December 2, 2015

VIA ELECTRONIC FILING

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: FirstLight Hydro Generating Company, FERC Project Nos. 2485 and 1889; Draft License Application

Dear Secretary Bose:

Pursuant to the regulations of the Federal Energy Regulatory Commission (Commission or FERC), Title 18 Code of Federal Regulations (18 C.F.R.) §5.16(c), FirstLight Hydro Generating Company (FirstLight) hereby submits this Draft License Application (DLA) as part of the Integrated Licensing Process (ILP) for the relicensing of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889) and Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485). The current license for both the Turners Falls and Northfield Mountain Projects expires on April 30, 2016.

FirstLight is seeking to combine the Turners Falls Project and Northfield Mountain Project into a single license, and requests that the single project be designated as the Northfield Project, comprised of two developments to be called the Turners Falls Development and Northfield Mountain Pumped Storage Development. The DLA refers to the two developments and single project.

This DLA was prepared in lieu of a Preliminary Licensing Proposal (PLP), in accordance with Section 5.16(c) of the Commission's regulations. FirstLight filed a notice of its intent to file a DLA in lieu of the PLP as part of its September 14, 2015 filing of the Updated Study Report (USR).

Status of FERC-Approved Studies

On August 14, 2013, FirstLight filed with FERC its Revised Study Plan (RSP), which included a total of 38 studies. On August 27, 2013 Entergy Corporation 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 FirstLight Projects, would be closing by December 29, 2014[1]. With the closure of VY, certain environmental baseline conditions could have changed during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which 20 studies were approved, or approved with FERC modifications. However, due to the impending closure of VY, FERC did not act on the remaining 18 aquatic related studies. The SPDL for these 18 studies were deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary

[1] The decommissioning of VY began on December 29, 2014.

John S. Howard
Director FERC Compliance, Hydro

FirstLight Power Resources, Inc.
99 Millers Falls Road
Northfield, MA 01360
Tel. (413) 659-4489/ Fax (413) 422-5900/
E-mail: john.howard@gdfsuezna.com

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 18 studies on February 21, 2014, approving the RSP with certain modifications. An additional Ichthyoplankton study emanating from a study dispute was added later bringing the total number of studies to 39.

On September 14, 2015, FirstLight filed its USR in which only summary reports were provided for many of the aquatic resource studies started in 2015. Of the 39 studies, FirstLight has filed completed reports on 14[2] studies. There are 24 studies still in progress and two (2) studies slated for the 2016 field season.

FirstLight's Proposal in the Draft License Application

The DLA includes a section on Proposed Actions and Alternatives, which typically includes, at a minimum, the no-action alternative and FirstLight's proposal. At this time, FirstLight's proposal is limited to two changes—modifications to the Project boundary and using more Upper Reservoir storage capacity at the Northfield Mountain Project. Since many of FirstLight's studies are not yet final, it would be premature for FirstLight to develop a complete licensing proposal for operating the Project in the new license term at this time. Once FirstLight's studies and TransCanada's studies are complete and FirstLight has had an opportunity to discuss the study results with resource agencies and other stakeholders, FirstLight will be in a better position to develop a comprehensive proposal for relicensing the Project.

Review of DLA and Filing of Comments

Pursuant to Section 5.16(e) of the Commission's regulations, comments on the DLA should be filed by March 1, 2016, 90 days after the date of this filing. Given that FirstLight's proposal for relicensing the Project is incomplete, FirstLight expects that stakeholders will reserve their right to provide substantive comments until after FirstLight has filed a more comprehensive proposal for relicensing the Project.

Exhibit F-Supporting Design Report

In 18 C.F.R. § 4.41(g) is Exhibit F, which consists of general design drawings and a supporting design report (SDR) relative to the safety of the Project. FirstLight respectively requests a waiver of the requirement to submit a SDR as the Turners Falls and Northfield Mountain Projects are already subject to FERC Part 12 Dam Safety regulations. In addition, all supporting design reports are currently on file with the Commission's Division of Dam Safety and Inspections in the New York Regional Office.

Availability of DLA

Some information in the DLA is Critical Energy Infrastructure Information (CEII), which has been removed from the public version of the DLA. In accordance with the Commission's filing guidelines, all CEII is included in a separate volume and has been clearly marked as CEII, as it contains detailed Project facility diagrams and other information relating to the "production, generation, transportation, transmission, or distribution of energy." 18 C.F.R. § 388.113(c).

FirstLight is filing the DLA with the Commission electronically. To access the DLA on the Commission's website (http://www.ferc.gov), go to the "eLibrary" link, and enter the docket number, P-1889 or P-2485. FirstLight is also making the DLA available for download at the following website http://www.northfieldrelicensing.com (click on "Documents", and then "2015 Documents").

[2] One of the 14 studies required an interim report and final report (counted as two reports).

FirstLight is making the DLA available to the public at the Northfield Mountain Visitor's Center at 99 Millers Falls Road, Northfield, MA during regular business hours.

If you have any questions, or need additional information, please feel free to contact me.

Sincerely,

John Howard

Before the Federal Energy Regulatory Commission

Draft Application for New License for Major Water Power Project – Existing Dam

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

FirstLight GDF SUEZ

INITIAL STATEMENT
ADDITIONAL INFORMATION
- **EXHIBIT A- PROJECT DESCRIPTION**
- **EXHIBIT B- PROJECT OPERATIONS AND RESOURCE UTILIZATION**
- **EXHIBIT C- CONSTRUCTION HISTORY**
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- **EXHIBIT E- ENVIRONMENTAL REPORT**
- **EXHIBIT F- GENERAL DESIGN DRAWINGS (CEII)**
- **EXHIBIT G- PROJECT BOUNDARY MAPS**
- **EXHIBIT H- PLANS AND ABILITY OF APPLICANT TO OPERATE THE PROJECT**

DECEMBER 2015

INITIAL STATEMENT PER 18 CFR § 4.51

Before the Federal Energy Regulatory Commission
Application for New License Major Water Power Project - Existing Dam

1. FirstLight Hydro Generating Company ("FirstLight" or "Applicant") applies to the Federal Energy Regulatory Commission ("Commission" or "FERC") for a new license for the existing Turners Falls Hydroelectric Project (Turners Falls Project), FERC Project Number 1889 and for the existing Northfield Mountain Pumped Storage Project (Northfield Mountain Project), FERC Project Number 2485, as described in the attached Exhibits. The current license for the Turners Falls Hydroelectric Project was issued on May 5, 1980 and expires on April 30, 2018. The license for the Northfield Mountain Project was issued on May 14, 1968 and also expires on April 30, 2018. Although the Turners Falls Project and Northfield Mountain Project are currently licensed as separate projects, FirstLight is seeking a single license for both developments, and will hereafter refer to the Turners Falls Project as the Turners Falls Development and the Northfield Mountain Project as the Northfield Mountain Pumped Storage Development or collectively as the Northfield Project (Project).

2. The location of the Project is:

The structures associated with the Turners Falls Development are located in the towns of Montague and Gill, MA. The Turners Falls bypass (Connecticut River) flanks the towns of Greenfield and Montague, MA. The Turners Falls Impoundment borders several towns including Gill, Montague, Northfield, and Erving, MA, with upper portions extending into Vernon, VT and Hinsdale, NH.

The structures associated with the Northfield Mountain Pumped Storage Development are located in the towns of Northfield and Erving, MA.

3. The exact name, address, and telephone number of the Applicant are:

FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel: 413-659-4489

The exact name, address, and telephone number of each person authorized to act as agent for the Applicant in this application are:

Mr. John S. Howard
Director FERC Compliance, Hydro
FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel: 413-659-4489
Email: John.Howard@gdfsuezna.com

Mr. Michael A. Swiger, Esq.
Ms. Julia S. Wood, Esq
Van Ness Feldman
1050 Thomas Jefferson Street, NW
Seventh Floor
Washington, DC 20007
Tel: 202-298-1800
Email: mas@vnf.com
jsw@vnf.com

4. The Applicant is a domestic corporation and is not claiming preference under section 7(a) of the Federal Power Act, 16 U.S.C. 796.

5. (i) The statutory or regulatory requirements of the State of Massachusetts which affect the Project as it exists with respect to bed and banks and the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purpose of the license under the Federal Power Act, are:

- Applicant must obtain a Water Quality Certification from the Massachusetts Department of Environmental Protection and Section 401 (a)(1) of the Clean Water Act.

(ii) The steps which the Applicant has taken or plans to take to comply with the regulations cited above are:

- The Applicant will submit a request for Water Quality Certification from the Massachusetts Department of Environmental Protection concurrent with the submittal of the Final Application for License to the Commission. Since this is an application for relicensing two existing developments, the Applicant expects to continue to operate the facility pursuant to approvals, licenses, permits, and exemptions already in effect.

6. FirstLight owns all of the existing Project facilities; there are no Federally owned or operated facilities associated with this application.

ADDITIONAL INFORMATION REQUIRED BY 18 C.F.R. § 5.18(A)

1. **Identify every person, citizen, association of citizens, domestic corporation, municipality, or state that has or intends to obtain and will maintain any proprietary right necessary to construct, operate or maintain the project:**

   FirstLight has or intends to obtain and will maintain the proprietary rights necessary to construct, operate and maintain the Project.

2. **Identify (providing names and mailing addresses):**

   (i) Every county in which any part of the project and any Federal facilities that would be used by the project would be located;

   Franklin County government in Massachusetts was abolished in 1997, although the county continues to exist as a geographical and political entity. County-wide comprehensive planning responsibilities are undertaken by the Franklin Regional Council of Governments (FRCOG). The FRCOG's offices are located at:

   The Franklin Regional Council of Governments
   12 Olive Street, Suite 2
   Greenfield, MA 01301-3318

   Upper portions of the Turners Falls Impoundment extend into the following Vermont and New Hampshire counties:

   Windham County
   P.O. Box 784
   Brattleboro, VT 05302

   Cheshire County
   Administration
   33 West Street
   Keene, NH 03431

   (ii) Every city, town, or similar local political subdivision:

   i. In which any part of the Project, and any Federal facility that would be used by the project, would be located; or

   Town of Erving
   12 East Main Street
   Erving, MA 01344

   Town of Gill
   325 Main Street
   Gill, MA 01354

   Town of Greenfield
   14 Court Street
   Greenfield, MA 01301

   Town of Northfield
   69 Main Street
   Northfield, MA 01360

   Town of Vernon
   567 Governor Hunt Road
   Vernon, VT 05354

   Town of Hinsdale
   Town Hall
   11 Main Street
   Hinsdale, NH 03451

   Town of Montague

1 Avenue A
Montague, MA 01376

ii. **That has a population of 5,000 or more people and is located within 15 miles of the project dam.**

The following cities and towns each have a population of 5,000 or more people (2010 census data) and are located within 15 miles of the Project dams:

Town of Amherst (population: 37,819)
Town Clerk
Town Hall
4 Boltwood Avenue
Amherst, MA 01002

Town of Greenfield (population: 17,456)
Town Clerk
14 Court Street
Greenfield, MA 01301

Town of Athol
(population: 8,265)
Town Clerk
584 Main Street, Suite 10
Athol, MA 01331

Town of Hadley (population: 5,250)
Town Clerk
100 Middle Street
Hadley, MA 01035

Town of Brattleboro (population: 7,414)
Town Clerk
230 Main Street, Suite 108
Brattleboro, VT 05301

Town of Montague (population: 8,437)
Town Clerk
One Avenue A
Turners Falls, MA 01376

Town of Deerfield (population: 5,125)
Town Clerk
8 Conway Street
South Deerfield, MA 01373

Town of Orange (population: 7,839)
Town Clerk
6 Prospect Street
Orange, MA 01364

(iii) Every irrigation district, drainage district or similar special purpose political subdivision (A) in which any part of the project is located, and any Federal facility that is or is proposed to be used by the project is located, or (B) that owns, operates, maintains, or uses any project facility or any Federal facility that is or is proposed to be used by the project:

There is no irrigation district, drainage district, or similar special purpose political subdivision in which any part of the Project is located or that owns, operates, maintains, or uses any project facility.

(iv) Every other political subdivision in the general area of the Project that there is reason to believe would likely be interested in, or affected by, the application.

There is no other political subdivision in the general area of the Project that there is reason to believe would be likely to be interested in, or affected by, this notification.

(v) All Indian tribes that may be affected by the Project.

Federally recognized tribes in Massachusetts include:

Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, MA 02535-1546

Mashpee Wampanoag Indian Tribe Council
P.O. Box 1048
Mashpee, MA 02649

There are no federally recognized tribes in New Hampshire or Vermont.

There are no state recognized tribes in Massachusetts or New Hampshire. There are two Vermont state-listed tribes as well as other tribes that may potentially be interested in the relicensing as listed below:

Nulhegan Abenaki Tribe
158 Whiting Lane
Brownington, VT 05860

Elnu Abenaki Tribe
Robert Longtoe Sheehan
Tribal Headquarters
5243 VT Route 30
Jamaica, VT 05343

Ms. Bonney Hartley
Stockbridge-Munsee Community
400 Broadway #718
Troy, NY 12181

Narragansett Indian Tribe
Narragansett Indian Longhouse
4425-A South County Trail
Charlestown, RI 02813

Nolumbeka Project
Joseph Graveline, President
The Nolumbeka Project Inc.
88 Columbus Avenue,
Greenfield, MA 01301

3.

(i) The Applicant has made a good faith effort to give notification by certified mail of the filing of the application to:

(A) Every property owner of record of any interest in the property within the bounds of the Project, or in the case of the Project without a specific boundary,

each such owner of property which would underlie or be adjacent to any Project works, including any impoundments; and

(B) The entities identified in paragraph (2) above, as well as any other federal, state, municipal or other local government agencies that there is reason to believe would likely be interested in or affected by the application.

Because this is an application for a new license under section 15 of the FPA, the Applicant is not required to provide notice by certified mail of the Application to landowners.

PURPA Benefits

FirstLight is not seeking any PURPA benefits in association with the relicensing of the Project.

ACRONYMS AND ABBREVIATIONS

2D	two dimensional
3D	three dimensional
A	ampere
AC	alternating current
ACHP	Advisory Council of Historic Preservation
AMC	Appalachian Mountain Club
ARLAC	Ashuelot River Local Advisory Committee
AWWA	American Whitewater Association
CAFRC	Conte Anadromous Fish Research Center
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFU	colony forming units
CL&P	Connecticut Light & Power
cm	centimeter
CRASC	Connecticut River Atlantic Salmon Commission
CRJC	Connecticut River Joint Commissions
CRSEC	Connecticut River Streambank Erosion Committee
CRWC	Connecticut River Watershed Council
CT	Connecticut
CTDEP	Connecticut Department of Environmental Protection
CTDEEP	Connecticut Department of Energy and Environmental Protection
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
°C	degrees Celsius
°F	degrees Fahrenheit
ft	foot or feet
ft^2	square feet
DLA	Draft License Application
DRTU	Deerfield River Chapter of Trout Unlimited
DO	dissolved oxygen
EA	Environmental Assessment
ECP	Erosion Control Plan
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FCD	Franklin Conservation District
FCRP	Friends of the Connecticut River Paddlers
FEMA	Federal Emergency Management Agency
FERC or Commission	Federal Energy Regulatory Commission
FIS	Flood Insurance Study
FGS	Field Geology Services
FirstLight	FirstLight Hydro Generating Company
FLA	Final License Application
FPA	Federal Power Act
FRCOG	Franklin Regional Council of Governments
FRR	Full River Reconnaissance
FSF	Four Star Farms
GPD	gallons per day

HEC	USACE Hydrologic Engineering Center
HPMP	Historic Properties Management Plan
hr	hour
ILP	Integrated Licensing Process
ISR	Initial Study Report
ISO-NE	ISO New England
kV	kilovolt
kW	kilowatt
kWH	kilowatt-hour
l	liter
LCCLC	Landowners and Concerned Citizens for License Compliance
MA	Massachusetts
MAEOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
MACRIS	Massachusetts Cultural Resources Information System
MADFW	Massachusetts Division of Fish and Wildlife
MAFBF	Massachusetts Farm Bureau Federation, Inc.
MAWMA	Massachusetts Water Management Act
MBI	Midwest Biodiversity Institute
MDEP	Massachusetts Department of Environmental Protection
m	meter
mi	mile
mg	milligram
MGD	million gallons per day
MHC	Massachusetts Historical Commission
mi^2	square miles
ml	milliliter
MOA	Memorandum of Agreement
msl	mean sea level
MVA	megavolt ampere
MW	megawatt
MWH	megawatt-hour
NEMBA	New England Mountain Biking Association
NEPA	National Environmental Policy Act
NEE	New England Environmental
NE FLOW	New England Flow
NEFU	New England Farmers Union
NEPOOL	New England Power Pool
NET	New England National Scenic Trail
NID	National Inventory of Dams
NIT	Narragansett Indian Tribe
NGVD29	National Geodetic Vertical Datum of 1929
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historical Resources
NHESP	Natural Heritage and Endangered Species Program
NHFGD	New Hampshire Fish and Game Department
NHPA	National Historic Preservation Act
NID	National Inventory of Dams
NLCD	National Land Cover Database
NMFS	National Marine Fisheries Service
NMTTC	Northfield Mountain Tour and Trail Center

NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NOI	Notice of Intent
NTU	Nephelometric Turbidity Unit
NU	Northeast Utilities
NWI	National Wetland Inventory
NY-ISO	New York ISO
O&M	operation and maintenance
PAD	Pre-Application Document
PCBs	polychlorinated biphenyls
PM&E	Protection, Mitigation & Enhancement
PIT	passive integrated transponder
Project	Northfield Project (collectively the Northfield Mountain Pumped Storage Development and the Turner Falls Development)
PSP	Proposed Study Plan
PVPC	Pioneer Valley Planning Commission
QA/QC	quality control/quality assurance
REA	Ready for Environmental Analysis
RM	River mile
RTE	Rare, Threatened, and Endangered
RRA	River Residents Association
RSP	Revised Study Plan
S&A	Simons and Associates
SAV	submerged aquatic vegetation
SCORP	State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SHPO	State Historic Preservation Officer
SPDL	Study Plan Determination Letter
TDS	total dissolved solids
TFI	Turners Falls Impoundment
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TN	total nitrogen
TNC	The Nature Conservancy
TP	total phosphorus
TSS	total suspended solids
Turners Falls Development	Turners Falls Hydroelectric Development
UMass	University of Massachusetts at Amherst
USACE	United States Army Corps of Engineers
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report
µS	microsiemens
UMass	University of Massachusetts at Amherst
VT	Vermont
VTANR	Vermont Agency of Natural Resources
VTDEC	Vermont Department of Environmental Conservation

VTDHP	Vermont Division of Historic Preservation
VTFWD	Vermont Fish and Wildlife Department
VY	Vermont Yankee Nuclear Facility
WMECO	Western Massachusetts Electric Company
WMA	Wildlife Management Area
WQC	Water Quality Certificate
YOY	young-of-the-year

Draft Application for New License for Major Water Power Project – Existing Dam

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

EXHIBIT A-PROJECT DESCRIPTION

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EXHIBIT A – PROJECT DESCRIPTION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51(b) describes the required content of this Exhibit.

Exhibit A is a description of the project. This exhibit need not include information on project works maintained and operated by the U.S. Army Corps of Engineers, the Bureau of Reclamation, or any other department or agency of the United States, except for any project works that are proposed to be altered or modified. If the project includes more than one dam with associated facilities, each dam and the associated component parts must be described together as a discrete development. The description for each development must contain:

1. *The physical composition, dimensions, and general configuration of any dams, spillways, penstocks, powerhouses, tailraces, or other structures, whether existing or proposed, to be included as part of the project;*

2. *The normal maximum surface area and normal maximum surface elevation (mean sea level), gross storage capacity, and usable storage capacity of any impoundments to be included as part of the project;*

3. *The number, type, and rated capacity of any turbines or generators, whether existing or proposed, to be included as part of the project;*

4. *The number, length, voltage, and interconnections of any primary transmission lines, whether existing or proposed, to be included as part of the project (see 16 U.S.C. 796(11));*

5. *The specifications of any additional mechanical, electrical, and transmission equipment appurtenant to the project; and*

6. *All lands of the United States that are enclosed within the project boundary described under paragraph (h) of this section (Exhibit G), identified and tabulated by legal subdivisions of a public land survey of the affected area or, in the absence of a public land survey, by the best available legal description. The tabulation must show the total acreage of the lands of the United States within the project boundary.*

1 TURNERS FALLS DEVELOPMENT

The Northfield Project (Project) consists of the Turners Falls Development and Northfield Mountain Pumped Storage Development.

The Turners Falls Development is located on the Connecticut River in the states of MA, New Hampshire (NH) and Vermont (VT) (Figure 1.0-1). The greater portion of the Turners Falls Development, 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 Project boundary extend into the town of Hinsdale, in Cheshire County, NH, and the town of Vernon, in Windham County, VT. The Turners Falls Dam is located at approximately river mile 122 (above Long Island Sound) on the Connecticut River, at coordinates 42°36’38.77” north and 72°33’05.76” west, in the towns of Gill and Montague, MA.

The Turners Falls Dam creates the Turners Falls Impoundment (TFI), which is approximately 20 miles long, and extends upstream to the base of TransCanada’s Vernon Hydroelectric Project and Dam (FERC No. 1904). Most of the TFI lies in MA, however, approximately 5.7 miles of the northern portion of the impoundment is located in NH and VT. The TFI also serves as the lower reservoir for the Northfield Pumped Storage Development (described later).

The Turners Falls Dam is located on a “Z turn” in the river, and is oriented on a northeast-southwest axis, with the impounded area on the east side of the dam, and extending north. At the southwest end of the Turners Falls Dam is the gatehouse (Figure 1.0-2). Below the dam, originating at the gatehouse, is the Turners Falls power canal. Paralleling this power canal is a bypassed section of the Connecticut River. Associated with this power canal are the two hydroelectric generating facilities: Station No. 1 and Cabot Station. Station No. 1 is located approximately one-third of the way down the power canal. Water is conveyed from the power canal, to a small branch canal feeding the Station No. 1 turbines, before discharging into the bypassed reach of the Connecticut River. Cabot Station is located at the downstream terminus of the power canal, where it rejoins the main stem of the Connecticut River. Station No. 1 and Cabot Station discharge into the Connecticut River approximately 0.9 miles and 2.7 miles downstream of the Turners Falls Dam, respectively.

At Turners Falls Dam, the total drainage area is approximately 7,163 square miles (mi^2), or about 64% of the Connecticut River Basin drainage area (11,250 mi^2). The Connecticut River is the largest and longest river in New England, and is tidal up to Windsor Locks, CT, which is located approximately 60 miles from Long Island Sound.

The Turners Falls Development consists of: 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) a reservoir known as the TFI. Each of these is described in detail below.

1.1 Turners Falls Dam

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 is founded on bedrock and connects Great Island to the west bank of the Connecticut River.

It includes four bascule[1] type gates, each 120 feet wide by 13.25 feet high and a fixed crest section which is normally not overflowed. All four bascule gates are operated by hydraulic cylinders. The bascule gate closest to the gatehouse (bascule gate no. 1) is typically used to provide any required flow releases to the bypass reach by means of "pond-following". Pond-following means that the gate can be set to discharge a certain magnitude of flow and the gate position automatically adjusts to release the same flow based on changes in the TFI elevation. The average height above bedrock is 35 feet and the dam crest elevation is 172.26 feet (NGVD29[2]). When fully upright, the top of the bascule gates are at elevation 185.5 feet.

The Gill Dam is approximately 55-feet-high and 493-feet-long extending from the Gill shoreline (east bank) to Great Island. It includes three 40-foot-wide by 39-foot-high tainter spillway gates. The tainter gates discharge water from the base of the gates. Each tainter[3] gate is operated by a motor/gearbox driving a torsion shaft connected to two lifting chains. When closed, the elevation atop the tainter gate is at elevation 185.5 feet.

1.2 Turners Falls Impoundment

The TFI, formed by the Turners Falls Dam, extends upstream approximately 20 miles to the base of TransCanada's Vernon Dam in Vernon, VT. To provide storage capacity for the Northfield Mountain Pumped Storage Development, the TFI elevation may vary, per the FERC license, from a minimum elevation of 176.0 feet 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. This fluctuation decreases as one travels upstream. The impoundment has a surface area of approximately 2,110 acres and a gross storage volume of approximately 20,300 acre-feet at elevation 185.0 feet msl (as measured at Turners Falls Dam).

The TFI, between Turners Falls Dam and Vernon Dam, has a water surface profile that varies pending the magnitude of flow in the Connecticut River and the storage used for the Northfield Mountain Pumped Storage Development. The profile slope steepens as the magnitude of flow increases. At pinch-points or hydraulic controls such as at the French King Gorge, the water level upstream of the hydraulic control is higher than below.

1.3 Gatehouse

The power canal gatehouse is located on the Montague side of the Connecticut River. It forms the abutment for connecting the Montague Dam spillway with the shoreline and is equipped with headgates controlling flow from the TFI to the power canal. The structure is of masonry and reinforced concrete foundations with a brick walled superstructure. The gatehouse is approximately 214-feet-long and houses 15 operable gates controlling flow 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 passes through the gatehouse at the east bank.

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[1] A bascule gate is a hinged crest gate. Each bascule gate is controlled by a pair of hydraulic cylinders, mounted in the concrete gravity dam.

[2] Unless otherwise noted in this License Application, reported elevations are based on the National Geodetic Vertical Datum (NGVD) of 1929.

[3] A tainter gate is a spillway gate whose face is a section of a cylinder; it rotates about a horizontal axis on the downstream end of the gate and can be closed under its own weight.

The local controls and operating equipment for the dam's bascule gates are in the gatehouse. They can also be operated remotely from the control room located at Northfield Mountain. The tainter gates are operated locally at the Gill Dam. The magnitude of flow passing through the gatehouse is a function of the gate(s) opening and the hydraulic head or the differential in the TFI elevation and the power canal elevation.

1.4 Power Canal

The power canal is approximately 2.1 miles long and ranges in width from approximately 920 feet in the Cabot forebay (downstream terminus of canal) to 120 feet in the canal proper. The canal has a design capacity of approximately 18,000 cubic feet per second (cfs). There are several entities that can withdraw water from the canal; Table 1.4-1 lists the water users, approximate hydraulic capacity, and FERC project number (where applicable).

Table 1.4-1: Entities Having Rights to Withdraw Water from Power Canal

Facility Name	Owner	Approximate Hydraulic Capacity (cfs)	FERC Project No.
Paperlogic	Southworth Company	113 cfs	N/A
Turners Falls Hydro, LLC	Turners Falls Hydro	288 cfs	2622
Station No. 1	FirstLight Hydro Generating Co.	2,210 cfs	1889
Cabot Station	FirstLight Hydro Generating Co.	13,728 cfs	1889
United States Geological Survey, Conte Anadromous Fish Laboratory	United States Geological Survey	Variable[4]	N/A

Paperlogic[5] and Turners Falls Hydro, LLC[6] have indentured water rights. FirstLight has an agreement with each of these entities which provides that the entity will not generate power unless the hydraulic capacity of the Station No. 1 and Cabot stations is exceeded. The United States Geological Survey (USGS), which withdraws water for the Conte Anadromous Fish Laboratory, also has a water use agreement with FirstLight; however, its water use is minimal.

1.5 Station No. 1

From the power canal there is an approximate 700-foot-long by 100-foot-wide branch canal. At the end of the branch canal is the entrance to Station No. 1, consisting of eight bays, each 15 feet wide for a total

[4] Per Exhibit B of the May 25, 1988 conveyance agreement, the allowable withdrawal rate (in cfs) and number of days of withdrawal varies based on the month. It can range from a maximum of 200 cfs for 13 days in October to a minimum of 2 cfs for 28 days in February.

[5] A water use agreement between then Esleeck Manufacturing Company (a predecessor to Paperlogic) and then Turners Falls Power and Electric Company (a predecessor to FirstLight) was signed in August 1928.

[6] A water exchange agreement between then Keith Paper Company (a predecessor to Turners Falls Hydro, LLC) and then Western Massachusetts Electric Company (a predecessor to FirstLight) was signed in September 1951.

intake width of 120 feet. Trashracks are angled across the entire entrance, totaling 114 feet wide by 20.5 feet high. With a normal canal elevation of approximately 173.5 feet, the effective trashrack opening is approximately 114 feet wide by 15.9 feet high, resulting in a gross area of 1,812.6 square feet (ft^2). The bar rack thickness is 0.375 inches and the bars are 3 inches on center, thus the clear spacing between bars is 2.625 inches.

After passing the trashrack, the intakes narrow down to four individual 13'-1.5" diameter penstocks feeding the original seven horizontal Francis turbines housed in the powerhouse. Only five of the turbines are operational. The powerhouse consists of brick masonry on concrete foundations. The powerhouse has five generators, all alternating current (AC) horizontal type, 60 cycle, and 2300 volt.

Penstock 1 feeds Unit 1, penstock 2 feeds Units 2 and 3, penstock 3 feeds Units 4 and 5, and penstock 4 feeds Units 6 and 7. Note that penstock 4 bifurcates into pipes leading to Units 6 and 7; Units 4 and 6 are no longer in service. Station No. 1 operates under a gross head of 43.7 feet, and has an approximate total electrical nameplate capacity and hydraulic capacity of 5,693 kilowatts (kW) and 2,210 cfs, respectively.

Table 1.5-1 includes information on Station No. 1's generators and turbines.

Table 1.5-1: Generator and Turbine Characteristics of Station No. 1

	Generators		Turbines			
Unit No.	**Electrical Capacity (kW)**	**Amps**	**Runner Size**	**Hydraulic Capacity (cfs)**	**Horsepower (hp)**	**Speed (rpm)**
1	1,500	376	2-48" horizontal runners	560	2100	200
2*	365	—	1-33" horizontal runner	140	590	257
3	1,276	314	2-42" horizontal runners	500	1900	200
4						
5	1,276	252	1-39" horizontal runner	490	1635	200
6						
7	1,276	251	2-42" horizontal runner	520	1955	200
Total	**5,693**			**2,210**		

*Unit 2 is directly connected to a 1600 amp, 257 rpm, 115 volt exciter.

Transmission facilities at Station No. 1 include generator leads and the 2.3 kV bus. Station No. 1 has one bank consisting of a single, three phase, 4800/6000 Ka, 2300-13800 volts, oil immersed, self-cooled transformer. The three stations service transformers are 7.5 kW, 1100/2200-110/220 transformers.

1.6 Cabot Station

Cabot Station is located at the downstream terminus of the power canal. The trashrack opening is 217 feet wide by 31 feet high, resulting in a gross area of 6,727 ft^2. The trashracks are angled, and include upper and lower racks. The top 11 feet of the upper racks have clear bar spacing of 0.94 inches (15/16-inch, and the bottom 7 feet of the upper racks have clear bar spacing of 5 inches. The entire 13 feet of the lower racks have clear bar spacing of 5 inches. After passing through the trashracks, flow is conveyed through one of six penstocks to turbines housed in the powerhouse. The powerhouse is a brick and steel structure set on a concrete substructure on a rock foundation. It houses six identical vertical, Francis type, single runner turbines. At a 60-foot head, each unit is rated at 13,867 horsepower. The wicket gates for each unit are operated by two servomotors.

Transmission facilities at Cabot Station consist of (i) generator leads and two 13.8 kV buses for three units each for a total of six units, (ii) one 13.8 kV transmission line, about 200 feet long and extending across the power canal to the Montague substation, and (iii) one 13.6/115 kV oil immersed air cooled transformer and appurtenant facilities. The six generators are vertical shaft 13.8 kV, 97.3 rpm with Kingsbury thrust bearings. Each unit has its own static excitation system rated at 160 volts DC, 781 amps.

Cabot Station has a total station nameplate capacity of 62.016 megawatts (MW) or approximately 10.336 MW/unit. The station has a total hydraulic capacity of approximately 13,728 cfs or 2,288 cfs/unit.

At the downstream terminus of the power canal and adjacent to the Cabot Powerhouse are eight wooden 16'-8" high by 13'-7" wide spillway gates, which permit the discharge of approximately 12,000 cfs. These gates are used to rapidly draw down the power canal in the event of a Cabot Station load rejection or canal dike breach or to sluice ice and debris. In addition, there is a 16'-2" wide by 13'-1" high log sluice gate located at the downstream end of the forebay.

1.7 Fish Passage Facilities

1.7.1 Upstream Fish Passage Facilities

The Turners Falls Development 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. These fish passage facilities were based on a design recommended by the United States Fish and Wildlife Service (USFWS). Fish ladders of similar design pass Pacific salmon species and American shad on the Columbia River. It was believed that these same designs could be applied to pass Atlantic salmon and American shad, the original target species. American shad is the primary species using these fish passage facilities.

The Cabot fishway is a modified "ice harbor" design; it consists of 66 pools, with each pool situated approximately one foot higher than the previous pool. Fish enter the Cabot fishway below Cabot Station. Fish pass through the Cabot fishway into the power canal; from there, they swim 2.1 miles upstream to the Gatehouse fishway.

Fish that bypass the Cabot fishway move upstream via the bypassed reach, where they will ultimately encounter the Turners Falls Dam. Fish arriving here are passed upstream via the Spillway fishway into a gallery leading to the Gatehouse fishway, where they rejoin fish that have passed to this point via the Cabot Ladder. The Spillway fishway is also of modified ice harbor design, with 42 pools.

Fish from the upstream end of the power canal can enter the gallery via two entrances; a 70-foot-long flume extending into the canal on the river side of the canal, and a 5-foot-wide opening on the town side of the canal and are passed upstream of the gatehouse via the Gatehouse fishway. The Gatehouse fishway is a vertical slot fishway which delivers fish into the TFI to continue their journey up the Connecticut River.

The Connecticut River Atlantic Salmon Commission (CRASC[7]) establishes an annual schedule for the operation of upstream fish passage facilities at the Connecticut River dams. The schedules are based on the projected movement of migratory fish and may be adjusted in season to address actual observations. Table 1.7.1-1 lists the 2015 schedule for upstream fish passage operations at the Turners Falls Development.

[7] CRASC membership consists of the USFWS, NMFS, and state fishery agencies from CT, MA, NH, and VT.

Table 1.7.1-1: Upstream Fish Passage Schedule for Cabot, Gatehouse, and Spillway Fishways

Development	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	salmon	adult	Apr 7-Jul 15	24 hours/day
	salmon	adult	Sep 15-Nov 15	24 hours/day
	shad & herring	adult	Apr 7-Jul 15	24 hours/day

Source: CRASC letter to FirstLight, 3/5/2015

Downstream Fish Passage Facilities

The 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. Downstream fish passage facilities at Cabot Station consist of: reduced bar-spacing in the upper 11 feet of the intake racks; a broad-crested weir developed specifically to enhance fish passage at the log sluice; the log sluice itself, which has been resurfaced to provide a passage route; above-water lighting; and a sampling facility.

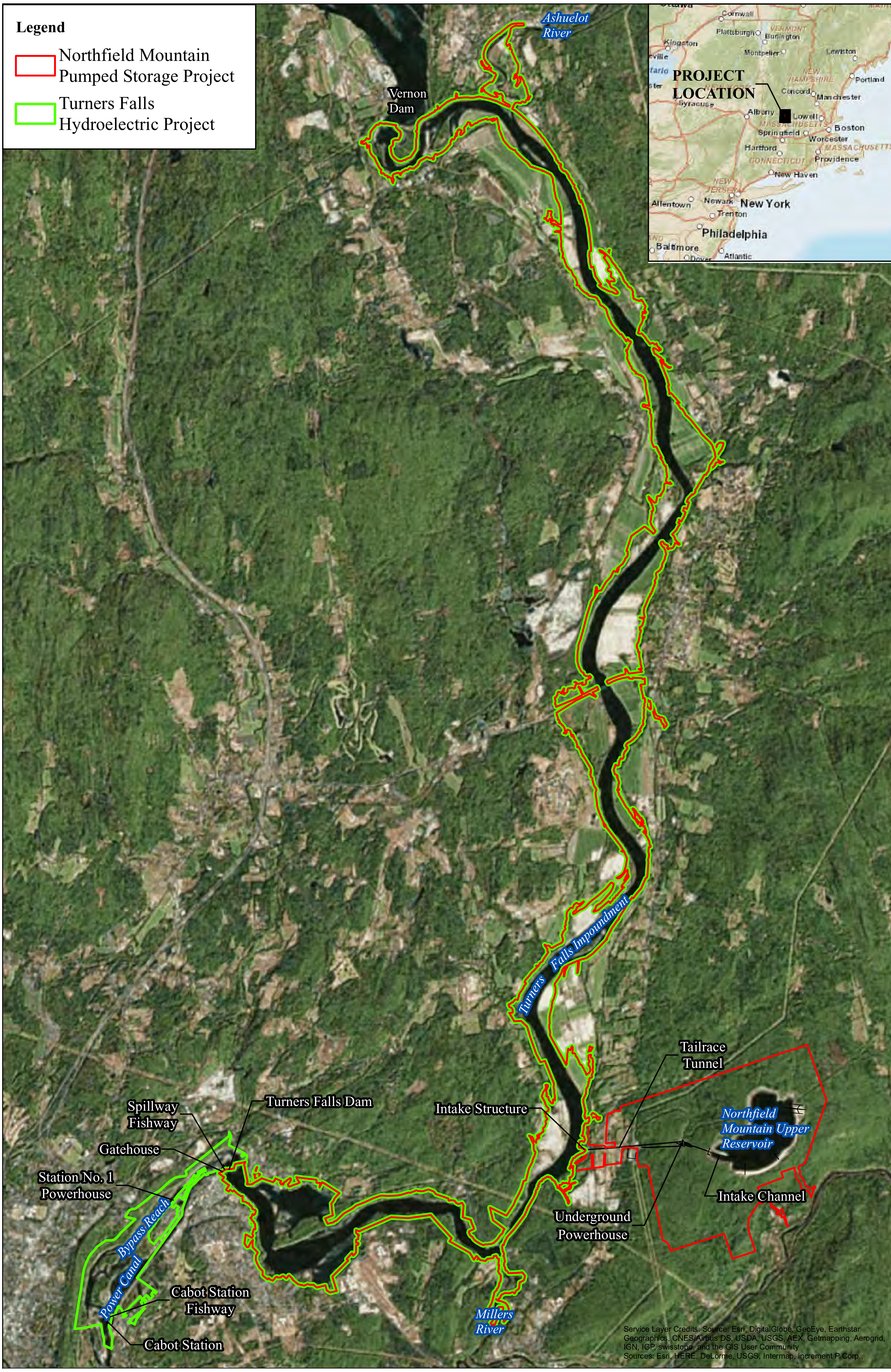
As described for upstream passage, the CRASC also establishes an annual schedule for the operation of downstream fish passage facilities at the Connecticut River dams. Table 1.7.1-2 lists the 2015 schedule for downstream fish passage operations at the Project.

Table 1.7.1-2: Downstream Fish Passage Schedule

Development	Downstream Fish Passage Exit	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	Log sluice and trash sluice	salmon	smolt	Apr 1-Jun 15	24 hours/day
		salmon	adult	Oct 15-Dec 31[1]	24 hours/day
		shad	adult	Apr 7-Jul 31	24 hours/day
		shad	juvenile	Aug 1-Nov 15	24 hours/day
		eels	adult	Sep 1-Nov 15	24 hours/day

[1]Downstream passage operation, for adults will only be required if 50 or more adults are documented as passing upstream of a dam/facility.

Source: CRASC letter to FirstLight, 3/5/2015



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

Draft License Application
Exhibit A

0 0.5 1 2 Miles
1 in = 1 miles

Figure 1.0-1
Turners Falls Development and Northfield Development Boundary Map

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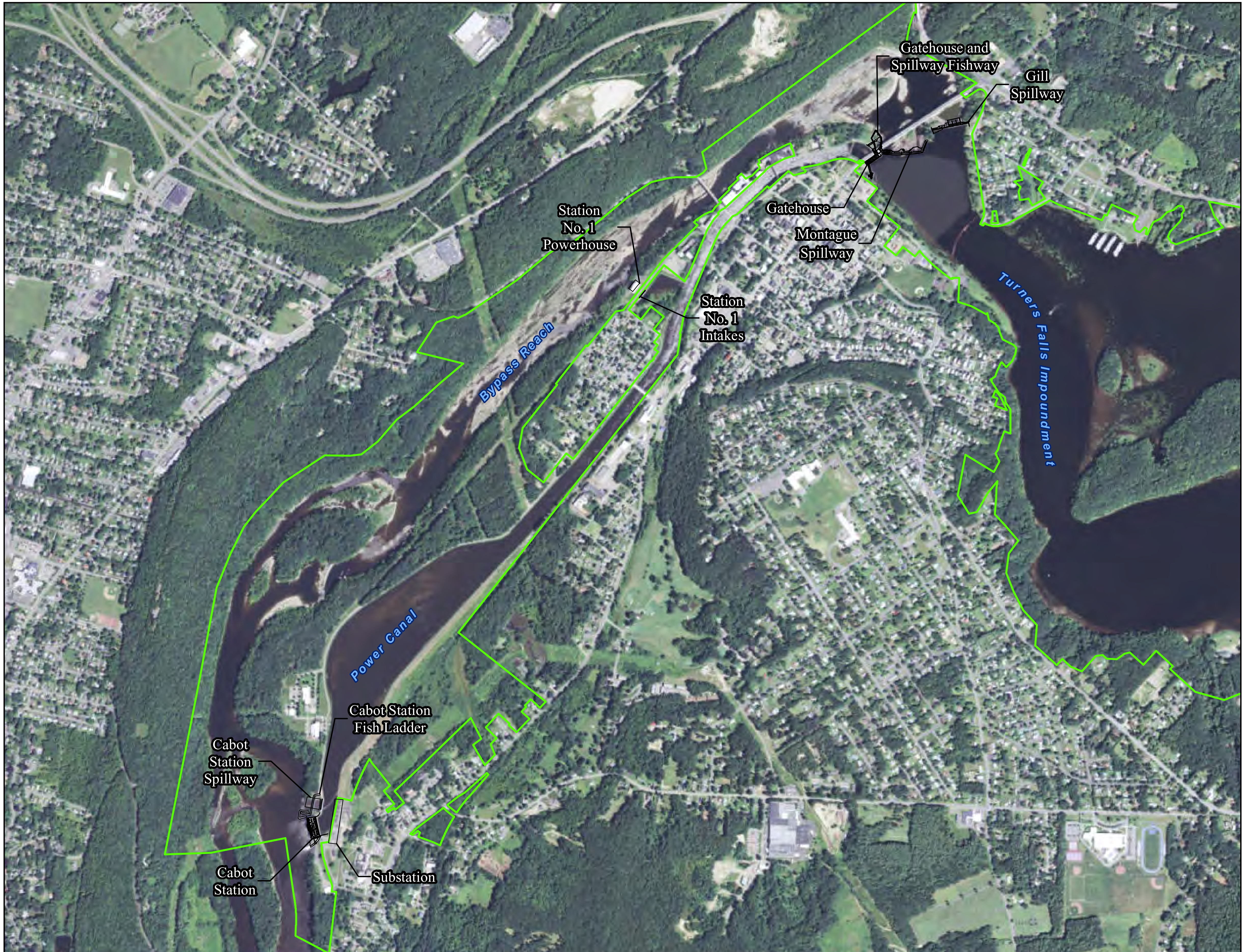

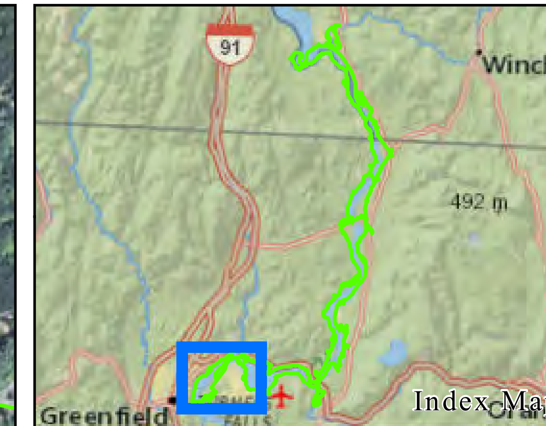

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Draft License Application
Exhibit A

Figure 1.0-2
Turners Falls Development
Features

Legend

Project Boundary

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Content may not reflect National Geographic's current map policy.

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

FirstLight GDF SUEZ

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2 NORTHFIELD MOUNTAIN PUMPED STORAGE DEVELOPMENT

The Northfield Mountain Pumped Storage Development (Figure 2.0-1) is a pumped-storage facility located on the Connecticut River in Massachusetts (MA) that uses the TFI as its lower reservoir. The tailrace of the Northfield Mountain Pumped Storage Development is located approximately 5.2 miles upstream of Turners Falls Dam, on the east side of the TFI. The Development's Upper Reservoir is a man-made structure situated atop Northfield Mountain, to the east of the Connecticut River. During pumping operations, water is pumped from the TFI to the Upper Reservoir. When generating, water is passed from the Upper Reservoir through an underground pressure shaft to a powerhouse cavern and then a tailrace tunnel delivers the water back to the TFI.

The Northfield Mountain Pumped Storage Development consists of: a) the Upper Reservoir dam/dikes; b) an intake; c) pressure shaft; d) an underground powerhouse; and c) a tailrace.

2.1 Northfield Mountain Upper Reservoir Dams and Dikes

Main Dam

The crest of this structure, known as the Main Dam, is at elevation 1010 feet, and is 30 feet wide, with a 2 foot high rock/earthfill wave berm along the upstream edge. The upstream slope is 1:1.8 (V:H) (the top 15 feet of the upstream slope is at a steeper 1:1.5 slope); downstream slope = 1:1.6. The top of impervious core is at elevation 1005.25 feet. The core is 12 feet wide with 3:1 (V:H) upstream and downstream slopes. The core is founded on sound groutable rock at approximately elevation 860 feet. There are sand and gravel filter zones upstream and downstream of the impervious core. Oversize rock zones form the upstream and downstream faces. The impervious core was raised in 1979 on the downstream portion of the crest in the Main Dam to elevation 1006.25 feet from station 3+00 to station 31+00 in response to settlement shortly after construction. This dam contains an intake structure and sub-foundation pipe for possible future water-supply diversion to the Quabbin Reservoir, a principal water supply for the City of Boston and parts of the Greater Boston metropolitan area.

Three Vertical Impervious-Core Rock-Fill Dikes

The three dikes, known as the North, Northwest and West Dikes, are constructed in a similar manner and to the same crest elevation as the main rock fill dam, with a central impervious core-filter and compacted rock-filled embankments. They help form the Upper Reservoir.

Concrete Gravity Dam

Located at the west end of the intake channel, the concrete gravity dam is 327 feet long and 10-20 feet high, with a crest at elevation 1010 feet. The downstream face has been back-filled to elevation 1002 feet. The concrete walls at both ends of the gravity section are constructed to a higher level, allowing a parapet wall to be constructed against the retaining wall on the right side of the intake. The remaining section, approximately perpendicular to the main section, varies from 5-10 feet in height.

Intake Channel

The intake channel directs water from the Upper Reservoir into the pressure conduit intake. The channel is 1,890 feet long and is excavated in rock with side slopes of 4:1 (V:H). The invert is 130 feet wide at elevation 880 feet. There is a small dam (submerged) at the upstream end of the intake channel with a stoplog and gate structure. The purpose of this control structure, a low dam between the Upper Reservoir and intake channel, is to prevent stormwater from entering the pressure conduit when the intake channel is dewatered. The submerged dam is 63 feet long with a crest at elevation 900 feet. It has two manually operated sluice gates (2.75 feet high by 6 feet wide), two 18 foot wide stoplog slots which usually hold eight concrete stoplogs (weighing approximately 3,000 lbs each).

Concrete Gravity Spillway Structure

The ungated concrete gravity overflow structure is 550 feet long with a crest elevation of 1006.5 feet. There is a 20 foot long notch at elevation 1005.0 feet near the center of the structure which is designed to concentrate small discharges due to precipitation and runoff when the reservoir is full. The remaining spillway length has been sized to prevent overtopping of the embankments due to over-pumping.

2.2 Pressure Shaft

The pressure conduit system consists of a reinforced concrete intake portal, a 200 foot long concrete lined transition section, a portal 55 feet wide by 80 feet high, an inclined concrete-lined pressure shaft connecting the intake and manifold shaft (31 feet diameter, 853 feet long, inclined 50º from the horizontal), concrete-lined manifold formed by branching of the pressure shaft into two 22 feet diameter conduits and then into four 14 feet diameter tunnels leading to four steel-lined penstocks (340 feet long, diameter decreases from 14 to 9.5 feet). During pumping operation, water is pumped from the TFI through a tailrace tunnel to the powerhouse cavern and then through the pressure shaft to the Upper Reservoir. During generation, water flows from the Upper Reservoir back through the pressure shaft to the powerhouse and then the tailrace tunnel delivers the water back to the TFI.

2.3 Tailrace Tunnel

Water flows between the powerhouse cavern and the TFI via the tailrace tunnel. There are four draft tubes connected by a manifold to a common tailrace tunnel. The tailrace tunnel is concrete-lined, horseshoe shaped and 5,136 feet long, with a maximum width of 33 feet and a height of 31 feet. The tunnel discharges during generation through a concrete exit structure into the TFI. The exit structure includes a transition from the horseshoe shape into a trapezoidal shape. Steel stop logs are used in the exit structure when needed to dewater the tailrace tunnel. A floating boom is provided across the exit channel to provide a barrier to large debris and boaters.

The trapezoidal trashrack opening has the following dimensions: top width: 99’-6”, bottom width: 74’4”, depth: 48’-0”, resulting in a gross area opening of 4,400 ft^2. The bar thickness is 0.75 inches, with a clear-spacing of 6 inches.

2.4 Upper Reservoir

The Upper Reservoir, formed by the Main Dam, the Rockfill Dikes, and the Concrete Gravity Dam, has a gross storage capacity of 17,050 acre-feet. Per the current FERC license for the Northfield Mountain Pumped Storage Development, the Upper Reservoir may operate between 1000.5 feet and 938 feet (constituting a 62.5 foot drawdown), which equates to a useable storage capacity of approximately 12,318 acre-feet. This is equivalent to approximately 8,475 MWhs of stored energy. The surface area at elevations 938 and 1000.5 feet are 134 and 286 acres, respectively. The Upper Reservoir was constructed to accommodate an elevation of 1004.5 feet as approved by FERC in 1976. In addition, the reservoir retains useable storage capacity down to elevation 920 feet. The useable storage volume between elevation 1004.5 feet and 920 feet is approximately 15,327 acre-feet, which is equivalent to approximately 10,465 MWhs of stored energy. FirstLight has received temporary amendments from FERC in the past to use more of the Upper Reservoir Storage. Most recently, from December 1, 2014 to March 31, 2015 FirstLight was granted a temporary amendment from FERC to use the storage between elevations 1004.5 feet and 920 feet.

2.5 Powerhouse

The underground powerhouse is 328 feet long and 70 feet wide, the floor of the spherical valve gallery is at elevation 56 feet, the roof is at 190 feet. It contains four reversible pump/turbines operating at gross heads ranging from 753 to 824.5 feet. The electrical capacities of the units are as follows: Unit 1: 267.9 MW, Unit 2: 291.7 MW, Unit 3: 291.7 MW and Unit 4: 291.7 MW, for a total station nameplate capacity of 1,143 MW[8]. Historically, the total station capacity was 1,080 MW (270 MW/unit); however, Units 2, 3 and 4 underwent efficiency improvements with the replacement of the turbine runner, and rewind of the motor-generator[9]. A new runner was installed in Unit 1 in 2004, and the rewind is scheduled to commence in August 2015 and end in February 2016.

When operating in a pumping mode, the maximum hydraulic capacity (4 pumps) is approximately 15,200 cfs (3,800 cfs/pump). Alternatively, when operating in a generation mode, the approximate maximum hydraulic capacity (4 turbines) is approximately 20,000 cfs (5,000 cfs/turbine).

Transmission Facilities

Each pair of units is provided with a dual secondary step-up transformer (rated 345/13.8 kV, 666 MVA, 3 phase, 60 cycle) to step from 13.8 kV generating voltage up to 345 kV. Each transformer is located in a vault, excavated in the rock adjacent to the powerhouse. For these two transformers, power is transmitted through two 345 kV pipe type cables, installed in the access tunnel, to the Northfield Switching Station which is located near the access tunnel.

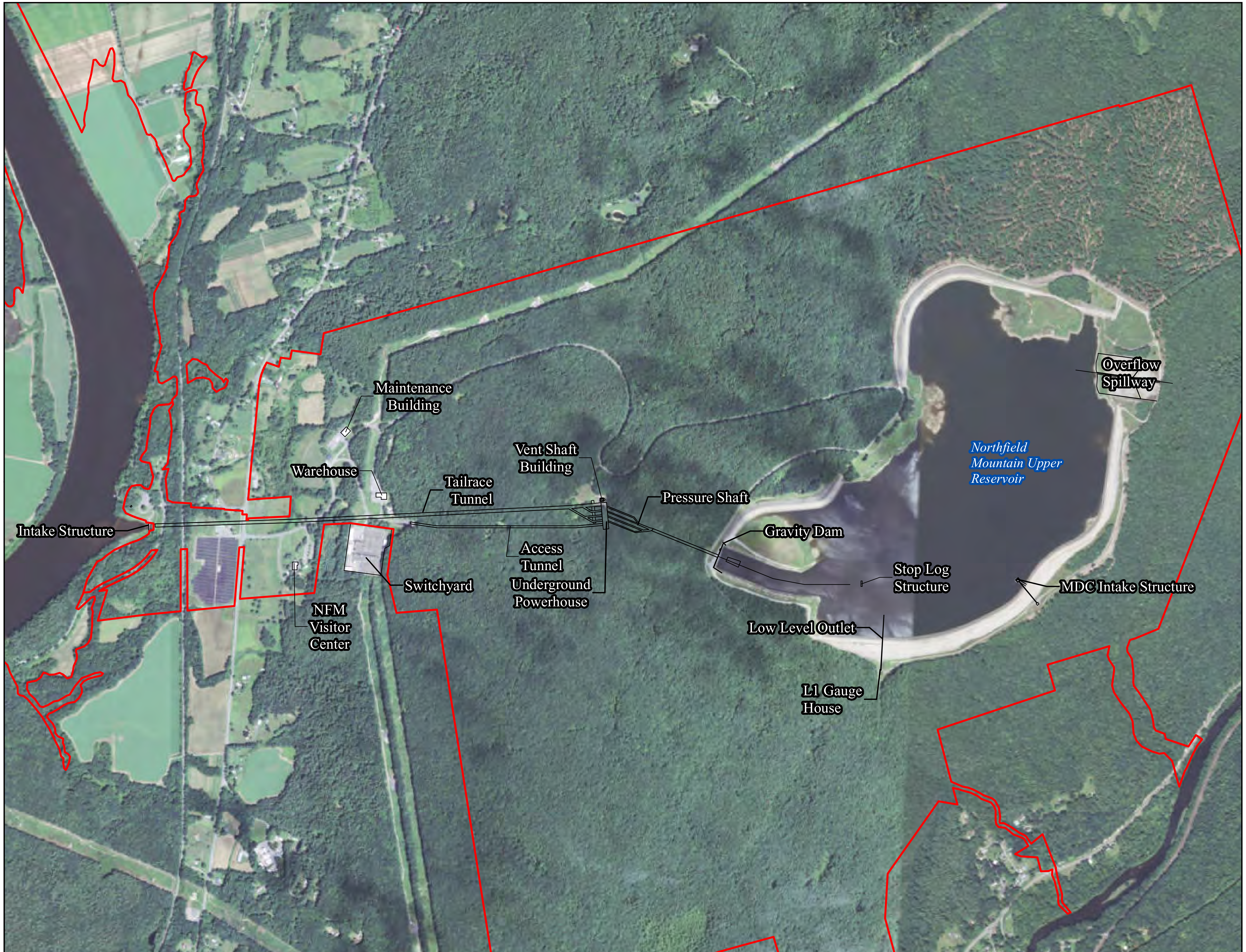
2.6 Fish Passage Facilities

A fixed-position guide net has historically been deployed since 1995 to reduce entrainment of Atlantic salmon smolts in flows pumped from the TFI to the Upper Reservoir. After the initial evaluation in 1995, further net modifications were field tested in 1996 and 1997. Since then, the guide net has been deployed annually during smolt migration season. During the period when the guide net was installed, FirstLight limited the number of pumps operating to a maximum of three. In 2015, the CRASC agreed to not require the installation of the barrier net. This decision was based on concerns for a variety of potential negative impacts or other effects to the relicensing studies being conducted in 2015. The barrier net is not intended to be installed in 2016 and thereafter.

[8] Note that after February 2016 the FERC nameplate rating will increase to 1,166.8 MW (291.7 MW x 4 units).

[9] On August 17, 2011, and supplemented on January 17, 2012, February 14, 2012, and February 24, 2012, FirstLight filed an amendment application to revise the authorized installed capacity of Northfield Mountain. FERC issued an order amending the license and revising annual changes on March 23, 2012.

Document Accession #: 20151202-5021   Filed Date: 12/02/2015



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

Draft License Application
Exhibit A

Figure 2.0-1
Northfield Mountain Pumped Storage
Development Features

Legend

Project Boundary

N

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1 inch = 1,200 feet

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3 ADDITIONAL EQUIPMENT

The Project also includes various turbine governors, generator exciters, batteries, control panels and circuit breakers.

4 LANDS OF THE UNITED STATES

There are approximately 20 acres of federal lands within the current Project boundary associated with the USGS's Conte Anadromous Fish Laboratory. However, the proposed Project boundary would not include any federal lands, because the lands are not needed for project purposes.

Draft Application for New License for Major Water Power Project – Existing Dam

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

EXHIBIT B-PROJECT OPERATION AND RESOURCE UTILIZATION

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EXHIBIT B – PROJECT OPERATION AND RESOURCE UTILIZATION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (c) describes the required content of this Exhibit.

Exhibit B is a statement of project operation and resource utilization. If the project includes more than one dam with associated facilities, the information must be provided separately for each such discrete development. The exhibit must contain:

(1) A statement whether operation of the powerplant will be manual or automatic, an estimate of the annual plant factor, and a statement of how the project will be operated during adverse, mean, and high water years;

(2) An estimate of the dependable capacity and average annual energy production in kilowatt hours (or a mechanical equivalent), supported by the following data:

(i) The minimum, mean, and maximum recorded flows in cubic feet per second of the stream or other body of water at the powerplant intake or point of diversion, with a specification of any adjustments made for evaporation, leakage, minimum flow releases (including duration of releases), or other reductions in available flow; monthly flow duration curves indicating the period of record and the gauging stations used in deriving the curves; and a specification of the period of critical streamflow used to determine the dependable capacity;

(ii) An area-capacity curve showing the gross storage capacity and usable storage capacity of the impoundment, with a rule curve showing the proposed operation of the impoundment and how the usable storage capacity is to be utilized;

(iii) The estimated hydraulic capacity of the powerplant (minimum and maximum flow through the powerplant) in cubic feet per second;

(iv) A tailwater rating curve; and

(v) A curve showing powerplant capability versus head and specifying maximum, normal, and minimum heads;

(3) A statement, with load curves and tabular data, if necessary, of the manner in which the power generated at the project is to be utilized, including the amount of power to be used on-site, if any, the amount of power to be sold, and the identity of any proposed purchasers; and

(4) A statement of the applicant's plans, if any, for future development of the project or of any other existing or proposed water power project on the stream or other body of water, indicating the approximate location and estimated installed capacity of the proposed developments.

1 EXISTING AND PROPOSED PROJECT OPERATIONS

1.1 Existing Project Operation

The Turners Falls Development consists of two facilities- Cabot Station and Station No. 1. Cabot Station is used at all river flows. During low flow periods, Cabot Station is operated as a peaking plant; during high flows 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 and typically operates when inflows to the Turners Falls Impoundment (TFI) are less than Station No. 1's hydraulic capacity of approximately 2,210 cfs or when inflows exceed the hydraulic capacity of Cabot Station.

The Northfield Mountain Pumped Storage Development 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 low-load periods when energy costs are low, while generation occurs during high-load periods when energy costs are high.

2 PROPOSED PROJECT OPERATIONS

At the time of filing the license application, not all of the FirstLight studies are complete. As such, FirstLight has not finalized its proposed operation for the Project. However, FirstLight is proposing to utilize more of the Upper Reservoir storage capacity. As noted in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938 feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

2.1 Annual Plant Factor

The average annual plant factor is determined using the following equation:

Average Annual Generation/Nameplate Capacity x 8,760 hrs per year= Avg. Annual Plant Factor

The Turners Falls Development has an average annual generation of approximately 328,022 MWh per year for the period 2000-2014, and an annual plant factor of approximately 55% (328,022/593,043) based on its current combined nameplate capacities of Cabot Station and Station No. 1 of 62.016 MW and 5.683 MW, respectively (total of 67.699 MW).

The Northfield Mountain Pumped Storage Development has an average annual generation of approximately 1,053,891 MWh per year and an average annual energy consumption of approximately 1,437,464 MWh/year for the period 2000-2014 (excluding 2010 due to the Northfield Mountain Pumped Storage Development being out of operation for several months). The Northfield Mountain Pumped Storage Development's annual plant factor is approximately 11% (1,053,891/9,804,192) based on its current nameplate capacity of 1119.2 MW.

2.2 Operation During Adverse, Mean, and High Water Years

Under the current FERC license, to provide the storage capacity for pumped storage operations of the Northfield Mountain Pumped Storage Development, the water level of the TFI can vary from a minimum elevation of 176.0 feet to a maximum operating elevation of 185.0 as measured at the Turners Falls Dam. Also under the current FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less below the Turners Falls Development. Below is a summary of how the Turners Falls Development and Northfield Mountain Pumped Storage Development operate over a range of flow conditions.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are < 1,433 cfs (Minimum Flow)

When naturally routed flows are very low, i.e. less than 1,433 cfs (current minimum flow), FirstLight generally maintains the TFI elevation between 180.5 and 182.0 feet to create sufficient hydraulic head to pass flow through the gatehouse.

At flows less than 1,433 cfs, Cabot Station does not operate and Station No. 1 operates as a run-of-river facility. Station No. 1 generally operates over two flow ranges as follows: a) at low flows (too low to operate one turbine at Cabot); and b) at flows exceeding Cabot's hydraulic capacity of approximately 13,728 cfs.

Bypass flows are provided at Turners Falls Dam as required for fishery needs during certain periods of the year. If bypass flows are required, they are provided by the bascule gate No. 1 closest to the gatehouse.

At these low flows (less than 1,433 cfs), the Northfield Mountain Pumped Storage Development may operate during peak hours of the day or when the price of power is high, while pumping back typically at night or when the price of power is less. The number of turbines operating and the magnitude of generation flow will vary depending on demand.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 1,433 cfs and 13,728 cfs (Cabot Capacity)

Under moderate flow conditions, i.e., naturally routed flows are between 1,433 cfs and 13,728 cfs (river flow exceeds 13,728 cfs approximately 34% of the time), the TFI elevation is typically managed around elevation 180.5 feet, but fluctuates under these inflow conditions due to Vernon peaking operations, Cabot peaking operations, and the pumping/generating cycle at the Northfield Mountain Pumped Storage Development. Under most circumstances, the TFI elevation fluctuates between 180.5 and 184.0 feet under these inflow conditions. The target elevation in the power canal at the Cabot forebay remains at 173.5 feet.

