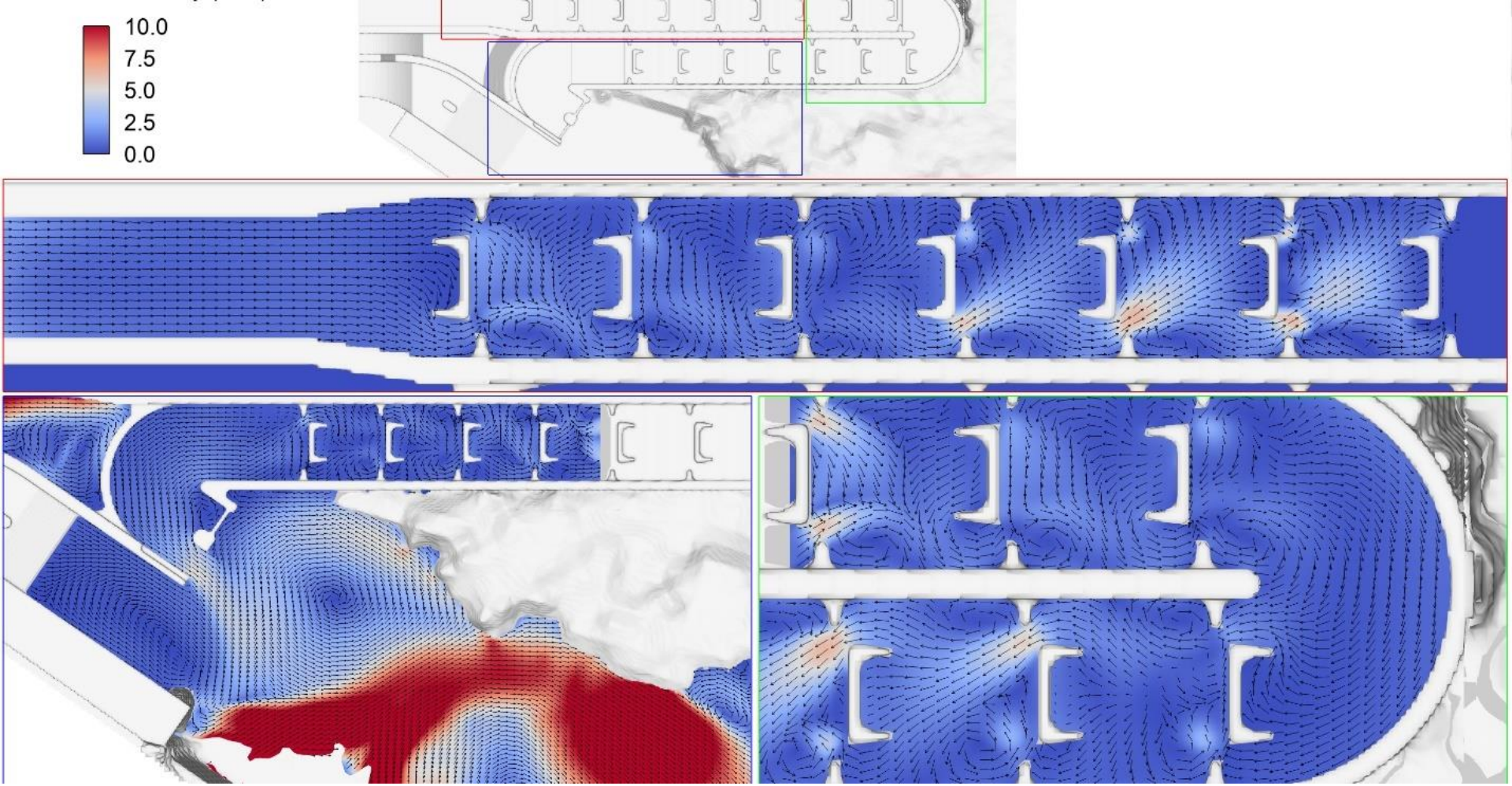
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder

Three-Dimensional Computational Fluid Dynamics Modeling: **Pawtucket Dam Fish Ladder**

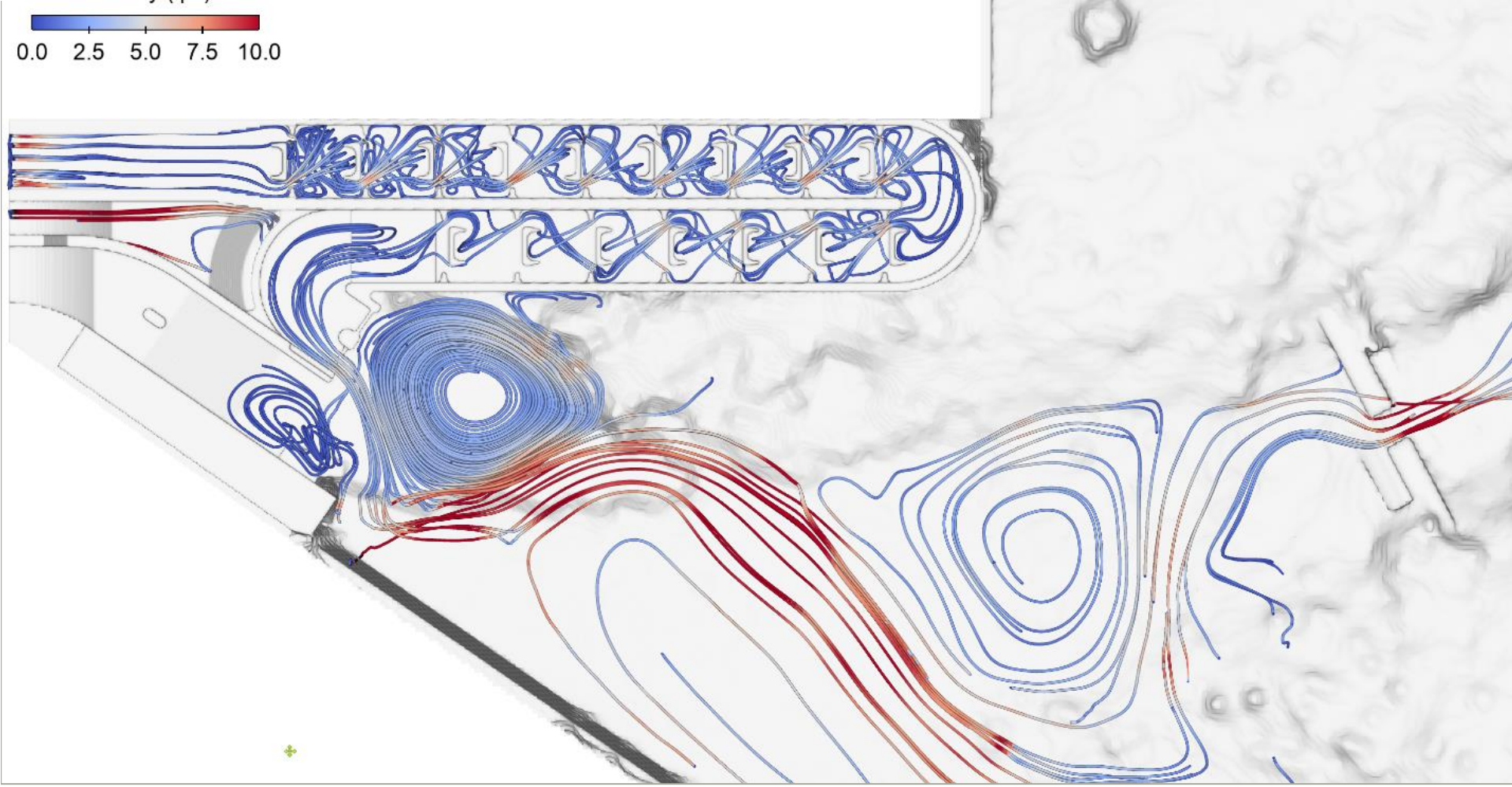
Flow Scenarios

Case	Fish Ladder (cfs)	Diffuser (cfs)	Crest Weir (cfs)	Sluice (cfs)	Notes:
1	30	60	300	0	Uses 40 ft section of crest weir adjacent to fish ladder
2	30	60	0	360	Replaced by Case 4
3	30	60	19,310	0	5% duration (26,000 cfs) minus E.L. Field Powerhouse operating at full capacity (6,600 cfs)
4	47	60	0	360	Updates the ladder flow to the measured value of 47 cfs



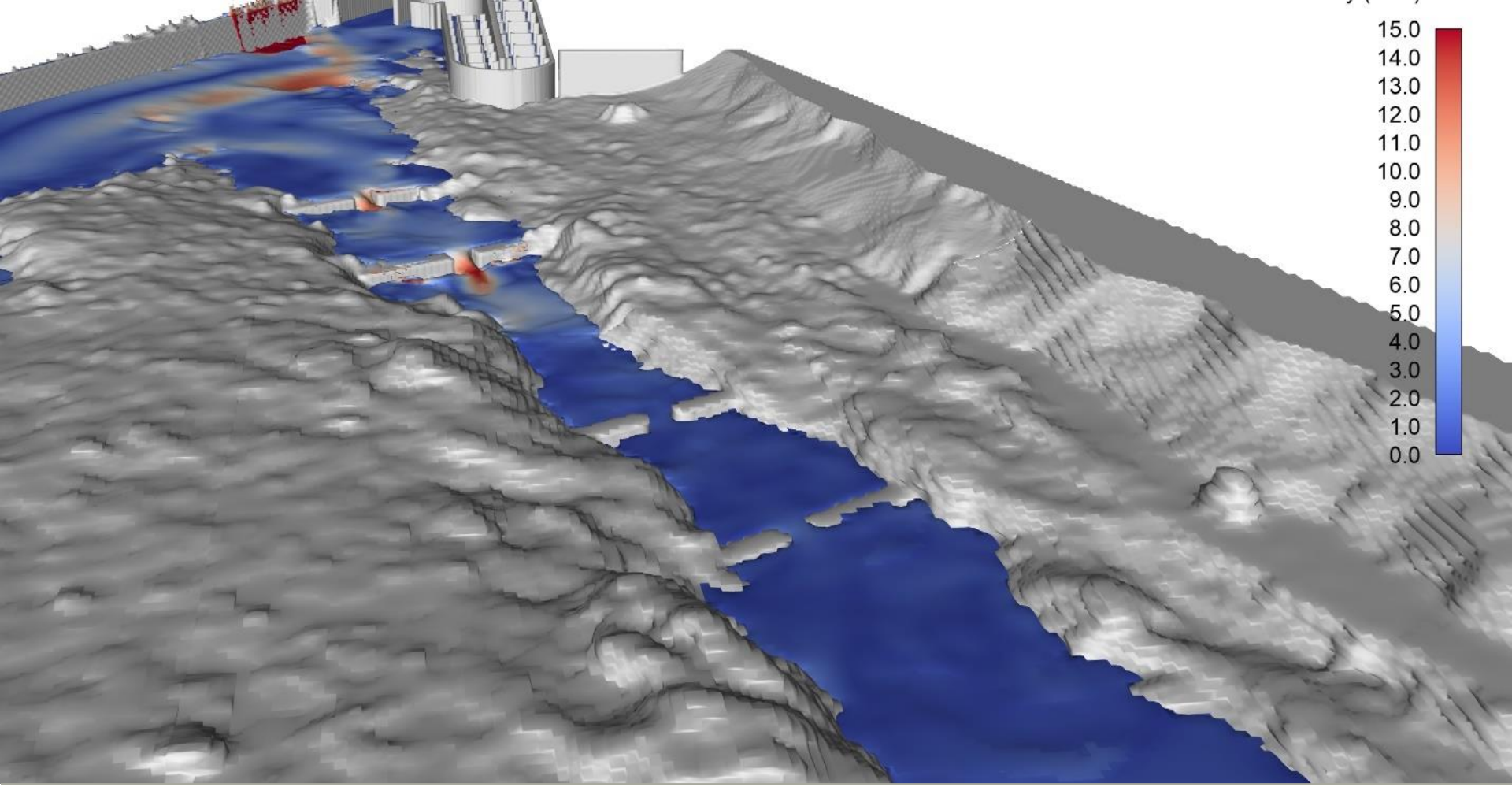
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 1



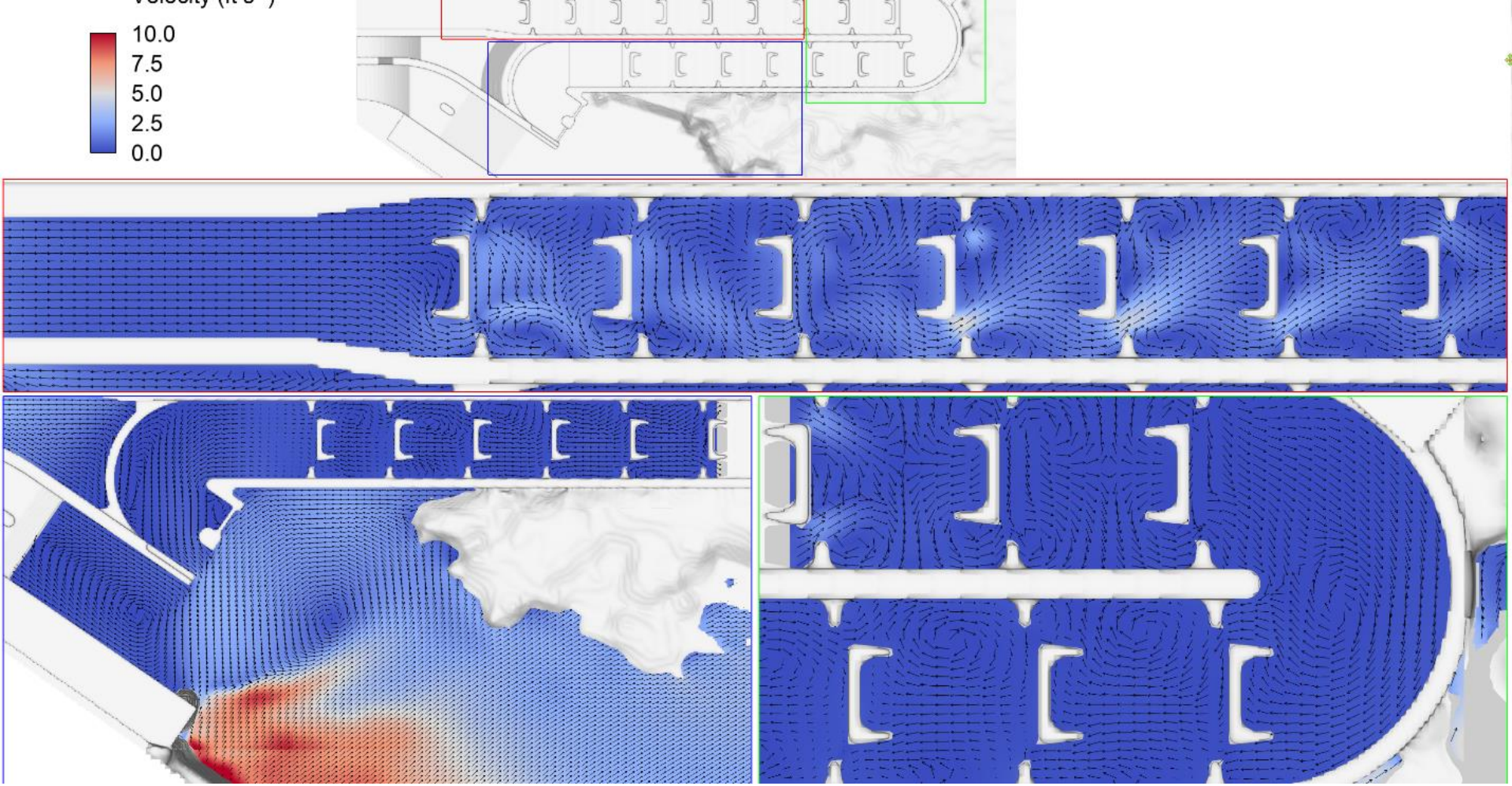
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 1



