Before the Federal Energy Regulatory Commission

Amended Final Application for New License for Major Water Power Project – Existing Dam

Turners Falls Hydroelectric Project (FERC Project Number 1889)
Northfield Mountain Project (FERC Number 2485)

VOLUME II OF V (PUBLIC), PART 4 OF 4

- **EXHIBIT E- ENVIRONMENTAL REPORT (PART 1 OF 4)**
- **EXHIBIT E- ENVIRONMENTAL REPORT (PART 2 OF 4)**
- **EXHIBIT E- ENVIRONMENTAL REPORT, APPENDICES (PART 3 OF 4) SECTION 1.0 INTRODUCTION TO 3.3.4 TERRESTRIAL RESOURCES**
- **EXHIBIT E- ENVIRONMENTAL REPORT, APPENDICES (PART 4 OF 4) SECTION 3.3.5 RARE, THREATENED, & ENDANGERED SPECIES TO END**

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	Appendix B- RTE- Northfield-Eagle Protection Plan
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Section 3.3.6 Recreation Resources	Appendix A- Recreation-Turners Falls Recreation Management Plan
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Appendix A- RTE- Turners Falls- Bald Eagle Protection Plan

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Amended Final Application for New License for Major Water Power Project – Existing Dam

Turners Falls Hydroelectric Project (FERC Project Number 1889)

Bald Eagle Protection Plan

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FirstLight

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BACKGROUND

The purpose of this plan is to guide the Licensee’s management and maintenance of lands at the Turners Falls Hydroelectric Project (Project) over the new license term for the protection of bald eagles.

Although bald eagles have been removed from the endangered species list, bald and golden eagles are still protected under multiple federal laws and regulations including the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Bald eagles’ winter along the Connecticut River in the Project area. Bald eagles are known to perch in riverbank trees and forage over the Connecticut River in Project vicinity. Several bald eagles, adults and juveniles, have been observed perching or foraging in the Turners Falls Impoundment (TFI) and Northfield Mountain in both 2014 and 2015, and three occupied bald eagle nests were located within the study area. These nests were found downstream on Third Island (below Cabot Station), near Smead Island, Barton Island in Barton Cove, and along the east bank of the TFI across from Stebbins Island in the upper reaches of the TFI. Since the study, FirstLight Visitor Center staff have provided anecdotal information on two additional eagle nests located within the TFI. One is located in the vicinity of Kidd’s Island either on the Island or the eastern shore in the Town of Northfield and one in Turners Falls, on the hillside in the general vicinity of the Turners Falls Airport runway.

PROTECTION MEASURES

Given the nature and scope of Project operations, no adverse effects on bald eagles are anticipated. In the event that tree removal or construction activities are necessary at the Project, FirstLight will implement the conservation measures described below to avoid effects to bald eagles.

Prior to any tree clearing within the Project boundary or areas immediately adjacent to the Project boundary by the Licensee or its contractors, the area to be cleared will be observed for bald eagle nests by the Licensee. If such nests are discovered, the Massachusetts Division of Fisheries and Wildlife (MADFW) and the United States Fish and Wildlife Service (USFWS) will be consulted prior to tree-clearing activities and the tree-clearing activities will be performed in accordance with the applicable regulations and guidance (i.e., the National Bald Eagle Management Guidelines, USFWS 2007).

During the nesting season (January 1 through September 30), no tree clearing will occur within 330 feet of, and no construction activities will occur within 660 feet of, any known bald eagle nests by the Licensee or its contractors. For any project-related construction activities, work that requires blasting or other activities that produce extremely loud noises within 1/2 mile of active nests will be avoided. The Licensee will consult with the MADFW and USFWS regarding tree clearing or construction activities that cannot meet these conditions.

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Appendix B- RTE- Northfield Mountain- Bald Eagle Protection Plan

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Amended Final Application for New License for Major Water Power Project – Existing Dam

Northfield Mountain Project (FERC Project Number 2485)

Bald Eagle Protection Plan

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Appendix C- RTE- Shortnose Sturgeon Biological Assessment

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Draft Biological Assessment for Shortnose Sturgeon

Federal Relicensing of the Northfield Mountain Pumped Storage Project (No. 2485) and the Turners Falls Hydroelectric Project (No. 1889)

Prepared for:

FirstLight

Prepared by:

Gomez and Sullivan Engineers

Kleinschmidt

Submitted to:

NOAA Fisheries

DECEMBER 2020

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LIST OF ABBREVIATIONS

ACOE	Army Corps of Engineers
BA	Biological Assessment
BO	Biological Opinion
°C	degree Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
CI	confidence interval
CSO	combined sewer overflows
CT	Connecticut
CTDEEP	Connecticut Department of Energy and Environmental Protection
d	days
DO	dissolved oxygen
DPS	Distinct Population Segments
ESA	Endangered Species Act
FERC or Commission	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro MA LLC and Northfield Mountain LLC
FLA	Final License Application
GHG	World Greenhouse Gases
h	hour
ha	hectare
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HEC-ResSim	Hydrologic Engineering Center's Reservoir System Simulation
HG&E	Holyoke Gas and Electric
ILP	Integrated Licensing Process
ISO-NE	ISO-New England
ITS	Incidental Take Statement
km	kilometer
L	liter
MA	Massachusetts
MADFW	Massachusetts Division of Fisheries and Wildlife
mg	milligram
m	meter
mm	millimeter
mtDNA	mitochondrial deoxyribonucleic acid
MW	megawatt
NADW	North Atlantic Deepwater
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NGVD29	National Geodetic Vertical Datum of 1929
Northfield Mountain Project	Northfield Mountain Pumped Storage Project (FERC No. 2485)

NPDES	National Pollutant Discharge Elimination System
NRF	Naturally Routed Flow
PAD	Pre-Application Document
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PM&E	Protection, Mitigation, and Enhancement
PSP	Proposed Study Plan
s	second
SD1	Scoping Document 1
SD2	Scoping Document 2
SNS	Shortnose Sturgeon
SPDL	Study Plan Determination Letter
RPA	reasonable and prudent alternative
TFI	Turners Falls Impoundment
TL	total length
Turners Falls Project	Turners Falls Hydroelectric Project (FERC No. 1889)
USACOE	United States Army Corps of Engineers
USFWS	Unites States Fish Wildlife Service
USGS	United States Geological Survey
VY	Vermont Yankee
WUA	Weighted Usable Area
YOY	young of year

EXECUTIVE SUMMARY

FirstLight MA Hydro LLC is the owner of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889). Northfield Mountain LLC is the owner of the Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485). Collectively referred to as FirstLight, the owners are seeking to relicense the hydroelectric projects with the Federal Energy Regulatory Commission (FERC). As part of relicensing, FirstLight is filing Amended Final License Applications, which include proposals for continued operation of the Projects. The proposals include several items, including improvements pertaining to fish passage, construction of recreation access areas, and modifications to operations that are designed to mitigate effects on several existing natural resources while providing the ability to provide clean, renewable hydroelectric power.

This draft Biological Assessment (BA) was prepared by FirstLight to support FERC's submission of a request for Endangered Species Act (ESA) Section 7 consultation with the National Marine Fisheries Service (NMFS) to consider the effects of two proposed actions – the relicensing of the Turners Falls Project and the relicensing of the Northfield Mountain Project. Because FirstLight is providing a comprehensive proposal that includes operation of both hydroelectric projects, the effects of FirstLight's comprehensive proposal are evaluated in this draft BA.

Shortnose Sturgeon (SNS) is the only federally listed fish species that could be affected by the Projects. SNS is under the jurisdiction of NMFS. Other federally listed species under the jurisdiction of the United States Fish and Wildlife Service (USFWS) are addressed in a separate BA.

The population of SNS in the Connecticut River historically ranged upstream to Great Falls, which is the current location of the Turners Falls Dam. The upstream portion of the population has been primarily isolated from the downstream portion since the historic construction of dams below Turners Falls, and remains divided by the Holyoke Dam, though recent fish passage improvement efforts have substantially increased the number of adult SNS moving from the lower portions of the Connecticut River to areas upstream of Holyoke Dam. The only spawning areas identified as currently supporting both the upstream and downstream portions of the population are upstream of Holyoke Dam, near Montague, in close proximity to the Turners Falls Project.

Studies performed at the Projects during relicensing informed FirstLight's development of several measures to enhance conditions for SNS in relation to the baseline condition (i.e., conditions that include Project operations consistent with the existing license). These measures are expected to provide considerably more habitat for SNS spawning and rearing, which are the critical life stages for this species that are affected by Project operations and have been included in FirstLight's comprehensive proposal for relicensing. Based on the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the Proposed Action, and the cumulative effects, it is concluded that the Projects are likely to adversely affect SNS because proposed construction is in close proximity to SNS habitat, and because proposed flows from the Projects affect habitat suitability for various life stages of SNS. However, the adverse effects of the Projects will be minimized, and conditions enhanced and improved for the Connecticut River population of SNS. As such, it is FirstLight's conclusion that the Proposed Action will not likely jeopardize the continued existence of SNS in the Connecticut River or the existence of the species within its range.

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1 INTRODUCTION

1.1 Background

FirstLight MA Hydro LLC owns and operates the Turners Falls Hydroelectric Project (Turners Falls Project) located on the Connecticut River near Montague, MA. Northfield Mountain LLC owns and operates the Northfield Mountain Pumped Storage Project (Northfield Mountain Project) located in Northfield, MA. The Northfield Mountain Project uses water from the Turners Falls Impoundment (TFI), which is created by the Turners Falls Dam, as part its pumped-storage operations. Hereinafter the two owners are collectively referred to as FirstLight.

FirstLight, in accordance with Sections (§§) 5.17 and 5.18 of Title 18 of the Code of Federal Regulations (CFR), is filing with the Federal Energy Regulatory Commission (FERC, the Commission) separate license applications for the two Projects, although a combined Exhibit E – Environmental Analysis was developed. The current license for the Turners Falls Project was issued on May 5, 1980 and expired on April 30, 2018. The license for the Northfield Mountain Project was issued on May 14, 1968 and also expired on April 30, 2018. Both Projects currently operate under annual licenses. FirstLight anticipates filing its Amended Final License Applications with FERC by December 6, 2020, which includes FirstLight's proposal for relicensing. FERC will decide whether to approve licenses for the Projects and what license conditions would be placed in any licenses issued.

1.2 Federally Listed Species Considered in this Biological Assessment

The Shortnose Sturgeon (SNS, *Acipenser brevirostrum*) is a federally endangered species listed under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543). SNS are known to occur below the Turners Falls Dam. SNS is the only federally listed fish species in areas affected by the Projects and the relicensing proposals. No critical habitat has been designated for SNS at this time. SNS is an anadromous fish species under the jurisdiction of the National Marine Fisheries Service (NMFS).

1.3 NMFS Consultation Record

FirstLight is relicensing the Projects using the Integrated Licensing Process (ILP), throughout which there have been intensive and documented consultation efforts between FirstLight and resource agencies, including NMFS. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC. The PAD included FirstLight's preliminary list of proposed studies. FERC conducted a public scoping process during which various resource issues were identified. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013.

FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013, and, per the Commission regulations, held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on the studies. On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013, with FERC addressing stakeholder comments.

On August 27, 2013, Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the two Projects, would be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions were anticipated to change during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which many of the studies were approved or approved with FERC modification. However, due to the impending closure of VY, FERC did not act on 19 proposed or requested studies pertaining to aquatic resources. The SPDL for these 19 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013, regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 19 studies on February 21, 2014, approving the RSP with certain modifications. Studies were completed over several subsequent years. The Draft License Application was filed with FERC on December 2, 2015, the Final License Application was filed with FERC on April 29, 2016, and an Amended Final License Application will be filed by December 6, 2020.

FirstLight consulted with NMFS on March 29, 2018, (meeting) and on October 17, 2019 (conference call). At the March 29, 2018 meeting NMFS identified various concerns regarding SNS including the impact of Turners Falls Project operations on known SNS spawning and rearing habitat near the Cabot tailrace (see descriptions of Project components in Section 2). At the meeting, NMFS stated it is charged with recovering the SNS population, and that maximizing spawning habitat gives SNS the best opportunity for recovery. NMFS noted that the success of early life stages is also critical to SNS restoration. NMFS stated it was seeking to increase spawning and rearing habitat not only in the documented locations, but in other areas of the bypass.

On the October 17, 2019, conference call, NMFS identified the following potential adverse effects of the Turners Falls Project on the SNS action area:

- The magnitude of flow in the bypass reach during the spawning and rearing period.
- Cabot peaking operations (sudden changes in flow) during the spawning and rearing periods.
- The frequency of Cabot emergency spill releases and bypass flume (log sluice) discharges on spawning and rearing habitat

NMFS noted that it is seeking higher flows in the bypass reach during the spawning and rearing period, reduced flow fluctuations from Cabot Station and reduced use of the Cabot emergency spill gates.

On April 17, 2020, FirstLight sent NMFS a preliminary draft Biological Assessment (BA) of SNS for review and comment. On May 8, 2020, and June 8, 2020, FirstLight and NMFS had conference calls to discuss the preliminary draft BA. On June 24, 2020, NMFS returned a marked-up copy of the preliminary draft BA to FirstLight. This draft BA addresses the comments raised by NMFS.

1.4 Purpose of this Document

This document is a draft Biological Assessment (BA) that describes the effects of FirstLight's proposed relicensing actions on SNS. The effects of the Proposed Action on all other federally listed species in Project-affected areas, all of which are under United States Fish and Wildlife Service (USFWS) jurisdiction, are evaluated in a separate BA. The analyses in this BA considers FirstLight's relicensing proposal (the Proposed Action) added to the environmental baseline and compares the effects of the Proposed Action to the effects of the baseline condition (i.e., effects to SNS from operations consistent with the existing license). Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this BA includes the effects of several activities that may affect the survival and recovery of the endangered species in the action area., Past and present effects of the Projects on listed species are part of the environmental baseline because the Turners Falls Project and Northfield Mountain Project are existing FERC-licensed facilities

2 PROJECT LAYOUT AND CURRENT OPERATIONS

2.1 Existing Facilities

The Northfield Mountain Project boundary includes the perimeter of the TFI down to the Turners Falls Dam and the area around the Northfield Mountain Project. The Turners Falls Project boundary also includes the perimeter of the TFI (overlapping with the Northfield Mountain Project boundary) and an area below the Turners Falls Dam down to Cabot Station. Figure 2.1-1 shows the overlapping Project boundary, and the separate Turners Falls and Northfield Mountain Project boundaries. The combined Project Boundaries for the Turners Falls Project and Northfield Mountain Project contain 7,246 acres of land and 2,238 acres of flowed land.

2.1.1 Turners Falls Project

The Turners Falls Project includes the Turners Falls Dam, which creates the TFI on the Connecticut River (Figure 2.1.1-1). The Turners Falls Dam consists of two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam, which are connected by a natural rock island known as Great Island. The 630-foot-long Montague Dam connects Great Island to the west bank of the Connecticut River and includes four bascule type gates, each 120-feet-wide by 13.25-feet-high and a fixed crest section which is normally not overflowed. The Gill Dam is approximately 55-feet-high and 493-feet-long extending from the Gill shoreline (east bank) to Great Island and includes three Tainter spillway gates, each 40-foot-wide by 39-foot-high.

Adjacent to the Montague Dam is the 214-foot-long gatehouse equipped with 15 operating gates controlling flow from the TFI to the power canal. Six (6) of the gates are 10'-8" high by 9' wide wooden gates and nine (9) of the gates are 12'-7" high by 9'-6" wide wooden gates. The Gatehouse fishway, described below, passes through the gatehouse at the east bank.

The power canal is approximately 2.1 miles long and has a design capacity of approximately 18,000 cubic feet per second (cfs). There are several water withdrawals from the power canal. The major ones are FirstLight's Station No. 1 and Cabot Station—these two hydroelectric projects are part of the Turners Falls Project. Station No. 1 is located closer to the upstream end of the power canal and Cabot Station is located at the downstream terminus of the power canal. The generation and hydraulic capacity of Station No. 1 are 5,683 kW and 2,210 cfs, respectively. The generation and hydraulic capacity of Cabot Station are 62.016 MW and 13,728 cfs, respectively. With the two generating stations combined, the total hydraulic capacity of the Turners Falls Project is 15,938 cfs.

In addition to Station No. 1 and Cabot Station, there are two other hydropower facilities on the canal that discharge into the bypass reach, when operating, including the Turners Falls Hydro, LLC project and Milton Hilton, LLC project. The Turners Falls Hydro project (FERC No. 2622) is owned and operated by Eagle Creek Renewable Energy and is currently undergoing licensing with FERC. It discharges into the bypass reach approximately 0.3 miles downstream of the Turners Falls Dam, which is upstream of the Station No. 1 tailrace. The Milton Hilton, LLC project is an unlicensed project owned and operated by a private developer. It discharges into the bypass reach approximately 0.5 miles downstream of the Turners Falls Hydro project tailrace, which is also upstream of the Station No. 1 tailrace.

The Turners Falls Project is equipped with three upstream fish passage facilities, including (in order from downstream to upstream): the Cabot fishway, the Spillway fishway, and the Gatehouse fishway. The Cabot fishway, located near the Cabot tailrace, moves migrating fish from the Connecticut River into the power canal. The Spillway fishway, located at the Turners Falls Dam, moves migrating fish from the Connecticut River into a gallery leading to the Gatehouse fishway; however, some fish do drop out into the power canal. The Gatehouse fishway, located at the Gatehouse, moves fish from the power canal to above the Turners Falls Dam. A downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no spill is occurring at Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal. SNS have not used the Project fishways, which have been primarily utilized by American Shad (*Alosa sapidissima*), Sea Lamprey (*Petromyzon marinus*), and a variety of resident fish species which are not listed under the ESA.

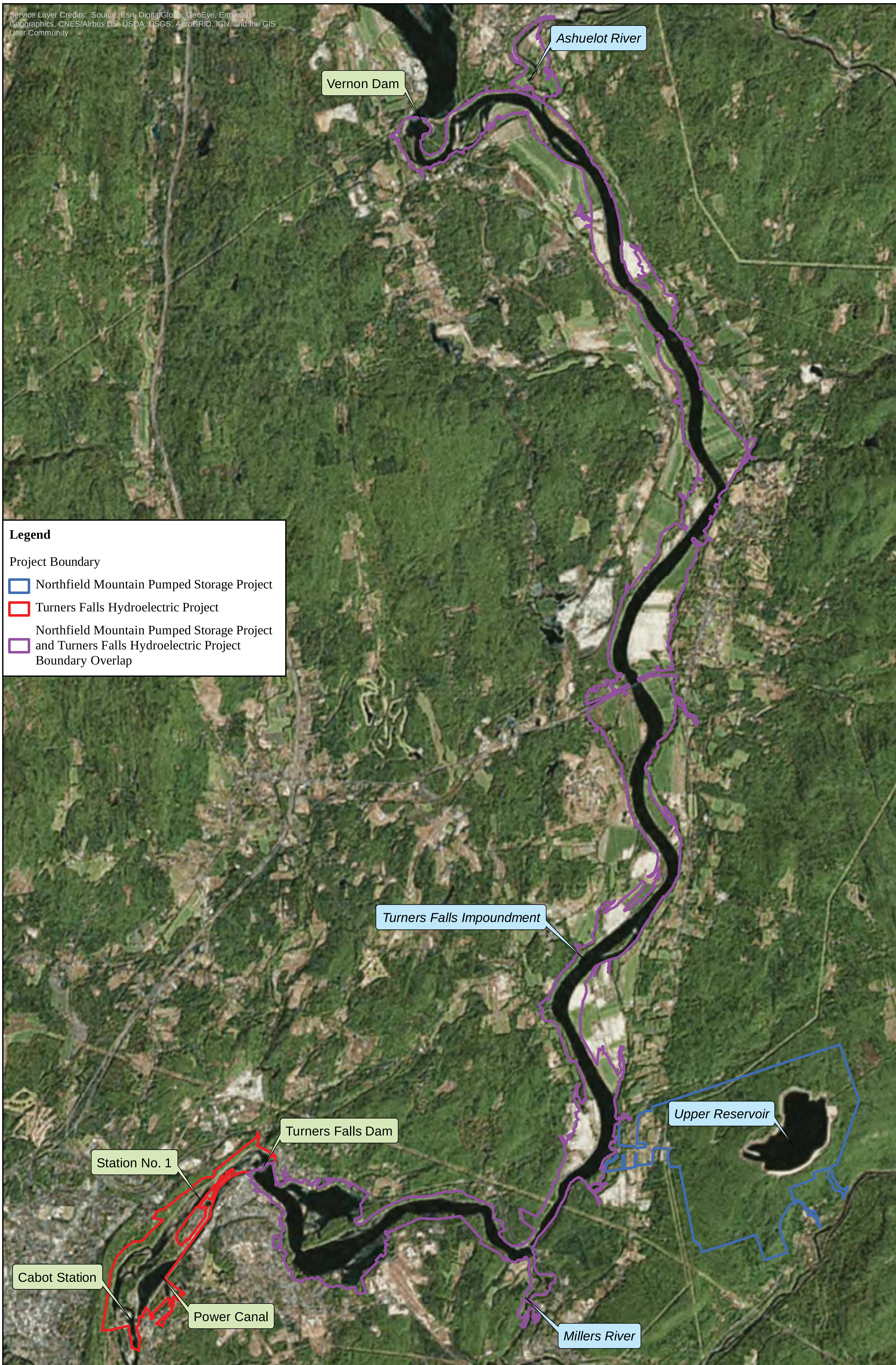
The TFI extends approximately 20 miles upstream to just below the Vernon Hydroelectric Project (FERC No. 1904), which is owned and operated by Great River Hydro. To provide storage capacity for the Northfield Mountain Project, the TFI elevation may vary, per the FERC license, from a minimum elevation of 176.0 feet[1] (National Geodetic Vertical Datum of 1929 (NGVD29)) to a maximum elevation of 185.0 feet constituting a 9-foot fluctuation as measured at the Turners Falls Dam. The usable storage capacity in this 9-foot fluctuation, as measured at the Turners Falls Dam, is approximately 16,150 acre-feet.

2.1.2 Northfield Mountain Project

The Northfield Mountain Project consists of an Upper Reservoir and dam/dikes, an intake, pressure shaft, underground powerhouse and tailrace (Figure 2.1.2-1). The crest elevation of the Upper Reservoir's Main Dam is at elevation 1010 feet. In addition to the Main Dam there are several dam/dikes that form the Upper Reservoir. The Upper Reservoir elevation may vary, per the FERC license, from a minimum elevation of 938 feet to a maximum elevation of 1000.5 feet constituting a 62.5-foot drawdown. FERC has allowed temporary variances to increase the maximum and minimum elevation to 1004.5 feet and 920 feet, respectively, during certain periods to meet electric grid system needs.

The intake channel directs water from the Upper Reservoir into the pressure conduit intake and eventually to the underground powerhouse. The electrical capacity of the four (4) reversible pump-turbines is 291.7 MW for a total station nameplate capacity of 1,166.80 MW. When operating at maximum pumping mode, the approximate hydraulic capacity is 15,200 cfs. Alternatively, when operating at maximum generation mode, the approximate hydraulic capacity is 20,000 cfs.

[1] The Project datum is the National Geodetic Vertical Datum of 1929 (NGVD29). All elevations in the license application for the Turners Falls Project and Northfield Mountain Project are based on the NGVD29 datum unless otherwise noted



Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

N

0 0.5 1 2 Miles

Figure 2.1-1
Project Boundary Map

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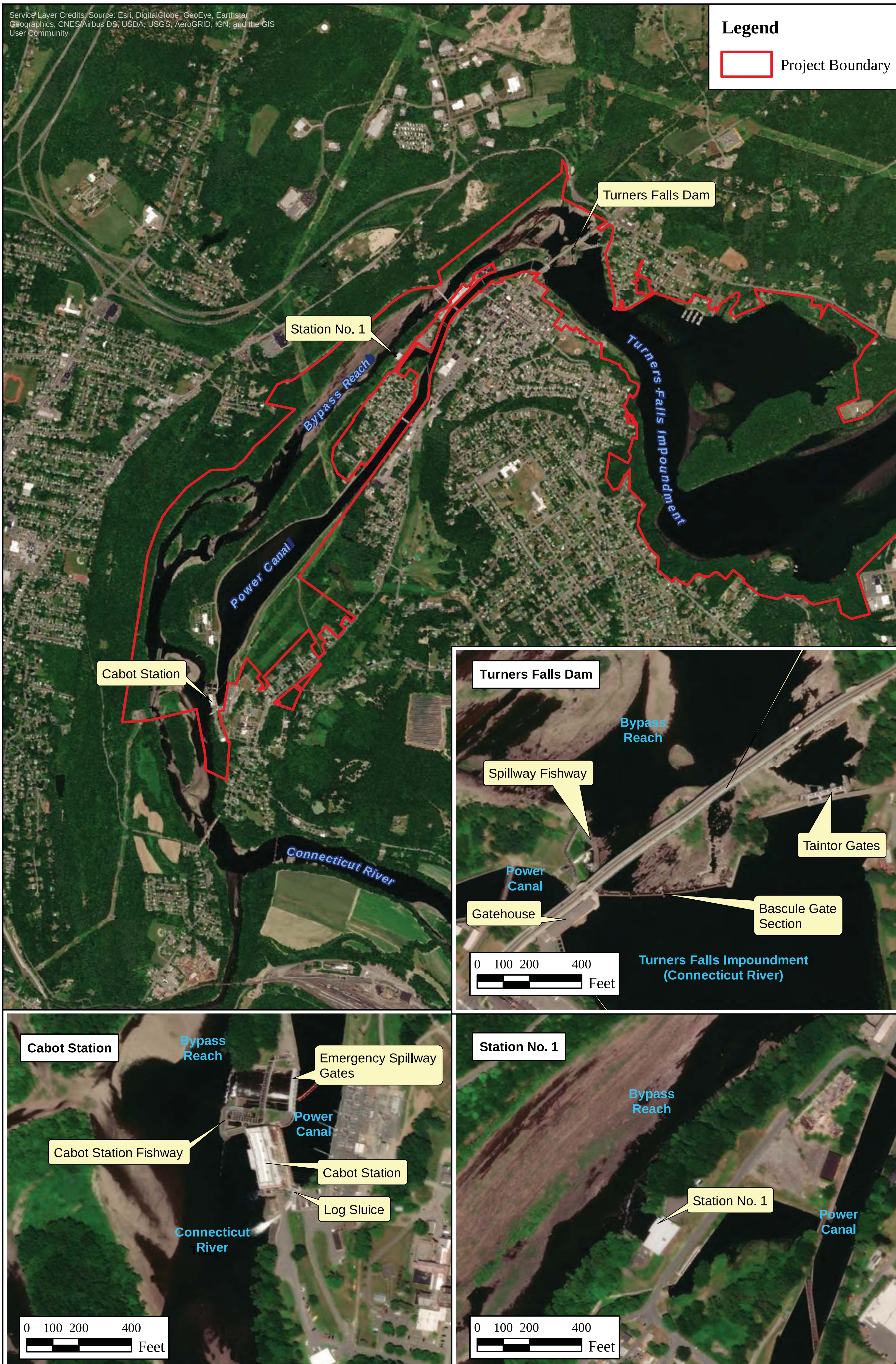

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

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0 0.125 0.25 0.5
Miles

Figure 2.1.1-1
Turners Falls Project Features

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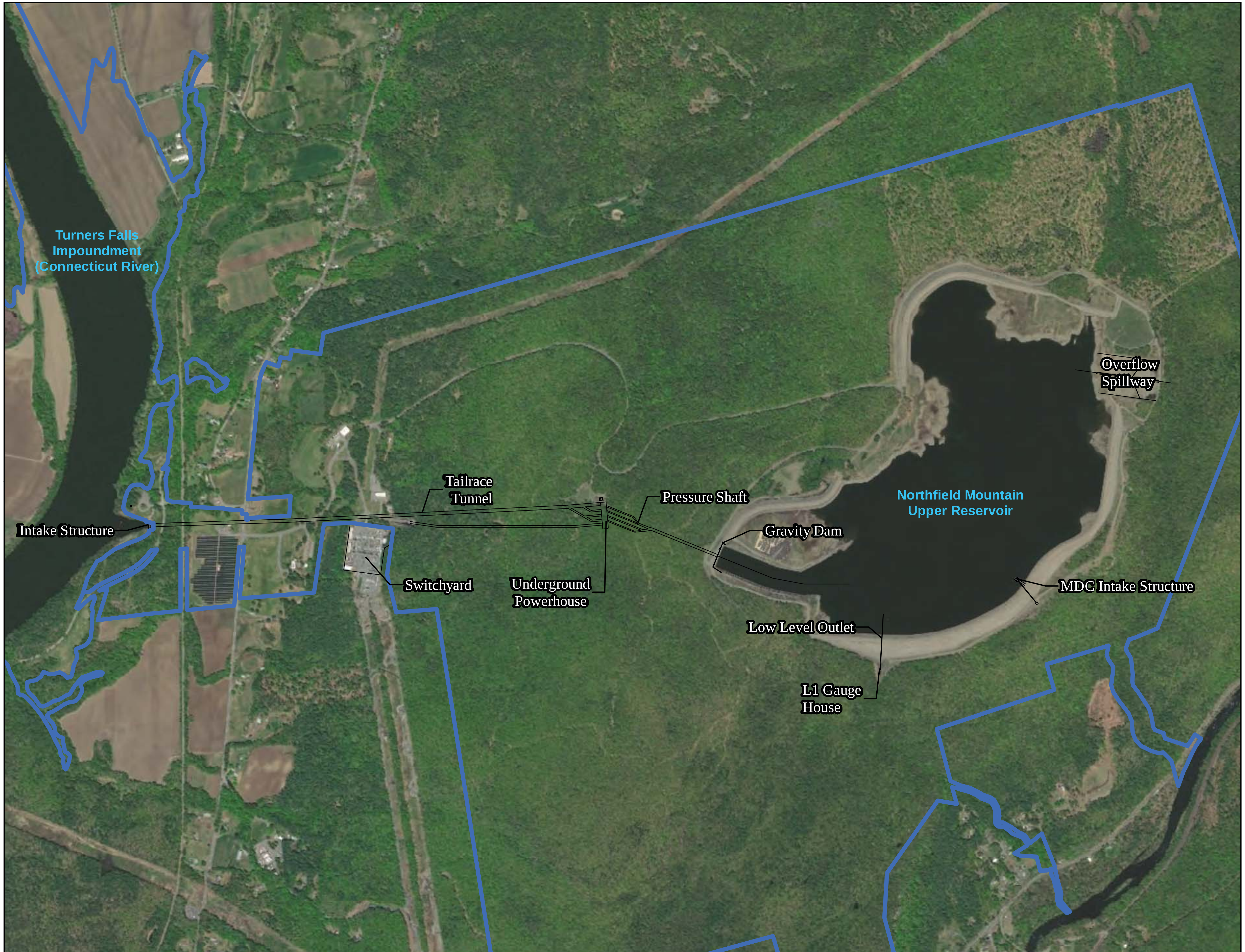

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

Figure 2.1.2-1
Northfield Mountain Project Features

Legend

Project Boundary

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

FirstLight

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2.2 Current Operations

2.2.1 Turners Falls Project

As noted above, the Turners Falls Project consists of two hydroelectric facilities- Cabot Station and Station No. 1. During periods when inflow is within the hydraulic range of Cabot Station, it is operated as a peaking plant; during periods of high inflow, in excess of 13,728 cfs (its approximate maximum hydraulic capacity), it operates as a base load plant. Station No. 1 is a base load plant with a hydraulic capacity of 2,210 cfs and typically operates when inflows to the TFI are less than the hydraulic capacity of a single Cabot Unit (~2,288 cfs) or when inflows exceed the hydraulic capacity of Cabot Station. Station No. 1 is manually operated, while Cabot is remotely operated. The current license requirements relative to Turners Falls Project operations are described below.

As noted above, the Turners Falls Hydro project and Milton Hilton, LLC project are also located on the canal. Milton Hilton, LLC[2] and Turners Falls Hydro[3] have indentured water rights. FirstLight currently has an agreement with each of these entities which provides that the entity will come on line when the naturally routed flow (NRF)[4] in the Connecticut River increases to 15,000 cfs (close to the combined capacity of Cabot and Station No. 1).

Under the current FERC license for the Turners Falls Project, FirstLight is required to release a continuous minimum flow of 1,433 cfs[5] or inflow, whichever is less below the Project. FirstLight typically maintains the minimum flow requirement through discharges at Cabot and/or Station No. 1.

Per the FERC license, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1, increasing to 400 cfs when fish passage starts by releasing flow through a bascule gate at the Turners Falls Dam. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to allow SNS egress through the bypass reach. The 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15.

The TFI elevation is currently licensed to fluctuate between 176.0 feet and 185.0 feet, as measured at the Turners Falls Dam. Though TFI water levels are managed at the Turners Falls Dam, generation and pumping from Northfield Mountain, and varying inflows all affect the TFI water levels.

2.2.2 Northfield Mountain Project

The Northfield Mountain Project is a pumped storage hydroelectric facility. Water is pumped from the TFI to the Upper Reservoir which has 12,318 acre-feet of useable storage available for pumped storage operations. Typically, pumping occurs during periods when energy prices are low, while generation occurs during periods when energy prices are high. Under the current FERC license, the Northfield Mountain Upper Reservoir elevation may fluctuate between 1000.5 feet and 938 feet.

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[2] A water use agreement between then Esleeck Manufacturing Company (a predecessor to Milton Hilton, LLC) and then Turners Falls Power and Electric Company (a predecessor to FirstLight) was signed in August 1928.
[3] A water exchange agreement between then Keith Paper Company (a predecessor to Eagle Creek Renewable Energy) and then Western Massachusetts Electric Company (a predecessor to FirstLight) was signed in September 1951.
[4] The naturally routed flow equals the sum of Vernon discharges plus flows recorded at USGS Gages on the Ashuelot and Millers Rivers.
[5] This equates to 0.20 cfs per square mile of drainage area at the Turners Falls Dam.

3 PROPOSED ACTION

In its Amended Final License Applications, FirstLight is proposing modifications to several components of the Projects designed to benefit various environmental and recreational resources. These include modifications to enhance conditions for SNS.

3.1 Proposed Project Facilities

3.1.1 Proposed Generation Facilities

FirstLight is not proposing any changes to existing developmental (i.e., generation) facilities at the Northfield Mountain Project.

Station No. 1 Upgrades

FirstLight is proposing changes to the Turners Falls Project, specifically, changes to Station No. 1. Station No. 1 is currently an unstaffed facility. To bring units on, an operator must visit the site. In addition, the five (5) units cannot be throttled over a range of flows, meaning each unit only discharges its maximum capacity. FirstLight is proposing to pass a portion of its proposed bypass flows via Turners Falls Dam spill and Station No. 1 discharge. By automating Station No. 1, it will allow FirstLight to a) remotely operate the units and b) operate the units over a wider range of flows (not just the maximum capacity). FirstLight proposes the following:

- For each unit, upgrading the brakes, controls, governors, grounding transformer, protective relaying, excitation system and turbine rehabilitations.
- Automation including auto synchronizing equipment and sensors to interface to the programmable logic controller (PLC).

At this time, FirstLight is not proposing to install a minimum flow turbine-generator at the Turners Falls Dam to generate with its proposed bypass flows. However, over the term of the next license FirstLight will continually evaluate the economic feasibility of adding a minimum flow turbine-generator or any other potential energy source.

3.1.2 Proposed Non-Generation Facilities

FirstLight is proposing to a) construct infrastructure necessary to pass FirstLight's proposed bypass flows in the winter, b) construct new fish passage facilities and c) construct new recreation facilities as described below.

Infrastructure Needed to Pass Winter Bypass Flows

FirstLight proposes to provide a bypass flow of 300 cfs, or inflow, whichever is less, as measured just below the Turners Falls Dam, from December 1 to March 31. There are two water conveyance structures at the Turners Falls Dam, including bascule gates and tainter gates. The tainter gates are designed to discharge flows greater than approximately 5,000 cfs. Of the four bascule gates, bascule gate no. 1 is pond following, meaning the crest of the bascule gate can be adjusted to pass a desired flow at a given TFI water level. FirstLight proposes to use this bascule gate to pass the winter flow; however, some modification to the gate is needed. Specifically, FirstLight proposes to add heaters to the gate to prevent ice build-up.

Proposed Upstream and Downstream Fish Passage Facilities

FirstLight proposes to construct various upstream and downstream fish passage facilities. Table 3.1.2-1 lists the proposed fish passage PM&E measures and the approximate number of years after license issuance they would become operational.

Table 3.1.2-1 FirstLight's Proposed PM&E Measures for Upstream and Downstream Fish Passage

Upstream or Downstream Passage	Assigned to Turners Falls Project or Northfield Mountain Project	Proposed PM&E Measure	Estimated No. of Years after License Issuance Proposed PM&E Measure becomes Operational
Upstream Passage	Turners Falls	Install Permanent Ultrasound Array in the Cabot Tailrace to deflect American Shad to the Bypass Reach	6
	Turners Falls	Construct a new Spillway Lift with Palisade Entrance at the Turners Falls Dam	6
	Turners Falls	Construct an Eelway near the Turners Falls Dam (interim passage within 1 year of license issuance, siting studies in the first year of the Spillway Lift operation, permanent eelway within 9 years of license issuance)	9
	Turners Falls	Retire Cabot Fish Ladder	6
	Turners Falls	Retire Entrance Portions of gatehouse ladder in canal	6
Downstream Passage	Northfield Mountain	Install a Barrier Net at Northfield Mountain Intake/ Tailrace to prevent entrainment (within 5 years license issuance)	5
	Turners Falls	Construct a Plunge Pool below Bascule Gate No. 1 located at the Turners Falls Dam. This work would likely be conducted at the same time as the Spillway Lift construction (Plunge pool constructed in concert with Spillway Lift, within 6 years from license issuance).	6
	Turners Falls	Construct a Bar Rack at the entrance to the Station No. 1 Forebay (within 8 years from license issuance).	8

Permanent Ultrasound Array. FirstLight proposes to install a permanent ultrasound array at the outer edge of the Cabot Station tailrace to deter upstream migrating adult American Shad from entering the tailrace area, but instead move them up the bypass reach to a new fish lift at the Turners Falls Dam (the Spillway Lift). FirstLight will install the permanent ultrasound array after the Spillway Lift is constructed. Once the ultrasound array is functioning FirstLight proposes to close the Cabot fish ladder to prevent American Shad from entering the power canal, where they may experience long delays or are never able to reach the TFI.

Construct new Spillway Lift and Plunge Pool. FirstLight proposes to construct a new Spillway Lift (with palisade entrance) and plunge pool below bascule gate no. 1 of the Turners Falls Dam. The Spillway Lift will include a single hopper that will lift fish approximately 39 feet to an exit trough that connects into the top of the existing Spillway Fish Ladder for fish to exit into the headpond through the existing gatehouse fish ladder. The lift will also utilize the existing entrance structure of the Spillway Fish Ladder for the entrance to the lift. A V-trap and brail system will be used instead of a crowder channel to capture fish in the hopper.

The plunge pool will include two concrete walls to create an approximately 110-foot-wide by 65-foot-long box below bascule gate no. 1 – one wall parallel to flow between bascule gate no. 1 and bascule gate no. 2, and one wall perpendicular to the flow from the end of the first wall to the fish lift entrance. Flow will pass from the pool either through a palisade structure adjacent to the fish lift entrance or by spilling over the downstream wall of the box. The flow from the palisade structure will also be used for attraction flow to the Spillway Lift.

Since the Spillway Lift and plunge pool are in the same location, these two projects would be constructed simultaneously.

Construct Eelway. Once all upstream and downstream fish passage structures at the Turners Falls Project are complete, FirstLight proposes to install an eelway near the Turners Falls Dam. Based on siting surveys and two temporary eelramp installations, over 90% of the elvers move upstream at the Spillway Ladder. FirstLight proposes to install an eelway at this location. The eelway will include a single tray lined with substrate for the eels to ascend on, piping providing flow through the substrate and attraction flow, and a collection tank at the tray exit.

Install Barrier Net. FirstLight proposes to install a barrier net in front of the Northfield Mountain Project intake/tailrace to prevent the entrainment of migratory fish when the Northfield Mountain Project is pumping. The net will be approximately 30-foot-high by 1050-feet-long wide with 3/4-inch mesh from top to bottom. The net will be positioned approximately in line with the river shoreline upstream and downstream of the Northfield Mountain Project tailrace. The net will be anchored at each end of the net at the shoreline with additional anchoring along the base of the net to prevent migrants from passing under the net.

FirstLight proposes to have the barrier net in place from August 1 to November 15 each year.

Construct a Bar Rack at Entrance to Station No. 1 Forebay. FirstLight proposes to install a bar rack, with ¾-inch clear spacing, at the location where flow from the main power canal is diverted into the Station No. 1 forebay. The rack will be approximately 58 feet wide across the entrance of the forebay and 21 feet tall. Approximately 4 feet of rock would be excavated from the bottom of the canal to provide sufficient area to prevent impingement. A new concrete base will be constructed below the rack for a foundation and to support diagonal bracing behind the rack. A new trash rake and conveyor for trash removal will also be installed for regular cleaning of debris from the rack.

Conceptual level drawings of the above structures, with the exception of the eelway and ultrasound array, are included in the Turners Falls Project Exhibit F (Spillway Lift, Plunge Pool, Station No. 1 Rack).

Retire Cabot Fish Ladder. Once the Spillway Fish Lift is functioning to pass fish and the ultrasound array is operational, FirstLight proposes to retire the Cabot Fish Ladder because all fish passage would be moved to the Spillway Lift. FirstLight does not believe continuing to introduce fish into the power canal where they encounter extensive delays or never reach the TFI is productive.

Retire Entrance Portion of Gatehouse Fish Ladder. The portion of the gatehouse ladder that includes the entrances on the right and left side of the canal walls will not be needed; however, the ladder will be used to move fish from the Spillway Lift into the TFI.

Conceptual level drawings of the above structures, with the exception of the eelway and ultrasound array, are included in the Turners Falls Project Exhibit F (Spillway Lift, Plunge Pool, Station No. 1 Rack) and in the Northfield Mountain Project Exhibit F (Barrier Net).

Proposed Recreation Features

Table 3.1.2-2 lists FirstLight's proposed recreation features, what Project it is assigned to, and the estimated number of years after license issuance it becomes operational. Any recreation feature located upstream of the Turner Falls Dam was assigned to the Northfield Mountain Project, which is consistent with the existing Northfield Mountain license. Any recreation feature located below the Turners Falls Dam was assigned to the Turners Falls Project.

Table 3.1.2-2 FirstLight's Proposed PM&E Measures for Recreation

Proposed PM&E Measure	Assigned to Turners Fall Project or Northfield Mountain Project	Estimated No. of Years after License Issuance Proposed PM&E Measure becomes Operational
At Riverview, relocate the existing Boat Tour Dock given that it would be enclosed by the proposed Barrier Net (within 4 years of license issuance)	Northfield Mountain	4
Create a new access trail with stairs for a put-in at Riverview (within 4 years of license issuance)	Northfield Mountain	4
Create a formal access trail for a put-in at Cabot Camp (within 4 years of license issuance)	Northfield Mountain	4
Create a formal access trail for a put-in just below the Turners Falls Dam (within 4 years of license issuance)	Turners Falls	4
Create a formal trail and steps for a take-out at Poplar Street (within 4 years of license issuance)	Turners Falls	4

Create a New Access Trail with Stairs for a Put-In at Riverview. A new put-in would be located off of Pine Meadow Road, where Fourmile Brook discharges into the TFI. The site would entail establishing a 6-foot wide stone path to timber and concrete stairs leading to a put-in on the northern bank along the brook. Pine Meadow Road would be widened to add approximately seven (7) parking spots and a sign (Project Name and FERC No.) would be installed near the stone path.

Relocation of the Boat Tour Dock at Riverview. The proposed barrier net would be in place from August 1 to November 15 during a portion of the summer recreation season. The current layout of the barrier net encloses the existing Boat Tour Dock. Given this, FirstLight proposes to relocate the dock further upstream of its current location. It would entail extending the existing road further north.

Formal Access Trail and Put-In at Cabot Camp. FirstLight proposes to create a 200-foot long, 10-foot wide formal path leading from the Cabot Camp parking area to an access point on the Millers River just upstream of the confluence with the Connecticut River. There is currently an informal path in this area. A sign (Project Name and FERC No.) and directional portage sign would be installed along the formal path leading the public from the parking lot directly to the 10-foot-wide gravel path leading to the water's edge.

Formal Access Trail and Put-In just below Turners Falls Dam. Stakeholders have requested a put-in just below the Turners Falls Dam to kayak/canoe/raft the bypass reach. There is an existing informal pathway leading to the base of the Turners Falls Dam just downstream of the existing Spillway Ladder. The proposed access would be provided via the existing bridge (aka the "IP Bridge") spanning the power canal. Once over the canal, a formal 12-ft wide path would lead recreationists to the base of the dam. The path would include a sign (Project name and FERC No.) just after exiting the IP bridge, and directional signs along the formalized path.

FirstLight also proposes to establish a weblink that would report the forecasted Turners Falls Dam discharge each day during the daylight hours from July 1 to October 15 to benefit whitewater boaters. FirstLight is not proposing to post the Turners Falls Dam discharge from April 1 to June 30 because it is a period when the federally endangered SNS could be utilizing the bypass reach for spawning and incubation which could be disturbed by whitewater boaters.

Formal Access Trail and Stairs for Take-out at Poplar Street. There is an existing take-out at Poplar Street; however, it is extremely steep. FirstLight has limited options due to steep topography and land ownership. FirstLight proposes to use the existing gravel parking lot leading to 20-foot wide timber stairs with a boat slide railing leading to a 5-foot long, 20-foot wide concrete landing/abutment. A 32-foot long gangway would be anchored to the concrete abutment and lead to a floating dock in the Connecticut River to accommodate fluctuations in the river elevation. The site would include a sign (Project name and FERC No.) at the top of the timber stairs.

Conceptual level drawings of the proposed recreation features are included in Recreation Management Plans developed for the Turners Falls Project and Northfield Mountain Project.

Proposed Recreation Management Plans

FirstLight has developed separate Recreation Management Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Proposed Historic Properties Management Plans

FirstLight has developed separate Historic Properties Management Plans for the Turners Falls Project and Northfield Mountain Project.

Proposed Bald Eagle Protection Plans

FirstLight has developed separate Bald Eagle Protection Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Proposed Invasive Plant Species Management Plans

FirstLight has developed separate Invasive Plant Species Management Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Sediment Management Plan

FirstLight previously filed with FERC on June 30, 2017 a Sediment Management Plan entitled Upper Reservoir Dewatering Protocols.

Northern Long-Eared Bat Protection Measures

The Licensee will implement the following measures to protect Northern Long-Eared Bat habitat: (1) avoid cutting trees equal to or greater than 3 inches in diameter at breast height within the project boundary from April 1 through October 31, unless they pose an immediate threat to human life or property; and (2) where trees need to be removed, only remove trees between November 1 and March 31.

3.2 Proposed Project Boundary

FirstLight is proposing changes to each Project Boundary as summarized below.

<u>Turners Falls Project and Northfield Mountain Project Overlapping Project Boundary Changes</u>

- The removal of a 0.2 acre parcel of land at 39 Riverview Drive in Gill, MA. These lands are owned by FirstLight but are not needed for Project operations or any other Project purpose. None of the lands FirstLight proposes to exclude from the Project boundaries contains historic properties eligible or potentially eligible for the National Register of Historic Places.

<u>Northfield Mountain Project Boundary Changes</u>

- The removal of an 8.1 acre parcel of land referred to as Fuller Farm located near 169 Millers Falls Road in Northfield, MA. These lands are not needed for Project operations or any other Project purpose.

- The addition of 135.5 acres[6] of land south of the Northfield Switching Station located in the Towns of Northfield and Erving in Massachusetts. Some of these lands are currently owned by Eversource and are necessary to include recreation trails associated with the Northfield Mountain Trail and Tour Center that are not currently enclosed in the Project Boundary.

<u>Turners Falls Project Boundary Changes</u>

- The removal of a 20.1 acre parcel of land currently occupied by the United States Geological Survey's (USGS) Silvio Conte Anadromous Fish Laboratory located at One Migratory Way, P.O Box 796, in Turners Falls, MA 01376. The Conte Lab lands are located just north of Cabot Station. These lands are not needed for Project operations or any other Project purpose.

- The addition of an 0.8 acre parcel of land owned by FirstLight at 21 Poplar Street (end of the street) in Montague, MA. These lands are needed for recreational purposes (take-out or put-in).

3.3 Proposed Project Safety

FirstLight anticipates that, as part of the relicensing process, FERC staff will evaluate the continued safety of the proposed Project facilities under the new license. FirstLight anticipates FERC will continue to inspect the Project during the new license term to assure continued adherence to FERC-approved plans and specifications, any special license articles pertaining to construction, operation and maintenance, and accepted engineering practices and procedures.

3.4 Proposed Project Operations

FirstLight proposes several operational changes as summarized in Section 3.5.

3.5 Proposed Environmental Measures

FirstLight proposes the following draft license articles relative to operations.

[6] Of the 135.5 acres, 12.5 acres is owned by FirstLight, while the remaining 122 acres is owned by Eversource.

Operational Regime

(a) The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with the following operational flow regime until the third (3rd) anniversary of the effective date of the new license.

Date	Total Bypass Flow[2]	Turners Falls Dam	[3]Station No. 1
01/01-03/31	1,500 cfs or the Naturally Routed Flow (NRF), whichever is less	300 cfs	1,200 cfs[4]
04/01-05-31[1]	6,500 cfs or the NRF, whichever is less	4,290 cfs	2,210 cfs[4]
06/01-06/15[1]	4,500 cfs or the NRF, whichever is less	2,990 cfs	1,510 cfs[4]
06/16-06/30[1]	3,500 cfs or the NRF, whichever is less	2,280 cfs	1,220 cfs[4]
07/01-08/31	1,800 cfs or the NRF, whichever is less	670 cfs	1,130 cfs[4]
09/01-11/30	1,500 cfs or the NRF, whichever is less	500 cfs	1,000 cfs[4]
12/01-12/31	1,500 cfs or the NRF, whichever is less	300 cfs	1,200 cfs[4]

[1]The flow split during these periods is approximately 67% from the Turners Falls Dam and 33% from Station No. 1. If FirstLight conducts further testing, in consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS) and Massachusetts Department of Fish and Wildlife (MADFW), and determines that migratory fish are not delayed by passing a greater percentage of the bypass flow via Station No. 1, it may increase the percentage through Station No. 1 upon written concurrence of those agencies.

[2]If the NRF is less than 6,500 cfs (04/01-05/31), 4,500 cfs (06/01-06/15) or 3,500 cfs (06/16-06/30) the flow split will still be set at approximately 67% of the NRF from the Turners Falls Dam and 33% of the NRF from Station No. 1. If the NRF is less than 1,800 cfs (7/1-8/31), 1,500 cfs (9/1-11/30), or 1,500 cfs (12/1-3/31), the Licensee shall maintain the Turners Falls Dam discharges at 670 cfs, 500, cfs, and 300 cfs, respectively.

[3]To maintain the flow split, Station No. 1 must be automated, which will not occur until Year 3 of the license. FirstLight proposes to maintain the flow split such that the Turners Falls Dam discharge will be as shown above, or higher flows will be spilled, in cases where the additional flow cannot be passed through Station No. 1.

[4]The Turners Falls Hydro (TFH) project (FERC No. 2622) and Milton Hilton, LLC project (unlicensed) are located on the power canal and discharge into the bypass reach upstream of Station No. 1. The hydraulic capacity of the TFH project and Milton Hilton, LLC project is 289 and 113 cfs, respectively. If the TFH project is operating, FirstLight will reduce its Station No. 1 discharge by 289 cfs. If the Milton Hilton, LLC project is operating, FirstLight will reduce its Station No. 1 discharge by 113 cfs.

(b) Maintain a continuous minimum flow below Cabot Station of 6,800 cfs from 6/1-6/15 and 5,800 cfs from 6/16-6/30 or the NRF, whichever is less.

The bypass flows and minimum flow below Cabot may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS, Massachusetts Department of Environmental Protection (MADEP) and MADFW.

(c) The NRF represents the inflow to the Turners Falls Dam. The NRF is defined as the sum of the Vernon Hydroelectric Project (FERC No. 1904) total discharge, Ashuelot River United States Geological Survey (USGS) gage flow and Millers River USGS gage flow.

(d) The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with the conditions in paragraph (a) and (b) and the following operational flow regime beginning on the third (3rd) anniversary of the effective date of the new license.

Date	Total Bypass Flow[2,3]	Maximum Flow below Cabot Station to Protect Puritan Tiger Beetles	Cabot Down-Ramping Rate to Protect Shortnose Sturgeon	Cabot Up-Ramping Rate to Protect Shortnose Sturgeon (4/1-5/31) and Odonates (6/1-8/15)
01/01-03/31	1,500 cfs or the NRF, whichever is less			
[1]04/01-05/31	6,500 cfs or the NRF, whichever is less		Down to 2,300 cfs/hour	Up to 2,300 cfs/hour
[1]06/01-06/15	4,500 cfs or the NRF, whichever is less			Up to 2,300 cfs/hr from 8:00 am to 2:00 pm
[1]06/16-06/30	3,500 cfs or the NRF, whichever is less			Up to 2,300 cfs/hr from 8:00 am to 2:00 pm
07/01-08/15	1,800 cfs or the NRF, whichever is less	Add no more than 4,600 cfs additional flow from Cabot Station from 1 am to 2 pm		Up to 2,300 cfs/hr from 8:00 am to 2:00 pm
08/16-08/31	1,800 cfs or the NRF, whichever is less	Add no more than 4,600 cfs additional flow from Cabot Station from 1 am to 2 pm		
09/01-11/30	1,500 cfs or the NRF, whichever is less			
12/01-12/31	1,500 cfs or the NRF, whichever is less			

[1]The flow split during these periods is approximately 67% from the Turners Falls Dam and 33% from Station No. 1. If FirstLight conducts further testing, in consultation with the NMFS, USFWS and MADFW, and determines that migratory fish are not delayed by passing a greater percentage of the bypass flow via Station No. 1, it may increase the percentage through Station No. 1 upon written concurrence of those agencies.

[2]If the NRF is less than 6,500 cfs (04/01-05/31), 4,500 cfs (06/01-06/15) or 3,500 cfs (06/16-06/30) the flow split will still be set as approximately 67% of the NRF from the Turners Falls Dam and 33% of the NRF from Station No. 1. If the NRF is less than 1,800 cfs (7/1-8/31), 1,500 cfs (9/1-11/30), or 1,500 cfs (12/1-3/31), the Licensee shall maintain the Turners Falls Dam discharges at 670 cfs, 500, cfs, and 300 cfs, respectively.

[3]The Turners Falls Hydro (TFH) project (FERC No. 2622) and Milton Hilton, LLC project (unlicensed) are located on the power canal and discharge into the bypass reach upstream of Station No. 1. The hydraulic capacity of the TFH project and Milton Hilton, LLC project is 289 and 113 cfs, respectively. If the TFH project is operating, FirstLight will reduce its Station No. 1 discharge by 289 cfs. If the Milton Hilton, LLC project is operating, FirstLight will reduce its Station No. 1 discharge by 113 cfs.

FirstLight has included two timing elements in its Proposed Action to address the new operational paradigm. First, FirstLight is proposing a three (3) year transition period in which it will institute new minimum flows in paragraph (a) and (b), as a license condition, and also put processes in place with GRH and ISO-NE to assure success in meeting its obligations for Cabot Station up and down ramping as well as Cabot Station peak demand flow restrictions. In addition, Station No. 1 upgrades will be completed during this period. In Year 4 of the new license, FirstLight will be responsible, as a license condition, for the full suite of flow enhancements shown in paragraphs (a), (b) and (d) (i.e. Cabot Station up and down ramping, Cabot Station peak demand flow restrictions).

In addition, and in an attempt to meet its obligations for delivering reliable power and capacity, FirstLight is also proposing exceptions where it can deviate from its Cabot Station up and down ramping and peak demand flow requirements for a finite period of time as described in (e) below if required to meet either its flood operations (or similar public safety obligation) or ISO-NE obligations, as well as due to unforeseen river conditions from the Vernon Project.

(e) If compliance with the prescribed operating limits (defined as Maximum Flow below Cabot Station, Cabot Down-Ramping Rate and Cabot Up-Ramping Rate which are shown as the last three columns in the table in paragraph (d)) would cause the Licensee to violate or breach any law, any applicable license, permit, approval, consent, exemption or authorization from a federal, state, or local governmental authority, any agreement with a governmental entity, or any tariff, capacity rating requirement, ramping criterion, or other requirement of the ISO-NE or its successors (ISO-NE), Licensee may deviate from the prescribed operating limitations to the least degree necessary in order to avoid such violation or breach. In addition, Licensee may deviate from the operating limits for the following reasons:

- To perform demonstrations of the resources' operating capabilities under ISO-NE rules and procedures. Licensee will use best efforts to be allowed by ISO-NE to perform these demonstrations at times that will not cause it to deviate from the operating limits.
- To manage the Turners Falls Impoundment within license limits following unexpected, significant increases or decreases in the NRF.
- To support the needs of ISO-NE grid operations by operating when called upon by the ISO-NE.
- If compliance with the prescribed operating limitations would cause a public safety hazard or prevent timely rescue.

With the exception of public safety, the Licensee agrees that under no conditions shall the four exceptions identified above occur in more than 10% of the hours each year that the limitations apply, without the written concurrence of the USFWS, NMFS, MADFW and MADEP.

The Licensee shall document on an hourly basis for each day any deviations from the Maximum Flow below Cabot Station, Cabot Down-Ramping Rate and Cabot Up-Ramping Rate restrictions. Each day, any deviations would be summed and at the end of each month between April 1 and August 31, the Licensee shall document the total number of deviations and provide the information to USFWS, NMFS, MADFW and MADEP on a monthly basis.

(f) Cabot Emergency Gate Use. The Licensee shall use the Cabot Emergency Gates under the following conditions: a) in case of a Cabot load rejection[7], b) in the case of dam safety issues such as potential canal overtopping or partial breach, and c) to discharge approximately 500 cfs between April 1 and June 15 for debris management. The Licensee shall avoid discharging higher flows through the gates from April 1 to June 15 whenever possible; however, if necessary, the Licensee shall coordinate with NMFS to minimize potential impact to SNS in the area below Cabot Station.

[7] A load rejection is when the Cabot Stations units are suddenly shut off. If this were to occur, the canal could potentially be overtopped. To prevent overtopping, the Cabot Emergency Gates open so that incoming flow down the power canal can be discharged via the Cabot Emergency Gates. Load rejections could occur at any time.

(g) Flood Flow Operations. The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with its existing agreement with the United States Army Corp of Engineers (USACOE). This agreement, memorialized in the *Reservoir and River Flow Management Procedures* (1976), as it may be amended from time to time, governs how the Turners Falls Project shall operate during flood conditions and coordinate its operations with the Licensee of the Northfield Mountain Pumped Storage Project (FERC No. 2485).

Turners Falls Impoundment Water Level Management

(a) The Licensee shall operate the TFI, as measured at the Turners Falls Dam, between elevation 176.0 feet and 185.0 feet NGVD29.

(b) The Licensee shall limit the rate of rise of the TFI water level, as measured at the Turners Falls Dam, to be less than 0.9 feet/hour from May 15 to August 15 between the hours of 8:00 am and 2:00 pm for the protection of odonates.

(c) The rate of rise of the TFI may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS and MADFW.

Whitewater Boating Flows

(a) The Licensee shall provide whitewater boating releases in accordance with the schedule below, or the NRF, whichever is less, from the Turners Falls Dam. The Licensee shall maintain the following whitewater release schedule. FirstLight will provide an annual schedule of releases on its website, for the period July-October by May 31 of each year.

Date	Turners Falls Dam Magnitude of Discharge	Turners Falls Dam Release Duration
1 Saturday in July	2,500 cfs or the NRF, whichever is less	4 hours
1 Saturday in August	2,500 cfs or the NRF, whichever is less	4 hours
3 Saturdays in September	3,500 cfs or the NRF, whichever is less	4 hours
1 Saturday in October	3,500 cfs or the NRF, whichever is less	4 hours
2 Saturdays in October	5,000 cfs or the NRF, whichever is less	4 hours

(b) The whitewater boating flows may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS and MADFW.

Northfield Mountain Upper Reservoir

(a) The Licensee shall operate the Northfield Mountain Pumped Storage Project Upper Reservoir between elevation 1004.5 and 920 feet NGVD29.

4 ACTION AREA

For purposes of this BA, action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

4.1 Geographic Area of Project Effects

Project elements of the Proposed Action include construction, maintenance, and operations. Each is defined below, and their geographic area of effect is identified based on features in Figure 4.1-1.

4.1.1 Construction

Construction will be limited to the Protection, Mitigation, and Enhancement (PM&E) measures proposed at the Projects. All proposed construction will be confined to specific areas within the Project boundaries (Figure 4.1-1).

4.1.2 Maintenance

Maintenance of Project facilities and lands will be limited to areas within the Project boundaries (Figure 4.1-1).

4.1.3 Operations

Project hydropower operations affect the Connecticut River corridor for approximately 57 river miles from Vernon Dam to Holyoke Dam (Figure 4.1-1; Table 4.1.3-1). The TFI water levels are affected by pumping and generation at the Northfield Mountain Project, along with operations at the Turners Falls Project. River flows from upstream, along with pumping and generation from the Northfield Mountain Project, can determine the amount of flow passed through the Turners Falls Project. Outflows through the Turners Falls Project affect flows and water levels in the Connecticut River from Turners Falls Dam to Holyoke Dam, but only when the river flows are below the combined hydraulic capacity of the Turners Falls Project and its minimum spill flow. Flows higher than 15,938 cfs, plus the minimum bypass flow at the time, results in additional spill over the dam, along with full generation at the Project.

Table 4.1.3-1: River Miles of Major Project Features

Location	River Mile
Vernon Dam*	142.1
Northfield Mountain Tailrace	127.3
Turners Falls Dam	122.2
Station No. 1	121.1
Cabot Station	119.3
Lower End of Turners Falls Project Boundary	119.0
Holyoke Dam*	85.5

**Vernon Dam and Holyoke Dam are not Project features but are included because they are considered the upstream and downstream extents, respectively, of the operational project element for the Northfield Mountain and Turners Falls Projects.*

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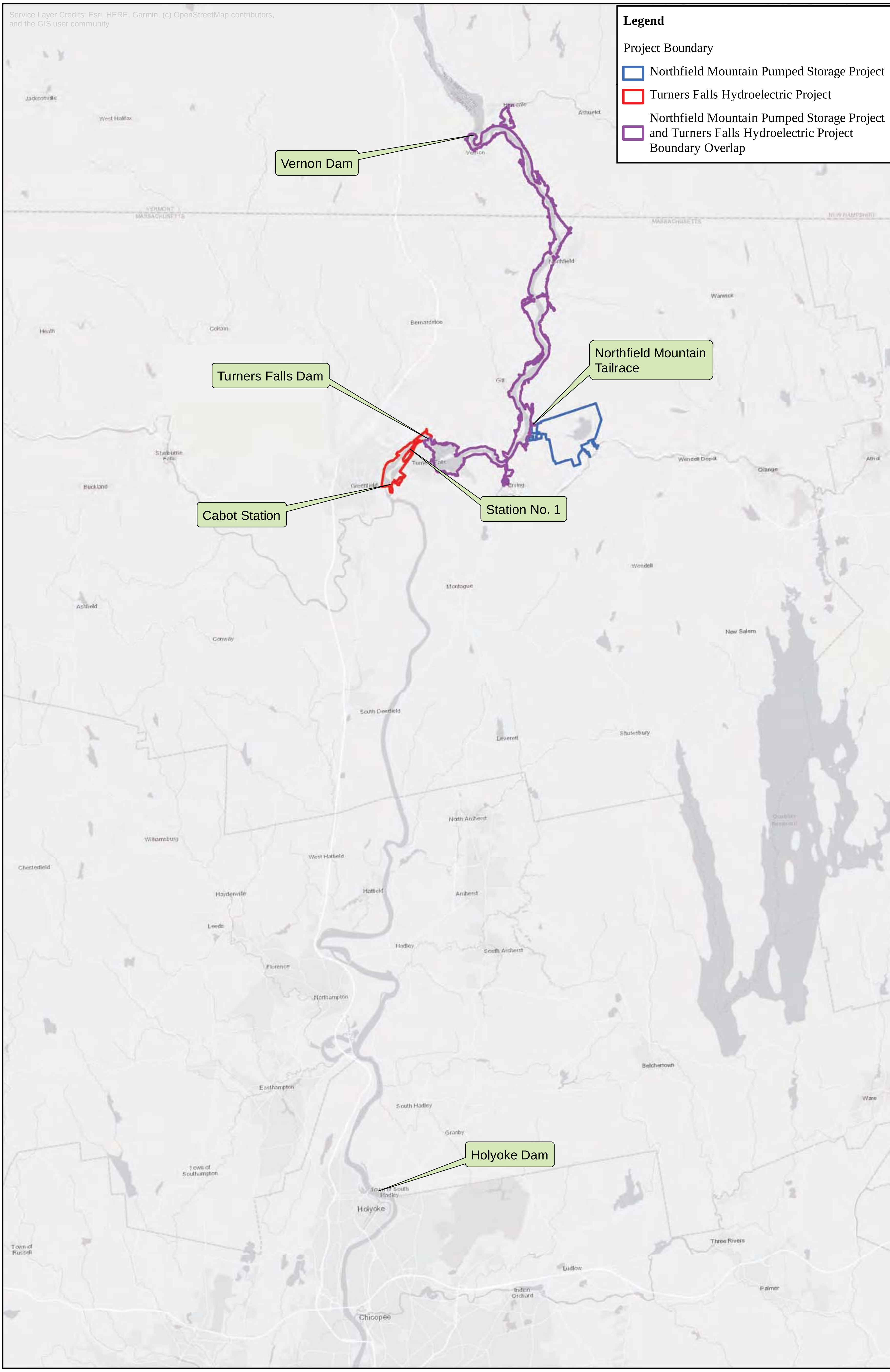

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

N

0 2.5 5 10 Miles

Figure 4.1-1
Geographic Area of Project Effects Map

Path: W:\gis\maps\SNS BA\Action Area.mxd

4.2 Affected Environment

The historical limit of SNS in the Connecticut River is at Turners Falls (river mile 122.2) (NMFS, 1998). They are known to seasonally inhabit all areas in the Connecticut River from Turners Falls Dam to the river mouth but flows within the hydraulic capacity of the Turners Falls Project are modified by operations at Holyoke Dam. Therefore, the affected environment, as it pertains to the effects of the Turners Falls Project and Northfield Mountain Project on SNS, includes areas of the Connecticut River below the Turners Falls Project from the Turners Falls Dam to the Holyoke Dam (Figure 4.2-1). Within the affected environment are areas that various life stages of SNS use during different times of the year for all necessary life history activities (see Section 5.4).

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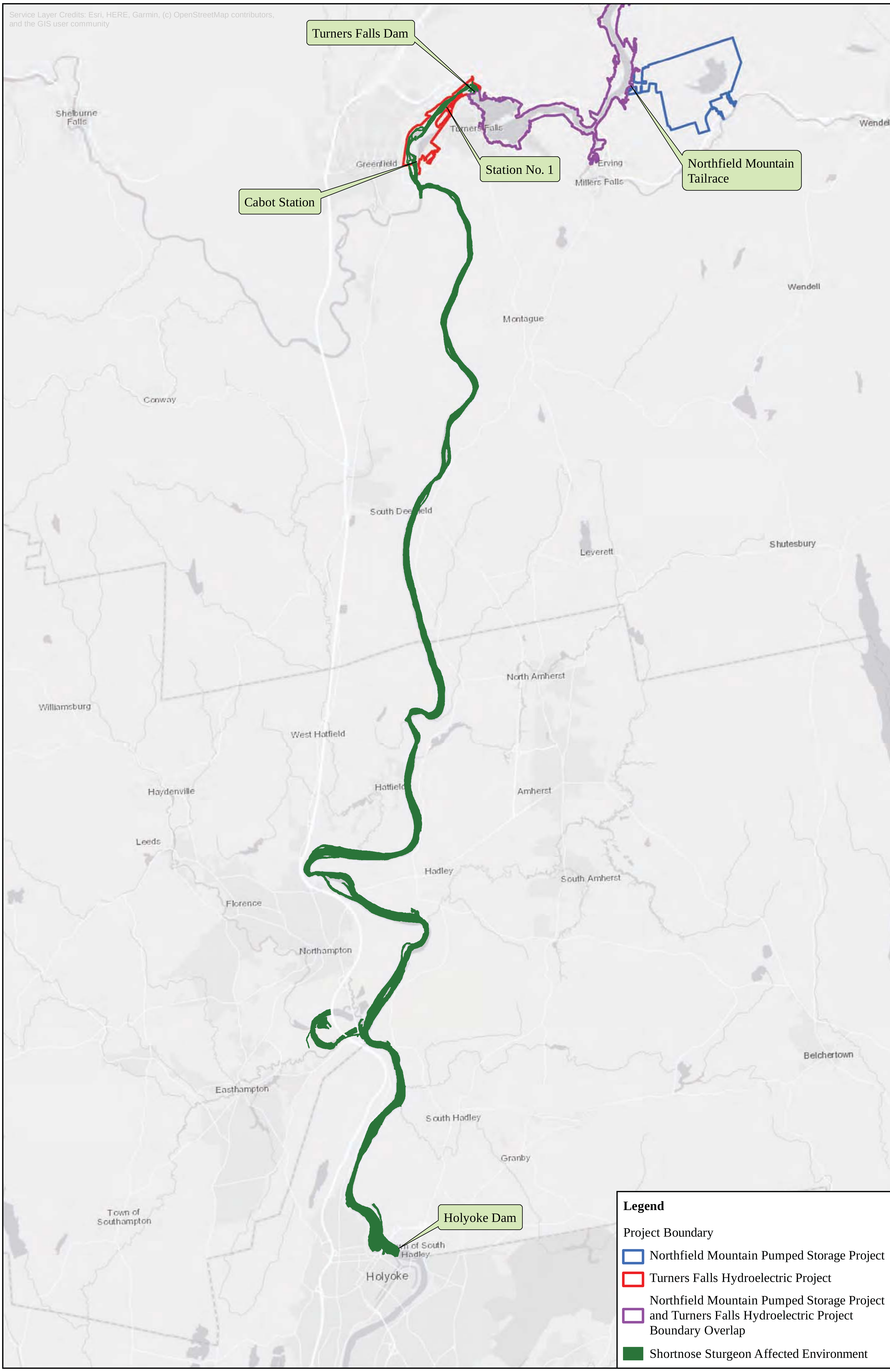

FirstLight

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

N

0 2 4 8 Miles

Figure 4.2-1
Affected Environment

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5 STATUS OF AFFECTED SPECIES

SNS were listed as endangered in 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. SNS are thought to have been abundant in nearly every large river along the East Coast prior to the 1880s. Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. The species remains listed as endangered throughout its range. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken; therefore, the species remains listed as a single entity throughout its range. No critical habitat has been designated for SNS.

5.1 Rangewide Threats to Shortnose Sturgeon Recovery

SNS occupy a variety of habitats at various points in their life including rivers, estuaries, bays, and coastal marine waters. Habitat alterations potentially affecting SNS include loss of access to historical habitat, loss of and alteration of spawning habitat, poor water quality and changes to water flow, substrate alteration, siltation and contamination. Some important aspects of habitat quality, especially water quality, have improved in many portions of their range during the last 30 years.

SNS throughout their range are exposed to a variety of habitat stressors from anthropogenic activities including obstructed or restricted access to riverine habitat; perturbations of habitat from dredging and construction and degraded habitat and water quality which may result in water quality standards that are below fish health standards and tissue contamination (SSSRT, 2010; NMFS, 1998). There are also potential emerging threats from new technologies (such as tidal turbines) and the consequences of climate change (NMFS, 2017, SSSRT, 2010, NMFS, 1998).

5.2 Population Status and Trends of Shortnose Sturgeon

5.2.1 Rangewide

There is no current rangewide population estimate for SNS. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT, 2010). There are 19 documented populations of SNS ranging from the St. Johns River, Florida to the Saint John River in New Brunswick, Canada. Recent developments in genetic research as well as differences in life history support the grouping of SNS into five genetically distinct groups, all of which have unique geographic adaptations (SSSRT, 2010). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is some migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g. Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (see Walsh *et al.* 2001; Grunwald *et al.* 2002; Waldman *et al.* 2002; Wirgin *et al.* 2005). Indirect gene flow estimates from mitochondrial deoxyribonucleic acid (mtDNA) indicate an effective migration rate of less than two individuals per generation. This means that while individual SNS may move between rivers, very few SNS are spawning outside their natal river. In the northern portion of their range in the United States, SNS are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson and Delaware Rivers.

5.2.2 Connecticut River

According to Kynard et al., (2016), 28,000 adult SNS would be predicted to reside in the Connecticut River based on a range-wide analysis of relatively recent populations. This number was derived from a significant relationship documented among rivers, where SNS abundance was positively correlated with the upstream spawning distance from the river mouth. The number of adults estimated almost two decades ago is on the order of approximately 2,000 individuals (Savoy, 2004; Kynard *et al*., 2016). Holyoke Gas and Electric (HG&E) is currently working cooperatively with NMFS, and researchers Micah Kieffer and Tom Savoy, to develop a new SNS population estimate for the Connecticut River

The current abundance and distribution of SNS in the Connecticut River are largely artifacts of the long-term presence of Holyoke Dam (Kynard *et al*., 2012). Prior to construction of dams in the lower portions of the Connecticut River, SNS migrated upstream from the lower river to spawn in areas near Great Falls, the current location of the Turners Falls Dam. Construction of the Holyoke Dam divided the population, isolating a portion of the population upstream of the dam, within the action area. Recent fish passage efforts at Holyoke Dam have resulted in greater passage of SNS to areas upstream of Holyoke Dam as well as improved downstream passage. Pre-spawn SNS remaining downstream of Holyoke Dam do not complete their migration to the historical spawning areas near Montague, and few fish have been documented spawning in what appears to be suitable habitat below Holyoke Dam (Kynard *et al*., 2016). However, during ichthyoplankton sampling in the Connecticut River during 2005 and 2006, three SNS larvae were captured downstream of Holyoke Dam (1 in 2005 and 2 in 2006; Kleinschmidt, 2006, 2007; SSSRT, 2010). Several studies have documented downstream dispersal of SNS in the Connecticut River (i.e. Kynard and Horgan, 2002; Taubert, 1980), and results of these studies would suggest that larvae spawned at Montague would not likely be in the migratory phase long enough to pass downstream of Holyoke Dam. One interpretation of these larval captures and available larval dispersal information is that significant spawning occurs downstream of Holyoke Dam, perhaps at several sites (SSSRT, 2010). The low numbers of larvae captured downstream of Holyoke in 2005 and 2006 were consistent with the low numbers of larvae captured at the Montague site during the same years: 0 in 2005 (346,660 m^3 of water sampled) and 4 eggs in 2006 (106,689 m^3 of water sampled; Kynard et al. 2012). Because spawning success at Holyoke appeared to reflect success at Montague during the same years (Kynard *et al.*, 2012), few eggs and larvae may have been available downstream of Holyoke Dam during the 2005 and 2006 sampling, resulting in the low number of captures. In addition, nets towed at mid-column that captured the three larvae below Holyoke totaled only 100 m^3 of water sampled, a very small amount of effort to have captured larvae dispersed over a long distance, suggesting increased sampling may have resulted in higher captures. The State of Connecticut is currently undertaking a number of studies of SNS below the Holyoke Dam including investigations of potential spawning locations. The contribution of any spawning below the Holyoke Dam to the Connecticut River population of SNS is currently unknown.

Of the total Connecticut River population, approximately 328 adult SNS were residing upstream of Holyoke Dam based on captures and tagging from 1990-2005 (B. Kynard, USGS, unpubl. data in SSSRT, 2010). Abundance of pre-spawning adult SNS in this area was estimated at 142.5 individuals each spring between 1994 and 2001 (Kynard *et al.*, 2012). SNS passed upstream at Holyoke in recent years (n = 193 since 2017) may contribute to the spawning population.

The most recent population estimate for SNS adults below Holyoke Dam found that the population was between 1,054 and 2,671 fish depending on the mark-recapture population statistic used (Savoy, 2004). Further, this portion of the population was showing an increasing trend from 1989 through 2002, and Savoy (2004) stated that this could have resulted from significant improvements in water quality and decreases in commercial fishing effort in the Connecticut River. The fish handled during the studies of the downstream population were relatively robust, and this portion of the population does not appear to be food-limited (Savoy, 2004). By comparison, male SNS upstream of Holyoke Dam grow slower than those downstream (Kynard *et al*., 2012), possibly due to some type of foraging or nutrient/mineral limitation. However, female SNS upstream of Holyoke Dam do not appear to exhibit the same growth limitation, possibly due to different foraging strategies between females and males that have not yet been identified (Kynard *et al*., 2012).

There was no information found on the portion of the population that would include juvenile SNS in the Connecticut River.

5.2.3 Action Area

There is a more robust (greater number and fitness) population of adult SNS downstream of Holyoke Dam. The portion of the population between Holyoke Dam and Turners Falls Dam is considered to be within the action area.

5.3 Shortnose Sturgeon Life History

SNS are an anadromous species, but their degree of anadromy varies by latitude. SNS in the northern (i.e. Bay of Fundy and Gulf of Maine) and southern rivers use habitats in saltwater, and near the saltwater/freshwater interface more extensively than populations of rivers in between (Kynard *et al*., 2016). This has been termed "amphidromous", whereby SNS move between fresh and saltwater at some point during their life, but not only for spawning. This is slightly different from classical anadromy, for which there are more clear distinctions on fresh and saltwater habitat uses.

5.3.1 Growth, Maturity, Fecundity, and Mortality Rates

SNS have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because SNS in southern rivers grow faster than those in northern rivers, SNS mature at younger ages in southern rivers (Dadswell et al. 1984). SNS are long-lived (30-40 years) and, with the oldest known female reaching 67 years of age and the oldest known male reaching 32 years. In the northern portion of their range, which includes the Connecticut River population, males reach maturity at five (5) to 10 years, while females mature between seven (7) and 13 years. Based on limited data, females spawn every three (3) to five (5) years while males spawn approximately every two (2) years. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell *et al*., 1984).

Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse *et al*., 1987; Crowder *et al*., 1994; Crouse, 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell, 1979), Upper Connecticut River (Holyoke Dam to Turners Falls Dam) (0.12; Taubert, 1980), and Pee Dee-Winyah River (0.08-0.12; Dadswell *et al*., 1984). Total instantaneous natural mortality (M) for SNS in the Lower Connecticut River (river mouth to Holyoke Dam) was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, *personal communication*). There is no recruitment information available for SNS because there are no commercial fisheries for the species. Estimates of annual egg production are difficult to calculate because females do not spawn every year (Dadswell *et al*., 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS, 1998). Thus, annual egg production is likely to vary greatly in this species.

5.3.2 Use of Riverine and Estuarine Environments

Much of the information for SNS is from riverine and estuarine environments, where they have been studied extensively throughout their range. Though they are known to make coastal migrations between rivers, much of the life of SNS is spent in riverine and estuarine habitats.

5.3.2.1 Spawning and Early Life Stages

SNS throughout their range typically spawn at water temperatures of 9–15°C (Dadswell, 1979, Kynard, 1997). The spawning period is estimated to last from a few days up to 30 days (SSSRT, 2010). Within a given river, SNS have been documented spawning at discrete sites within different rivers, returning to the same areas over multiple spawning events (Kieffer and Kynard, 1993; Kynard et al., 2012; Squiers *et al*., 1982). Spawning occurs in freshwater over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al*., 1984; NMFS, 1998). During spawning, individual females deposit eggs in batches over the course of 20 or more hours, moving relatively short distances during this time (Kynard et al., 2012). The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid-to-late spring (northern rivers) when the freshwater temperatures increase to 8-9°C. Eggs are 3-3.5mm in diameter, are negatively buoyant, and become adhesive once they are immersed in water (Dadswell, 1979; Dadswell *et al*., 1984; Kynard, 1997). They do not tend to drift far from the spawning locations and enlarge after adhesion to the substrate (Kynard, 1997; Kynard *et al*., 2012). Development of fertilized eggs is correlated with water temperature. In one study, SNS hatched after just 8 days in water temperatures of 17°C (Buckley and Kynard, 1981).

Upon hatching, SNS are blackish-colored and 7-11 mm long (Buckley and Kynard, 1981). Yolk-sac larvae are capable of only "swim-up and drift" swimming behavior and are ill-equipped to survive as free-swimming individuals in the open river (SSSRT, 2010). Yolk-sac larvae are known to form aggregations with other larvae in concealment (SSSRT, 2010). Sheltering in dark substrate (i.e. in the interstitial spaces between rocks/cobble at the spawning site) may enhance survival during this life stage by avoiding predators (SSSRT, 2010). Eggs and yolk-sac larvae may be concentrated near the spawning area for up to four (4) weeks post-spawning. In 9-12 days, the yolk sac is absorbed and the SNS develop into larvae which are about 15 mm long (Buckley and Kynard, 1981).

SNS larvae are believed to begin downstream migrations at about 20 mm total length (TL). Laboratory studies suggest that young SNS move downstream in a 2-step migration: a 2 to 3-day downstream migration by larvae followed by a residency period by young of the year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard, 1997). Little is known about YOY behavior and movements in the wild but SNS at this age are believed to remain in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell et al., 1984, Kynard, 1997). Foraging of YOY and yearling SNS appears to be somewhat adaptive, with consumed food items changing with the abundance of available prey that are both drifting and residing in the benthos (Carlson and Simpson, 1987). The most important food items documented on the Hudson River were midges and amphipods, and based on diet, young SNS likely prefer to forage over substrates exhibiting high production of benthic invertebrates such as sandy mud (Carlson and Simpson, 1987).

5.3.2.2 Juvenile and Adult Habitat Uses and Movements

SNS have been documented using a wide range of depths. A minimum depth of 0.6 m (1.9 feet) is necessary for the unimpeded swimming by adults (SSSRT, 2010). SNS are known to occur at depths of up to 30 m (98 feet) but are generally found in waters less than 20 m (66 feet) (Dadswell *et al*., 1984). SNS have also demonstrated tolerance to a wide range of salinities (SSSRT, 2010).

In most rivers, juvenile SNS that are over one year old join adults and show similar patterns of habitat use (Kynard, 1997). Above Holyoke Dam on the Connecticut River, where some juveniles and adults continuously reside in freshwater, there was no habitat segregation by age as both adults and juveniles used the same river reaches (Savoy 1991, Seibel, 1991). In the southeast, juveniles age one and older make seasonal migrations like adults, moving upriver during warmer months where they shelter in deep holes, before returning to the fresh/saltwater interface when temperatures cool (SSSRT, 2010). Conversely, juveniles of this age in the Saint John River, Canada, preferred different habitat than adults. Dadswell (1979) reported juveniles prefer freshwater habitats until they reach about 45 cm (17.7 inches) total length or age eight.

In the northern extent of their range, SNS exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8°C, pre-spawning SNS move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. SNS spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats.

Adult SNS typically leave the spawning grounds soon after spawning to forage. Kynard et al., (2012) documented that spent females in the Connecticut River had lost between 20–40% of pre-spawning weight from egg deposition; males lost between 5–7% of pre-spawning weight. Dadswell (1979) documented both males and females actively feed immediately after spawning. Because substrate type strongly affects composition of benthic prey, both juvenile and adult SNS primarily forage over sandy-mud bottoms, which support benthic invertebrates (Kynard, 1997). They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley, 1963; Dadswell, 1979). Foraging in the colder rivers in the northern part of their range appears to cease during winter months when SNS become inactive.

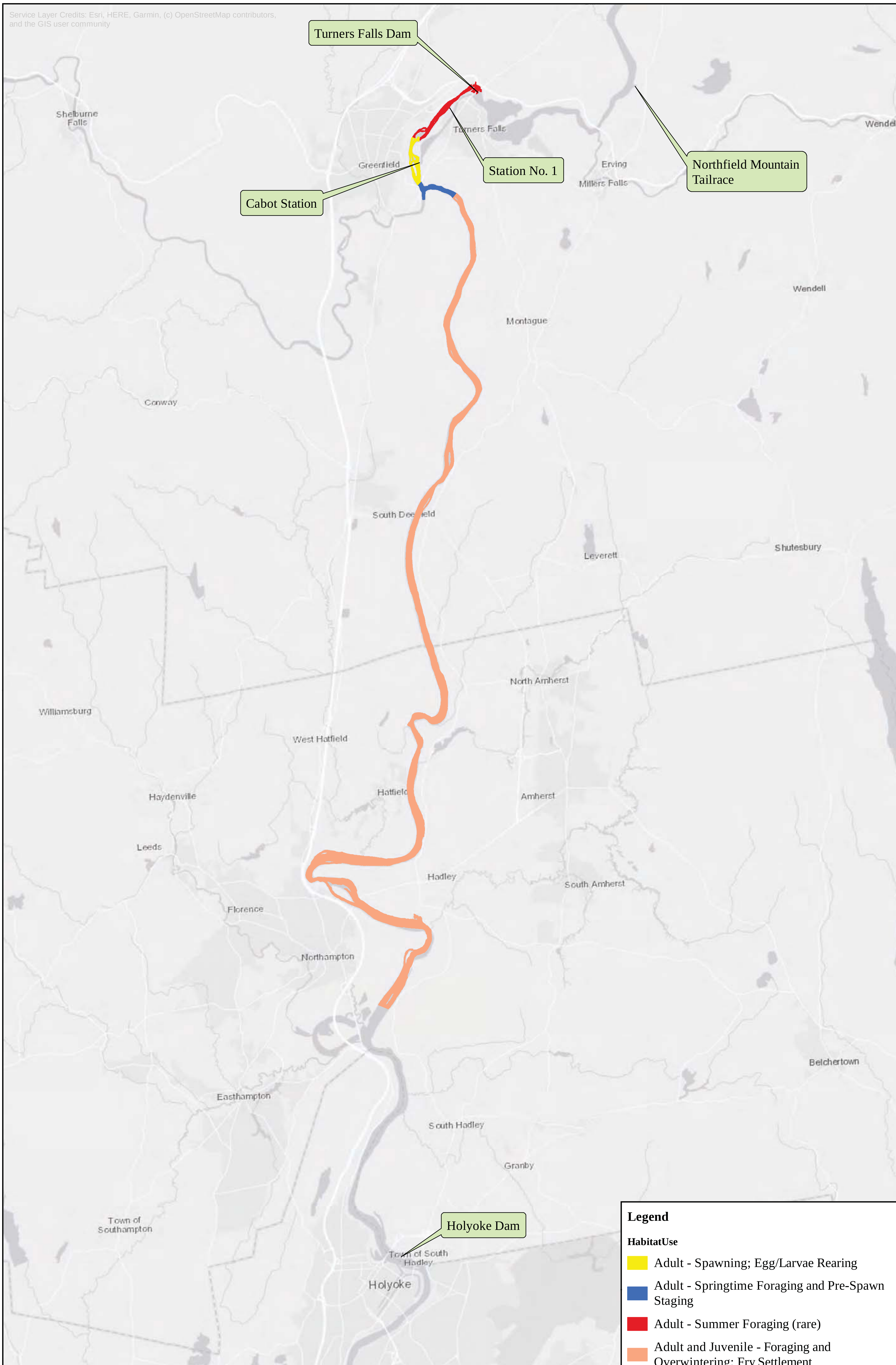
During the winter, both juveniles and adults form dense aggregations in relatively deep river segments (3-10m) in northern populations (Kynard et al., 2012). Kynard et al., (2012) examined habitat data and discovered that the quality of wintering areas differs. Wintering sites appear to be entirely in freshwater in the Merrimack River (Kieffer and Kynard, 1993), Connecticut River (Buckley and Kynard, 1985a, T. Savoy CTDEEP, pers. comm., Kynard et al., 2012), and Hudson River (Dovel et al., 1992). The number of wintering sites in any river was unrelated to population size and may be indicative of life history adaptations to each river system (Kynard et al., 2012).

5.3.3 Use of Coastal Environments

Movement among river systems has been documented across the entire species range, with most coastal migrants occurring in the northern portion of the range, where populations are large (Dadswell *et al*., 1984; Kynard, 1997; Kynard *et al*., 2016). They have been documented migrating in the nearshore zone along the coast and moving in complex patterns using non-natal river, coastal, and estuarine habitats (Kynard *et al*., 2016). Presumably, these movements could pertain to foraging, and migrations from larger rivers with higher abundances of SNS to smaller, surrounding coastal and non-natal river areas could be related to density-dependent factors (Kynard *et al*., 2016). For example, if abundance of SNS is high and suitable forage becomes scarcer, some individuals may migrate to more distant foraging areas outside of that river system. Additionally, some migrants are known to forage and overwinter in some rivers, but migrate to different rivers to spawn, presumably their natal river (Altenritter *et al*., 2018).

5.4 Shortnose Sturgeon Movements, Habitat Use and Current Project Effects in the Action Area

The Connecticut River SNS population, like every other SNS population, uses freshwater for spawning and rearing. However, this population primarily uses habitats within freshwater for foraging and wintering, in comparison to the northern and southern riverine populations that would utilize saltwater habitats more often (Kynard *et al*., 2016). The life history and population of SNS in the action area has been studied extensively by researchers at the Silvio O. Conte Anadromous Fish Research Laboratory (see Kynard *et al.,* 2012). Though the SNS that move downstream of Holyoke Dam are known to use estuarine habitats further downriver for foraging, those that remain in the action area only have access to freshwater habitats. SNS are known to exhibit specific life history movements and habitat use within the action area. This includes movements and activities, such as pre-spawn and spawning migrations, egg and larval development, fry dispersal, foraging, and overwintering (Figure 5.4-1). Further details on each of these activities and current Project-related effects are provided in the subsections below.



FirstLight

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

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0 2 4 8 Miles

Figure 5.4-1
Known Habitat Use by Shortnose Sturgeon in Action Area

Note: Locations are general and were derived from Kynard et al. (2012)

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5.4.1 Upstream Extent of Migration and Habitat Use

5.4.1.1 Historical Extent and Passage at Holyoke Dam

The Turners Falls Dam is the natural upstream limit of the Connecticut River SNS population (NMFS, 1998). The Holyoke Dam, which is currently the furthest-downstream dam on the river, divides the Connecticut River SNS population, and historically was a complete barrier to upstream migration until fish passage facilities were installed there. Upstream passage of SNS at Holyoke Dam from 1975 to 1999 only averaged four (4) fish per year, and SNS were not allowed to pass upstream of the dam from 1999 to 2017 until a downstream fish passage facility was built to pass downstream migrating SNS as well as other diadromous and resident species. From 2017 through 2019, a total of 193 SNS have been lifted upstream at Holyoke Dam. SNS in the action area belong to the portion of the population that appears to stay within the areas upstream of Holyoke Dam as well as that portion of the population that migrates downstream past the Holyoke Dam and returns upstream via the fishway at the Holyoke Dam.

5.4.1.2 Documented Presence/Absence in the Turners Falls Impoundment

In August 2017, an angler reported catching and releasing an adult-sized SNS below the Vernon Dam (the upper end of the TFI). This was the first documented report of a SNS being collected upstream of the Turners Falls Dam. NMFS has confirmed that although this report appears to be legitimate, they are not aware of any other documented incidents of SNS upstream of the Turners Falls Dam. Since the existence of a population of ESA listed SNS in the TFI could have implications for license conditions, FirstLight worked to proactively address this reported capture. To answer the question of whether the single capture of a SNS indicated the presence of a population in the TFI, FirstLight investigated scientific methods which could determine the existence of such a population. Since SNS are federally endangered and collection requires an ESA Section 10 research permit, netting for SNS was not an option that could be pursued in a timely manner. However, environmental DNA (eDNA) is a sampling method for detecting aquatic species which can provide a measure of species presence, density, and distribution without having to collect the fish. Fish release DNA into their surrounding environment via slime, scales, epidermal cells, or feces.

FirstLight collected a total of 170 water samples which were filtered during the two surveys on July 18 and 19 and August 14, 2018. There was no SNS DNA detected in the water samples collected in the TFI; however, SNS DNA was detected downstream in an area that SNS are known to occupy in the summer (these locations were used to confirm the validity of the sampling technique and subsequent detection analysis). The samples taken below Vernon Dam and within the TFI did not detect the presence of SNS and thus, based on this information combined with the lack of additional documented captures of SNS in the TFI, FirstLight considers the likelihood of a population, as opposed to a single SNS in the TFI, to be very low. A report entitled *Environmental DNA Sampling for Shortnose Sturgeon* summarizing the eDNA findings was filed with FERC on November 8, 2018.

During an October 17, 2019 conference call, NMFS noted that it had provided funds to support efforts led by the USGS Conte Lab to gill net upstream of the Turners Falls Dam to attempt to determine if SNS were present. Though the details of the gillnetting surveys were not provided to FirstLight, NMFS reported that no SNS were found in any of the gill net sets. No SNS were captured or observed in the TFI during extensive boat electrofishing and gillnetting surveys that were performed as part of Relicensing Study 3.3.11 – *Fish Assemblage Assessment* in June/July and September 2015. In addition, no SNS were collected in boat electrofishing and gillnetting surveys conducted as part of TransCanada (now Great River Hydro) relicensing studies which sampled the reach immediately downstream of Vernon Dam during June, August, and October 2015 (Normandeau 2016A,B). Further, boat electrofishing was conducted to assess the ecological effects of the Vermont Yankee Nuclear Power Station from 1968 through 2011. Standardized methodology was used from 1991 through 2014 to sample the reach from Vernon Dam to approximately five miles downstream. With some exceptions due to extreme flow conditions, sampling was conducted monthly from July through October at 4 to 5 sites for general species collections and twice monthly from July through October at six sites for targeted anadromous species collections. Despite decades of electrofishing surveys that documented at least 35 species, no SNS were ever collected in those studies (Aquatec 1993, 1995, Normandeau, 1997-2016).

5.4.1.3 Current Upstream Extent

Given the historical extent, along with the extensive data collection and study findings described above the current upstream extent of the SNS population in the Connecticut River is considered to be the Turners Falls Dam.

5.4.2 Spawning Migrations and Habitats

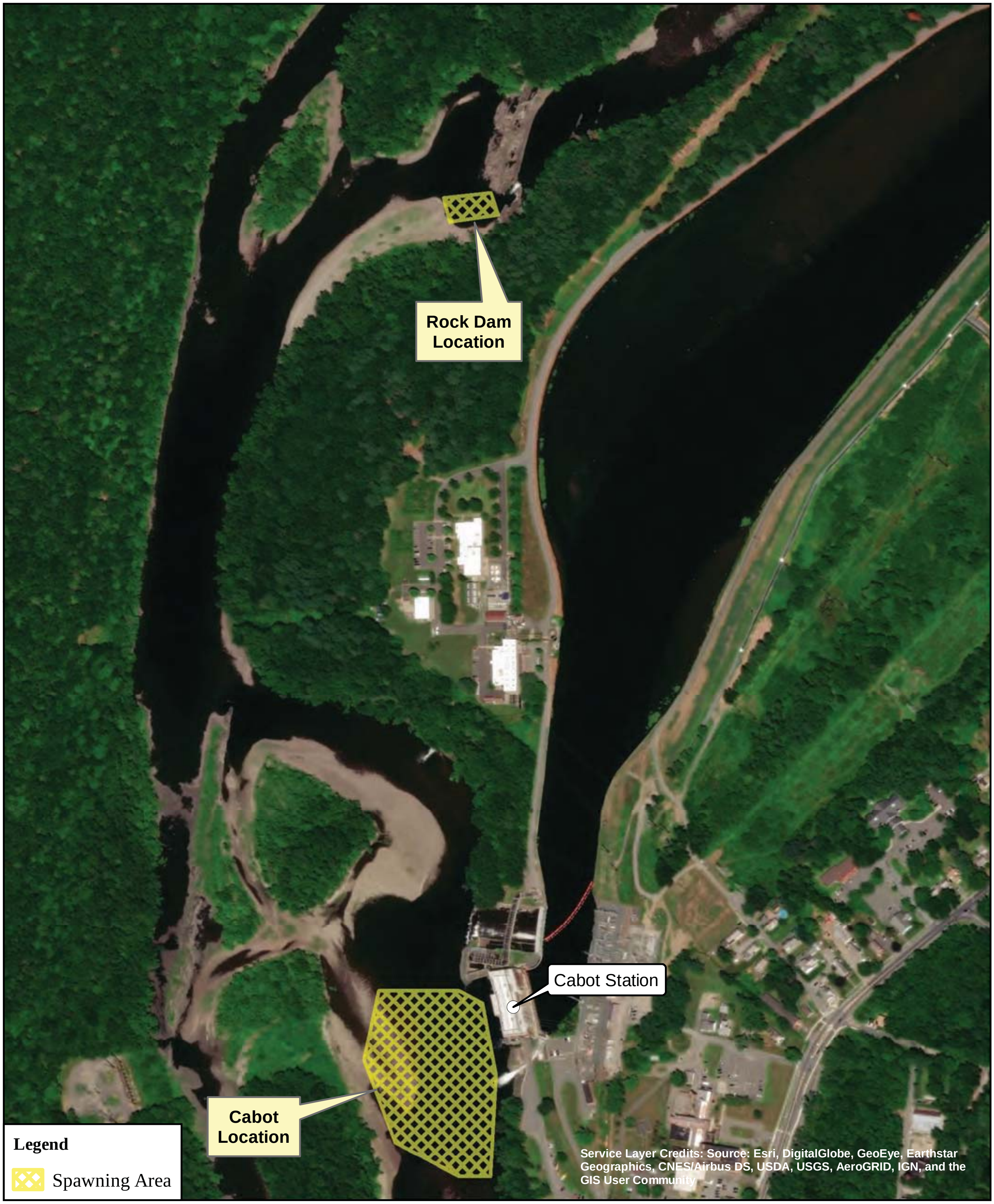
Pre-spawn adult SNS have been documented departing wintering areas downstream of the Turners Falls Dam as early as April 12, and as late as May 3, at a variety of flows and water temperatures but within a narrow day-length window (Kynard *et al.*, 2012). Spawning in the action area has also been documented to occur within a specific day-length window of 13.9–14.9-hours, which corresponds to April 27 through May 22. Documented spawning has occurred only when daily mean water temperatures of 6.5–15.9°C and mean daily river flows of 4,273 to 31,819 cfs occurred within the April 27 through May 22 window (Kynard *et al.*, 2012). Therefore, the presence of pre-spawn and spawning fish in the action area, regardless of inter- and intra-annual variability is constrained conservatively to April and May.

Movements of tagged fish suggest that pre-spawn fish arrive in the general Montague area, and then exhibit searching behavior to choose specific sites for spawning. Kynard *et al*., (2012) have documented SNS choosing the same two sites for spawning within the action area each year, both of which are located within a 2-km (1.2 mi) reach near Montague, MA (Figure 5.4.2-1). The primary spawning location chosen by SNS is in the tailrace of Cabot Station at the Turners Falls Project. This spawning site is approximately 2.7 hectares (ha) or 6.7 acres in area. The secondary, smaller site (0.4 ha or 0.99 acres in area) chosen by SNS is located downstream of a natural rock formation locally known as Rock Dam, which is within the Turners Falls Project bypass reach. The spatial extent of these sites was determined from the tracked locations of spawning SNS over several years (Kynard et al., 2012).

In general, spawning has been more commonly successful at the location near Cabot Station than it has been near Rock Dam. Discharges or discharge spikes of approximately 35,000 cfs were correlated with spawning failure at the location near Cabot Station. Spawning failed or did not occur at the Rock Dam site at discharges in the bypass reach above approximately 21,000 cfs, but also if flows in the bypass reach were reduced below approximately 2,500 cfs.

Operational flows at the Turners Falls Project have also been cited as potentially impacting SNS spawning in the action area. Kynard *et al*., (2012) noted that Cabot Station peaking operations did not result in abandonment of spawning by SNS, but that changes in flow could result in rapid changes of velocities. SNS are known to release eggs continuously in small batches, and once they start releasing eggs, they do not stop until they are finished, even if conditions become unsuitable. Therefore, changes in velocities near Cabot Station could be resulting in egg mortality if SNS are spawning in areas with unsuitable velocities (Kynard *et al.,* 2012). At the Rock Dam site, flow changes in the bypass reach, as resulting from flow regulation from the Turners Falls Project, have been shown to change the flow between suitable and unsuitable spawning conditions relatively rapidly (Kynard *et al.,* 2012). Disruption of spawning, and sediment mobilization that could harm eggs, was also noted as a potential effect caused by the episodic operation of the emergency spillway gates at Cabot Station (Kynard *et al*., 2012); however, this issue was studied by FirstLight during the relicensing process, and it was determined that operation of the emergency spillway gates would not likely effect SNS to the degree that common springtime flow events could.

After spawning, SNS need to recover lost energy, and begin to actively forage. SNS in the action area have been documented moving downstream to the Deerfield River confluence, and subsequently further downstream, to forage (see Section 5.4.5). Some post-spawn fish leave the action area, passing downstream to areas below Holyoke Dam.



FirstLight

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Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

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Feet

Figure 5.4.2-1: Documented Shortnose Sturgeon Spawning Locations in the Action Area

Notes: Locations drawn based on Fig. 2 from Chapter 3 of Kynard et al. (2012).

Path: W:\gis\maps\SNS BA\SNS Known Spawning Locations.mxd

5.4.3 Egg/Larvae Maturation and Habitats

Eggs and larvae are present at rearing areas within the action area from the time they are spawned until they mature into fry. The widest predicted time period that eggs and larvae would be present in the action area, based on studies by Kynard *et al.,* (2012) would be from late April through mid-June. SNS eggs and larvae have been captured in drift and kick nets and/or observed during SCUBA surveys in close proximity to spawning SNS, and within or immediately downstream of the primary spawning areas (Kynard *et al*., 2012). Kynard *et al.,* (2012) noted that SNS eggs would not drift long distances, such as from the Rock Dam spawning area to the Cabot Station spawning area. However, Kynard *et al*., (2012) noted that shoals downstream of the Cabot and Rock Dam locations could become exposed due to a combination of Project operations and low natural river discharges. They identified these shoals as potential nursery locations, and visually surveyed for eggs and larvae during multiple years when the shoals below Cabot Station became exposed. Though other species of eggs and larvae were observed on the shoals during the surveys, no SNS eggs or larvae were found stranded on dewatered shoals (Kynard *et al*., 2012; Kieffer and Kynard, 2007). Additionally, based on data gathered during Relicensing Study 3.3.1 – *Instream Flow Habitat Assessments in the Bypass Reach and Below Cabot Station*, suitable habitat does not persist at these shoals given the variety of flows that could occur during the SNS rearing period. This is due to their flat, shallow nature which promotes dewatering at low flow and high velocities at higher flows. By contrast, more persistent habitat is available to the egg/larval stages within and in close proximity to the SNS spawning habitat area at Cabot Station. As such, successful egg and larval development is most likely occurring within and near the spawning area identified by Kynard *et al*., (2012) rather than at the downstream shoals.

5.4.4 Dispersal of Fry

Research by Kynard *et al*., (2012) has found that dispersal of fry typically occurs in the late May and early June period. Fry are only present near the rearing areas for a day or two, and then disperse downstream to settle within the reach of the Connecticut River between Fourth Island and Mitch's Island (Kynard *et al*., 2012). There have been no direct studies of Project effects on fry in the action area, though flows can influence the amount of suitable habitat available. FirstLight has included SNS fry in its analyses from Relicensing Study 3.3.1 and they are also considered in the effects section of this BA.

5.4.5 Adult and Juvenile Foraging

According to Kynard *et al*., (2012, SNS have also been documented using specific areas for seasonal foraging in the action area, including:

- Spring
    - Connecticut River between the mouth of the Deerfield River and Fourth Island, along with areas of the lower Deerfield River. This may include staging (pre-spawn) adults, post-spawn adults, and non-spawning adults. Fish that forage here stay until summertime, after which they migrate downstream to summer foraging areas.
    - Juvenile SNS foraging in the Connecticut River between Fourth Island and Mitch's Island.
- Summer into Fall
    - Adult and juvenile SNS foraging in the Connecticut River between Fourth Island and Mitch's Island.
    - Rare occurrences of adult SNS migration to the Turners Falls Dam, presumably for foraging

After foraging in the summer and early fall, adult and older (2+ year) juvenile SNS migrate to overwintering habitats in November. The seasonal habitat use and movements of younger juveniles have not been studied, but they are presumed to forage in the reach between Fourth Island and Mitch's Island (Kynard *et al*., 2012).

There have been no direct studies of Project effects on SNS foraging in the action area, though flows can influence the amount of suitable habitat available. FirstLight has included SNS foraging in its analyses from Relicensing Study 3.3.1 and potential effects of foraging are also considered in the effects section of this BA.

5.4.6 Juvenile Migrations

Though little is known about juvenile SNS, laboratory studies suggest that juveniles (1-3 years old) employ two primary strategies. One strategy would be migrating in a general downstream direction, resulting in passage to areas below Holyoke Dam, and the other would be to trend upstream, staying within the action area (Kynard *et al*., 2012; SSSRT, 2010).

5.4.7 Overwintering

Between Turners Falls Dam and Holyoke Dam, adult and 1+ year old juvenile SNS have been observed overwintering in groups, primarily at five locations between Whitmore Pool and Elwell Island. Whitmore Pool is approximately 6.9 miles downstream of Cabot Station, and Elwell Island is approximately 22.3 miles downstream of Cabot Station. The greatest numbers of overwintering SNS have been observed at Whitmore Pool. Some fish have also been observed overwintering alone, but still within the river reach between Whitmore Pool and Elwell Island. Areas with deep water, low water velocities, and sandy substrate are common micro-habitat variables between the overwintering sites (Kynard *et al*., 2012). Wintering adults selected sand substrate, bottom velocity between 0.2 to 3.1 ft/sec, and deep (depths 13-29 feet), and juveniles have been observed in between the adults (Kynard *et al*., 2012). Most overwintering SNS in northern rivers such as the CT, are relatively sedentary, are often oriented parallel and very close (touching or nearly touching) to each other, and typically only move short distances within their chosen overwintering sites. They have been observed moving further, and toward the shorelines, during high flow events (Kynard *et al*., 2012). Discharge spikes that have resulted in this type of behavior during overwintering were greater than approximately 35,000 cfs.

The location and wintering strategy for SNS less than 2-year-old is unknown, but they are presumed to use slow-velocity areas with available forage during the winter (Kynard *et al*., 2012).

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6 ENVIRONMENTAL BASELINE

The environmental baseline include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this BA includes the effects of several activities that may affect the survival and recovery of the endangered species in the action area. Because the Turners Falls Project and Northfield Mountain Project are existing, FERC-licensed facilities, past and present effects of the Projects on listed species are part of the environmental baseline; future effects of these projects would be considered effects of the Proposed Action.

6.1 Effects of Federal Actions that have Undergone Formal or Early Section 7 Consultation

The NMFS has undertaken ESA Section 7 consultations to address the effects of federal actions on threatened and endangered species in the action area. In addition to numerous informal consultations for activities such as bridge crossings, shoreline construction, docks, etc. where NMFS has concurred with an action agency's determination that the proposed action was "not likely to adversely affect" SNS, NMFS has carried out a number of formal consultations, described briefly here.

In June 1992, NMFS issued a Biological Opinion to the New England District Army Corps of Engineers (ACOE) for maintenance dredging of the Connecticut River Federal Navigation Project. In this Opinion, NMFS concluded that the proposed long-term maintenance dredging project was likely to jeopardize the continued existence of SNS in the Connecticut River due to the high number of SNS expected to be killed or otherwise affected by hopper dredging operations. In cooperation with the ACOE, NOAA Fisheries developed a reasonable and prudent alternative (RPA) which would avoid jeopardy to SNS in the Connecticut River. The RPA included a time of year restriction and a change in disposal location. The accompanying Incidental Take Statement (ITS) indicated that NOAA Fisheries believed up to 10 SNS were likely to be taken from dredging operations on an annual basis but due to difficulty in monitoring take, the ITS exempted the take of five observed mortalities in the dredge hopper annually. This action has been ongoing since the 1960s and continues today. Dredging occurs early every year and no mortalities have been observed in recent years.

On January 27, 2005, NOAA Fisheries issued a BO on the effects of the FERC proposal to issue a new License Order for the Holyoke Hydroelectric Project on the Connecticut River in Massachusetts, consistent with a proposed Settlement Agreement. In this Opinion, NMFS concluded that the continued operation of the Holyoke Project, consistent with the new License Order and Settlement Agreement, was not likely to jeopardize the continued existence of SNS. This Opinion replaced an Opinion issued in 1999 which concluded that the Holyoke Project was likely to jeopardize the continued existence of SNS. The Holyoke Dam has impeded or obstructed natural upstream and downstream migration of the Connecticut River population of SNS for 150 years. Without passage at the dam, SNS above the dam have access to spawning habitat but not to downstream foraging habitat and SNS below Holyoke Dam have access to foraging habitat but have great difficulty accessing upstream spawning habitat. This consultation has been reinitiated a number of times with the most recent Biological Opinion issued in December 2019. The Opinion includes an Incidental Take Statement exempting the take of a number of SNS annually over the life of the project's FERC license.

6.2 Non-Federally Regulated Actions

Unauthorized take of SNS is prohibited by section 9 of the ESA. However, SNS are taken incidentally in anadromous fisheries along the East Coast and may be targeted by poachers (NMFS, 1998). Poaching has been documented in some locations on the Connecticut River. SNS could be easily targeted if their aggregation areas are known by poachers, though poaching appears to be limited, likely due to severe federal punishments (Kynard *et al*., 2016).

The Connecticut River is an important corridor for migratory movements of various diadromous species including Alewife (*Alosa pseudoharengus*), American Eel (*Anguilla rostrata*), Blueback Herring (*Alosa aestivalis*), American Shad, Striped Bass (*Morone saxatilis*), and Sea Lamprey. Capture of SNS in commercial gillnet fisheries can result in lethal or non-lethal effects. The current drift gillnet fishery for American Shad on the Connecticut River runs from April 1 through June 15 each year, from the river mouth to Glastonbury, CT, and could intercept SNS moving in the tidal estuary. This fishery is estimated to capture less than 10 fish annually, though this estimate was not scientifically verified (Kynard *et al.*, 2012); additionally, this fishery appears to be declining in effort over time (CTDEEP, 2017). There are no commercial fisheries in the action area.

SNS are occasionally captured incidentally in rivers by recreational anglers, though the frequency of this has not been studied (Kynard *et al*., 2016). Though they are not legal to harvest, there could be some injury or mortality effects of incidental catch. In the action area, the only fisheries are recreational, primarily targeting resident species and American Shad. It is possible that anglers could hook SNS unintentionally when fishing for other species, particularly during the months of April and May when spawning American Shad and Walleye could also be present at SNS spawning areas during the SNS spawning window. Incidental disturbance or capture by anglers in the action area has not been reported and could be considered a rare occurrence that would affect few SNS individuals. Similarly, the effects of recreationalists walking on wading shoals are likely to be minimal. Access to rearing shoals is also difficult, and unsafe, during much of the spawning/rearing period. Once flows recede to the point that rearing shoals are both accessible and safely wadable/walkable, the shoals would be subjected to the effects of dewatering. By this time in a typical year, SNS eggs would have hatched and fry would have drifted downstream.

Boating in the action area is most common during the summer in the lower portions of the Holyoke Impoundment. Given their benthic nature, boat strikes could occur if SNS are residing in relatively shallow water or if they are jumping/breaching at the same time a boat is passing. Boat strikes in this area have not been reported, though they are possible and could affect a small number of SNS individuals. Boating is considerably less common during the spawning/rearing periods, particularly in the areas close to the Turners Falls Project where boating conditions can be difficult. As such, disturbance of SNS, or boat strikes during the spawning/rearing period would be an infrequent occurrence.

6.3 Other Factors

Several factors have effected SNS populations in the past, many of which could have lasting effects to the present day and could continue affecting SNS populations into the future, in addition to the Proposed Action.

6.3.1 Shortnose Sturgeon Life History

The life-history patterns of SNS have enabled populations to survive, despite many of the impacts outlined below in this document. However, recovery of the Connecticut River population, or the portion of the population within the action area, could be affected by life-history patterns that affect the rate at which the SNS population could change in relation to benefits provided by the Proposed Action.

6.3.1.1 Consistent Homing to Discrete Sites

SNS in the Connecticut River have been documented homing to the same relatively small sites each year, not only in the Connecticut River, but throughout their range (Kynard *et al*., 2012; Kynard *et al.*, 2016). Providing benefits to the population via increasing the amount of suitable spawning habitat is dependent upon use of newly suitable habitats by SNS, and there being a current limitation on spawning habitat. There are some potentially suitable spawning areas under the baseline condition that SNS have not been observed using, such as the right channel (looking downstream) of Rawson Island and areas near the Montague Bridge (see Section 7.2.1.1, Figure 7.2.1.1-9). Though providing more consistently suitable spawning habitat throughout the area may allow SNS to select new spawning habitats, it is not clear how quickly SNS would start utilizing the newly-available habitats after initiation of the Proposed Action. Recent increases in the number of SNS passed at Holyoke Dam (n = 193 since 2017) may cause spawning SNS to seek additional spawning habitats. However, if adult SNS are intent to continue spawning in the known locations, and their progeny would also home precisely to these locations, then it could take several years before other habitats become utilized for spawning. However, studies of restored habitat use from other river basins are encouraging. In less than a decade, approximately one-third of SNS spawning events documented on the Kennebec River by Wippelhauser *et al*., (2015) were within historic habitat that had been inaccessible to SNS for 162 years. In this case, the Kennebec River SNS population includes migrants that are known to reside in other river systems, is relatively large at around 9,436 adults (1998-2000 estimate, Wippelhauser and Squiers, 2015), and appeared to be expanding their use of spawning habitats by using previously-accessible and newly-accessible habitats (Wippelhauser *et al*., (2015). By comparison, the entire Connecticut River population is smaller and does not appear to host very many migrants from other river systems (Savoy, 2004; Kynard *et al*., 2016).

6.3.1.2 Growth and Maturation

SNS are long-lived, but grow slowly, and females take 7-13 years to reach sexual maturity. Therefore, it would take several years before SNS that are spawned and hatched soon after initiation of the Proposed Action are recruited to the population as spawning adults. Assessments of population size in the Connecticut River have been based on adult abundance, and changes to adult abundance may not be noticeable for several years after initiation of the Proposed Action.

6.3.1.3 Emigration/Immigration

Because SNS are known to migrate along the coast between rivers, there is the potential for emigration from the Connecticut River population to other rivers, or for immigration into the Connecticut River from other rivers. Though this would not affect the total population number rangewide, the degrees of immigration and emigration could affect the population of SNS within a river at a given time. Immigration into the Connecticut River from the Hudson River has been documented in relatively low numbers, along with emigration from the Connecticut River to the Housatonic River (Savoy, 2004; SSSRT, 2010). SNS that emigrate along the coast and throughout estuaries could be susceptible to several threats in the ocean that they are not exposed to in a riverine environment, such as predation by seals, ship strikes, incidental capture by commercial fishing vessels, and interactions with turbines used for tidal power (SSSRT, 2010; Kynard *et al*., 2016).

For the portion of the SNS population in the Connecticut River residing in the action area, immigration (passage upstream at Holyoke) or emigration (passage downstream at Holyoke) can affect the number of SNS within the action area at a given time. Though this does not immediately effect the total population size, it could result in changes to the number of spawning adults within the reach in future years, which could then affect the total population size through spawning and recruitment. In particular, older female SNS above Holyoke Dam appear to be driven to forage in the estuary, and eventually pass downstream of Holyoke Dam to do so (Kynard *et al*., 2012); this strategy may be less common upstream of Holyoke Dam than historically due to the presence of Holyoke Dam, but these movements could become more prevalent as passage is improved and more SNS from below Holyoke Dam contribute to the population in the action area.

6.3.2 Dams

The position of the Projects relative to other dams in the Connecticut River watershed is important in the context of the environmental baseline, and for FirstLight's proposal. The Turners Falls and Northfield Mountain Projects are located on the Connecticut River at river mile 122 and 127, respectively. They are located between Great River Hydro's (GRH) Vernon Project upstream and HG&E's Holyoke Project downstream. There are also several other dams in the watershed that could directly or indirectly affect SNS in the action area.

6.3.2.1 Restrictions on Access to Habitats

The historical construction of dams in the lower portions of main-stem rivers restricted access by SNS to historic spawning and rearing habitats and has been identified as one cause of SNS population declines in several rivers (SSSRT, 2010). The continued presence of these dams would be limiting to the populations of SNS that use those rivers. Alternatively, dam removal projects have been shown to improve or restore access by SNS to historic habitats (e.g. Wippelhauser *et al*., 2015), which has the potential to allow for population increases. On the Connecticut River, the historical upstream extent of SNS was at Great Falls, the location of the current Turners Falls Dam. The Holyoke Dam was constructed in 1849 at Hadley Falls, a steep rapid on the river that SNS could traverse (Kynard *et al*., 2012). This dam divided the population of SNS into two subpopulations, likely affecting the downstream portion of the population by restricting access to spawning habitats, and the upstream portion to rich tidal feeding grounds (Kynard, 1997). The current dam at Holyoke is the third structure to be built at this location and provides water for hydropower and the Holyoke Canal System. There have been several recent improvements to upstream and downstream fish passage at Holyoke Dam, but it was likely a complete barrier to SNS for an estimated seven generations of SNS, leaving the population upstream of the dam isolated (Kynard *et al*., 2012). Though the Enfield Dam is no longer an impediment, and fish passage has improved at Holyoke Dam, the historical effects of damming and segmentation on the population of SNS still persist today (Kynard *et al*., 2016).

6.3.2.2 Watershed-wide River Flow Regulation

Upstream of the Project, and several other hydropower facilities, is the Fifteen Mile Falls Project including the Moore, Comerford and McIndoes Developments which are also owned by GRH and were licensed in April 2002. These developments have significant storage capacity and their operations influence flows to the Wilder Project and eventually to the Turners Falls and Northfield Mountain Projects. These dams are used to control floods—storing high inflows in the spring and reducing dam discharges—and subsequently discharging the stored water when flows recede. This extends the cool, high discharge period beyond natural conditions. The extension of this discharge for even a week could be sufficient to close the discharge window and cause spawning failure (Kynard *et al*., 2012). Reproductive success for SNS depends on suitable river conditions during their spawning window.

6.3.2.3 Hydropower Facilities and Operations

The installation and configuration of hydropower facilities can result in changes to habitat availability and suitability for SNS. On the Connecticut River, previous operations of the Holyoke Hydroelectric Project at Holyoke Dam impacted SNS. Quick reductions in spillage at Holyoke Dam from the 1950's through the early 2000's resulted in stranding of adult SNS in apron pools below the dam (Kynard *et al*., 2012). Downstream passage was also an issue, with adults exhibiting high mortality rates when passing downstream through the Project turbines (Kynard *et al*., 2012). Both of these issues at Holyoke Dam negatively impacted the population of SNS, and several measures have been taken at the facility to alleviate those issues.

Further upstream, the configuration of the Turners Falls Project, no stranding has ever been observed and SNS are not intentionally passed upstream. However, this Project has affected habitat by altering the frequency, duration, magnitude, and timing of flows passed through the original river channel between the Turners Falls Dam and Cabot Station by passing up to nearly 16,000 cfs into the power canal and passing it back into the river at Station No. 1 and Cabot Station. Historically, it is possible that SNS spawned throughout what is now known as the bypass reach, though they have only been documented spawning in one small area within the bypass reach under the current baseline condition. Additionally, when inflows are less than the hydraulic capacity of the Turners Falls Project, Cabot Station is operated as a peaking facility whereby discharges are high during high power demand periods and lower during lower power demand periods. These operations could also impact SNS spawning areas and rearing habitats (as described further in Section 7.2).