When naturally routed flows are between 1,433 cfs and 13,728 cfs (the approximate hydraulic capacity of Cabot Station), FirstLight will typically operate Cabot Station, while Station No. 1 remains idle. Depending on the inflow, electrical demand or energy pricing, Cabot Station may be operated as a peaking facility, with the number of peaks per day varying with electrical demand and / or price. If demand and / or price are high, such as in the summer and winter, Cabot may be peaked twice a day, in the morning and late afternoon. Outside of these hours, Cabot's generation is typically curtailed to base load needs, by reducing the flow through the gatehouse. Excess inflow to Turners Falls Dam is stored within the TFI. If inflow is consistently in the 13,728 cfs range, Cabot will operate continuously at full capacity.

In the summer and winter seasons, the Northfield Mountain Pumped Storage Development typically peaks twice a day- in the morning and late afternoon. During other months, commonly called shoulder months, the Northfield Mountain Pumped Storage Development may be peaked one to two times a day, pending electrical demand and / or price. In both cases, water is typically pumped back to the Upper Reservoir during the night or during low energy priced hours.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 13,728 cfs and 15,937 cfs (full capacity of Station No. 1 and Cabot)

Under these flow conditions, operations are similar to above; however, Cabot is typically operated at full hydraulic capacity, while the remaining flow is passed through Station No. 1. On an annual basis, river flow exceeds 15,937 cfs approximately 28% of the time.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 15,937 cfs and 30,000 cfs

Under normal to somewhat high flows, as the naturally routed inflow to TFI exceeds the hydraulic capacity of Cabot and Station No. 1, both facilities operate at full capacity. Per the agreement with the United States Army Corps of Engineer (USACE) as required by Article 43 of the Turners Falls Project license, the maximum TFI elevation during inflows of this magnitude is 186.5 feet, although FirstLight typically opens the bascule gates at the Turners Falls Dam, as needed, to maintain the impoundment elevation closer to 180-182 feet. On an annual basis, river flow exceeds 30,000 cfs approximately 11% of the time.

Per the USACE agreement, FirstLight must release water through Cabot and Station No.1 and over the Turners Falls Dam spillway so that at the start of the Northfield pumping, there is enough water stored in the TFI to restore the Upper Reservoir to its full capacity.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 30,000 cfs and 65,000 cfs

When flows are in this high range, Turners Falls Development and Northfield Mountain Pumped Storage Development operations are generally the same as above, with one exception: the USACE requires that FirstLight draw the TFI elevation down as far as possible, but not below elevation 176.0 feet. In drawing the TFI down, discharges cannot be increased by more than 10,000 cfs per hour above the naturally routed flows. The TFI elevation is maintained down until the naturally routed flow drops below 30,000 cfs or the actual discharge exceeds 65,000 cfs. When the actual discharge past Turners Falls Dam rises to 65,000 cfs (river flow exceeds 65,000 cfs approximately 1% of the time), the discharge is maintained at 65,000 cfs until the TFI elevation has fallen to 176.0 feet or the TFI begins to rise, at which point a constant impoundment elevation is maintained.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 65,000 cfs and 126,000 cfs

Per the USACE agreement, when the naturally routed flow exceeds 65,000 cfs, but is expected to be less than 126,000 cfs (this flow is very rarely exceeded), the outflow at Turners Falls should be regulated according to the operating schedule of the Northfield Mountain Pumped Storage Development. If the Northfield Mountain Pumped Storage Development is operating, it is required to keep the combined useable volume of the Upper Reservoir and TFI constant. If the Northfield Mountain Pumped Storage Development is not operating, it is required to keep the TFI elevation constant until the spillway gates are wide open.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows exceed 126,000 cfs

When the naturally routed flow is expected to be greater than 126,000 cfs, the operating rules continue to require the following: if the Northfield Mountain Pumped Storage Development has not been operating in the previous hour, it is required to maintain a constant TFI elevation. If the Northfield Mountain Pumped Storage Development has been operating in the previous hour, it is required to maintain a constant combined useable storage volume.

2.3 HEC-ResSim Operations Model

FirstLight developed an operations model to better understand how operational changes at the three[1] TransCanada hydroelectric projects and FirstLight's Northfield Project affect the timing of river flows and

[1] TransCanada is in the process of relicensing three projects in series on the Connecticut River located immediately upstream of the Turners Falls Development and having the same license expiration date of April 30, 2018 as the

energy generation. The model takes into account each Project's engineering data and operational constraints, such as current FERC licensed water level fluctuations and minimum flow requirements. The model outputs include hourly flow and generation from the TransCanada and FirstLight hydroelectric facilities.

The model calibration procedure involved adjusting several model parameters and constraints to reasonably match historic (2002-2003) Project data (flow, stage, generation). The calibrated model was subsequently updated to reflect today's equipment; this model is termed the baseline model. The baseline model was subsequently used to predict the impact of Project operations on generation over a longer-term period (1960-2013).

The Baseline model results show that for the period 1960-2013 the average annual generation at the Turners Falls Development and the Northfield Mountain Pumped Storage Development is x and y *[to be inserted when final*] MWh, respectively.

Some sections of this license application, including Exhibit D and Exhibit E-Developmental Analysis, utilize the Baseline model outputs. Sections using model outputs will explicitly state when model results (as opposed to actual data) are presented.

3 DEPENDABLE CAPACITY AND AVERAGE ANNUAL GENERATION

3.1 Estimate of Dependable Capacity and Average Annual Generation

The net dependable capacity of the Turners Falls Development is 67.699 MW (62.016 MW at Cabot and 5.683 MW at Station No. 1).

The net dependable capacity of the Northfield Mountain Pumped Storage Development is 1,143 MW[2].

Average annual generation of the Turners Falls Development for the period 2000-2014 was 328,022 MWh. The monthly and annual generation at the Turners Falls Development for the period 2000-2014 is provided in Table 3.1-1.

Average annual net generation at the Northfield Mountain Pumped Storage Development for the period 2000-2014 (excluding 2010) was 1,053,891 MWh. Average annual pumping generation use by the Northfield Mountain Pumped Storage Development for the same time period was 1,437,464 MWh. The monthly and annual net generation and pumping energy use for the period 2000-2014 is provided in Table 3.1-2 and Table 3.1-3, respectively.

3.2 Streamflow

FirstLight estimates the total instantaneous inflow to the TFI – referred to as the naturally routed flow-- as the sum of the Vernon Hydroelectric Project discharge and inflow from two larger tributaries equipped with United States Geological Survey gages – the Ashuelot and Millers Rivers. The drainage areas at the Vernon Dam and Turners Falls Dam are 6,266 square miles (mi^2) and 7,163 mi^2, respectively, a difference of 897 mi^2. Thus, 87% of the inflow to the TFI is controlled by the Vernon Hydroelectric Project. Information on the Ashuelot and Millers Rivers is shown in Table 3.2-1.

FirstLight Projects. They included in upstream to downstream order: Wilder Hydroelectric Project (FERC No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904).
[2] Note that after February 2016 the FERC nameplate rating will increase to 1,166.8 MW (291.7 MW x 4 units).

Table 3.2-1: USGS Gages on Tributaries to the Turners Falls Impoundment

Gage No.	Gage Name	Period of Record	Drainage Area	Regulation
01161000	Ashuelot River at Hinsdale, NH	1907-current	420 mi^2	Regulated by Corps Storage Reservoir- Surry Dam since 1941.
01166500	Millers River at Erving, MA	1915-current	372 mi^2	Regulated by Corps Storage Reservoirs- Tully Dam and Birch Hill Dams since 1949 and 1941, respectively.

The total drainage area of these two gages is 792 mi^2, which represents 88% (792/897) of the remaining drainage area.

TransCanada reports the Vernon Hydroelectric Project discharge to FirstLight, including flow through the Vernon turbines (total station hydraulic capacity of 17,130 cfs) plus any spill via the gates. Spill at Vernon is estimated via rating curves for the various gates.

FirstLight sums the reported Vernon Hydroelectric Project instantaneous discharge plus the flow contributions from the Millers and Ashuelot Rivers as measured at the USGS gages and then adjusts it based on the travel time required to reach the Turners Falls Dam. FirstLight refers to the adjusted flow on its log sheets as the "natural routed flow". Note that the electronically available data is only available for the period 2000-2014. Thus, to estimate the inflow to Turners Falls Dam over a long period of record a different method was used to estimate inflow as described below.

The Connecticut River flow at the Turners Falls Dam was estimated using two USGS gages as listed in Table 3.2-2.

Table 3.2-2: USGS Gages to Estimate inflow to Turners Falls Dam

Gage No.	Gage Name	Period of Record	Drainage Area	Regulation
01170500	Connecticut River at Montague City, MA	1904-current	7,860 mi^2	Regulated seasonally by dams on the CT River (and other major tributaries): First and Second CT Lakes, Moore Reservoir and Comerford Reservoir.
0117000	Deerfield River at West Deerfield, MA	1940-current	557 mi^2	Regulated seasonally by dams on the Deerfield River: Somerset and Harriman Reservoirs.

The Montague USGS gage is located approximately 4,500 feet downstream of the Cabot Powerhouse. It represents the total flow on the Connecticut River including flow from the Deerfield River. The Deerfield River USGS gage is located further upstream from its confluence with the Connecticut River. As noted above, the drainage area of the Connecticut River at the Turners Falls Dam is 7,163 mi^2. The additional drainage area at the Montague USGS gage compared to the Turners Falls Dam is 697 mi^2, of which the bulk of the increase is attributable to the Deerfield River (557 mi^2 as measured at the USGS gage and 665 mi^2 as measured at its confluence with the Connecticut River). The Deerfield River gage flow was prorated by a factor of 1.25 (697/557) to represent the additional flow from the 697 mi^2 drainage area. This prorated flow was then subtracted from the corresponding flow measured at the Montague USGS Gage to estimate the flow at Turners Falls Dam. The following equation was applied to estimate the flow at Turners Falls Dam:

$Q_{Turners\ Falls\ Dam} = Q_{Montague\ USGS\ Gage} - 1.25(Q_{Deerfield\ USGS\ Gage})$, where

$Q_{Turners\ Falls\ Dam}$=	calculated approximate inflow to Turners Falls Dam (cfs)
$Q_{Montague\ USGS\ Gage}$=	flow recorded at the Montague USGS Gage (cfs)
1.25 =	ratio of the drainage areas (697/557)
$Q_{DeerfieldUSGS\ Gage}$=	flow recorded at the Deerfield USGS gage (cfs)

The annual and monthly mean and median flows, and flow per square mile of drainage area at the Turners Falls Dam was calculated for the period 1940-2013 as shown in Table 3.2-3.

Table 3.2-3: Estimated Connecticut River at Turners Falls Dam Drainage Area= 7,163 mi^2, Period of Record Oct 1941-Dec 2013 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	10,153	9,753	18,889	33,399	19,513	11,848	8,207	7,447	6,328	11,701	13,940	14,504	14,008
Mean/ mi^2	1.42	1.36	2.64	4.66	2.72	1.65	1.15	1.04	0.88	1.63	1.95	2.02	1.96
Median	7,862	7,699	13,450	30,163	17,200	8,893	4,908	4,104	4,072	6,038	9,883	9,525	8,464
Median/ mi^2	1.10	1.07	1.88	4.21	2.40	1.24	0.69	0.57	0.57	0.84	1.38	1.33	1.18

Figures 3.2-1 through 3.2-5 show the annual and monthly flow duration curves representing calculated Turners Falls Dam average daily flows, respectively.

3.3 Area Capacity Curve

The TFI stage versus storage curve is shown in Table 3.3-1 and plotted in Figure 3.3-1. The TFI licensed operating range is between 185 feet and 176 feet, a 9 foot fluctuation providing a total usable storage of approximately 16,150 acre-ft. The TFI has a surface area of approximately 2,110 acre at elevation 185 ft.

The Upper Reservoir stage versus storage curves is shown in Table 3.3-2 and plotted in Figure 3.3-2. The Upper Reservoir licensed operating range is between 1000.5 and 938 ft, a 62.5 foot fluctuation providing a total usable storage of 12,318 acre-feet. As noted earlier, FirstLight is proposing to increase the Upper Reservoir storage operating limits to be between 1004.5 ft and 920 ft, a 84.5 foot fluctuation providing a total usable storage of 15,327 acre-ft. The Upper Reservoir has a surface area of approximately 278 acres at elevation 1000.5 ft.

Combined Useable Storage Volume in the Northfield Mountain Pumped Storage Development System

The combined useable volume in the Northfield Mountain Pumped Storage Development is the sum of useable water volumes in the Upper Reservoir and the TFI. At any given time, a comparison of the actual combined useable storage volume and the useable storage in the full Upper Reservoir (12,318 acre-feet) provides an indication of whether the TFI useable storage volume is adequate for filling the deficit in the Upper Reservoir. The useable volume in the Upper Reservoir plus the useable volume in the TFI equals 12,318 acre-feet when the system is balanced. At any given time three situations are possible as follows:

- *Combined Useable Storage = 12,318 acre-feet*. This indicates a balanced condition, where the total storage in the TFI and Upper Reservoir is 12,318 acre-feet.
- *Combined Useable Storage < 12,318 acre-feet*. This indicates there is insufficient water available in the TFI to refill the Upper Reservoir. During periods of low flow, this deficiency can be rectified by curtailing generation at Cabot or Station No. 1 to allow the TFI to fill.
- *Combined Useable Storage > 12,318 acre-feet*. This indicates there is more than enough water available in the TFI to refill the Upper Reservoir.

In general, FirstLight strives to maintain a near balanced condition or a positive imbalance where the combined useable storage is close to 12,318 acre-feet.

3.4 Hydraulic Capacity

The Turners Falls Hydroelectric Development includes two facilities – Station No. 1 and Cabot Station located on the power canal. Unit hydraulic capacities of Station No. 1 are shown in Table 3.4-1. At Station No. 1, only five (5) of the seven (7) turbines are operational. The total hydraulic capacity of Station No. 1 is 2,210 cfs.

Table 3.4-1 Station No. 1 Hydraulic Capacity

Unit No.	Hydraulic Capacity (cfs)
1	560
2*	140
3	500
4	--
5	490
6	--
7	520
Total	2,210

*Unit No. 2 is directly connected to a 1600 amp, 257 rpm, 115 volt exciter.

Cabot Station has six identical turbines for a total hydraulic capacity of 13,728 cfs or approximately 2,288 cfs/turbine.

The Northfield Mountain Pumped Storage Development includes four reversible pump turbines. The hydraulic capacity of the Northfield Mountain Pumped Storage Development when in a pumping and generating mode is approximately 15,200 cfs (3,800 cfs/pump) and 20,000 cfs (5,000 cfs/turbine), respectively.

3.5 Tailwater Rating Curve

Station No. 1 discharges into the Turners Falls bypass reach further upstream than Cabot Station. The Station No. 1 tailwater rating curve is shown in Figure 3.5-1.

Cabot Station discharges into the end of the Turners Falls bypass reach. The Cabot Station tailwater rating curve is shown in Figure 3.5-2.

The Northfield Mountain Pumped Storage Development uses the TFI as its lower reservoir. TFI elevations reflect multiple influences, including operations of the Vernon Hydroelectric Project, Northfield Mountain Pumped Storage Development, and Turners Falls Development. Therefore, Northfield Mountain Pumped Storage Development hourly operations do not necessarily correlate with TFI elevations, such that a traditional tailwater elevation versus plant discharge relationship can be produced. However, FirstLight maintains a long-term water logger in the Northfield Mountain tailrace and hourly TFI elevations at the tailrace are electronically available for the period 2000-2014. An elevation duration curve was developed at the Northfield Mountain tailrace as shown in Figure 3.5-3. The tailrace elevation generally ranges from 181.1 ft (90% exceedance elevation) to 184.9 ft (10% exceedance elevation).

3.6 Powerplant Capability versus Head Curve

Head (feet) versus generation capacity (kW) curves for Station No. 1 and Cabot Station are shown in Figure 3.6-1 and 3.6-2, respectively.

Head versus generation capacity curves for the Northfield Mountain Pumped Storage Development is shown in Figure 3.6-3.

4 UTILIZATION OF PROJECT POWER

The primary purpose of the Project is to supply energy, capacity, regulation and other ancillary services to the New England ISO Interconnection, a regional transmission organization that coordinates the movement of wholesale electricity.

The Northfield Mountain Pumped Storage Development typically pumps water to the Upper Reservoir during the low cost hours of the night, when the power demand is low and generates during the higher priced hours of the day when power demand is high. The Northfield Mountain Pumped Storage Development provides critical energy, operating reserves and operational flexibility to ISO-NE system operation. The fact that ISO-NE, as part of its daily operational planning processes, can rely on the Northfield Mountain Project to supply these operational flexibilities from a certain fuel supply is of high value to ISO-NE and the New England region. In many periods, this significant supply of operational flexibility has avoided the commitment of many other less flexible resources to provide for a more efficient system dispatch. This peak load ability provides rapid response power resources to the grid to prevent regional blackouts.

Storage provides other important reliability benefits to the system. These include helping to manage light load, or excess generation conditions during off peak periods and the ability to respond very quickly to energy and operating reserve needs on the power system during any time of the day or year. New England is deficient in flexible, quick-start capacity today and will remain so for at least the near future.

5 PLANS FOR FUTURE DEVELOPMENT

There are no plans for future development of the Project.

Table 3.1-1.Turners Falls Development- Summary of Monthly and Annual Generation (MWH) for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	28,432	18,654	38,145	34,688	39,156	26,144	13,313	22,643	10,714	15,350	23,739	23,573	294,551
2001	21,281	19,462	21,789	23,905	27,295	16,773	6,504	1,875	2,766	4,012	9,147	13,482	168,291
2002	12,713	19,935	31,642	38,169	38,051	28,866	13,579	6,776	7,017	11,432	22,380	22,830	253,390
2003	18,684	14,809	24,167	41,200	40,239	21,315	7,551	19,320	15,825	25,252	26,701	26,774	281,837
2004	25,901	15,833	26,903	33,799	35,155	20,759	13,250	22,084	28,301	16,303	23,364	39,848	301,500
2005	34,623	21,565	25,497	39,151	42,809	36,913	20,571	10,860	13,190	27,190	34,807	35,016	342,192
2006	37,182	35,423	31,076	42,935	38,360	41,285	27,079	26,590	12,804	32,698	43,538	43,658	412,628
2007	26,814	17,662	31,725	39,604	41,986	22,144	21,251	10,740	6,579	22,768	36,026	33,569	310,868
2008	38,050	39,282	43,283	37,361	32,209	27,491	28,503	37,856	16,278	23,966	36,272	42,953	403,504
2009	31,690	23,968	44,716	43,861	39,277	29,916	42,117	33,954	10,548	29,548	39,309	40,310	409,214
2010	31,416	27,633	41,142	43,506	32,466	20,856	14,012	13,797	7,541	37,047	38,314	35,832	343,562
2011	26,269	19,431	39,341	39,448	45,213	34,294	14,704	18,156	25,336	38,674	35,033	44,346	380,245
2012	34,633	25,227	40,104	30,139	42,125	29,565	11,983	8,349	9,577	24,229	24,868	33,528	314,327
2013	27,118	26,881	33,500	44,208	33,628	40,650	40,622	18,168	21,957	13,963	25,577	30,104	356,376
2014	35,353	22,059	23,709	38,911	45,584	28,200	32,620	23,501	9,183	21,757	25,366	41,609	347,852
Average	28,677	23,188	33,116	38,059	38,237	28,345	20,511	18,311	13,174	22,946	29,629	33,829	328,022

Table 3.1-2 Northfield Mountain Pumped Storage Development- Summary of Net Monthly and Annual Generation (MWH) for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	109,864	93,567	92,126	89,140	109,320	100,727	137,576	153,957	131,579	123,193	98,718	113,447	1,353,214
2001	101,351	77,503	107,797	121,528	117,901	123,672	137,954	149,880	145,696	138,503	114,467	119,844	1,456,096
2002	95,850	78,303	97,810	103,238	108,275	92,970	111,514	132,978	145,309	125,227	121,123	119,287	1,331,884
2003	95,056	92,116	81,976	65,973	71,618	94,434	96,930	85,811	99,356	61,691	86,925	102,546	1,034,432
2004	99,038	68,077	83,489	75,299	81,302	91,938	89,748	91,846	104,555	87,248	90,696	93,304	1,056,540
2005	81,856	47,618	60,445	58,132	60,958	92,404	104,355	95,351	73,493	77,921	76,339	81,201	910,073
2006	79,856	58,120	76,698	81,847	86,519	79,207	101,082	102,527	91,914	80,443	96,297	100,885	1,035,395
2007	93,798	54,954	43,704	46,464	60,212	87,499	107,016	142,983	139,486	122,630	98,251	103,570	1,100,567
2008	90,188	91,888	101,507	99,094	95,346	116,186	153,354	102,877	82,032	77,478	85,450	84,183	1,179,583
2009	66,037	52,512	61,739	68,409	60,943	79,981	97,749	124,674	93,964	92,274	77,584	96,730	972,596
[1]2010	86,164	73,981	78,598	52,630	672	0	0	0	0	0	18,440	62,204	372,689
2011	65,671	64,477	46,452	42,301	50,058	56,290	103,392	79,772	67,771	76,893	52,454	51,629	757,160
2012	45,074	26,698	52,722	68,596	74,068	55,938	98,932	110,138	61,517	59,794	72,925	55,424	781,826
2013	66,781	65,362	57,176	51,085	61,099	60,465	109,059	76,220	57,764	60,570	64,130	79,232	808,943
2014	68,726	64,673	67,949	58,571	81,431	74,821	98,883	101,214	99,761	82,828	89,316	87,993	976,166
[2]Average	82,796	66,848	73,685	73,548	79,932	86,181	110,539	110,731	99,586	90,478	87,477	92,091	1,053,891

[1]The Northfield Mountain Pumped Storage Development was out of operation for much of 2010.
[2]The average does not include 2010, given this year was an anomaly due to the Northfield Mountain Pumped Storage Development extended outage.

Table 3.1-3 Northfield Mountain Pumped Storage Development- Summary of Net Monthly and Annual Generation (MWH) Consumption in Pumping Mode for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	157,351	131,094	125,737	129,019	144,954	139,323	190,031	205,477	184,650	167,439	139,645	155,752	1,870,472
2001	138,633	105,502	150,565	164,074	160,922	172,880	187,517	203,549	201,358	191,469	153,844	168,665	1,998,978
2002	136,523	103,437	141,198	133,679	146,994	132,568	146,600	185,188	196,329	174,822	168,801	167,005	1,833,144
2003	130,126	124,585	112,260	98,449	89,020	133,009	134,548	119,934	134,217	84355	116,700	139,201	1,416,404
2004	141,351	90,200	112,840	103,857	112,097	125,896	112,995	128,896	136,736	119,890	122,353	128,224	1,435,335
2005	110,358	61,864	87,156	74,377	86,454	125,696	138,225	126,601	98027	109,068	104,009	109,238	1,231,073
2006	109,578	82,360	98,692	107,359	118,492	110,219	133,915	139,214	120,725	113,678	125,271	139,147	1,398,650
2007	132,605	76,064	54,029	62,831	82,046	118,986	146,089	194,557	195,152	165,484	133,335	141,776	1,502,954
2008	127,655	128,575	138,742	141,327	127,381	160,269	212,444	146,638	111,357	104,468	120,801	118,252	1,637,909
2009	90,332	82,182	76,542	97,149	86,154	107,715	135,735	176,610	131,289	126,293	106,205	133,929	1,350,135
[1]2010	126,198	99,201	109,006	71,612	83	0	0	0	0	0	32,244	89,887	528,231
2011	96,439	82,752	72,367	55,866	69,610	81,690	142,141	106,248	93,523	110,491	71,918	69,741	1,052,786
2012	57,045	38,936	65,705	93,555	99,673	77,037	132,357	140,865	86,191	74,027	99,027	77,183	1,041,601
2013	88,692	85,026	71,356	68,421	83,307	81,206	144,181	94,930	80,654	76,997	84,133	110,535	1,069,438
2014	85,727	87,745	87,358	84,204	105,758	100,985	129,180	129,100	128,599	113,603	119,270	114,094	1,285,623
[2]Average	114,458	91,452	99,611	101,012	108,062	119,106	148,997	149,843	135,629	123,720	118,951	126,624	1,437,464

[1]The Northfield Mountain Pumped Storage Development was out of operation for much of 2010.
[2]The average does not include 2010, given this year was an anomaly due to the Northfield Mountain Pumped Storage Development extended outage.

Figure 3.2-1. Connecticut River at Turners Falls Dam, Jan-Mar Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi2

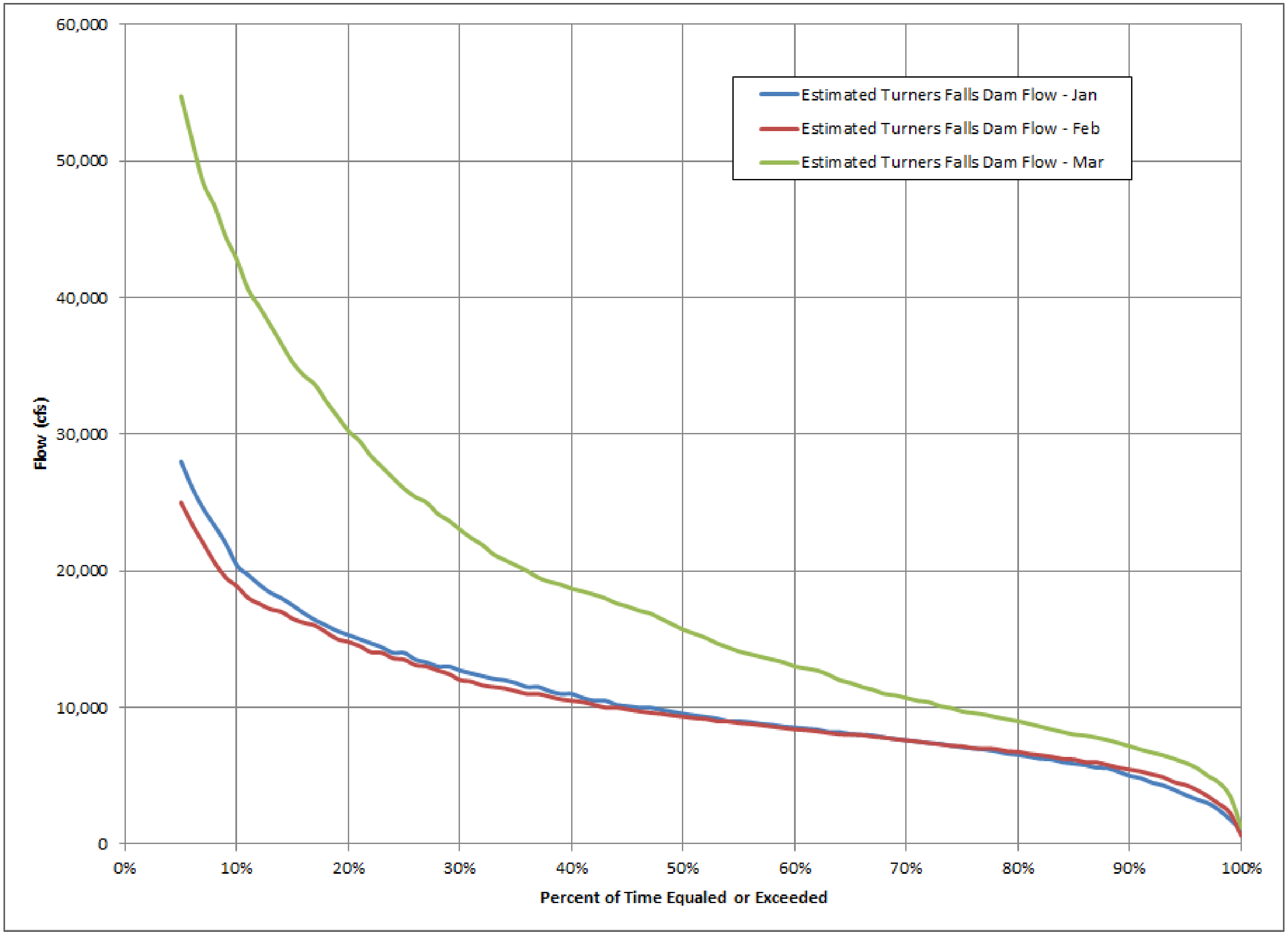


Figure 3.2-2. Connecticut River at Turners Falls Dam, Apr-Jun Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi2

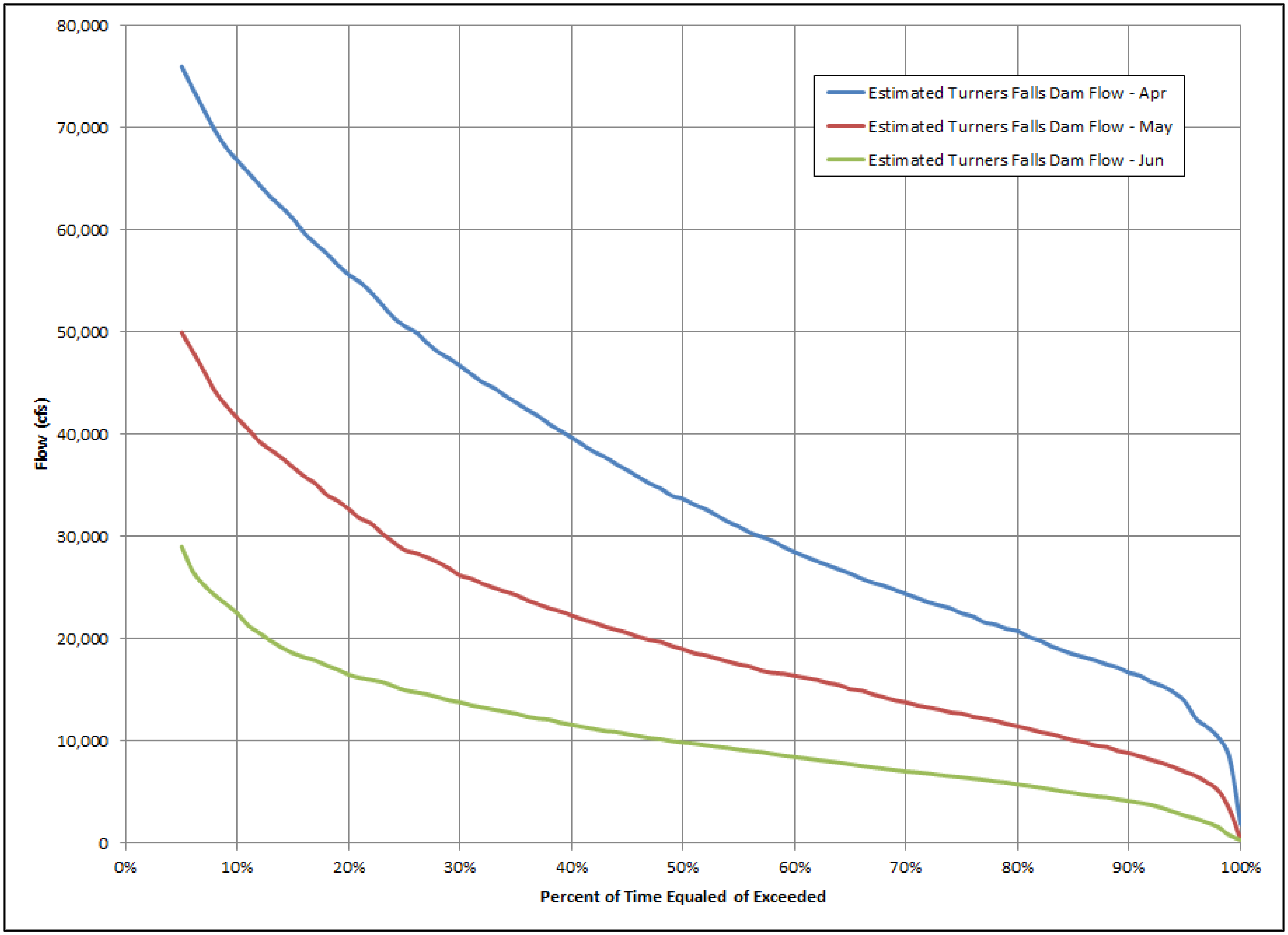


Figure 3.2-3. Connecticut River at Turners Falls Dam, Jul-Sep Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi2

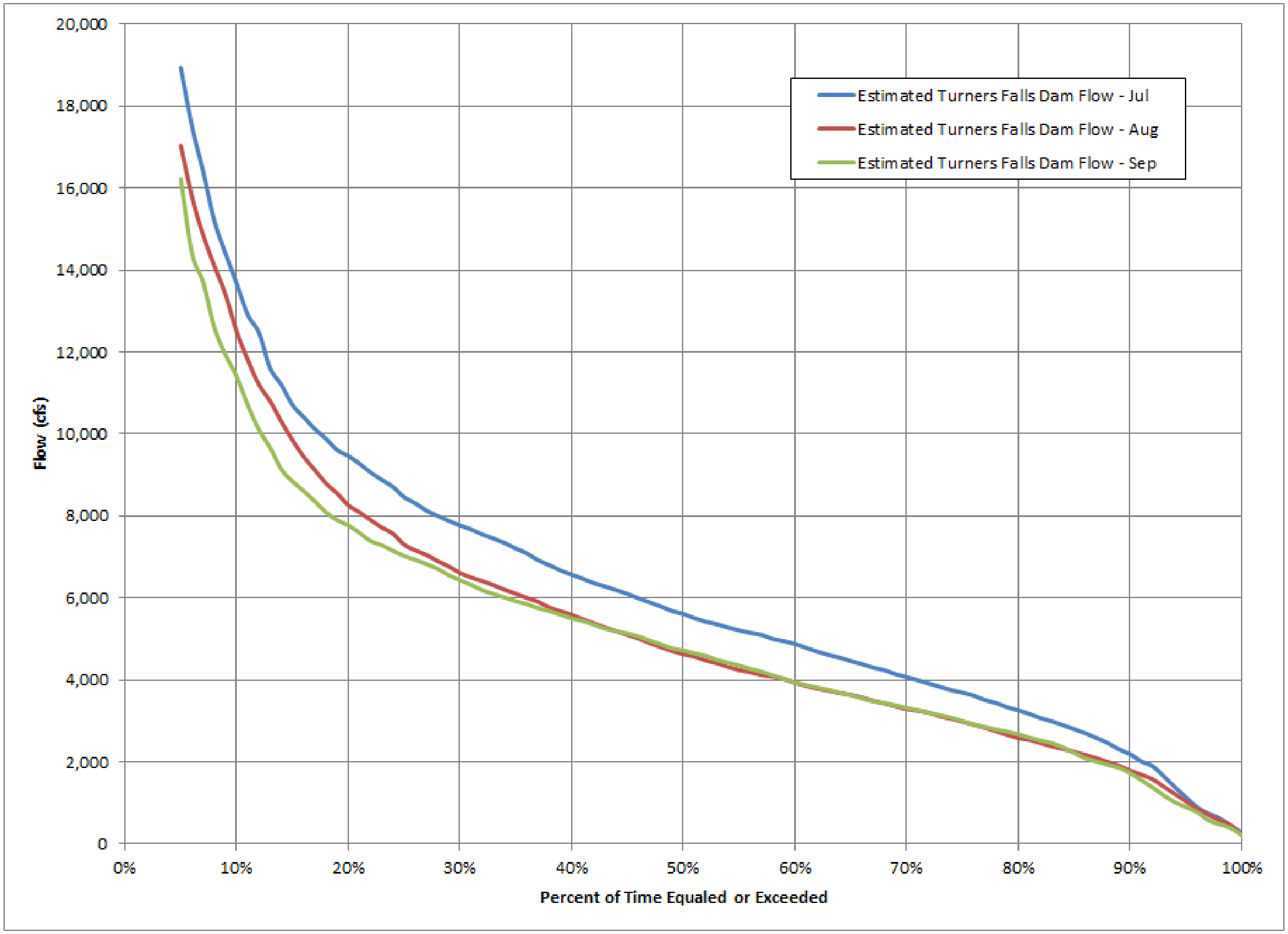


Figure 3.2-4. Connecticut River at Turners Falls Dam, Oct-Dec Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi2

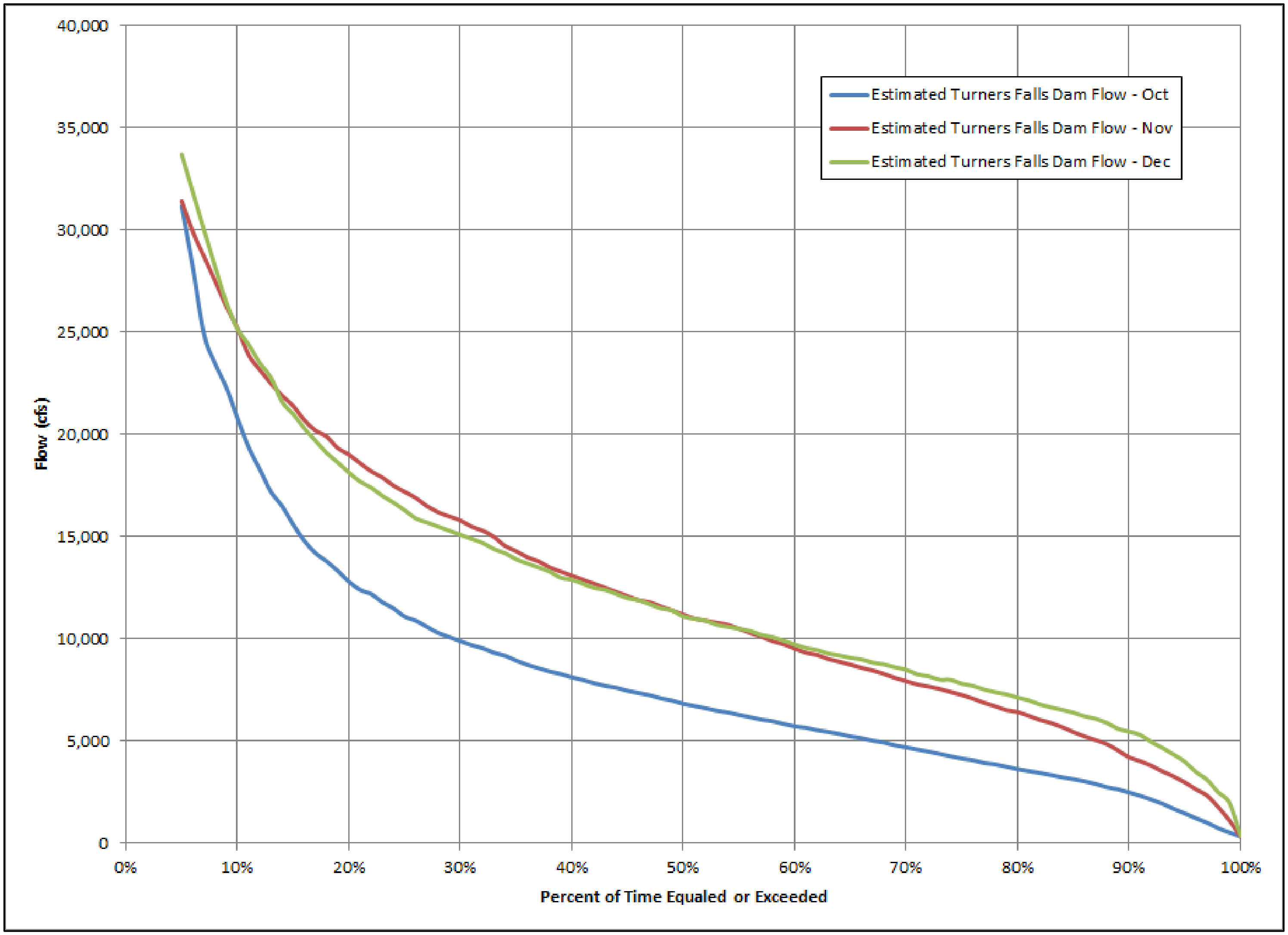


Figure 3.2-5. Connecticut River at Turners Falls Dam, Annual Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi2

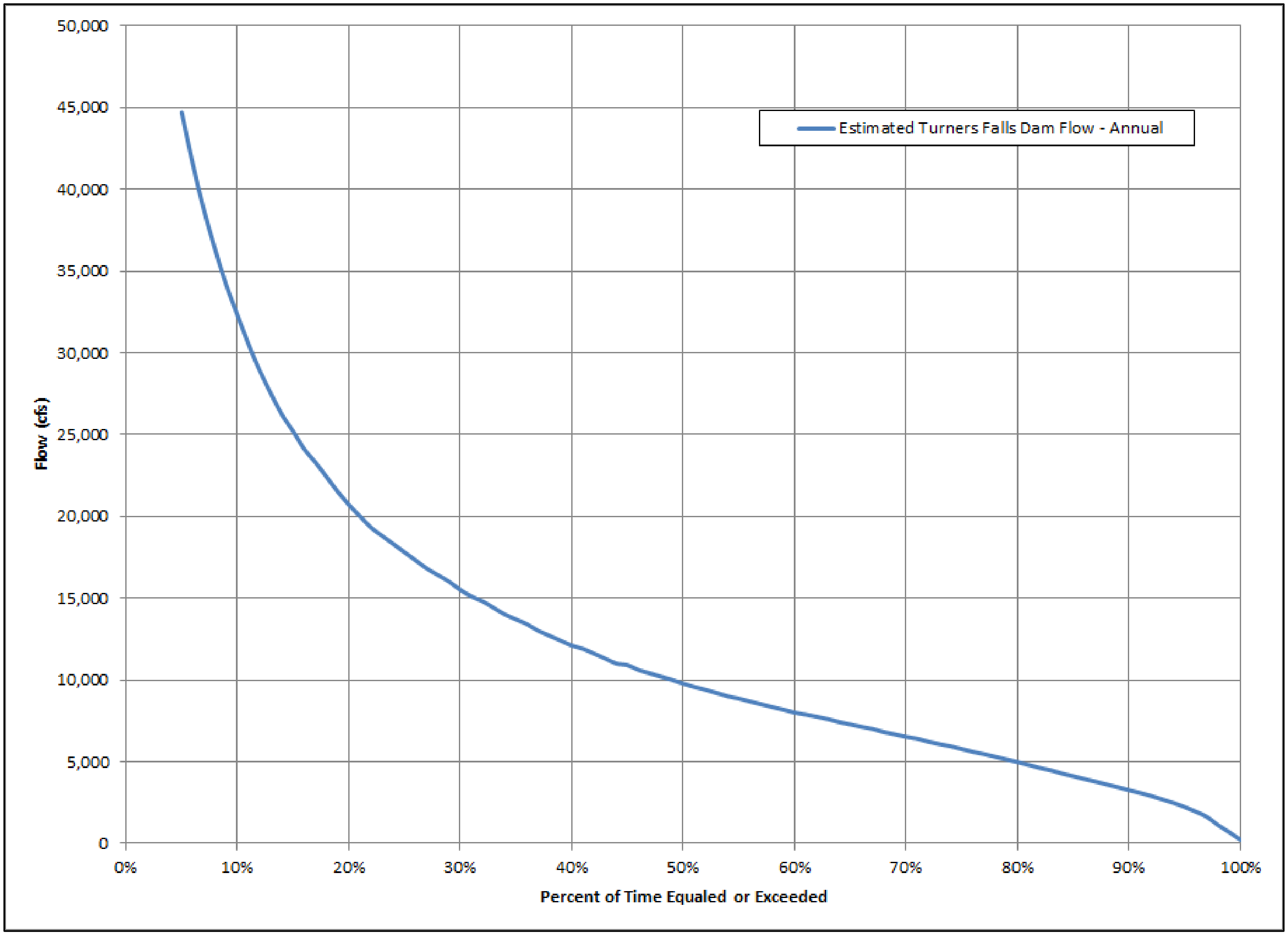


Table 3.3-1: Turners Falls Impoundment Stage versus Storage Curve table

Turners Falls Impoundment Elev (ft)	**Storage** (acre-ft)
172.26	0
176	4,150
177	5,600
178	7,500
179	9,200
180	11,100
181	13,000
182	14,750
183	16,600
184	18,450
185	20,300
186	22,100
186.5	23,000

Figure 3.3-1: Turners Falls Impoundment Stage versus Storage Curve

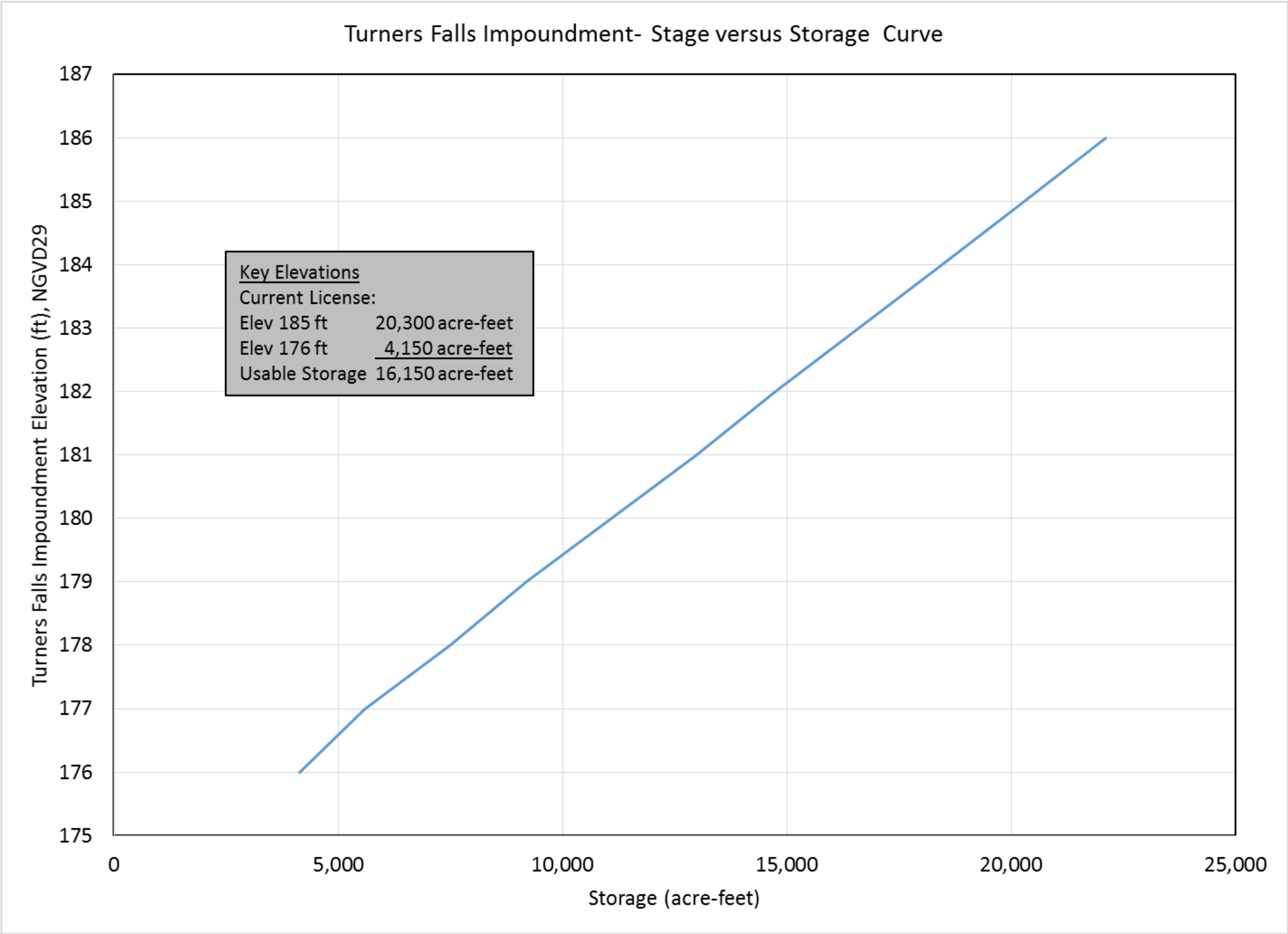


Table 3.3-2: Upper Reservoir Stage versus Storage Curve table

Upper Reservoir Elev (ft)	**Storage** (acre-ft)	**Upper Reservoir Elev** (ft)	**Storage** (acre-ft)
920	0	966	6,141
921	88	967	6,328
922	177	968	6,519
923	269	969	6,713
924	363	970	6,910
925	459	971	7,110
926	558	972	7,314
927	658	973	7,520
928	760	974	7,729
929	865	975	7,940
930	972	976	8,155
931	1,081	977	8,374
932	1,192	978	8,596
933	1,306	979	8,820
934	1,422	980	9,046
935	1,540	981	9,276
936	1,660	982	9,508
937	1,781	983	9,743
938	1,905	984	9,980
939	2,030	985	10,221
940	2,157	986	10,464
941	2,286	987	10,710
942	2,417	988	10,958
943	2,550	989	11,208
944	2,685	990	11,461
945	2,823	991	11,751
946	2,962	992	11,971
947	3,101	993	12,229
948	3,244	994	12,489
949	3,387	995	12,750
950	3,532	996	13,014
951	3,678	997	13,280
952	3,827	998	13,547
953	3,976	999	13,816
954	4,128	1000	14,087
955	4,281	1000.5	14,223
956	4,436	1001	14,360
957	4,593	1002	14,633
958	4,752	1003	14,969
959	4,912	1004	15,187
960	5,077	1004.5	15,327
961	5,248		
962	5,425		
963	5,597		
964	5,775		
965	5,956		

Figure 3.3-2: Northfield Mountain Upper Reservoir Stage versus Storage Curve

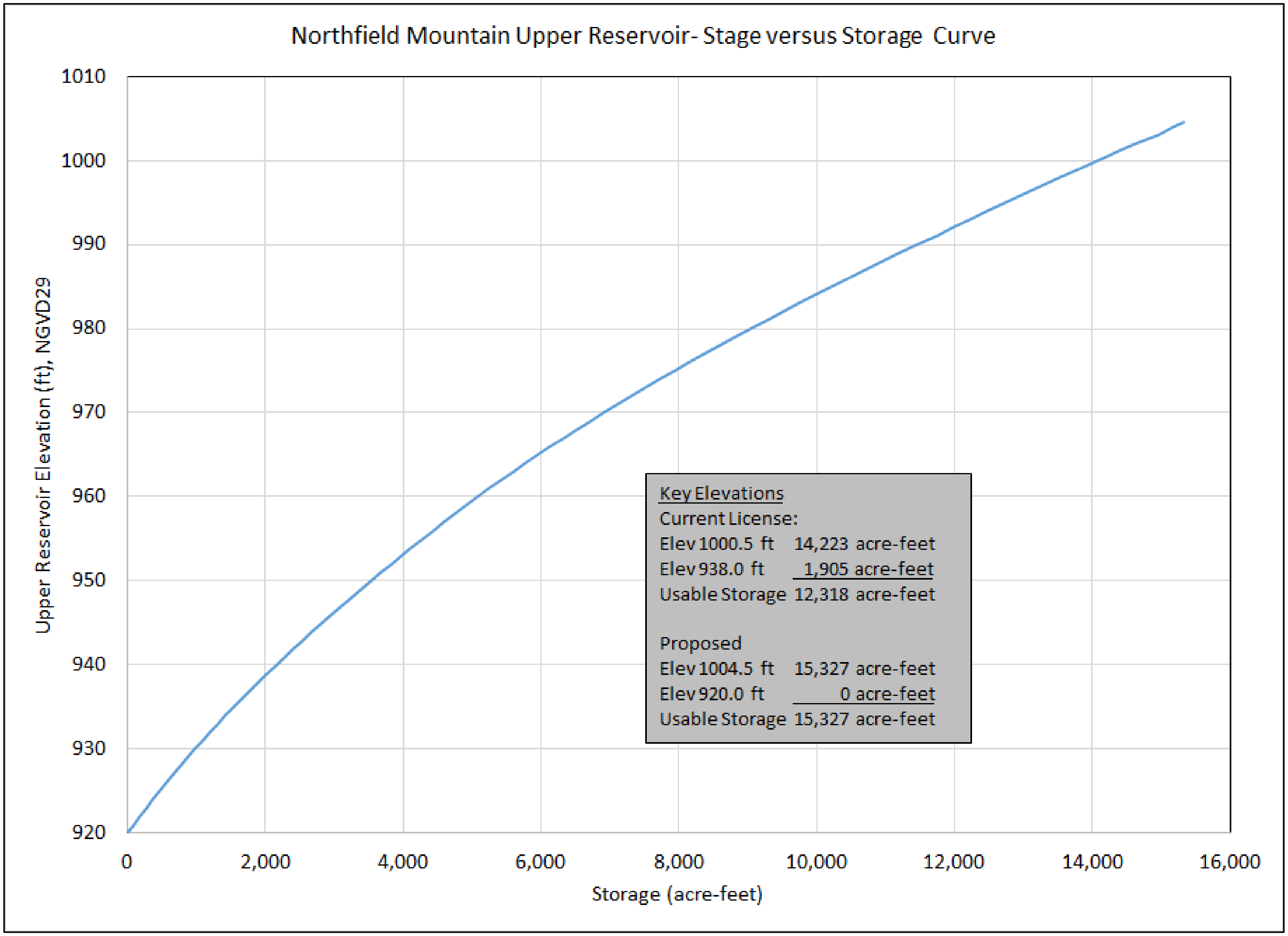


Figure 3.5-1: Station No. 1 Tailwater Rating Curve

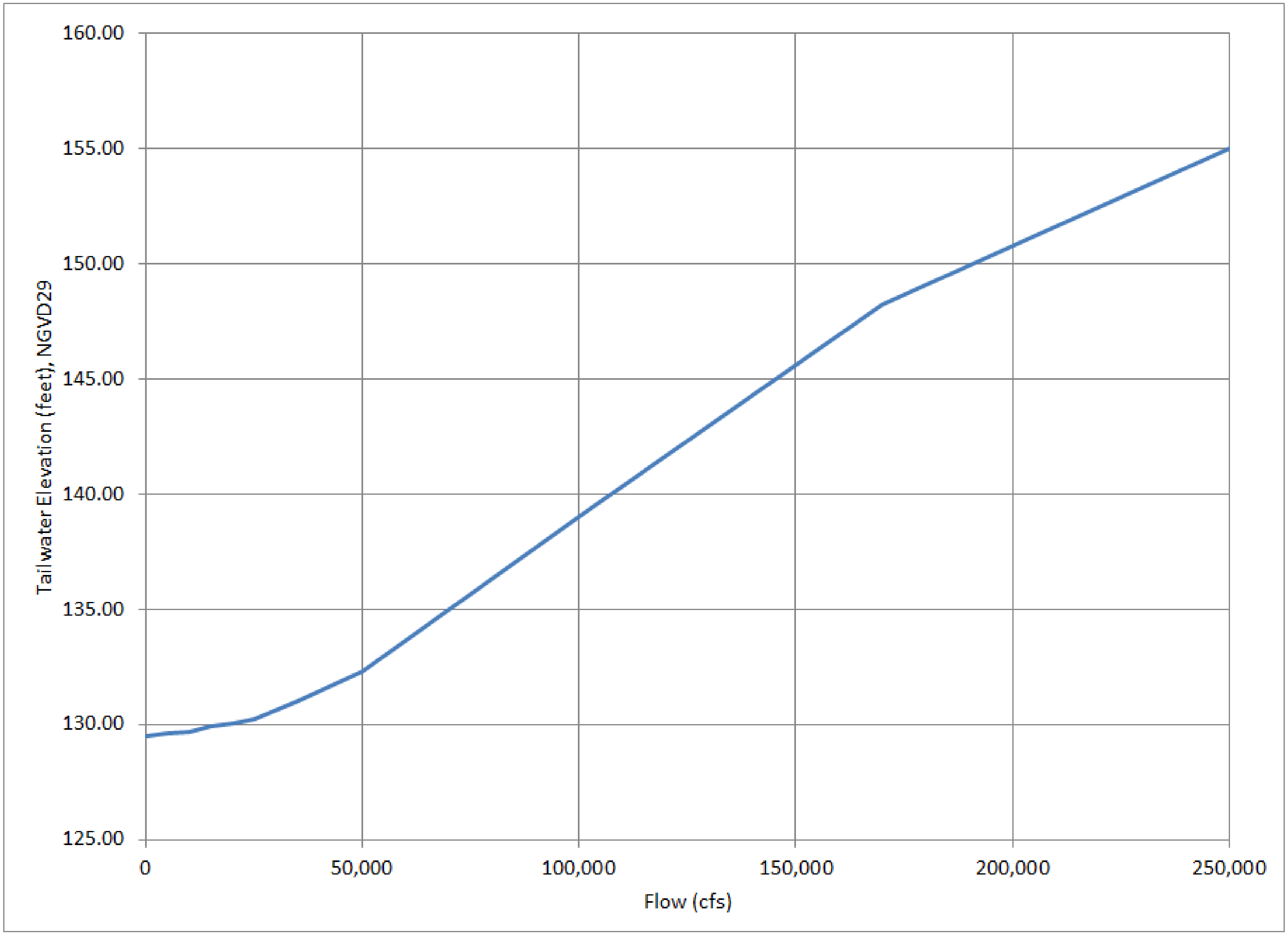


Figure 3.5-2: Cabot Station Tailwater Rating Curve

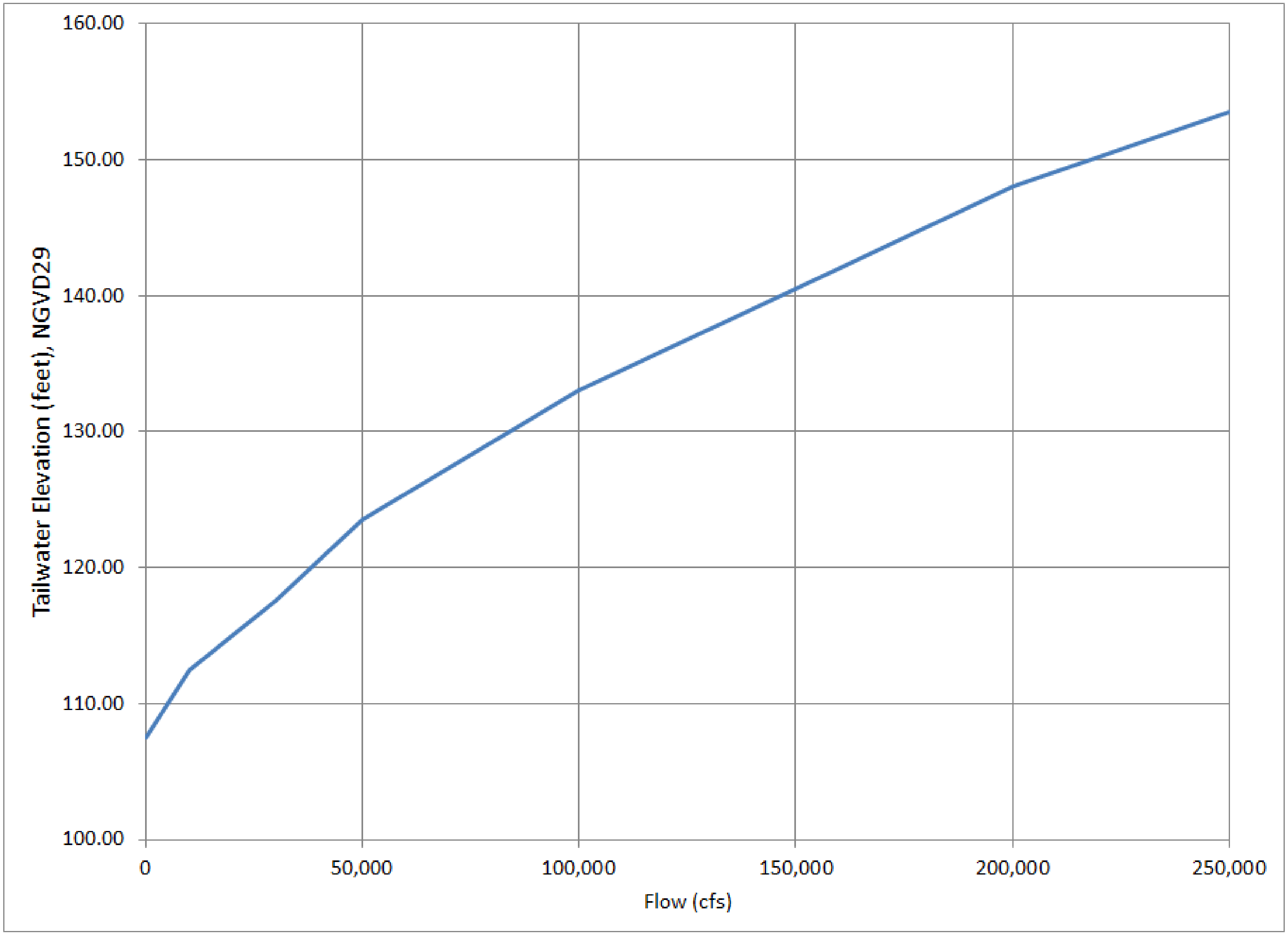


Figure 3.5-3: Turners Falls Impoundment- Elevation Duration Curve at Northfield Mountain Pumped Storage Development Tailrace
(based on hourly data from 2000-2014)