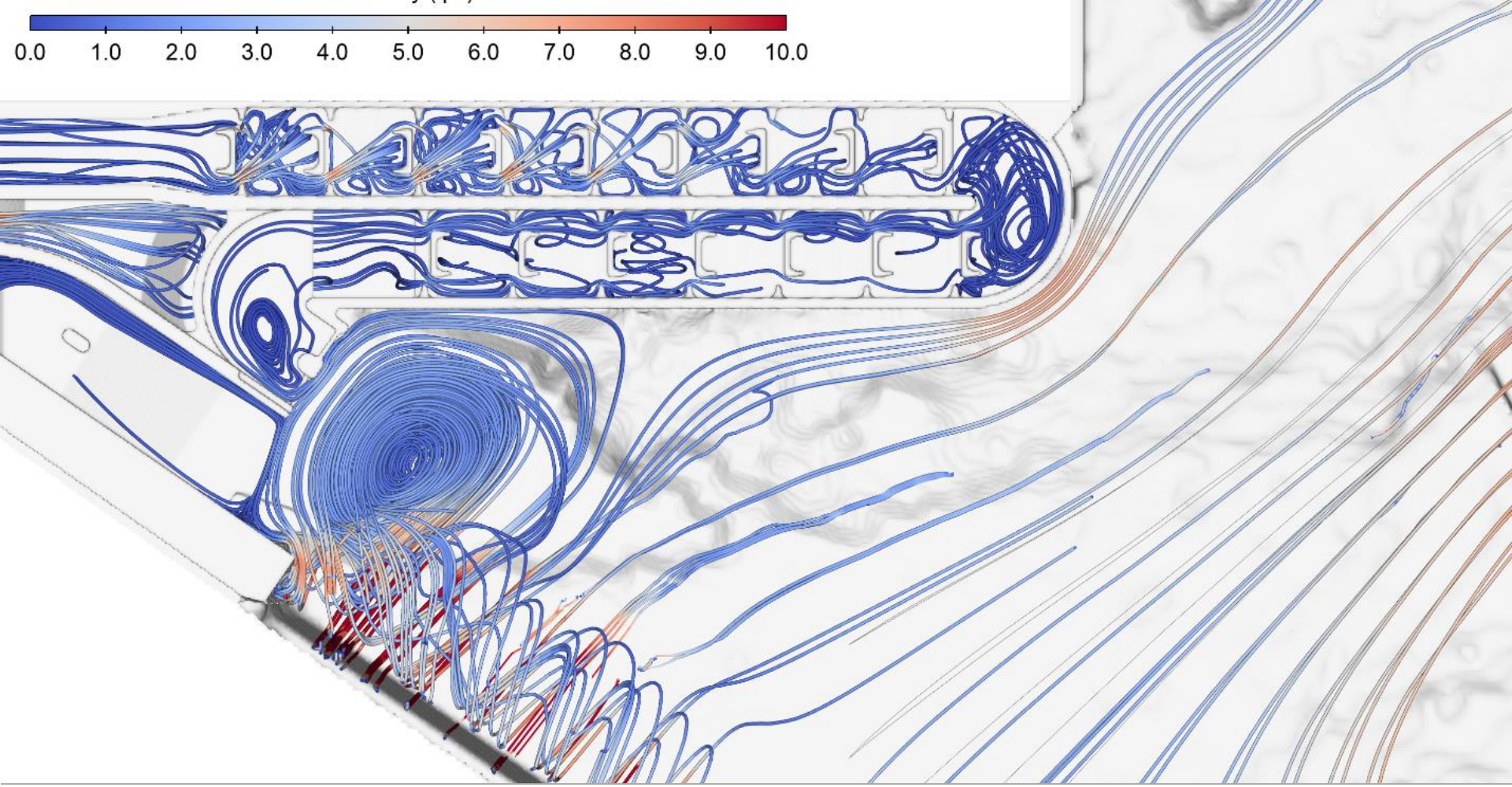
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 1



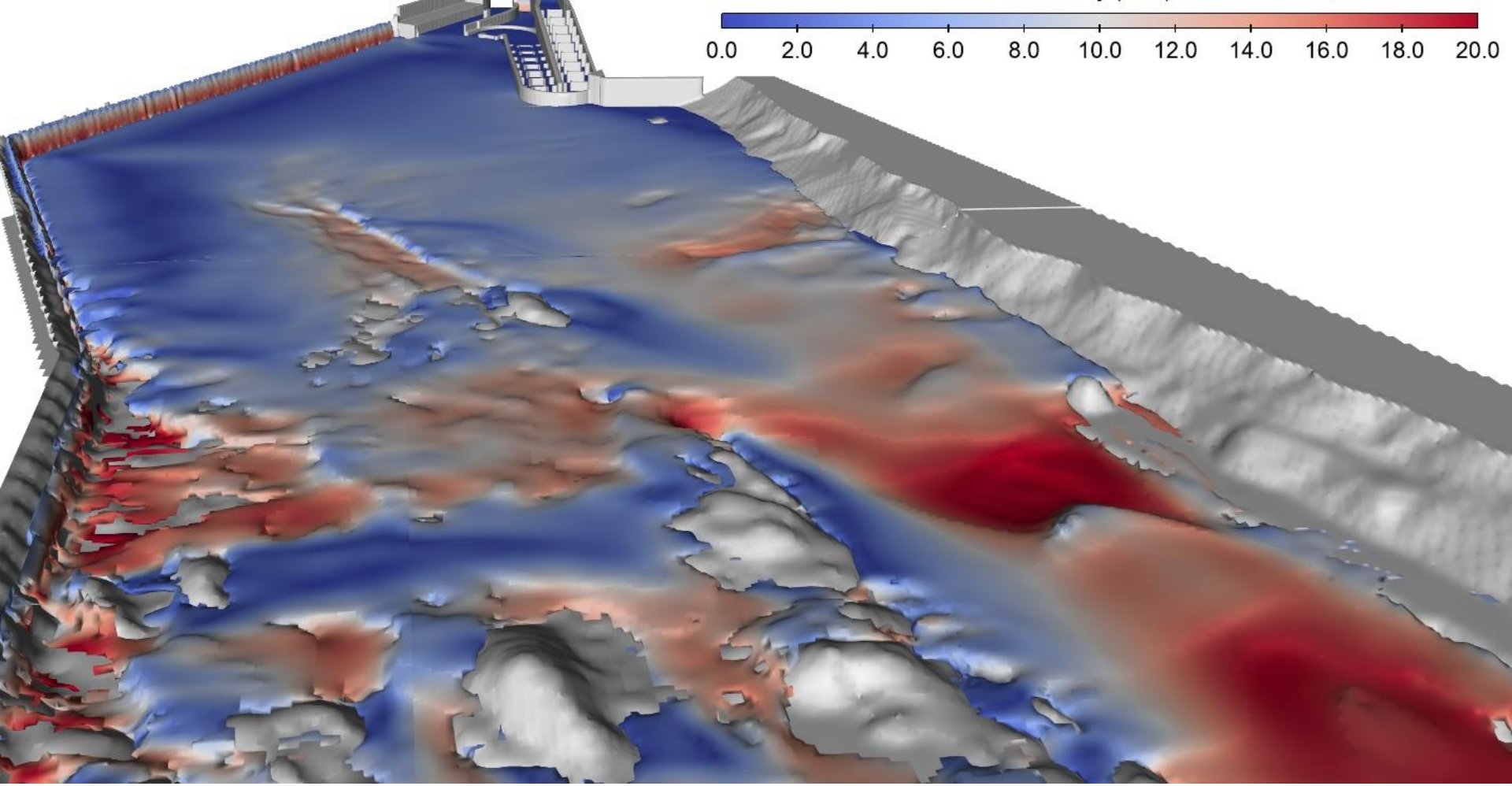
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 2



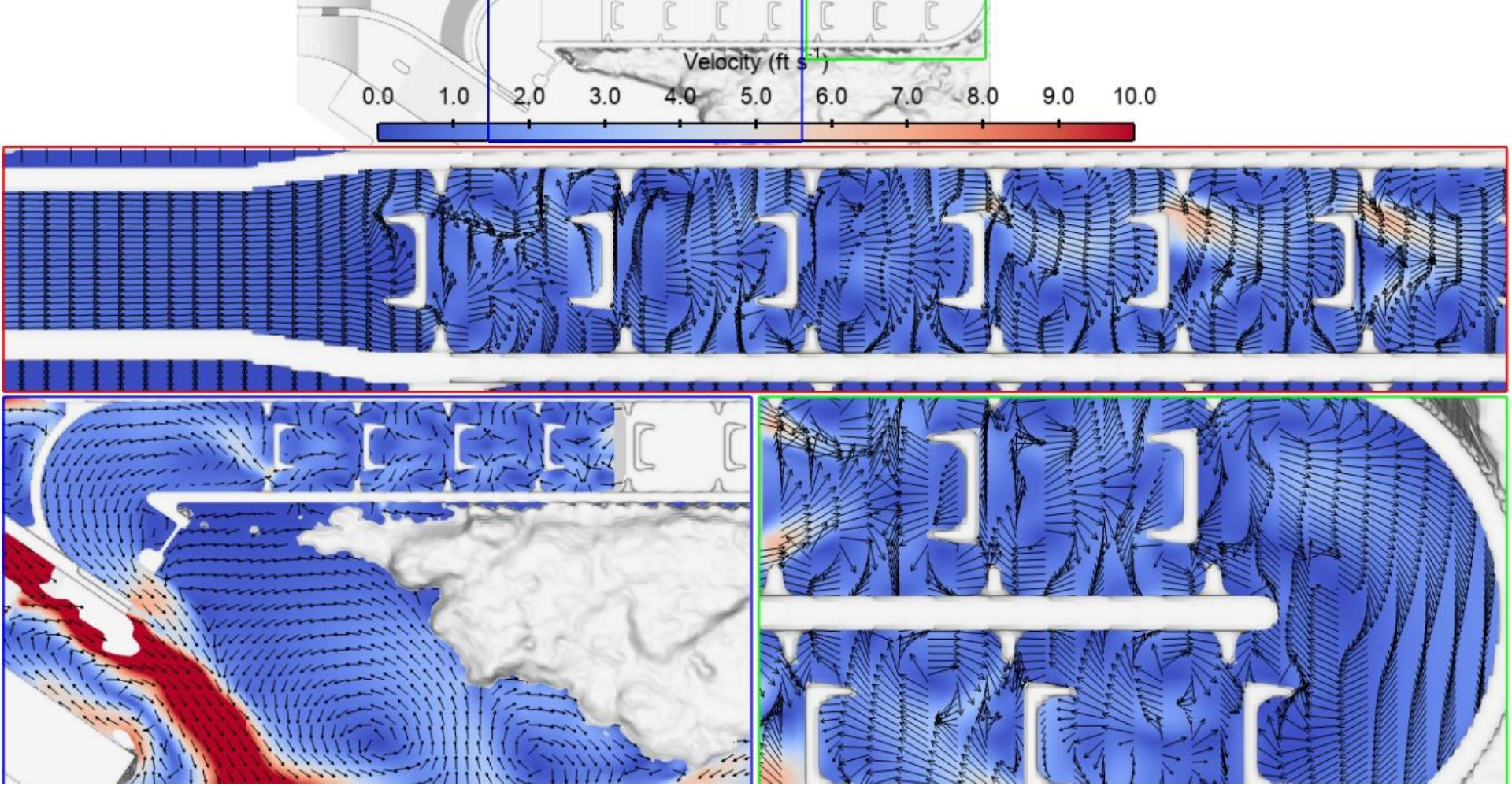
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 2



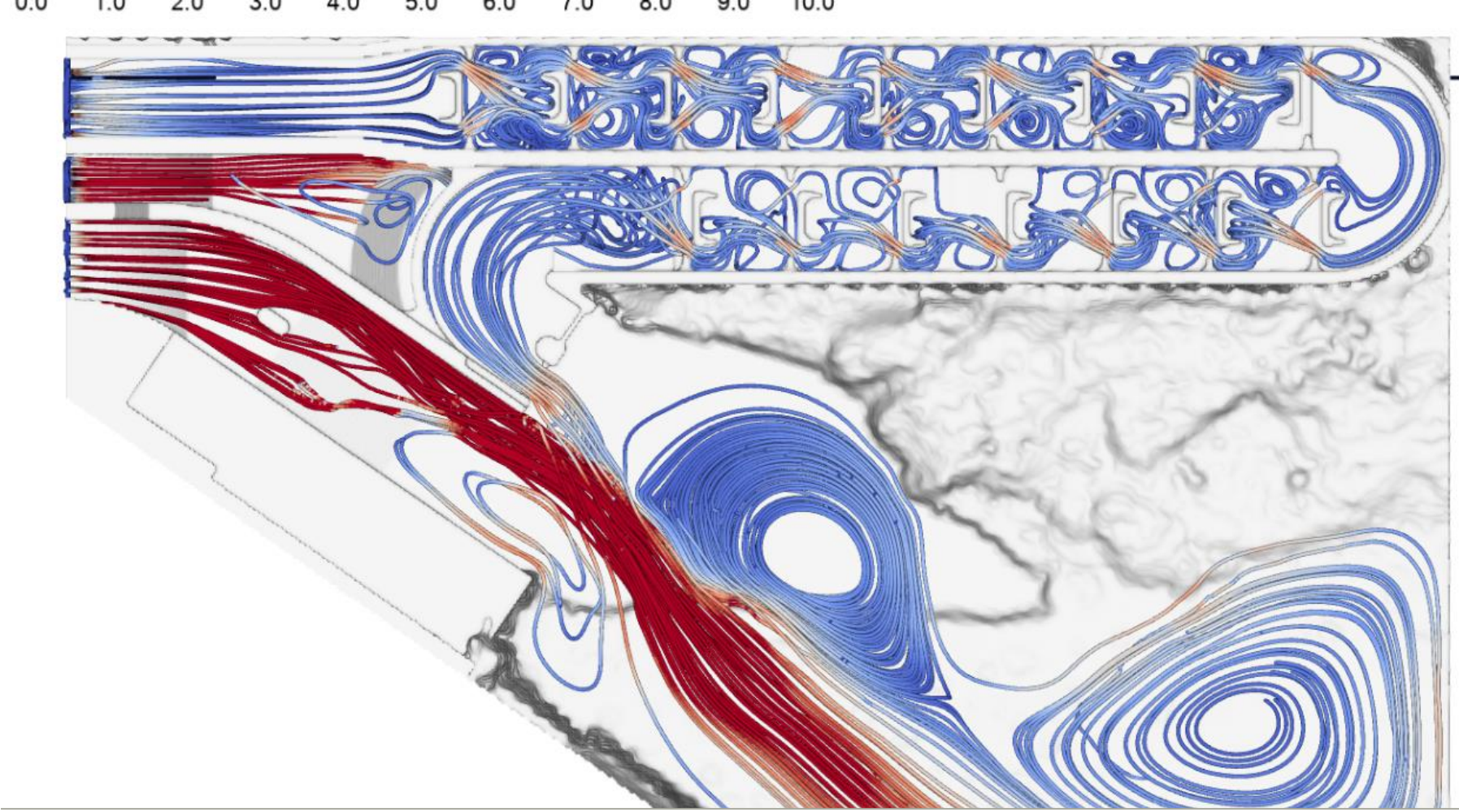
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 2