Upstream hydroelectric projects are also important aspects of the environmental baseline, and FirstLight's proposal. The Vernon Project is one of three GRH projects also undergoing relicensing in parallel to the Turners Falls and Northfield Mountain Projects. The other two projects are the Bellows Falls and Wilder Projects which are located immediately upstream of the Vernon Project. All three GRH facilities are used to meet peak demand and, thus, control the inflows to the Turners Falls and Northfield Mountain Projects.

6.3.2.4 Fish Passage

Kynard *et al*., (2012) states that their long-term study supports the idea that re-establishing natural upstream and downstream passage migrations for Connecticut River SNS is the only way to restore natural population abundance and structure. For most of the period that Holyoke Dam was in place, SNS could pass downstream beyond Holyoke Dam, but could not return back upstream. SNS killed during downstream migration at Holyoke Dam were lost from the population, and those that passed to reaches below Holyoke Dam were not able to return upstream to spawn again. As such, upstream and downstream passage rates for SNS at the Holyoke Dam have likely been a major driver in the overall population size. Improvements to upstream and downstream passage at Holyoke Dam have the potential to increase the size of the Connecticut River population of SNS by allowing more spawning fish to the reach near Turners Falls Dam, and more to survive downstream passage to return and spawn in future years.

Improvement in passage of SNS at Holyoke Dam in both directions also has the potential to allow for a more natural pattern of migration, which historically may have meant more use of lower-river and estuarine areas by SNS that spawn at Montague. This could have benefits to the overall population by increasing growth rates of SNS and enhancing reproductive capabilities of individual fish. Improved passage would also allow larger female sturgeon, which currently leave the action area to forage in the estuary, to return and spawn, each of which develop large quantities of eggs compared to younger, smaller females that are currently spawning at Montague. Because passage improvements at Holyoke were implemented relatively recently, these effects could occur over the course of the Proposed Action's license period.

The combination of increased passage at Holyoke Dam and increases to the amount of spawning habitat available near Montague has potential for increasing the population size of SNS in the Connecticut River. Alternatively, if Holyoke Dam does not pass many SNS, it is possible that the benefits from increasing the amount of habitat available to spawning SNS through the Proposed Action would become limited by the number of spawning females in the action area.

In 2017, a rogue SNS was caught by an angler near Vernon Dam. It is unclear how this rogue individual got into the TFI. FirstLight conducted eDNA testing throughout the TFI and no population of SNS were detected. FirstLight has developed a SNS handling plan in case any SNS are caught in the proposed Spillway Lift.

6.3.2.5 Turners Falls Project – Emergency Spillway and Log Sluice Gate Events

As part of relicensing, FirstLight was required to evaluate the frequency and impact of water releases from the Cabot emergency spill gates and downstream fish passage bypass flume (or Log Sluice) on SNS spawning and rearing habitat in the Cabot tailrace and downstream of Cabot Station (see Study No. 3.3.3.12 *Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat).* The emergency spill gates are needed in case water levels in the power canal, which are continually monitored, start to rise or if there is a load rejection at Cabot Station. During these events the emergency gates automatically open to prevent overtopping of the canal. The log sluice is used to pass downstream migrants past Cabot Station. These structures are in close proximity to the known SNS spawning area near Cabot Station, and associated rearing areas (Figures 2.1.1-1 and 5.4.2-1).

The log sluice gate is approximately 16 feet wide, but there is an 8-foot-wide weir that is inserted in the sluice opening during downstream fish passage periods. The weir has an elliptical floor and was developed specifically to enhance fish passage. Operation of the sluice gate with the weir installed during the downstream fish passage season results in a flow of ~220 cfs. Even with a constant gate opening, the actual flow through the sluice gate can vary slightly due to changes in forebay water level. The weir can be lifted out of the water at the sluice gate, allowing flow to be increased for the purposes of:

- Raking debris from the trashracks at Cabot Station and passing the debris through the sluice;
- Passing logs that accumulate at the weir;
- Preventing logs from becoming caught in the weir during high river flows; and
- Passing ice that accumulates at the Cabot trashrack.

Passing debris and logs would typically result in a relatively short-term flow increase on the order of minutes to hours at the sluice gate, except during high flow events when the incoming debris load is high. When river flow is greater than around 30,000 cfs, FirstLight closes the sluice gate to prevent the formation of an eddy downstream of the sluice when it is open under these higher flows. The eddy can cause undermining at the end of the sluice; the bank in this location has been stabilized with rip-rap to prevent erosion. Under lower river flows and tailwater elevation, the relatively low flow input from the sluice and the coarse nature of the substrate in the area likely precludes mobilization of fine sediment that would affect SNS rearing.

The emergency spillway gates, adjacent to and upstream of Cabot Station, comprise 10 vertical, downward-opening slide gates that are 12 feet wide by 12 feet high, with individually driven rack and pinion operators. Eight of the gates are used to discharge canal flows and two of the gates supply attraction water to the Cabot fish ladder. In this report, these eight gates are referred to as the "spill gates." The discharge capacity of these eight spill gates is approximately 12,000 cubic feet per second (cfs) at the normal canal level of 173.5 feet (NGVD29). The maximum Cabot fish ladder attraction water provided through the other two gates is approximately 335 cfs.

The canal level at Cabot Station is constantly monitored. For safety reasons, the spill gates automatically open and the gates at the Turners Falls Gatehouse automatically close in the event an abnormal high or low canal level is detected, or when there is a load rejection at Cabot Station. An abnormally low canal level could indicate a dike breach which could cause inundation of houses along Montague City Road. A load rejection at Cabot Station could cause the canal level to rise and overflow, inundating surrounding areas. During events when the gates are operated automatically, the canal level will drop rapidly and excess water would flow through the spill gates for a short period, just minutes.

The spill gates have also been used for operational reasons in the past. During periods of high river flows, at least one spillway gate is opened to allow river debris entering the canal and caught on the trash boom to be discharged back to the river to prevent obstructions at the Cabot Station intake racks. Likewise, in the winter and spring, when there is excess ice in the canal, gates would be opened to route ice down the emergency spillway. Operators would also routinely open one or more gates when necessary to help remove debris from the trash boom. The gates discharge water to the river just upstream of Cabot Station, in close proximity to known SNS spawning and rearing habitats. In general, the evaluation of the emergency spillway gate operation found that:

- Given the size of the spawning area and the relatively narrow areas affected by increased velocity and suspended sediment resulting from emergency spill events, SNS could move relatively short distances to a more suitable area if a spill event occurred during spawning.
- Emergency spillway operations have the potential to mobilize sediment at a comparable magnitude to sediment mobilization predicted during high bypass flow (i.e. 20,000 cfs) and full capacity generation at Cabot Station in the absence of spill. These potential impacts could be most severe when the spill flow is high, bypass flows are moderate, and Cabot Station continues generation during the spill event. Such an event results in water from the emergency spillway rushing across

the channel, toward Smead Island, where it encounters greater amounts of sand, which could then become mobilized and transported downstream.

- Water velocities at the rearing area did not change considerably due to emergency spillway operation, and were relatively swift under most conditions, likely preventing deposition. As such, there is no indication that SNS eggs will become smothered by sand mobilized near Cabot Station during discharges from the emergency spillway. Additionally, predicted sediment mobilization did not appear to be considerably different than what could be encountered naturally during high (flow > 20,000 cfs) bypass reach flow. Flows of this magnitude, and sometimes much greater, occur naturally nearly every spring and can occur prior to and/or during the SNS spawning period. It is also possible that high flow in the bypass reach would mobilize sediment and move it out of the area prior to discharge events from the emergency spillway, resulting in less sediment that could become mobile due to emergency spill.

During recent years, FirstLight has modified operation of the emergency spillway gates, such that spill events of the greatest magnitude only result from emergencies (i.e. load rejection). In these cases, high amounts of spill would be necessary to ensure station viability and/or public safety. Small amounts of water (i.e. 300 cfs) have been passed through one of the gates continuously for trash/debris and ice management, consistent with FirstLight's proposed operation of the gate.

6.3.3 Natural Stochastic Events

The Proposed Action includes provisions for flow rates in the bypass reach and downstream areas that would be beneficial to spawning and rearing SNS (see Sections 7.2.1.1 and 7.2.1.2). High and low flow events occur naturally, and Connecticut River SNS populations have survived through many such events; however, they do have effects on the population. High river flows that are above the hydraulic capacity of the Turners Falls Project are not within either Project's structural or operational capabilities to control. Flooding that occurs during the spawning and/or rearing season could result in a lack of successful spawning and/or egg survival (Kynard *et al*., 2016). Alternatively, if flows are too low during the spawning and/or rearing period, SNS may have difficulty traversing shallow areas to reach spawning habitats, may encounter velocities that are too low to be suitable at spawning habitats, and/or rearing locations could become dewatered (Kynard *et al*., 2016; Kieffer and Kynard, 2007). Neither Project can protect SNS against periods of low inflow.

The effects of stochastic events also go beyond the spawning and rearing period. River conditions in the summer and fall affect foraging efficiency of Connecticut River SNS, which could determine their condition going into winter (Kynard *et al*., 2016). If they are not in good condition going into winter, pre-spawn SNS may not have the energy to make an upstream migration to spawning areas in the spring (Kynard *et al*., 2016). High river flows during the summer foraging period, and overwintering period, have been identified by Kynard *et al*., (2016) as potentially causing energetic crises for pre-spawning Connecticut River SNS that could result in spawning migration failure the following spring.

6.3.4 Scientific Studies

Previous research projects conducted in the Connecticut River since 1976 may have influenced the survival, reproduction and/or migration of individual SNS. Research projects conducted in the action area include capture, measuring, weighing, tagging (internal and external) and obtaining eggs from SNS. Currently two ongoing research projects are permitted by NOAA Fisheries. Micah Kieffer (USGS) and Tom Savoy (Connecticut Department of Environmental Protection) possess ESA Section 10(a) (1) (A) Permits to conduct scientific research on SNS in the Connecticut River. In addition, as a requirement of their Incidental Take Statement issued to FERC as part of the ESA consultation, HG&E is conducting a post construction monitoring study to determine the effectiveness of the new downstream passage facility.

6.3.5 Contaminants and Water Quality

Heavy usage of the Connecticut River and development along the waterfront have likely affected SNS throughout the action area. Construction sites often result in excessive water turbidity, which could influence SNS spawning and/or foraging ability. Industries along the Connecticut River include or have included in the past, hydroelectric and other energy generating facilities, an armory, firearms factory, industrial mills and various other industrial pursuits. The effect of general pollution on SNS in the Connecticut River is unknown.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges containing elevated temperatures or high biological demand, can reduce DO concentrations. SNS are known to be adversely affected by DO concentration below 5 mg/L. SNS may be less tolerant of low DO concentrations in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flournoy *et al*., 1992). At these temperatures, concomitant low levels of DO may be lethal. Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of SNS populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

The New England Interstate Water Pollution Control Commission issued a report in early 1998 on water quality threats. This report indicated that the Connecticut River had several major water quality issues. These included: toxins, such as polychlorinated biphenyls (PCBs); combined sewer overflows (CSOs) which can cause poor water quality conditions in urban areas after storm events; and non-point source pollution. All four of the states with Connecticut River waters have public health advisories regarding the consumption of fish caught in the river (MA: PCBs, CT: mercury and PCBs).

Coal tar deposits released in the Connecticut River have likely affected spawning success, egg survival and/or larval development. Coal tar contains toxic Polycyclic Aromatic Hydrocarbons (PAHs) that are known to be carcinogenic. Other pollutants in the Connecticut River, such as PCBs, could affect SNS reproduction as well. In the Connecticut River, coal tar leachate was suspected of impairing SNS reproductive success. Kocan *et al*., (1993) conducted a laboratory study to investigate the survival of SNS eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of SNS embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to SNS embryos and larvae under laboratory exposure conditions (NMFS, 1998).

Major National Pollutant Discharge Elimination System (NPDES) permit holders in the Project areas include the Montague Wastewater Treatment Facility, the Erving Wastewater Treatment Plant #1, and the Hinsdale Wastewater Treatment Plant. The Erving and Hinsdale facilities discharge into the river upstream of Turners Falls Dam, whereas the Montague Wastewater Treatment Plant discharge is a short distance downstream of Cabot Station, which is within the action area.

Overall patterns of improving water quality in New England Rivers in recent decades have likely benefitted SNS and will continue to benefit SNS if good water quality is maintained.

6.3.6 Interactions with Native and Non-native Species

In general, predation on adult sturgeon appears to be relatively limited, likely due to their large size and protective scutes, though some predatory fish may attempt to consume juvenile sturgeon (i.e. Gadomski and Parsley, 2005). There are numerous non-native predatory species that have been introduced to the Connecticut River, including Channel Catfish (*Ictalurus punctatus*), Northern Pike (*Esox lucius*), Walleye (*Sander vitreus*), Smallmouth Bass (*Micropterus dolomieu*), and Largemouth Bass (*Micropterus salmoides*). Striped Bass are a native, anadromous fish that enter the lower Connecticut River, and populations of this predatory species have fluctuated in recent decades. Though Flathead Catfish

(*Pylodictis olivaris*) are not currently known to be in the Connecticut River, their potential range expansion to the Connecticut River could threaten future populations of SNS given that this species has been observed consuming juvenile Atlantic Sturgeon (USFWS 2019; Flowers *et al*., 2011). Northern Snakehead (*Channa argus*) is an example of another predatory species that has not yet been introduced to the Connecticut River, but could have future effects on SNS populations if this species becomes established in the river (i.e. Lecky, 2010).

Several native and non-native fish and other aquatic species have the potential to prey on early life stages of SNS or compete with adult and juvenile SNS for food and space. Though interactions with other native species would have occurred historically, the aquatic species assemblage is much different than it was historically for several reasons, including the introduction of non-native species. This could result in different interactions between native species than would have occurred naturally, along with additional interactions with non-native species. Common Carp (*Cyprinus carpio*), which were introduced to the Connecticut River in the late 1800s and are common in the river, also feed in benthic areas and are known to drastically change aquatic food webs and habitats (Nico *et al*., 2020). Common Carp could compete with adult and juvenile SNS for food, and they have also been documented consuming the eggs of other species of sturgeon (Miller and Beckman, 1996; Caroffino *et al*., 2010).

Crayfish tend to reside in the interstitial spaces often synonymous with substrate that would be considered suitable for SNS spawning and rearing; crayfish were identified by Caroffino *et al*., (2010) to be a major consumer of sturgeon eggs. Rusty Crayfish (*Orconectes rusticus*) is a non-native crayfish that is widely distributed in the Connecticut River. Though Kynard and Horgan (2002) found predation rates on SNS eggs and larvae were low, native Fallfish (*Semotilus corporalis*) were documented consuming SNS eggs.

6.3.7 Climate Change

This section presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of SNS. Additionally, available information on the predicted effects of climate change in the action area, and how listed SNS may be affected by those predicted environmental changes over the life of the Proposed Action, are include herein.

The global mean temperature has risen 0.76°C (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC, 2007). Based on substantial evidence, there is a high confidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC, 2007); these trends have been most apparent over the past few decades.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. The Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation (NAST 2000). The Hadley model scenario projects less warming and a significant increase in precipitation (about 20%) (NAST, 2000). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3°-5°C (5°-9°F) on average in the next 100 years which is more than the projected global increase. A warming of about 0.2°C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC, 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions.

Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al*., 2008). The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al*., 2008). Data from the 1960s through 2006 show that the North Atlantic Oscillation NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC, 2007). This warming extends over 0.62 miles deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC, 2007). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene et al. 2008). There is evidence that the NADW has already freshened significantly (IPCC, 2007). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole Earth system (Greene *et al*., 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Connecticut River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Warming is likely to continue in the U.S. over the next 25 to 50 years, regardless of reduction in GHGs, due to emissions that have already occurred. It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST, 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC, 2007).

Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2°C (0.4°F) per decade; and 3) a rise in sea level (NAST, 2000). Sea level is expected to continue rising during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

6.3.7.1 Predicted Impacts of Climate Change Related to Shortnose Sturgeon

Climate change may affect SNS in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. SNS spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile SNS have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, the location of SNS spawning and rearing habitat could be affected. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. In most river systems, spawning occurs miles upstream of the salt wedge. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers like the Connecticut River, including the action area. SNS are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, SNS may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all SNS life stages, including adults, may become susceptible to stranding. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey.

Cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing SNS in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species. In the action area, SNS are known to spawn within a narrow day-length window that must also overlap with other suitable conditions such as water temperatures and flow rates. If water temperatures warm and hydrology changes, the amount of overlap of the SNS spawning day length window with the other conditions could be reduced.

6.3.8 Conservation and Recovery Actions Reducing Threats to Listed Species

In 1998, NMFS issued the Final Recovery Plan for SNS (NMFS, 1998). The long-term recovery objective for SNS is to recover all discrete population segments to levels of abundance at which they no longer require protection under the ESA. To achieve and preserve minimum population sizes for each population segment, the final recovery plan recommends identifying and preserving essential habitats and monitoring and minimizing mortality. Other key recovery tasks are to define essential habitat characteristics, assess mortality factors, and protect SNS through applicable federal and state regulations.

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7 EFFECTS OF THE PROPOSED ACTION

Effects of the Action are all consequences to listed species or designated critical habitat that are caused by the Proposed Action, including the consequences of other activities that are caused by the Proposed Action. A consequence is caused by the Proposed Action if it would not occur "but for" the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR § 402.02).

Because there has been no population of SNS documented in the TFI despite extensive efforts to find them there, the effects of the Proposed Action are evaluated for the action area between the Turners Falls Dam and Holyoke Dam.

7.1 Protection, Mitigation, and Enhancement Measures

7.1.1 Fish Passage Measures – Construction and Operation

FirstLight's proposal includes provisions for providing improved fish passage measures, primarily pertaining to American Shad, at the Turners Falls Dam spillway, and discontinuing operation of fish passage at the Cabot Station ladder.

7.1.1.1 Spillway Fish Lift and Turners Falls Plunge Pool Construction

Designs for construction of a lift at the Turners Falls Dam spillway, at the location of the current fish ladder, along with the plunge pool proposed to improve downstream fish passage, are in the conceptual phases. Therefore, the exact details and extent of the construction activities are unknown. However, these items will likely require in-stream access of heavy equipment, drilling into bedrock, and localized dewatering of areas to aid in safe and effective construction activities. Potential effects on SNS from this type of construction could include noise disturbance, disruption of substrate, stranding during dewatering efforts, and encounters of individual fish with heavy equipment and activities being performed by the heavy equipment (e.g. construction of cofferdams). FirstLight anticipates that construction will be performed outside of the SNS spawning and rearing season, even though SNS are not known to be present in this area at that time. FirstLight will also consult with NMFS during the design and permitting phases for this construction, to ensure that the effects of any construction activities on SNS would be minimized. Due to the uncertainty of any proposed construction and because any potential effects would be directly related to details of construction that are unknowable at this time, any consequences of construction activities are not reasonably certain to occur at this time and are therefore not considered further in this BA. It is anticipated that permits will need to be obtained from the U.S. Army Corps of Engineers. Additional consultation to consider the effects of construction activities on SNS may be necessary at such time that any permits are proposed.

7.1.1.2 Spillway Fish Lift Operation and Maintenance

Though SNS are not known to inhabit the area directly below Turners Falls Dam during the fish passage season, and they have never been observed passing the spillway fish ladder, rare occurrences of SNS entering fish ladders have been documented (Kynard, 2008). On the Connecticut River, SNS enter and pass at the Holyoke Dam via a fish lift. Therefore, if SNS encounter a fish lift at the Turners Falls Dam spillway, some individuals may be drawn to and enter the lift. It is also possible that the frequency of SNS inhabiting areas directly below the Turners Falls Dam could increase based on the proposed operational changes and associated increases in habitat suitability outlined in Section 7.2, increasing their likelihood of encountering a lift at the dam. Therefore, SNS could be captured in the fish lift, or be impacted by fish lift maintenance activities. FirstLight has developed a SNS Handling Plan (Appendix A), which includes measures for fish lift operators to follow, should SNS be encountered in the proposed fish lift during routine operations and maintenance activities. For individual SNS that are captured in the lift, there could be effects from capture, handling, and transport (i.e. injury, mortality). However, the measures in the SNS Handling

Plan are designed to minimize those effects, such that SNS are returned back to the Connecticut River safely and without additional stressors.

7.1.2 Construction and Maintenance of Recreation Areas

Proposed recreational enhancements below Turners Falls Dam are limited to development of:

- Formal Access Trail and Put-In just below Turners Falls Dam
- Formal Access Trail and Stairs for Take-out at Poplar Street

These proposed recreational enhancements are improvements on existing trails and river access points. Most construction would be minor, such as vegetation clearing and would be primarily within onshore areas. Installation of the stairs at Poplar Street would occur on the riverbank and could extend into the water. The put-in below Turners Falls Dam would include a ramp extending into the water. The designs for recreational enhancements are currently conceptual, and the exact details and extent of construction activities are not known. Therefore, any construction activities involving recreational sites below Turners Falls Dam that are on or near the water may temporarily affect SNS (e.g. noise disturbance, localized dewatering, disturbance of near-shore substrates). Construction downstream of Turners Falls Dam involving recreation sites will be performed in accordance with applicable permits, which would include any required monitoring and mitigation measures for SNS, as necessary. FirstLight will also consult with NMFS during the design and permitting phases for this construction, to ensure that the effects of any construction activities on SNS would be minimized. Due to the uncertainty of any proposed construction and because any potential effects would be directly related to details of construction that are unknowable at this time, any consequences of construction activities are not reasonably certain to occur at this time and are therefore not considered further in this BA. It is anticipated that permits will need to be obtained from the U.S. Army Corps of Engineers. Additional consultation to consider the effects of construction activities on SNS may be necessary at such time that any permits are proposed.

Most maintenance of recreation areas is not likely to result in any impacts to SNS unless there would need to be repairs of in or near-water structures requiring the use of heavy equipment. If this type of maintenance is encountered, it will be considered construction, and will be performed in accordance with applicable permits, which would include any required monitoring and mitigation measures for SNS, as necessary.

Because the recreational enhancements proposed for the action area are only improvements upon existing access locations, FirstLight does not anticipate changes to effects on SNS from recreational uses.

7.1.3 Ultrasound Array Installation and Operation

FirstLight is proposing to install and operate an ultrasound array at Cabot Station to prevent American Shad from being attracted to and remaining in the Cabot Station tailrace and promoting their passage into the bypass reach where they could then migrate up to a fish lift at the Turners Falls Dam. Unlike most other fish species, it has been demonstrated that American Shad are able to detect sound up to 180 kHz (Higgs *et. al*., 2004). The ultrasound array studied at Cabot Station as part of relicensing (Study 3.3.19 – *Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace*) was modified to improve its effectiveness over the course of the study. The latest design evaluated in 2018 consisted of multiple transducers that sent out a repeating pattern of 1.5 millisecond pulses, repeated every 200 milliseconds for ten seconds, followed by a one-second rest period. The sound was transmitted at a frequency of 125 kHz.

Studies suggest that sturgeon species can detect sounds from below 100 Hz to around 1.0 kHz (Popper, 2005). Therefore, SNS are not capable of detecting sounds in the high frequency range utilized in an ultrasound array studied at the Project, which was designed to be heard by American Shad. As sturgeon are not able to detect the sound emitted by the ultrasound array, no behavioral or physiological response is anticipated by any SNS.

Further, the ultrasound array would be installed in a manner that does not impact SNS. The ultrasound array installed in 2018 consisted of transducers attached to existing walls at Cabot Station and also suspended below floating buoys that were strung together with mooring lines. This configuration allowed for deployment of the array without any disturbance of the substrate near Cabot Station. Final designs for an ultrasound array at Cabot Station, if similar to the design studied in 2018, would not impact SNS or SNS habitat. FirstLight will continue to consult with NMFS to ensure that final designs, installation, and operation of the array does not affect SNS.

7.2 Project Operations

Though many of FirstLight's proposed operational measures take into consideration several resources, there was consideration given to the habitat needs of SNS for several items in the proposals for the Projects. To assist FirstLight in considering the needs of SNS, extensive data collection and modeling were completed by FirstLight through development of an operations model using HEC-ResSim[8], along with data collection, modeling, and analyses from other relicensing studies[9,10]. Results of the studies, and tools developed during the studies, are useful for evaluating the impacts of proposed operational effects on SNS relative to the baseline condition.

The analyses below focus on comparing the amounts of suitable habitat present between modeled baseline and proposed conditions. The baseline operational condition includes Project operations consistent with the existing license. FirstLight has developed hourly flow timeseries data for baseline and proposed conditions using a combination of the HEC-ResSim operations model and a HEC-RAS hydraulic model. Baseline conditions were modeled with the FirstLight Projects and the upstream Great River Projects (Vernon, Bellow Falls, and Wilder) operating under presently licensed conditions. Under proposed conditions, the FirstLight Projects were modeled with their higher bypass flows, ramping rate restrictions and other proposed operational measures as described in Section 3.5. Under proposed operations, FirstLight assumed that the minimum flows below the three upstream Great River Projects (Wilder, Bellows Falls, Vernon) would be equivalent to FirstLight's proposed bypass flows but adjusted by drainage area. This assumption was based on FERC performing an Environmental Analysis (EA) that incorporates the combined effects of the series of hydroelectric projects on the Connecticut River that are undergoing relicensing (Wilder to Turners Falls). Minimum flows released from the upstream projects affect inflows into the Turners Falls Impoundment. If inflows to the Turners Falls Impoundment from the upstream projects is too low, the Turners Falls Project would not be able to release the proposed minimum flow and would instead release inflow. As such, minimum flows adjusted to the drainage area of the upstream projects would be a reasonable outcome of FERC's EA and subsequent license requirements for the upstream projects.

From the timeseries data, FirstLight evaluated flow frequencies and magnitudes that would be relevant to SNS given their seasonal needs based on their life-history and presence in various areas relevant to Project effects.

Additionally, FirstLight evaluated the effects of each operational scenario on habitat by comparing the flows provided from the timeseries datasets to the habitat-flow relationships developed for various life stages of SNS. The habitat-flow relationships were developed as part of Study No. 3.3.1 during relicensing, with the amount of suitable habitat represented by Weighted Usable Area (WUA). For this study the bypass reach and the reach below Cabot Station was delineated into five (5) reaches. The five reaches were delineated primarily based on hydraulics as described below.

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[8] Relicensing Study 3.8.1 – *Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation, and Hydropower Generation*
[9] Relicensing Study 3.2.2 – *Hydraulic Modeling of Turners Falls Impoundment, Bypass Reach, and below Cabot Station*
[10] Relicensing Study 3.3.1 – *Instream Flow Habitat Assessments in the Bypass Reach and Below Cabot Station*

- Reach 1 – Extends from the Turners Falls Dam to the just upstream of the Station No. 1 tailrace. The only known current use of Reach 1 by SNS is foraging by adults in the summer, and this was identified by Kynard *et al*., (2012) as a rare occurrence.
- Reach 2 – Extends from just upstream of the Station No. 1 tailrace downstream to Rock Dam and the upstream end of Rawson Island. There are no known current uses of Reach 2 by SNS, despite extensive study by Kynard *et al*., (2012). However, in the rare case that adults forage further upstream in Reach 1 during the summer, these individuals would have passed through Reach 2.
- Reach 3 – Extends from Rock Dam/Upstream end of Rawson Island downstream to the USGS Gage on the Connecticut River at Montague. Reach 3 hydraulics are complex, given that they are influenced by the magnitude of bypass flow, magnitude of Cabot Station generation flow and the magnitude of flow discharging into Reach 3 from the Deerfield River. This reach contains the only known spawning and rearing habitats that are being utilized by SNS in the action area.
- Reach 4 – Extends from the Montague USGS Gage downstream to the Route 116 Bridge in Sunderland, MA, a distance of approximately nine (9) miles. These areas contain large amounts of foraging habitat for adults, juveniles, and fry, along with overwintering locations, for SNS.
- Reach 5 – Extends from the Route 116 Bridge in Sunderland, MA to the Dinosaur Footprints near Northampton, MA. This reach is heavily influenced by the Holyoke Dam impoundment levels and is characteristic of a riverine impoundment. The upper portions of Reach 5 are known to be used by SNS for foraging and overwintering, and the lower portions of Reach 5 are primarily an impounded riverine corridor that SNS migrate through during upstream and downstream migrations (Kynard *et al*., 2012). Given flow attenuation and the increasing effects of the Holyoke Impoundment with distance downstream, the effects of the Projects would be greater in Reach 4 than Reach 5. In Reach 5, changes in water levels and velocities resulting from Project operations occur but are very limited in magnitude and would not be expected to affect SNS. Evaluations in Reach 4 are therefore more conservative to the resource. As such, the extent of SNS analyses for this BA focuses on Reaches 1 through 4.

The effects of proposed Project operations for measures developed and proposed specifically for SNS, along with a more general overview of the effects of the entire flow proposal on SNS, are examined in this BA.

7.2.1 Measures Developed for Shortnose Sturgeon

Based on data collected, available literature, and discussions with NMFS staff, the spawning and rearing conditions provided by the baseline condition at the Turners Falls Project are potentially limiting the SNS population. This limitation could result from flow variability at the known spawning areas, which limits the viability of habitats in those areas, but potentially also throughout the entire reach above Cabot Station, which may be unused by SNS due to a lack of suitability consistently provided by the baseline flow condition. The primary baseline operational conditions that could be most limiting to the SNS population include:

- Bypass reach minimum flows during the spawning and rearing periods
- Rapid changes in flow from Cabot Station
- Dewatering of rearing shoals

FirstLight has developed measures, based on the best available data, which are intended to benefit the SNS population by improving the conditions available to SNS during the spawning and rearing periods. These measures include:

- Considerably higher bypass reach flows relative to the baseline condition during the spawning and rearing periods

- Ramping restrictions at Cabot Station during the spawning period
- Continuously operating one unit at Cabot Station during the latter portion of the rearing period

Analyses pertaining to these measures are provided below.

7.2.1.1 Bypass Flows throughout Sturgeon Spawning Period

Though SNS are currently only known to spawn in Reach 3, the proposed minimum flows in the Turners Falls Project bypass reach could facilitate their movements throughout the bypass reach and would also support a high percentage of total potential habitat available for spawning SNS in Reaches 1, 2, and 3 during the spawning season (Table 7.2.1.1-1). Given that the spawning habitat vs. flow relationship levels off, and may begin to decline, at the highest flows modeled in Reaches 1 and 2, the proposed minimum flows would provide the highest amount that would have been provided historically, without the presence of the Project. When river flows are within the Project's capacity to control, passing water through Cabot Station provides better habitat than would be present if the Project were not present or operational. This occurs because habitat would begin to decline at high flows in Reaches 1 and 2, and also because generation from Cabot Station results in a higher amount of habitat in Reach 3 than would be available under any potential bypass flow rate.

SNS have been identified as spawning within a relatively narrow day length window between April 27 and May 22, bypass flows specifically identified for SNS will be provided from April 1 through May 31 to allow for early arrival of pre-spawn fish, or a delayed spawning season. Start dates earlier than the known spawning period could also provide a benefit if SNS begin spawning sooner due to climate change.

In Reach 1, the baseline operational condition during the SNS spawning period allows flows in the bypass reach to drop to approximately 400 cfs from the Turners Falls Dam when inflows are relatively low and within the Turners Falls Project's hydraulic capacity. Based on modeled historical baseline conditions, this occurs at some point during the spawning season every year, and in some years, 400 cfs in Reach 1 would be the median flow during the spawning period (Figure 7.2.1.1-1). Alternatively, FirstLight's proposed bypass reach flow would be expected to provide 4,290 cfs from Turners Falls Dam to Reach 1, and the frequency of higher flows would be similar to the baseline condition (Figure 7.2.1.1-1). Increasing the minimum base flow in Reach 1 would result in a four-fold increase in the amount of habitat provided by the minimum flow in Reach 1 from around 200,000 ft^2 during the baseline condition, to over 800,000 ft^2 during the proposed condition (Figure 7.2.1.1-2). Spatially, the proposed minimum flow would provide more contiguous areas of suitable spawning habitat in Reach 1 than is available under the minimum flow for the baseline condition (Figure 7.2.1.1-3).

In Reach 2, the baseline operational condition during the SNS spawning period allows flows in the bypass reach to drop to approximately 400 cfs from the Turners Falls Dam when inflows are relatively low and within the Turners Falls Project's hydraulic capacity. Based on modeled historical baseline conditions, this occurs at some point during the spawning season every year (Figure 7.2.1.1-4). Alternatively, FirstLight's proposed bypass reach flow would be expected to provide a minimum of 6,500 cfs to Reach 2 during the entire spawning period most years (Figure 7.2.1.1-4). Years with flows in Reach 2 that are lower than 6,500 cfs would be indicative of periods of very low inflow, during which all inflow would be flowing through Reach 2 and Cabot Station would not be operating; as such, during low flow years, the flow through Reach 2 would be consistent with natural low-flow conditions. The proposed bypass minimum flow would substantially increase the amount of suitable spawning habitat in Reach 2, from around 156,000 ft^2 during the baseline condition, to over 1,400,000 ft^2 during the proposed condition (Figure 7.2.1.1-5). Spatially, the proposed minimum flow would provide considerably more contiguous areas of suitable spawning habitat than is available under the minimum flow for the baseline condition (Figure 7.2.1.1-6).

The bypass reach flows entering Reach 3 are the same as those flowing through Reach 2. Therefore, even on an or-inflow basis, the proposed condition would still provide 6,500 cfs or more during most years, in comparison to lower flows provided by the baseline condition (Figure 7.2.1.1-4). Evaluating habitat in

Reach 3 is more complex than in Reaches 1 and 2, due to incoming flow from the bypass reach, varying flows from Cabot Station, and inflows from the Deerfield River, leading to complex hydraulic interactions. Instead of several habitat suitability curves, habitat suitability in Reach 3 can be represented by matrices with bypass reach flow on one axis, and Cabot Station flow on the other axis. The higher proposed bypass reach flow would result in approximately 2 – 2.5 times more suitable habitat area at the full range of Cabot Station flow conditions given low and high Deerfield River inflows (Figure 7.2.1.1-7 and 7.2.1.1-8; Table 7.2.1.1-2). Additionally, at a bypass reach flow of 6,500 cfs, the proposed condition would eliminate the effect of Deerfield River peaking conditions that are observed as a slight effect in the baseline condition (Table 7.2.1.1-2). As such, the amount of habitat area provided to spawning SNS in Reach 3 would be more resilient to changes in flow from the Deerfield River under the proposed condition than it currently is under the baseline condition. Persistent habitat mapping in the reach confirms the increased resilience of habitat for the proposed condition as well, with large amounts of contiguous habitat that would remain suitable under the full range of Cabot Station generation flows (Figure 7.2.1.1-9). This is in comparison to the baseline condition, for which there are relatively few contiguous areas of persistent suitable habitat over the range of Cabot Station flows (Figure 7.2.1.1-9).

Table 7.2.1.1-1: Percent of Maximum Potential Modeled Habitat Provided by Proposed April/May Bypass Flows to Spawning SNS

Reach	Proposed Minimum Flow (cfs) from Source			% of Maximum Habitat Provided
	Turners Falls Dam	Station No. 1	Cabot Station	
1	4,290	-	-	96.0
2	4,290	2,210	-	92.6
3	4,290	2,210	0	97.2
	4,290	2,210	2,500	98.8
	4,290	2,210	4,500	99.2
	4,290	2,210	7,000	99.9
	4,290	2,210	14,000	97.7

Note: 100% of habitat would be the maximum amount of habitat provided at any modeled flow rate. Flow from Deerfield River is assumed to be 200 cfs for Reach 3 for the habitat calculations. Though spawning has never been documented in Reaches 1 and 2, the information is provided here in the event of habitat use expansion by SNS. Flow from Cabot Station only affect spawning habitats in Reach 3.

Table 7.2.1.1-2: Range of Suitable Habitat Area for SNS Spawning Proposed and Baseline Conditions in Reach 3 given Low and High Deerfield River Flows

Deerfield River Flow	Suitable Habitat Area (ft^2)			
	Baseline Condition		Proposed Condition	
	Minimum	Maximum	Minimum	Maximum
Low (200 cfs)	602,575	962,181	1,548,065	1,975,287
High (1,445 cfs)	644,565	1,028,240	1,548,065	1,975,287

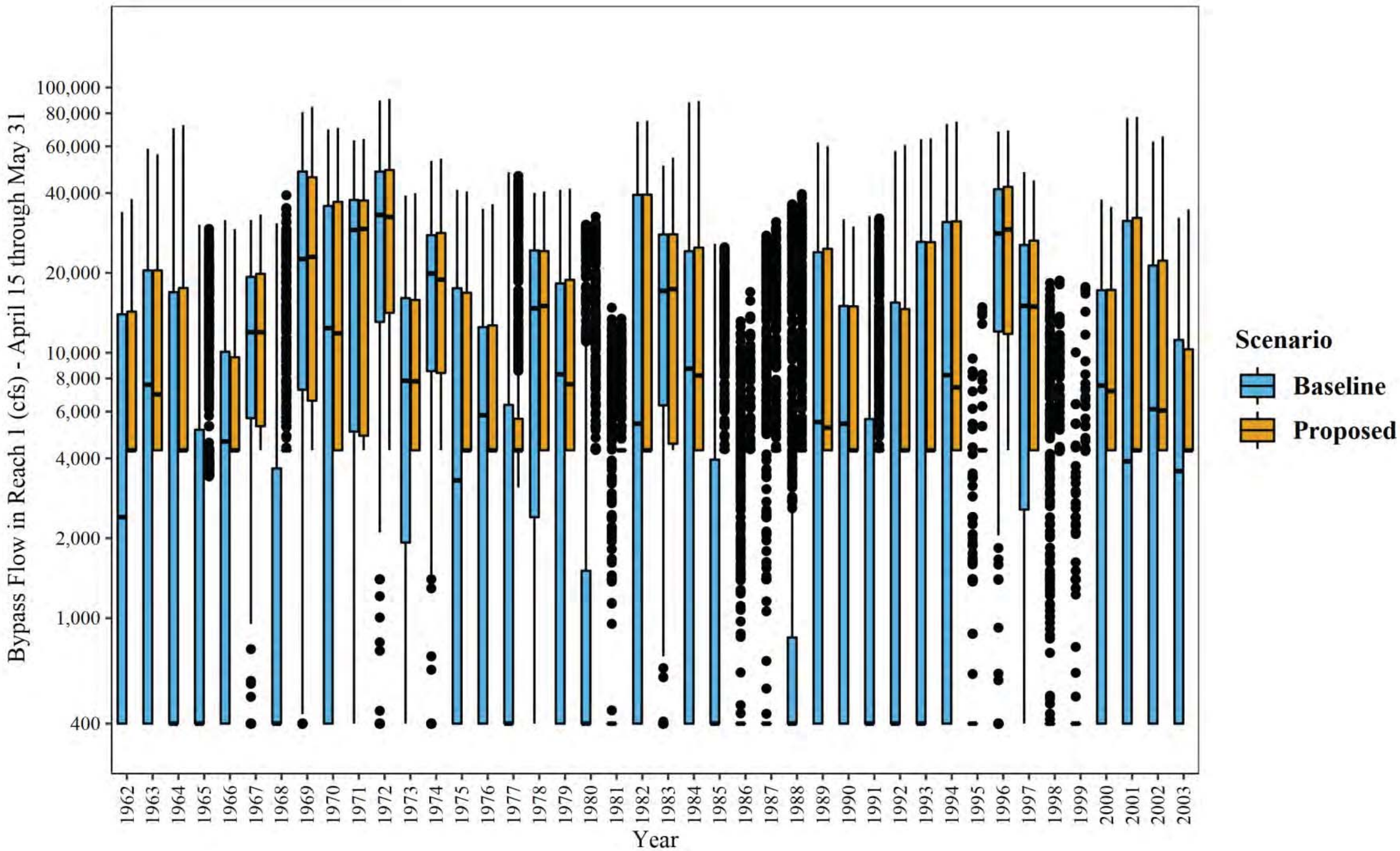

Figure 7.2.1.1-1: Distribution of Flows Modeled in Reach 1 for Baseline and Proposed Conditions during the SNS Spawning Period

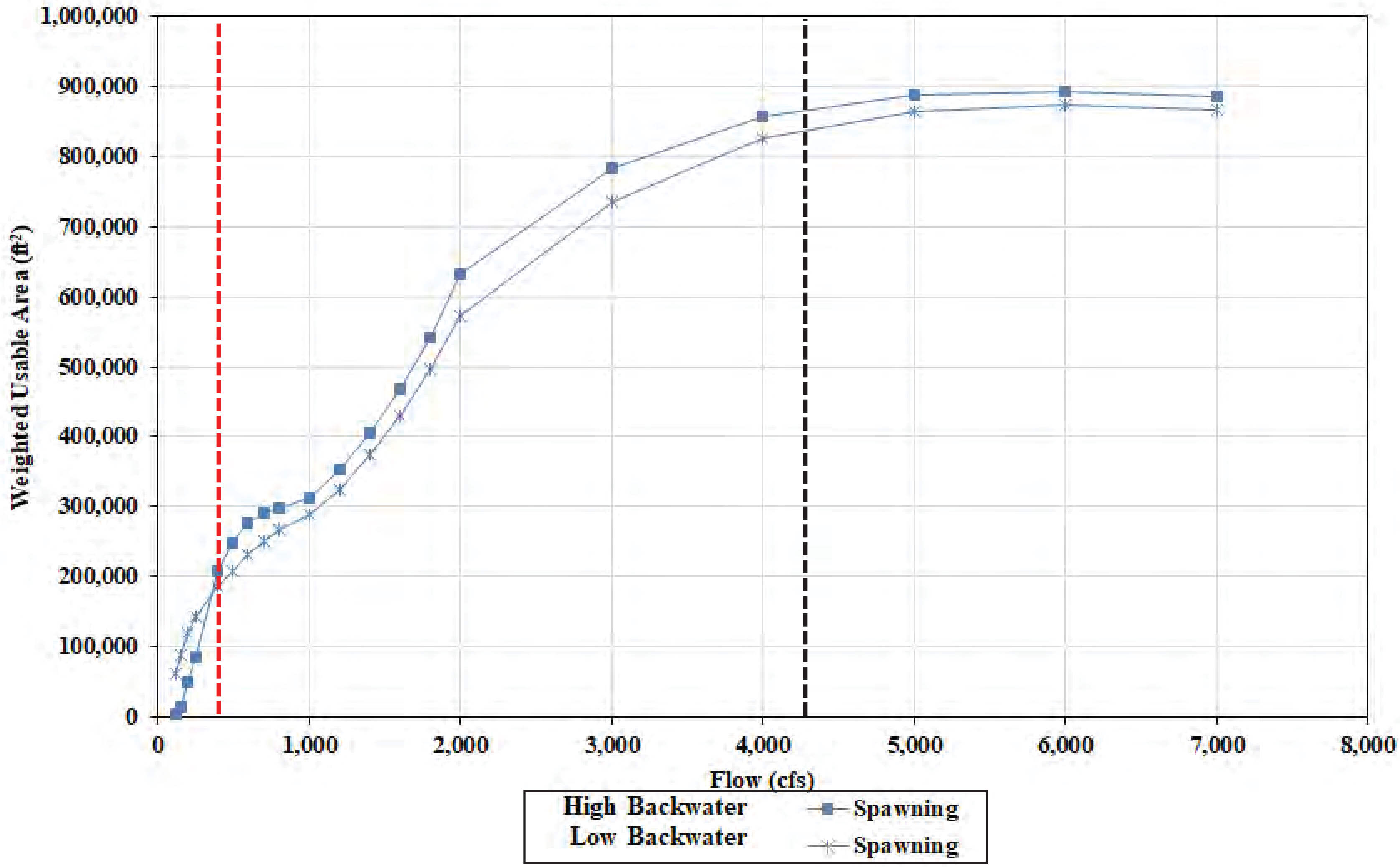

Figure 7.2.1.1-2: Habitat vs. Flow Relationship for SNS Spawning in Reach 1

Note: The vertical black dashed line indicates the proposed minimum flow, whereas the red vertical dashed line indicates the baseline minimum flow.

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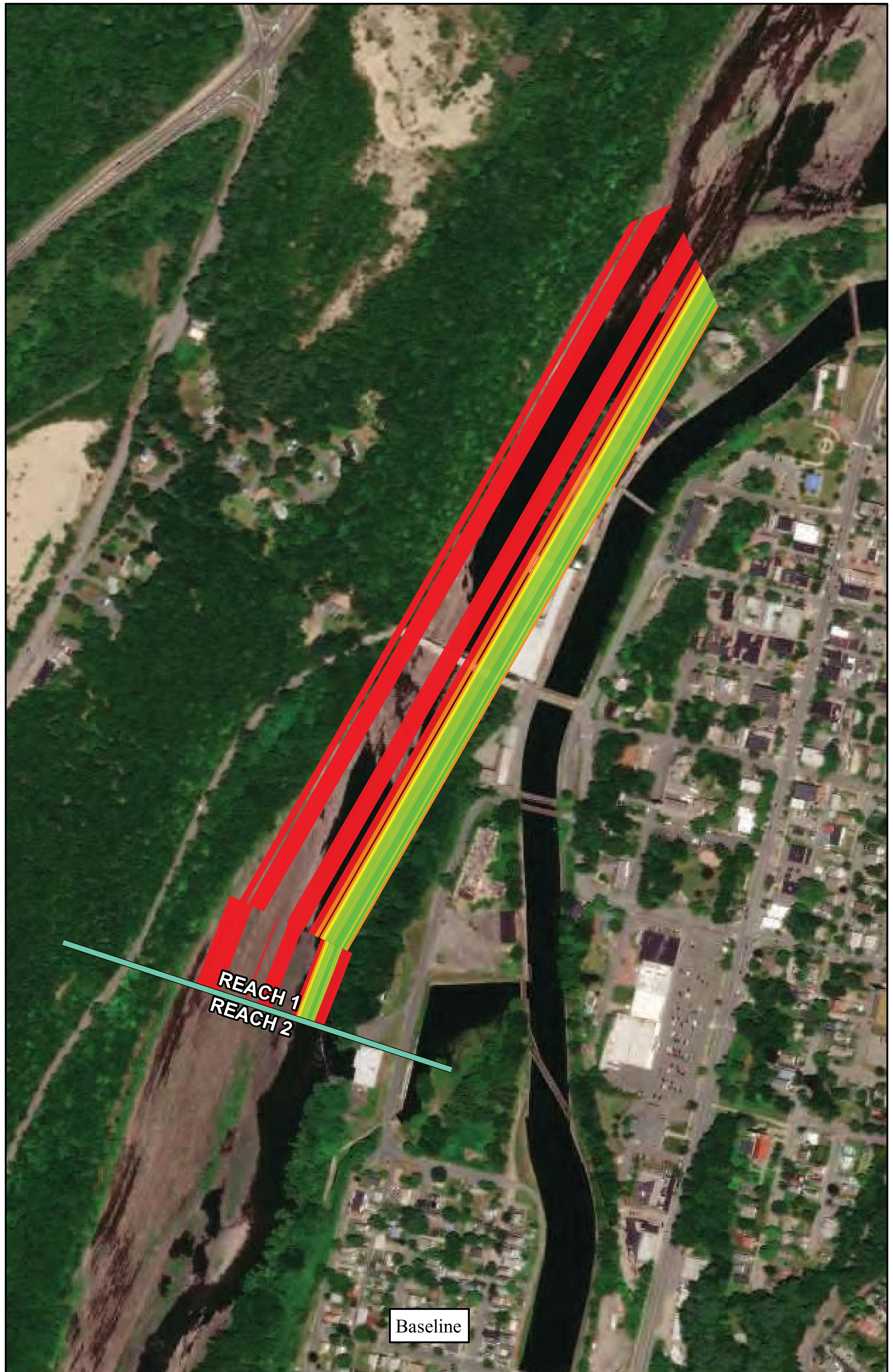

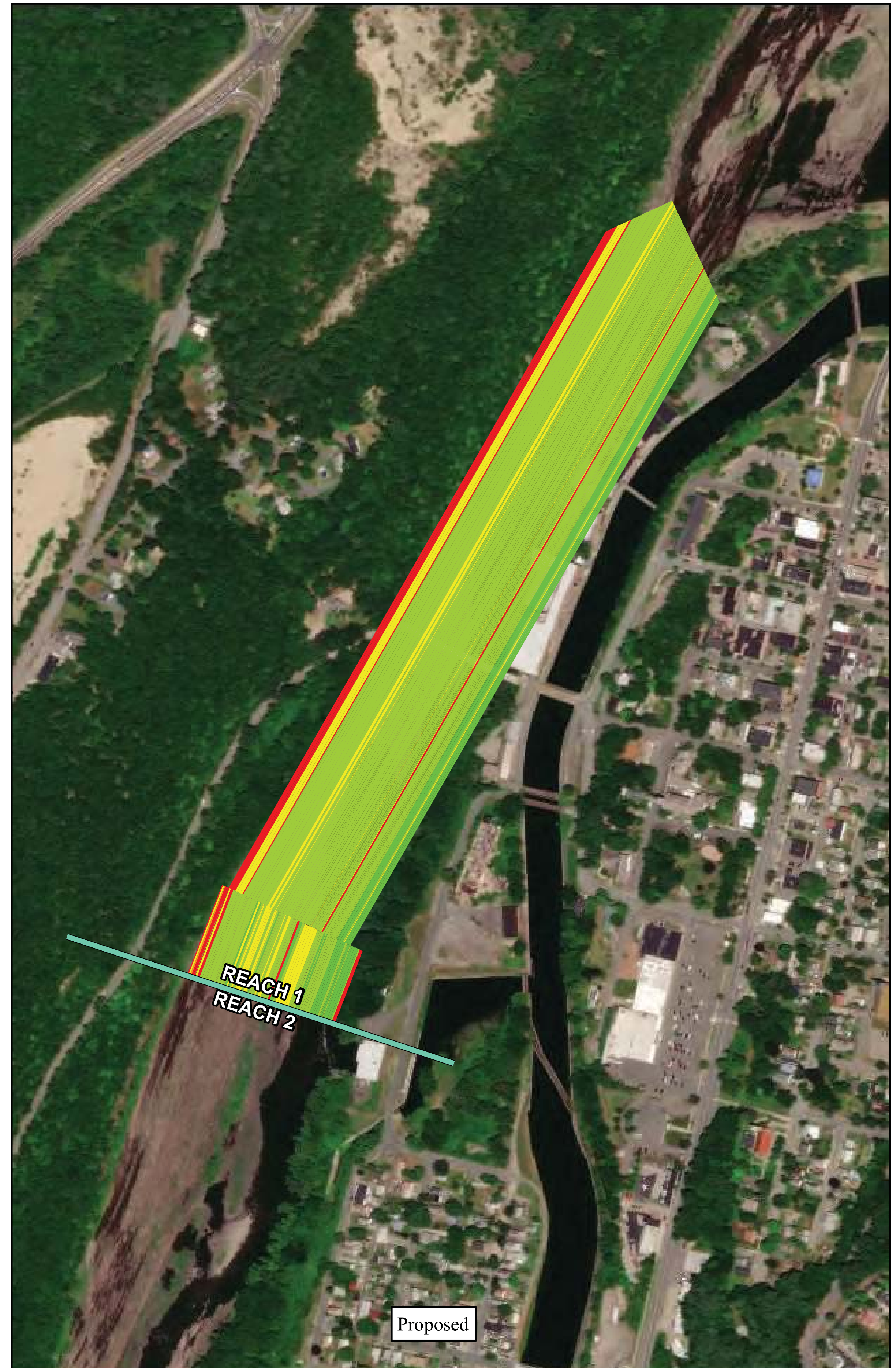

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

BIOLOGICAL ASSESSMENT

Shortnose Sturgeon - Spawning
1-D Portion of Reach 1

Legend

Reach Extent

Combined Suitability Index

- 0.75 - 1
- 0.50 - 0.75
- 0.25 - 0.50
- 0 - 0.25
- 0

N

NOTES:
1. Baseline scenario depicted using Bypass flow of 400 cfs, Station 1 flow of 96 cfs.
2. Proposed scenario depicted using Bypass flow of 4,350 cfs, Station 1 flow of 96 cfs.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 250 500 1,000 Feet

1 inch = 500 feet

Path: W:\gis\studies\sturgeon_biological_assessment\r1_sns_spawning_400_4350_St1_96.mxd

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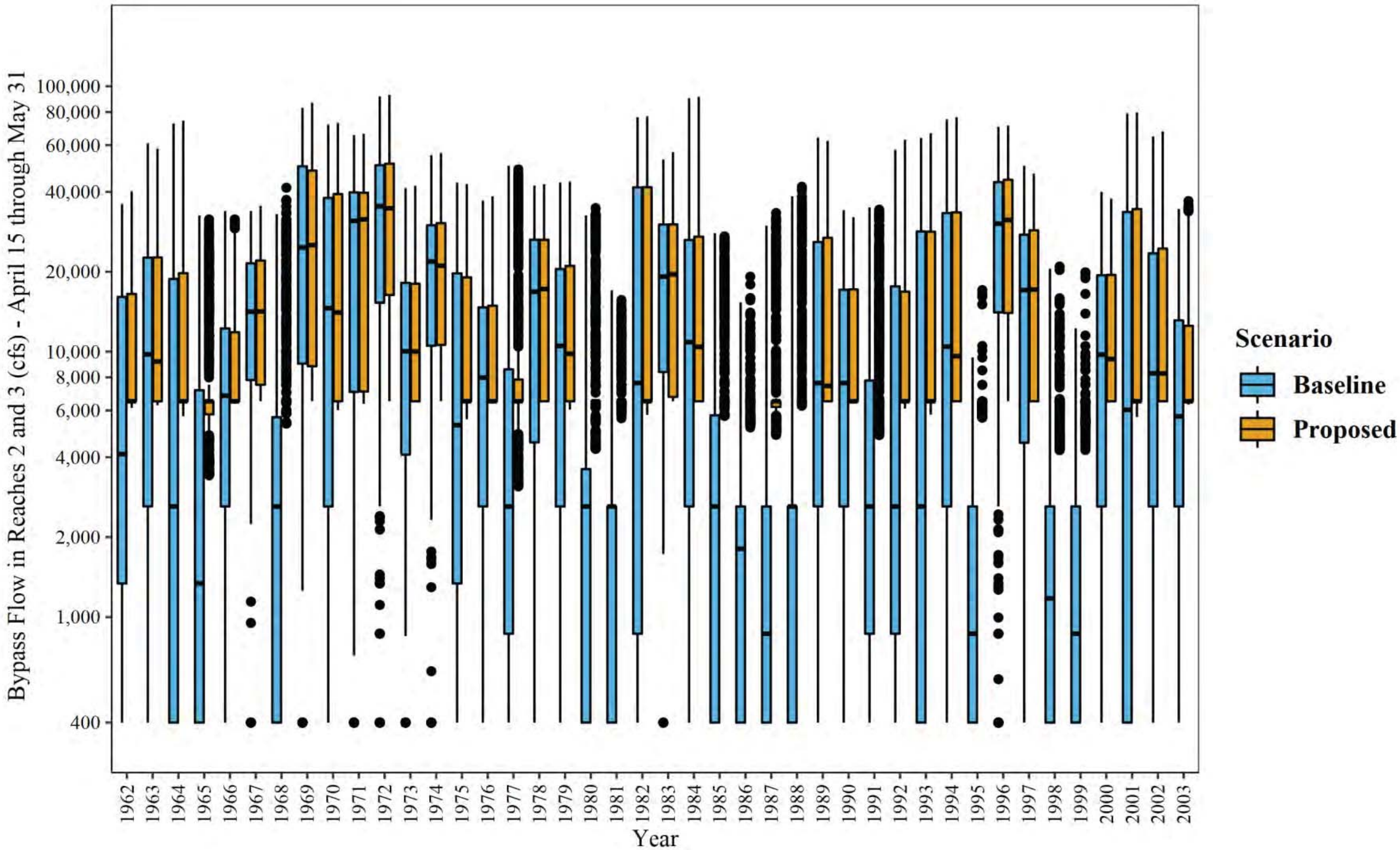


Figure 7.2.1.1-4: Distribution of Flows Modeled in Reaches 2 and 3 for Baseline and Proposed Conditions during the SNS Spawning Period

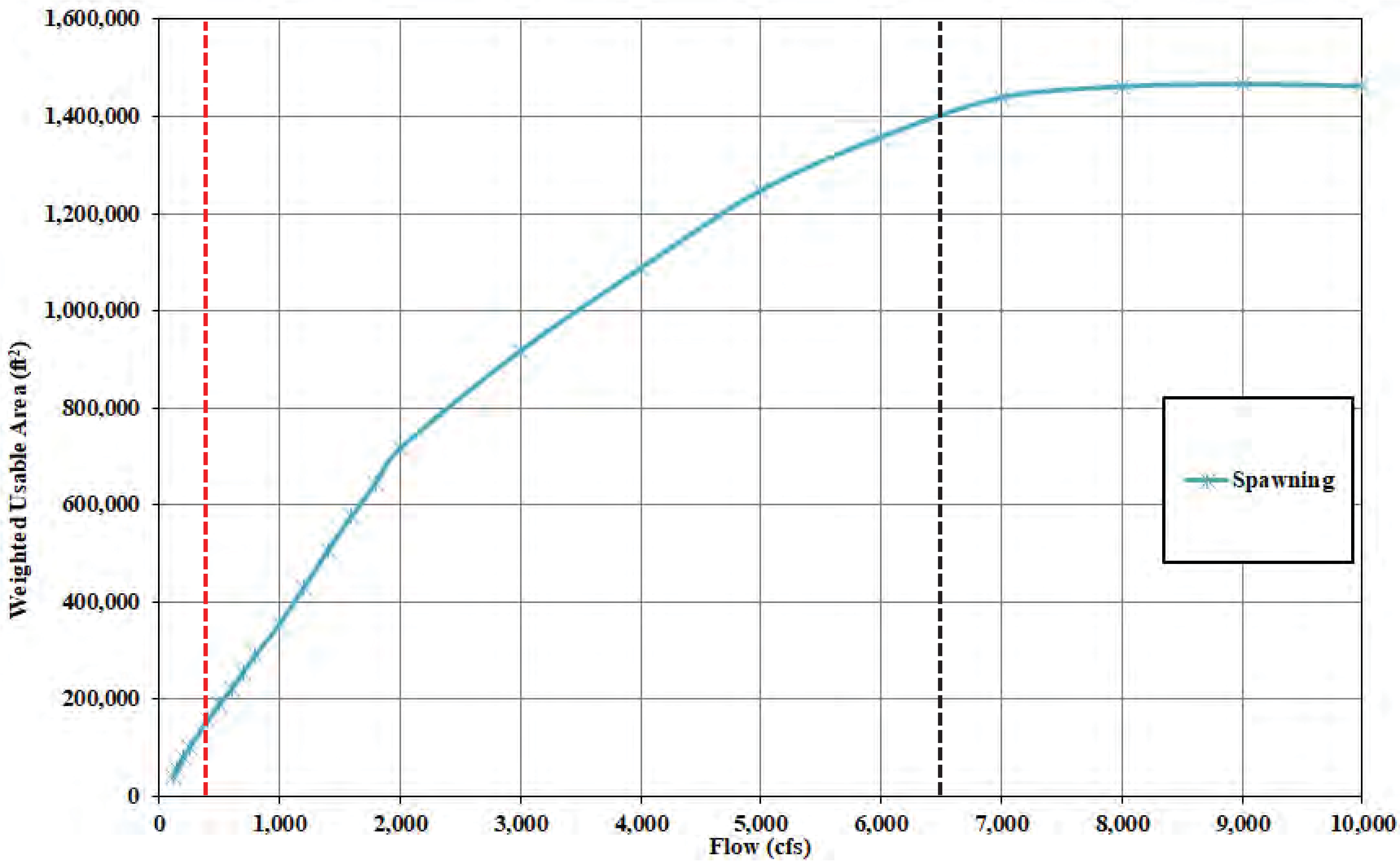
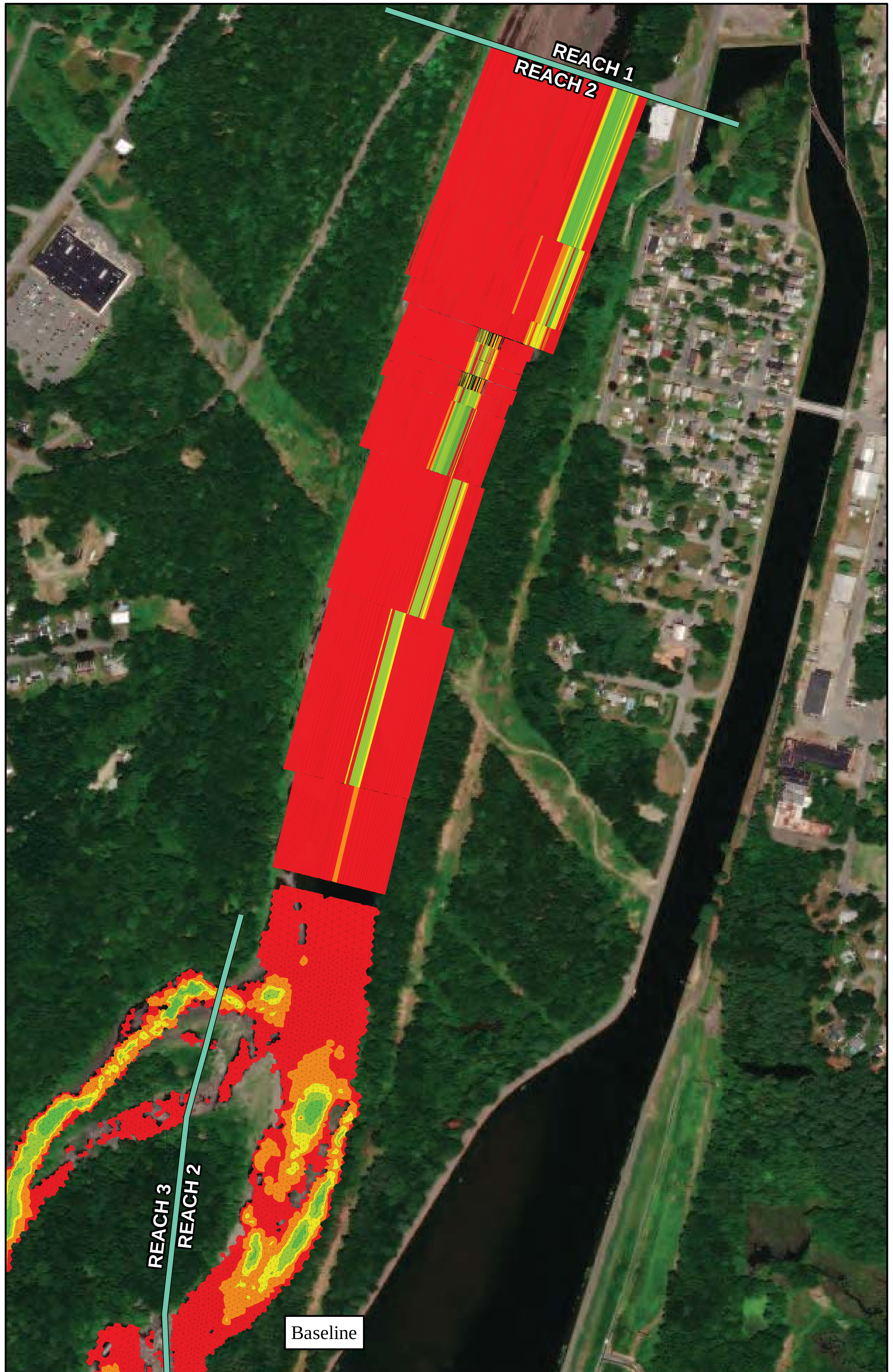
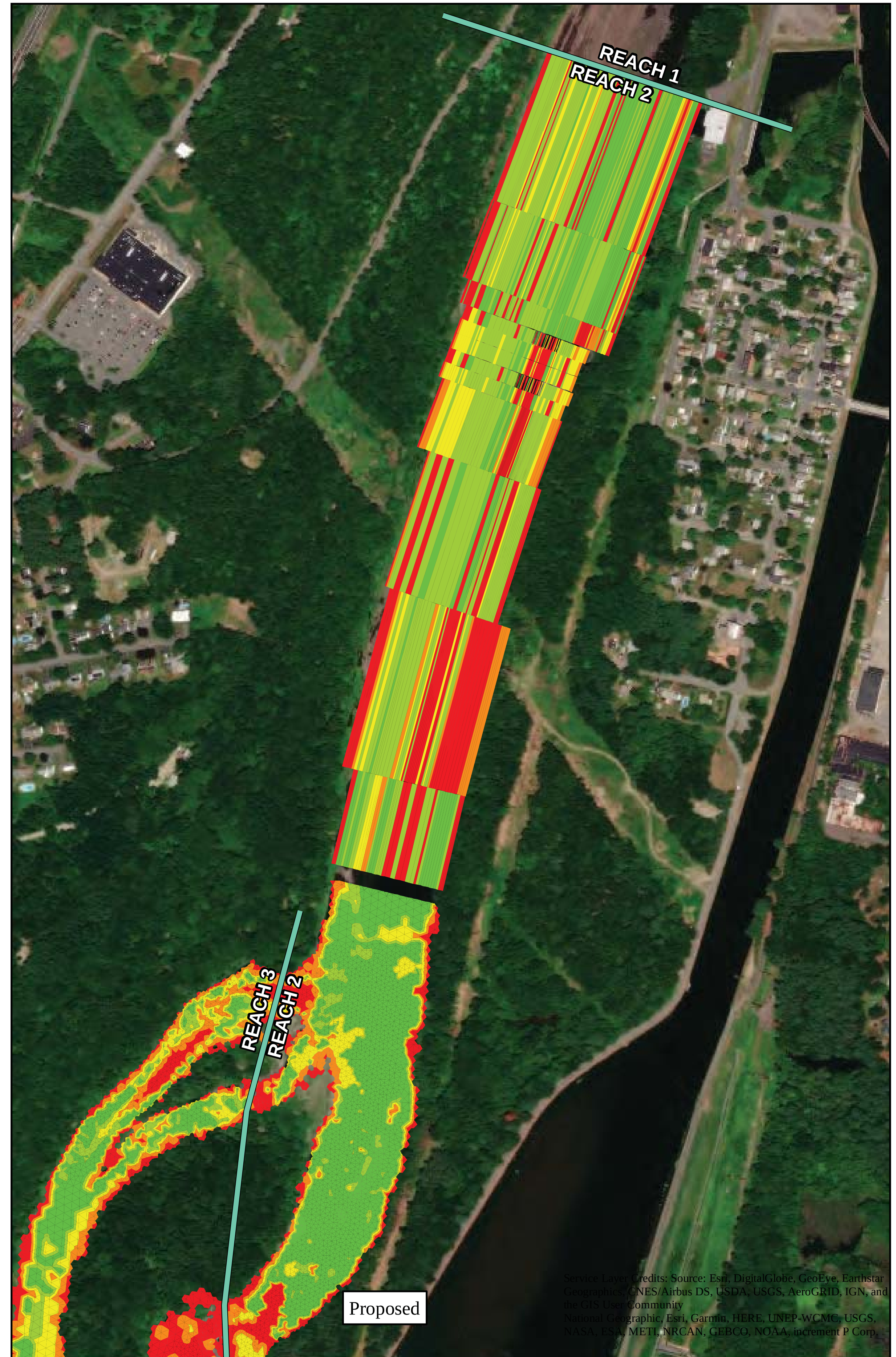


Figure 7.2.1.1-5: Habitat vs. Flow Relationship for SNS Spawning in Reach 2

Note: The vertical black dashed line indicates the proposed minimum flow, whereas the red vertical dashed line indicates the baseline minimum flow.





FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Biological Assessment

Shortnose Sturgeon - Spawning
1-D Portion of Reach 2

Legend

Reach Extent

Combined Suitability Index

0.75 - 1
0.50 - 0.75
0.25 - 0.50
0 - 0.25
0

N

NOTES:
Flows shown were chosen from available models developed for Relicensing Study 3.3.1, and may not be exact relative to Baseline and Proposed Conditions, but are considered to be representative. Modeled flows used to create this map are:

Baseline Modeled Flows
Bypass: 500 cfs

Proposed Modeled Flows
Bypass: 6,500 cfs

0 275 550 1,100
Feet

1 inch = 550 feet

FirstLight

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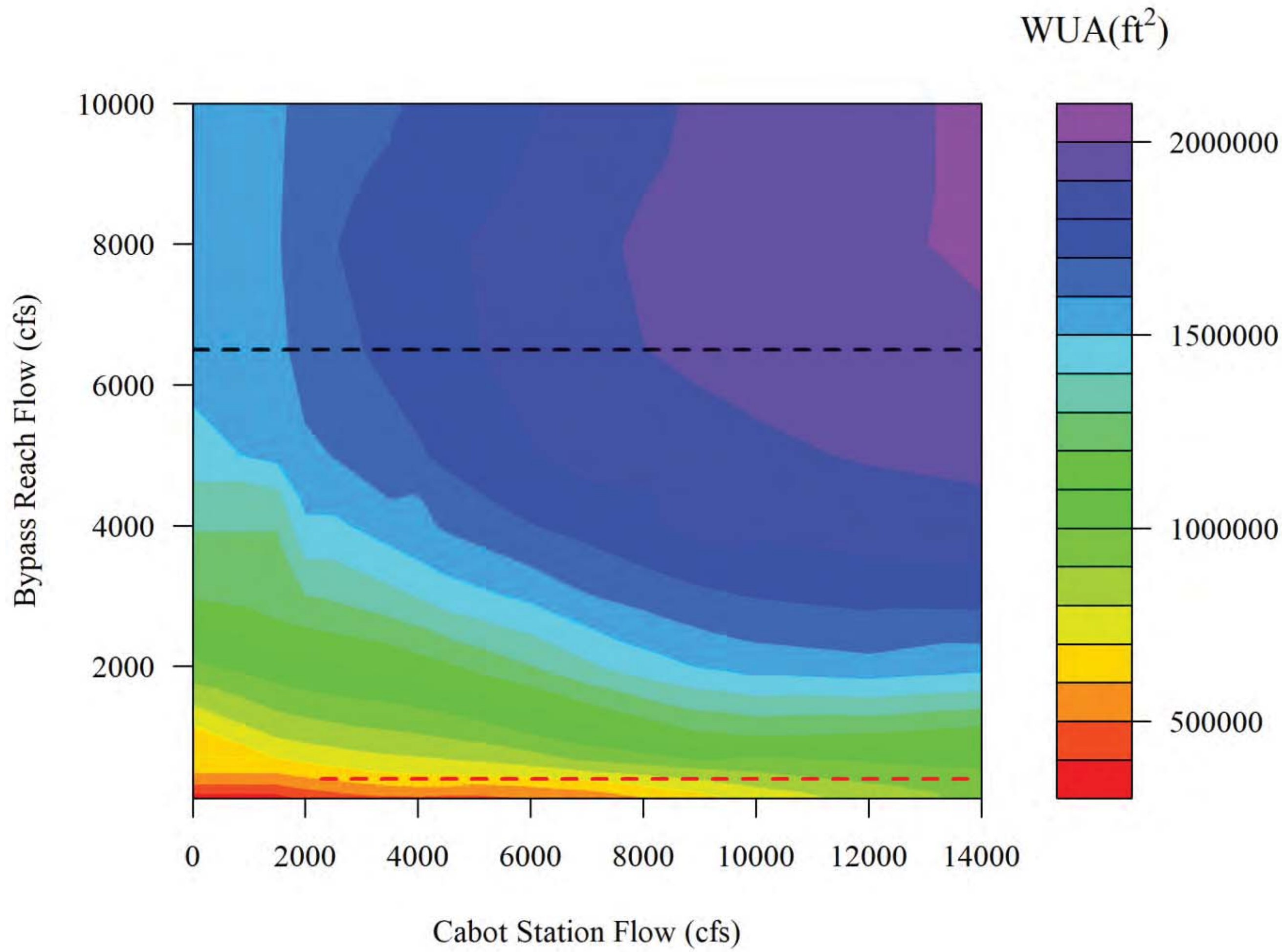

Figure 7.2.1.1-7: Habitat vs. Flow Relationship for SNS Spawning in Reach 3 with Deerfield River Flow at 200 cfs

Note: The horizontal black dashed line indicates the proposed minimum flow, whereas the red horizontal dashed line indicates the baseline minimum flow.

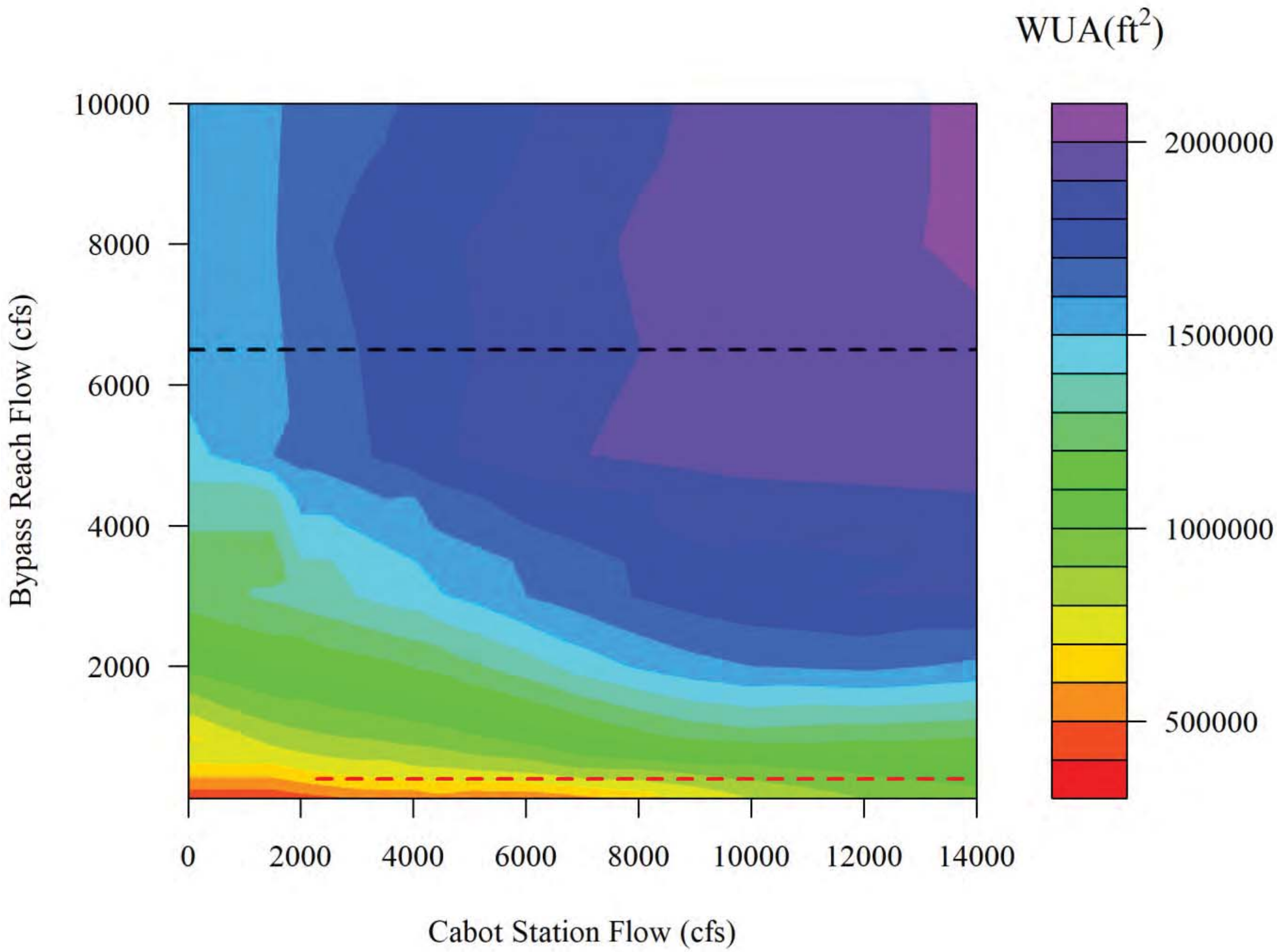

Figure 7.2.1.1-8: Habitat vs. Flow Relationship for SNS Spawning in Reach 3 with Deerfield River Flow at 1,445 cfs

Note: The horizontal black dashed line indicates the proposed minimum flow, whereas the red horizontal dashed line indicates the baseline minimum flow.

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Biological Assessment
Shortnose Sturgeon - Spawning

Legend

Reach Extent

Persistent Habitat - Cabot Flow 1 Thru 2

N

NOTES:
Flows shown were chosen from available models developed for Relicensing Study 3.3.1, and may not be exact relative to Baseline and Proposed Conditions, but are considered to be representative. Modeled flows used to create this map are:

Baseline Modeled Flows
Bypass: 500 cfs
Cabot 1: 2,500 cfs
Cabot 2: 14,000 cfs

Proposed Modeled Flows
Bypass: 6,500 cfs
Cabot 1: 0 cfs
Cabot 2: 14,000 cfs

0 500 1,000 2,000 Feet

1 inch = 1,000 feet

FirstLight

Path: W:\gis\studies\sturgeon_biological_assessment\sns_spawning_persistent_b500_vs_b6500.mxd

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7.2.1.2 Bypass Flows and Cabot Station Base Loading during Sturgeon Rearing Period

SNS eggs and larvae can be present both during the spawning period, and for a short time afterward because they take time to hatch and mature before becoming fry. They could therefore be present at and around spawning areas into early June, after which they disperse downstream as fry (Kynard *et al*., 2012). After the proposed April/May spawning period, bypass flows are proposed to be reduced slightly in June, but special consideration was given to SNS eggs and larvae with regard to the amount of suitable habitat that would be present. Continuously operating (base loading) one unit at Cabot Station was identified as an additional step to further limit flow changes and drastic flow reductions. This would be performed in June, after the decrease in total bypass flow from 6,500 to 4,500. The effects of base loading on rearing habitat only pertains to Reach 3, whereas changes in bypass flows could affect rearing in Reaches 1, 2, and 3.

In Reach 1, the baseline operational condition during the SNS spawning period, when eggs and larvae could be present, allows flows in the bypass reach to drop to approximately 400 cfs from the Turners Falls Dam when inflows are relatively low and within the Turners Falls Project's hydraulic capacity. Based on modeled historical baseline conditions, this occurs at some point during the spawning season every year, and in some years, 400 cfs in Reach 1 is the median flow during the spawning period (see Section 7.2.1.1, Figure 7.2.1.1-1). Alternatively, FirstLight's proposed bypass reach flow would be expected to provide 4,290 cfs from Turners Falls Dam to Reach 1, and the frequency of higher flows would be similar to the baseline condition (see Section 7.2.1.1, Figure 7.2.1.1-1). Increasing the minimum base flow in Reach 1 would result in a four-fold increase in the amount of habitat provided by the minimum flow in Reach 1 from less than 600,000 ft^2 during the baseline condition, to approximately 1,350,000 ft^2 during the proposed condition (Figure 7.2.1.2-1). The effects of backwatering from Station No. 1 are also eliminated at this spill flow (Figure 7.2.1.2-1). Even though flows would be provided on an "or-inflow" basis, when bypass flows are reduced to a proposed minimum of 2,990 cfs from Turners Falls Dam on June 1, historical timeseries data suggests that flows in Reach 1 would fall no lower than 2,000 cfs during the June 1-15 period (Figure 7.2.1.2-2). Flows of 2,000 cfs and greater offer the most habitat for eggs/larvae of SNS in Reach 1 (approximately 1,350,000 ft^2). Alternatively, the baseline condition provided flows as low as 400 cfs during the latter portion of the egg/larvae period every year, providing only 600,000 ft^2 of suitable habitat (Figure 7.2.1.2-2). Therefore, based on the habitat vs. flow relationship and anticipated inflows, the proposed conditions would offer considerably more habitat to SNS eggs and larvae, consistently each year throughout the spawning season and the remainder of the egg/larval period. Spatially, the increase in the amount of habitat provided by the proposed condition in Reach 1, relative to the baseline condition, is substantial (Figure 7.2.1.2-3).

In Reach 2, the baseline operational condition during the SNS spawning period, when eggs and larvae could be present, allows flows in the bypass reach to drop to approximately 400 cfs from the Turners Falls Dam when inflows are relatively low and within the Turners Falls Project's hydraulic capacity. Based on modeled historical baseline conditions, this occurs at some point during the spawning season every year (see Section 7.2.1.1, Figure 7.2.1.1-4). Alternatively, FirstLight's proposed bypass reach flow would be expected to provide a minimum of 6,500 cfs to Reach 2 during the entire spawning period most years (see Section 7.2.1.1, Figure 7.2.1.1-4). Years with flows in Reach 2 that are lower than 6,500 cfs would be indicative of periods of very low inflow, during which all inflow would be flowing through Reach 2 and Cabot Station would not be operating; as such, during low flow years, the flow through Reach 2 would be consistent with natural low-flow conditions. The proposed bypass minimum flow would substantially increase the amount of suitable rearing habitat in Reach 2, from around 791,000 ft^2 during the baseline condition, to approximately 2,000,000 ft^2 during the proposed condition (Figure 7.2.1.2-4). Even though flows would be provided on an "or-inflow" basis, when total bypass flows are reduced to a proposed minimum of 4,500 cfs on June 1, historical timeseries data suggests that flows in Reach 2 would fall no lower than 2,000 cfs during the June 1-15 period, with several years when the minimum flow did not fall below 4,500 (Figure 7.2.1.2-5). Flows of 2,000 cfs and greater offer a high percentage of habitat for eggs/larvae of SNS in Reach 2 and 4,500 cfs offers nearly the maximum amount of available potential habitat in Reach 2 (approximately 2,000,000 ft^2). Alternatively, the baseline condition provides flows as low as 400 cfs during the latter portion of the egg/larvae period every year, providing only approximately 791,000 ft^2 of suitable habitat (Figure 7.2.1.2-4). Therefore, based on the habitat vs. flow relationship and anticipated inflows, the proposed conditions would offer considerably more habitat to SNS eggs and larvae, consistently each year throughout the spawning season and the remainder of the egg/larval period. Spatially, the increase in the amount of habitat provided by the proposed condition in Reach 2, relative to the baseline condition, is substantial (Figure 7.2.1.2-6).

The bypass reach flows entering Reach 3 are the same as those flowing through Reach 2. Therefore, even on an or-inflow basis, the proposed condition would still provide considerably more water than would be provided by the baseline condition during the spawning season (see Section 7.2.1.1, Figure 7.2.1.1-4) and through the remainder of the rearing period (Figure 7.2.1.2-5). Evaluating habitat in Reach 3 is more complex than in Reaches 1 and 2, due to incoming flow from the bypass reach, varying flows from Cabot Station, and inflows form the Deerfield River, leading to complex hydraulic interactions. Instead of several habitat suitability curves, habitat suitability in Reach 3 can be represented by matrices with bypass reach flow on one axis, and Cabot Station flow on the other axis. The higher proposed minimum bypass reach flows, and one unit base loaded at Cabot Station in June, would result in more suitable habitat area at the full range of Cabot Station flow conditions given low and high Deerfield River inflows (Figure 7.2.1.2-7 and 7.2.1.2-8; Table 7.2.1.2-1). Specifically, the baseline minimum flow conditions could provide as little as 1,568,286 ft^2 of habitat for eggs and larvae, and the maximum amount of habitat provided by the baseline condition (2,322,338 ft^2) is less than the minimum amount of habitat provided by the proposed conditions (2,456,255 ft^2). As such, the amount of habitat area provided to spawning SNS in Reach 3 would be more resilient under the proposed condition than it currently is under the baseline condition. Persistent habitat mapping in the reach confirms the increased resilience of habitat for the proposed condition as well, with large amounts of contiguous habitat that would remain suitable under the range of Cabot Station generation flows proposed (Figure 7.2.1.2-9). This is particularly evident in the right (west) channel around the Smead Island Complex, across from Cabot Station (Figure 7.2.1.2-9).

After mid-June, eggs and larvae would have matured to the fry stage and would be dispersing downstream. At this point, total bypass flows are proposed to be reduced to 3,500 cfs. Continuing base loading (the hydraulic equivalent of a single Cabot unit) through the end of June would promote continued dispersal of fry downstream and maintain more habitat for post-drift fry in Reach 4 when compared to the baseline condition (Figure 7.2.1.2-10). Though peaking during this period could limit habitat suitability for fry in Reach 4, the frequency and magnitude of peaking are likely to be reduced relative to the baseline condition due to higher proposed bypass flows and base loading at Cabot Station. This would provide benefits to fry in Reach 4 compared to the baseline condition during periods when inflows are lower than the hydraulic capacity of the Turners Falls Project.

Table 7.2.1.2-1: Range of Suitable Habitat Area for SNS Rearing under Proposed and Baseline Conditions in Reach 3 given Low and High Deerfield River Flows

Deerfield River Flow	Suitable Habitat Area (ft²)							
	Baseline Condition			Proposed Condition (April-May)			Proposed Condition (June 1-15)	
	Minimum	Maximum		Minimum	Maximum		Minimum	Maximum
Low (200 cfs)	1,568,286	2,246,625		2,456,255	2,668,282		2,525,535	2,658,099
High (1,445 cfs)	1,623,492	2,322,338		2,456,255	2,668,282		2,536,206	2,671,332

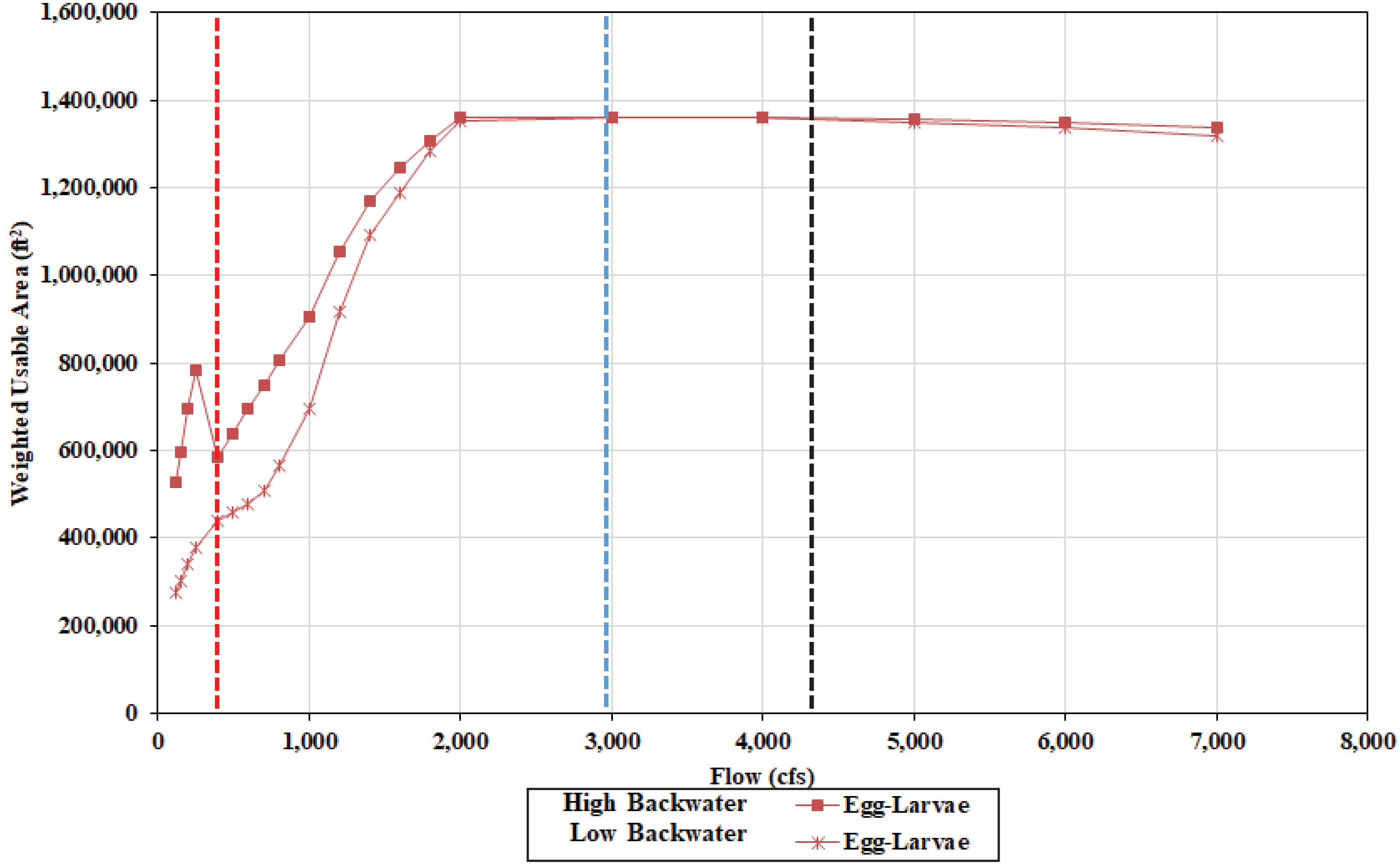

Figure 7.2.1.2-1: Habitat vs. Flow Relationship for SNS Eggs and Larvae in Reach 1

Note: The vertical black dashed line indicates the proposed minimum flow from April-May and the blue vertical dashed line indicates the proposed minimum flow from June 1-15, whereas the red vertical dashed line indicates the baseline minimum flow.

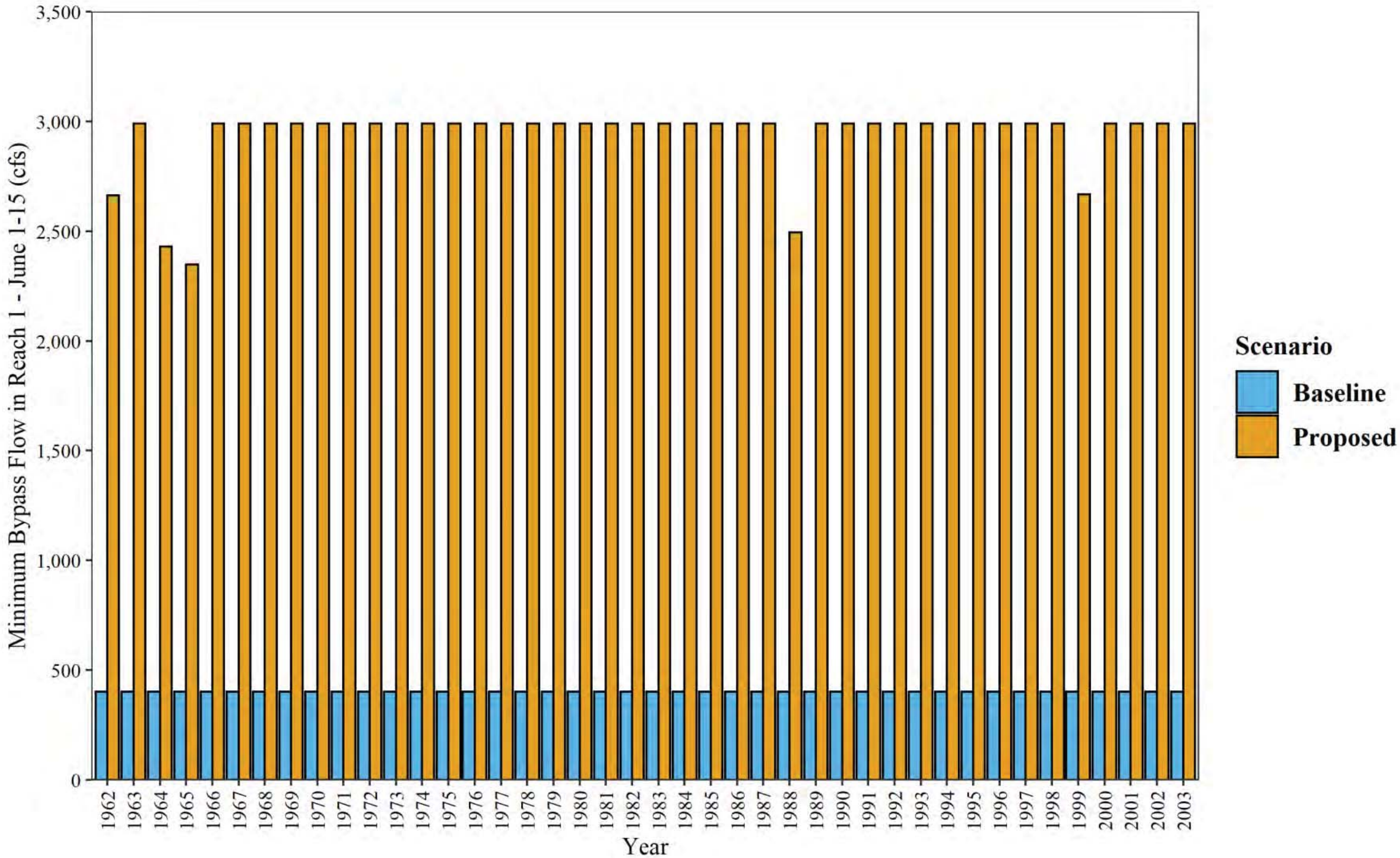

Figure 7.2.1.2-2: Minimum Modeled Flow Provided during the June 1-15 Portion of the SNS Rearing Season in Reach 1

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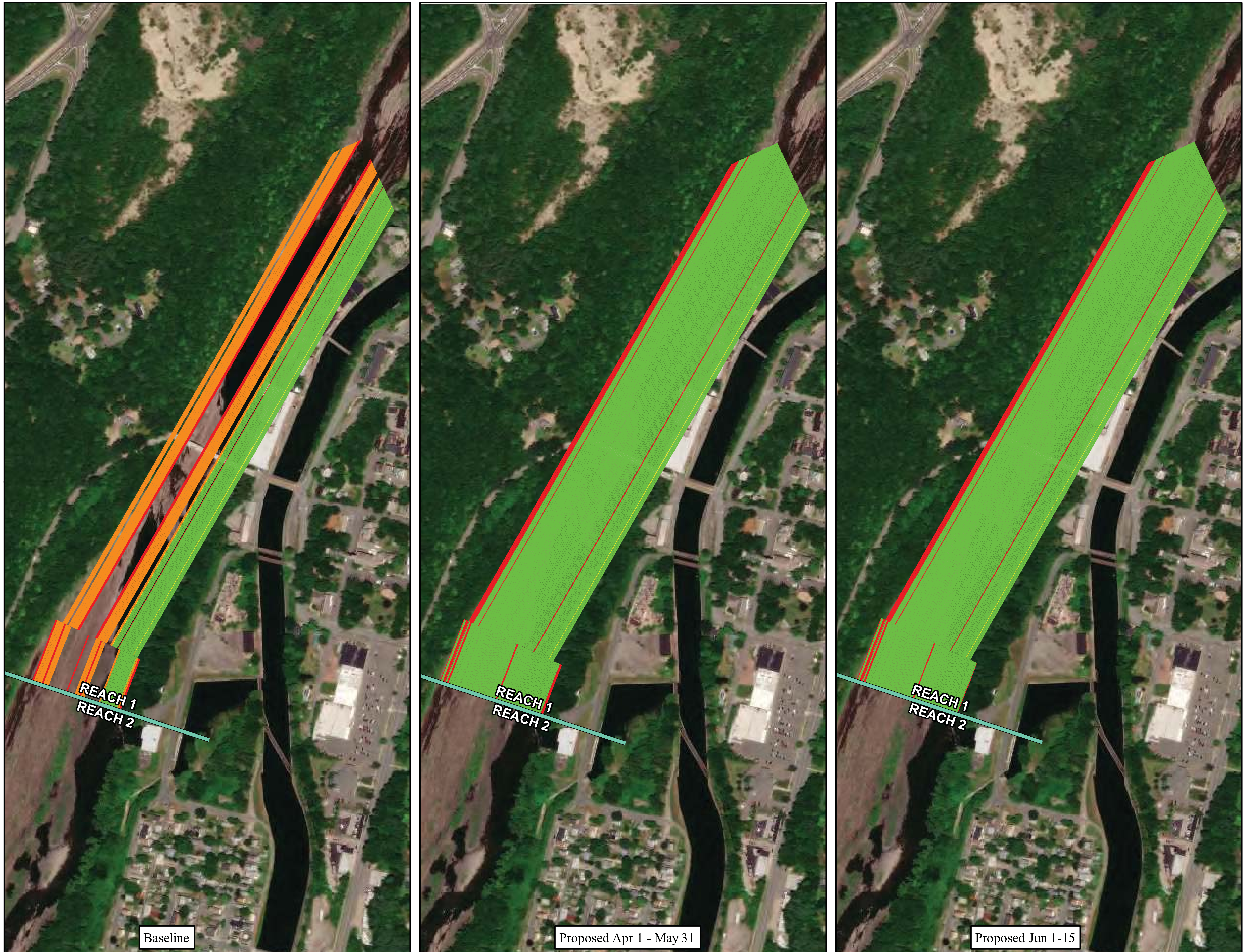

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

RELICENSING STUDY 3.3.1

Shortnose Sturgeon - Egg
1-D Portion of Reach 1

Legend

N

Reach Extent

Combined Suitability

- 0.75 - 1
- 0.50 - 0.75
- 0.25 - 0.50
- 0 - 0.25
- 0

NOTES:
1. Baseline scenario depicted using Bypass flow of 400 cfs, Station 1 flow of 96 cfs.
2. Proposed April 1 - May 31 scenario depicted using Bypass flow of 4,350 cfs, Station 1 flow of 96 cfs.
3. Proposed June 1 - 15 scenario depicted using Bypass flow of 3,000 cfs, Station 1 flow of 96 cfs.

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 250 500 1,000 Feet

1 inch = 500 feet

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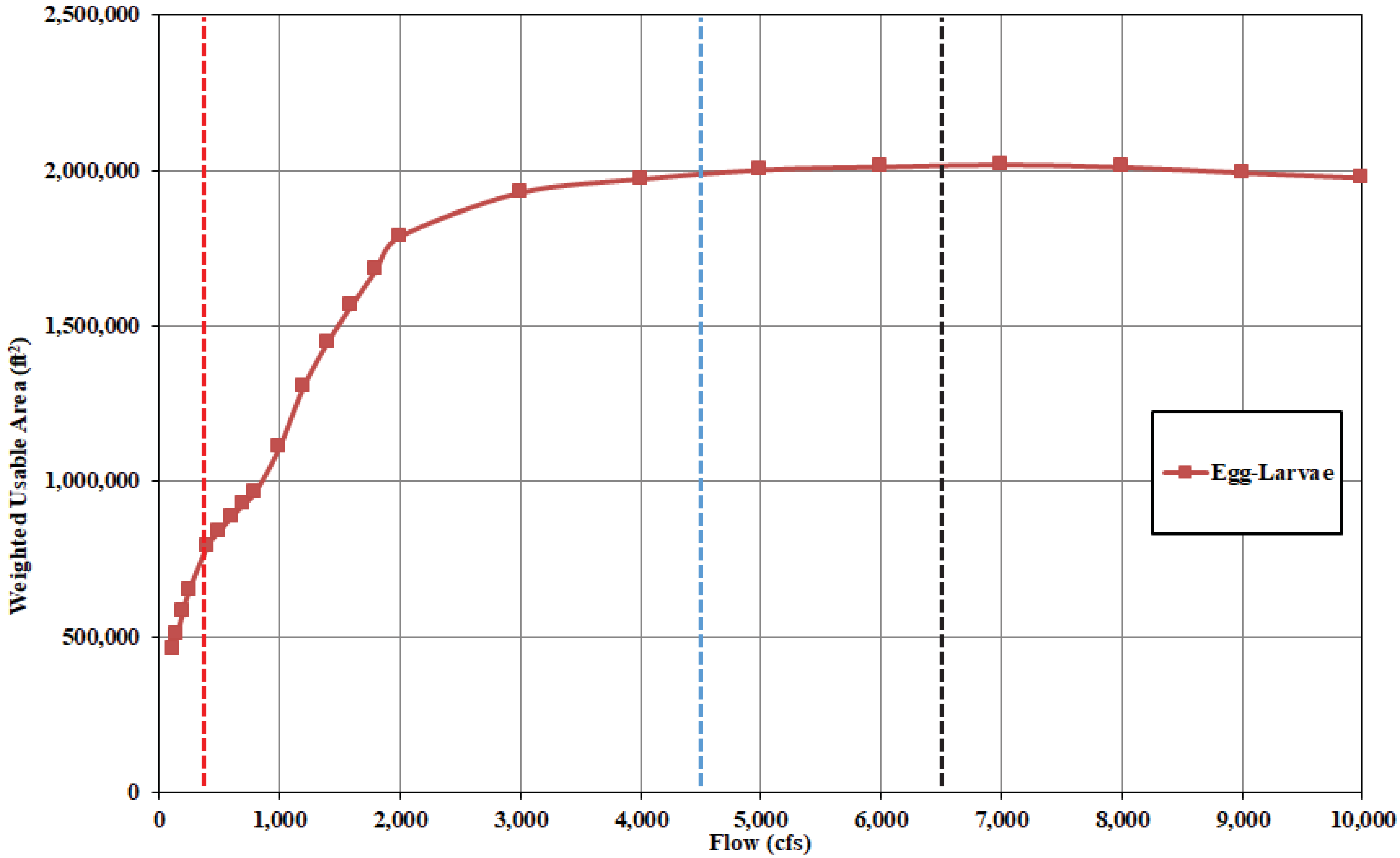


Figure 7.2.1.2-4: Habitat vs. Flow Relationship for SNS Eggs and Larvae in Reach 2

Note: The vertical black dashed line indicates the proposed minimum flow from April-May and the blue vertical dashed line indicates the proposed minimum flow from June 1-15, whereas the red vertical dashed line indicates the baseline minimum flow.

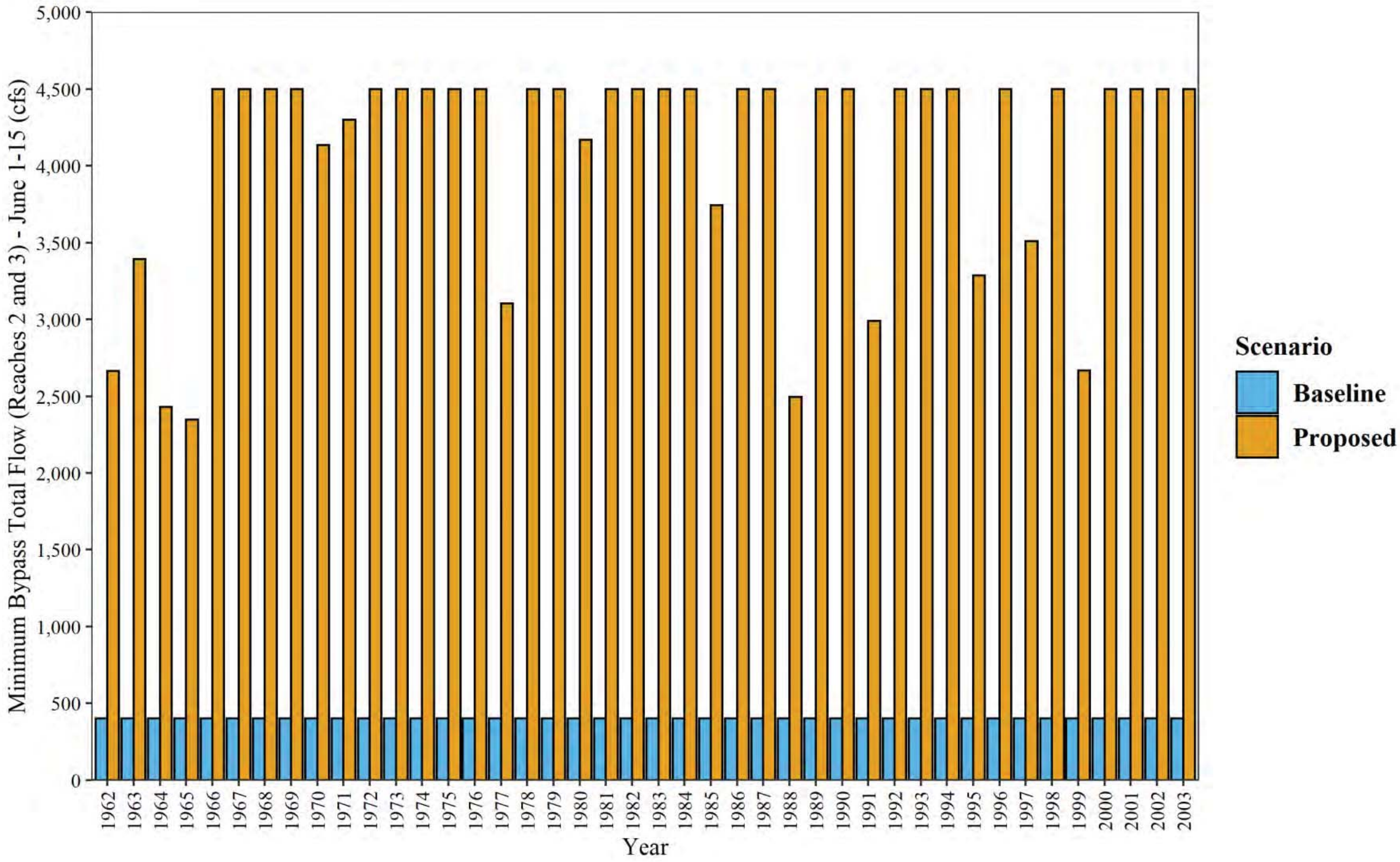
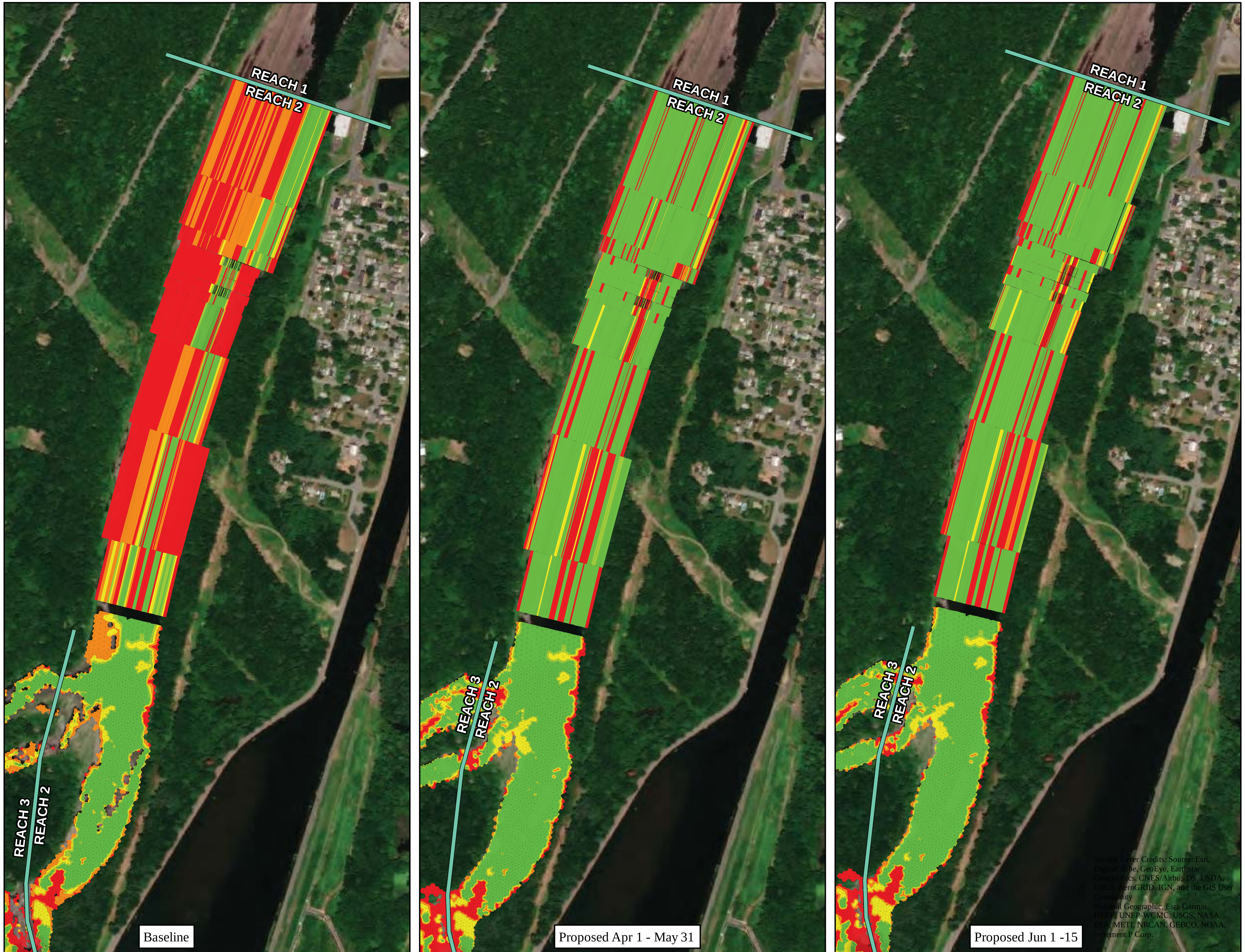


Figure 7.2.1.2-5: Minimum Modeled Flow Provided during the June 1-15 Portion of the SNS Rearing Season in Reach 2



FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Biological Assessment

Shortnose Sturgeon - Egg/Embryo
1-D Portion of Reach 2

Legend

N

Reach Extent

Combined Suitability Index

- 0.75 - 1
- 0.50 - 0.75
- 0.25 - 0.50
- 0 - 0.25
- 0

NOTES:
Flows shown were chosen from available models developed for Relicensing Study 3.3.1, and may not be exact relative to Baseline and Proposed Conditions, but are considered to be representative. Modeled flows used to create this map are:

Baseline Modeled Flows
Bypass: 500 cfs

Proposed Apr 1 - May 31 Modeled Flows
Bypass: 6,500 cfs

Proposed June 1 - 15 Modeled Flows
Bypass: 4,400 cfs

0 300 600 1,200 Feet

1 inch = 600 feet

FirstLight

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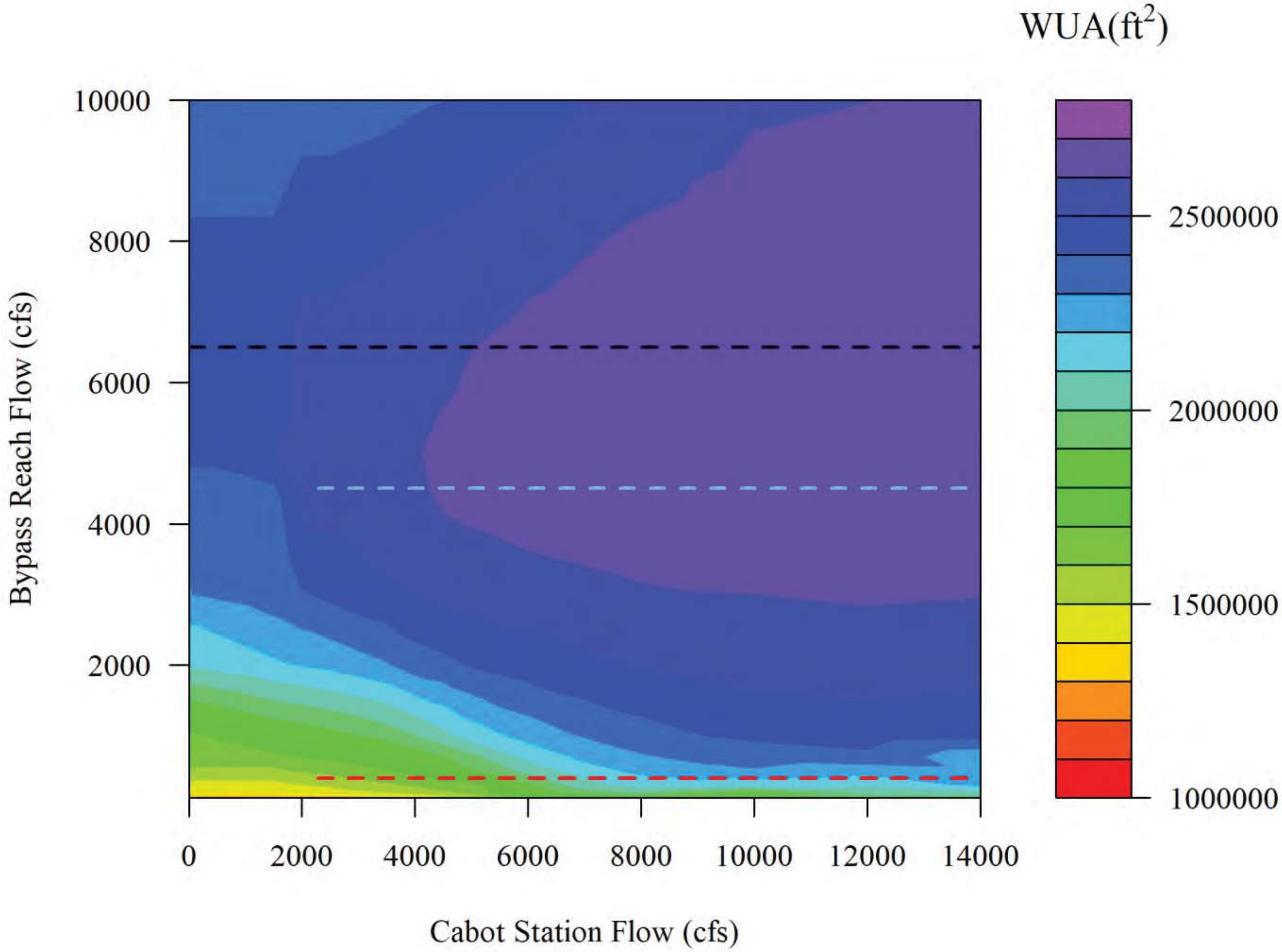

Figure 7.2.1.2-7: Habitat vs. Flow Relationship for SNS Egg and Larvae in Reach 3 with Deerfield River Flow at 200 cfs

Note: The horizontal black dashed line indicates the proposed minimum flow during April-May, the horizontal light blue line indicates the proposed minimum flow from June 1-15, whereas the red horizontal dashed line indicates the baseline minimum flow.

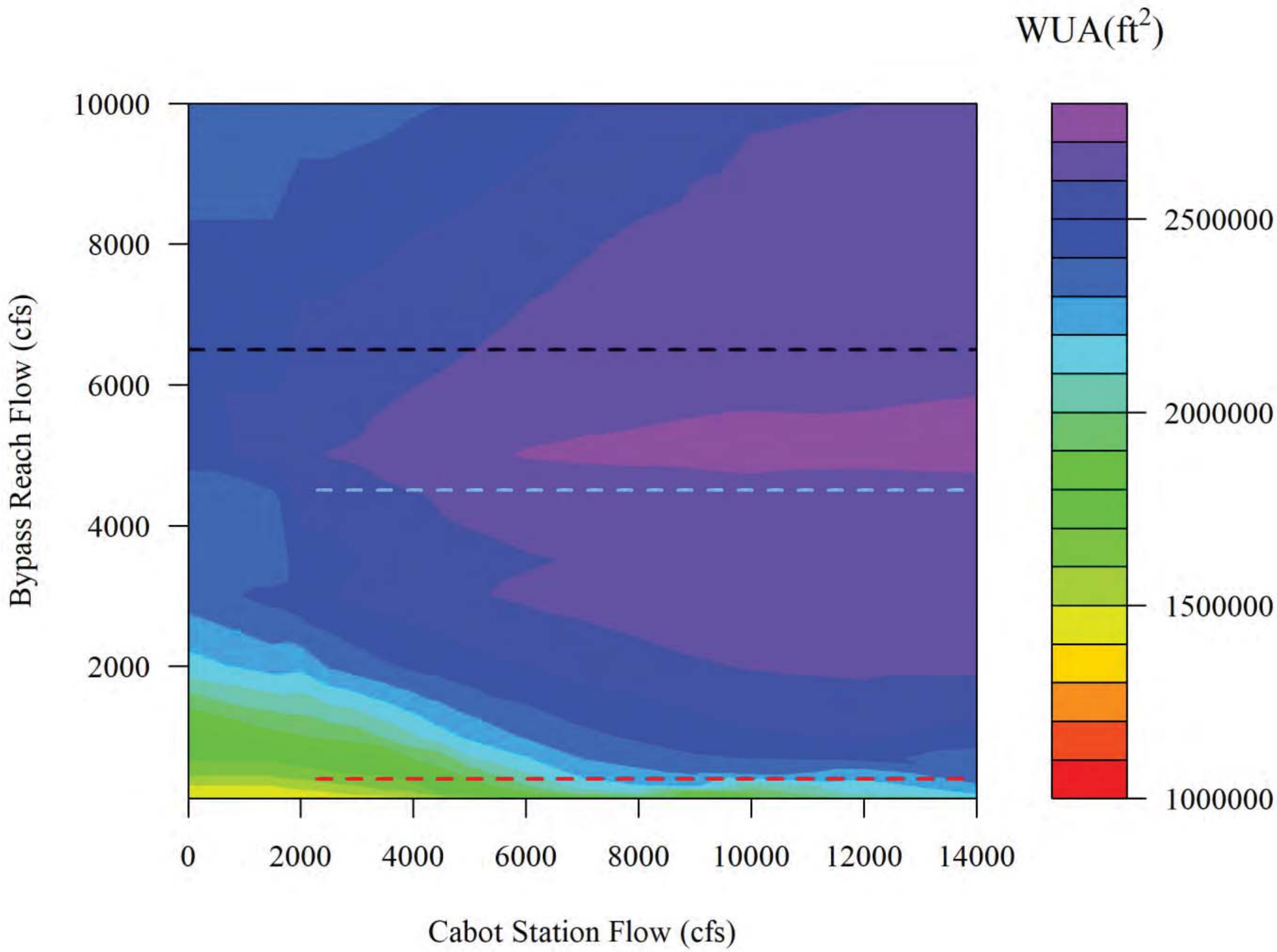

Figure 7.2.1.2-8: Habitat vs. Flow Relationship for SNS Egg and Larvae in Reach 3 with Deerfield River Flow at 1445 cfs

Note: The horizontal black dashed line indicates the proposed minimum flow during April-May, the horizontal light blue line indicates the proposed minimum flow from June 1-15, whereas the red horizontal dashed line indicates the baseline minimum flow.