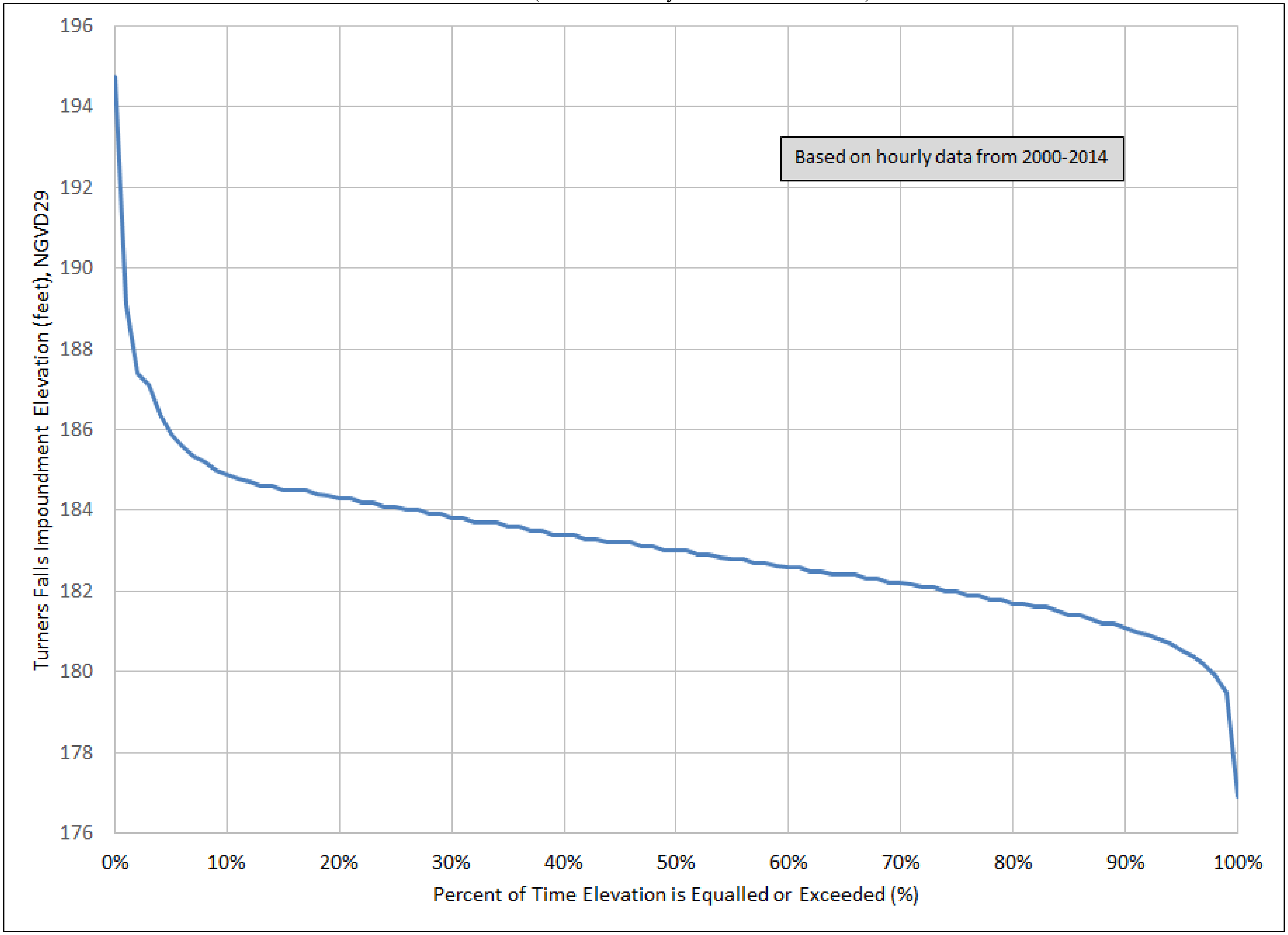


Figure 3.6-1. Station No. 1 - Plant Capability (MW) versus Head (ft) Curve

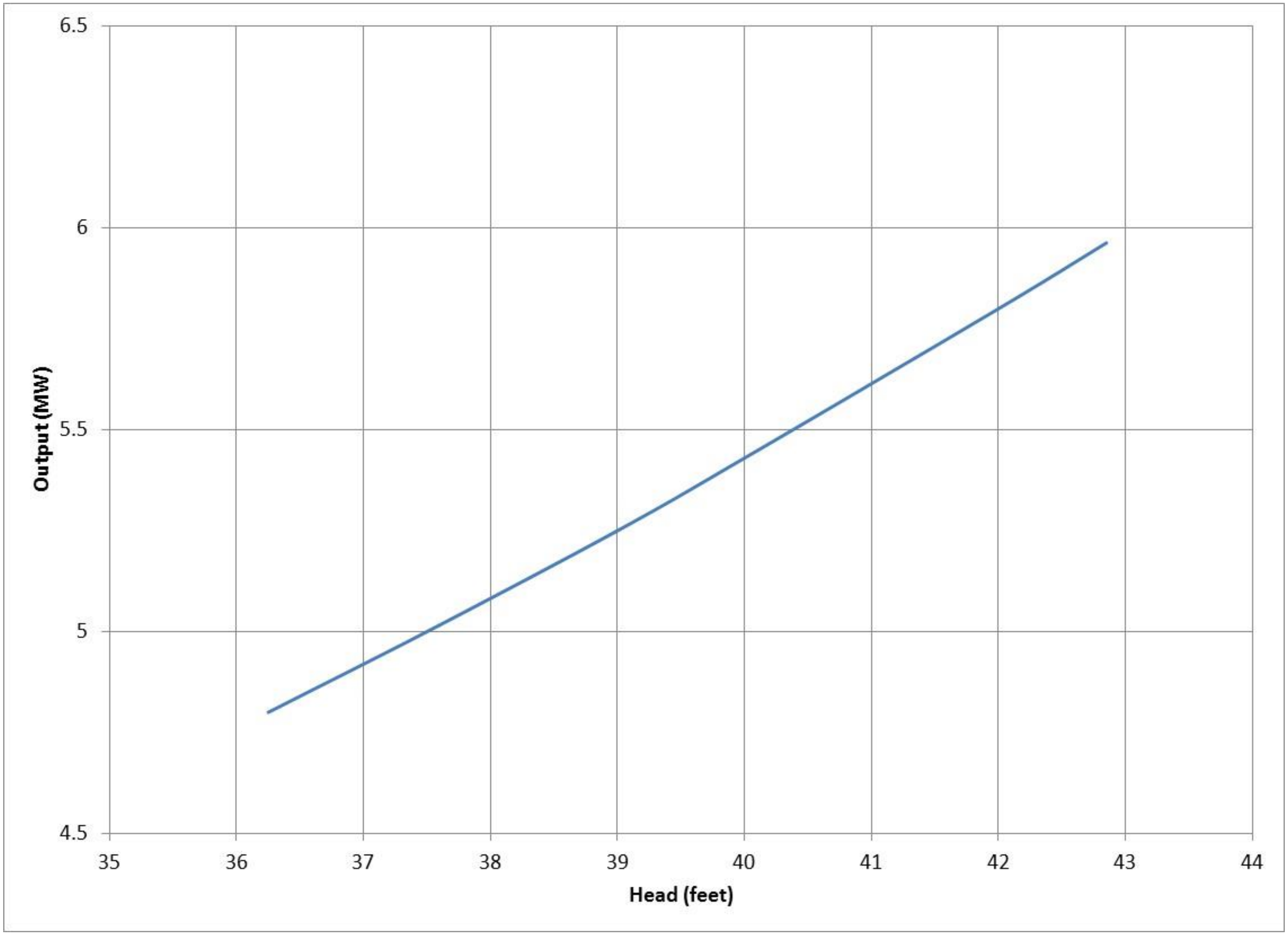


Figure 3.6-2. Cabot Station - Plant Capability (MW) versus Head (ft) Curve

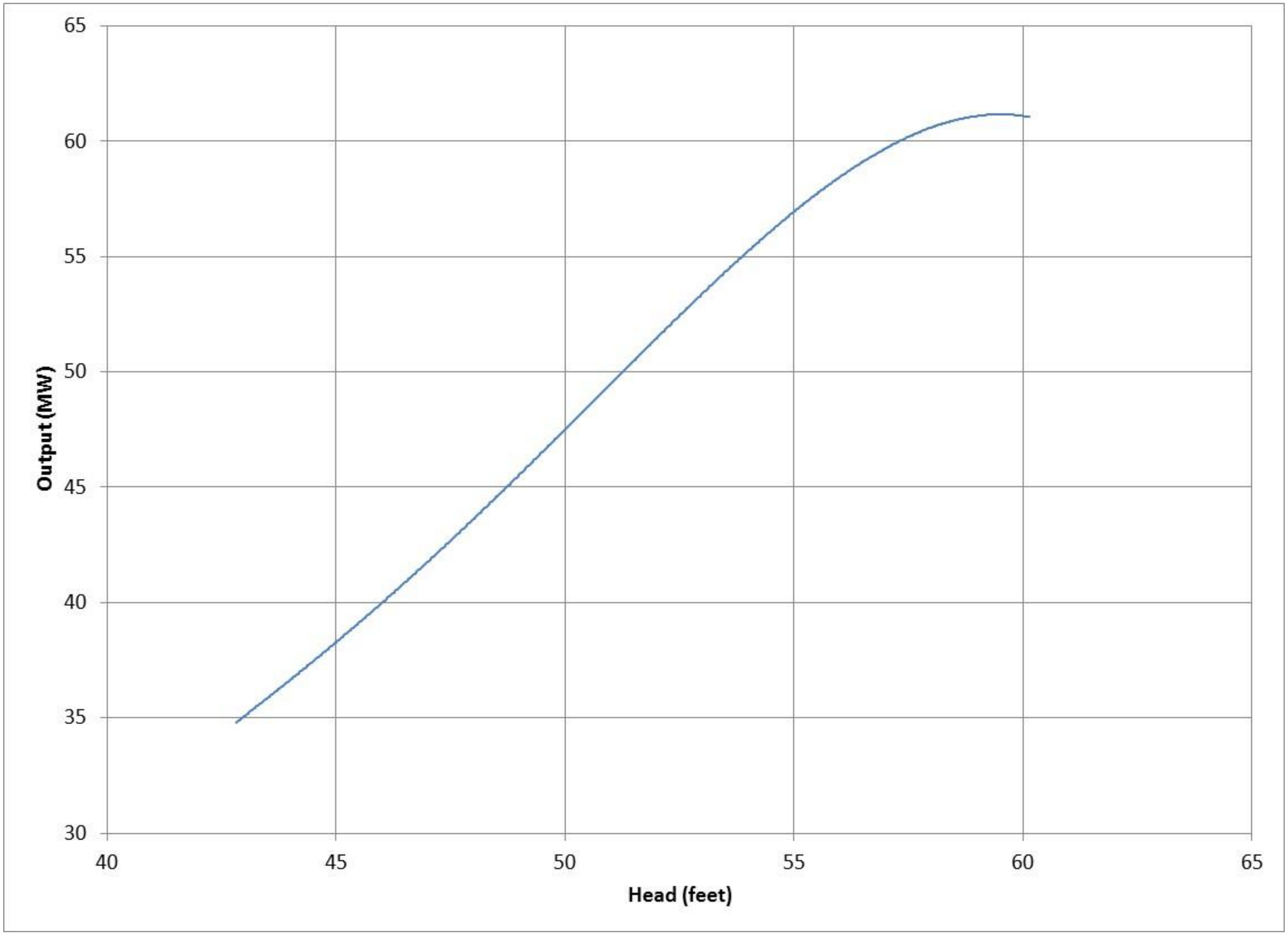
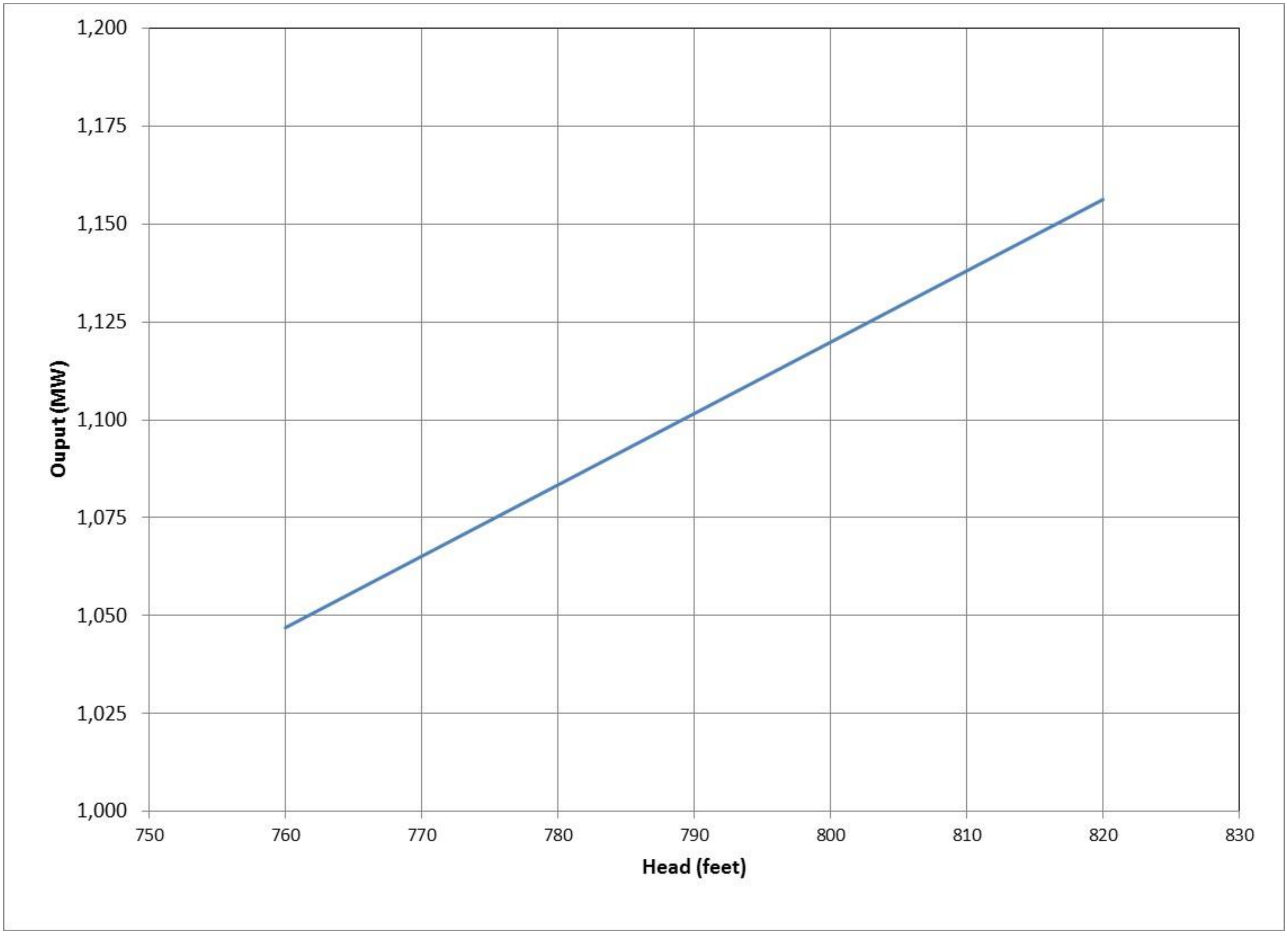


Figure 3.6-3. Northfield Mountain Pumped Storage Development - Plant Capability (MW) versus Head (ft) Curve



Draft Application for New License for Major Water Power Project – Existing Dam

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

EXHIBIT C-CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION

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EXHIBIT C – CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (d) describes the required content of this Exhibit.

(d) Exhibit C is a construction history and proposed construction schedule for the project. The construction history and schedules must contain:

(1) If the application is for an initial license, a tabulated chronology of construction for the existing projects structures and facilities described under paragraph (b) of this section (Exhibit A), specifying for each structure or facility, to the extent possible, the actual or approximate dates (approximate dates must be identified as such) of:

(i) Commencement and completion of construction or installation;

(ii) Commencement of commercial operation; and

(iii) Any additions or modifications other than routine maintenance; and

(2) If any new development is proposed, a proposed schedule describing the necessary work and specifying the intervals following issuance of a license when the work would be commenced and completed.

1 PROJECT HISTORY

FirstLight Hydro Generating Company (FirstLight) is licensed by the Federal Energy Regulatory Commission to operate the Northfield Project (Project).

Turners Falls Development

The Turners Falls Development is located on the Connecticut River in the states of Massachusetts (MA), New Hampshire (NH) and Vermont (VT). The greater portion of the Turners Falls Development, including developed facilities 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 the Project boundary extend into the town of Hinsdale, in Cheshire County, NH, and the town of Vernon, in Windham County, VT. The Turners Falls Dam is located at approximately river mile 122 (above Long Island Sound) on the Connecticut River, at coordinates 42°36'38.77" north and 72°33'05.76" west, in the towns of Gill and Montague, MA.

The Turners Falls Development currently consists of: 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) a reservoir known as the Turners Falls Impoundment (TFI).

The original Turners Falls Dam and canal was constructed in the 1860s. Improvements to the dam and enlargement of the canal, as well as the construction of the Cabot Station and Station No. 1 powerhouses commenced in the early 1900s; Station No. 1 commenced operation in 1905, while the Cabot Station powerhouse commenced operation in 1915. In 1944, the Federal Power Commission, predecessor to the FERC, issued to Western Massachusetts Electric Company a 50-year license for the Turners Falls Development designated as FERC No. 1889. The Turners Falls Development began operation with six vertical Francis turbines at Cabot Station with a capacity of 51 MW and six horizontal Francis turbines at Station No. 1 with a capacity of 6 MW.

To accommodate for Northfield Mountain, the Turners Falls license was amended by FERC in the same Order as the original license for the Northfield Project. This amendment approves the reconstruction of the Turners Falls Dam and Canal gatehouse. The completion of these improvements resulted in an increase in the permitted headpond level to elevation 185.0 ft. A subsequent license for the Turners Falls Project was issued by FERC in 1980.

Northfield Mountain Pumped Storage Development

The Northfield Mountain Pumped Storage Development is a pumped-storage facility located on the eastern bank of the Connecticut River in MA and is located approximately 5.2 miles upstream of Turners Falls Dam. The TFI serves as its lower reservoir. This Development's Upper Reservoir is a man-made structure situated atop Northfield Mountain, to the east of the Connecticut River. During pumping operations, water is pumped from the TFI to the Upper Reservoir. When generating, water is passed from the Upper Reservoir through an underground pressure shaft to a powerhouse cavern and then a tailrace tunnel delivers the water back to the TFI.

The Northfield Mountain Pumped Storage Development currently consists of: a) an Upper Reservoir and dam/dikes; b) an intake channel; c) pressure shaft; d) an underground powerhouse; and c) a tailrace tunnel. The TFI serves as the lower reservoir.

On May 14, 1968, the Federal Power Commission issued an original license to Connecticut Light and Power Company, Hartford Electric Company, and Western Massachusetts Electric Company for the construction of the proposed 1,000 MW Northfield Mountain Hydroelectric Project. The Project included four (4) 250 MW reversible pump-turbines. Construction of the Northfield Project began in 1968, and was completed when the first unit went into commercial operation in 1972.

The Project is maintained through regularly scheduled maintenance inspections and replacement of deficient equipment as necessary. In addition to the routine maintenance, various components of the Project have been refurbished. An overview of the history of Project improvements is summarized in Table 1.0-1.

Table 1.0-1. Turners Falls Development and Northfield Mountain Pumped Storage Development Milestones.

Date	Location/Equipment	Description
Turners Falls Development		
1906	Turners Falls, Station No.1	Station No.1 - Generation Units began operation
1918	Turners Falls, Cabot Station	Cabot Station - Generation Units began operation
1973	Turners Falls, Station No.1	Powerhouse deactivated
1982	Turners Falls, Station No.1	Units 1,2&3 refurbished, Powerhouse reactivated
1987	Turners Falls, Station No.1	Units 5&7 overhauled
1987	Turners Falls, Cabot Station	30 ton Gantry Crane replaced
1990	Turners Falls, Cabot Station	Control update to allow remote operation
1995	Turners Falls, Cabot Station	Control update to allow automated operation for Gatehouse and Canal
2002	Turners Falls, Cabot Unit 1-6	Generator step-up transformers upgraded
2002	Turners Falls, Cabot Unit 1&2	Turbine runner replacement and generator rewind
2003	Turners Falls, Cabot Unit 3&4	Turbine runner replacement and generator rewind
2004	Turners Falls, Cabot Unit 5&6	Turbine runner replacement and generator rewind
2006	Turners Falls, Cabot Station	Trashrack frames and supporting structure replaced
Northfield Mountain Pumped Storage Development		
1972	Northfield	First unit, Unit 4 began commercial operation
2004	Northfield, Unit 1	Turbine runner and generator circuit breaker replacement
2006	Northfield, Unit 3	Electrical equipment replacement
2007	Northfield	1X Main power step-up Transformer replacement
2008	Northfield, Units 2 and 4	Electrical equipment replacement
2011	Northfield, Unit 3	Turbine runner and 3X Main power step-up Transformer replacement and generator rewind
2012	Northfield, Unit 2	Turbine runner replacement and generator rewind
2014	Northfield Unit 4	Turbine runner replacement and generator rewind

2 SCHEDULE FOR PROPOSED PROJECT DEVELOPMENT

As noted earlier in the Draft License Application, the closure of the Vermont Yankee Nuclear facility (VY) during the relicensing study period resulted in delaying the aquatic and water quality studies one year. In FERC's February 21, 2014 study plan determination letter (Appendix C of that determination), it states that the aquatic and water studies reports should be filed by March 31, 2016, after the Draft License Application is to be filed. Given the delay in conducting the aquatic and water quality studies due to closure of VY in December 2014, coupled with FERC requiring two additional studies in 2016, FirstLight has not completed all of it scientific studies needed to support a full license application. Until these studies are complete, FirstLight is not proposing any new development at the Project.

Draft Application for New License for Major Water Power Project – Existing Dam

Northfield Project

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

EXHIBIT D – STATEMENT OF COST AND FINANCING

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EXHIBIT D – STATEMENT OF COSTS AND FINANCING

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (e) describes the required content of this Exhibit.

(e) Exhibit D is a statement of costs and financing. The statement must contain:

(1) If the application is for an initial license, a tabulated statement providing the actual or approximate original cost (approximate costs must be identified as such) of:

(i) Any land or water right necessary to the existing project; and

(ii) Each existing structure and facility described under paragraph (b) of this section (Exhibit A).

(2) If the applicant is a licensee applying for a new license, and is not a municipality or a state, an estimate of the amount which would be payable if the project were to be taken over pursuant to section 14 of the Federal Power Act upon expiration of the license in effect [see 16 U.S.C. 807], including:

(i) Fair value;

(ii) Net investment; and

(iii) Severance damages.

(3) If the application includes proposals for any new development, a statement of estimated costs, including:

(i) The cost of any land or water rights necessary to the new development; and

(ii) The cost of the new development work, with a specification of:

(A) Total cost of each major item;

(B) Indirect construction costs such as costs of construction equipment, camps, and commissaries;

(C) Interest during construction; and

(D) Overhead, construction, legal expenses, taxes, administrative and general expenses, and contingencies.

(4) A statement of the estimated average annual cost of the total project as proposed specifying any projected changes in the costs (life-cycle costs) over the estimated financing or licensing period if the applicant takes such changes into account, including:

(i) Cost of capital (equity and debt);

(ii) Local, state, and Federal taxes;

(iii) Depreciation and amortization;

(iv) Operation and maintenance expenses, including interim replacements, insurance, administrative and general expenses, and contingencies; and

(v) The estimated capital cost and estimated annual operation and maintenance expense of each proposed environmental measure.

(5) A statement of the estimated annual value of project power, based on a showing of the contract price for sale of power or the estimated average annual cost of obtaining an equivalent amount of power (capacity and energy) from the lowest cost alternative source, specifying any projected changes in the cost of power from that source over the estimated financing or licensing period if the applicant takes such changes into account.

(6) A statement specifying the sources and extent of financing and annual revenues available to the applicant to meet the costs identified in paragraphs (e) (3) and (4) of this section.

(7) An estimate of the cost to develop the license application;

(8) The on-peak and off-peak values of project power, and the basis for estimating the values, for projects which are proposed to operate in a mode other than run-of-river; and

(9) The estimated average annual increase or decrease in project generation, and the estimated average annual increase or decrease of the value of project power, due to a change in project operations (i.e., minimum bypass flows; limits on reservoir fluctuations).

1 COST OF ORIGINAL DEVELOPMENT

This application is for a new license, not an initial license; the Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project were previously licensed in 1980 and 1968, respectively. Accordingly, the Commission's regulations do not require FirstLight to include a statement of costs of lands, water rights, structures or facilities. 18 C.F.R. § 4.51(e)(1). FirstLight is seeking a single license for the facilities and are referenced below as the Turners Falls Development and the Northfield Mountain Pumped Storage Development (collectively the Northfield Project or Project).

2 ESTIMATED AMOUNT PAYABLE IN THE EVENT OF PROJECT TAKEOVER

To date, no agency or interested party has recommended a Federal takeover of the Project pursuant to Section 14 of the Federal Power Act (FPA). If such a takeover were to occur, FirstLight would have to be reimbursed for the net investment, not to exceed the fair value of the property taken, plus severance damages, if any, to property of the licensee valuable, serviceable, and dependent for its usefulness on the continuance of the license, but not taken. (Section 14, FPA).

2.1 Fair Value

The term "fair value" is not defined in the FPA Section 14. Because of the unique role of the Project in ensuring electrical reliability of the regional grid, FirstLight believes an approximation of fair value is the cost to construct and operate a comparable power generating facility.

2.2 Net Investment

The FPA defines "net investment" as the original cost, plus additions, minus the sum of the following items (to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment): (a) unappropriated surplus; (b) aggregate credit balances of current depreciated accounts; and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves.

The Turners Falls and Northfield Mountain Pumped Storage Development's net investments are $284,970,827 and $926,156,091, respectively, with a combined net investment of $1,211,126,918.

2.3 Severance Damages

Severance damages are determined either by the cost of replacing (retiring) equipment that is "dependent for its usefulness upon the continuance of the License" but not taken (Section 14, FPA). If a takeover were proposed, FirstLight would calculate severance damages at that time.

3 ESTIMATED CAPITAL COST OF PROPOSED DEVELOPMENT

The Draft License Application (DLA) is incomplete at this time as many of the studies have not been finalized. At this time, FirstLight is not proposing to add any additional power generation facilities to the Turners Falls Development or Northfield Mountain Pumped Storage Development.

4 ESTIMATED AVERAGE ANNUAL COST OF PROJECT AS PROPOSED

The average annual cost of the Project as proposed includes capital costs, taxes, depreciation, as well as operations and maintenance costs. The average annual costs also will include capital costs and operation and maintenance expenses associated with proposed Protection, Mitigation and Enhancement (PME&E) measures. At this time, because some studies are incomplete, FirstLight is not proposing any PM&E measures. When studies are complete and the impact of Project operations on various resources are further evaluated, FirstLight will evaluate potential PM&E measures.

4.1 Capital Costs

The estimated average annual capital costs for the Turners Falls Development and Northfield Mountain Pumped Storage Development as currently proposed are $1,901,763 and $15,308,478, respectively (total of $17,210,241). These costs include life cycle costs such as runner replacements, generator rewinds, and oil circuit breaker replacements and routine replacement of vehicles and tools.

4.2 Taxes

The actual annual property taxes for the fiscal year ending June 2015 for the Turners Falls Development and Northfield Mountain Pumped Storage Development are $3,747,920 and $8,307,402, respectively. FirstLight estimates paying for the Turners Falls Development and Northfield Mountain Pumped Storage Development approximately $2,627,492 and $11,166,499, respectively in Development-related Federal income taxes, and approximately $157,649 and $669,989, respectively in Development-related state income taxes annually. A summary of the local, state and federal taxes for the fiscal year ending June 2015 are shown in Table 4.2-1.

Table 4.2-1: Federal, State, and Local Taxes Associated with the Project (FY 2015 dollars)

Tax	Turners Falls Development	Northfield Mountain Pumped Storage Development	Total
Local (property)	$3,747,920	$8,307,402	$12,055,322
State	$157,649	$669,989	$827,638
Federal	$2,627,492	$11,166,499	$13,793,991
Total	**$6,533,061**	**$20,143,890**	**$26,676,951**

4.3 Depreciation and Amortization

The estimated annual depreciation and amortization costs associated with the Turners Falls Development and the Northfield Mountain Pumped Storage Development are $6,771,000 and $28,957,000 (total of $35,728,000), respectively.

4.4 Operation and Maintenance Expenses

Annual operations and maintenance (O&M) expenses include interim replacements, insurance, and administrative and general costs associated with the operation of the Project, as well as compliance with environmental measures. The estimated O&M costs for the Turners Falls Development and Northfield Mountain Pumped Storage Development as currently proposed are approximately $3,731,591 per year and $11,023,783 per year, respectively (total of $14,755,374).

4.5 Costs of Environmental Measures

FirstLight is not proposing any environmental measures until the results of the on-going studies have been completed and the results analyzed. If measures are added, they would add capital costs, and increase annual operations and maintenance costs for the Project.

5 ESTIMATED ANNUAL VALUE OF PROJECT POWER

Turners Falls Development

If all of the Turners Falls Development generation was sold into the market, it would be priced at the Day Ahead and Real Time Locational Marginal Prices that clear for each generator. For 2013, the Turners Falls Development had a realized energy value of $58.18 per MWh (this is a realized value calculated as revenue divided by generation). The economic analysis of the Turners Falls Development also recognizes that the New England Power Pool (NEPOOL) market values the capacity, reserve and ancillary/regulation services provided by generation facilities.

Capacity is required by NEPOOL to ensure the reliability of the electric system and the price is established by NEPOOL through the forward capacity auction process. For 2013, the actual capacity revenue received by the Turners Falls Development was $2.22 million.

In addition to energy and capacity the Turners Falls Development produces ancillary and real-time reserve services necessary for effective system control. For 2013, the ancillary services revenue has been calculated as ($112,592) per year and the revenue from real-time reserve is $77,441.

Table 5.0-1 below shows the total valuation of the power based on the product components identified above. This assumes an average net generation of 356,376 MWh annually. The annual market value of the energy, capacity and reserve and ancillary services is approximately $22,915,259 per year, which equates to $64.30 per MWh.

Table 5.0-1: Valuation of the Annual Output of the Turners Falls Development (2013)

Revenue Source	Value
Energy ($58.185/MWh for Year 2013 for 356,376 MWh)	$20,735,750
Capacity	$2,214,660
Reserve	$77,441
Ancillary*	($112,592)
Total Value	$22,915,259
Total Value per MWh ($22,915,259/356,376 MWh)	$64.30

NOTE: Numbers may not be exact due to rounding.
* Ancillary includes Utility charges for electric production

Northfield Mountain Pumped Storage Development

If all of the Northfield Mountain Pumped Storage Development generation was sold into the market, it would be priced at the Day Ahead and Real Time Locational Marginal Prices that clear for each generator. For 2013, the Northfield Mountain Pumped Storage Development had a realized energy value of $85.17 per MWh (this is a realized value calculated as revenue divided by generation). The economic analysis of the Northfield Mountain Pumped Storage Development also recognizes that the NEPOOL market values the capacity, reserve and ancillary/regulation services provided by generation facilities.

Capacity is required by NEPOOL to ensure the reliability of the electric system and the price is established by NEPOOL through the forward capacity auction process. For 2013, the calendar average forward capacity auction clearing price was $2.951/KW-month while the capacity revenue received by the Northfield Mountain Pumped Storage Development was approximately $35.5 million.

Forward Reserve Market is an ISO-New England (ISO-NE) market to acquire, in advance, capability to supply pool-required Operating Reserve. It is a voluntary market and the price is set through two Forward Reserve Auctions per year, a four month summer season and an eight month winter season. In 2013, the Northfield Mountain Pumped Storage Development participated in the forward reserve auction and real-time reserves with the revenue received from this market of $14,931,318.

In addition to energy, capacity and forward reserve market, the Northfield Mountain Pumped Storage Development produces ancillary and regulation services that provide spinning and offline reserve and "fine tuning" necessary for effective system control by responding to minute-to-minute changes in load. For 2013, the ancillary services and regulation revenue has been calculated as $3,561,234.

Table 5.0-2 below shows the total valuation of the power based on the product components identified above. Off-peak energy costs for pumping in 2013 reflects the NEPOOL Western Massachusetts real time Locational Marginal Price for all of 2013. This assumes an average net generation of 808,943 MWh annually. The annual market value of the energy, cost for energy, capacity and forward reserve and ancillary/regulation services is approximately $81,791,723, which equates to $101.11 per MWh.

Table 5.0-2: Valuation of the Annual Output of the Northfield Mountain Pumped Storage Development (2013)

Revenue Source	Value
Energy ($85.172/MWh for 808,943 MWh)	$68,899,098
Energy for Pumping ($40.012/MWh) for 1,069,438 MWh	($42,790,965)
Capacity	$35,520,940
Locational Forward Reserve Market and Real-Time Reserves	$14,931,318
Ancillary (NCPC, Posturing, ISO-Fees)	$1,670,097
Regulation	$3,561,234
Total Value	$81,791,723
Total Value per MWh ($81,791,723/808,943 MWh)	$101.11

NOTE: Numbers may not be exact due to rounding.
* Ancillary includes ISO-NE expenses

6 SOURCES AND EXTENT OF FINANCING

The Project's finances capital projects using cash flow from operations and as necessary additional debt obligations. The Project is part of a portfolio of 13 hydro assets which together service an existing first mortgage bond obligation. Based on the value of Project power, the Project should have adequate financial resources to meet the costs of operation of the Project for the term of the new license.

7 ESTIMATED COST TO DEVELOP LICENSE APPLICATION

The cost to develop the information necessary to complete the license application through November 2015 is estimated to be $18,100,000. Note that cost is expected to rise as some studies are not final. This estimate includes all study costs, Integrated Licensing Process (ILP) costs, and personnel and administrative costs associated with processing.

8 ON-PEAK AND OFF-PEAK VALUES OF POWER

The Northfield Mountain Pumped Storage Development and the Turners Falls Development operate within NEPOOL, whose geographic area includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont[1].

The Market has provided the historical 2013 Real Time On-Peak and Off-Peak prices for the Northfield Mountain Pumped Storage Development generation node:

On Peak Price	$62.99/MWh
Off-Peak Price	$47.34/MWh

The Market has provided the historical 2013 Real Time On-Peak and Off-Peak prices for the Turners Falls Development generation node:

On Peak Price	$63.43/MWh
Off-Peak Price	$48.70/MWh

9 ESTIMATED AVERAGE ANNUAL INCREASE OR DECREASE IN PROJECT GENERATION

At the time of filing the license application, not all of the FirstLight studies are complete. Thus, FirstLight has not determined if average annual Project generation will increase or decrease. FirstLight has not finalized its proposed operation for the Project. However, FirstLight is proposing to utilize more of the Upper Reservoir storage capacity, which could result in an increase in Project generation. As noted in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938 feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

[1] The data referenced were the historical Day Ahead LMP values for Northfield Mountain for 2013 retrieved from nMarket. The Northfield Mountain Pricing node (Pnode) ID is #14220.

Draft Application for New License for Major Water Power Project – Existing Dam

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

EXHIBIT E- ENVIRONMENTAL REPORT

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EXHIBIT E – ENVIRONMENTAL REPORT

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 5.18(b) describes the required content of this Exhibit.

Exhibit E—Environmental Exhibit. The specifications for Exhibit E in §§4.41, 4.51, or 4.61 of this chapter shall not apply to applications filed under this part. The Exhibit E included in any license application filed under this part must address the resources listed in the Pre-Application Document provided for in §5.6; follow the Commission's "Preparing Environmental Assessments: Guidelines for Applicants, Contractors, and Staff," as they may be updated from time-to-time; and meet the following format and content requirements:

(1) General description of the river basin. Describe the river system, including relevant tributaries; give measurements of the area of the basin and length of stream; identify the project's river mile designation or other reference point; describe the topography and climate; and discuss major land uses and economic activities.

(2) Cumulative effects. List cumulatively affected resources based on the Commission's Scoping Document, consultation, and study results. Discuss the geographic and temporal scope of analysis for those resources. Describe how resources are cumulatively affected and explain the choice of the geographic scope of analysis. Include a brief discussion of past, present, and future actions, and their effects on resources based on the new license term (30–50 years). Highlight the effect on the cumulatively affected resources from reasonably foreseeable future actions. Discuss past actions' effects on the resource in the Affected Environment Section.

(3) Applicable laws. Include a discussion of the status of compliance with or consultation under the following laws, if applicable:

> *(i) Section 401 of the Clean Water Act. The applicant must file a request for a water quality certification (WQC), as required by Section 401 of the Clean Water Act no later than the deadline specified in §5.23(b). Potential applicants are encouraged to consult with the certifying agency or tribe concerning information requirements as early as possible.*
>
> *(ii) Endangered Species Act (ESA). Briefly describe the process used to address project effects on federally listed or proposed species in the project vicinity. Summarize any anticipated environmental effects on these species and provide the status of the consultation process. If the applicant is the Commission's non-Federal designee for informal consultation under the ESA, the applicant's draft biological assessment must be included.*
>
> *(iii) Magnuson-Stevens Fishery Conservation and Management Act. Document from the National Marine Fisheries Service (NMFS) and/or the appropriate Regional Fishery Management Council any essential fish habitat (EFH) that may be affected by the project. Briefly discuss each managed species and life stage for which EFH was designated. Include, as appropriate, the abundance, distribution, available habitat, and habitat use by the managed species. If the project may affect EFH, prepare a draft "EFH Assessment" of the impacts of the project. The draft EFH Assessment should contain the information outlined in 50 CFR 600.920(e).*
>
> *(iv) Coastal Zone Management Act (CZMA). Section 307(c)(3) of the CZMA requires that all federally licensed and permitted activities be consistent with approved state Coastal Zone Management Programs. If the project is located within a coastal zone boundary or if a project affects a resource located in the boundaries of the designated coastal zone, the applicant must certify that the project is consistent with the state Coastal Zone Management Program. If the project is within or affects a resource within the coastal zone, provide the date the applicant sent the consistency certification information to the state agency, the date the state agency received the certification, and*

the date and action taken by the state agency (for example, the agency will either agree or disagree with the consistency statement, waive it, or ask for additional information). Describe any conditions placed on the state agency's concurrence and assess the conditions in the appropriate section of the license application. If the project is not in or would not affect the coastal zone, state so and cite the coastal zone program office's concurrence.

(v) National Historic Preservation Act (NHPA). Section 106 of NHPA requires the Commission to take into account the effect of licensing a hydropower project on any historic properties, and allow the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the proposed action. "Historic Properties" are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). If there would be an adverse effect on historic properties, the applicant may include a Historic Properties Management Plan (HPMP) to avoid or mitigate the effects. The applicant must include documentation of consultation with the Advisory Council, the State Historic Preservation Officer, Tribal Historic Preservation Officer, National Park Service, members of the public, and affected Indian tribes, where applicable.

(vi) Pacific Northwest Power Planning and Conservation Act (Act). If the project is not within the Columbia River Basin, this section shall not be included. The Columbia River Basin Fish and Wildlife Program (Program) developed under the Act directs agencies to consult with Federal and state fish and wildlife agencies, appropriate Indian tribes, and the Northwest Power Planning Council (Council) during the study, design, construction, and operation of any hydroelectric development in the basin. Section 12.1A of the Program outlines conditions that should be provided for in any original or new license. The program also designates certain river reaches as protected from development. The applicant must document consultation with the Council, describe how the act applies to the project, and how the proposal would or would not be consistent with the program. (vii) Wild and Scenic Rivers and Wilderness Acts. Include a description of any areas within or in the vicinity of the proposed project boundary that are included in, or have been designated for study for inclusion in, the National Wild and Scenic Rivers System, or that have been designated as wilderness area, recommended for such designation, or designated as a wilderness study area under the Wilderness Act.

(4) Project facilities and operation. Provide a description of the project to include:

(i) Maps showing existing and proposed project facilities, lands, and waters within the project boundary;

(ii) The configuration of any dams, spillways, penstocks, canals, powerhouses, tailraces, and other structures;

(iii) The normal maximum water surface area and normal maximum water surface elevation (mean sea level), gross storage capacity of any impoundments;

(iv) The number, type, and minimum and maximum hydraulic capacity and installed (rated) capacity of existing and proposed turbines or generators to be included as part of the project;

(v) An estimate of the dependable capacity, and average annual energy production in kilowatt hours (or mechanical equivalent);

(vi) A description of the current (if applicable) and proposed operation of the project, including any daily or seasonal ramping rates, flushing flows, reservoir operations, and flood control operations.

(5) Proposed action and action alternatives.

(i) The environmental document must explain the effects of the applicant's proposal on resources.

For each resource area addressed include:

(A) A discussion of the affected environment;

(B) A detailed analysis of the effects of the applicant's licensing proposal and, if reasonably possible, any preliminary terms and conditions filed with the Commission; and

(C) Any unavoidable adverse impacts.

(ii) The environmental document must contain, with respect to the resources listed in the Pre-Application Document provided for in §5.6, and any other resources identified in the Commission's scoping document prepared pursuant to the National Environmental Policy Act and §5.8, the following information, commensurate with the scope of the project:

(A) Affected environment. The applicant must provide a detailed description of the affected environment or area(s) to be affected by the proposed project by each resource area. This description must include the information on the affected environment filed in the Pre-Application Document provided for in §5.6, developed under the applicant's approved study plan, and otherwise developed or obtained by the applicant. This section must include a general description of socio-economic conditions in the vicinity of the project including general land use patterns (e.g., urban, agricultural, forested), population patterns, and sources of employment in the project vicinity.

(B) Environmental analysis. The applicant must present the results of its studies conducted under the approved study plan by resource area and use the data generated by the studies to evaluate the beneficial and adverse environmental effects of its proposed project. This section must also include, if applicable, a description of any anticipated continuing environmental impacts of continued operation of the project, and the incremental impact of proposed new development of project works or changes in project operation. This analysis must be based on the information filed in the Pre-Application Document provided for in §5.6, developed under the applicant's approved study plan, and other appropriate information, and otherwise developed or obtained by the Applicant.

(C) Proposed environmental measures. The applicant must provide, by resource area, any proposed new environmental measures, including, but not limited to, changes in the project design or operations, to address the environmental effects identified above and its basis for proposing the measures. The applicant must describe how each proposed measure would protect or enhance the existing environment, including, where possible, a non-monetary quantification of the anticipated environmental benefits of the measure. This section must also include a statement of existing measures to be continued for the purpose of protecting and improving the environment and any proposed preliminary environmental measures received from the consulted resource agencies, Indian tribes, or the public. If an applicant does not adopt a preliminary environmental measure proposed by a resource agency, Indian tribe, or member of the public, it must include its reasons, based on project specific information.

(D) Unavoidable adverse impacts. Based on the environmental analysis, discuss any adverse impacts that would occur despite the recommended environmental measures. Discuss whether any such impacts are short- or long-term, minor or major, cumulative or site-specific.

(E) Economic analysis. The economic analysis must include annualized, current cost-based information. For a new or subsequent license, the applicant must include the cost of operating and maintaining the project under the existing license. For an original license, the applicant must estimate the cost of constructing, operating, and maintaining the proposed project. For either type of license, the applicant should estimate the cost of each proposed resource protection, mitigation, or enhancement measure and any specific measure filed with the Commission by agencies, Indian tribes, or members of the public when the application is filed. For an existing license, the applicant's economic analysis must estimate the value of

developmental resources associated with the project under the current license and the applicant's proposal. For an original license, the applicant must estimate the value of the developmental resources for the proposed project. As applicable, these developmental resources may include power generation, water supply, irrigation, navigation, and flood control. Where possible, the value of developmental resources must be based on market prices. If a protection, mitigation, or enhancement measure reduces the amount or value of the project's developmental resources, the applicant must estimate the reduction.

(F) Consistency with comprehensive plans. Identify relevant comprehensive plans and explain how and why the proposed project would, would not, or should not comply with such plans and a description of any relevant resource agency or Indian tribe determination regarding the consistency of the project with any such comprehensive plan.

(G) Consultation Documentation. Include a list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in preparation of the Environmental Document.

H) Literature cited. Cite all materials referenced including final study reports, journal articles, other books, agency plans, and local government plans.

(6) The applicant must also provide in the Environmental Document:

(A) Functional design drawings of any fish passage and collection facilities or any other facilities necessary for implementation of environmental measures, indicating whether the facilities depicted are existing or proposed (these drawings must conform to the specifications of §4.39 of this chapter regarding dimensions of full-sized prints, scale, and legibility);

(B) A description of operation and maintenance procedures for any existing or proposed measures or facilities;

(C) An implementation or construction schedule for any proposed measures or facilities, showing the intervals following issuance of a license when implementation of the measures or construction of the facilities would be commenced and completed;

(D) An estimate of the costs of construction, operation, and maintenance, of any proposed facilities, and of implementation of any proposed environmental measures.

(E) A map or drawing that conforms to the size, scale, and legibility requirements of §4.39 of this chapter showing by the use of shading, cross-hatching, or other symbols the identity and location of any measures or facilities, and indicating whether each measure or facility is existing or proposed (the map or drawings in this exhibit may be consolidated).

1 INTRODUCTION

1.1 FirstLight's Application for a New License

FirstLight Hydro Generating Company (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 or Commission) an Application for New License for Major Project- Existing Dam. The current license for the Turners Falls Hydroelectric Project (Turners Falls Project) was issued on May 5, 1980 and expires on April 30, 2018. The license for the Northfield Mountain Pumped Storage Project was issued on May 14, 1968 and also expires on April 30, 2018. Although the Turners Falls Project and Northfield Project are currently licensed as separate projects, FirstLight is seeking a single license for both developments, and will hereafter refer to the Turners Falls Project as the Turners Falls Development and the Northfield Project as the Northfield Mountain Pumped Storage Development or collectively as the Northfield Project (or Project).

The Turners Falls Development includes the Turners Falls Dam, which creates the Turners Falls Impoundment (TFI) on the Connecticut River. 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 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 ranges in width from approximately 920 feet in the Cabot Station forebay (downstream terminus of canal) to 120 feet in the canal proper. The canal has a design capacity of approximately 18,000 cfs. Several entities withdraw water from the power canal. The major ones are FirstLight's Station No. 1 and Cabot Station. 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 are 5,963 kW and 2,210 cfs, respectively. The generation and hydraulic capacity of Cabot Station are 62.016 MW and 13,728 cfs, respectively.

The Turners Falls Development 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 and Spillway fishways move migrating fish from the Connecticut River into the power canal and the Gatehouse fishway 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 TransCanada. To provide storage capacity for the Northfield Mountain Pumped Storage Development, the TFI elevation may vary, per the FERC license, from a minimum elevation[1] of 176.0 feet to a maximum elevation of 185.0 feet constituting a 9 foot fluctuation as

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

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.

The Northfield Mountain Pumped Storage Development consists of an Upper Reservoir and dam/dikes, an intake, pressure shaft, underground powerhouse and tailrace. 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 forming 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 elevation to 1004.5 feet 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. At the time of filing this document, the electrical capacity of the four (4) reversible pump-turbines is as follows: Unit 1: 267.9 MW, Unit 2: 291.7 MW. Unit 3: 291.7 MW and Unit 4: 291.7 MW for a total station nameplate capacity of 1,143.0 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.

Because many studies needed to inform a FirstLight proposal are incomplete[2], FirstLight is not proposing any changes to the Project at this time with the exception of the Upper Reservoir and minor changes to the Project Boundary. FirstLight is proposing to utilize more of the Upper Reservoir storage capacity year round. As noted above and again in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938 feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

1.2 Purpose of Action and Need for Power

1.2.1 Purpose of Actions

FERC must decide whether to issue a new hydropower license to FirstLight for the Project and what conditions should be placed on any license issued. In deciding whether and under what conditions to issue a license for a hydroelectric project, pursuant to Section 10(a)(1) of the Federal Power Act (FPA), FERC must determine that the Project will be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and developmental purposes for which licenses are issued, FERC is required under Section 4 (e) of the FPA to give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality.

Issuing a new license for the Project would allow FirstLight to continue to generate and transmit electricity at the Project for the term of the new license, making electric power from a renewable resource available to serve regional demand.

Exhibit E of this license application has been prepared in accordance with 18 CFR § 5.18(b) and in general conformance with the Commission's Preparing Environmental Assessments: Guidelines for Applicants, Contractors and Staff (FERC, 2008). Exhibit E is designed to support FERC's required analysis under the National Environmental Policy Act of 1969 (NEPA), as amended. The Exhibit when finalized will analyze the environmental and economic effects associated with the continued operation of the Project, as proposed by FirstLight. This Exhibit when finalized will include measures proposed by FirstLight for the Protection, Mitigation and Enhancement (PM&E) of resources that would potentially be affected by FirstLight's proposed Project. The effects of a no-action alternative will also be considered.

[2] Due to the closure of the Vermont Yankee Nuclear in December 2014, FERC delayed the start of 13 fish and aquatic and water quality studies until 2015 (11 studies) and 2016 (2 studies).

1.2.2 Need for Power

The Project is located within the ISO-New England (ISO-NE) power system, which is responsible for dispatch and movement of wholesale power in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. ISO-NE prepares a 10-year load projection in energy demand, which it utilizes to plan improvements to the existing transmission system. ISO-NE currently predicts that the New England region, peak summer energy usage demand for the 10-year period from 2014 through 2023 will increase annually by 1.3%[3]. Over the term of the license, the Project will provide power and ancillary services to help meet this growing demand.

The Turners Falls Development is operated as a baseload, voltage control, and reserve capacity facility within the regional electrical system.

The Northfield Mountain Pumped Storage Development is vitally important to the reliability and efficient operation of the New England electric grid. With the Upper Reservoir at its current maximum elevation of 1000.5 ft, it can operate at full generating capacity output from its four (4) generating units for approximately 8.5 hours and produce 8,475 MWH of power. During high electrical demand periods, such as excessively warm periods in the summer, the Northfield Mountain Pumped Storage Development is called upon by ISO-NE to meet electrical demands, including significant ramping demands, or held for quick start contingency response as needed to meet the circumstances.

ISO-NE is an independent, non-profit, Regional Transmission Organization, responsible for reliably operating New England's approximately 32,000 MW bulk electric power generation and transmission system. During many periods of the year, ISO-NE calls upon the Northfield Mountain Pumped Storage Development to balance the system to accommodate both changes in load and generation. In the last 12 years, FirstLight has obtained four (4) temporary amendments from FERC to utilize additional Upper Reservoir storage that the Project was designed to provide for generation during periods of high electrical demand in New England. During these times, possessing reliable energy supplies and significant operating flexibility at the Northfield Mountain Pumped Storage Development to address both load and supply changes (e.g. changing interchange schedules, accommodating block loading of other units' commitment and decommitment) is critical to ISO-NE's reliable operation of the power system. The Northfield Mountain Pumped Storage Development provides critical energy, operating reserves and operational flexibility to ISO-NE system operation.

In December 2014, the Vermont Yankee Nuclear Power Station (619 MW), located in Vernon, VT was taken off-line. In addition, the Pilgrim Nuclear Power Station (680 MW), located in Plymouth, MA is reportedly closing no later than June 2019. Several of the region's older generators—and some of its largest—have already ceased operations or plan to exit the markets by 2018. They take with them over 3,500 MW of regional capacity including: Braydon Point Station (1,535 MW from oil and coal), Mount Tom Station (143 MW from coal), Norwalk Harbor Station (342 MW from oil), Salem Harbor Station (749 MW from oil and coal) and Vermont Yankee (609 MW from nuclear). In addition these facilities, ISO-NE notes several other facilities at risk.

The value of the Northfield Mountain Pumped Storage Development was demonstrated following the August 14, 2003 major blackout in the New York ISO (NY-ISO) grid. On August 15, ISO-NE parted all electrical ties to the New York electrical system to prevent the blackout from spreading further. When it was time to rejoin the two power grids, ISO-NE requested the connection be made at the Northfield Mountain Pumped Storage Development. Once the lines were energized, final adjustments were made by having the Northfield Mountain Pumped Storage Development reduce generation to allow for a smooth

[3]ISO-NE Regional System Plan for 2014 at Section 1.3.1.1 (page 9) – *(Comment – the section states "The ISO forecasts the 10-year growth rate to be 1.3% per year for the summer peak demand, 0.6% per year for the winter peak demand, and 1.0% per year for the annual use of electric energy. The annual load factor (i.e., the ratio of the average hourly load during a year to peak hourly load) continues to decline from 56.1% in 2014 to 54.7% in 2023.")*

synchronization of the two systems. The interconnection of the two systems allowed NY-ISO to begin restoration of the north portion of the NY power grid.

1.3 Applicable Statutory and Regulatory Requirements

Issuance of a new license for the Project is subject to numerous requirements under the FPA and other applicable statutes. The major acts and related requirements are described below. Actions undertaken by FirstLight or the agency with jurisdiction related to each requirement also are described.

1.3.1 Clean Water Act

Section 401 of the Clean Water Act (CWA) requires FirstLight to obtain certification from the state in which the Project discharges water of the Project's compliance with applicable provisions of the CWA, or a waiver of certification from the appropriate state agency, which for the Project is the Massachusetts Department of Environmental Protection (MADEP). FERC regulations require that a request for CWA Section 401 certification be filed within 60 days of FERC's issuance of a notice of acceptance of the final license application and ready for environmental analysis (REA). FirstLight has consulted with the MADEP throughout the relicensing. FirstLight is prepared to file its application for CWA Section 401 certification with the MADEP in a timely manner.

1.3.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires Federal agencies to consult with the USFWS and NMFS to ensure that their actions are not likely to jeopardize the continued existence of any threatened or endangered species, or result in the destruction or adverse modification of critical habitat for these listed species. FirstLight has been designated as FERC's non-federal representative for purposes of informal consultation with the USFWS and NMFS under Section 7 of the ESA, which is ongoing.

Several species listed as threatened or endangered under the ESA occur or may occur in the Project area. FirstLight will develop a draft Biological Assessment to evaluate the impacts of relicensing the Project on such species once relicensing studies are complete.

1.3.3 Magnuson-Fishery Conservation and Management Act

The Magnuson-Fishery Conservation and Management Act requires Federal agencies to consult with the Secretary of Commerce with respect to any action it undertakes that may adversely affect Essential Fish Habitat (EFH). Although NMFS has designated EFH for Atlantic salmon on the Connecticut River, the designation only applies to the mixing water and brackish salinity zone and tidal freshwater salinity zone of the Connecticut River; it does not apply to the Project area. The CRASC has ceased its Atlantic salmon restoration efforts due to low return rates and the shifting focus to other anadromous fish. Accordingly, FirstLight does not anticipate that relicensing the Project will adversely affect EFH for Atlantic salmon. EFH has not been designated for any other species in the Project area.

1.3.4 Coastal Zone Management Act of 1972

Under § 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended, (CZMA), (16 U.S.C. § 1456(3)(A)), the Commission cannot issue a license for a Project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program or waives its concurrence.

The official Massachusetts coastal zone includes the lands and waters within an area defined by the seaward limit of the state's territorial sea, extending from the Massachusetts-New Hampshire border south to the Massachusetts-Rhode Island border, and landward to 100 feet inland of specified major roads, rail lines, other visible rights-of-way. The Project is not located within the state's coastal zone boundary and does not affect any land or water use or natural resource of the state's coastal zone. Therefore, the Project is not subject to Massachusetts coastal zone program review. In correspondence dated June 9, 2015, the Massachusetts Office of Coastal Zone Management confirmed that the relicensing the Project is not an activity subject to the state's federal consistency review. The state's letter is attached as Attachment A of Exhibit E.

1.3.5 National Historic Preservation Act of 1966

As the lead Federal agency for hydropower relicensing, FERC is required to take into account the effects of its undertakings on historic properties under Section 106 of the National Historic Preservation Act (NHPA). FERC designated FirstLight as its non-Federal representative for prefiling consultation under Section 106 by notice issued December 21, 2012.

As part of its role as FERC's non-federal representative, FirstLight developed and executed several studies to identify and assess, in consultation with the MHC, VDHP and NHDHR, Nolumbeka Inc., and potentially affected Indian tribes, any adverse effects on historic properties resulting from continued operation of the Project, as required under 36 CFR § 800.5. The results of those studies are discussed in Section 3.3.8.

1.4 Public Review and Consultation

The Commission's regulations (18 CFR § 5.1(d)) require an applicant to consult with appropriate Federal and state agencies, Indian tribes, and members of the public that may be interested in the proceeding before filing an application for a license. In addition, Section 5.18(b)(5)(ii)(G) requires documentation of such consultation in the form of a list of consulted entities. Confirmation of FirstLight's prefiling consultation is included in Section 6.

1.4.1 Scoping

Issuance of a license requires preparation of either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS), in accordance with the NEPA. The preparation of an EA or EIS is supported by a scoping process to ensure the identification and analysis of all pertinent issues.

On December 21, 2012, the Commission issued a notice of commencement of proceeding stating FERC intended to prepare an EIS for the Project together with three other hydroelectric projects owned and operated by TransCanada, located in series on the Connecticut River above the Turners Falls Dam previously had the same license expiration date as the FirstLight Project (April 30, 2018). However, on January 16, 2015, TransCanada requested a 1-year license extension, which was granted by FERC on July 22, 2015 making the new license expiration date April 30, 2019. The projects in downstream to upstream order include Vernon Hydroelectric Project (FERC No. 1904), Bellows Falls Hydroelectric Project (FERC No. 1855) and Wilder Hydroelectric Project (FERC No. 1892).

Also on December 21, 2012, the Commission issued Scoping Document 1 (SD1). SD1 provided Relicensing Participants with FERC's preliminary list of issues and alternatives to be addressed in an EIS, for the Project relicensing and enabled Relicensing Participants to more effectively participate in and contribute to the scoping process.

The Commission held three public scoping meetings as follows:

- Projects: Vernon Project, Northfield Mountain Pumped Storage Development and Turners Falls Development - Turners Falls, MA (January 30, 2013)
- Projects: Northfield Mountain Pumped Storage Development and Turners Falls Development- Turners Falls, MA (January 31, 2013)
- Projects: Cumulative River Projects' Cumulative Effects- Turners Falls, MA (January 31, 2013)

A site visit to the FirstLight Developments was conducted on October 4, 5 and 11, 2012. Though typically the site visits are held after the filing of the Pre-Application Document (PAD) and in association with the scoping process, FERC held the site visits prior to formal scoping meetings before the onset of winter limited access to the project facilities. The scoping meetings (January 30-31, 2013) and site visits (October, 4, 5, 11, 2012) were noticed in a local newspaper and the Federal Register. The scoping meetings were recorded and the transcript posted by the Commission on its Internet E-Library.

The Commission requested that written comments on SD1 and FirstLight's PAD be provided to the Commission no later than March 1, 2013. In addition to the oral comments received during the scoping meetings, the Commission received over 50 comment letters by the March 1, 2013 deadline. Table 1.4.1-1 lists Relicensing Participants that filed comments on SD1.

Based on the Commission's review of oral comments during the January 30 and 31 scoping meetings and written comments on SD1 and the PAD, on April 15, 2013, the Commission issued Scoping Document 2 (SD2), which replaced SD1.

1.4.2 Interventions

At this time, the Commission has not solicited motions to intervene.

1.4.3 Relicensing Studies

1.4.3.1 FERC's Determination on Revised Study Plan

Pursuant to 18 C.F.R. § 5.11 of the Commission's regulations, FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013, and distributed the PSP to interested resource agencies and stakeholders for review and comment. In addition, pursuant to 18 C.F.R. § 5.11(e), FirstLight held an initial meeting on all studies in the PSP at the Northfield Mountain Visitor Center at the Northfield Mountain Pumped Storage Development on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. On June 28, 2013, although not required by FERC regulations, 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 with FERC a Revised Study Plan (RSP) on August 14, 2013, which addressed 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 FirstLight Project, 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 20 studies were approved, or approved with FERC modifications. However, due to the impending closure of VY, FERC did not act on 18 proposed or requested studies pertaining to aquatic resources. The SPDL for these 18 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 18 studies on February 21, 2014, approving the RSP with certain modifications. Table 1.4.3.1-1 lists the 38 studies included in FirstLight's RSP and the additional one (1) study emanating from the study dispute described next. Thus, the total number of FERC-approved studies is 39.

1.4.3.2 FERC's Determination Regarding Study Disputes

On March 13, 2014, the USFWS filed with FERC a notice of study dispute regarding FERC's February 21, 2014 SPDL. The USFWS dispute focused on an entrainment study of the early life stage of American Shad at the Northfield Mountain Pumped Storage Development. Table 1.4.3.2-1 summarizes the communications relative to the Study Dispute. In the end, FirstLight and the USFWS came to agreement on conducting the study and thus FERC did not act on the dispute.

On January 22, 2015, FERC issued its Determination on Requests for Study Modifications and New Studies. In it, FERC approved the ichthyoplankton study plan submitted by FirstLight on October 16, 2014, with modification. Thus, the total number of FERC-approved studies is 39.

1.4.3.3 FERC's Determination on Initial Study Report

FirstLight filed with FERC an Initial Study Report (ISR) on the 38 studies required by the FERC determination on September 16, 2014 (the ichthyoplankton study had not been approved by this date). Of the 38 required studies, FirstLight filed study reports for studies 3.1.1, *2013 Full River Reconnaissance*, and 3.6.2 *Recreation Facilities Inventory and Assessment*. FirstLight held ISR meetings on September 30, October 1 and October 15, 2014. FirstLight filed a meeting summary for the September 30 and October 1 meetings on October 15, 2014. FirstLight filed a meeting summary for the October 15 meeting on November 4, 2014. Fifteen (15) stakeholders filed letters regarding FirstLight's ISR with FERC. On January 22, 2015, FERC issued a Determination on Requests for Study Modifications and New Studies. In that letter FERC approved modifications to Study No. 3.3.9 *2D Modeling of the Northfield Mountain Pumped Storage Development Tailrace*, and Study No. 3.3.12 *TFI Littoral Zone and Spawning Habitat*. In addition FERC approved, in part, certain modifications to Study Nos. 3.1.1, 3.1.2, 3.3.4, 3.3.14 and 3.6.2[4]. Requested modification to Study Nos. 3.3.1, 3.3.12 and 3.6.1[5], and the requested new study to identify habitat suitability parameters for state-listed mussel species were not approved by FERC.

1.4.3.4 FERC's Determination on Updated Study Report

FirstLight filed with FERC an Updated Study Report (USR) on September 14, 2015, and held an USR meeting on September 29-30, 2015. FirstLight filed an USR meeting summary on October 14, 2015. FirstLight filed study reports for the following studies:

- Study No. 3.3.2 Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot
- Study No. 3.3.4 Evaluate Upstream Passage of American Eel at Turners Falls (Year 1 results)
- Study No. 3.3.14 Aquatic Habitat Mapping of Turners Falls Impoundment
- Study No. 3.3.17 Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat
- Study No. 3.3.18 Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms
- Study No. 3.4.2 Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats
- Study No. 3.6.3 Whitewater Boating Evaluation
- Study No. 3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats
- Study No. 3.6.7 Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use
- Study No. 3.7.3 Traditional Cultural Properties

FirstLight anticipates the USR process for those studies will be complete before FirstLight files its Final License Application (FLA) in April 2016. Comments on the USR and USR meeting summary were required to be filed with FERC by November 13, 2015, 30 days after FirstLight filed its meeting summary.

[This section will be completed in the FLA. FirstLight]

[4] Study Nos. 3.1.1: *2013 Full River Reconnaissance*, 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*, 3.3.4 *Evaluate Upstream Passage of American Eel*, 3.3.14 *Aquatic Habitat Mapping of the Turners Falls Impoundment* , and 3.6.2 *Recreation Facilities Inventory*.
[5] Study Nos. 3.3.1: *Instream Flow Studies in Bypass Channel and below Cabot Station*, 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 in the Cabot Tailrace*, 3.6.1 *Recreation Use/User Contact Survey*.

1.4.3.5 Study Status

Twelve (12) of the 39 FERC-approved studies have been completed and reports filed. Anticipated completion dates[6] for the remaining studies were included in FirstLight's cover letter transmitting the USR meeting dates as shown in Table 1.4.3.5-1. Two (2) studies are slated for field work in 2016.

Because many of the study results will not be processed until after the FLA is required to be filed, FirstLight anticipates filing a supplement to its FLA to incorporate key study results.

[6] As corrected at the USR meetings, the filing date for Study 3.1.2 was incorrectly noted in the transmittal letter as 3/1/2016. It should have read 6/30/2016.