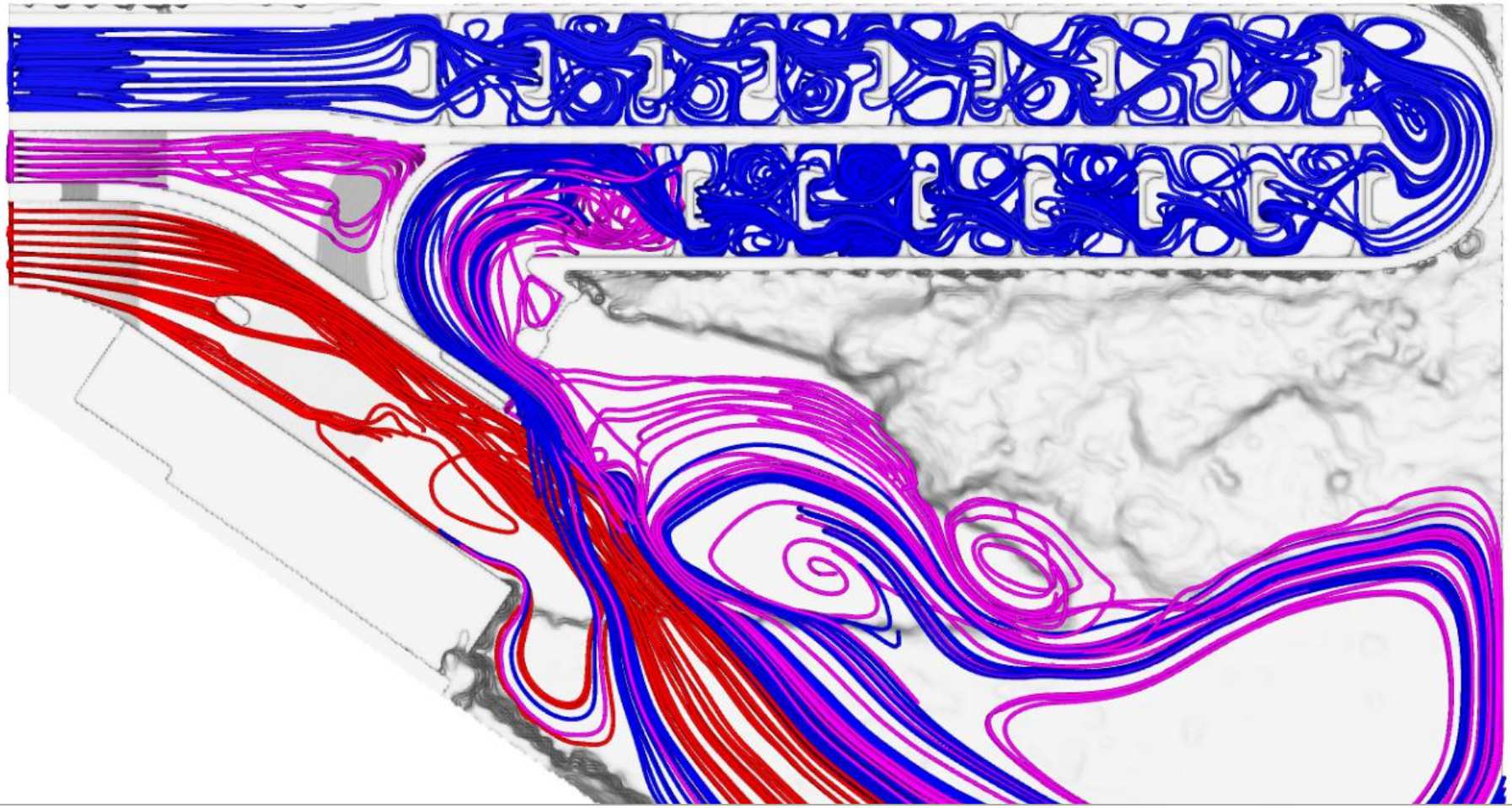
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 4



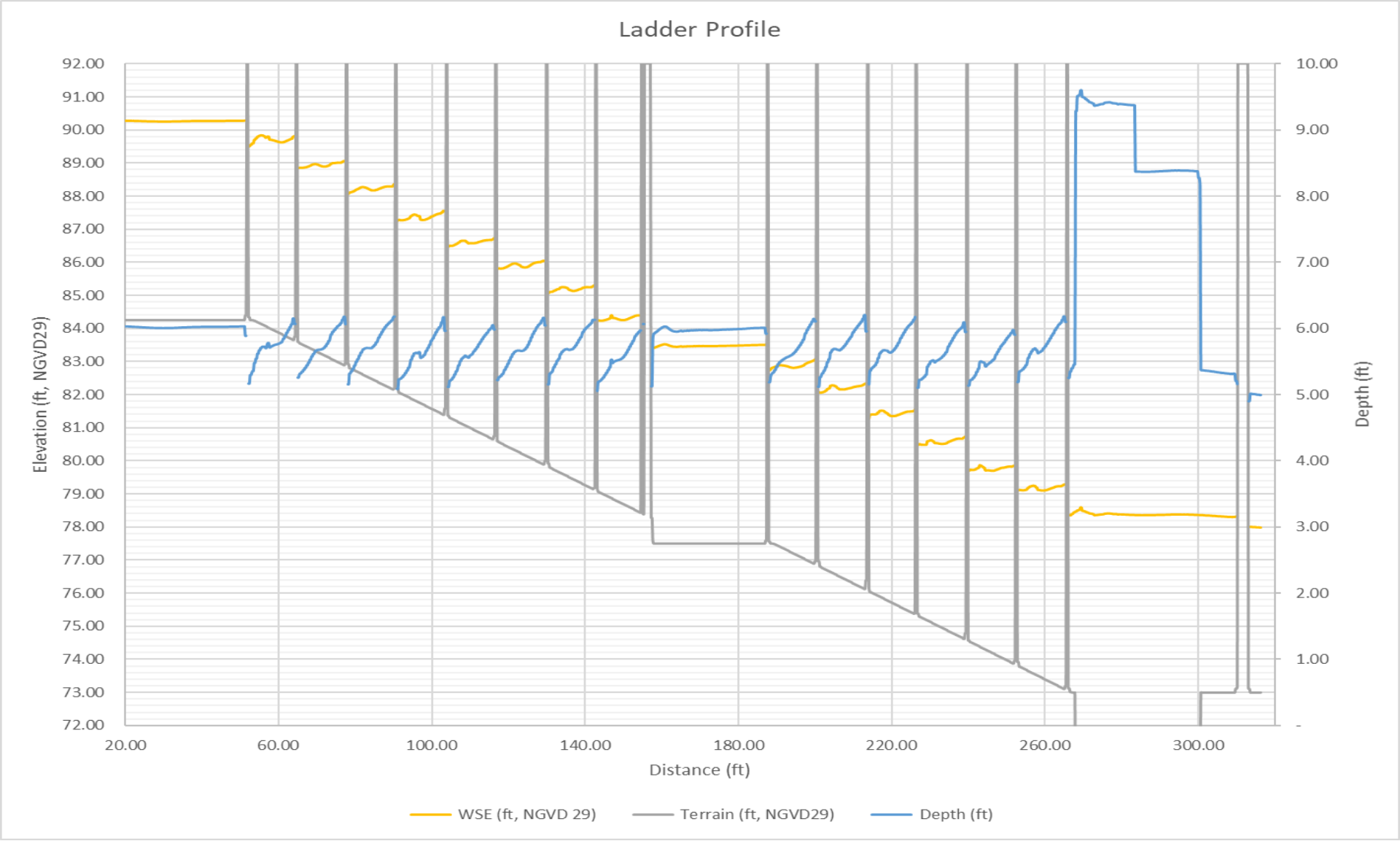
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 4



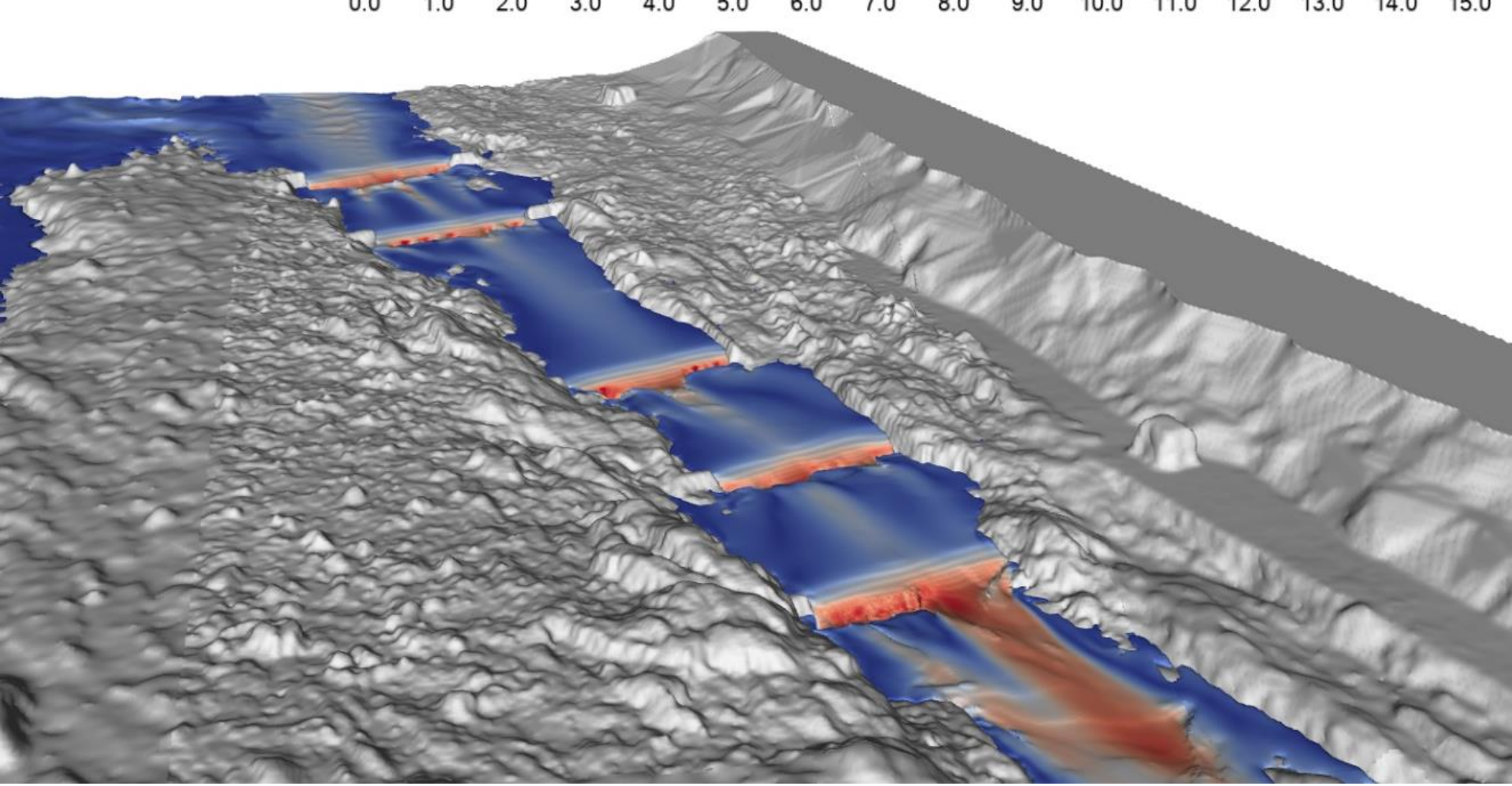
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 4



Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 4



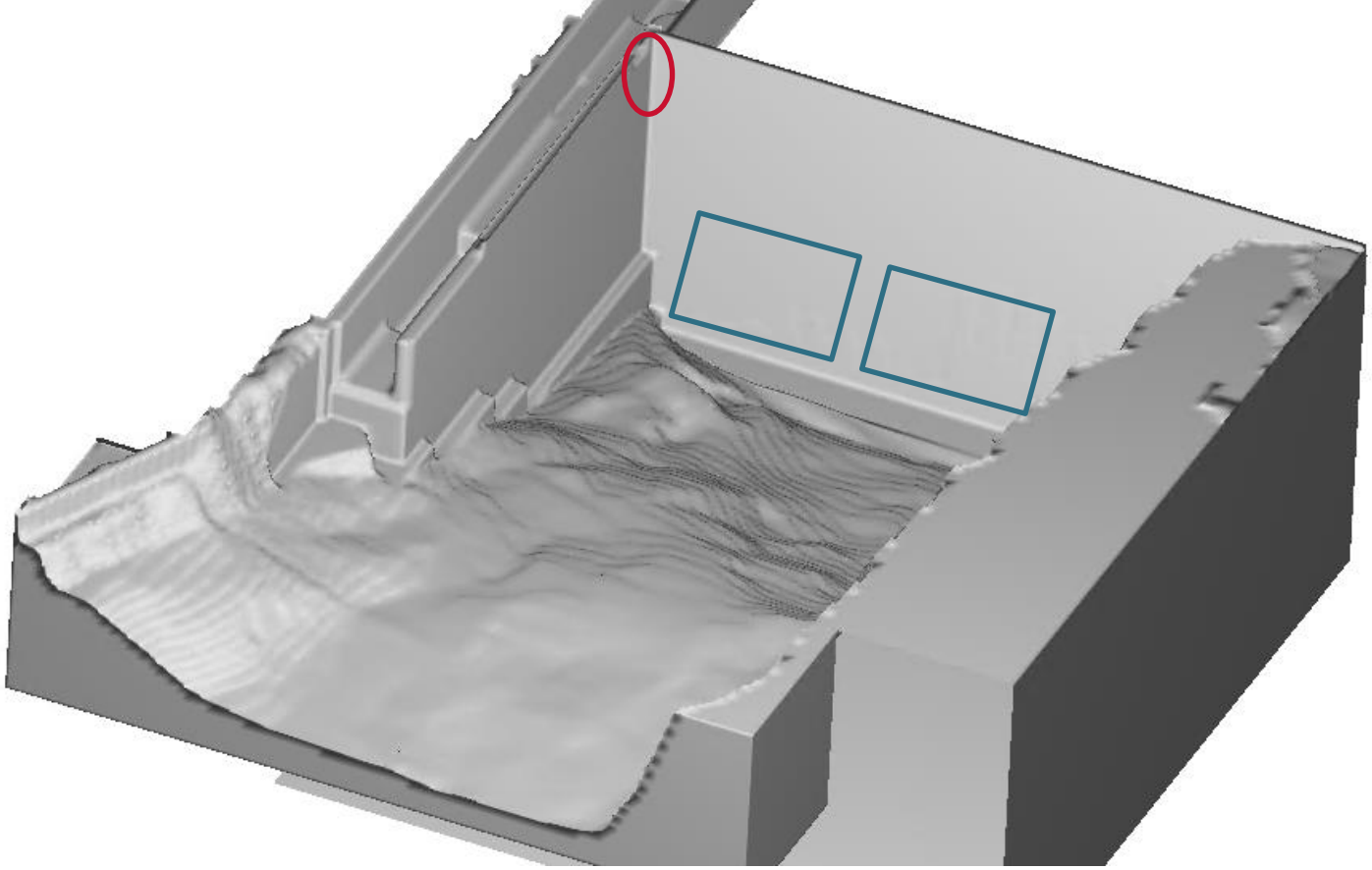
Three-Dimensional Computational Fluid Dynamics Modeling:

Results Summary – Pawtucket Fish Ladder Case 4

CFD Model Study:

Study Methods: E.L. Field Powerhouse Forebay Model

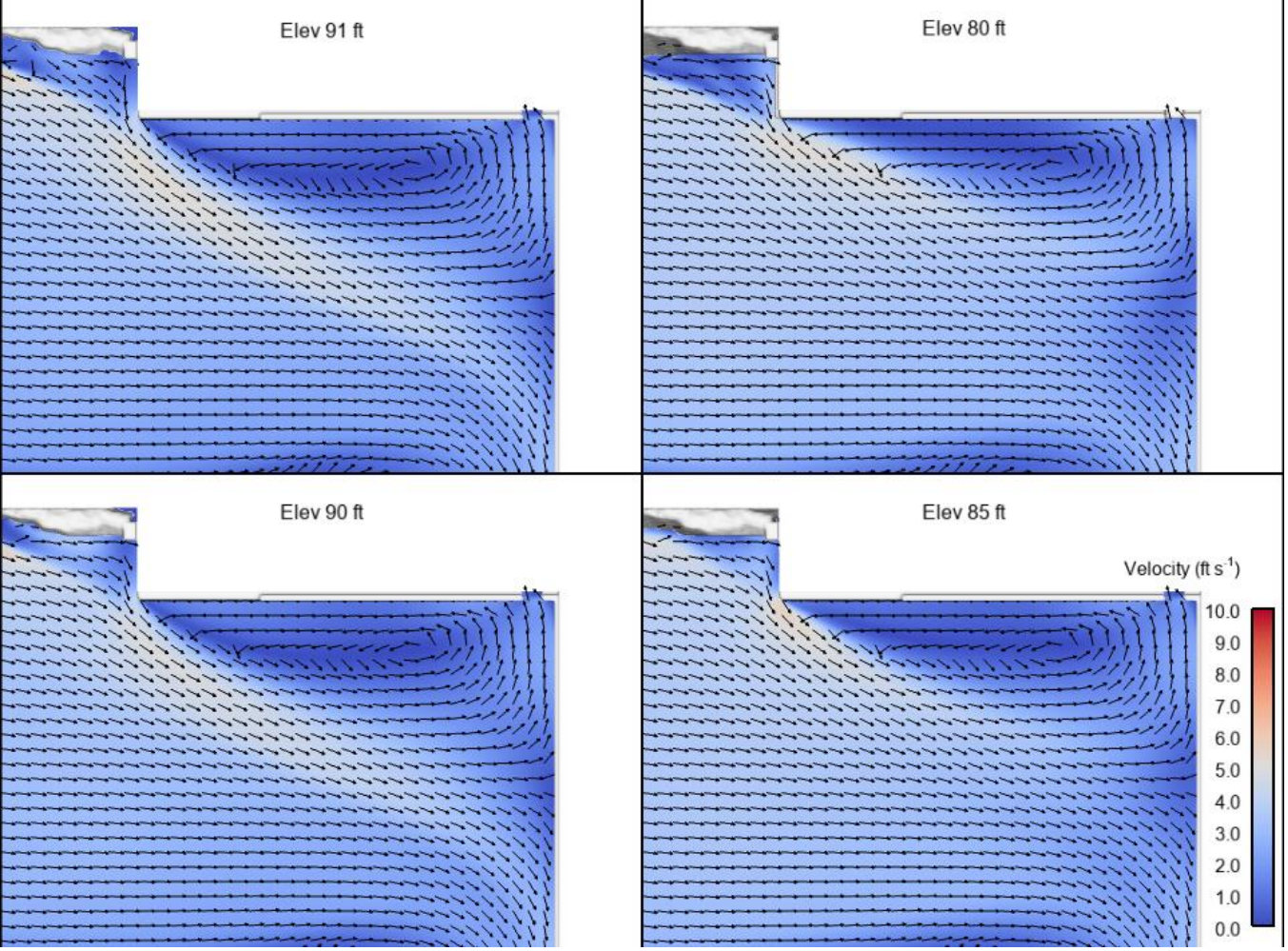
Case	Unit 1 Discharge (cfs)	Unit 2 Discharge (cfs)	AWS Discharge (cfs)	Forebay WSE (ft, NGVD29 [NGVD88])	Notes:
1	3,300	3,300	130	91.0 [90.2]	5% exceedance flow tailwater El. (26,000 cfs)
2	1,310	1,310	130	91.0 [90.2]	75% exceedance flow tailwater El. (2,750 cfs)
3	600	600	130	91.0 [90.2]	Minimum unit operations



CFD Model Study: **Results Summary – ELF Forebay**

Model Setup

- 175 ft of river upstream
- 2-Powerhouse inlets (blue) [~31-ft x 32-ft]
- Bypass Inlet (red) [4-ft wide]

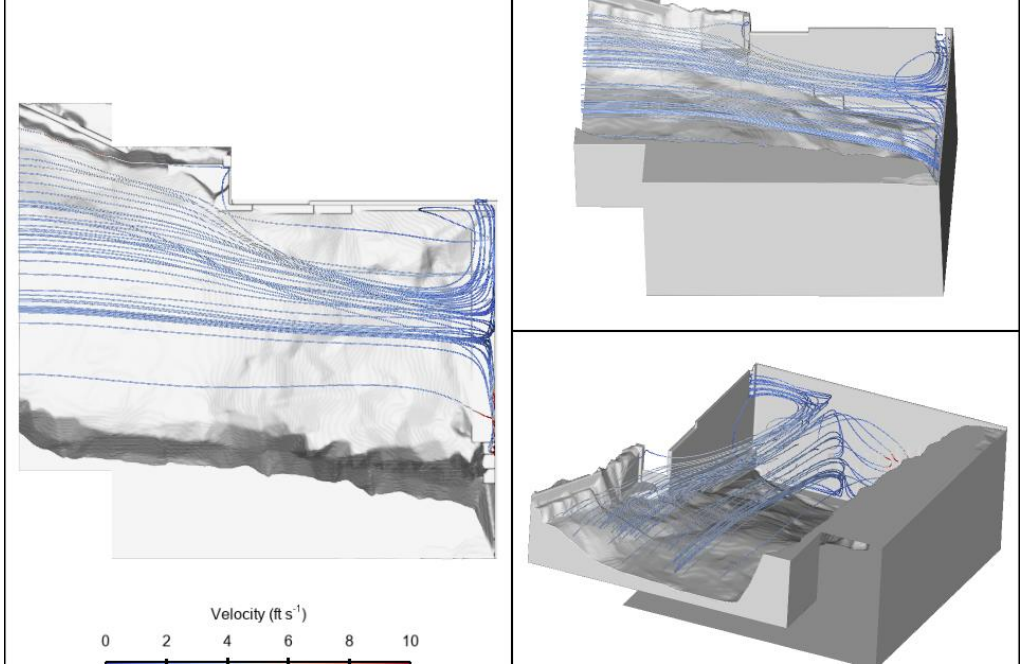


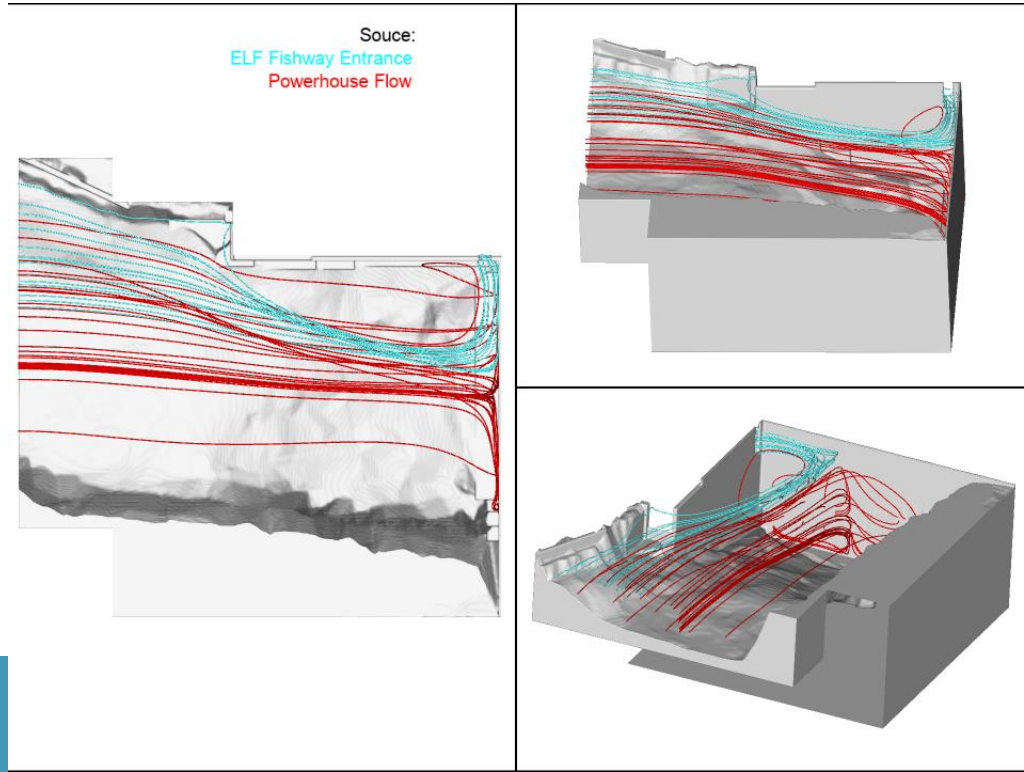
CFD Model Study:

Results Summary – ELF Forebay – High Flow (6,730 cfs)

CFD Model Study:

Results Summary – ELF Forebay – High Flow (6,730 cfs)

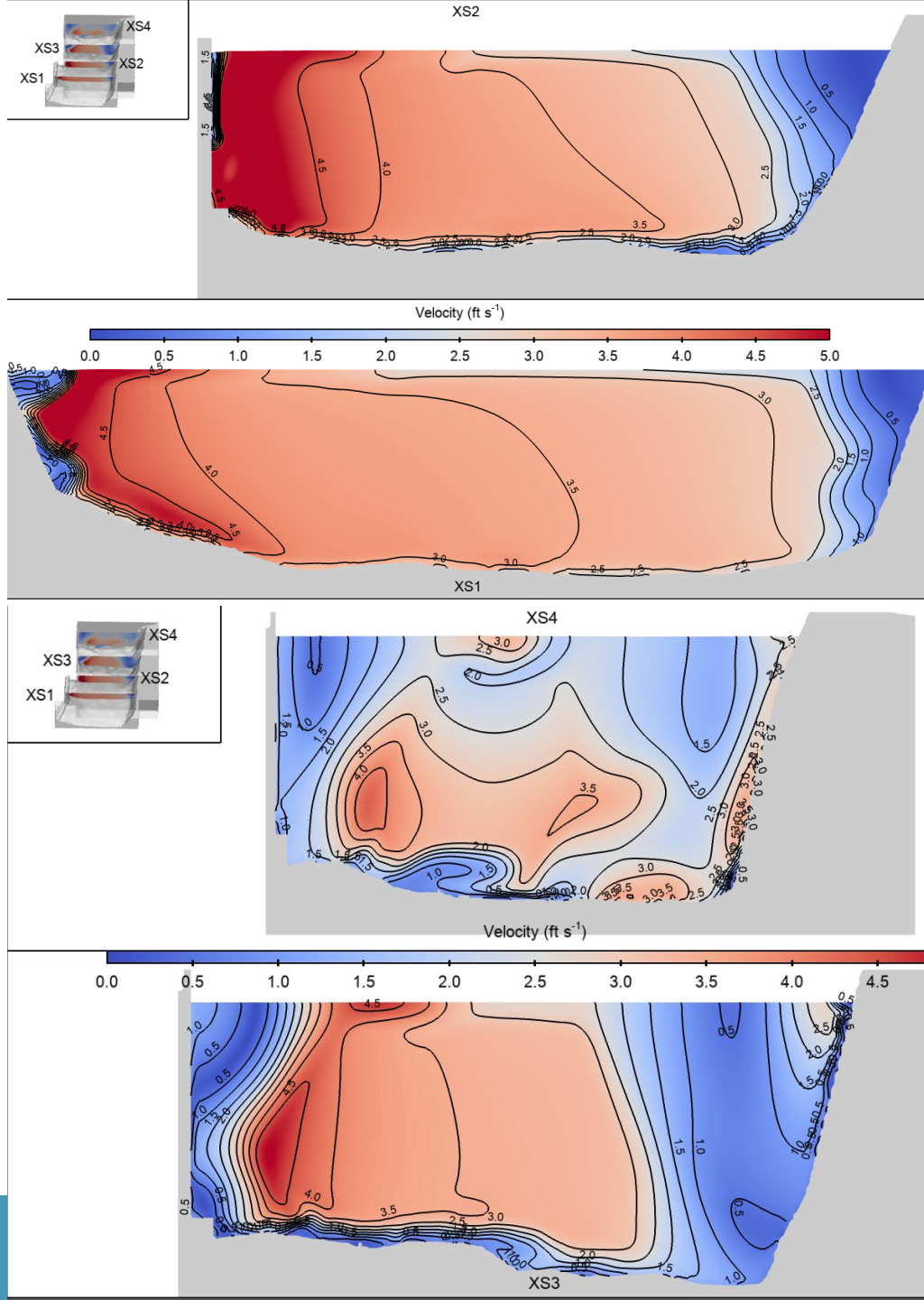




CFD Model Study:

Results Summary – ELF Forebay – High Flow (6,730 cfs)

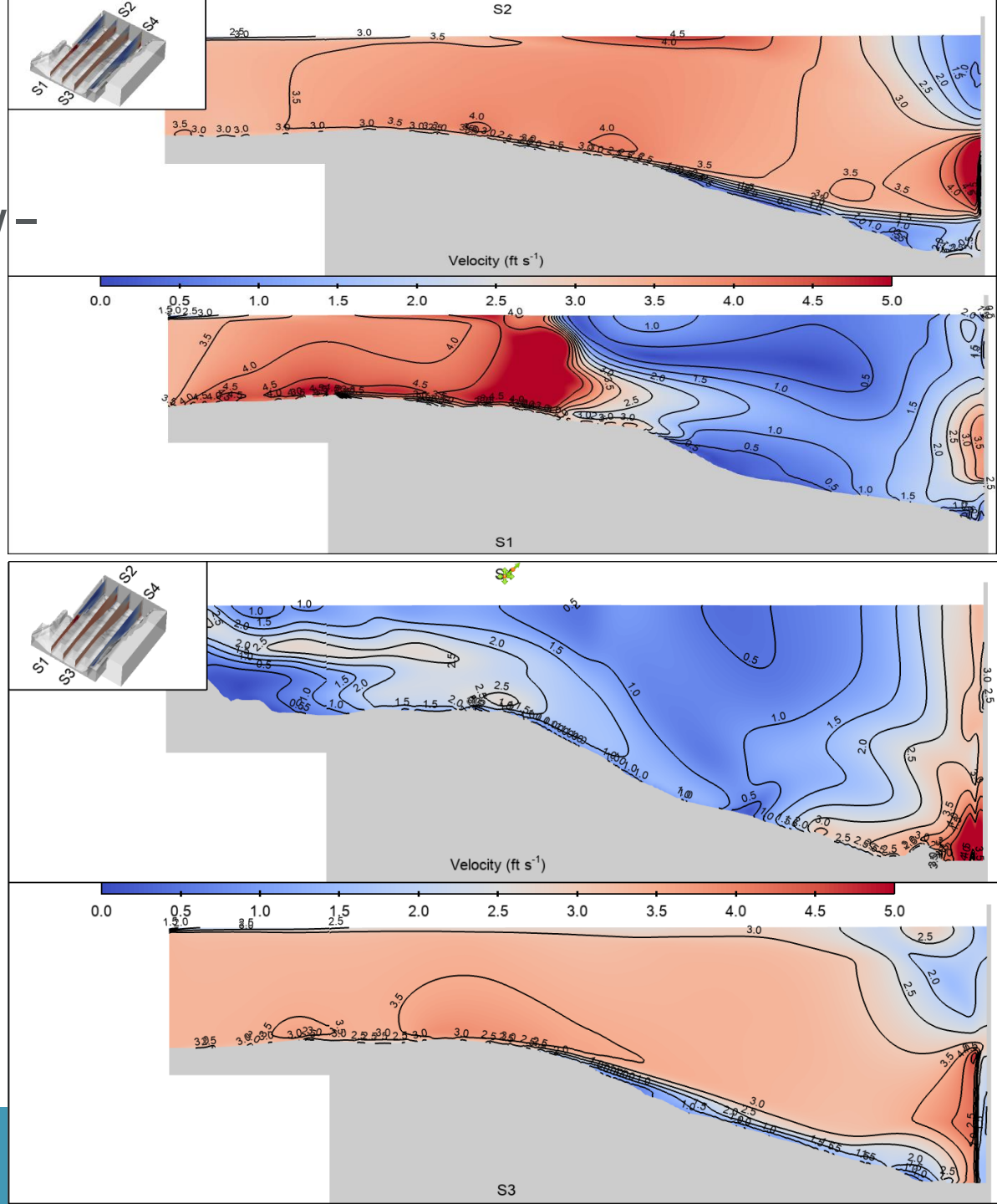
- Velocity contours on cross sections



CFD Model Study:

Results Summary – ELF Forebay – High Flow (6,730 cfs)

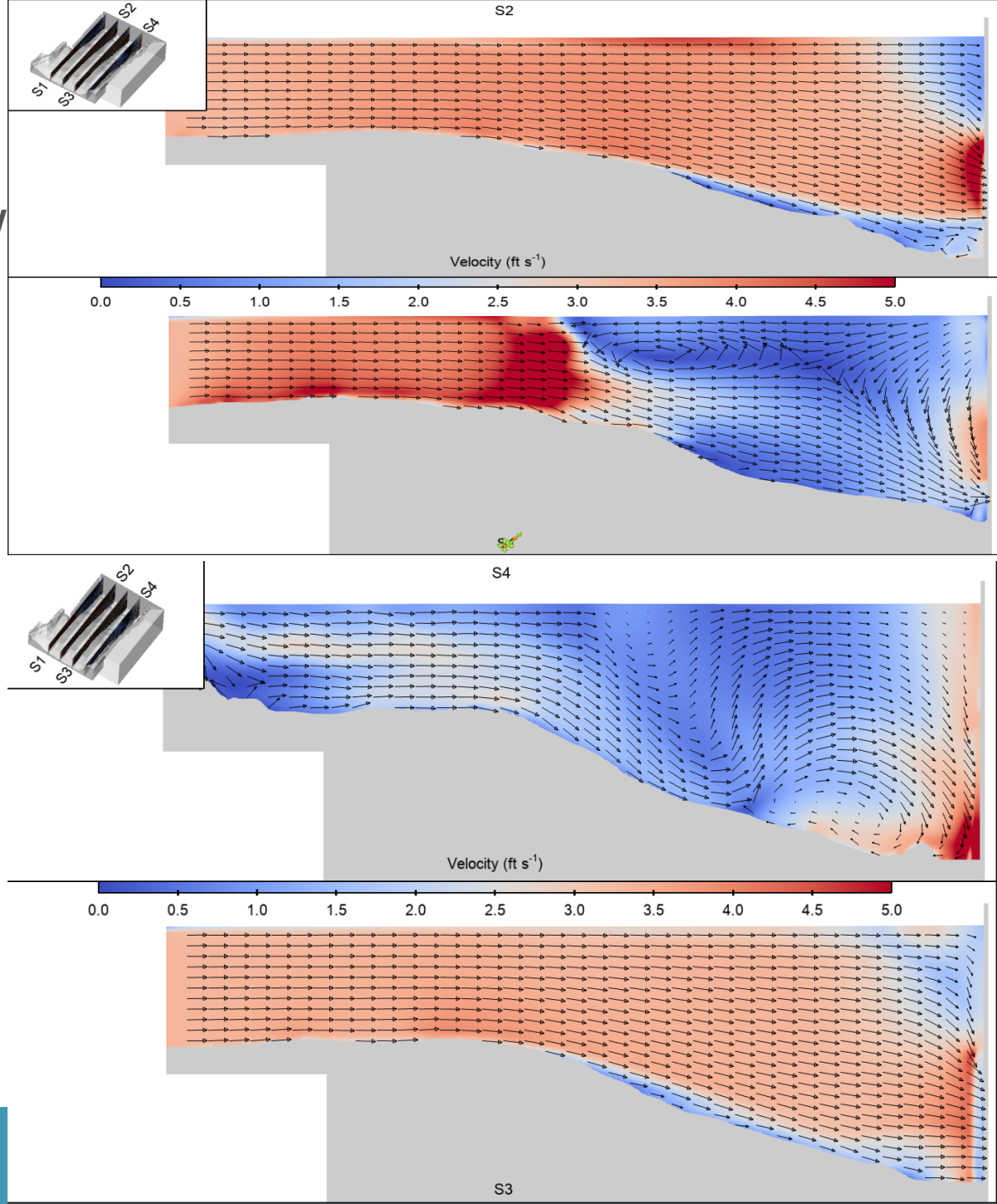
- Velocity contours on profile sections



CFD Model Study:

Results Summary – ELF Forebay High Flow (6,730 cfs)

- Velocity contours on profile sections

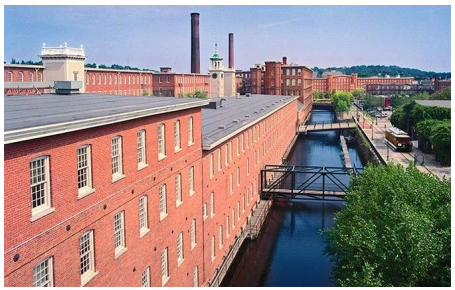
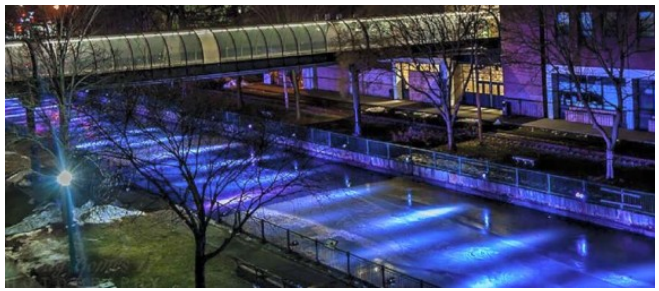


Resources, Ownership, Boundaries, and Land Rights Study Report

Resources, Ownership, Boundaries, and Land Rights Study Report: **Goals and Objectives**

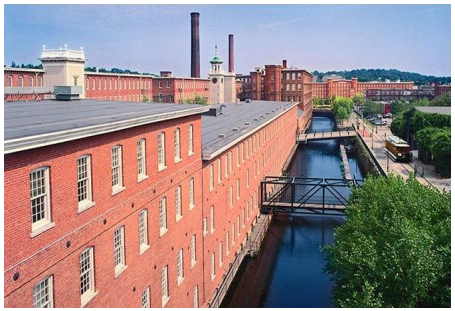
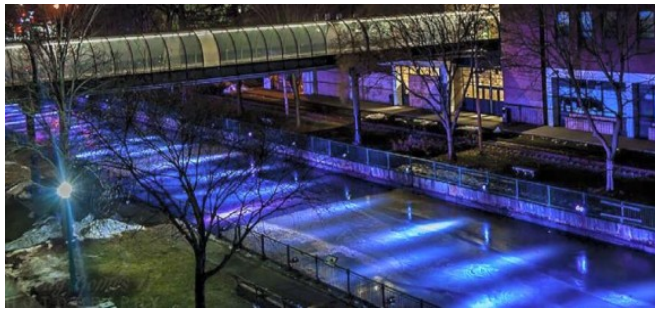
- The goal of this study is to determine current ownership of resources within the canal system and existing Project Boundary, and document maintenance responsibilities, access rights, and clarify FERC jurisdiction.

- The specific objectives of this study are as follows:
  - Determine the current ownership of resources within the canal system in a comprehensive manner;
  - Record maintenance responsibilities and obligations to resources within the canal system;
  - Clarify FERC jurisdiction;
  - Document recreational, educational, or other land access rights to resources within the canal system; and
  - Develop a GIS database of resources, ownership, boundaries, and land rights.

Resources, Ownership, Boundaries, and Land Rights Study Report: **Study Methods**

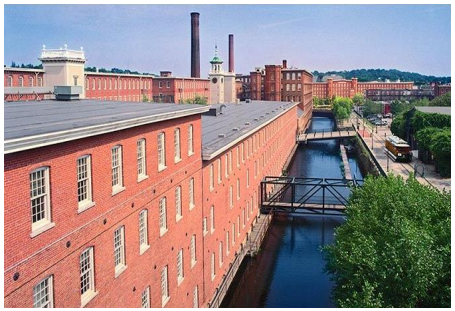
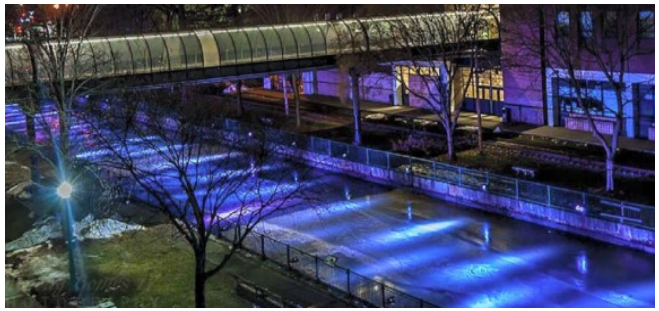
- **Literature Review and Analysis**
  - Boott compiled and reviewed available ownership and rights documentation. As appropriate and relevant, public guidance, conceptual planning, and management documentation was reviewed by Boott.
  - Boott reviewed the three legal documents that establish most of the ownership and easement rights of the Lowell canal system: the 1984 *Great Deed*, 1986 *Order of Taking*, and the 1995 *Grant of Easement*. These were filed as appendices to the Study Report.
  - The GIS Database was developed using ESRI's ArcMap, ArcCatalog, and ArcGIS Online. The publically-accessible database was developed using ArcGIS Experience Builder. Exports of the database were provided in the Study Report as an appendix.