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Biological Assessment

Shortnose Sturgeon - Egg/Larvae

Legend

Reach Extent

Persistent Habitat - Cabot Flow 1 Thru 2

N

NOTES:
Flows shown were chosen from available models developed for Relicensing Study 3.3.1, and may not be exact relative to Baseline and Proposed Conditions, but are considered to be representative. Modeled flows used to create this map are:

Baseline Modeled Flows
Bypass: 500 cfs
Cabot 1: 2,500 cfs
Cabot 2: 14,000 cfs

Proposed Apr 1 - May 31 Modeled Flows
Bypass: 6,500 cfs
Cabot 1: 0 cfs
Cabot 2: 14,000 cfs

Proposed June 1 - 15 Modeled Flows
Bypass: 4,400 cfs
Cabot 1: 2,500 cfs
Cabot 2: 14,000 cfs

0 500 1,000 2,000 Feet

1 inch = 1,000 feet

FirstLight

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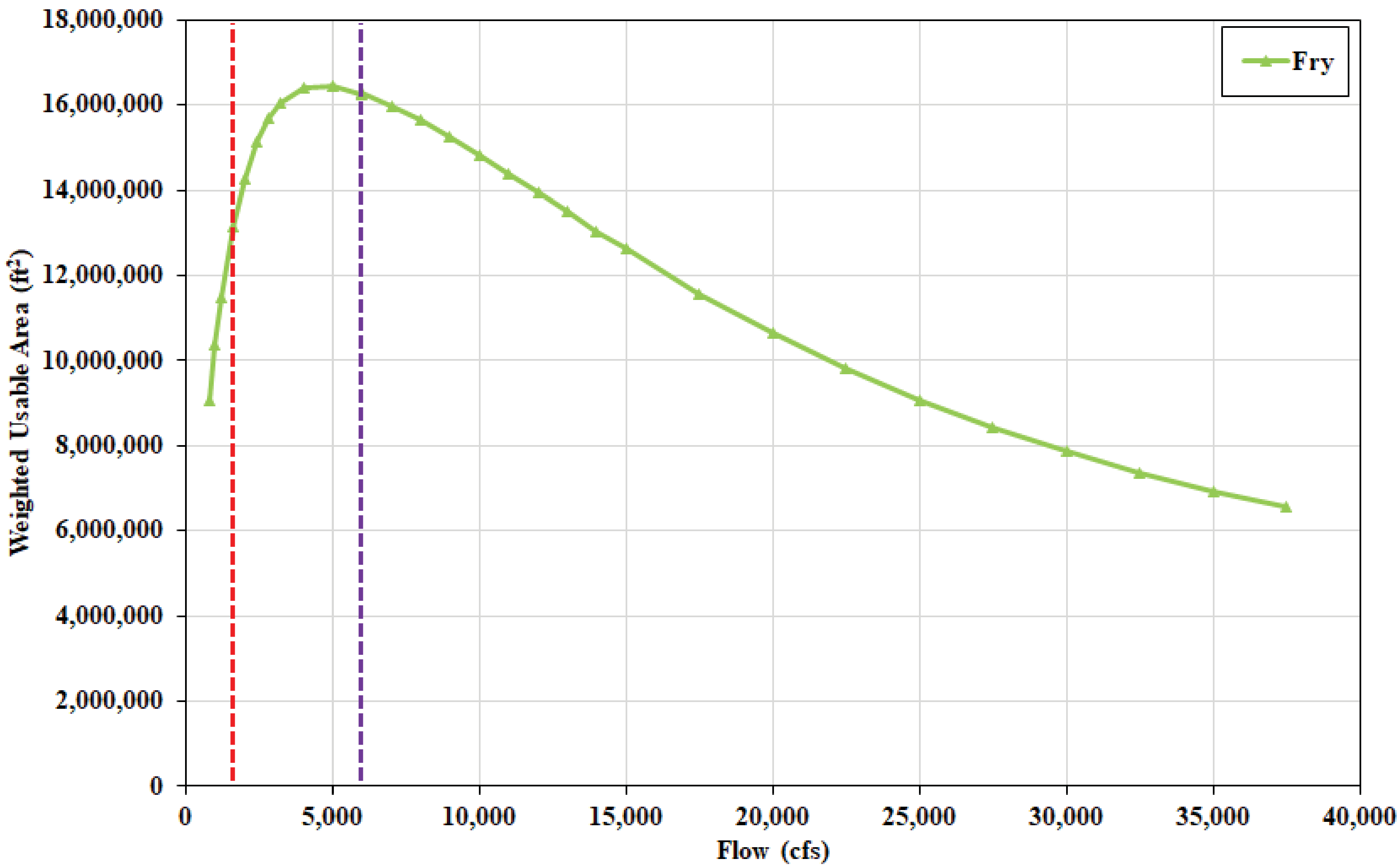

Figure 7.2.1.2-10: Habitat vs. Flow Relationship for SNS Fry in Reach 4

Note: The vertical lines indicate minimum downstream flows for the June 16-30 period. The purple vertical dashed line indicates the proposed minimum flow of approximately 5,988 cfs (approximates 3,500 from bypass reach plus one Cabot Station unit plus 200 cfs from Deerfield River), whereas the red vertical dashed line indicates the baseline minimum flow (approximates 1,433 cfs + 200 cfs from Deerfield River).

7.2.1.3 Ramping Restrictions throughout Spawning Period

As noted on the October 17, 2019 conference call, NMFS indicated that turning Cabot Station rapidly on and off may cause spawning to cease and the SNS egg and larval rearing area to become dewatered or inundated with high velocity flow. To address NMFS' concern, FirstLight is proposing to limit up and down ramping to 1 unit per hour from April 1 to May 31, 24 hours/day.

Kynard *et al*., (2012) studied SNS during spawning at the Rock Dam and Cabot Station spawning areas for 17 years and noted that spawning had not failed near Cabot Station due to peaking operations. However, this change could benefit SNS by limiting the frequency of rapid changes (i.e. sub-daily) that may affect SNS spawning and rearing.

7.2.2 Overall Flow Proposal

7.2.2.1 Spawning and Rearing

The combined flow proposal during the SNS spawning and rearing period includes a combination of bypass flows, ramping restrictions, and Cabot Station base loading, all of which were developed with detailed consideration given to SNS. As discussed in Section 7.2.1, these portions of the flow proposal were designed to benefit SNS spawning and rearing, and/or to mitigate specific effects pertaining to Cabot Station peaking. These actions combined are anticipated to provide conditions that are beneficial for SNS by providing large amounts of suitable spawning and rearing habitat in Reaches 1, 2, and 3 that were unused by SNS during the baseline condition. The proposed condition would provide SNS with the opportunity to expand their spawning to additional suitable areas, primarily in the Turners Falls bypass reach, should they choose to do so. Further, any eggs spawned in new areas would be more likely to survive to the fry stage due to the large amounts of suitable habitat provided through the rearing season by the proposed flows when compared to baseline flows.

7.2.2.2 Foraging

The only known foraging of SNS in the action area occurs on occasions when adults enter the Turners Falls Project bypass reach during the summer; under baseline conditions these occurrences have been rare. Proposed minimum flows in the bypass reach are 1,800 cfs, with 670 cfs spilling from Turners Falls Dam from July 1 through August 31, 500 cfs spilling from the dam from September 1 through November 30, and the remainder being passed through Station No. 1. These flows are considerably higher than the baseline condition, under which 400 cfs is passed from the Turners Falls Dam until the end of the fish passage season at the Project (or July 15), after which the flow is reduced to 120 cfs until river temperatures fall below 7°C in the fall. The higher proposed bypass reach flows could encourage adult SNS to forage more frequently in the bypass reach and other areas near the Turners Falls Project during the summer and early fall period. The proposed summer bypass flows would increase the amount of adult SNS habitat available slightly in Reach 1 (Figure 7.2.2.2-1), to a greater degree in Reaches 2 and 3 (Figures 7.2.2.2-2 and 7.2.2.2-3). In Reach 3, greater amounts of habitat would be available at a variety of Cabot Station flow rates in comparison to the baseline condition (Figure 7.2.2.2-3).

Most SNS, including both adults and juveniles, are known to forage within the relatively long reach of the Connecticut River between Fourth Island and Mitch's Island during the summer and fall, prior to migrating to overwintering areas within the reach in November. The areas closest to the Projects were evaluated in a 9-mile reach, identified as Reach 4 during Relicensing Study 3.3.1. Reach 4 extends from Montague to the Route 116 Bridge in Sunderland. Of any reach between Turners Falls Dam and the Sunderland Bridge, Reach 4 contains the greatest amounts of SNS adult and juvenile foraging habitat, with more than 15,000,000 ft^2 of suitable foraging habitat available between the Project's baseline minimum flow and the maximum hydraulic capacity (Figure 7.2.2.2-4).

The current minimum flow at the Turners Falls Project is 1,433 cfs or inflow, whichever is less. The proposed minimum summer bypass flow is 1,800 cfs or inflow, whichever is less. These flows would be passed downstream in the Connecticut River to Reach 4. Additionally, the Deerfield River also provides flow to Reach 4. The proposed minimum flow would provide an estimated increase of 933,000 ft^2 and 956,000 ft^2 for adult and juveniles SNS in Reach 4, respectively (Figure 7.2.2.2-4). This represents an increase in the amount of suitable foraging habitat of 5.2 and 5.5% in Reach 4 for adult and juvenile SNS, respectively.

Proposed changes to summertime operations also include seasonal peaking restrictions to decrease water level fluctuations during the adult Puritan Tiger Beetle activity period at Rainbow Beach, located within the downstream portion of the SNS summer foraging area, along with TFI hourly water level change restrictions and downstream up-ramping restrictions to protect emerging odonates. These measures will change the timing of peaking and/or spill events and could limit the magnitude of peaking flows. Overall, the effects on SNS foraging would likely be positive but relatively limited given the large amounts of habitat available at the range of flows within the Turners Falls Project capacity. In general, the overall frequency, duration, and magnitude of flows is in Reach 4 is driven by annual and inter-annual flow variability in the Connecticut River (Figure 7.2.2.2-5).

Whitewater release events are proposed to occur occasionally during the summer and fall. These events would be infrequent, and would provide bypass reach flows of 2,500 cfs, 3,500 cfs, or 5,000 cfs in the bypass reach from Turners Falls Dam. These releases may affect the behavior of any adult SNS foraging in or near the bypass reach by changing water level and velocity conditions. Additionally, the activities of whitewater boaters could affect the behavior of foraging adult SNS. This effects would be brief and infrequent, and would not be expected to injure the few SNS that could be foraging in the bypass reach. Each of the proposed whitewater flows would retain high amounts of suitable habitat for adult SNS for the duration of the whitewater release event (Figure 7.2.2.2-1 and Figure 7.2.2.2-3). Additionally, because generation at Station No. 1 and/or Cabot Station would likely need to be reduced to provide the whitewater spill events, there would be limited to no effect on flows and habitats downstream of the Turners Falls Project when compared to the time leading up to the whitewater releases.

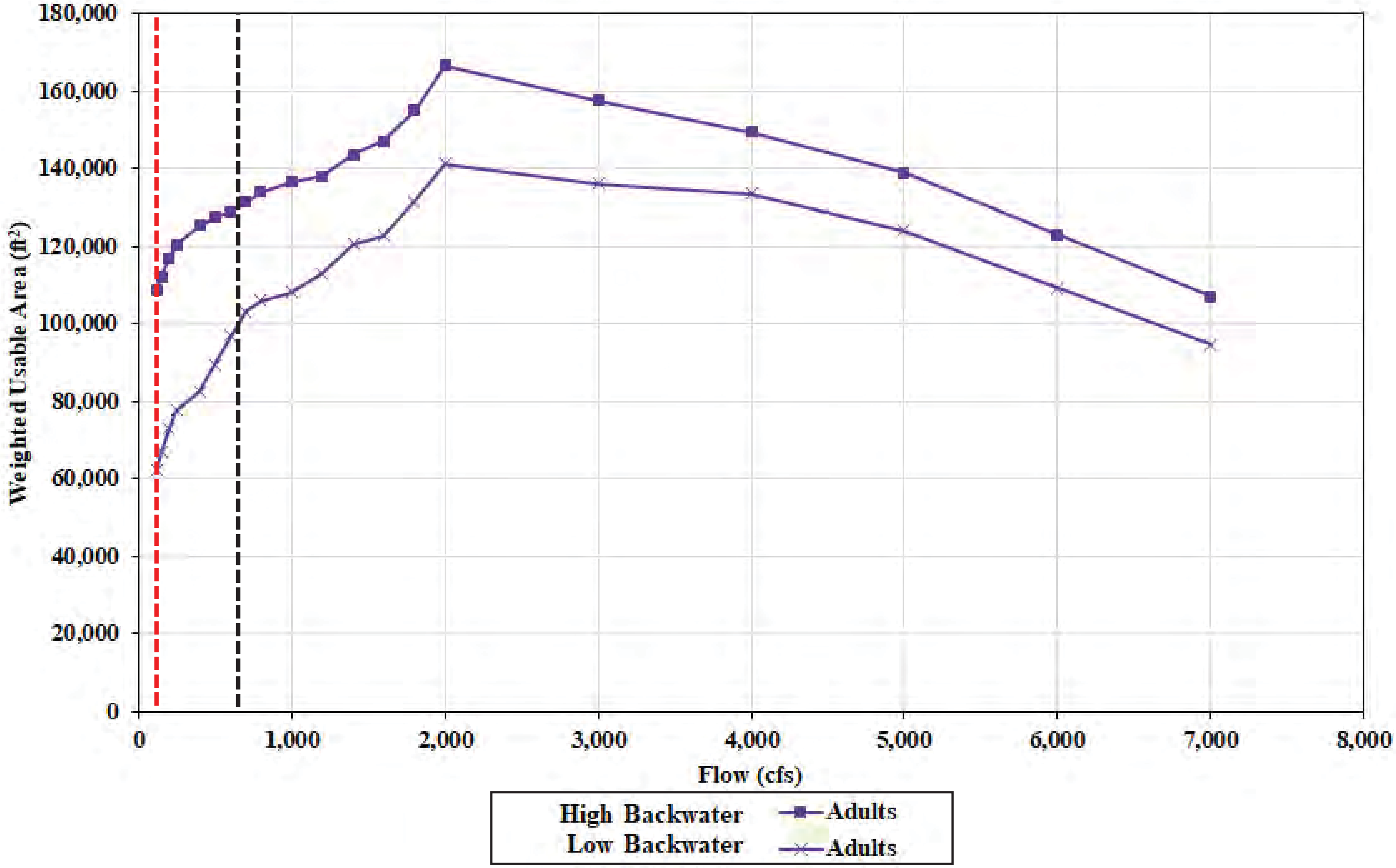

Figure 7.2.2.2-1: Habitat vs. Flow Relationship for SNS Adult in Reach 1

Note: The vertical black dashed line indicates the proposed minimum flow from July 1 through August 31 (670 cfs), the vertical blue dashed line indicates the proposed minimum flow from September 1 through November 30 (500 cfs), whereas the red vertical dashed line indicates the baseline summer minimum flow (120 cfs).

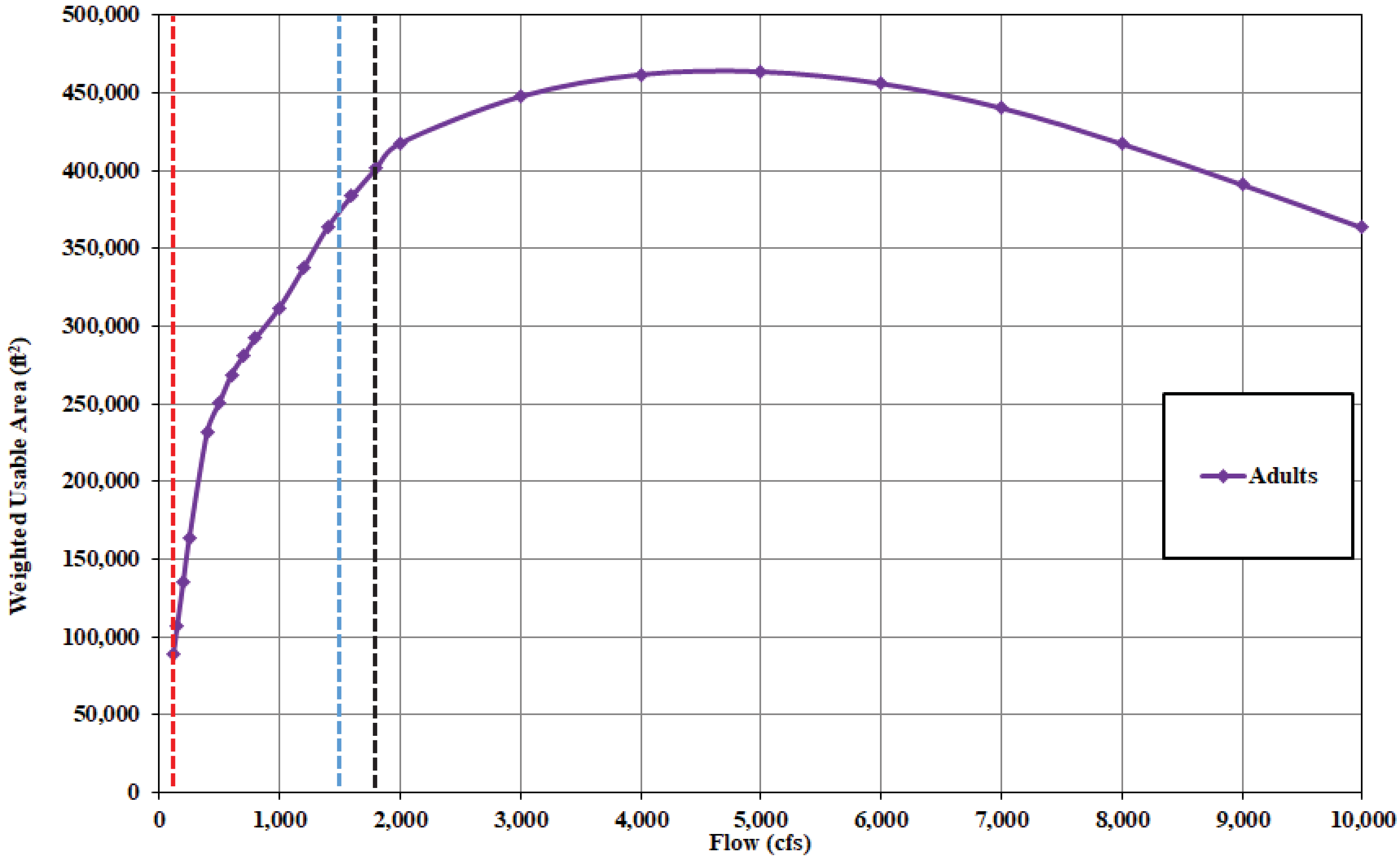

Figure 7.2.2.2-2: Habitat vs. Flow Relationship for SNS Adult in Reach 2

Note: The vertical black dashed line indicates the proposed summer minimum flow from July 1 through November 30 (1,800 cfs), whereas the red vertical dashed line indicates the baseline summer minimum flow (120 cfs).

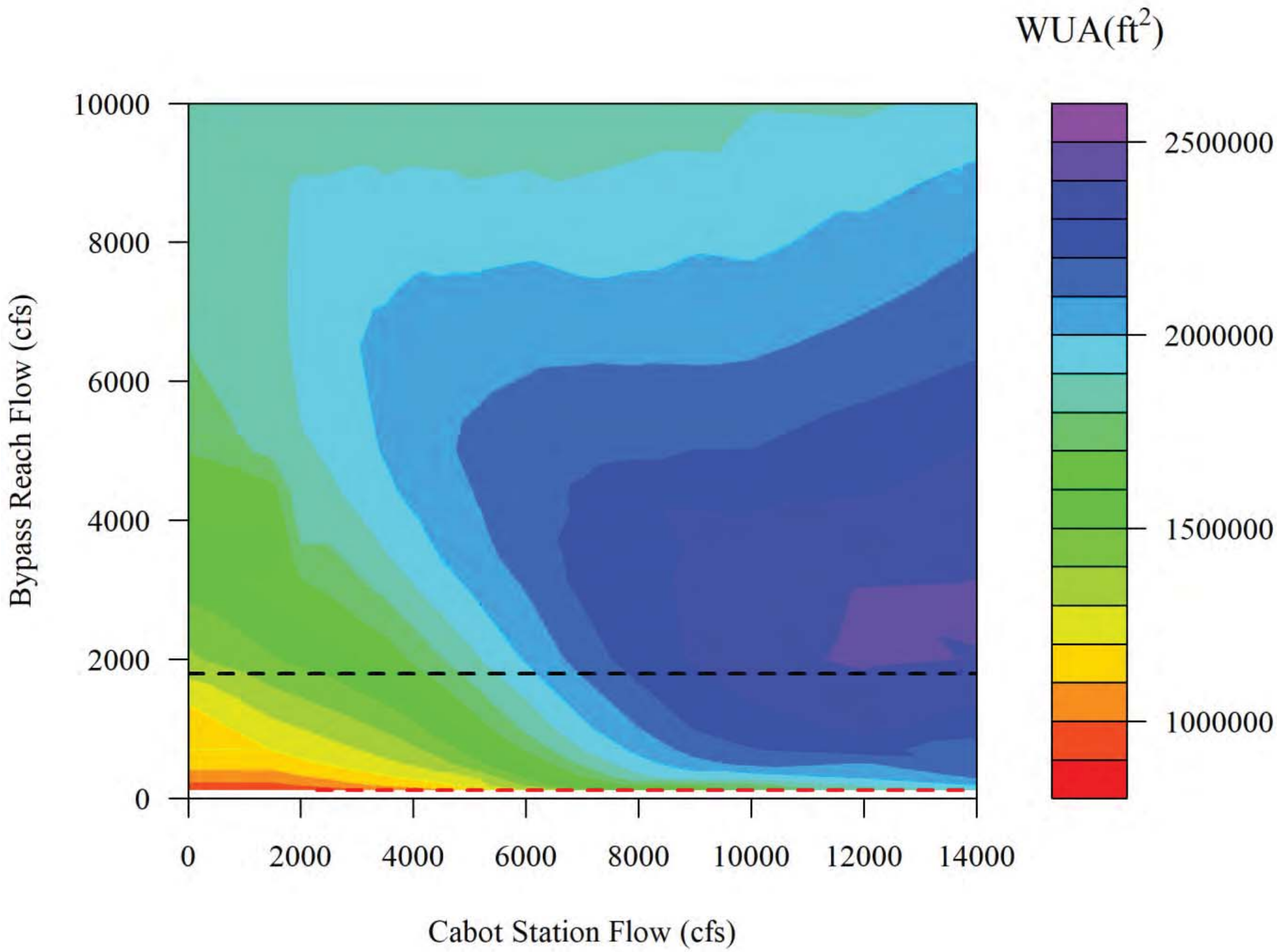

Figure 7.2.2.2-3: Habitat vs. Flow Relationship for SNS Adult in Reach 3

Note: Modeled Deerfield River Flow = 200 cfs. The horizontal black dashed line indicates the proposed bypass reach summer minimum flow from July 1 through November 30 (1,800 cfs), whereas the red horizontal dashed line indicates the baseline bypass reach summer minimum flow (120 cfs).

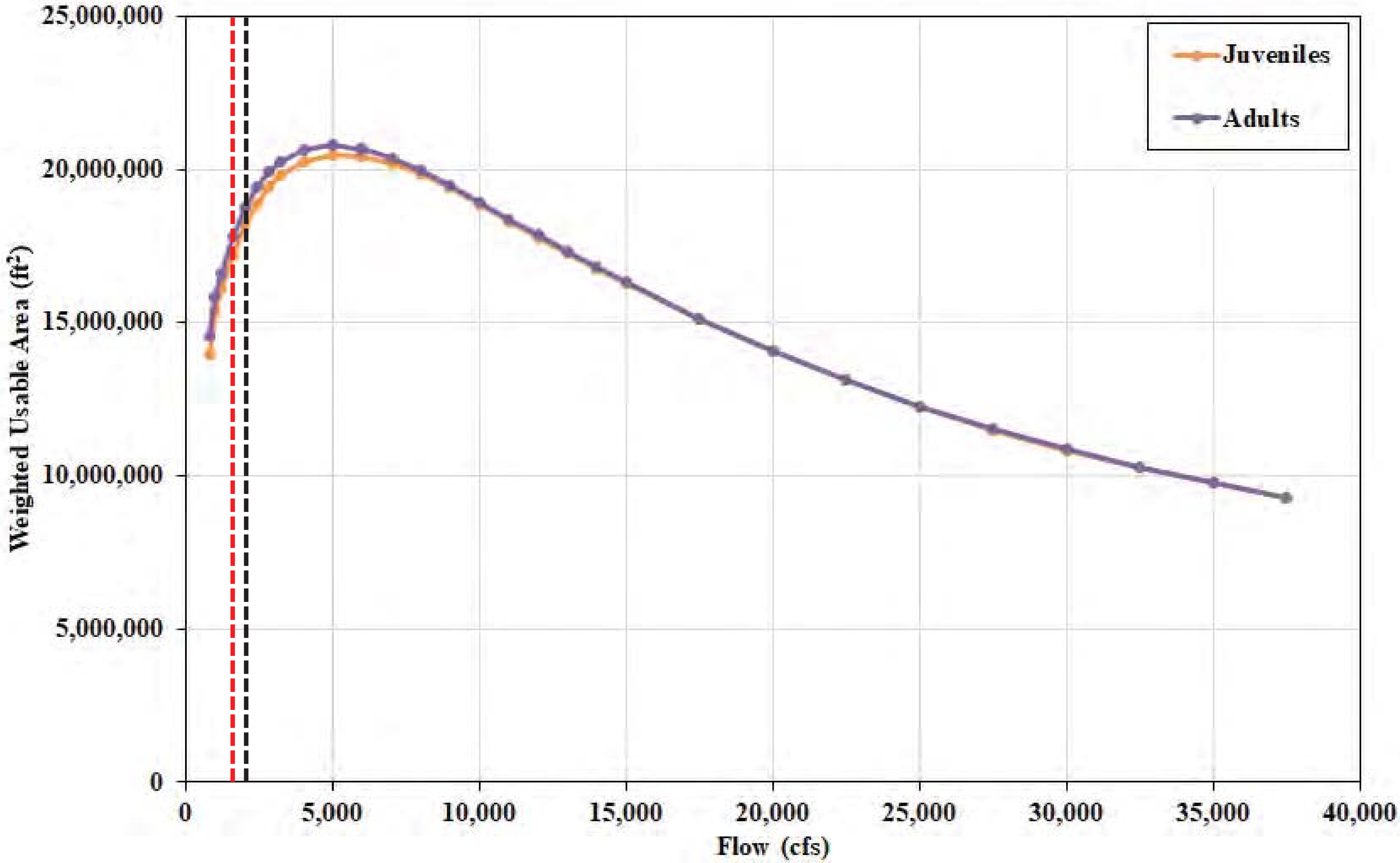

Figure 7.2.2.2-4: Habitat vs. Flow Relationship for SNS Adults and Juveniles in Reach 4

Note: The vertical black dashed line indicates conditions for the proposed downstream reach summer minimum flow from July 1 through November 30 (approximates 1,800 cfs plus 200 cfs from the Deerfield River), whereas the red vertical dashed line indicates the baseline downstream reach summer minimum flow (approximates 1,433 cfs plus 200 cfs from Deerfield River).

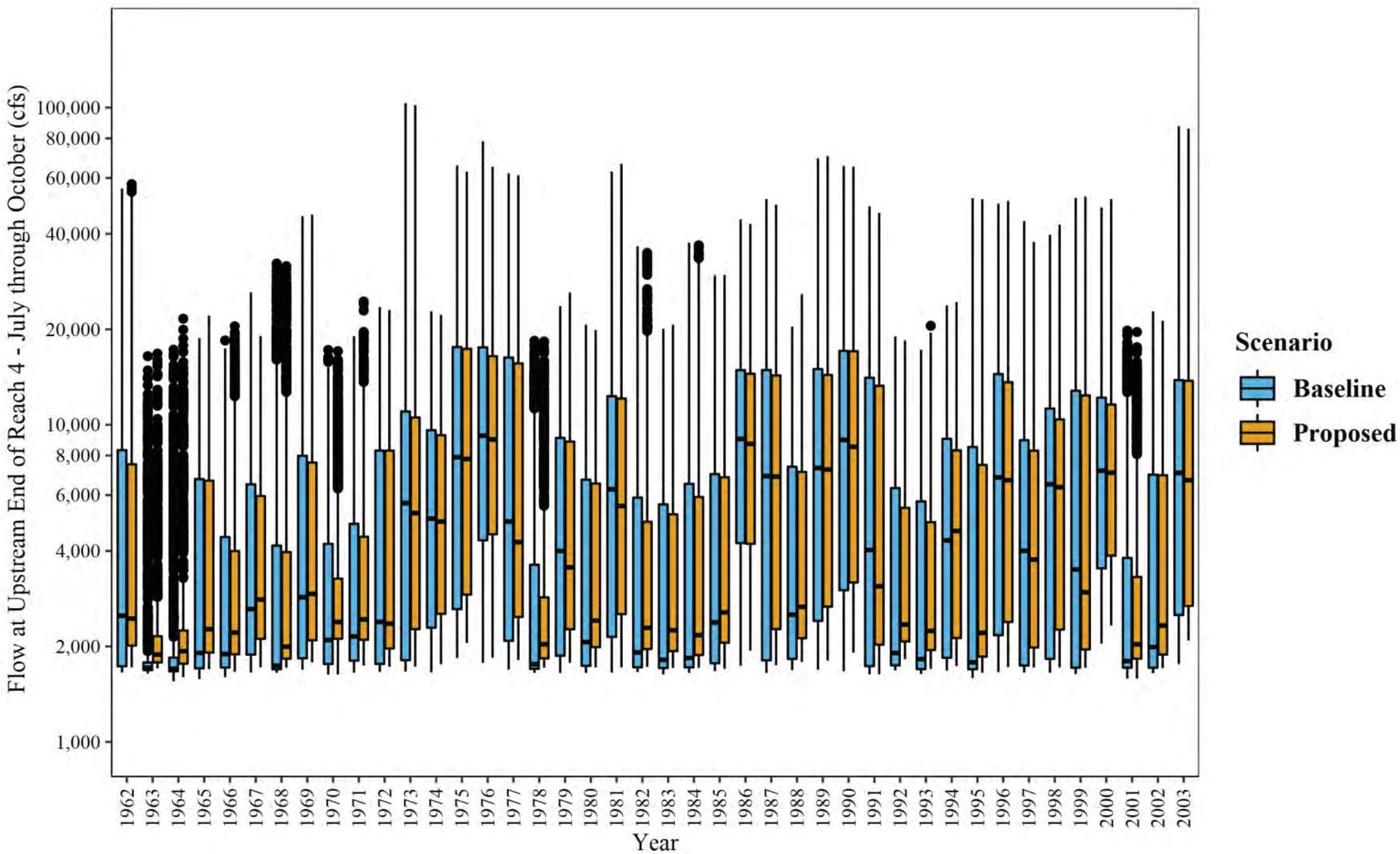

Figure 7.2.2.2-5: Distribution of Flows Modeled Entering Reach 4 for Baseline and Proposed Conditions during the SNS Foraging Period

7.2.2.3 Overwintering

FirstLight has proposed a winter bypass reach minimum flow of 1,500 cfs, or inflow, whichever is less. This would also be the minimum flow downstream of the Turners Falls Project. The baseline condition minimum flow of 1,433 cfs or inflow, whichever is less, below the Project has typically been provided from Cabot Station and/or Station No. 1. The proposed condition would result in more spill over the dam during the winter months, along with slightly narrower peaking range due to the increased flow provided to the bypass reach that would not be available for generation.

SNS residing below the Turners Falls Project and above Holyoke Dam overwinter at the bottom of deep, slow pools that are located several miles downstream of the Turners Falls Project. Whitmore Pool is the closest known overwintering area, at approximately 6.9 miles below Cabot Station, and would be the overwintering area most likely to be affected by changes in flow from the Projects. The proposed flows are not likely to change flows observed at Whitmore Pool during the winter months (Figure 7.2.2.3-1), therefore the overwintering habitat conditions are also not likely to change relative to the baseline condition. Further, the depths and velocities of these deep pool areas would be relatively resistant to change due to changes in flow from upstream; Kynard *et al*., (2012) observed changes in behavior at flows considerably higher than the Turners Falls Project capacity.

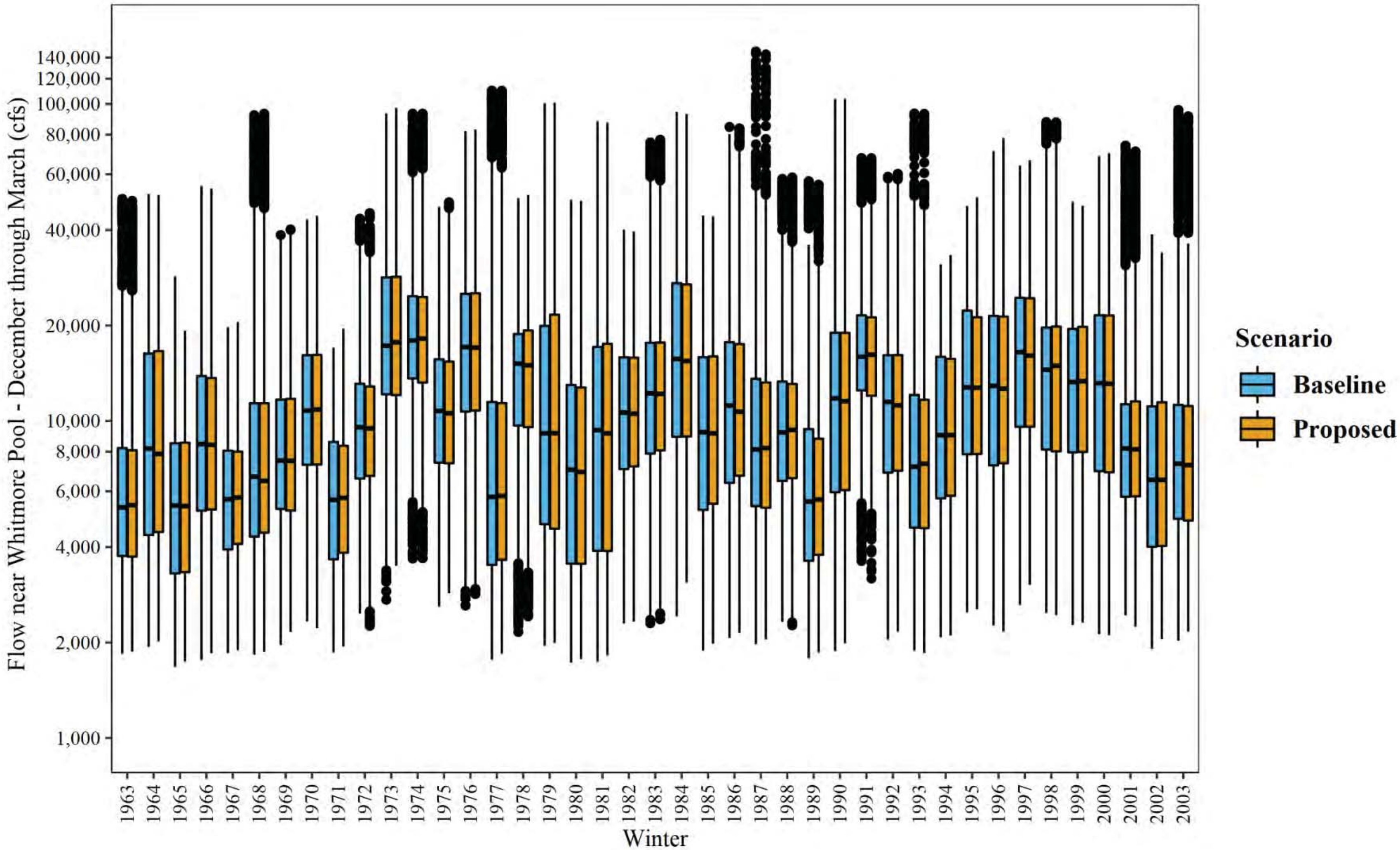

Figure 7.2.2.3-1: Distribution of Flows Modeled Entering Reach 4 for Baseline and Proposed Conditions during the SNS Overwintering Period

7.2.2.4 Year-Round

Only the proposed expanded operations at Northfield Mountain Project have the slight potential to affect underlying flow patterns on a year-round basis. However, the effects of the Northfield Mountain Project on overall flows downstream has been, and would continue to be limited by the current agreement (pursuant to Article 43 of the current Northfield Mountain Project license) with the USACOE for providing coordinated operation of the Turners Falls Project and Northfield Mountain Project during flood conditions on the Connecticut River in accordance with rules and regulations prescribed by the USACOE. In general, the agreement allows FirstLight to operate the Northfield Mountain Project within its FERC license requirements without causing river flows downstream of Turners Falls Dam to significantly exceed those that would have occurred absent the Northfield Mountain Project. It is expected that this agreement would be maintained as part of FirstLight's proposed operations in the new license. The continuation of the agreement with the USACOE would prevent unnatural flow patterns during flood conditions caused by the Northfield Mountain Project if no agreement was in place. Therefore, the expanded operations at the Northfield Project would not be expected to impact flows and habitat downstream of Turners Falls Dam.

In the previous sub-sections, several plots were provided showing the distribution of flow patterns for baseline and proposed conditions. This included critical periods for spawning, rearing, foraging, and overwintering, which when combined, span the entire year. The plots were developed using modeled flow datasets for the proposed and baseline conditions that were developed using FirstLight's HEC-ResSim operations model, along with a HEC-RAS model. The modeled flow data consisted of a long-term (42-year) hourly timeseries. Along with many other operational conditions, the proposed timeseries included expanded Northfield Mountain Project operations, whereas the baseline timeseries did not. Other than the specific proposed flow changes (e.g. increased bypass flows) that affected flow in the timeseries data and associated plots, the distribution of flows below Turners Falls Dam within a given seasonal period are similar between the proposed and baseline conditions. No effects on flow frequencies or magnitude from Northfield Mountain expanded operations are evident within the modeled flow datasets, and therefore, this proposed operational change would not have any effects on SNS.

7.2.2.5 Exceptions

FirstLight offers the following additional information in support of the necessity of the proposed limited exceptions to the operating limitations on Cabot Station ramping (i.e. not more than 2,300 cfs change per hour up and down from April 1-May 31 and not more than 2,300 cfs per hour up ramping from June 1-August 15) and peaking (i.e. not more than two additional units added between 1 am and 2 pm for the period July 1-August 31). These exceptions are driven by the need to maintain FirstLight's ability to respond to operating directives of the New England Independent System Operator (ISO-NE) to maintain power system reliability during rare events.

FirstLight agrees, to the degree ISO-NE rules and the Independent Market Monitor allow, to offer the Cabot generation for ISO-NE dispatch in a way to minimize the need for exceptions due to ISO-NE dispatch reasons as much as possible and anticipates being able to stay below the proposed 10% threshold for use of the exceptions. However, the threshold is needed to ensure that Cabot Station can operate in a manner that continues to support delivery of clean capacity to maintain system reliability for ISO-NE during these infrequent events. By way of illustration, here are examples of the system operational needs over the last five years and how the proposed exceptions would have occurred in those years:

- ISO-NE has only experienced three deficiencies in the ability to meet regional energy and operating reserve requirements during the last five years (2015-2019), only one of which (August 11, 2016) was during the April-August time period but not in the hours the limitations would apply. In these cases, ISO-NE needs support from all available resources.

- Apart from the historic deficiencies identified above, by offering the Cabot generation as we propose under historic operating conditions, there would have been one exception[11] due to ISO-NE dispatch reasons during the hours the limitations would apply in the last five years (2015-2019).

Although the hours when deviations might be required are limited based on historic operation, the New England energy markets rules are constantly being refined and the regional energy mix and demand is also rapidly evolving. For that reason and given the term of the license, FirstLight requires additional flexibility to adapt to conditions as they develop over time.

There are also two other drivers for the necessity of the 10% threshold for operating exceptions.

- Managing upstream deviations: Under its current FERC license, Vernon's owner must provide FirstLight with day ahead estimates of the total station discharge and updates to those estimates in real time throughout the operating day. Historically, significant deviations to the day ahead estimates have occurred on a frequent basis and have led FirstLight to make significant changes to its Cabot generation schedule to accommodate the Vernon deviations. To the degree that Vernon's new FERC license does not lead to improvements in the accuracy of these day ahead estimates, FirstLight must maintain operating flexibility at Cabot to manage the TFI elevation to prevent violating its license limits, safe recreation limits including proposed whitewater flows, proposed rate of rise restrictions, etc. FirstLight has proposed to FERC new reporting requirements for Vernon's owner in our Amended Final License Application to try and minimize the need for exceptions due to inaccurate estimates of Vernon outflow.
- ISO-NE Testing Requirements: Under current ISO-NE rules, Cabot Station generally can perform maximum generation tests without requiring an exception. However, ISO-NE reserves the right to test the Cabot generators' ramping capability or maximum generation, including during the hours of the Cabot operating restrictions. FirstLight must maintain the flexibility to perform these tests in the event that the ISO-NE requires them.

In total, FirstLight believes that the occurrences of exceptions are likely to be infrequent based upon historical data, and FirstLight further agrees to use its best efforts to minimize exceptions whenever possible. However, the operational requirements of the station and ISO-NE require that this flexibility be preserved to ensure that this important source of clean capacity is available in those situations when it is needed for system reliability based upon the independent judgment of ISO-NE.

[11] On May 10, 2015, the energy price went to $1,056/MWh in hour ending 9:00 pm and Cabot Station would have needed to add two units for one hour to the four units that were already running.

7.3 Summary of Effects

Kynard *et al*., (2012) suggests that the abundance of SNS between Holyoke and Turners Falls Dams was stable, likely due to density dependent mechanisms related to the size of the area, food abundance, or both. More recently (2017-2019), 193 SNS have been passed upstream of Holyoke Dam, which would represent a substantial addition to the SNS population residing in the action area. Based on FirstLight's habitat assessment, and information presented by Kynard *et al*., (2012), spawning and rearing habitats are relatively limited in the action area in comparison to the more abundant juvenile and adult foraging habitats. Therefore, one limiting factor for this SNS population could be the amount of suitable spawning and rearing habitat.

The Proposed Action is consistent with measures identified by NMFS as being beneficial to SNS and would substantially and consistently increase the amount of spawning and rearing habitat available for SNS. More spawning and rearing habitat that is consistently available at a variety of river flows and operational conditions would result in greater spawning success for mature adult SNS, and better survival for early life stage individuals. If SNS choose to spawn in more or larger areas near the Turners Falls Project as a result of the Proposed Action, then their eggs would be distributed over a wider area. Because the abundance of fry is negatively correlated with the density of spawned eggs (Kynard *et al*., 2016), reducing the overall density of spawned eggs by providing more habitat could facilitate population growth by increasing the survival of early life stage individuals. This population growth could also be aided by some increases to the amount of foraging habitats. Individual SNS that take advantage of improved foraging habitats could exhibit higher growth rates, survival, and fecundity, resulting in further increases to the population. Though no stranding has ever been observed at the Project, the minimum proposed flows in the bypass reach would prevent stranding of SNS by providing considerably more depth and wetted area than current minimum flow conditions. As shown in the habitat analyses, this provides many areas of interconnected habitats that allow for movements into and out of the areas of the bypass reach that have been rarely used by SNS under the baseline condition.

All other measures in the Proposed Action would have discountable or no effects on SNS due to similar conditions relative to the baseline condition or specific mitigation actions (i.e. SNS Handling Plan).

8 CONCLUSION

Based on the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the Proposed Action, and the cumulative effects, it is concluded that the Projects are likely to adversely affect SNS because proposed construction is in close proximity to SNS habitat, and because proposed flows from the Projects affect habitat suitability for various life stages of SNS. However, the adverse effects of the Projects will be minimized, and conditions enhanced and improved for the Connecticut River population of SNS because the Proposed Action includes the following PM&E measures:

1) Proposed flow conditions offer considerable increases in the amount of suitable spawning and rearing habitat for SNS to use near the Turners Falls Project, which would be beneficial to the SNS population.
2) Proposed flow conditions offer increases in the amount of foraging habitat in the Turners Falls Project bypass reach and habitats downstream of the Project.
3) Effects of the proposed flow conditions on wintering habitat are not anticipated to change relative to the baseline condition and are considered discountable.
4) Appropriate permits will be obtained for any proposed construction activities that would occur in or along the river below the Turners Falls Dam, and measures will be taken during construction to minimize any potential effects on SNS, such that few, if any individual SNS would be exposed to the impacts of construction. Therefore, effects of proposed construction on SNS would be considered discountable.
5) A SNS Handling Plan, developed by FirstLight for approval by NMFS, addresses potential impacts of capturing SNS in a proposed fish lift.
6) Because no critical habitat is designated in the action area, none will be affected by the Proposed Action.

As such, the Proposed Action will not likely jeopardize the continued existence of SNS in the Connecticut River or the existence of the species within its range.

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APPENDIX A: SNS HANDLING PLAN

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SHORTNOSE STURGEON HANDLING PLAN FOR THE TURNERS FALLS HYDROELECTRIC PROJECT (FERC NO. 1889)

1. INTRODUCTION

The Turners Falls Hydroelectric Project is located in Montague, MA. In its Amended Final License Application (AFLA), FirstLight has proposed to install, maintain, and operate a fish lift at the Turners Falls Dam spillway. The current facilities include a fish ladder at the dam spillway, and another further downstream at Cabot Station. The proposed fish lift, designed primarily to pass American Shad (*Alosa sapidissima*), could also attract Shortnose Sturgeon (*Acipenser brevirostrum*, SNS) where they would then become captured by the lift. SNS are listed as endangered under the federal Endangered Species Act (ESA). No SNS have been captured in the Turners Falls fish passage facilities to date, no sturgeon have been documented spawning upstream of Rock Dam, and only one SNS has ever been observed in the Turners Falls Dam spillway area (Kieffer and Kynard, 2012; Kynard et al. 2012). However, SNS may more readily enter a fish lift than the current fish passage facilities and applicable protocols need to be in place to ensure proper handling of these endangered fish if they are found in the lift.

This plan provides procedures for the handling and documentation of any SNS that may be incidentally collected by the Spillway Fishway at Turners Falls Dam during routine fishway operations and maintenance. Agency Contact information and reporting forms follow these procedures. This handling plan has been adapted for the Turners Falls Project from handling plans for other hydroelectric facilities with mechanical fish passage structures that incidentally capture SNS (HG&E 2010, NextEra 2012; Exelon 2018).

2. TRAINING

All personnel potentially handling sturgeon as outlined in this plan will be trained in proper handling by NMFS staff or a NMFS designated representative, such as a current Section 10 permit holder. Contact NMFS (see contact list below) for approved trainers.

3. MONITORING

During fish lift operations, monitoring of fish passed through the lift will be identified and counted at a viewing window. If SNS are observed at this viewing window, the exit to the Turners Falls Impoundment will be closed until any SNS are captured and processed. During potential maintenance activities that require dewatering of the lift components, any areas being dewatered will be monitored for SNS that could be residing in the lift. If any are observed during the dewatering process, SNS will be captured and processed in accordance with this plan.

4. STURGEON PROCESSING AND DATA COLLECTION

Any SNS collected in the Turners Falls Spillway Fish Lift will be safely secured in an appropriate container, such as a transport bag, holding tank, or fish sampling table, such that the fish remains completely submerged except when necessarily removed from the water briefly for measurements or tagging procedures. The fish should be shielded from direct sunlight and prevented from leaping out of holding containment. Dissolved oxygen concentrations of at least 5 mg/l must be maintained. Circulating flow, water exchanges, mechanical aeration, or bubbling oxygen gas may be used.

The following Handling and Data Collection Procedures shall be implemented:

1. Wear rubber or plastic gloves to prevent abrasion and mucus removal.
2. Record date, time and physical conditions on a reporting sheet (see attached).
3. Record location where fish was collected on reporting sheet.
4. Record the weight, length, and condition of the fish on the reporting sheet.
5. Standardized length measurements will be taken from the tip of the snout to the fork in the tail (fork length) and from the tip of the snout to the end of the long (dorsal) caudal lobe.
6. Scan entire body for existing PIT tags using a handheld scanner and visually for any external tags. Note identifiers for any tags detected on the reporting sheet.
7. If no PIT tag is detected, a new tag (FDXb, 134.2 kHz) will be inserted immediately anterior to the dorsal fin, and posterior to the dorsal scutes on the left side (Figure 1), following the methods of Kahn and Mohead (2010). Insertion instruments and tags should be cleaned, sterilized by immersion in alcohol, and allowed to air dry prior to tag insertion. The new tag should be scanned, and its unique identifier recorded prior to insertion, and scanned again immediately after insertion (prior to release) to verify function and identifier recording.

    a. Sturgeon < 300 mm fork length will not be tagged. If necessary, to prevent harm or mortality to small juvenile sturgeon (300 – 500 mm), a PIT tag may be inserted in the widest dorsal position just to the left of the dorsal scute.

8. Photographs of the sturgeon including a) dorsal view, b) ventral view, c) left side, and d) right side, plus any additional photos to document any injuries. A card with the date, time, location, any identifying numbers (sample number, PIT number), and Section 7 permit number should also be visible in any photographs taken.
9. Obtain a genetic sample.
    a. Wash hands and use disposable gloves.
    b. Take a one-cm square clip from the pelvic fin. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.
    c. Place clip into an individual vial of 95% non-denatured ethanol and, using permanent marker, label with the species, date, name of project, fork length and total length, and an identifier linking the sample to the appropriate observer report.
    d. Seal vial with a lid and secure lid with tape. Cover any markings with cellophane tape to minimize the chance of smearing or erasure.
    e. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send to the NMFS-approved lab for processing. Contact NMFS (see Contact List) for lab, chain-of-custody and shipping requirements.
    f. At least two fish lift operating staff will be trained in these procedures. These staff will be on-site during the normal fish passage operating season from mid-March to early-June, and on-call for the remainder of the year.
10. Sturgeon will be returned to the river in the Turners Falls Spillway area immediately after processing.

11. If any live or dead sturgeon are found, the licensee will report to NMFS within 24 hours or on the next business day (see contact information below). Any dead specimens or body parts will be photographed, measured and retained by FirstLight until NMFS has contacted the co-investigators on NOAA's Sturgeon Salvage Permit to determine the need for sturgeon parts for scientific or educational use.

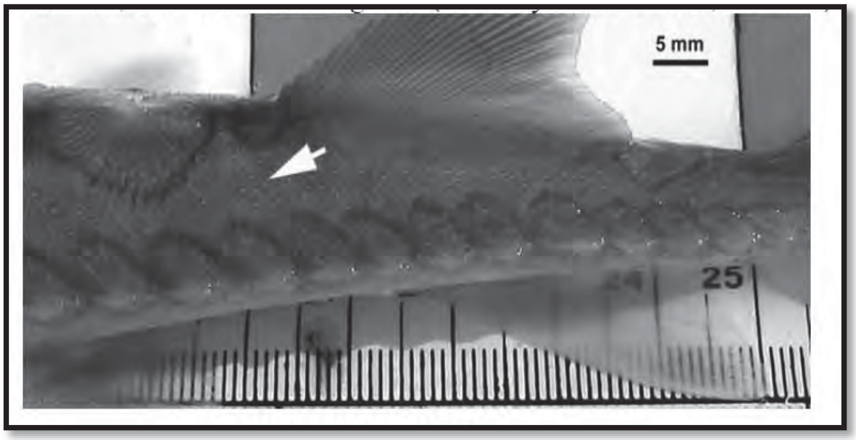


Figure 1: Standardized location for PIT tagging sturgeon (Photo credit, James Henne, USFWS, Figure 2 in Kahn and Mohead, 2010)

5. REPORTING

1. Any documentation of SNS occurrence in the Turners Falls Dam Spillway Fishway, shall be reported to NMFS (see contact information below) within 24 hours or on the next business day.
2. Any handling of collected sturgeon shall be reported to NMFS within 24 hours or on the next business day via submission of the reporting form.
3. Any severely injured (e.g., with apparently life-threatening injury) sturgeon shall be reported to NMFS immediately.
4. A report detailing and compiling any sturgeon handling shall be submitted to NMFS annually.

Contact Information

Julie Crocker
Protected Resource Division
NOAA Fisheries
55 Great Republic Drive
Gloucester, MA 01930
978-281-9300
julie.crocker@noaa.gov

Any observations of SNS will be made to: incidental.take@noaa.gov

FirstLight Contact

Steve Leach
Fisheries Biologist
FirstLight Power
15 Cabot Street
Montague, MA 01376
413-422-5950
sleach@firstlightpower.com

Shortnose Sturgeon Reporting Sheet for the Turners Falls Project Spillway Fish Lift

Date:____________________ Time:____________________ Sample No.: ________________________

Physical Conditions

Spill Gates Open (circle one): YES NO

If yes, circle gate**:** BG1 BG2 BG3 BG4 TG1 TG2

Estimated Spill Flow: ______________________cfs

Gauged River Flow (USGS Gage 01170500): ______________________cfs

Water Temperature, Surface: ____________°C Bottom:______________°C

Indexed fish lift fullness: (circle one): **0 1 2 3 4 5**

Location where fish was recovered:

____

Biological Data Total Length:________mm Fork Length:________mm Weight:___________kg

General Condition (circle one): Excellent Good Fair Poor Mortality

Does the sturgeon have visible injuries/abrasions? (circle one): YES NO

If Yes, denote and code on sturgeon diagram on back of sheet.

Photo Checklist Dorsal: ☐ Ventral: ☐ Left: ☐ Right: ☐ Injuries: ☐

(include card or sample envelope with Sample No., Date, and Time in photos)

Tagging Data

Existing Tag Detected? (circle one): YES NO

If Yes, what type? (circle applicable and note tag number): CARLIN PIT RADIO OTHER:

If No, was fish tagged? (circle one): YES NO Type:_____________ ID:

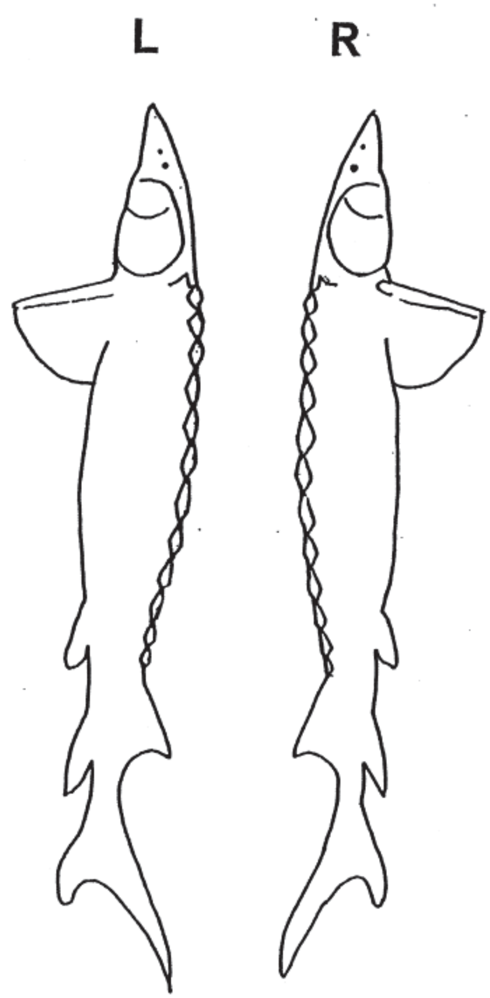
Comments/Disposition of Fish:

Observer
print name: Signature:

ABRASION CODES

	Code	Description
	0	none
Abrasion	1	Light abrasions or worn scutes, whitened but not red.
	2	Moderate abrasions of skin or scutes, erosion of skin over bony structure, reddening.
	3	Excessive wear of skin, scutes, or other bony structure, bony structure exposed, excessive reddening or minor bleeding, patches of skin missing
Tears	4	minor fin tears
	5	major fin tears, bleeding or missing large portions of fin
	6	skin tears, bleeding, loose skin flaps
Puncture	7	minor puncture wounds
	8	major punctures into body cavity or skull
Other	9	spinal damage, severe lacerations

Sample No.: ______________________



Coding Instructions for STURGEON REPORTING SHEET

1. **Date**: enter todays date in the format mm/dd/yyyy.
2. **Time**: enter time that fish was collected (if known lift time, note that in comments).
3. **Spill Gates Open**: if any spill gates open circle yes and enter estimated total spill flow.
4. **Gauged River Flow**: enter discharge from the Montague USGS gage: https://waterdata.usgs.gov/ma/nwis/uv?site_no=01170500
5. **Water Temperature:** enter water temperature in °C.
6. **Fishway Operating (circle):** circle as appropriate (yes or no)
7. **Indexed fish lift fullness**: For the fish lift, if operating, circle fullness according to the following criteria:

Fullness Index	**Criteria**	**Count Estimate Range Guideline**[1][12]		
		Low	**Mid**	**High**
0	No fish observed	0	0	0
1	Fish present, no accumulation at exit gate as hopper emptied	10	50	100
2	Fish accumulated at exit gate, but covered not more than approximately half of the hopper floor as hopper emptied.	100	150	200
3	Hopper appeared to contain a substantial number of fish but much of the hopper floor was visible before hopper emptied; once most water was gone fish covered most of the hopper floor.	200	250	400
4	Hopper more crowded but some floor was visible before hopper emptied; once most water was gone, multiple layers of fish covered most of the hopper floor.	300	400	600
5	Hopper crowded, nearly all of the hopper floor obscured by fish before hopper emptied; multiple layers of fish covered the hopper floor; emptying process lasts longer.	400	600	1000

8. **Location where fish was recovered:** write in location.
9. **Total Length:** measure from tip of snout to tip of longest lobe of caudal fin.
10. **Fork Length**: measure from tip of snout to shortest point between lobes of caudal fin.
11. **Weight**: Be sure to subtract the weight of wet weighing bag, etc. from total weight to record fish weight.
12. **General Condition**: Circle one according to description:
    a. **Excellent:** fish does not appear stressed, behavior appears normal, no injuries beyond minor abrasions (non-reddened or bleeding) consistent with lift, trap, and handling or healed wounds.
    b. **Good**: fish does not appear stressed, behavior appears normal; injuries may include non-deleterious abrasions, scute wear and fin tear.
    c. **Fair**: fish may show signs of stress (purpling of snout, belly), but behavior appears normal and maintains equilibrium in water; fish may have multiple non-life threatening injuries including abrasion, scute wear, fin tear, and minor punctures.
    d. **Poor**: fish shows signs of stress, behavior is unusually excited or unusually lethargic (handling does not elicit response); fish has difficulty maintaining equilibrium; abrasions and / or injuries are extensive with significant eroded or torn tissue that is raw or bleeding. [if

[12] Numeric estimates are guidelines only. Qualitative descriptions are the approved indexing criteria.

condition does not improve in circulating water tank, hold and report immediately per life-threatening injury protocol]; major injuries (even if fish otherwise appears to behave normally, such as major puncture to body cavity or skull, damaged spine, or severe lacerations [hold fish and report immediately per life-threatening injury protocol].

   e. **Mortality**: retain and report per protocol.

13. **Visible injuries/abrasions?:** circle yes or no; if yes, circle locations on diagram and code severity:
14. **Photo Checklist**: check-list to indicate that required photographs have been taken. If not, note why in comments. [note: multiple injuries can be captured in one photograph where applicable – not necessary to take one photograph for each area indicated in diagram if they can be captured in the same frame]. Include scale envelope or label with Sample #, Date, and Time in each photo].
15. **Existing Tag Detected**: scan visually, with Biomark Pocket Reader, Avid Power Tracker II, and metal detector. If any tag(s) detected circle yes, if not, circle no; if yes, circle appropriate and record number and any other pertinent descriptions; if no:
16. **Was fish tagged?**: if no existing tag, was a new PIT inserted? Circle yes or no; if yes, record the number; if no, record reason.
17. **Comments/Disposition:** record any specific comments, release point and time and note fish behavior upon release; if fish was held and reported note that, reason, and who was contacted.
18. **Observer**: print and sign.

6. REFERENCES

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HG&E (City of Holyoke Gas and Electric Dept.). 2010. 2010 Shortnose Sturgeon Incidental Take Monitoring Report for the Holyoke Project (FERC No. P-2004). Annual report submitted to FERC, December 2010.

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Appendix D- RTE- Puritan Tiger Beetle Biological Assessment

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Draft Biological Assessment

Federal Relicensing of the
Northfield Mountain Pumped Storage Project (No. 2485)
and the Turners Falls Hydroelectric Project (No. 1889)

Prepared for:

FirstLight

Prepared by:

Gomez and Sullivan Engineers

Submitted to:

U.S. Fish & Wildlife Service
Department of the Interior

DECEMBER 2020

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LIST OF ABBREVIATIONS

ACOE	Army Corps of Engineers
BA	Biological Assessment
BO	Biological Opinion
°C	degree Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
CSO	combined sewer overflows
CT	Connecticut
CTDEEP	Connecticut Department of Energy and Environmental Protection
DBA	Draft Biological Assessment
DO	dissolved oxygen
ESA	Endangered Species Act
FERC or Commission	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro MA LLC and Northfield Mountain LLC
FLA	Final License Application
ft	feet
hr	hour
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HEC-ResSim	Hydrologic Engineering Center's Reservoir System Simulation
HG&E	Holyoke Gas and Electric
ILP	Integrated Licensing Process
IPaC	USFWS Information for Planning and Consultation tool
ISO-NE	ISO-New England
kW	kilowatt
MA	Massachusetts
MADEP	Massachusetts Department of Environmental Protection
MADFW	Massachusetts Division of Fisheries and Wildlife
MA NHESP	Massachusetts Natural Heritage and Endangered Species Program
MW	megawatt
NMFS	National Marine Fisheries Service
NGVD29	National Geodetic Vertical Datum of 1929
Northfield Mountain Project	Northfield Mountain Pumped Storage Project (FERC No. 2485)
NRF	Naturally Routed Flow
PAD	Pre-Application Document
PCB	polychlorinated biphenyls
PM&E	Protection, Mitigation, and Enhancement
PSP	Proposed Study Plan
ROR	Run of River
RTK-GPS	Real-Time Kinematic Global Positioning System
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter

TFI	Turners Falls Impoundment
Turners Falls Project	Turners Falls Hydroelectric Project (FERC No. 1889)
USACOE	United States Army Corps of Engineers
USFWS	Unites States Fish Wildlife Service
USGS	United States Geological Survey
VY	Vermont Yankee
WQC	Water Quality Certification
WSE	Water Surface Elevation

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EXECUTIVE SUMMARY

FirstLight MA Hydro LLC is the owner of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889). Northfield Mountain LLC is the owner of the Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485). Collectively referred to as FirstLight, the owners are seeking to relicense the hydroelectric projects with the Federal Energy Regulatory Commission (FERC). As part of relicensing, FirstLight is filing Amended Final License Applications, which includes proposals for continued operation of the Projects. The proposals include several items, including improvements pertaining to fish passage, construction of recreation access areas, and modifications to operations that are designed to mitigate effects on several existing resources while providing the ability to provide clean, renewable hydroelectric power.

This draft Biological Assessment (BA) was prepared by FirstLight to support FERC's submission of a request for Endangered Species Act (ESA) Section 7 consultation with the United States Fish and Wildlife Service (USFWS) to consider the effect of two proposed actions: the relicensing of the Turners Falls Project and the relicensing of the Northfield Mountain Project. Because FirstLight is providing a comprehensive proposal that includes operation of both hydroelectric projects, the effects of FirstLight's comprehensive proposal are evaluated in this draft BA.

Six federally-listed species that could be present in the Project-affected areas were initially identified for inclusion in this draft BA, including Puritan Tiger Beetle (*Cicindela puritana*), Shortnose Sturgeon (*Acipenser brevirostrum*), Dwarf Wedgemussel (*Alasmidonta heterodon*), Northeastern Bulrush (*Scirpus ancistrochaetus*), Small Whorled Pogonia (*Isotria medeoloides*), and Northern Long-Eared Bat (*Myotis septentrionalis*). Of these species, only the Puritan Tiger Beetle was included for detailed analysis in this draft BA because it could potentially be affected by proposed changes to Project operations. The effects on Shortnose Sturgeon were included in a separate draft BA to be submitted to the National Marine Fisheries Service (NMFS) and the other species would not be affected by the Project's proposals.

The only known remaining population of Puritan Tiger Beetle in Massachusetts resides at Rainbow Beach near Northampton, which is 33 miles below the Northfield Mountain Project tailrace and 25 miles below the Cabot Station tailrace, which is the primary hydropower discharge for the Turners Falls Project. Other populations of Puritan Tiger Beetle reside further downstream in the tidal portions of the river in Connecticut, and at beaches/bluffs along the shoreline of the Chesapeake Bay in Maryland. The population at Rainbow Beach has been subjected to several threats, including the historical construction of dams and associated changes in hydrology, recreational use of the beach, land use practices nearby and along the Connecticut River corridor, encroachment of native and non-native vegetation, and interactions with other species, including other species of tiger beetle.

FirstLight has gathered the best available scientific data and has analyzed the effects of water levels on habitat for long-term (i.e. annual and multi-year cohort) and short-term (i.e. seasonal, daily, and hourly) timescales. To perform the analysis, FirstLight characterized the frequency, timing, and magnitude of inundation at Rainbow Beach, along with changes in water level, as relevant to the habitat utilized by various life stages and activities of the Puritan Tiger Beetle. The analysis was robust, with 28 years of hourly flow data routed to Rainbow Beach through a HEC-RAS hydraulic model.

Based on the analyses presented in this draft BA, FirstLight concluded that the operations proposed for the new licenses may affect Puritan Tiger Beetles but are not likely to adversely affect or jeopardize the continued existence of the Puritan Tiger Beetle at Rainbow Beach. The baseline environmental condition has been amenable to adult Puritan Tiger Beetle foraging and mating, due to very slow water level fluctuations at Rainbow Beach, along with peaks that occur during the night when the beetles are at higher elevations of the beach. Additionally, operational flows affect larval habitat infrequently and with limited magnitudes relative to those incurred by river flows above the Projects' abilities to control.

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1 INTRODUCTION

1.1 Background

FirstLight MA Hydro LLC owns and operates the Turners Falls Hydroelectric Project (Turners Falls Project) located on the Connecticut River near Montague, MA. Northfield Mountain LLC owns and operates the Northfield Mountain Pumped Storage Project (Northfield Mountain Project) located in Northfield, MA. The Northfield Mountain Project uses water from the Turners Falls Impoundment (TFI), which is created by the Turners Falls Dam, as part its pumped-storage operations. Hereinafter the two owners are collectively referred to as FirstLight.

FirstLight, in accordance with Sections (§§) 5.17 and 5.18 of Title 18 of the Code of Federal Regulations (CFR), is filing with the Federal Energy Regulatory Commission (FERC, the Commission) separate license applications for the two Projects, although a combined Exhibit E – Environmental Analysis was developed. The current license for the Turners Falls Project was issued on May 5, 1980 and expired on April 30, 2018. The license for the Northfield Mountain Project was issued on May 14, 1968 and expired on April 30, 2018. Both Projects currently operate under annual licenses. FirstLight anticipates filing its Amended Final License Application with FERC by December 6, 2020, which includes FirstLight’s proposal for relicensing. FERC will decide whether to approve licenses for the Projects and what license conditions would be placed in any licenses issued.

1.1.1 Consultation History

FirstLight is relicensing the Projects using the Integrated Licensing Process (ILP), throughout which there have been intensive and documented consultation efforts between FirstLight and resource agencies, including USFWS. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC. The PAD included FirstLight’s preliminary list of proposed studies. FERC conducted a public scoping process during which various resource issues were identified. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013.

FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013, and, per the Commission regulations, held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on the studies. On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013, with FERC addressing stakeholder comments.

On August 27, 2013, Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the two Projects, would be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions were anticipated to change during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which many of the studies were approved or approved with FERC modification. However, due to the impending closure of VY, FERC did not act on 19 proposed or requested studies pertaining to aquatic resources. The SPDL for these 19 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013, regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 19 studies on February 21, 2014, approving the RSP with certain modifications. Studies were completed over several subsequent years. The Draft License Application was filed with FERC on December 2, 2015, the Final License Application was filed with FERC on April 29, 2016, and an Amended Final License Application will be filed with FERC by December 6, 2020.

For the purposes of this Draft Biological Assessment (BA), a preliminary outline was provided to the USFWS via email on December 12, 2019 and was discussed with them via teleconference on December 16, 2019. On April 17, 2020, FirstLight sent the USFWS a preliminary Draft BA for review and comment. On June 2, 2020. FirstLight and USFWS had a conference call to discuss the Draft BA. On August 27, 2020, FirstLight received comments from the USFWS on the Draft BA. FirstLight has provided responses to the USFWS comments in Appendix D, and has revised the analyses in this Draft BA as appropriate.

1.2 Federally Listed Species Considered in this Biological Assessment

This BA addresses the effects associated with the relicensing of the Turners Falls Project and the Northfield Mountain Project on federally listed endangered and threatened species. During relicensing proceedings and resource agency consultation for the Turners Falls Project and Northfield Mountain Project, along with recent evaluations using USFWS's Information for Planning and Consultation (IPaC) tool, six federally-listed species that could be present in the Project-affected areas were identified, including:

- Puritan Tiger Beetle (*Cicindela puritana*) – Threatened
- Shortnose Sturgeon (*Acipenser brevirostrum*) – Endangered
- Dwarf Wedgemussel (*Alasmidonta heterodon*) – Endangered
- Northeastern Bulrush (*Scirpus ancistrochaetus*) – Endangered
- Small Whorled Pogonia (*Isotria medeoloides*) – Threatened
- Northern Long-Eared Bat (*Myotis septentrionalis*) – Threatened

FirstLight has conducted several studies to gather information necessary to understand the locations and extent of protected resources, along with potential effects of Project operations, land management practices, and recreational use on protected resources. The species above were considered for inclusion in this BA as follows.

Puritan Tiger Beetle

The Puritan Tiger Beetle was listed as a threatened species by the USFWS in 1990 due to its limited distribution, coupled with threats from habitat loss and degradation, along with its vulnerability to natural and human threats (USFWS 1993a). It is a predatory invertebrate, with adults that forage and breed on sandy beaches, depositing eggs on adjacent cliff/bluff faces or upper portions of beach areas. Larvae burrow into sparsely vegetated or non-vegetated areas of the cliff/ bluff faces and upper beach areas and take approximately two years to complete their life cycle through three larval instar stages. The Puritan Tiger Beetle is known to inhabit areas that are downstream of the Turners Falls Project, where Project affects could have potential impacts, and the effects are discussed in this BA.

Shortnose Sturgeon

Shortnose Sturgeon is an endangered fish species known to be present downstream of the Turners Falls Project. This species is addressed in a separate BA, to be submitted to the National Marine Fisheries Service (NMFS).

Dwarf Wedgemussel

The Dwarf Wedgemussel was listed as an endangered species by the USFWS in 1990. The largest of the Dwarf Wedgemussel populations in the Connecticut River watershed, which numbers in the tens of thousands, can be found in two stretches of the Upper Connecticut River, identified by USFWS in its 2007 5-Year Review to be located in Coos, Grafton, Sullivan, and Cheshire counties, New Hampshire and Essex, Orange, Windsor, and Windham counties, Vermont. The Dwarf Wedgemussel is an oval-shaped bivalve with a smooth, thin shell. It lives in rivers and creeks of varying sizes, settling on sand and gravel bottoms. It can be found in water depths ranging from a few inches to over 20 feet. This species is generally found in a firm substrate.

In 2011, a freshwater mussel survey was conducted in a 20-mile reach of the Turners Falls Impoundment (TFI), and a 3.5-mile reach from Turners Falls Dam to the confluence with the Deerfield River (2.7 of the 3.5 miles is in the bypass reach), as well as 2.1 miles of the power canal (FirstLight 2012). The objective of the survey was to assess the distribution, abundance and habitat of freshwater mussels. The TFI and bypass reach surveys were conducted during low flow in August and the power canal survey was conducted during the September canal drawdown. Five freshwater mussel species were found, including the Eastern Elliptio, Alewife Floater, Eastern Lampmussel, Eastern Floater, and Triangle Floater, but no Dwarf Wedgemussel were found.

In 2014, FirstLight conducted a quantitative survey and habitat assessment of freshwater mussels in the Connecticut River from Cabot Station downstream to the Route 116 Bridge in Sunderland (Study No. 3.3.16 *Habitat Assessment Surveys and Modeling of Suitable Habitat for State-Listed Mussels Species in the Connecticut River below Cabot*). The objectives of the survey were to delineate populations of state-listed mussels and suitable habitat; characterize the distribution, abundance, demographics, and habitat use of these populations; and to identify potential habitat for listed species based on their habitat preferences. The Dwarf Wedgemussel was included in the study as one of the target species, but none were documented. Further, none were documented during additional semi-quantitative (i.e., timed qualitative) surveys and habitat measurements that were conducted at 26 sites in the study area. The most recent report of Dwarf Wedgemussel in this reach was from ~1978 (shell only).

Extensive mussel surveys have also been completed further downstream by Holyoke Gas and Electric (HG&E), including areas in the Holyoke Dam impoundment, which is the next river segment downstream of where FirstLight completed surveys in 2014. A single Dwarf Wedgemussel had been documented below Hadley Falls (the location of Holyoke Dam) in 1999. HG&E completed surveys every four years (2005, 2009, and 2013) in the impoundment, along with areas downstream of the dam. Though Dwarf Wedgemussel were a target species for these surveys, none were documented (HG&E 2014).

In general, extensive surveys that have been completed within the Project areas of the Turners Falls and Northfield Mountain Projects, along with areas further downstream to Holyoke Dam, have not documented any Dwarf Wedgemussel. Therefore, the Dwarf Wedgemussel is not present in Project-affected areas and is not further discussed in this BA.

Northeastern Bulrush

The Northeastern Bulrush is a leafy bulrush in the sedge family currently known only from populations scattered from New Hampshire and Massachusetts, south to West Virginia. In New England, the species is primarily found along the Connecticut River valley in New Hampshire and Vermont, and north-central Massachusetts. The species is described from a variety of wetlands along its extensive range. In the northern extent of its range, the bulrush is found most commonly on the edge of shallow beaver ponds, usually in full sun or similar habitats where water levels may vary.

Based on the 1993 recovery plan for the species at the time of publishing, 33 populations of the species were known to occur (USFWS, 1993b). Of the total number of known populations four occurred within north-central Massachusetts and Southern Vermont/New Hampshire. In these states the bulrush was known to occur in Franklin County, Massachusetts (one population), Cheshire County, New Hampshire (one population), and Windham County, Vermont (two known populations) (USFWS, 1993b). USFWS occurrence data does not identify specific locations that have been documented within these counties.

FirstLight has conducted several studies that identify the distribution of botanical resources within the Turners Falls and Northfield Mountain Project areas, along with identification of Project effects. Assessments of botanical resources included vegetation inventories in the following areas:

- Upland areas along the TFI including areas within the Project Boundary and areas up to 200 feet from shore where the Project Boundary is along the shoreline;
- Upland areas adjacent to the bypass reach, defined as extending from the Turners Falls Dam to the Cabot Station tailrace;
- The Connecticut River from the Cabot Station tailrace to the Route 116 Bridge in Sunderland; and
- Approximately 2,011 acres of land of Northfield Mountain, of which approximately 405-407 acres is the Upper Reservoir.

Despite extensive survey efforts, and identification of 390 plant species in the study areas in 2014 and 2015, no Northeastern Bulrush, or any other federally listed botanical species, were found. Therefore, the Northeastern Bulrush is not present in Project areas, and is not further discussed in this BA.

Small Whorled Pogonia

The Small Whorled Pogonia is a member of the Orchid family with colonies in a relatedly broad but sparse distribution in the Atlantic seaboard states from Maine to Georgia, with other occurrences in several other eastern and midwestern states. According to the Revised Recovery Plan (USFWS 1992), the Small Whorled Pogonia occurs on upland sites in mixed-deciduous or mixed-deciduous/coniferous forests that are in second- or third-growth successional stages. According to the IPaC search, the species may be present in the Hadley area, which is outside of the direct Project areas. Despite extensive survey efforts that included upland habitats within the Project areas completed by FirstLight during relicensing, no Small Whorled Pogonia were found. Therefore, because this species does not exist in the Project areas, it would not be affected by any construction or maintenance activities. The only Project effects in the Hadley area are limited to water level changes along the Connecticut River shorelines, where this upland species would not be present. Because the locations of the habitat for Small Whorled Pogonia would not overlap with any locations where there are Project-related effects, this species is not further discussed in this BA.

Northern Long-eared Bat

The Northern Long-Eared Bat overwinters in caves or old mines with high humidity and stable temperatures. During the summer the bats will roost in large diameter trees, preferring those with exfoliating bark. Reproduction begins in late summer or fall, with delayed implantation resulting in pupping in the following spring. The Project area includes old growth hemlock, shagbark hickory, silver maple, and several other species which are large in diameter and possess bark characteristics which could provide potential summer roosting habitat for the Northern Long-Eared Bat. During the 2014 and 2015 field work, this species was not observed in the Project-affected areas.

On April 2, 2015 the Northern Long-Eared Bat was listed as federally threatened. The primary reason for the listing of this species is the dramatic population decline which has resulted from the spread of white-nose syndrome. The USFWS has the authority to write special rules and exemptions for threatened species under section 4(d) of the federal Endangered Species Act. These rules are referred to as 4(d) rules. On January 14, 2016, USFWS issued a Final 4(d) Rule for the Northern Long-Eared Bat, imposing several specific conservation measures. On April 27, 2016, USFWS announced its determination that it would not designate critical habitat for the Northern Long-Eared Bat, having determined that summer habitat is not limited or in short supply and summer habitat loss is not a range-wide threat to the species. Purposefully harming Northern Long-Eared Bat remains prohibited except in defense of human health and safety. Most incidental take of Northern Long-Eared Bat (defined as impacts to the species from otherwise legal activities) is allowed without the need for a federal permit with the following specific exceptions:

- All incidental take within known hibernacula is prohibited;
- Incidental take resulting from tree removal within a 0.25-mile buffer around known occupied Northern Long-Eared Bat hibernacula or within a 150-foot buffer around known occupied maternity roost trees during the pup season (June 1 through July 31).

Project operations (i.e. water level and flow management) are not anticipated to have any effects on the Northern Long-Eared Bat or its habitat; effects would be limited to actions that involve tree removal, which is sometimes necessary for Project maintenance or safety. However, no known hibernacula or occupied maternity roost trees have been known to be present within or near the Project area, and none have been identified by the agencies. FirstLight will implement best-management practices for this species by incorporating the following restriction into its relicensing proposal for both the Turners Falls and Northfield Mountain Projects:

The Licensee shall implement the following measures to protect Northern Long-Eared Bat habitat: (1) avoid cutting trees equal to or greater than 3 inches in diameter at breast height within the project boundary from April 1 through October 31, unless they pose an immediate threat to human life or property (hazard trees); and (2) where non-hazard trees need to be removed, only remove non-hazard trees between November 1 and March 31.

By using this practice, potential Project effects due to maintenance (e.g. tree cutting) would minimize effects on Northern Long-Eared Bat. The proposed restrictions have been recently identified by FERC as a measure that would result in a “not likely to adversely affect” finding (FERC 2020). Therefore, this species is not discussed further in this BA.

1.3 Critical Habitat Addressed in this Biological Assessment

No designated critical habitat areas are in the Project-affected areas.

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2 PROJECT DESCRIPTION

2.1 Existing Facilities

The Northfield Mountain Project boundary includes the perimeter of the TFI down to the Turners Falls Dam and the area around the Northfield Mountain Project. The Turners Falls Project boundary also includes the perimeter of the TFI (overlapping with the Northfield Mountain Project boundary) and an area below the Turners Falls Dam down to Cabot Station. Figure 2.1-1 shows the overlapping Project boundary, and the separate Turners Falls and Northfield Mountain Project boundaries. The combined Project Boundary for the Turners Falls Project and Northfield Mountain Project contains 7,246 acres of land and 2,238 acres of flowed land.

2.1.1 Turners Falls Project

The Turners Falls Project includes the Turners Falls Dam, which creates the TFI on the Connecticut River (Figure 2.1.1-1). The Turners Falls Dam consists of two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam, which are connected by a natural rock island known as Great Island. The 630-foot-long Montague Dam connects Great Island to the west bank of the Connecticut River and includes four bascule type gates, each 120-feet-wide by 13.25-feet-high and a fixed crest section which is normally not overflowed. The Gill Dam is approximately 55-feet-high and 493-feet-long extending from the Gill shoreline (east bank) to Great Island and includes three tainter spillway gates, each 40-foot-wide by 39-foot-high.

Adjacent to the Montague Dam is the 214-foot-long gatehouse equipped with 15 operating gates controlling flow from the TFI to the power canal. Six (6) of the gates are 10’-8” high by 9’ wide wooden gates and nine (9) of the gates are 12’-7” high by 9’-6” wide wooden gates. The Gatehouse fishway, described below, passes through the gatehouse at the east bank.

The power canal is approximately 2.1 miles long and has a design capacity of approximately 18,000 cubic feet per second (cfs). There are several water withdrawals from the power canal. The major ones are FirstLight’s Station No. 1 and Cabot Station—these two hydroelectric projects are part of the Turners Falls Project. Station No. 1 is located closer to the beginning of the power canal and Cabot Station is located at the downstream terminus of the power canal. The generation and hydraulic capacity of Station No. 1 is 5,683 kW and 2,210 cfs, respectively. The generation and hydraulic capacity of Cabot Station is 62.016 MW and 13,728 cfs, respectively. With the two generating stations combined, the total hydraulic capacity of the Turners Falls Project is 15,938 cfs.

In addition to Station No. 1 and Cabot Station, there are two other hydropower facilities on the canal that discharge into the bypass reach, when operating, including the Turners Falls Hydro, LLC project and Milton Hilton, LLC project. The Turners Falls Hydro project (FERC No. 2622) is owned and operated by Eagle Creek Renewable Energy and is currently undergoing licensing with FERC. It discharges into the bypass reach approximately 0.3 miles downstream of the Turners Falls Dam, which is upstream of the Station No. 1 tailrace. The Milton Hilton, LLC project is an unlicensed project owned and operated by a private developer. It discharges into the bypass reach approximately 0.5 miles downstream of the Turners Falls Hydro project tailrace, which is upstream of the Station No. 1 tailrace.

The Turners Falls Project is equipped with three upstream fish passage facilities, including (in order from downstream to upstream): the Cabot fishway, the Spillway fishway, and the Gatehouse fishway. The Cabot fishway, located near the Cabot tailrace, moves migrating fish from the Connecticut River into the power canal. The Spillway fishway, located at the Turners Falls Dam, moves migrating fish from the Connecticut River into a gallery leading to the Gatehouse fishway; however, some fish do drop out into the power canal. The Gatehouse fishway, located at the Gatehouse, moves fish from the power canal to above the Turners Falls Dam. A downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no spill is occurring at Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal.

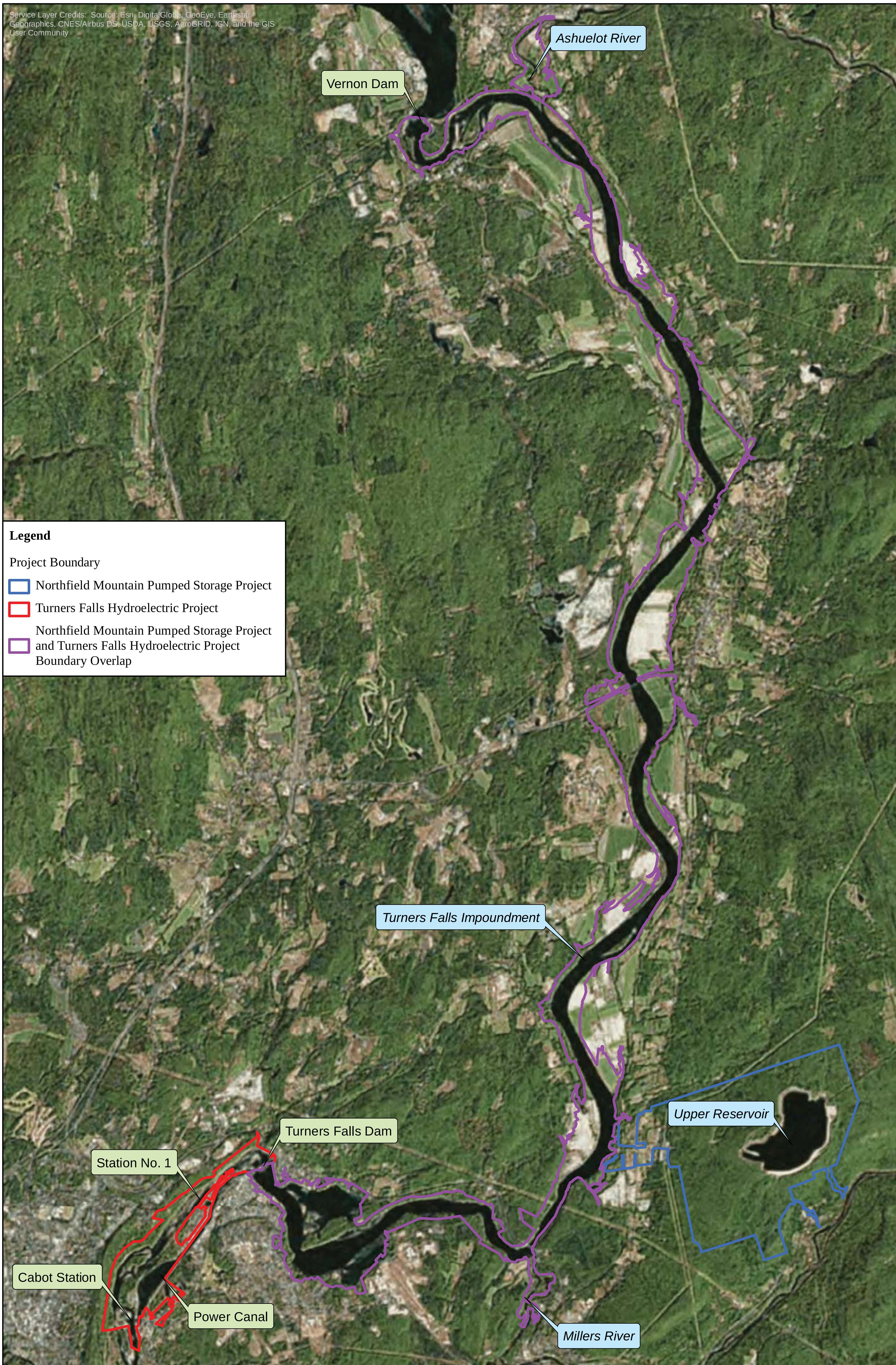
The TFI extends approximately 20 miles upstream to just below the Vernon Hydroelectric Project (FERC No. 1904), which is owned and operated by Great River Hydro. To provide storage capacity for the Northfield Mountain Project, the TFI elevation may vary, per the FERC license, from a minimum elevation of 176.0 feet[1] (National Geodetic Vertical Datum of 1929 (NGVD29)) to a maximum elevation of 185.0 feet constituting a 9-foot fluctuation as measured at the Turners Falls Dam. The usable storage capacity in this 9-foot fluctuation, as measured at the Turners Falls Dam, is approximately 16,150 acre-feet.

2.1.2 Northfield Mountain Project

The Northfield Mountain Project consists of an Upper Reservoir and dam/dikes, an intake, pressure shaft, underground powerhouse and tailrace (Figure 2.1.2-1). The crest elevation of the Upper Reservoir's Main Dam is at elevation 1010 feet. In addition to the Main Dam there are several dam/dikes that form the Upper Reservoir. The Upper Reservoir elevation may vary, per the FERC license, from a minimum elevation of 938 feet to a maximum elevation of 1,000.5 feet constituting a 62.5-foot drawdown. FERC has allowed temporary variances to increase the maximum and minimum elevation to 1,004.5 feet and 920 feet, respectively, during certain periods to meet electric grid system needs.

The intake channel directs water from the Upper Reservoir into the pressure conduit intake and eventually to the underground powerhouse. The electrical capacity of the four (4) reversible pump-turbines is 291.7 MW for a total station nameplate capacity of 1,166.80 MW. When operating at maximum pumping mode, the approximate hydraulic capacity is 15,200 cfs. Alternatively, when operating at maximum generation mode, the approximate hydraulic capacity is 20,000 cfs.

[1] The Project datum is the National Geodetic Vertical Datum of 1929 (NGVD29). All elevations in the license application for the Turners Falls Project and Northfield Mountain Project are based on the NGVD29 datum unless otherwise noted



FirstLight

N

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

0 0.5 1 2 Miles

Figure 2.1-1
Project Boundary Map

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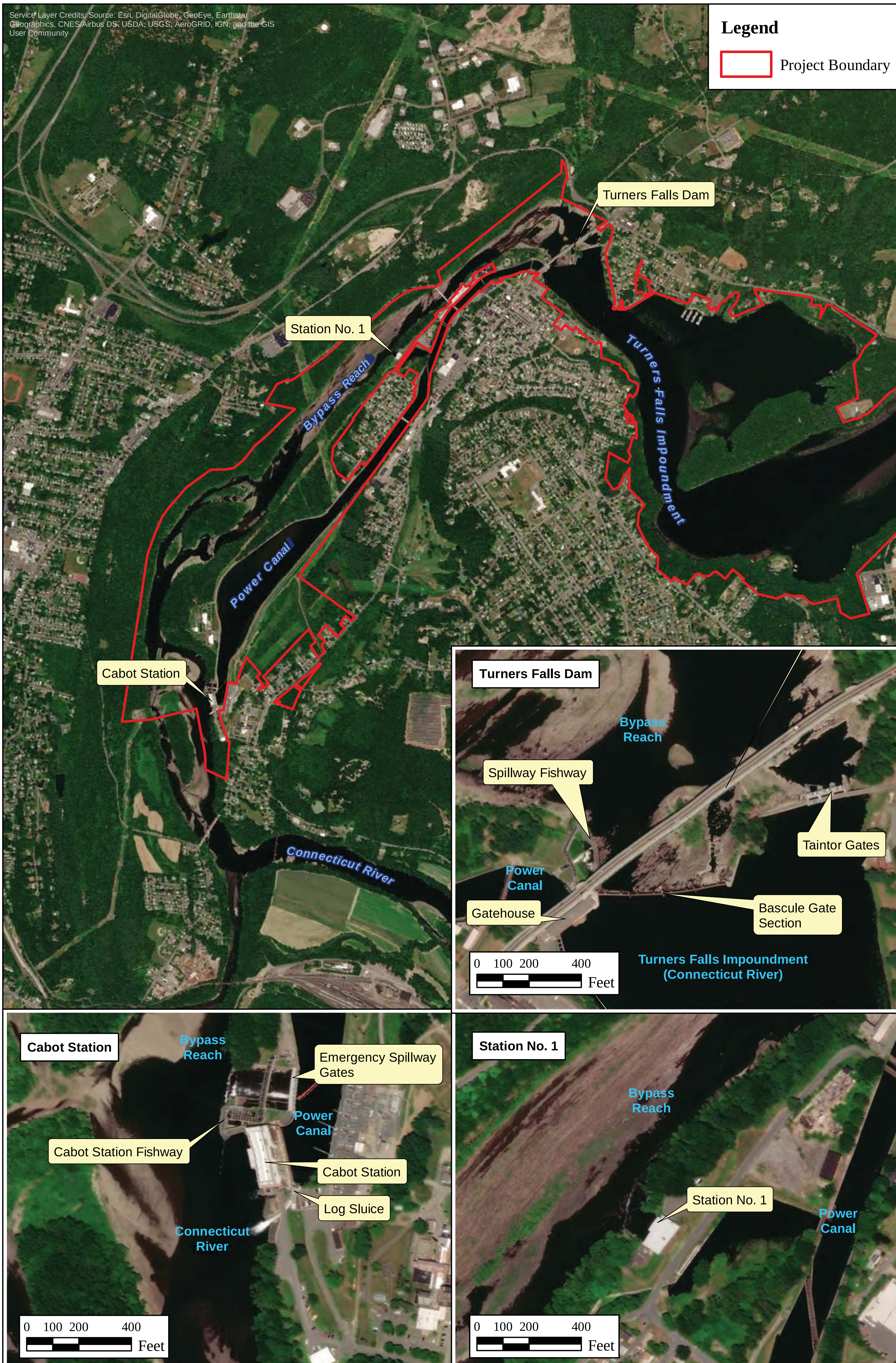


FirstLight

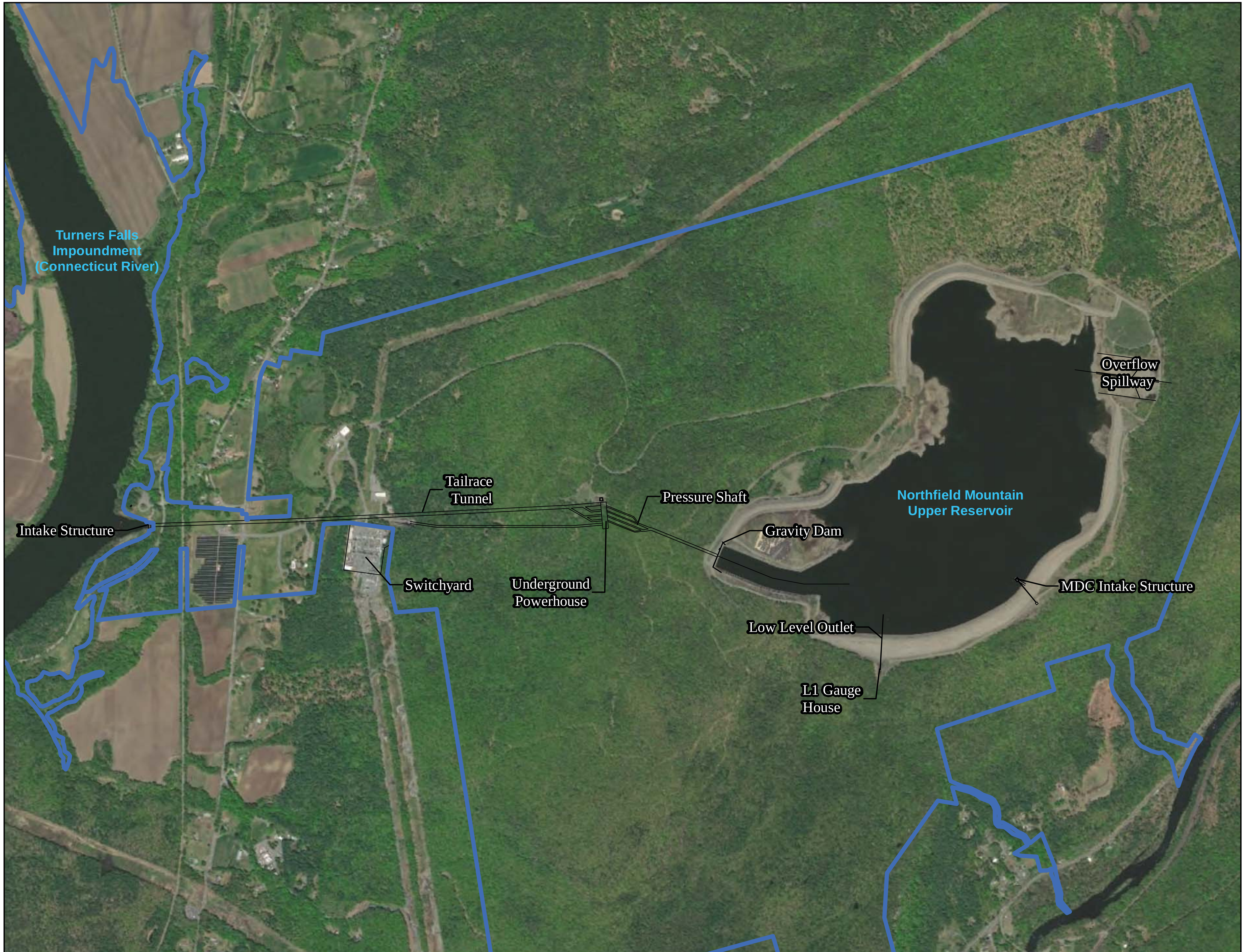
N

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

0 0.125 0.25 0.5
Miles

Figure 2.1.1-1
Turners Falls Project Features

Path: W:\gis\maps\PTB BA\Turners Falls Project Features detail.mxd



Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

Figure 2.1.2-1
Northfield Mountain Project Features

Legend

Project Boundary

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

FirstLight

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2.2 Current Operations

2.2.1 Turners Falls Project

As noted above, the Turners Falls Project consists of two hydroelectric facilities- Cabot Station and Station No. 1. During periods when inflow is within the hydraulic range of Cabot Station, it is operated as a peaking plant; during periods of high inflow, in excess of 13,728 cfs (its approximate maximum hydraulic capacity), it operates as a base load plant. Station No. 1 is a base load plant with a hydraulic capacity of 2,210 cfs and typically operates when inflows to the TFI are less than the hydraulic capacity of a single Cabot Unit (~2,288 cfs) or when inflows exceed the hydraulic capacity of Cabot Station. Station No. 1 is manually operated, while Cabot is remotely operated. The current license requirements relative to Turners Falls Project operations are described below.

As noted above, the Turners Falls Hydro project and Milton Hilton, LLC project are also located on the canal. Milton Hilton, LLC[2] and Turners Falls Hydro[3] have indentured water rights. FirstLight currently has an agreement with each of these entities which provides that the entity will come on line when the naturally routed flow (NRF)[4] in the Connecticut River increases to 15,000 cfs (close to the combined capacity of Cabot and Station No. 1).

Under the current FERC license for the Turners Falls Project, FirstLight is required to release a continuous minimum flow of 1,433 cfs[5] or inflow, whichever is less below the Project. FirstLight typically maintains the minimum flow requirement through discharges at Cabot and/or Station No. 1.

Per the FERC license, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1, increasing to 400 cfs when fish passage starts by releasing flow through a bascule gate at the Turners Falls Dam. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to allow Shortnose Sturgeon egress through the bypass reach. The 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15.

The TFI elevation is currently licensed to fluctuate between 176.0 feet and 185.0 feet, as measured at the Turners Falls Dam. Though TFI water levels are managed at the Turners Falls Dam, generation and pumping from Northfield Mountain, and varying inflows all affect the TFI water levels.

2.2.2 Northfield Mountain Project

The Northfield Mountain Project is a pumped storage hydroelectric facility. Water is pumped from the TFI to the Upper Reservoir which has 12,318 acre-feet of useable storage available for pumped storage operations. Typically, pumping occurs during periods when energy prices are low, while generation occurs during periods when energy prices are high. Under the current FERC license, the Northfield Mountain Upper Reservoir elevation may fluctuate between 1,000.5 feet and 938 feet.

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[2] A water use agreement between then Esleeck Manufacturing Company (a predecessor to Milton Hilton, LLC) and then Turners Falls Power and Electric Company (a predecessor to FirstLight) was signed in August 1928.
[3] A water exchange agreement between then Keith Paper Company (a predecessor to Eagle Creek Renewable Energy) and then Western Massachusetts Electric Company (a predecessor to FirstLight) was signed in September 1951.
[4] The naturally routed flow equals the sum of Vernon discharges plus flows recorded at USGS Gages on the Ashuelot and Millers Rivers.
[5] This equates to 0.20 cfs per square mile of drainage area at the Turners Falls Dam.

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3 PROPOSED ACTION

In its Amended Final License Application, FirstLight is proposing modifications to several components of the Projects designed to benefit various environmental and recreational resources. These include modifications to benefit Puritan Tiger Beetle.

3.1 Proposed Project Facilities

3.1.1 Proposed Generation Facilities

FirstLight is not proposing any changes to existing developmental (i.e., generation) facilities at the Northfield Mountain Project.

Station No. 1 Upgrades

FirstLight is proposing changes to the Turners Falls Project, specifically, changes to Station No. 1. Station No. 1 is currently an unstaffed facility. To bring units on, an operator must visit the site. In addition, the five (5) units cannot be throttled over a range of flows, meaning each unit only discharges its maximum capacity. FirstLight is proposing to pass a portion of its proposed bypass flows via Turners Falls Dam spill and Station No. 1 discharge. By automating Station No. 1, it will allow FirstLight to a) remotely operate the units and b) operate the units over a wider range of flows (not just the maximum capacity). FirstLight proposes the following:

- For each unit, upgrading the brakes, controls, governors, grounding transformer, protective relaying, excitation system and turbine rehabilitations.
- Automation including auto synchronizing equipment and sensors to interface to the programmable logic controller (PLC).

At this time, FirstLight is not proposing to install a minimum flow turbine-generator at the Turners Falls Dam to generate with its proposed bypass flows. However, over the term of the next license FirstLight will continually evaluate the economic feasibility of adding a minimum flow turbine-generator or any other potential energy source.

3.1.2 Proposed Non-Generation Facilities

FirstLight is proposing to a) construct infrastructure necessary to pass FirstLight's proposed bypass flows in the winter, b) construct new fish passage facilities and c) construct new recreation facilities as described below.

Infrastructure Needed to Pass Winter Bypass Flows

FirstLight proposes to provide a bypass flow of 300 cfs, or inflow, whichever is less, as measured just below the Turners Falls Dam, from December 1 to March 31. There are two water conveyance structures at the Turners Falls Dam, including bascule gates and tainter gates. The tainter gates are designed to discharge flows greater than approximately 5,000 cfs. Of the four bascule gates, bascule gate no. 1 is pond following, meaning the crest of the bascule gate can be adjusted to pass a desired flow at a given TFI water level. FirstLight proposes to use this bascule gate to pass the winter flow; however, some modification to the gate is needed. Specifically, FirstLight proposes to add heaters to the gate to prevent ice build-up.

Proposed Upstream and Downstream Fish Passage Facilities

FirstLight proposes to construct various upstream and downstream fish passage facilities. Table 3.1.2-1 lists the proposed fish passage PME measures and the approximate number of years after license issuance they would become operational.

Table 3.1.2-1 FirstLight's Proposed PME Measures for Upstream and Downstream Fish Passage

Upstream or Downstream Passage	Assigned to Turners Falls Project or Northfield Mountain Project	Proposed PM&E Measure	Estimated No. of Years after License Issuance Proposed PM&E Measure becomes Operational
Upstream Passage	Turners Falls	Install Permanent Ultrasound Array in the Cabot Tailrace to deflect American Shad to the Bypass Reach	6
	Turners Falls	Construct a new Spillway Lift with Palisade Entrance at the Turners Falls Dam	6
	Turners Falls	Construct an Eelway near the Turners Falls Dam (interim passage within 1 year of license issuance, siting studies in the first year of the Spillway Lift operation, permanent eelway within 9 years of license issuance)	9
	Turners Falls	Retire Cabot Fish Ladder	6
	Turners Falls	Retire Entrance Portions of gatehouse ladder in canal	6
Downstream Passage	Northfield Mountain	Install a Barrier Net at Northfield Mountain Intake/ Tailrace to prevent entrainment (within 5 years license issuance)	5
	Turners Falls	Construct a Plunge Pool below Bascule Gate No. 1 located at the Turners Falls Dam. This work would likely be conducted at the same time as the Spillway Lift construction (Plunge pool constructed in concert with Spillway Lift, within 6 years from license issuance).	6
	Turners Falls	Construct a Bar Rack at the entrance to the Station No. 1 Forebay (within 8 years from license issuance).	8

Permanent Ultrasound Array. FirstLight proposes to install a permanent ultrasound array at the outer edge of the Cabot Station tailrace to deter upstream migrating adult American Shad from entering the tailrace area, but instead move them up the bypass reach to a new fish lift at the Turners Falls Dam (the Spillway Lift). FirstLight will install the permanent ultrasound array after the Spillway Lift is constructed. Once the ultrasound array is functioning FirstLight proposes to close the Cabot fish ladder to prevent American Shad from entering the power canal, where they may experience long delays or are never able to reach the TFI.

Construct new Spillway Lift and Plunge Pool. FirstLight proposes to construct a new Spillway Lift (with palisade entrance) and plunge pool below bascule gate no. 1 of the Turners Falls Dam. The Spillway Lift will include a single hopper that will lift fish approximately 39 feet to an exit trough that connects into the top of the existing Spillway Fish Ladder for fish to exit into the headpond through the existing gatehouse fish ladder. The lift will also utilize the existing entrance structure of the Spillway Fish Ladder for the entrance to the lift. A V-trap and brail system will be used instead of a crowder channel to capture fish in the hopper.

The plunge pool will include two concrete walls to create an approximately 110-foot-wide by 65-foot-long box below bascule gate no. 1 – one wall parallel to flow between bascule gate no. 1 and bascule gate no. 2, and one wall perpendicular to the flow from the end of the first wall to the fish lift entrance. Flow will pass from the pool either through a palisade structure adjacent to the fish lift entrance or by spilling over the downstream wall of the box. The flow from the palisade structure will also be used for attraction flow to the Spillway Lift.

Since the Spillway Lift and plunge pool are in the same location, these two projects would be constructed simultaneously.

Construct Eelway. Once all upstream and downstream fish passage structures at the Turners Falls Project are complete, FirstLight proposes to install an eelway near the Turners Falls Dam. Based on siting surveys and two temporary eelramp installations, over 90% of the elvers move upstream at the Spillway Ladder. FirstLight proposes to install an eelway at this location. The eelway will include a single tray lined with substrate for the eels to ascend on, piping providing flow through the substrate and attraction flow, and a collection tank at the tray exit.

Install Barrier Net. FirstLight proposes to install a barrier net in front of the Northfield Mountain Project intake/tailrace to prevent the entrainment of migratory fish when the Northfield Mountain Project is pumping. The net will be approximately 30-foot-high by 1050-feet-long wide with 3/4-inch mesh from top to bottom. The net will be positioned approximately in line with the river shoreline upstream and downstream of the Northfield Mountain Project tailrace. The net will be anchored at each end of the net at the shoreline with additional anchoring along the base of the net to prevent migrants from passing under the net.

FirstLight proposes to have the barrier net in place from August 1 to November 15 each year.

Construct a Bar Rack at Entrance to Station No. 1 Forebay. FirstLight proposes to install a bar rack, with ¾-inch clear spacing, at the location where flow from the main power canal is diverted into the Station No. 1 forebay. The rack will be approximately 58 feet wide across the entrance of the forebay and 21 feet tall. Approximately 4 feet of rock would be excavated from the bottom of the canal to provide sufficient area to prevent impingement. A new concrete base will be constructed below the rack for a foundation and to support diagonal bracing behind the rack. A new trash rake and conveyor for trash removal will also be installed for regular cleaning of debris from the rack.

Conceptual level drawings of the above structures, with the exception of the eelway and ultrasound array, are included in the Turners Falls Project Exhibit F (Spillway Lift, Plunge Pool, Station No. 1 Rack).

Retire Cabot Fish Ladder. Once the Spillway Fish Lift is functioning to pass fish and the ultrasound array is operational, FirstLight proposes to retire the Cabot Fish Ladder because all fish passage would be moved to the Spillway Lift. FirstLight does not believe continuing to introduce fish into the power canal where they encounter extensive delays or never reach the TFI is productive.

Retire Entrance Portion of Gatehouse Fish Ladder. The portion of the gatehouse ladder that includes the entrances on the right and left side of the canal walls will not be needed; however, the ladder will be used to move fish from the Spillway Lift into the TFI.

Conceptual level drawings of the above structures, with the exception of the eelway and ultrasound array, are included in the Turners Falls Project Exhibit F (Spillway Lift, Plunge Pool, Station No. 1 Rack) and in the Northfield Mountain Project Exhibit F (Barrier Net).

Proposed Recreation Features

Table 3.1.2-2 lists FirstLight's proposed recreation features, what Project it is assigned to, and the estimated number of years after license issuance it becomes operational. Any recreation feature located upstream of the Turner Falls Dam was assigned to the Northfield Mountain Project, which is consistent with the existing Northfield Mountain license. Any recreation feature located below the Turners Falls Dam was assigned to the Turners Falls Project.

Table 3.1.2-2: FirstLight's Proposed PME Measures for Recreation

Proposed PM&E Measure	Assigned to Turners Fall Project or Northfield Mountain Project	Estimated No. of Years after License Issuance Proposed PM&E Measure becomes Operational
At Riverview, relocate the existing Boat Tour Dock given that it would be enclosed by the proposed Barrier Net (within 4 years of license issuance)	Northfield Mountain	4
Create a new access trail with stairs for a put-in at Riverview (within 4 years of license issuance)	Northfield Mountain	4
Create a formal access trail for a put-in at Cabot Camp (within 4 years of license issuance)	Northfield Mountain	4
Create a formal access trail for a put-in just below the Turners Falls Dam (within 4 years of license issuance)	Turners Falls	4
Create a formal trail and steps for a take-out at Poplar Street (within 4 years of license issuance)	Turners Falls	4

Create a New Access Trail with Stairs for a Put-In at Riverview. A new put-in would be located off of Pine Meadow Road, where Fourmile Brook discharges into the TFI. The site would entail establishing a 6-foot wide stone path to timber and concrete stairs leading to a put-in on the northern bank along the brook. Pine Meadow Road would be widened to add approximately seven (7) parking spots and a sign (Project Name and FERC No.) would be installed near the stone path.

Relocation of the Boat Tour Dock at Riverview. The proposed barrier net would be in place from August 1 to November 15 during a portion of the summer recreation season. The current layout of the barrier net encloses the existing Boat Tour Dock. Given this, FirstLight proposes to relocate the dock further upstream of its current location. It would entail extending the existing road further north.

Formal Access Trail and Put-In at Cabot Camp. FirstLight proposes to create a 200-foot long, 10-foot wide formal path leading from the Cabot Camp parking area to an access point on the Millers River just upstream of the confluence with the Connecticut River. There is currently an informal path in this area. A sign (Project Name and FERC No.) and directional portage sign would be installed along the formal path leading the public from the parking lot directly to the 10-foot-wide gravel path leading to the water's edge.

Formal Access Trail and Put-In just below Turners Falls Dam. Stakeholders have requested a put-in just below the Turners Falls Dam to kayak/canoe/raft the bypass reach. There is an existing informal pathway leading to the base of the Turners Falls Dam just downstream of the existing Spillway Ladder. The proposed access would be provided via the existing bridge (aka the "IP Bridge") spanning the power canal. Once over the canal, a formal 12-ft wide path would lead recreationists to the base of the dam. The path would include a sign (Project name and FERC No.) just after exiting the IP bridge, and directional signs along the formalized path.

FirstLight also proposes to establish a weblink that would report the forecasted Turners Falls Dam discharge each day during the daylight hours from July 1 to October 15 to benefit whitewater boaters. FirstLight is not proposing to post the Turners Falls Dam discharge from April 1 to June 30 because it is a period when the federally endangered SNS could be utilizing the bypass reach for spawning and incubation which could be disturbed by whitewater boaters.

Formal Access Trail and Stairs for Take-out at Poplar Street. There is an existing take-out at Poplar Street; however, it is extremely steep. FirstLight has limited options due to steep topography and land ownership. FirstLight proposes to use the existing gravel parking lot leading to 20-foot wide timber stairs with a boat slide railing leading to a 5-foot long, 20-foot wide concrete landing/abutment. A 32-foot long gangway would be anchored to the concrete abutment and lead to a floating dock in the Connecticut River to accommodate fluctuations in the river elevation. The site would include a sign (Project name and FERC No.) at the top of the timber stairs.

Conceptual level drawings of the proposed recreation features are included in Recreation Management Plans developed for the Turners Falls Project and Northfield Mountain Project.

Proposed Recreation Management Plans

FirstLight has developed separate Recreation Management Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Proposed Historic Properties Management Plans

FirstLight has developed separate Historic Properties Management Plans for the Turners Falls Project and Northfield Mountain Project.

Proposed Bald Eagle Protection Plans

FirstLight has developed separate Bald Eagle Protection Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Proposed Invasive Plant Species Management Plans

FirstLight has developed separate Invasive Plant Species Management Plans for the Turners Falls Project and Northfield Mountain Project, which are included in Exhibit E.

Sediment Management Plan

FirstLight previously filed with FERC on June 30, 2017 a Sediment Management Plan entitled Upper Reservoir Dewatering Protocols.

Northern Long-Eared Bat Protection Measures

The Licensee will implement the following measures to protect Northern Long-Eared Bat habitat: (1) avoid cutting trees equal to or greater than 3 inches in diameter at breast height within the project boundary from April 1 through October 31, unless they pose an immediate threat to human life or property (hazard trees); and (2) where non-hazard trees need to be removed, only remove non-hazard trees between November 1 and March 31.

3.2 Proposed Project Boundary

FirstLight is proposing changes to each Project Boundary as summarized below.

<u>Turners Falls Project and Northfield Mountain Project Overlapping Project Boundary Changes</u>

- The removal of a 0.2 acre parcel of land at 39 Riverview Drive in Gill, MA. These lands are owned by FirstLight but are not needed for Project operations or any other Project purpose. None of the lands FirstLight proposes to exclude from the Project boundaries contains historic properties eligible or potentially eligible for the National Register of Historic Places.

<u>Northfield Mountain Project Boundary Changes</u>

- The removal of an 8.1 acre parcel of land referred to as Fuller Farm located near 169 Millers Falls Road in Northfield, MA. These lands are not needed for Project operations or any other Project purpose.

- The addition of 135.5 acres[6] of land south of the Northfield Switching Station located in the Towns of Northfield and Erving in Massachusetts. Some of these lands are currently owned by Eversource and are necessary to include recreation trails associated with the Northfield Mountain Trail and Tour Center that are not currently enclosed in the Project Boundary.

Turners Falls Project Boundary Changes

- The removal of a 20.1 acre parcel of land currently occupied by the United States Geological Survey's (USGS) Silvio Conte Anadromous Fish Laboratory located at One Migratory Way, P.O Box 796, in Turners Falls, MA 01376. The Conte Lab lands are located just north of Cabot Station. These lands are not needed for Project operations or any other Project purpose.

  The addition of an 0.8 acre parcel of land owned by FirstLight at 21 Poplar Street (end of the street) in Montague, MA. These lands are needed for recreational purposes (take-out or put-in).

3.3 Proposed Project Safety

FirstLight anticipates that, as part of the relicensing process, FERC staff will evaluate the continued safety of the proposed Project facilities under the new license. FirstLight anticipates FERC will continue to inspect the Project during the new license term to assure continued adherence to FERC-approved plans and specifications, any special license articles pertaining to construction, operation and maintenance, and accepted engineering practices and procedures.

3.4 Proposed Project Operations

FirstLight proposes several operational changes as summarized in Section 3.5.

3.5 Proposed Environmental Measures

FirstLight proposes the following draft license articles relative to operations.

Operational Regime

(a) The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with the following operational flow regime until the third (3rd) anniversary of the effective date of the new license.

Date	Total Bypass Flow[2]	Turners Falls Dam	[3]Station No. 1
01/01-03/31	1,500 cfs or the Naturally Routed Flow (NRF), whichever is less	300 cfs	1,200 cfs[4]
04/01-05-31[1]	6,500 cfs or the NRF, whichever is less	4,290 cfs	2,210 cfs[4]
06/01-06/15[1]	4,500 cfs or the NRF, whichever is less	2,990 cfs	1,510 cfs[4]
06/16-06/30[1]	3,500 cfs or the NRF, whichever is less	2,280 cfs	1,220 cfs[4]
07/01-08/31	1,800 cfs or the NRF, whichever is less	670 cfs	1,130 cfs[4]
09/01-11/30	1,500 cfs or the NRF, whichever is less	500 cfs	1,000 cfs[4]
12/01-12/31	1,500 cfs or the NRF, whichever is less	300 cfs	1,200 cfs[4]

[1]The flow split during these periods is approximately 67% from the Turners Falls Dam and 33% from Station No. 1. If FirstLight conducts further testing, in consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS) and Massachusetts Department of Fish and Wildlife (MADFW), and determines that migratory fish are not delayed by passing a greater percentage of the bypass flow via Station No. 1, it may increase the percentage through Station No. 1 upon written concurrence of those agencies.

[2]If the NRF is less than 6,500 cfs (04/01-05/31), 4,500 cfs (06/01-06/15) or 3,500 cfs (06/16-06/30) the flow split will still be set at approximately 67% of the NRF from the Turners Falls Dam and 33% of the NRF from Station

[6] Of the 135.5 acres, 12.5 acres is owned by FirstLight, while the remaining 122 acres is owned by Eversource.

Date	Total Bypass Flow[2]	Turners Falls Dam	[3]Station No. 1
No. 1. If the NRF is less than 1,800 cfs (7/1-8/31), 1,500 cfs (9/1-11/30), or 1,500 cfs (12/1-3/31), the Licensee shall maintain the Turners Falls Dam discharges at 670 cfs, 500, cfs, and 300 cfs, respectively. [3]To maintain the flow split, Station No. 1 must be automated, which will not occur until Year 3 of the license. FirstLight proposes to maintain the flow split such that the Turners Falls Dam discharge will be as shown above, or higher flows will be spilled, in cases where the additional flow cannot be passed through Station No. 1. [4]The Turners Falls Hydro (TFH) project (FERC No. 2622) and Milton Hilton, LLC project (unlicensed) are located on the power canal and discharge into the bypass reach upstream of Station No. 1. The hydraulic capacity of the TFH project and Milton Hilton, LLC project is 289 and 113 cfs, respectively. If the TFH project is operating, FirstLight will reduce its Station No. 1 discharge by 289 cfs. If the Milton Hilton, LLC project is operating, FirstLight will reduce its Station No. 1 discharge by 113 cfs.			

(b) Maintain a continuous minimum flow below Cabot Station of 6,800 cfs from 6/1-6/15 and 5,800 cfs from 6/16-6/30 or the NRF, whichever is less.

The bypass flows and minimum flow below Cabot may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS, Massachusetts Department of Environmental Protection (MADEP) and MADFW.

(c) The NRF represents the inflow to the Turners Falls Dam. The NRF is defined as the sum of the Vernon Hydroelectric Project (FERC No. 1904) total discharge, Ashuelot River United States Geological Survey (USGS) gage flow and Millers River USGS gage flow.

(d) The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with the conditions in paragraph (a) and (b) and the following operational flow regime beginning on the third (3rd) anniversary of the effective date of the new license.

Date	Total Bypass Flow[2,3]	Maximum Flow below Cabot Station to Protect Puritan Tiger Beetles	Cabot Down-Ramping Rate to Protect Shortnose Sturgeon	Cabot Up-Ramping Rate to Protect Shortnose Sturgeon (4/1-5/31) and Odonates (6/1-8/15)
01/01-03/31	1,500 cfs or the NRF, whichever is less			
[1]04/01-05/31	6,500 cfs or the NRF, whichever is less		Down to 2,300 cfs/hour	Up to 2,300 cfs/hour
[1]06/01-06/15	4,500 cfs or the NRF, whichever is less			Up to 2,300 cfs/hr from 8:00 am to 2:00 pm
[1]06/16-06/30	3,500 cfs or the NRF, whichever is less			Up to 2,300 cfs/hr from 8:00 am to 2:00 pm
07/01-08/15	1,800 cfs or the NRF, whichever is less	Add no more than 4,600 cfs additional flow from Cabot		Up to 2,300 cfs/hr from 8:00 am to 2:00 pm

Date	**Total Bypass Flow[2,3]**	**Maximum Flow below Cabot Station to Protect Puritan Tiger Beetles**	**Cabot Down-Ramping Rate to Protect Shortnose Sturgeon**	**Cabot Up-Ramping Rate to Protect Shortnose Sturgeon (4/1-5/31) and Odonates (6/1-8/15)**
		Station from 1 am to 2 pm		
08/16-08/31	1,500 cfs or the NRF, whichever is less	Add no more than 4,600 cfs additional flow from Cabot Station from 1 am to 2 pm		
09/01-11/30	1,500 cfs or the NRF, whichever is less			
12/01-12/31	1,500 cfs or the NRF, whichever is less			

[1]The flow split during these periods is approximately 67% from the Turners Falls Dam and 33% from Station No. 1. If FirstLight conducts further testing, in consultation with the NMFS, USFWS and MADFW, and determines that migratory fish are not delayed by passing a greater percentage of the bypass flow via Station No. 1, it may increase the percentage through Station No. 1 upon written concurrence of those agencies.

[2]If the NRF is less than 6,500 cfs (04/01-05/31), 4,500 cfs (06/01-06/15) or 3,500 cfs (06/16-06/30) the flow split will still be set as approximately 67% of the NRF from the Turners Falls Dam and 33% of the NRF from Station No. 1. If the NRF is less than 1,800 cfs (7/1-8/31), 1,500 cfs (9/1-11/30), or 1,500 cfs (12/1-3/31), the Licensee shall maintain the Turners Falls Dam discharges at 670 cfs, 500, cfs, and 300 cfs, respectively.

[3]The Turners Falls Hydro (TFH) project (FERC No. 2622) and Milton Hilton, LLC project (unlicensed) are located on the power canal and discharge into the bypass reach upstream of Station No. 1. The hydraulic capacity of the TFH project and Milton Hilton, LLC project is 289 and 113 cfs, respectively. If the TFH project is operating, FirstLight will reduce its Station No. 1 discharge by 289 cfs. If the Milton Hilton, LLC project is operating, FirstLight will reduce its Station No. 1 discharge by 113 cfs.