Table 1.4.1-1: Scoping Comment Summary

Relicensing Participant	Association	Date of Letter
Jennifer Tufts	Northfield Open Space Committee	1/31/2013
Thomas and Patricia Shearer	Public	1/31/2013
Warren Ondras	Public	1/31/2013
Board of Selectman	Town of Montague	2/06/2013
Mike Bathory, Alan Wallace	Landowners and Concerned Citizens for License Compliance (LCCLC)	2/11/2013
Mary Joe Maffei, Manager	Manager of Amherst High School Nordic Ski Team	2/16/2013
Peter Conway Stanley and Geri Johnson Robert and Linda Emond Walter and Mary Ann Patenaude Michael and Diane Kane Cynthia Dale Robert Strafford and Family Leena Newcomb Vivien Venskowski Betsy and Jean Egan	The River Residents Association (RRA)	2/16/2013- 3/01/2013
Nathan L'Etoile, Co-Owner	Four Star Farms (FSF)	2/20/2013
Jeffrey Squire, President	Western Massachusetts Climbers' Coalition	2/20/2013
Board of Selectman	Town of Montague	2/21/2013
Bill Llewelyn, Chair	Town of Northfield Conservation Commission (NCC)	2/22/2013
Barbara Skuly, Chairman	Ashuelot River Local Advisory Committee (ARLAC)	2/24/2013
Karl Meyer	Public	2/25/2013
Richard Bonanno, Director	Massachusetts Farm Bureau Federation, Inc (MAFBF)	2/25/2013
River Resident (no name given)	Public	2/26/2013
Louis Chiarella, Mary Colligan	National Marine Fisheries Service (NMFS)	2/27/2013
Glen Normandeau, Executive Director	New Hampshire Fish and Game Department (NHFGD)	2/27/2013
Caleb Slater, Thomas French	Massachusetts Division of Fisheries and Wildlife (MADFW), Natural Heritage and Endangered Species Program (NHESP)	2/28/2013
Chris Curtis	Public	2/28/2013
Ken Kimball, Norm Sims	Appalachian Mountain Club (AMC)	2/28/2013
Ken Kimball, Norm Sims, Bob Nasdor, Thomas Christopher	AMC, American Whitewater Association (AWWA), New England Flow (NE FLOW)	2/28/2013
Dr. Richard Palmer	University of Massachusetts at Amherst (UMass)	2/28/2013
Carolyn Shores Ness, Vice Chair	Franklin Conservation District (FCD)	2/28/2013

Relicensing Participant	Association	Date of Letter
Ken Kimball, Norm Sims, Noah Pollock, Stephan Syz	AMC, Vermont River Conservancy (VRC), Friends of the Connecticut River Paddlers (FCRP)	2/28/2013
Kevin Mendik	National Park Service (NPS)	2/28/2013
Joseph Graveline, President	The Nolumbeka Project, Inc	2/28/2013
Bill Perlman, Jerry Lund, Tom Miner	Franklin Regional Council of Governments (FRCOG)	3/01/2013
Mike Bathory	LCCLC	3/01/2013
Gill Selectboard	Town of Gill	3/01/2013
Robert Kubit	Massachusetts Department of Environmental Protection (MADEP)	3/01/2013
Roger Noonan, President	New England Farmers Union (NEFU)	3/01/2013
Don Pugh	Deerfield River Chapter of Trout Unlimited (DRTU)	3/01/2013
Rebecca Brown, President	Connecticut River Joint Commissions (CRJC)	3/01/2013
Elizabeth Muzzey, Director and State Historic Preservation Officer	New Hampshire Division of Historical Resources (NHDHR)	3/01/2013
Brian Fitzgerald, Streamflow Protection Coordinator	Vermont Department of Environmental Conservation (VTDEC)	3/01/2013
Gregg Comstock, PE, Supervisor, Water Quality Planning	New Hampshire Department of Environmental Services (NHDES)	3/01/2013
Kim Lutz, Director, Kathryn Mickett Kennedy, Applied River Scientist	The Nature Conservancy (TNC)	3/01/2013
Howard Fairman	Public	3/01/2013
Richard Bonanno, President	Massachusetts Farm Bureau Federation Inc. (MAFBF)	3/01/2013
Andrea Donlon, River Steward	Connecticut River Watershed Council (CRWC)	3/01/2013
Stephanie Krug, President	New England Mountain Biking Association (NEMBA)	3/01/2013
Stephanie Krug, President	NEMBA	3/01/2013
Tim Welsh	FERC	3/01/2013
Thomas Chapman, Supervisor	United States Fish and Wildlife Service (USFWS)	3/01/2013
Joanne McGee	Public	3/01/2013
Kurt Heidinger, Director	BioCitizens	3/01/2013
Don Stevens, Chief	Nulhegan Band of the Coosuk- Abenaki Nation	3/18/2013

Table 1.4.3.1-1: FERC Study Determination Summary

Study No.	Study Name	Studies Proposed by FirstLight in its RSP	Studies Approved or Modified by FERC in its September 13, 2013 Determination		Studies Approved or Modified by FERC in its February 21, 2014 Determination		Studies Approved or Modified by FERC in its January 22, 2015 Determination on Request for Study Modification and New Studies	
			Approved	Modified	Approved	Modified	Approved	Modified
3.1.1	2013 Full River Reconnaissance	X		X				X
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability	X		X				
3.1.3	Northfield Mountain Project Sediment Management Plan	X		X				
3.2.1	Water Quality Monitoring Study	X				X		
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station	X		X				
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	X				X		
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	X				X		
3.3.3	Evaluate Downstream Passage of Juvenile Shad	X				X		
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)	X	X		X			
3.3.5	Evaluate Downstream Passage of American Eel	X				X		
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	X				X		
3.3.7	Fish Entrainment and Turbine Mortality Study	X				X		
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays	X		X				
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	X		X				
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	X				X		
3.3.11	Fish Assemblage Assessment	X				X		

Study No.	Study Name	Studies Proposed by FirstLight in its RSP	Studies Approved or Modified by FERC in its September 13, 2013 Determination		Studies Approved or Modified by FERC in its February 21, 2014 Determination		Studies Approved or Modified by FERC in its January 22, 2015 Determination on Request for Study Modification and New Studies	
			Approved	Modified	Approved	Modified	Approved	Modified
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 in the Tailrace and Downstream from Cabot Station	X			X			
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	X				X		
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	X			X			
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	X				X		
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	X				X		
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary Backwater Area Access and Habitat	X			X			
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	X				X		
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	X				X		
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project						X	
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary	X	X					
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat	X	X					

Study No.	Study Name	Studies Proposed by FirstLight in its RSP	Studies Approved or Modified by FERC in its September 13, 2013 Determination		Studies Approved or Modified by FERC in its February 21, 2014 Determination		Studies Approved or Modified by FERC in its January 22, 2015 Determination on Request for Study Modification and New Studies	
			Approved	**Modified**	**Approved**	**Modified**	**Approved**	**Modified**
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	X		X				
3.6.1	Recreation Use/User Contact Survey	X		X				
3.6.2	Recreation Facilities Inventory and Assessment	X		X				X
3.6.3	Whitewater Boating Evaluation	X		X				
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	X		X				
3.6.5	Land Use Inventory	X	X					
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	X	X					
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	X		X				
3.7.1	Phase 1A Archaeological Survey	X		X				
3.7.2	Reconnaissance-Level Historic Structures Survey	X		X				
3.7.3	Traditional Cultural Properties Study	X		X				
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	X		X				

Table 1.4.3.2-1: Summary of Communications Regarding Study Dispute

Date	Action
March 26, 2014	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
March 28, 2014	FirstLight files letter with FERC including: Attachment A- graph of MWh pumping for the months of May, June and July for 1991-1993 and 2011-2013, Attachment B: Excel files for developing the Attachment A figures, and Attachment C: discharge comparison between the original and upgraded pumps at the Northfield Mountain Pumped Storage Development.
March 31, 2014	FERC issues notice of Dispute Resolution Panel Meeting and Technical Conference.
April 1, 2014	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
April 7, 2014	FirstLight submits comments and information regarding the study dispute.
April 8, 2014	FERC holds Dispute Resolution Panel Meeting and Technical Conference at the Northfield Mountain Visitors Center.
April 15, 2014	As requested by the USFWS FirstLight submits a) drawings and photographs of the Northfield tailrace/intake and b) dye testing information.
April 22, 2104	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
May 2, 2014	USFWS submits response to FirstLight's April 7, 2014 filing (above).
May 2, 2014	USFWS files conceptual framework for assessing ichthyoplankton entrainment at the Northfield Mountain Pumped Storage Development.
May 2, 2014	FirstLight submits letter supporting USFWS's proposed ichthyoplankton entrainment study at the Northfield Mountain Pumped Storage Development.
May 2, 2014	FERC issues notice of suspending the Dispute Resolution Panel until further notice.
September 3, 2014	FERC issues notice that FirstLight must develop a more detailed ichthyoplankton study plan by October 15, 2014.
October 16, 2014	FirstLight filed a detailed ichthyoplankton study plan with FERC.

Table 1.4.3.5-1: Proposed Study Report Filing Dates

Study No.	Title	Proposed Report Completion Date
3.1.1	2013 Full River Reconnaissance	Already filed
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability	6/30/2016
3.1.3	Sediment Monitoring Study	9/1/2016
3.2.1	Water Quality Monitoring Study	3/1/2016
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot	Already filed
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	9/1/2016
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	9/1/2016
3.3.3	Evaluate Downstream Passage of Juvenile American Shad	9/1/2016
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls	3/1/2016
3.3.5	Evaluate Downstream Passage of American Eel (2015 & 2016 study)	3/1/2017
3.3.6	Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	3/1/2016
3.3.7	Fish Entrainment and Turbine Passage Mortality Study	10/1/2016
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays	12/1/2015
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	12/1/2015
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	3/1/2016
3.3.11	Fish Assemblage Assessment	3/1/2016
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 in the Tailrace and Downstream from Cabot Station	3/1/2016
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	6/1/2016
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	Already filed
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area	6/1/2016
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	3/1/2016
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat	Already filed
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	Already filed
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	3/1/2017
3.3.20	Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project	3/1/2016
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources	12/31/2015
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats	Already filed
3.5.1	Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	12/31/2015
3.6.1	Recreation Use/User Contact Survey	12/31/2015
3.6.2	Recreation Facilities Inventory and Assessment	Already filed
3.6.3	Whitewater Boating Evaluation	Already filed

Study No.	Title	Proposed Report Completion Date
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	Already filed
3.6.5	Land Use Inventory	12/31/2015
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	6/30/2016
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	Already filed
3.7.1	Phase 1A, 1B and II Archaeological Surveys	Already filed (Phase 1A only)
3.7.2	Survey and National Register Evaluation of Historic Architectural Resources	Already filed
3.7.3	Traditional Cultural Properties Study	Already filed
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	3/1/2017

2 PROPOSED ACTIONS AND ALTERNATIVES

This section describes the existing Project (i.e., the No-Action Alternative) and FirstLight's proposed changes to the existing Project (i.e., proposed Project). Section 2.1 describes the No-Action Alternative, the baseline from which to compare all action alternatives. Section 2.2 describes FirstLight's proposed Project. Section 2.3 describes any other action alternatives proposed at this time. Section 2.4 describes alternatives considered but not analyzed in detail in this document.

2.1 No Action Alternative

Under the No-Action Alternative, the Project would continue to operate under the terms of the current license, including maintaining the current Project Boundary, facilities and operation and maintenance procedures.

2.1.1 Existing Project Facilities

The Turners Falls Development consists of: a) two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam connected by a natural rock island, b) an approximate 20-mile long TFI serving as the lower reservoir for the Northfield Mountain Pumped Storage Development, c) a gatehouse, d) a power canal, e) two hydroelectric projects located on the power canal including Station No. 1 and Cabot Station, f) three fish passage facilities and g) a downstream fish passage facility located at the downstream terminus of the power canal. The Turners Falls Development also includes recreation facilities and use areas.

The Northfield Pumped Storage Development consists of a) and Upper Reservoir dams and dikes, b) an intake channel, c) pressure shaft, d) tailrace tunnel, e) powerhouse and d) tailrace. The Northfield Mountain Pumped Storage Development also includes recreation facilities and use areas.

The location of major Turners Falls Development and Northfield Mountain Pumped Storage Development facilities is shown in Figure 2.1.1-1 and 2.1.1-2, respectively.

Detailed descriptions of the above facilities are provided in Exhibit A of this license application.

2.1.2 Existing Project Boundary

The existing Project Boundary contains 7,246 acres of land and 2,238 acres of flowed land (Figure 2.1.2-1). These lands are located in three states- Massachusetts, New Hampshire and Vermont. The majority of the Project Boundary (6,150 acres) is located in Franklin County, MA 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 (727 acres) and the town of Vernon, in Windham County, VT (369 acres).

2.1.3 Existing Project Safety

The Turners Falls Development has been operating for more than 36 years under its existing license and the Northfield Mountain Pumped Storage Development has been operating for more than 48 years under its existing license. During this time FERC staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the licenses and proper maintenance. In addition, both developments have been inspected and evaluated every five (5) years by an independent consultant and a consultant's safety report has been submitted for FERC's review.

2.1.4 Existing Project Operations

The Turners Falls Development consists of two facilities- Cabot Station and Station No. 1. Cabot Station is used at all river flows. During low flow periods, Cabot Station is operated as a peaking plant; during high flows 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 and typically operates when inflows to the TFI are less than Station No. 1's hydraulic capacity of approximately 2,210 cfs or when inflows exceed the hydraulic capacity of Cabot Station.

The Northfield Mountain Pumped Storage Development 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 low-load periods, while generation occurs during high-load periods.

2.1.5 Existing Environmental Measures

Water Level and Flow Management

- Under the FERC license for the Turners Falls Development, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow (equivalent to 0.2 x the drainage area), whichever is less below the Project. FirstLight typically maintains the minimum flow requirement through discharges at Cabot and/or Station No. 1.
- Under the FERC license, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1, and increases to 400 cfs when fish passage starts by releasing flow through a bascule gate. 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 protect Shortnose Sturgeon. 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 15th.
- Under the FERC license, the TFI elevation may fluctuate between 176.0 feet msl and 185.0 feet msl, as measured at the Turners Falls Dam.
- Under the FERC license, the Northfield Mountain Upper Reservoir elevation may fluctuate between 1,000.5 feet msl and 938 feet msl.

Upstream and Downstream Fish Passage

- The Turners Falls Development includes three fishways- Cabot fishway, Spillway fishway and Gatehouse fishway.
- The Turners Falls Development includes a downstream fish passage system located near the downstream terminus of the power canal adjacent to Cabot Station.

Recreation

- FirstLight maintains several public recreation facilities within the Project Boundary as described in detail in Section 3.3.6.

2.1.6 Measures in Current FERC Licenses

The following is a description of key license requirements for the Turners Falls Project (now development) and Northfield Project (now development).

Turners Falls Project (now Development)

Article 30 requires the Licensee to pay reasonable annual charges to the United States for the cost of administration of Part I of the FPA, based on the authorized installed capacity.

Article 31 requires the Licensee to implement, and modify when appropriate, an emergency action plan to provide early warning to upstream and downstream inhabitants and property owners in the event of an impending or actual sudden release of water caused by an accident or failure of the Turners Falls Project works.

Article 32 requires the Licensee to operate the Turners Falls Project in accordance with its agreement with the United States Army Corps of Engineers (USACE) for the coordinated operation of the Turners Falls Project for flood control.

Article 33 requires the Licensee to provide public recreation at the Turners Falls Project in accordance with the Turners Falls Project's approved Recreation Plan.

Article 34 requires the Licensee to maintain a continuous minimum flow of 1,433 cfs (0.20 cubic feet per second per square mile of drainage basin) or a flow equal to the inflow of the reservoir, whichever is less, from the project into the Connecticut River. These flows may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) in the interest of recreation and protection of the fisheries resources, upon mutual agreement between the Licensees for Projects Nos. 1889 and 2485 and the Massachusetts Division of Fisheries and Wildlife. During the period of each year from May 1 until there are no substantial numbers of juvenile or adult shad in the reach of the river where the project is located, but in any event no later than October 1, the following portion of that total minimum flow shall be released from the Turners Falls Dam: until the Montague spillway fishway begins operating, 200 cfs; after that fishway begins operating, 400 cfs..

Article 35 describes the Licensee's obligations with respect to unrecorded archeological or historical sites discovered during construction or development of project works or other facilities at the Turners Falls Project, and in the event any such sites are discovered, requires the Licensee to consult with the State Historic Preservation Officer to develop a mitigation plan for the protection of significant archeological or historic resources.

Article 36 requires the Licensee to install and operate signs, lights, sirens, barriers or other necessary devices to warn the public of fluctuations in flow and protect recreation users of the Turners Falls Project.

Article 38 requires the Licensee to file annual reports with FERC detailing operation of the Turners Falls Project's fish passage facilities, problems in design or operation, and listing the number, by species, of all fish passed upstream.

Article 40 requires the Licensee to coordinate operation of the Turners Falls Project with operation of the Northfield Mountain Project.

Article 42 requires the Licensee to coordinate operation of the Turners Falls Project, electrically and hydraulically, with other power systems as the Commission may direct in the interest of power and other beneficial public uses of water resources.

Article 43 authorizes the Licensee to grant permission for certain types of use and occupancy of Turners Falls Project lands, and requires the Licensee to consult with federal and state agencies prior to conveying certain interests, pursuant to FERC's standard use and occupancy article.

<u>Northfield Mountain Pumped Storage Project (now Development)</u>

Article 39 requires the Licensee to make modifications to the Northfield Mountain Project works, operate the Northfield Mountain Project, and take such steps as ordered by the Commission, in the interest of boating safety, upon recommendation by the Commission, the USACE, the U.S. Coast Guard, or an interested agency of the Commonwealth of Massachusetts.

Article 40 requires the Licensee, following consultation with the USFWS and fishery agencies of the Commonwealth of Massachusetts, to study or pay for the cost of studies relating to fish protection at the

Northfield Mountain Project, and undertake further study if the Commission finds that changed conditions or changed use of the Connecticut River fishery so warrant.

Article 41 requires the Licensee to develop recreational resources at the Northfield Mountain Project.

Article 43 requires the Licensee to enter into an agreement with the USACE for coordinated operation of the Turners Falls and Northfield Projects during flood conditions on the Connecticut River.

Article 45 requires the Licensee to coordinate operation of the Northfield Mountain Project with operation of the Turners Falls Project.

Article 48 requires the Licensee to pay reasonable annual charges to the United States for the cost of administration of Part I of the FPA, based on the authorized installed capacity.

Article 50 requires the Licensee to implement a cooperative land and water management plan for the Bennett Meadow Wildlife Management Area.

Article 51 requires the Licensee to report to the Commission and the MHC any fossils or archeological artifacts discovered during construction, operation, or maintenance of recreation developments at the Northfield Mountain Project, and authorizes the Commission to require archeological or paleontological surveys or salvage operations deemed necessary to prevent the destruction or loss of such findings.

Article 52 authorizes the Licensee to grant permission for certain types of use and occupancy of Northfield Mountain Project lands, and requires the Licensee to consult with federal and state agencies prior to conveying certain interests, pursuant to FERC's standard use and occupancy article.

2.2 FirstLight's Proposal

At this time, FirstLight's relicensing proposal is limited to two changes—modifications to the Project boundary and using more Upper Reservoir storage capacity at the Northfield Mountain Pumped Storage Development year round. Since many of FirstLight's studies are not yet final it would be premature for FirstLight to develop a complete licensing proposal for operating the Project in the new license term at this time. Once FirstLight's studies and TransCanada's studies are complete and FirstLight has had an opportunity to discuss the study results with resource agencies and other stakeholders, FirstLight will be in a better position to develop a comprehensive proposal for relicensing the Project.

At the time of this filing, the FERC-approved aquatic studies and water quality study have not been completed. In addition, two additional studies (Study No. 3.3.5 *Evaluate Downstream Passage of American Eel* and Study No. 3.3.19 *Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace*) are to be filed with FERC by March 1, 2017, nearly one year after the FLA is filed. The delay in conducting the aquatic studies and water quality study was requested by the resource agencies as a result of the decommissioning of the Vermont Yankee Nuclear Power Plant and expected water quality improvements.

In addition, on January 16, 2015 TransCanada filed a letter with FERC requesting an extension of the license term for its Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855) and Vernon (FERC No. 1904) Hydroelectric Projects. Specifically, TransCanada sought a one year license term extension that would move the license expiration date from April 30, 2018 to April 30, 2019. On July 22, 2015, FERC granted TransCanada a one year extension requiring it file its FLA by April 30, 2017. Given the above, one of the unknowns at this juncture is how future project operations at the TransCanada facilities could impact the flow regime passed below the Vernon Hydroelectric Project and into FirstLight's TFI.

2.2.1 Proposed Project Facilities

2.2.1.1 Generation Facilities

At this time, FirstLight is not proposing any changes to existing developmental (i.e., generation) facilities. FirstLight is, however, proposing to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

2.2.1.2 Non Generation Facilities

At this time, given that several FERC-approved studies have not been completed or started, FirstLight is not proposing any PM&E measures for implementation in the new license.

Proposed Project Boundary

As described in Exhibit G, FirstLight is proposing two changes to Project Boundary.

- 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.
- Removal of an 8.1 acre parcel of land referred to as Fuller Farm located near 169 Millers Falls Road in Northfield, MA.

2.2.2 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.

2.2.3 Proposed Project Operations

FirstLight is proposing to modify the operations of the Upper Reservoir to utilize more of its storage capacity to allow for additional operational flexibility. FirstLight proposes to reduce the minimum elevation from 938 feet msl to 920 feet msl, and increase the maximum elevation from 1,000.5 feet msl to 1,004.5 feet msl, year-round. This would increase the Upper Reservoir's useable storage capacity from 12,318 acre-feet to 15,327 acre-feet, an increase of 3,009 acre-feet, and allow an increase in generation at full load for 1.8 hours. The additional storage capacity increases the Development's maximum daily generation from 8,475 MWh to 10,465 MWh, or an increase of 1,990 MWh per day.

2.2.4 Proposed Environmental Measures

At this time, FirstLight is not proposing any environmental measures.

2.3 Alternatives Considered But Eliminated From Further Analysis

FirstLight considered but eliminated from further analysis the following alternatives:

- Retire the Project
- Issue a Non-Power License
- Federal Agency Takeover of the Project
- Construction of a New Lower Reservoir to Create a Closed Loop System for the Northfield Mountain Pumped Storage Development

2.3.1 Retire the Project

Project retirement would involve surrender or termination of the existing license with appropriate conditions. No relicensing participant has suggested that removal of the Project dams would be appropriate in this case; therefore, FirstLight has not analyzed it as a reasonably foreseeable alternative to relicensing the Project with appropriate resource management measures.

In SD2, FERC stated:

> *Decommissioning some or all of Connecticut River projects would require denying the relicense applications and surrender or termination of the existing licenses with appropriate conditions. There would be significant costs involved with decommissioning the projects and/or removing project facilities. The projects provide a viable, safe, and clean renewable source of power to the region. Based on the 17 factors (to be considered when determining whether a more thorough analysis of decommissioning is warranted), outlined in The Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing,*[7] *we do not consider decommissioning to be a reasonable alternative for the Connecticut River projects, at this time.*

2.3.2 Issue a Non-Power License

A non-power license is a temporary license that FERC issues when it determines that a project should no longer be used for power purposes. FERC's statement from SD2 regarding a non-power license analysis follows:

> *A non-power license is a temporary license the Commission would terminate whenever it determines that another governmental agency is authorized and willing to assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this time, no governmental agency has suggested a willingness or ability to take over any of these five projects. No party has sought a non-power license, and we have no basis for concluding that the TransCanada and FirstLight projects should no longer be used to produce power. Thus, we do not consider a non-power license a reasonable alternative to relicensing the projects.*

Because the Project power is needed and FirstLight believes that a new license can be issued that will satisfy the FPA's public interest/comprehensive development standard, FirstLight believes there is no basis for the Commission to conclude that the Project should no longer be used for power generation. Thus, issuance of a non-power license is not a reasonable alternative to issuance of a new license with appropriate PM&E measures.

2.3.3 Federal Agency Takeover of the Project

Federal takeover of the Project is not a reasonably foreseeable alternative. As FERC stated in SD2:

> *We do not consider federal takeover to be a reasonable alternative. Federal takeover of the project would require congressional approval. While that fact alone would not preclude further consideration of this alternative, there is currently no evidence showing that federal takeover should be recommended to Congress. No party has suggested that federal takeover would be appropriate, and no federal agency has expressed interest in operating any of these five projects.*

Therefore, FirstLight has not analyzed federal takeover of the Project as a reasonably foreseeable alternative to relicensing.

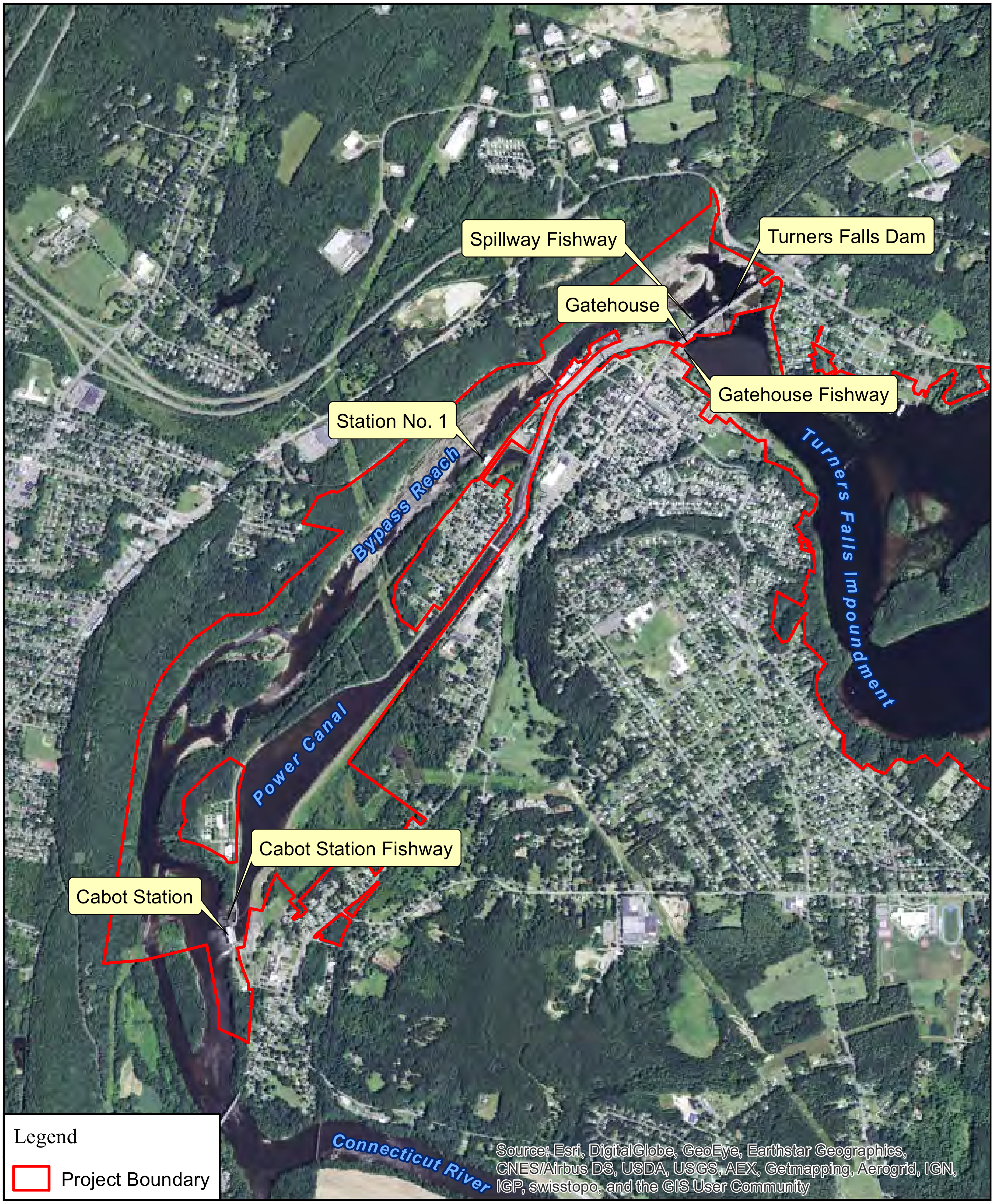
2.3.4 Construction of a New Lower Reservoir to Create a Closed Loop System for the Northfield Mountain Pumped Storage Development

In comments received on SD1 some stakeholders recommended that development and implementation of a closed loop system for the operation of the Northfield Mountain Pumped Storage Development should be evaluated as part of the NEPA implementation process. In response, in SD2 FERC stated:

[7] http://www.ferc.gov/industries/hydropower/indus-act/itf/nepa_final.pdf

> *Construction of a new lower reservoir would likely have significant impacts on the environment and a high cost. Therefore, we will not commit to conducting a detailed analysis of such an alternative until we better understand the environmental effects of the existing project.*

FirstLight does not believe that construction of a new lower reservoir is a reasonable alternative to relicensing the Project and therefore has not conducted further analysis of this alternative.



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Northfield Mountain Pumped Storage Project No. 2485
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Draft License Application
Exhibit E

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Figure 2.1.1-1
Turners Falls Development Features

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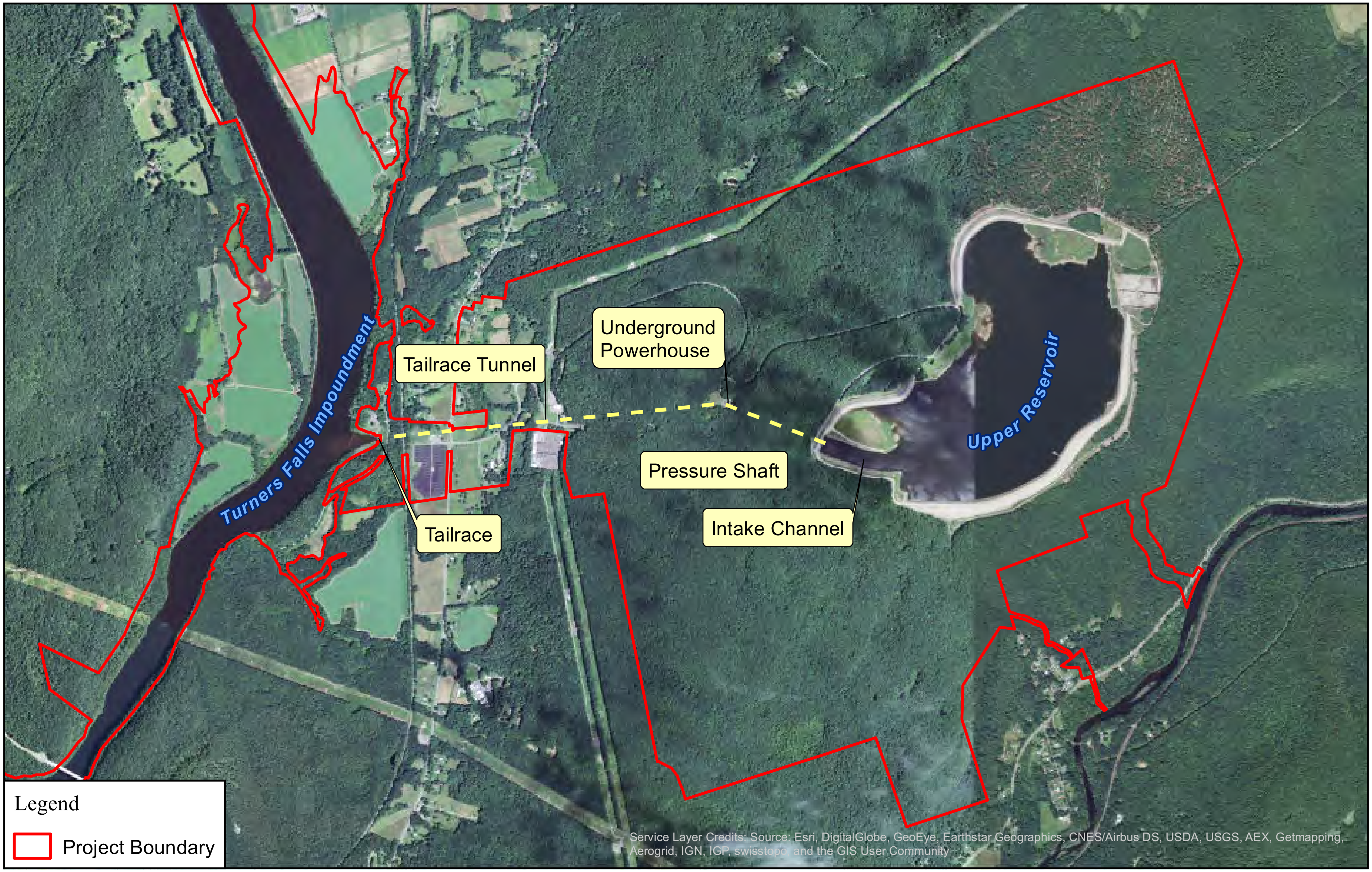

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Figure 2.1.1-2
Northfield Mountain
Pumped Storage Development

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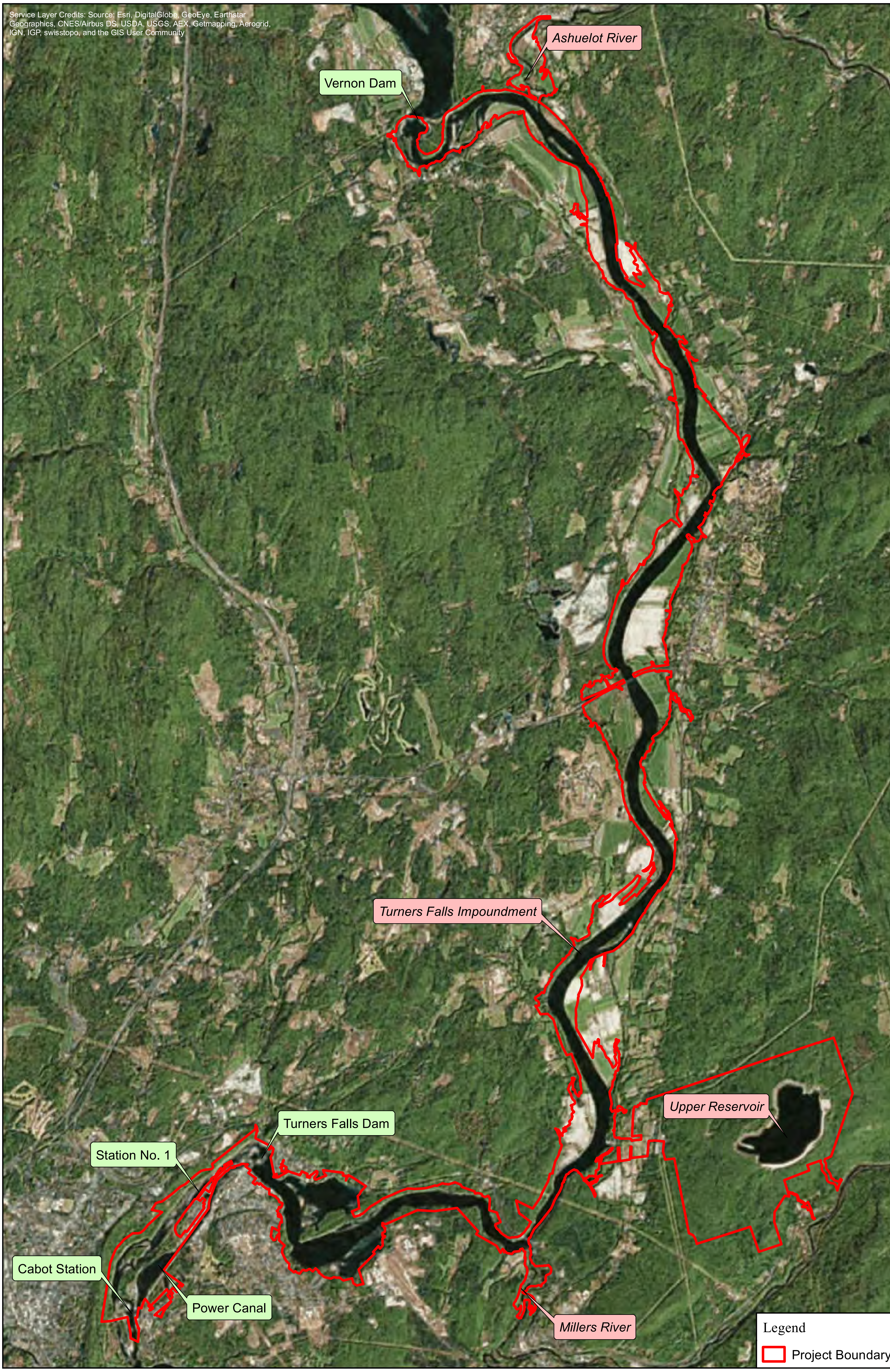

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Figure 2.1.2-1
Project Boundary Map

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3 ENVIRONMENTAL ANALYSIS

3.1 General Description of River Basin

The Connecticut River and its tributaries drain an area of about 11,250 mi^2, constituting the largest river drainage system in New England. From its origin in the Connecticut Lakes Region near the Canadian border, the 410-mile-long Connecticut River flows southward to form the boundary between New Hampshire and Vermont, then through Massachusetts and Connecticut to Long Island Sound (Carr & Kennedy, 2008).

According to the USGS's Watershed Boundary Dataset, the Connecticut River subregion, which is part of the New England region, is divided into two basins at Vernon Dam in Vermont—the Upper Connecticut basin and the Lower Connecticut basin. (For the purposes of this document, the Connecticut River subregion may also be referred to as a basin or watershed.) The Project boundary falls within the Middle Connecticut subbasin of the Lower Connecticut basin, and almost entirely within the Fall River-Connecticut River watershed within that subbasin (USGS, 2010). Figure 3.1-1 provides an overview of the entire Connecticut River subregion and its major tributaries and mainstem dams, while Figure 3.1-2 shows a close-up of the Middle Connecticut subbasin and tributaries and dams in the Project area.

In Massachusetts, the Lower Connecticut River basin covers an area of approximately 2,728 mi^2, occupying all of Franklin and Hampshire Counties, most of Hampden County, the eastern third of Berkshire County, and the western half of Worcester County. In this region, tributary streams entering the Connecticut River from the west originate in the Berkshire Mountains and have steeper gradients than tributary streams originating in the Central Highlands to the east (Simcox, 1992). The Middle Connecticut River subbasin in Massachusetts is bordered by the Deerfield River subbasin to the northwest, the Millers River subbasin to the northeast, the Westfield River subbasin to the southwest, and the Chicopee River subbasin to the southeast (Carr & Kennedy, 2008).

3.1.1 Topography

The Turners Falls Development and Northfield Mountain Pumped Storage Development are located in the New England Upland section of the New England physiographic province of Massachusetts. The Connecticut River Valley is a dominant feature within this section. The Connecticut River Valley is generally narrow in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development, with some areas of floodplain characterized by river and stream terrace silt, sand, and gravel. Other areas are characterized by steep rocky banks, especially the French King Gorge area, immediately downstream of the Northfield Mountain Pumped Storage Development's tailrace (FirstLight, 2007).

The topography of the Connecticut River Valley is mostly level to rolling, with some higher hills. One such hill is Northfield Mountain, where the Northfield Mountain Pumped Storage Development is located. The Northfield Mountain Pumped Storage Development's Upper Reservoir is man-made and was formed using impervious core rock fill structures, a concrete gravity dam, natural features, and excavation of a conveyance channel into bedrock.

3.1.2 Climate

The climate in the Project area is a humid continental climate, with warm summers and cold, snowy winters. This climate type is found over large areas of land masses in the temperate regions of the mid-latitudes where there is a zone of conflict between polar and tropical air masses. The humid continental climate is marked by variable weather patterns and a relatively large seasonal temperature variance. Shown in Table 3.1.2-1 is the long term monthly average air temperature and precipitation amounts as recorded in Springfield, MA approximately 40 miles south of Turners Falls, MA.

Average annual precipitation totals approximately 43.9 inches in Springfield, MA.

3.1.3 Land and Water Use

3.1.3.1 Major Land Uses

Land use in the Connecticut River watershed is approximately 77% forested, 9% agricultural, 7% wetlands, and 7% developed. Land use is generally rural agrarian and undeveloped at the headwaters in northern Vermont and New Hampshire, transitioning to densely populated urban areas in the south-central river valley in Connecticut. Down-river from the City of Hartford, CT, the basin is again largely undeveloped, making the Connecticut River the only major river in the northeastern United States without a significant port, harbor, or urban area at its mouth (Zimmerman, 2006).

The portion of the Connecticut River basin above the USGS stream gaging station in Thompsonville, CT (near the Massachusetts border) encompasses approximately 9,660 mi^2 in New Hampshire, Vermont, and Massachusetts. This region has a population of approximately one million people distributed amongst densely populated urban areas in the southernmost section in Massachusetts to sparsely populated rural and agricultural regions in the northern areas in New Hampshire and Vermont. The agricultural land use in New Hampshire and Vermont is predominantly related to dairy farm operations, while that in Massachusetts primarily consists of orchards, row crops, and some dairy operations. The land use in this portion of the basin is about 80% forested, 9% agricultural, 6% wetlands, and 5% developed (Deacon *et al*., 2006).

Figure 3.1.3.1-1 shows land use and land cover in the vicinity of the Project.

3.1.3.2 Major Water Uses

Water uses in the Connecticut River watershed include water supply, dilution of treated or untreated municipal or industrial discharges, contact and non-contact cooling water, water for agricultural irrigation and snow making, and water for power generation (CRJC, 2009). Other than for hydropower, the primary purpose of water withdrawals from the TFI is for agricultural irrigation.

3.1.3.3 Basin Dams and other Energy Producers

The USACE's National Inventory of Dams (NID) contains 990 dams in the Connecticut River watershed. More than half of these dams (553) are primarily used to support recreation; in many cases "recreation" is designated as the primary purpose, but in fact, many of the impoundments are the result of older mill dams that are no longer used for a specific purpose. Dams used primarily for water supply (131) are the second-most common type of dam, followed by those used for hydroelectric power generation (123) and flood control (75). Water supply dams store water in the Connecticut River watershed—particularly the Quabbin Reservoir in the Chicopee subbasin which serves as the primary source of drinking water for the City of Boston and several municipalities in the Greater Boston area. Hydroelectric dams are found at many locations along the Connecticut River and its major tributaries. Flood control dams are mostly found on smaller rivers throughout the watershed (USGS, 2011).

Of the dams in the Connecticut River watershed, approximately 64 are considered large, defined as those with the capacity to hold 10% of the mean annual streamflow volume during any particular day (or, in the absence of streamflow information, have a large water storage capacity in relation to their drainage area). Classification of large dams was determined by The Nature Conservancy (TNC) through analysis of streamflow data provided by the USGS (USGS, 2011).

There are 12 hydropower dams along the mainstem Connecticut River, including the Turners Falls Dam. The upstream end of the Project Boundary is the base of Vernon Dam, approximately 20 miles upstream of the Turners Falls Dam. The next hydropower dam downstream of the Turners Falls Dam is Holyoke Dam, approximately 35 miles downstream. Table 3.1.3.3-1 lists hydropower projects up to Moore Dam and their characteristics. Figure 3.1-1 depicts all dams along the mainstem Connecticut River, while Figure 3.1-2 shows selected dams in the Project area.

3.1.3.4 Tributary Streams

Major tributaries to the TFI include the Ashuelot River in New Hampshire, which drains 420 mi^2 from the east and enters the Connecticut River just below Vernon Dam, and the Millers River, which drains 392 mi^2 from the east and enters downstream of the Northfield Mountain tailrace. Additionally, the Deerfield River, which drains 665 mi^2 from the west, enters the Connecticut River just downstream of the Cabot Station tailrace.

Smaller named streams entering the TFI, from upstream to downstream, include Newton Brook, Pauchaug Brook, Bottom Brook, Mill Brook, Mallory Brook, Millers Brook, Bennett Brook, Merriam Brook, Otter Run, Ashuela Brook, Dry Brook, Pine Meadow Brook, and Fourmile Brook (Wandle, 1984).

Figure 3.1-1 depicts major tributaries in the entire Connecticut River watershed, while Figure 3.1-2 shows tributaries in the vicinity of the Project.

Table 3.1.2-1: Average Climate Conditions in Springfield, MA

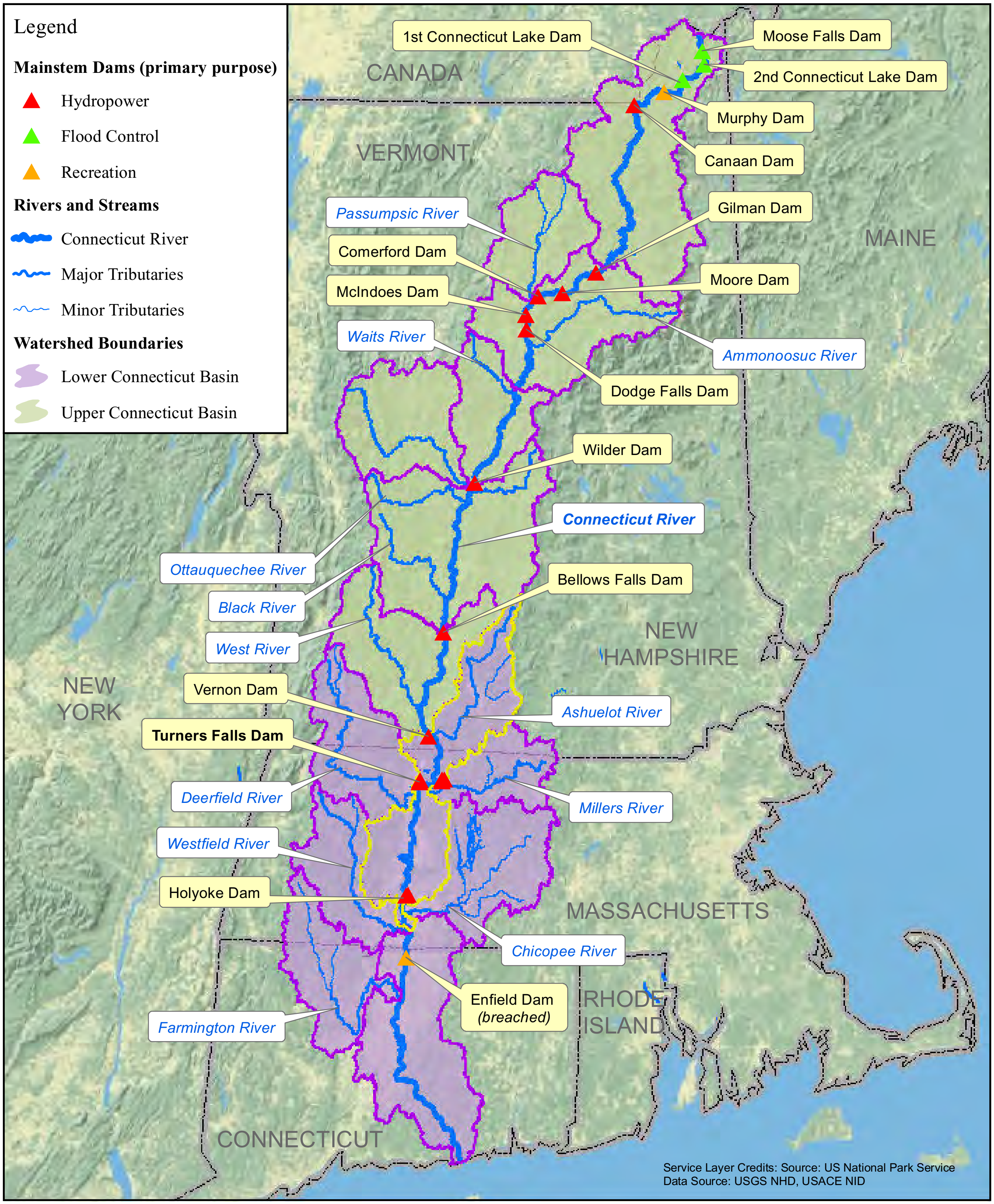
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temperature (°F)	27	30	38	50	60	69	74	73	65	54	44	31
Average Precipitation (in)	3.2	3.0	3.5	3.9	4.1	4.1	3.6	3.5	3.5	3.6	4.1	3.8

Source: http://www.explore-massachusetts.com/massachusetts-climate.html

Table 3.1.3.3-1: Hydropower Projects on the Connecticut River

FERC Project No.	Project Name	River Mile *(above Long Island Sound)*	Licensee	License Expiration
2004	Holyoke	87	City of Holyoke Gas & Electric Co.	08/31/2039
1889	Turners Falls	122	FirstLight Hydro Generating Co.	04/30/2018
2485[1]	Northfield Mountain Pumped Storage	127	FirstLight Hydro Generating Co.	04/30/2018
1904	Vernon	142	TransCanada Hydro Northeast, Inc.	04/30/2019
1855	Bellows Falls	174	TransCanada Hydro Northeast, Inc.	04/30/2019
1892	Wilder	217	TransCanada Hydro Northeast, Inc.	04/30/2019
8011	Dodge Falls	270	Dodge Falls Hydro Co.	Exempt
2077	Fifteen Mile Falls (McIndoes, Comerford, and Moore Dams)	274 281 288	TransCanada Hydro Northeast, Inc.	03/31/2042
2392	Gilman	302	Ampersand Gilman Hydro, L.P.	03/31/2024
7528	Canaan	373	Public Service Co. of NH	07/31/2039

[1]The Northfield Mountain Pumped Storage Development does not “dam” the Connecticut River; rather it pumps from, and discharges to, the Connecticut River.



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

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Figure 3.1-1
Connecticut River Watershed, Major Tributaries, and Mainstem Dams

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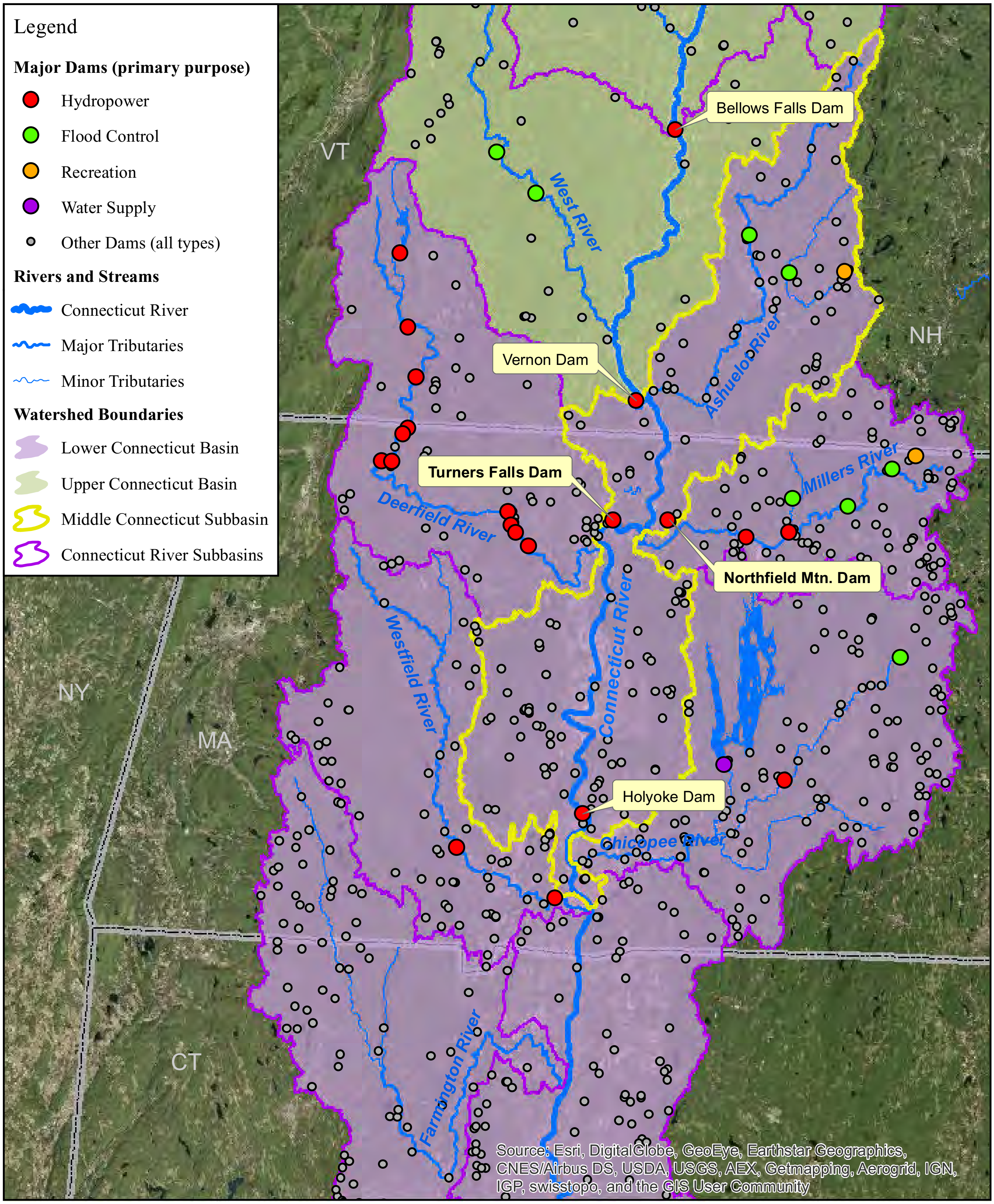

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Figure 3.1-2
Connecticut River Subbasins, Tributaries, and Dams in the Project Area

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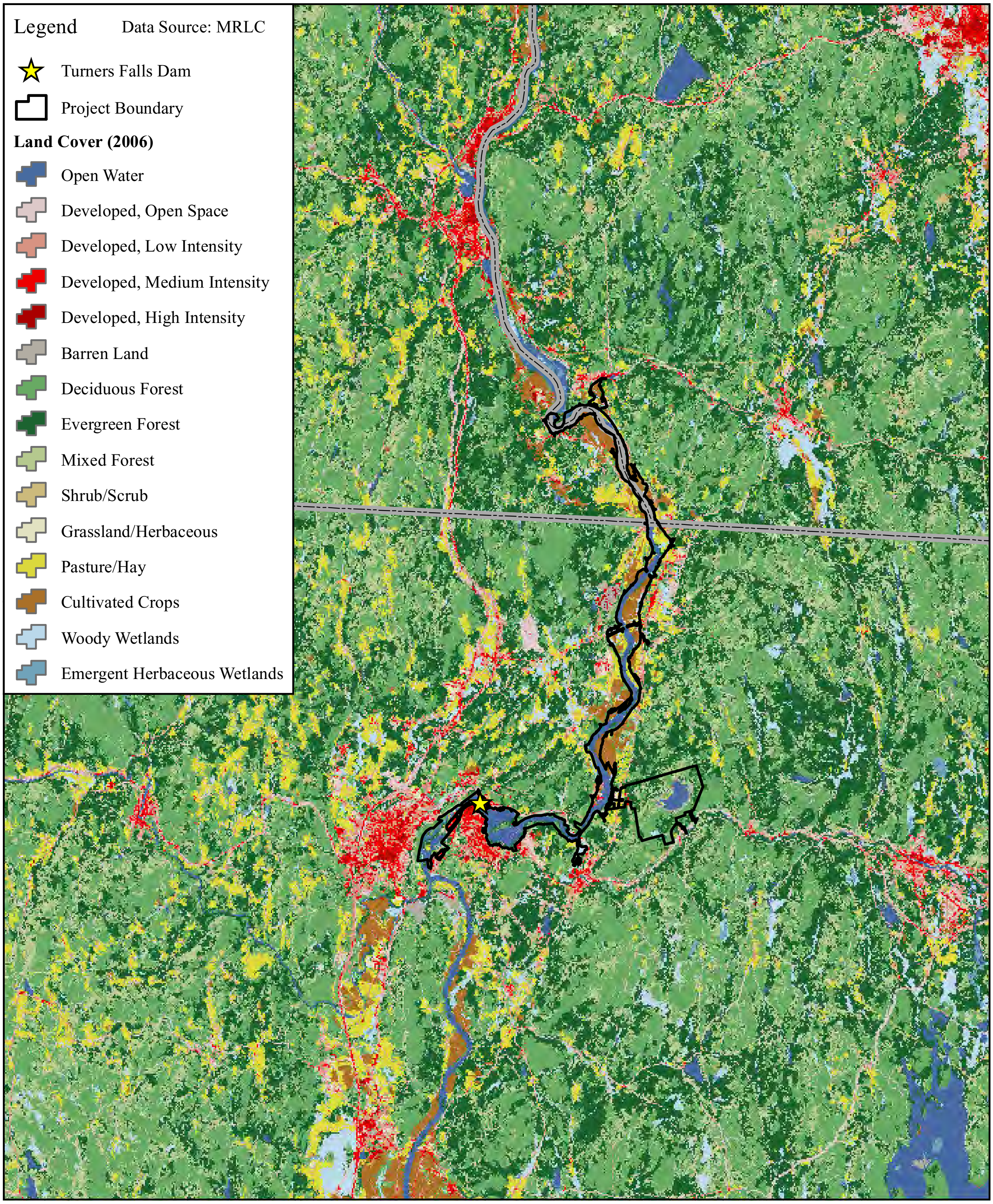

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Figure 3.1.3.1-1
Land Cover in the Project Vicinity

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3.2 Cumulative Effects

3.2.1 Cumulatively Affected Resources

According to § 1508.7 of the Council on Environmental Quality's regulations for implementing NEPA, an action may cause cumulative impacts on the environment if its impacts overlap in space and time with the impacts of other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

FERC noted the following in SD2 relative to cumulative effects, which includes the effects of the three (3) TransCanada Projects and FirstLight's Turners Falls Development and Northfield Mountain Pumped Storage Development:

> *Based on information in the Pre-Application Documents and staff analysis of the written comments submitted from agencies and other stakeholders on the SD1 document and comments from the January 2013 public scoping meetings, we identified the following resources that may be cumulatively affected by the proposed operation and maintenance of the five Connecticut River Projects: water quality and quantity*[8] *(including power generation), fishery resources (including anadromous and catadromous fish and fish passage), floodplain communities, freshwater mussels, sediment movement, recreational uses and rare, threatened and endangered species.*

Provided below is the geographic and temporal scope of the cumulative effects analysis for these resources, and past, present and reasonably foreseeable future actions considered in the analysis.

3.2.2 Geographic Scope of Analysis for Cumulatively Affected Resources

The geographic scope of the cumulative effects analysis defines the physical limits or boundaries of the proposed action's effect on the resources. Because the proposed action would affect the resources differently, the geographic scope for each resource may vary. FERC's SD2 described the geographic scope for cumulative effects as follows:

> Due to the extensive seasonal storage capacity at Moore reservoir, we have identified the geographical extent of cumulative effects on water quantity and water quality *to include the Connecticut River from the base of Moore dam to the mouth of the Connecticut River at Long Island Sound. We chose this geographic area to recognize the cumulative operational influences of the upstream water storage, and the operations of the five Connecticut River projects on water quantity throughout this area and subsequently on water quality that could occur downstream to mouth of the Connecticut River at Long Island Sound.*
>
> Because hydroelectric dams influence both upstream and downstream fish migration within river systems, we have identified the geographical extent of potential cumulative effects on *anadromous, catadromous, and diadromous fish species to include the Connecticut River from Long Island Sound upstream to each species' historical habitat range.*
>
> We have identified the geographical extent of cumulative effects on *resident fish species, freshwater mussels, and sediment movement to include the upper extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland,*[9] *Massachusetts. We chose this geographic area because the operation of the five projects could be a contributing factor to sediment movement*

---

[8] *Water quantity is defined as flow magnitude, flow frequency, flow duration, flow timing, and rate of change.*

[9] The Route 116 Bridge is located at the approximate upstream extent of the Holyoke Project (FERC No. 2004) impoundment.

within the river and cumulative effects on resident fisheries and freshwater mussel habitat in this area.

We have identified the geographic scope of cumulative effects on *terrestrial and floodplain communities to include the 100-year floodplain (as defined by the Federal Emergency Management Agency) adjacent to the project-affected areas from the upstream extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland, Massachusetts. We chose this geographic area because the operation of the projects, in combination with other land uses in the Connecticut River Basin, may cumulatively affect floodplain communities adjacent to project reservoirs and downstream riverine reaches in this area.*

The presence of multiple dams on the Connecticut River may cumulatively affect multi-day paddle trips. *Based on our independent review and stakeholder comments, we find the geographic scope of the cumulative effects on recreation for multi-day paddling trips on the Connecticut River may extend as far upstream as Murphy Dam (RM 383) in Pittsburg, New Hampshire, where the natural riverine reaches become navigable (CRWC, 2007; American Whitewater, 2013)[10] and downstream to the Holyoke dam (FERC No. 2004), the most downstream dam, in Holyoke, Massachusetts.*

FirstLight has included this geographic area in the cumulative effects analysis for the resources identified by FERC.

3.2.3 Temporal Scope of Analysis for Cumulatively Affected Resources

The temporal scope of the cumulative effects analysis addresses past, present, and future actions and their effects on each affected resource. Based on the expected term of a new license, the temporal scope of analysis addresses reasonably foreseeable actions for 30-50 years into the future.

3.2.4 Past, Present and Reasonably Foreseeable Future Actions

The cumulative effects of past and present actions on the resources listed below are addressed in the Affected Environmental Section of this Exhibit E.

- Sediment Movement (Section 3.3.1 Geology and Soils)
- Water Quantity and Quality (Section 3.3.2, Water Resources),
- Anadromous, Catadromous, and Diadromous fish species (Section 3.3.3 Aquatic Resources)
- Resident Fish Species, Freshwater Mussels, (Section 3.3.3 Aquatic Resources)
- Terrestrial and Floodplain Communities (Section 3.3.4 Terrestrial Resources)
- Recreation for Multi-day Paddling Trips (Section 3.3.6, Recreation Resources)

[10] The Connecticut River Watershed Council (2007). The Connecticut River boating guide: Source to sea (3rd ed.). The Globe Peqout Press: Guilford, Connecticut. American Whitewater (2013). Retrieved on 4/11/2013 from http://www.americanwhitewater.org/content/River/detail/id/10545

3.3 Proposed Action and Action Alternative

3.3.1 Geology and Soils

3.3.1.1 Affected Environment

3.3.1.1.1 Geology

Bedrock Geology

The Connecticut River Valley was formed by erosion of sedimentary rocks before the glacial period. These sedimentary rocks, largely sandstone, shale, and conglomerate, interspersed with volcanic rocks, were formed about 190 to 200 million years ago in the Jurassic and Triassic period. The bordering uplands are underlain by older, less erodible metamorphic and igneous rocks (Simcox, 1992).

The bedrock geology in the vicinity of the Project is illustrated in Figure 3.3.1.1.1-1 and described further below.

Turners Falls Development

The bedrock geology surrounding the Turners Falls Development is based on a USGS characterization of near-surface bedrock in the New England region (Robinson & Kapo, 2003). Although the dominant bedrock geology surrounding the Turners Falls Development is sedimentary (such as arkose, siltstone, sandstone, shale, and conglomerate), tilted basalt layers have formed distinctive ridges in many parts of the river valley. The Jurassic-age Holyoke basalt results in a prominent north-south trending ridge from southern Connecticut into central Massachusetts, which then curves to trend east-west in the Holyoke Range.

Northfield Mountain Pumped Storage Development

At the Northfield Mountain Pumped Storage Development, the pressure shaft, powerhouse, and tailrace were excavated through the bedrock of Northfield Mountain. Several geological investigations were conducted as part of the initial licensing and construction of the Project (CL&P *et al*., 1966). These investigations show that Northfield Mountain is the northwest flank of a broad dome structure having a northeast-southwest axis. The rocks comprising this dome are hard, crystalline metasediments of mid-Paleozoic age. In geologic studies, these have been grouped into two formations, the Dry Hill granite gneiss and the Poplar Mountain gneiss. The Dry Hill granite gneiss has a maximum thickness of about 800 feet and is about 460 feet thick at the powerhouse site. This formation forms the crest of Northfield Mountain. It is overlain and underlain by the Poplar Mountain gneiss, which crops out near the discharge portal of the tailrace tunnel. The Dry Hill granite gneiss consists of massive beds or layers of evenly foliated granite gneiss, ranging in thickness up to 150 feet, separated by relatively thinner members of biotite-rich gneiss. The Poplar Mountain gneiss consists of medium to coarse, feldspathic, biotite-rich granite gneiss interbedded with biotite schists and quartzitic members. While these are hard, durable, crystalline rocks, the Poplar Mountain gneiss is more micaceous and thinly foliated than the Dry Hill granite gneiss. The cover over the bedrock in the Upper Reservoir area is very thin. Bedrock is exposed in many areas at the ground surface and in other areas covered by a thin mantle of glacial outwash.