Resources, Ownership, Boundaries, and Land Rights Study Report: **Results Summary**

Literature Review and Analysis

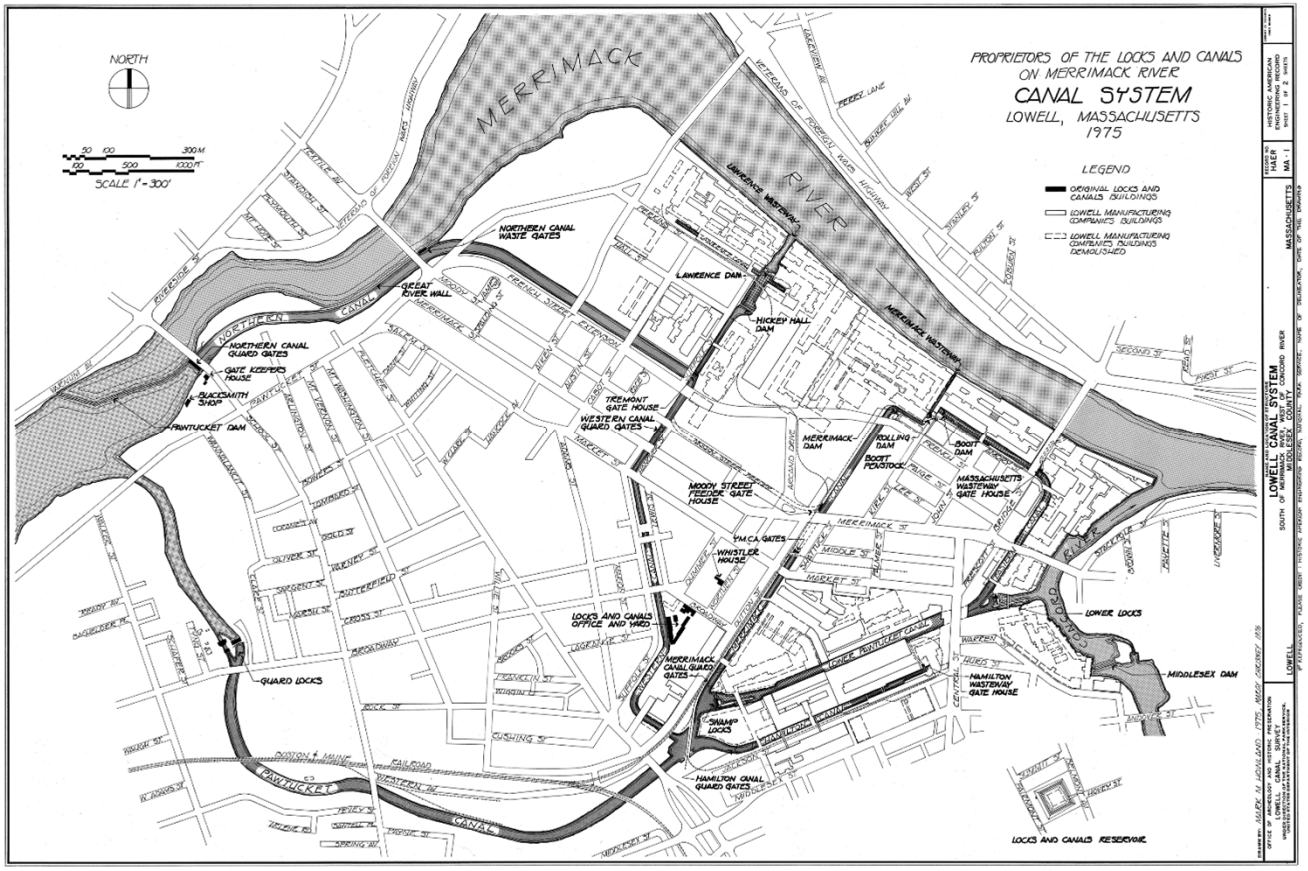
- Section 5.1 Conceptual Planning of the Lowell Canal System
  - The *1977 Report of the LHCDC* proposed cooperative undertaking of the NPS and the Commonwealth of Massachusetts, acting through what is today the Massachusetts Department of Conservation and Recreation (MADCR). It was understood that almost all the structures would remain in private ownership, but the structures would be developed and managed by NPS and MADCR. Privately owned but publicly managed.
  - 1980 *Details of the Preservation Plan* and the 1981 *Final General Management Plan* provided more context and details to the roles of NPS, the Commonwealth of Massachusetts (acting through MADCR), the City of Lowell, and private companies.
  - Ultimately, the conceptual framework for the rights and responsibilities for management of the Lowell canal system remain consistent within the conceptual public planning documents (1977-1990).

Resources, Ownership, Boundaries, and Land Rights Study Report: **Results Summary**

Literature Review and Analysis

- Section 5.2 Ownership of the Lowell Canal System
  - Ownership of the Lowell canal system is largely determined by the 1984 *Great Deed* and 1986 *Order of Taking*.
    - Proprietors owns much of the Pawtucket Canal and structures of the Pawtucket Canal.
    - Boott owns the other canals, and specific dams, lock structures, and hydroelectric equipment within those canals, often based on elevation.
    - MADCR owns most of the gatehouses and several other historical structures throughout the Lowell canal system, also often based on elevation.



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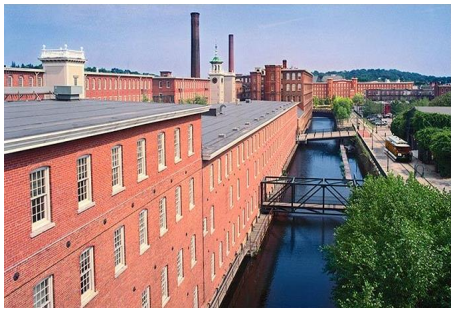
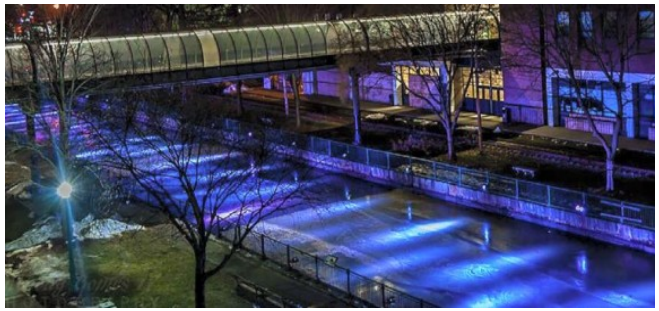
Resources, Ownership, Boundaries, and Land Rights Study Report: **Results Summary**

Literature Review and Analysis

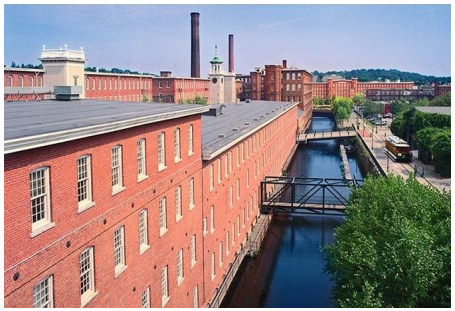
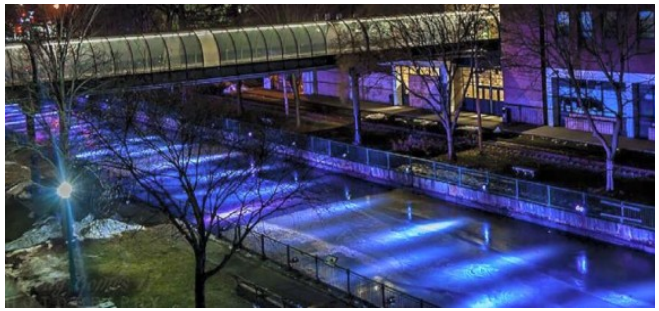
- Section 5.3 Easement Rights
  - Easement rights to structures of the Lowell canal system are held by Proprietors, Boott, MADCR, and NPS.
    - Boott obtained easement rights, in common with Proprietors, to the Pawtucket Canal and structures of the Pawtucket Canal. These easement rights allow Boott to access, operate, maintain, repair, and replace the Pawtucket Canal and structures of the Pawtucket Canal.
    - In the 1986 *Order of Taking*, MADCR obtained a permanent and exclusive easement to structures of the canal system, including canal walls, beds, and bottoms, for purposes including conservation, preservation, construction of boat ramps, and docks, and other uses consistent with the use of the system as a park.
    - NPS obtained similar easement rights through the 1995 *Grant of Easement*.

Resources, Ownership, Boundaries, and Land Rights Study Report: **Results Summary**

Literature Review and Analysis

- Section 5.4 Resource Rights
  - Recreational resources: Conceptual planning documents and legal ownership and easement documents are all consistent regarding recreational resource rights. MADCR owns exclusive rights to use the entire canal system for "recreational, educational, and navigational purposes." MADCR holds an exclusive and permanent easement for placement and attachment of docks, wharves, walls, and boat ramps of a temporary or permanent nature.
  - Air resources: The 1986 *Order of Taking* transferred to MADCR "all air rights over the canals, including the canal walls and any dams thereon."
  - Boott and Proprietors retain certain rights to flow water through the downtown canal system.
  - Boott holds rights to use structures of the canal system for the purposes of producing power.

Resources, Ownership, Boundaries, and Land Rights Study Report: **Results Summary**

Literature Review and Analysis

- Section 5.5 Historical Management Agreement
  - 1979 Agreement
  - 1991 Memorandum of Understanding
    - Ownership and "duty of care"
- These agreements are the "bookends" to the legal documents (1984 *Great Deed* and 1986 *Order of Taking*)

APPENDIX D: AGREEMENTS BETWEEN MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL MANAGEMENT AND NATIONAL PARK SERVICE CONCERNING CANAL USE, DEVELOPMENT, AND MANAGEMENT

Acquisition	Lead Agency
Canal Banks and Walls (variable boundary)	DEM
Gatehouses (11)	DEM assisted by NPS
Locks (2 single and 2 double)	DEM
Dam	Locks and Canals
Interpretive Water Access Rights/Recreational Boating	DEM
Water Use Rights/Hydro	NPS assisted by DEM
Bridges	DEM and City of Lowell
Canal Boats - 8 to 40 person capacity	Preservation Commission and NPS

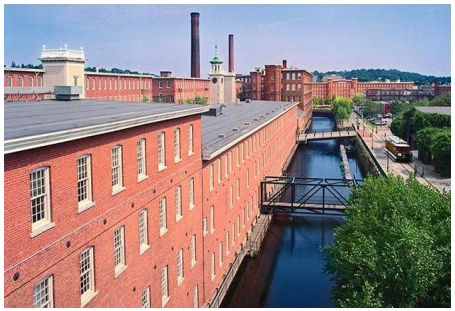
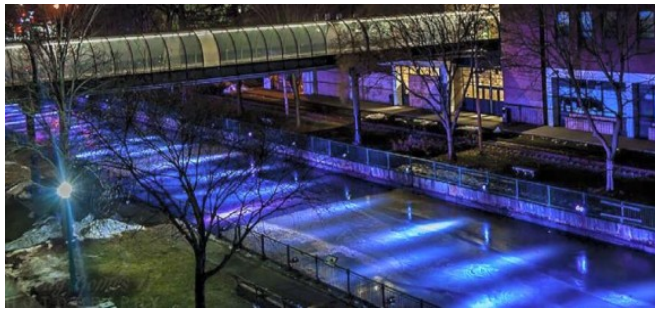
Development	Lead Agency
Canal Banks and Walls (landscaping and damage repair)	DEM assisted by NPS
Locks	DEM/NPS
Gatehouses	DEM/NPS
Dam	Locks and Canals
Bridges	DEM/City of Lowell (DEM will coordinate, funding to be determined)
Barge Landings	DEM/NPS
Displays and Signs	DEM/NPS (joint effort prior to 4/80)

Maintenance	Lead Agency
Canal Banks and Walls	DEM
Locks	DEM
Gatehouses	DEM and Locks and Canals
Dam	Locks and Canals
Bridges	DEM/City of Lowell
Dredging/Debris Removal	DEM (initially NPS)
Barge Landings	NPS/DEM (Francis Gate, Northern Canal)
Boats	NPS
Water Flow Levels	NPS/Locks and Canals
Maintenance Staff	DEM or contractual arrangement

Visitor Services (4-month operation)	Lead Agency
Overall Cooperative Lead Agency	NPS
Interpretive Staffing	NPS/DEM
Boat Operators (16)	NPS
Security	NPS

Resources, Ownership, Boundaries, and Land Rights Study Report: **Variances from FERC-approved Study Plan**

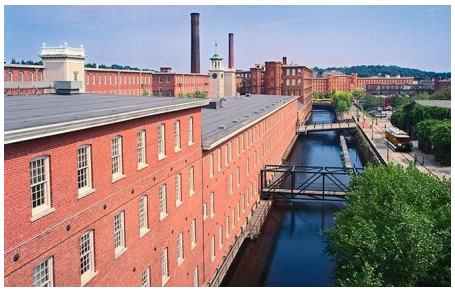
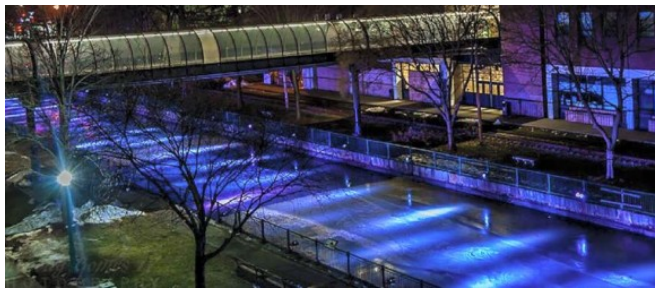
- The Resources, Ownership, Boundaries, and Land Rights Study Report was conducted in full accordance with the methods described in the FERC-approved study plan.

Historically Significant Waterpower Equipment Study

Historically Significant Waterpower Equipment Study: **Goals and Objectives**

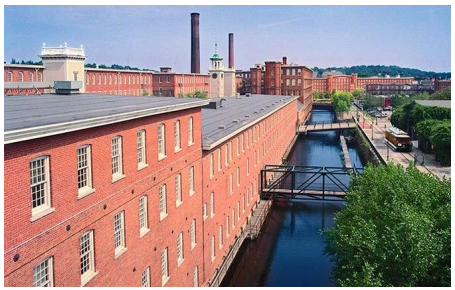
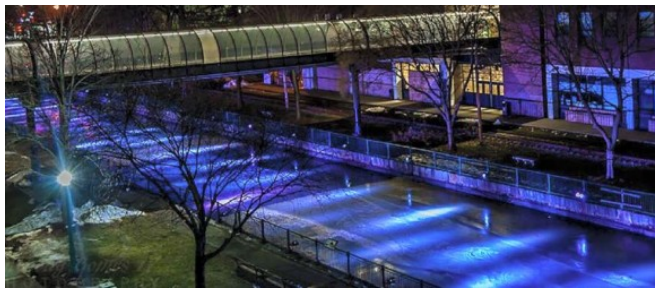
- The goal of this study is to identify and document historically significant waterpower equipment. The specific objectives of this study are as follows:
  - Conduct a site visit to identify historically significant waterpower equipment of interest to the NPS for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;
  - Photo-document historically significant waterpower equipment identified in consultation with the NPS;
  - Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used; and
  - Document current ownership of historically significant waterpower equipment.

Historically Significant Waterpower Equipment Study: **Study Methods**

- **Documentary Research**
  - Gray & Pape conducted documentary research in the records held by NPS at Lowell to identify the component elements of the larger canal system and the equipment used to operate water control devices.

  - In July 2020, a site visit was held at Lowell with NPS to visit various locations associated with the control of water through the canal system. This tour included inspection of the Swamp Locks Gate House, the Hamilton Wasteway Gate House, the Lower Locks Gate House, the Boott Dam Gate House, the Moody Street Feeder Gate House, and the Northern Canal Gate House. Various types of gate operating mechanisms were observed.