FirstLight has included two timing elements in its Proposed Action to address the new operational paradigm. First, FirstLight is proposing a three (3) year transition period in which it will institute new minimum flows in paragraph (a) and (b), as a license condition, and also put processes in place with GRH and ISO-NE to assure success in meeting its obligations for Cabot Station up and down ramping as well as Cabot Station peak demand flow restrictions. In addition, Station No. 1 upgrades will be completed during this period. In Year 4 of the new license, FirstLight will be responsible, as a license condition, for the full suite of flow enhancements shown in paragraphs (a), (b) and (d) (i.e. Cabot Station up and down ramping, Cabot Station peak demand flow restrictions).

In addition, and in an attempt to meet its obligations for delivering reliable power and capacity, FirstLight is also proposing exceptions where it can deviate from its Cabot Station up and down ramping and peak demand flow requirements for a finite period of time as described in (e) below if required to meet either its flood operations (or similar public safety obligation) or ISO-NE obligations, as well as due to unforeseen river conditions from the Vernon Project.

(e) If compliance with the prescribed operating limits (defined as Maximum Flow below Cabot Station, Cabot Down-Ramping Rate and Cabot Up-Ramping Rate which are shown as the last three columns in the table in paragraph (d)) would cause the Licensee to violate or breach any law, any applicable license, permit, approval, consent, exemption or authorization from a federal, state, or local governmental authority, any agreement with a governmental entity, or any tariff, capacity rating requirement, ramping criterion, or other requirement of the ISO-NE or its successors (ISO-NE), Licensee may deviate from the prescribed operating limitations to the least degree necessary in order to avoid such violation or breach. In addition, Licensee may deviate from the operating limits for the following reasons:

- To perform demonstrations of the resources' operating capabilities under ISO-NE rules and procedures. Licensee will use best efforts to be allowed by ISO-NE to perform these demonstrations at times that will not cause it to deviate from the operating limits.
- To manage the Turners Falls Impoundment within license limits following unexpected, significant increases or decreases in the NRF.
- To support the needs of ISO-NE grid operations by operating when called upon by the ISO-NE.
- If compliance with the prescribed operating limitations would cause a public safety hazard or prevent timely rescue.

With the exception of public safety, the Licensee agrees that under no conditions shall the four exceptions identified above occur in more than 10% of the hours each year that the limitations apply, without the written concurrence of the USFWS, NMFS, MADFW and MADEP.

The Licensee shall document on an hourly basis for each day any deviations from the Maximum Flow below Cabot Station, Cabot Down-Ramping Rate and Cabot Up-Ramping Rate restrictions. Each day, any deviations would be summed and at the end of each month between April 1 and August 31, the Licensee shall document the total number of deviations and provide the information to USFWS, NMFS, MADFW and MADEP on a monthly basis.

(f) Cabot Emergency Gate Use. The Licensee shall use the Cabot Emergency Gates under the following conditions: a) in case of a Cabot load rejection[7], b) in the case of dam safety issues such as potential canal overtopping or partial breach, and c) to discharge approximately 500 cfs between April 1 and June 15 for debris management. The Licensee shall avoid discharging higher flows through the gates from April 1 to June 15 whenever possible; however, if necessary, the Licensee shall coordinate with NMFS to minimize potential impact to SNS in the area below Cabot Station.

(g) Flood Flow Operations. The Licensee shall operate the Turners Falls Hydroelectric Project in accordance with its existing agreement with the United States Army Corp of Engineers (USACOE). This agreement, memorialized in the *Reservoir and River Flow Management Procedures* (1976), as it may be amended from time to time, governs how the Turners Falls Project shall operate during flood conditions and coordinate its operations with the Licensee of the Northfield Mountain Pumped Storage Project (FERC No. 2485).

Turners Falls Impoundment Water Level Management

(a) The Licensee shall operate the TFI, as measured at the Turners Falls Dam, between elevation 176.0 feet and 185.0 feet NGVD29.

(b) The Licensee shall limit the rate of rise of the TFI water level, as measured at the Turners Falls Dam, to be less than 0.9 feet/hour from May 15 to August 15 between the hours of 8:00 am and 2:00 pm for the protection of odonates.

[7] A load rejection is when the Cabot Stations Units are suddenly shut off. If this were to occur, the canal could potentially be overtopped. To prevent overtopping, the Cabot Emergency Gates open so that incoming flow down the power canal can be discharged via the Cabot Emergency Gates. Load rejections could occur at any time.

(c) The rate of rise of the TFI may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS and MADFW.

Whitewater Boating Flows

(a) The Licensee shall provide whitewater boating releases in accordance with the schedule below, or the NRF, whichever is less, from the Turners Falls Dam. The Licensee shall maintain the following whitewater release schedule. FirstLight will provide an annual schedule of releases on its website, for the period July-October by May 31 of each year.

Date	Turners Falls Dam Magnitude of Discharge	Turners Falls Dam Release Duration
1 Saturday in July	2,500 cfs or the NRF, whichever is less	4 hours
1 Saturday in August	2,500 cfs or the NRF, whichever is less	4 hours
3 Saturdays in September	3,500 cfs or the NRF, whichever is less	4 hours
1 Saturday in October	3,500 cfs or the NRF, whichever is less	4 hours
2 Saturdays in October	5,000 cfs or the NRF, whichever is less	4 hours

(b) The whitewater boating flows may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) upon mutual agreement among the Licensees for Projects Nos. 1889 and 2485 and the USFWS, NMFS and MADFW.

Northfield Mountain Upper Reservoir

(a) The Licensee shall operate the Northfield Mountain Pumped Storage Project Upper Reservoir between elevation 1004.5 and 920 feet NGVD29.

4 ACTION AREA

4.1 Geographic Area of Project Effects

Project elements of the Proposed Action include construction, maintenance, and operations. Each are defined below, and their geographic area of effect is identified based on features in Figure 4.1-1.

4.1.1 Construction

Construction will be limited to the Protection, Mitigation, and Enhancement (PM&E) measures proposed at the Projects. All proposed construction will be confined to specific areas within the Project boundaries (Figure 4.1-1).

4.1.2 Maintenance

Maintenance of Project facilities and lands will be limited to areas within the Project boundaries (Figure 4.1-1).

4.1.3 Operations

Project hydropower operations affect the Connecticut River corridor for approximately 57 river miles from Vernon Dam to Holyoke Dam (Figure 4.1-1; Table 4.1.3-1). The TFI water levels are affected by pumping and generation at the Northfield Mountain Project, along with operations at the Turners Falls Project. River flows from upstream, along with pumping and generation from the Northfield Mountain Project, can determine the amount of flow passed through the Turners Falls Project. Outflows through the Turners Falls Project affect flows and water levels in the Connecticut River from Turners Falls Dam to Holyoke Dam, but only when the river flows are below the combined hydraulic capacity of the Turners Falls Project and its minimum spill flow. In particular, flows higher than 15,938 cfs, plus the minimum bypass flow at the time, exceed the hydraulic capacity of the Project and result in additional flow over the dam and to the Connecticut River downriver of the Project.

Table 4.1.3-1: River Miles of Major Project Features

Location	River Mile
Vernon Dam*	142.1
Northfield Mountain Tailrace	127.3
Turners Falls Dam	122.2
Station No. 1	121.1
Cabot Station	119.3
Lower End of Turners Falls Project Boundary	119.0
Holyoke Dam*	85.5

**Vernon Dam and Holyoke Dam are not Project features but are included because they are considered the upstream and downstream extents, respectively, of the operational project element for the Northfield Mountain and Turners Falls Projects.*

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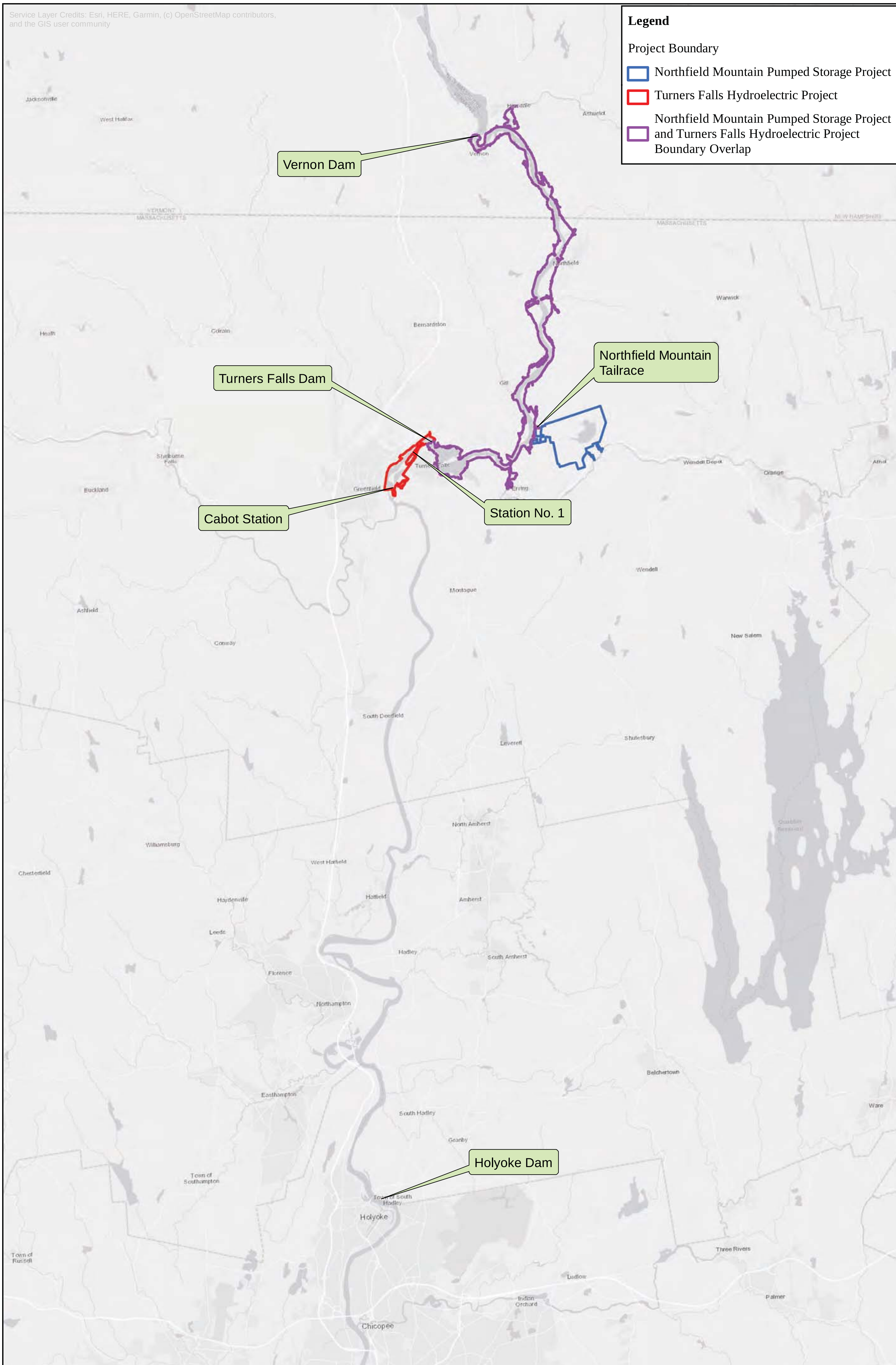

Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

N

0 2.5 5 10 Miles

Figure 4.1-1
Geographic Area of Project Effects Map

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4.2 Affected Environment

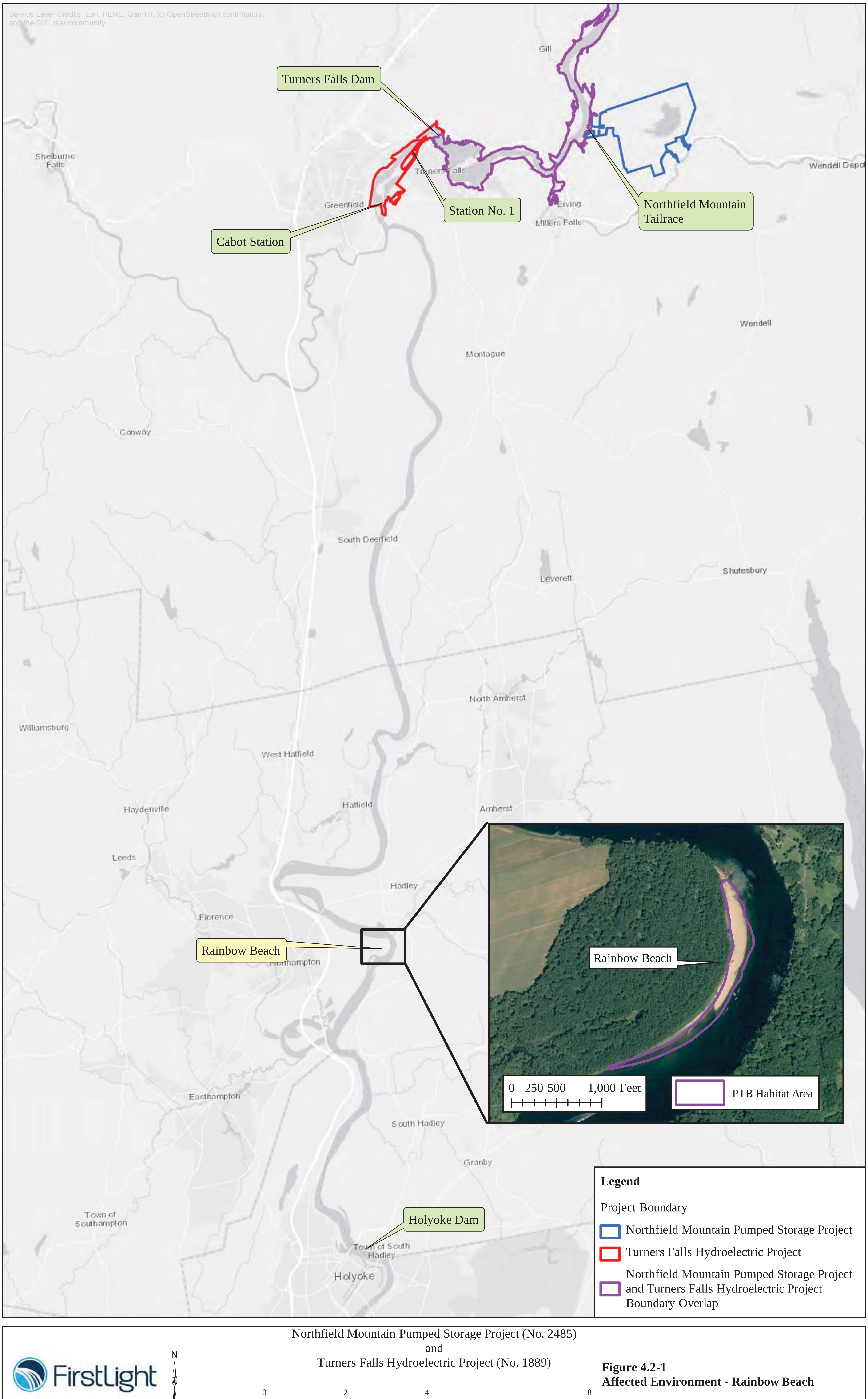
The Puritan Tiger Beetle is an invertebrate predator, which was historically found on beaches in Connecticut, New Hampshire, Massachusetts, and along the shores of the Chesapeake Bay in Maryland. The distribution of the Puritan Tiger Beetle is now limited to areas along the Chesapeake Bay in Maryland, and along the Connecticut River in New England (USFWS 1993a). In New England, there remains one metapopulation consisting of four sites near Cromwell, CT and one single site in Massachusetts, located in Northampton. As such, the only Puritan Tiger Beetle habitat that would be affected by Project operations is that utilized by the population in Massachusetts.

The Massachusetts population occurs along a ~2,100-foot-long sparsely vegetated sandy beach, known as Rainbow Beach, located within the Rainbow Beach Conservation Area. This area is co-owned and managed by the State of Massachusetts and the City of Northampton. Rainbow Beach is located approximately 25 miles downstream of Cabot Station at the Turners Falls Project (Figure 4.2-1). Rainbow Beach is the only confirmed Puritan Tiger Beetle habitat within the affected area that maintains a population. Puritan Tiger Beetles have historically been recorded at other sites near Rainbow Beach in small numbers but have not been found maintaining populations or meta-populations. For example, both adults and larvae have been observed on the steep, eroding banks a short distance upstream from Rainbow Beach. This area has been termed "North Bank". Researchers believe that this habitat could be a population sink, based on the bank/habitat characteristics, rather than a source to the Rainbow Beach population (C. Davis, *pers. comm.*).[8] Additionally, on the opposite bank from Rainbow Beach is a small area with steep-banked eroding shoreline where larvae have been observed (C. Davis, *pers. comm.*); some adults could fly there from Rainbow Beach to lay eggs, and it is possible that larvae there could return to Rainbow Beach as adults if they survive. However, the contribution to the Rainbow Beach population has not been quantified and would be minimal. In 2014, a survey was completed by FirstLight, assisted by Chris Davis, to find and characterize additional Puritan Tiger Beetle habitat along the river near Rainbow Beach. In addition to Rainbow Beach, six areas were investigated where Puritan Tiger Beetle presence was historically recorded, and/or if the locations contained habitats characteristics that could be suitable for Puritan Tiger Beetle (FirstLight 2016a). None of these other locations were determined to provide suitable habitat for Puritan Tiger Beetle populations. Therefore, Rainbow Beach is considered to be the only location in the action area with a Puritan Tiger Beetle population, and is the only location analyzed in this Biological Assessment.

The habitat at Rainbow Beach is unique in that it harbors the only known existing population of Puritan Tiger Beetle within a non-tidal riverine shoreline habitat. The habitat structure and those selected for various activities by the Puritan Tiger Beetle are therefore quite different than those observed at other beaches, including the nearest known population in Cromwell, Connecticut, approximately 58 river miles downstream of Rainbow Beach (e.g. Gwiazdowski 2020). The beach at Cromwell is narrow, tidal, is subjected to tidal fluctuations twice per day on the order of 2-3 feet, and contains an area of dense, damp sand within the intertidal zone. This intertidal zone is used by Puritan Tiger Beetles for oviposition and larval development, apparently due to the combination of suitable moisture, temperature, and sediment grain size (Gwiazdowski 2020). In contrast, the habitat at Rainbow Beach consists of a narrow area near the water-land interface that is wetted by waves and boat wakes on short-term time scales (i.e. minute/hourly). The location of the water-land interface at Rainbow Beach can also vary seasonally, daily, and sub-daily depending on the baseflow in the river, flows from the Turners Falls Project, and water levels at Holyoke Dam. Despite these factors, water levels at Rainbow Beach fluctuate considerably less on a daily and hourly basis than the tidal Connecticut River during the adult active period (see Figure D-1 and Figure D-2 of Appendix D). Rainbow Beach is much larger and broader than the beach in Cromwell and contains broad areas of soft sand that dries out during low flow periods. This type of area is not suitable for

[8] Chris Davis has been the lead researcher on the Puritan Tiger Beetle recovery efforts at Rainbow Beach from 1997 through the present, which has included translocation of larvae, habitat management, and surveys of adult (mark/recapture) and larval populations through a USFWS contract.

egg deposition and egg/larval survival (e.g. Gwiazdowski 2020). Because of the different habitat structure on Rainbow Beach, Puritan Tiger Beetles exhibit different behavioral patterns for finding and using suitable habitat. Adult Puritan Tiger Beetle traverse the broad areas of Rainbow Beach to forage and mate near the water-land interface during the day before moving back up to the higher elevations on the beach to oviposit. Gwiazdowski (2020) did not positively identify oviposition near the water-land interface on Rainbow Beach, though some oviposition was found higher on the beach. Puritan Tiger Beetle have been observed ovipositing and larvae have been documented along a narrow strip of land with areas of silt deposition at some of the highest elevations on Rainbow Beach (C. Davis, *pers. comm*.; Davis 2020). These areas contain sparse vegetation and have a combination of adequate moisture, temperature, and sediment grain size for oviposition (Davis 2020). Davis (2020) performed larval counts at Rainbow Beach during fall 2020 and documented most larvae in the northern portions of the beach at relatively high elevations within sparsely-vegetated areas. Though the survey area included a 10-meter swath of potential larval habitat, larvae were found primarily within 3-4 meters of the vegetation line at the highest elevations along the beach, consistent with previous findings (Davis 2020). Researchers associated with Gwiazdowski (2020) reportedly also collected additional information of larval habitat at Rainbow Beach, which would be referenced to the transect survey data collected by FirstLight (C. Davis, *pers. comm.*). The transect survey data were provided to USFWS to support the larval survey efforts being performed by Gwiazdowski (2020). These data may be useful for evaluating the locations and elevations of larval habitat on Rainbow Beach but have not been provided to FirstLight at this time.



Northfield Mountain Pumped Storage Project (No. 2485)
and
Turners Falls Hydroelectric Project (No. 1889)

Figure 4.2-1
Affected Environment - Rainbow Beach

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4.2.1 Ongoing Activities

Public Use and Recreation

According to USFWS (2019), the Rainbow Beach population is subjected to unregulated recreational use, primarily in the summer. There are some State regulations for Wildlife Management Areas that prohibit certain activities, such as camping and fires, but the regulations have not been enforced at the site and measures to protect the habitat and individual beetles have not been implemented (USFWS 2019). Years with hot, long summers exhibit the greatest amount of recreational use on the beach, with up to 3,094 recreational users documented in 2005 (HG&E 2008). Approximately 1,539 of those recreationalists were observed using the beach (HG&E 2008).

Abbott (2003) found that areas selected by foraging and breeding adult Puritan Tiger Beetles on Rainbow Beach overlapped with areas commonly used for human recreation, and determined that the Puritan Tiger Beetles are likely being disrupted by human disturbances which could be limiting successful reproduction. The beetles were using areas near the water's edge for foraging and mating, and recreational use of the beach was also concentrated along the shoreline where motorboats and personal watercraft were anchored (Abbott 2003). The types of recreation observed by Abbott (2003) at Rainbow Beach included sunbathing, grilling food, swimming walking and running along the shorelines, playing horseshoes, playing catch with footballs and discs, playing volleyball, including with erected nets and posts, off-road vehicle use (observations of tracks), pets (including unleashed dogs). Adult Puritan Tiger Beetle will flush and relocate to other areas of the beach when humans or dogs come within a close distance of them, and these disturbances could limit foraging and mating activities on Rainbow Beach (Abbott 2003).

Abbott (2003) reported the greatest number of boats and people at Rainbow Beach in the afternoon hours when compared to midday and morning. In the afternoon on weekends, an average of 103.5 people and 26.7 boats were observed on six visits between June 28 and August 14, 2003. This is in comparison to 20.4 people and 4.4 boats in the afternoon on weekdays (n=14) during the same period. More recent documentation of extensive recreation similar to that observed by Abbott (2003) at Rainbow Beach is shown in screenshots of drone footage from July 4, 2016 (Figures 4.2.1-1 and 4.2.1-2). This degree and type of recreation is not limited to federal holidays, given photographic footage obtained from social media that spans the months of May through September from recent years (Attachment 1 to Appendix D). Similar to Abbot (2003), much of the recreation documented in these photographs is concentrated near the shoreline, and includes boats pulled into the sand/water interface area of the beach, and large numbers of people using the beach.

Abbott (2003) also observed boat wakes that appeared to disturb adult Puritan Tiger Beetle, noting that weekend use of the river can be so high that boat wakes on Rainbow Beach can be almost continuous at times. There is currently a no-wake zone in place near Rainbow Beach, but it is unclear how often this restriction is followed. Based on the drone footage from which Figures 4.2.1-1 and 4.2.1-2 were derived, and from the photographs provided in Attachment 1 to Appendix D, boat wakes are frequent on Rainbow Beach when people are boating in the river at and around the beach.

The impacts of extensive amounts of reported recreation use on Rainbow Beach during the COVID-19 pandemic have not been studied but could have long-term impacts on the Puritan Tiger Beetle population. During interviews with reporters, local law enforcement officials have stated that there could be 1,000 people or more using Rainbow Beach on Saturdays and Sundays in 2020, with recent increases in observed boating and recreation caused by the COVID-19 pandemic.[9] These numbers are an order of magnitude higher than those observed by Abbott (2003). In the most recent preliminary draft of Gwiazdowski (2020), provided to FirstLight on November 13, 2020, high recreational use of the beach that interfered with surveys was described. Specifically, visitor activity precluded establishing transects at Rainbow Beach on Sunday

[9] https://www.masslive.com/police-fire/2020/08/theres-way-too-many-people-with-more-boat-traffic-than-ever-massachusetts-environmental-police-and-local-officers-team-up-to-patrol-connecticut-river.html

July 26, 2020. The site was revisited by Gwiazdowski (2020) on Wednesday/Thursday July 29/30, 2020, during which the author described much of Quadrat 3 at Transect 2 having human and dog footprints that obscured the sand surface, along with children playing in the transect, and obscuring all sand in Quadrats 1 and 2. In the morning prior to this disturbance of sand, Gwiazdowski (2020) had documented oviposition in Quadrat 2. As such, the disturbance caused by human recreation directly overlapped with critical activities being performed by Puritan Tiger Beetle.

Figure 4.2.1-1: Rainbow Beach from a Drone (Source: YouTube, https://www.youtube.com/watch?v=2v2bSRT2H4k)

Figure 4.2.1-2: Rainbow Beach from a Drone (Source: YouTube, https://www.youtube.com/watch?v=2v2bSRT2H4k)

Nearby Land Use

The land around Rainbow Beach is primarily forested, but there is also existing cropland along the river upstream from the beach, with agricultural crops that were observed growing very close to the bank. The effects that this land use may have on Puritan Tiger Beetle has not been studied, but could potentially include effects from chemicals, fertilizers, and sediments in storm runoff.

Vegetation Growth and Management

The transitional area between the exposed sand and the riparian forest at Rainbow Beach is dominated by Rough Cocklebur (*Xanthium strumarium*), Sandbar Willow (*Salix exigua*), Dogbane (*Apocynum cannabinum*), Black Willow (*Salix nigra*), Eastern Cottonwood (*Populus deltoides*), and Silver Maple (*Acer saccharinum*). Rough Cocklebur and Sandbar Willow are major contributors to vegetation succession at Rainbow Beach, which may eventually reduce suitable Puritan Tiger Beetle habitat. In addition, exotic, invasive species such as Purple Loosestrife (*Lythrum salicaria*) and Japanese Knotweed (*Polygonum cuspidatum*) are present on the site. Both of these species are known to grow and spread rapidly and out-compete native species. Massachusetts Natural Heritage Endangered Species Program (MA NHESP) began vegetation treatment of native and non-native species during the summer of 2019 in larval areas in the northern and southern sections of the beach.

Population Augmentation

Population augmentation of Puritan Tiger Beetles at Rainbow Beach was first performed between the years 2000 and 2006, during which 3rd instar larvae were transported to the site from the Connecticut sites (USFWS 2019). Initially, the population increased after these translocations occurred, until 2009, after which the population began to decline again for unknown reasons (USFWS 2019). More recently, the USFWS funded a project to develop and update a rearing facility, for propagation of Puritan Tiger Beetles (USFWS 2019); as a result of this program, 90 larvae were released at Rainbow Beach in 2016, 726 were released in 2017, and 23 were released in 2018. The numbers of adults observed at Rainbow Beach, along with preliminary evidence of large numbers of 2nd and 3rd instar burrows, suggests that reintroduction efforts using larval beetles has been successful (USFWS 2019).

Water Level Management at Holyoke Dam

Licensed hydropower operations at the Holyoke Project (FERC Project No. 2004) include a modified run-of-river (ROR) protocol, whereby water levels in the Holyoke Impoundment, which includes Rainbow Beach, are managed. Holyoke Gas and Electric (HG&E) maintains the Holyoke Project Impoundment elevation between 99.47 feet and 100.67 feet, NGVD29. Further details are provided in Section 5.4.3.

4.2.2 Project-Related Conservation Measures for Puritan Tiger Beetle

The proposed Cabot Station peaking restrictions from July 1 through August 31 of each year were developed specifically to mitigate the potential effects of peaking on adult foraging and breeding Puritan Tiger Beetles. This summer period typically has relatively low river flows when peaking at Cabot Station could have the greatest impact on water level changes downstream due to a greater differential between base flows and the maximum generating capacity of the Turners Falls Project. The 1:00 am to 2:00 pm restriction was developed to limit water level increases (while accounting for travel time and attenuation from Cabot Station discharges) at Rainbow Beach at times when adult Puritan Tiger Beetle would typically be foraging and mating during the daylight hours.

Though not developed specifically for Puritan Tiger Beetle, other proposed operations could provide benefits to the adult life stage of the Puritan Tiger Beetle, including:

- Higher summer minimum flows than currently licensed in the Bypass Reach, which would reduce downstream fluctuations caused by operations at Cabot Station

- Ramping restrictions at Cabot Station, which would also reduce downstream fluctuations caused by operations at Cabot Station

Another measure that was not developed for, but is applicable to, the Puritan Tiger Beetle is the current agreement (Pursuant to Article 43 of the current Northfield Mountain Project license) with the Department of the Army (i.e. United States Army Corps of Engineers (USACOE)) for providing coordinated operation of the Turners Falls Project and Northfield Mountain Project during flood conditions on the Connecticut River in accordance with rules and regulations prescribed by the USACOE. In general, the agreement allows FirstLight to operate the Northfield Mountain Project within its FERC license requirements without causing river flows downstream of Turners Falls Dam to significantly exceed those that would have occurred absent the Northfield Mountain Project. This agreement would likely be maintained as part of FirstLight's proposed operations in the new license. The agreement with the USACOE would prevent unnatural flow and inundation patterns during flood events that could have been caused by the Northfield Mountain Project if no agreement were in place.

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5 SPECIES INFORMATION

The Puritan Tiger Beetle exhibits a two-year life cycle. For approximately 22 months out of the two years, the Puritan Tiger Beetle is in a larval stage, after which individuals emerge as adults that feed, breed, and then die (Abbott 2003; USFWS 1993a). Their habitat consists of sandbars that depend on the dynamic interaction of moving water and shifting sands; this includes regular high flows and winter ice scour that maintains existing bars, builds new bars, and controls vegetation growth, along with lower summer flows for foraging, reproduction, and larval development (USFWS 1993a; Kennedy et al. 2018). The details of each life stage is included below.

5.1 Larval Life Stage

Puritan Tiger Beetle larvae require sandy habitat, which allows for digging of deep vertical channels. In contrast to the Common Tiger Beetle (*Cicindela repanda*), Puritan Tiger Beetle larval burrows are short and angled. Puritan Tiger Beetle larval habitat is generally 10-20% vegetative cover with an interspersion of open sandy areas. Davis (2020) documented larvae at Rainbow Beach in areas where silt had deposited from high flow events on the Connecticut River. These areas are at higher elevations on the beach, and larvae have not been documented in the broader lower-elevation areas of the beach that contain soft sand. The soft sand is not likely suitable for burrowing, and also becomes very hot and dry during the summer, which would not be suitable for larval survival.

According to Connecticut Department of Energy and Environmental Protection (CTDEEP), approximately a week after being deposited in the sand by adult females, the eggs hatch into larvae about one-third of an inch long (CTDEEP 1999). The larvae then dig a burrow into the sand, and reside near the surface of the burrow, blocking the entrance with their large heads, and wait for prey, which they capture with sickle-like mandibles (CTDEEP 1999). After 2 to 4 weeks, the larvae molt into a slightly larger second-instar stage, which dig burrows that are 1.5 to 2 feet deep (CTDEEP 1999). At Rainbow Beach, they stay active until mid-October, after which they will close their burrows and overwinter. In approximately mid-May of the following spring, they become active and open their burrows to feed through mid-June. They then close their burrows until early September when they molt to the third-instar larval stage. These larvae remain active until mid-October, after which when they close their burrows and overwinter for a second winter. The following spring, they become active again around mid-May and begin to pupate and transform into adults in June. The adult beetles emerge from their burrows as a mobile predator beetle.

Larval Puritan Tiger Beetle capture prey from their burrow openings (USFWS 1993a). Though submersion of Puritan Tiger Beetles has not been tested, studies on other species have shown that the larval stages of Tiger Beetles can close their burrows and withstand submersion for longer than adults (Brust and Hoback 2009). Of six larvae Tiger Beetle species tested, all survived submersion for more than 56 hrs (2.3 days) and the longest period of survival post submersion was 136.6 hrs (5.7 days) (Brust and Hoback 2009). Brust et al. (2005) found that survival of riverine shoreline populations of a different species of Cicindela tiger beetles was relatively high for four days of immersion, but further submersion resulted in much fewer surviving. It should be noted that the tests for riverine populations were limited to hypoxic water, and none were tested for survival in aerated water (Brust et al. 2005). In riverine habitats where there is dissolved oxygen present in the water, especially during times of high river flow and submersion, larvae could remain in burrows and extract dissolved oxygen from the water and survive for longer periods (Brust et al. 2005). It is therefore likely that the larvae of Puritan Tiger Beetles along the Connecticut River in Massachusetts would be able to survive relatively long periods of inundation because dissolved oxygen concentrations in the river, especially during inundation periods, would be relatively high (FirstLight 2016b).

Inundation of larval Puritan Tiger Beetles also routinely occurs within populations that exist along tidal beaches. Though the tidal effects have not been studied for the Puritan Tiger Beetle larvae, a similar species, the Northeastern Beach Tiger Beetle (*Cicindela dorsalis dorsalis*), is known to benefit from tidal fluctuations (USFWS 1994). Periodic inundation is important to larvae of this species by providing both moisture that prevents desiccation and abundant prey that allows for greater growth rates (USFWS 1994). Given the locations of Puritan Tiger Beetle populations along areas that become periodically inundated, it is also possible that inundation is also beneficial for the Puritan Tiger Beetle larvae.

5.2 Adult Life Stage

Adults emerge from larval burrows and are present at Rainbow Beach from the third week of June until the end of August, with numbers typically peaking during the latter half of July (C. Davis, *pers. comm.*). Based on a survey performed by Babione (2003), emergence occurs at night. After they emerge, adults typically live for a month or less (Abbott 2003), during which they forage for arthropods and mate on open sandy beaches adjacent to larval sites. They cannot withstand as much submersion time as larvae, with reported submersion survival of other species of adult tiger beetles ranging from 9-22 hours, though some findings indicate that adults could survive up to 72 hours of submersion (Brust and Hoback 2009; Brust et al. 2005). Adult Puritan Tiger Beetles are most active on warm sunny days from the time they emerge through August (Abbott 2003), and actively feed in the wrack along the shoreline (USFWS 1993). Adults are not typically active near the water-land interface during the night at Rainbow Beach. They have been observed moving to the higher elevations of the beach in the later part of the day (C. Davis, *pers. comm.*). Puritan Tiger Beetle adults are known to select specific sites for oviposition, with the composition and texture of sand being an important factor for effective oviposition, egg survival, and subsequent larval development (Omland 2002; Gwiazdowski 2020). At Rainbow Beach, this area is a narrow strip along the upper elevations of the beach, near the vegetation line. The sand here is more dense than other areas of the beach and is being selected for oviposition by the adult beetles (C. Davis, *pers. comm.*). Recent surveys documented habitat suitable for oviposition in areas where silt was deposited after high flow events on the Connecticut River (Davis 2020). The draft of Gwiazdowski (2020) that was provided to FirstLight on November 13, 2020 did not describe the elevations or exact locations of the quadrats surveyed on Rainbow Beach in 2020, though researchers did not positively identify oviposition in the quadrat closest to the water-land interface. The primary adult Puritan Tiger Beetle activity at night is oviposition, which has been observed in the larval habitat area in the evenings as temperatures cool down, typically from 5:00pm through 11:00pm (C. Davis, *pers. comm.*). However, surveys from Gwiazdowski (2020) of a different Puritan Tiger Beetle population near Cromwell, CT documented oviposition occurring from the late afternoon, through the night, and into the morning hours. Though the sample size was small, Gwiazdowski (2020) also observed oviposition holes at Rainbow Beach between approximately 7:00am and 10:00am, which could have been made in the morning hours.

5.3 Population Status

5.3.1 Rangewide

Puritan Tiger Beetles occur in two distinct regions: along the Chesapeake Bay in Maryland and along the Connecticut River in New England (USFWS 2019). The Chesapeake Bay population consists of two metapopulations, one of which is located on the western shore of the bay in Calvert County and the other is located along the Sassafras River portion of the eastern shore of the bay (USFWS 2019). The New England population consists of one metapopulation along the Connecticut River in tidal waters of Connecticut, and at a single location further upstream in Massachusetts at Rainbow Beach.

5.3.1.1 Chesapeake Bay Population

Puritan Tiger Beetles along the Chesapeake Bay occupy naturally-eroding cliffs, and are most abundant at sites where the bluffs are long and high with sandy soil and little to no vegetation (USFWS 2019). Erosion of the bluffs is considered to be an important process for maintaining larval habitat (USFWS 2019). The Calvert County metapopulation consists of eleven extant subpopulations and tends to be largest with total population estimates between 4,000 and 8,000 beetles depending on the year (USFWS 2019). Though there has been high variability in counts between years, there is no apparent population trend (USFWS 2019). The largest subpopulations are at Warrior Rest and Calvert Cliffs State Park, both of which are protected from development and are largely undeveloped (USFWS 2019). The Sassafras River/Eastern Chesapeake Bay metapopulation consists of eleven documented subpopulations of varying sizes, with a total population size between 2,000 and 6,000 individuals per year (USFWS 2019). Despite large fluctuations, this population has exhibited an increasing trend (USFWS 2019).

Because several of the subpopulations within both the Calvert County and Sassafras River metapopulations follow similar patterns through time, it is likely that they are primarily influenced by large-scale weather patterns that exhibits similar effects on the habitat or the beetles across a relatively large area (USFWS 2019).

5.3.1.2 New England Population

Metapopulations of Puritan Tiger Beetle in New England once ranged as far upstream as Claremont, New Hampshire, though most historical locations were located between Hadley, MA and Cromwell-Portland, CT (USFWS 2019). The only extant locations are near Cromwell-Portland, CT and Hadley/South Hadley, MA at Rainbow Beach. Puritan Tiger Beetle have not been observed at any of the other historical sites on the Connecticut River since the early 1900's to 1930's (USFWS 1993a; USFWS 2019). The Connecticut metapopulation is relatively large and consists of four primary subpopulations. The total beetle counts of the metapopulation reached 1,631 individuals in 2012, but have been lower in recent years, averaging approximately 500 individuals. The Cromwell North subpopulation has represented much of the total population since the mid 2000's. This was not always the case; the Cromwell South subpopulation consistently represented a substantial proportion of the population prior to the mid-2000's, though counts there have been extremely low in recent years (USFWS 2019). USFWS (2019) did not identify this as an issue or state any reasons for the decline of this subpopulation, possibly because the overall size of the Connecticut metapopulation has been stable, though the decline of the Cromwell South population could be due to increased vegetation growth at this area (C. Davis, *pers. comm.*).

By comparison, the Massachusetts population at Rainbow Beach consists of a single location and is much smaller than all other populations. Though small numbers of Puritan Tiger Beetles have been observed in the surrounding areas, Rainbow Beach is the only known location supporting the population. Additional details are provided in Section 5.3.2, as the entire population is within the action area.

5.3.2 Action Area

The Puritan Tiger Beetle population, with its two-year life cycle, contains two cohorts with adults that emerge in even and odd years. Counts of Puritan Tiger Beetles at Rainbow Beach have typically been lower than 20 individuals in most years, with the exception of years that were influenced by population augmentation methods, when counts have exceeded 80 individuals (Figure 5.3.2-1). The most recent peak count was 101 adults in 2019 (unpublished data, C. Davis, *pers. comm.*). The peak daily counts represent approximately 38% of the total adult count for that year (C. Davis, *pers. comm.*). During recent years, the even-year cohort at Rainbow Beach has been considerably larger than the odd-year cohort except for 2019, though this period was influenced by population augmentation.

The habitat at Rainbow Beach has been subjected to several threats. Heavy recreational use at Rainbow Beach has been well-documented, along with the encroachment of non-native vegetation. These threats pose both direct threats to the physical habitat, and recreational usage has been shown to further affect Puritan Tiger Beetle by disturbing their feeding and breeding (Abbott 2003). Another species of tiger beetle, *Cicindela repanda*, also inhabits Rainbow Beach, and in greater numbers than the Puritan Tiger Beetle; this species has the potential to affect populations of Puritan Tiger Beetle via interspecies competition (Knisley (n.d.); USFWS 2019), though there is some separation in timing of activity periods between Puritan Tiger

Beetle and *C. repanda* that may limit the degree to which interspecies competition occurs at Rainbow Beach (C. Davis, *pers. comm.*).

Changes in flow regimes from upstream have been theorized to be affecting the habitat, and potentially beetle behavior, because much of Rainbow Beach is relatively shallow-sloping and is sensitive to changes in water level. To explore this further, FirstLight has plotted the distribution of flows encountered by 2-year Puritan Tiger Beetle cohorts, along with the peak counts observed as adults (Figure 5.3.2-2). There was no apparent correlation between the flow distributions (i.e. high, medium, low flow distributions) encountered by Puritan Tiger Beetle cohorts and their peak counts.

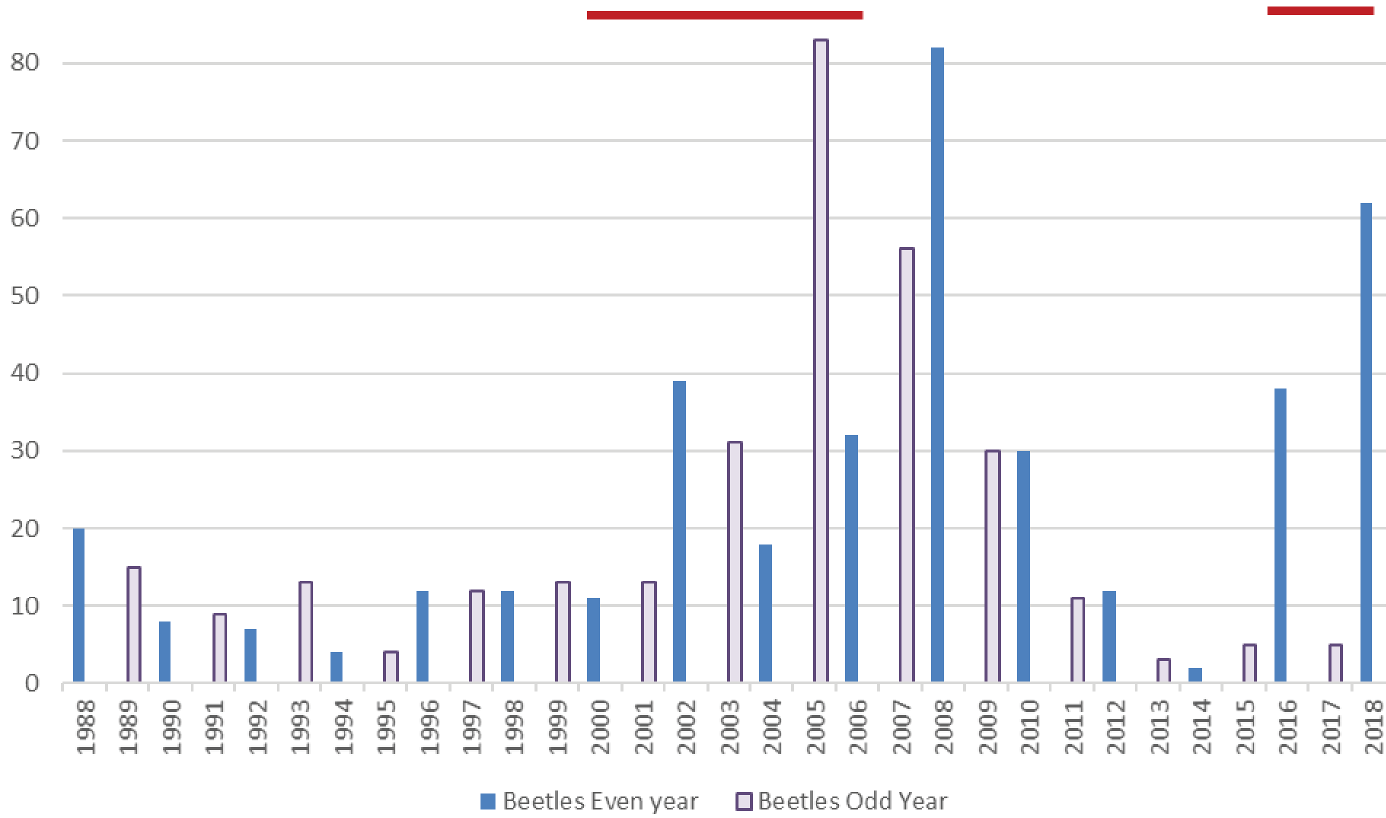

Figure 5.3.2-1: Plot from USFWS (2019) showing peak Puritan Tiger Beetle counts at Rainbow Beach, Massachusetts, including the years where lab-reared larvae where introduced to the site to augment the population, 1988-2018.

Note: Red horizontal bars at the top of the plot indicate periods when the population was augmented, and the effects of augmentation could also last for several years if augmentation resulted in successful breeding of translocated individuals and if survival of their progeny occurred.

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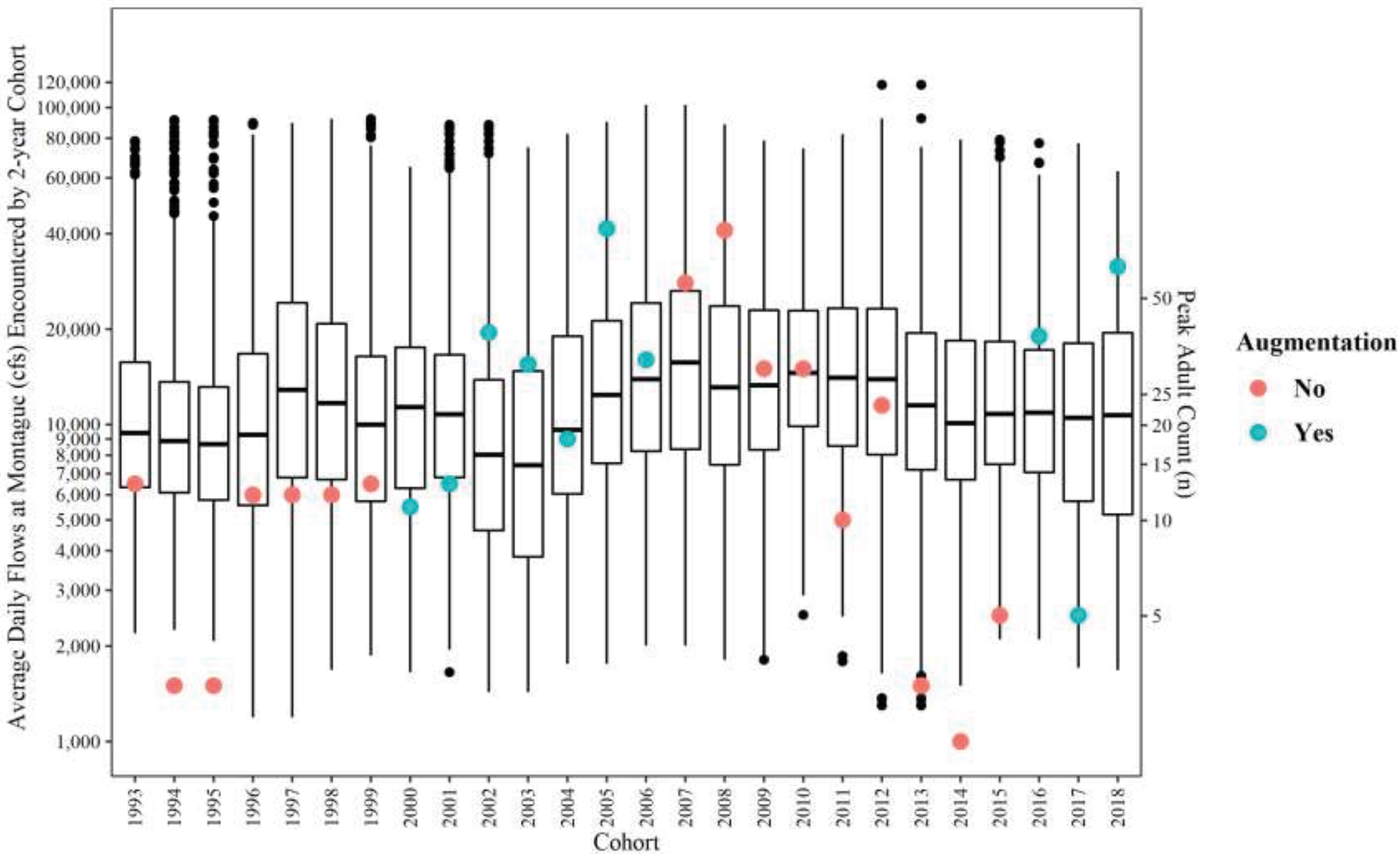

Figure 5.3.2-2: Average Daily Flows in the Connecticut River at Montague Encountered by Puritan Tiger Beetle Cohorts and Adult Counts of those Cohorts, 1993 through 2018.

Note: Years when the population was augmented are noted in the plot. The distribution of average daily flows that is included for each cohort includes two years of flow data at Montague, MA, ranging from July 1 two years prior to the adult count, to the end of June of the year of the adult count (i.e. for the 1994 cohort, flow data ranged from July 1, 1992 through June 30, 1994). .

5.4 Cumulative Effects

FirstLight considered past, present, and reasonably-foreseeable activities that could have cumulative effects on the Puritan Tiger Beetle on Rainbow Beach in conjunction with the Project proposals. For the purposes of this BA, the future is defined as the duration of the new licenses for the Northfield Mountain and Turners Falls Projects.

5.4.1 Alterations to Hydrology

The underlying hydrology at Rainbow Beach has been altered by the development and operation of storage reservoirs further upstream in the watershed. The flow in the Connecticut River at the Northfield Mountain and Turners Falls Projects is influenced by these upstream storage reservoirs, which alter river hydrology by decreasing high flows in the spring and increasing low flows in the summer. Hydrology is also affected by USACOE flood control dams on tributaries to the Connecticut River upstream of Turners Falls Dam, specifically:

- Union Village: Ompompanoosuc River;
- Dewey Mills and North Hartland: Ottauquechee River;
- Stoughton Pond and North Springfield: Black River;
- Ball Mountain and Townshend: West River;
- Surry Mountain and Otter Brook: Ashuelot River; and
- Tully Lake and Birch Hill; Millers River.

Main-stem dams on the Connecticut River that include sizable storage include:

- Second Connecticut Lake Dam;
- First Connecticut Lake Dam;
- Murphy Dam (Lake Francis);
- Moore Dam; and
- Comerford Dam.

Changes in operation of these reservoirs have the potential to change the frequency, timing, and magnitude of flows that enter the Project areas, which could then result in larger-scale changes in flow patterns of the water passing through the Turners Falls Project that will then flow to Rainbow Beach. Additionally, two storage reservoirs similarly affect the hydrology in the Deerfield River[10], which enters the Connecticut River below the Turners Falls Project but upstream of Rainbow Beach. Changes in how these storage reservoirs operate could occur in the future through federal relicensing or alterations to flood control practices. Substantial alterations to hydrologic patterns could affect Puritan Tiger Beetle habitat at Rainbow Beach by changing the frequency, timing, and magnitude of flows and inundation of habitat. The topography of Rainbow Beach is known to change over time, given its sandy characteristics along a river bend, and changes in the underlying hydrology and associated sediment loading and deposition could affect the topography and substrate suitability of the beach. In general, the overall effects that these actions would have on the Puritan Tiger Beetle or its habitat are unknown but would require separate consultation pursuant to Section 7 of the Endangered Species Act. USFWS (1993a) identified these historical changes in hydrology as an impact on the underlying processes that create and maintain Puritan Tiger Beetle habitat.

[10] Storage reservoirs in the Deerfield River include Somerset and Harriman.

Additionally, changes in daily operations of FERC-regulated hydropower dams in the Connecticut River upstream of the Turners Falls and Northfield Mountain Projects could affect daily flow fluctuations on the Connecticut River at Rainbow Beach by changing daily and hourly inflows arriving at the Projects. The FERC-regulated projects on the main-stem of the Connecticut River listed upstream to downstream include:

- Canaan;
- Gilman;
- Moore;
- Comerford;
- McIndoes;
- Dodge Falls;
- Wilder;
- Bellows Falls; and
- Vernon.

Though these effects appear to be relatively minor in comparison to greater hydrologic changes in the watershed, alterations to those operations could also have some daily or sub-daily effects on Puritan Tiger Beetle habitat inundation.

5.4.2 Historical Construction of Dams

The historical construction of several dams on the Connecticut River likely inundated locations containing historic Puritan Tiger Beetle habitats. At the present, there are very few areas with suitable habitat for Puritan Tiger Beetle on the Connecticut River. These dams have also altered sedimentation processes in the river, which could have been historically important to the development of beach and sandbar areas that may have supported populations of Puritan Tiger Beetles either permanently or ephemerally. The status of Puritan Tiger Beetle at Rainbow Beach prior to the development of Holyoke Dam is not known. However, the habitat on and around Rainbow Beach may have been quite different prior to the development of Holyoke Dam and the associated impoundment. Currently, Rainbow Beach is within the Holyoke Impoundment, the operation of which can affect habitat inundation on the beach as described in the following section.

5.4.3 Water Level Management at Holyoke Dam

The Holyoke Project owned by HG&E was issued a new license by FERC on August 20, 1999 and the Massachusetts Department of Environmental Protection (MADEP) issued a final Water Quality Certification (WQC) in 2001. The Project currently consists of a 30-foot-high, 985-foot-long dam topped by five 3.5-foot high inflatable rubber dam sections that were installed in 2001. There are two hydropower units at the Holyoke Dam with a total hydraulic capacity of 8,270 cfs. Holyoke Dam also feeds the Holyoke Canal System with multiple hydropower units and a total capacity of about 6,000 cfs resulting in a total flow used for hydropower generation of about 14,250 cfs. As part of the license, the Holyoke Impoundment was required to be operated in a run-of-river mode with a variation of +/- 0.2 feet from the normal impoundment level of 100.37 feet. On March 12, 2004, HG&E filed a Settlement Agreement with the FERC that proposed resolutions of a series of issues raised upon rehearing of the August 20, 1999 project license. In an order issued April 19, 2005 (2005 Order), the FERC approved the Settlement Agreement and revised a number of license articles accordingly. The 2005 Order also incorporated the 2001 WQC and a January 27, 2005 Biological Opinion (BO) issued by the NMFS. In 2006, FERC issued an order accepting Holyoke's proposed plan on how ROR project operations would be achieved, monitored and recorded. In addition, this Order also approved Holyoke's proposal to test modifications of ROR provisions (by increasing the amount of Water Surface Elevation (WSE) fluctuation at the Holyoke Dam) to more effectively limit water level fluctuation on the Puritan tiger beetle at Rainbow Beach. In 2008, Holyoke submitted a report to FERC containing the results of modified ROR study that showed that the modified ROR procedures are beneficial to the Puritan Tiger Beetle (by limiting the daily WSE fluctuations) at Rainbow Beach and also results in a smoothing effect of flows downstream of Holyoke. Then, after additional studies and agency consultation, FERC issued on May 18, 2016 an order amending the comprehensive Operations and Flow Plan with a WSE range at the Holyoke Dam of between 99.2 and a normal maximum of 100.6 feet. Based on discussions with Paul Ducheney of HG&E, the WSE fluctuation is generally between 99.47 and 100.67 feet. In studies performed by HG&E, the lower limit was shown to reduce impoundment elevations and water level fluctuations at Rainbow Beach, which would be beneficial to the Puritan Tiger Beetle when inflows are less than 11,000 cfs (HG&E 2012; HG&E 2015).

The range of water levels licensed at Holyoke Dam can affect inundation of Puritan Tiger Beetle habitat to a greater degree than operations of the Turners Falls and Northfield Mountain Projects, as shown in analyses presented in Section 6 of this BA. FirstLight did not have access to long-term water level data from the Holyoke Project[11] in its analyses to fully understand how it is operated in relation to incoming flows from the Projects; however, water level data collected in 2012 and associated modeling of water levels at Rainbow Beach suggest that the Holyoke Project is typically operated in between the high and low impoundment conditions (Appendix A). The license for the Holyoke Project expires in 2039, which would occur within the duration of the proposed licenses at the Turners Falls and Northfield Projects. Changes to licensed water level operations at Holyoke Dam would have the potential for impacts (positive or negative) for Puritan Tiger Beetles and would require separate consultation pursuant to Section 7 of the Endangered Species Act.

5.4.4 Recreational Usage of the Rainbow Beach Conservation Area

The presence of Rainbow Beach Conservation Area provides protection for the Puritan Tiger Beetle habitat by preventing development and restricting use of the land along Rainbow Beach. However, management of the conservation area by the State of Massachusetts and the City of Northampton also has the potential to affect the population of Puritan Tiger Beetles at Rainbow Beach. Heavy recreation use is likely negatively impacting the population of Puritan Tiger Beetles at Rainbow Beach (see Section 4.2.1). Restrictions for recreational use, and enforcement practices, are likely to change with time. Recreation on Rainbow Beach is heavy during the summer months, especially during hot, dry summer periods (HG&E 2008). For example, in summer 2005, which was long and hot, HG&E (2008) documented that 3,094 recreationalists had used Rainbow Beach, 1,539 of which were estimated to be on the beach, 555 in the water, and 1,000 on boats. As identified in Section 4.2.1, current levels of recreation may be higher than historically documented.

Greater restriction and enforcement of measures that could protect Puritan Tiger Beetles would offer the greatest benefit to the population, whereas further relaxed restrictions and limited enforcement could result in negative impacts to the population. Additionally, management actions to control vegetation on and along Rainbow Beach are important for maintenance of Puritan Tiger Beetle habitat; previous vegetation treatments at Rainbow Beach were found to be inadequate to maintain larval habitats, and in the case of some early vegetation management efforts (2001-2004), resulted in increased plant growth due to disturbance of the substrate (USFWS 2019). Further experimental vegetation control efforts are currently underway, and if they are successful, could provide a benefit to Puritan Tiger Beetle, as they have shown to be for a population on the Sassafras River in Maryland. Alternatively, limiting the extent of effective methods and/or ending vegetation control efforts in the future could negatively impact Puritan Tiger Beetle.

[11] FirstLight requested water level data from HG&E several times but no data were provided.

5.4.5 Contaminants and Water Quality

Industries along the Connecticut River include or have included in the past, hydroelectric and other energy generating facilities, an armory, firearms factory, industrial mills and various other industrial pursuits. The effect of general pollution on Puritan Tiger Beetle along the Connecticut River is unknown.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges containing elevated temperatures or high biochemical oxygen demand, can reduce DO concentrations, which could affect submerged Puritan Tiger Beetle larvae that rely on pulling DO from the water during submersion periods. Recent water quality studies performed by FirstLight suggest that DO is generally good in the Connecticut River, but low DO may have been an issue historically. Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (e.g., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of the Puritan Tiger Beetle population.

The New England Interstate Water Pollution Control Commission issued a report in early 1998 on water quality threats. This report indicated that the Connecticut River had several major water quality issues. These included: toxins, such as polychlorinated biphenyls (PCBs); combined sewer overflows (CSOs) which can cause poor water quality conditions in urban areas after storm events; and non-point source pollution.

5.4.6 Global Climate Change

Global climate change is predicted to have several effects to the Connecticut River watershed, including increasing the frequency of flood events each year, earlier spring snowmelt, increases in winter/spring precipitation, and less snowfall and accumulation of snowpack (Kennedy et al. 2018). Changes to regional climate over the span of the Project licenses could therefore result in alterations to the processes that underlie maintenance of the habitat structure and inundation patterns at Rainbow Beach (e.g. sedimentation processes and seasonal hydrology).

5.4.7 Native and Non-Native Species Interactions

Competition and predation on adults by *C. repanda* was identified by Knisley (n.d.) to be a natural mortality factor for Puritan Tiger Beetle. *C. repanda* is a native species of tiger beetle known to be present on Rainbow Beach in considerably high abundance compared to the Puritan Tiger Beetle (USFWS 2019). As such, *C. repanda* could be limiting, and may affect the future of the Puritan Tiger Beetle population at Rainbow Beach through interspecies interactions.

There are also predators to Puritan Tiger Beetles, including vertebrate and invertebrate insectivores that may feed on adults, along with parasitic wasps that lay eggs on tiger beetle larvae, after which the wasp larvae parasitize the tiger beetle larvae (Knisley n.d.; USFWS 1993a). Changes in populations of these species, expansions of these species due to climate change or anthropogenic effects, or introductions of non-native species that may occur over the term of the proposed Project licenses, could all impact Puritan Tiger Beetle populations.

6 EFFECTS ANALYSIS

The effects analysis of this BA compares the proposed action (Section 3) to the environmental baseline condition. Environmental baselines include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this BA includes the effects of several activities that may affect the survival and recovery of the endangered species in the action area. Because the Turners Falls Project and Northfield Mountain Project are existing, FERC-licensed facilities, ongoing effects of the Projects as currently licensed on listed species are part of the environmental baseline.

For the purpose of the analyses in the sections below, the environmental baseline for Project operations is considered to be current licensed operations and is hereafter referred to as the baseline condition. The proposed condition analyzed includes operational changes associated with FirstLight's relicensing proposal.

Evaluating Project effects on Puritan Tiger Beetle relies on several approaches combined to accurately depict conditions in a complex and changing riparian environment. These approaches include:

- Establishing the size and elevations of Puritan Tiger Beetle habitat at Rainbow Beach using survey data (Section 6.1.2)
- Determining the flow and water level relationship at Rainbow Beach using relationships between constant-flow hydraulic models (Section 6.1.3.1)
- Characterizing flow and water level attenuation between the Turners Falls Project and Rainbow Beach by developing synthetic hydrographs (Section 6.1.3.2)
- Evaluating the frequency and magnitude of exposure to operational effects by analyzing water level timeseries data (hourly) developed using unsteady-state[12] hydraulic modeling, where input flows were based on flow data from the Connecticut River (Section 6.1.4). This analysis takes into account the attenuation and lag of flows from Montague to Rainbow Beach
- Comparing Baseline and Proposed conditions by analyzing water level timeseries data developed using unsteady-state hydraulic modeling, where flow inputs were based on modeled operational conditions (Section 6.1.5)

Two models were used for this assessment as described below.

Hydraulic Model

FirstLight developed a hydraulic model[13] of the Connecticut River from the Montague USGS gage to Holyoke Dam. The model was calibrated to observed water surface elevations in this reach and was used to predict water elevations at Rainbow Beach under existing and proposed operations. Background on the hydraulic modeling is included in the report: Relicensing Study 3.2.2 – Hydraulic Modeling of Turners Falls Impoundment, Bypass Reach, and below Cabot Station. Unsteady-state hydraulic models were ultimately used to evaluate how baseline and proposed operations could impact water levels at Rainbow Beach.

Given that observed water level data were not available at Holyoke Dam for timeseries modeling, both high and low Holyoke Impoundment conditions were evaluated separately for various modeling analyses; however, it should be noted that, based on a small amount of water level data available at Holyoke Dam

[12] Unsteady-state means the flow changes from hour to hour, similar to a time-varying hydrograph.
[13] The hydraulic model used is the Hydroelectric Engineering Center's River Analysis System (HEC-RAS) software.

from 2012, modeled water levels at Rainbow Beach are typically in between water levels modeled for high and low operating ranges when actual historic Holyoke Impoundment data are used (Appendix A).

Operations Model

FirstLight developed an operations model[14] of the Connecticut River that included Great River Hydro's Wilder, Bellows Falls, and Vernon Hydroelectric Projects, FirstLight's Northfield Mountain Pumped-Storage Project and Turners Falls Hydroelectric Project, and HG&E's Holyoke Hydroelectric Project. The model was developed on an hourly time step for the period 1962-2003. The operations model is a tool to simulate different operating conditions (bypass flows, peaking restrictions, ramping restrictions, water level restrictions, etc.). The operations model was used to simulate baseline conditions and the proposed conditions as outlined in Section 3. The key output from the operations model that was used for the Puritan Tiger Beetle assessment is the flow at Montague. The flow at Montague under baseline and proposed conditions was used as "input" to the hydraulic model. Background on the operations modeling is included in the report: Relicensing Study 3.8.1 – Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation, and Hydropower Generation.

[14] The operations model used is the Hydroelectric Engineering Center's Reservoir System Simulation (HEC-ResSim) software.

6.1 Exposure to Project Elements

6.1.1 Project Elements

The Projects have operated under the current licenses since May 5, 1980 and May 14, 1968 for the Turners Falls Project and Northfield Mountain Project, respectively. Proposed construction and routine maintenance would be confined to the direct Project areas, many miles from the Puritan Tiger Beetle habitat at Rainbow Beach (Table 6.1.1-1). Therefore, the only Project element that could affect the Puritan Tiger Beetle is Project operations, which can affect water levels downstream to Holyoke Dam.

Table 6.1.1-1: River Miles of Major Project Features relative to Rainbow Beach and Puritan Tiger Beetle Habitat

Location	River Mile	Relative River Mile from Rainbow Beach
Vernon Dam*	142.1	47.8
Northfield Mountain Tailrace	127.3	33.0
Turners Falls Dam	122.2	27.9
Station No. 1	121.1	26.8
Cabot Station	119.3	25.0
Lower End of Turners Falls Project Boundary	119.0	24.7
Montague USGS Gage**	118.5	24.2
Rainbow Beach (Puritan Tiger Beetle Habitat)	94.3	0.0
Holyoke Dam*	85.5	-8.8

**Vernon Dam and Holyoke Dam are not Project features but are included because they are considered the upstream and downstream extents, respectively, of the operational project element for the Northfield Mountain and Turners Falls Projects.*
*** The Montague USGS Gage is also not a project feature and is located on the Connecticut River just downstream of the confluence with the Deerfield River.*

6.1.2 Locations of Habitat Relative to Water Levels

The topography of Rainbow Beach was surveyed by FirstLight in November 2014 using a Real-Time Kinematic Global Positioning System (RTK-GPS), which provided survey-grade accuracy. The survey data were used to develop a terrain model (Figure 6.1.2-1). The locations of larval and adult Puritan Tiger Beetle habitat in relation to elevation at Rainbow Beach was inferred based on observed habitat use from various population assessments, along with discussions with USFWS and MA NHESP. For the purposes of this analysis, potential larval habitat ranges between elevations 102.75 feet through 104.0 feet, which includes the upper portions of the sandy Rainbow Beach area, up into areas of sparse vegetation growth. The amount of potential larval habitat area at various elevations was calculated from the November 2014 survey (Table 6.1.2-1). It should be noted that not all of the larval habitat areas defined within this elevation range are utilized by Puritan Tiger Beetle larvae. Instead, larvae have been found within approximately 2-4 meters of the vegetation line at the higher elevations along the beach (C. Davis, *pers. comm.*).

The areas with potential larval habitat were included in the area surveyed in 2014, as river flows were relatively high during the survey with a mean daily flow of 19,500 cfs at the Montague USGS Gage, which inundated the lower portions of adult habitat. Adult habitat is present from elevations 101.0 feet through 104.0 feet, with foraging and mating occurring toward the water's edge and oviposition occurring within the larval habitat (between elevations 102.75 feet and 104.0 feet). Because the location of the water-land interface is dependent on flow in the river at Rainbow Beach, along with the water level at Holyoke Dam, the actual foraging/mating locations of Puritan Tiger Beetle would be variable with time. In Figure 6.1.2-1, all areas of adult habitat are visible on the map because the aerial images were taken on July 13, 2018 when flows at Montague were low, averaging approximately 2,820 cfs, and reaching a maximum of 3,130 cfs around mid-day.

Table 6.1.2-1: Amount of Potential Larval Habitat Area Above Various Elevations at Rainbow Beach.

Elevation (ft, NGVD29)	Square Feet	Acres	% Available
104.0	0	0.000	0.0%
103.9	4,818	0.111	6.0%
103.8	10,566	0.243	13.1%
103.7	16,248	0.373	20.2%
103.6	22,284	0.512	27.7%
103.5	28,574	0.656	35.5%
103.4	35,036	0.804	43.6%
103.3	41,586	0.955	51.7%
103.2	47,940	1.101	59.6%
103.1	53,917	1.238	67.1%
103.0	60,753	1.395	75.6%
102.9	69,394	1.593	86.3%
102.8	76,734	1.762	95.4%
102.75	80,411	1.846	100.0%

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Figure 6.1.2-1:
Rainbow Beach Topography Relative to Puritan Tiger Beetle Habitat

Contour Line (ft, NGVD29)

- 102.75'
- 104'

Survey Elevation (ft, NGVD29)

- 102.00' to 102.75'
- 102.76' to 104.0'
- 104.01' to 116.55'

Elevation (ft, NGVD29)

- >108'
- 107' to 108'
- 106' to 107'
- 105' to 106'
- 104' to 105'
- 103' to 104'
- 102.02' to 103'

Aerial Imagery Flown:
July 13, 2018
Elevation Data Collected:
November 26, 2014

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)

0 112.5 225 450
Feet

1 inch = 225 feet

FirstLight

Path: W:\gis\studies\3_5_1\maps\rainbow_beach_terrain_and_points.mxd

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6.1.3 Effects of Flows on Water Levels at Rainbow Beach

6.1.3.1 Flow and Water Level Relationships at Rainbow Beach

Water levels at Rainbow Beach in the Connecticut River were calculated using hydraulic modeling of constant flow rates, and the relationship was developed by interpolating between the modeled flow rates. During high Holyoke Impoundment conditions (100.67 feet), constant flows of approximately 5,000 cfs, 15,500 cfs, and 22,000 cfs would reach elevations 101.0 feet, 102.75 feet, and 104.0 feet, respectively (Figure 6.1.3.1-1). These elevations correspond to the lowest elevation of adult habitat, the lowest elevation of larval habitat, and the highest elevation of any habitat, for Puritan Tiger Beetle at Rainbow Beach, respectively. During low Holyoke Impoundment conditions, flows of, 9,500 cfs, 17,500 cfs, and 23,000 cfs would reach those respective elevations (Figure 6.1.3.1-1).

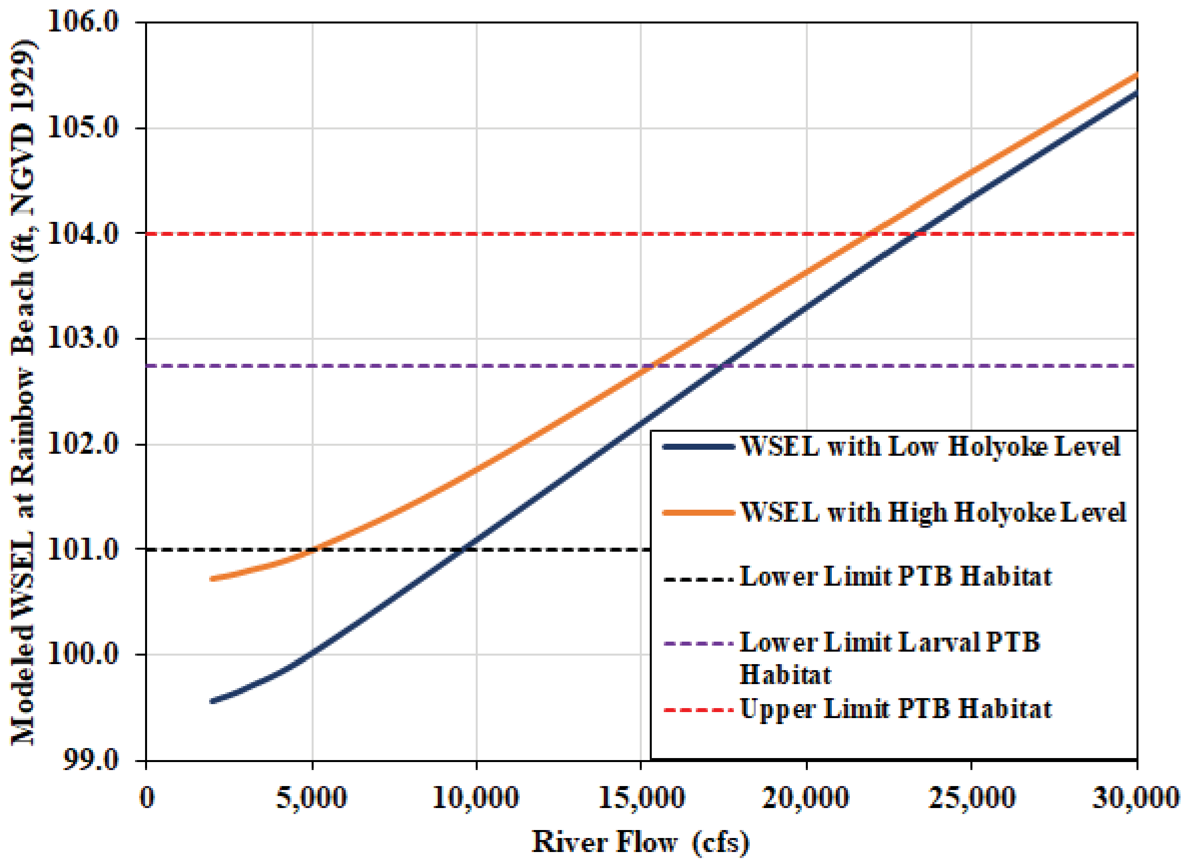

Figure 6.1.3.1-1: Modeled Water Surface Elevations at Rainbow Beach based on River Flow and the Range of Licensed Water Levels at Holyoke Dam

Note: these modeled elevations are for steady-state conditions.

6.1.3.2 Characterization of Attenuation and Lag Time of Project Flows

Though the results presented above were useful for developing the flow and water level relationships at Rainbow Beach, the amount of flow released from the Turners Falls Project does not result in the same amount of flow reaching Rainbow Beach due to substantial attenuation that occurs over the approximately 25 miles of river that separate Rainbow Beach from the Turners Falls Project. Further, there is a considerable time lag between when flows leave the Turners Falls Project and when they reach Rainbow Beach. As part of the other studies, FirstLight installed water level loggers near Rainbow Beach and at Holyoke Dam that measured the water surface elevations every 15 minutes. Figure 6.1.3.2-1 shows the observed flow at the Montague USGS Gage and the observed water levels at Rainbow Beach and Holyoke Dam from July 7-10, 2017. As Figure 6.1.3.2-1 shows there is a lag and attenuation of Montague USGS Gage flows based on the observed Rainbow Beach water surface elevations.

FirstLight developed several synthetic hydrographs representing Cabot peaking, which were then analyzed in the unsteady-state hydraulic model to determine the travel time and attenuation relationship from Cabot to Rainbow Beach. Summaries and timeseries figures of the synthetic hydrograph modeling results are included in Appendix B and Appendix C, respectively. The modeling indicates that peak releases from Cabot generally take over six hours to reach Rainbow Beach and the timing and magnitude of attenuation is related to the length and magnitude of Cabot peak flow releases, along with underlying conditions such as base flows in the Connecticut River and water levels at Holyoke Dam.

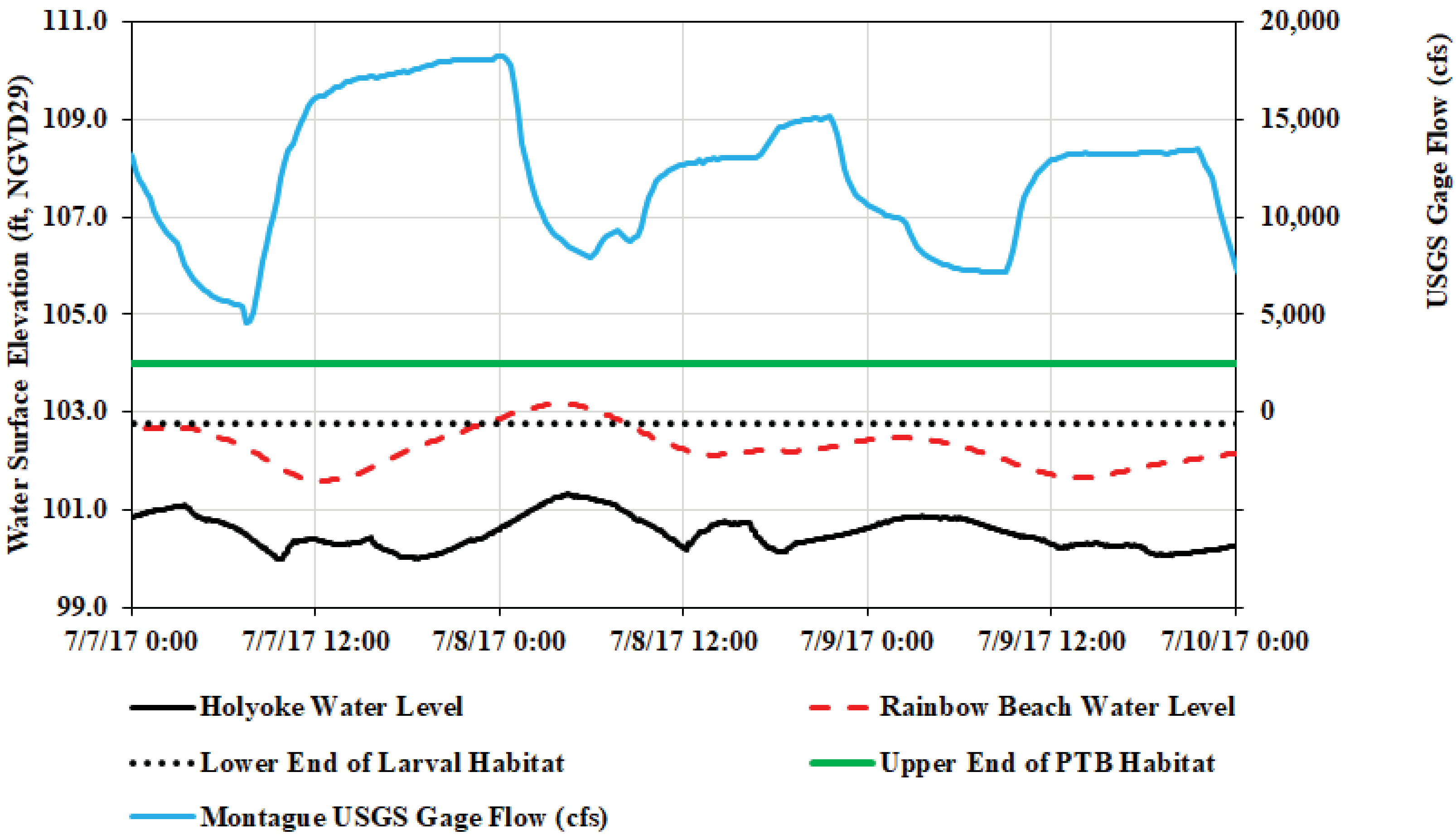

Figure 6.1.3.2-1: Example of Peaking Flow Changes from Cabot Station and Resulting Water Level Changes at Rainbow Beach

Note: Water level data were modeled using a HEC-RAS model based on actual water level data collected near Holyoke and Rainbow Beach.

6.1.4 Frequency, Duration, and Magnitude of Exposure

Given the variable effects of river flows, Project peaking flows, and Holyoke Impoundment water levels, as described in the sections above, unsteady-state hydraulic modeling was necessary to characterize the frequency, duration, and magnitude of exposure under the baseline environmental flow condition for each life stage and activity period of the Puritan Tiger Beetle. This modeling was performed using 28 years of hourly timeseries flow data (1991-2018) in the Connecticut River at the Montague USGS gage, routed to Rainbow Beach using HEC-RAS. The models produced flow and water level timeseries at Rainbow Beach for those 28 years given low and high Holyoke Impoundment conditions.

Above the Turners Falls Project hydraulic capacity (15,978 cfs plus minimum spill flows), changes in downstream flows are due to changes in spill over the dam, and/or due to changes in flows from tributaries downstream of the Turners Falls Project (i.e. Deerfield River). As such, the analyses in this section focus on the effects that are within Project control, when flows at the Montague USGS gage are less than 18,000 cfs. Note that the Montague USGS gage includes flow from the Deerfield River.

6.1.4.1 Larval Habitat

Two primary periods for larvae were analyzed. One of these periods was between May 15 and October 15, during which larvae can have their burrows opened and be actively feeding. The other period is from October 16 through May 14, during which they would be inactive, with their burrows closed.

Throughout the year, and primarily during the inactive period when river flows in the Connecticut River tend to be higher, larvae are subjected to natural high flow inundation events. FirstLight performed an analysis on the duration of inundation. For the analysis, an inundation event was defined as a period where water surface elevations at Rainbow Beach were 104 feet or greater without reprieve. A reprieve was defined as a period where water levels dropped below 104 feet for longer than one day (24 hours).

Within the 1991-2018 timeseries, inundation events experienced by Puritan Tiger Beetles that began during the inactive period could be relatively long, with the longest annual complete inundation events typically lasting multiple weeks, but even up to approximately two months (Figure 6.1.4.1-1 and Figure 6.1.4.1-2). Most events occurred during the spring freshet in March and April. During the active period, duration events were typically much shorter (Figure 6.1.4.1-3 and Figure 6.1.4.1-4). However, one long-duration event, which would have lasted 30 days if Holyoke Impoundment was held at a low level and 60 days if Holyoke Impoundment was held at a high level, began on October 8, 2005. Though this inundation event occurred within the active period for larvae, it began near the end of the active period with most of the inundation occurring during the inactive period.

Given that these levels of inundation occur each year, and the Puritan Tiger Beetle persists on Rainbow Beach, this population has been resilient to sustained inundation periods.

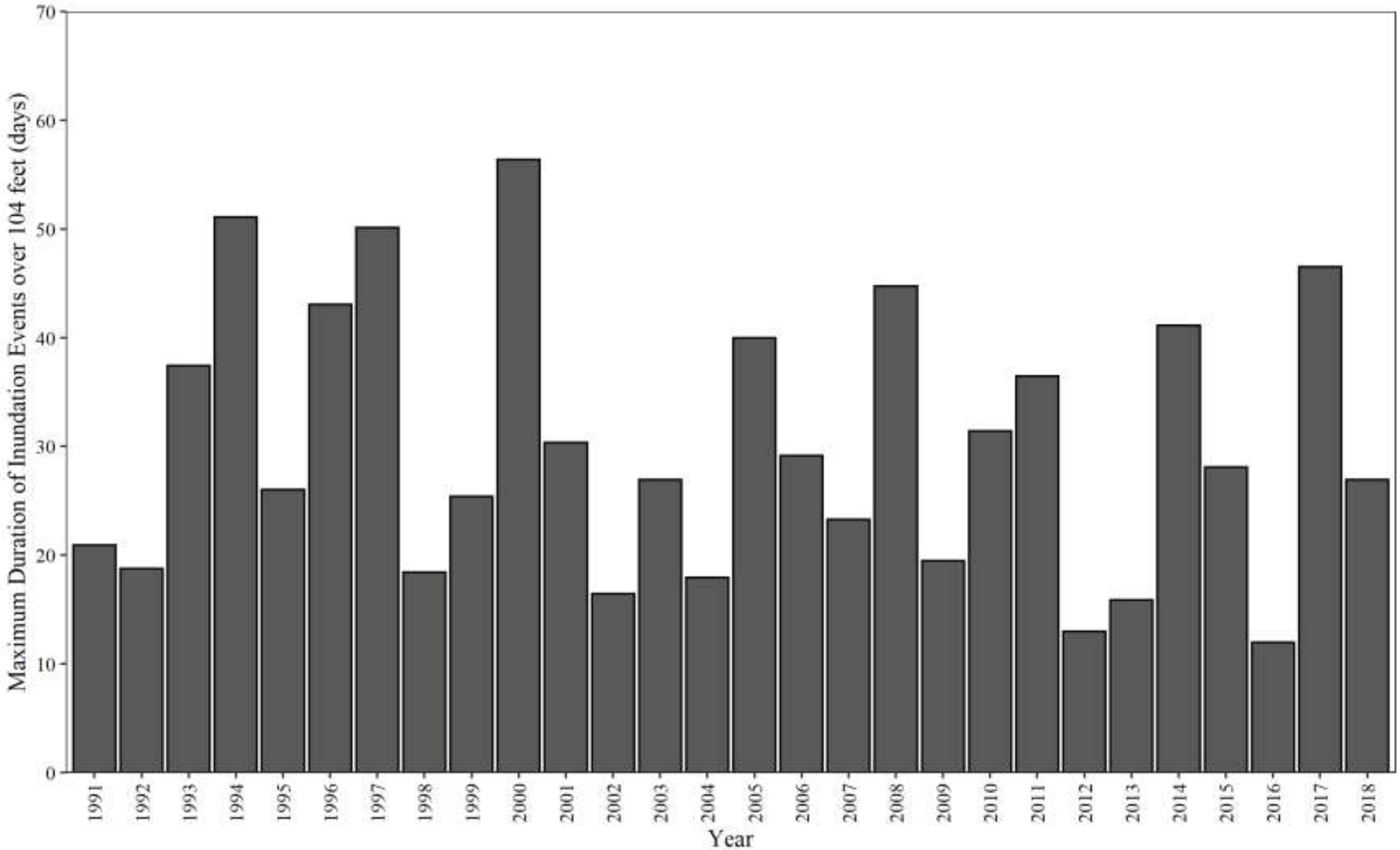

Figure 6.1.4.1-1: Maximum Duration of Events that began during the Inactive Larval Period and Inundated All of the Larval Puritan Tiger Beetle Habitat, given a Low Holyoke Impoundment Operational Condition.

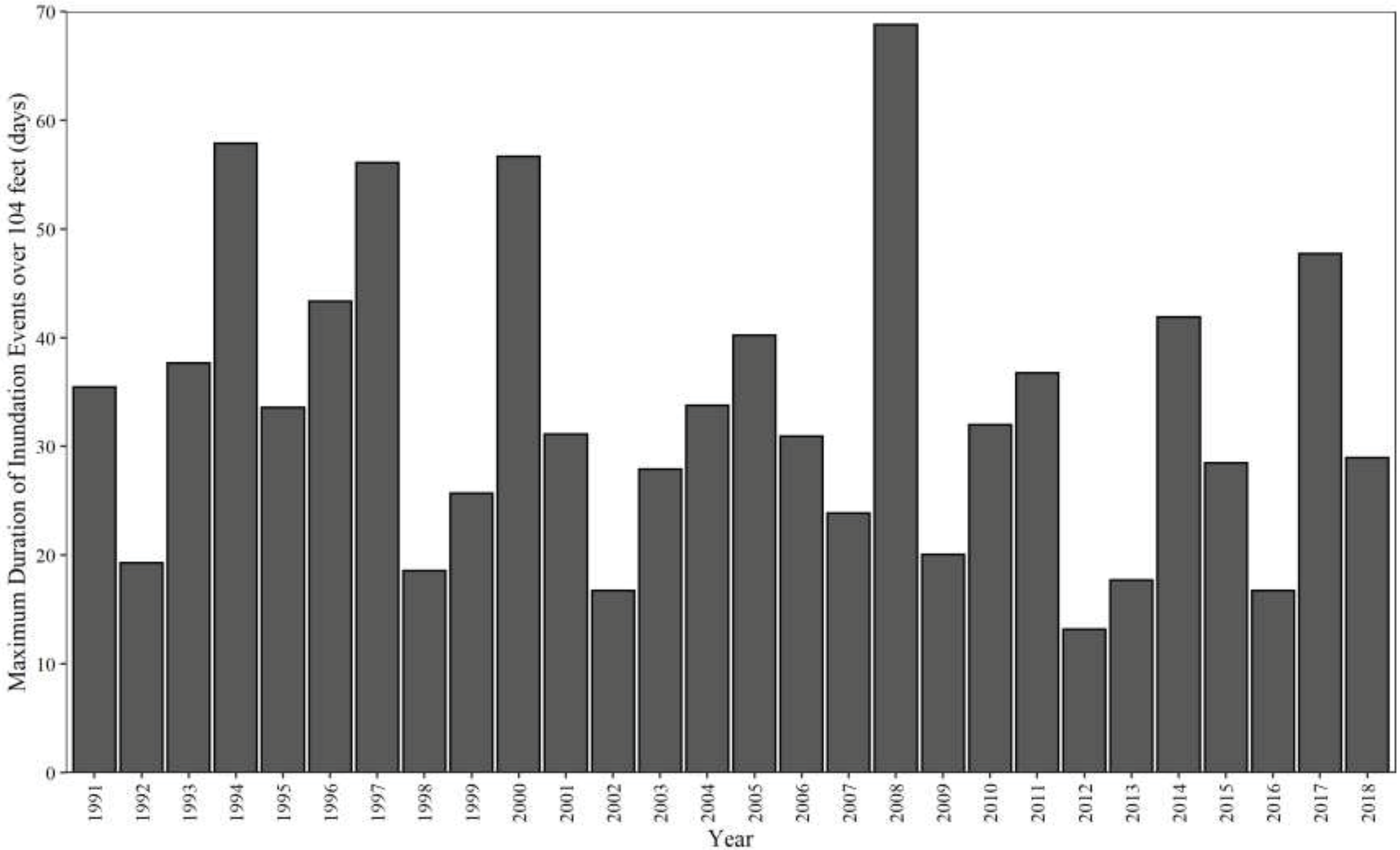

Figure 6.1.4.1-2: Maximum Duration of Events that began during the Inactive Larval Period and Inundated All of the Larval Puritan Tiger Beetle Habitat, given a High Holyoke Impoundment Operational Condition.

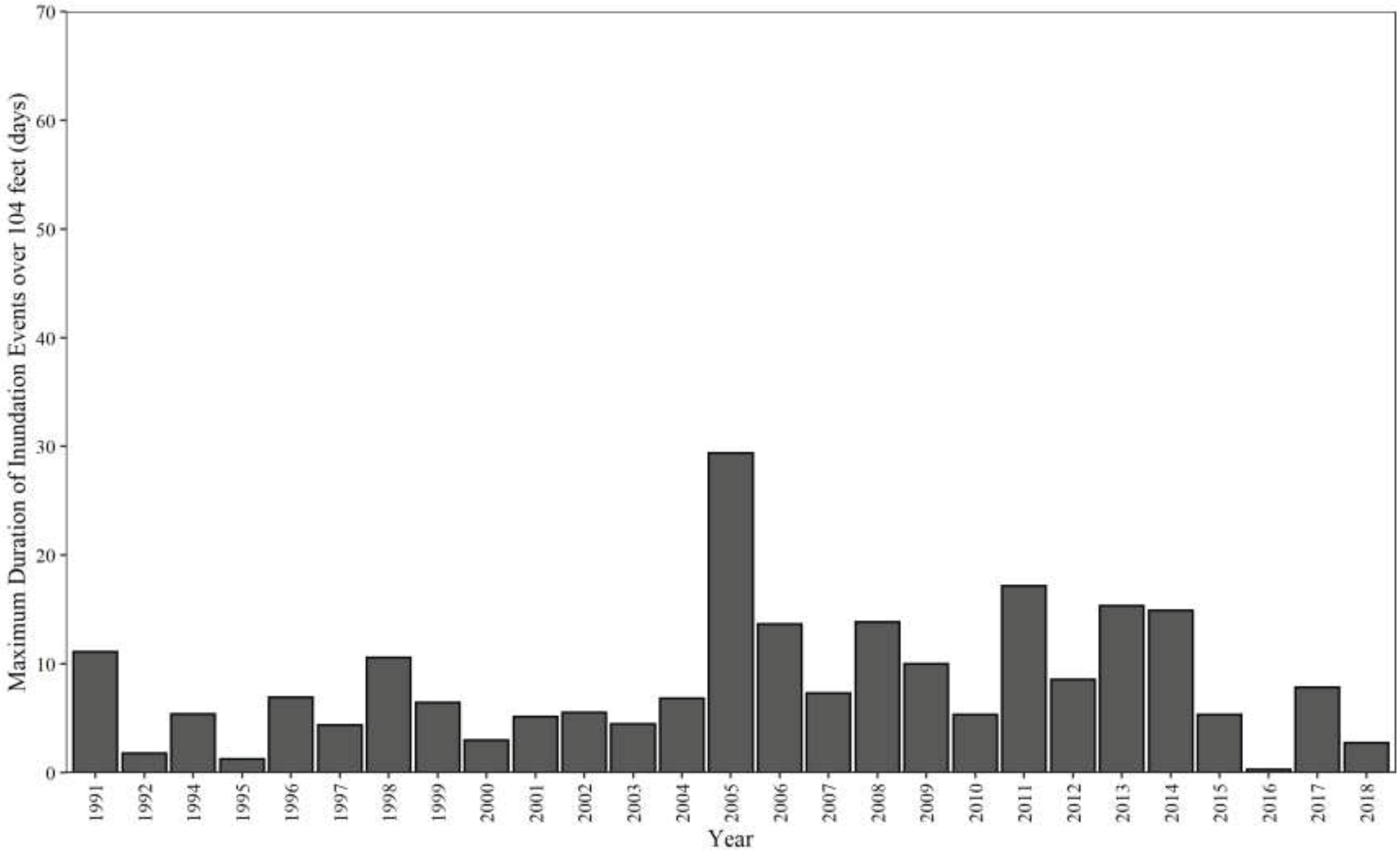

Figure 6.1.4.1-3: Maximum Duration of Events that began during the Active Larval Period and Inundated All of the Larval Puritan Tiger Beetle Habitat, given a Low Holyoke Impoundment Operational Condition.

Note: The longest inundation event of nearly 30 days began on October 8, 2005, near the end of the larval active period.

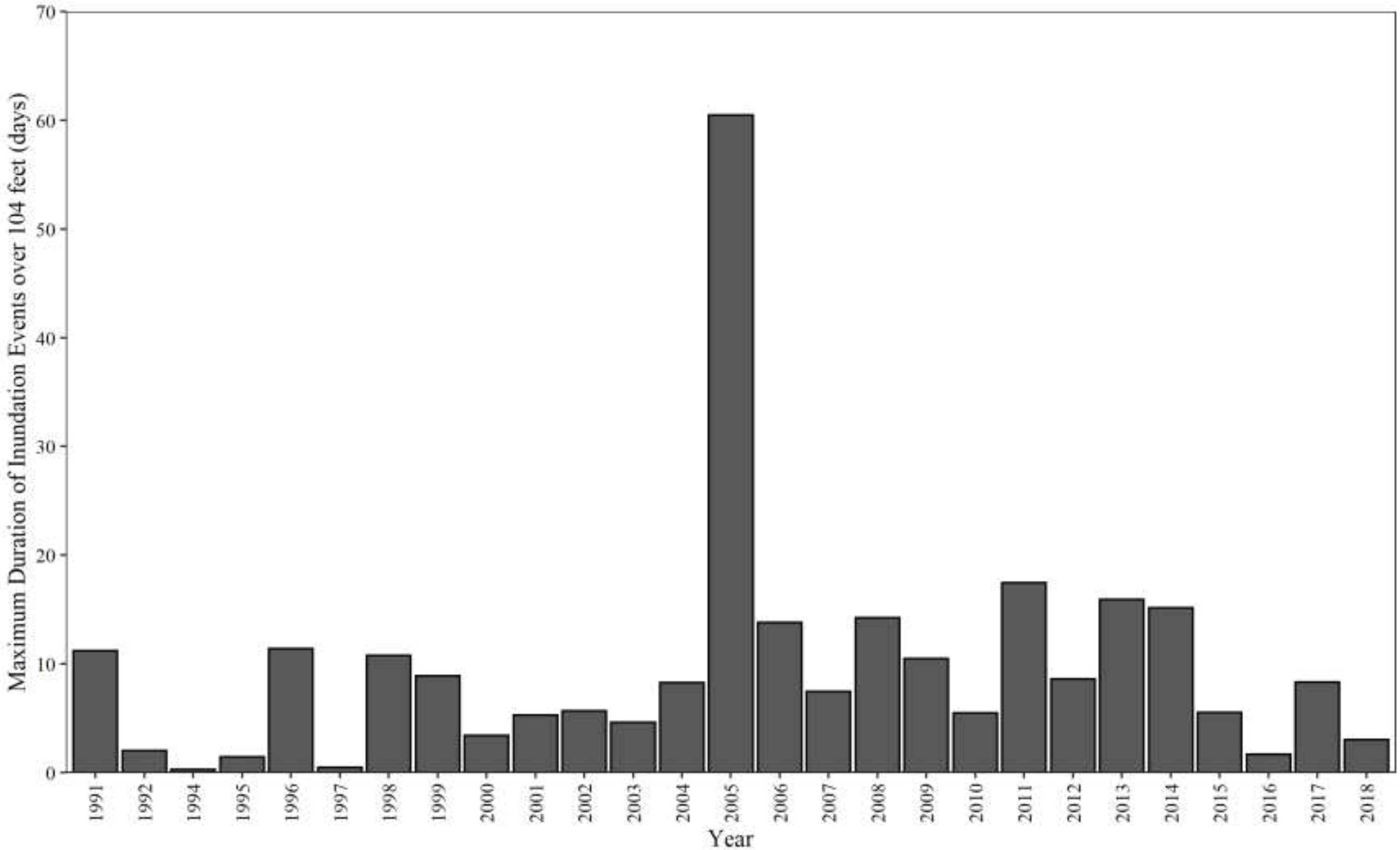

Figure 6.1.4.1-4: Maximum Duration of Events that began during the Active Larval Period and Inundated All of the Larval Puritan Tiger Beetle Habitat, given a High Holyoke Impoundment Operational Condition.

Note: The longest inundation event of 60 days began on October 8, 2005, near the end of the larval active period.

6.1.4.1.1 Larval Activity Period

Based on the active periods of the larval life stage of Puritan Tiger Beetle, larval instars could be feeding between May 15th and October 15th. Potential larval Puritan Tiger Beetle habitat at Rainbow Beach ranges from elevations 102.75 feet to 104 feet.

Distributions of daily average flows at Montague for each larval activity period included high, medium, and low-flow years (Figure 6.1.4.1.2-1). During the adult Puritan Tiger Beetle active season, average daily flows at Montague were 18,000 cfs or greater approximately 13.7% of the days within this time period; flows of this level and higher were considered above the Turners Falls Project's capacity to control and would have provided inundation consistent with natural high-flow conditions.

When flows in the river are within Project capacity, and with the Holyoke Impoundment at low operating levels, there would have been no inundation of any larval habitat 89.3% of days within the dataset during the active larval period (Table 6.1.4.1.1-1; Figure 6.1.4.1.1-2). At high Holyoke Impoundment operating levels, there would have been slightly more frequent inundation, with no inundation of any larval habitat 83.3% of the time (Table 6.1.4.1.1-1; Figure 6.1.4.1.1-2).

Available research suggests that the immobile life stage of tiger beetles can benefit from occasional inundation that brings food items to their locations and prevents desiccation. Active larvae can also close their burrows and survive through inundation events, especially if dissolved oxygen concentrations are high. As such, given the infrequent and relatively limited inundation of available habitat when river flows are within Project control, the effects of Project flows under the baseline condition on active larvae have likely been insignificant.

Table 6.1.4.1.1-1: Proportion of Time Period when River Flows were within Project Capacity and Minimum Daily Habitat Reached or Exceeded Availability Thresholds for the Active Larval Period, 1991-2018

Minimum Daily Habitat Availability on Rainbow Beach (Larval Active Period)	Holyoke Level	
	Low	High
100%	89.3%	83.3%
75%	92.9%	88.8%
50%	95.7%	92.8%
25%	97.8%	95.9%
10%	98.7%	97.4%

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

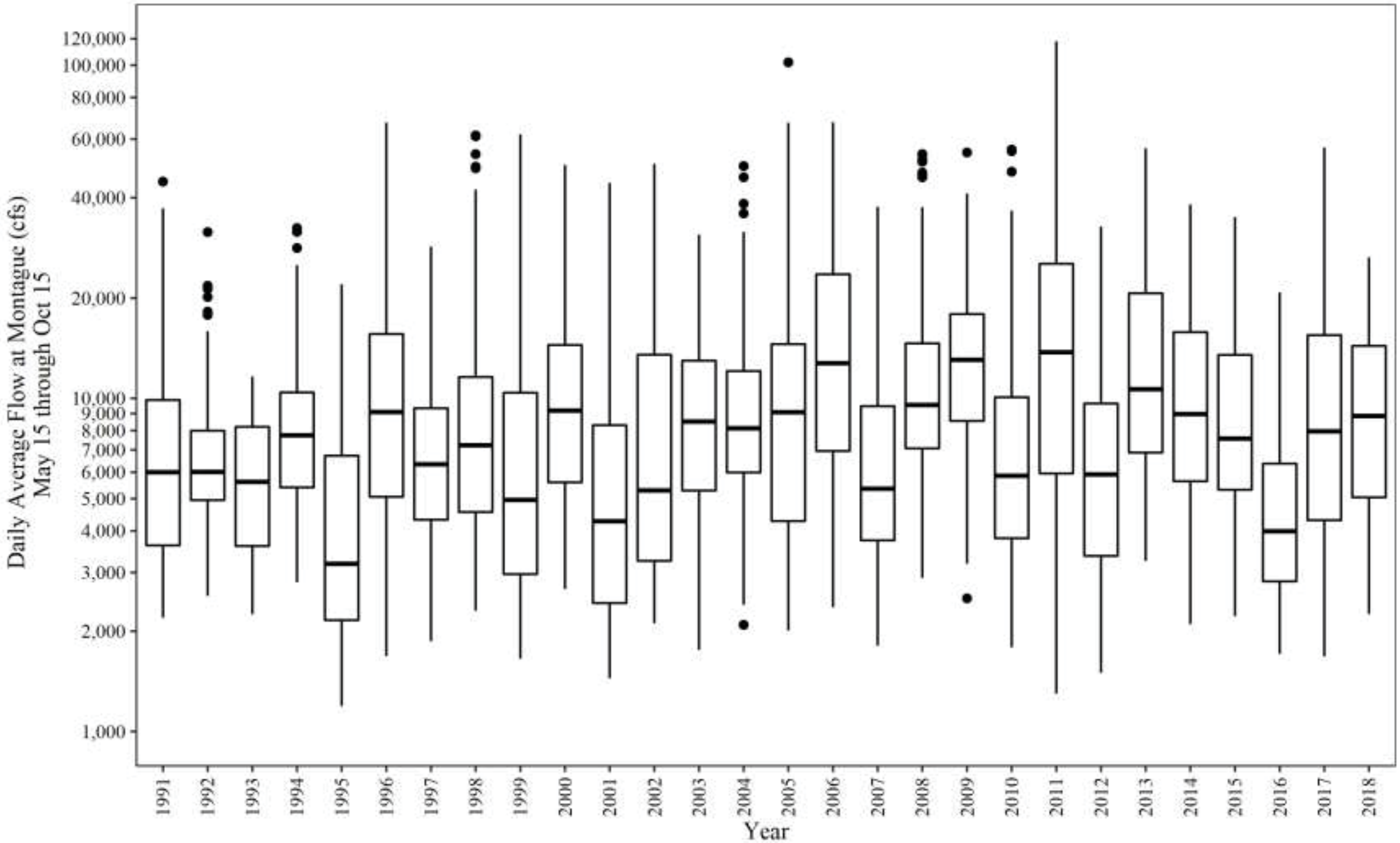

Figure 6.1.4.1.1-1: Distribution of Average Daily Flows on the Connecticut River at Montague during the Larval Activity Period, 1991-2018

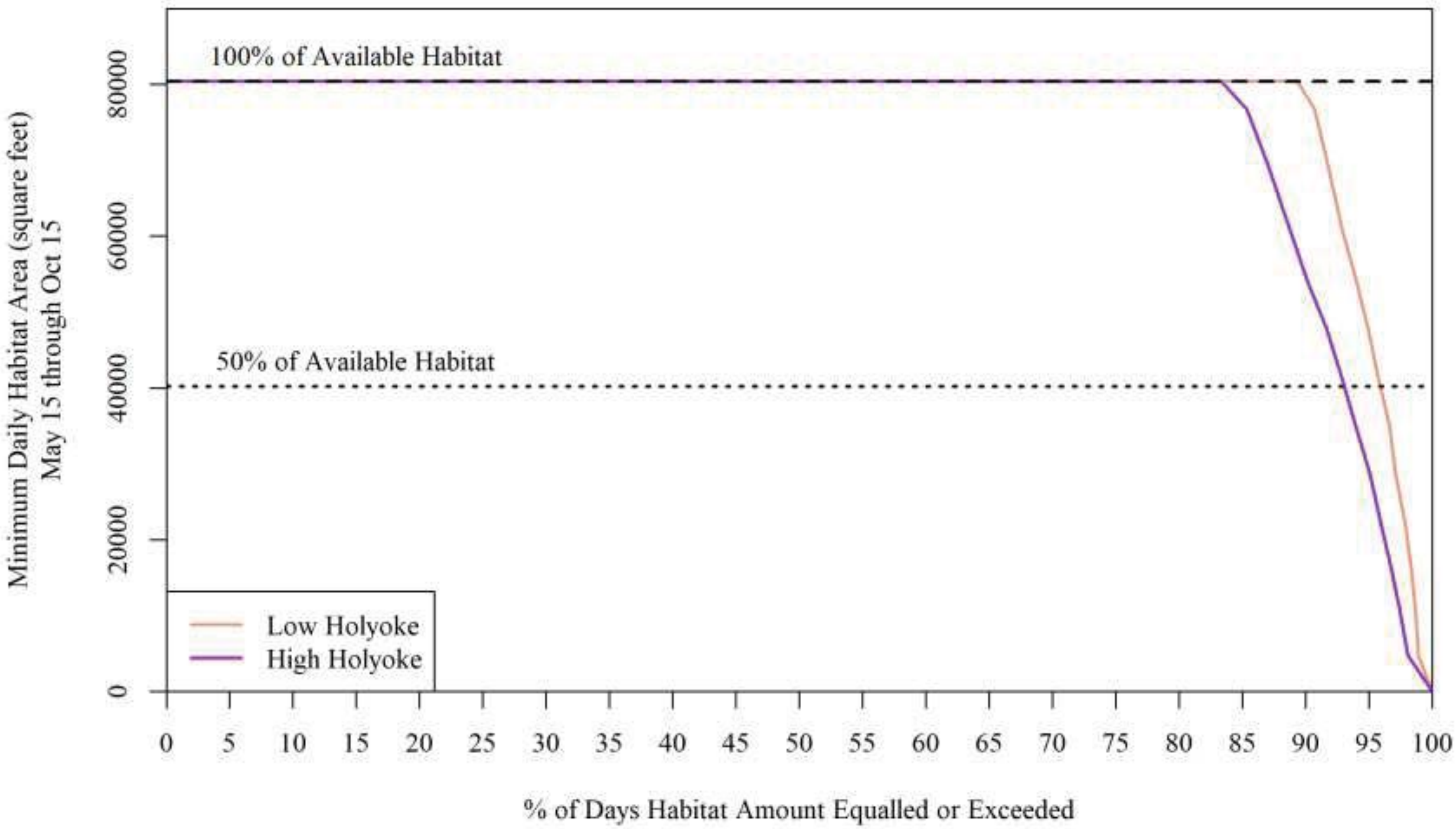

Figure 6.1.4.1.1-2: Duration Curve of the Minimum Daily Amount of Habitat Available at Rainbow Beach for Larvae during the Larval Activity Period, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

6.1.4.1.2 Inactive Period

Larval Puritan Tiger Beetle close off their burrows for a long period of overwintering. For the purposes of this analysis, the inactive period occurs between October 16 and May 14. More inundation of larval habitats would be anticipated during the inactive larval season than any other time of the year due to higher flows that commonly occur in this period (Figure 6.1.4.1.2-1). Within the dataset analyzed, average daily flows in the Connecticut River were 18,000 cfs or greater, and were therefore above the Project's capabilities to control, approximately 38.3% of the time. During these periods, inundation of some or all larval habitat on Rainbow Beach would occur, depending on the magnitude and duration of river flows, but it would do so independent of Project operations.

When flows in the river are within Project capacity, and with the Holyoke Impoundment at low operating levels, there would have been no inundation of any larval habitat 76.7% of days within the 28-year dataset during the inactivity period (Table 6.1.4.1.2-1; Figure 6.1.4.1.2-2). At high Holyoke Impoundment operating levels, there would have been more frequent inundation, with no inundation of any larval habitat 63.9% of the time (Table 6.1.4.1.2-1; Figure 6.1.4.1.2-2).

Due to high river flows (above Project control) that commonly occur during the inactive period, larval Puritan Tiger Beetles at Rainbow Beach have historically sustained extended periods of inundation, on the order of weeks to months of being submerged without reprieve (see Section 6.1.4.1). By comparison, inundation of inactive larvae when river flows are with Project control are less frequent and have been primarily limited to the lower portions of the habitat area. As such, the effects of Project flows under the baseline condition on inactive larvae have likely been insignificant.

Table 6.1.4.1.2-1: Percentage of Time Period when Minimum Daily Habitat Reached or Exceeded Availability Thresholds for the Inactive Larval Period, 1991-2018

Minimum Daily Habitat Availability on Rainbow Beach (Inactive Larval Period)	Holyoke Level	
	Low	**High**
100%	76.7%	63.9%
75%	85.6%	75.5%
50%	92.6%	85.3%
25%	96.5%	93.1%
10%	98.0%	95.9%

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

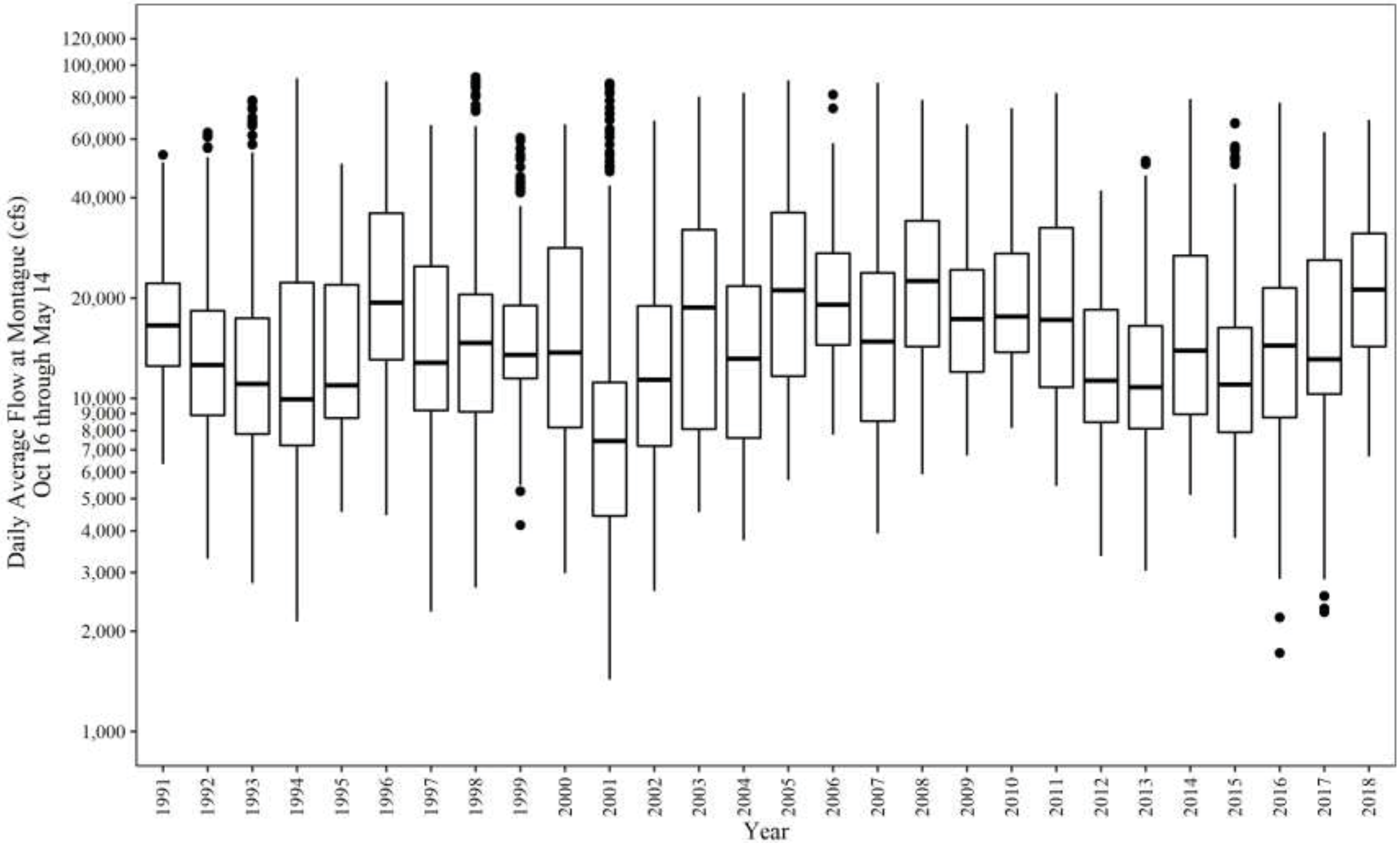

Figure 6.1.4.1.2-1: Distribution of Average Daily Flows on the Connecticut River at Montague during the Inactive Larval Period, 1991-2018

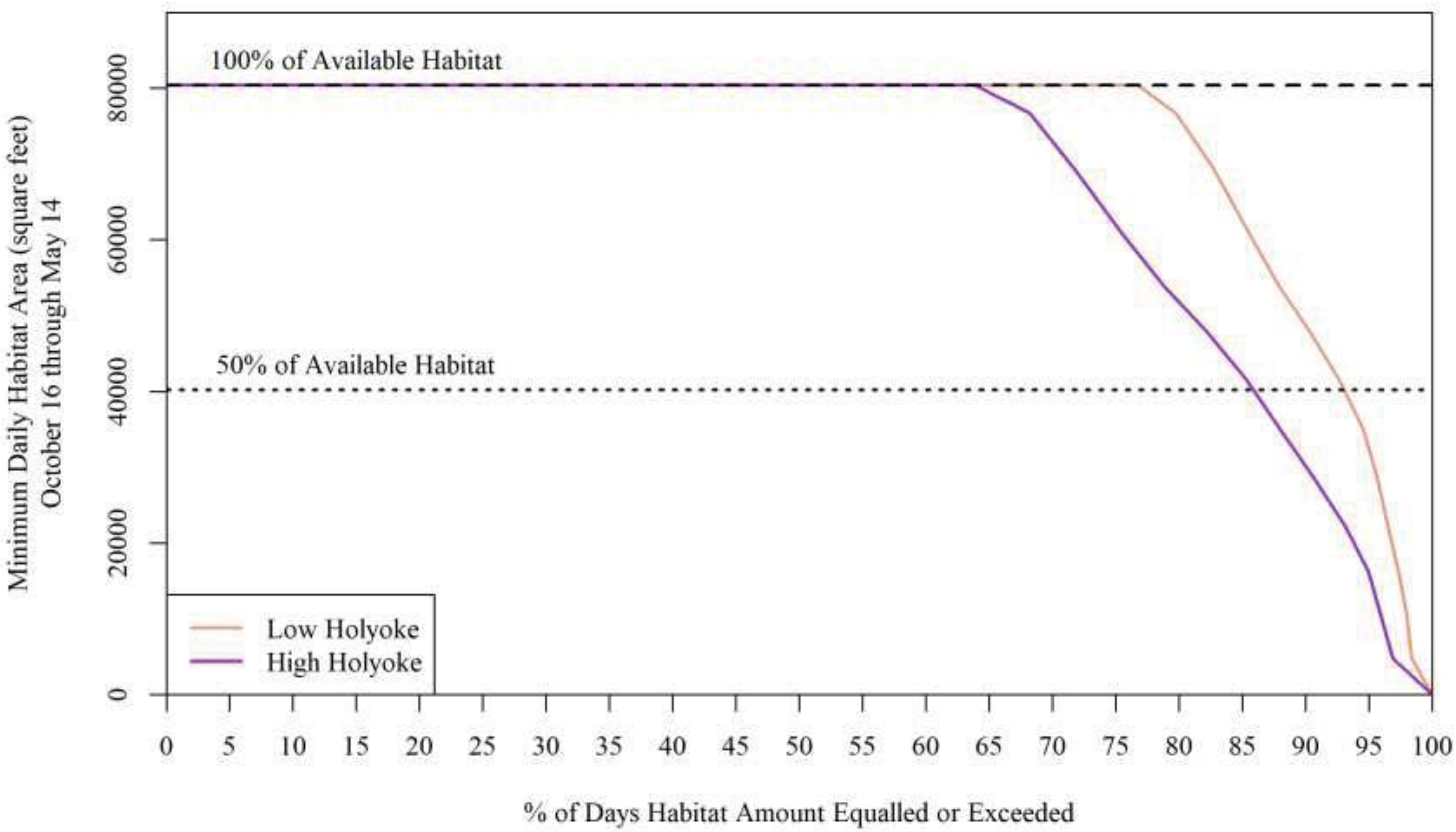

Figure 6.1.4.1.2-2: Duration Curve of the Minimum Daily Amount of Habitat Available at Rainbow Beach for Larvae during the Inactive Larval Period, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

6.1.4.2 Adult Habitat

During the adult life stage of the Puritan Tiger Beetle, there are four primary phases that could be affected by Project operations. These include:

- Emergence
- Foraging
- Mating
- Oviposition

The adult active season at Rainbow Beach was analyzed as June 16th through September 7th. Emergence would typically occur at night during the adult active season, whereas foraging and mating would occur primarily during the daytime hours. Oviposition at Rainbow Beach has been observed primarily in the early evening hours as the beach is cooling, though this activity has been observed elsewhere from the late afternoon through the morning. Adult Puritan Tiger Beetle habitat at Rainbow Beach ranges from elevations 101 feet to 104 feet. If all the habitat becomes inundated during the foraging/mating period, the adults will leave the beach and are not known to return (C. Davis, *pers. comm.*). Emergence and oviposition could occur in the upper portions of the beach along a narrow strip near the vegetation line (conservatively, between elevations 102.75 and 104 feet), whereas foraging and mating can occur within all habitat on Rainbow Beach (between 101 and 104 feet).

The analyzed dataset includes years with high, moderate, and low flow during the adult Puritan Tiger Beetle active season (Figure 6.1.4.2-1). During the adult Puritan Tiger Beetle active season, average daily flows at Montague were 18,000 cfs or greater 11.1% of the days within this time period; flows of this level and higher were above the Turners Falls Project's capacity to control.

Based on the hydraulic modeling, when the Project is in control of the river (i.e., Montague flows < 18,000 cfs), peak water levels each day at Rainbow Beach primarily occur at night, between 11pm and the early morning hours, for low and high Holyoke Impoundment operational conditions (Figures 6.1.4.2-2 and 6.1.4.2-3). For adult Puritan Tiger Beetle, this time window pertains primarily to emergence, with the peak daily flows reaching Rainbow Beach during the foraging/mating and oviposition periods only rarely.

Each of the activity periods within the adult Puritan Tiger Beetle active season are addressed in the subsections below.