Faulting within the area of Northfield Mountain appears to be minimal. The major fault of the area is the Border Fault between the Triassic sandstones of the Connecticut Valley and the meta-sediments. Within the vicinity of the Northfield Mountain Pumped Storage Development, the fault lies west of the Connecticut River and well away from structures of the facility.

Surficial Geology

Surficial geology of the Connecticut River Valley region in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development is illustrated in Figure 3.3.1.1.1-2.[11] Surficial geologic units in the Northfield Mountain Pumped Storage Development Upper Reservoir area predominantly consist of thin glacial till and shallow bedrock. In the vicinity of the Northfield Mountain Pumped Storage Development tailrace, surficial geologic units consist of coarse and fine glacial stratified deposits (sorted and stratified sediments composed of gravel, sand, silt, and clay deposited in layers by glacial meltwater) and floodplain alluvium closer to the river.

Most of the surficial deposits in the general region of the TFI are deposits of the last two continental ice sheets that covered all of New England in the latter part of Pleistocene Ice Age. These deposits can be categorized into three groups: glacial tills, glacial stratified deposits, and post-glacial deposits (S&A, 2014):

> *Glacial till* – Glacial till is the most widespread glacial deposit, and was laid down directly by glacier ice. It consists of non-sorted, generally non-stratified mixtures of particles ranging in grain size from clay to large boulders in a matrix of predominantly fine sand and silt. Till blankets the bedrock surface in variable thicknesses, ranging from a few inches to more than 200 feet. The Upper Till was deposited during the last glaciations (Wisconsin Ice Age), and the Lower Till was deposited during the older Illinoian Ice Age. In the Connecticut Valley area, the till was derived mainly from the Triassic sedimentary rocks. The Lower Till contains relatively high percentages of silt- and clay-size particles, and the Upper Till are better sorted and contain less fine-grained materials (S&A, 2014).
>
> *Glacial stratified deposits* – During retreat of the last ice sheet, materials in the glacier were deposited in glacial streams, lakes and marine environments that occupied the valleys and lowlands. Because these materials were deposited in water, they tend to be stratified and well-sorted gravel, sand, silt and clay. Glacial stratified deposits are the predominant surficial materials in the Connecticut River Valley. These deposits generally overlie till; however in some places till is not present and the stratified deposits lie directly on bedrock. The largest glacial lake in the region was Lake Hitchcock which occupied the Connecticut Valley area. Lake Hitchcock was dammed behind a mass of earlier deltaic sediments in the Cromwell-Rock Hill area of central Connecticut. The lake lengthened northward into northern Vermont and New Hampshire as the ice sheet retreated. The principal bottom sediments of Lake Hitchcock are varved clay, silt, and fine sand at least 300 feet in maximum thickness, which are overlain by a continuous blanket of sand 2 to 25 feet thick (S&A, 2014).
>
> *Post-glacial deposits* – The two principal post-glacial deposits are floodplain alluvium and aeolian deposits. Floodplain alluvium consists of sand, gravel, and silt, stratified and well sorted to poorly sorted. The grain size distribution of alluvium generally varies over short distances, both vertically and laterally. Along smaller streams, alluvium is commonly less than 5 feet thick. The most extensive deposits of alluvium in the region are along the Connecticut River, where the materials are predominantly sand, fine gravel, and silt, with thickness up to about 25 feet. Alluvium typically overlies thicker glacial stratified deposits. The aeolian deposits in the region consist of windblown silt and sand that form a discontinuous but widespread blanket, about 5 feet in maximum thickness over bedrock and glacial deposits (S&A, 2014).

The French King Gorge area along the TFI consists of bedrock outcrops, thin glacial till, and areas of coarse stratified glacial deposits. Further downstream in the area of the Turners Falls Dam, bypass reach and power canal, surficial geologic units include coarse stratified glacial deposits, stream terrace deposits, floodplain alluvium and bedrock outcrops.

[11] Surficial geology information is not available for New Hampshire.

Terrace and Floodplain Surfaces

A description of the stream terrace deposits along the river was provided in a geomorphic characterization of the TFI (Field Geology Services, 2007). This characterization is relied on to describe the geologic history of the terrace and floodplain formations adjacent to the Connecticut River in the TFI area.

While the width and orientation of the valley through which the Connecticut River flows is the result of ancient geological processes, the valley bottom is composed of a series of terraces stepping up from the river with the highest and, therefore, oldest geomorphic surface formed since the last Ice Age (i.e., < 15,000 years). These terrace surfaces are seen throughout the TFI area. The width of the valley is narrowest through the French King Gorge where the river encounters bedrock nearly continuously. However, only 10% of the channel through the TFI encounters bedrock, with most of the channel flowing against glacial, lacustrine, or alluvial sediments.

When glacial ice retreated from the Connecticut River Valley at the end of the last Ice Age great quantities of sediment were washed into the valley from the tributaries and from the glacial ice melting to the north, forming large deltas. One such delta in Rocky Hill, CT naturally damned the width of the valley and created a long narrow lake, known as Lake Hitchcock, that extended as far north as West Burke, VT. The lake's water surface in the TFI area was likely more than 150 feet higher than the current level of the Connecticut River (Field Geology Services, 2007). Tributaries built deltas at the lake's margins that are today the highest terraces in the valley. These areas provide an excellent source of sand and gravel, as evidenced by the gravel pits excavated below their surfaces. The delta front sloped down to the lake bottom, which itself was over 75 feet above the current river level; the terrace on which the town of Northfield rests is a remnant of the old lake bottom surface. Eventually the natural dam holding back Lake Hitchcock was broken and the Connecticut River was able to erode through the old lake sediments.

The river's downcutting was stopped when hard bedrock was encountered as was the case at the deep areas within Barton Cove, where a large waterfall previously existed and carved large plunge pools downstream. Upstream, the river was graded to the top of this bedrock barrier and began eroding laterally into the old lake bottom sediments, creating a wide floodplain. This higher floodplain level was abandoned when the river resumed downcutting. Once reaching a new graded level, the river eroded laterally to create its current floodplain in a process that continues until this day.

3.3.1.1.2 Soils

The two dominant soil types associated with abandoned and active floodplains in the TFI area are the Hadley very fine sandy loam and the Suncook loamy sand (Field Geology Services, 2007). The stratigraphy of sediments underneath these floodplain surfaces is characterized by poorly consolidated alternating fine sand and silt layers.

The Agawam fine sandy loam is the dominant soil type associated with the older and higher terraces, but several other soil types also occur. The stratigraphy underlying each terrace depends largely on the depositional environment in which the terrace surface formed (e.g., deltaic, lacustrine). In most instances the uppermost sediments exposed in these high banks are well stratified sands with the underlying sediments at river level varying between well sorted sand, cobbly to gravelly sand, or varved lacustrine clays. Given the close proximity in which the varied depositional environments were found, the type of sediment exposed at the base of the high banks along the river can vary over short distances. Bedrock ledge is also intermittently seen at the base of the banks and buried in the sediment above.

The recently updated soil survey maps for Franklin County, MA were obtained to describe the soil resources in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development. Soil survey data were also obtained for Windham County, Vermont and Cheshire County, New Hampshire. Figure 3.3.1.1.2-1 (eight pages) depicts the soils types within 2,000 feet of the shoreline in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development, or within the Project boundaries. Note that the legend for these figures is located at the end of Figure 3.3.1.1.2-1. The top ten soil series, in terms of areal coverage, in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development are listed in Table 3.3.1.1.2-1.

3.3.1.1.3 Shoreline and Streambank Characterization

The Northfield Mountain Pumped Storage Development Upper Reservoir shoreline is composed of constructed dikes created with fill material from excavation areas during the construction of the Project. Additional bank types include steep areas cut into bedrock, particularly at the intake canal, and gently sloping unvegetated areas that are alternately exposed and inundated in response to changing water levels.

Starting in 1998, Full River Reconnaissance (FRR) surveys were conducted every 3-5 years to document TFI streambank characteristics, such as steepness, material type, degree of vegetative cover, and severity of erosion. The most recent FRR was conducted in 2013 (relicensing Study No. 3.1.1) (S&A, 2014). The 2013 FRR reported that riverbanks in the TFI generally consist of an upper bank that is often above water except during high flow conditions, and a lower bank that is frequently submerged. These banks consist of a range of materials from silt or sand to solid rock.

The results of the 2013 FRR indicated that the majority of the upper riverbanks in the TFI were found to have moderate or steep slopes, heights greater than 12 ft., be comprised of silt/sand, and have heavy vegetation. The majority of the lower riverbanks were found to have flat/beach to moderate slopes, be comprised of silt/sand, and have none to very sparse vegetation. Erosion conditions in the TFI were found to be generally stable with None/Little current erosion occurring through much of this reach.

As noted in the 2013 FRR report (S&A, 2014), 84.8% of the total length of the TFI riverbanks were found to have None/Little erosion[12], 14.1% Some erosion, 0.5% Some to Extensive erosion, and 0.6% Extensive erosion. Furthermore, 5.5% of the total length of TFI riverbanks were found to have Potential Future Erosion, 0.6% Active Erosion, 9.1% Eroded, 83.5% Stable, and 1.3% in the Process of Stabilization. Table 3.3.1.1.3-1 presents summary statistics of the TFI streambank features and characteristics as noted during the 2013 FRR, while Table 3.3.1.1.3-2 provides definitions for each classification. Figure 3.3.1.1.3-1 depicts the extent of current erosion found along the streambanks of the TFI.

3.3.1.1.4 Suspended Sediment

TFI suspended sediment values have been observed to have a strong correlation to flow. That is, the highest suspended sediment concentration (SSC) values are often observed during the highest periods of flow while the lowest SSC values are often observed during the lowest period of flows. During a three year observation period (2013-2015), three mainstem flow thresholds were observed in regard to SSC values: <12,000 cfs, 12,000-35,000 cfs, and >35,000 cfs. Median SSC values for mainstem flows below 12,000 cfs observed during this period (as measured in the vicinity of the Rt. 10 Bridge) were 2.9 mg/L while flows between 12,000-35,000 cfs and greater than 35,000 cfs had observed median SSC values of 12.45 mg/L and 144.61 mg/L, respectively (GSE, 2015). Figure 3.3.1.1.4-1 demonstrates this relationship.

Furthermore, the flow and SSC levels of the Connecticut River in the Project boundary are very much correlated with the season. The seasonal hydrology pattern in this area is typically defined by: 1) a spring freshet typically occurring in late March and into May when the highest annual flows and SSC values are normally observed (barring a significant basin wide rain event or Hurricane in the summer or fall); 2) moderate flows and SSC values throughout the early summer as the spring freshet subsides; 3) low flows and SSC values throughout the summer and early fall; and 4) low to moderate flows and SSC values during

[12] Riverbanks consist of an irregular surface and include a range of natural materials, above ground vegetation, and below ground roots of different densities and sizes. Due to these characteristics, there are small areas of disturbance which often occur at interfaces between materials, particularly in the vicinity of the water surface. These small disturbed areas can be considered as erosion, or sometimes can result from deposition or even eroded deposition. No natural riverbank exists which does not have at least some relatively small degree of disturbance or erosion associated with the natural combination of sediment types/sizes and vegetation. As such, the extent of erosion for generally stable riverbanks that included these relatively small disturbed areas was characterized as None/Little during the 2013 FRR.

the fall. Significant basin wide or local rain events occasionally cause spikes in flow and SSC values during the summer and fall before conditions return to a lower, more steady state. SSC values observed during typical high, moderate, and low flow periods are shown in Figures 3.3.1.1.4-2 – 3.3.1.1.4-4. Table 3.3.1.1.4-1 demonstrates the seasonal range of flows and SSC values observed during the three year observation period (2013-2015).

3.3.1.2 Environmental Effects

Potential geology and soils Project related effects could include shoreline erosion within the TFI and the entrainment of sediment into the Northfield Mountain Pumped Storage Development works during Project operations.

Numerous studies have been conducted since 1979 to characterize streambank conditions of the TFI to understand the causes of erosion and to identify the most appropriate approaches for bank stabilization. In addition to studies conducted in the 1970s, 1980s, and 1990s, the Erosion Control Plan (ECP) was developed in 1998 (S&A, 1999) to address stabilization and preventative maintenance of erosion sites in the TFI, regardless of cause.

As part of the ECP a reconnaissance level survey of the length of the TFI streambanks was conducted to identify and rank erosion sites without regard to the cause of erosion and whether it appeared to be related to the Project. From this survey a list of the 20 most severely eroded sites was developed. Following completion of this list, the Licensee began stabilizing these sites using various techniques including bio-engineering. The 1998 list of sites has served as the basis for the construction of 18,150 linear feet of stabilization efforts from 1999 through 2014. As of the 2013 FRR, 15 of the 20 sites identified in 1998 had been stabilized. Of the five (5) sites not stabilized, two are located in areas where extreme hydraulic conditions exist that are proximate to non-Project related manmade structures (just below Vernon Dam and just upstream of the Route 10 Bridge), one site is located on an island (island locations have typically not been as high priority to repair as streambank locations), and two other sites were not selected for stabilization based on feedback from stakeholders and landowners.

Table 3.3.1.2-1 denotes the current status of the twenty most severely eroded sites identified during the 1998 FRR while Figure 3.3.1.2-1 denote the locations where stabilization efforts associated with the ECP have occurred.

In addition to the 18,150 linear feet of TFI riverbanks that have been stabilized since 1998 through implementation of the ECP, previous stabilization work associated with construction of the Northfield Mountain Pumped Storage Development totaled 25,900 feet of rip-rap or rip-rap with vegetation with an additional 2,600 feet of grading and planting. Furthermore, an additional 2,000 ft of experimental stabilization was constructed by the USACE in the 1970s. Overall stabilization work (not including grading and planting) associated with construction of the Northfield Mountain Pumped Storage Development and other work such as that constructed by the USACE along with implementation of the ECP totals approximately 48,980 linear feet of riverbanks (9.28 miles).

Over the past 15 years, TFI riverbank conditions with respect to erosion have improved. The 1998 FRR identified 3.4% of TFI riverbanks as being Severely eroded while the 2013 FRR found that only 0.6% of riverbanks were classified as having Extensive erosion.[13] The majority of the 20 most severely eroding sites identified in 1998 have successfully been treated, are now stable and supporting heavy vegetation, and have not experienced any significant erosion. Moreover, erosion sites in 1998 were quite large in magnitude and stark in appearance with very little vegetation and significant potential for ongoing erosion and sediment production. By contrast, in 2013, eroding sites were found to be generally smaller in magnitude with a greater degree of vegetation. In addition, based on the findings of the 2013 FRR it was observed that from

[13] Due to classification differences between the 1998 and 2013 FRR's "Severely Eroded" and "Extensive Erosion" were the most severe erosion classifications for the 1998 and 2013 FRR, respectively.

2008 to 2013 there has been an increase in riverbank stability, and therefore a corresponding decrease in eroding banks, of approximately 1.5% (S&A, 2014).

To put the current health of the TFI streambanks with respect to erosion processes into context and to better understand the current condition of the TFI, the results of the 2013 FRR were compared with the conclusions of the Connecticut River bank erosion comparison study conducted by Simons and Associates (S&A) in 2012 (S&A, 2012). The 2012 S&A report examined and compared riverbank erosion in the TFI to other reaches of the Connecticut River including impoundments upstream and downstream of the TFI and free flowing stretches of the river. Key conclusions from this report, which were reinforced by the results of the 2013 FRR, found that:

- The segment of river with the greatest extent of eroding riverbanks is the un-impounded northern reach (Pittsburg, NH down to Gilman Dam). At the time of the available study (Field Geological Services, 2004), 48.4% of the riverbanks were experiencing moderate or more significant erosion. Riverbanks that had been rip-rapped covered 17.1% of the length of the river.[14]
- Despite the fact that similar percentages of riverbank have been stabilized in the northern, free-flowing reach and in the TFI; the percentage of erosion in the TFI is only about one-third the extent of erosion that is occurring in the northern, un-impounded reach of the Connecticut River (16.7% compared to 48.4%).
- Several erosion sites were identified and photographed in the Bellows Falls, Vernon, Turners Falls, and Holyoke Impoundments in 1997. These erosion sites were photographed again in 2008. All of the erosion sites in 1997 in the Bellows Falls and Holyoke Impoundments, and all but one of the 1997 erosion sites in the Vernon Impoundment, remain in essentially the same state of erosion when photographed in 2008. Many of these sites are significant in both size and severity. In contrast, most of the erosion sites in the TFI in 1998 have been stabilized and are no longer eroding as of 2008 (when previously identified erosion sites were re-photographed in 3 impoundments and when the most recent FRR was conducted in the TFI), with several additional erosion sites scheduled to be stabilized as part of the "Erosion Control Plan for the Turners Falls Pool of the Connecticut River" (S&A, 1999) by 2012.
- In addition to the direct stabilization of many of the erosion sites in the TFI that were identified in the 1998 Erosion Control Plan (ECP), there is evidence of some natural stabilization processes including increased upper bank vegetation and areas of dense low bank aquatic vegetation that are helping provide a degree of additional stability in some areas.
- Based on the state of erosion in the northern un-impounded reach as well as the state of continued erosion in the Bellows Falls, Vernon and Holyoke impoundments, the riverbanks in the TFI are in the best condition (more stable and less eroding) than in any other part of the Connecticut River.

The causes of erosion in the TFI are currently being evaluated in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* (Study No. 3.1.2). Study No. 3.1.2 will evaluate and identify the causes of erosion, and the forces associated with them, in the TFI and determine to what extent they are related to Project operations. Based on past experience conducting FRRs and other geomorphic evaluations of the Connecticut River, it is anticipated that potential causes of erosion could include:

- Hydraulic shear stress due to flowing water;
- Water level fluctuations due to hydropower operations;
- Boat waves;
- Land management practices and anthropogenic influences to the riparian zone;

[14] The study reach along the Connecticut River from Pittsburg, NH to Gilman Dam is 85 miles.

- Animals;
- Wind waves;
- Seepage and piping;
- Freeze-thaw; and
- Ice or debris

The potential primary causes of erosion that are being examined in greater detail include:

- Hydraulic shear stress due to flowing water;
- Water level fluctuations due to hydropower operations;
- Boat waves;
- Land management practices and anthropogenic influences to the riparian zone; and
- Ice

As of the date of this filing, Study No. 3.1.2 is still ongoing.

In regard to the entrainment of suspended sediment into the Northfield Mountain Pumped Storage Development works and the Connecticut River, FirstLight is conducting Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* (Study No. 3.1.3). As of the date of this filing, Study No. 3.1.3 is still ongoing. Preliminary results from Study No. 3.1.3 indicate that during high (>35,000 cfs) and moderate (12,000-35,000 cfs) flow conditions, SSC values observed during generation were found to be lower than those observed during pumping; that is, SSC values observed at the tailrace were lower than those observed in the mainstem. This indicates: 1) that net deposition is occurring in the Upper Reservoir over time, and 2) there are no correlations between typical Project operations and increased mainstem SSC values. These observations are further supported by the results of the annual Upper Reservoir bathymetry surveys which demonstrated a net accumulation of sediment over time.

In addition to suspended sediment monitoring, various modeling efforts are underway as part of Study No. 3.1.3 to better understand the potential entrainment of sediment into the Northfield Mountain Pumped Storage Development works and the potential discharge of the entrained sediment to the Connecticut River during drawdown or dewatering activities. The results of the modeling efforts, combined with the other elements of Study No. 3.1.3, will be used to inform management measures to minimize potential environmental effects.

3.3.1.3 Cumulative Impacts

The Council of Environmental Quality (CEQ) regulations define “cumulative effects” as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR §1508.7).

For this analysis, the action is the relicensing and continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development, as well as the upstream projects owned by TransCanada, which is also conducting relicensing studies on erosion. The cumulatively affected resource is the Connecticut River Basin. The cumulative impact of the Project on the affected resource is still being evaluated as part of Relicensing Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* and Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan*. Study No. 3.1.2 will evaluate and identify the causes of erosion, and the forces associated with them, in the TFI and determine to what extent they are related to Project operations. The results of Study No. 3.1.3 will be used to help inform sediment management measures that will avoid or minimize the entrainment of sediment in the Northfield Mountain Pumped Storage Development works and the Connecticut River. Final reports for Study No. 3.1.2 and 3.1.3 will be filed in the second quarter of 2016 and September 1, 2016, respectively.

3.3.1.4 Proposed Environmental Measures

No environmental measures are proposed at this time. Proposed environmental measures will be reviewed upon completion of Study No. 3.1.2 and 3.1.3.

3.3.1.5 Unavoidable Adverse Impacts

Northfield Mountain Pumped Storage Development operations, under FirstLight's proposed action, would continue to alter water levels on an intra-daily time step in the TFI.

Relicensing Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* is still ongoing with the final report due the second quarter of 2016. The results of this study will identify the causes of erosion in the TFI and the impact of fluctuating water levels, if any, on TFI streambank erosion.

Relicensing Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* is also still ongoing with the final report due September 1, 2016. The results of Study No. 3.1.3 will be used to inform management measures to minimize the entrainment of sediment into the Northfield Mountain Pumped Storage Development works and discharge to the Connecticut River during drawdown or dewatering activities.

Table 3.3.1.1.2-1: Description of Common Soil Types in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

Series	Percent Areal Coverage	Description
Windsor	21%	The Windsor series consists of very deep, excessively drained soils formed in sandy outwash or eolian deposits. They are nearly level through very steep soils on glaciofluvial landforms.
Agawam	10%	The Agawam series consists of very deep, well drained soils formed in sandy, water deposited materials. They are level to steep soils on outwash plains and high stream terraces.
Unadilla	9%	The Unadilla series consists of deep and very deep, well drained soils formed in silty, lacustrine sediments or old alluvial deposits. These soils are on valley terraces and lacustrine plains.
Hadley	9%	The Hadley series consists of very deep well drained soils formed in silty alluvium. They are nearly level soils on flood plains.
Chatfield	7%	The Chatfield series consists of well drained and somewhat excessively drained soils formed in till derived from parent materials that are very low in iron sulfides. They are moderately deep to bedrock. They are nearly level through very steep soils on glaciated plains, hills, and ridges.
Yatesville-Holyoke complex	7%	The Yatesville series consists of moderately deep, well drained soils formed in a loamy till. Nearly level to moderately steep soils on hills and ridges. The Holyoke series consists of shallow, well drained and somewhat excessively drained soils formed in a thin mantle of till derived mainly from basalt and red sandstone, conglomerate, and shale. Nearly level to very steep soils on bedrock controlled ridges and hills.
Udorthents	6%	Disturbed soils; cut and fill areas, urban land.
Poocham	3%	The Poocham series consists of very deep well drained soils formed in wind or water deposited silts and very fine sands. They are on terrace escarpments and along deeply dissected drainageways.
Merrimac	2%	The Merrimac series consists of very deep, somewhat excessively drained soils formed in outwash. They are nearly level through very steep soils on outwash terraces and plains and other glaciofluvial landforms.
Tunbridge	2%	The Tunbridge series consists of moderately deep, well drained soils on glaciated uplands. They are formed in loamy till.

Table 3.3.1.1.3-1: Summary Statistics of Riverbank Features and Characteristics – Turners Falls Impoundment

Riverbank Features	Characteristics					
Upper Riverbank Slope	Overhanging 1.8%	Vertical 1.6%	Steep 28.0%	Moderate 59.8%	Flat 8.8%	
Upper Riverbank Height	Low 15.5%	Medium 5.7%	High 78.8%			
Upper Riverbank Sediment	Clay -	Silt/Sand 95.6%	Gravel -	Cobbles -	Boulders 0.9%	Bedrock 3.5%
Upper Riverbank Vegetation	None to Very Sparse 1.9%	Sparse 1.3%	Moderate 17.1%	Heavy 79.7%		
Lower Riverbank Slope	Vertical 0.8%	Steep 2.3%	Moderate 27.5%	Flat/Beach 69.4%		
Lower Riverbank Sediment	Clay <0.1%[15]	Silt/Sand 59.6%	Gravel 7.9%	Cobbles 8.7%	Boulders 11.9%	Bedrock 11.9%
Lower Riverbank Vegetation	None to Very Sparse 88.3%	Sparse 3.5%	Moderate 3.2%	Heavy 5.0%		
Type of Erosion	Falls-Undercut 43.4%	Falls-Gullies 0.03%	Topples 1.1%	Slide or Flow 6.2%	Planar Slip 1.1%	Rotational Slump 1.5%
Potential Indicators of Erosion	Tension Cracks <0.10[16]%	Exposed Roots 38.1%	Creep/Leaning Trees 62.7%	Overhanging Bank 12.7%	Notch 5.0%	Other 1.1%
Stage of Erosion	Potential Future Erosion 5.5%	Active Erosion 0.6%	Eroded 9.1%	Stable 83.5%	In Process of Stabilization 1.3%[17]	

[15] Clay was found in few segments of the river but where some clay was found the sediment was dominated by another type of sediment either vertically or horizontally within a segment. When this occurred the segment was classified using the dominant sediment type. For example, some clay was observed in segment 342 (just downstream of Vernon Dam on the left bank) but the segment was classified using the dominant sediment type.
[16] Tension cracks can only be observed from land-based observations. Some tension cracks were observed during the land-based survey and are reported at those sites as indicated in the notes for the land-based work. Tension cracks were not observed to be significant in the more general top of bank observations when walking along the length of the Impoundment.
[17] While originally not one of the RSP erosion condition classifications, one riverbank segment was classified as being "In the Process of Stabilization" due to the fact that riverbank stabilization work was being constructed at this

Riverbank Features	**Characteristics**				
Extent of Current Erosion	None/Little 84.8%	Some 14.1%	Some to Extensive 0.5%	Extensive 0.6%	

particular segment (421, Bathory/Gallagher 2013) during the 2013 FRR. A gravel beach at the top of the lower riverbank had been placed along with large woody debris. Vegetation was then being planted to provide additional stabilization on the gravel beach as well as extending other vegetation onto portions of the upper riverbank.

Table 3.3.1.1.3-2: Riverbank Classification Definitions

RIVERBANK CHARACTERISTICS *(Upper and Lower)*[18]	
Riverbank Slope	**Overhanging** – any slope greater than 90º
	Vertical – slopes that are approximately 90º
	Steep – exhibiting a slope ratio greater than 2 to 1
	Moderate – ranging between a slope ratio of 4 to 1 and 2 to 1
	Flat – exhibiting a slope ratio less than 4 to 1[19]
Riverbank Height	**Low –** height less than 8 ft above normal river level[20]
	Medium – height between 8 and 12 ft above normal river level
	High – height greater than 12 ft above normal river level
Riverbank Sediment	**Clay –** any sediment with a diameter between .001 mm and 2 mm
	Silt / Sand – any sediment with a diameter between .062 mm and 2 mm
	Gravel – any sediment with a diameter between 2 mm and 64 mm
	Cobbles – any sediment with a diameter between 64 mm and 256 mm
	Boulders – any sediment with a diameter between 256 mm and 2048 mm
	Bedrock – unbroken, solid rock
Riverbank Vegetation	**None to Very Sparse –** less than 10% of the total riverbank segment is composed of vegetative cover
	Sparse – 10-25% of the total riverbank segment is composed of vegetative cover
	Moderate – 25-50% of the total riverbank segment is composed of vegetative cover
	Heavy – 50 % or greater of the total riverbank segment is composed of vegetative cover
Sensitive Receptors	Important wildlife habitat located at or near the riverbank.
EROSION CLASSIFICATIONS	
Type(s) of Erosion[21]	**Falls –** Material mass detached from a steep slope and descends through the air to the base of the slope. Includes erosion resulting from transport of individual particles by water.
	Topples – Large blocks of the slope undergo a forward rotation about a pivot point due to the force of gravity. Large trees undermined at the base enhance formation.
	Slides – Sediments move downslope under the force of gravity along one or several discrete surfaces. Can include planar slips or rotational slumps.
	Flows – Sediment/water mixtures that are continuously deforming without distinct slip surfaces.
Indicators of Potential Erosion	**Tension Cracks –** a crack formed at the top edge of a bank potentially leading to topples or slides (FGS, 2007)
	Exposed Roots – trees located on riverbanks with root structures exposed, overhanging.
	Creep – defined as an extremely slow flow process (inches per year or less) indicated by the presence of tree trunks curved downslope near their base (FGS, 2007)
	Overhanging Bank – any slope greater than 90º
	Notching – similar to an undercut, defined as an area which leaves a vertical stepped face presumably after small undercut areas have failed.
	Other – Indicators of potential erosion that do not fit into one of the four categories listed above will be noted by the field crew.[22]

[18] All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) were based on approximate estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that does not include quantitative analysis.
[19] Beaches are defined as a lower riverbank segment with a flat slope
[20] For the purpose of this report, Normal Water Level was defined as water levels within typical pool fluctuation levels, but below Ordinary High Water (186').
[21] FGS, 2007
[22] Segments with features classified as "Other" exhibited various erosion processes that did not fit in one of the existing classification categories.

Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of potential erosion
	Active Erosion – riverbank segment exhibits one or more types of erosion as well as evidence of recent erosion activity
	Eroded – riverbank segment exhibits indicators that erosion has occurred (e.g. lack of vegetation, etc.), however, recent erosion activity is not observed. A segment classified as Eroded would typically be between Active Erosion and Stable on the temporal scale of erosion.
	Stable – riverbank segment does not exhibit types or indicators of erosion
Extent of Current Erosion	**None/Little**[23] **–** generally stable bank where the total surface area of the bank segment has approximately less than 10% active erosion present.
	Some – riverbank segment where the total surface area of the bank segment has approximately 10-40% active erosion present
	Some to Extensive – riverbank segment where the total surface area of the bank segment has approximately 40-70% active erosion present
	Extensive – riverbank segment where the total surface area of the bank segment has approximately more than 70% active erosion present

[23] Riverbanks consist of an irregular surface and include a range of natural materials (silt/sand, gravel, cobbles, boulders, rock, and clay), above ground vegetation (from grasses to trees), and below ground roots of different densities and sizes. Due to these characteristics, there are small areas of disturbance which often occur at interfaces between materials, particularly in the vicinity of the water surface. These small disturbed areas can be considered as erosion, or sometimes can result from deposition or even eroded deposition. No natural riverbank exists which does not have at least some relatively small degree of disturbance or erosion associated with the natural combination of sediment types/sizes and vegetation. As such, the extent of erosion for generally stable riverbanks that include these relatively small disturbed areas is characterized as little/none.

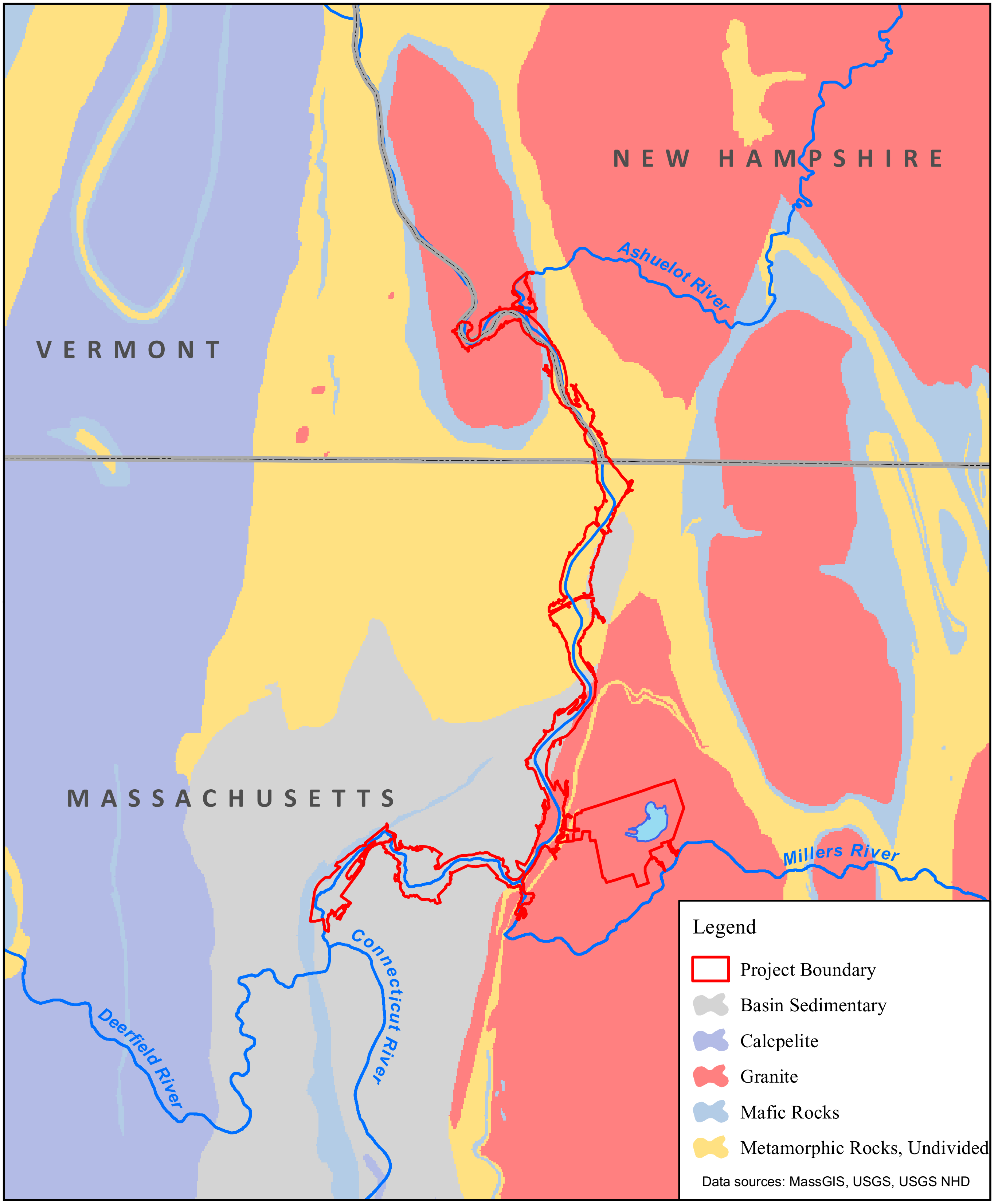
Table 3.3.1.1.4-1: Seasonal Range of Flows and SSC (2013-2015)[24]

Season	Months	Flow Range (cfs)	Median Flow (cfs)	SSC Range (mg/L)	Median SSC (mg/L)
Spring 2013	April - June	2,251-55,570	14,751	0.17-163.46	5.28
Summer 2013	July & August	1,318-61,733	8,750	0.29-149.62	5.20
Fall 2013	September-November	1,423-18,769	5,931	0.37-4.40	2.12
Spring 2014	April - June	1,731-68,338	20,080	0.05-449.76	11.47
Summer 2014	July & August	1,535-26,481	6,762	0.49-86.51	3.67
Fall 2014	September-November	1,360-25,450	5,160	0.14-157.3979	6.36
Spring 2015	April - June	1,668-66,725	15,340	2.00-43.02	10.68
Summer 2015	July	1,661-42,859	8,062	0.19-19.62	7.28

[24] SSC values were measured in the vicinity of the Rt. 10 Bridge

Table 3.3.1.2-1: Twenty Sites with Highest Erosion Rank from the Erosion Control Plan (1998) and Current Status

Site #	Site Name	Length in feet 1998	Status as of 2013 FRR
1	Vernon Dam	827	Base of Vernon dam. Left Bank - Not selected for stabilization due to extreme hydraulic conditions associated with Vernon spillway
2	Rod &Gun Club	20	Restored - 240 ft stabilized in 2004 – Turners Falls Rod & Gun Club
3	Bennett Meadow	100	Restored - 50 ft stabilized in 2005 – Bennett Meadows
4	Urgiel Upstream	1150	Restored - 1200 ft stabilized in 2001 – Urgiel Upstream
5	RT. 10	730	Upstream of RT 10 Bridge Left Bank - Not selected for stabilization due to unique hydraulic conditions in the vicinity of the Route 10 Bridge
6	Skalski	1640	Restored - 1600 ft stabilized in 2004 – Skalski
7	Flagg Farm	2180	Restored - 2500 ft stabilized 1999-2000 – Flagg
8	West bank	630	Not selected for stabilization – opposite great meadow
9	Old VT bridge west bank	260	Restored - 915 ft stabilized in 2007 – Kendall
10	River Road	500	Restored - 980 ft stabilized in 2003 – River Road
11	Urgiel Downstream	690	Restored - 980 ft stabilized in 2005 – Urgiel Downstream
12	Durkee Point	20	Restored - 500 ft stabilized in 2003 – Durkee Point
13	Across from River Road	20	Restored - Stabilized in 2009 – 1725 ft, Split River
14	Country Road (south)	2300	Restored - 850 ft stabilized in 2006 – Country Road (includes site #20)
15	NH island	210	Point of island. Not recommended for restoration, except for possible Preventative Maintenance work
16	Kaufold/Split River farm	4000	Restored – Stabilized in 2010-2012 – 1360 ft, Upper Split River 1; 1000 ft, Upper Split River 2; 1250 ft, Bathory-Gallagher; Wallace-Watson, 1000 ft. (Note: The combination of these sites was formerly known as the Kaufold site)
17	Rod & Gun Club at Narrows East Bank	560	Restored - 1000 ft stabilized by preventative maintenance in 2008 – Montague
18	Narrows	700	Restored - 1000 ft stabilized by preventative maintenance in 2008 – Campground Point
19	VT	450	Not selected for stabilization – below Davenport Island
20	Country Road (North)	480	Restored - 850 ft stabilized in 2006 – Country Road (included as part of site # 14)



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0 1.5 3 6 Miles

Figure 3.3.1.1.1-1 Bedrock Geology in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

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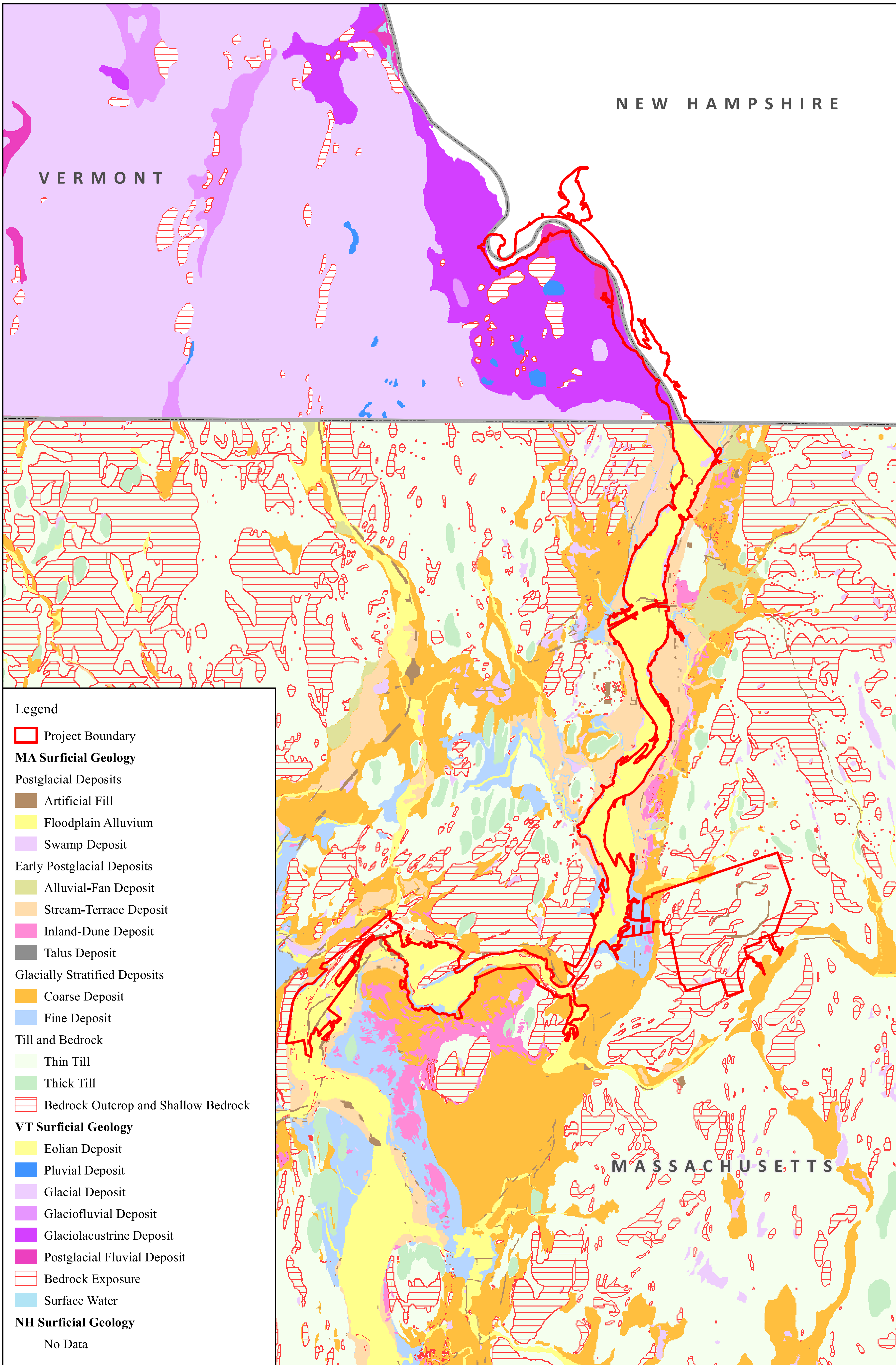

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Miles

Figure 3.3.1.1.1-2 Surficial Geology in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

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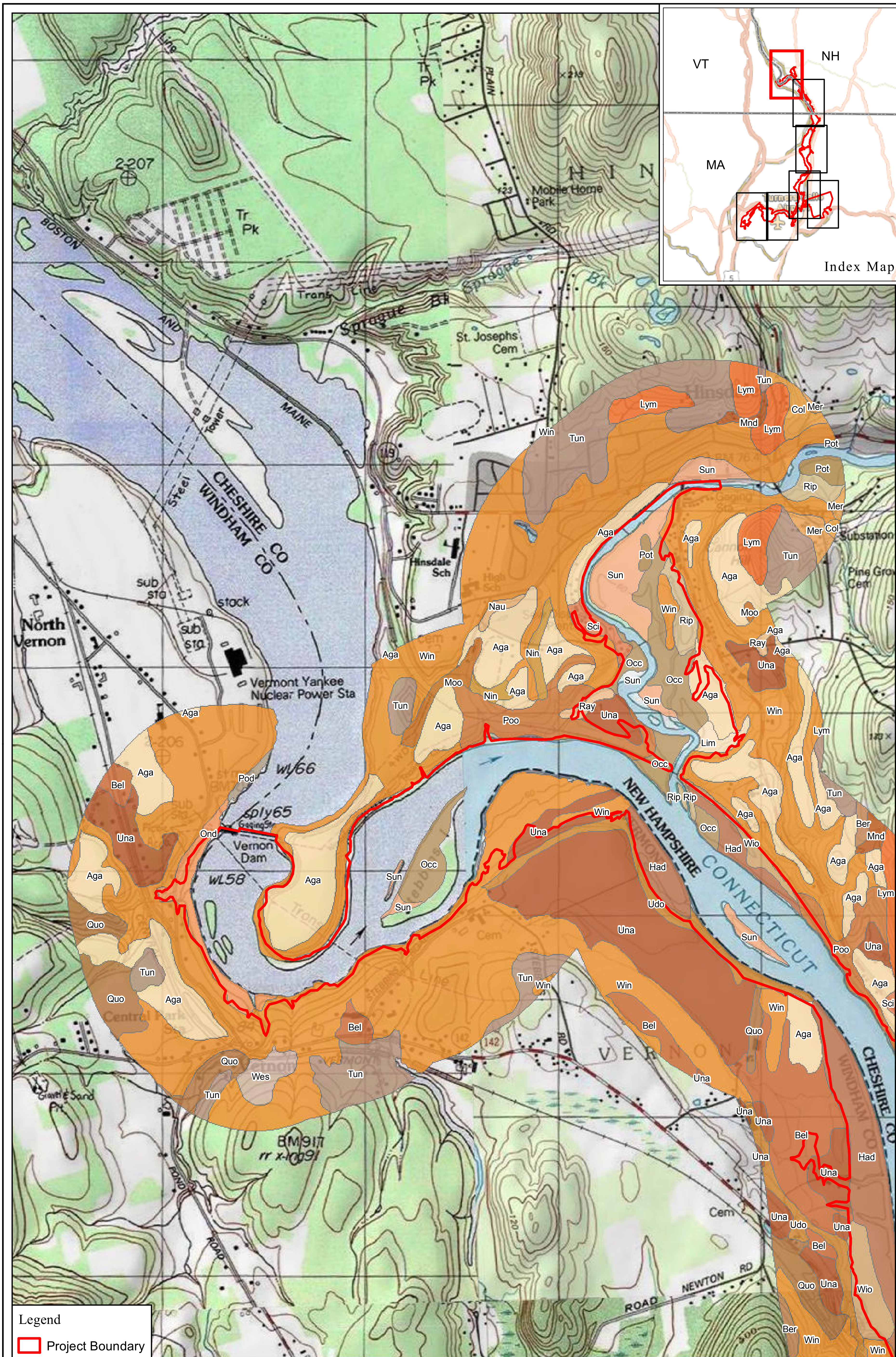

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 1

N

0 750 1,500 3,000 Feet

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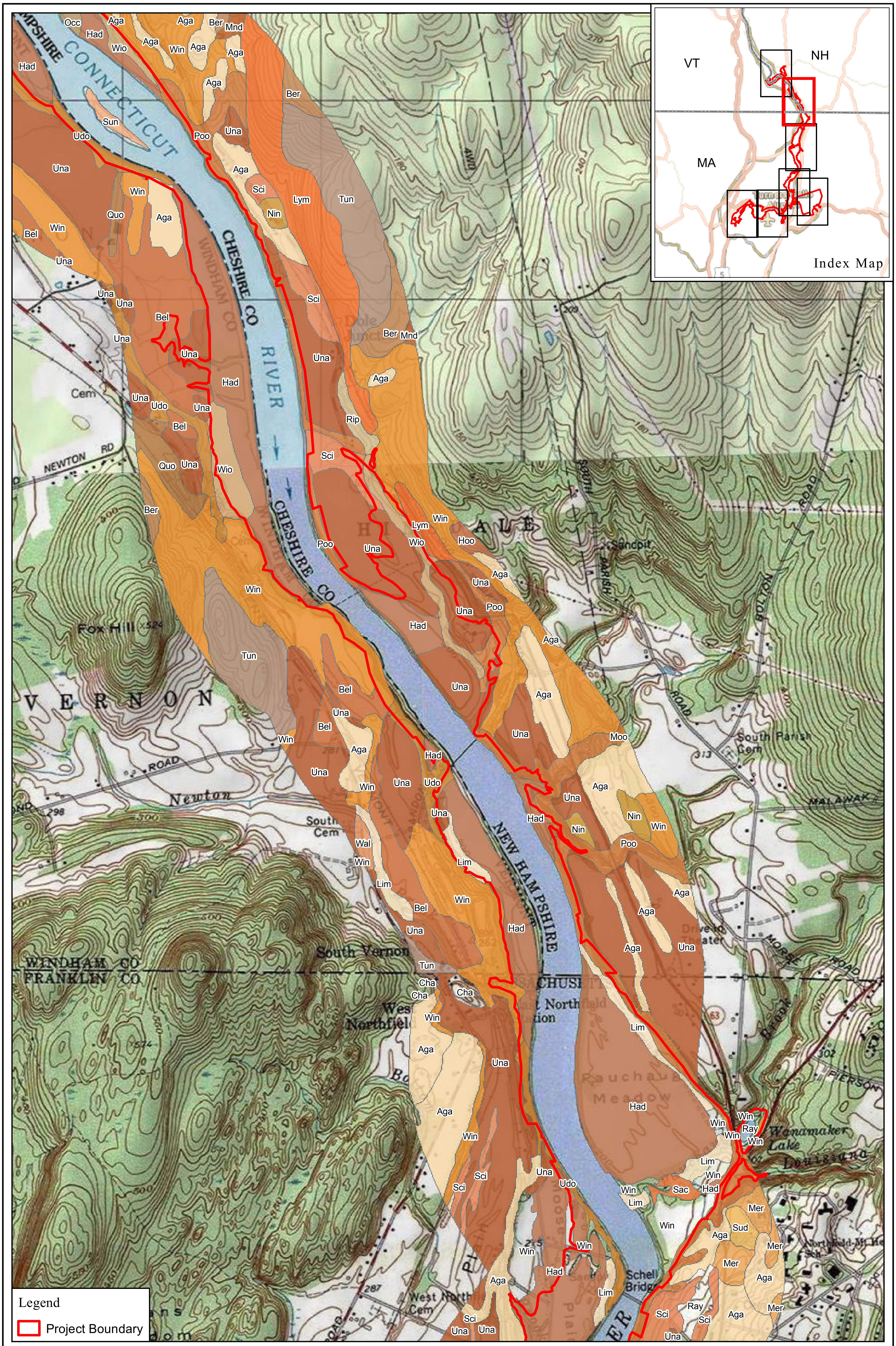

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 2

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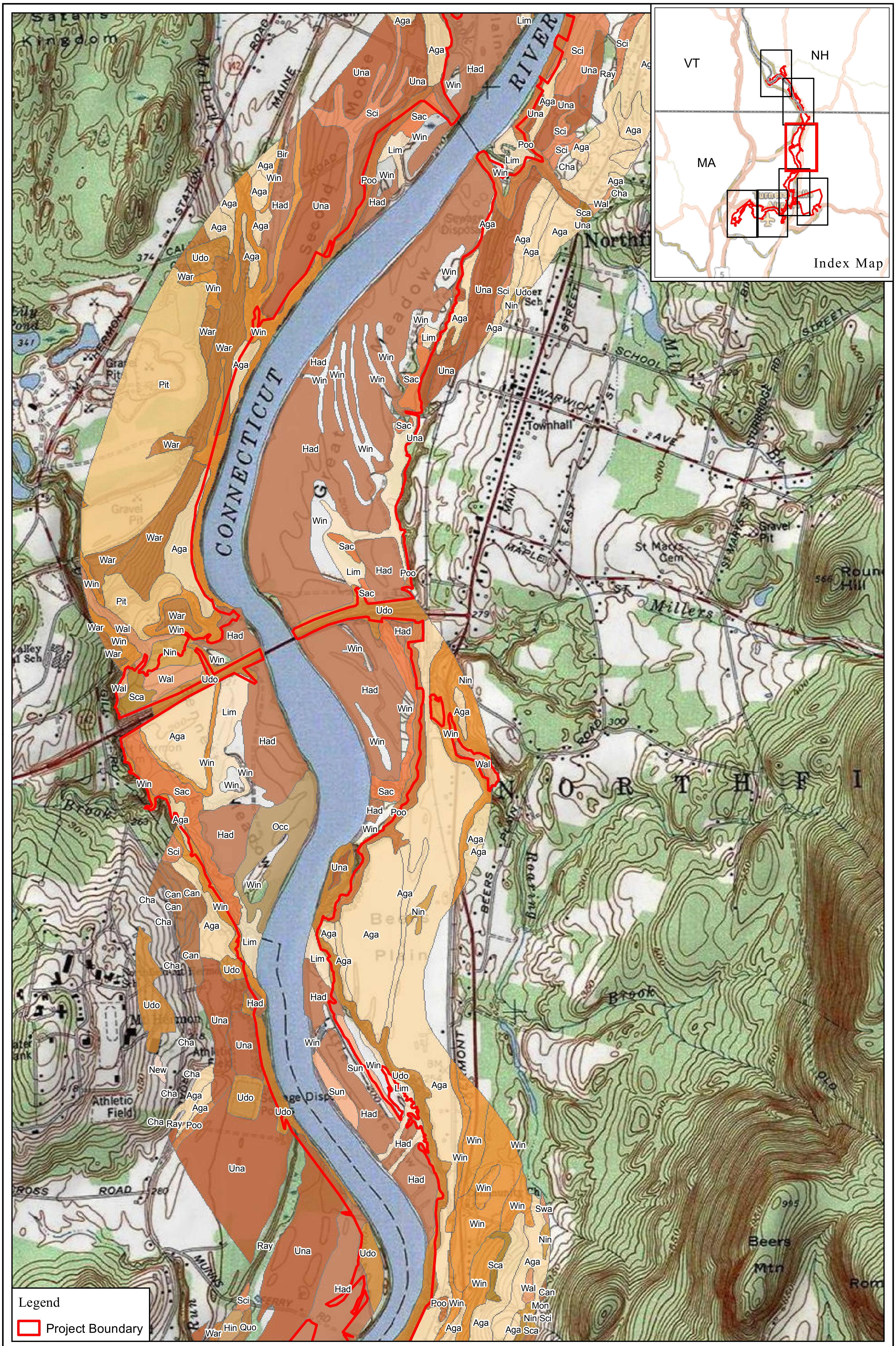

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 3

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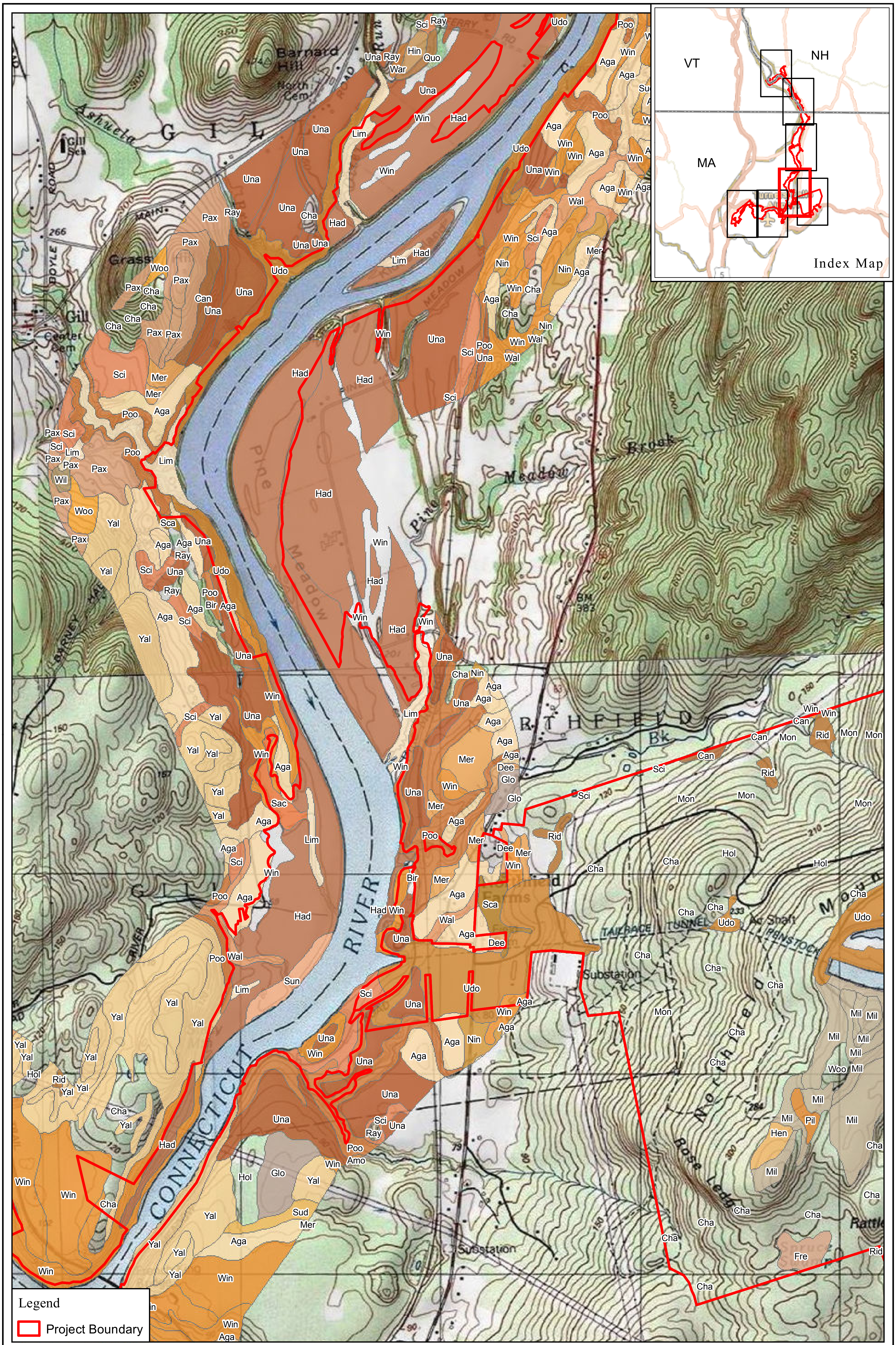

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 4

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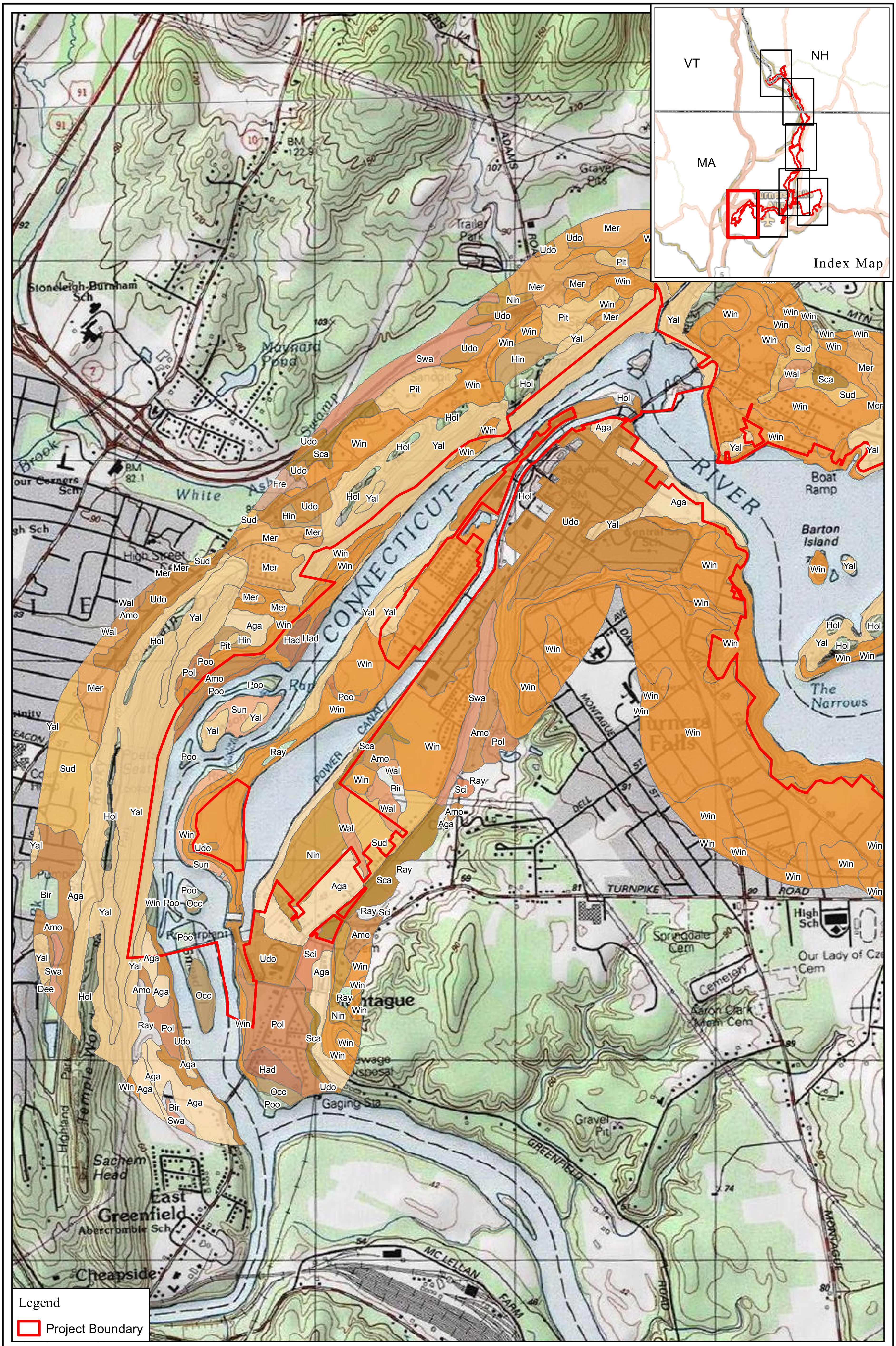

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 5

N

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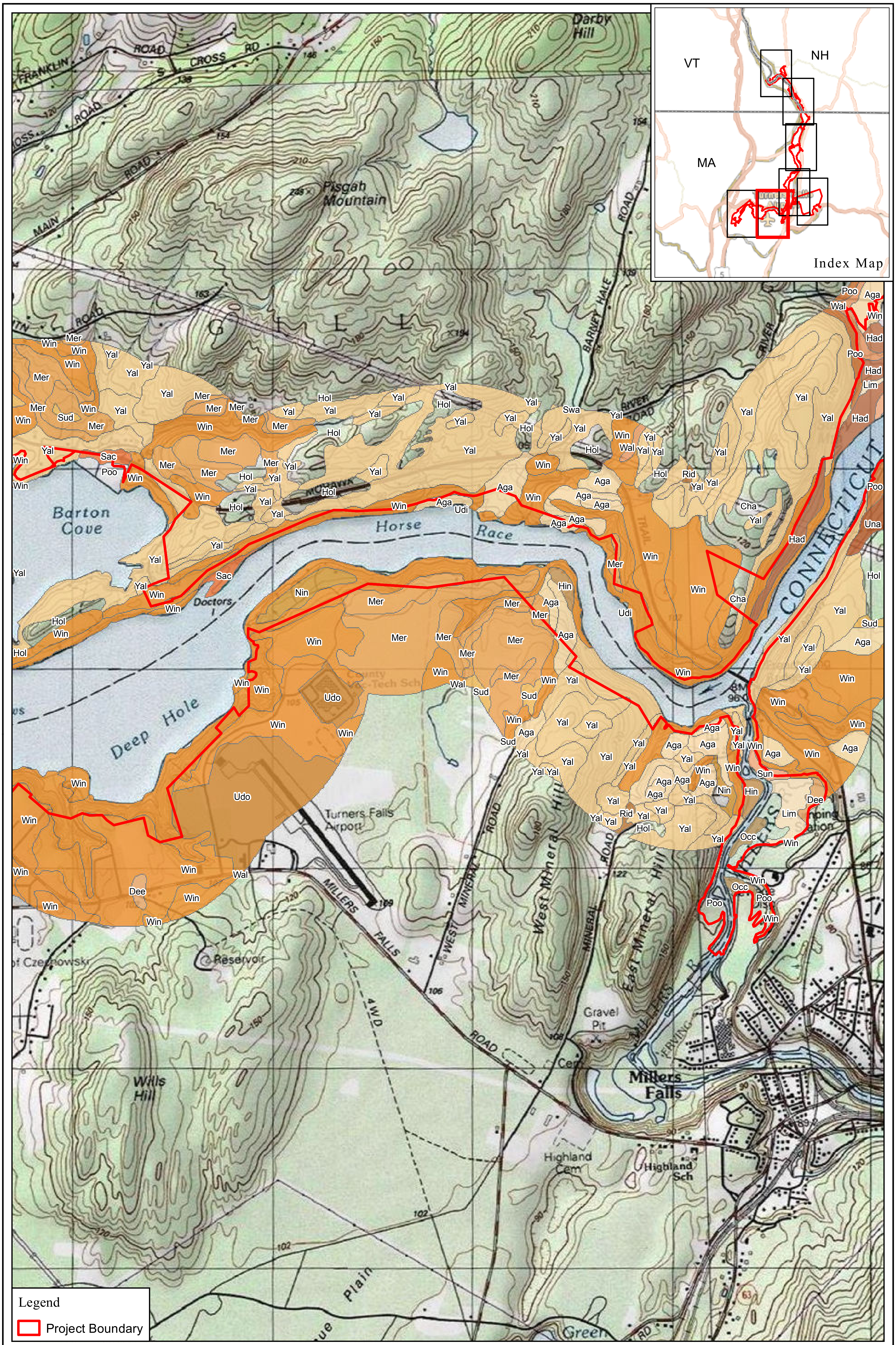