Historically Significant Waterpower Equipment Study: **Results Summary**

Documentary Research

- The results of the literature review are presented in the Study Report.
  - Removal and replacement of individual pieces of equipment was nearly continual, from the day the system first became operational.
  - It is the totality of the system of waterpower and water-control machinery at Lowell that is historically significant.
  - Several pieces of equipment appear to be historically significant, distinct from their role as a part of the larger system. These pieces of equipment include
    - The surviving 1870 hydraulic gate hoist system at the Pawtucket Canal Guard Locks;
    - The Francis turbine powered belt-and-line shafting gate operating system at the Pawtucket Gate House;
    - The extant gate operating system at the Moody Street Feeder Gate House;
    - Northern Canal Waste Gatehouse Hydraulic Equipment;
    - Boott Dam Gatehouse Hydraulic Equipment.

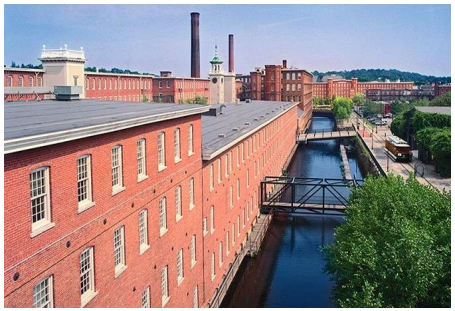
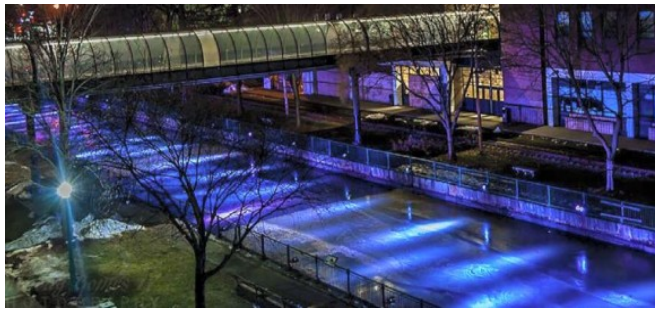
Historically Significant Waterpower Equipment Study: **Results Summary**

Figure 5-4. Pawtucket Gate House, belt-and-line shaft system.

Figure 6-1. Moody Street Gate House, gate hoisting mechanisms.

The Historically Significant Waterpower Equipment Study: **Variances from FERC-approved Study Plan**

- The Historically Significant Waterpower Equipment Study was conducted in full accordance with the methods described in the FERC-approved study plan.

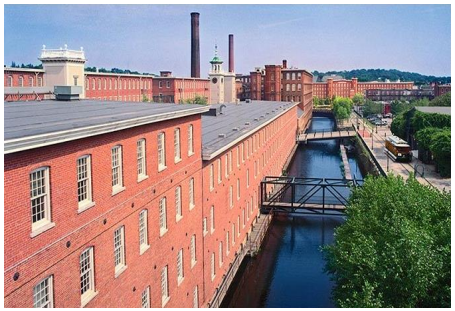
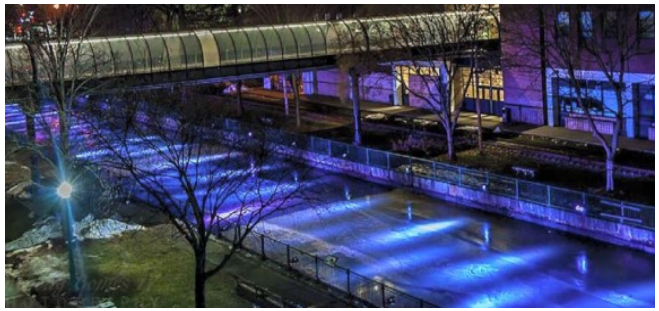



Water Level and Flow Effects on Historic Resources Study

Water Level and Flow Effects on Historic Resources Study: **Goals and Objectives**

- The goal of this study is to assess the potential effect of water level fluctuations within the headpond, Northern Canal, and the Pawtucket Canal on the historic structures.

- The specific objectives of this study are as follows:
  - Evaluate how Project operations, including manipulation of the new crest gate system, canal head gates, spillways, locks, fish passage structures, and generating units will change water levels in the Upper Pawtucket and Northern Canals;
  - Determine the extent to which water flows or elevations are having an effect on historic resources;
  - Conduct a structural assessment of the Great River Wall; and
  - Identify potential impacts of current Project operations on nationally significant historic resources, including a structural assessment of the Great River Wall.

Water Level and Flow Effects on Historic Resources Study: **Methods**

- **Documentation Review of Existing Conditions:** Documents reviewed are listed in Section 5 of the Study Report and include comments from stakeholders and documents received from NPS.

- **Site Visit to Document Existing Conditions:** Boott conducted a site visit to historic canal structures with input from NPS to identify issues previously noted by the NPS related to the flow and water levels on historic structures.

- **Canal Water Level Monitoring:** Boott installed level loggers at four locations within the canal system, which recorded relative water depths at 15-minute intervals over the study period (March 10 to September 23, 2020).

- **Project Operations Review**: Boott reviewed Project operational data including headpond elevation, forebay elevation, Project operations, and Merrimack River flows (January 1995 through December 2010).

- **Analysis of Potential Project Related Effects:** Using data gathered from the above methods to determine Project-specific damage to any historic infrastructure.

Water Level and Flow Effects on Historic Resources Study: **Results Summary**

- Great River Wall Visual Assessment (Filed CUI/CEII)
  - On October 5-6, 2021, Christopher Shantie, P.E., and Anthony Arce, EIT, of HDR observed the existing conditions of the Great River Wall, and took photographs as needed to correspond to the visual observations.
  - The goal of this visit was to document the existing condition of the Great River Wall that could be visually observed from the safety of available access points. No access into the bypass reach was permitted nor was the canal dewatered for observation.

Closing

Upcoming ILP Milestones

- Based on FERC's June 2021 *Revised Process Plan and Schedule and Determination on Requests for Study Modifications for the Lowell Hydroelectric Project*

Milestone	Responsible Party	Date
Study Report Meeting on All Studies	**All stakeholders**	**November 16, 2021**
Revised Initial Study Report Meeting Summary	Boott	December 01, 2021
Any Disputes/Requests to Amend Study Plan Due	**All stakeholders**	**December 31, 2021**
Responses to Disputes/Amendment Requests Due	**All stakeholders**	**January 30, 2022**
Director's Determination on Disputes/Amendments	FERC	March 02, 2022

Any Disputes/Requests to Amend Study (18 C.F.R. § 5.15(d))

- *Criteria for modification of approved study.* Any proposal to modify an ongoing study must be accompanied by a showing of good cause why the proposal should be approved, and must include, as appropriate to the facts of the case, a demonstration that:
  - (1) Approved studies were not conducted as provided for in the approved study plan; or
  - (2) The study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.

- If requesting new studies, stakeholders must consider FERC's Criteria (18 C.F.R. § 5.15(e)).

- www.LowellProjectRelicensing.com

Contact Information

- Stakeholders can contact Boott with questions or comments:

Kevin Webb
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Hydro Licensing Manager
670 N. Commercial Street, Suite 204
Manchester, NH 03101
(978) 935-6039
kwebb@centralriverspower.com

ATTACHMENT B

November 16, 2021 FERC USR Meeting Questions:

1) There were 18 radio-tagged juvenile alosines identified as having not passed downstream during the juvenile alosine telemetry assessment in 2019. What were the final detection locations for those individuals?
2) Can you provide a frequency distribution for the number of passage attempts prior to successful passage?

Request #1:

Table 1. Final detection location (receiver station and coverage area) for eighteen radio-tagged juvenile alosines which approached the Lowell Project but failed to pass downstream, fall 2019.

Final Detection		No. Individuals
Station	Location	
20	0.6 miles upstream Pawtucket Dam	1
26	Upstream Pawtucket Gatehouse	3
28	Downstream Pawtucket Gatehouse	7
30	E.L. Field Forebay	7

Request #2:

Fall 2019 Telemetry Studies:

During preparation of the fall 2019 downstream passage radio-telemetry study reports for adult American eel and juvenile alosines, passage attempts at the Northern Gatehouse and E.L. Field Forebay were evaluated using a threshold interval for determining the continued presence of a transmitter within the detection zone of a specific receiver which was defined as the 95th percentile of the observed set of interval durations. The 95th percentile was calculated from the duration between detections for ***all*** individuals at the Northern Gatehouse and ***all*** individuals within the area of detection in the E.L. Field Forebay. Initially, this threshold was attempted on an individual basis. However, due to the variation in detection timing, values calculated for the number of events per individual ranged from single digits to several hundred attempts and were determined unrealistic and, therefore, unreliable. Determining this threshold on the suite of individuals yielded a more realistic result regarding the number of attempts made.

Juvenile Alosines:

Based on the 95th percentile threshold used to identify attempts made at the Northern Gatehouse and the E.L. Field Forebay (14.5 minutes and 25.2 seconds, respectively), all juvenile alosines which were detected at either location were determined to have made only a single attempt. No individuals exhibited a duration lying outside of the 95th percentile for all individuals in the Northern Gatehouse or the E.L. Field Forebay. Table 2 provides the minimum, maximum and quartile values for attempt durations among all juvenile alosines at the two evaluated passage points.

Adult American Eels:

Based on the 95th percentile threshold used to identify attempts made at the Northern Gatehouse and the E.L. Field Forebay (14.4 seconds and 32.4 seconds, respectively), all radio-tagged adult eels which were

detected at either location were determined to have made only a single attempt. No individuals exhibited a duration lying outside of the 95th percentile for all individuals in the Northern Gatehouse or the E.L. Field Forebay. Table 2 provides the minimum, maximum and quartile values for attempt durations among all radio-tagged adult American eels at the two evaluated passage points.

Table 2. Total number of Northern Gatehouse and E.L. Field Forebay approach events for radio-tagged fall migrants and minimum, maximum, and quartile values for observed range of event durations (in hours).

Species	Location	No. Events	Min.	Max.	Q25	Median	Q75
Juvenile Alosine	E.L. Field Forebay	126	0.001	182.2	0.013	0.003	0.036
	Northern Gatehouse	145	<0.001	405.7	0.076	0.004	0.418
American Eel	E.L. Field Forebay	61	0.002	134.9	0.017	0.027	0.055
	Northern Gatehouse	144	0.001	203.9	0.005	0.008	0.015

Spring 2020 Telemetry Study – Upstream Passage:

During preparation of the spring 2020 adult alosine telemetry report, upstream forays for both river herring and American shad were determined manually due to overlap in stations which confounded calculations of detection timing, preventing the reliable use of the 95th percentile threshold for defining events (as defined previously for adult eels and juvenile alosine downstream passage). Information related to the duration of upstream forays in the direction of the Pawtucket Dam fish ladder and the E.L. Field Powerhouse fish lift was provided in the USR. Figures 1, 2, and 3 provide frequency histograms representing the number of passage attempts made by adult river herring in the direction of the fish lift (Figure 1), fish ladder (Figure 2) and adult American shad in the direction of the fish lift (Figure 3). As described in the USR, foray events for adult American shad up the Lowell bypassed reach and towards the Pawtucket Dam fish ladder were limited to a single event.

Spring 2020 Telemetry Study – Downstream Passage:

Methodology for defining downstream passage attempts at the Northern Gatehouse and E.L. Field Forebay for outmigrating adult American shad and river herring during the spring 2020 telemetry study were the same as those previously described for adult eels and juvenile alosines during the fall 2019 downstream studies. Events were defined through the use of a 95th percentile threshold calculated from the duration between detections for all individuals at each site.

Based on the 95th percentile threshold used to identify attempts made at the Northern Gatehouse and the E.L. Field Forebay (3.4 minutes and 5.6 minutes), adult alosines which were detected at either location were determined to have exhibited a range in the number of passage attempts. Table 3 provides the minimum, maximum and quartile values for attempt durations among all radio-tagged adult American shad and river herring at the two evaluated passage points. Figures 4 through 7 provide frequency histograms representing the number of passage attempts made by adult river herring at the Northern Gatehouse (Figure 4) and E.L. Field Forebay (Figure 5) and adult American shad at the Northern Gatehouse (Figure 6) and E.L. Field Forebay (Figure 7).

Table 3. Total number of Northern Gatehouse and E.L. Field Forebay approach events for radio-tagged adult American shad and river herring and minimum, maximum, and quartile values for observed range of event durations (in hours).

Species	Location	No. Events	Min.	Max.	Q25	Median	Q75
American Shad	E.L. Field Forebay	30028	0.001	90.7	0.050	0.008	0.142
	Northern Gatehouse	8219	0.001	330.9	0.053	0.031	0.100
Adult Alosines	E.L. Field Forebay	22051	<0.001	80.7	0.113	0.017	0.341
	Northern Gatehouse	1508	0.001	114.9	0.242	0.129	0.571

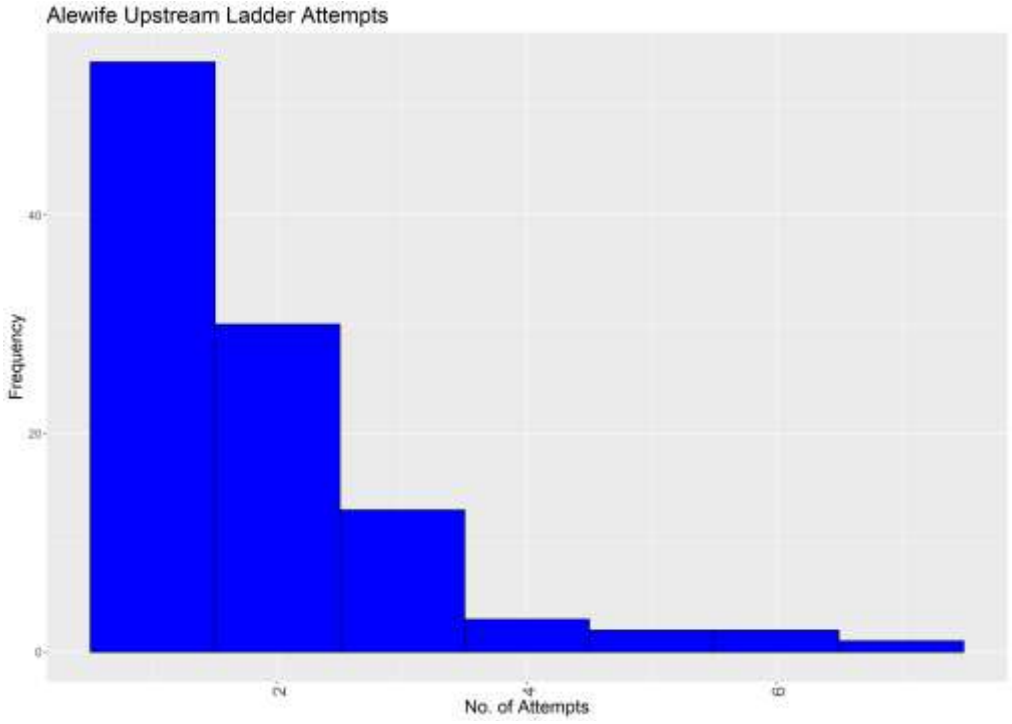

Figure 1. Frequency duration for upstream passage attempt numbers for adult river herring in the direction of the Pawtucket Dam fish ladder.