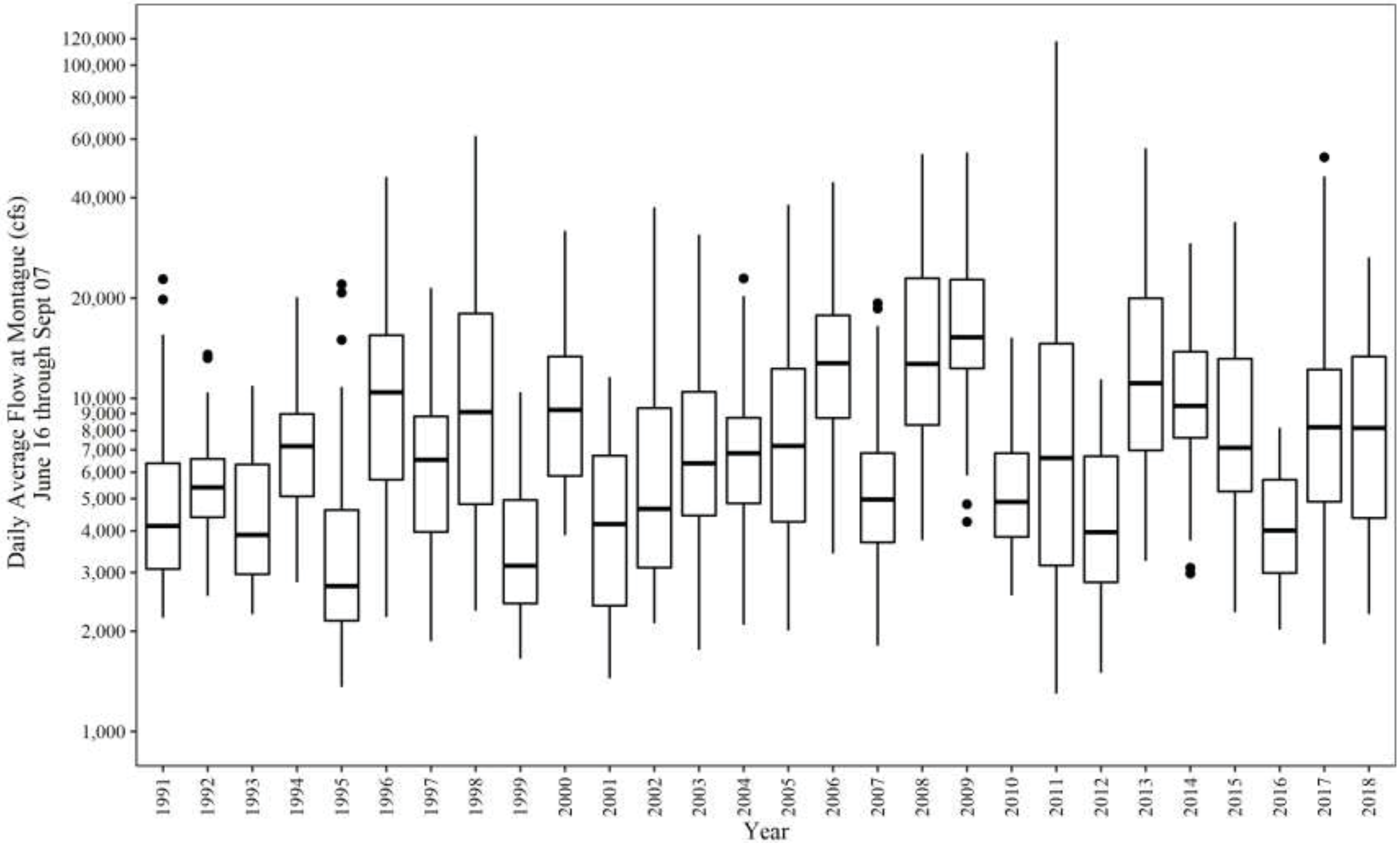

Figure 6.1.4.2-1: Distribution of Average Daily Flows on the Connecticut River at Montague during the Adult Puritan Tiger Beetle Activity Period, 1991-2018

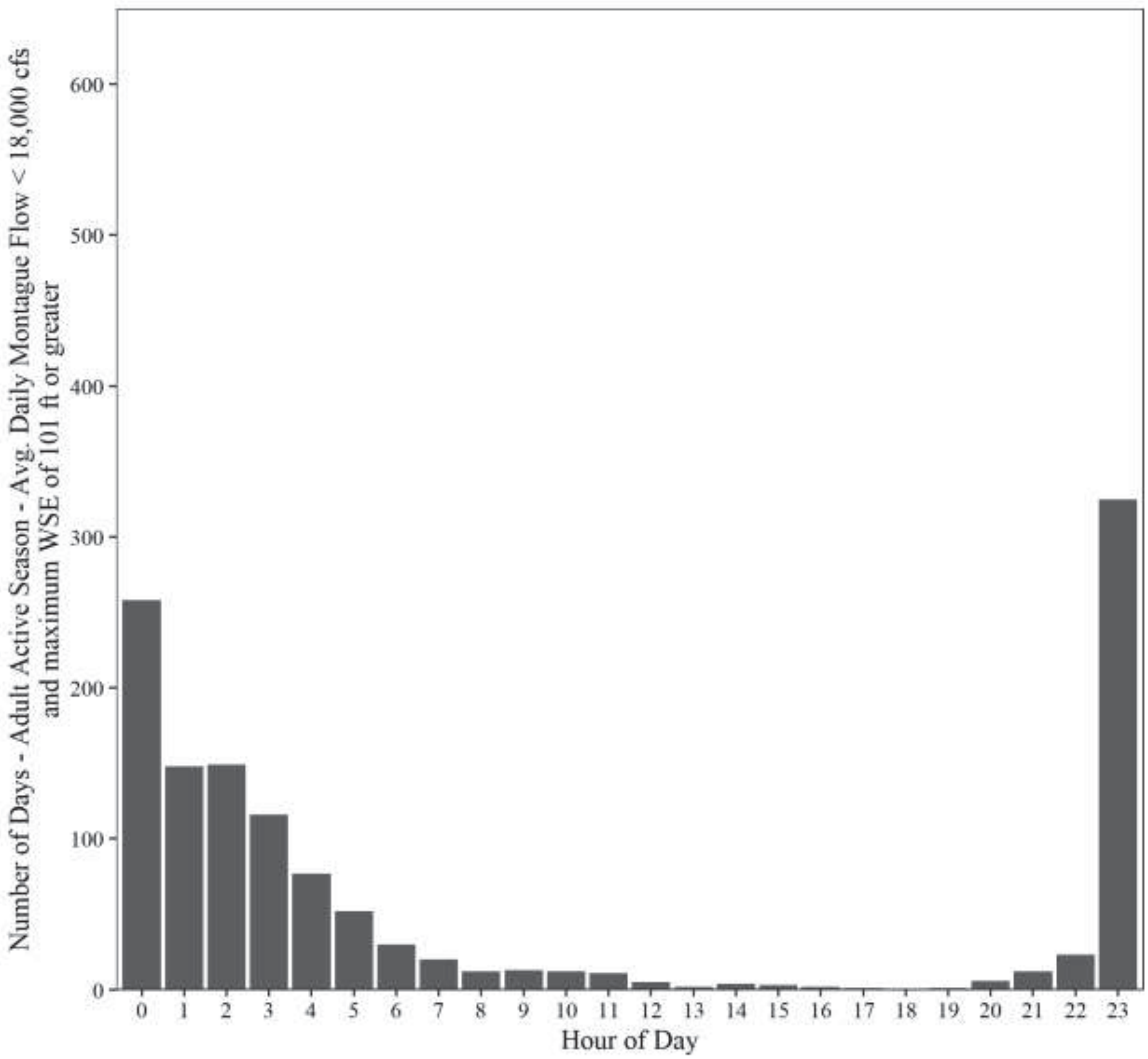

Figure 6.1.4.2-2: Distribution of the Hours of Peak Daily Flows at Rainbow Beach during the Adult Puritan Tiger Beetle Activity Period under Low Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached adult Puritan Tiger Beetle habitat (101 feet or greater).

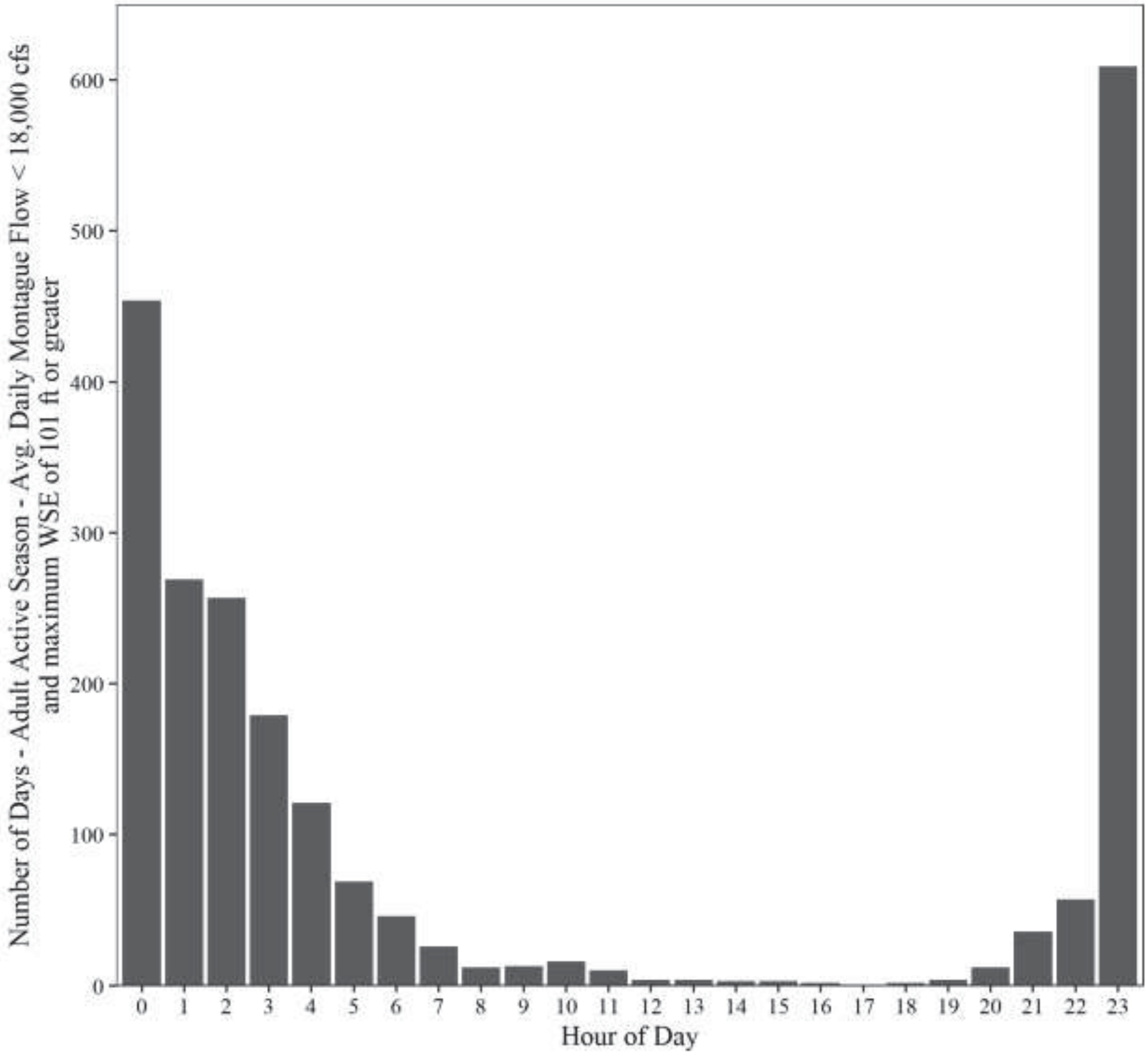

Figure 6.1.4.2-3: Distribution of the Hours of Peak Daily Flows at Rainbow Beach during the Adult Puritan Tiger Beetle Activity Period under High Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached adult Puritan Tiger Beetle habitat (101 feet or greater).

6.1.4.2.1 Emergence

As identified in Section 6.1.4.2, peak daily flows that occur when flows are within the Turners Falls Project hydraulic capacity would typically reach Rainbow Beach between 11pm and the early morning hours. During this time, adult Puritan Tiger Beetles that had been foraging, mating, and depositing eggs would be relatively high up on the beach. The primary activity during these hours would be new emergence of Puritan Tiger Beetles from their larval burrows.

Puritan Tiger Beetles could emerge any time during the adult active season, though most would be emerging during the peak adult activity season in July, and evidence suggests that they emerge at night. The emergence period, for the purposes of this analysis, is therefore defined conservatively as 8pm through 9am from June 16 through September 7, and the emergence habitat for Puritan Tiger Beetle is the larval habitat portion of the beach between 102.75 and 104.0 feet. To evaluate the potential for disruption of emergence, FirstLight calculated the minimum amount of habitat available during each day of the emergence period for the 1991-2018 flow timeseries analyzed.

Though peak water levels reach Rainbow Beach during the emergence period most of the time during the adult activity period, water levels do not typically reach the larval habitat from which adult Puritan Tiger Beetles would emerge when average daily flows at Montague are less than 18,000 cfs and the Turners Falls Project is in control of river inflows (Figure 6.1.4.2.1-1). With the Holyoke Impoundment at low operating levels, there would have been no inundation of any emergence habitat 93.1% of days within the 28-year dataset during the emergence period (Table 6.1.4.2.1-1; Figure 6.1.4.2.1-1). At high Holyoke Impoundment operating levels, there would only be slightly more frequent inundation, with no inundation of any emergence habitat 89.1% of the time (Table 6.1.4.2.1-1; Figure 6.1.4.2.1-1). Greater maximum daily inundation levels, which would have resulted in less minimum daily habitat for emergence, were very infrequent (Table 6.1.4.2.1-1; Figure 6.1.4.2.1-1). For example, at least 75% of the habitat would have been available to emerging Puritan Tiger Beetles 96.1% and 92.6% of the time given low and high Holyoke Impoundment conditions, respectively.

In the limited number of instances where water levels reach the larval habitat from which adults will emerge, hourly water level changes at Rainbow Beach during the emergence period also tend to be very small, primarily between 0.15 feet/hr (1.8 inches/hr) decreases or increases, and often much less (Figure 6.1.4.2.1-2; Figure 6.1.4.2.1-3).

Table 6.1.4.2.1-1: Percentage of Time Period when Minimum Daily Habitat Reached or Exceeded Availability Thresholds for the Emergence Period, 1991-2018, 8:00pm through 9:00am

Minimum Daily Habitat Availability at Rainbow Beach (Emergence)	Holyoke Level	
	Low	High
100%	93.1%	89.1%
75%	96.1%	92.6%
50%	98.1%	95.9%
25%	99.3%	98.1%
10%	99.7%	99.1%

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

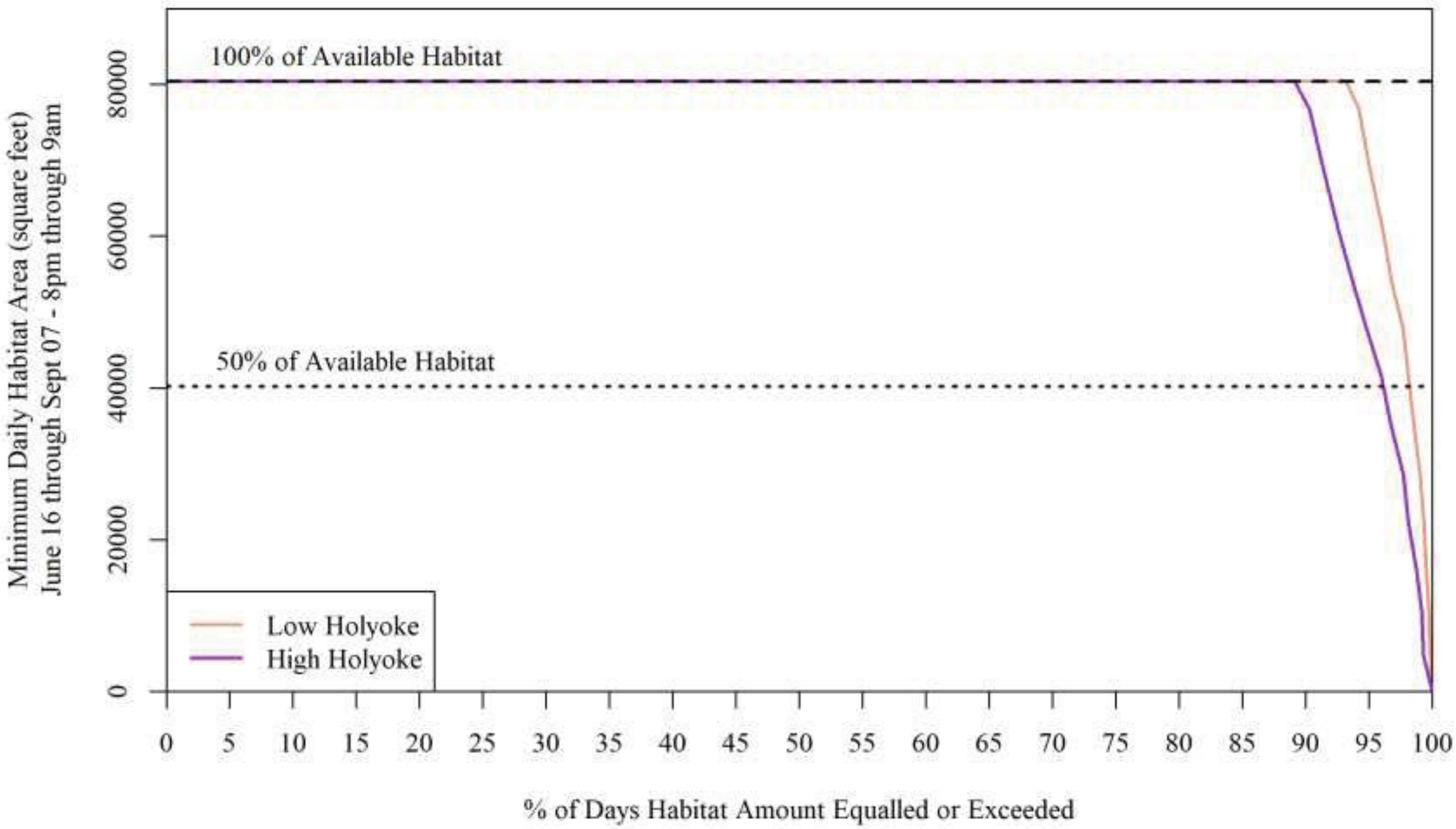

Figure 6.1.4.2.1-1: Duration Curve of the Minimum Daily Amount of Habitat Available at Rainbow Beach for Emerging Puritan Tiger Beetle during the Emergence Period, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

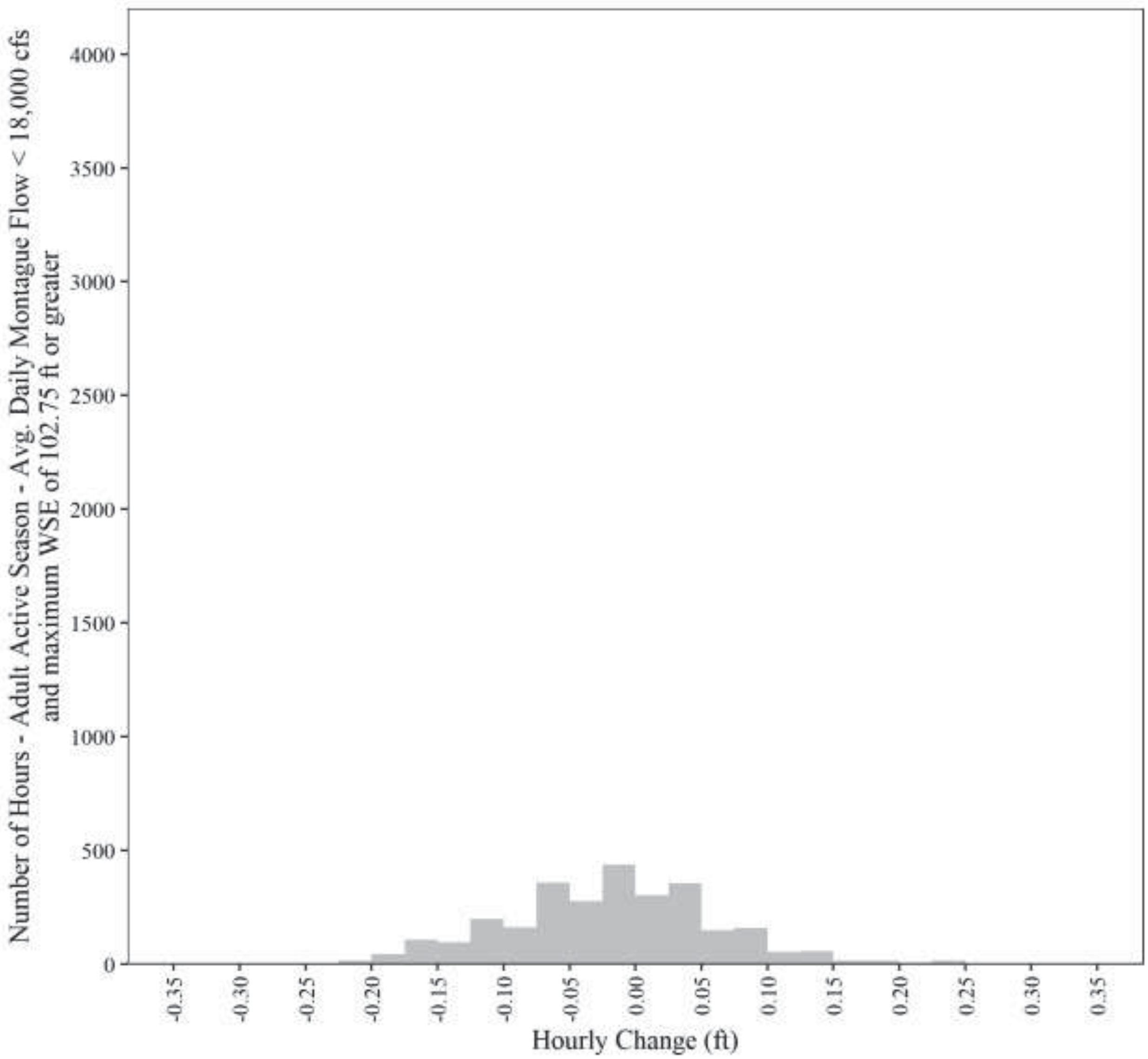

Figure 6.1.4.2.1-2: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Emerging Puritan Tiger Beetle during the Adult Active Season, Low Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle larval/emergence habitat (102.75 feet or greater).

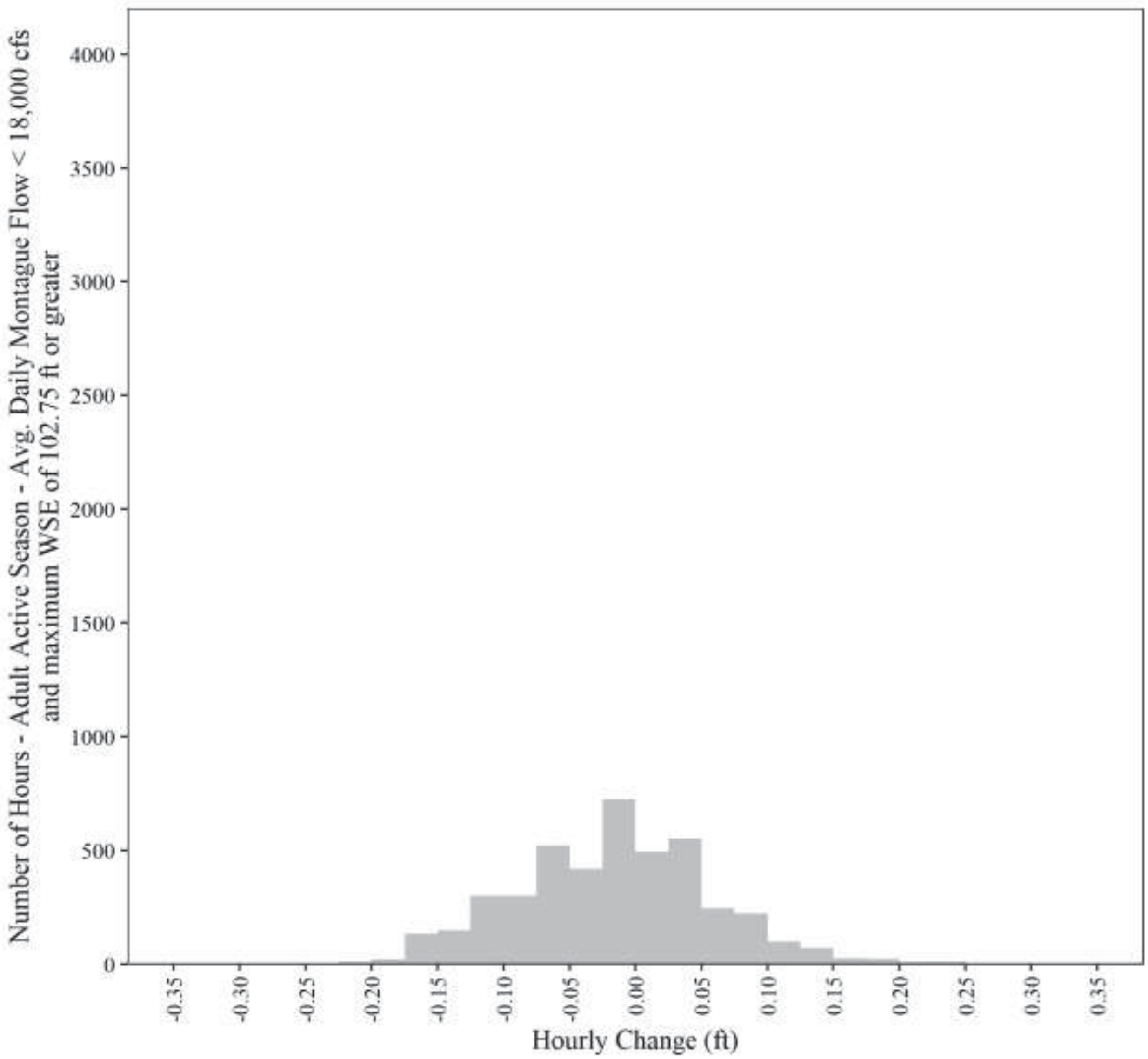

Figure 6.1.4.2.1-3: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Emerging Puritan Tiger Beetle during the Adult Active Season, High Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle larval/emergence habitat (102.75 feet or greater).

6.1.4.2.2 Foraging/Mating

Adults could be actively foraging and mating from June 16 through September 7 during the daytime (for analysis purposes, 9am through 8pm); this is referred to as the foraging/mating period. With Holyoke Impoundment under a low water level condition, as operated at the Holyoke Project, maximum daily water levels at Rainbow Beach would be expected to reach the lowest elevations of existing Puritan Tiger Beetle foraging/mating habitat nearly 36% of the time during the foraging/mating period when average daily flows at Montague are less than 18,000 cfs (Table 6.1.4.2.2-1; Figure 6.1.4.2.2-1). With a high Holyoke Impoundment condition, the frequency of inundation of the lowest portions of habitat would be greater, reaching adult foraging/mating habitat nearly 72% of the time. Inundation higher up on the beach, within the adult foraging and mating habitat and time period, occurs with considerably lower frequencies, but is consistently higher for high Holyoke Impoundment conditions (Table 6.1.4.2.2-1; Figure 6.1.4.2.2-1).

Maximum daily water levels at Rainbow Beach are strongly related to average daily flows in the Connecticut River at Montague (Figure 6.1.4.2.2-2). On an annual basis, low-flow years typically result in less maximum daily inundation of adult Puritan Tiger Beetle foraging and mating habitat (Figure 6.1.4.2.2-3), with the overall pattern being similar to the average daily flow at Montague (see Figure 6.1.4.1.1-1). Normal operations at the Turners Falls Project would result in less inundation when the Holyoke Project is operating at its low impoundment level when compared to its high impoundment level (Figure 6.1.4.2.2-3).

Hourly water level changes at Rainbow Beach during the foraging/mating period also tend to be very small, primarily between 0.15 feet/hr (1.8 inches/hr) decreases or increases, and often much less (Figure 6.1.4.2.2-4; Figure 6.1.4.2.2-5).

Puritan Tiger Beetle adults forage and mate along the water/land interface. They are highly mobile, invertebrate predators and can move quickly. As such, the low degrees of water level change at the beach would not be likely to affect adult Puritan Tiger Beetle. Further, given that daily peak water levels at Rainbow Beach tend to occur at night, the lowest water levels would occur primarily during the day, providing high amounts of water/land interface area available to foraging/mating adult Puritan Tiger Beetles.

Table 6.1.4.2.2-1: Percentage of Time Period when Maximum Daily Water Level Reached or Exceeded Elevation Thresholds for the Foraging/Mating Period, 1991-2018, 9:00am through 8:00pm

Water Surface Elevation at Rainbow Beach (ft)	Holyoke Level	
	Low	High
104.0	0.09%	0.19%
103.5	0.52%	1.89%
103.0	3.49%	7.17%
102.5	8.82%	13.20%
102.0	14.47%	23.01%
101.5	22.68%	41.63%
101.0	35.83%	71.99%

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

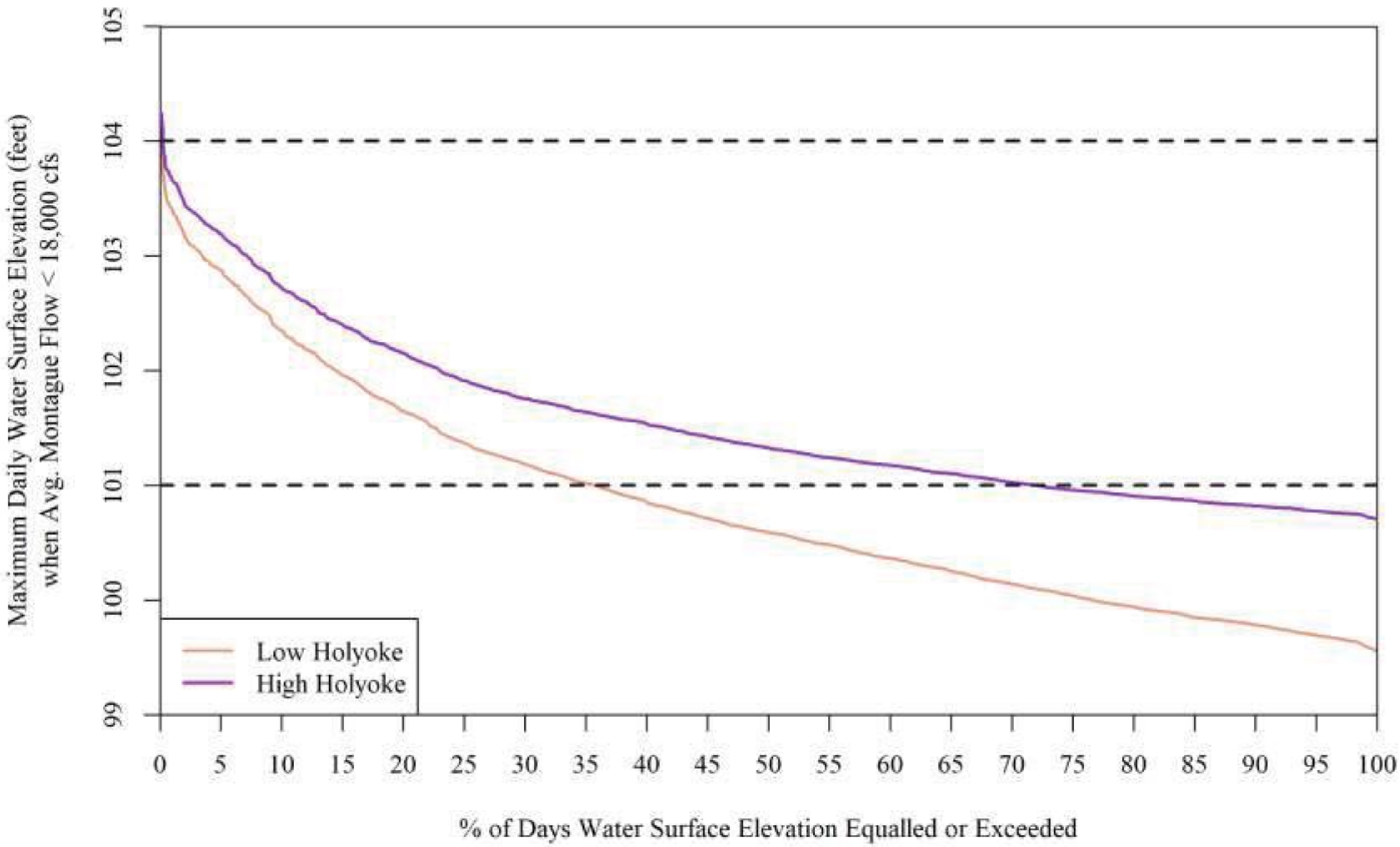

Figure 6.1.4.2.2-1: Duration Curve of the Maximum Daily Water Surface Elevation at Rainbow Beach for Foraging/Mating Puritan Tiger Beetle during the Adult Active Season, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

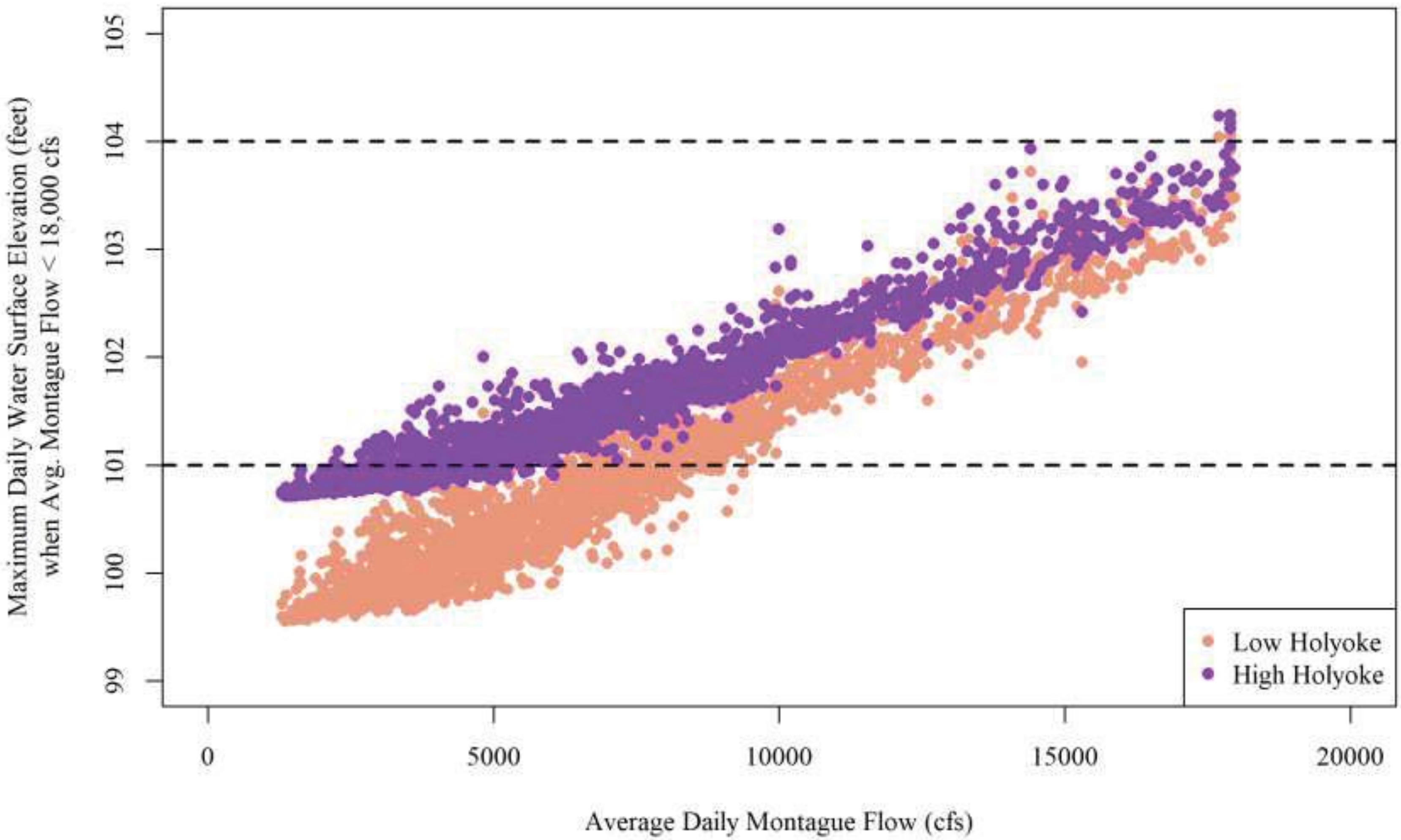

Figure 6.1.4.2.2-2: Scatterplot of the Maximum Daily Water Surface Elevation at Rainbow Beach by Average Daily Montague Flow for Foraging/Mating Puritan Tiger Beetle during the Adult Active Season, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

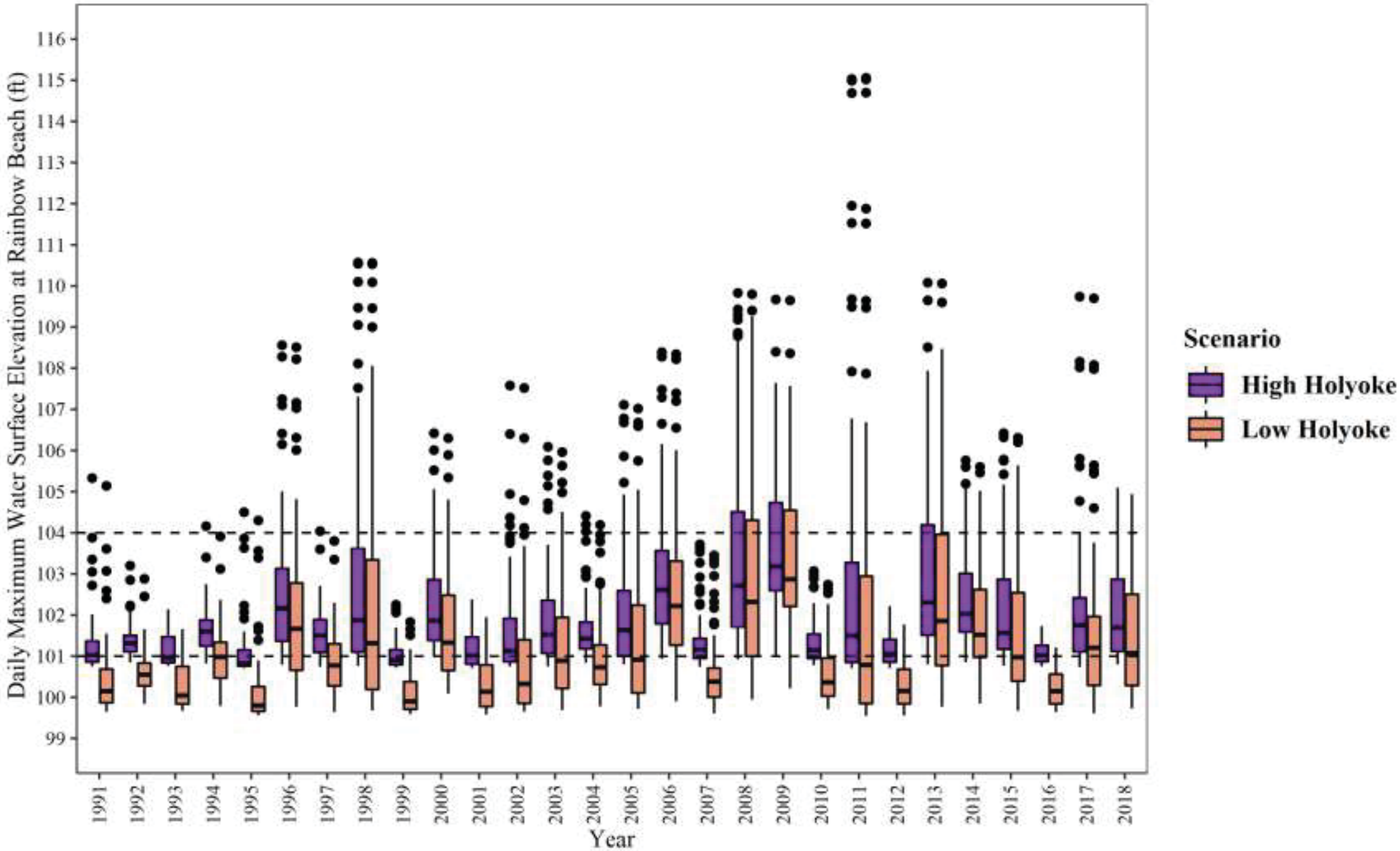

Figure 6.1.4.2.2-3: Distribution of the Maximum Daily Water Surface Elevations at Rainbow Beach for Foraging/Mating Puritan Tiger Beetle during the Adult Active Season, 1991-2018

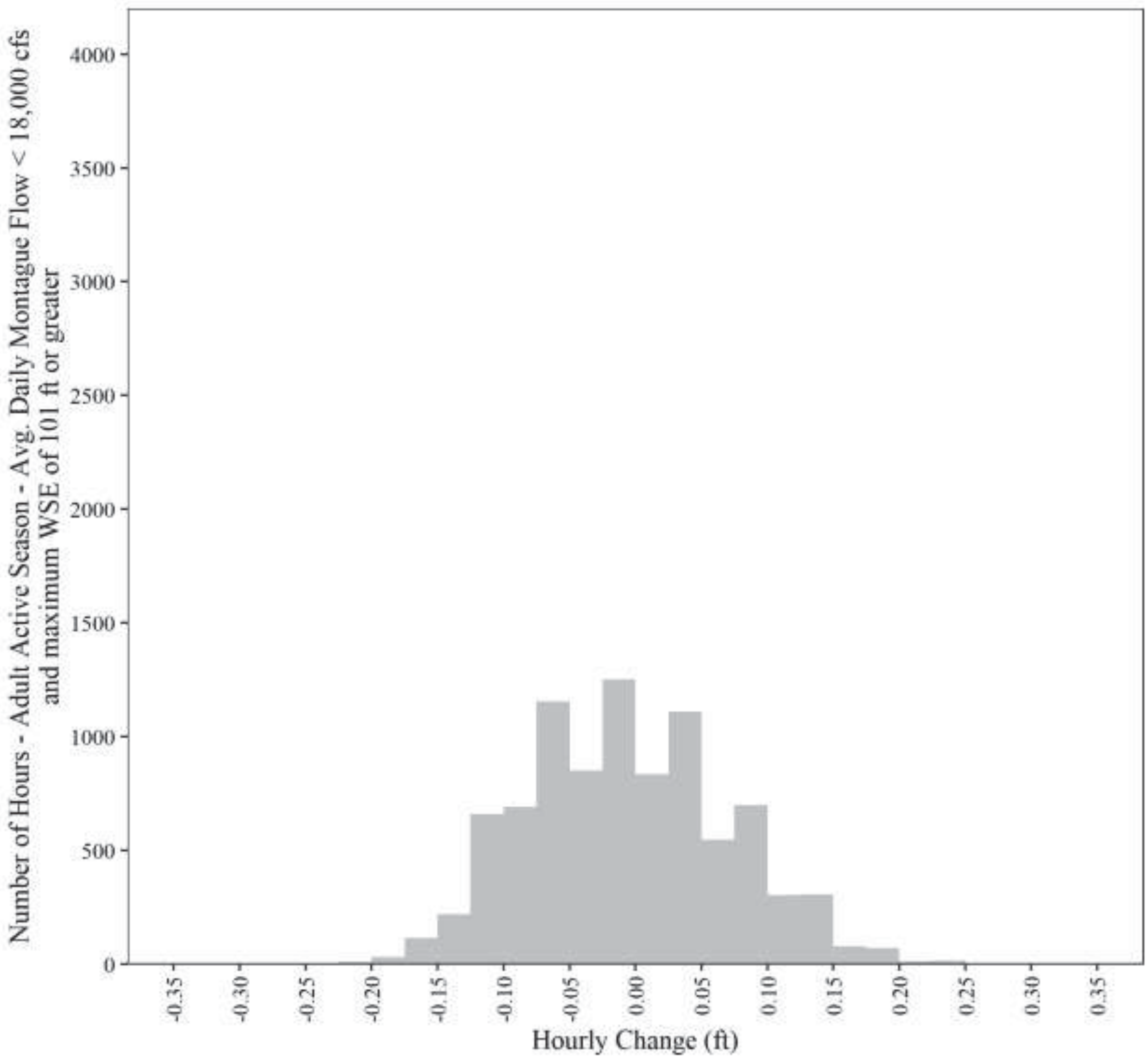

Figure 6.1.4.2.2-4: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Foraging/Mating Puritan Tiger Beetle during the Adult Active Season, Low Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle foraging/mating habitat (101 feet or greater).

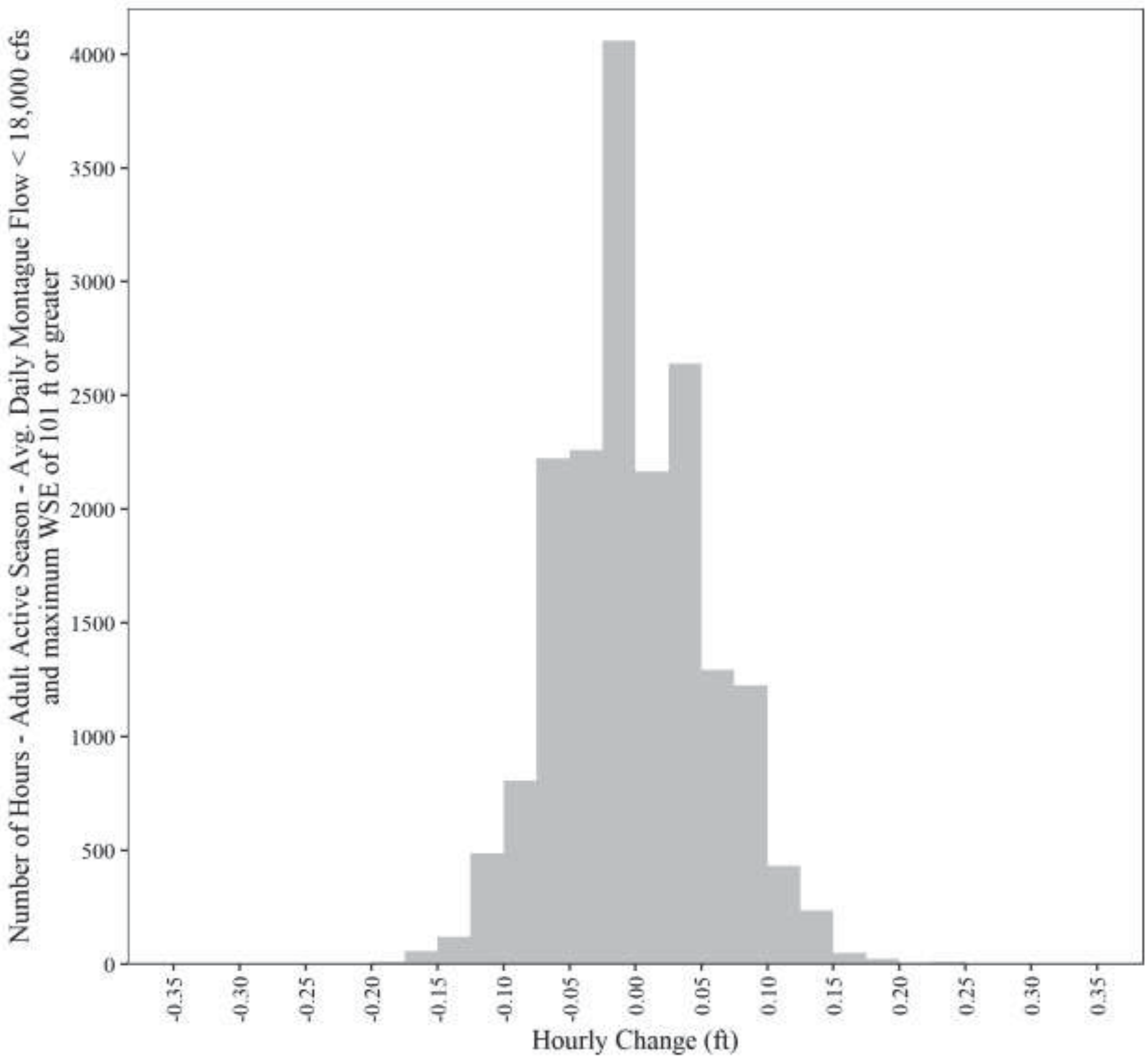

Figure 6.1.4.2.2-5: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Foraging/Mating Puritan Tiger Beetle during the Adult Active Season, High Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle foraging/mating habitat (101 feet or greater).

6.1.4.2.3 Oviposition

Adult Puritan Tiger Beetle could lay eggs (oviposit) any time during the adult active season. The oviposition period, for the purposes of this analysis, is therefore defined conservatively as any time of day from June 16 through September 7, and the habitat within which adult Puritan Tiger Beetle would oviposit was considered larval habitat between 102.75 and 104.0 feet.

When average daily flows at Montague are less than 18,000 cfs and the Turners Falls Project is in control of river inflows, daily water level peaks from the Project do not typically reach the habitat where adult Puritan Tiger Beetles would deposit their eggs (Figure 6.1.4.2.3-1). With the Holyoke Impoundment at low operating levels, there would have been no inundation of any oviposition habitat 94.4% of days within the 28-year dataset during the oviposition period (Table 6.1.4.2.3-1; Figure 6.1.4.2.3-1). At high Holyoke Impoundment operating levels, there would only be slightly more frequent inundation, with no inundation of any oviposition habitat 89.7% of the time (Table 6.1.4.2.3-1; Figure 6.1.4.2.3-1). Greater maximum daily inundation levels, which would have resulted in less minimum daily habitat during oviposition, were infrequent (Table 6.1.4.2.3-1; Figure 6.1.4.2.3-1). For example, at least 75% of the habitat would have been available to Puritan Tiger Beetles to deposit eggs 93.3% and 89.5% of the days within the adult active season given low and high Holyoke Impoundment conditions, respectively. Since oviposition can occur almost any time of the day or night, and because adults can move to areas that they choose as being suitable for oviposition, the minimum amount of habitat available on a given day is conservative. Therefore, most of the time during the adult active period, all or most of the habitat would be available for oviposition, including areas that become infrequently but periodically wetted by river flow. As described previously, occasional inundation could be important to prevent eggs and larvae from desiccating, and to maintain conditions with more dense sand that is suitable for oviposition.

In the limited number of instances where water levels reach the larval habitat from which adults will also oviposit, hourly water level changes at Rainbow Beach during the oviposition period also tend to be very small, primarily between 0.15 feet/hr (1.8 inches/hr) decreases or increases, and often much less (Figure 6.1.4.2.3-2; Figure 6.1.4.2.3-3). These slow rates of change would not be likely to disturb or inundate adult Puritan Tiger Beetles.

Table 6.1.4.2.3-1: Percentage of Time Period when Minimum Daily Habitat Reached or Exceeded Availability Thresholds for the Oviposition Period, 1991-2018

Minimum Daily Habitat Availability on Rainbow Beach (Oviposition)	Holyoke Level	
	Low	High
100.0	90.2%	85.3%
75.0	93.3%	89.5%
50.0	96.1%	93.1%
25.0	97.9%	96.1%
10.0	98.8%	97.7%

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

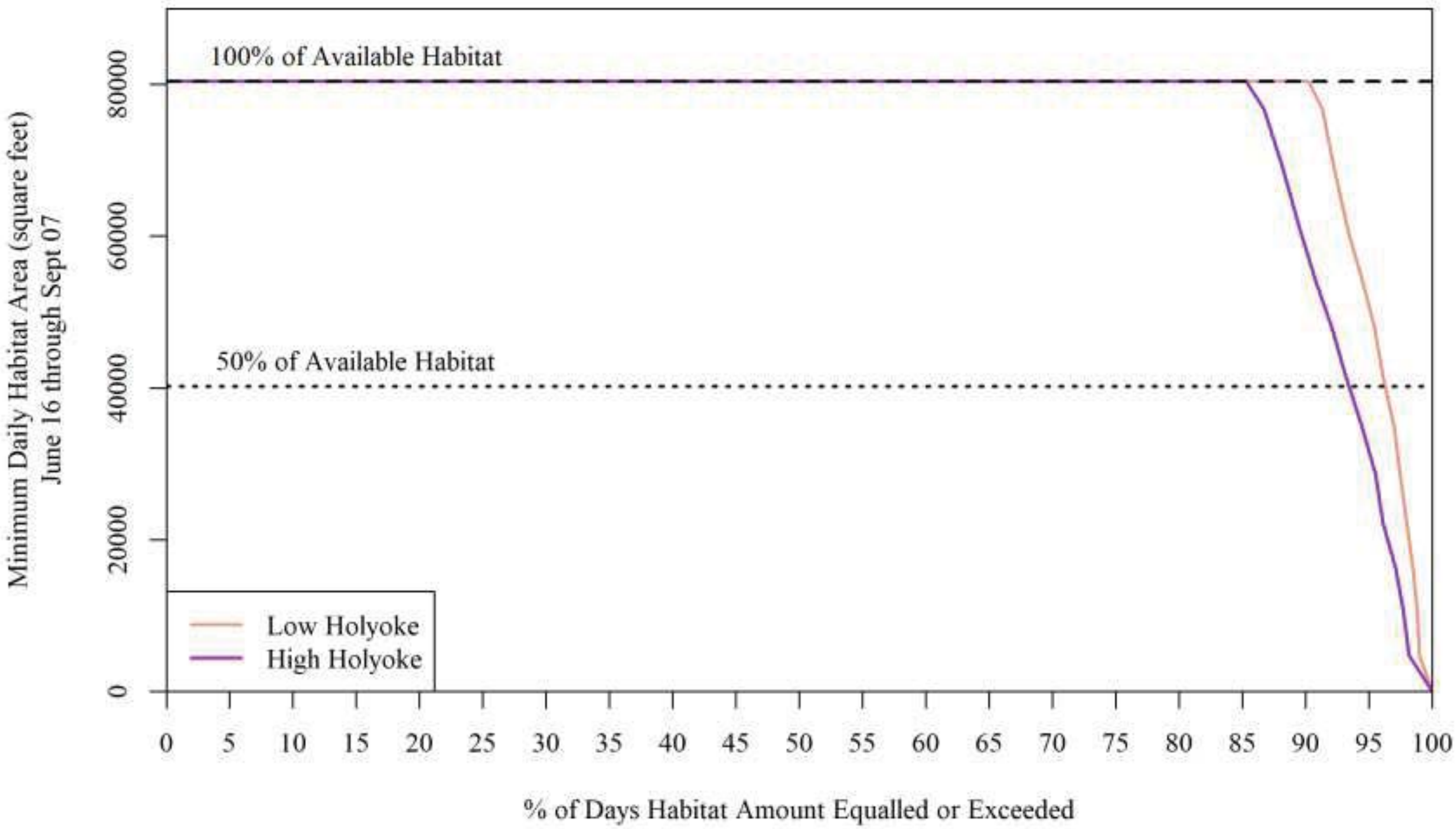

Figure 6.1.4.2.3-1: Duration Curve of the Minimum Daily Amount of Habitat Available at Rainbow Beach for Puritan Tiger Beetle during the Oviposition Period, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs).

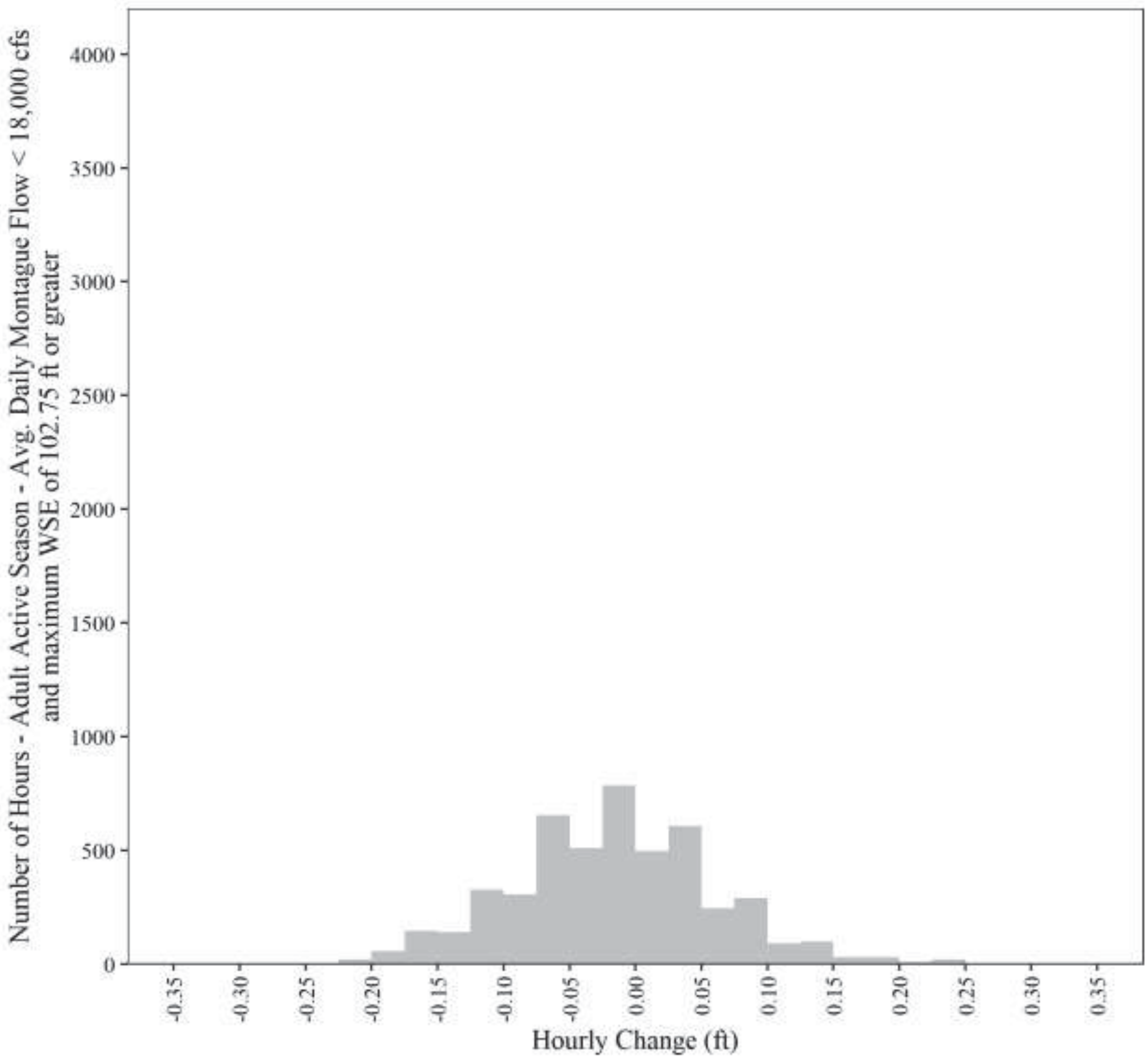

Figure 6.1.4.2.3-2: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Ovipositing Puritan Tiger Beetle during the Adult Active Season, Low Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle larval/oviposition habitat (102.75 feet or greater).

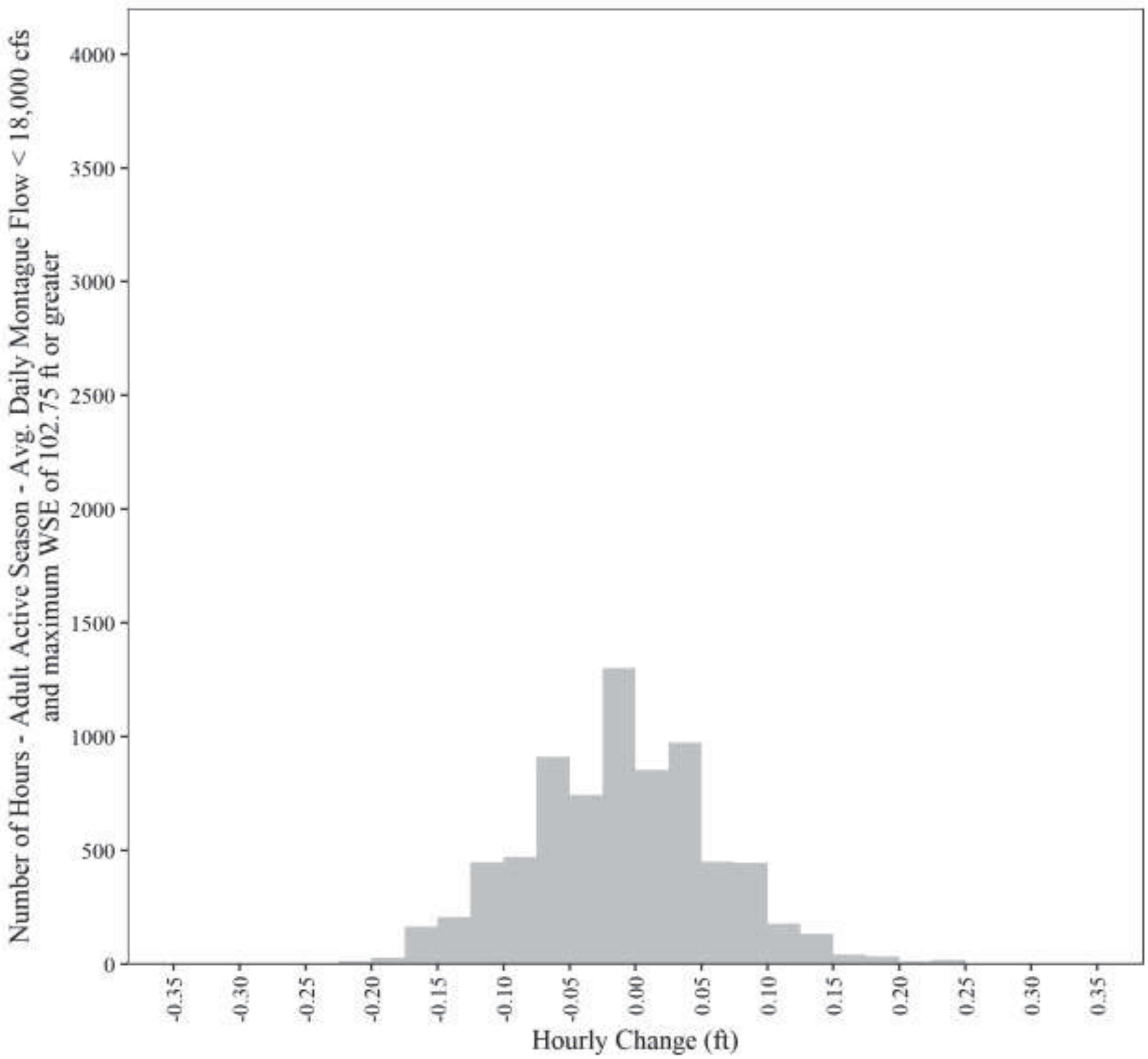

Figure 6.1.4.2.3-3: Frequency of the Hourly Water Surface Elevation Changes at Rainbow Beach for Ovipositing Puritan Tiger Beetle during the Adult Active Season, High Holyoke Impoundment Conditions, 1991-2018

Note: Data were filtered to reflect river flows within Project generating capacity plus the design generating capacity from Deerfield River Project No. 2 of 1,450 cfs and other smaller inflows. (Avg. Daily Montague Flow < 18,000 cfs), and during the periods when water levels reached Puritan Tiger Beetle larval/oviposition habitat (102.75 feet or greater).

6.1.5 Comparison of Baseline and Proposed Conditions

The operations model described in Section 6 was used to simulate baseline conditions and the proposed conditions outlined in Section 3 on an hourly time step for the period 1962-2003. The key output from the operations model, which served as "input" to the hydraulic model, is the flow at Montague for baseline and proposed conditions. The hydraulic model simulated the timeseries of flows at Montague under baseline and proposed conditions to estimate the water elevations at Rainbow Beach under these two operating conditions.

The proposed condition incorporates all of FirstLight's proposed operations that are outlined in Section 3 of this BA (i.e. bypass flows, ramping rates, peaking restrictions, expanded operations at Northfield Mountain, Turners Falls Impoundment restrictions). Though the operations model (1962-2003) simulated a different time period than the available Montague Flow data analyzed in Section 6.1.4 (1991-2018), the modeled datasets contained 42 years of data[15] that included considerable season and annual variation in river flows.

Based on the modeled data, water levels and associated habitats at Rainbow Beach are similar under baseline and proposed conditions on a seasonal and annual basis (Figures 6.1.5-1 and 6.1.5-2), during the larval activity period (Figures 6.1.5-3 and 6.1.5-4) and the adult activity period (Figures 6.1.5-5 and 6.1.5-6). Inter- and intra-annual differences in flows, along with variation in the water levels in the Holyoke Impoundment as controlled by HG&E at the Holyoke Dam, results in more differences in inundation than FirstLight's proposal. Though FirstLight is proposing whitewater releases in the bypass reach at the Turners Falls Project, the effects on flows downstream of the Project are expected to be minimal, along with any potential changes in water levels at Rainbow Beach (see response to USFWS Comment 2 in Appendix D for additional detail).

Given the similarities in water levels between baseline and proposed conditions, there would be no measurable change in inundation of Puritan Tiger Beetle habitats on Rainbow Beach; therefore, the effects of the proposed condition relative to the baseline are insignificant.

[15] As described in Study 3.8.1, the period of record used for the HEC-ResSim analysis was 1962 to 2003. FirstLight had hoped to extend the period of record to 2012 or later but based on extensive correspondence with the USACOE and The Nature Conservancy, it was not possible to obtain the necessary data to extend the period of record past 2003.

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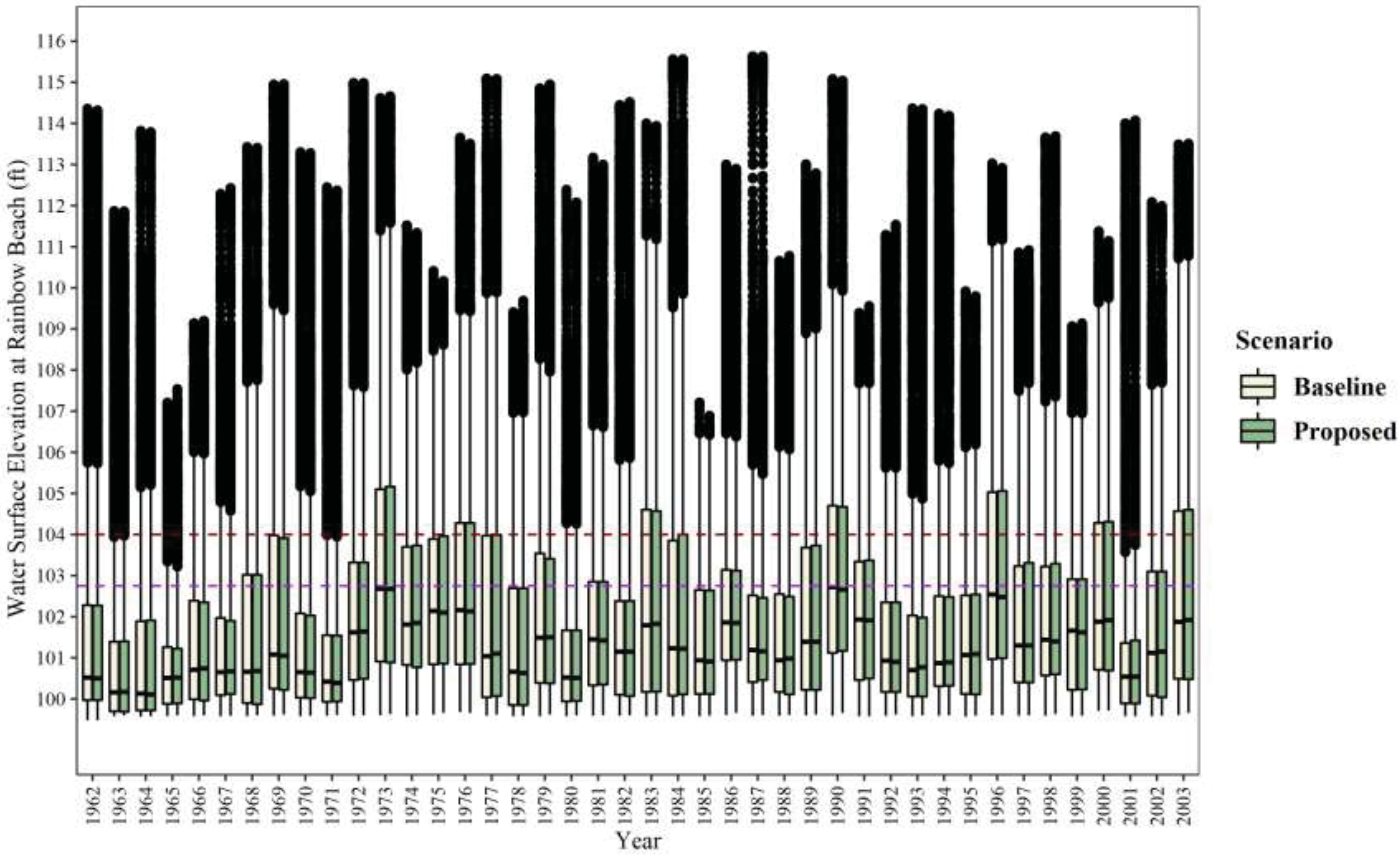

Figure 6.1.5-1: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions on an Annual Basis, given a Low Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The purple dashed line is the lowest elevation of larval habitat at el. 102.75 ft., and the red dashed line is the highest elevation of larval habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

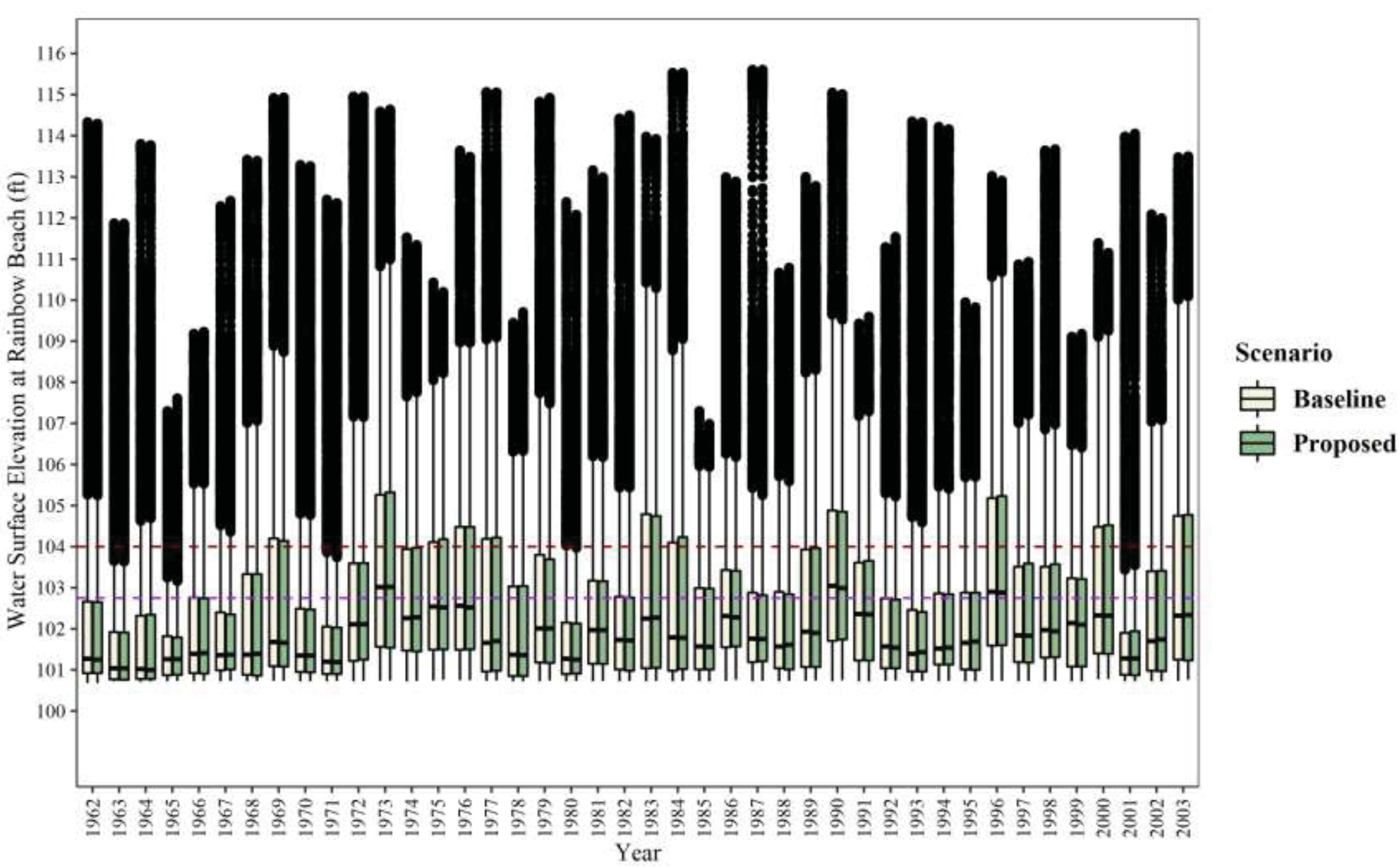

Figure 6.1.5-2: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions on an Annual Basis, given a High Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The purple dashed line is the lowest elevation of larval habitat at el. 102.75 ft., and the red dashed line is the highest elevation of larval habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

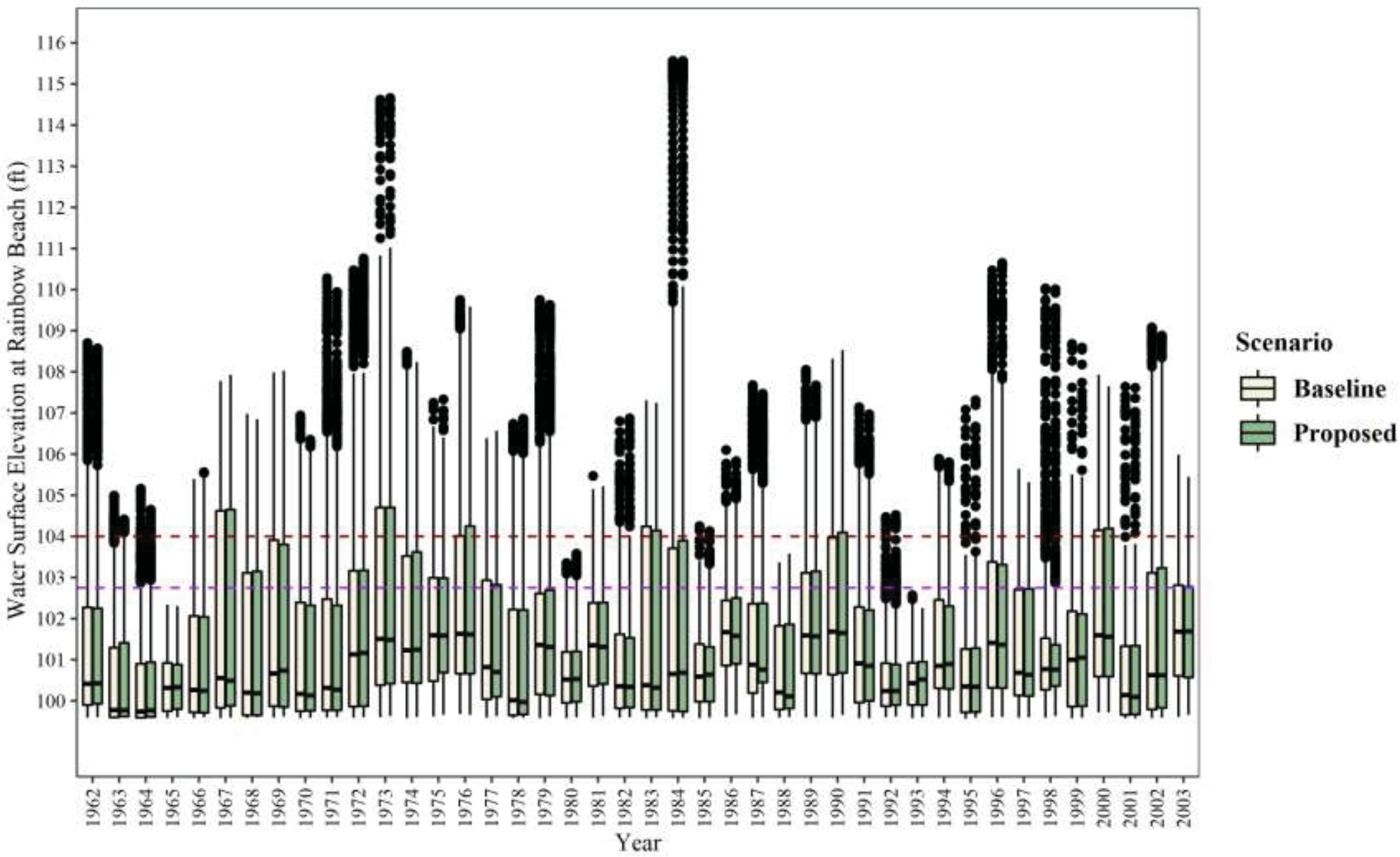

Figure 6.1.5-3: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions during the Larval Activity Period, given a Low Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The purple dashed line is the lowest elevation of larval habitat at el. 102.75 ft., and the red dashed line is the highest elevation of larval habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

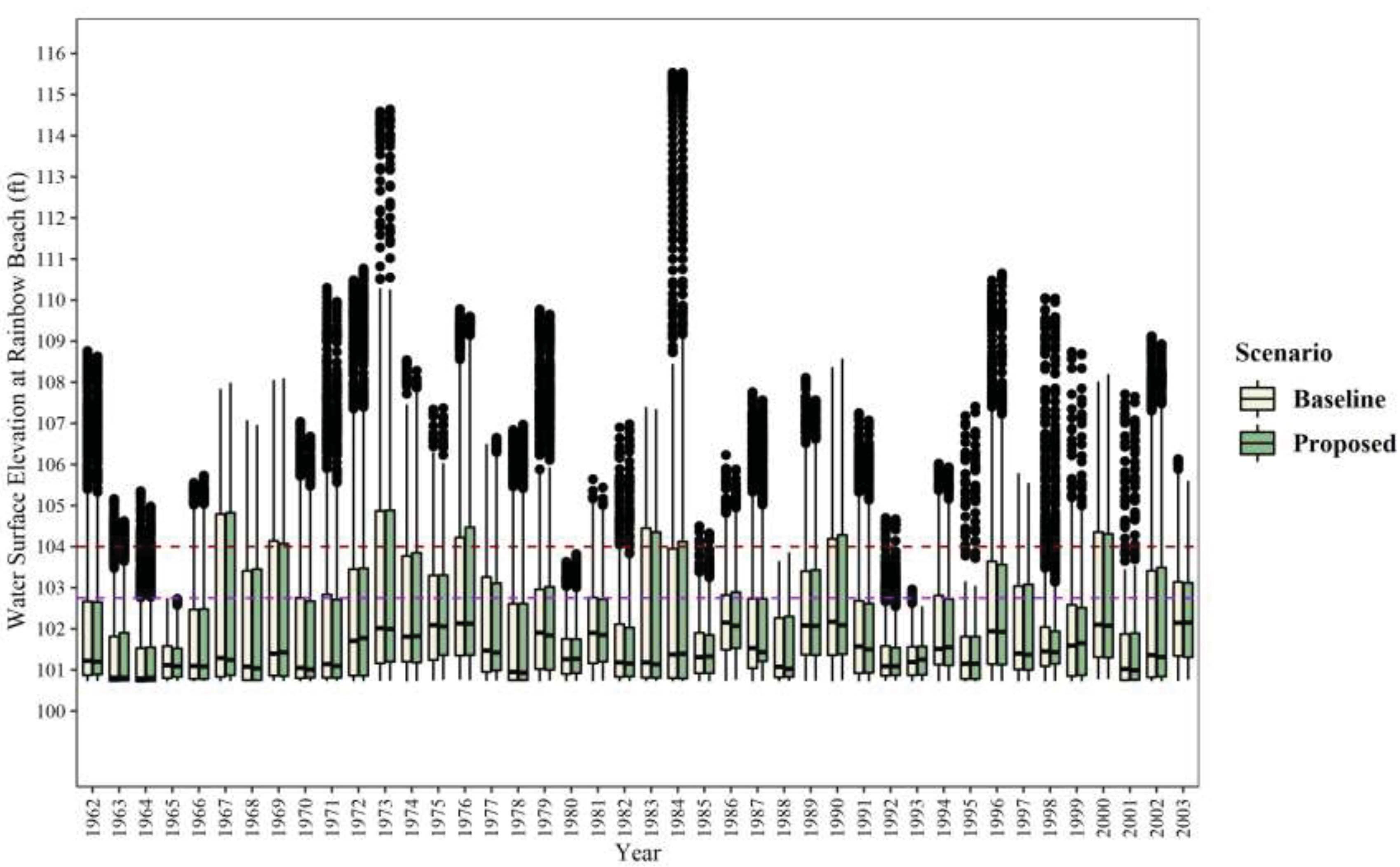

Figure 6.1.5-4: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions during the Larval Activity Period, given a High Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The purple dashed line is the lowest elevation of larval habitat at el. 102.75 ft., and the red dashed line is the highest elevation of larval habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

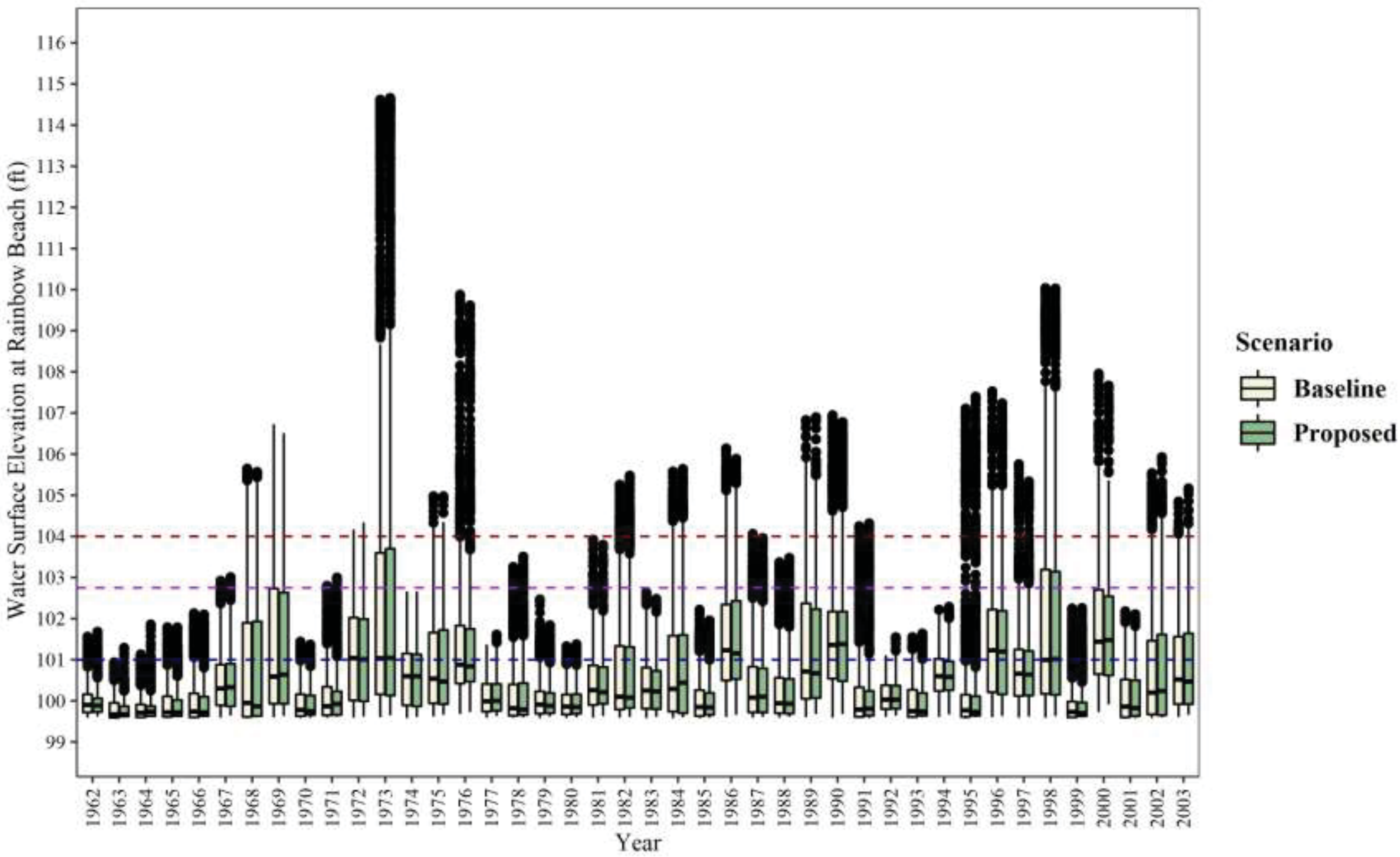

Figure 6.1.5-5: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions during the Puritan Tiger Beetle Adult Activity Period given a Low Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The blue dashed line is the lowest elevation of foraging/mating habitat at el. 101.0 ft., the purple dashed line is the lowest elevation of oviposition and emergence habitat at el. 102.75 ft., and the red dashed line is the highest elevation of adult habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

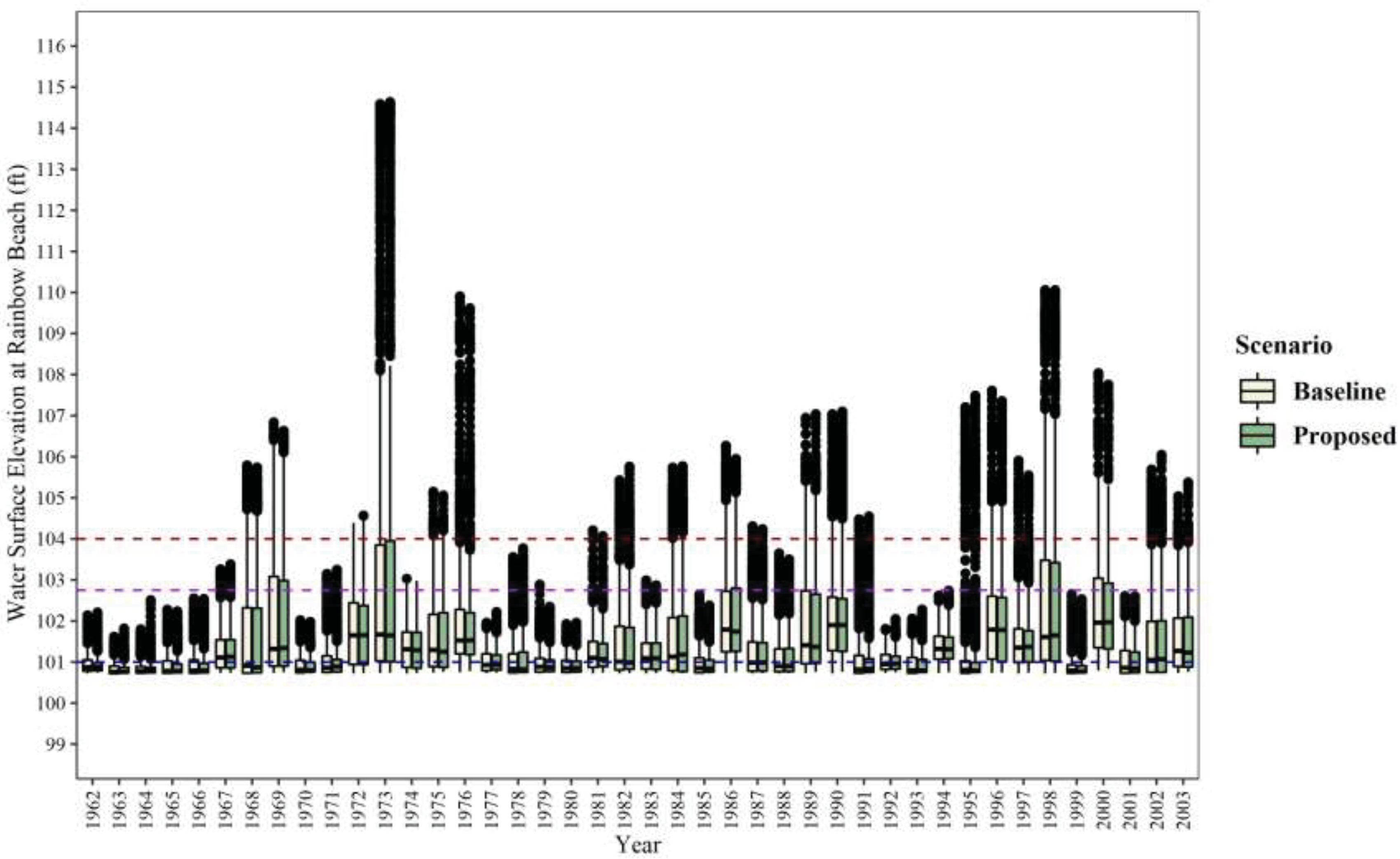

Figure 6.1.5-6: Water Surface Elevations at Rainbow Beach for Baseline and Proposed Conditions during the Puritan Tiger Beetle Adult Activity Period given a High Holyoke Impoundment Condition, 1962-2003.

Note: Based on hourly modeled data. The blue dashed line is the lowest elevation of foraging/mating habitat at el. 101.0 ft., the purple dashed line is the lowest elevation of oviposition and emergence habitat at el. 102.75 ft., and the red dashed line is the highest elevation of adult habitat at el. 104.0 ft. Dots above the lines from the boxplot are considered outliers from the distributions.

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6.2 Anticipated Response to Exposure

In general, the exposure of any life stage or activity of Puritan Tiger Beetle to Project flow regimes under the baseline condition has been very limited. This is due primarily to the linear distance (~25 river miles) between the Turners Falls Project and Rainbow Beach, which results in considerable flow and water level attenuation. Additionally, the timing of peaking flows at the Turners Falls Project has been amenable to Puritan Tiger Beetle by providing the lowest water levels at Rainbow Beach primarily during the daytime, along with night-time water level peaks at Rainbow Beach that infrequently reach the elevations where adults are emerging and depositing eggs, and larvae are residing. As such, the current pattern of Project peaking flows has likely been beneficial to adult foraging and mating, and insignificant for all activities that occur within larval habitats (i.e. emergence, oviposition, and larval activity/inactivity) given natural inter-annual and intra-annual variability in river flows, along with the life history strategies and capabilities of the Puritan Tiger Beetle.

Though changes to inundation of Puritan Tiger Beetle habitats are not anticipated for the proposed condition, the proposed condition would improve upon the baseline condition by formalizing a restriction for the timing and magnitude of peaking during the adult Puritan Tiger Beetle foraging and mating activity period. This operational restriction would then reduce the already low likelihood of a small number of daily peaks reaching Rainbow Beach during the daytime foraging/mating period. It is important for Puritan Tiger Beetle that the amenable condition currently being provided is maintained. The current operational license did not restrict peaking activity to the timing and duration of peaking that has actually occurred, but instead was primarily driven by inflows and electricity markets. The pattern of daily and seasonal inflows could change over the next several decades due to global climate change, alterations in operations at upstream hydropower projects and/or storage reservoirs, and/or changes in peak electricity pricing and demand. The proposed restrictions would ensure that changes in patterns of peaking flows would not negatively affect the foraging and mating of adult Puritan Tiger Beetle over the term of the next license, relative to the baseline condition.

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7 CONCLUSION AND DETERMINATION OF EFFECTS

The potential impacts of construction, maintenance, and operation of new hydropower licenses at the Northfield Mountain Project and Turners Falls Project on Federally protected species have been evaluated. The known distribution, habitats, and life history of those species, and the potential impacts of the proposed conditions for the new licenses, have been considered in this BA.

Based on the presented analyses, FirstLight concludes that the operations proposed for the new licenses may affect Puritan Tiger Beetles because operational flows affect water levels at Rainbow Beach. However, proposed operations are not likely to adversely affect or jeopardize the continued existence of the Puritan Tiger Beetle, including the population at Rainbow Beach. Reasons for this include:

- Effects on larvae, along with emergence and oviposition by adult Puritan Tiger Beetle, are insignificant for baseline and proposed conditions.
- Effects on adult foraging and mating have been primarily beneficial under the baseline condition, and the proposed condition seeks to codify and maintain those benefits by providing the lowest water levels at Rainbow Beach during the daytime.

FirstLight requests concurrence with the U.S. Fish and Wildlife Service regarding this determination.

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APPENDIX A: MODELED WATER SURFACE ELEVATION DATA USING ACTUAL HOLYOKE IMPOUNDMENT LEVEL DATA

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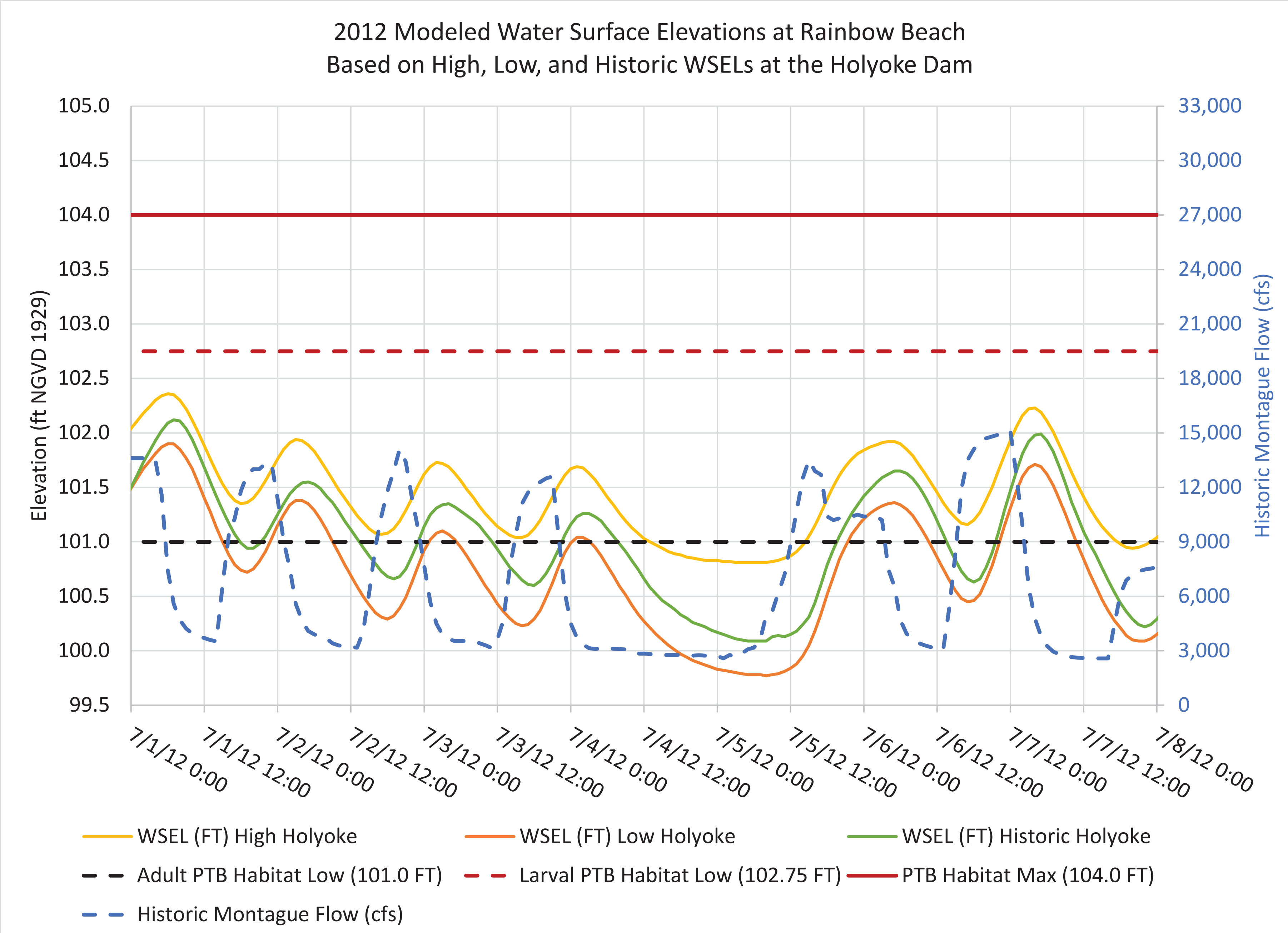
2012 Modeled Water Surface Elevations at Rainbow Beach
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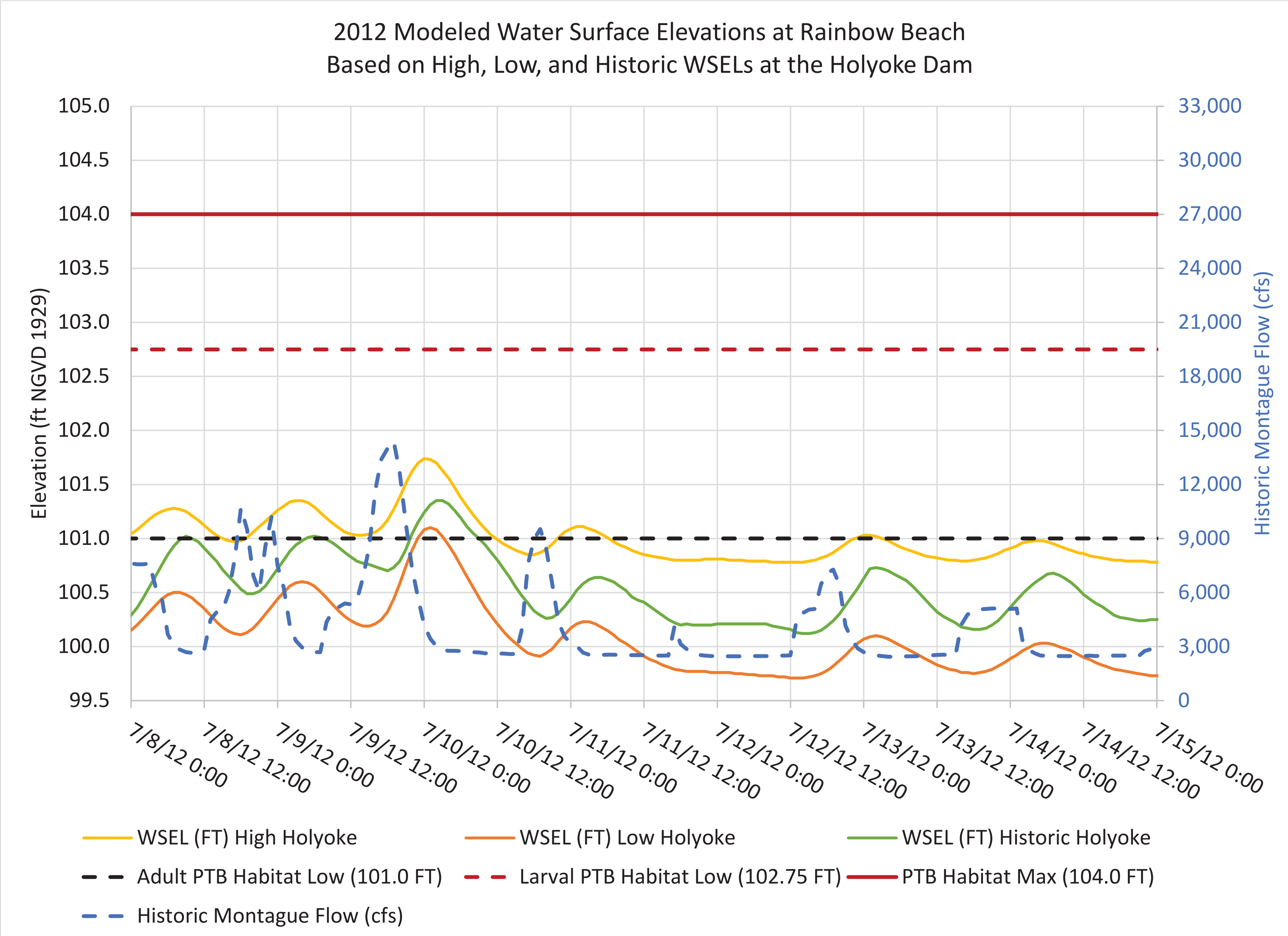

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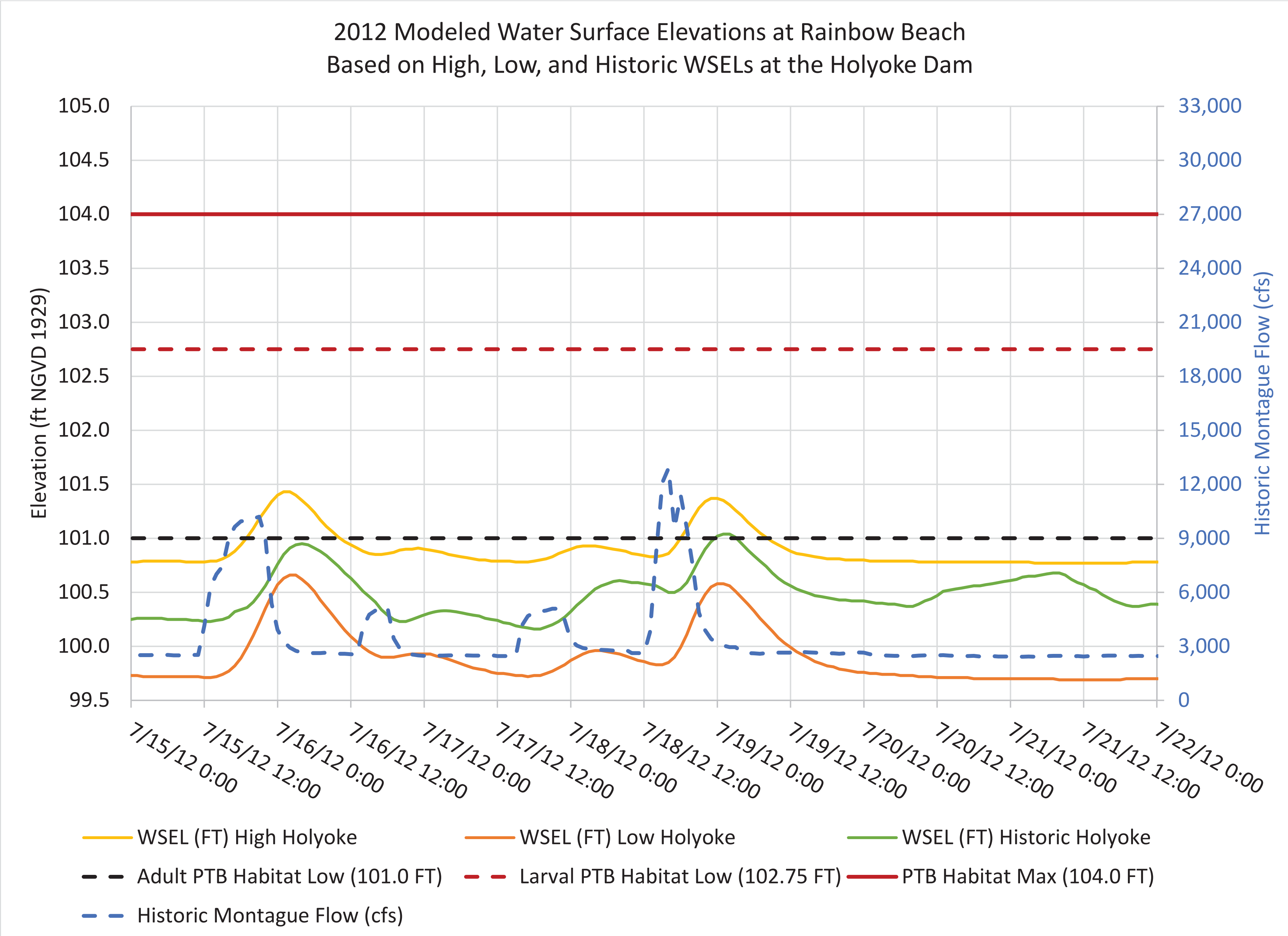
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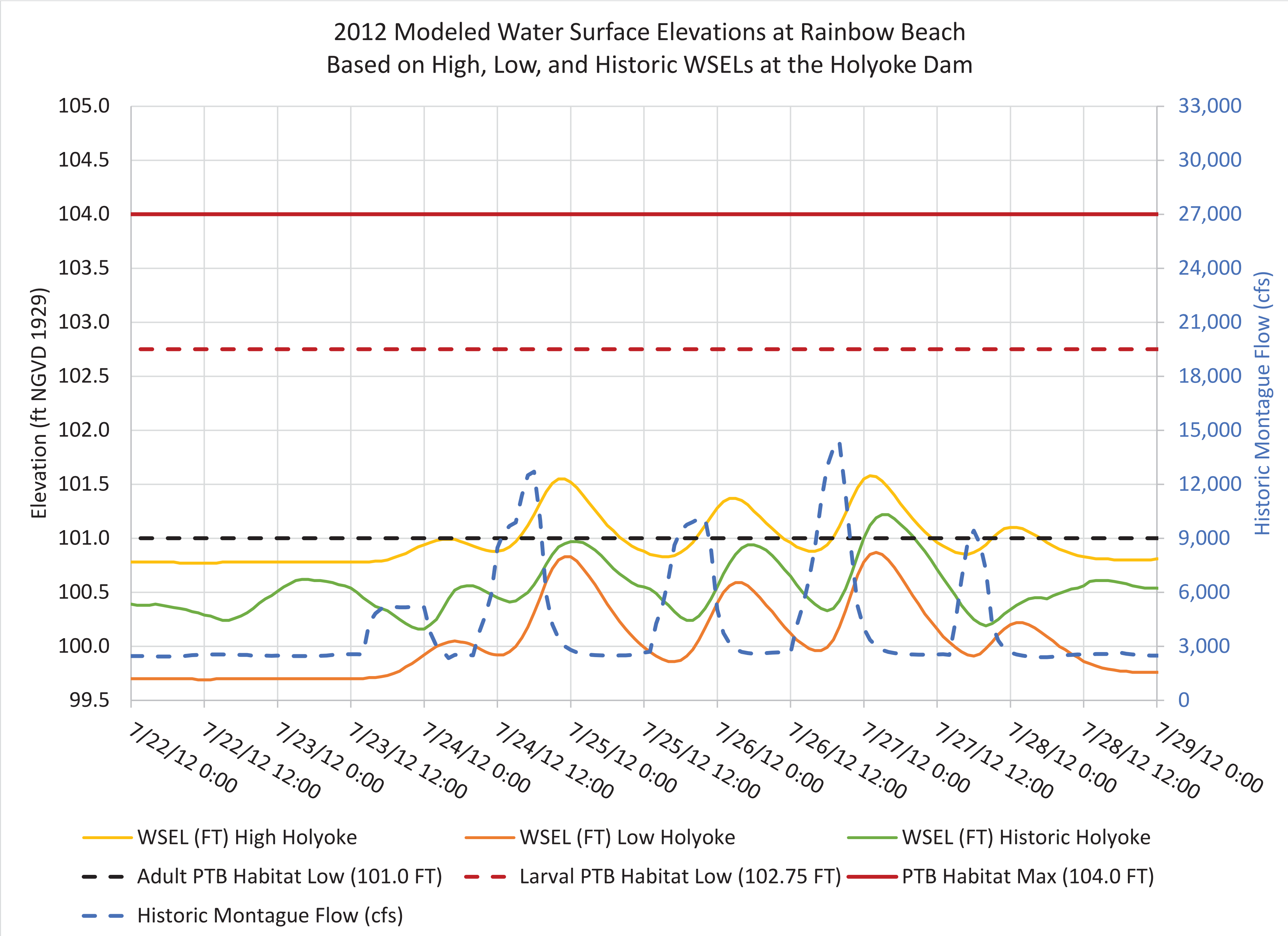
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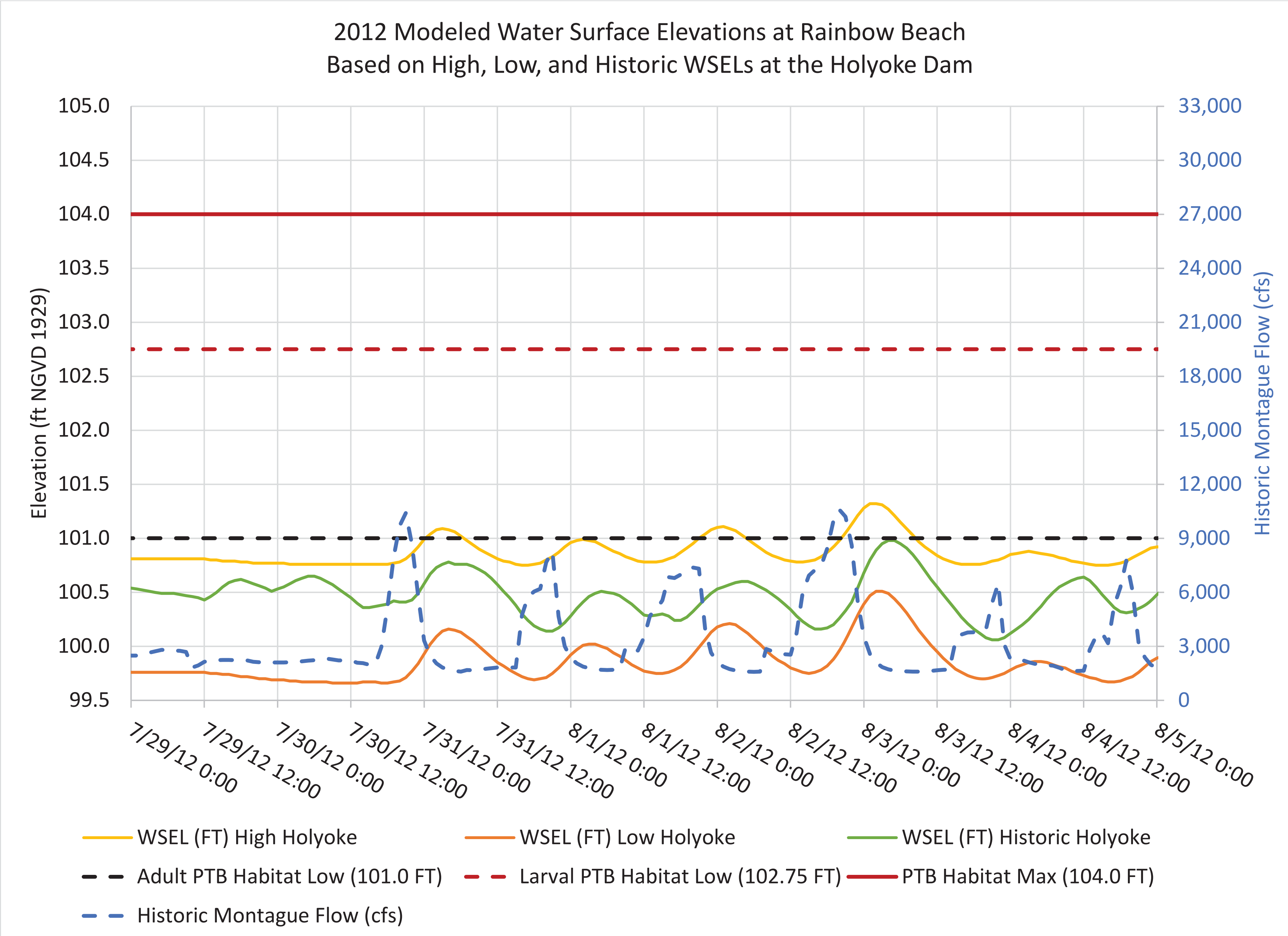

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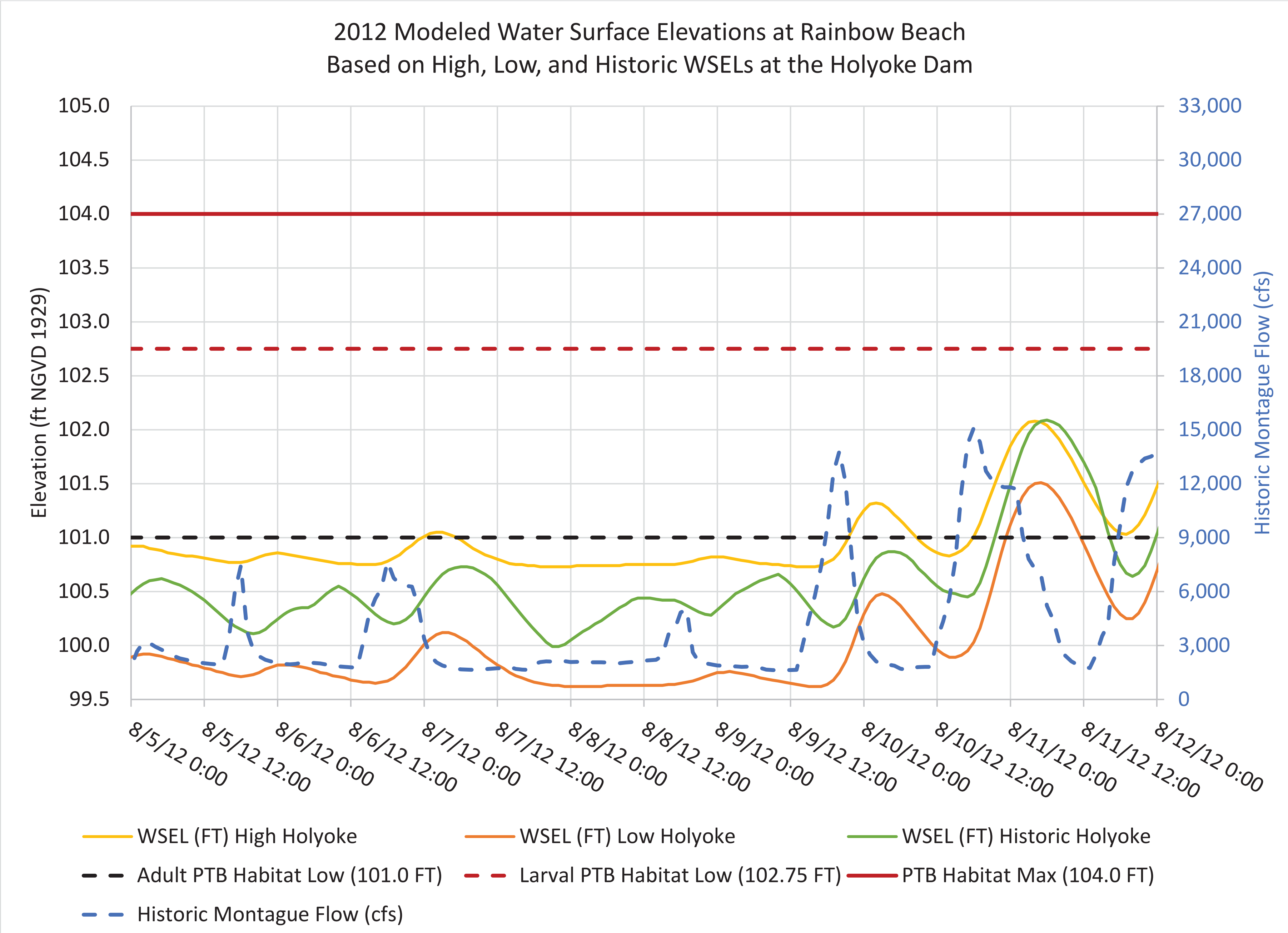
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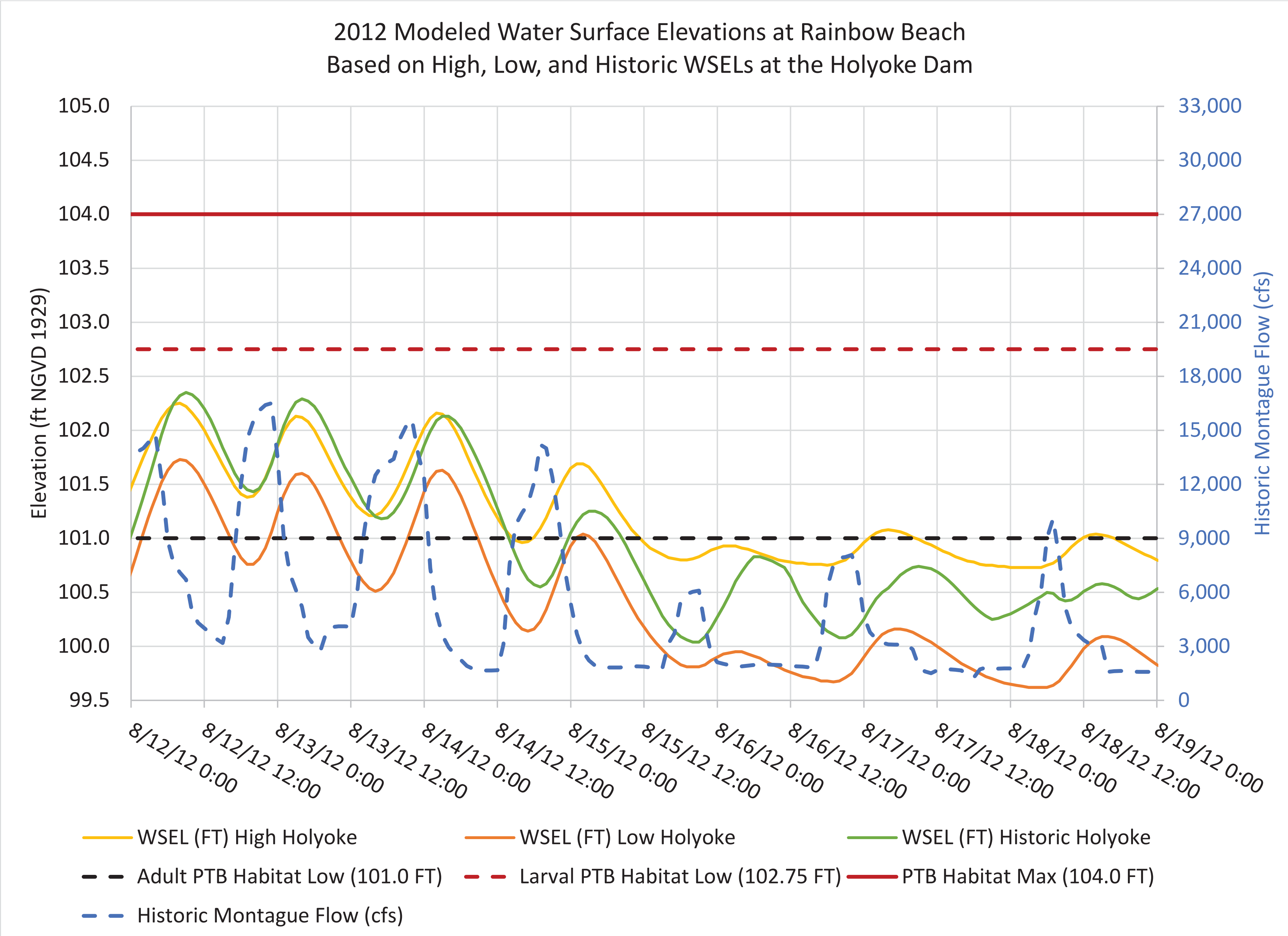