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 6

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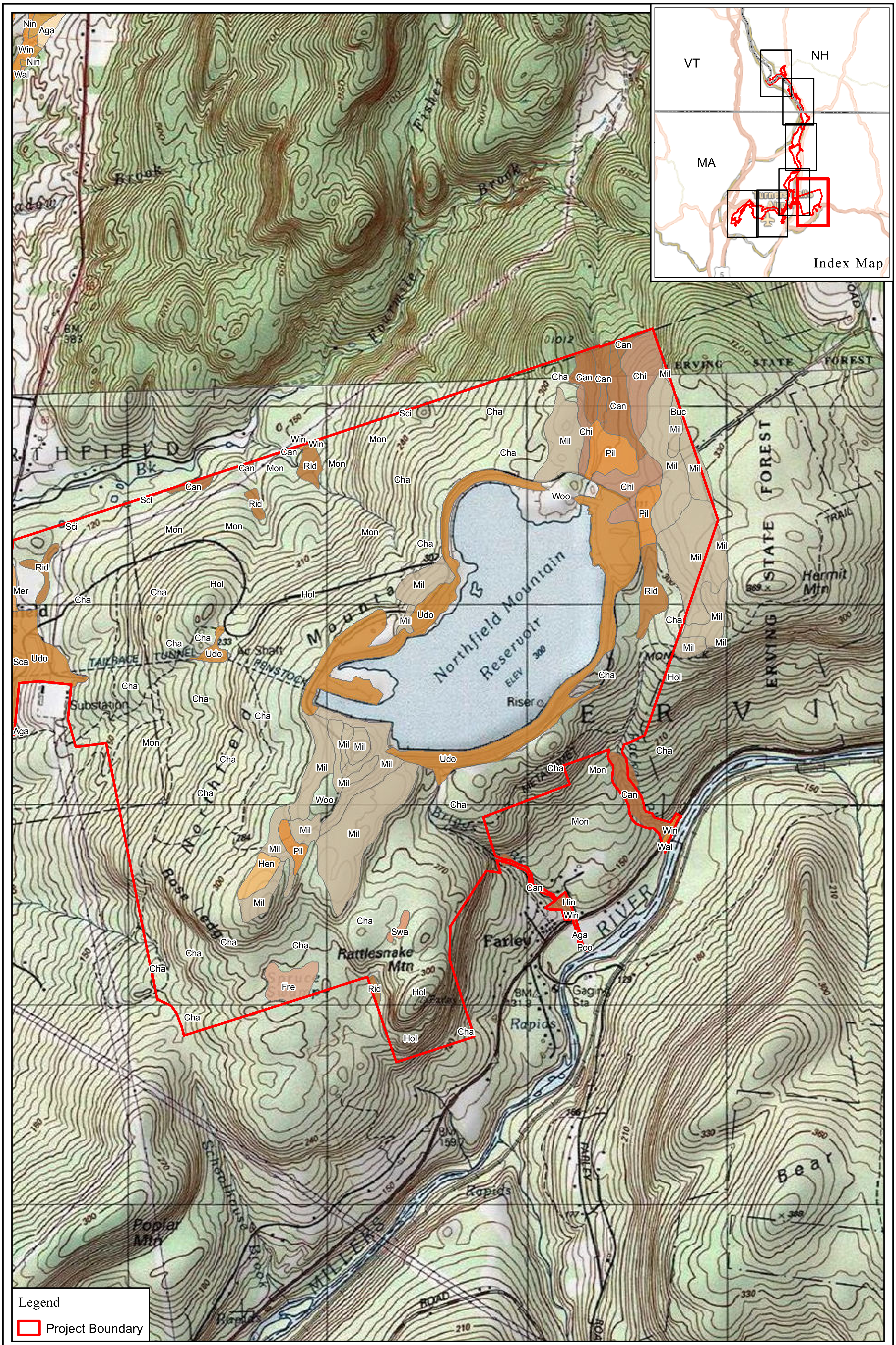

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 7

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Figure 3.3.1.1.2-1:
Legend for Soils in the Vicinity of the
Turners Falls and Northfield Mountain Projects
(Page 8 of 8)

- Aga -- Agawam
- Amo -- Amostown
- Bel -- Belgrade
- Ber -- Berkshire
- Bir -- Birdsall
- Buc -- Bucksport
- Can -- Canton
- Chi -- Chichester
- Chr -- Charlton
- Cht -- Chatfield
- Col -- Colton
- Dee -- Deerfield
- Fre -- Freetown
- Glo -- Gloucester
- Had -- Hadley
- Hen -- Henniker
- Hin -- Hinckley
- Hls -- Hollis
- Hly -- Holyoke
- Hoo -- Hoosic
- Lim -- Limerick
- Lym -- Lyman
- Mer -- Merrimac
- Mil -- Millsite
- Mnd -- Monadnock
- Mnt -- Montauk
- Moo -- Moosilauke
- Nau -- Naumburg
- New -- Newfields
- Nin -- Ninigret
- Occ -- Occum
- Ond -- Ondawa
- Pax -- Paxton
- Pil -- Pillsbury
- Pit -- Pits, gravel
- Pod -- Podunk
- Pol -- Pollux
- Poo -- Poocham
- Pot -- Pootatuck
- Quo -- Quonset
- Ray -- Raynam
- Rid -- Ridgebury
- Rip -- Rippowam
- Riv -- Riverwash
- Sac -- Saco
- Sca -- Scarboro
- Sci -- Scio
- Sct -- Scituate
- Sud -- Sudbury
- Sun -- Suncook
- Swa -- Swansea
- Tun -- Tunbridge
- Udo -- Udorthents
- Una -- Unadilla
- Wal -- Walpole
- War -- Warwick
- Wds -- Woodstock
- Wes -- Westbury
- Wil -- Wilbraham
- Win -- Winsdor
- Wio -- Winooski
- Woo -- Woodbridge
- Yal -- Yalesville-Holyoke complex

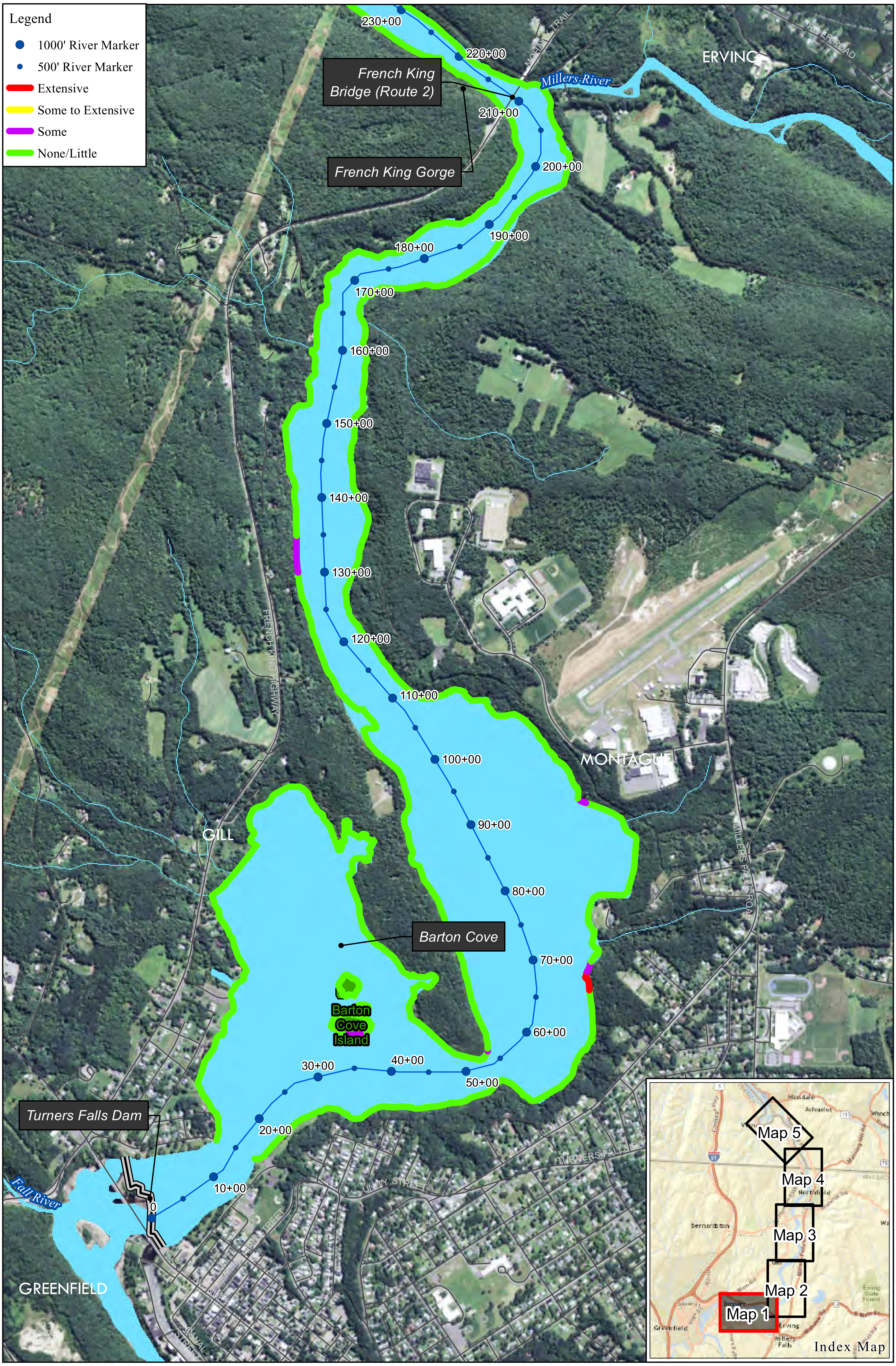

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 1

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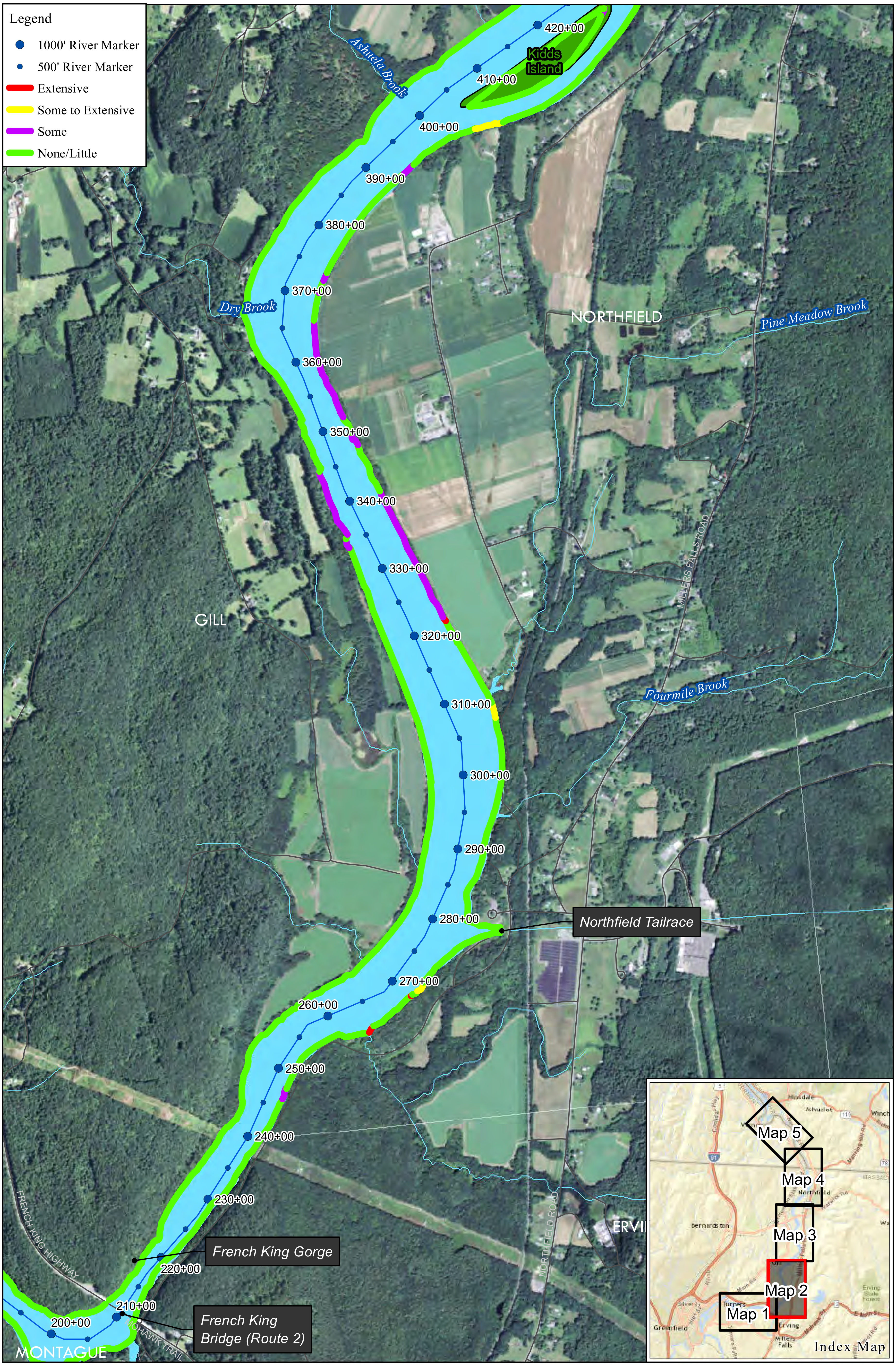

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 2

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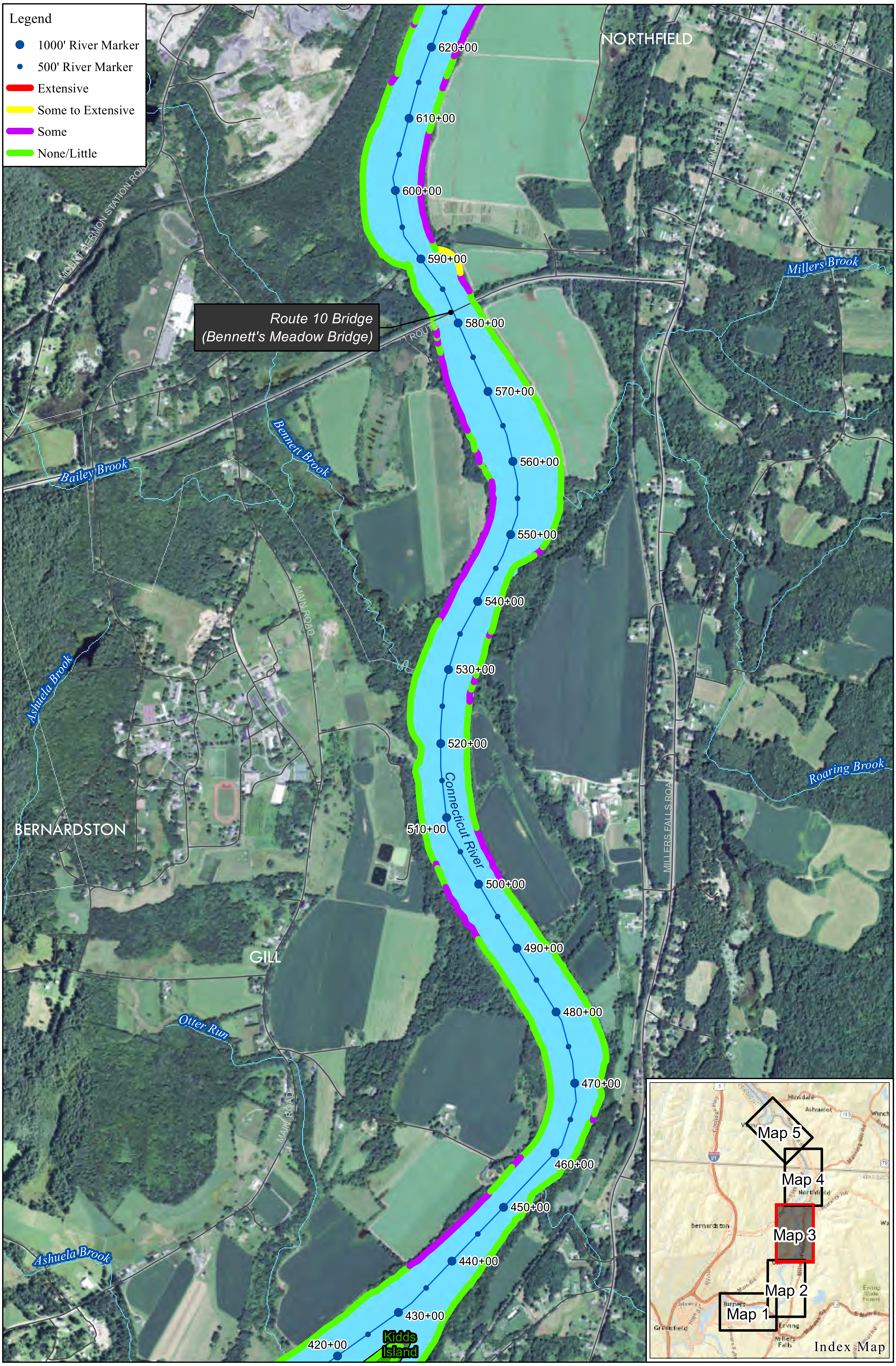

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 3

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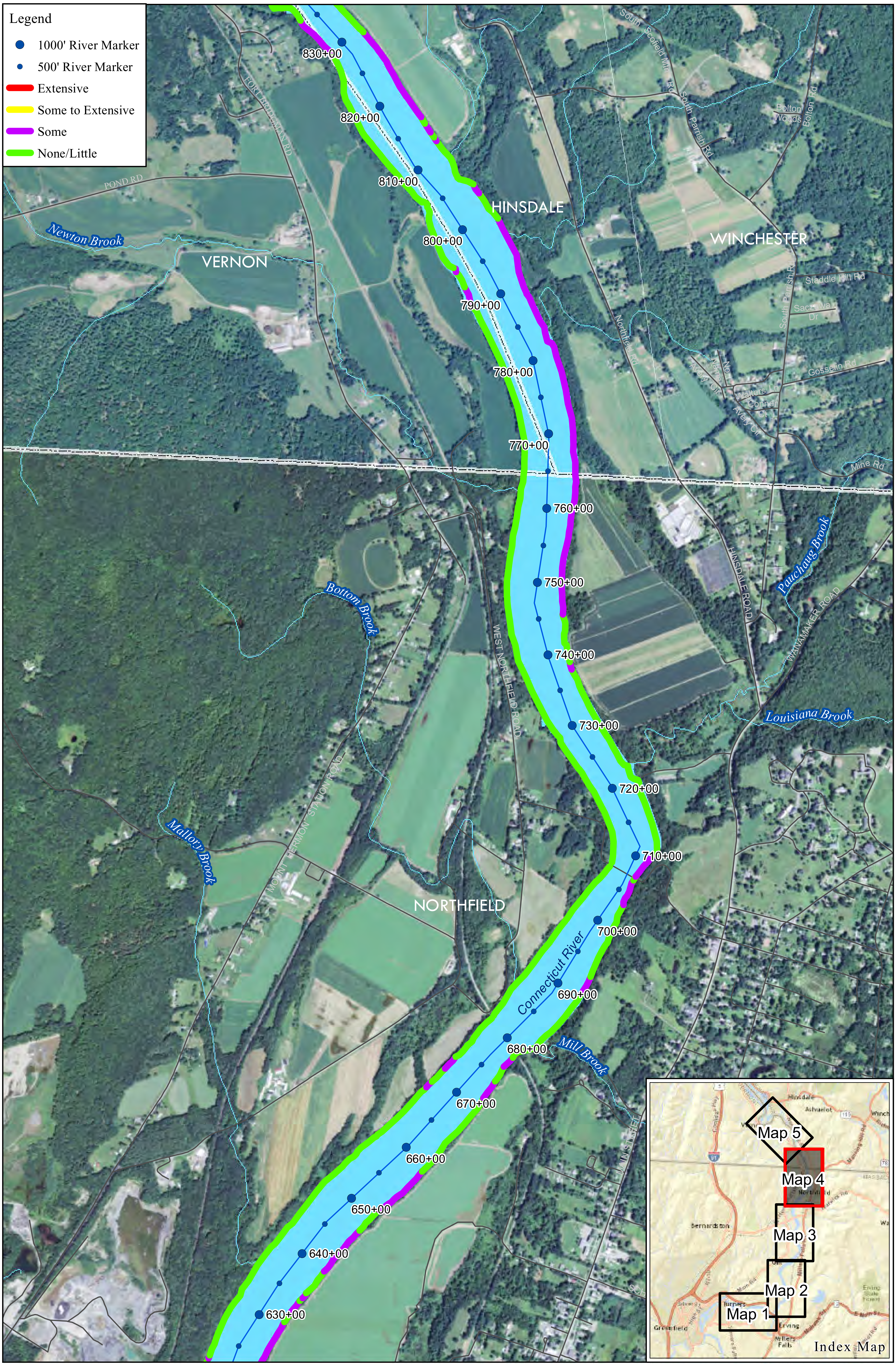

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 4

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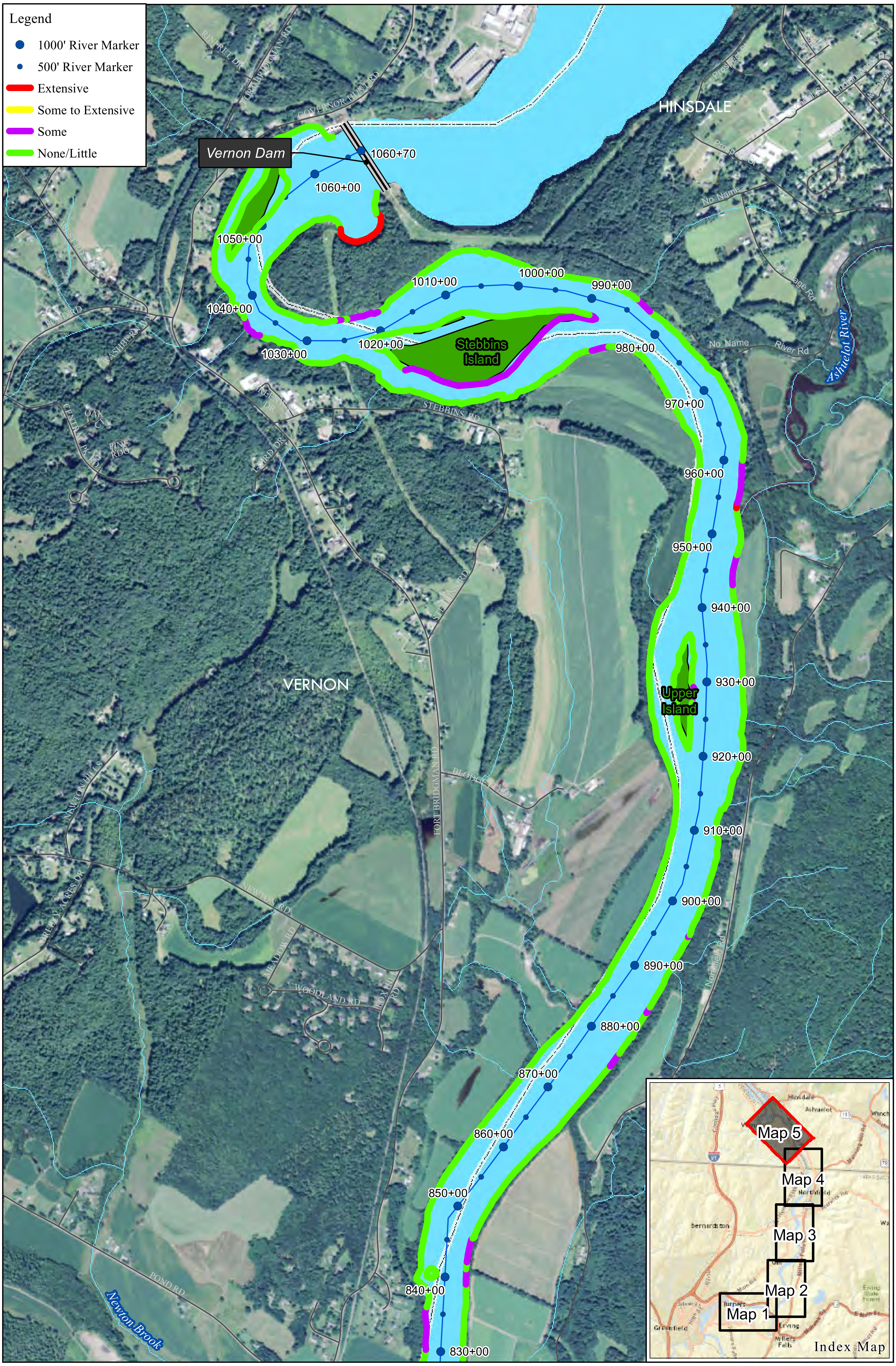

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 5

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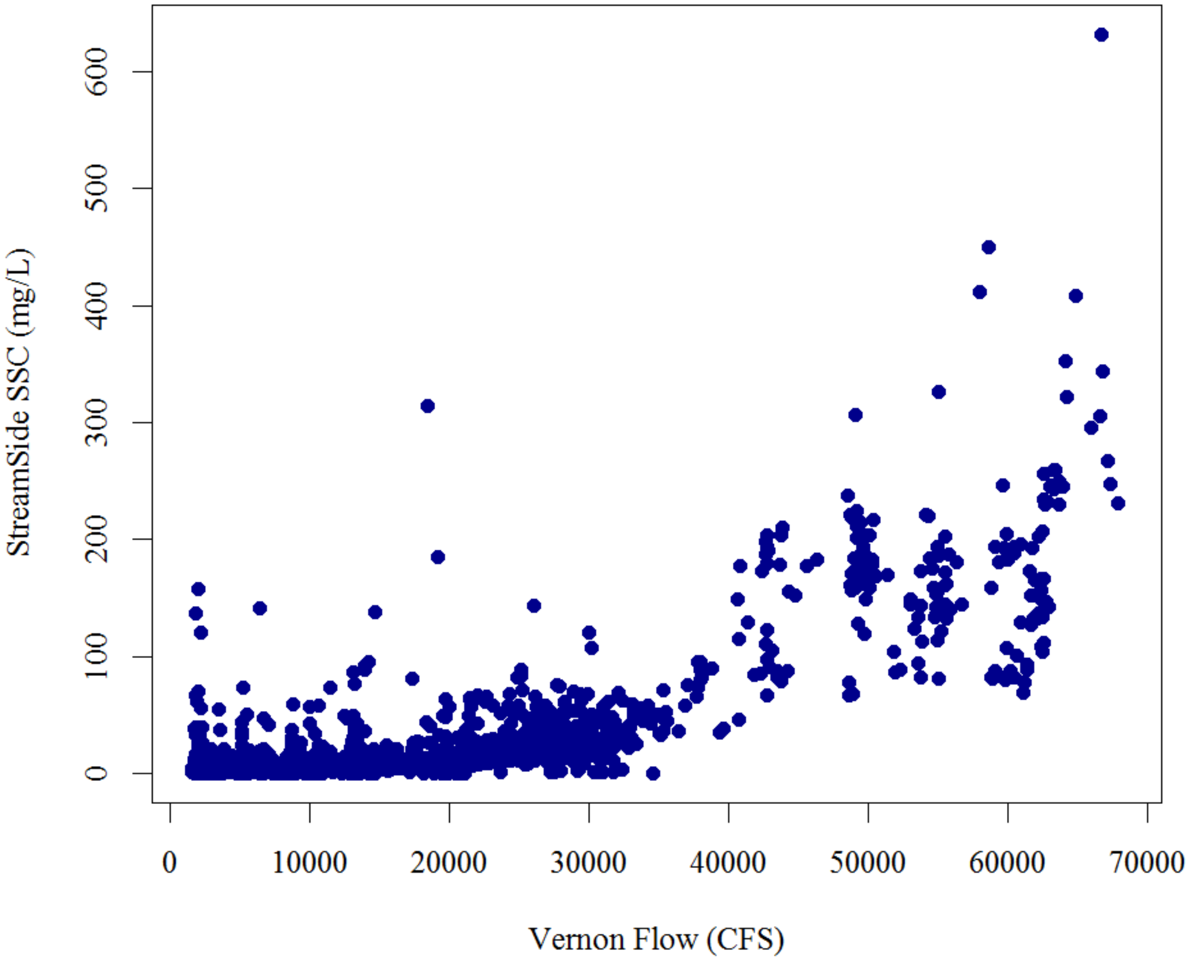

Figure 3.3.1.1.4-1: Connecticut River SSC vs. Vernon Discharge (2013-2015)[25]

[25] As measured in the vicinity of the Rt. 10 Bridge

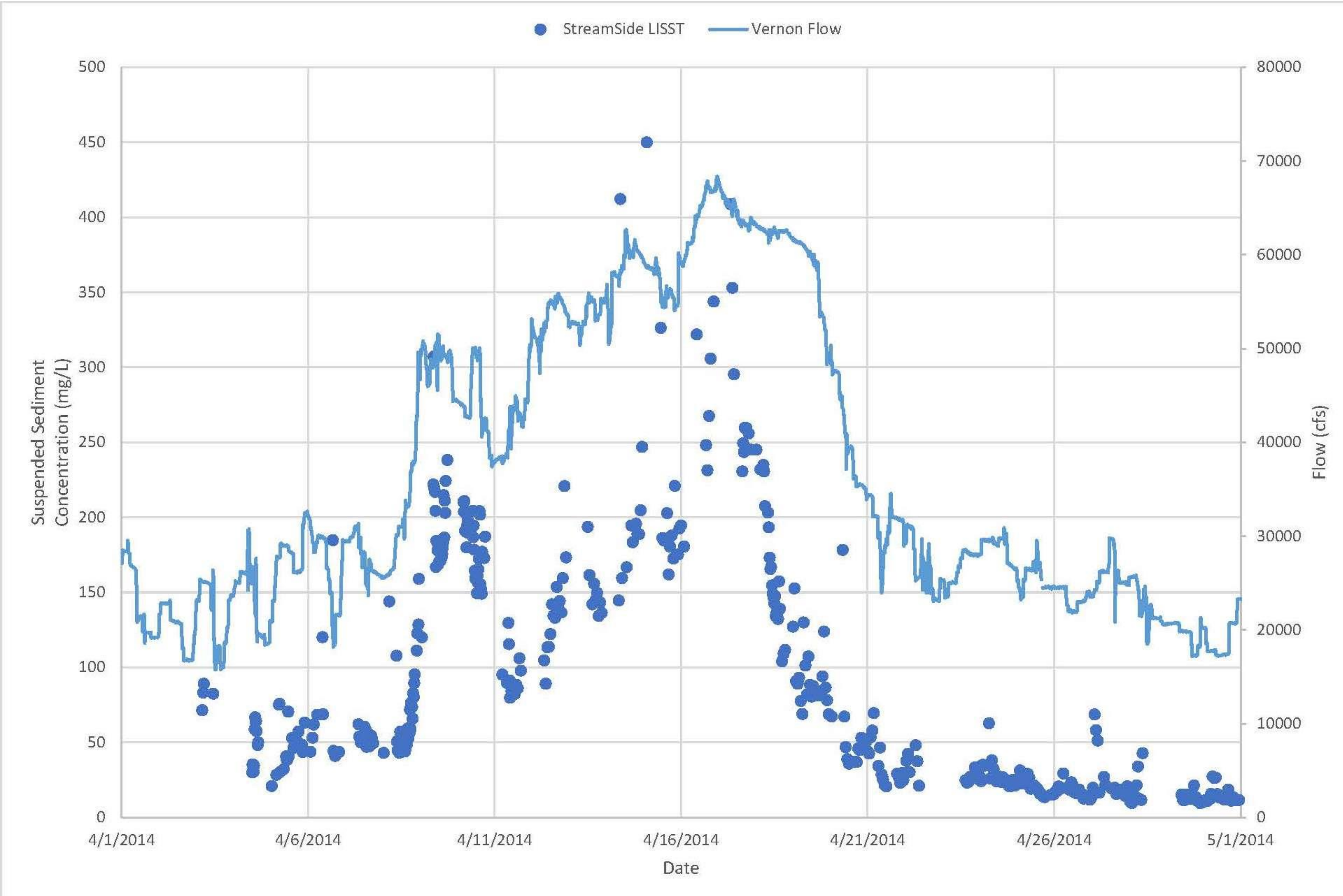

Figure 3.3.1.1.4-2: 2014 Spring Freshet – SSC vs. Flow[26]

[26] SSC values were measured in the vicinity of the Rt. 10 Bridge

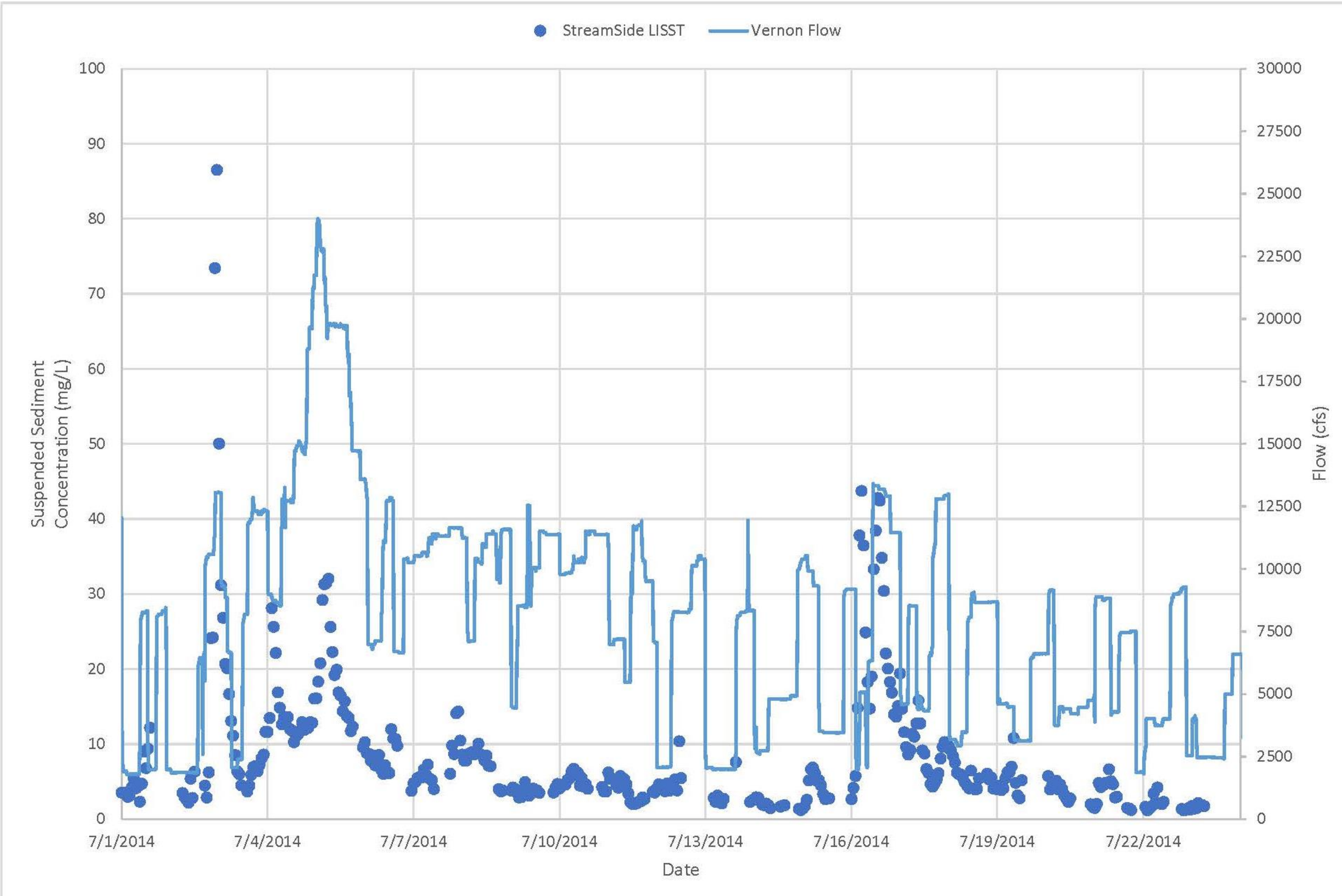

Figure 3.3.1.1.4-3: Typical Summer Period – SSC vs. Flow[27]

[27] SSC values were measured in the vicinity of the Rt. 10 Bridge

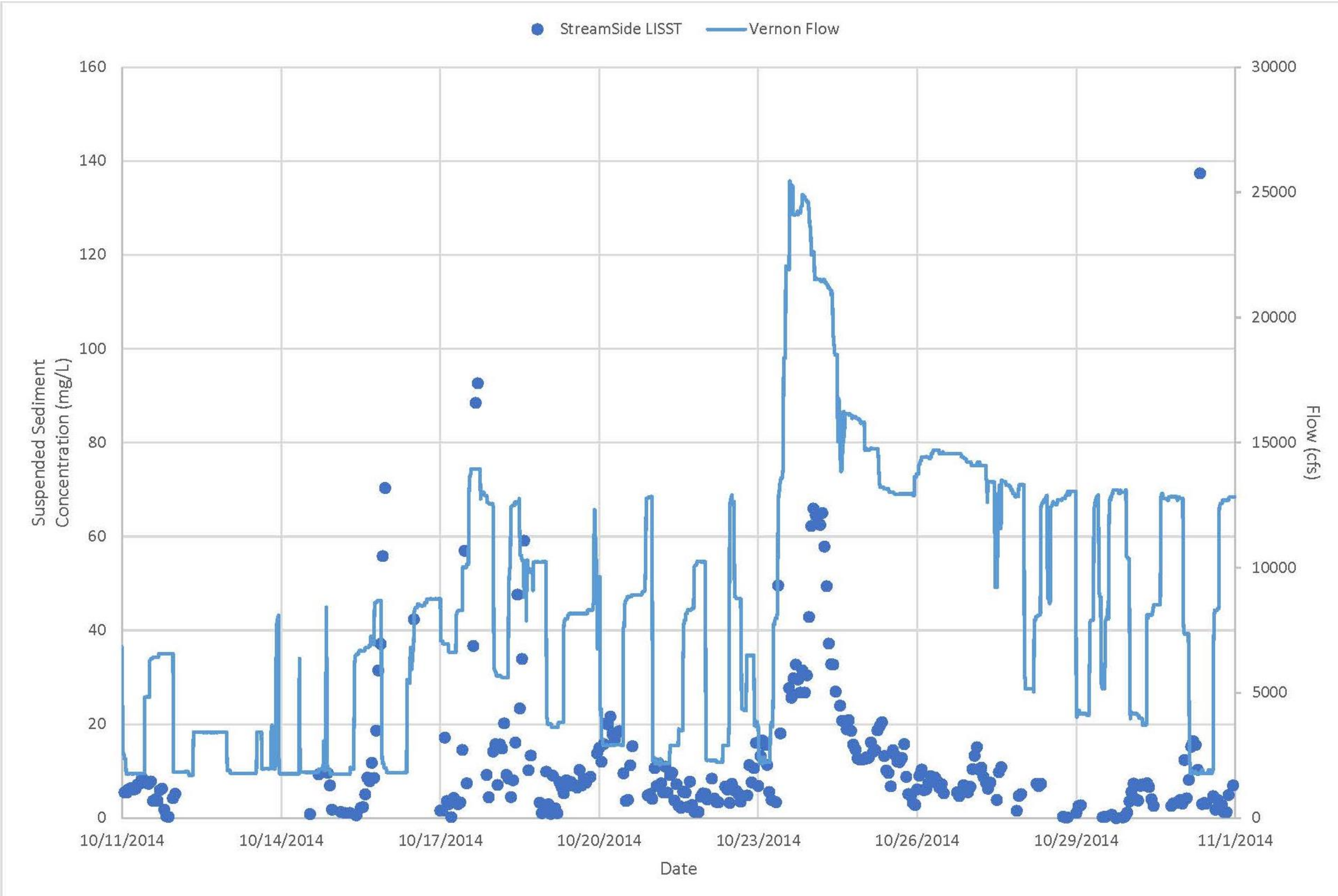

Figure 3.3.1.1.4-4: Typical Fall Period – SSC vs. Flow[28]

[28] SSC values were measured in the vicinity of the Rt. 10 Bridge

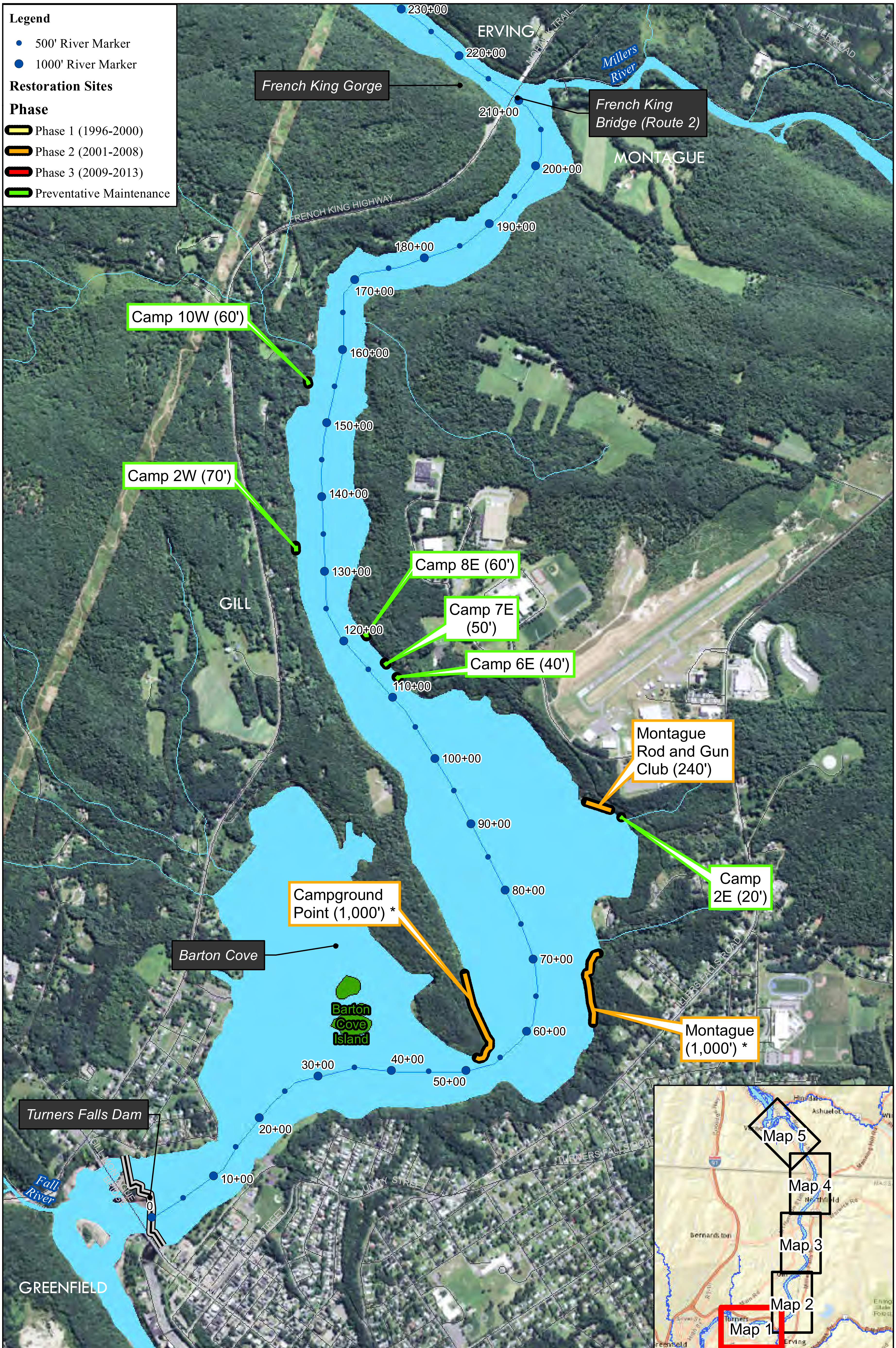

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Figure 3.3.1.2-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 1

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0 625 1,250 2,500 Feet

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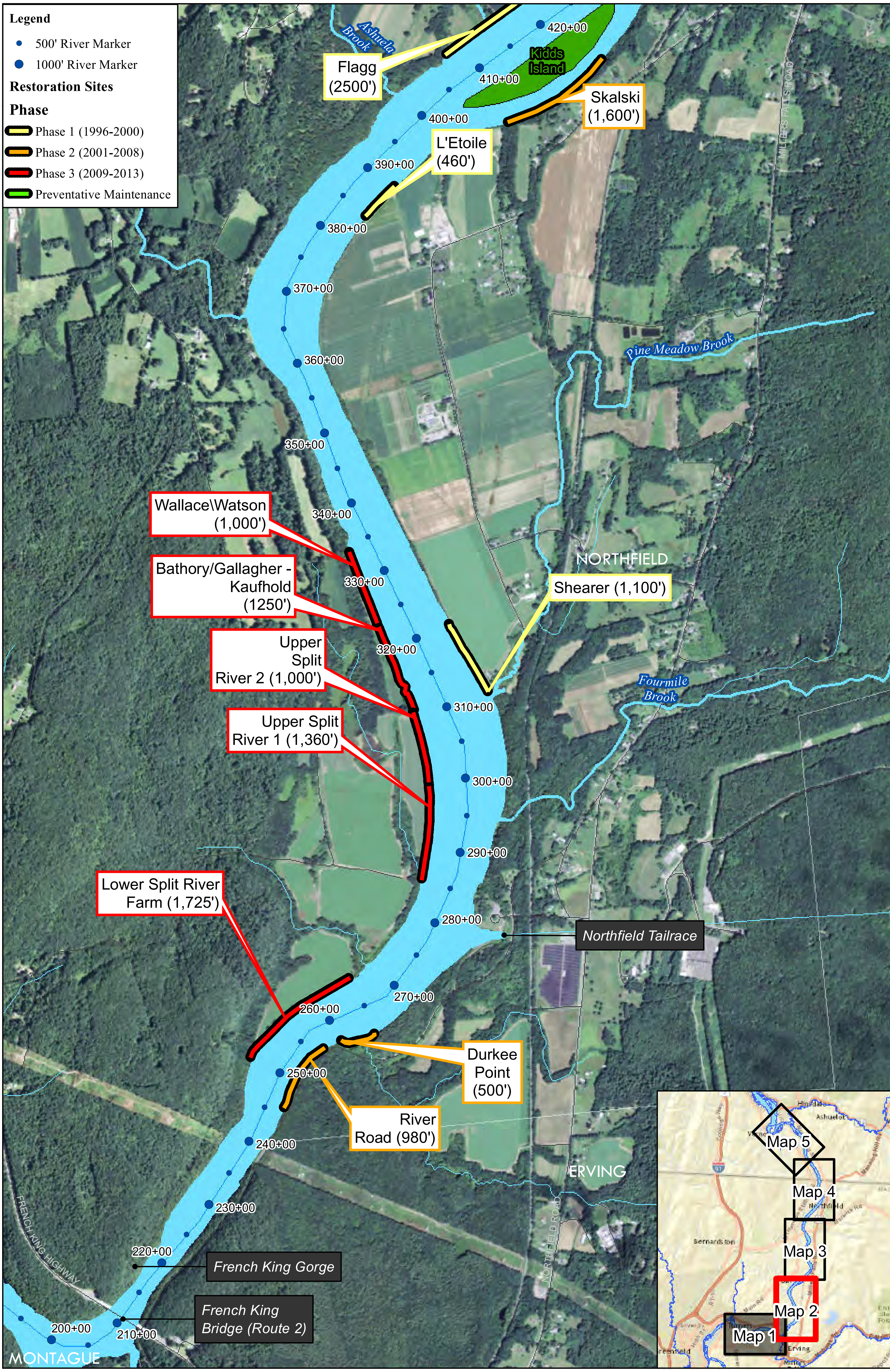

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0 625 1,250 2,500 Feet

Figure 3.3.1.2-2:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 2

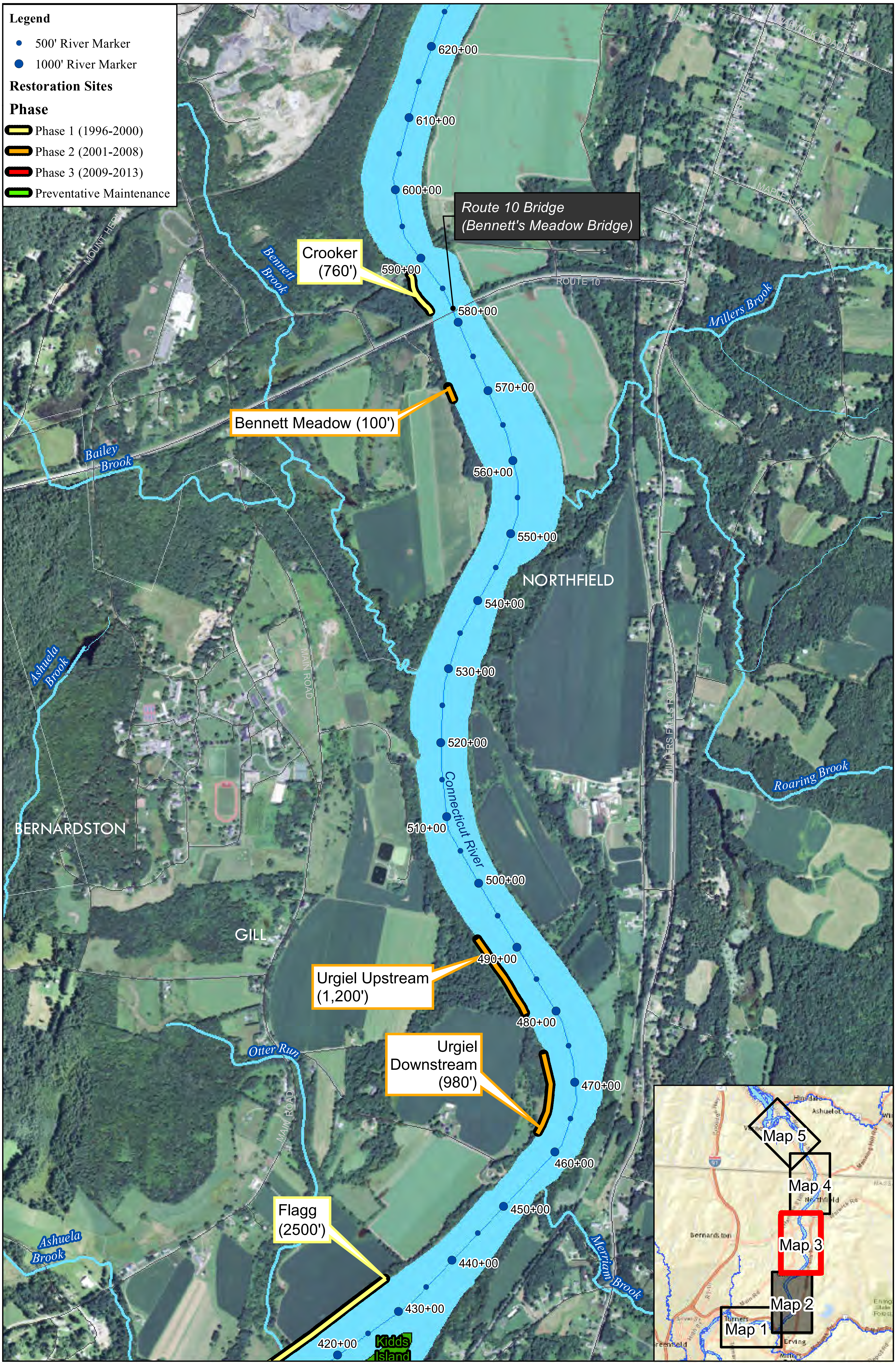

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Figure 3.3.1.2-3:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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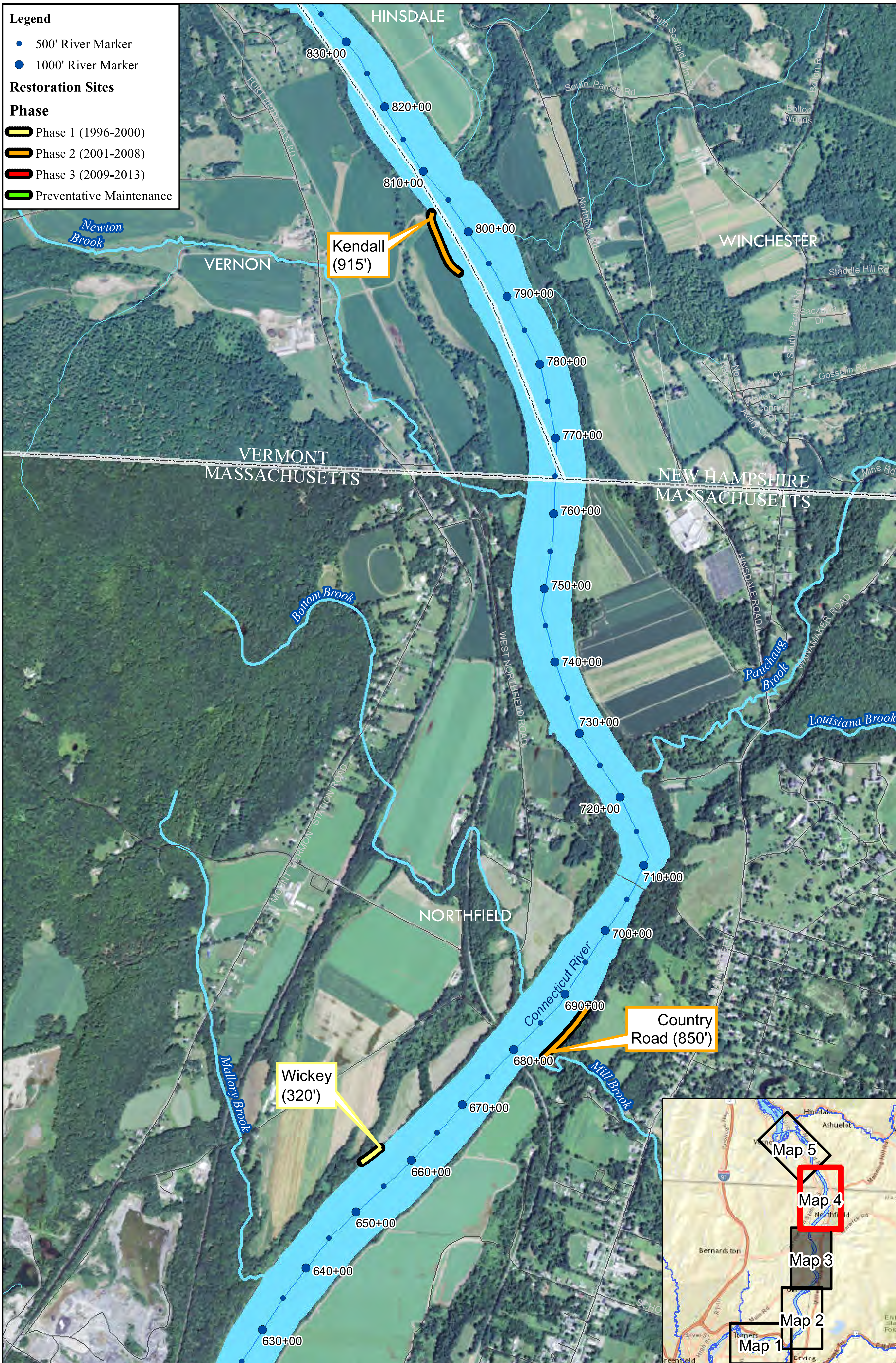

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

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Figure 3.3.1.2-4:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 4

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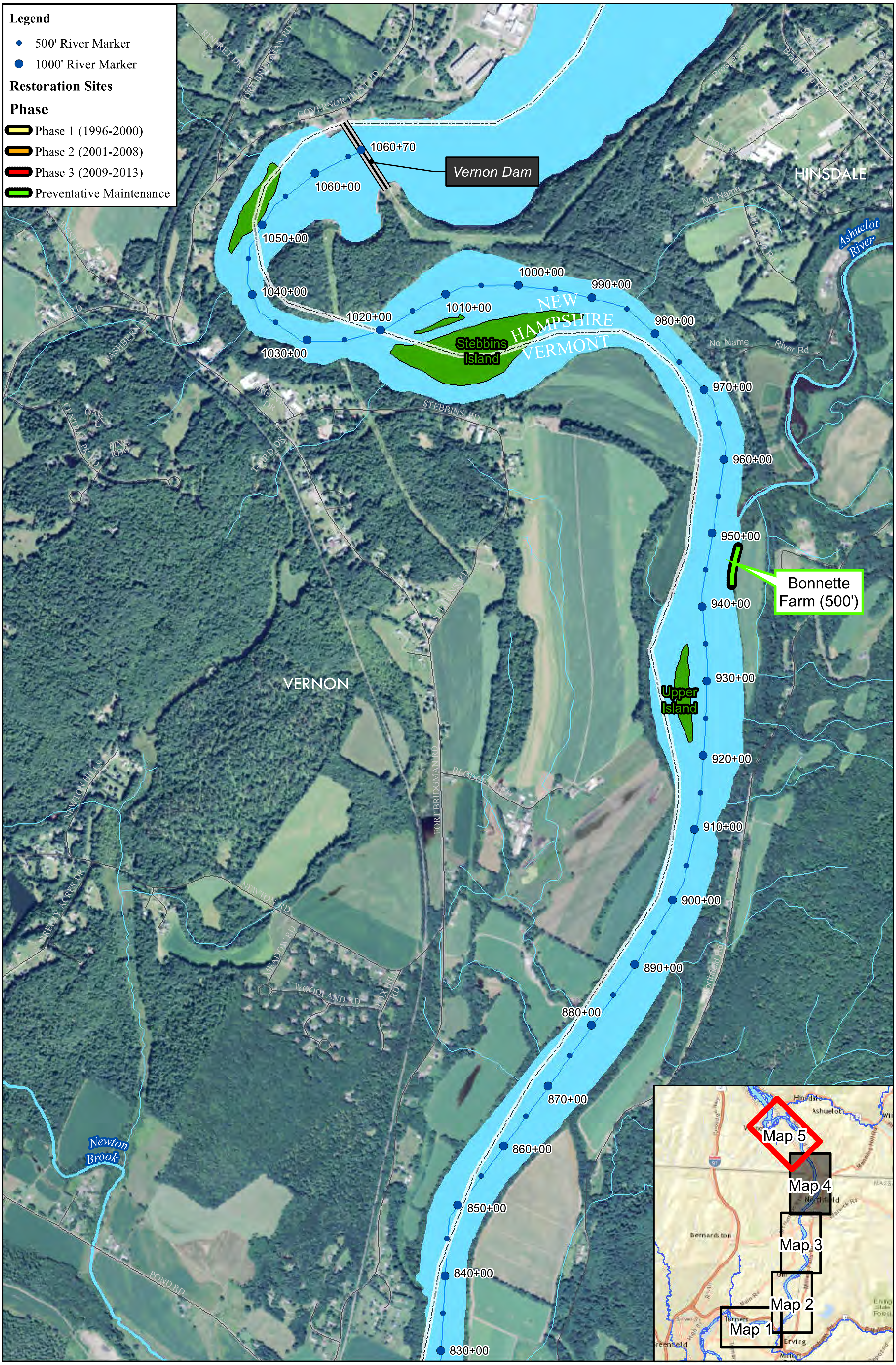

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Draft License Application
Exhibit E

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Figure 3.3.1.2-5:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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3.3.2 Water Resources

3.3.2.1 Affected Environment

3.3.2.1.1 Water Quantity

The Connecticut River drains an area of 11,250 mi^2. Within Massachusetts, the Connecticut River traverses approximately 67 river miles and drains approximately 2,726 mi^2. The total watershed area upstream of the Turners Falls Dam is 7,163 mi^2.

Upstream Dams

Inflows to the TFI are largely controlled by operations at several upstream dams on the Connecticut River. More specifically, five upstream dams on the Connecticut River operate as seasonal storage reservoirs, where water elevations are typically lowered in the fall and winter, and refilled with the spring freshet. The seasonal operation and re-regulation of discharges from these dams provides benefits to downstream hydropower facilities by curtailing high flows in the spring and increasing low flows in the summer for the benefit of hydropower production. These dams and storage volumes, in upstream to downstream order, include the following:

First Connecticut Lake,	3.33 billion ft^3
Second Connecticut Lake,	506 million ft^3
Lake Francis,	4.326 billion ft^3
Moore Reservoir, and	4.97 billion ft^3
Comerford Reservoir.	1.279 billion ft^3

Pursuant to a 1993 Headwater Benefit Agreement among predecessor companies and TransCanada, FirstLight pays an annual headwater benefit fee to TransCanada for the seasonal operation of its storage reservoirs (primarily driven by Moore Reservoir), which provides an incremental increase in generation at Cabot and Station No. 1. The Northfield Mountain Pumped Storage Development does not receive any benefit as its operation is independent of river flows.

In addition to the seasonal storage reservoirs, the next three projects (operated by TransCanada) above Turners Falls Dam - namely Vernon, Bellows Falls, and Wilder - operate as peaking hydropower facilities, whereby flows can fluctuate on an hourly basis. Like Turners Falls Dam, the minimum flow at Vernon Dam is equivalent to 0.2 cfs per square mile of drainage area or 1,250 cfs, which is provided from generation. The Vernon Hydroelectric Project has a station hydraulic capacity of 17,130 cfs[29] and when operating at full capacity, it exceeds the full hydraulic capacity of the Turners Falls Development of 15,938 cfs, not accounting for incremental inflow from the 897 mi^2 between the two dams. The magnitude and timing of discharges from the Vernon Hydroelectric Project are critical to the operation of the Turners Falls and Northfield Mountain Pumped Storage Developments.