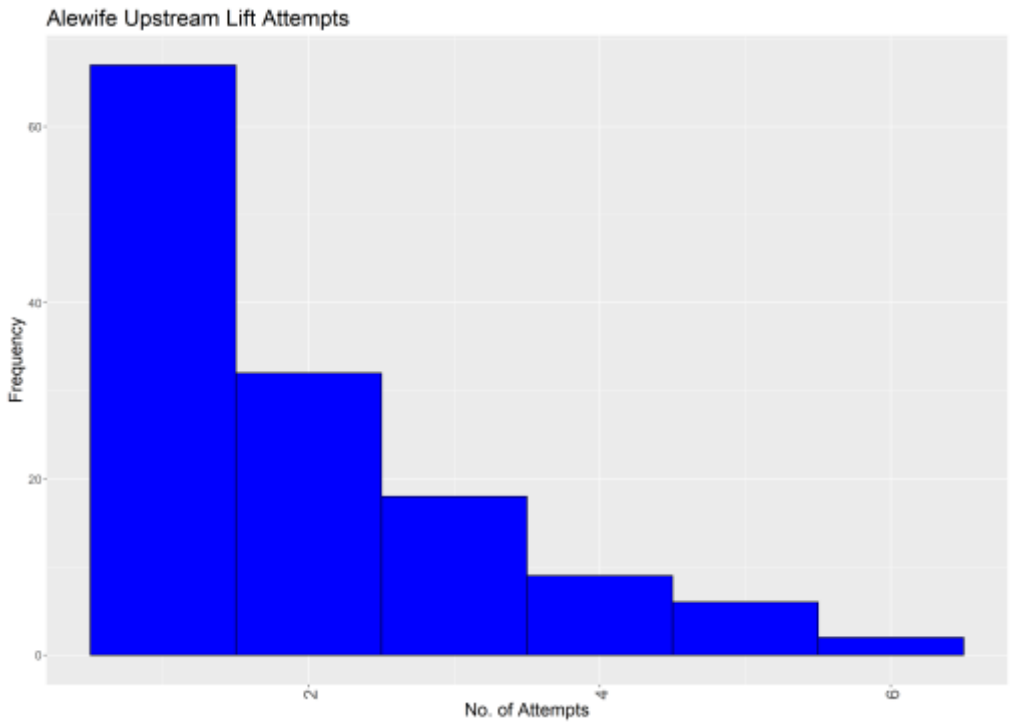

Figure 2. Frequency duration for upstream passage attempt numbers for adult river herring in the direction of the E.L. Field Powerhouse fish lift.

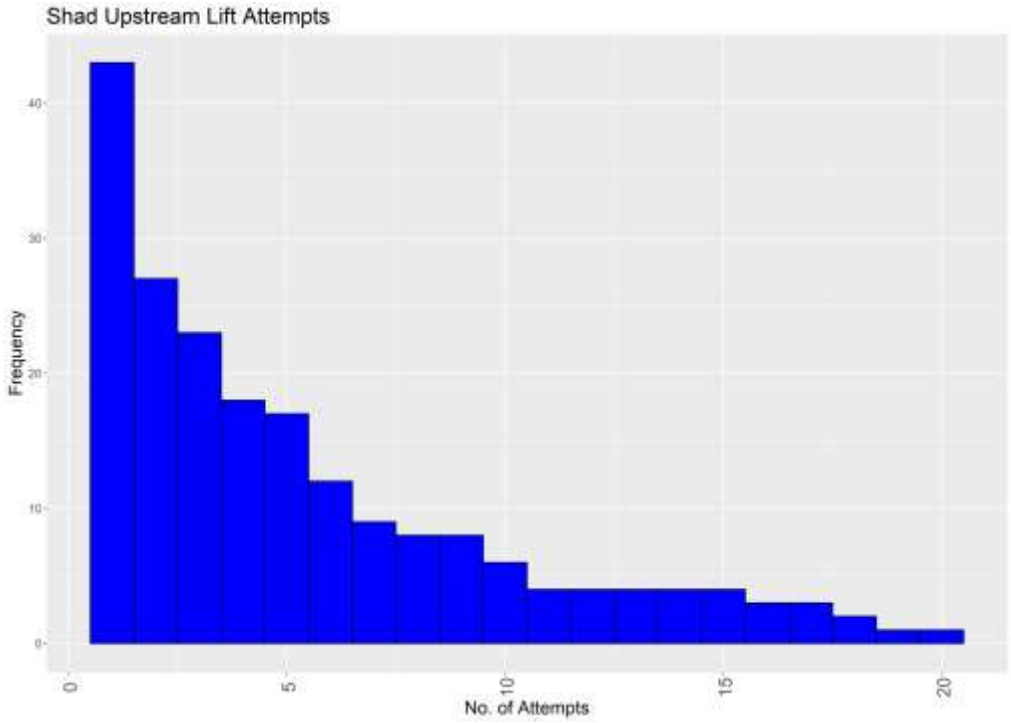

Figure 3. Frequency duration for upstream passage attempt numbers for adult American shad in the direction of the E.L. Field Powerhouse fish lift.

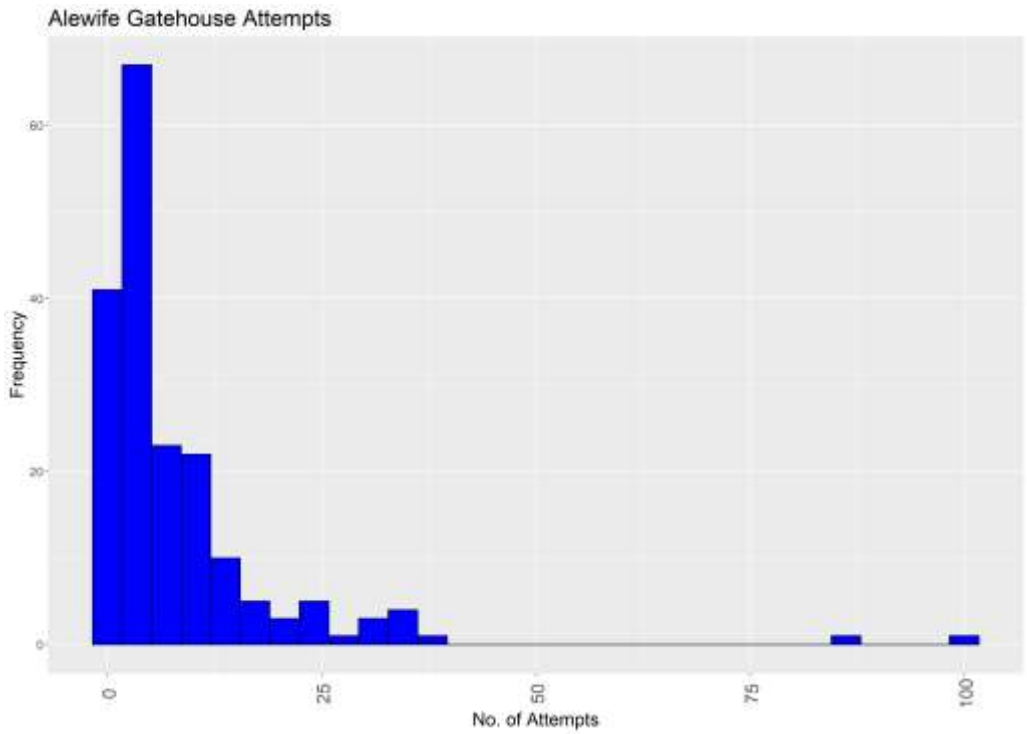

Figure 4. Frequency duration for downstream passage attempt numbers for adult river herring at the Northern Gatehouse.

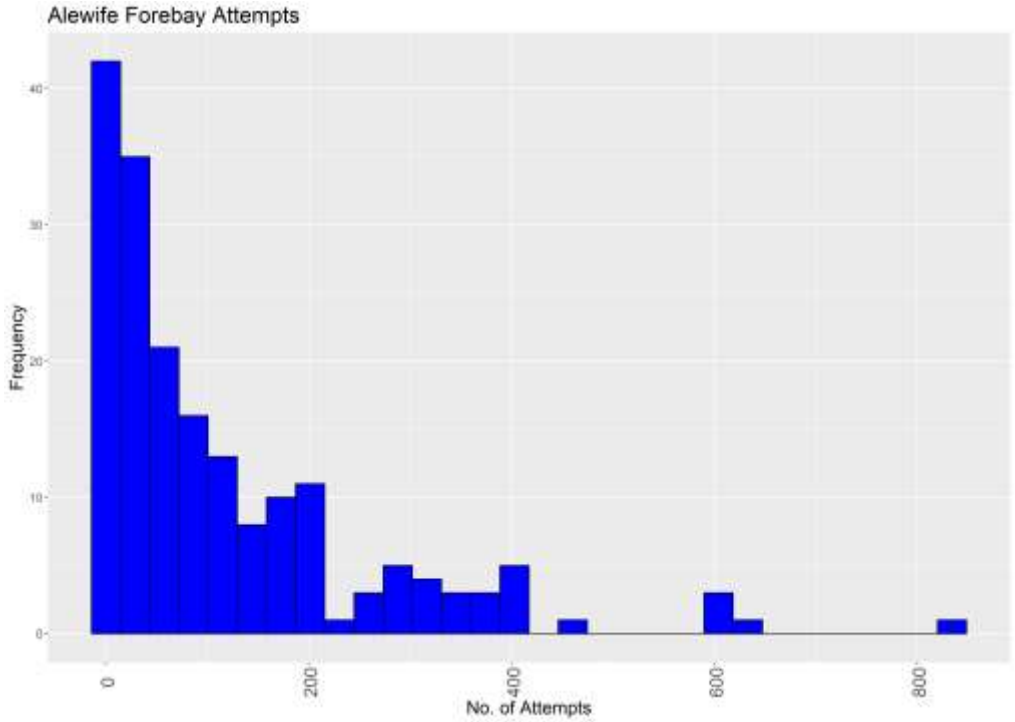

Figure 5. Frequency duration for downstream passage attempt numbers for adult river herring at the E.L. Field Powerhouse.

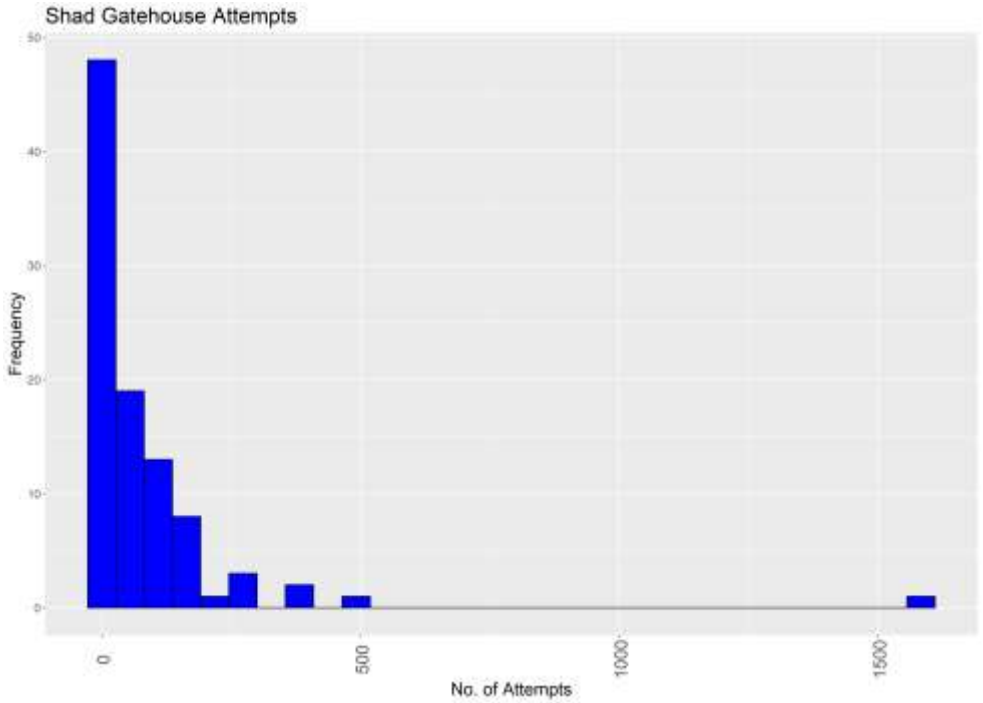

Figure 6. Frequency duration for downstream passage attempt numbers for adult American shad at the Northern Gatehouse.

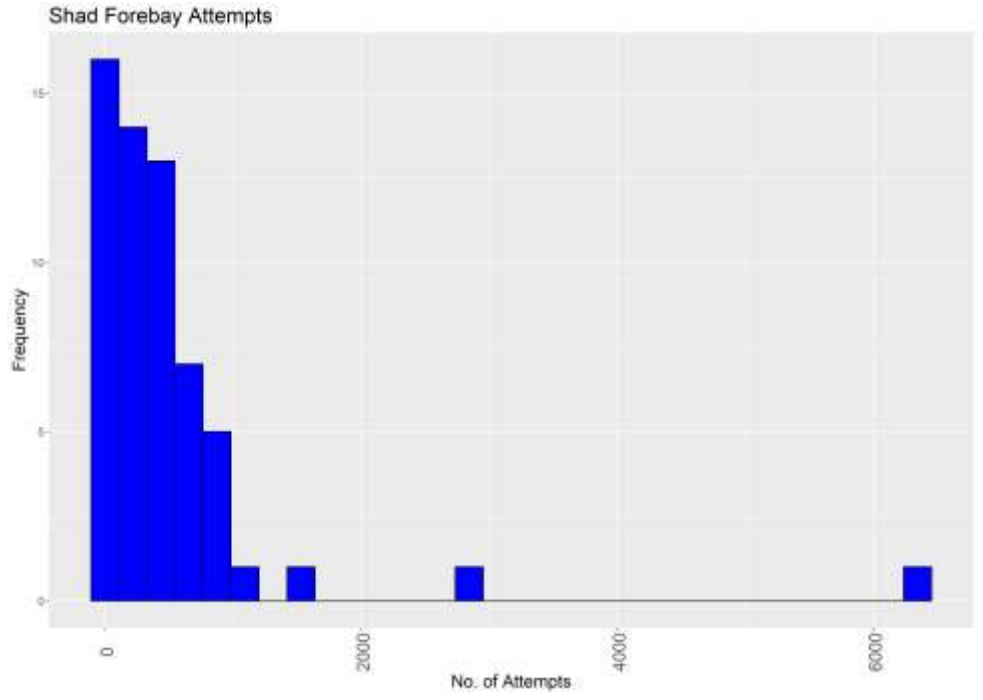

Figure 7. Frequency duration for downstream passage attempt numbers for adult American shad at the E.L. Field Powerhouse.