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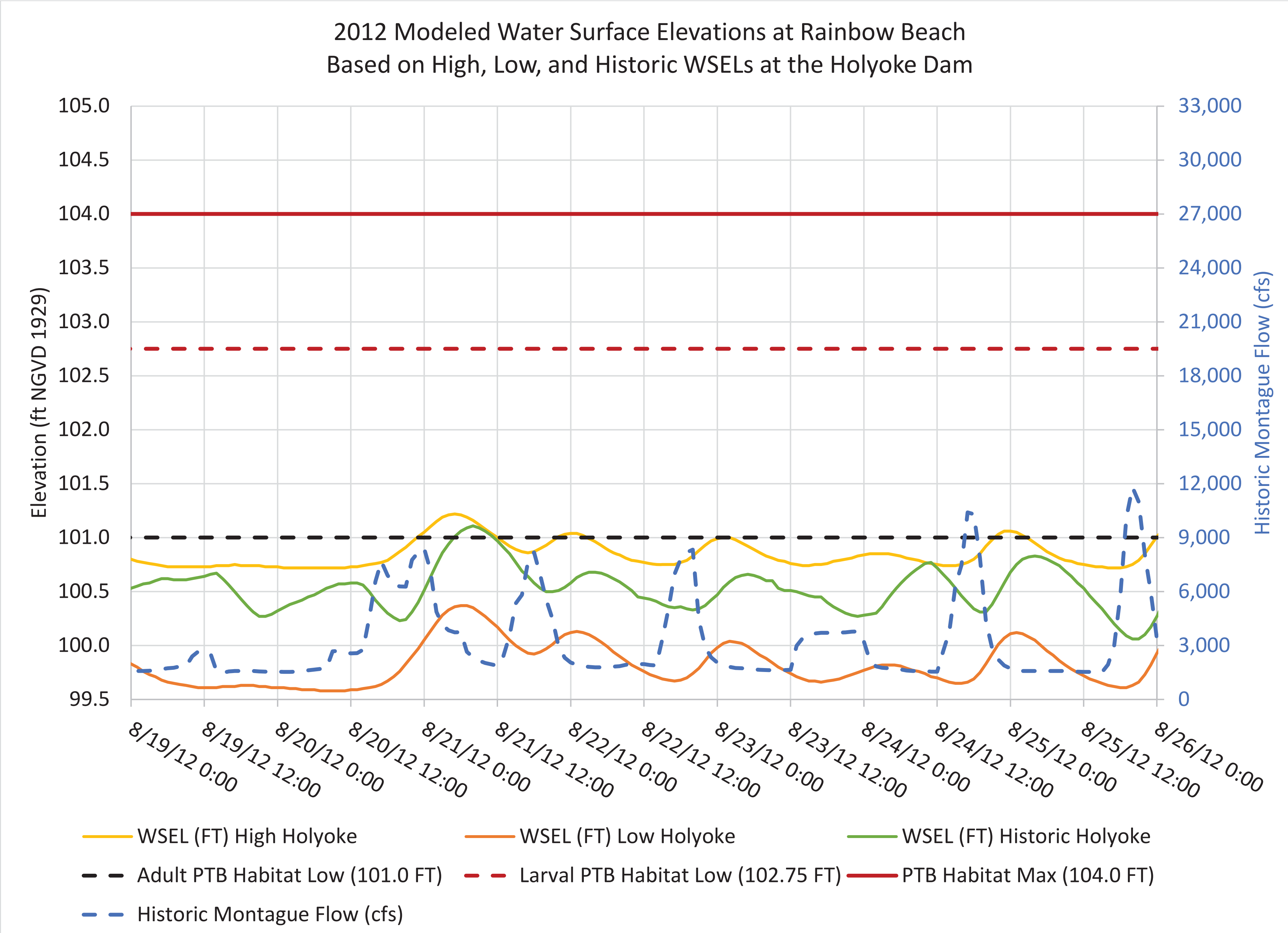
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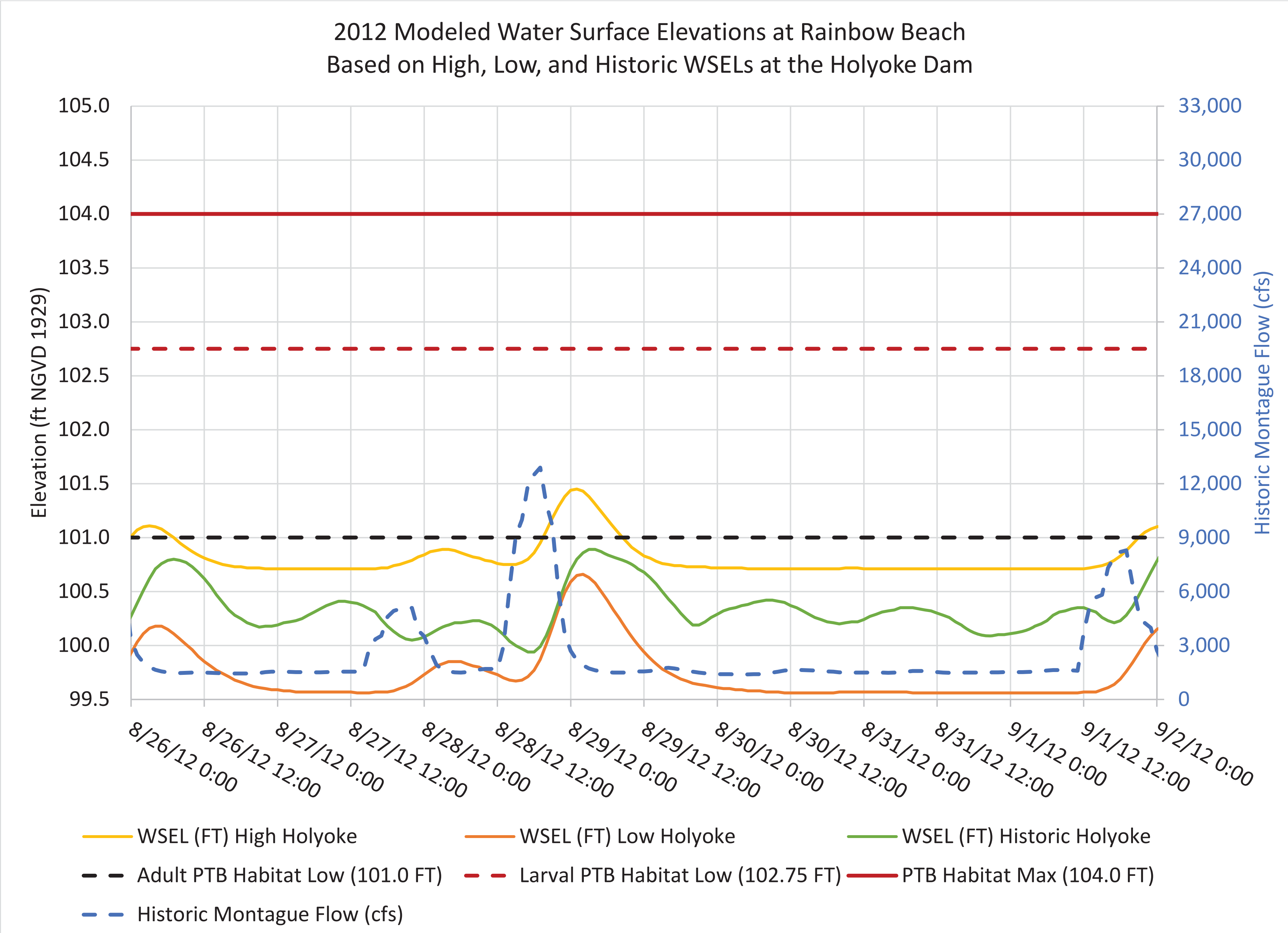
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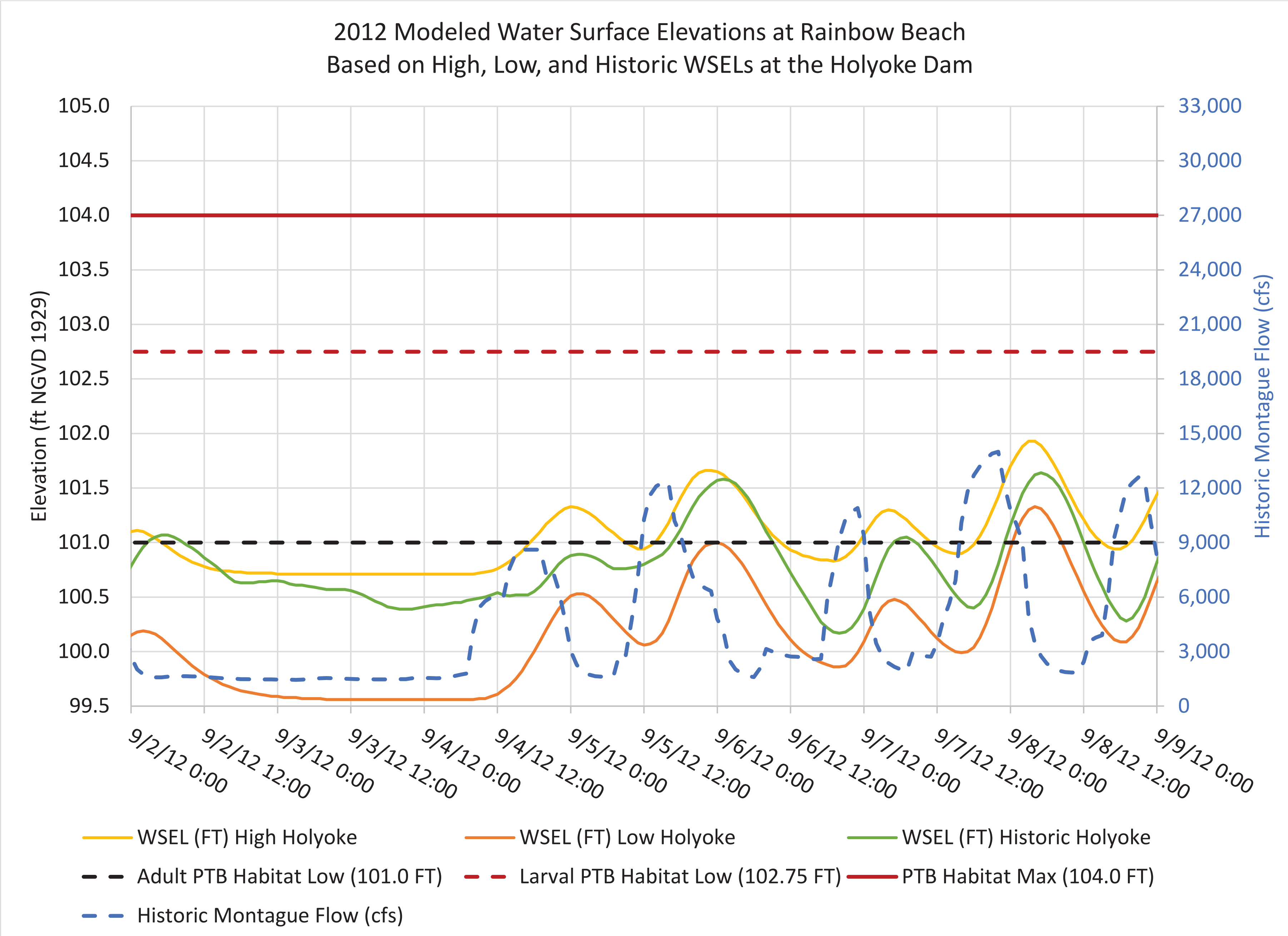

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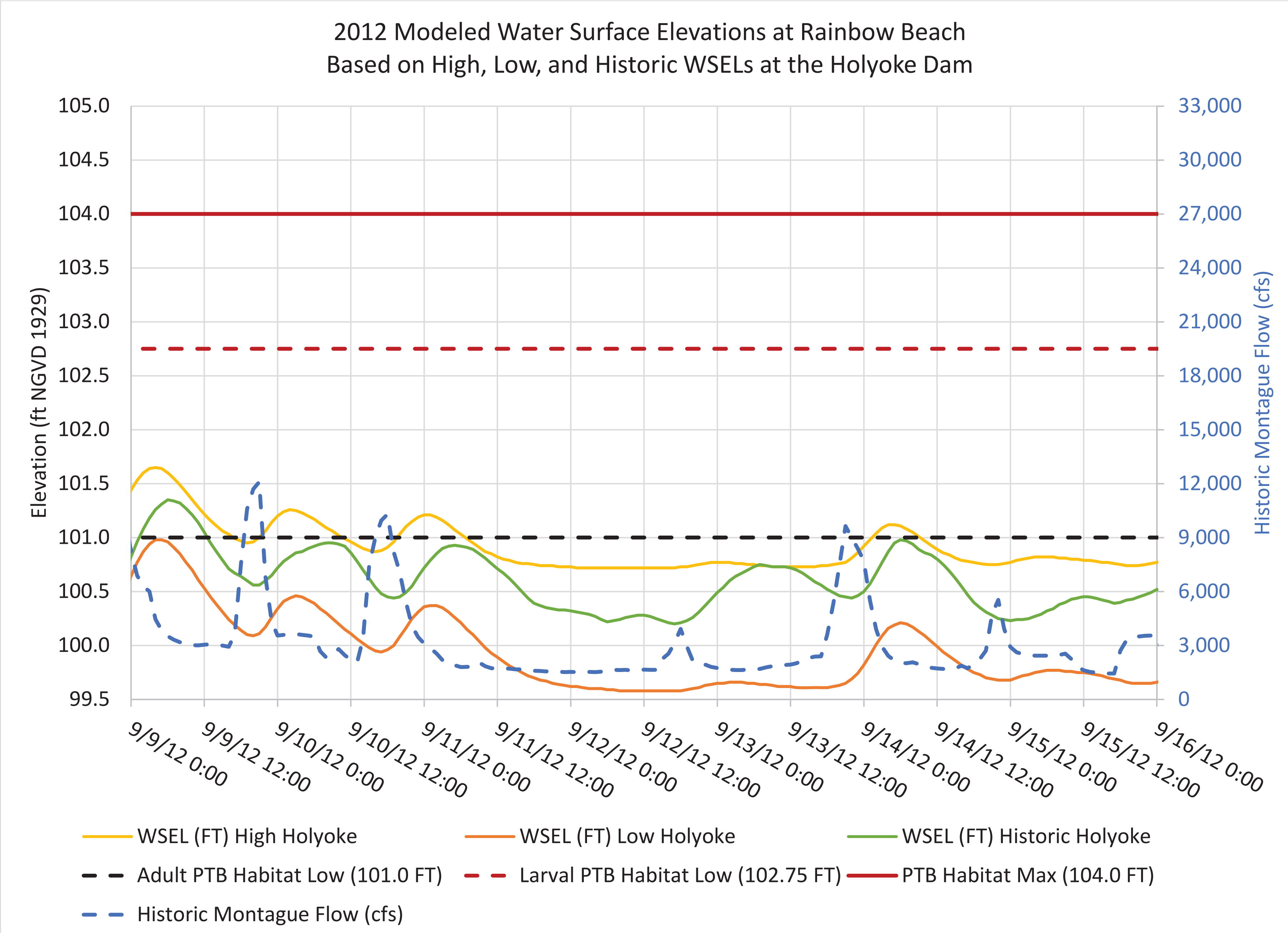
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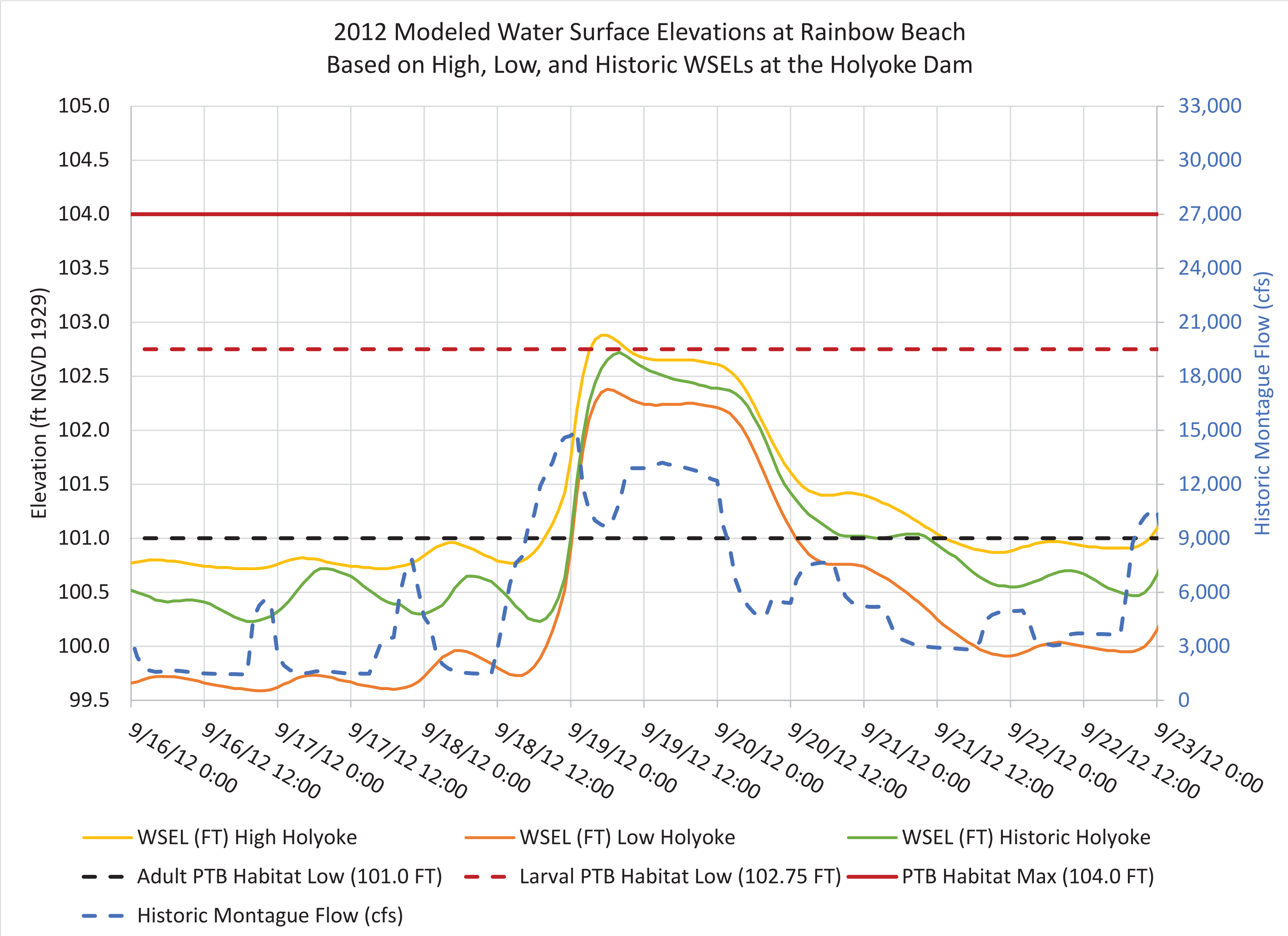

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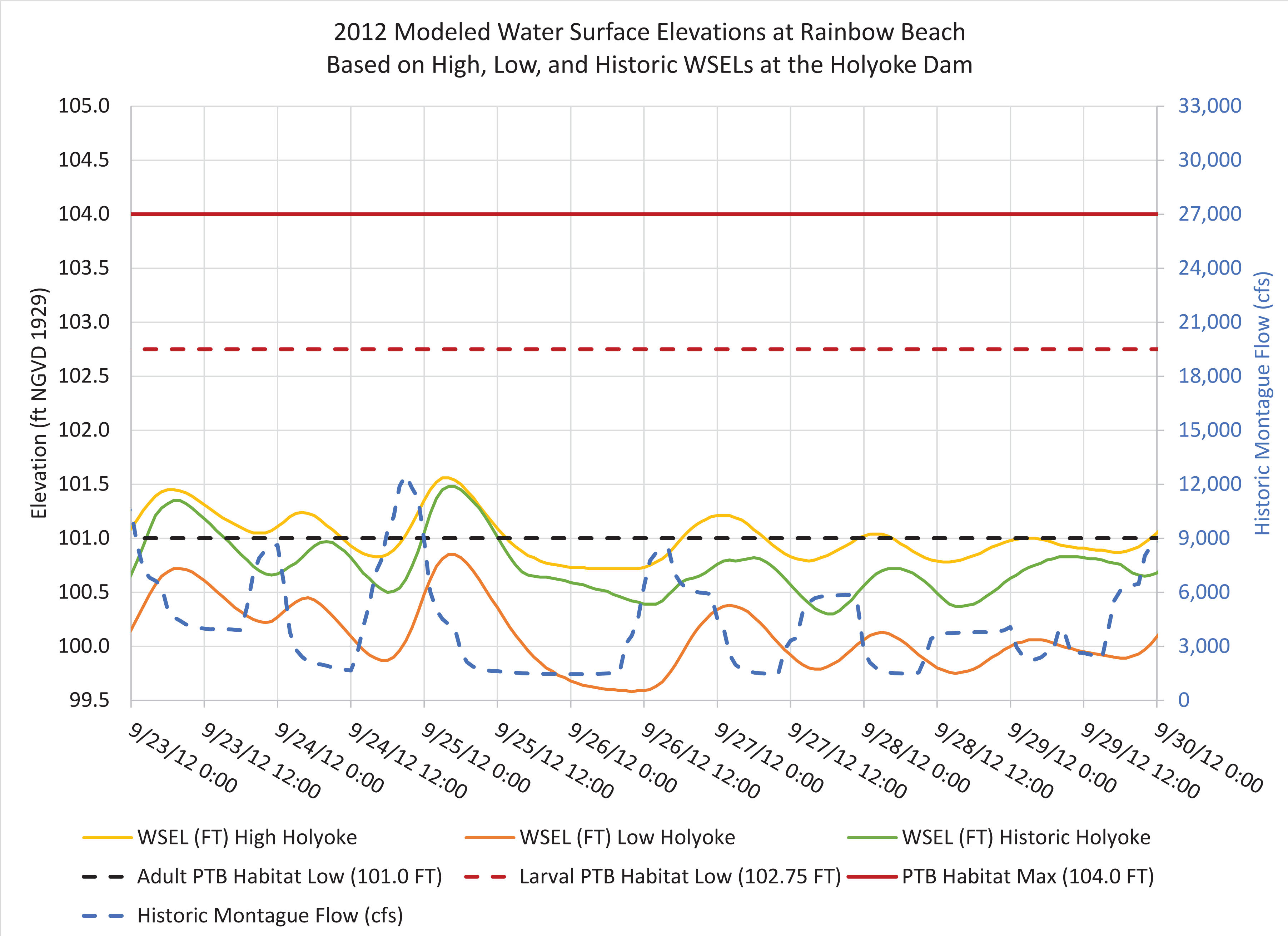

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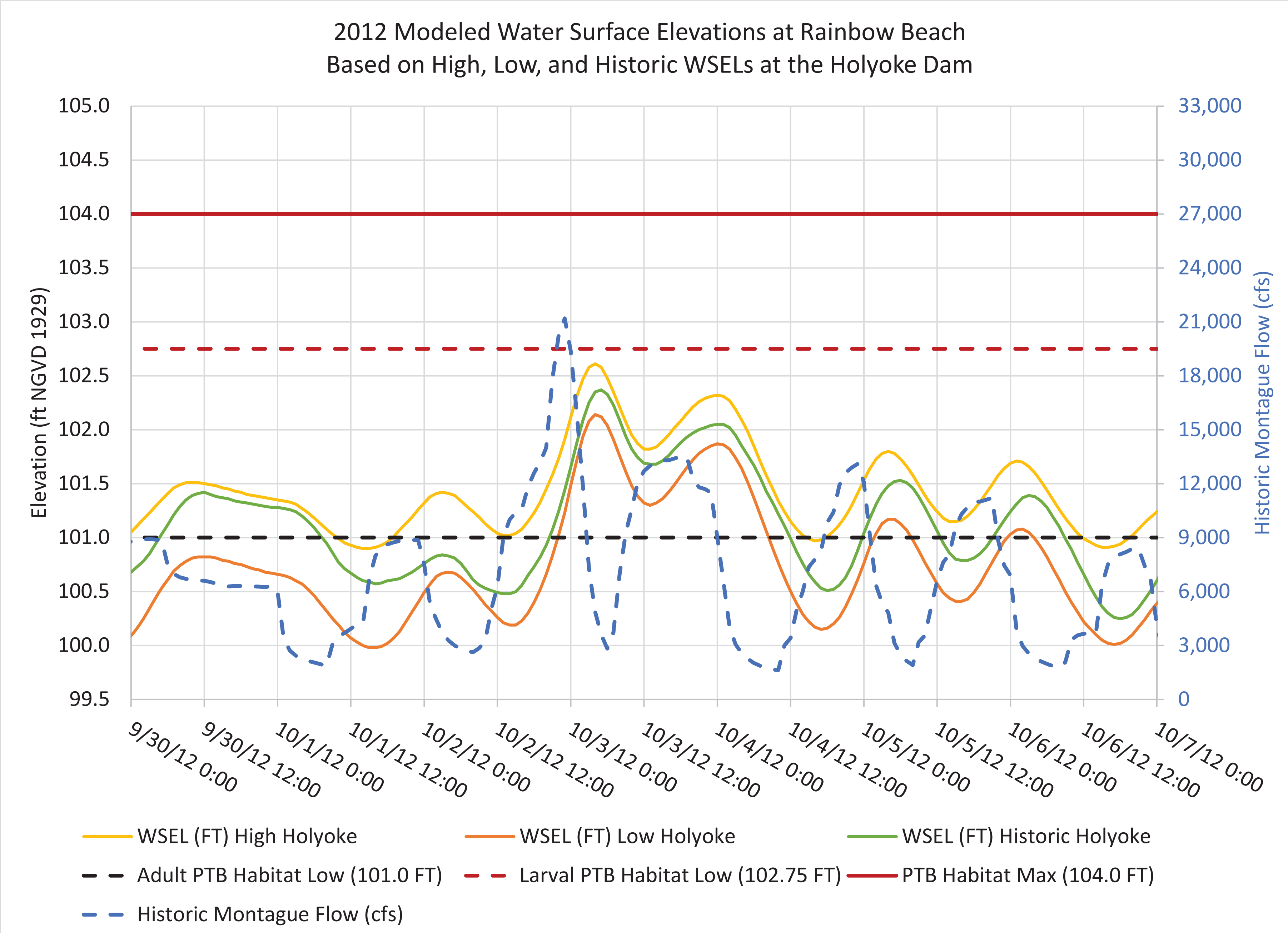
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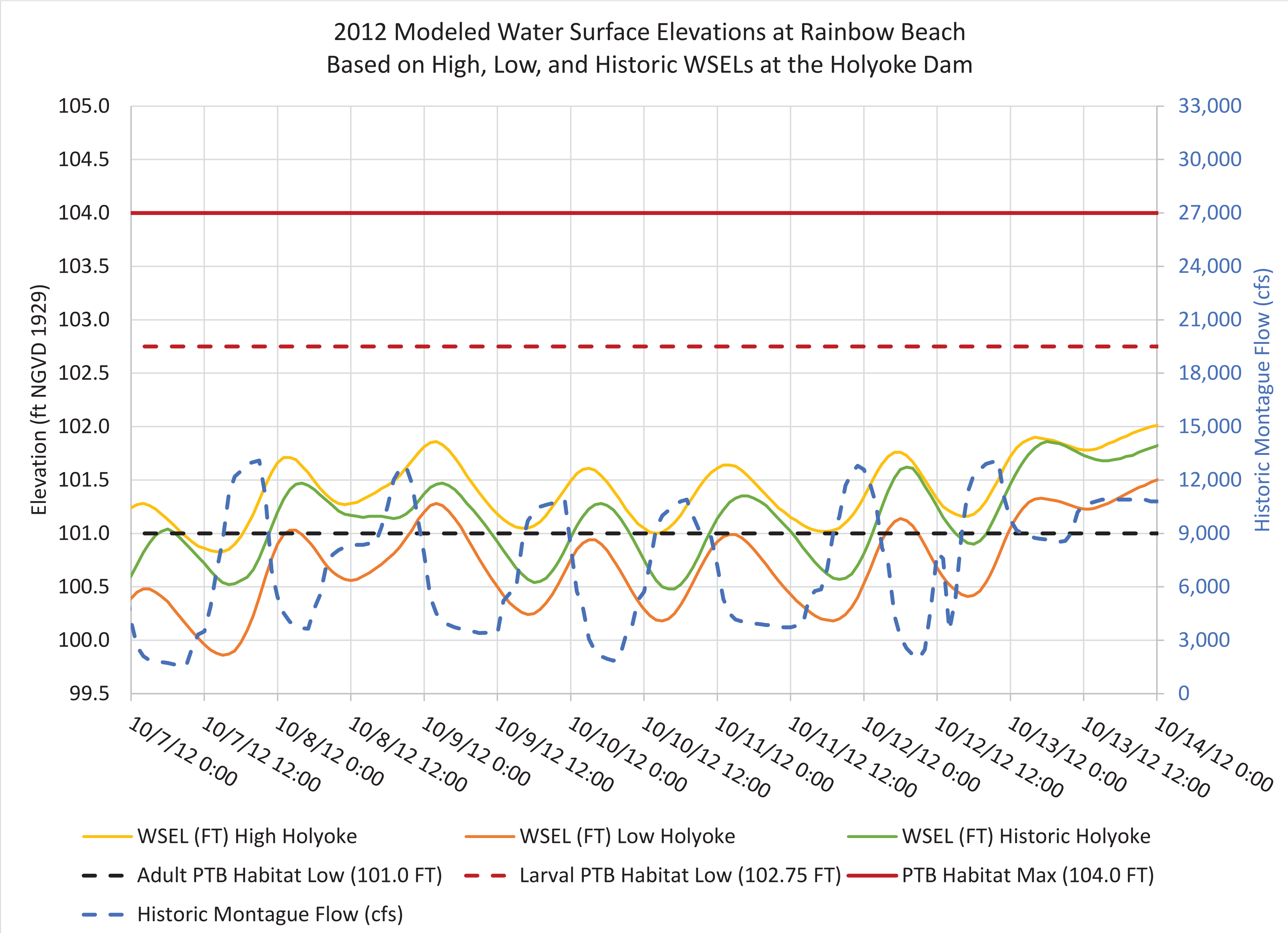
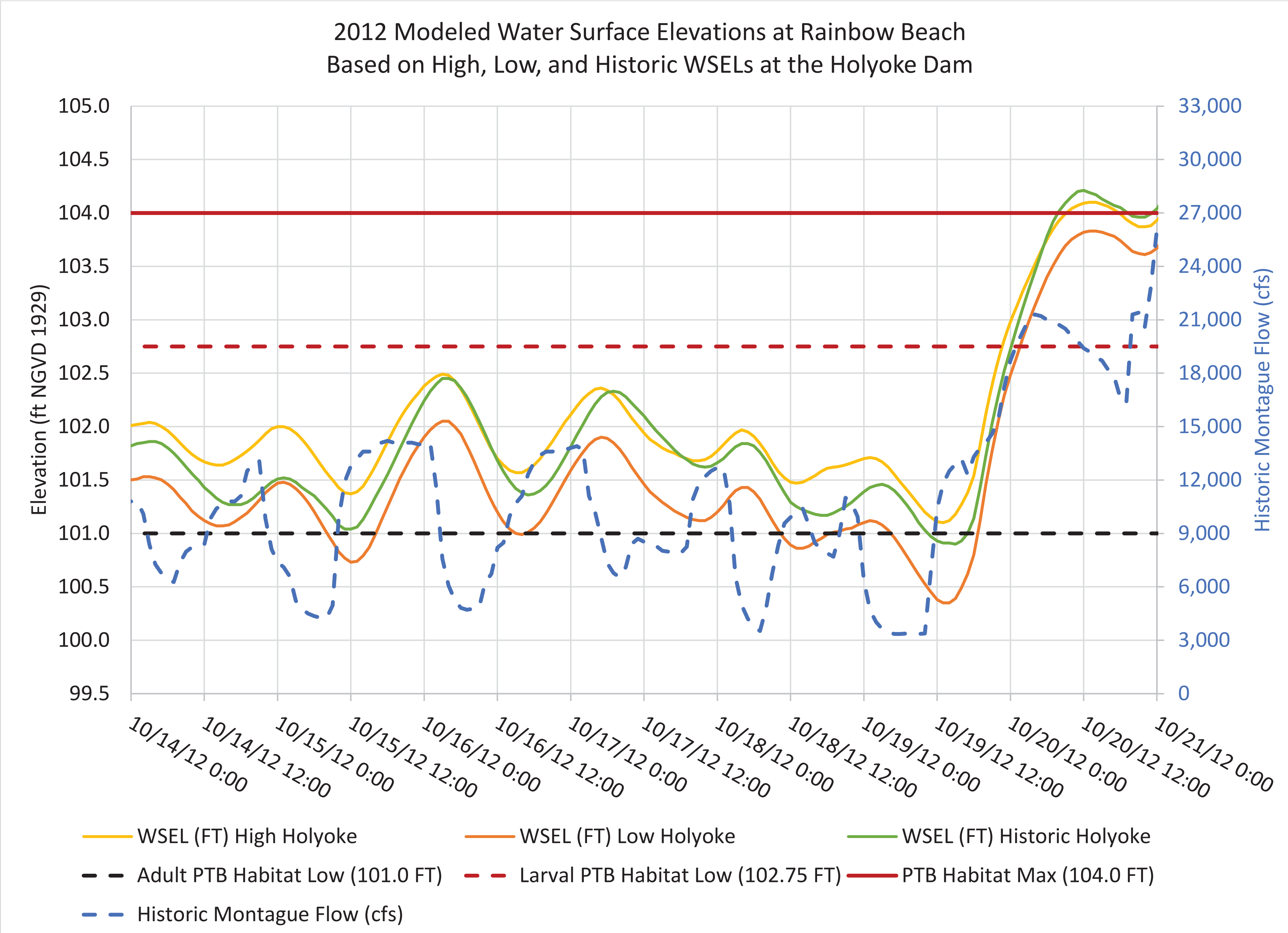
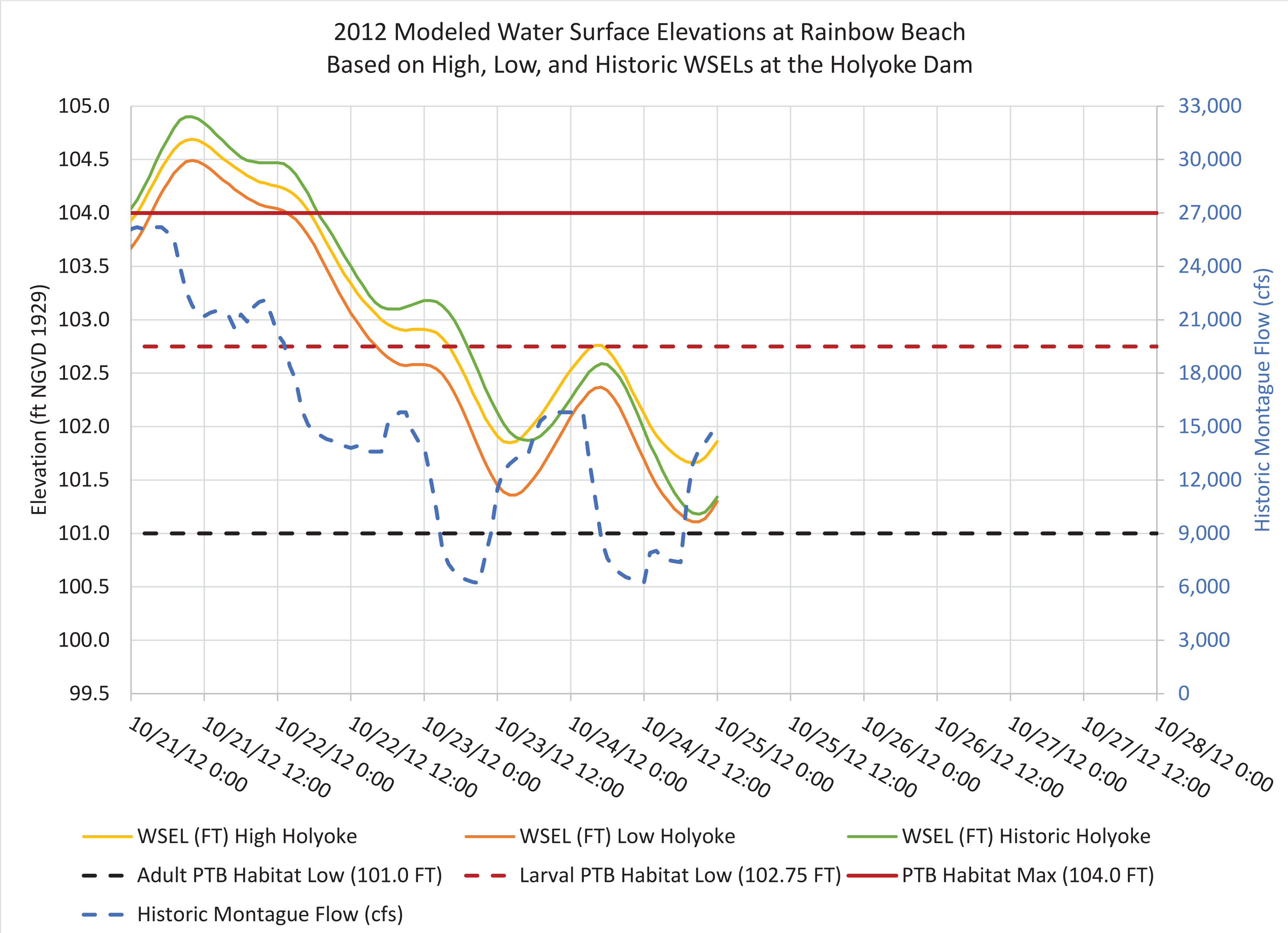


2012 Modeled Water Surface Elevations at Rainbow Beach
Based on High, Low, and Historic WSELs at the Holyoke Dam
Elevation (ft NGVD 1929)
Historic Montague Flow (cfs)
105.0
104.5
104.0
103.5
103.0
102.5
102.0
101.5
101.0
100.5
100.0
99.5
33,000
30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
10/7/12 0:00
10/7/12 12:00
10/8/12 0:00
10/8/12 12:00
10/9/12 0:00
10/9/12 12:00
10/10/12 0:00
10/10/12 12:00
10/11/12 0:00
10/11/12 12:00
10/12/12 0:00
10/12/12 12:00
10/13/12 0:00
10/13/12 12:00
10/14/12 0:00
WSEL (FT) High Holyoke
WSEL (FT) Low Holyoke
WSEL (FT) Historic Holyoke
Adult PTB Habitat Low (101.0 FT)
Larval PTB Habitat Low (102.75 FT)
PTB Habitat Max (104.0 FT)
Historic Montague Flow (cfs)


2012 Modeled Water Surface Elevations at Rainbow Beach
Based on High, Low, and Historic WSELs at the Holyoke Dam
Elevation (ft NGVD 1929)
Historic Montague Flow (cfs)
105.0
104.5
104.0
103.5
103.0
102.5
102.0
101.5
101.0
100.5
100.0
99.5
33,000
30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
10/14/12 0:00
10/14/12 12:00
10/15/12 0:00
10/15/12 12:00
10/16/12 0:00
10/16/12 12:00
10/17/12 0:00
10/17/12 12:00
10/18/12 0:00
10/18/12 12:00
10/19/12 0:00
10/19/12 12:00
10/20/12 0:00
10/20/12 12:00
10/21/12 0:00
WSEL (FT) High Holyoke
WSEL (FT) Low Holyoke
WSEL (FT) Historic Holyoke
Adult PTB Habitat Low (101.0 FT)
Larval PTB Habitat Low (102.75 FT)
PTB Habitat Max (104.0 FT)
Historic Montague Flow (cfs)



2012 Modeled Water Surface Elevations at Rainbow Beach
Based on High, Low, and Historic WSELs at the Holyoke Dam
Elevation (ft NGVD 1929)
105.0
104.5
104.0
103.5
103.0
102.5
102.0
101.5
101.0
100.5
100.0
99.5
Historic Montague Flow (cfs)
33,000
30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
10/21/12 0:00
10/21/12 12:00
10/22/12 0:00
10/22/12 12:00
10/23/12 0:00
10/23/12 12:00
10/24/12 0:00
10/24/12 12:00
10/25/12 0:00
10/25/12 12:00
10/26/12 0:00
10/26/12 12:00
10/27/12 0:00
10/27/12 12:00
10/28/12 0:00
WSEL (FT) High Holyoke
WSEL (FT) Low Holyoke
WSEL (FT) Historic Holyoke
Adult PTB Habitat Low (101.0 FT)
Larval PTB Habitat Low (102.75 FT)
PTB Habitat Max (104.0 FT)
Historic Montague Flow (cfs)

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APPENDIX B: SYNTHETIC MODELING SUMMARIES

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Synthetic Modeling Summary:

- A low Holyoke WSEL boundary condition results in a larger amount of WSEL increase at Rainbow Beach, but a lower overall WSEL.
- Higher baseflow result in a faster arrival time of the peak at Rainbow Beach
- While a longer peaking duration, delays the arrival of the peak at Rainbow Beach this is largely a function of a longer rise to higher WSEL associated with the longer peaking duration..

Below are summaries of the model results and some figures.

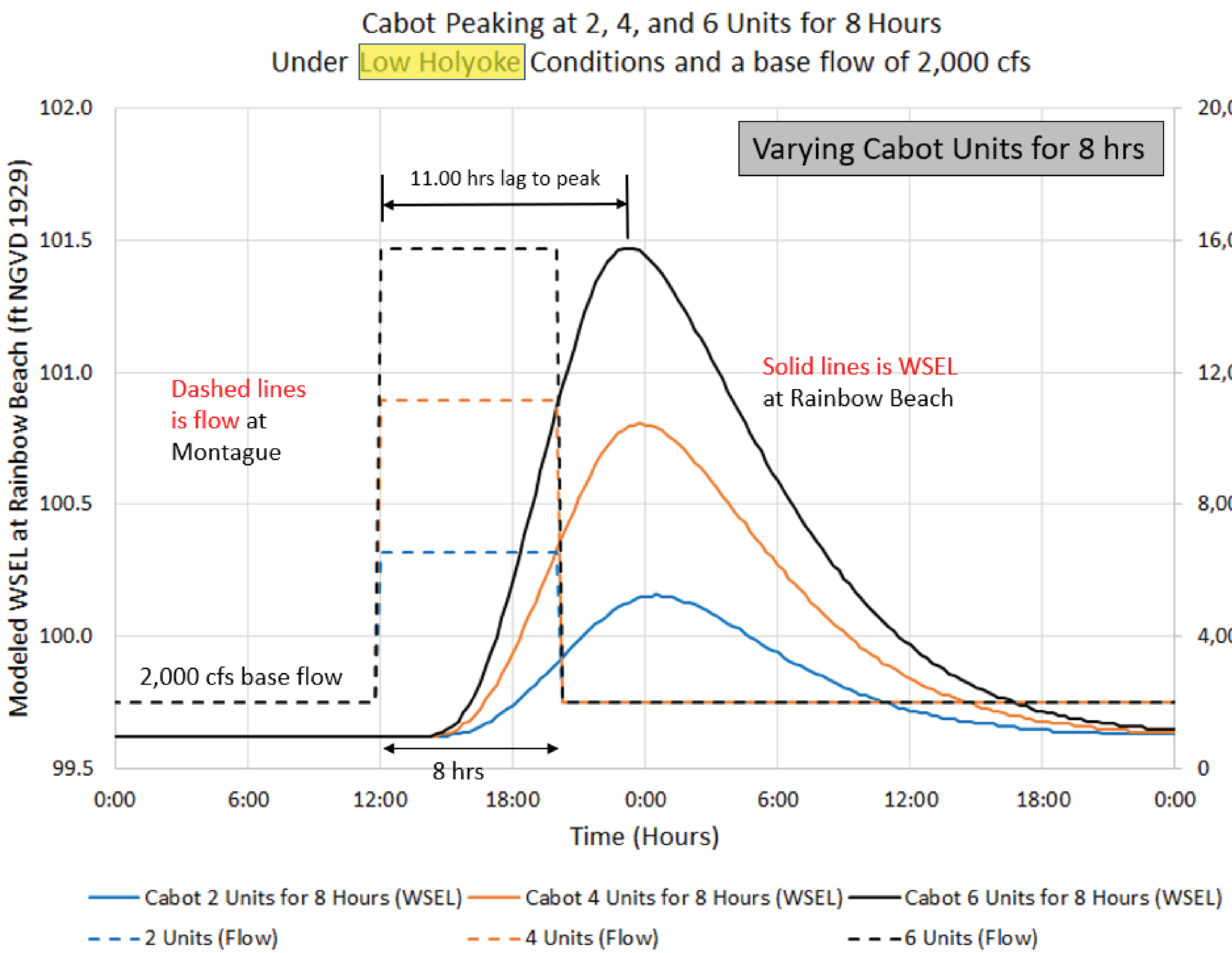
	Low Holyoke				**High Holyoke**				**Difference Between High - Low Holyoke**			
	2000 cfs Base Flow and 2 Cabot Units				**2000 cfs Base Flow and 2 Cabot Units**				**2000 cfs Base Flow and 2 Cabot Units**			
Length of Cabot Release (Hours)	**2**	**4**	**8**	**12**	**2**	**4**	**8**	**12**	**2**	**4**	**8**	**12**
Max WSEL Increase (ft)	0.14	0.28	0.54	0.71	0.09	0.19	0.34	0.45	-0.05	-0.09	-0.20	-0.26
Max Elevation (ft NGVD29)	99.76	99.90	100.16	100.33	100.83	100.93	101.08	101.19	1.07	1.03	0.92	0.86
Timing of Peak (Hours since start at Montague)	8.75	10.00	12.50	14.75	6.25	8.50	10.75	14.50	-2.50	-1.50	-1.75	-0.25
1/2 of Peak (ft NGVD29)	99.69	99.76	99.89	99.98	100.79	100.84	100.91	100.97	1.09	1.07	1.02	0.99
Time of 1/2 rising peak since Start	5.25	6.25	7.75	8.75	4.25	5.25	6.75	7.75	-1.00	-1.00	-1.00	-1.00
	4000 cfs Base Flow and 2 Cabot Units				**4000 cfs Base Flow and 2 Cabot Units**				**4000 cfs Base Flow and 2 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.19	0.36	0.64	0.83	0.13	0.25	0.45	0.59	-0.06	-0.11	-0.19	-0.24
Max Elevation (ft NGVD29)	100.17	100.34	100.62	100.81	101.06	101.18	101.38	101.52	0.89	0.84	0.76	0.71
Timing of Peak (Hours since start at Montague)	7.50	8.75	11.50	14.50	6.25	7.75	10.75	14	-1.25	-1.00	-0.75	-0.50
1/2 of Peak (ft NGVD29)	100.08	100.16	100.30	100.40	101.00	101.06	101.16	101.24	0.92	0.90	0.85	0.84
Time of 1/2 rising peak since Start	4.75	5.75	7.00	8.00	4.25	5.00	6.50	7.25	-0.50	-0.75	-0.50	-0.75

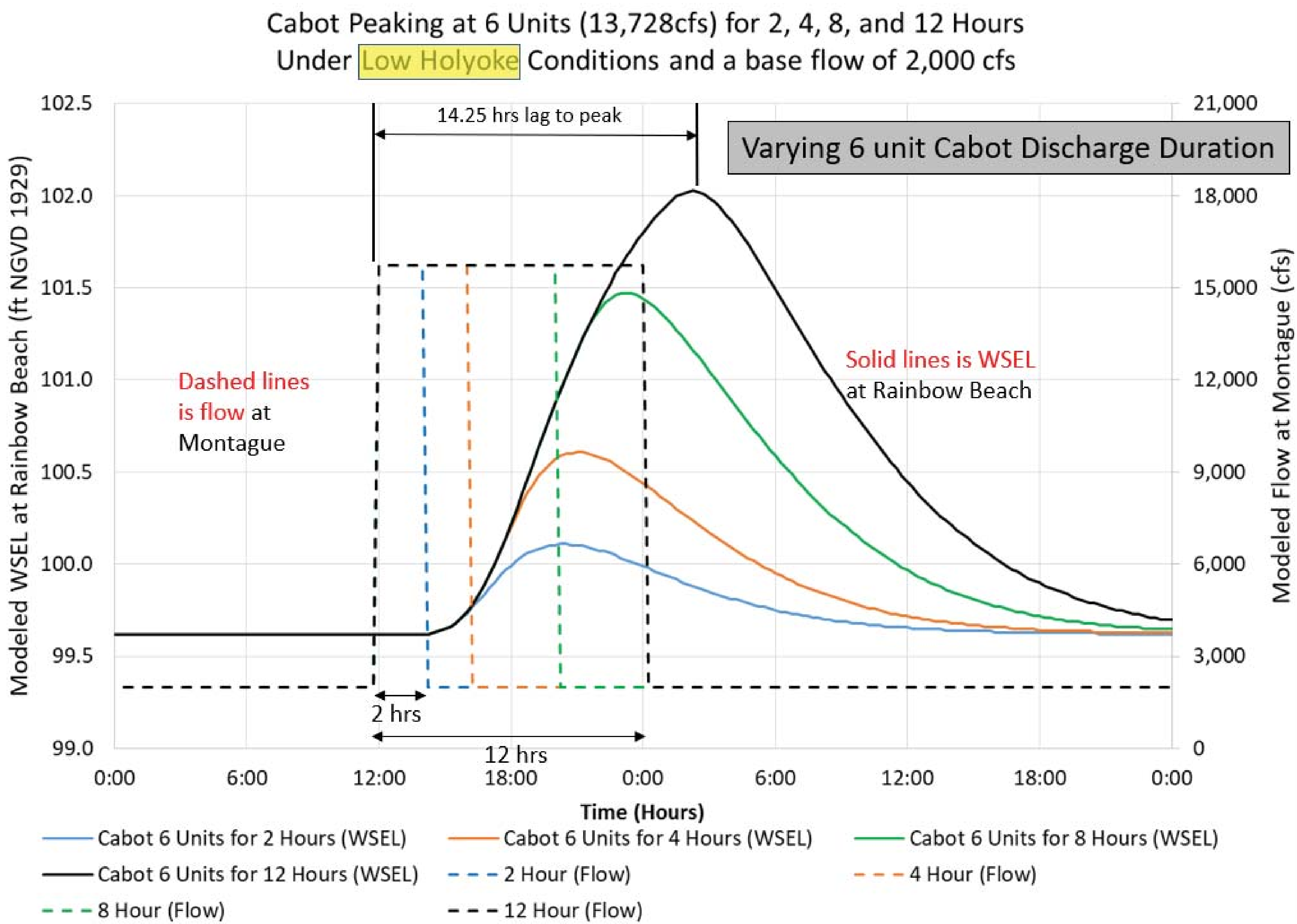
	6000 cfs Base Flow and 2 Cabot Units				6000 cfs Base Flow and 2 Cabot Units				6000 cfs Base Flow and 2 Cabot Units			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.21	0.39	0.67	0.86	0.17	0.3	0.52	0.66	-0.04	-0.09	-0.15	-0.20
Max Elevation (ft NGVD29)	100.64	100.82	101.10	101.29	101.37	101.5	101.72	101.86	0.73	0.68	0.62	0.57
Timing of Peak (Hours since start at Montague)	7.00	8.50	10.75	14.50	6.75	7.50	10.25	13.75	-0.25	-1.00	-0.50	-0.75
1/2 of Peak (ft NGVD29)	100.54	100.63	100.77	100.86	101.285	101.35	101.46	101.53	0.75	0.72	0.70	0.67
Time of 1/2 rising peak since Start	4.25	5.25	6.50	7.50	4.00	4.75	6.25	7.00	-0.25	-0.50	-0.25	-0.50
	2000 cfs Base Flow and 4 Cabot Units				**2000 cfs Base Flow and 4 Cabot Units**				**2000 cfs Base Flow and 4 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.31	0.62	1.19	1.57	0.21	0.43	0.83	1.09	-0.10	-0.19	-0.36	-0.48
Max Elevation (ft NGVD29)	99.93	100.24	100.81	101.19	100.95	101.17	101.57	101.83	1.02	0.93	0.76	0.64
Timing of Peak (Hours since start at Montague)	8.25	9.00	11.75	14.75	6.75	8.00	10.75	14.00	-1.50	-1.00	-1.00	-0.75
1/2 of Peak (ft NGVD29)	99.78	99.93	100.22	100.41	100.85	100.96	101.16	101.29	1.07	1.02	0.94	0.88
Time of 1/2 rising peak since Start	5.00	5.75	7.25	8.25	4.25	5.00	6.75	7.75	-0.75	-0.75	-0.50	-0.50
	4000 cfs Base Flow and 4 Cabot Units				**4000 cfs Base Flow and 4 Cabot Units**				**4000 cfs Base Flow and 4 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.39	0.74	1.31	1.68	0.28	0.55	0.99	1.26	-0.11	-0.19	-0.32	-0.42
Max Elevation (ft NGVD29)	100.37	100.72	101.29	101.66	101.21	101.48	101.92	102.19	0.84	0.76	0.63	0.53
Timing of Peak (Hours since start at Montague)	7.50	8.75	11.00	14.25	6.50	8.00	10.50	13.75	-1.00	-0.75	-0.50	-0.50
1/2 of Peak (ft NGVD29)	100.18	100.35	100.64	100.82	101.07	101.21	101.43	101.56	0.89	0.86	0.79	0.74
Time of 1/2 rising peak since Start	4.50	5.25	6.75	7.50	4.00	5.00	6.25	7.25	-0.50	-0.25	-0.50	-0.25
	6000 cfs Base Flow and 4 Cabot Units				**6000 cfs Base Flow and 4 Cabot Units**				**6000 cfs Base Flow and 4 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.63	0.78	1.34	1.69	0.34	0.63	1.09	1.37	-0.29	-0.15	-0.25	-0.32
Max Elevation (ft NGVD29)	101.06	101.21	101.77	102.12	101.54	101.83	102.29	102.57	0.48	0.62	0.52	0.45
Timing of Peak (Hours since start at Montague)	6.75	8.25	10.75	13.75	6.75	7.75	10.50	13.75	0.00	-0.50	-0.25	0.00
1/2 of Peak (ft NGVD29)	100.75	100.82	101.10	101.28	101.37	101.52	101.75	101.89	0.63	0.70	0.65	0.61
Time of 1/2 rising peak since Start	4.00	5.00	6.25	7.00	3.75	4.75	6.00	6.75	-0.25	-0.25	-0.25	-0.25
	2000 cfs Base Flow and 6 Cabot Units				**2000 cfs Base Flow and 6 Cabot Units**				**2000 cfs Base Flow and 6 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12

Max WSEL Increase (ft)	0.49	0.99	1.85	2.41	0.34	0.71	1.38	1.79	-0.15	-0.28	-0.47	-0.62
Max Elevation (ft NGVD29)	100.11	100.61	101.47	102.03	101.08	101.45	102.12	102.53	0.97	0.84	0.65	0.50
Timing of Peak (Hours since start at Montague)	8.25	9.00	11.00	14.25	6.75	7.75	10.75	13.75	-1.50	-1.25	-0.25	-0.50
1/2 of Peak (ft NGVD29)	99.865	100.115	100.545	100.825	100.91	101.10	101.43	101.64	1.04	0.98	0.89	0.81
Time of 1/2 rising peak since Start	4.75	5.50	7.00	7.75	4.25	5.00	6.50	7.25	-0.50	-0.50	-0.50	-0.50
	4000 cfs Base Flow and 6 Cabot Units				**4000 cfs Base Flow and 6 Cabot Units**				**4000 cfs Base Flow and 6 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.60	1.13	1.98	2.51	0.44	0.86	1.56	1.98	-0.16	-0.27	-0.42	-0.53
Max Elevation (ft NGVD29)	100.58	101.11	101.96	102.49	101.37	101.79	102.49	102.91	0.79	0.68	0.53	0.42
Timing of Peak (Hours since start at Montague)	7.75	8.50	10.75	14.00	6.50	7.50	10.50	13.50	-1.25	-1.00	-0.25	-0.50
1/2 of Peak (ft NGVD29)	100.28	100.55	100.97	101.24	101.15	101.36	101.71	101.92	0.87	0.82	0.74	0.69
Time of 1/2 rising peak since Start	4.50	5.00	6.50	7.25	4.00	4.75	6.00	7.00	-0.50	-0.25	-0.50	-0.25
	6000 cfs Base Flow and 6 Cabot Units				**6000 cfs Base Flow and 6 Cabot Units**				**6000 cfs Base Flow and 6 Cabot Units**			
Length of Cabot Release (Hours)	2	4	8	12	2	4	8	12	2	4	8	12
Max Increase (ft)	0.63	1.16	2.00	2.50	0.51	0.96	1.67	2.09	-0.12	-0.20	-0.33	-0.41
Max Elevation (ft NGVD29)	101.06	101.59	102.43	102.93	101.71	102.16	102.87	103.29	0.65	0.57	0.44	0.36
Timing of Peak (Hours since start at Montague)	6.75	7.75	10.50	13.75	6.25	7.50	10.25	13.50	-0.50	-0.25	-0.25	-0.25
1/2 of Peak (ft NGVD29)	100.75	101.01	101.43	101.68	101.46	101.68	102.04	102.25	0.71	0.67	0.60	0.56
Time of 1/2 rising peak since Start	4.00	4.75	6.00	6.75	3.75	4.50	5.75	6.50	-0.25	-0.25	-0.25	-0.25

At Rainbow Beach about 25 miles downstream of Cabot Station (Low Holyoke Conditions more WSEL change and a slower peak arrival time than under High Holyoke)				
Baseflow (cfs)	**Number of Cabot Units**	**Length of Cabot Peak (hours)**	**Maximum WSEL increase (ft)**	**Delay of the Peak (hours)**
2,000	2	2	0.14	8.75
2,000	2	4	0.28	10
2,000	2	8	0.54	12.5
2,000	2	12	0.71	14.75
4,000	2	2	0.19	7.5
4,000	2	4	0.36	8.75
4,000	2	8	0.64	11.5
4,000	2	12	0.83	14.5
6,000	2	2	0.21	7
6,000	2	4	0.39	8.5
6,000	2	8	0.67	10.75
6,000	2	12	0.86	14.5
2,000	4	2	0.31	8.25
2,000	4	4	0.62	9
2,000	4	8	1.19	11.75
2,000	4	12	1.57	14.75
4,000	4	2	0.39	7.5
4,000	4	4	0.74	8.75
4,000	4	8	1.31	11
4,000	4	12	1.68	14.25
6,000	4	2	0.63	6.75
6,000	4	4	0.78	8.25
6,000	4	8	1.34	10.75
6,000	4	12	1.69	13.75
2,000	6	2	0.49	8.25
2,000	6	4	0.99	9
2,000	6	8	1.85	11
2,000	6	12	2.41	14.25
4,000	6	2	0.60	7.75
4,000	6	4	1.13	8.5
4,000	6	8	1.98	10.75
4,000	6	12	2.51	14
6,000	6	2	0.63	6.75
6,000	6	4	1.16	7.75
6,000	6	8	2.00	10.5
6,000	6	12	2.50	13.75

Note: model timestep was 15 minutes


Cabot Peaking at 2, 4, and 6 Units for 8 Hours
Under Low Holyoke Conditions and a base flow of 2,000 cfs
Varying Cabot Units for 8 hrs
11.00 hrs lag to peak
8 hrs
Dashed lines is flow at Montague
Solid lines is WSEL at Rainbow Beach
2,000 cfs base flow
Modeled WSEL at Rainbow Beach (ft NGVD 1929)
Modeled Flow at Montague (cfs)
Time (Hours)
102.0
101.5
101.0
100.5
100.0
99.5
20,000
16,000
12,000
8,000
4,000
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
Cabot 2 Units for 8 Hours (WSEL)
Cabot 4 Units for 8 Hours (WSEL)
Cabot 6 Units for 8 Hours (WSEL)
2 Units (Flow)
4 Units (Flow)
6 Units (Flow)


Cabot Peaking at 6 Units (13,728cfs) for 2, 4, 8, and 12 Hours
Under Low Holyoke Conditions and a base flow of 2,000 cfs
Varying 6 unit Cabot Discharge Duration
14.25 hrs lag to peak
Dashed lines is flow at Montague
Solid lines is WSEL at Rainbow Beach
2 hrs
12 hrs
Modeled WSEL at Rainbow Beach (ft NGVD 1929)
Modeled Flow at Montague (cfs)
Time (Hours)
102.5
102.0
101.5
101.0
100.5
100.0
99.5
99.0
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
Cabot 6 Units for 2 Hours (WSEL)
Cabot 6 Units for 4 Hours (WSEL)
Cabot 6 Units for 8 Hours (WSEL)
Cabot 6 Units for 12 Hours (WSEL)
2 Hour (Flow)
4 Hour (Flow)
8 Hour (Flow)
12 Hour (Flow)

APPENDIX C: TIMESERIES GRAPHS OF SYNTHETIC MODELING SCENARIOS

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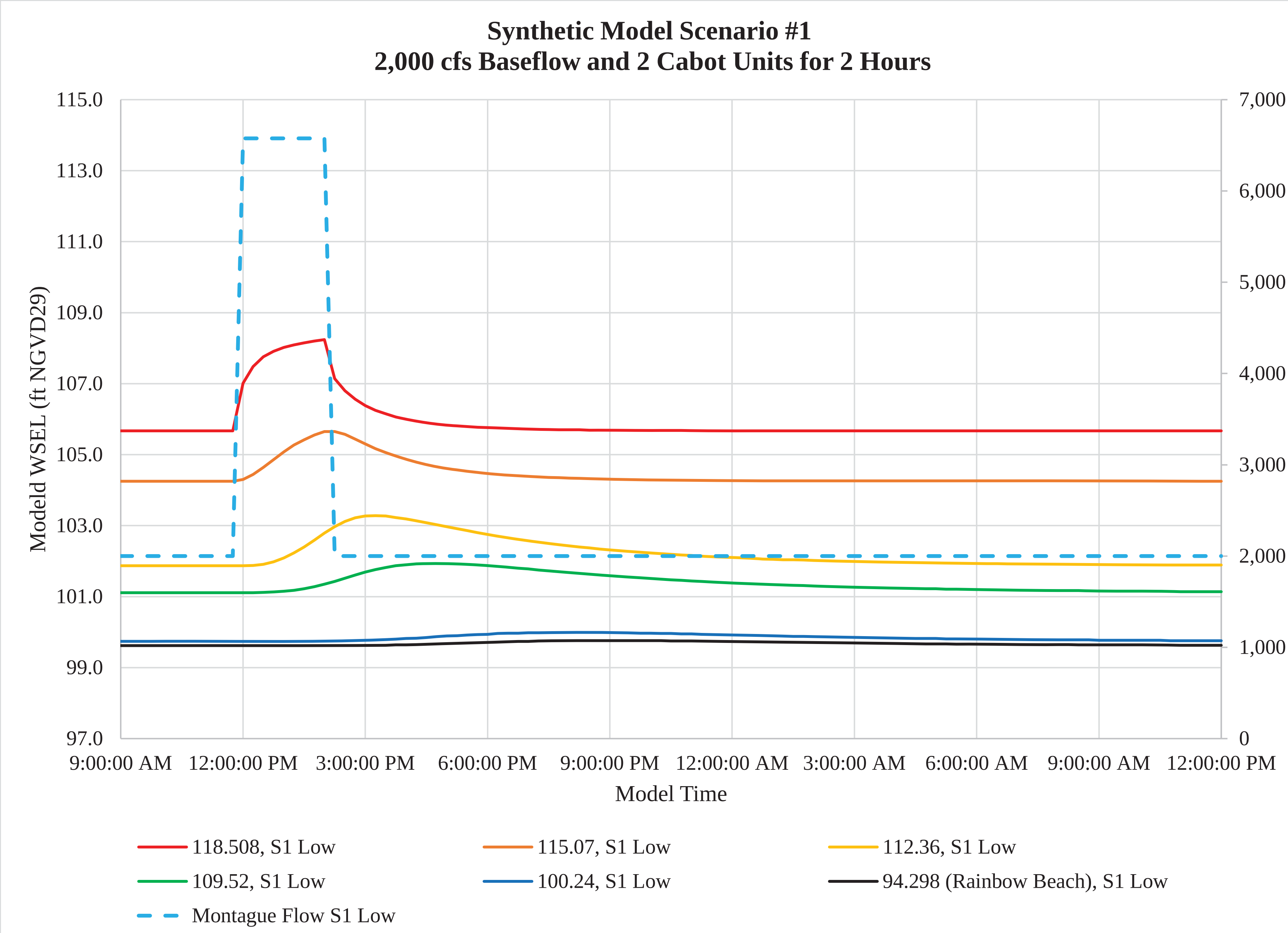
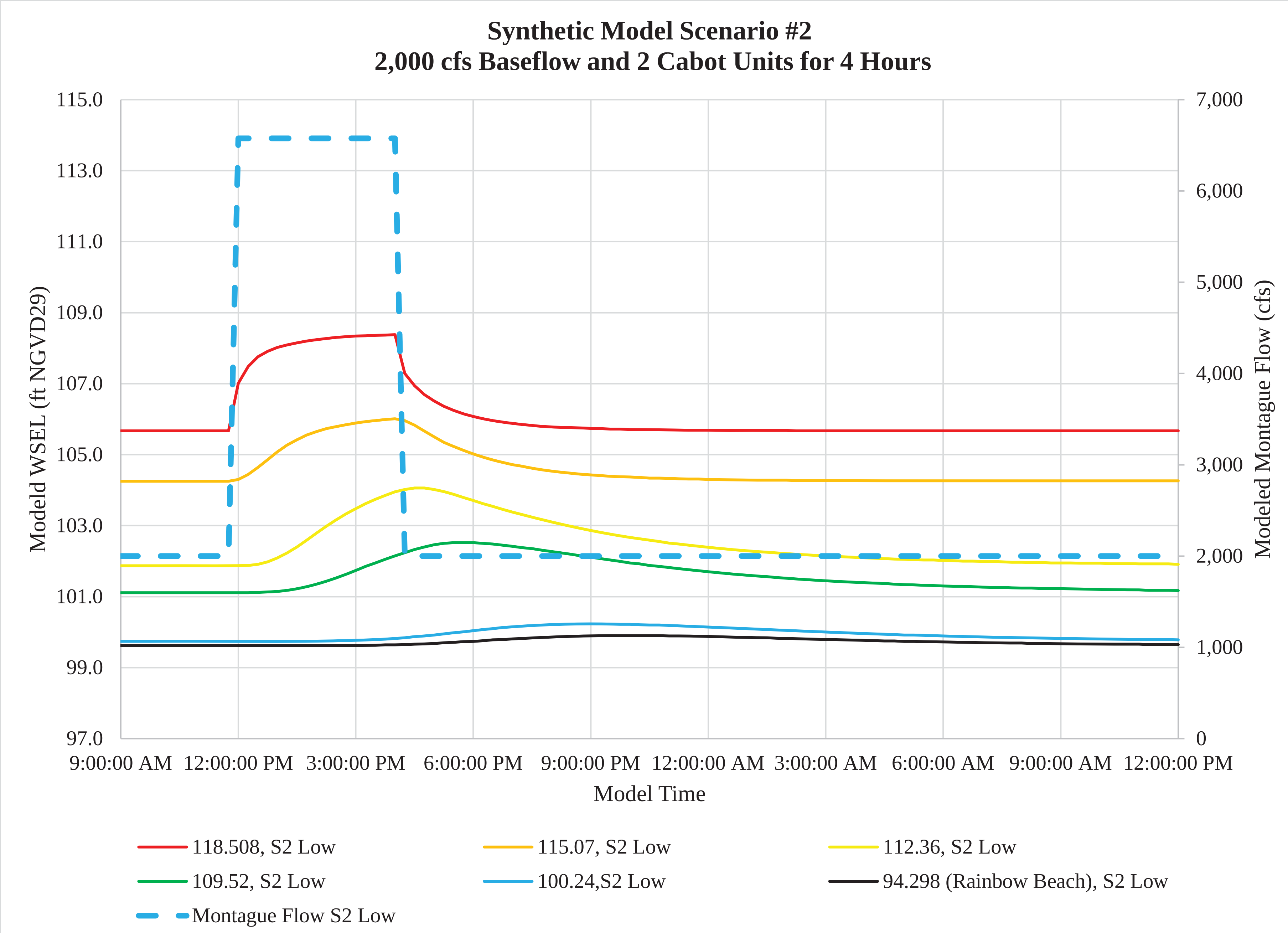
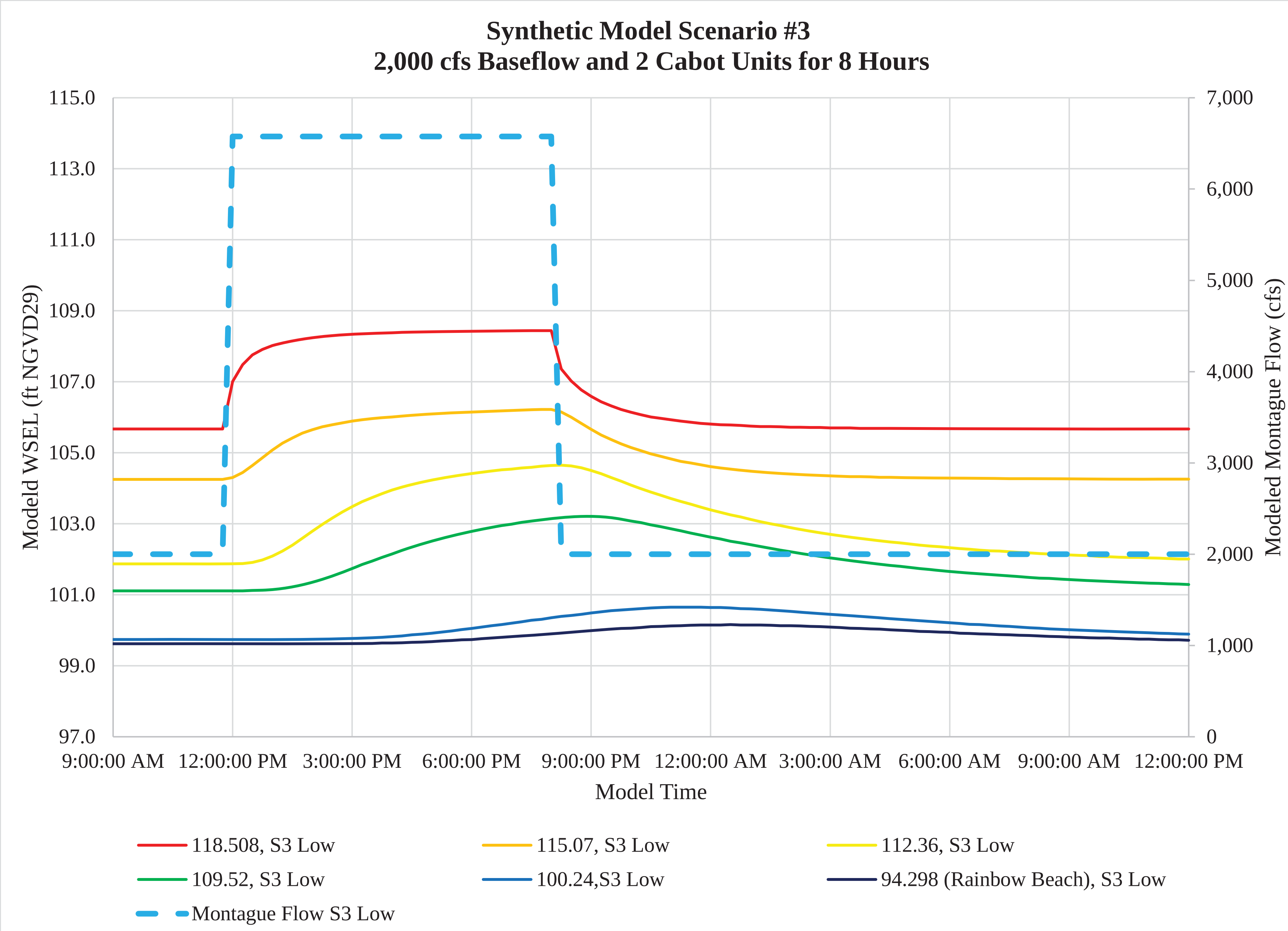
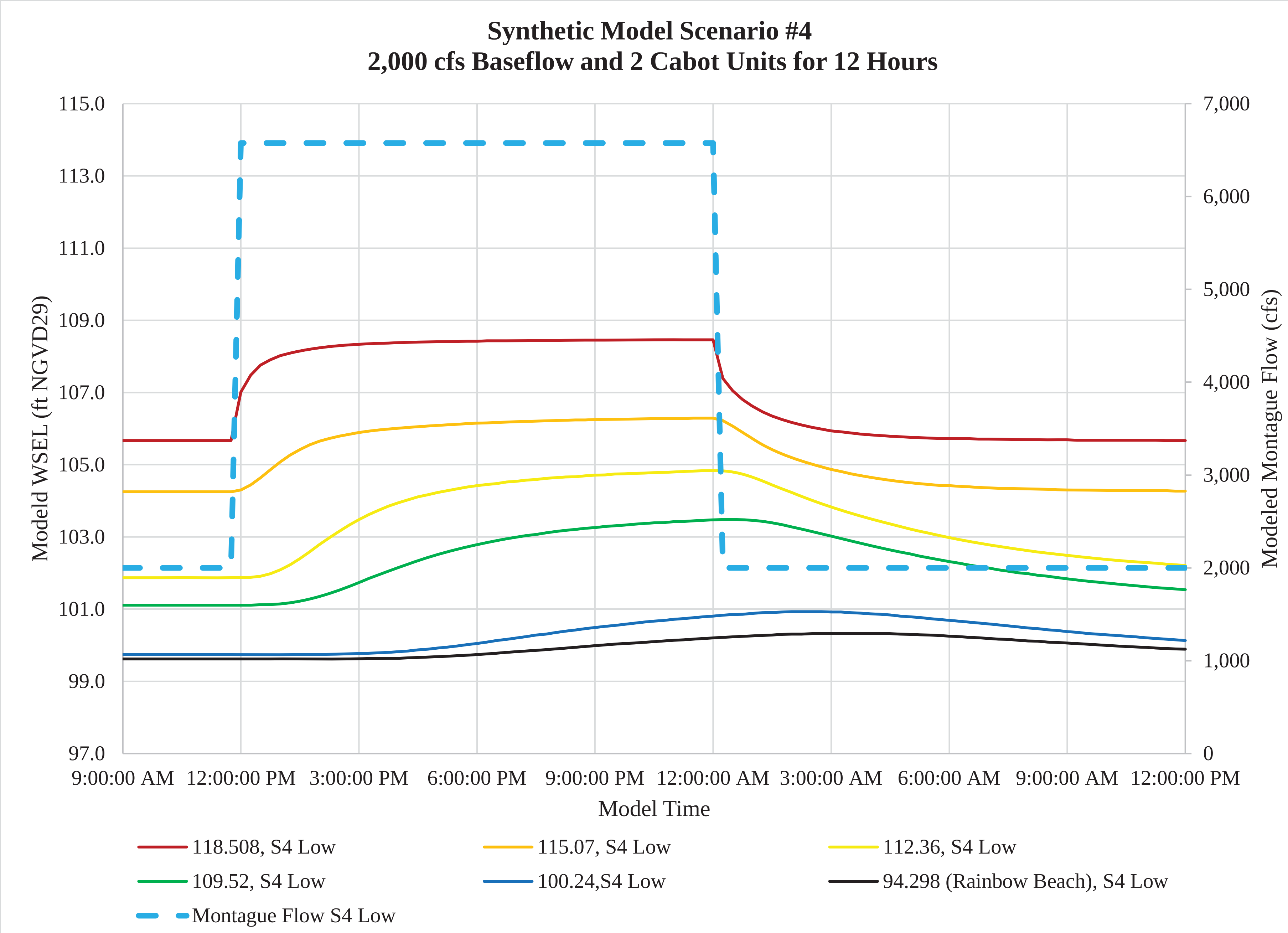
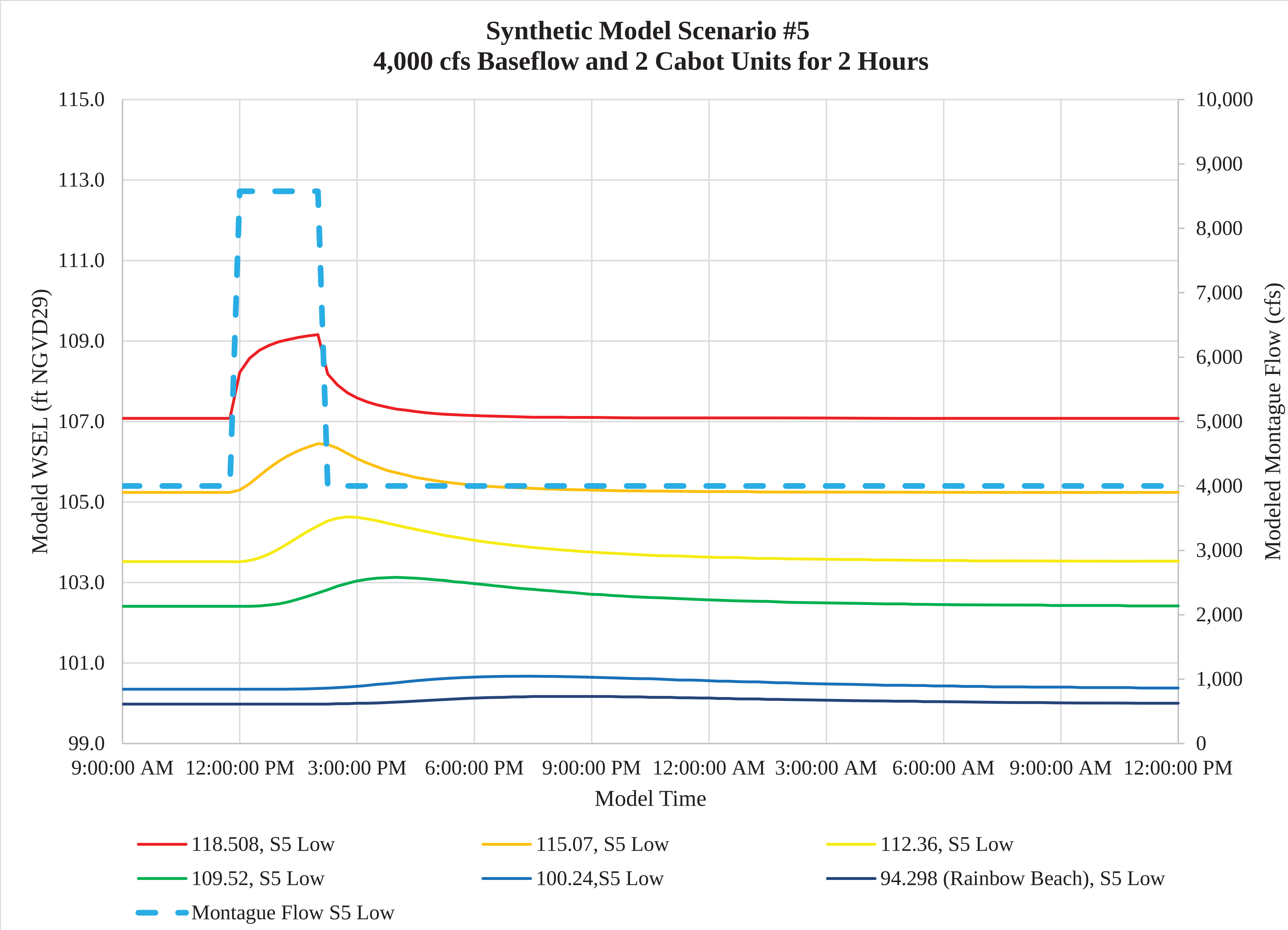

Synthetic Model Scenario #1
2,000 cfs Baseflow and 2 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S1 Low
115.07, S1 Low
112.36, S1 Low
109.52, S1 Low
100.24, S1 Low
94.298 (Rainbow Beach), S1 Low
Montague Flow S1 Low


Synthetic Model Scenario #2
2,000 cfs Baseflow and 2 Cabot Units for 4 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
Modeld WSEL (ft NGVD29)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S2 Low
115.07, S2 Low
112.36, S2 Low
109.52, S2 Low
100.24,S2 Low
94.298 (Rainbow Beach), S2 Low
Montague Flow S2 Low

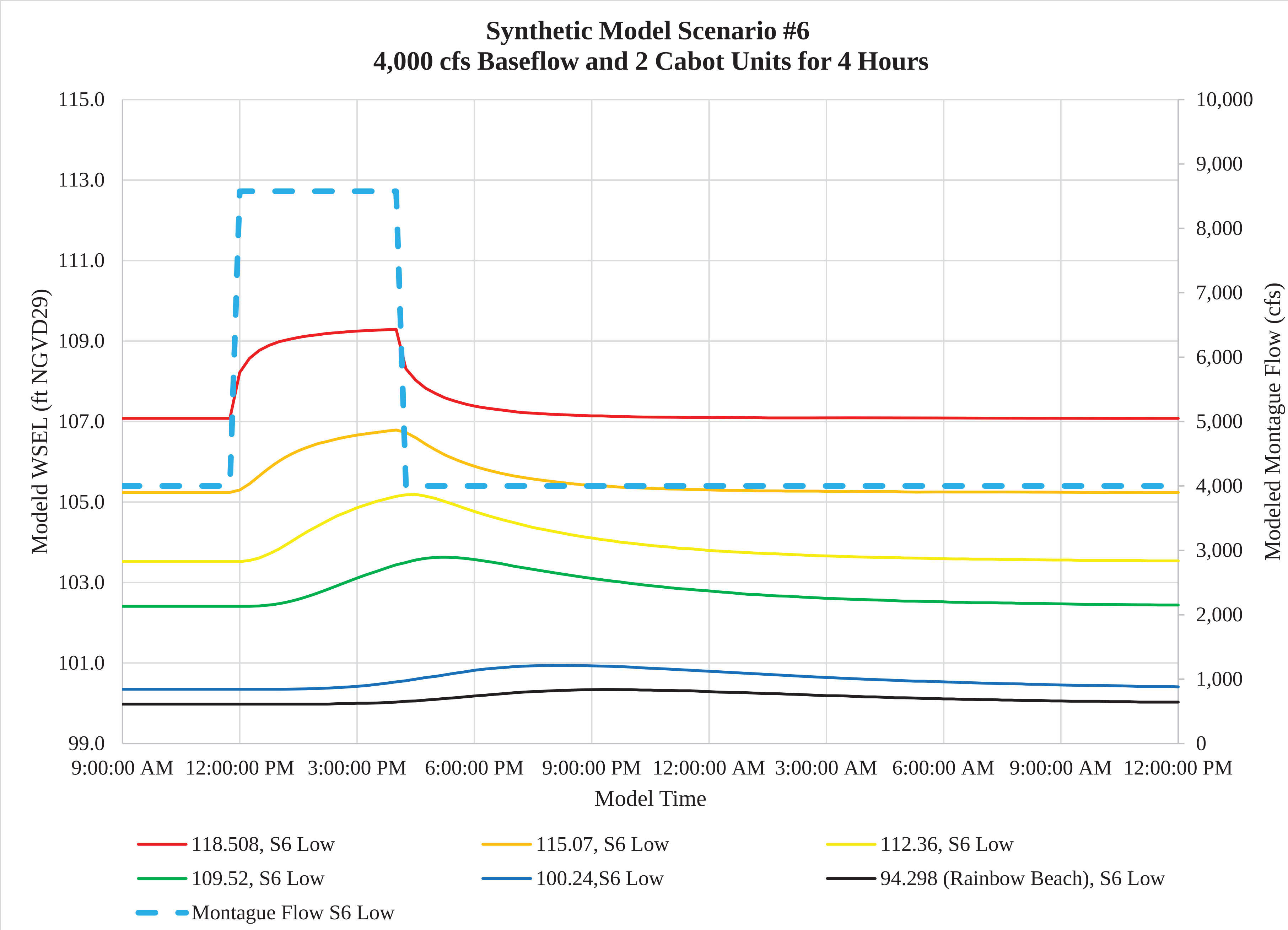


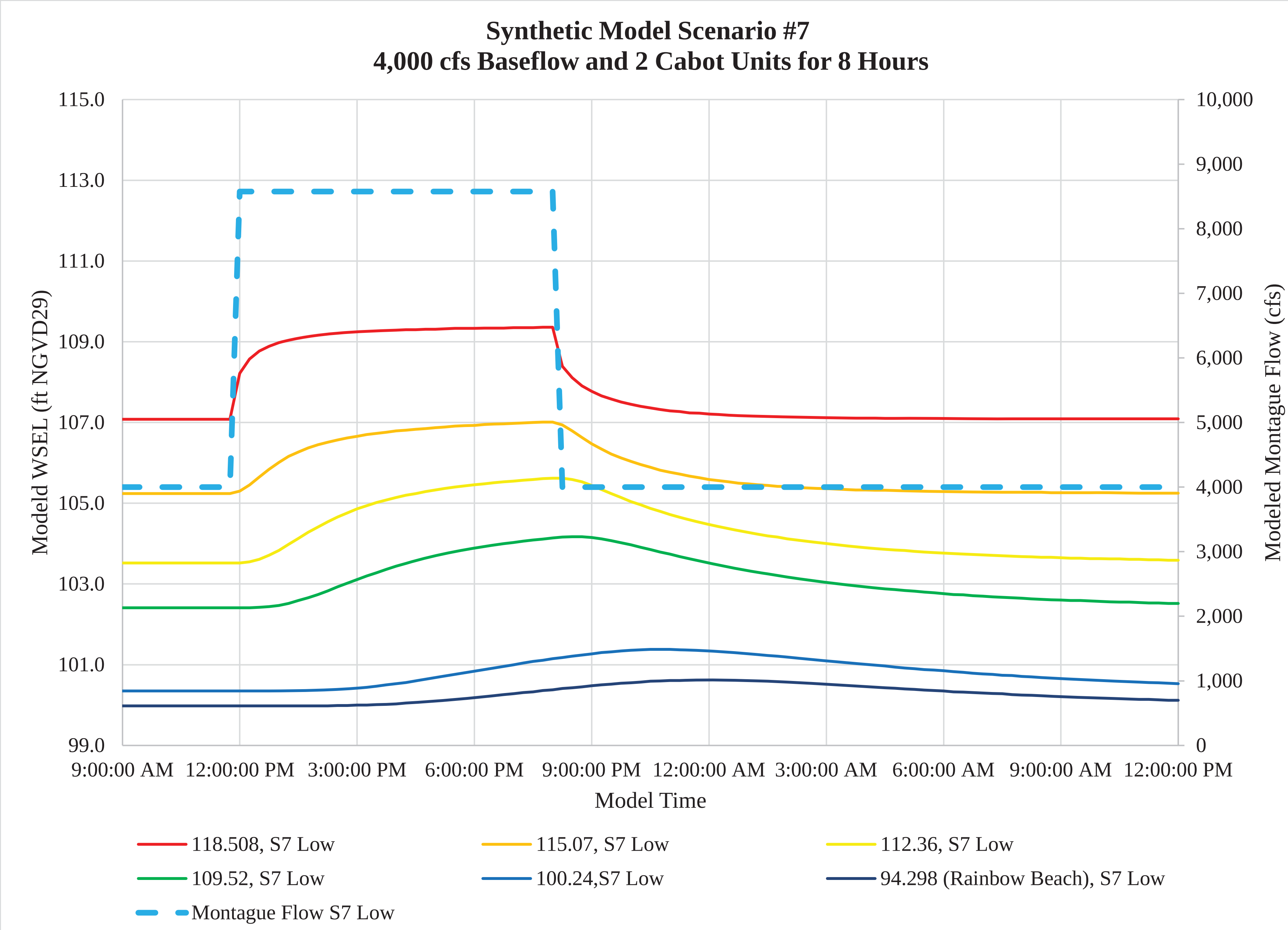
Synthetic Model Scenario #3
2,000 cfs Baseflow and 2 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
Modeled Montague Flow (cfs)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S3 Low
115.07, S3 Low
112.36, S3 Low
109.52, S3 Low
100.24,S3 Low
94.298 (Rainbow Beach), S3 Low
Montague Flow S3 Low

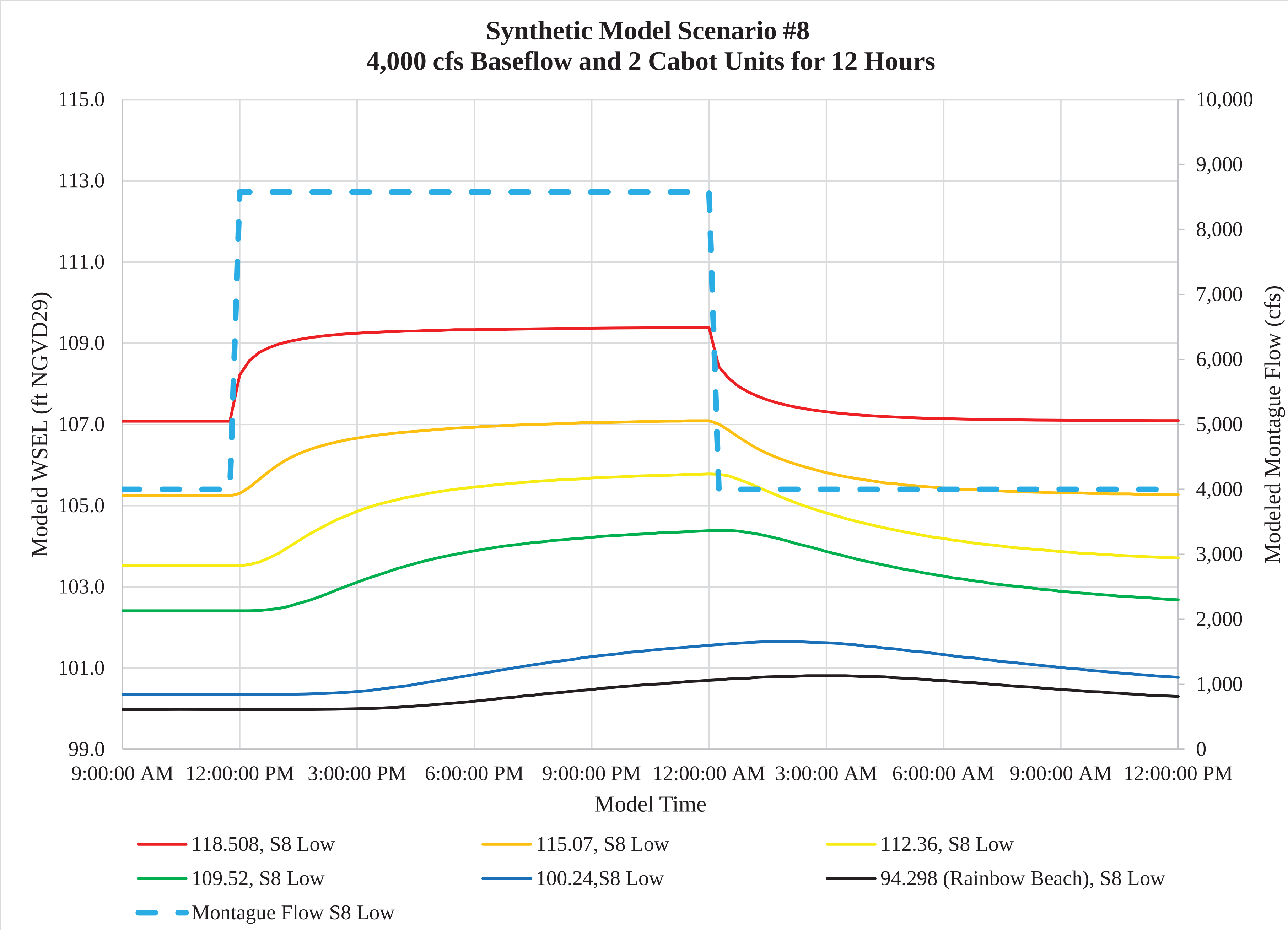

Synthetic Model Scenario #4
2,000 cfs Baseflow and 2 Cabot Units for 12 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
Modeled Montague Flow (cfs)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S4 Low
115.07, S4 Low
112.36, S4 Low
109.52, S4 Low
100.24,S4 Low
94.298 (Rainbow Beach), S4 Low
Montague Flow S4 Low



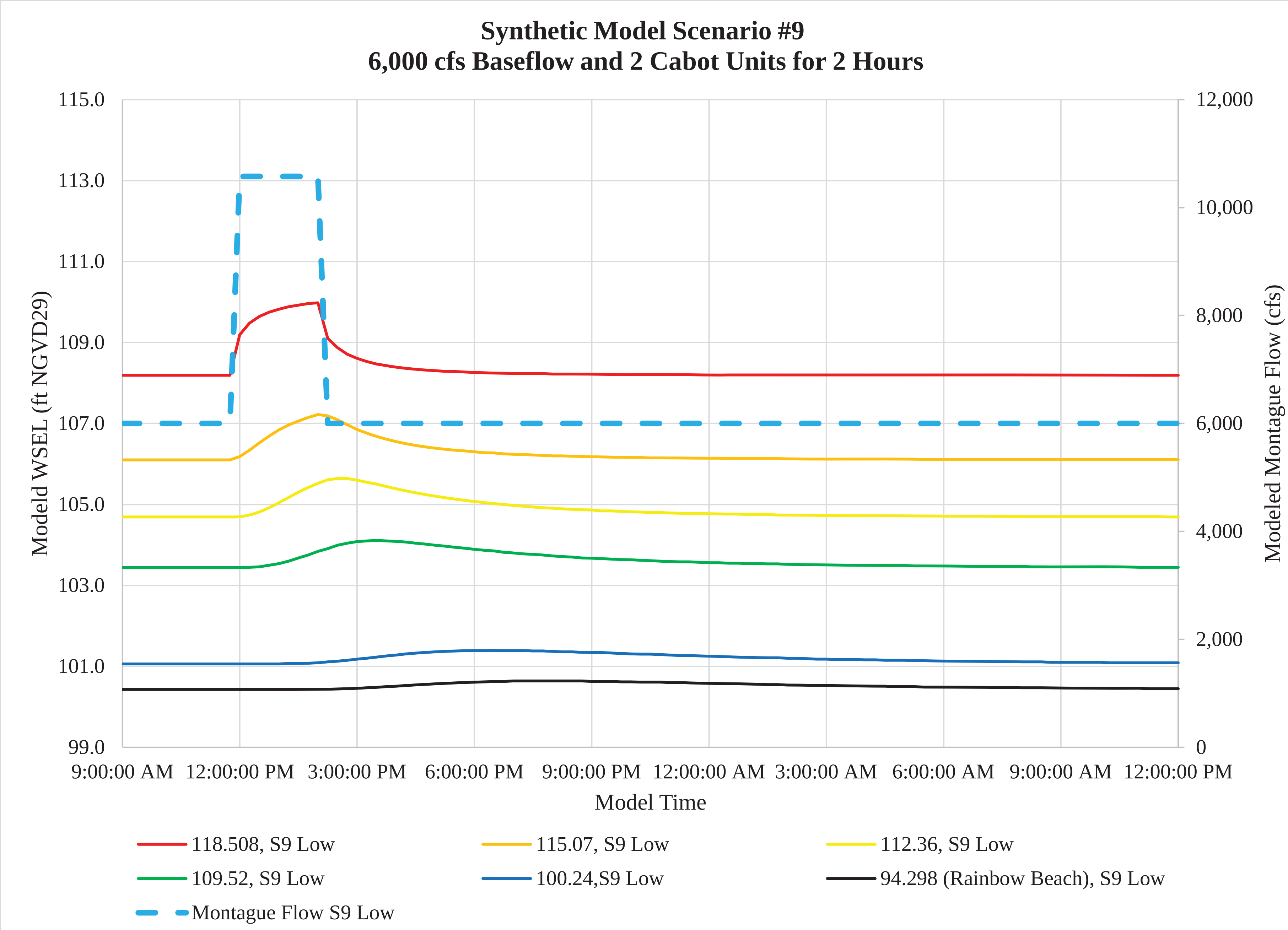
Synthetic Model Scenario #5
4,000 cfs Baseflow and 2 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S5 Low
115.07, S5 Low
112.36, S5 Low
109.52, S5 Low
100.24,S5 Low
94.298 (Rainbow Beach), S5 Low
Montague Flow S5 Low

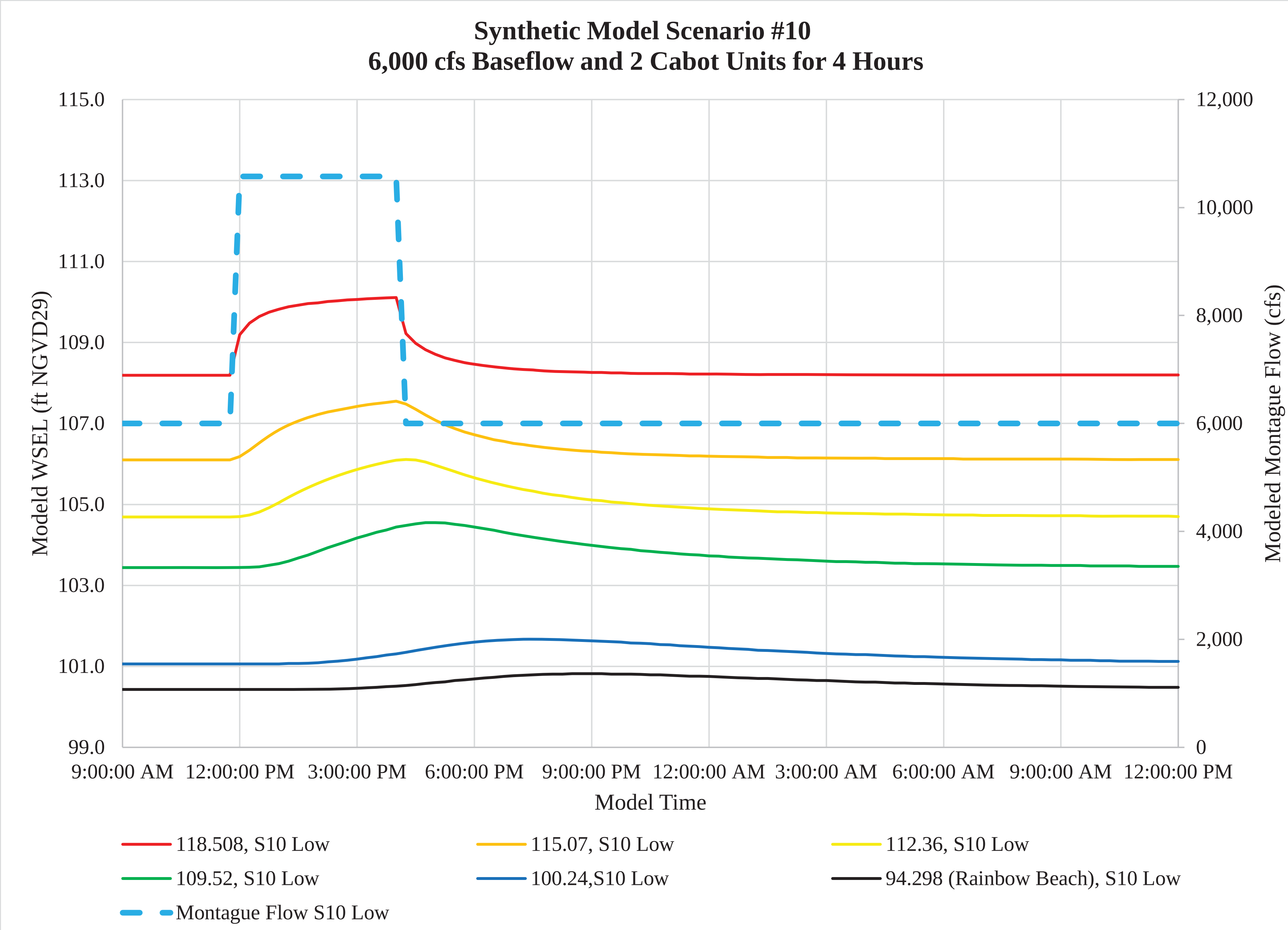

Synthetic Model Scenario #6
4,000 cfs Baseflow and 2 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeled Montague Flow (cfs)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S6 Low
115.07, S6 Low
112.36, S6 Low
109.52, S6 Low
100.24,S6 Low
94.298 (Rainbow Beach), S6 Low
Montague Flow S6 Low


Synthetic Model Scenario #7
4,000 cfs Baseflow and 2 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S7 Low
115.07, S7 Low
112.36, S7 Low
109.52, S7 Low
100.24,S7 Low
94.298 (Rainbow Beach), S7 Low
Montague Flow S7 Low

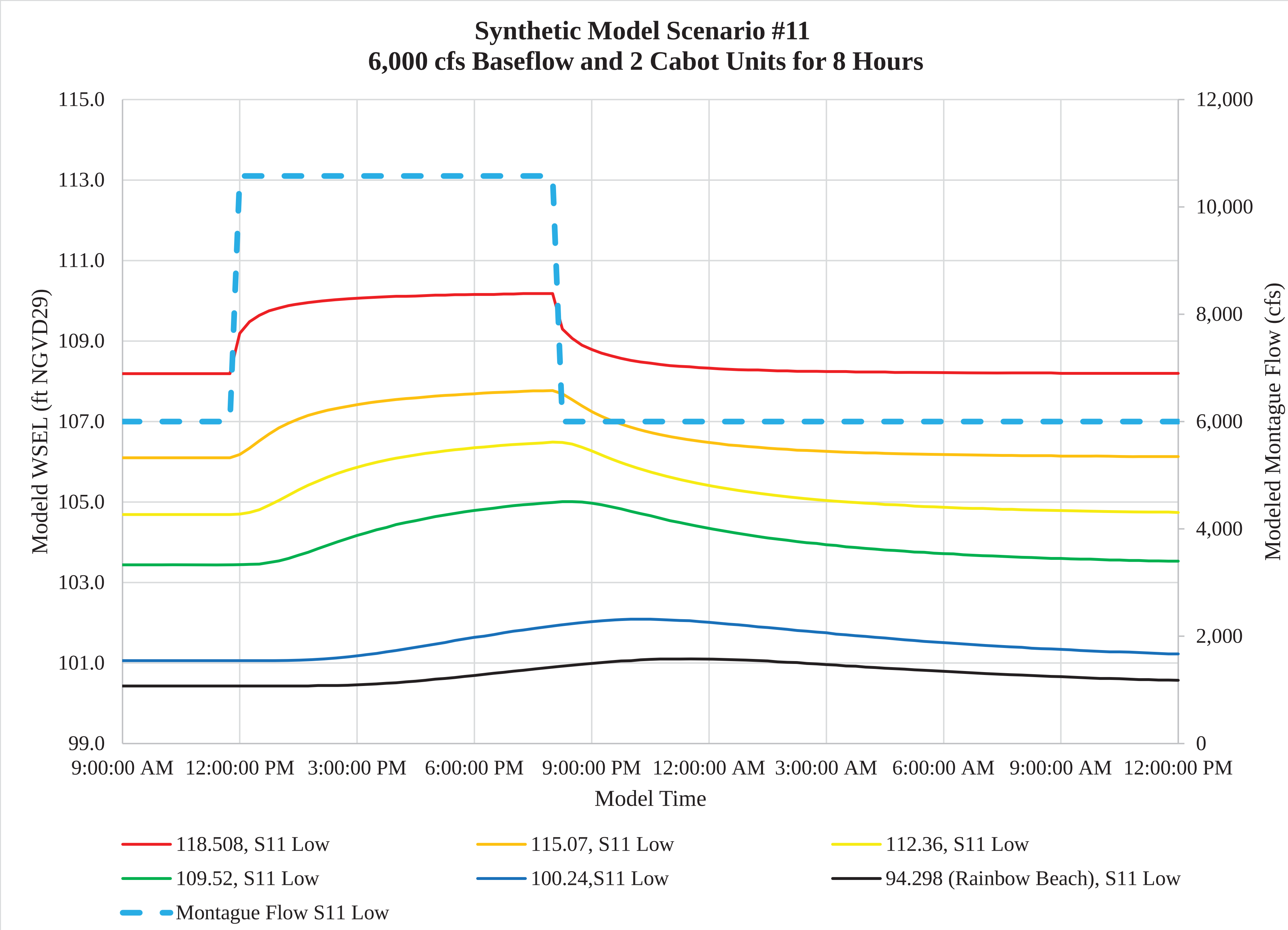


Synthetic Model Scenario #8
4,000 cfs Baseflow and 2 Cabot Units for 12 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeld WSEL (ft NGVD29)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S8 Low
115.07, S8 Low
112.36, S8 Low
109.52, S8 Low
100.24,S8 Low
94.298 (Rainbow Beach), S8 Low
Montague Flow S8 Low

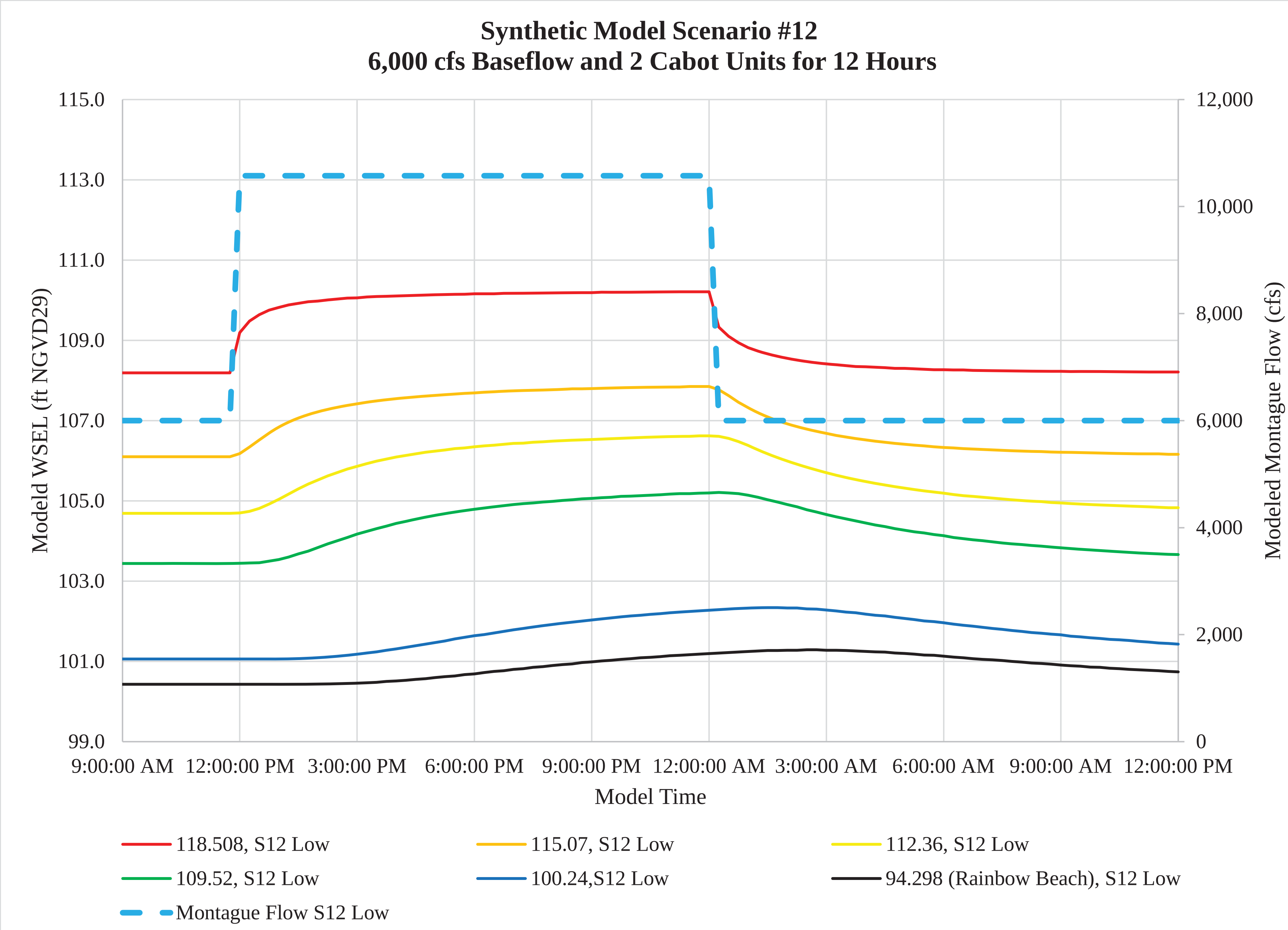

Synthetic Model Scenario #9
6,000 cfs Baseflow and 2 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S9 Low
115.07, S9 Low
112.36, S9 Low
109.52, S9 Low
100.24,S9 Low
94.298 (Rainbow Beach), S9 Low
Montague Flow S9 Low

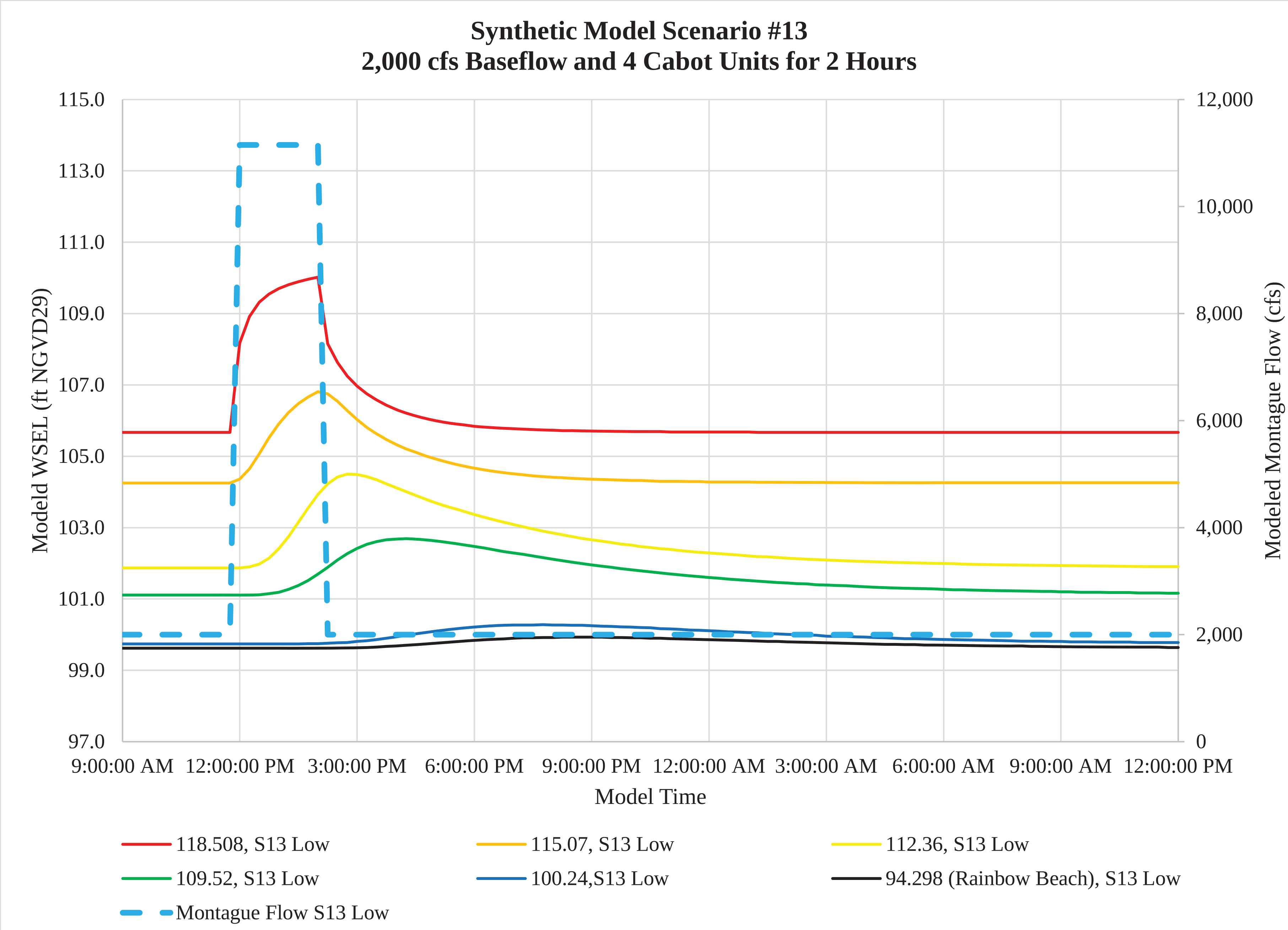


Synthetic Model Scenario #10
6,000 cfs Baseflow and 2 Cabot Units for 4 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S10 Low
115.07, S10 Low
112.36, S10 Low
109.52, S10 Low
100.24,S10 Low
94.298 (Rainbow Beach), S10 Low
Montague Flow S10 Low

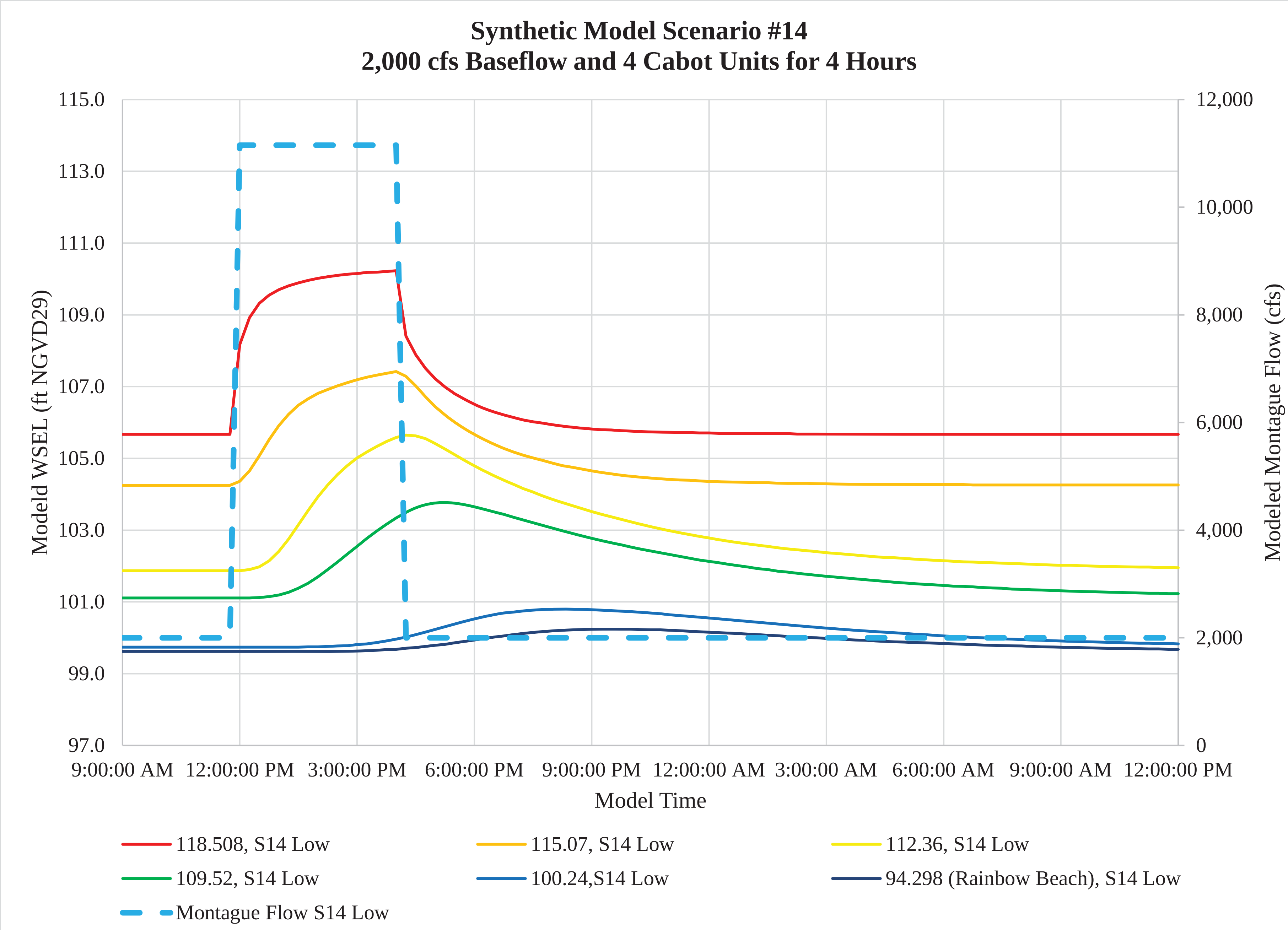


Synthetic Model Scenario #11
6,000 cfs Baseflow and 2 Cabot Units for 8 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S11 Low
115.07, S11 Low
112.36, S11 Low
109.52, S11 Low
100.24,S11 Low
94.298 (Rainbow Beach), S11 Low
Montague Flow S11 Low

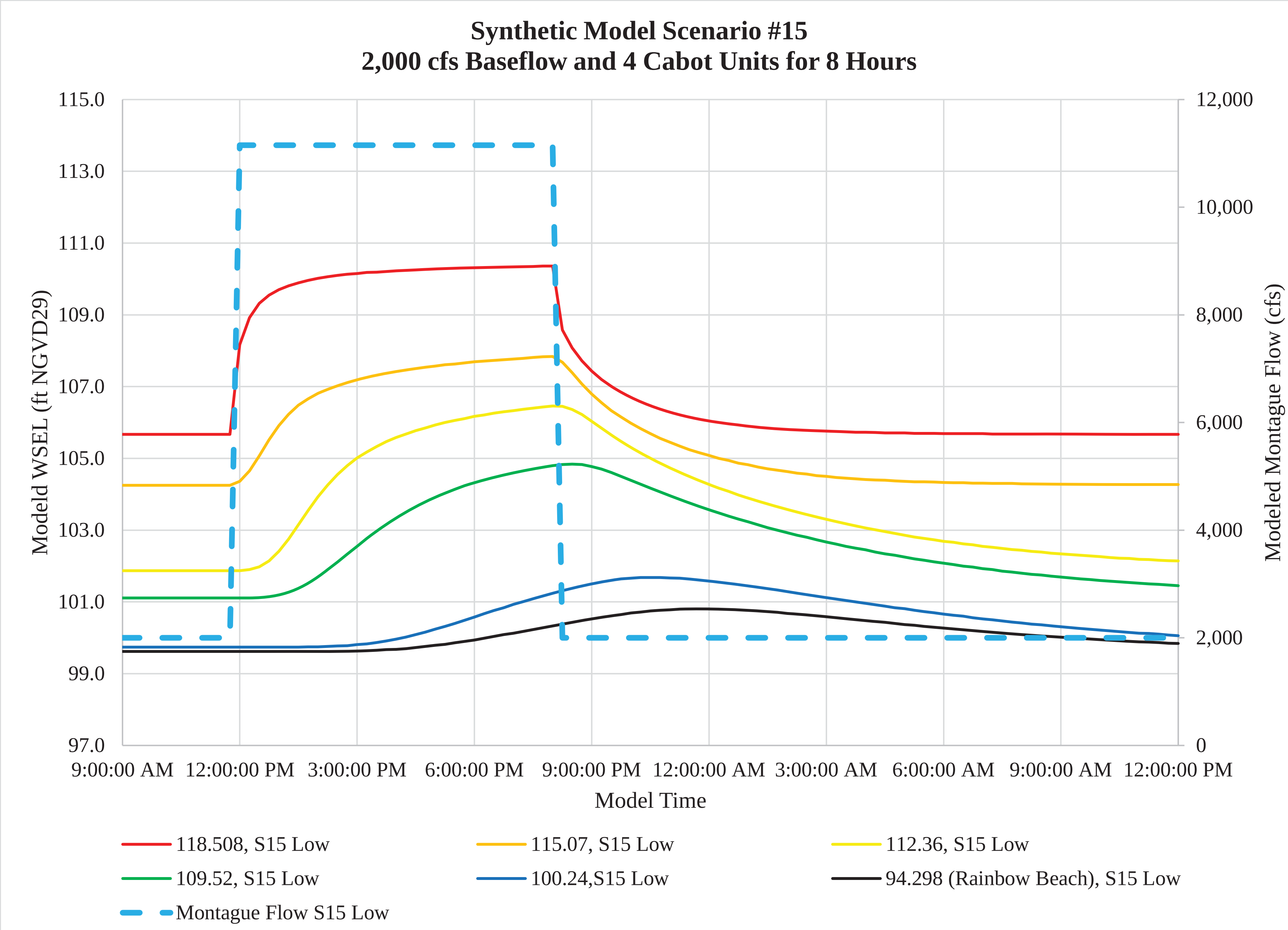

Synthetic Model Scenario #12
6,000 cfs Baseflow and 2 Cabot Units for 12 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S12 Low
115.07, S12 Low
112.36, S12 Low
109.52, S12 Low
100.24,S12 Low
94.298 (Rainbow Beach), S12 Low
Montague Flow S12 Low