Vernon Hydroelectric Project FERC license Article 304[30] requires TransCanada to coordinate project operations with FirstLight. A letter Agreement amending the original 1993 Headwater Benefit Agreement was filed with FERC on June 20, 2003. The Agreement requires TransCanada to provide FirstLight by 8:00 am each day, with its estimate of total discharge (cfs-hours) expected the next day at the Vernon Project. When TransCanada receives the hourly dispatch schedule for the next day from the ISO-NE, it faxes or emails the schedule for Vernon discharges to FirstLight by 2:00 pm. There is no current requirement, however, for TransCanada to provide an hourly dispatch schedule the day ahead. If any subsequent dispatch

[29] FERC Order Amending License and Revising Annual Charges, Project No. 1904-042, July 28, 2006.
[30] Article 304 was added to the license in 1992 (59 FERC ¶62,267) and generally requires the Licensee of Project No. 1904 (Vernon Hydroelectric Project) to develop and file with the Commission a coordination agreement with the licensee of certain downstream facilities in the event that the regional central dispatch system or NEPEX was ever discontinued. The dispatching of these hydropower projects under that system was discontinued several years ago in connection with the restructuring of the New England power markets.

schedules are received during the operating day showing changes in the projected hourly release schedules, the revised schedule for Vernon is faxed or emailed to FirstLight. Not having reliable and timely estimates of Vernon's hourly release schedule the day ahead prevents FirstLight from the most efficient management of the TFI for power production.

Hydrology and Streamflow

USGS streamflow monitoring gages located on the Connecticut River and its tributaries to the Connecticut River in the Project area are described below and shown in Figure 3.3.2.1.1-1.

Connecticut River at North Walpole, NH (No. 01154500, 5,493 mi^2).

This gage is located upstream of the Vernon Dam, in Vernon, VT. Between the North Walpole gage and the Turners Falls Dam are the Vernon Hydroelectric Project and the Northfield Mountain Pumped Storage Development[31]. The gage has a period of record from March 1942 to present. USGS notes that the flow measured at this gage is regulated by power plants and by reservoirs in the watershed, including First Connecticut and Second Connecticut Lakes, Lake Francis, and Moore and Comerford Reservoirs.

Using the gage's period of record, annual and monthly flow duration curves were developed as shown in Figure 3.3.2.1.1-2 through Figure 3.3.2.1.1-6. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-1.

Connecticut River at Vernon, VT (No. 01156500, 6,266 mi^2)

Over 87% of the drainage area at the Turners Falls Dam is from inflow received by the Vernon Hydroelectric Project. The remaining 13% of drainage area is from tributaries to the TFI, primarily the Ashuelot and Millers Rivers. A USGS gage was located directly below Vernon Dam, and was active from approximately Oct 1944 to Sep 1973, but was discontinued by the USGS when the Turners Falls Dam was raised causing the backwater, at times, to extend to the base of Vernon Dam, thus impacting the gage's rating curve. Using the gage's historic average daily flow data (Oct 1944-Sep 1973), an annual and monthly flow duration curves were developed as shown in Figure 3.3.2.1.1-7 through Figure 3.3.2.1.1-11. With the Vernon Hydroelectric Project having a hydraulic capacity of 17,130 cfs, on an annual basis, TransCanada can control discharges into the TFI approximately 84% of the time; 16% of the time Vernon's hydraulic capacity is exceeded. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-2.

- Ashuelot River at Hinsdale, NH (No. 01161000, 420 mi^2)

The Ashuelot River enters the TFI approximately 3.5 miles upstream of the Massachusetts border from the east. Ashuelot River flows are regulated by the USCOE Surry Mountain Lake 33 miles upstream (since 1942), the USCOE's Otter Brook Lake, 29 miles upstream on Otter Brook (since 1958), and by small hydro plants upstream. The Ashuelot River gage became active in 1907.

- Millers River at Erving, MA (No. 01166500, 372 mi^2)

This gage is located 5.5 miles upstream of the mouth of the Millers River. The Millers River enters the TFI approximately 4.0 miles upstream of the Turners Falls Dam, immediately downstream of the French King Bridge. Millers River flows are regulated by power plants and by Lake Monomonac and other reservoirs; high flow is regulated by the USCOE's Birch Hill Reservoir, 22 miles upstream (since 1941) and Tully Lake (since 1948). The Millers River gage became active in 1915.

- Deerfield River near West Deerfield, MA (No. 01170000, 557 mi^2)

31 Prior to December 2014, the Vermont Yankee Nuclear Facility withdrew cooling water from the Vernon Impoundment.

This gage is located 9.2 miles upstream of the mouth of the Deerfield River, which enters the Connecticut River mainstem approximately 3,500 feet below the Cabot Station tailrace. Deerfield River flows are regulated by Somerset Reservoir (since 1913), by Harriman Reservoir (since 1924), and by several power plants upstream. The period of record for this gage includes discharge records from March to November 1904, January 1905, March to December 1905, and October 1940 to current year.

- Connecticut River at Montague City, MA (No. 01170500, 7,860 mi^2)

This gage is located downstream of Cabot Station and approximately 1,000 feet downstream from the mouth of the Deerfield River (total drainage area of 663 mi^2). The gage has a period of record from April 1940 to present. USGS remarks for the gage indicate that flow is regulated by power plants and by upstream reservoirs in the watershed.

Using the gage's period of record, annual and monthly flow duration curves were developed as shown in Figures 3.3.2.1.1-12 through Figure 3.3.2.1.1-16. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-3.

Estimated Connecticut River Flow at Turners Falls Dam (7,163 mi^2)

The Connecticut River flow at the Turners Falls Dam was estimated using the Montague and Deerfield River USGS gages for overlapping periods of record. The additional drainage area at the Montague gage compared to the Turners Falls Dam is 697 mi^2, of which the bulk of the increase is attributable to the Deerfield River (557 mi^2 as measured at the USGS gage and 665 mi^2 as measured at its the confluence with the Connecticut River). The Deerfield River gage flow data were prorated by a factor of 1.25 (697/557) to represent the additional inflow from the 697 mi^2 drainage area. This prorated flow was then subtracted from the corresponding flow measured at the Montague gage to estimate flows at Turners Falls Dam.

Annual and monthly flow duration curves for the period Jan 1941 through Dec 2014 were calculated for Turners Falls Dam, and are presented in Figure 3.3.2.1.1-17 through Figure 3.3.2.1.1-21. With the Turners Falls Development having a hydraulic capacity of 15,938 cfs, on an annual basis, FirstLight can control discharges from the Turners Falls Development approximately 76% of the time; 24% of the time the Turners Falls Development's hydraulic capacity is exceeded. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-4.

Overview of Water-Related Project Features

This section describes the major water-related components of the Turners Falls Development and Northfield Mountain Pumped Storage Development, associated gaging stations maintained by the Licensee, and typical water level and flow conditions measured at these gages based on 10 years of data (2000-2009). FirstLight maintains hourly data (elevations, discharges, generation, and pumping) on daily log sheets. These data were used to develop numerous graphs in this section to summarize how the Turners Falls Development and Northfield Mountain Pumped Storage Development operate. The hourly data from 2000-2009 were used to develop duration curves of elevation and flow. Both annual and monthly (three months/plot) duration curves were developed to illustrate seasonal variability. All gages referenced below are shown in Figure 3.3.2.1.1-22. Note that all FirstLight gages that measure the water surface elevation are based on the same msl datum (specifically NGVD 1929 datum).

Water Withdrawals

This section summarizes additional surface water withdrawals in the TFI. The Massachusetts Water Management Act (MAWMA), which became effective in March 1986, authorizes the MADEP to regulate the quantity of water withdrawn from both surface and groundwater supplies. The MAWMA consists of a registration program (for withdrawals existing in 1988) and a permit program for withdrawals commencing after 1988. Since 1988, persons withdrawing water from ground or surface sources in excess of an annual average of 100,000 gallons per day (GPD) or 9 million gallons in any three month period must either file an annual registration (for existing withdrawals) or apply for a MAWMA Permit (new withdrawals). Non-consumptive uses, such as hydroelectric facilities, are not required to register or obtain MAWMA permits.

The TFI is not used as a source of domestic drinking water supply or for industrial purposes. Farms along the TFI use river water for irrigation.

A list of current MAWMA water registrations and permits was obtained from the MADEP. The water withdrawal registrations and permits within the Connecticut River basin, for the towns of Northfield and Montague (including the Village of Turners Falls) were reviewed. The MADEP shows that the only current surface water withdrawal permitted or registered under the MAWMA from Connecticut River waters is for agricultural purposes: Four Star Farms, in Northfield (MAWMA Permit No.: 9P2-1-06-217.03), is allowed an authorized daily withdrawal volume of 0.167 million gallons per day (MGD or 0.26 cfs) from the TFI. Compared to the Connecticut River flow at this location, this withdrawal volume is negligible. In addition to Four Star Farms, Sudbury Nurseries West, LLC at Great Meadow Road in Northfield is currently permitted a withdrawal from the TFI under the MAWMA.

In addition to the registered Four Star Farms withdrawal under the MAWMA, FirstLight is aware of four water withdrawals, in the Massachusetts reach of the TFI, where no MAWMA water registrations and permits were obtained from the MADEP. From north to south, they include:

Nourse Farms, Inc. Caldwell Road, West Northfield, MA (two withdrawal locations);
Smiarowski Brothers, LLC, Great Meadow Road, Northfield, MA;
Northfield Mount Hermon School, off Main Street, Gill, MA;
Spilt River Farm, River Road, Gill MA.

There are several entities withdrawing water from the Turners Falls power canal. For a description of water usage on the canal, refer to Exhibit A (Table 1.4-1) which lists the water users, approximate hydraulic capacity, and FERC project number (where applicable).

3.3.2.1.2 Water Quality

Water Quality Standards and Classifications

Massachusetts

The Massachusetts Surface Water Quality Standards (314 CMR 4.00) assign all inland, coastal, and marine waters to classes according to the intended beneficial uses of those waters. For example, Class A waters are designated as the source of public water supplies and, where compatible with this use, should also be suitable for supporting aquatic life, recreational uses such as swimming and boating, and fish consumption. Class B waters are not designated as a source of public water supplies, but are designated for all of the other Class A uses. Class C waters should be suitable for aquatic life and recreational uses where contact with the water is incidental, such as boating and fishing, but may not be suitable for swimming, diving, or water skiing. Inland waters are also subcategorized as to fishery type (e.g., “warm water fishery”) based on the waterbody’s natural capacity to support these resources.

The Commonwealth of Massachusetts classifies the entire Connecticut River as Class B, Warm Water Fishery. Applicable water quality standards for Massachusetts are listed in Table 3.3.2.1.2-1.

New Hampshire

New Hampshire water quality standards apply to the Connecticut River upstream of the Massachusetts border. The state of New Hampshire has designated the entire Connecticut River as Class B.

According to applicable water quality standards for New Hampshire, Class B waters shall: have *Escherichia coli* levels that do not exceed a geometric mean of 126 colonies/100 milliliter (ml, based on at least 3 samples obtained over a 60-day period) or more than 406 colonies/100 ml in any one sample; have no objectionable physical characteristics; and contain a dissolved oxygen content of at least 75% of saturation.

The New Hampshire Rivers Management and Protection Act (RSA 483) provides general guidance for future land use in the New Hampshire corridor of the Connecticut River. Under this act, the Connecticut River is designated as a rural river segment from the point 0.3 miles below the Vernon Dam to the Massachusetts line (RSA 483:15, VIII). The law defines these waters as "*adjacent to lands which are partially or predominantly used for agriculture, forest management and dispersed or clustered residential development. Management of rural river... segments shall maintain and enhance the natural, scenic, and recreational values of the river for agricultural, forest management, public water supply, and other purposes which are compatible with the instream public uses of the river and the management and protection of the resources for which the...segment is designated*" (RSA 483:7-a River Classification Criteria, I(b)).

Vermont

Although the Connecticut River is commonly thought to define the boundary between Vermont and New Hampshire, it is located in New Hampshire (i.e., the state border is on the Vermont shoreline[32]). However, Vermont considers most of the Connecticut River to be a Class B waterbody. Vermont's water numerical quality standards for Class B waters include: *Escherichia coli* are not to exceed 77 organisms/100 ml, and dissolved oxygen levels shall not be less than 5 milligram/liter (mg/l) and 60% saturation at all times (for warm water fish habitat waters). Vermont's water quality standards also include narrative protective criteria.

Historical Water Quality

The following sections describes water quality conditions in the Project area based on information from historical studies.

Water Quality Assessment and Impairments

Every two years, states must file a document called the "Integrated List" to comply with sections 303d and 305b of the Clean Water Act. The Integrated Lists for Massachusetts and New Hampshire divide the Connecticut River into distinct segments for the purpose of determining water quality uses and impairments. The 2014 Integrated Lists for Massachusetts and New Hampshire report that the entire Connecticut River is water quality impaired. Impaired waters are listed as "Category 5," which indicates that a total maximum daily load (TMDL) study is required for that particular water body.

From upstream to downstream, a description of each water body segment and associated water quality impairments is listed below.

Based on New Hampshire's Watershed Report Card (2012 report), the Connecticut River from the Vernon Dam downstream to the state line (Segment NHRIV802010501-05) is listed as impaired (Category 5 – TMDL Needed). This segment supports swimming and boating uses, but does not meet state standards for supporting aquatic life due to aluminum, copper, and low pH from unknown sources. New Hampshire's general statewide fish consumption advisory due to mercury applies to this segment of the Connecticut River.

Vermont's Integrated List (2014 report) indicates that the Connecticut River from the Vernon Dam downstream to the state line (Segment VT13-05) is impacted by flow alteration (Part F - Waters Altered by

[32] The border between New Hampshire and Vermont was set by King George II in 1764 as the western bank of the Connecticut River. The U.S. Supreme Court re-affirmed this boundary in 1934 as the ordinary low-water mark on the Vermont shore, and markers were set. In some places, the state line is now inundated by the impoundments of dams built after this time.

Flow Regulation). The aquatic life support use is impacted by fluctuating flows due to hydropower production.

The entire mainstem Connecticut River in Massachusetts is listed as impaired due to PCBs in fish tissue based on results from the Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) as discussed further below.

From the New Hampshire/Vermont border to the Route 10 Bridge (Segment MA34-01, 3.5 miles) in Massachusetts, the Connecticut River is listed as impaired by MADEP (Category 5- Waters Requiring a TMDL) due to “other flow regime alterations,” and “alteration in stream-side or littoral vegetative covers.”

The section of the river between the Route 10 Bridge crossing the TFI and the Turners Falls Dam (Segment MA34-02, 11.2 miles) is listed as impaired by MDEP (Category 5- Waters Requiring a TMDL) due to “alteration in stream-side or littoral vegetative covers.” Additionally, Barton Cove is listed as impaired for non-native aquatic plants (Eurasian water milfoil).

From the Turners Falls Dam to the confluence with the Deerfield River (Segment MA34-03, 3.6 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to total suspended solids, “low flow alterations” and “other flow regime alterations.”

From the confluence with the Deerfield River to Holyoke Dam (Segment MA4-04, 34.4 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to *E. coli* bacteria.

The Northfield Mountain Reservoir (Segment MA34061) is listed as a Massachusetts Category 3 Waters, meaning “No Uses Assessed.”

2003 Massachusetts Water Quality Assessment

Water quality sampling in the Connecticut River Watershed was conducted by MADEP in April - September 2003, as part of its five-year rotating watershed monitoring and management schedule (Carr & Kennedy, 2008). This effort includes two locations in the Connecticut River in the Project area: Station CT06 on the Connecticut River, at the Route 10 Bridge in Northfield; and Station 02A on the Connecticut River, downstream of the Fourmile Brook confluence in Northfield, and east of Pisgah Mountain Road in Gill (Figure 3.3.2.1.2-1). The parameters included in the sampling were: dissolved oxygen, pH, conductivity, water temperature, total dissolved solids, total suspended solids, ammonia, nitrate–nitrite, total phosphorus, chlorophyll-a, fecal coliform, and *E. coli* bacteria.

Water quality data collected at stations CT06 and 02A are summarized in Table 3.3.2.1.2-2 and Table 3.3.2.1.2-3. The data were used by the MADEP to assess the status of the designated uses as defined in the Massachusetts Surface Water Quality Standards.

Data collected from Station CT06 between April and October 2003 were used to assess water quality conditions as the river entered the state. All measurements were indicative of good water quality conditions (Carr & Kennedy, 2008).

Station 02A is located in the TFI, downstream of the Fourmile Brook confluence, approximately 5.5 river miles downstream of station CT06, in the vicinity of the Northfield Mountain Pumped Storage picnic area. Data were collected from this station between July and September 2003. All measurements were indicative of good water quality conditions (Carr & Kennedy, 2008).

NHDES Water Quality Data

The NHDES, assisted by the USEPA, assessed the entire Connecticut River mainstem in New Hampshire in 2004. The parameters included in the sampling were bacteria, dissolved oxygen, pH, specific conductance, temperature, and metals. Sampling locations included the Connecticut River at the Route 10 Bridge in Northfield, and the Ashuelot River at the Route 119 Bridge in Hinsdale.

Results from this effort were reported by the Connecticut River Joint Commissions (CRJC) and indicated that the river's quality fully supports swimming and other forms of recreation, although it was reported that elevated aluminum and copper levels may affect aquatic habitat in the river below Vernon Dam. The copper levels may be related to contributions from the Ashuelot River (CRJC, 2009).

CRWC Volunteer Monitoring

The CRWC conducted a volunteer water quality monitoring program in the Connecticut River in 2007 and 2008. Sampling was conducted at six locations, which included four sites in the Connecticut River. One of these sites was located in the TFI, at the Franklin County Boat Club docks at Barton Cove in Gill, MA (Figure 3.3.2.1.2-1). Parameters included water temperature, dissolved oxygen, conductivity and transparency.

In 2007, measurements were collected on: August 30, September 20, and October 23. In 2008, measurements were collected on: June 11, July 9, August 13, September 9 and 18, and October 7. The data for the Barton Cove site are presented in Table 3.3.2.1.2-4. The results reported that all the water temperature and dissolved oxygen measurements met the Massachusetts Water Quality Standard for warm water fisheries. Dissolved oxygen at the Barton Cove site ranged from 7.14 mg/l to 9.55 mg/l. Specific conductance readings at the site ranged from 80.7 microsiemens (µS) to 146.2 µS. Transparency was consistently measured as greater than 120 centimeters (cm), indicating very clear water.

In addition, the CRWC, in cooperation with Franklin Regional Council of Governments (FRCOG), the Pioneer Valley Planning Commission (PVPC) and the University of Massachusetts Water Resources Research Center, has conducted water sampling for bacterial analysis in the TFI at the state boat launch at Barton Cove for the last several years. Data from 2010-2011 is presented in Table 3.3.2.1.2-5. Several measurements from this location in 2011 exceeded the Massachusetts Water Quality maximum standard of 235 colonies/100 ml for *E. coli*. River flows were appreciably higher in 2011 compared to 2010. All of the corresponding *E. coli* measurements from 2010 met the Massachusetts Water Quality Standard.

USGS Water Quality Monitoring

Water quality measurements were occasionally taken by the USGS at the Montague City gage site. Data includes physicochemical measurements and nutrients collected most recently in 2006-2007, as shown in Table 3.3.2.1.2-6. In addition to collecting data from this site, a study of total nitrogen concentrations and loads was conducted by the USGS from December 2002 to September 2005 at 13 river sites in the upper Connecticut River Basin. In this study, the mean annual load and yield of total nitrogen at the Connecticut River at North Walpole, NH, was estimated at 9.60 million pounds/year and 1,750 (pounds/mi^2)/year, respectively. The mean annual load and yield of total nitrogen leaving the upper Connecticut River Basin, as estimated at the Connecticut River at Thompsonville, CT, was 21.6 million pounds/year and 2,230 (pounds/mi^2)/year, respectively (Deacon *et al.*, 2006).

USEPA Connecticut River Fish Tissue Contaminant Study

The Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) was a collaborative federal and state project designed to provide a baseline of tissue contaminant data from several fish species, to better understand the risk to human health from eating Connecticut River fish, and to learn what threat eating these fish poses to other mammals, birds, and fish. For this study the Connecticut River was divided into eight sampling reaches with Reach 4 being the TFI.

Smallmouth bass, yellow perch and white suckers were collected during 2000 from the mainstem of the Connecticut River and composite samples were analyzed for total mercury, PCBs, organochlorine pesticides, and dioxins. Levels of contaminants were compared to USEPA and other current human health subsistence and recreational (sport) fisher and ecological risk screening criteria, and also were statistically compared between reaches and species.

Based on the information from this study, it was reported that fish tissue in the Connecticut River contained contaminants exceeding various human health and ecological risk screening values, and that state health agencies will evaluate existing advisories and consider the need for others, to adequately protect human health (Hellyer, 2006).

Existing Water Quality

As part of the relicensing process, FERC approved Revised Study Plan No. 3.2.1 *Water Quality Study*. As noted earlier (Section 1.4.3.1), closure of the Vermont Yankee Nuclear Power Plant (VY), located upstream of the Northfield Project, would change certain environmental baseline conditions during the relicensing study period. Due to the impending closure of VY, the implementation of the water quality study was delayed for a year. Consequently, the final results of the water quality study are not available for inclusion in the Draft License Application; a final report is due to be submitted to FERC by March 1, 2016.

The purpose of the water quality study was to document baseline water quality conditions including water temperature, DO and other water quality parameters upstream and downstream of the Project.

A total of 18 water quality sampling stations were located from below Vernon Dam to downstream of Cabot Station as summarized in Table 3.3.2.1.2-7. Sampling sites were located in the TFI (Sites 1-7), bypass reach (Sites 8-9), Turners Falls power canal (Site 10), below Cabot Station and above the Deerfield River confluence (Site 11) and below Cabot Station below the Deerfield River confluence (Sites 12-18). At each sampling site one of the following was measured a) continuous temperature and DO, b) vertical profiles of temperature and DO, or c) continuous temperature (see Table 3.3.2.1.2-7).

Continuous temperature and DO data were collected every 15 minutes from early April to mid-November 2015 at nine (9) locations as shown in Figure 3.3.2.1.2-2, 3.3.2.1.2-3 and 3.3.2.1.2-4. DO and temperature profiles were collected bi-weekly from early April to mid-November at three (3)[33] relatively deep locations within the TFI as shown in Figure 3.3.2.1.2-5. In addition, continuous temperature data were collected every 15 minutes from early April to mid-November at seven (7) locations downstream of Cabot Station to Holyoke Dam as shown in Figure 3.3.2.1.2-6.

3.3.2.2 Environmental Effects

3.3.2.2.1 Water Quantity

The following subsections address the expected water quantity effects of FirstLight's proposed operation.

Hydrology and Streamflow

Under FirstLight's proposed action, the Northfield Mountain Pumped Storage Development would continue to withdraw and discharge water from/to TFI. These operations would continue to alter the TFI impoundment levels on an intra-daily timeframe.

Other than the evaporative losses due to the Upper Reservoir, which are small, the Northfield Mountain Pumped Storage Development does not result in any net water loss to the Connecticut River Basin.

Under FirstLight's proposed action, the Turners Falls Development would continue to operate to alter flow on an intra-daily timeframe.

3.3.2.2.2 Water Quality

Study No. 3.2.1 Water Quality Study is incomplete, therefore, the effects of Project operations on DO and temperature are yet to be determined. A final report is slated to be completed by March 1, 2016.

[33] At one of these locations—Upstream of the Turners Falls Dam boat barrier--continuous DO and temperature data were collected as well.

3.3.2.3 Cumulative Effects

The Council of Environmental Quality (CEQ) regulations define "cumulative effects" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7).

For this analysis, the action is the relicensing and continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development. FERC has identified the geographical extent of cumulative effects on water quantity and water quality to include the Connecticut River from the base of Moore dam to the mouth of the Connecticut River at Long Island Sound. This geographic area was chosen to recognize the cumulative operational influences of the upstream water storage, and the operations of the five Connecticut River projects on water quantity throughout this area and subsequently on water quality that could occur downstream to mouth of the Connecticut River at Long Island Sound. The temporal scope of this analysis includes a discussion of the past, present, and reasonably foreseeable future actions, and their effects on the resource 50 years into the future.

The potential impact of the Project is associated with whether the continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development affects water quantity and quality of the Lower Connecticut River, which had already been altered by construction of numerous dams. These potential impacts will be better understood when relicensing studies are complete.

3.3.2.4 Proposed Environmental Measures

No environmental measures are proposed at this time.

3.3.2.5 Unavoidable Adverse Impacts

Cabot Station peaking operations, under FirstLight's proposed action, would continue to alter flow on an intra-daily time step in the Connecticut River below Cabot Station.

This section will be developed following completion of the data analyses and reporting for the ongoing studies.

Table 3.3.2.1.1-1: Connecticut River at North Walpole, NH (USGS Gage No. 01154500), Drainage Area= 5,493 mi^2, Period of Record: Mar 1942-Sep Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	7,677	7,095	13,563	27,134	16,386	8,517	5,201	4,393	3,978	6,976	9,127	9,209	9,941
Mean/mi^2	1.40	1.29	2.47	4.94	2.98	1.55	0.95	0.80	0.72	1.27	1.66	1.68	1.81
Median	6,000	5,860	9,910	23,000	14,000	7,025	3,820	3,150	3,050	6,911	7,550	7,280	6,490
Median/mi^2	1.09	1.07	1.80	4.19	2.55	1.28	0.70	0.57	0.56	1.26	1.37	1.33	1.18

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-2: Connecticut River below Vernon Dam (USGS Gage No. 01156500), Drainage Area= 6,266 mi^2, Period of Record: Oct 1944-Sep 1973 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	7,422	7,300	14,558	32,110	18,991	8,750	4,833	3,636	3,704	5,270	8,550	8,809	10,319
Mean/mi^2	1.18	1.17	2.32	5.12	3.03	1.4	0.77	0.58	0.59	0.84	1.36	1.41	1.65
Median	6,400	6,400	9,400	27,050	15,800	7,030	3,800	3,080	2,970	3,880	7,105	7,170	6,535
Median/mi^2	1.02	1.02	1.50	4.32	2.52	1.12	0.61	0.49	0.47	0.62	1.13	1.14	1.04

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-3: Connecticut River at Montague City, MA (USGS Gage No. 01170500), Drainage Area= 7,860 mi^2, Period of Record: Apr 1940-Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	12,094	11,565	21,144	37,154	21,726	13,408	9,383	8,574	7,152	13,211	15,560	16,984	15,909
Mean/mi^2	1.54	1.47	2.69	4.73	2.76	1.71	1.19	1.09	0.91	1.68	1.98	2.16	2.02
Median	9,600	9,345	15,500	33,700	19,100	9,910	5,650	4,680	4,700	6,850	11,100	11,300	9,800
Median/mi^2	1.22	1.19	1.97	4.29	2.43	1.26	0.72	0.60	0.60	0.87	1.41	1.44	1.25

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-4: Estimated Connecticut River at Turners Falls Dam Drainage Area= 7,163 mi^2, Period of Record Jan 1941-Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	10,242	9,682	18,514	34,713	19,680	11,887	8,432	7,549	6,267	11,710	13,810	14,793	14,079
Mean/mi^2	1.43	1.35	2.58	4.71	2.75	1.66	1.18	1.05	0.87	1.63	1.93	2.07	1.97
Median	7,963	7,711	13,200	30,238	17,316	8,900	4,965	4,147	4,059	6,058	9,845	9,613	8,489
Median/mi^2	1.11	1.08	1.84	4.22	2.42	1.24	0.69	0.58	0.57	0.85	1.37	1.34	1.19

Data Source: Estimated from manipulation of USGS gages

Table 3.3.2.1.2-1: Massachusetts Water Quality Standards for Class B Waters – Warm Water Fisheries

Parameter	Standard
Dissolved Oxygen (DO)	Shall not be less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
Temperature	Temperature shall not exceed 83 °F (28.3 °C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3 °F (1.7 °C) in rivers and streams designated as cold water fisheries nor 5 °F (2.8 °C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month).
pH	Shall be in the range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
Bacteria – beaches	E. coli: the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml. Enterococci: the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml.
Bacteria – other waters	E. coli: the geometric mean of all samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml. Enterococci: geometric mean of all samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml.
Solids	These waters shall be free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
Color and Turbidity	These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.
Oil and Grease	These waters shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life.
Taste and Odor	None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this Class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.

Note: MA Standards also include narrative criteria applicable to all surface waters related to aesthetics, bottom pollutants or alteration, nutrients, radioactivity, and toxic substances.

Table 3.3.2.1.2-2: MADEP 2003 Water Quality Data Results – Physical Parameters

Date	Temp (°C)	pH	Conductivity (µS/cm)	TDS (mg/l)	DO (mg/l)	DO (% sat)
Station CT06 – Connecticut River at Route 10 Bridge						
04/29/03	8.9	7.1 c	92.5	59.2	12.1	106
06/02/03	16.6	7.2	122	77.9	9.4	99
08/05/03	23.9	7.2 c	121	77.2	7.7 u	92 u
08/06/03	23.9	7.0 c	120	76.8	7.0	84
09/09/03	21.5	7.3 uc	153	98.0	8.5	97
10/01/03	15.8	7.2	112 u	71.9 u	9.4 u	95 u
Station 02A – Connecticut River downstream of Fourmile Brook confluence						
07/08/03	27.7	7.6	139	90.0	8.3 i	105 i
07/09/03	27.2	7.5	138	89.0	7.8 i	99 i
08/05/03	23.7	7.2 uc	119	78.0	7.6	90
08/06/03	23.7	7.3 c	108	70.0	7.5	88
09/09/03	21.7	7.5 uc	152	99.0	9.3	106

Notes:
i = potentially inaccurate reading
u = unstable reading
c = meter not calibrated or calibration result outside accepted range of calibration standard

Table 3.3.2.1.2-3: MADEP 2003 Water Quality Data Results – Biological and Chemical Parameters

Date	Time (24 hr)	QA/QC	Fecal coliform (CFU/ 100mL)	E. coli (CFU/ 100mL)	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Chl-a (mg/m^3)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
Station CT06 – Connecticut River at Route 10 Bridge													
04/30/03	08:00	-	2	1	1.4	-	-	-	<0.06	-	-	0.021	5.2
06/04/03	08:05	-	20	5	0.40	26	37	-	<0.02	-	-	0.016	2
07/09/03	08:15	-	30	16	0.46	28	44	<1.0	<0.02	-	-	0.011	<2
08/06/03	07:45	-	250	30	1.0	25	33	1.0	0.11	-	-	0.019	4
09/10/03	08:00	-	4	2	-	-	-	<1.0	<0.02	0.17	R	0.010	<2
10/01/03	08:20	-	500	120	-	-	-	-	<0.02	0.14 f	R	R	6
Station 02A – Connecticut River downstream of Fourmile Brook confluence													
07/09/03	09:09	Left	24	20	-	-	-	<1.0	-	-	-	-	-
		Right	40	12	-	-	-	1.1	-	-	-	-	-
		Center	30	10	0.50	30	44	-	<0.06	-	-	0.011	<2
08/06/03	07:55	Left	500	160	-	-	-	-	-	-	-	-	-
		Right	600	70	-	-	-	-	-	-	-	-	-
		Center	1900	130	1.3	23 d	29	1.3	<0.02	-	-	0.020	2
09/10/03	08:12	Left	10	8	-	-	-	-	-	-	-	-	-
		Right	12	10	-	-	-	-	-	-	-	-	-
		Center	<2	<2	-	-	-	1.6	<0.02	0.16	R	0.008	<2

Note: R = data removed due to quality assurance flag in report.

Table 3.3.2.1.2-4: CRWC 2007-2008 Water Quality Data Results for Barton Cove

Date	Time (24 hr)	Air Temp (°C)	Water Temp (°C)	Transparency (cm)	Specific Conductance (µS)	DO (mg/l)	DO (% sat)
8/30/2007	8:33	22.9	25.2	>120	146.2	7.22	86.1
9/20/2007	8:32	16.7	20.0	>120	138.7	7.33	99.3
10/23/2007	8:33	17.5	17.0	>120	134.8	7.81	82.0
6/11/2008	8:57	21.8	23.7	>120	126.7	9.55	113.1
7/9/2008	8:50	25.8	26.5	>120	104.5	8.52	105.1
8/13/2008	8:33	19.1	20.3	>120	80.7	8.52	93.5
9/9/2008	8:49	19.3	23.1	>120	117.4	7.14	83.3
9/18/2008	10:12	19.3	20.7	—	120.3	8.41	93.3
10/7/2008	8:43	10.8	14.9	>120	126.4	8.06	79.7

Sources: Donlon, 2008 and Donlon, 2009

Table 3.3.2.1.2-5: CRWC Bacteria Sampling Results for Barton Cove, 2010-2011

Date	E. coli (colonies/100 ml)	Wet Weather Event[1]	Montague Daily Flow (cfs)
6/2/2010	63		4,870
6/9/2010	65		15,900
6/16/2010	80		7,620
6/23/2010	186	Wet	8,780
6/30/2010	17		13,500
7/7/2010	98		4,540
7/14/2010	114		3,440
7/21/2010	23		4,710
7/28/2010	12		5,140
8/4/2010	35		5,650
8/11/2010	224		5,860
8/18/2010	2		2,950
9/8/2010	21		2,960
9/15/2010	3		3,000
9/22/2010	9		2,570
9/29/2010	171	Wet	8,990
10/6/2010	33	Wet	23,200
5/25/2011	1553.1*		25,200
6/1/2011	1046.2*		33,700
6/8/2011	83.9		10,400
6/15/2011	228.2		22,500
6/22/2011	1553.1*		10,600
6/29/2011	224.7	Wet	17,000
7/6/2011	387.3*		9,440
7/20/2011	218.7		5,040
8/3/2011	275.5*		2,670
8/17/2011	488.4*	Wet	26,800
8/24/2011	172.5		12,900

[1]"Wet" signifies wet weather event defined as >0.1 inches of rain in 24 hours.
*Result indicates exceedance of Massachusetts Criteria for single E. coli sample of 235 colonies/100ml.
Source: http://www.umass.edu/tei/mwwp/ctrivermonitoring.html

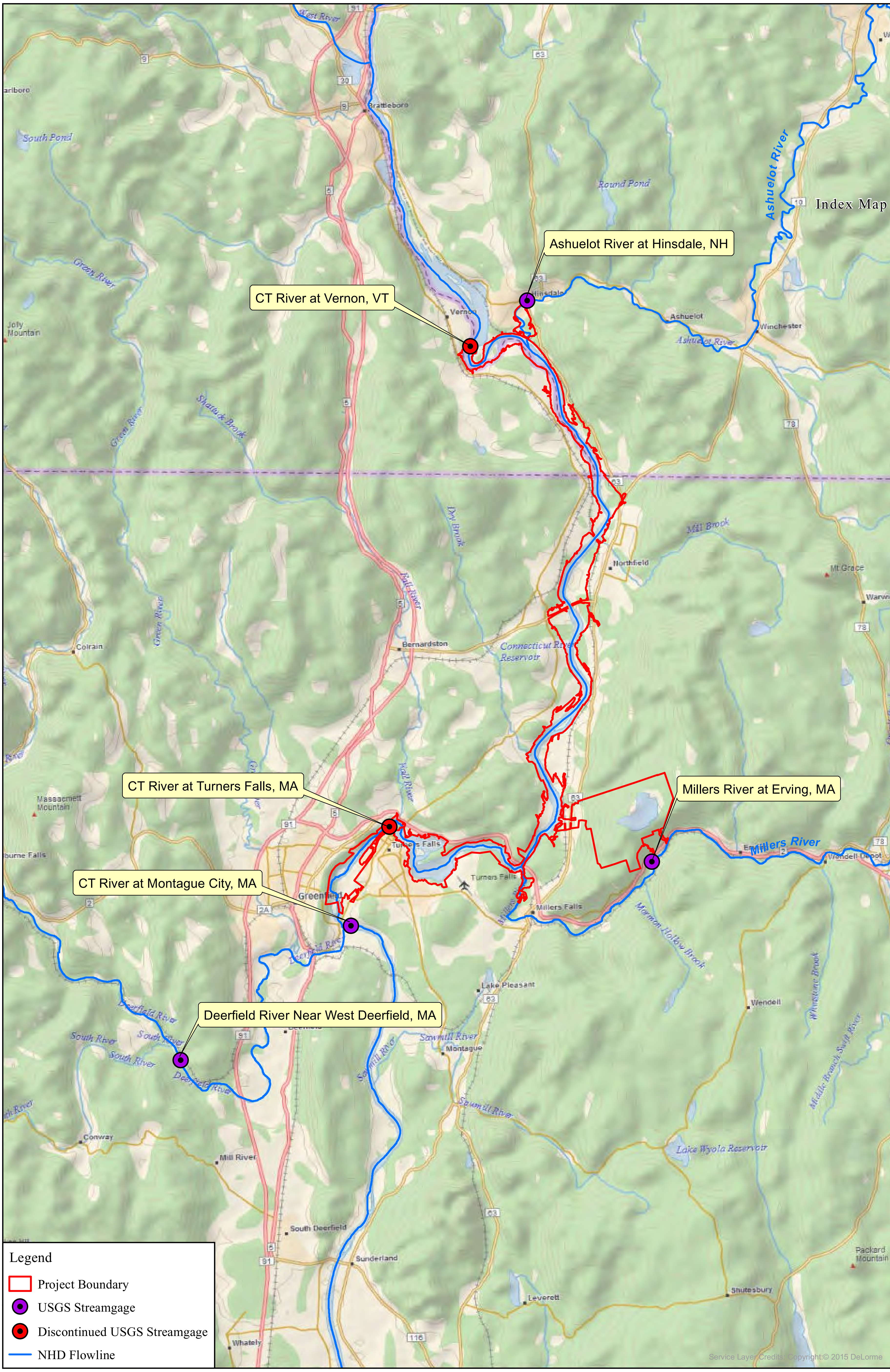
Table 3.3.2.1.2-6: Select Water Quality Data from USGS Montague City Gage

Date/Time	Discharge (cfs)	pH	Nitrogen, total (mg/l)	Ammonia, as N (mg/l)	Nitrate + Nitrite (mg/l)	Orthophosphate (mg/l)	Phosphorus, total (mg/l)
10/26/2006 9:15	21,600	7.0	0.47	0.011 e	0.190	< 0.018	0.075
12/15/2006 7:30	16,000	7.3	0.46	0.023	0.285	0.013 e	0.040
2/8/2007 11:30	7,790	6.9	0.63	0.034	0.458	0.020	0.033
3/29/2007 11:00	53,800	7.0	0.75	0.030	0.339	0.012 e	0.142
4/20/2007 11:00	78,800	7.0	0.63	0.010 e	0.254	0.011 e	0.160
5/3/2007 11:15	35,200	7.0	0.49	0.011 e	0.268	0.012 e	0.034
5/17/2007 11:45	24,200	7.3	0.52	0.014 e	0.287	0.009 e	0.033
6/28/2007 12:00	2,430	7.3	0.51	0.020 e	0.310	0.013 e	0.016
8/2/2007 12:30	1,790	7.5	0.46	< 0.020	0.257	0.017 e	0.015
9/6/2007 8:00	1,750	7.4	0.39	0.014 e	0.238	0.013 e	0.008
Nutrient Criteria Reference Conditions for Ecoregion VIII Streams - Subecoregion 58 (Northeastern Highlands)							
Minimum			0.34		0.010		0.002
Maximum	-	-	0.84	-	2.850	-	0.450
25th percentile			0.42		0.160		0.005

Notes: "e" = estimated. Nutrient criteria from USEPA, 2001

Table 3.3.2.1.2-7: Water Quality Monitoring Sampling Locations

Station No.	Type	Location	Comments
Connecticut River- Turners Falls Impoundment (Temperature and DO)			
1	Continuous	Below the Vernon Dam and Ashuelot River Confluence	Near thalweg at 25% depth
2	Profile	Deep area upstream of Northfield Mountain	Collect profile at one meter depth increments
3	Continuous	Above the Northfield Mountain Tailrace; Downstream of Kidds Island	Near thalweg at 25% depth
4	Continuous	Northfield Mountain Tailrace	Within the Northfield Mountain Tailrace at 25% depth
5	Continuous	Below the Northfield Mountain Tailrace; Upstream of Millers River Confluence	Near thalweg at 25% depth
6	Profile	Deepest area of Turners Falls Impoundment	Collect profile at one meter depth increments
7	Profile and Continuous	Upstream of the Turners Falls Dam at Boat Barrier	Collect profile at one meter depth increments and install continuous meter at 25% depth
Connecticut River- Bypass Reach (Temperature and DO)			
8	Continuous	Upstream of Station No. 1	Mid-channel, mid-depth
9	Continuous	Upstream of Rock Dam; west channel at Rawson Island	Mid-channel, mid-depth
Turners Falls Power Canal (Temperature and DO)			
10	Continuous	At the Railroad Bridge	Mid-channel, mid-depth
Connecticut River- Below Cabot Station (Temperature and DO)			
11	Continuous	Below the Cabot Station tailrace, upstream of Deerfield River confluence	Thalweg, mid-depth.
Connecticut River- Cabot Station to Holyoke Dam (Temperature)			
12	Continuous	Downstream of the Deerfield River confluence	Anchored near bottom, near shore
13	Continuous	Third Island	Anchored near bottom, near shore of island
14	Continuous	Second Island, near shore of island.	Anchored near bottom, near shore of island
15	Continuous	Submerged shallow bar	Anchored near bottom, at sandbar
16	Continuous	Submerged shallow bar	Anchored near bottom, at sandbar
17	Continuous	River right channel at Elwell Island	Anchored near bottom, near shore
18	Continuous	Mitch's Island	Anchored near bottom, near shore



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

Draft License Application
Exhibit E

0 1 2 4 Miles

Figure 3.3.2.1.1-1
USGS Stream Gage Locations

Path: W:\gis\maps\dla\figure_3_3_2_1_1-1.mxd

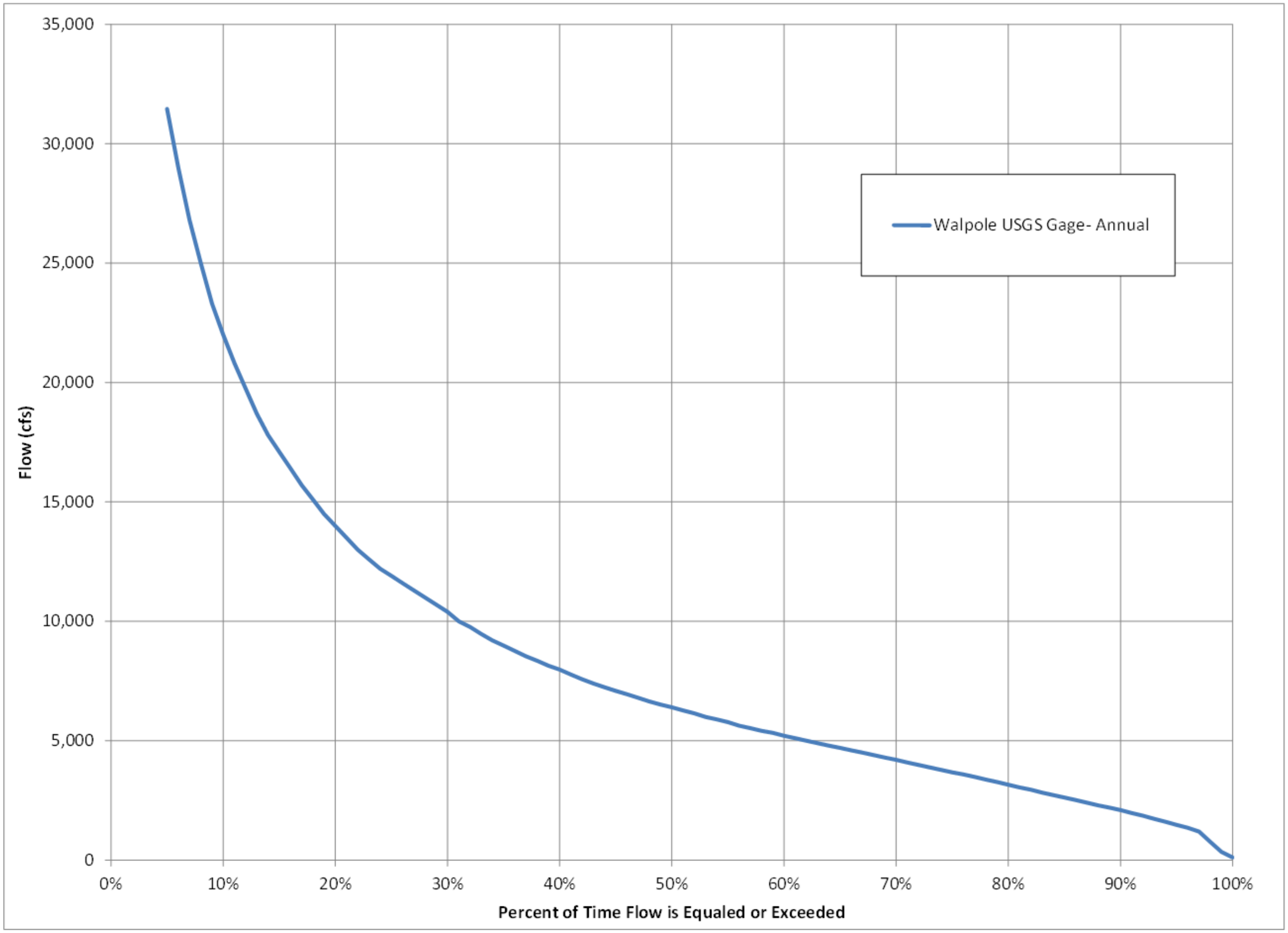


Figure 3.3.2.1.1-2: Connecticut River at Walpole, NH, Annual Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

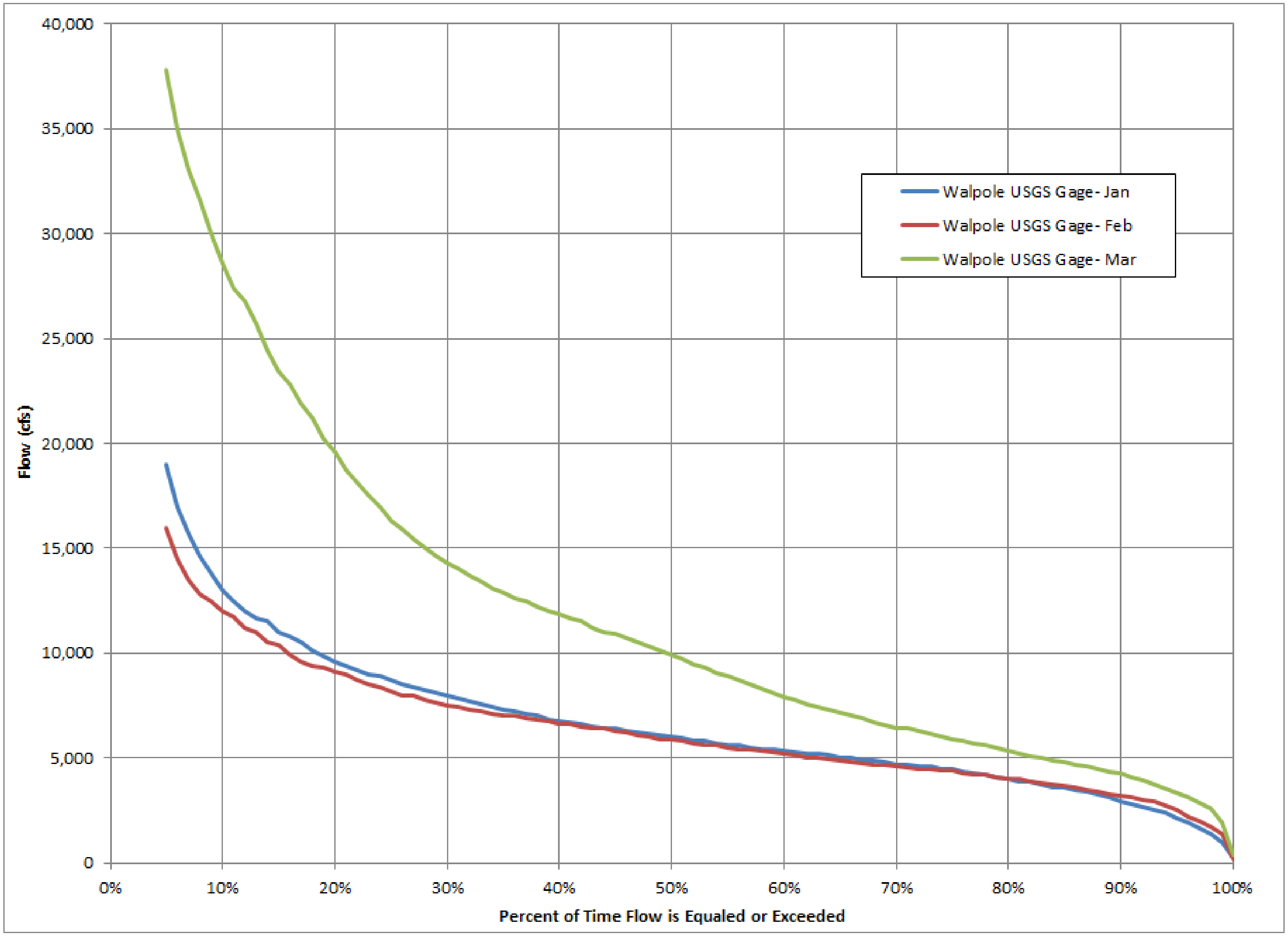


Figure 3.3.2.1.1-3: Connecticut River at Walpole, NH, Jan, Feb and Mar Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

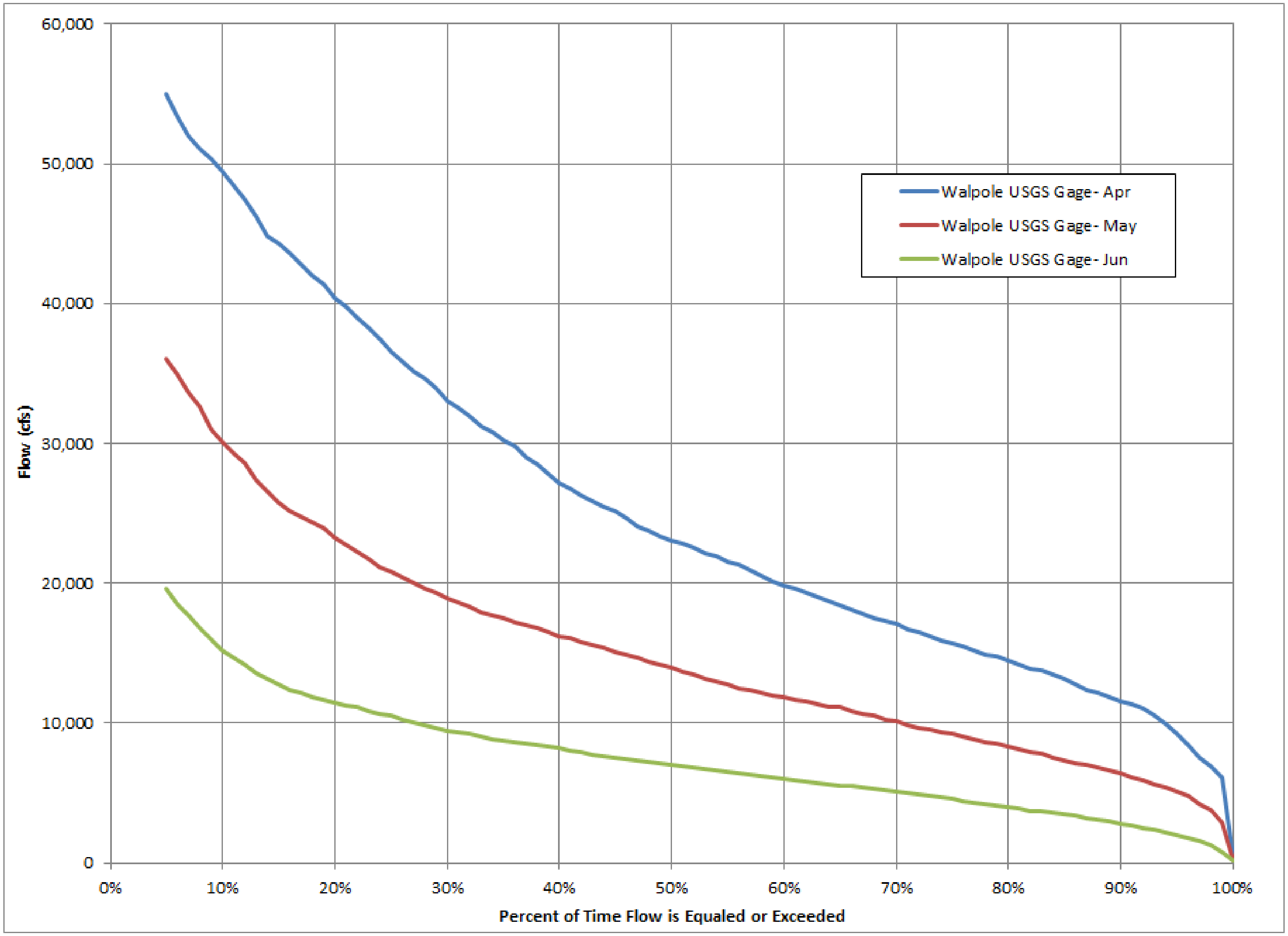


Figure 3.3.2.1.1-4: Connecticut River at Walpole, NH, Apr, May and Jun Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi²

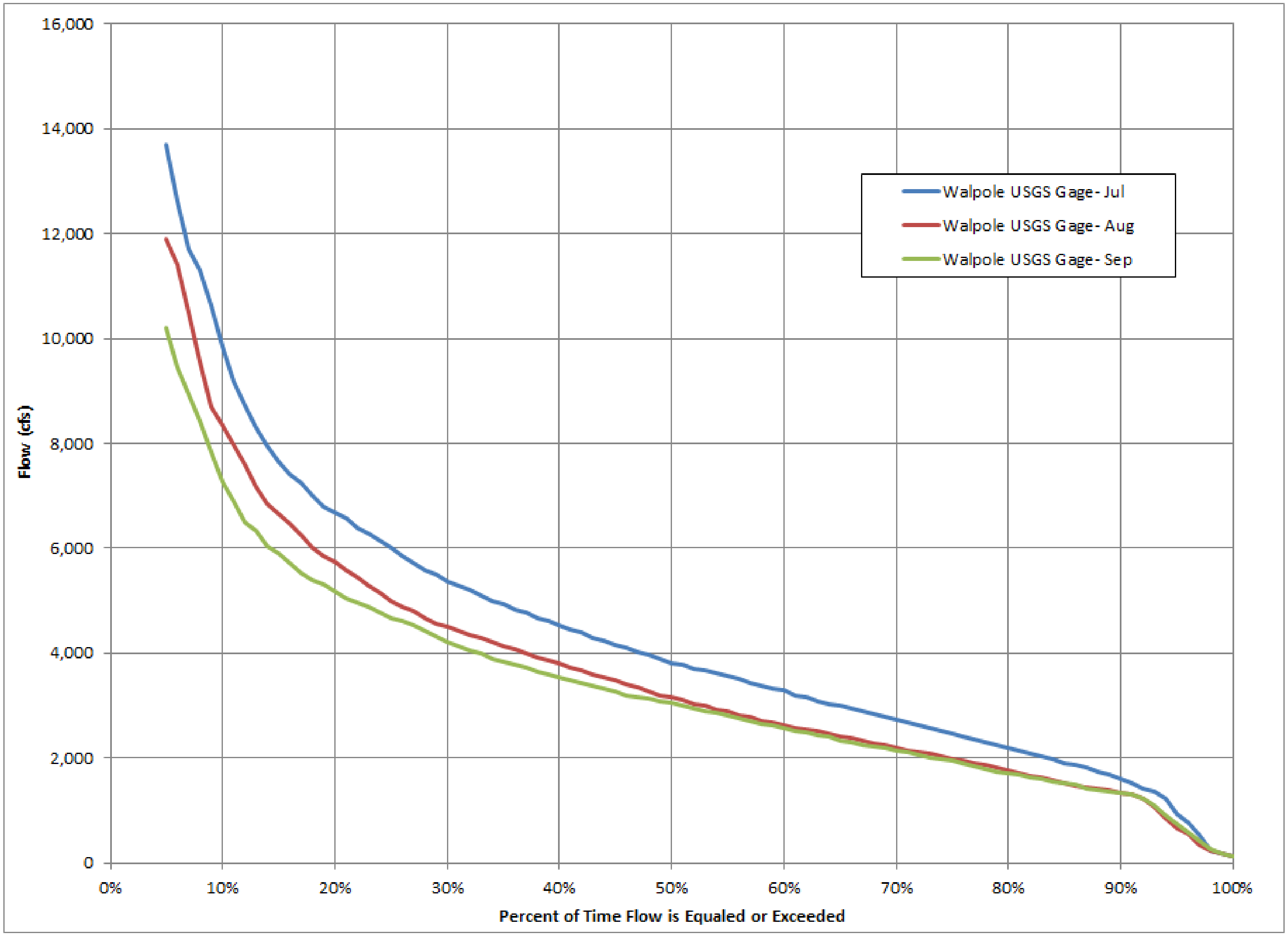


Figure 3.3.2.1.1-5: Connecticut River at Walpole, NH, Jul, Aug and Sep Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

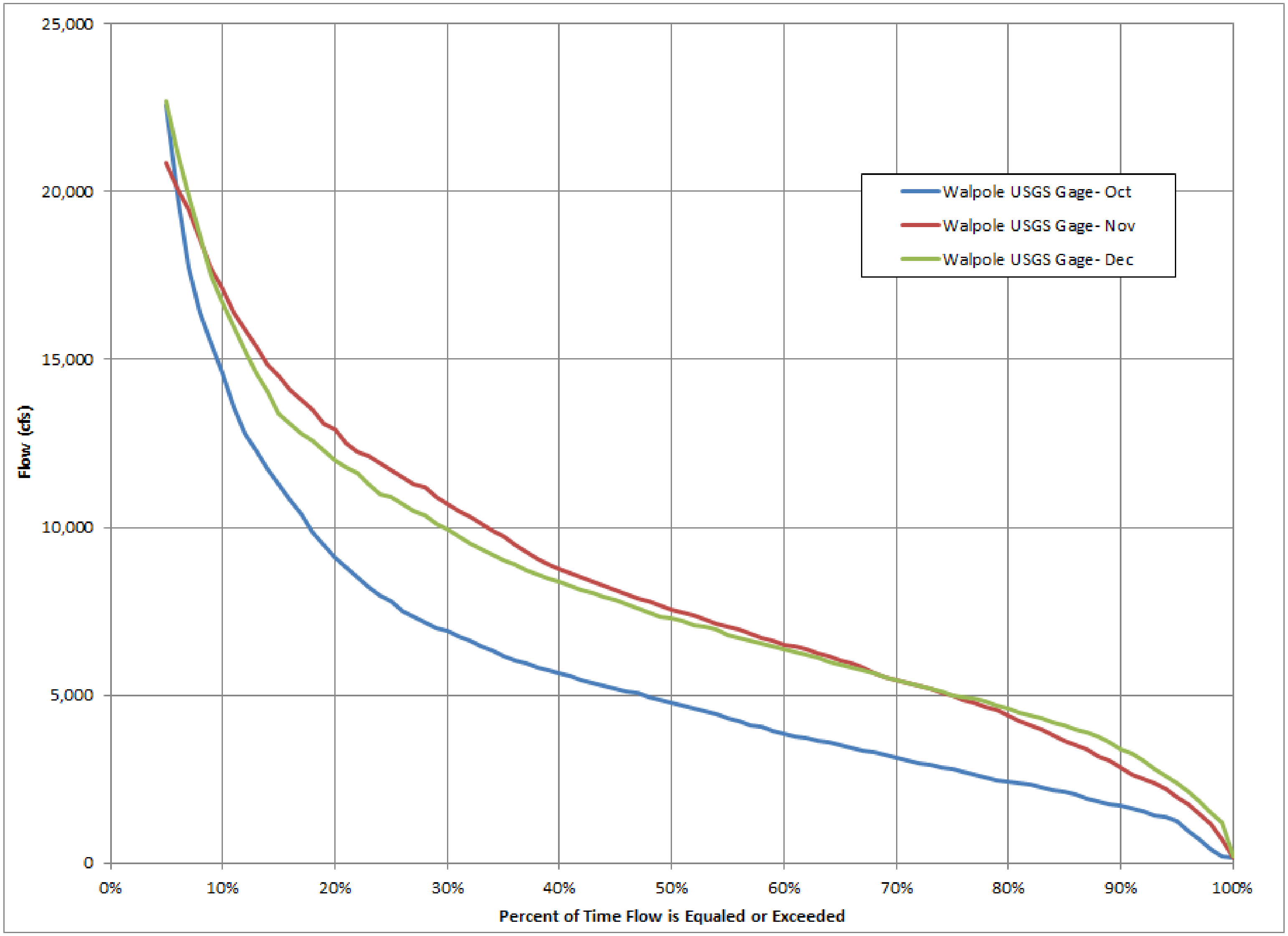


Figure 3.3.2.1.1-6: Connecticut River at Walpole, NH, Oct, Nov, and Dec Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

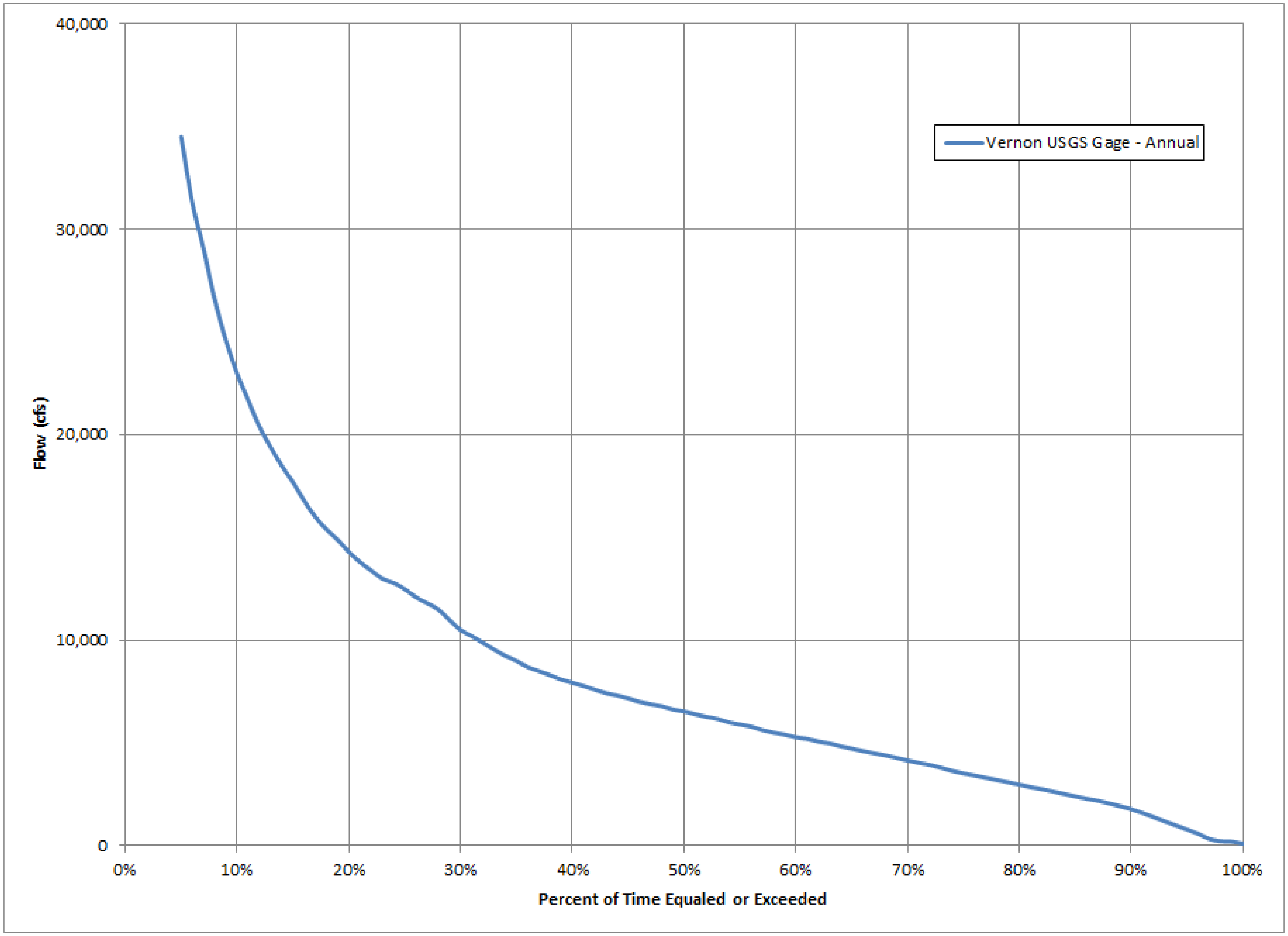


Figure 3.3.2.1.1-7: Connecticut River below Vernon Dam, VT, Annual Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