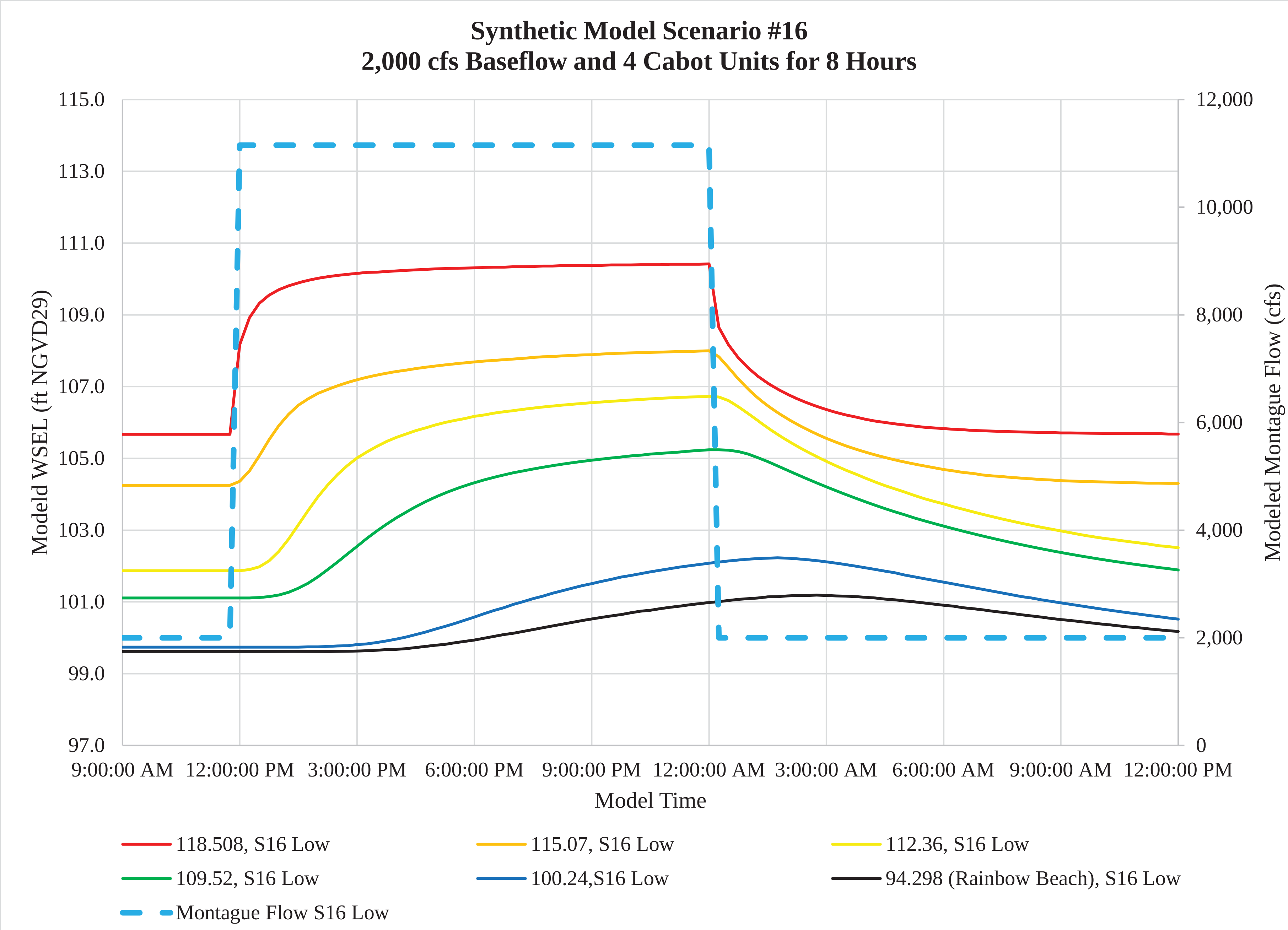
Synthetic Model Scenario #13
2,000 cfs Baseflow and 4 Cabot Units for 2 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
Modeld WSEL (ft NGVD29)
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S13 Low
115.07, S13 Low
112.36, S13 Low
109.52, S13 Low
100.24,S13 Low
94.298 (Rainbow Beach), S13 Low
Montague Flow S13 Low



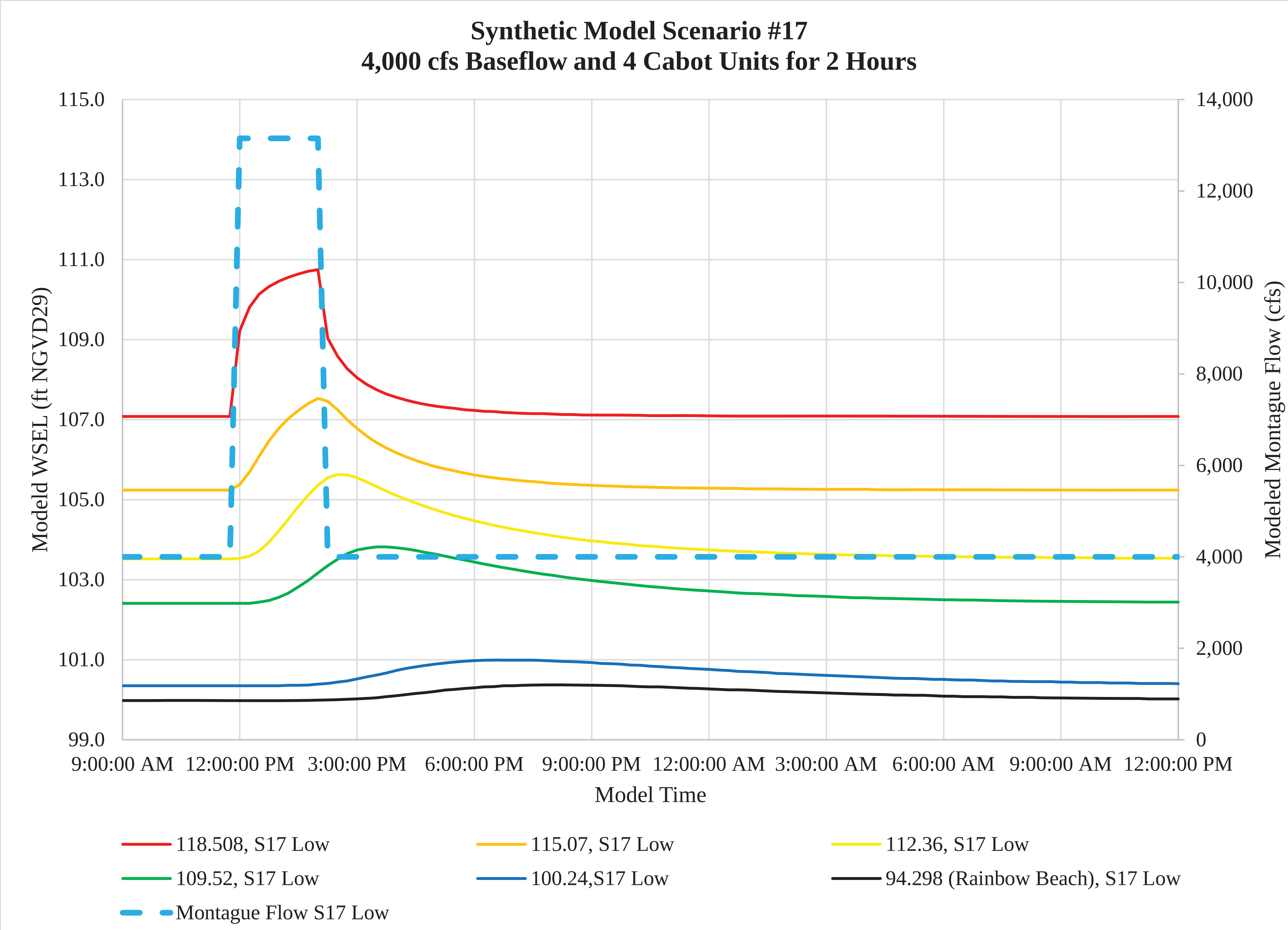
Synthetic Model Scenario #14
2,000 cfs Baseflow and 4 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S14 Low
115.07, S14 Low
112.36, S14 Low
109.52, S14 Low
100.24,S14 Low
94.298 (Rainbow Beach), S14 Low
Montague Flow S14 Low



Synthetic Model Scenario #15
2,000 cfs Baseflow and 4 Cabot Units for 8 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S15 Low
115.07, S15 Low
112.36, S15 Low
109.52, S15 Low
100.24,S15 Low
94.298 (Rainbow Beach), S15 Low
Montague Flow S15 Low

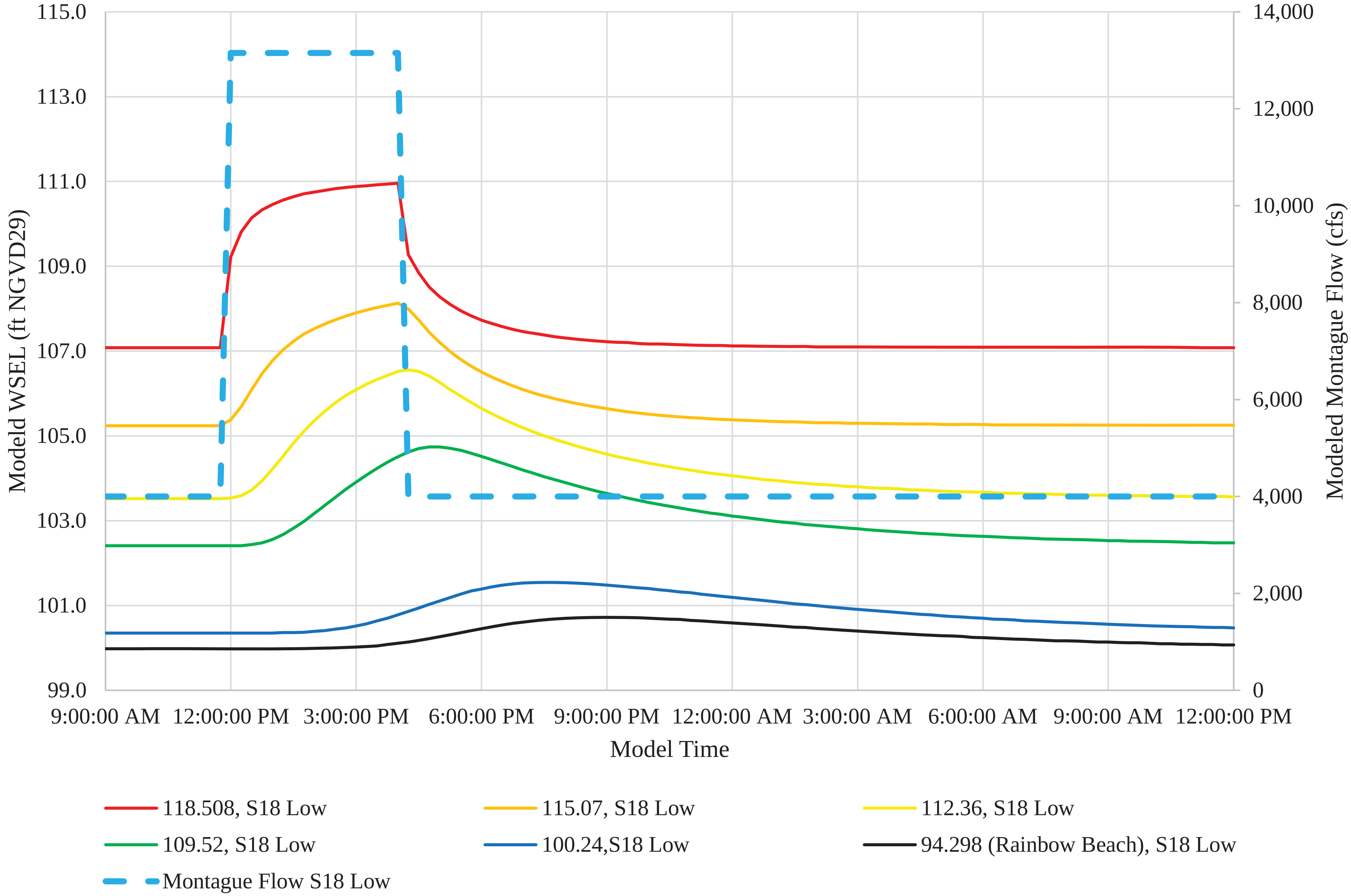


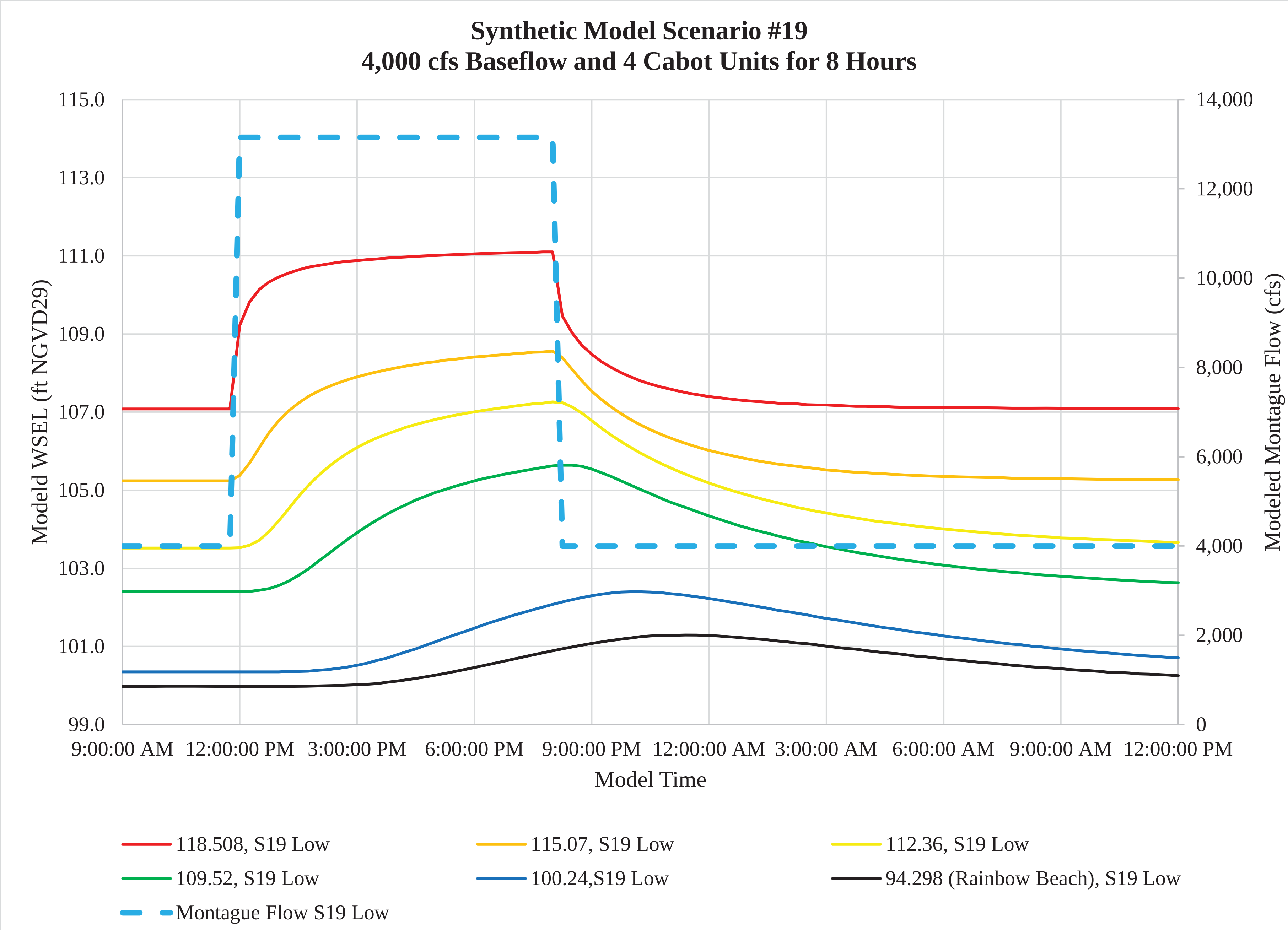
Synthetic Model Scenario #16
2,000 cfs Baseflow and 4 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S16 Low
115.07, S16 Low
112.36, S16 Low
109.52, S16 Low
100.24,S16 Low
94.298 (Rainbow Beach), S16 Low
Montague Flow S16 Low



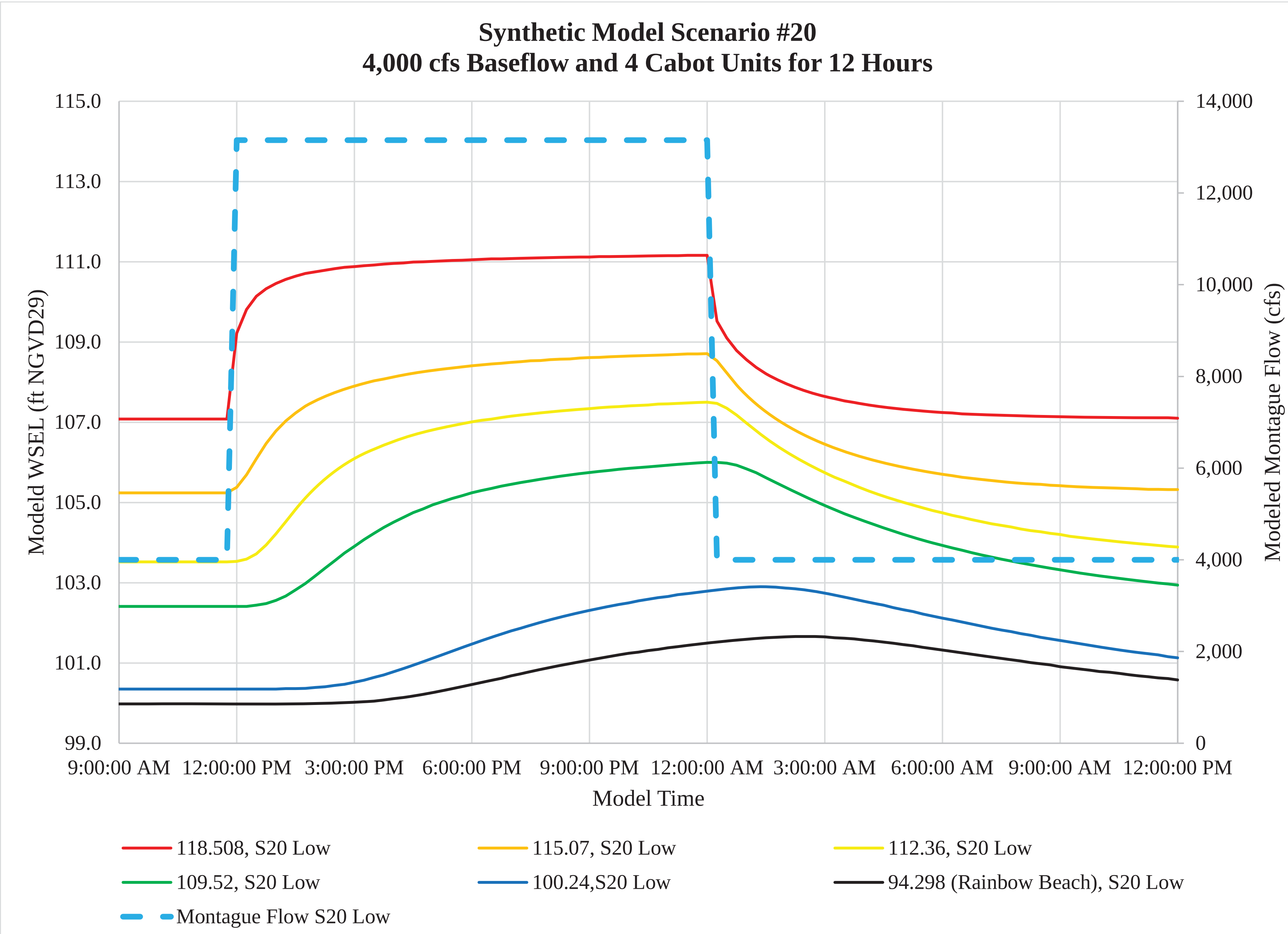
Synthetic Model Scenario #17
4,000 cfs Baseflow and 4 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S17 Low
115.07, S17 Low
112.36, S17 Low
109.52, S17 Low
100.24,S17 Low
94.298 (Rainbow Beach), S17 Low
Montague Flow S17 Low

Synthetic Model Scenario #18
4,000 cfs Baseflow and 4 Cabot Units for 4 Hours

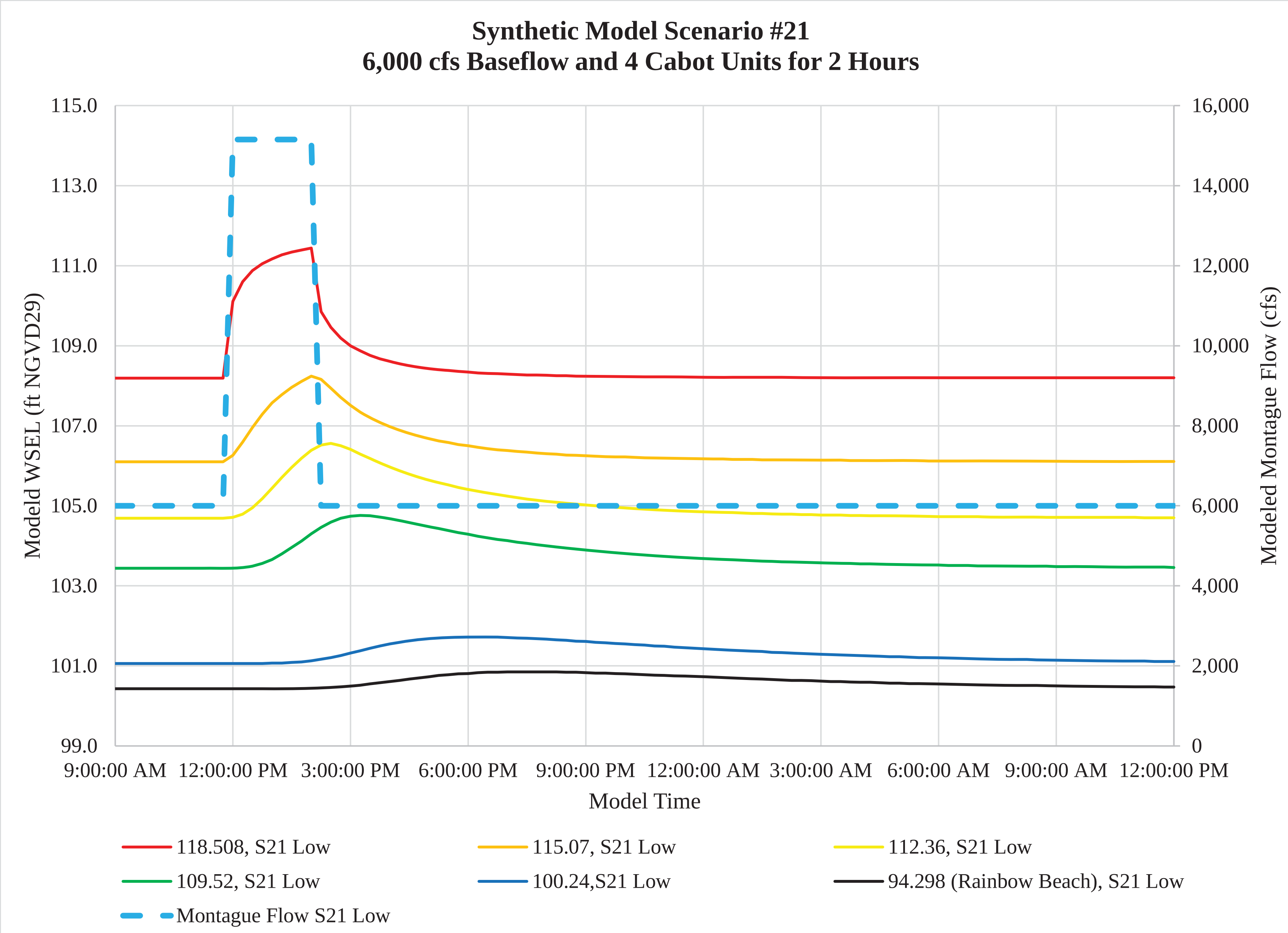




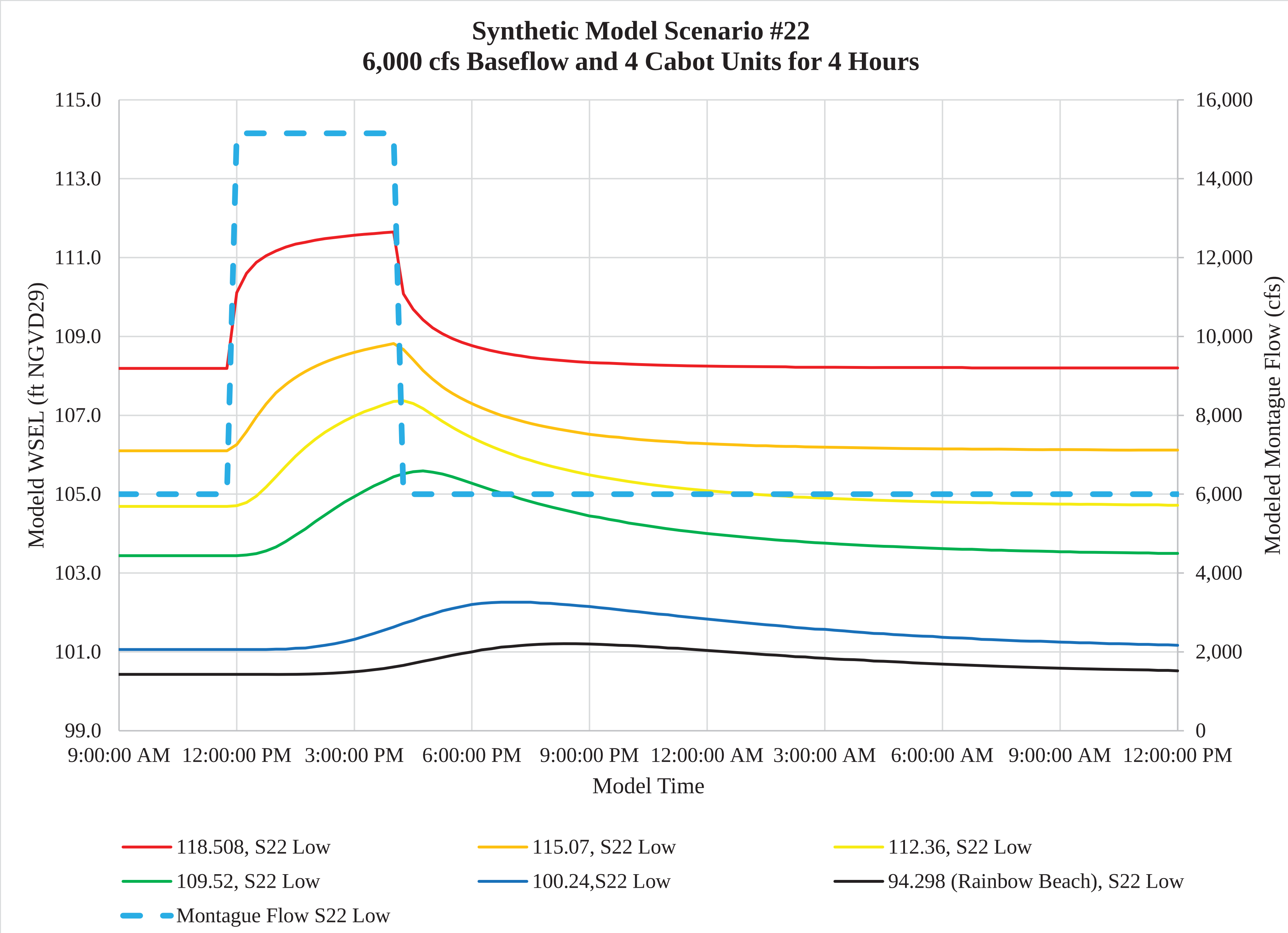
Synthetic Model Scenario #19
4,000 cfs Baseflow and 4 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S19 Low
115.07, S19 Low
112.36, S19 Low
109.52, S19 Low
100.24,S19 Low
94.298 (Rainbow Beach), S19 Low
Montague Flow S19 Low

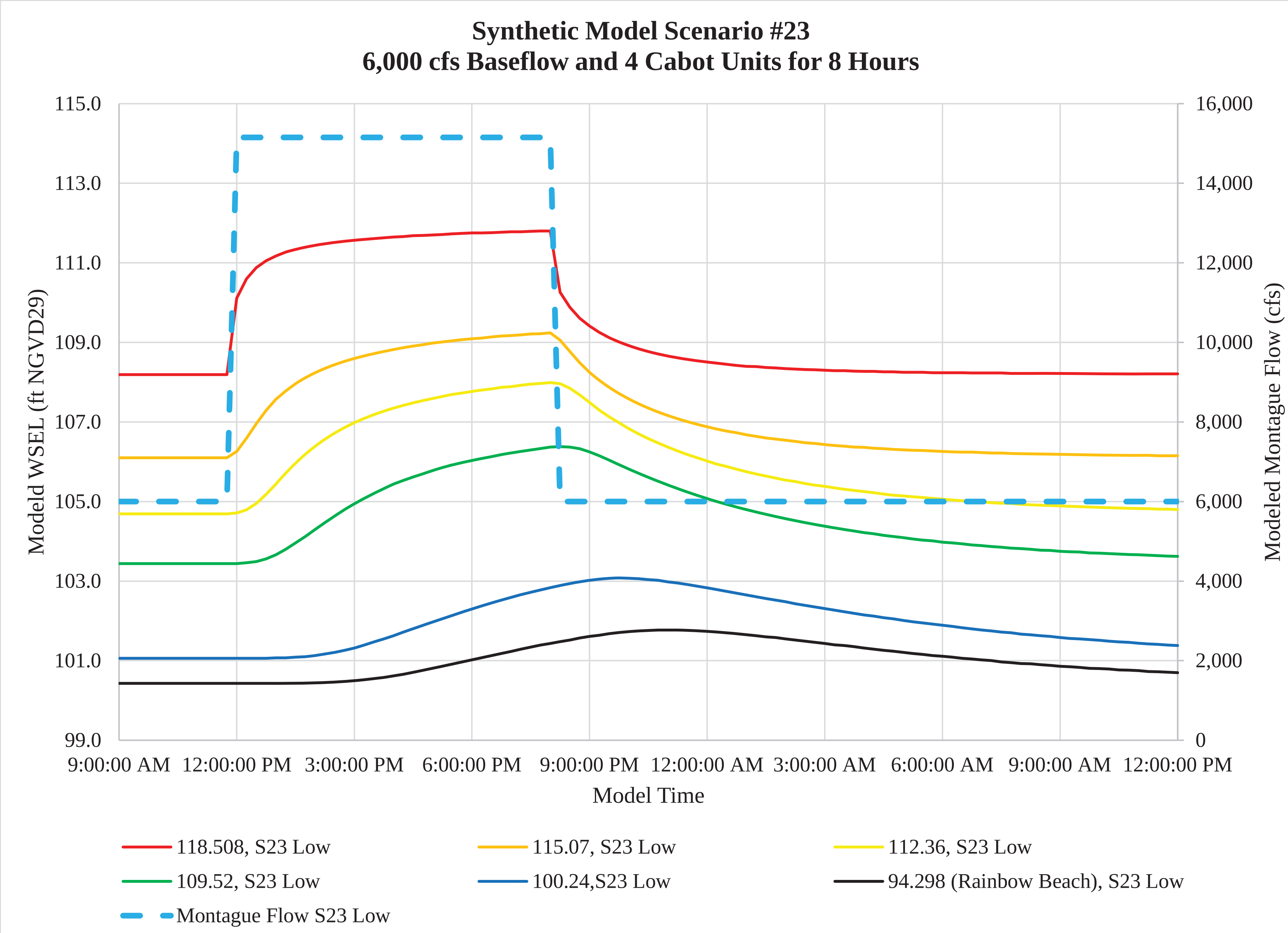


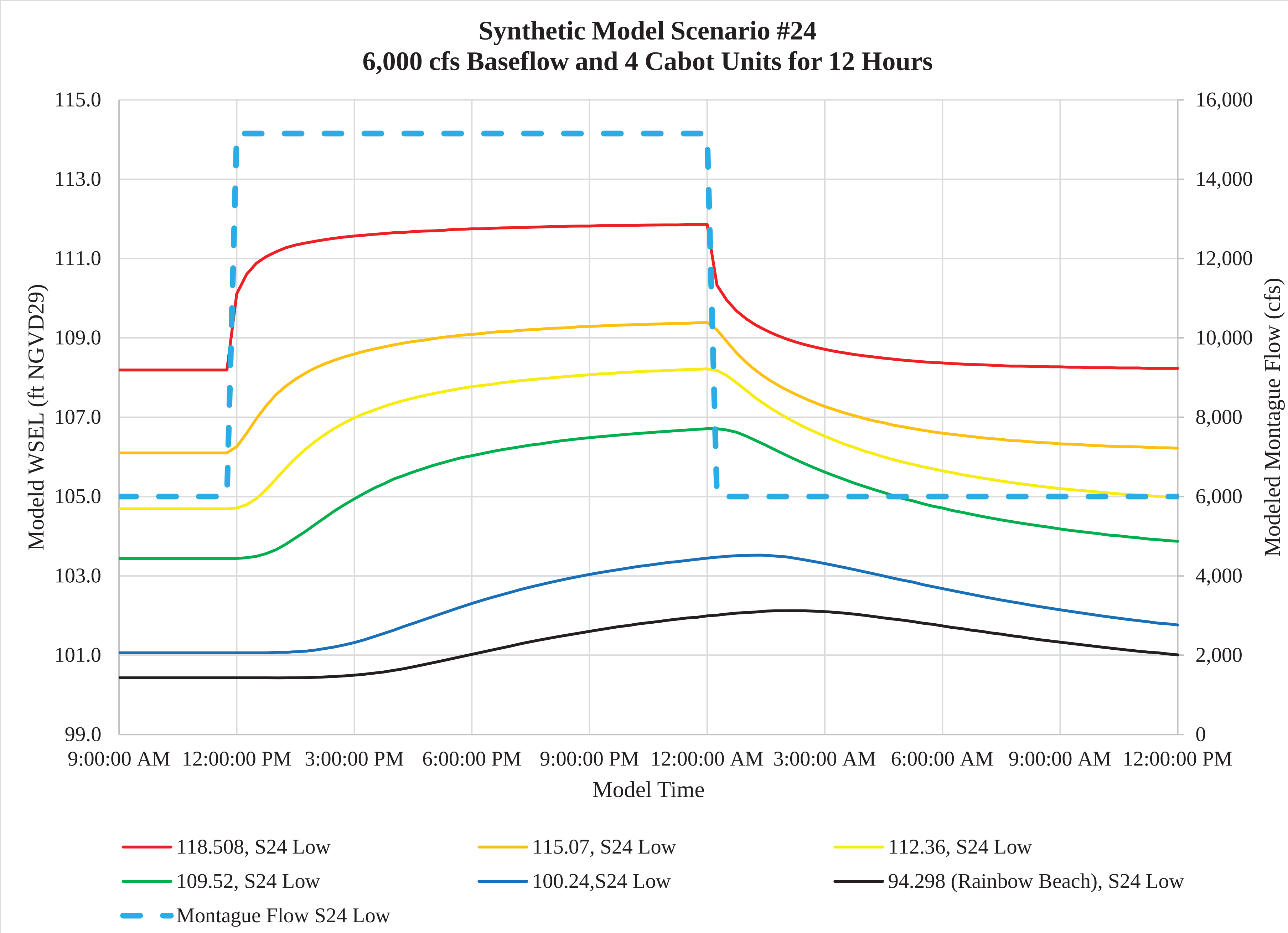
Synthetic Model Scenario #20
4,000 cfs Baseflow and 4 Cabot Units for 12 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeld WSEL (ft NGVD29)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S20 Low
115.07, S20 Low
112.36, S20 Low
109.52, S20 Low
100.24,S20 Low
94.298 (Rainbow Beach), S20 Low
Montague Flow S20 Low

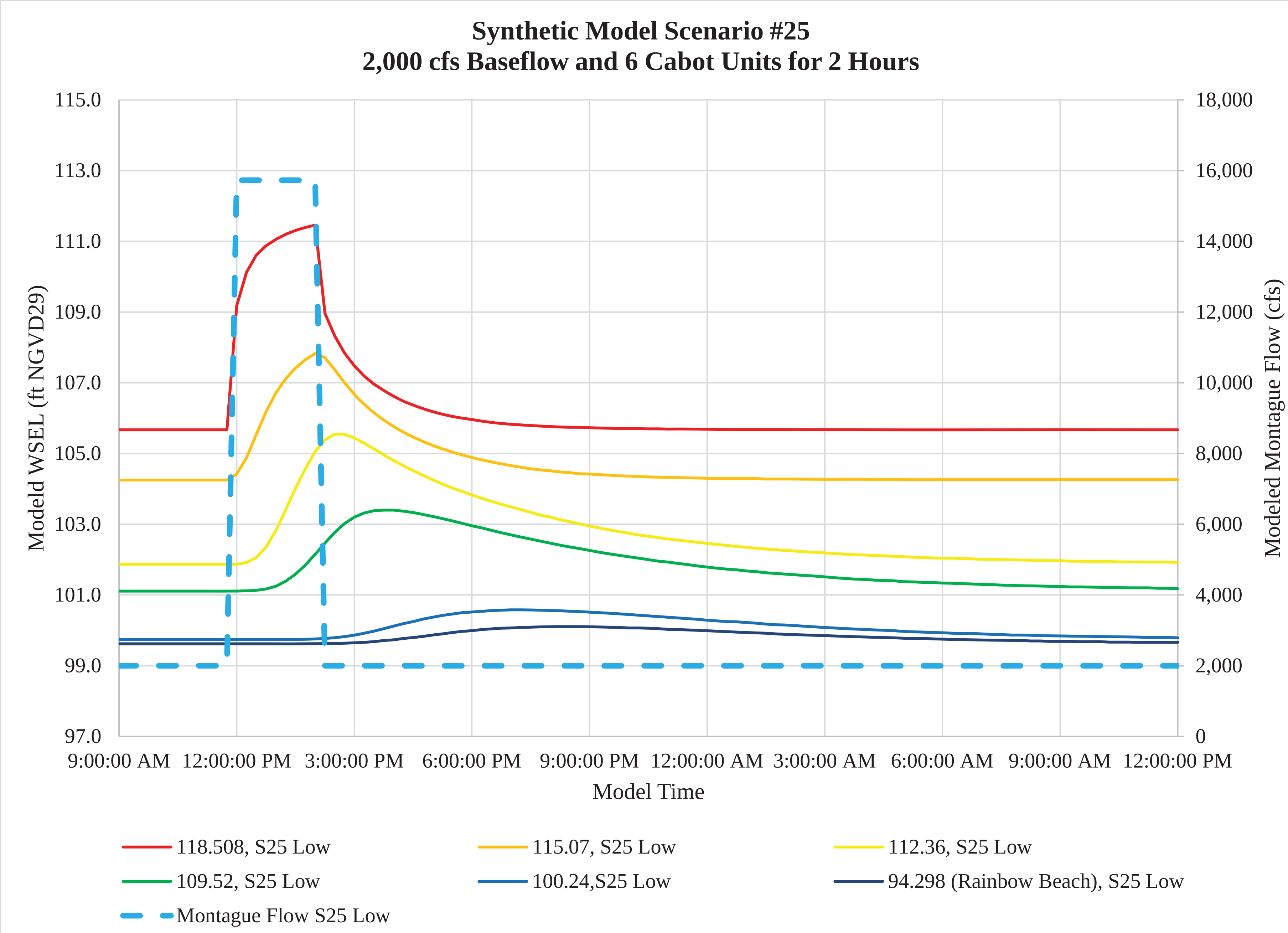


Synthetic Model Scenario #21
6,000 cfs Baseflow and 4 Cabot Units for 2 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S21 Low
115.07, S21 Low
112.36, S21 Low
109.52, S21 Low
100.24,S21 Low
94.298 (Rainbow Beach), S21 Low
Montague Flow S21 Low

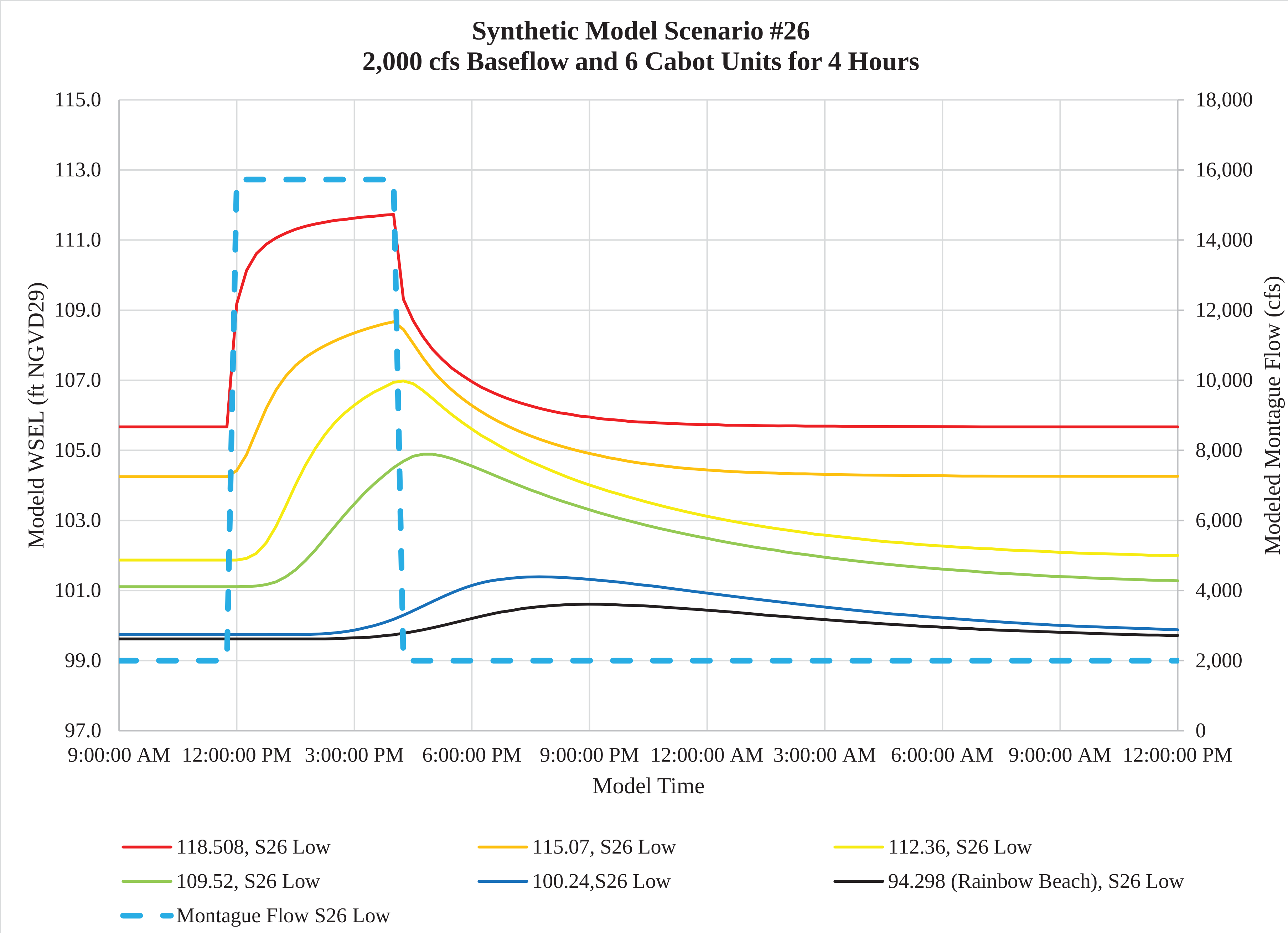

Synthetic Model Scenario #22
6,000 cfs Baseflow and 4 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S22 Low
115.07, S22 Low
112.36, S22 Low
109.52, S22 Low
100.24,S22 Low
94.298 (Rainbow Beach), S22 Low
Montague Flow S22 Low


Synthetic Model Scenario #23
6,000 cfs Baseflow and 4 Cabot Units for 8 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S23 Low
115.07, S23 Low
112.36, S23 Low
109.52, S23 Low
100.24,S23 Low
94.298 (Rainbow Beach), S23 Low
Montague Flow S23 Low


Synthetic Model Scenario #24
6,000 cfs Baseflow and 4 Cabot Units for 12 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeled Montague Flow (cfs)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S24 Low
115.07, S24 Low
112.36, S24 Low
109.52, S24 Low
100.24,S24 Low
94.298 (Rainbow Beach), S24 Low
Montague Flow S24 Low



Synthetic Model Scenario #25
2,000 cfs Baseflow and 6 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
Modeled Montague Flow (cfs)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S25 Low
115.07, S25 Low
112.36, S25 Low
109.52, S25 Low
100.24,S25 Low
94.298 (Rainbow Beach), S25 Low
Montague Flow S25 Low


Synthetic Model Scenario #26
2,000 cfs Baseflow and 6 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
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18,000
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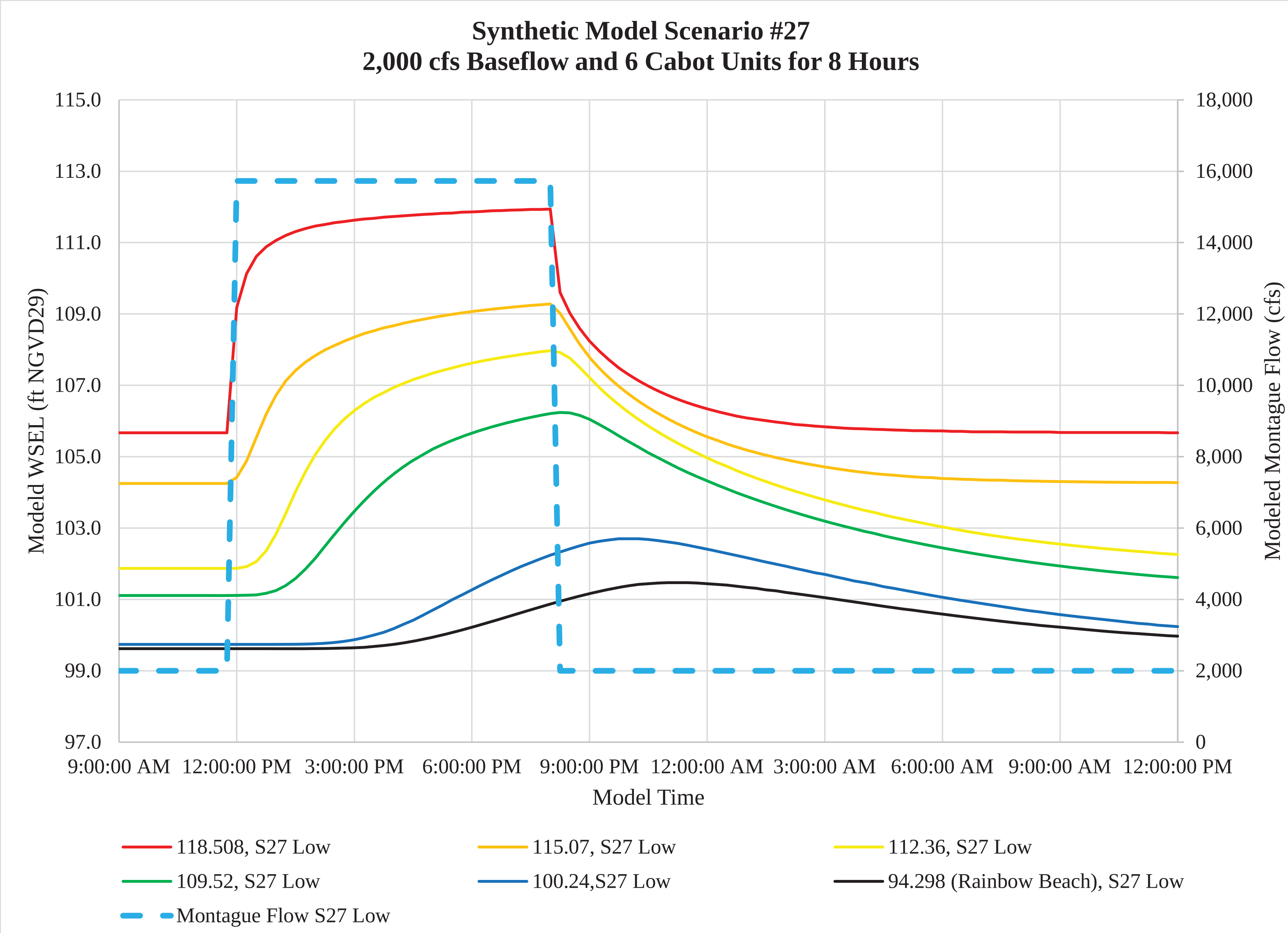
9:00:00 AM
12:00:00 PM
Model Time
118.508, S26 Low
115.07, S26 Low
112.36, S26 Low
109.52, S26 Low
100.24,S26 Low
94.298 (Rainbow Beach), S26 Low
Montague Flow S26 Low



Synthetic Model Scenario #27
2,000 cfs Baseflow and 6 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
Model Time
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
97.0
18,000
16,000
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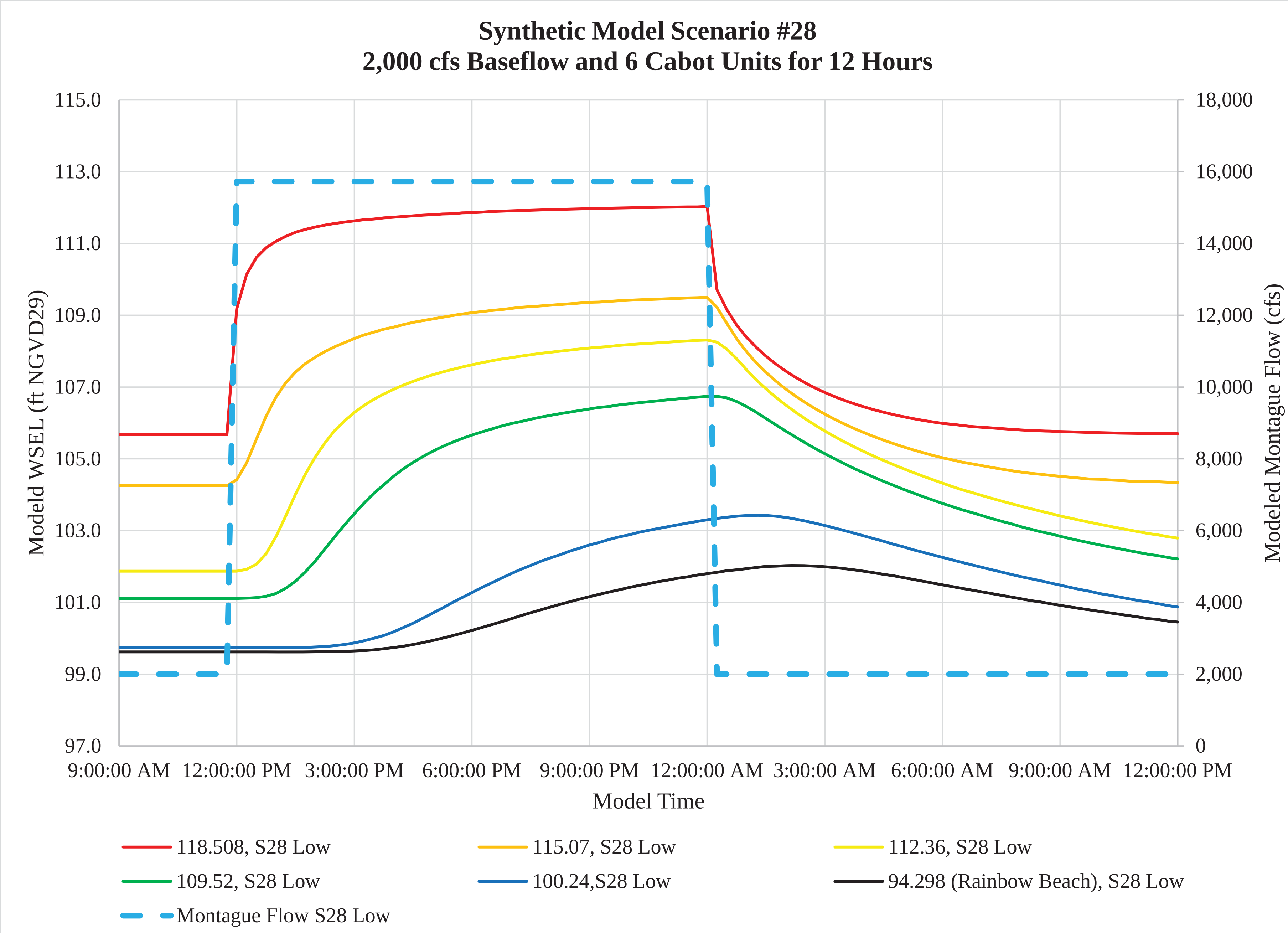
9:00:00 AM
12:00:00 PM
118.508, S27 Low
115.07, S27 Low
112.36, S27 Low
109.52, S27 Low
100.24,S27 Low
94.298 (Rainbow Beach), S27 Low
Montague Flow S27 Low



Synthetic Model Scenario #28
2,000 cfs Baseflow and 6 Cabot Units for 12 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
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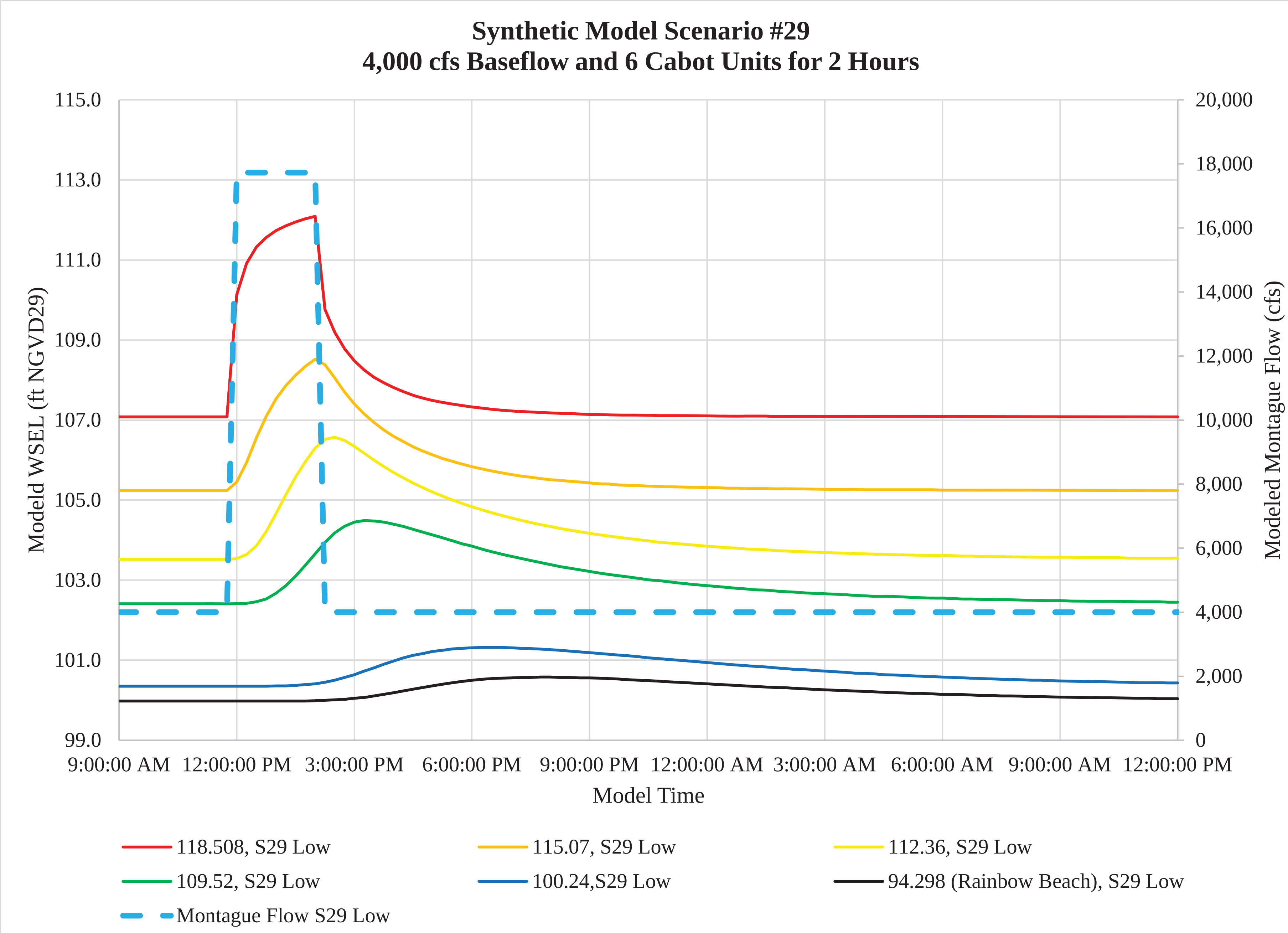
9:00:00 AM
12:00:00 PM
Model Time
118.508, S28 Low
115.07, S28 Low
112.36, S28 Low
109.52, S28 Low
100.24,S28 Low
94.298 (Rainbow Beach), S28 Low
Montague Flow S28 Low



Synthetic Model Scenario #29
4,000 cfs Baseflow and 6 Cabot Units for 2 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeled Montague Flow (cfs)
20,000
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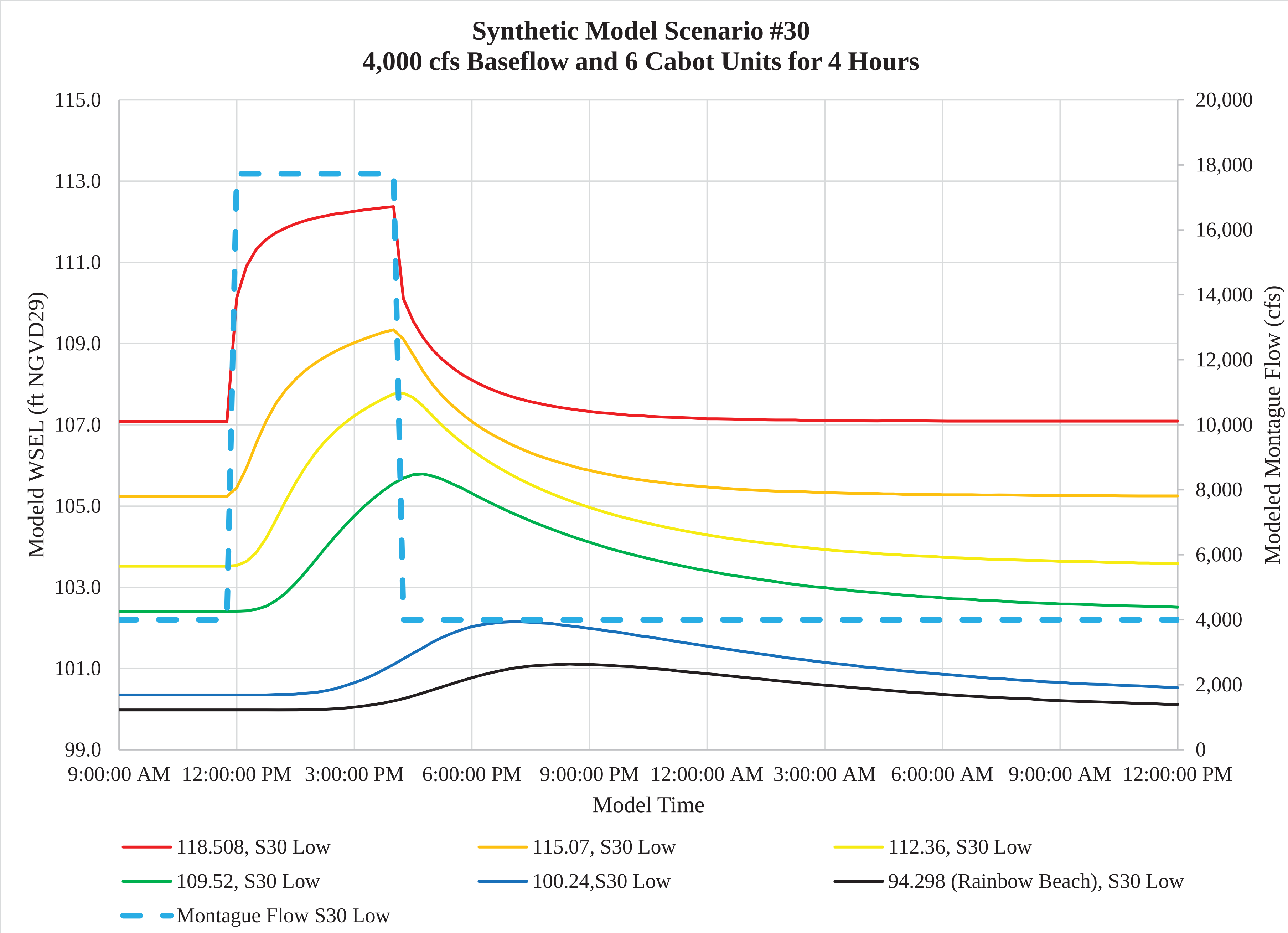
9:00:00 AM
12:00:00 PM
Model Time
118.508, S29 Low
115.07, S29 Low
112.36, S29 Low
109.52, S29 Low
100.24,S29 Low
94.298 (Rainbow Beach), S29 Low
Montague Flow S29 Low


Synthetic Model Scenario #30
4,000 cfs Baseflow and 6 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeled Montague Flow (cfs)
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6:00:00 PM
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12:00:00 AM
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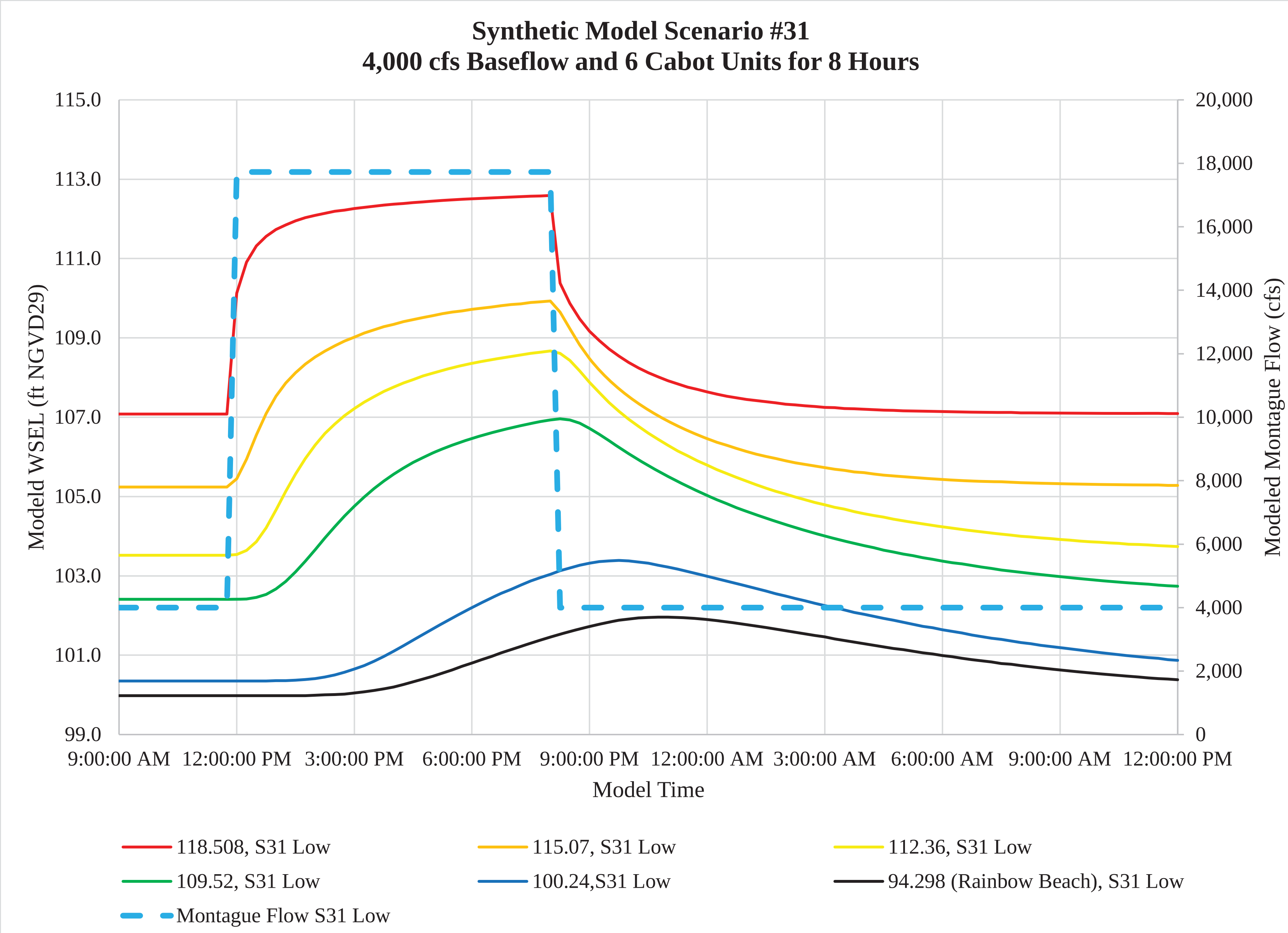
9:00:00 AM
12:00:00 PM
Model Time
118.508, S30 Low
115.07, S30 Low
112.36, S30 Low
109.52, S30 Low
100.24,S30 Low
94.298 (Rainbow Beach), S30 Low
Montague Flow S30 Low


Synthetic Model Scenario #31
4,000 cfs Baseflow and 6 Cabot Units for 8 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
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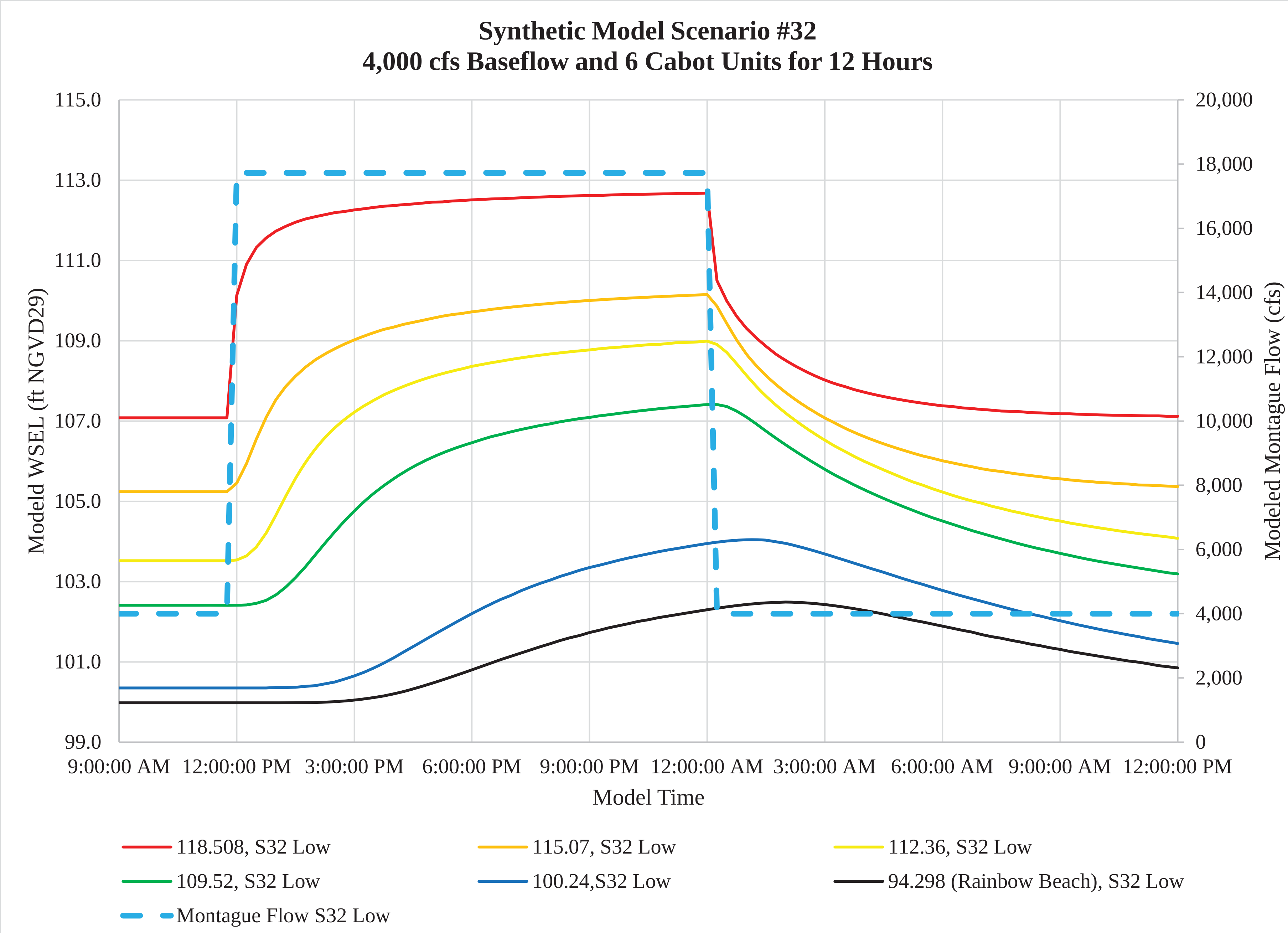
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S31 Low
115.07, S31 Low
112.36, S31 Low
109.52, S31 Low
100.24,S31 Low
94.298 (Rainbow Beach), S31 Low
Montague Flow S31 Low



Synthetic Model Scenario #32
4,000 cfs Baseflow and 6 Cabot Units for 12 Hours
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
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18,000
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9:00:00 AM
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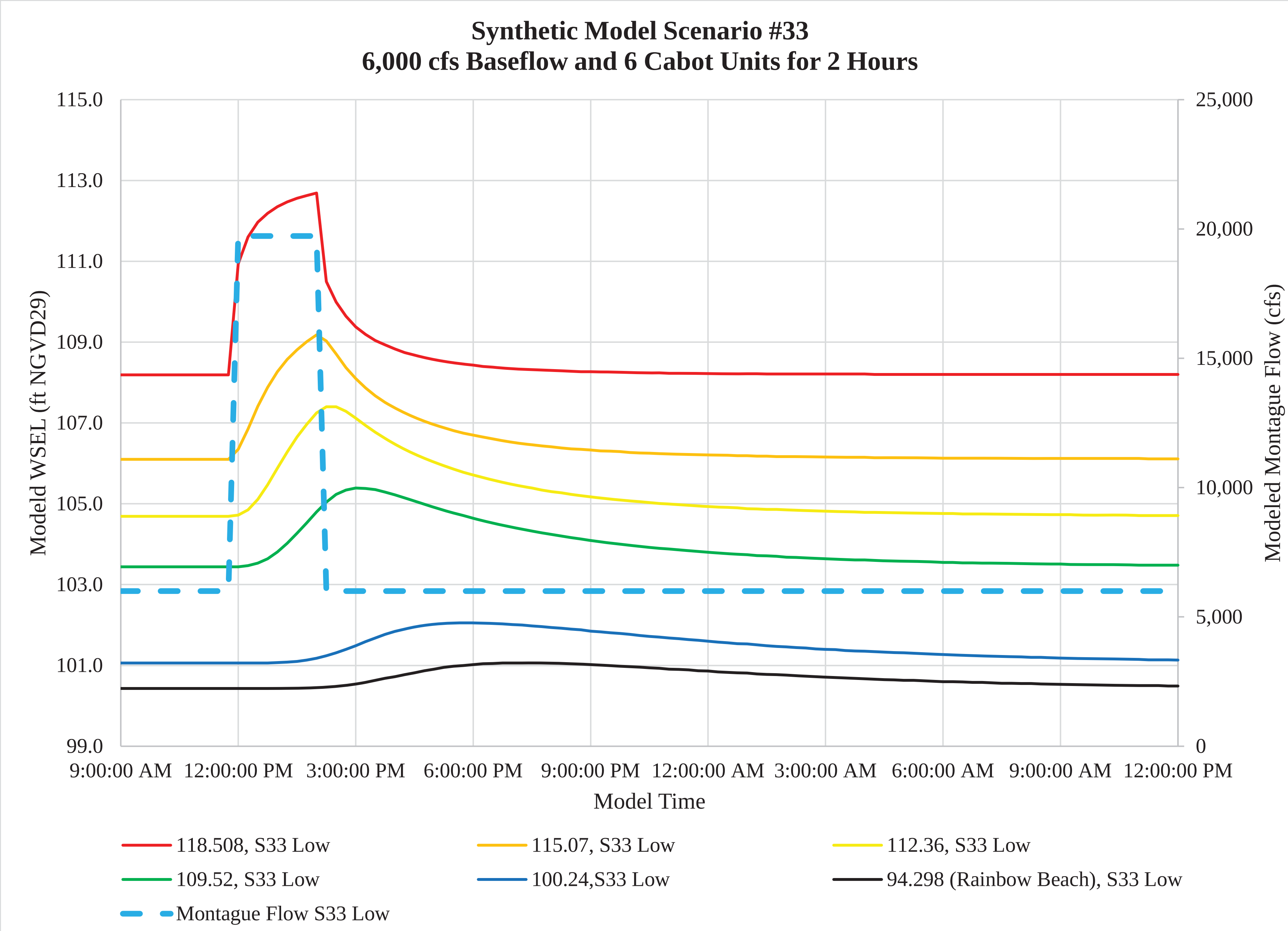
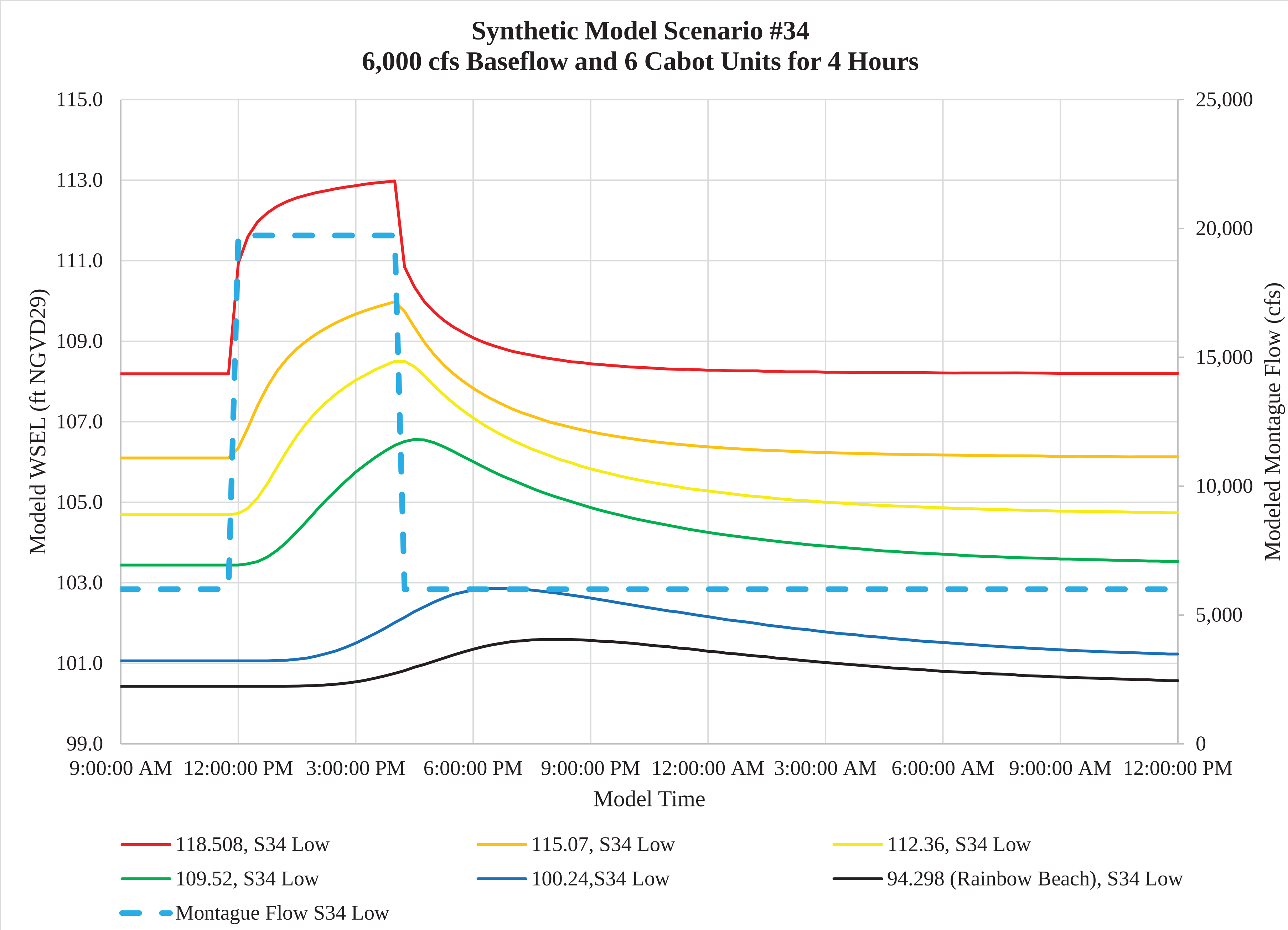
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S32 Low
115.07, S32 Low
112.36, S32 Low
109.52, S32 Low
100.24,S32 Low
94.298 (Rainbow Beach), S32 Low
Montague Flow S32 Low


Synthetic Model Scenario #33
6,000 cfs Baseflow and 6 Cabot Units for 2 Hours
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
25,000
20,000
15,000
10,000
5,000
0
Modeld WSEL (ft NGVD29)
Modeled Montague Flow (cfs)
9:00:00 AM
12:00:00 PM
3:00:00 PM
6:00:00 PM
9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S33 Low
115.07, S33 Low
112.36, S33 Low
109.52, S33 Low
100.24,S33 Low
94.298 (Rainbow Beach), S33 Low
Montague Flow S33 Low



Synthetic Model Scenario #34
6,000 cfs Baseflow and 6 Cabot Units for 4 Hours
Modeld WSEL (ft NGVD29)
115.0
113.0
111.0
109.0
107.0
105.0
103.0
101.0
99.0
Modeled Montague Flow (cfs)
25,000
20,000
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9:00:00 PM
12:00:00 AM
3:00:00 AM
6:00:00 AM
9:00:00 AM
12:00:00 PM
Model Time
118.508, S34 Low
115.07, S34 Low
112.36, S34 Low
109.52, S34 Low
100.24,S34 Low
94.298 (Rainbow Beach), S34 Low
Montague Flow S34 Low

APPENDIX D: RESPONSE TO USFWS COMMENTS ON JANUARY 9, 2020 DRAFT

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FirstLight provided a draft of this draft biological assessment to the USFWS on January 9, 2020. FirstLight met with the USFWS on June 2, 2020 to discuss the draft. On August 27, 2020, the USFWS provided written comments on the draft. FirstLight's responses to these comments are provided below. USFWS comments are included in italic text and FirstLight's responses are in bold.

1.2 Federally Listed Species Considered in this Biological Assessment
Northern Long-Eared Bat

USFWS Comment 1:

FirstLight proposes to implement a seasonal tree clearing restriction for trees greater than 3 inches diameter at breast height, between June 1 and July 31, to avoid the time period when the northern long-eared bat may be occupying nearby roost trees. FirstLight states this measure would result in the Project having no effect on the species.

Although the proposed measure is consistent with the activities analyzed in the Service's January 5, 2016, Programmatic Biological Opinion (PBO) and associated 4(d) rule, it still may result in adverse effects. While the time-of-year restriction for tree clearing to occur outside of June and July reduces the likelihood of adverse effects on adult and flightless young, it does not avoid all adverse effects. The northern long-eared bat is active from approximately April 1 through October 31, so a time-of-year restriction for tree clearing activities that avoids this active period would be needed to avoid direct adverse effects to northern long-eared bats.

Additionally, on January 28, 2020, the U.S. District Court for the District of Columbia remanded the Service's listing decision for the northern long-eared bat. The Service is in the process of reconsidering our listing decision. While the species' threatened status and 4(d) rule remain in place during this process, both could change as a result of the Service's status review for the northern long-eared bat. Any change in the 4(d) rule could necessitate reinitiation of consultation under section 7 of the ESA. Therefore, the Service recommends that FirstLight, as the non-Federal representative of the Federal Energy Regulatory Commission, consult on the northern long-eared bat as if the 4(d) rule were not in place.

FirstLight's Response:

In response to the USFWS comments, FirstLight has expanded proposed restrictions for tree clearing activities that could impact the Northern Long-eared Bat. The revised proposed restrictions are:

The Licensee shall implement the following measures to protect northern long-eared bat habitat: (1) avoid cutting trees equal to or greater than 3 inches in diameter at breast height within the project boundary from April 1 through October 31, unless they pose an immediate threat to human life or property; and (2) where trees need to be removed, only remove trees between November 1 and March 31.

At other hydroelectric projects, FERC has indicated that this restriction would result in a "may affect, but not likely to adversely affect" finding.

3.5 Proposed Environmental Measures

USFWS Comment 2:

FirstLight proposes to provide eight recreational whitewater boating flow releases from the Turners Falls Dam, ranging from 2,500 cubic feet per second (cfs) up to 5,000 cfs for a duration of 4 hours per event. Five of these releases are proposed to occur during the active period for the Puritan tiger beetle (PTB). The DBA should include an analysis of potential impacts of these releases on water levels at Rainbow Beach (i.e., timing, duration, level of inundation, etc.).

FirstLight's Response:

As part of the FirstLight's relicensing proposal, FirstLight plans to implement a schedule of whitewater releases from the Turners Falls Dam, nearly 28 miles upstream of Rainbow Beach. These releases would be contingent on the Natural Routed Flow (NRF) inflow to the Turners Falls Impoundment being equal to or greater than the releases. Five of the releases would occur on Saturdays during the adult active period for PTB during July, August, and September, and three other releases would occur in October as shown in the table below.

FirstLight is also proposing higher minimum flow releases from the Turners Falls Dam and from Station No. 1, which is located 1.1 miles downstream of the Turners Falls Dam (Table D-1). With these minimum flows being provided, FirstLight would need to release only 700 cfs of additional flow to the bypass reach to provide the whitewater releases during July and August. An increase in 700 cfs in the bypass reach would result in miniscule effects at Rainbow Beach once the flow joins other likely flows from Station No. 1, Cabot Station, and is attenuated over such a long distance downstream. In September when proposed whitewater releases are 3,500 cfs for 4 hours, 2,000 cfs of additional flow would be required to be released to the bypass reach. It is anticipated that Cabot Station will need to reduce generation by one unit to provide the whitewater flow release at the dam. Thus, the flow in the river below the Project would be similar during the whitewater release as it was prior to the release (since the releases are contingent on the NRF), and there would be minimal, if any, effects of water level fluctuations at Rainbow Beach.

Synthetic hydrograph modeling conducted by FirstLight as described in Section 6.1 and Appendices B and C, estimated that with a baseflow of 2,000 cfs and 4 hours of 2 unit generation (4,576 cfs) at Cabot, the maximum water surface elevation increase at Rainbow Beach would be between 0.2 and 0.3 feet. The added distance of the releases for the whitewater flows (Turners Falls Dam) and since a large portion of the releases would be instead of the bypass flows, very limited effects are likely 28 miles downstream at Rainbow Beach.

Table D-1: Proposed Whitewater Releases and Bypass Reach Minimum Flows

Date	*Turners Falls Dam Magnitude of Discharge (or NRF whichever is less)*	*Turners Falls Dam Release Duration*	*Proposed Bypass Flow (TFD and Station No.1*	*Difference in bypass flow and WW flow*	*Hours of single unit at Cabot Station to make up the difference.*
1 Saturday in July	*2,500 cfs*	*4 hours*	*1,800*	*700 cfs*	**1.2**
1 Saturday in August	*2,500 cfs*	*4 hours*	*1,800*	*700 cfs*	**1.2**
3 Saturdays in September	*3,500 cfs*	*4 hours*	*1,500*	*2,000 cfs*	**3.5**
1 Saturday in October	*3,500 cfs*	*4 hours*	*1,500*	*2,000 cfs*	**3.5**
2 Saturdays in October	*5,000 cfs*	*4 hours*	*1,500*	*3,500 cfs*	**6.1**

4.2.1 Ongoing Activities

USFWS Comment 3

FirstLight states that observations made during relicensing studies by FirstLight's consultants confirmed recreational use at Rainbow Beach is still occurring in a similar manner reported by Abbott (2003). Please provide any available documentation of these observations including date and time of the observations, photographs, field notes, and comparison of observed activities with those described in previous reports. In addition, if available, please provide the date and time of day the photos shown in Figures 4.2.1-1 and 4.2.1-2 were taken.

FirstLight's Response:

Due to the prevalence of social media, there is extensive information available on the amount and type of recreational activities occurring on Rainbow Beach. Figures 4.2.1-1 and 4.2.1-2 in the draft BA are screenshots of a YouTube video, which was titled "Rainbow beach on the Connecticut River Northampton mass July 4 2016".[16] The video included drone footage and the time of day the footage was taken is not known. The footage shows a footprint-covered beach with groups of people positioned up and down the beach and many boats pulled up to the water-land interface. There were also many boats passing beyond the beach at high rates of speed, with boat wakes evident through much of the video. The people on the beach were performing a variety of activities, such as walking on the beach, playing lawn/beach games, playing with dogs, and relaxing on lawn chairs either in the sun or under tents or sunshades that had been pitched. Most people on the beach were recreating close to the water-land interface, though people were observed in the video up to the vegetation, and footprints suggest a broad use of Rainbow Beach.

Though this footage was taken on a holiday when recreational activity was expected to be high, a search of social media indicates that extensive recreation on the beach is common during the daytime from May through September.[17] Photos pulled from Facebook from 2010 through 2020 that show evidence of extensive recreation on the beach are provided in Attachment 1. During interviews with reporters, local law enforcement officials have stated that there could be 1,000 people or more using Rainbow Beach on Saturdays and Sundays in 2020, with recent increases in observed boating and recreation caused by the COVID-19 pandemic.[18]

Abbott (2003) reported the greatest number of boats and people at Rainbow Beach in the afternoon hours when compared to midday and morning. In the afternoon on weekends, an average of 103.5 people and 26.7 boats were observed on six visits between June 28 and August 14, 2003. This is in comparison to 20.4 people and 4.4 boats in the afternoon on weekdays (n=14) during the same period. Recreational use was described by Abbott (2003) as being typically concentrated along the shoreline where motorboats and personal watercraft were anchored, and recreational activities observed included sunbathing, grilling food, swimming, walking, running along the shoreline, playing horseshoes, playing catch, and playing volleyball. The recent reports cited above from social media and local law enforcement indicate that these activities are still occurring, though the overall amount of use appears to have increased when compared to observations by Abbott (2003).

The impacts of increased amounts of reported recreation use on Rainbow Beach during the COVID-19 pandemic have not been studied but could have long-term impacts on the Puritan Tiger Beetle population. In the most recent preliminary draft of Gwiazdowski (2020), provided to FirstLight on November 13, 2020, high recreational use of the beach that interfered with surveys was described. Specifically, visitor activity precluded establishing transects at Rainbow Beach on Sunday July 26,

[16] https://www.youtube.com/watch?v=2v2bSRT2H4k
[17] https://www.facebook.com/pages/Rainbow%20Beach%20(Ct%20River)/106091049481721
[18] https://www.masslive.com/police-fire/2020/08/theres-way-too-many-people-with-more-boat-traffic-than-ever-massachusetts-environmental-police-and-local-officers-team-up-to-patrol-connecticut-river.html

2020. The site was revisited by Gwiazdowski (2020) on Wednesday/Thursday July 29/30, 2020, during which described much of Quadrat 3 at Transect 2 having human and dog footprints that obscured the sand surface, along with children playing in the transect, and obscuring all sand in Quadrats 1 and 2. In the morning prior to this disturbance of sand, Gwiazdowski (2020) had documented oviposition in Quadrat 2. As such, the disturbance caused by human recreation directly overlapped with critical activities being performed by Puritan Tiger Beetle.

4.2.2 Project-Related Conservation Measures for Puritan Tiger Beetle

USFWS Comment 4:

FirstLight proposed both monthly and daily peaking restrictions to limit water level increases at Rainbow Beach and minimize the potential effects of peaking during the months and times of day when adult PTB typically would be foraging and mating (i.e., during daylight hours). We understand the proposed peaking restrictions from July 1 through August 31 of each year are consistent with current operations and including the restrictions in the proposal would formalize these operations. However, the available information indicates that certain PTB activities, such as oviposition (Gwiazdowski 2020) and adult emergence (Babione 2003), occur outside of daylight hours. In addition, there is new information regarding the location where certain activities occur. Gwiazdowski's (2020) preliminary findings revealed that over 90 percent of oviposition holes were found in Quadrat 1 (the zone near, and below, the wrack line). Lastly, the first through third instar life stages are not encompassed in the monthly peaking restriction period. We recommend FirstLight incorporate this information into the DBA's effects analyses and conclusions relative to the effects of the proposed operational measures on the PTB. Given the importance of the Rainbow Beach population as a component of the species' limited distribution at the northern periphery of its range, we recommend FirstLight consider additional operational measures to minimize Project-related effects on the species and its habitat (e.g., expanding the time period for peaking restrictions to include first through third instar life stages).

FirstLight's Response:

FirstLight concurs with the USFWS that Puritan Tiger Beetle engage in certain activities outside of daylight hours. Specifically, emergence and oviposition by adults. In this BA, FirstLight has appropriately incorporated the best available species- and site-specific data regarding the timing and location that individual Puritan Tiger Beetles perform specific activities.

FirstLight has reviewed Gwiazdowski (2020), including the latest draft provided to FirstLight on November 13, 2020. Gwiazdowski (2020) evaluated the location and timing of Puritan Tiger Beetle oviposition at the primary population in southern Connecticut at Cromwell on the Connecticut River, approximately 58 river miles downstream of Rainbow Beach, in 2019 and 2020. Gwiazdowski (2020) also provided information from one survey at Rainbow Beach in 2020. By visually searching for oviposition holes in the sand, the study found that most Puritan Tiger Beetle were ovipositing primarily below the wrack line at the Cromwell, CT location, within the tidal zone, where the sand was consistently damp (a location defined as Quadrat 1). Oviposition occurred during late afternoon, night, and early morning, with approximately half of oviposition holes made between 1:00am and 6:00am.

FirstLight has determined that the result of Gwiazdowski (2020) finding evidence of oviposition occurring in the intertidal zone is not applicable to Rainbow Beach given the drastic differences in the structure of habitat inhabited by the southern Connecticut population when compared to the Rainbow Beach population. The site in southern Connecticut is a relatively narrow strip of habitat where water levels are driven by daily tidal fluctuations rather than river flow from upstream. These daily tidal fluctuations are more frequent and greater in magnitude than those that occur at Rainbow Beach during the adult active period (Figure D-1 and Figure D-2), and much of the habitat on the beach becomes inundated due to the tidal cycle. The tidal patterns consistently create a strip of dense,

damp sand that would become exposed twice per day between high tides. In contrast, the habitat at Rainbow Beach consists of a narrow area near the water-land interface that is wetted by waves and boat wakes on short-term time scales (i.e. minute/hourly). The location of the water-land interface at Rainbow Beach can also vary seasonally, daily, and sub-daily depending on the baseflow in the river, flows from the Turners Falls Project, and water levels at Holyoke Dam, as described in FirstLight's analysis. Despite these factors, water levels at Rainbow Beach fluctuate considerably less on a daily and hourly basis than the tidal Connecticut River during the adult active period (Figure D-1 and Figure D-2).

The habitat structure of Rainbow Beach also differs substantially from the narrow beach in tidal portions of the Connecticut River (Figure D-3). This difference in habitat structure results in different locations of suitable and selected habitat when the two beaches are compared. When river flows and water levels at Holyoke are low, much of Rainbow Beach is exposed, providing a large area for adult Puritan Tiger Beetle to traverse between the vegetation line and the water-land interface. However, much of Rainbow Beach consists of dry, soft sand that is not suitable for oviposition, egg survival, or for maintaining larval burrows (e.g. Gwiazdowski 2020; Omland 2002). Researchers at Rainbow Beach have documented that adult Puritan Tiger Beetles spend the daytime foraging and mating near the water-land interface and associated wrack. In the evening, they move to higher ground to oviposit. This behavior would result in oviposition at higher elevations of the beach rather than near the water-land interface. Though the preliminary draft of Gwiazdowski (2020) did not specifically define the locations of the quadrats surveyed at Rainbow Beach, no positive identification of oviposition was observed in Quadrat 1 (presumably areas of damp sand near the water-land interface). Rather, oviposition was positively identified at higher elevations on the beach.

Larvae have been documented in a narrow strip of land at Rainbow Beach, primarily within a few meters of the vegetation line, where there is a suitable combination of temperature, moisture, and sediment grain size (Davis 2020[19]). FirstLight's analyses pertaining to larval habitat are conservative and encompass a broader area above 102.75 feet in elevation. It is apparent that adult Puritan Tiger Beetles are selecting habitat that is both suitable for oviposition and for larval burrowing and development. In a riverine shoreline environment, selection of habitat that is higher in elevation on the beach would prevent larvae from becoming inundated for long periods of time during wet seasons or years, when the water-land interface would be higher than dry seasons and years. Additionally, the selected habitat is low enough in elevation to become periodically inundated, which could maintain sand density and composition and bring food and moisture to the primarily sessile Puritan Tiger Beetle larvae. Davis (2020) documented the importance of silt deposits in the higher-elevation locations of the beach that were present where most larvae were found in recent surveys. This would indicate habitats that are suitable for both oviposition and larval development (Davis 2020).

Given the differences in habitat structure and use as described above, and because water level water level increases resulting from Project operations have insignificant effects on larvae at Rainbow Beach, FirstLight has determined that additional operational restrictions (e.g. extending the period of peaking restrictions to encompass larval periods) would not affect Puritan Tiger Beetle at Rainbow Beach.

[19] Davis (2020) is provided in Attachment 2 to this appendix.

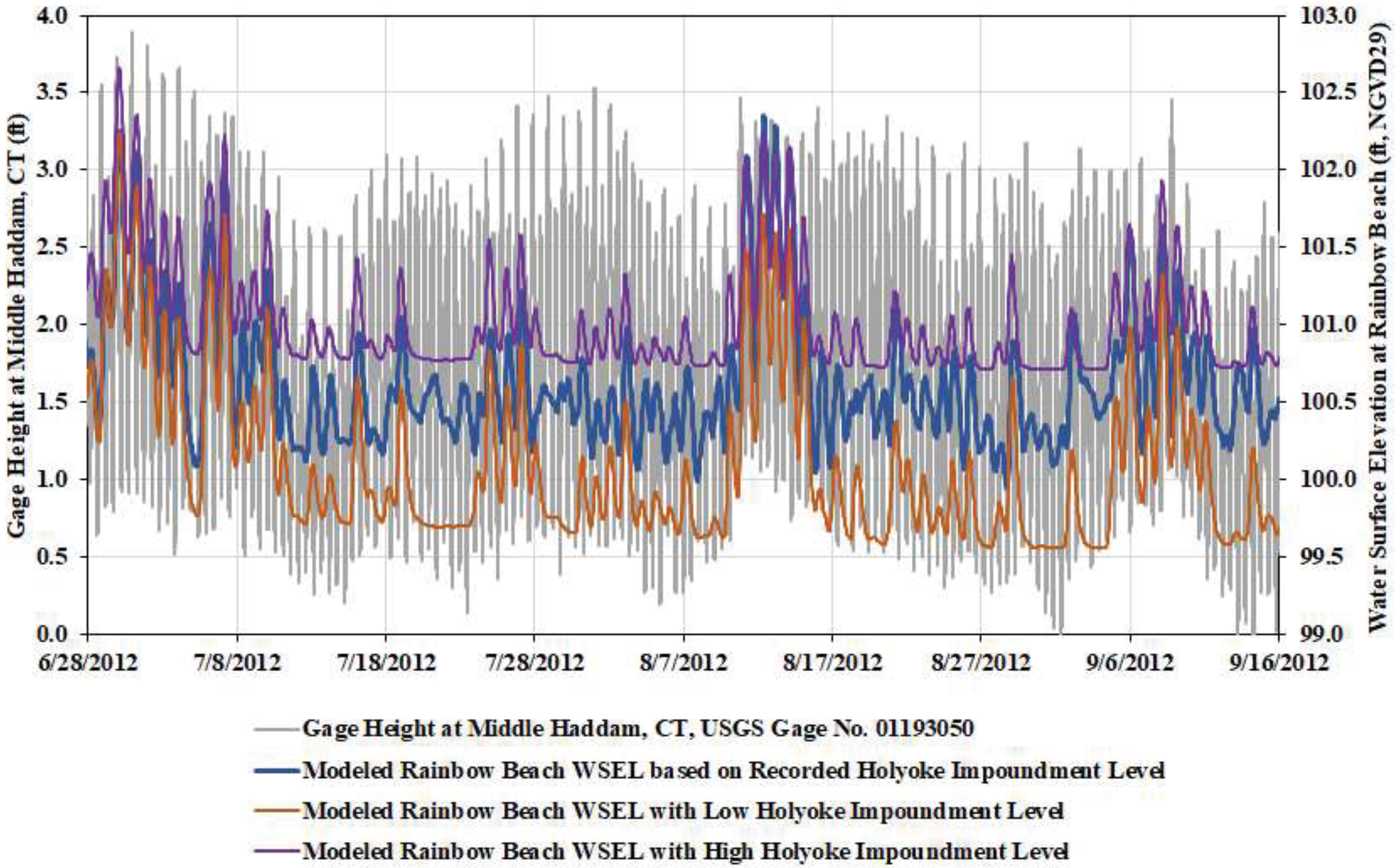

Figure D-1: Modeled Water Surface Elevations on Rainbow Beach near Holyoke, MA and USGS Gage Heights in tidal water at Middle Haddam, CT from late June to mid-September.

Note: The USGS Gage Connecticut River at Middle Haddam, CT is approximately 9.6 river miles downstream of the Puritan Tiger Beetle population at Cromwell, CT. A similar tidal variation was noted at the USGS Gage Connecticut River at Hartford, CT which is located about 15 river miles upstream of the Cromwell site. Hourly recorded water surface elevations at Holyoke Dam used for water surface elevation modeling at Rainbow Beach were obtained from the USFWS.

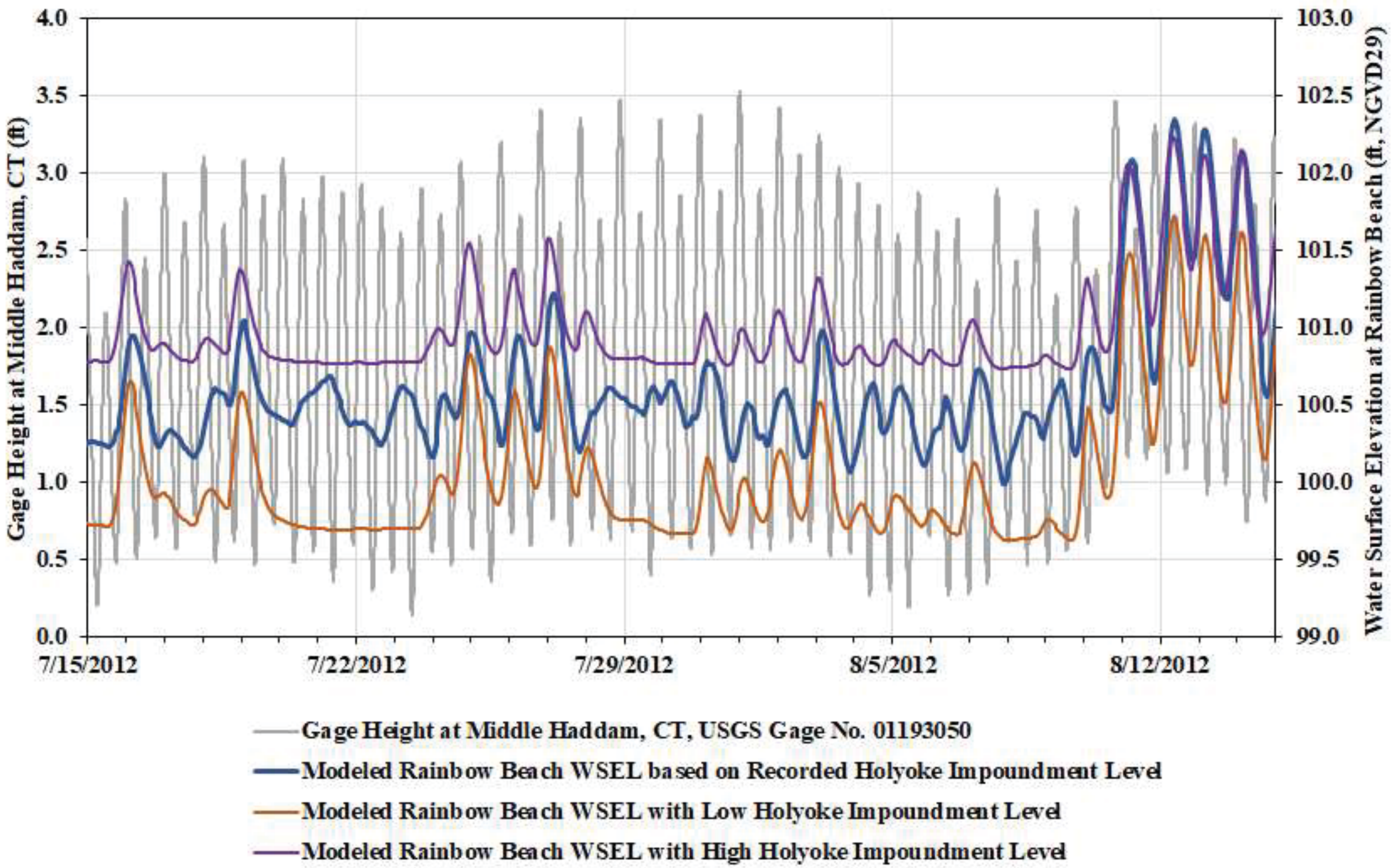

Figure D-2: Modeled Water Surface Elevations on Rainbow Beach near Holyoke, MA and USGS Gage Heights in tidal water at Middle Haddam, CT from mid-July to mid-August (peak adult active period for Puritan Tiger Beetle).

Note: The USGS Gage Connecticut River at Middle Haddam, CT is approximately 9.6 river miles downstream of the Puritan Tiger Beetle population at Cromwell, CT. A similar tidal variation was noted at the USGS Gage Connecticut River at Hartford, CT which is located about 15 river miles upstream of the Cromwell site. Hourly recorded water surface elevations at Holyoke Dam used for water surface elevation modeling at Rainbow Beach were obtained from the USFWS.

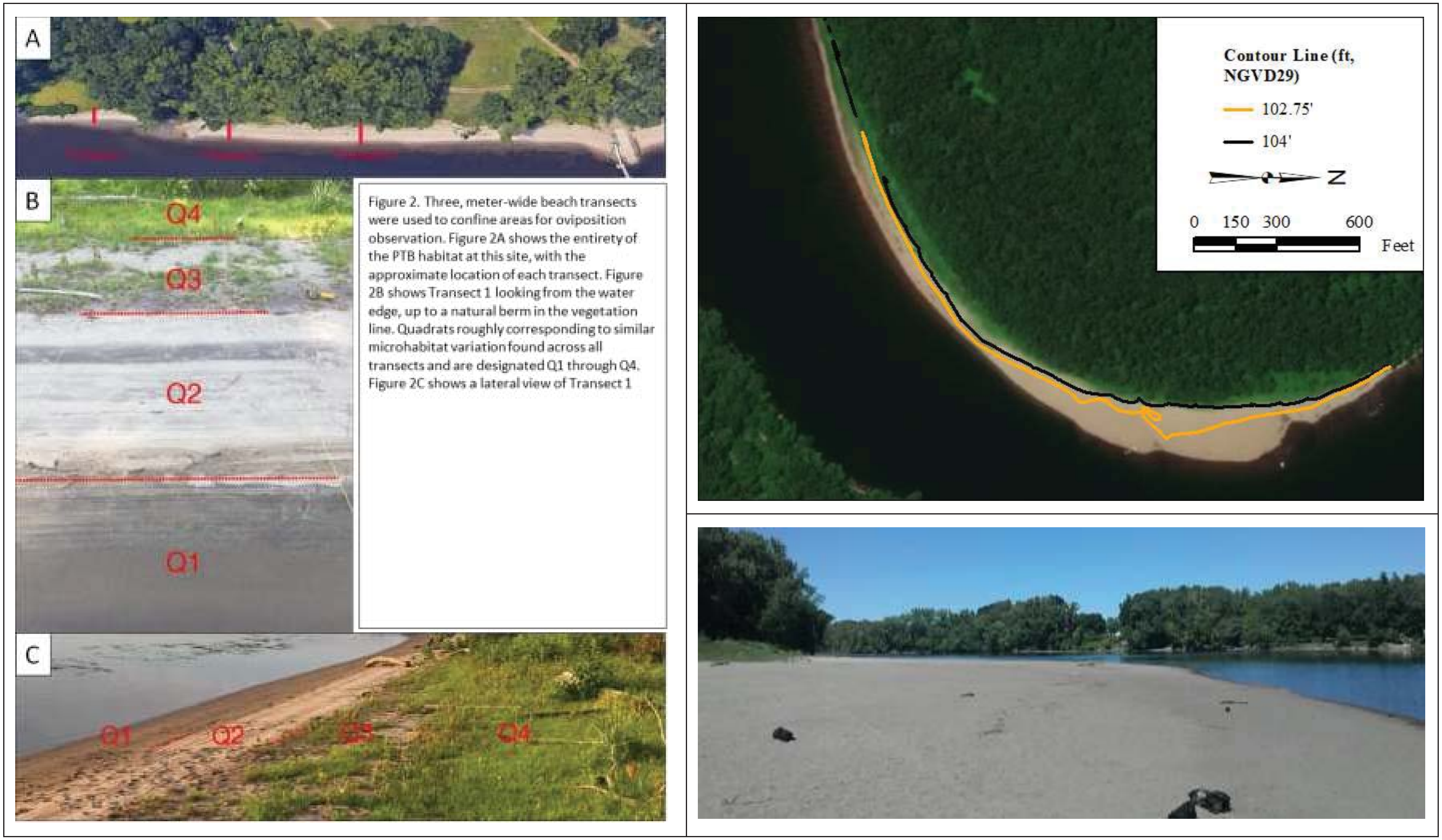

Figure D-3: Figure from Gwiazdowski (2020) showing the structure of Puritan Tiger Beetle habitat in Cromwell, CT (left panels) and a map and photograph of Rainbow Beach (right panel) for comparison.

5.4.3 Water Level Management at Holyoke Dam

USFWS Comment 5:

FirstLight states that, based on studies performed by Holyoke Gas & Electric (HG&E), maintaining the water surface elevation near 99.47 feet was shown to reduce water level fluctuations at Rainbow Beach, which would be beneficial to PTB when inflows are less than 11,000 cfs. The HG&E reports cited in the DBA not only refer to a maximum inflow (11,000 cfs), but also an average daily flow of less than 7,000 cfs (HG&E 2012). Once flows exceed those parameters, HG&E loses the ability to control water surface elevations at Rainbow Beach in part due to the backwatering effect of The Narrows, a natural topographic constriction in the river located upstream of Holyoke Dam and downstream of Rainbow Beach. Results of the hydraulic modeling undertaken by HG&E (2012) suggested that during sustained high inflows the upper impoundment response is less predictable due to the hydraulic control created by The Narrows. We recommend the DBA discuss how the hydraulic model used to analyze inundation at Rainbow Beach accounts for the unpredictability of water surface elevation response when instantaneous flows exceed 11,000 cfs or average daily flows exceed 7,000 cfs.

FirstLight's Response:

The USFWS states that prior studies by HG&E indicated that water levels at Rainbow Beach become less predictable during sustained high inflows due to a hydraulic control at The Narrows. FirstLight developed a hydraulic model that was well calibrated to observed water surface elevations at various locations in the reach between the Montague USGS gage and Holyoke Dam, including above and below The Narrows (observed water level data was obtained at Holyoke Dam). Based on the modeling, water surface elevations at Rainbow Beach become less dependent on water levels at the Holyoke Dam and more dependent on the constriction at The Narrows as flows increase beyond a certain point. FirstLight's hydraulic model includes both the effects of water levels at Holyoke Dam and the constriction at The Narrows and are confident the hydraulic model reflects the switch in hydraulic control. The hydraulic model is accurate for providing water levels at Rainbow Beach across the modeled flow range, especially at flows up to 30,000 cfs.

Given the variations in natural river flows, Project peaking flows, and Holyoke Impoundment water levels, unsteady-state hydraulic modeling was necessary. Output from the modeling was used to characterize the frequency, duration, and magnitude of exposure under the baseline and proposed environmental flow condition for each life stage and activity period of the Puritan Tiger Beetle. FirstLight's unsteady-state hydraulic model allowed for accurate hourly predictions of water levels at Rainbow Beach based on the substantial routing and attenuation of flow that occurs as releases flow downstream from the Turners Falls Project in the Connecticut River.

6.1.2 Locations of Habitat Relative to Water Levels

USFWS Comment 6:

FirstLight states the locations of larval and adult PTB habitat in relation to elevation at Rainbow Beach was inferred based on observed habitat use from various population assessments. As noted above, information collected as part of an oviposition research project during July 2019 (Gwiazdowski 2020) showed oviposition occurring down-gradient from presumed larval habitat at one of the PTB sites in Cromwell, Connecticut. We recommend FirstLight incorporate this information into the DBA effects analyses and conclusions relative to the effects of its proposed operational measures on the PTB.

FirstLight's Response:

As stated in FirstLight's response to USFWS Comment 4, Rainbow Beach and the location in Cromwell, Connecticut are very different in habitat structure and habitat use. The findings there by Gwiazdowski (2020) in Cromwell, CT are therefore not applicable to Rainbow Beach, where researchers have been documenting habitat use extensively. Additional research performed in 2020

by Dr. Gwiazdowski and Chris Davis, who are both Puritan Tiger Beetle experts, confirmed that Puritan Tiger Beetles on Rainbow Beach are exhibiting different behaviors regarding where eggs are deposited and larvae persist relative to the Cromwell, CT location. Therefore, the results from Gwiazdowski (2020) that were from substantially different habitats at Cromwell, CT do not change the analyses and conclusions of FirstLight's analysis regarding the location of oviposition and larval habitat at Rainbow Beach.

Researchers associated with the Gwiazdowski (2020) surveys at Rainbow Beach have reportedly also collected larval distribution data that are tied to survey points that FirstLight provided to the USFWS in support of those field efforts (C. Davis, *pers. comm.*). Results from those larval surveys, which could then be tied to FirstLight's elevation surveys, would confirm whether the 102.75 elevation boundary previously identified as potential larval habitat is appropriate or if analyses would need to be modified. Though the surveys have been completed, and some preliminary results were provided for oviposition surveys (Gwiazdowski 2020), USFWS has indicated that the further results will not be available until after the AFLA and this BA will be filed with FERC.

6.1.3.2 Characterization of Attenuation and Lag Time of Project Flows

USFWS Comment 7:

FirstLight states that peak releases from Cabot generally take over six hours to reach Rainbow Beach, and the timing and magnitude of attenuation is related to the length and magnitude of Cabot peak flow releases, along with other factors. FirstLight proposes peaking restriction from 1 a.m. to 2 p.m., which is intended to minimize inundation at Rainbow Beach during daylight hours. The synthetic hydrograph modeling analyzed multiple operational scenarios based on differing base flows, number of units generating at Cabot, and generation time. While these scenarios inform lag time for peak flows to reach Rainbow Beach under a range of operations, it is unclear which, if any, correlate to FirstLight's proposed operations.

We recommend running scenarios that cover the range of potential Cabot operations under the proposed peaking restriction in order to determine when peak flows under each scenario would reach Rainbow Beach. We request that FirstLight address the issue raised by HG&E relative to the model becoming less predictable during sustained high inflows due to the hydraulic control created by The Narrows; this is relevant as Cabot generation duration increases.

FirstLight's Response:

The purpose of the synthetic hydrograph modeling was to develop reasonable estimates or brackets for the attenuation and travel times to Rainbow Beach based on variables such as: baseflow, number of generating units, and duration of Cabot generation under low and high Holyoke downstream boundary conditions. This was done as a simplistic representation of Project effects without additional confounding variables such as changing inflows, downstream tributary inflows, and Holyoke Impoundment levels. FirstLight Project's operation at any given time depends on the flow into the TFI and water level restrictions within the TFI, energy demand schedules, and other factors such as downstream tributary inflows and Holyoke Impoundment levels also affect water levels at Rainbow Beach.

FirstLight's proposed measure in July and August, which was developed to minimize effects on the foraging/mating activities of Puritan Tiger Beetle is to add no more than 4,600 cfs additional flow from Cabot Station from 1:00am to 2:00pm. This is the equivalent of adding no more than two units at Cabot Station relative to the existing baseflow at the Project in that time window. Synthetic hydrograph scenarios 1 through 12 would correspond to the proposed maximum increases in generation that could occur in that time window, and they cover the range of Project operations that could occur given the proposed restriction at a range of base flows. The 1:00am to 2:00pm time window was chosen because generation increases within this time would be expected to cause water level increases at Rainbow Beach during the daytime, when adult Puritan Tiger Beetles would be

foraging and mating near the water-land interface. By restricting flow increases at the Project to no more than approximately two units during the 1:00am and 2:00pm time, any potential Project-related water level increases at Rainbow Beach during the daytime would be slow and limited in magnitude when compared to higher levels of generation increases. For example, Synthetic Hydrograph Scenario 2 estimated that with a baseflow of 2,000 cfs and 4 hours of 2 unit generation (4,576 cfs) at Cabot Station, total daytime increases in water surface elevations at Rainbow Beach would be between 0.2 and 0.3 feet (less than 4 inches) over the span of four hours or more (e.g. less than one inch per hour increase). Effects on Puritan Tiger Beetle daytime activities would be insignificant. Further, any effects at Rainbow Beach given this type of scenario may not be noticeable to Puritan Tiger Beetle given other variables such as tributary inflows, Holyoke Impoundment level variation, waves, and boat wakes.

Assuming high enough inflows and TFI levels, and a variety of variables being held constant, conditions resulting from other synthetic hydrographs scenarios (e.g. Scenarios 13-34) would be possible outside of the July/August 1:00am and 2:00pm time window. Higher generation scenarios, if they occurred, would be expected to result in somewhat faster and larger increases at Rainbow Beach during the night, consistent with what has occurred under baseline conditions (see Section 6.1.4 of the DBA). Because adult Puritan Tiger Beetles at Rainbow Beach move to the higher elevations of the beach at night, near the vegetation line, the effects of water level increases at night would not be expected to reach the locations of adults and larvae when river flows are within the capacity of the Project to control. Effectively, the peaking restriction window codifies the current operational regime which has provided low water surface elevations at Rainbow Beach during the day but allows for some inundation of what is primarily an unused portion of the beach at night, which could bring new wrack and associated food sources for Puritan Tiger Beetle foraging.

As previously stated and described in FirstLight's response to Comment 5, the USFWS statement that water levels at Rainbow Beach become less predictable during sustained high inflows due to a hydraulic control at The Narrows is incorrect. FirstLight's hydraulic model is accurate for a wide variety of flows, especially up to 30,000 cfs, which is far greater than the generation capacity of the Turners Falls Project.

6.1.4.1 Larval Habitat

USFWS Comment 8:

Figures 6.1.4.1-1 and 6.1.4.1-2 show bar graphs of the maximum duration of inundation events over 104 feet in days from 1991 through 2018 under both low and high Holyoke impoundment levels. We request FirstLight organize these graphs by active and inactive larval periods, as the impacts of inundation likely differ based on larval activity level. For example, sustained inundation may not have an impact to growth when larvae typically are not feeding (e.g., winter), whereas there could be a substantial impact to growth due to sustained inundation during the summer, when food intake is high.

FirstLight's Response:

FirstLight has revised the BA to include the requested bar graphs for active and inactive larval periods.

6.1.4.2 Adult Habitat

USFWS Comment 9:

The DBA states that emergence would typically occur at night, whereas foraging, mating, and oviposition would occur primarily during the daytime hours; however, Gwiazdowski (2020) documented oviposition occurring at night. Therefore, two of the four adult PTB phases may be impacted by the proposed peaking restriction measure, which is intended to minimize daytime inundation of PTB habitat at Rainbow Beach. We recommend FirstLight update its analysis to account for this new information.

FirstLight's Response:

The referenced statement from FirstLight's January 2020 draft DBA was incorrect, and not consistent with FirstLight's actual analyses as described in the subsections following the statement. The analyses provided in the January draft by FirstLight evaluated each adult Puritan Tiger Beetle activity based on the following time periods:

- **Foraging/Mating: June 16 through September 7, 9am through 8pm**
- **Oviposition: June 16 through September 7, 5pm through 11pm**
- **Emergence: June 16 through September 7, 8pm through 9am**

The time periods were derived from observations of Puritan Tiger Beetle activity at Rainbow Beach. However, based on the limited historical observations of oviposition timing at Rainbow Beach, and the results of Gwiazdowski (2020), which reported oviposition occurring from the late afternoon into the morning hours, FirstLight has revised the oviposition analysis to include all 24 hours per day during the adult active period from June 16 through September 7.

6.1.4.2.2 Foraging/Mating

USFWS Comment 10:

The DBA identifies foraging as a daytime activity, although it also may occur at night. Babione (2003) collected both unmarked and marked adult beetles in a night survey. The unmarked individuals constituted 72 percent (13 of 18) of collected individuals and were presumed to be newly emerged adults, as the night survey immediately followed day surveys. Of the five marked individuals captured at night, three were marked during a prior day survey and two during a prior night survey. While we do not know why the marked beetles were active at night, potential reasons include foraging, mating, or oviposition activity.

FirstLight's Response:

The survey described in Babione (2003) was an experiment to determine if a night survey would be as efficient and effective as a daytime survey. The survey design included two sites along the beach, each with three stations for monitoring (3 meters from the forest, center of the beach, and 3 meters from the water's edge). To capture adult beetles at each station, a Coleman lantern was placed at the center of a large sheet and the beetles were caught using a net, presumably when they moved across the sheet.

Though Babione (2003) captured Puritan Tiger Beetles, including a large percentage that had not been marked during daytime surveys, the survey report did not include information on which stations the beetles were captured at. Therefore, FirstLight does not have information from the survey pertaining to habitat use of specific locations on the beach, which would have provided context for which activities the beetles may have been engaged in. Additionally, Babione (2003) theorized that newly emerged adults could have been attracted to the light utilized by the survey, and that the beetles appeared to be "mesmerized" by the light. It was not identified in the survey report whether these individuals would have been actively moving around or performing various activities without the light provided from the lamps.

The best available data from Rainbow Beach and elsewhere suggests that foraging is a daytime activity, where these visual predators benefit from warm temperatures on the sand that allow them to move rapidly in search of prey. At Rainbow Beach, the adult beetles have been documented making forays to the water-land interface during the daytime and back up to near the vegetation and within the larval habitat in the events. In contrast, there has been no information provided suggesting that there are forays to the water-land interface for foraging/mating at night. The report from Babione (2003) does not indicate whether adult Puritan Tiger Beetles would be doing anything other than potentially emerging from larval habitats and moving toward an artificial light source. Therefore,

the timing of adult Puritan Tiger Beetle activities in FirstLight's analyses have not been modified based on Babione (2003). However, as indicated in the response to Comment 9, FirstLight has revised the daily time period for the oviposition analysis based on Gwiazdowski (2020) and the USFWS comments. The diel periods for each activity in the analyses, based on the best available data, are:

- **Foraging/Mating: June 16 through September 7, 9am through 8pm**
- **Oviposition: June 16 through September 7, 24 hours per day**
- **Emergence: June 16 through September 7, 8pm through 9am**

USFWS Comment 11:

Figure 6.1.4.2-2 shows the relationship between average daily flow at the Montague, Massachusetts, U.S. Geological Survey gage and the maximum daily water surface elevation at Rainbow Beach. The figure shows a linear relationship, even above 11,000 cfs. We request FirstLight explain this apparent contradiction with the HG&E report (2012), which states that at this threshold the stage response decouples due to The Narrows.

FirstLight's Response:

As stated in FirstLight's response to Comment 5, water surface elevations at Rainbow Beach become less dependent on water levels at the Holyoke Dam and more dependent on the constriction at The Narrows as flows increase beyond a certain point. Figure 6.1.4.2.2-2[20] shows how the Low or High Holyoke water surface elevation downstream boundary becomes less of a factor as flows increase since the separation of scatterplot lines decreases. However, there is no specific "decoupling" threshold. The HG&E Report (2012) described the effect of the Narrows as "decoupling" in a few areas, such as the first paragraph in Section III on page 12. However in other areas of the document, such as in Section IV Cumulative Analysis & Summary on page 24, the following verbiage is used: "During peak inflows greater than 11,000 cfs measured at the Montague Gage, drawdowns of the lower impoundment up to 1.6 feet at the Dam were likely to result in stage fluctuations at Rainbow Beach of less than 0.5 feet." This statement is comparable to the gradual effects that the Narrows provide with increasing flows.

While the HG&E results were based on a direct assessment of water level recorder data, FirstLight's results are based on a calibrated hydraulic model run in unsteady-state mode, which can account for natural hydraulic constriction points and changing flows through time. FirstLight's unsteady-state hydraulic model allowed for accurate hourly predictions of water levels at Rainbow Beach based on the substantial routing and attenuation of flow that occurs as releases flow downstream from the Turners Falls Project in the Connecticut River. For the analyses provided in the DBA, these hourly water levels were put into context of biological relevance to the Puritan Tiger Beetle.

Natural hydraulic constriction points such as The Narrows below Rainbow Beach and the French King Gorge in the Turners Falls Impoundment are examples of hydraulic controls where the influence is a gradual and becomes more dominant as flows increase. This type of a gradual relationship is shown on water level recorder data plots in the HG&E reports and FirstLight data such as Appendix A of this BA and corresponds well to relationships shown in output from FirstLight hydraulic model.

USFWS Comment 12:

Figure 6.1.4.2.2-5 shows the frequency of hourly water level changes in feet at Rainbow Beach during the PTB daytime active period (9am to 8pm) from June 16 through September 7. We request FirstLight generate this same figure for the period 8pm to 9am in order to understand the magnitude and frequency of hourly water surface elevation changes during the PTB nighttime active period.

FirstLight's Response:

Based on the USFWS comment, FirstLight has provided histograms for the time period of 8pm to 9am in the revised draft in order to understand the magnitude and frequency of hourly water surface elevation changes during the Puritan Tiger Beetle nighttime for the activities that can occur at night (emergence) and over the full 24 hours of a day (oviposition).

[20] Note: The USFWS comment referred to Figure 6.1.4.2-2, which was a histogram of the daily timing of peak daily flows at Rainbow Beach given low Holyoke Impoundment conditions. The correct figure number for the figure referenced is 6.1.4.2.2-2.

USFWS Comment 13

To better assess potential impacts to all adult phases, we recommend supplementing the synthetic hydrograph model output to include duration of inundation (i.e., the period of time, in hours, where elevation for a given scenario exceeds 101 feet).

As stated in previous comments, the synthetic hydrographs are a simplified modeling analysis that was developed for a specific purpose (i.e. evaluating travel time and attenuation of operational flows). The synthetic hydrograph analyses do not incorporate a variety of important factors that also affect water surface elevations at Rainbow Beach. Therefore, effects on all activities and life stages for the Puritan Tiger Beetle were evaluated using more appropriate methodologies in the DBA.

Given the variable effects of river flows, Project peaking flows, and Holyoke Impoundment water levels, unsteady-state hydraulic modeling was necessary to characterize the frequency, duration, and magnitude of exposure under the baseline environmental flow condition for each life stage and activity period of the Puritan Tiger Beetle (see Section 6.1.4). This modeling was performed using 28 years of hourly timeseries flow data (1991-2018) in the Connecticut River at the Montague USGS gage, routed to Rainbow Beach using HEC-RAS. The models produced flow and water level timeseries at Rainbow Beach for those 28 years given low and high Holyoke Impoundment conditions.

Further, the focus of the USFWS on evaluating duration of inundation at elevations as low as 101 feet is unfounded based on the behavior and habitat use of this species. Adult Puritan Tiger Beetle forage and mate among the wrack and near the water-land interface, regardless of where the actual water level is at the time. The further down the water surface elevation is, the greater the distance for the beetles to reach the water-land interface and wrack line after leaving the higher elevations of the beach. As such, higher water levels along the lowest elevations of the beach do not necessarily result in less foraging and mating habitat. Area of the entire beach is irrelevant if much of the beach is unused by the Puritan Tiger Beetle, and high numbers of Puritan Tiger Beetle in Cromwell, CT at a much smaller beach would suggest that area is not the driving factor in population size at the much larger Rainbow Beach. Rather, more appropriate analyses for adult Puritan Tiger Beetles include an evaluation of the frequency, duration, and magnitude of inundation of potential larval habitats where adults oviposit and emerge.

FirstLight has analyzed this larval/oviposition/emergence area conservatively, beginning at elevations of 102.75 feet, even though recent field studies have documented the larval habitat as a very narrow strip of land near the highest elevations on the beach, within a few meters of the vegetation line (Davis 2020). In support of the Gwiazdowski (2020) surveys, FirstLight provided survey (including elevation) data to USFWS. Researchers associated with Gwiazdowski (2020) reportedly collected additional larval distribution and density data that could be tied to FirstLight's elevation data. These data and associated results would be relevant to any modifications to FirstLight's analyses regarding larval habitat. However, USFWS has indicated that the results of these surveys would not be available for FirstLight to review until after the AFLA and BA are filed with FERC. Therefore, there is currently no basis to analyze duration of inundation (which is a larval issue) down to 101 feet in elevation. Applicable analyses to adult activities that could occur down to 101 feet in elevation (i.e. foraging/mating) are included in the analyses within the BA.

6.1.4.2.3 Oviposition

USFWS Comment 14

In this section of the DBA, FirstLight cites evidence suggesting PTB oviposit in the evening (5p.m. through 11p.m.), but in section 6.1.4.2, FirstLight states "…oviposition would occur primarily during the daytime hours." Please clarify this inconsistency. Also, the DBA describes oviposition as occurring between elevations 102.75 to 104.0 feet, which is within the presumed larval habitat; however, the most recent information on the life history of the PTB (Gwiazdowski 2020) indicates oviposition could occur between elevations 101 and 102.75. In addition, Gwiazdowski (2020) indicates the oviposition period includes overnight hours, essentially extending the species' oviposition period to any time of day or night. Consequently, we recommend FirstLight (1) undertake a new analysis that considers habitat inundation frequency and duration at elevations 101 to 102.75 feet based on a 24-hour oviposition period, and (2) consider additional measures to minimize impacts to the species' habitat based on new information and FirstLight's analyses.

FirstLight's Response:

As stated in FirstLight's response to Comment 9, the statement from the January draft DBA suggesting that oviposition would occur primarily during the daytime hours was incorrect, and not consistent with FirstLight's actual analyses as described in the subsections following the statement. FirstLight has corrected this error/inconsistency in the updated draft.

As stated in FirstLight's response to USFWS Comment 4, Rainbow Beach and the location in Cromwell, Connecticut are very different in habitat structure and habitat use. The findings there by Gwiazdowski (2020) are therefore not applicable to Rainbow Beach, where researchers have been documenting habitat use extensively. Additional research performed in 2020 by Dr. Gwiazdowski and Chris Davis, who are both Puritan Tiger Beetle experts, confirmed that Puritan Tiger Beetles on Rainbow Beach are exhibiting different behaviors regarding where eggs are deposited and larvae persist relative to the Cromwell, CT location. At Rainbow Beach, oviposition was positively identified in Quadrats 2 and 3, which was higher in elevation than Quadrat 1 near the water's edge. The larval habitat documented at Rainbow Beach in 2020 is limited to a narrow strip near the vegetation line, which is at a relatively high elevation on the beach. FirstLight's analysis of all areas down to elevation 102.75 includes this narrow strip of confirmed larval habitat, but also encompasses broad areas that could be used as oviposition habitat by adult Puritan Tiger Beetles. Therefore, FirstLight's analysis is already highly conservative to the resource and there is no basis for FirstLight's larval/oviposition analyses to include areas down to 101 feet in elevation.

The results from Gwiazdowski (2020) suggest a wider daily period of oviposition, from late afternoon into the morning hours. As stated in FirstLight's response to Comment 9, FirstLight has revised the oviposition analysis to include all 24 hours per day during the adult active period from June 16 through September 7.

6.2 Anticipated Response to Exposure

USFWS Comment 15:

We recommend this section be updated to incorporate new Puritan tiger beetle life history information and address the potential impacts of the proposed operational measures on oviposition/hatch success in the context of successful recruitment and population sustainability at Rainbow Beach.

FirstLight's Response:

FirstLight has revised its analysis, as appropriate, based on the new information that was made available by Gwiazdowski (2020) and additional information collected at Rainbow Beach in by Roger Gwiazdowski and Chris Davis in 2020. These revisions include evaluating oviposition for all 24 hours of the day, along with providing additional descriptions regarding habitat use and selection in the text.

7 Conclusion and Determination of Effects

USFWS Comment 16:

FirstLight identifies several non-project-related factors affecting PTB populations at Rainbow Beach, including recreational impacts, competition with C. repanda, and invasive species. These factors, along with the past and current flow regimes implemented at Holyoke and Turners Falls, and the interrelationship of operations at both projects and effects to the PTB, are part of the environmental baseline for the PTB in the action area. If a future consultation under section 7 of the ESA is necessary, non-Project-related, non-Federal activities occurring, or reasonably certain to occur, in the action area would be considered as cumulative effects. The proposed Project and any potential direct and indirect effects of the Project on the PTB would be determined separately from those actions included in the baseline and cumulative effects.

FirstLight's Response:

FirstLight has revised this section per the USFWS comments and removed factors pertaining to the environmental baseline, which are included in earlier sections of the DBA.

USFWS Comment 17:

Given the new information relative to the timing and location of PTB oviposition (Gwiazdowski 2020), we recommend FirstLight revise relevant analyses regarding potential effects to all PTB life stages and reconsider the effects determinations under section 7 of the ESA.

FirstLight's Response:

FirstLight has revised its analysis, as appropriate, based on the new information that was made available by Gwiazdowski (2020) and additional information collected at Rainbow Beach in by Roger Gwiazdowski and Chris Davis in 2020. These revisions include evaluating oviposition for all 24 hours of the day, along with providing additional descriptions regarding habitat use and selection in the text. Despite the revised analyses, the effects determination has not changed.

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ATTACHMENT 1: PHOTOS OF RECREATION ON RAINBOW BEACH FROM FACEBOOK

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August 3, 2020

June 14, 2020

May 24, 2020

July 13, 2019

July 4, 2019

July 4, 2019

June 27, 2019

July 1, 2018

August 13, 2016

August 9, 2014

August 10, 2013 (from opposite side of the river)

July 21, 2013

June 26, 2010

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ATTACHMENT 2: DAVIS (2020)

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Larval Surveys

At

Rainbow Beach

Fall 2020

by

Chris Davis

Introduction

Surveys were conducted at Rainbow Beach, Northampton, MA for 2^{nd} and 3^{rd} instar larvae of the Puritan Tiger Beetle (*Cicindela puritana*) in October and November 2020. Rainbow Beach is jointly owned by The City of Northampton and the MA Division of Fisheries and Wildlife and represents the single population of this species in Massachusetts. Surveys were conducted over a 4-week period in order to capture the highest count possible and the full extent of the density and distribution of larvae. Puritan Tiger Beetles are a summer active species and the larvae reflect 2 cohorts. 2^{nd} instars are from eggs oviposited in 2020 and 3^{rd} instars from eggs oviposited in 2019.

Methods

Survey plots were established beginning at the northern end of the larval habitat. Each plot measured ten meters by twenty meters with the longer distance running parallel to the edge of the vegetation. A ten-meter width was determined based on previous larval surveys. Ten meters was chosen because it encompassed the extent of potential larval habitat from vegetation to dry hot sand.

GPS waypoints were recorded and flags were placed at the margins of each plot. Each researcher began a slow weaving ambulation through the habitat from either end of a plot from vegetation edge to a 10-meter mark in the sand. A thin carbon fiber rod was used to probe larval burrows for depth and angle. A co-occurring species, the Riparian Tiger Beetle (*Cicindela repanda*), also has active larvae in the fall. Puritan Tiger beetle burrows are deeper and have a nearly vertical axis. Once a burrow was identified as a Puritan larva, a scuff mark was made near the burrow to eliminate duplicate counting. In total, 17 plots were established from the northern end of the beach along the vegetation to the south, ending approximately midway through the habitat. The area to the south was considered inappropriate larval habitat due to thick vegetation and larger sand particle substrate.

3rd instar larval burrow with fine silt substrate.

Larval habitat plots 3&4.

Results

The three fall 2020 surveys confirmed that all larvae were located in a 3-4 meters band of preferred oviposition substrate. Adults will lay eggs in this band with scattered vegetation and silty depressions. The areas above the band terminate in dense vegetation and roots and areas below the band in coarse dry sand. Previous larval surveys indicate that a 25%-35% vegetative cover is selected by females (Davis, 2004). This suggest that the micro-climatic conditions of temperature and moisture are met. The open and unvegetated areas beyond 3-4 meters from vegetation lacked a silt component and since no larvae were found there it is assumed that conditions are too hot and dry to be selected for ovipositing.

Plot	10/7/2020 2nd/3rd instar (total)	10/21/2020 2nd/3rd instar (total)	11/5/2020 2nd/3rd instar (total)
1	10/28 (38)	14/34 (48)	0/8
2	29/35 (64)	43/60 (103)	4/33
3	2/5 (7)	23/24 (47)	0/5
4	2/5 (7)	13/23 (36)	1/5
5	12/27 (39)	40/72 (112)	4/28
6	8/22 (30)	11/38 (49)	3/32
7	1/8 (9)	3/24 (27)	0/10
8	1/10 (11)	10/22 (32)	0/7
9	24/49 (73)	17/79 (96)	2/25
10	12/14 (26)	12/19 (31)	0/6
11	0/2 (2)	0/1 (1)	0/0
12	0/3 (3)	1/2 (3)	0/0
13	0/3 (3)	1/2 (3)	0/0
14	2/0 (2)	2/4 (6)	0/0
15	1/2 (3)	0/2 (2)	0/2
16	1/0 (1)	1/1 (2)	0/1
17	0/2 (2)	0/4 (4)	0/1
Subtotals	105/215	191/411	14/163
Total	320	602	177

The table above outlines the density and distribution for all 17 plots. The greatest density of larval occurred in plots 1-10 and comprise 95% of active larvae as the mean for all 3 surveys.

Beach sections.

Larval habitat at Rainbow Beach 2020. Plots 1-10 in blue, plots 11-17 in red. Plots 1-10 contain 95% of larvae observed during three surveys.

Discussion

Adult Puritan Tiger beetles are found along the shoreline during the flight period from mid-June to late August (Davis, C. 2018). Counts beginning in1997, including mark/recapture, identified areas with the highest number of adults. The northern end of the beach has consistently had the greatest concentration of adults. A smaller numbers of adults have been observed at the southern end of the beach and relatively few in the center shoreline of the beach. The center shoreline typically has a steeper profile and reduced area of wet substrate. Additionally, recreational use likely supplants beetles to each end of the beach. Adult and larval counts indicate that the northern end of the beach represents the highest quality of habitat available.

Peak adult counts were 90 for 2019 and 101 for 2020. Survey conditions for adults for both years lacked the optimal sunny days and likely resulted in an under count of the population for each year.

During the fall 2020 surveys, we noted that many larvae occurred where finer silt material, deposited as water receded from the vegetation, providing an apparent preferred oviposting condition. Sand samples collected in 2004 indicate that larvae occurred where substrates were approximately 80% medium(0.5mm) grain and 20% fine(0.25mm) grain. Beginning at plot 17 and continuing to the southern end of the beach, sand particle size is too large and vegetation cover is dominated by grasses and herbaceous plants with significant root mat resulting in inappropriate micro-climatic conditions.

References

Davis, C. 2004. Report on Vegetation Removal in Puritan Tiger Beetle Larval Habitat, Rainbow Beach, Northampton, MA. Unpublished report submitted to Silvio O. Conte National Fish and Wildlife Refuge.

Davis, C. 2018 Puritan Tiger Beetle Recovery Activities. Unpublished report submitted to U.S. FWS.

Appendix A- Recreation-Turners Falls- Recreation Management Plan

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Amended Final Application for New License for Major Water Power Project – Existing Dam

Turners Falls Hydroelectric Project (FERC Project Number 1889)

Recreation Management Plan

FirstLight

DECEMBER 2020

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LIST OF ABBREVIATIONS

ADA	Americans with Disabilities Act
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight MA Hydro, LLC
MA	Massachusetts
NH	New Hampshire
PM&E	Protection, Mitigation and Enhancement
Project	Turners Falls Hydroelectric Project
RMP	Recreation Management Plan
TFI	Turners Falls Impoundment
VT	Vermont

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1 INTRODUCTION AND PURPOSE

The Turners Falls Hydroelectric Project (Project, FERC No. 1889) is owned and operated by FirstLight MA Hydro LLC (hereinafter referred to as FirstLight). The Project is located on the Connecticut River in the states of Massachusetts (MA), New Hampshire (NH), and Vermont (VT).

The Project lands and waters provide a variety of recreational activities, such as walking, hiking, cross-country skiing, snowshoeing, angling, boating, camping, biking, climbing, and picnicking.

The purpose of the Recreation Management Plan (RMP) is to guide FirstLight's management and maintenance of recreation facilities at the Project over the new license term consistent with FERC's requirements to provide adequate public access to Project lands and waters.

Existing Project Recreation Sites addressed in the Project RMP include the following:

- Gatehouse Fishway Viewing Area,
- Turners Falls Branch Canal Area,
- Cabot Woods Fishing Access, and
- Turners Falls Canoe Portage.

These facilities were originally approved by FERC by an Order dated March 17, 1982. FirstLight will continue to operate and maintain these existing Project Recreation Sites, and add additional recreation facilities including:

- **Formal Access Trail and Put-In just below Turners Falls Dam.** Stakeholders have requested a put-in just below the Turners Falls Dam to kayak/canoe/raft the bypass reach. There is an existing informal pathway leading to the base of the Turners Falls Dam just downstream of the existing Spillway Ladder. The proposed access would be provided via the existing bridge (aka the "IP Bridge") spanning the power canal. Once over the canal, a formal 12-ft wide path would lead recreationists to the base of the dam. The path would include a sign (Project name and FERC No.) just after exiting the IP bridge, and directional signs along the formalized path.

  FirstLight also proposes to establish a weblink that would report the forecasted Turners Falls Dam discharge each day during the daylight hours from July 1 to October 15 to benefit whitewater boaters. FirstLight is not proposing to post the Turners Falls Dam discharge from April 1 to June 30 because it is a period when the federally endangered Shortnose Sturgeon could be utilizing the bypass reach for spawning and incubation which could be disturbed by whitewater boaters.

- **Formal Access Trail and Stairs for Take-out at Poplar Street.** There is an existing take-out at Poplar Street; however, it is extremely steep. FirstLight has limited options due to steep topography and land ownership. FirstLight proposes to use the existing gravel parking lot leading to 20-foot wide timber stairs with a boat slide railing leading to a 5-foot long, 20-foot wide concrete landing/abutment. A 32-foot long gangway would be anchored to the concrete abutment and lead to a floating dock in the Connecticut River to accommodate fluctuations in the river elevation. The site would include a sign (Project name and FERC No.) at the top of the timber stairs.

These proposals are discussed in Section 4.

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2 PROJECT DESCRIPTION

The Project is located on the Connecticut River in the states of MA, NH and VT. The Turners Falls Impoundment (TFI) is created by the Turners Falls Dam. The TFI serves as the lower reservoir for the Northfield Mountain Pumped Storage Project. The Project Boundary is shown on Figure 2.0-1. The Project Boundary overlaps with the Northfield Mountain Pumped Storage Project (FERC No. 2485) Boundary along nearly the entire perimeter of the TFI. The TFI is a shared project feature with the Northfield Mountain Pumped Storage Project. The greater portion of the Project, including developed facilities and most of the lands within the Project Boundary, is located in Franklin County, MA; specifically, in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of the Project Boundary extend into the towns of Hinsdale, in Cheshire County, NH, and Vernon, in Windham County, VT. The TFI, which is approximately 20 miles long, extends upstream to the base of Great River Hydro's Vernon Hydroelectric Project and Dam (FERC No. 1904).

Key Project features are shown in Figure 2.0-2 and consist of the following: a) two individual concrete gravity dams separated by an island; b) a gatehouse controlling flow to the power canal; c) the power canal and a short branch canal; d) two hydroelectric powerhouses, located on the power canal, known as Station No. 1 and Cabot Station; e) a bypassed section of the Connecticut River and f) three fish ladders including the Cabot fish ladder, Spillway fish ladder and gatehouse fish ladder.

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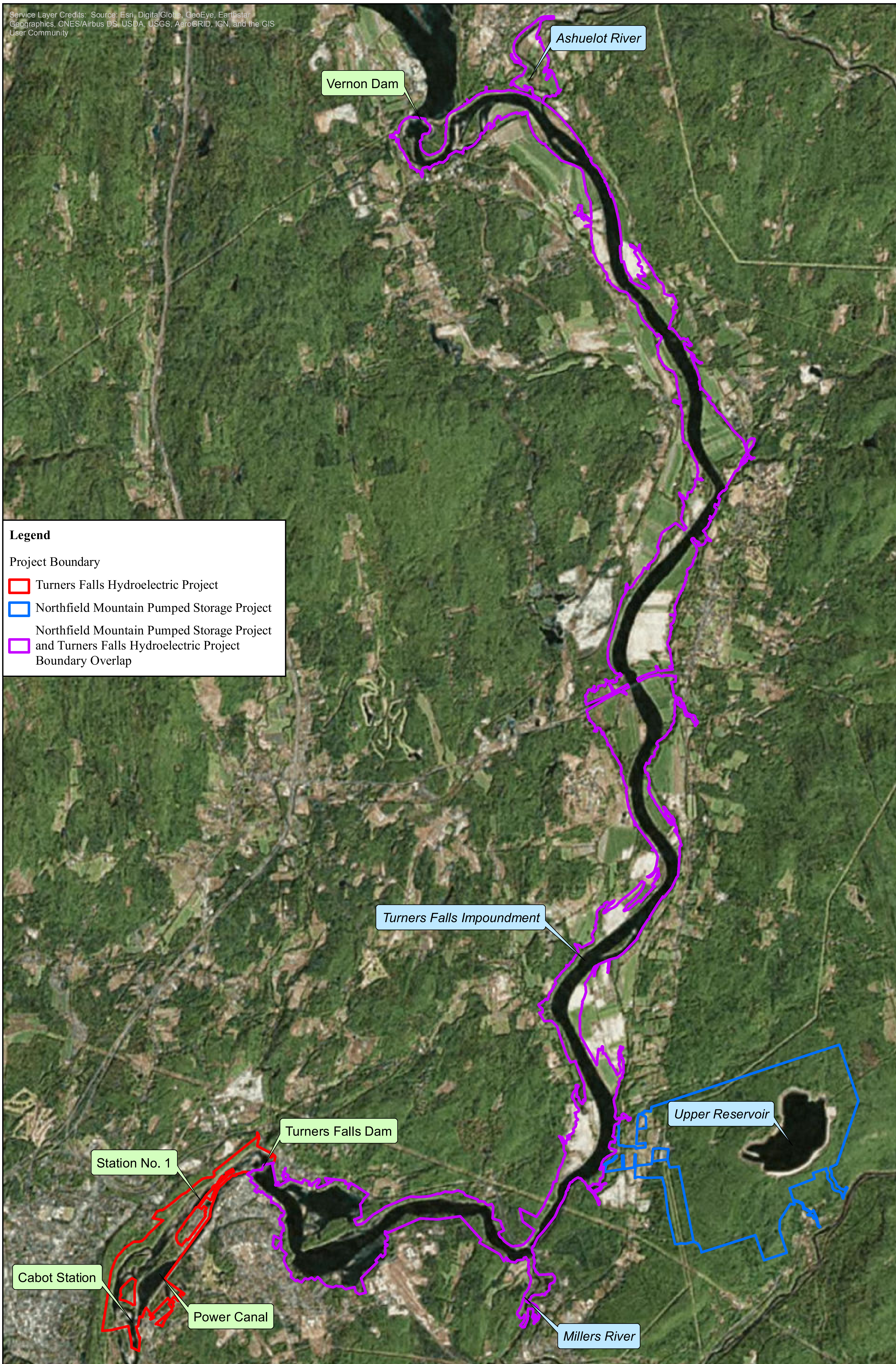

FirstLight

FIRSTLIGHT MA HYDRO LLC
Turners Falls Hydroelectric Project (No. 1889)

Recreation Management Plan

N

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Figure 2.0-1
Turners Falls Hydroelectric Project Boundary Map

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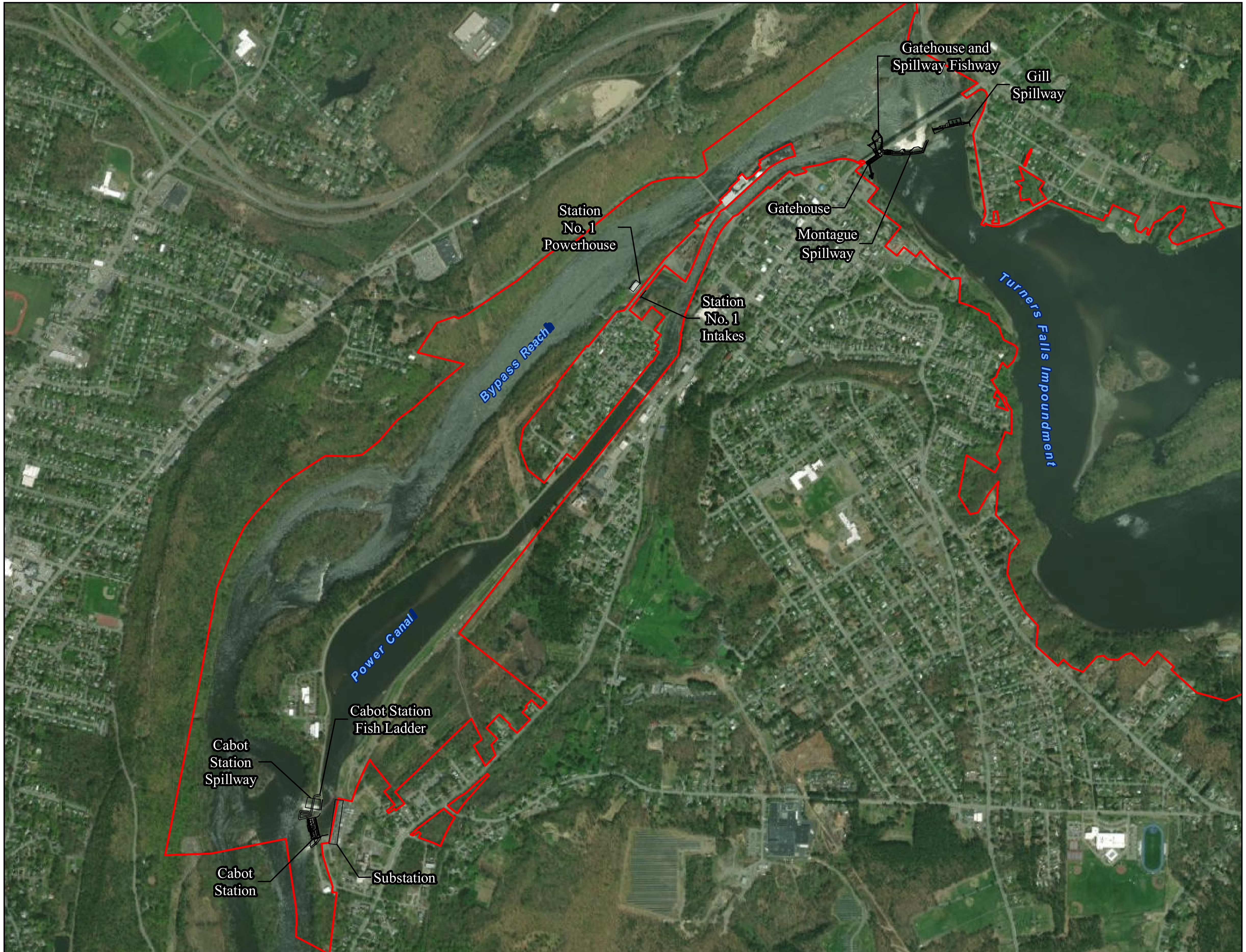

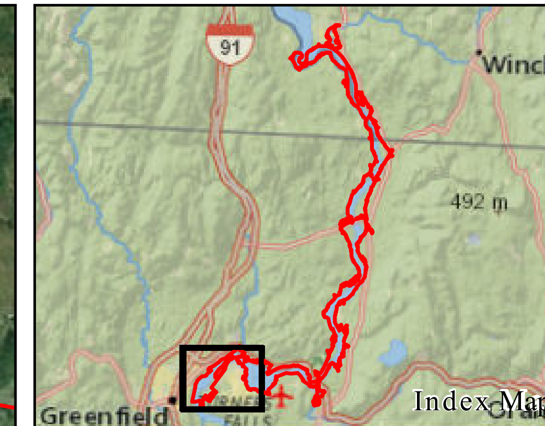

FIRSTLIGHT MA HYDRO LLC
Turners Falls Hydroelectric Project No. 1889

Recreation Management Plan

Figure 2.0-2
Turners Falls Hydroelectric Project
Features

Legend

Project Boundary

N

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 600 1,200 2,400
Feet

1 inch = 1,200 feet

FirstLight

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3 EXISTING PROJECT RECREATION SITES

From upstream to downstream, FirstLight operates and maintains the following existing Project Recreation Sites, as shown in Figure 3.0-1. Consistent with past practice, FirstLight will continue to operate and maintain these Project Recreation Sites as part of the Project RMP. Table 3.0-1 and Table 3.0-2 summarize the facilities and amenities associated with the existing Project Recreation Sites (FirstLight, 2014 & 2015).

3.1 Gatehouse Fishway Viewing Area

Location: The Gatehouse Fishway Viewing Area is located is located on the north side of 1st Street across from the town operated Unity Park in Montague, MA.

Description of Facilities: The Gatehouse Fishway Viewing Area provides the public an opportunity to view the fish that use the fishway. There are two floors to the facility. On the upper level there are Americans with Disabilities Act (ADA) accessible restrooms. The upper level also has a viewing platform that is ADA accessible and contains interpretive displays and a closed-circuit television feed from the fishway counting room. The bottom level contains the fishway viewing area, additional interpretive displays, and also contains the counting room, which is not open to the public. The facility is staffed with seasonal employees during viewing times. The site also contains a picnic area on the north side of 1st Street. The picnic area contains picnic tables, grills, a bike rack and parking. The Canalside Rail Trail starts at the picnic area within the site and continues along the Turners Falls Power Canal.

Site Operation: The fishway viewing facility is open to the public free of charge during fish migration season, typically mid-May to mid-June. Timing may vary depending on weather and river conditions. Hours of operation are Wednesday through Sunday from 9:00 am to 5:00 pm. The viewing area is contained within a fence which is locked during the off-season. The picnic area is located outside of the fence, allowing it to be open year-round from dawn until dusk, unless there is a scheduled event.

3.2 Turners Falls Branch Canal Area

Location: Turners Falls Branch Canal Area is located off Power Street in Montague, MA, along the Station No. 1 forebay.

Description of Facilities: The Turners Falls Branch Canal Area is a day use overlook that provides benches.

Site Operation: The site is available to the public free of charge year-round. There are no posted hours of operation.

3.3 Cabot Woods Fishing Access

Location: Cabot Woods Fishing Access is located on Migratory Way in Montague, MA between the power canal and the bypass reach.

Description of Facilities: Cabot Woods Fishing Access is open for day use activities. Recreation facilities provided at the site include picnic tables and two parking areas (upper and lower). The access road along the canal is open to the public. Over time, several informal trails to the shore have been established by anglers.

Site Operation: The fishing access is open year-round free of charge from dawn to dusk. The site abuts a fence belonging to the U.S. Geological Survey's Conte Anadromous Fish Laboratory. The gate at the head of the road (Migratory Way) into the fishing access and Conte Fish Laboratory is currently open 6:00 a.m. to 7:00 p.m. from May 1 through September 30 and 6:00 a.m. to 5:00 pm from October 1 through April 30. However, the upper parking lot can be used when the gate is closed. Migratory Way is plowed in the winter allowing use of the access road, although the parking areas are not plowed. Swimming is prohibited at this site and signs are posted indicating that it is not safe to swim.

3.4 Turners Falls Canoe Portage

Location: The Turners Falls canoe portage operation provides boaters with a means of circumventing the Turners Falls Dam. Boaters wishing to proceed downriver of Barton Cove call FirstLight for vehicular portage. They are then picked up and driven downstream of the Turners Falls Dam to the Poplar Street Access site in Montague, where they can continue their trip. Signs explaining the canoe portage operation procedures and providing the portage request call-in number are located at the following Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage Project Recreation Sites: Munn's Ferry Boat Camping Recreation Area, Boat Tour and Riverview Picnic Area, Barton Cove Nature Area and Campground, Barton Cove Canoe and Kayak Rental Area, and at the Poplar Street Access Site. Instructions are to paddle to the Barton Cove Canoe and Kayak Rental Area, unload gear, and then call (413) 659-3761 to request a pickup. Typically, a vehicle for the portage will arrive within 15 to 90 minutes of the telephone call. Barton Cove Canoe and Kayak Rental Area has a phone during business hours that boaters can use from Memorial Day through Labor Day. During the off-season, boaters need to use their own phones to make the portage request.

Site Operation: Portage around the Turners Falls Dam for paddlers is available to the public at no charge seven days per week during the paddling season, typically mid-May through mid-November. The site is open from dawn until dusk.

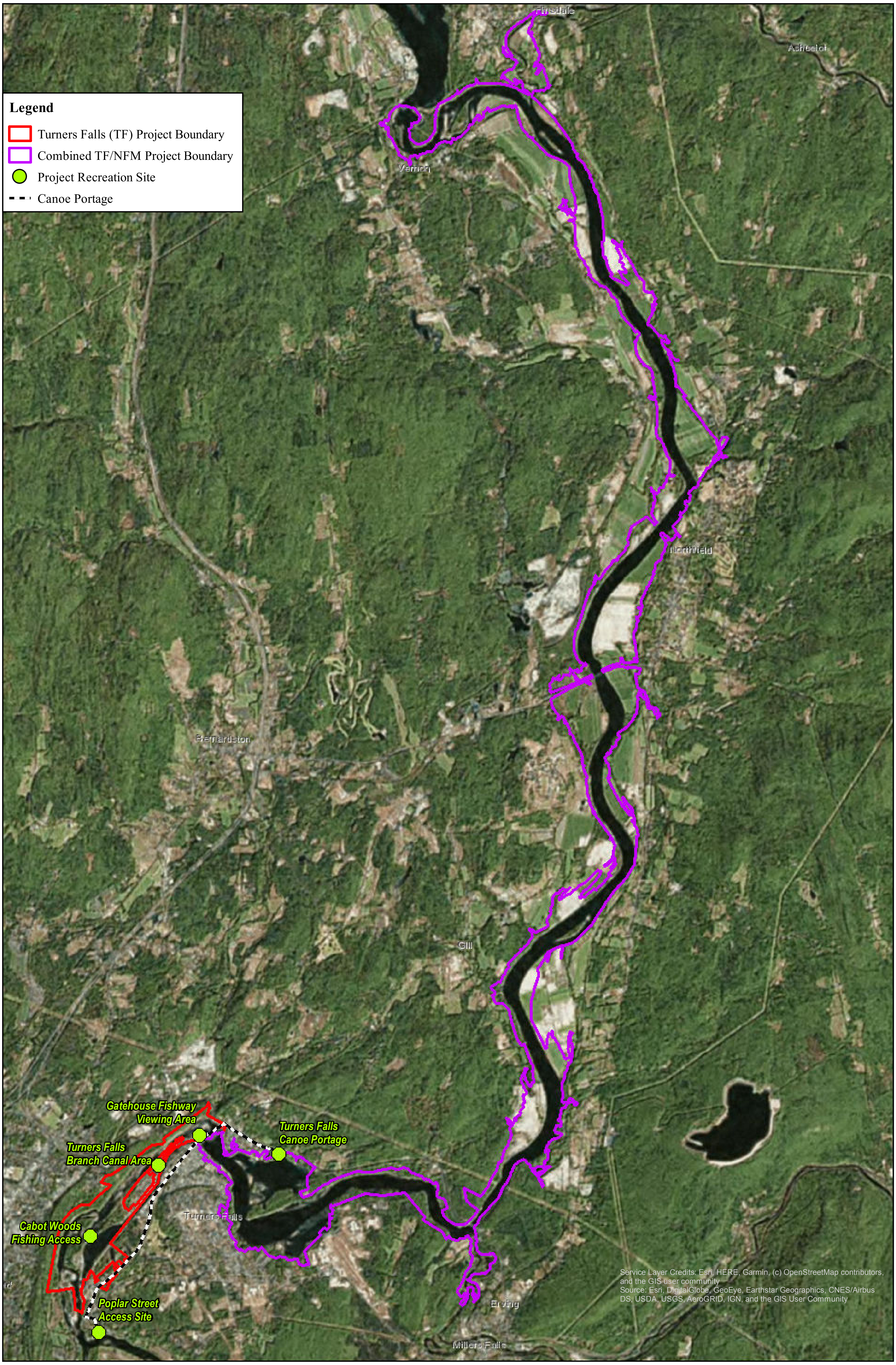
.

Table 3.0-1: Turners Falls Project: Existing FERC-Approved Project Recreation Sites and Facilities Summary

Recreation Site Name	Recreation Facilities/Amenities
Gatehouse Fishway Viewing Area	• parking area (approximately 27 single vehicle spaces; 2 ADA spaces) • picnic area (approximately 6 tables) • bike rack • trail • fishway viewing visitor center (ADA accessible) • restrooms (ADA accessible) • interpretive sign
Turners Falls Branch Canal Area	• Overlook (approximately 4 benches)
Cabot Woods Fishing Access	• parking areas (approximately 17 single vehicle spaces; 2 ADA spaces) • picnic area (approximately 3 tables)
Turners Falls Canoe Portage	• canoe portage take-out (at Barton Cove Canoe & Kayak Rental area) • canoe portage put-in (at Poplar Street Access Site) • On-call vehicular canoe & kayak transport service

Table 3.0-2: Turners Falls Project: Existing FERC-Approved Recreation Sites, Facilities, and Amenities

Recreation Site Name	Recreation Facility/Amenity Type	Facility/ Amenity Status	Latitude	Longitude	FERC Citation & Date	Notes
Barton Cove Canoe and Kayak Rental Area	Take-out	Constructed	42.6082	72.5375	18 FERC 62,467 03/17/1982	Put-in and take-out counted as 1 canoe portage on Form 80
Gatehouse Fishway Viewing Area	Visitor Center	Constructed	42.6097	72.5542	18 FERC 62,467 03/17/1982	fishway viewing areas
Gatehouse Fishway Viewing Area	Picnic Area	Constructed	42.6088	72.5532	18 FERC 62,467 03/17/1982	Approximately 6 tables
Gatehouse Fishway Viewing Area	Interpretive Sign	Constructed	42.6092	72.5536	18 FERC 62,467 03/17/1982	fish species traveling through fish ladder system
Turners Falls Branch Canal Area	Overlook	Constructed	42.6062	72.5629	18 FERC 62,467 03/17/1982	Approximately 4 benches
Cabot Woods Fishing Access	Picnic Area	Constructed	42.5948	72.5788	18 FERC 62,467 03/17/1982	Approximately 3 tables
Cabot Woods Fishing Access	Access Point	Constructed	42.5950	72.5772	18 FERC 62,467 03/17/1982	Angler access
Turners Falls Canoe Portage	Put-in	Constructed	42.5802	72.5752	18 FERC 62,467 03/17/1982	Poplar Street Access Site



FIRSTLIGHT MA HYDRO LLC
Turners Falls Hydroelectric Project (No. 1889)

Recreation Management Plan

N

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Figure 3.0-1:
Existing Project Recreation Sites

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4 RECREATION SITE MODIFICATIONS AND ENHANCEMENTS

4.1 Formal Access Trail and Put-In Just Below Turners Falls Dam

New Project Recreation Site: Stakeholders have requested a put-in just below the Turners Falls Dam to kayak/canoe/raft the bypass reach. There is an existing informal pathway leading to the base of the Turners Falls Dam just downstream of the existing Spillway Ladder. The proposed access would be provided via the existing bridge (aka the "IP Bridge") spanning the power canal. Once over the canal, a formal 12-ft wide path would lead recreationists to the base of the dam. The path would include a sign (Project name and FERC No.) just after exiting the IP bridge, and directional signs along the formalized path. A proposed concept drawing of the put-in in plan (Drawing SW-1) is included in Appendix A.

4.2 Poplar Street Take-Out

Project Recreation Site Improvements:

There is an existing take-out at Poplar Street; however, it is extremely steep. FirstLight has limited options due to steep topography and land ownership. FirstLight proposes to use the existing gravel parking lot leading to 20-foot wide timber stairs with a boat slide railing leading to a 5-foot long, 20-foot wide concrete landing/abutment. A 32-foot long gangway would be anchored to the concrete abutment and lead to a floating dock in the Connecticut River to accommodate fluctuations in the river elevation. The site would include a sign (Project name and FERC No.) at the top of the timber stairs. A proposed concept drawing of the take-out in plan (Drawing PS-1) and profile (Drawing PS-2) is included in Appendix A.

4.3 Flow Weblink

FirstLight proposes to establish a weblink that would report the forecasted Turners Falls Dam discharge each day during the daylight hours from July 1 to October 15 to benefit whitewater boaters. FirstLight is not proposing to post the Turners Falls Dam discharge from April 1 to June 30 because it is a period when the federally endangered Shortnose Sturgeon could be utilizing the bypass reach for spawning and incubation which could be disturbed by whitewater boaters.

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5 IMPLEMENTATION SCHEDULE FOR RECREATION MODIFICATIONS AND ENHANCEMENTS

Table 5.0-1 lists FirstLight's recreation protection, mitigation and enhancement (PM&E) measures for the Turners Falls Project and the estimated implementation schedule, including the number of years after license issuance for the recreation modifications and enhancements to become operational.

Table 5.0-1. FirstLight's Proposed PM&E Measures for Recreation at the Turners Falls Project

Recreation Protection, Mitigation and Enhancement Measures	Task	Estimated No. of Years after License Issuance Recreation Modifications and Enhancements become Operational			
		1	2	3	4
Create a formal access trail for a put-in just below the Turners Falls Dam (within 4 years of license issuance)	Engineering/Design				
	Permitting				
	Construction				
	Operational				
Create a formal trail and steps for a take-out at Poplar Street (within 4 years of license issuance)	Engineering/Design				
	Permitting				
	Construction				
	Operational				

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6 MANAGEMENT AND MAINTENANCE MEASURES FOR PROJECT RECREATION SITES

FirstLight will continue to operate and maintain the existing Project Recreation Sites, as well as the new Project Recreation Site at the Turners Falls Dam Downstream Put-In and the improvements at the Poplar Street Access. Table 6.0-1 identifies the amenities at each Project Recreation Site that are governed by the management and maintenance measures discussed herein.

6.1 Access Roads and Parking Areas

Access roads and parking areas with paved surfaces will be inspected prior to the beginning of the summer recreation season and periodically over the course of the operating season. If an issue with the condition of a road or paved surface is noted, a plan to repair the road will be developed and action will be taken. If the road condition is unsafe it will be closed until repairs can be made.

Access roads and parking areas with gravel surfaces will be inspected prior to the beginning of the summer recreation season and reviewed periodically over the course of the operating season. If an issue with the condition of a road or parking area is noted, a plan to repair the road will be developed and action will be taken. If the road condition is unsafe it will be closed until repairs can be made.

6.2 Boat Docks

Prior to installation, boat docks will be inspected. The inspection will include the access ramp, docks, deck surface, hardware and other components. If a problem is noted, plans to repair or replace the docks will be developed and implemented. Docks will be periodically inspected during the operating season.

6.3 Picnic Areas

Picnic areas will be inspected prior to the beginning of the summer recreation season to assure that the sites are free of debris. Amenities such as picnic tables, grills, and benches will be reviewed for vandalism and condition prior to opening of the sites. Excess vegetation will be removed as needed. If an issue with the amenities arises, a plan to repair or replace the amenity will be developed and implemented. If recreationists note an issue at a facility, an inspection will occur to determine if actions are needed.

6.4 Restrooms

Project Recreation Sites containing restroom facilities will be inspected prior to opening to assure that they are clean and functioning properly. These facilities will be maintained on a regular basis. Vault toilets and portable restroom facilities will be pumped out as necessary to maintain sanitary conditions. If a problem with the structure or facility is noted, it may be closed to execute needed repairs. Restrooms will be inspected on a routine basis and repairs or maintenance will be performed as issues arise.

6.5 Signs

All signs posted at points of public access to the Project as required by 18 CFR Section 8.2 (knows as Part 8 signs) and public safety signs at recreation sites will be inspected and repaired prior to the beginning of the summer recreation season. This inspection will include the condition of the sign and a review of presented information to assure that is appropriate and legible. If an issue with the sign is noted or reported the sign will be scheduled for repair or replacement.

6.6 Buildings and Other Structures

Buildings and other structures that are part of the Project Recreation Sites will be maintained and cleaned on a regular basis during the operating season. Structures will be inspected annually and if a structure requires repair, it may be closed until the repairs are complete.

6.7 Trails

Informal fishing access trails at Cabot Woods Fishing Access will be inspected on an annual basis to determine if there are existing safety hazards. If an issue is observed FirstLight will establish a plan to correct the issue and execute the plan.

6.8 Non-motorized Boat Put-Ins/Take-Outs

Non-motorized boat put-ins/take-outs will be inspected for condition prior to the beginning of the summer recreation season and periodically over the course of the operating season. If an issue with the condition of the put-in/take-out is noted, a plan to repair the site will be developed and action will be taken. If recreationists note an issue at a put-in/take-out, an inspection will occur to determine if actions are needed.

Table 6.0-1: Amenities at Project Recreation Sites to which Management and Maintenance Measures Apply

Project Recreation Site	Management and Maintenance Measures							
	Access Roads and Parking Areas	Boat Docks	Picnic Areas	Restrooms	Signs	Buildings and Other Structures	Trails	Non-motorized Boat Put-ins/Take-Outs
Gatehouse Fishway Viewing Area	✓		✓	✓	✓	✓		
Turners Falls Dam Put-In					✓			✓
Turners Falls Branch Canal Area						✓		
Cabot Woods Fishing Access	✓		✓		✓			
Turners Falls Canoe Portage	✓				✓			✓
Poplar Street Put-in	✓	✓			✓			✓

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7 FEES

FERC allows FirstLight to collect fees at Project Recreation Sites to help defray the cost of constructing, operating, and maintaining such facilities. FirstLight does not currently charge any fees for use of Turners Falls Project facilities. Over the term of the new license, FirstLight may choose to implement reasonable fees to offset rising costs in labor and utilities; changes in operation; or to offset the costs of operating and maintenance costs at the Project Recreation Sites and capital recreation investments.

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8 LITERATURE CITED

FirstLight (2014). Initial Study Report Summary Relicensing Study 3.6.2 Recreation Facilities Inventory and Assessment. Prepared for FirstLight Hydro Generating Company.

FirstLight (2015). Relicensing Study 3.6.2 Recreation Facilities Inventory and Assessment Addendum. Prepared for FirstLight Power Resources. Northfield, MA.

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APPENDIX A – CONCEPTUAL DRAWINGS OF RECREATION FACILITY MODIFICATIONS AND ENHANCEMENTS

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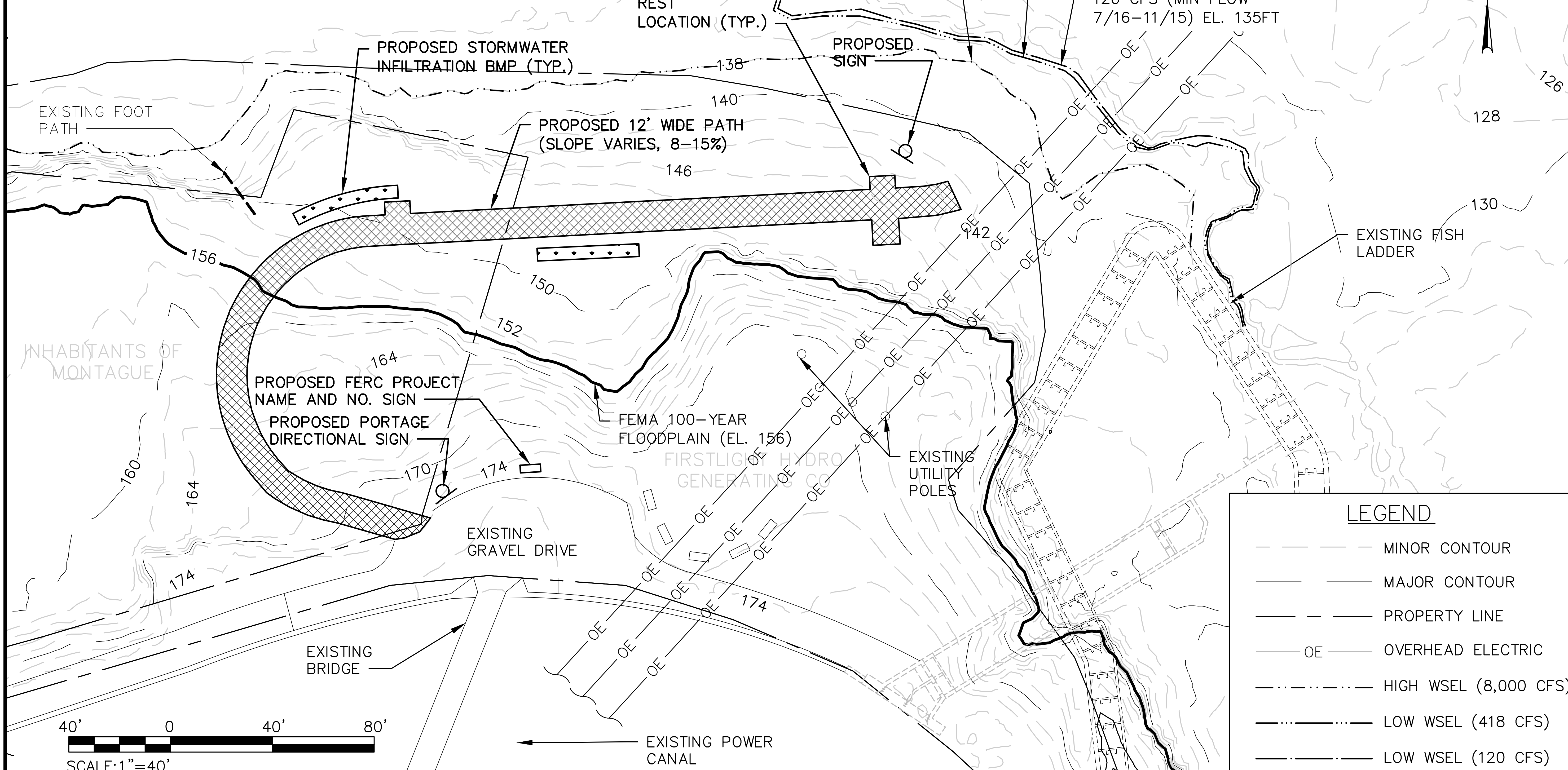
NOTES:
1. FEMA 100-YR FLOODPLAIN LIMITS BASED ON APPROXIMATE WSEL AT RIVER MILE 15.6 ON PANEL 01P OF THE 1982 TOWN OF MONTAGUE FIS STUDY.
2. ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).



LEGEND

— — —	MINOR CONTOUR
———	MAJOR CONTOUR
—— — ——	PROPERTY LINE
—— OE ——	OVERHEAD ELECTRIC
—·-·—·-·—	HIGH WSEL (8,000 CFS)
—···——···—	LOW WSEL (418 CFS)
—·——·—	LOW WSEL (120 CFS)

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

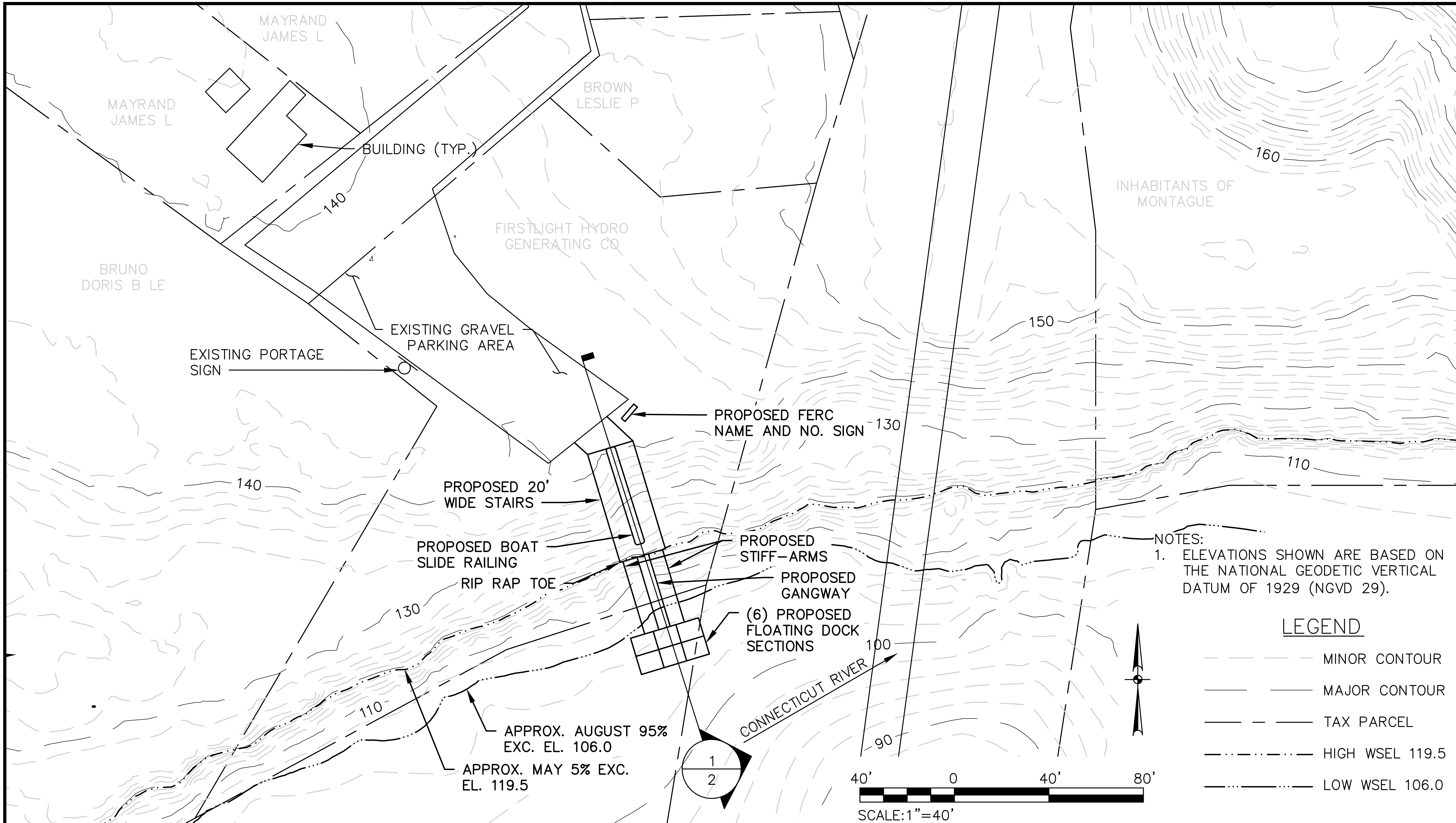
DESIGNED BY:	KJC
DRAWN BY:	KJC
CHECKED BY:	RLS
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	7-11-19

AMENDED FINAL LICENSE APPLICATION

TURNERS FALLS SPILLWAY CARRY-IN PORTAGE - EXISTING GRADE PATH - PLAN

SCALE: 1" = 40'
DRAWING NO.: SW-1

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



NOTES:
1. ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

LEGEND
- MINOR CONTOUR
- MAJOR CONTOUR
- TAX PARCEL
- HIGH WSEL 119.5
- LOW WSEL 106.0

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	KJC
DRAWN BY:	KJC
CHECKED BY:	RLS
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	4-9-20

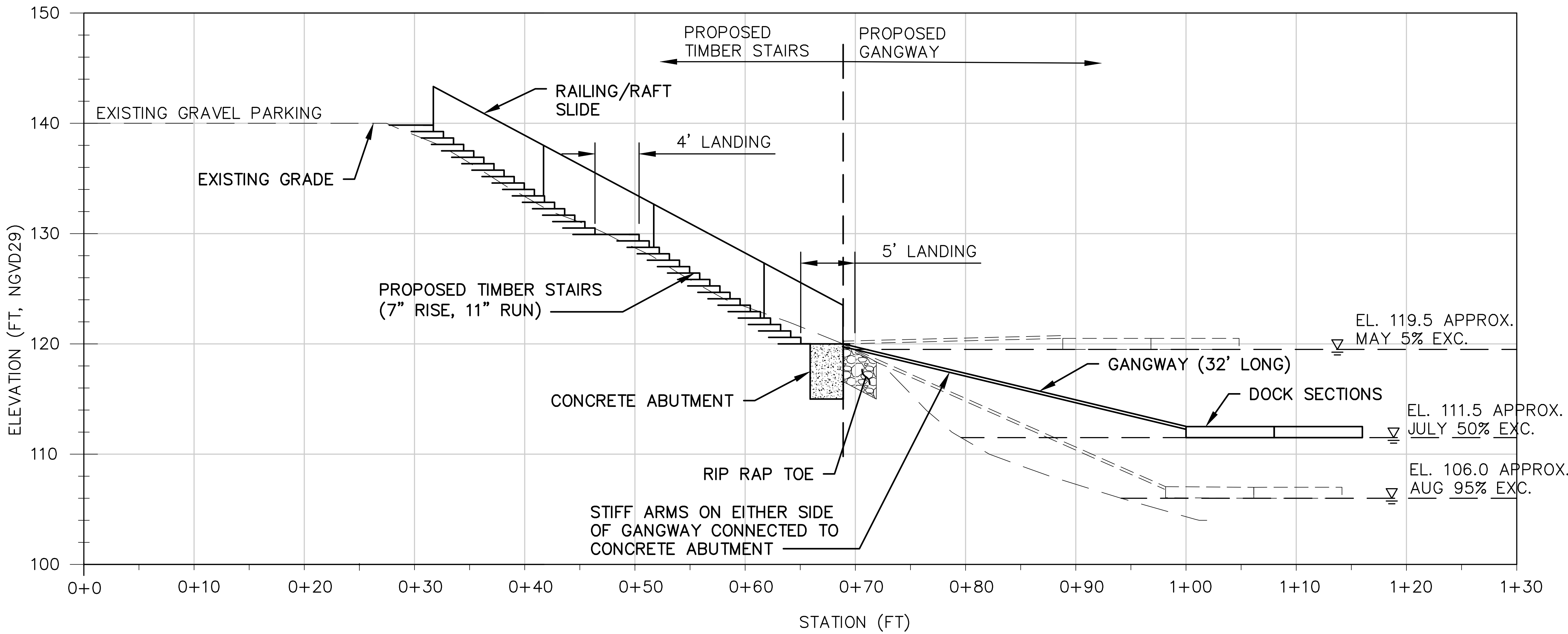
AMENDED FINAL LICENSE APPLICATION

POPLAR STREET - TAKE-OUT - PLAN

SCALE: 1" = 40'

DRAWING NO.: PS-1

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



1/2 STAIR PROFILE
SCALE: 1" = 10'

10' 0 10' 20'
SCALE:1"=10'

NOTES:
1. ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY: KJC	
DRAWN BY: KJC	
CHECKED BY: RLS	
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	4-9-20

AMENDED FINAL LICENSE APPLICATION

POPLAR STREET - TAKE-OUT - PROFILE

SCALE:	1" = 10'	DRAWING NO.:	PS-2

Appendix B- Recreation-Northfield Mountain- Recreation Management Plan

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Amended Final Application for New License for Major Water Power Project – Existing Dam

Northfield Mountain Pumped Storage Project (FERC Project Number 2485)

Recreation Management Plan

FirstLight

DECEMBER 2020

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LIST OF ABBREVIATIONS

ADA	Americans with Disabilities Act
FERC	Federal Energy Regulatory Commission
FirstLight	Northfield Mountain LLC
MA	Massachusetts
NH	New Hampshire
NMTTC	Northfield Mountain Tour and Trail Center
PM&E	Protection, Mitigation and Enhancement
Project	Northfield Mountain Pumped Storage Project
RMP	Recreation Management Plan
TFI	Turners Falls Impoundment
VT	Vermont

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1 INTRODUCTION AND PURPOSE

The Northfield Mountain Pumped Storage Project (Project, FERC No. 2485) is owned and operated by Northfield Mountain LLC (hereinafter referred to as FirstLight). The Project is located adjacent to the Connecticut River and uses the Turners Falls Impoundment (TFI) as its lower reservoir. The Project and the TFI are located in the states of Massachusetts (MA), New Hampshire (NH), and Vermont (VT).

The Project lands and waters provide a variety of recreational activities, such as walking, hiking, cross-country skiing, snowshoeing, angling, boating, camping, biking, climbing, and picnicking.

The purpose of the Recreation Management Plan (RMP) is to guide FirstLight's management and maintenance of recreation facilities at the Project over the new license term consistent with FERC's requirements to provide adequate public access to Project lands and waters.

Existing Project Recreation Sites addressed in the Project RMP include the following:

- Munn's Ferry Boat Camping Recreation Area,
- Boat Tour and Riverview Picnic Area,
- Northfield Mountain Tour and Trail Center, which includes the Northfield Mountaintop Observation Area and the Northfield Mountain Trail System,
- Barton Cove Nature Area and Campground,
- Barton Cove Canoe and Kayak Rental Area, and
- Turners Falls Canoe Portage.

These facilities were originally approved by FERC by Orders dated July 5, 1977, March 17, 1982, and June 30, 2003. FirstLight will continue to operate and maintain these existing Project Recreation Sites, and add or enhance additional recreation facilities including:

- **Relocation of the Boat Tour Dock at Riverview**. The proposed barrier net would be in place from August 1 to November 15 during a portion of the summer recreation season. The current layout of the barrier net encloses the existing Boat Tour Dock. Given this, FirstLight proposes to relocate the dock further upstream of its current location. It would entail extending the road further north.

- **Create a New Access Trail with Stairs for a Put-In at Riverview.** A new put-in would be located off of Pine Meadow Road, where Fourmile Brook discharges into the TFI. The site would entail establishing a 6-foot wide stone path to timber and concrete stairs leading to a put-in on the northern bank along the brook. Pine Meadow Road would be widened to add approximately seven (7) parking spots and a sign (Project Name and FERC No.) would be installed near the stone path.

- **Formal Access Trail and Put-In at Cabot Camp.** FirstLight proposes to create a 200-foot long, 10-foot wide formal path leading from the Cabot Camp parking area to an access point on the Millers River just upstream of the confluence with the Connecticut River. There is currently an informal path in this area. A sign (Project Name and FERC No.) and directional portage sign would be installed along the formal path leading the public from the parking lot directly to the 10-foot-wide gravel path leading to the water's edge.

These proposals are discussed in Section 4.

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2 PROJECT DESCRIPTION

The Project is a pumped-storage facility located on the Connecticut River in MA that uses the TFI as its lower reservoir. The TFI is created by the Turners Falls Dam. The Project Boundary is shown on Figure 2.0-1. The Project Boundary overlaps with Turners Falls Hydroelectric Project (FERC No. 1889) Boundary along nearly the entire perimeter of the TFI, but it does not include the Turners Falls Dam. The TFI is a shared project feature with the Turners Falls Hydroelectric Project. The greater portion of the TFI and most of the lands within the Project Boundary, are located in Franklin County, MA; specifically, in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of Project Boundary extend into the towns of Hinsdale, in Cheshire County, NH, and Vernon, in Windham County, VT. The TFI, which is approximately 20 miles long, extends upstream to the base of Great River Hydro's Vernon Hydroelectric Project and Dam (FERC No. 1904).

Key Project features are shown in Figure 2.0-2 and consist of the following: a) Upper Reservoir dam/dikes, b) an intake channel, pressure shaft, c) an underground powerhouse and d) a tailrace tunnel. The tailrace is located approximately 5.2 miles upstream of Turners Falls Dam, on the east side of the TFI.

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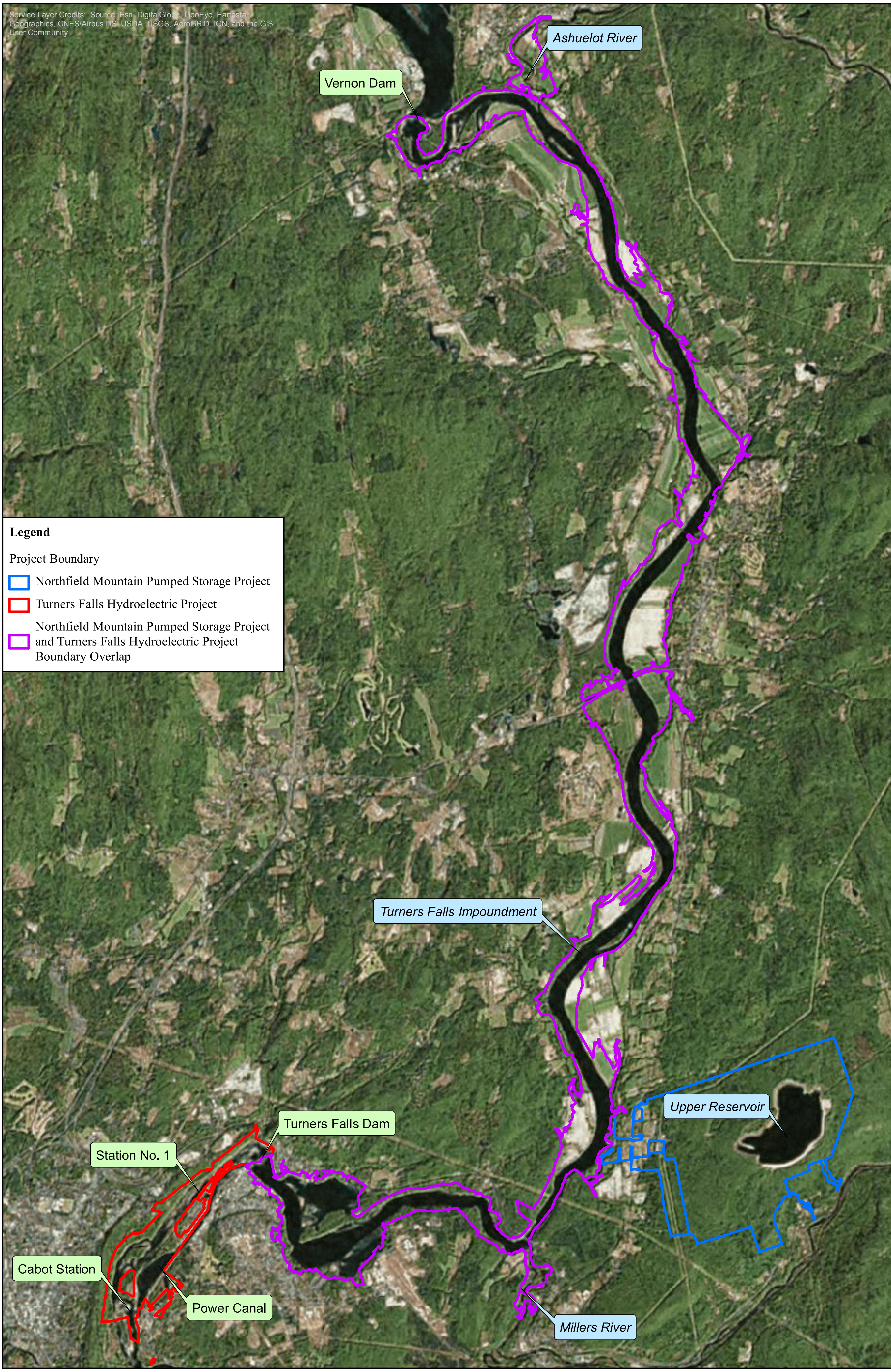

NORTHFIELD MOUNTAIN LLC
Northfield Mountain Pumped Storage Project (No. 2485)

Recreation Management Plan

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Figure 2.0-1
Northfield Mountain Pumped Storage Project Boundary Map

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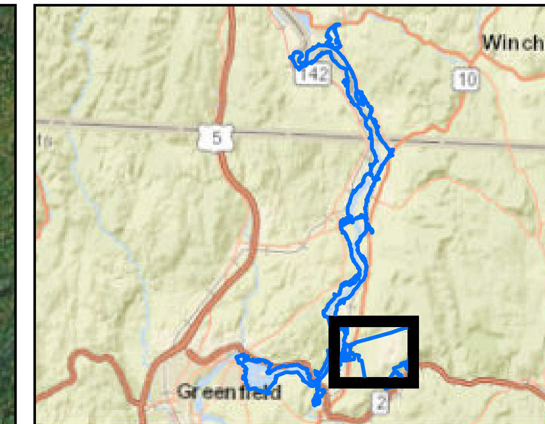

NORTHFIELD MOUNTAIN LLC
Northfield Mountain Pumped Storage Project No. 2485

Recreation Management Plan

Figure 2.0-2
Northfield Mountain Pumped Storage
Project Features

Legend

Project Boundary

N

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Feet

1 inch = 1,200 feet

FirstLight

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3 EXISTING PROJECT RECREATION SITES

From upstream to downstream, FirstLight operates and maintains the following existing Project Recreation Sites, as shown in Figure 3.0-1. Consistent with past practice, FirstLight will continue to operate and maintain these Project Recreation Sites as part of the Project RMP. Table 3.0-1 and Table 3.0-2 summarize the facilities and amenities associated with the existing Project Recreation Sites (FirstLight, 2014 & 2015).

3.1 Munn's Ferry Boat Camping Recreation Area

Location: Munn's Ferry is located on the east side of the Connecticut River (TFI) in Northfield, MA.

Description of Facilities: Munn's Ferry is a water access only overnight and day use site. The camping area at Munn's Ferry includes tent campsites each with a trash can, tent platform, picnic table, grill, and, in some cases, a fire ring.

Site Operation: Munn's Ferry is open from Memorial Day to Columbus Day. Individuals must reserve a site and pay a fee prior to camping. The dock is available during the operating season.

3.2 Boat Tour and Riverview Picnic Area

Location: The Boat Tour and Riverview Picnic Area is located off Pine Meadow Road on the east shore of the Connecticut River (TFI) in Northfield, MA.

Description of Facilities: The Boat Tour and Riverview Picnic area provides an area for picnicking along the river, which includes picnic tables and grills. There is a pavilion, which can be rented for group events. The site includes restroom facilities and benches. The site also offers river tours on the Heritage Riverboat, which travels along the Connecticut River between Barton Cove and the Riverview Picnic Area. The riverboat is operated by FirstLight and typically leaves from the Riverview Picnic Area dock.

A formal parking lot is available for those using the picnic area and those who are boarding the Heritage Riverboat. There are Americans with Disabilities Act (ADA) accessible parking spaces and an ADA compliant bathroom at the site.

Site Operation: The site is open from dawn to dusk free of charge, although there is a fee to rent the pavilion or cruise on the riverboat. The site opens Memorial Day weekend and closes Columbus Day weekend. The river boat operates from July to mid-October. The dock is in place during the operating season and removed during the off-season. The entrance to the site has a gate, which is open when the site is open to the public.

3.3 Northfield Mountain Tour and Trail Center

Location: The Northfield Mountain Tour and Trail Center (NMTTC) is located off Millers Falls Road in Northfield, MA.

Description of Facilities: The NMTTC offers a Visitor Center, parking area, trails and a mountaintop observation area. The Visitor Center offers self-guided interpretive displays, meeting rooms, a lounge, and public restrooms. The center also offers recreation and environmental education programs year-round, including programs for school classes and organized groups. There is a paved parking area located adjacent to the Visitor Center. Additional overflow parking is provided on a nearby mowed area. Horse trailers and buses utilize the cul-de-sac on the west side of the Visitor Center for parking. ADA accessible parking is available at the Visitor Center, along with a ramp to access the facility.

Site Operation: The Visitor Center is typically open year-round for day use activities from 9:00 am to 4:30 pm Wednesday through Sunday. The Center is also open on certain holidays, which are noted on FirstLight's web page https://www.firstlightpower.com/recreation/?location_id=386. The Northfield Mountain trail system is also open year round, depending on trail and weather conditions. Use of the Visitor

Center is free, as is summer trail use and snowshoeing. FirstLight charges a fee for cross country skiing. A fee may also be charged for the recreation and environmental educational activities to help offset their cost.

3.3.1 Mountaintop Observation Area

The Mountaintop Observation Area is a wooden observation platform providing views of the Upper Reservoir from its southern shore. The platform is approximately 20 feet by 20 feet and is accessible from the Northfield Mountain Trail System's Summit Trail.

3.3.2 Trail System

The Northfield Mountain Trail System includes approximately 25 miles of trails, which are used for hiking, mountain biking, equestrian use, snowshoeing, cross-country skiing, and other non-motorized multi-use activities. A map of the trail system is provided in Figure 3.3.2-1. Approximately 18 miles of trail are wide (8'-15') level corridors with an improved base. Approximately 7 miles are narrow single track trails on natural soils. These trails are typically used for hiking, biking, and snowshoeing. Rose Ledge and a portion of the Farley Ledge are also located within the vicinity of the Northfield Mountain Tour and Trail Center. Rose Ledge can be accessed via the Northfield Mountain Tour and Trail Center parking area and trail system. Both Rose Ledge and Farley Ledge can be accessed via parking and trails outside the Project Boundary on private property.

3.4 Barton Cove Nature Area and Campground

Location: Barton Cove Nature Area and Campground is located on Barton Cove Road (TFI) in Gill, MA.

Description of Facilities: The Barton Cove Nature Area has a set of flush toilets and showers. The site has grills, picnic tables, and a walking trail leading to an overlook. There is a paved parking area at the Nature Area and an adjacent overflow parking area.

The Barton Cove Campground has group campsites, trailer sites, and tent sites. One of the tent sites is considered ADA accessible. Each campsite has a picnic table and fire ring. There are community trash containers in the campground. The group sites also have grills and additional picnic tables. There are vault toilets located within the campground. There is an additional parking area within the campground.

Site Operation: The Nature Area is open to the public free of charge, from dawn to dusk year round. The parking area at the Nature Area is plowed during the winter months. The campground is open Memorial Day to Labor Day. Quiet hours are from 10:00pm to 8:00 am. There is a fee for overnight camping and sites may be reserved ahead of time.

3.5 Barton Cove Canoe and Kayak Rental Area

Location: This site is located on the northern shore of the Connecticut River (TFI), off Route 2 in Gill, MA.

Description of Facilities: Barton Cove Canoe and Kayak offers paddlecraft rentals and picnicking. There is a natural gravel carry-in paddlecraft launch, a rental office, picnic tables, parking and a portable sanitation facility. Paddlecraft rentals include personal flotation devices (PFDs) and paddles or oars.

Site Operation: The facility is open from Memorial Day Weekend to Labor Day Weekend and is gated in the off-season. The rental office is open on weekends from 9:00 am to 6:00 pm and Monday through Friday 9:00 am to 5:00 pm. Individuals can use the site free of charge, although there is a fee to rent paddlecraft.

3.6 Turners Falls Canoe Portage

Location: The Turners Falls canoe portage operation provides boaters with a means of circumventing the Turners Falls Dam. Boaters wishing to proceed downriver of Barton Cove call FirstLight for vehicular portage. They are then picked up and driven downstream of the Turners Falls Dam to the Poplar Street Access site in Montague, where they can continue their trip. Signs explaining the canoe portage operation procedures and providing the portage request call-in number are located at the following Recreation Sites: Munn's Ferry Boat Camping Recreation Area, Boat Tour and Riverview Picnic Area, Barton Cove Nature Area and Campground, Barton Cove Canoe and Kayak Rental Area, and at the Poplar Street Access Site. Instructions explaining the canoe portage operation procedures are also on FirstLight's web page https://www.firstlightpower.com/recreation/?location_id=396. Instructions are to paddle to the Barton Cove Canoe and Kayak Rental Area, unload gear, and then call (413) 659-3761 to request a pick up. Typically, a vehicle for the portage will arrive within 15 to 90 minutes of the telephone call. Barton Cove Canoe and Kayak Rental Area has a phone during business hours that boaters can use from Memorial Day through Labor Day. During the off-season, boaters need to use their own phones to make the portage request.

Site Operation: Portage around the Turners Falls Dam for paddlers is available to the public at no charge seven days per week during the paddling season, typically mid-May through mid-November. The site is open from dawn till dusk.

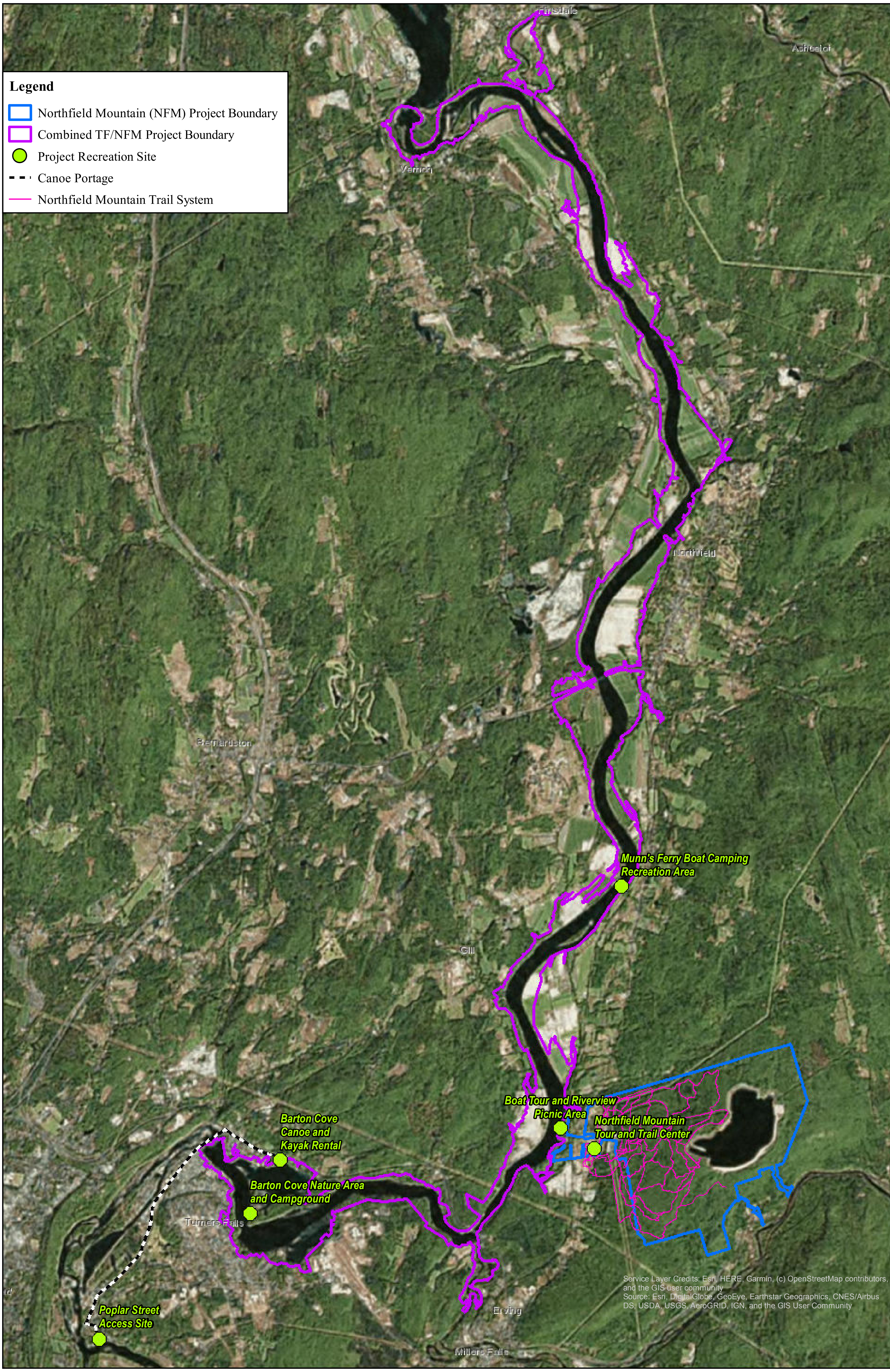
Table 3.0-1: Northfield Mountain Project: Existing FERC-Approved Recreation Sites and Facilities Summary

Recreation Site Name	Recreation Facilities/Amenities
Munn's Ferry Boat Camping Recreation Area	• water access only campsites (approximately 4-5 tent platform sites) • pedestrian foot bridge • picnic area (approximately 1 table) • dock
Boat Tour and Riverview Picnic Area	• parking area (approximately 54 single vehicle spaces; 2 ADA) • restroom (ADA compliant) • picnic area (approximately 10 tables) • pedestrian foot bridge • picnic pavilion (approximately 8 tables) • boat tour • dock
Northfield Mountain Tour and Trail Center	• parking area (approximately 50 single vehicle spaces; 3 ADA) • restroom • picnic area (approximately 7 tables) • overlook • visitor center and interpretive displays • winter area • trail system
Barton Cove Nature Area and Campground	• nature area parking area (approximately 26 single vehicle spaces) • campground parking (approximately 28 single vehicle spaces) • showers • restroom facilities (2 facilities; ADA compliant) • picnic area (approximately 15 tables) • overlook • interpretive sign • walk-in campground (approximately 2 group sites; 28 campsites; and 1 ADA campsite) • nature trail • dock
Barton Cove Canoe and Kayak Rental Area/Turners Falls Canoe Portage	• parking area (approximately 28 single vehicle spaces) • picnic area (approximately 6 tables) • seasonal restroom • paddlecraft rental service • canoe put-in and take-out (serves as portage take-out) • on-call vehicular canoe & kayak transport service

Table 3.0-2: Northfield Mountain Project: Existing FERC Approved Recreation Sites, Facilities, and Amenities

Recreation Site Name	Recreation Facility/Amenity Type	Facility/ Amenity Status	Latitude	Longitude	FERC Citation & Date	Notes
Munn's Ferry Boat Camping Recreation Area	Campground	Constructed	42.6512	72.4666	59 FPC 126 July 5, 1977	Water access only, approximately 4 tent sites and 1 shelter site
Munn's Ferry Boat Camping Recreation Area	Picnic Area	Constructed	42.6512	72.4666	59 FPC 126 July 5, 1977	Approximately 1 table
Boat Tour and Riverview Picnic Area	Picnic Area	Constructed	42.6133	72.4792	59 FPC 126 July 5, 1977	Approximately 12 tables
Boat Tour and Riverview Picnic Area	Picnic Pavilion	Constructed	42.6140	72.4788	59 FPC 126 July 5, 1977	Approximately 8 tables
Boat Tour and Riverview Picnic Area	Other Use (Interpretive Boat Tour)	Constructed	42.6130	72.4797	59 FPC 126 July 5, 1977	Heritage Dock
Northfield Mountain Tour and Trail Center	Picnic Area	Constructed	42.6104	72.4713	59 FPC 126 July 5, 1977	Approximately 7 tables
Northfield Mountain Tour and Trail Center	Overlook	Constructed	42.6095	72.4495	59 FPC 126 July 5, 1977	Platform overlooking upper reservoir
Northfield Mountain Tour and Trail Center	Trails	Constructed	N/A	N/A	59 FPC 126 July 5, 1977	
Northfield Mountain Tour and Trail Center	Visitor Center	Constructed	42.6108	72.4716	59 FPC 126 July 5, 1977	Environmental and Educational programs, video displays
Northfield Mountain Tour and Trail Center	Interpretive Display	Constructed	42.6108	72.4716	59 FPC 126 July 5, 1977	
Northfield Mountain Tour and Trail Center	Winter Area	Constructed	42.6108	72.4716	59 FPC 126 July 5, 1977	Skiing, cross country skiing, snowshoeing

Recreation Site Name	Recreation Facility/Amenity Type	Facility/ Amenity Status	Latitude	Longitude	FERC Citation & Date	Notes
Barton Cove Nature Area and Campground	Picnic Area	Constructed	42.6040	72.5332	59 FPC 126 July 5, 1977	Approximately 15 tables
Barton Cove Nature Area and Campground	Overlook	Constructed	42.6031	72.5336	59 FPC 126 July 5, 1977	Platform overlooking Barton Cove
Barton Cove Nature Area and Campground	Campground	Constructed	42.5999	72.5440	59 FPC 126 July 5, 1977	Approximately 2 group sites and 29 camp sites (1 ADA)
Barton Cove Nature Area and Campground	Interpretive Display	Constructed	42.6042	72.5328	59 FPC 126 July 5, 1977	
Barton Cove Nature Area and Campground	Trail	Constructed	N/A	N/A	59 FPC 126 July 5, 1977	Approx. 4,250 feet long nature trail
Barton Cove Canoe and Kayak Rental Area	Picnic Area	Constructed	42.6082	72.5377	103 FERC 62,189 06/30/2003	Approximately 6 tables
Barton Cove Canoe and Kayak Rental Area//Turners Falls Canoe Portage	Take-out	Constructed	42.6082	72.5375	18 FERC 62,467 03/17/1982	Put-in and take-out counted as 1 canoe portage
Barton Cove Canoe and Kayak Rental Area	Other Use (paddlecraft rentals)	Constructed	42.6082	72.5377	103 FERC 62,189 06/30/2003	Paddlecraft for rent



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NORTHFIELD MOUNTAIN LLC
Northfield Mountain Pumped Storage Project (No. 2485)

Recreation Management Plan

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Figure 3.0-1:
Existing Project Recreation Sites

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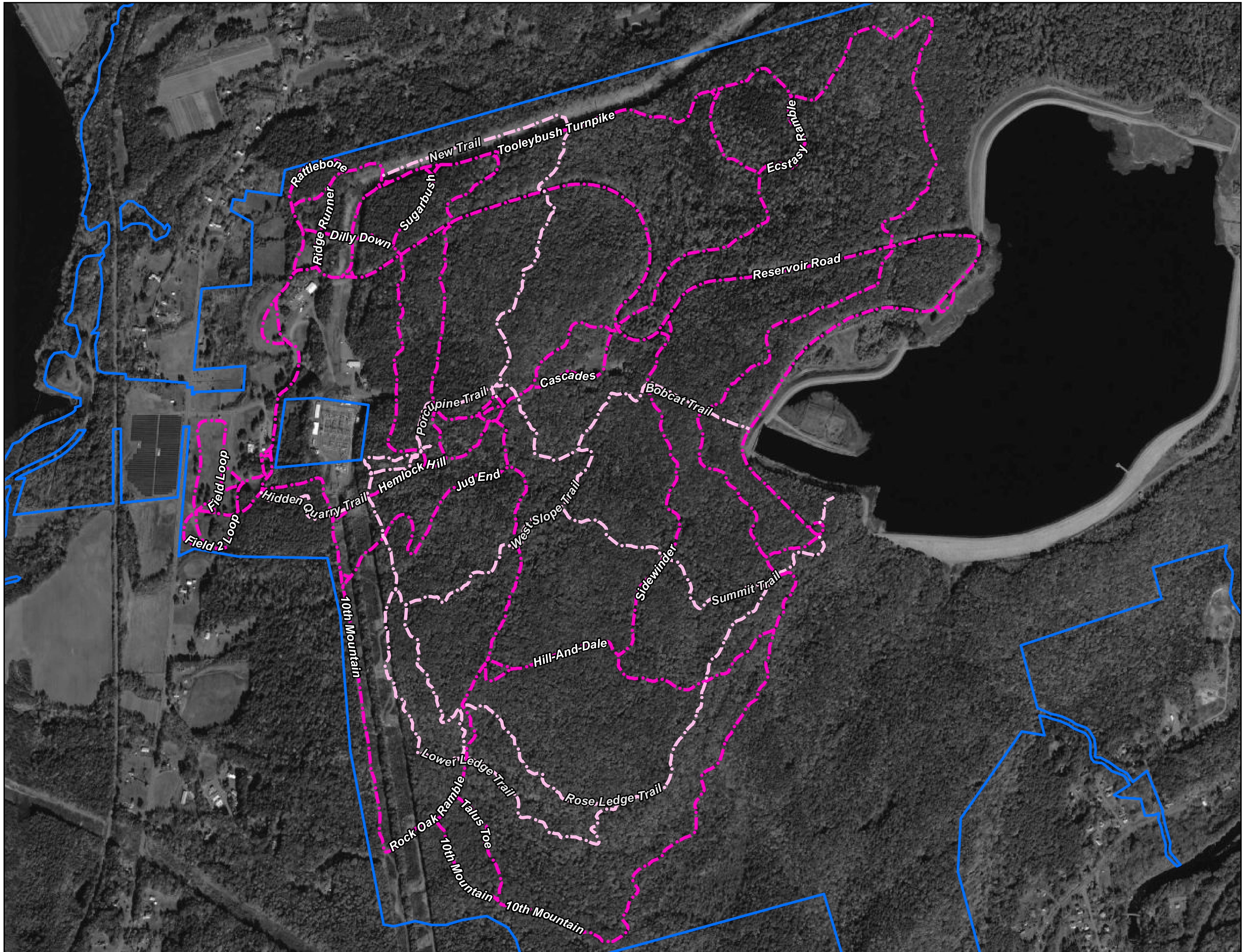

NORTHFIELD MOUNTAIN LLC
Northfield Mountain Pumped Storage Project No. 2485

Recreation Management Plan

Figure 3.3.2-1:
Existing Northfield Mountain
Trail System

Legend

FERC Project Boundary

NFM Trail Type

Ski Trail

Snowshoe Trail

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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1 inch = 1,000 feet

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4 RECREATION SITE MODIFICATIONS AND ENHANCEMENTS

4.1 Relocation of the Boat Tour Dock at Riverview

Modification: The proposed barrier net would be in place from August 1 to November 15 during a portion of the summer recreation season. The current layout of the barrier net encloses the existing Boat Tour Dock. Given this, FirstLight proposes to relocate the dock further upstream of its current location. It would entail extending the existing road further north. A proposed concept drawing of the relocated dock in plan (Drawing RV-1) and profile (Drawing RV-2) is included in Appendix A.

4.2 Create a New Access Trail with Stairs for a Put-In at Riverview

New Project Recreation Site: A new put-in would be located off of Pine Meadow Road, where Fourmile Brook discharges into the TFI. The site would entail establishing a 6-foot wide stone path to timber and concrete stairs leading to a put-in on the northern bank along the brook. Pine Meadow Road would be widened to add approximately seven (7) parking spots and a sign (Project Name and FERC No.) would be installed near the stone path. A proposed concept drawing of the put-in in plan and profile (Drawing RV-3) is included in Appendix A.

4.3 Formal Access Trail and Put-In at Cabot Camp

New Project Recreation Site: FirstLight proposes to create a 200-foot long, 10-foot wide formal path leading from the Cabot Camp parking area to an access point on the Millers River just upstream of the confluence with the Connecticut River. There is currently an informal path in this area. A sign (Project Name and FERC No.) and directional portage sign would be installed along the formal path leading the public from the parking lot directly to the 10-foot-wide gravel path leading to the water's edge. A proposed concept drawing of the put-in in plan (Drawing CC-1) and profile (Drawing CC-2) is included in Appendix A.

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5 IMPLEMENTATION SCHEDULE FOR RECREATION MODIFICATIONS AND ENHANCEMENTS

Table 5.0-1 lists FirstLight's recreation protection, mitigation and enhancement (PM&E) measures for the Northfield Mountain Project and the estimated implementation schedule, including the number of years after license issuance for the recreation modifications and enhancements to become operational.

Table 5.0-1. FirstLight's PM&E Measures for Recreation at the Northfield Mountain Project

Proposed PM&E Measure	Task	Estimated No. of Years after License Issuance PM&E Measure becomes Operational			
		1	2	3	4
At Riverview, relocate the existing Boat Tour Dock given that it would be enclosed by the proposed Barrier Net (within 4 years of license issuance)	Engineering/Design				
	Permitting				
	Construction				
	Operational				
Create a new access trail with stairs for a put-in at Riverview (within 4 years of license issuance)	Engineering/Design				
	Permitting				
	Construction				
	Operational				
Create a formal access trail for a put-in at Cabot Camp (within 3 years of license issuance)	Engineering/Design				
	Permitting				
	Construction				
	Operational				

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6 MANAGEMENTAND MAINTENANCE MEASURES FOR PROJECT RECREATION SITES

FirstLight will continue to operate and maintain the existing Project Recreation Sites, as well as the new Project Recreation Sites at the Riverview and Cabot Camp Access Area. In addition, FirstLight will operate and maintain the improvements at the Boat Tour and Riverview Picnic Area. Table 6.0-1 identifies the amenities at each Project Recreation Site that are governed by the management and maintenance measures discussed herein.

6.1 Access Roads and Parking Areas

Access roads and parking areas with paved surfaces will be inspected prior to the beginning of the summer recreation season and periodically over the course of the operating season. If an issue with the condition of a road or paved surface is noted, a plan to repair the road will be developed and action will be taken. If the road condition is unsafe it will be closed until repairs can be made.

Access roads and parking areas with gravel surfaces will be inspected to the beginning of the summer recreation season and reviewed periodically over the course of the operating season. If an issue with the condition of a road or parking area is noted, a plan to repair the road will be developed and action will be taken. If the road condition is unsafe it will be closed until repairs can be made.

6.2 Boat Docks

Prior to installation, boat docks will be inspected. The inspection will include the access ramp, docks, deck surface, hardware and other components. If a problem is noted, plans to repair or replace the docks will be developed and implemented. Docks will be periodically inspected during the operating season.

6.3 Picnic Areas

Picnic areas will be inspected prior to the beginning of the summer recreation season to assure that the sites are free of debris. Amenities such as picnic tables, grills, and benches will be reviewed for vandalism and condition prior to opening of the sites. Excess vegetation will be removed as needed. If an issue with the amenities arises, a plan to repair or replace the amenity will be developed and implemented. If recreationists note an issue at a facility, an inspection will occur to determine if actions are needed.

6.4 Campsites

Campsites will be inspected prior to opening to assure that the sites are free of debris. Amenities such as picnic tables, grills, and fire rings will be reviewed for vandalism and condition prior to opening of the sites. Excess vegetation will be removed as needed. If an issue with the amenities arises, a plan to repair or replace the amenity will be developed and implemented. If recreationists note an issue at a facility, an inspection will occur to determine if actions are needed.

6.5 Restrooms

Project Recreation Sites containing restroom facilities will be inspected prior to opening to assure that they are clean and functioning properly. These facilities will be maintained on a regular basis. Vault toilets and portable restroom facilities will be pumped out as necessary to maintain sanitary conditions. If a problem with the structure or facility is noted, it may be closed to execute needed repairs. Restrooms will be inspected on a routine basis and repairs or maintenance will be performed as issues arise.

6.6 Shower Facilities

Shower facilities will be inspected prior to opening to assure that they are clean and functioning properly. These facilities will be maintained on a regular basis and will be inspected on a routine basis. Repairs or maintenance will be performed as issues arise. If a problem with the structure or facility is noted, it may be closed to execute needed repairs.

6.7 Signs

All signs posted at points of public access to the Project as required by 18 CFR Section 8.2 (knows as Part 8 signs) and public safety signs at recreation sites will be inspected and repaired prior to the beginning of the summer recreation season. This inspection will include the condition of the sign and a review of presented information to assure that is appropriate and legible. If an issue with the sign is noted or reported the sign will be scheduled for repair or replacement.

6.8 Buildings and Other Structures

Buildings and other structures that are part of the Project Recreation Sites will be maintained and cleaned on a regular basis during the operating season. Structures will be inspected annually and if a structure requires repair, it may be closed until the repairs are complete.

6.9 Trails

The NMTTC trail system will be inspected on a routine basis to determine if there is a need for maintenance to the trail tread or drainage, as well as the need for trail clearing or grading. The trail system will be routinely inspected for potential damaged or hazard trees. If an issue is reported or observed, a plan to correct the issue will be developed and implemented.

The Barton Cove Nature Trail will be inspected on a routine basis to determine if there is a need for maintenance to the trail tread or drainage. The trail will also be inspected to determine the need for trail clearing. The trail will be inspected for potential damaged or hazard trees routinely. If a tree is a safety concern or an issue with the trail is reported, a plan to correct the issue will be developed and implemented.

6.10 FirstLight Heritage Riverboat

The Heritage will be maintained and operated in accordance with Federal (including U.S. Coast Guard), State, and Local, laws and regulations.

6.11 Non-motorized Boat Put-ins/Take-outs

Non-motorized boat put-ins/take-outs will be inspected for condition prior to the beginning of the summer recreation season and periodically over the course of the operating season. If an issue with the condition of the put-in/take-out is noted, a plan to repair the site will be developed and action will be taken. If recreationists note an issue at a put-in/take-out, an inspection will occur to determine if actions are needed.

Table 6.0-1: Amenities at Project Recreation Sites to which Management and Maintenance Measures Apply

	Management and Maintenance Measures										
Project Recreation Site	**Access Roads and Parking Areas**	**Boat Docks**	**Picnic Areas**	**Campsites**	**Restrooms**	**Shower Facilities**	**Signs**	**Buildings and Other Structures**	**Trails**	**Riverboat**	**Non-motorized Boat Put-ins/Take-Outs**
Munn's Ferry Boat Camping Recreation Area		✓	✓	✓	✓		✓	✓			✓
Boat Tour and Riverview Picnic Area	✓	✓	✓		✓		✓	✓		✓	
Riverview Put-in	✓						✓				✓
Northfield Mountain Tour and Trail Center	✓		✓		✓		✓	✓	✓		
Cabot Camp Put-in	✓						✓				✓
Barton Cove Nature Area and Campground	✓	✓	✓	✓	✓	✓	✓		✓		✓
Barton Cove Canoe and Kayak Rental Area	✓		✓		✓		✓	✓			✓
Turners Falls Canoe Portage	✓						✓				✓

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7 FEES

FERC allows FirstLight to collect fees at Project Recreation Sites to help defray the cost of constructing, operating, and maintaining such facilities. FirstLight currently charges fees for certain amenities or activities to offset operating and maintenance costs at the Project Recreation Sites; however, they do not cover all expenses incurred by FirstLight in operating and maintaining the Project Recreation Sites. Over the term of the new license, FirstLight may choose to implement reasonable fee changes to offset rising costs in labor and utilities; changes in operation; or to offset the costs of capital recreation investments.

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8 LITERATURE CITED

FirstLight (2014). Initial Study Report Summary Relicensing Study 3.6.2 Recreation Facilities Inventory and Assessment. Prepared for FirstLight Hydro Generating Company.

FirstLight (2015). Relicensing Study 3.6.2 Recreation Facilities Inventory and Assessment Addendum. Prepared for FirstLight Power Resources. Northfield, MA.

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APPENDIX A – CONCEPTUAL DRAWINGS OF RECREATION FACILITY MODIFICATIONS AND ENHANCEMENTS

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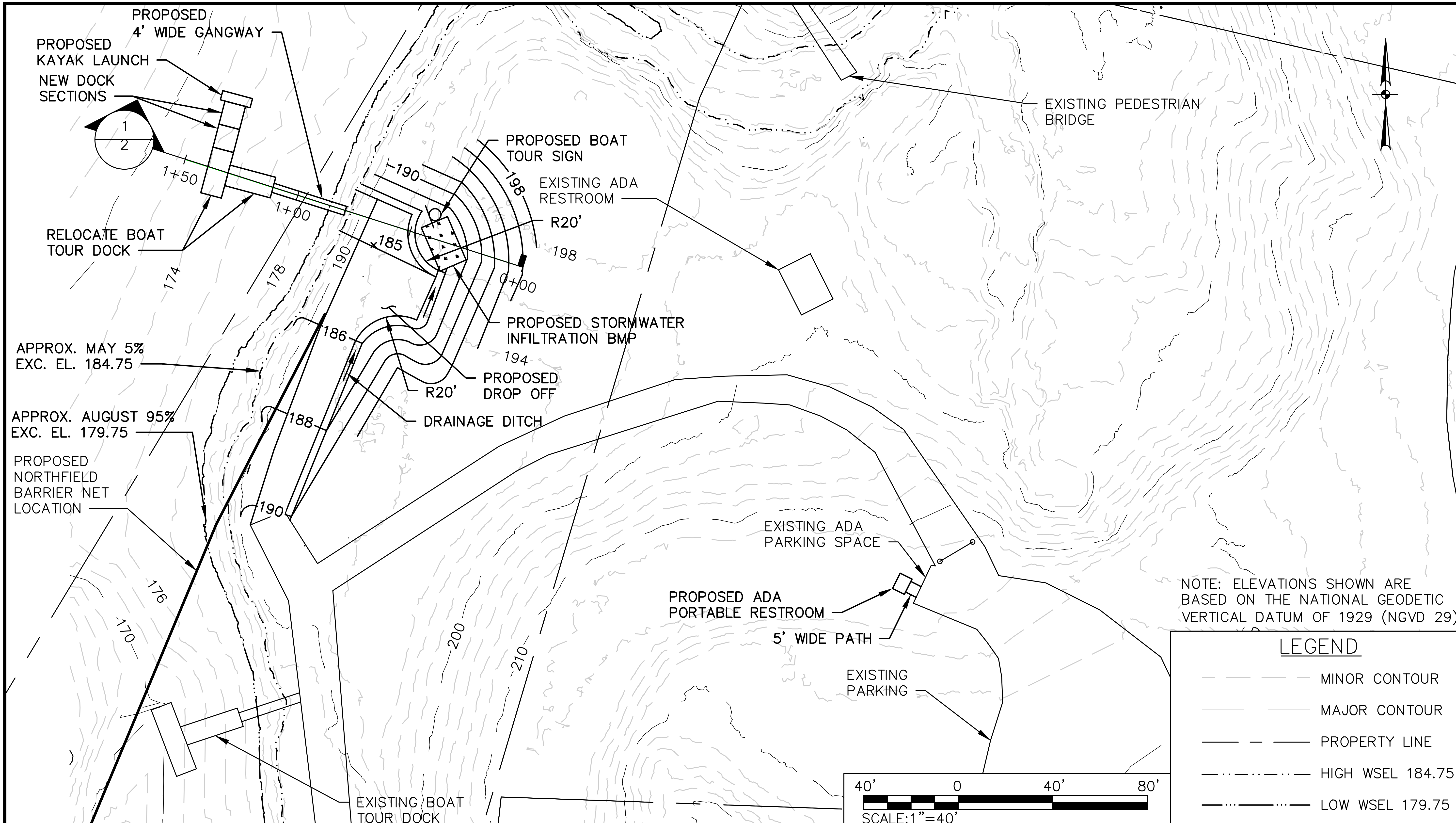
IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY: KJC	
DRAWN BY: KJC	
CHECKED BY: RLS	
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	02-19-20

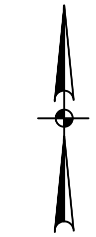
AMENDED FINAL LICENSE APPLICATION

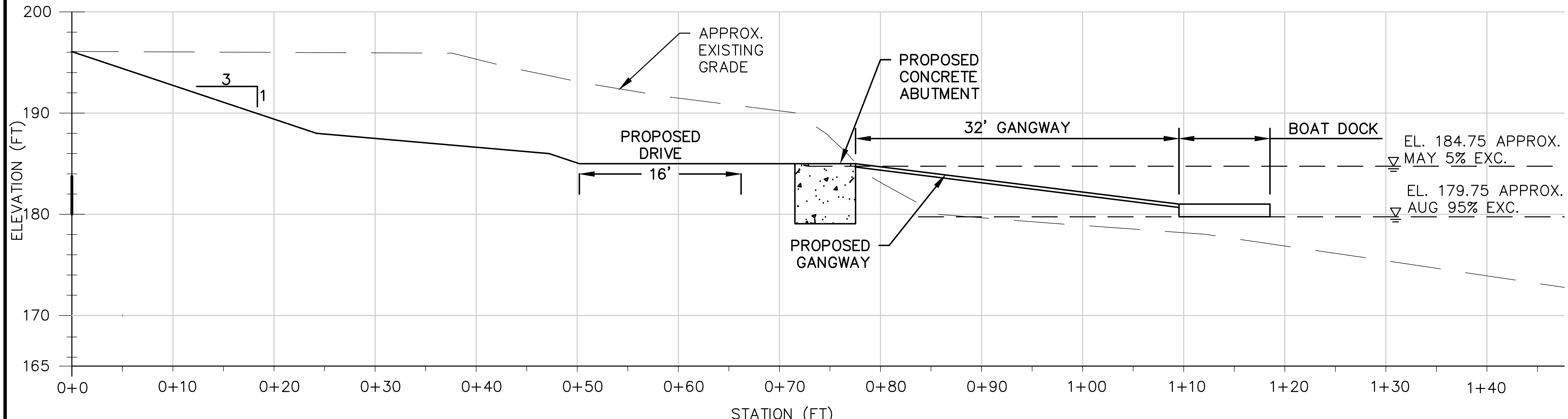
RIVERVIEW - BOAT TOUR DOCK RELOCATION - PLAN

SCALE: 1" = 40'

DRAWING NO.: RV-1

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.





1 / 2 BOAT DOCK PROFILE

SCALE: 1" = 10'

NOTE: ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
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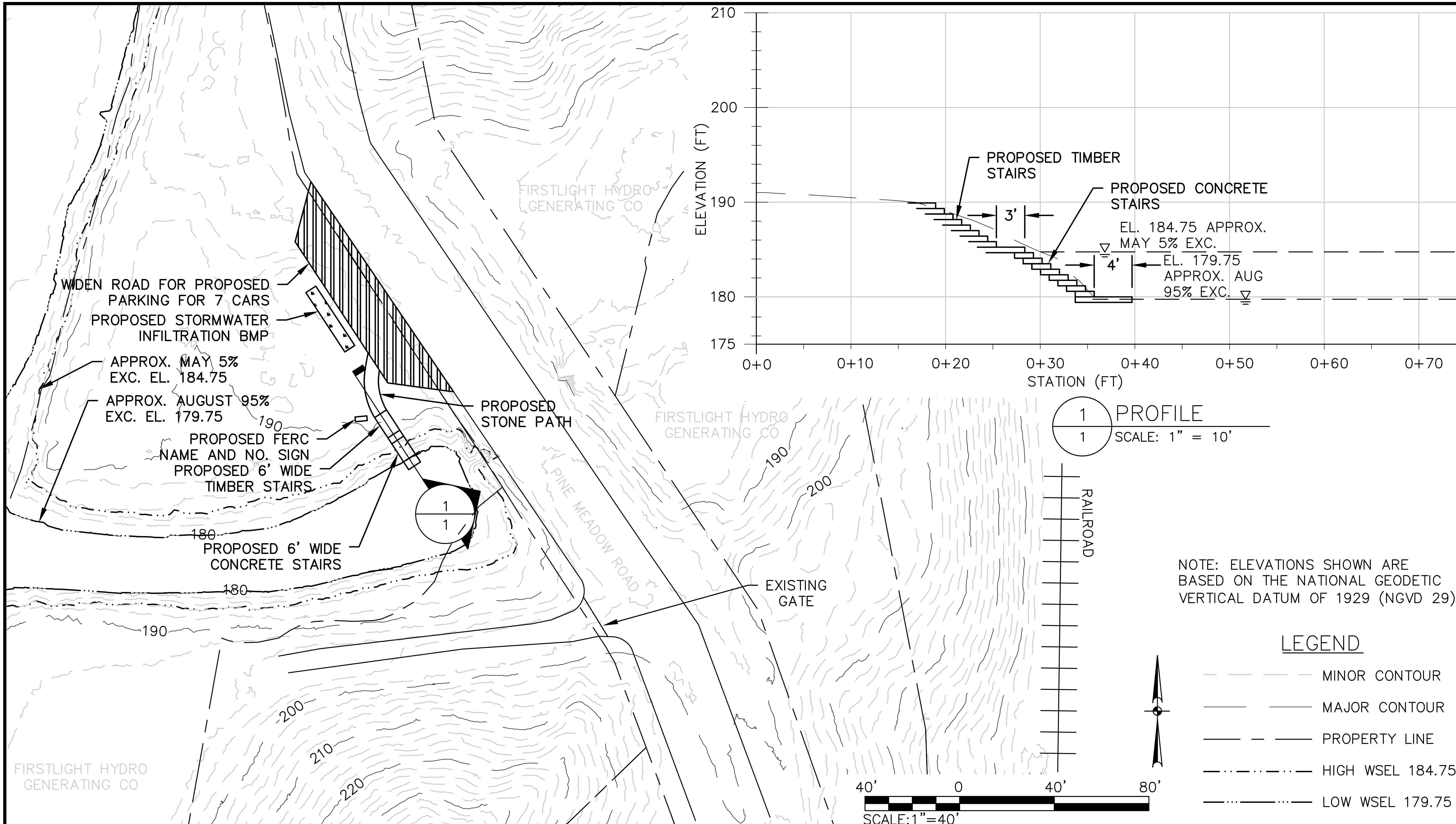
DESIGNED BY: KJC	
DRAWN BY: KJC	
CHECKED BY: RLS	
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	02-19-20

AMENDED FINAL LICENSE APPLICATION

RIVERVIEW - BOAT TOUR DOCK RELOCATION - PROFILE

SCALE:	1" = 10'	DRAWING NO.:	RV-2



NOTE: ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR
- PROPERTY LINE
- HIGH WSEL 184.75
- LOW WSEL 179.75

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
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DESIGNED BY: KJC	
DRAWN BY: JSC	
CHECKED BY: RLS	
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	07-11-19

AMENDED FINAL LICENSE APPLICATION

RIVERVIEW - PORTAGE PARKING AND STAIRS - PLAN

SCALE:	1" = 40'	DRAWING NO.:	RV-3

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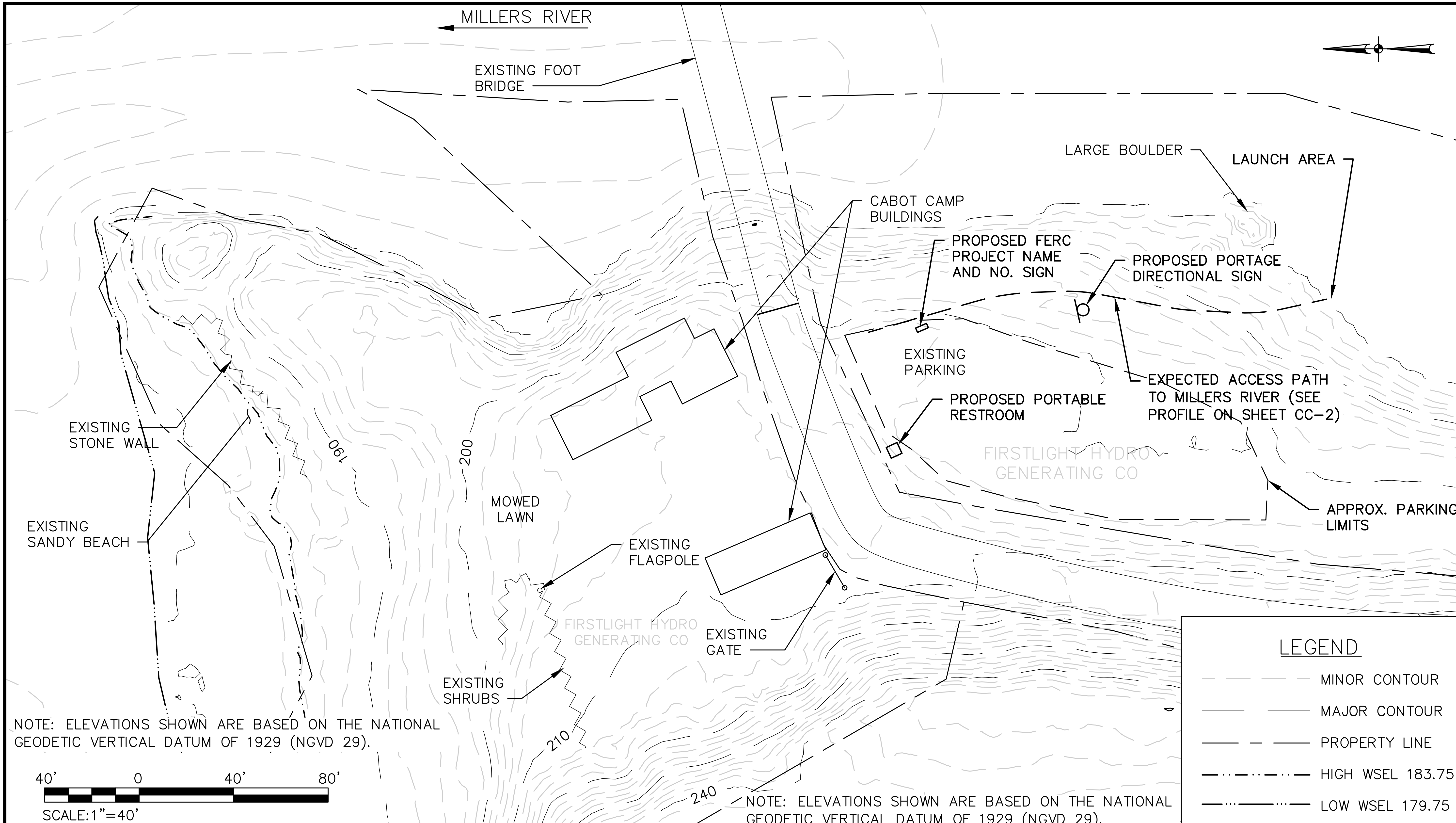

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
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DESIGNED BY:	KJC
DRAWN BY:	JSC
CHECKED BY:	RLS
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	2-19-20

AMENDED FINAL LICENSE APPLICATION

CABOT CAMP - CARRY-IN LAUNCH PATH - PLAN

SCALE: 1" = 40' DRAWING NO.: CC-1

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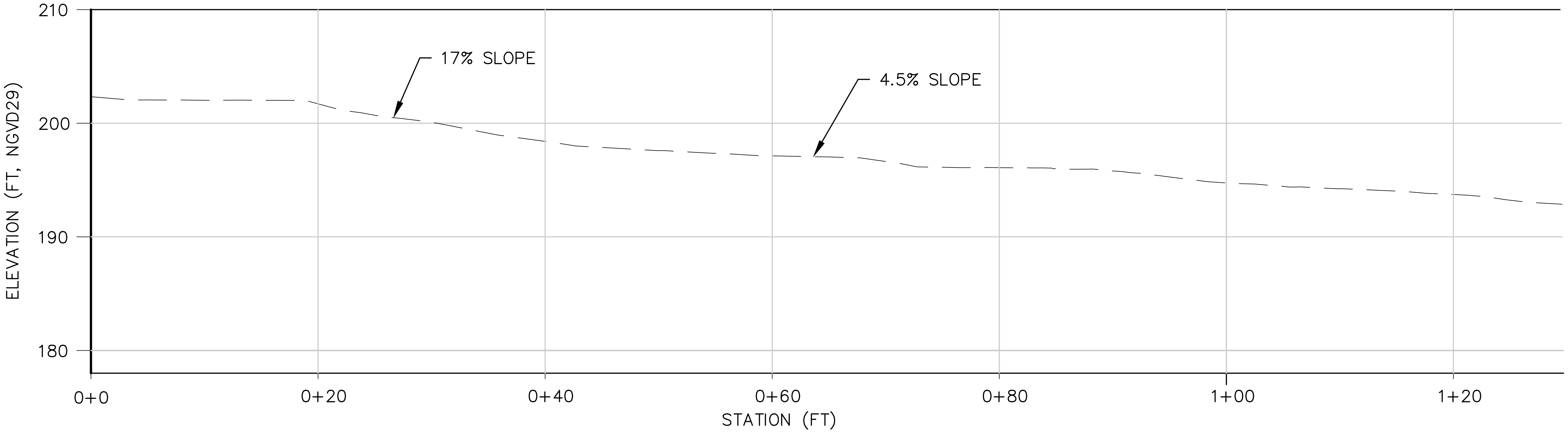

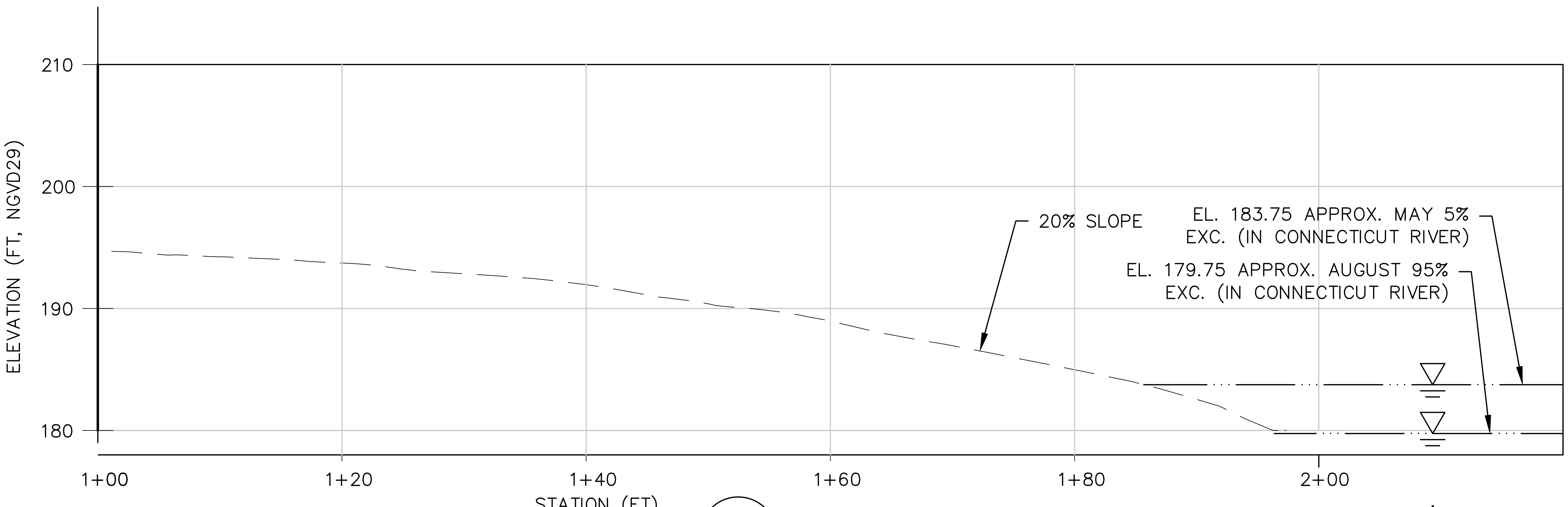

1 / 2 ACCESS
SCALE: 1" = 10'

10' 0 10' 20'
SCALE:1"=10'

NOTE: ELEVATIONS SHOWN ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

NO.	DATE	DESCRIPTION	BY	APP

FOR: FirstLight

BY: GOMEZ AND SULLIVAN ENGINEERS
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DESIGNED BY:	KJC
DRAWN BY:	JSC
CHECKED BY:	RLS
APPROVED BY:	-
PROJECT NO.:	1490
DATE:	2-19-20

AMENDED FINAL LICENSE APPLICATION

CABOT CAMP - CARRY-IN LAUNCH PATH - PROFILE

SCALE: 1" = 10'

DRAWING NO.: CC-2

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