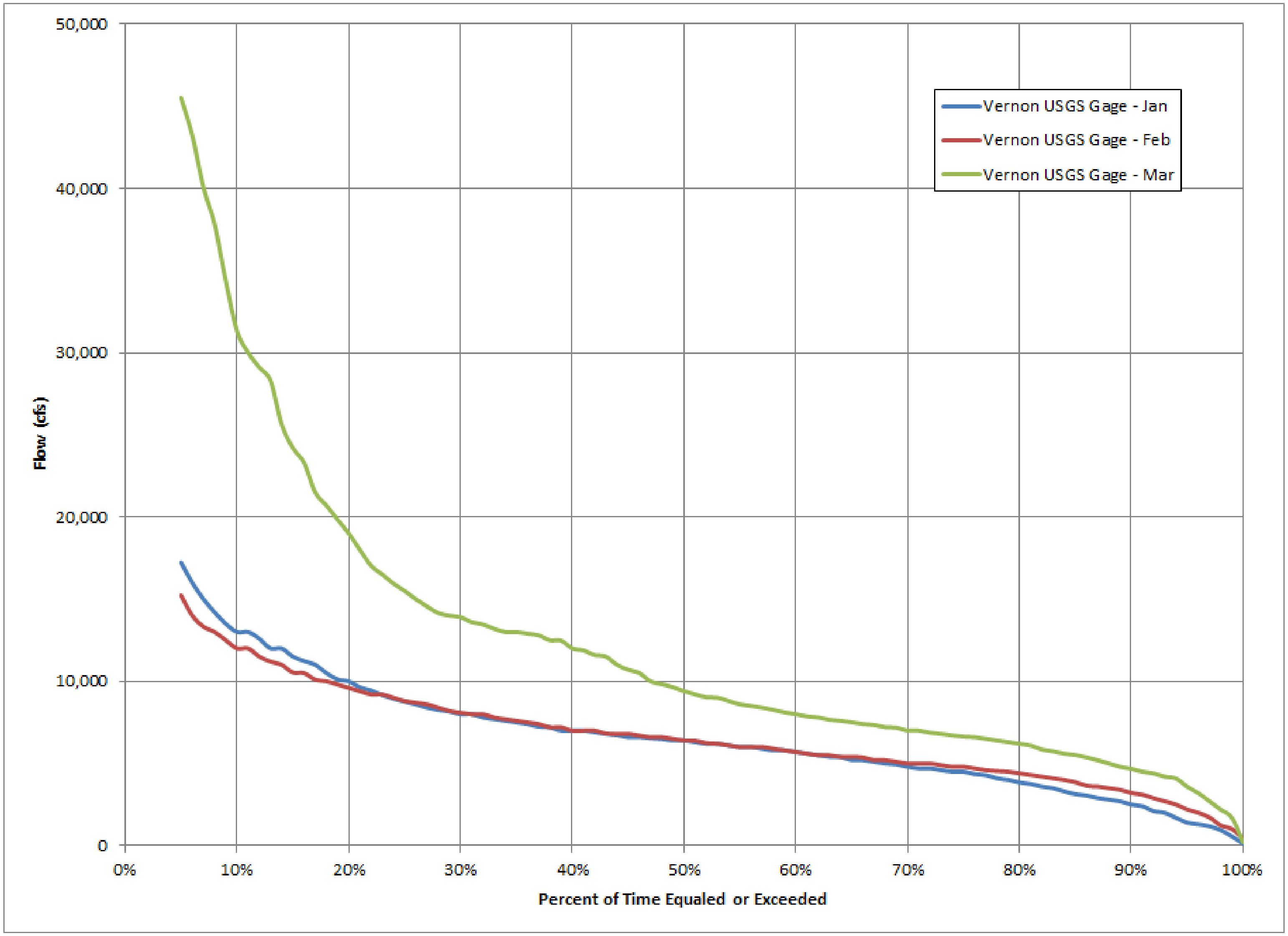


Figure 3.3.2.1.1-8: Connecticut River below Vernon Dam, VT, Jan, Feb and Mar Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi²

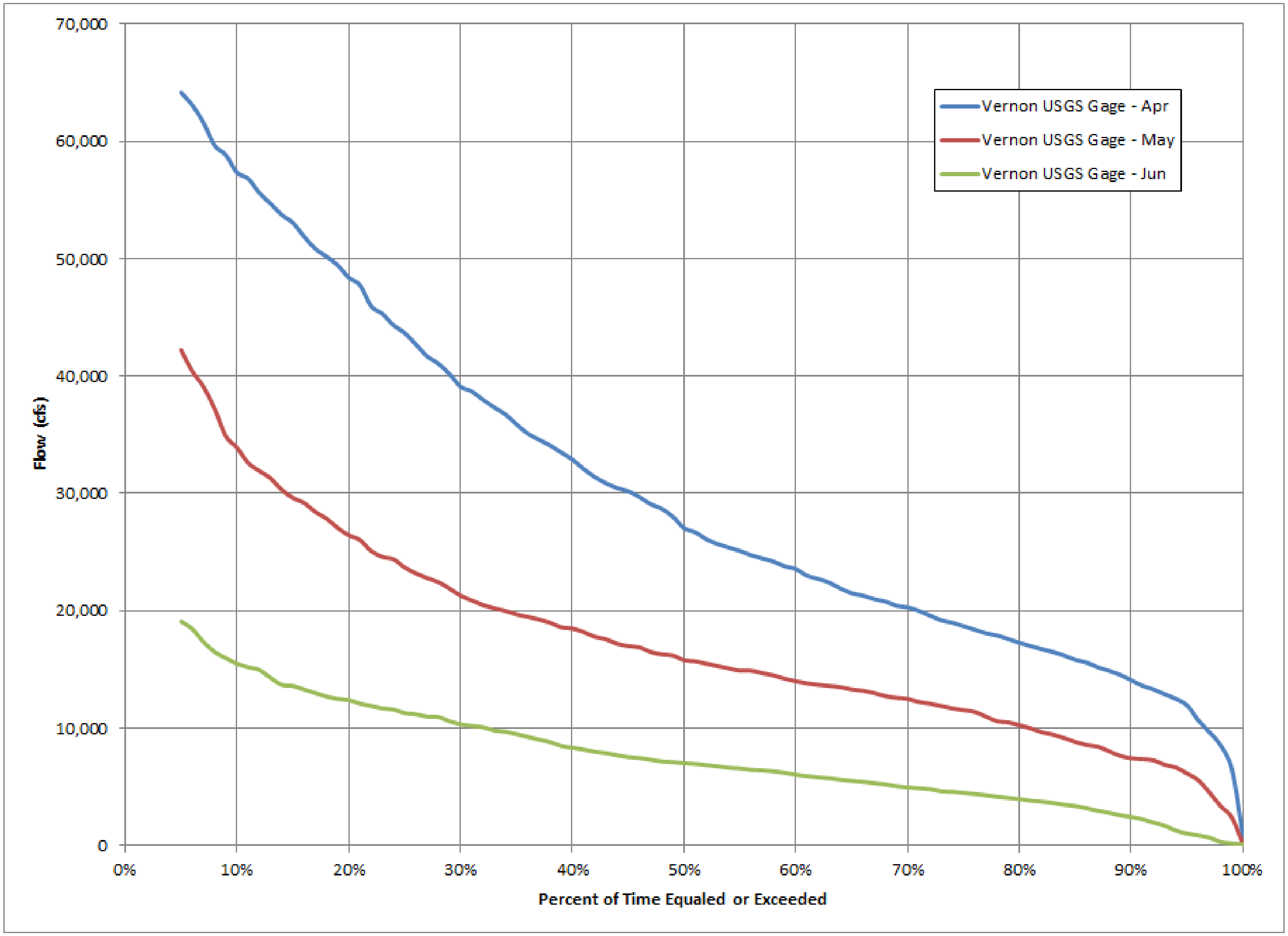


Figure 3.3.2.1.1-9: Connecticut River below Vernon Dam, VT, Apr, May and Jun Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

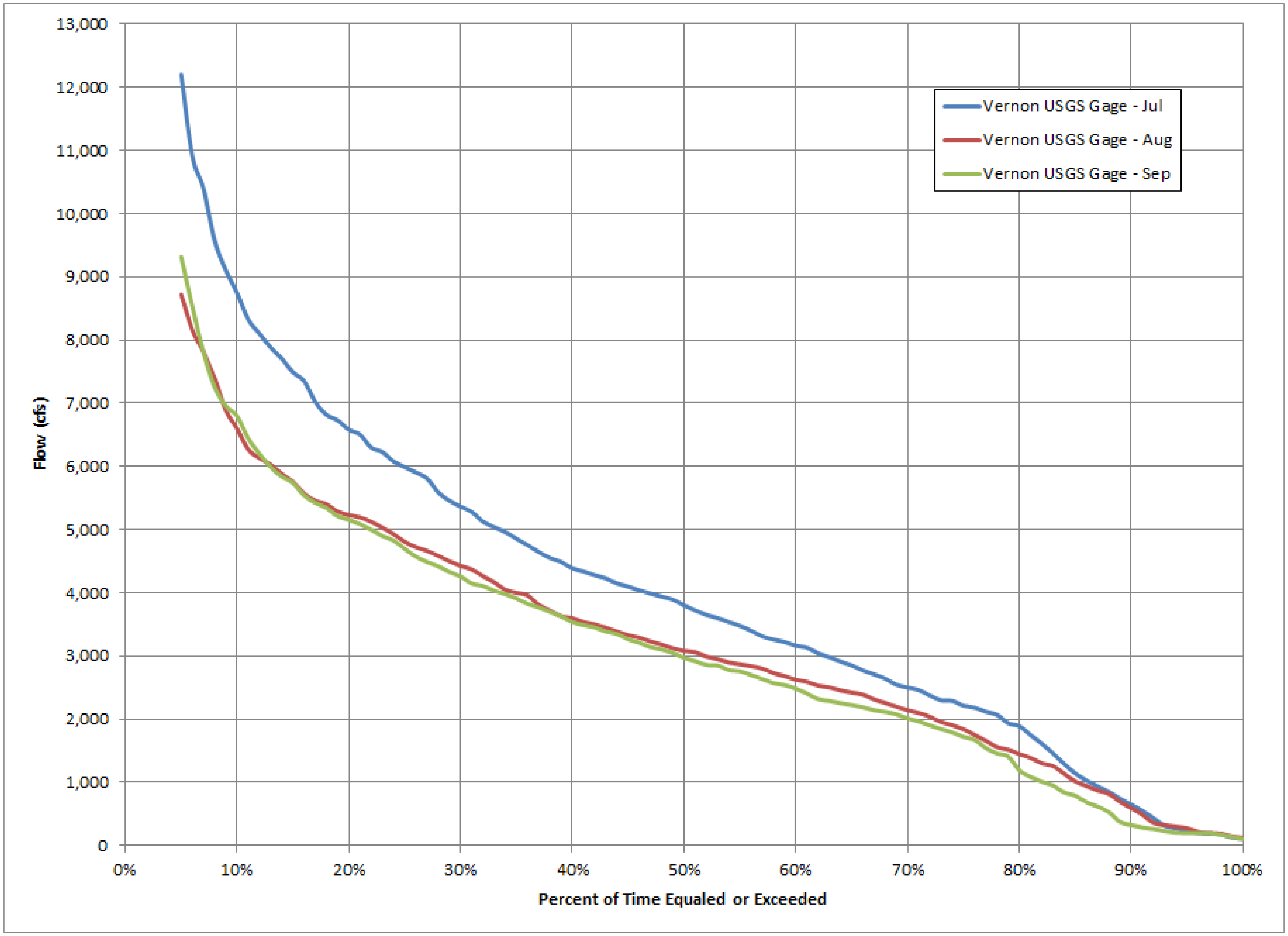


Figure 3.3.2.1.1-10: Connecticut River below Vernon Dam, VT, Jul, Aug and Sep Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

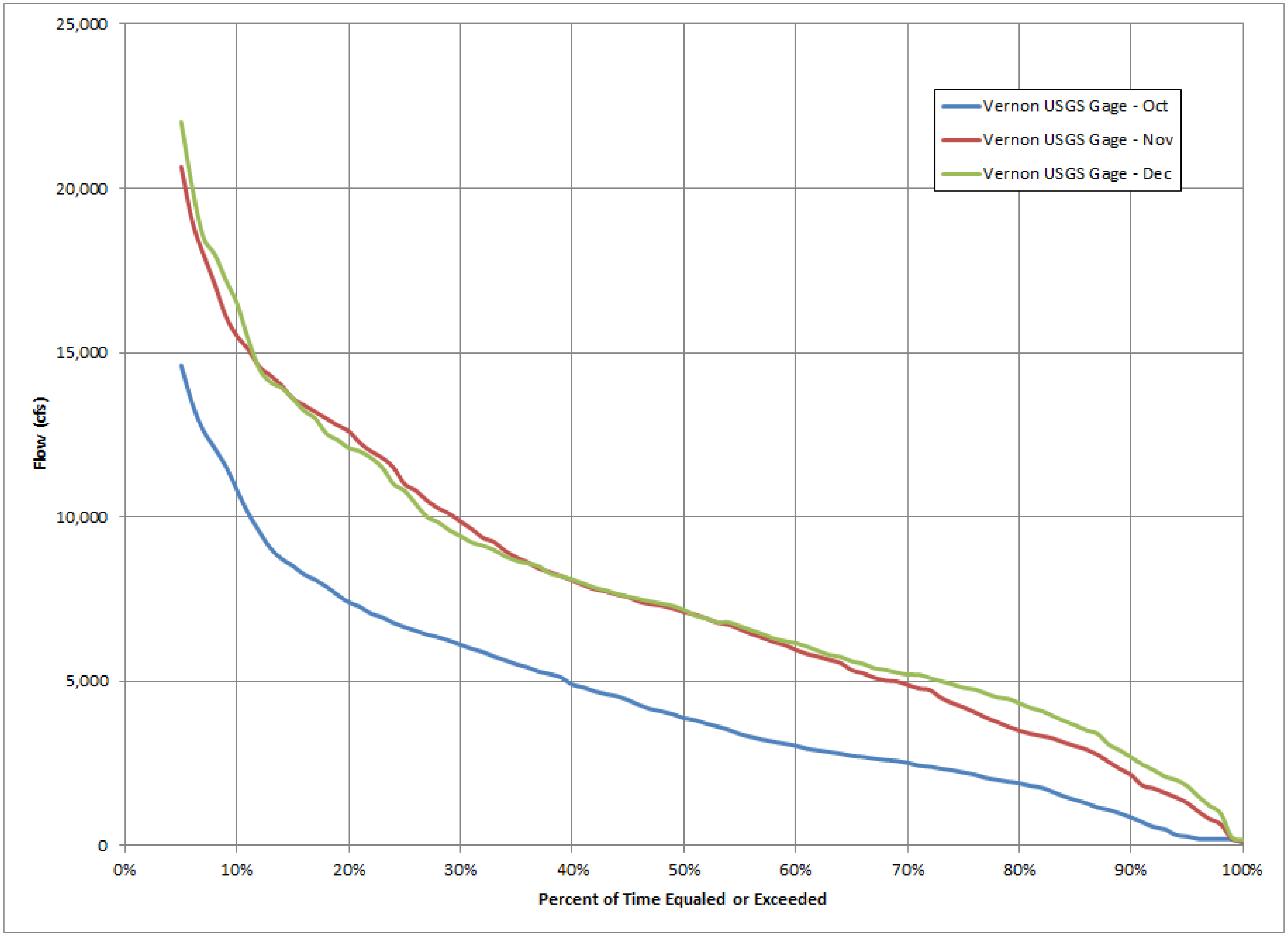


Figure 3.3.2.1.1-11: Connecticut River below Vernon Dam, VT, Oct, Nov and Dec Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

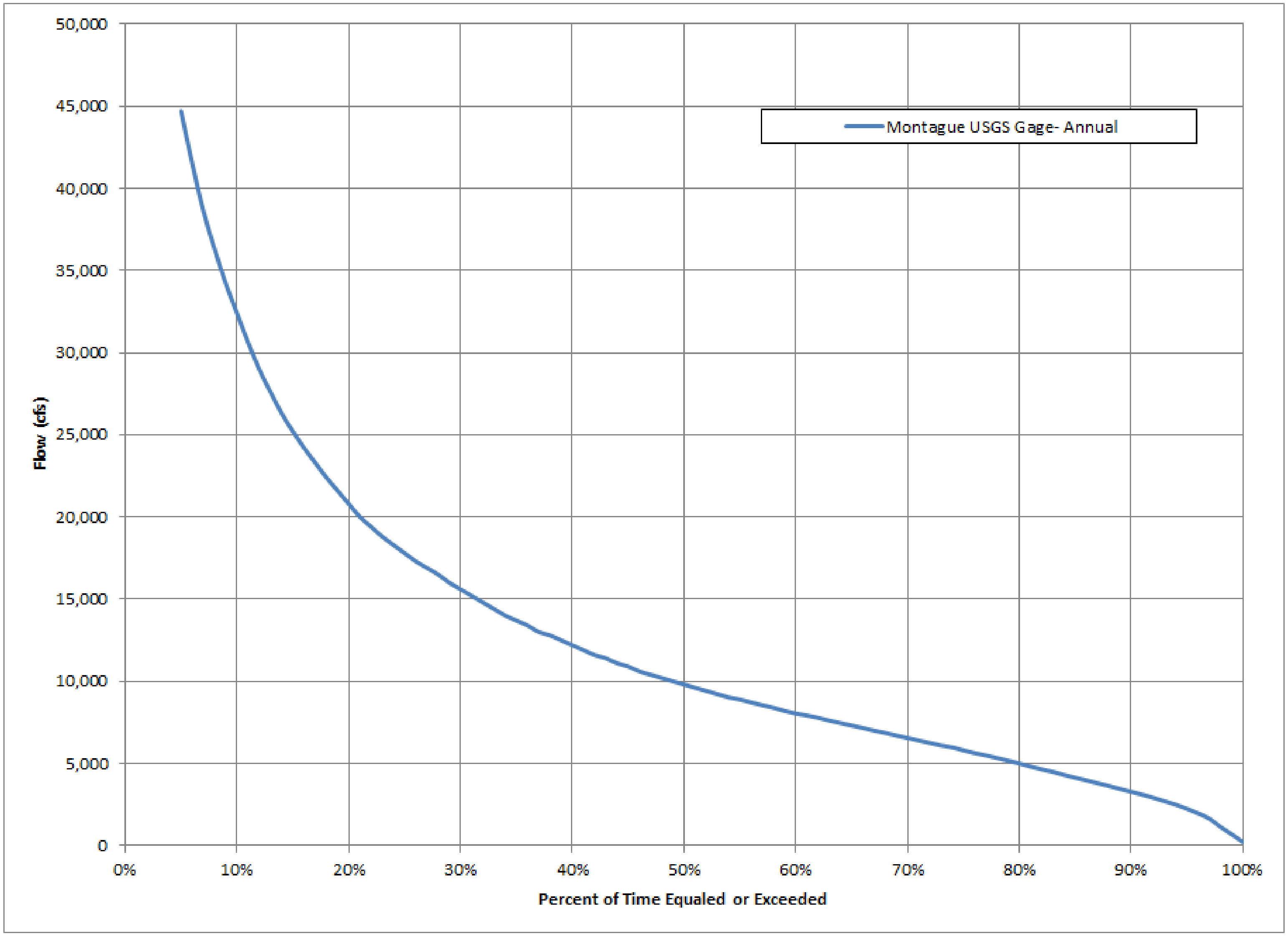


Figure 3.3.2.1.1-12: Connecticut River at Montague, MA, Annual Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

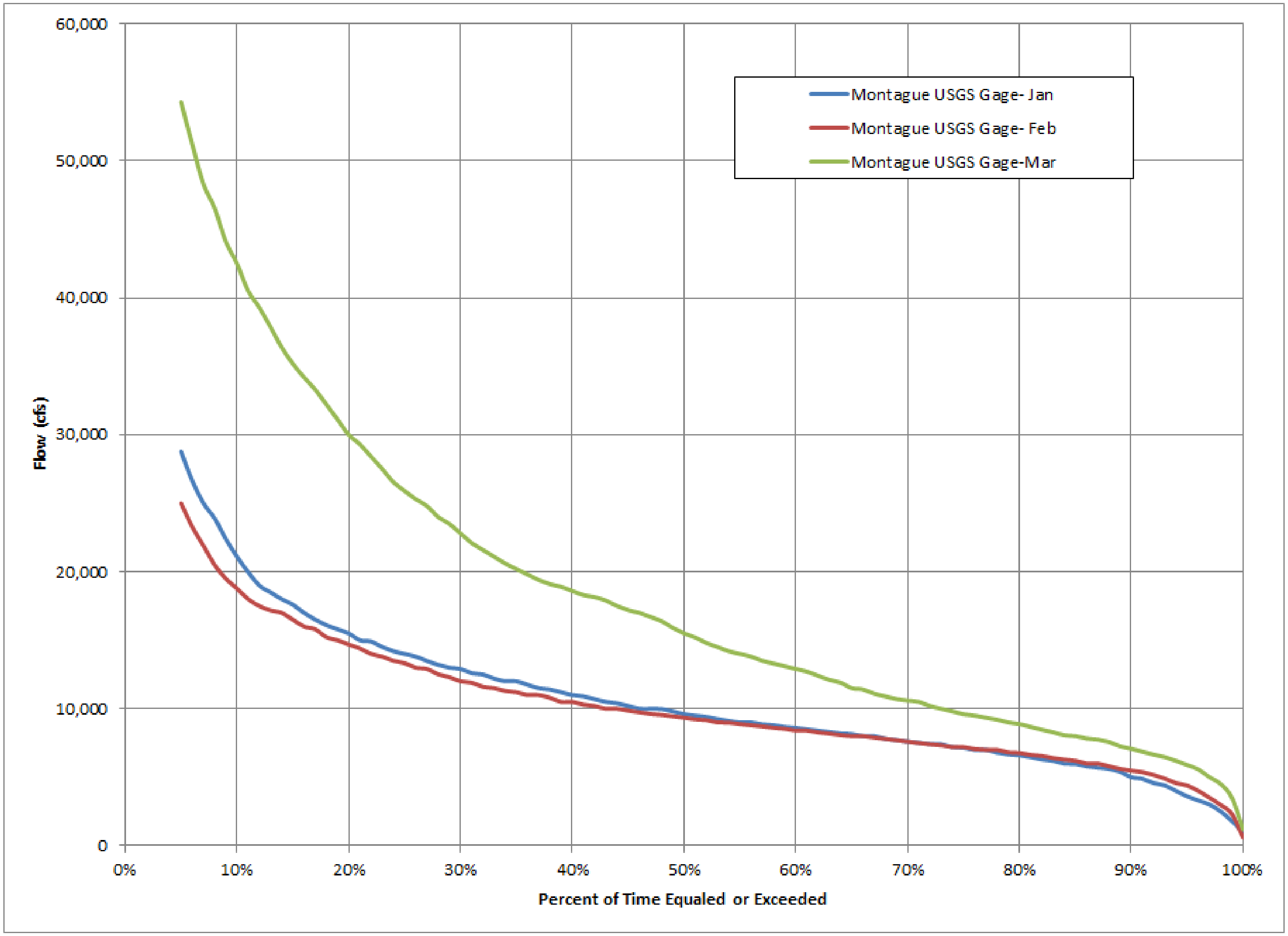


Figure 3.3.2.1.1-13: Connecticut River at Montague, MA, Jan, Feb and Mar Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

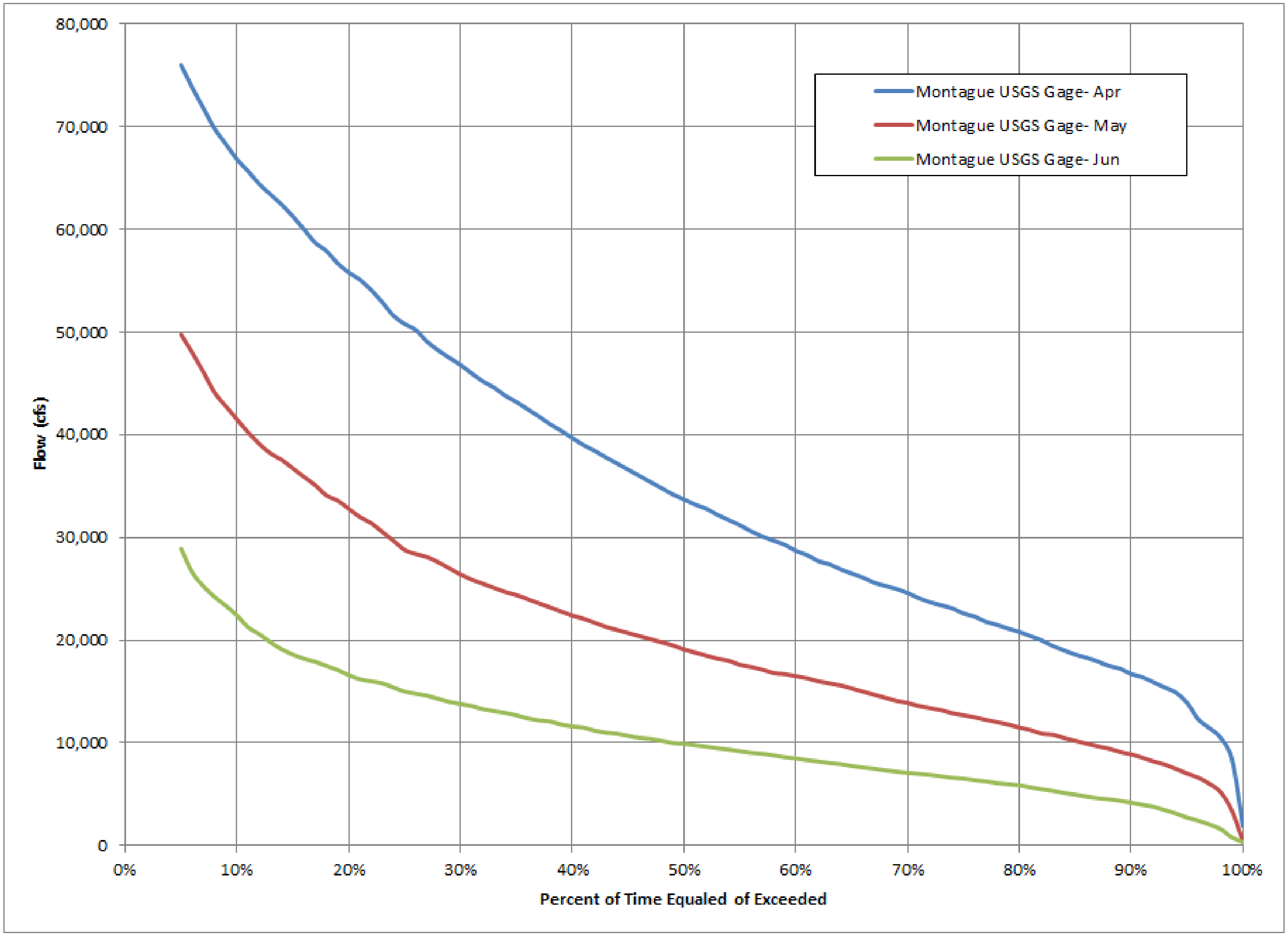


Figure 3.3.2.1.1-14: Connecticut River at Montague, MA, Apr, May and Jun Annual Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi²

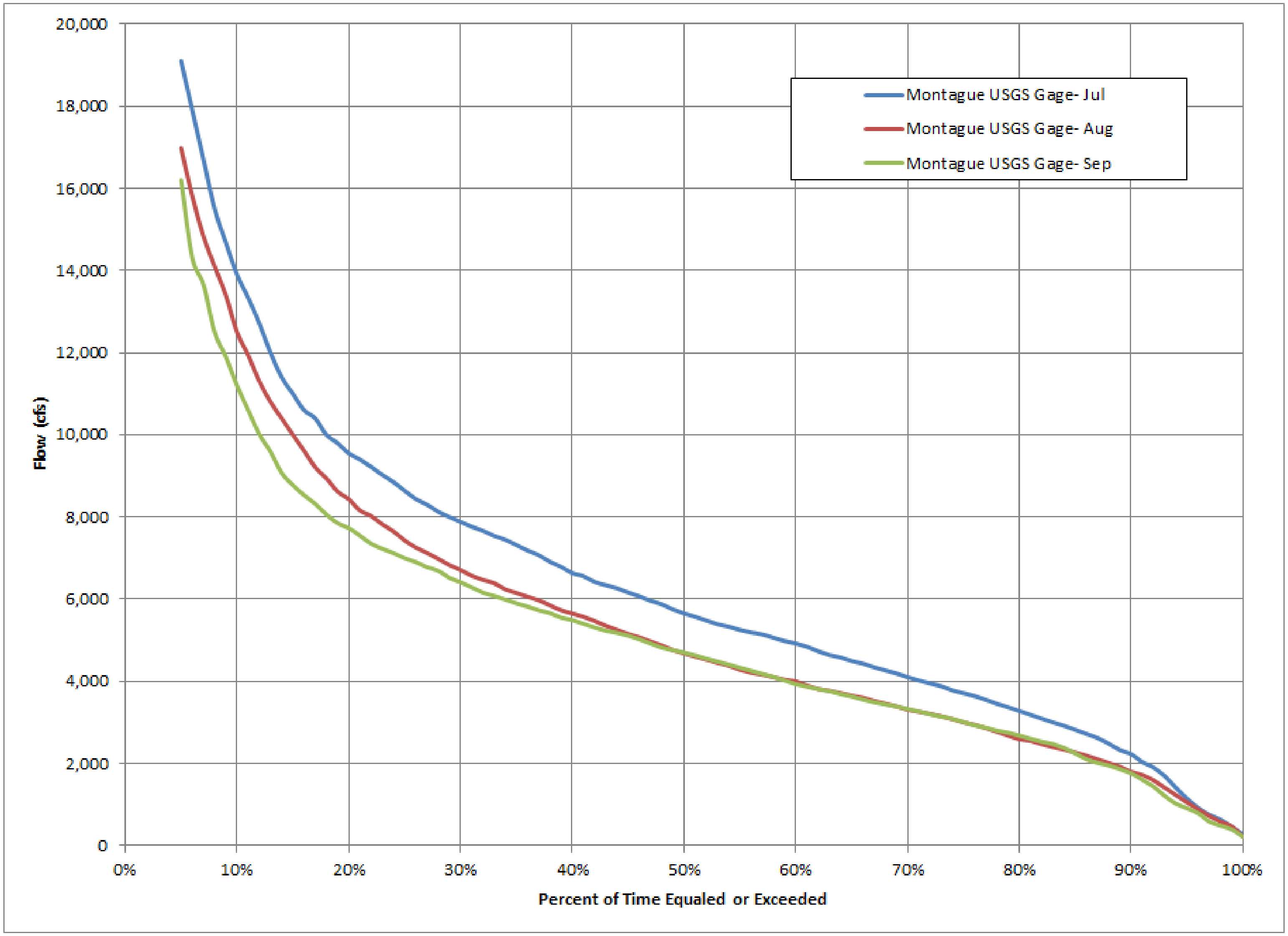


Figure 3.3.2.1.1-15: Connecticut River at Montague, MA, Jul, Aug and Sep Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi²

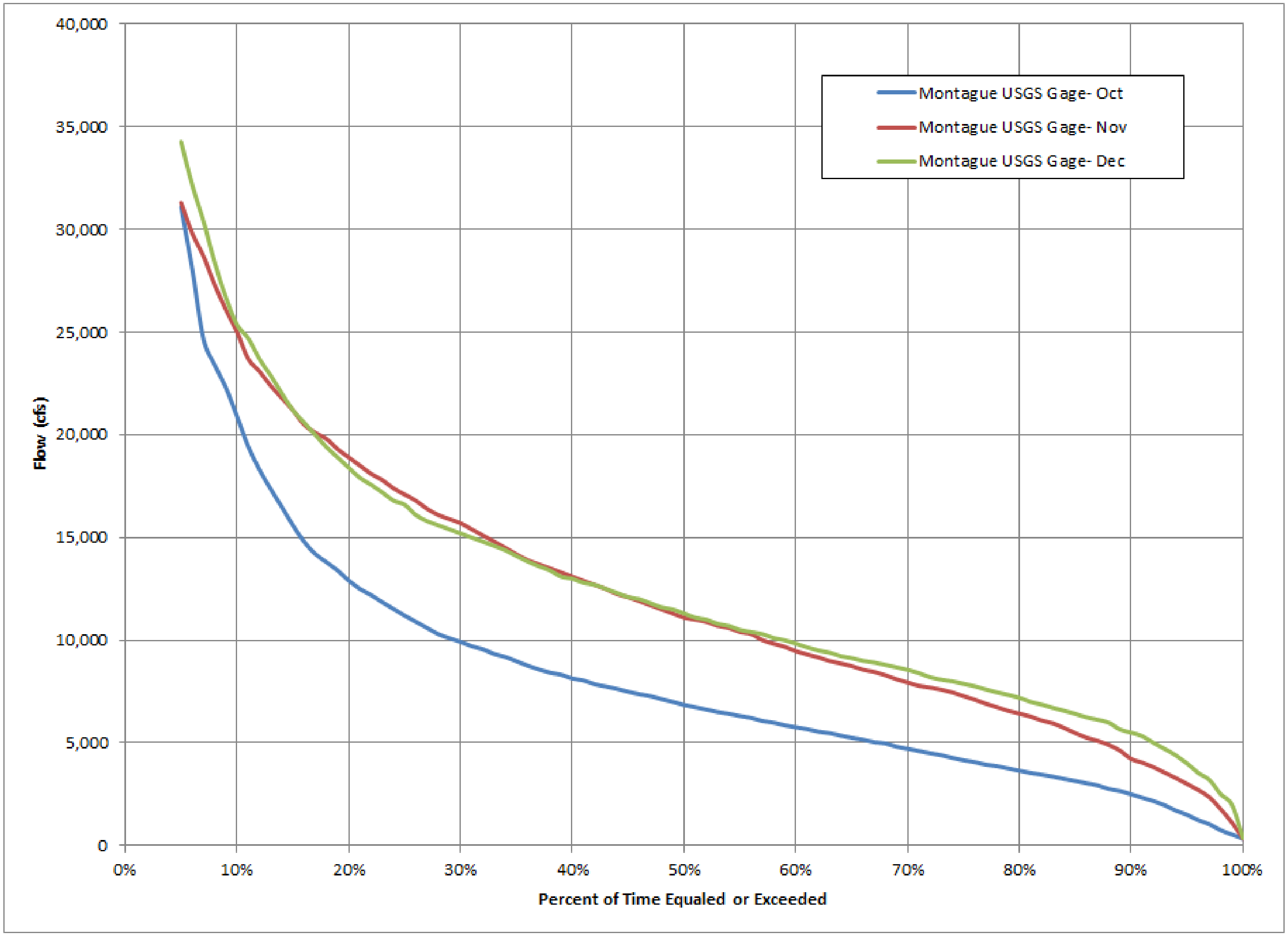


Figure 3.3.2.1.1-16: Connecticut River at Montague, MA, Oct, Nov and Dec Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

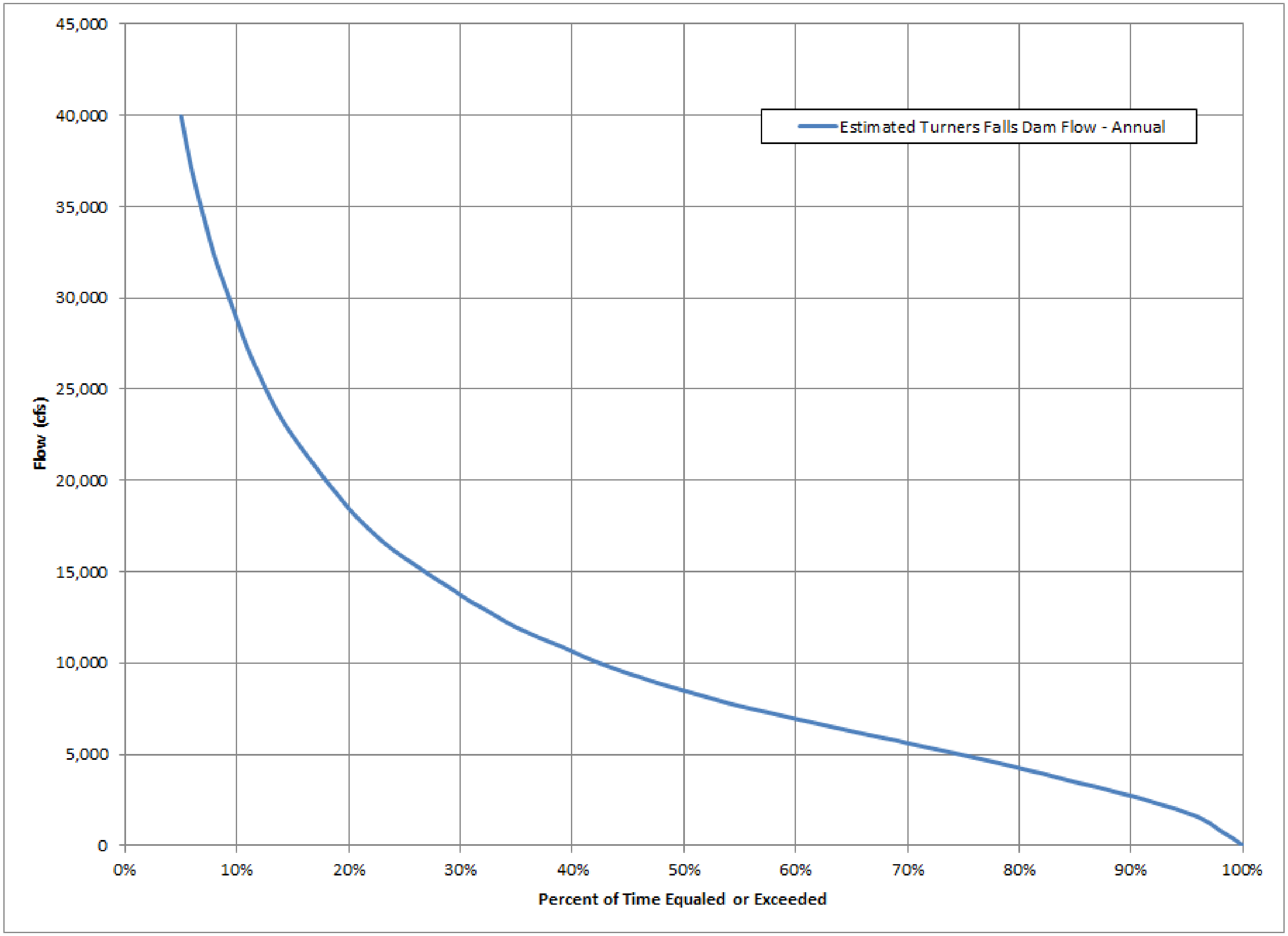


Figure 3.3.2.1.1-17: Connecticut River at Turners Falls Dam, Annual Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

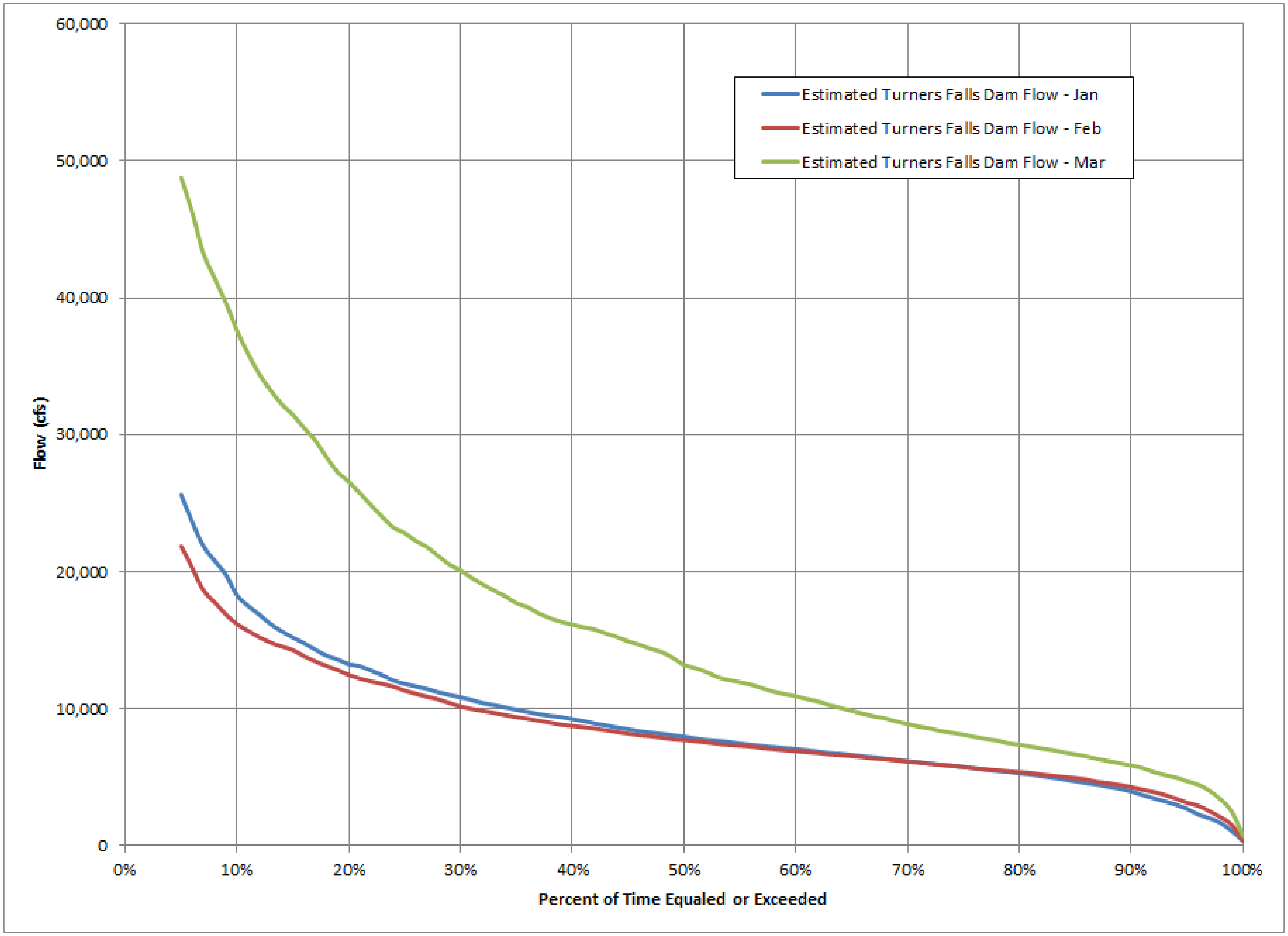


Figure 3.3.2.1.1-18: Connecticut River at Turners Falls Dam, Jan, Feb and Mar Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

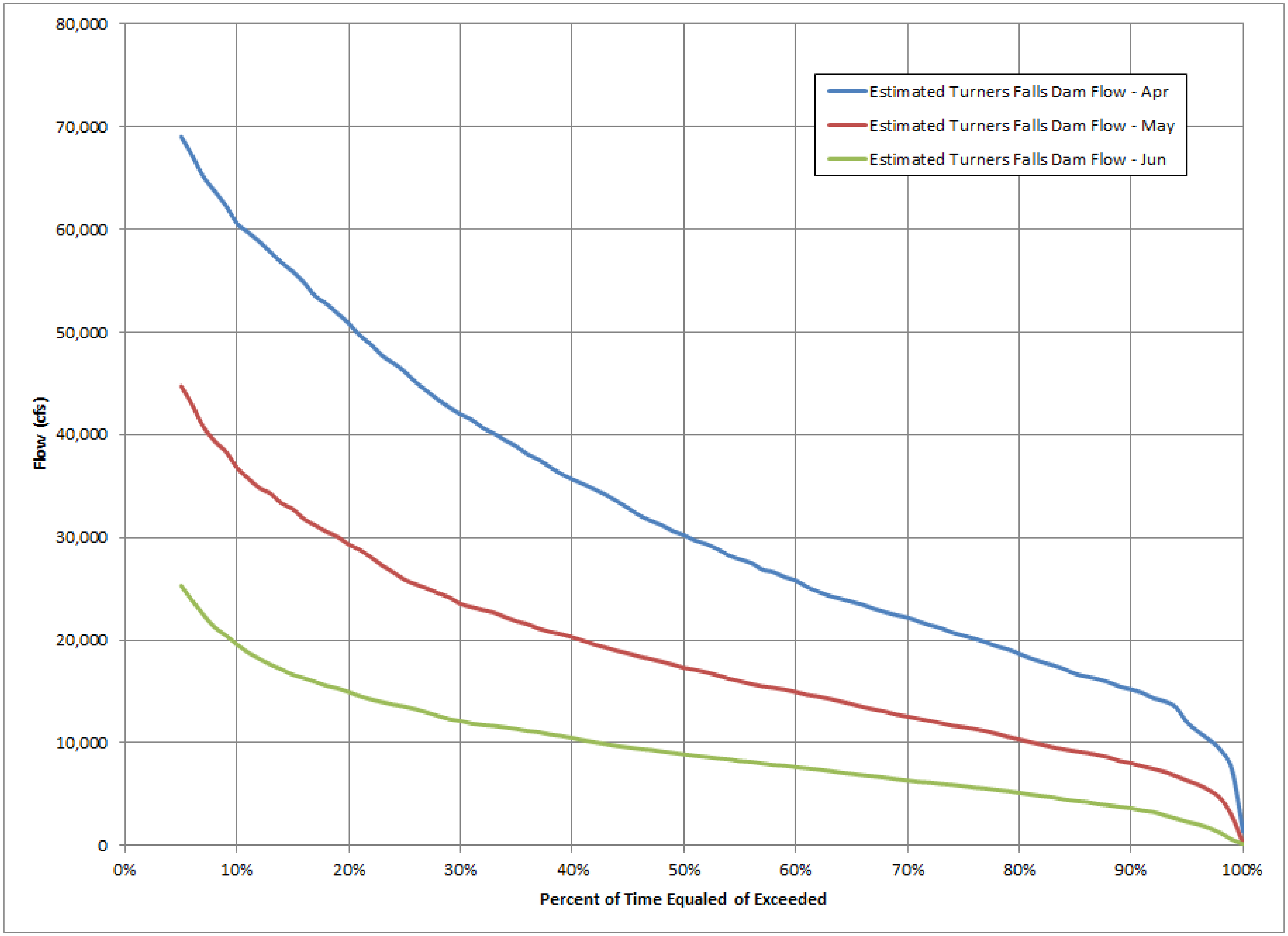


Figure 3.3.2.1.1-19: Connecticut River at Turners Falls Dam, Apr, May and Jun Annual Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

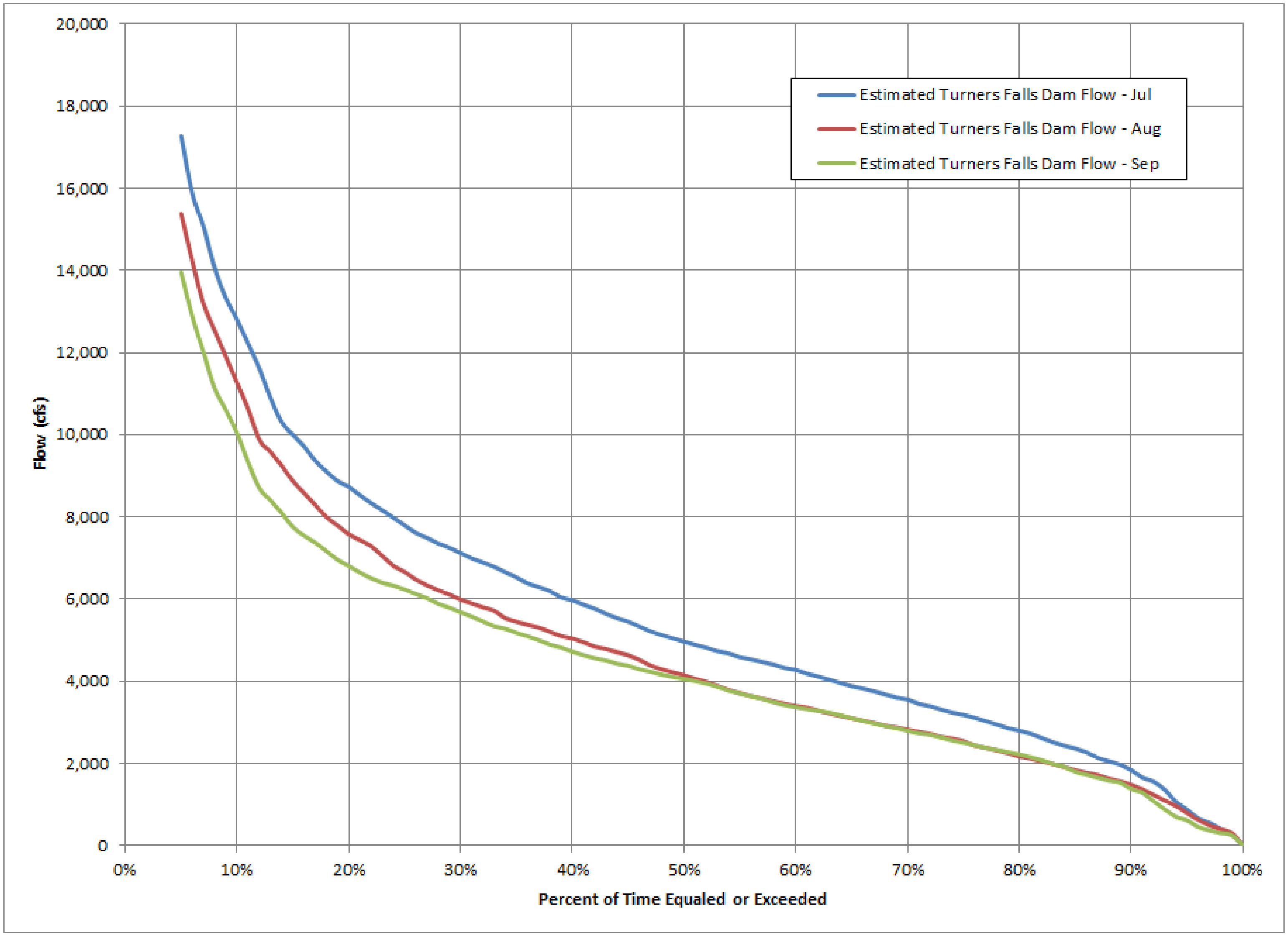


Figure 3.3.2.1.1-20: Connecticut River at Turners Falls Dam, Jul, Aug and Sep Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

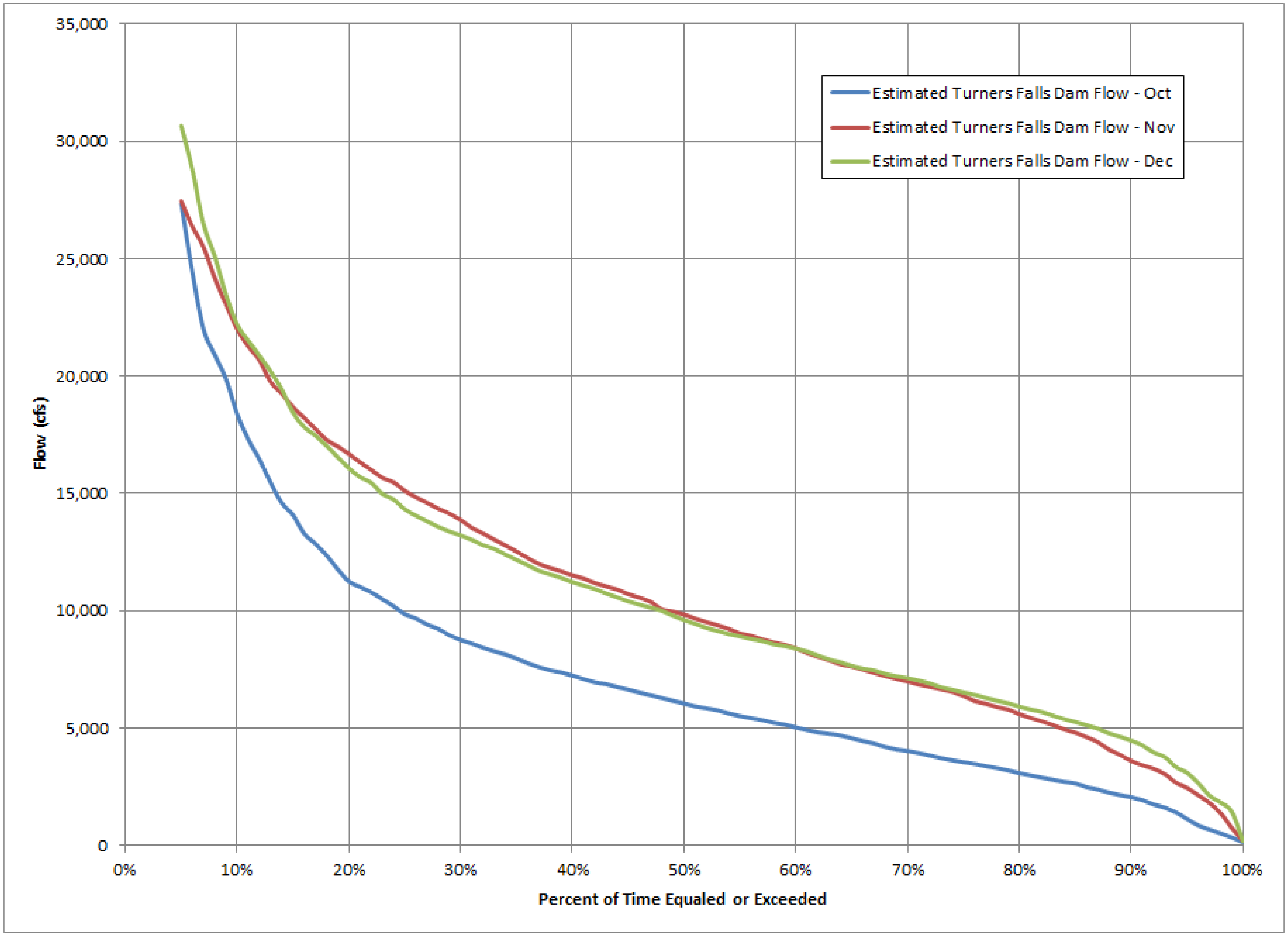


Figure 3.3.2.1.1-21: Connecticut River at Turners Falls Dam, Oct, Nov and Dec Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

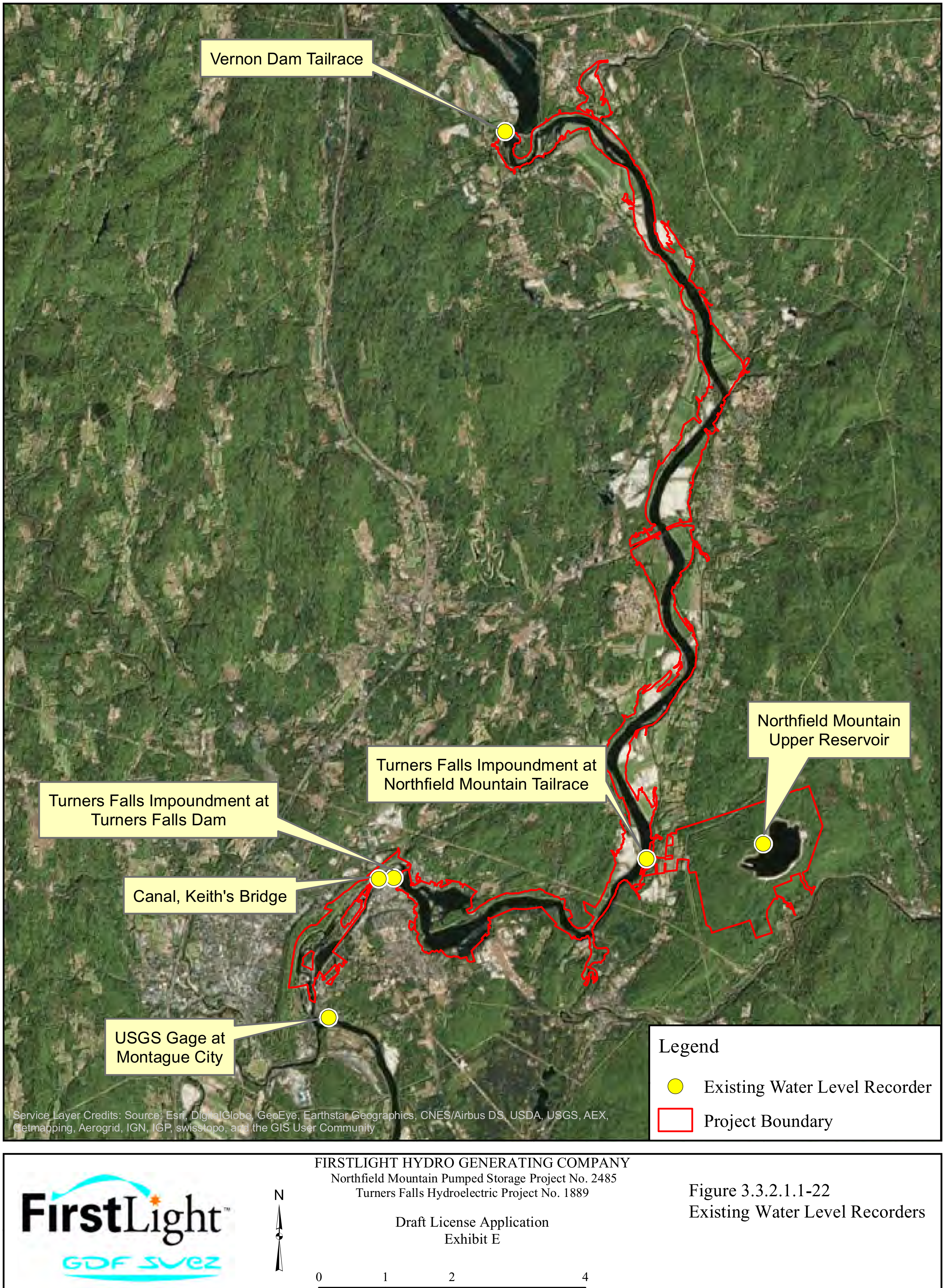


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Figure 3.3.2.1.1-22
Existing Water Level Recorders

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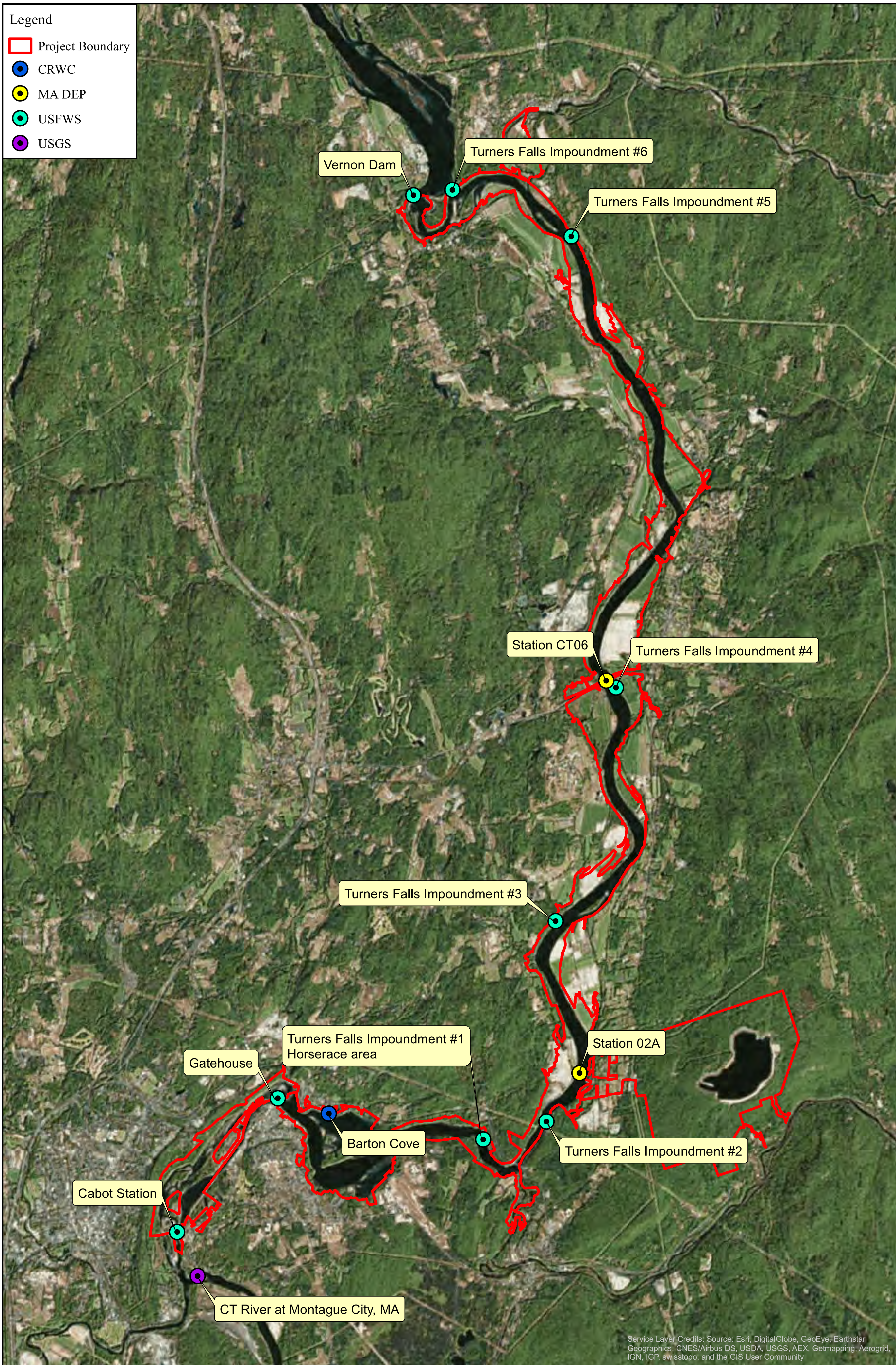

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N

0 0.5 1 2 Miles

Figure 3.3.2.1.2-1
Water Quality Sampling Locations
(Agency and Volunteer Groups)
in the Vicinity of the Project

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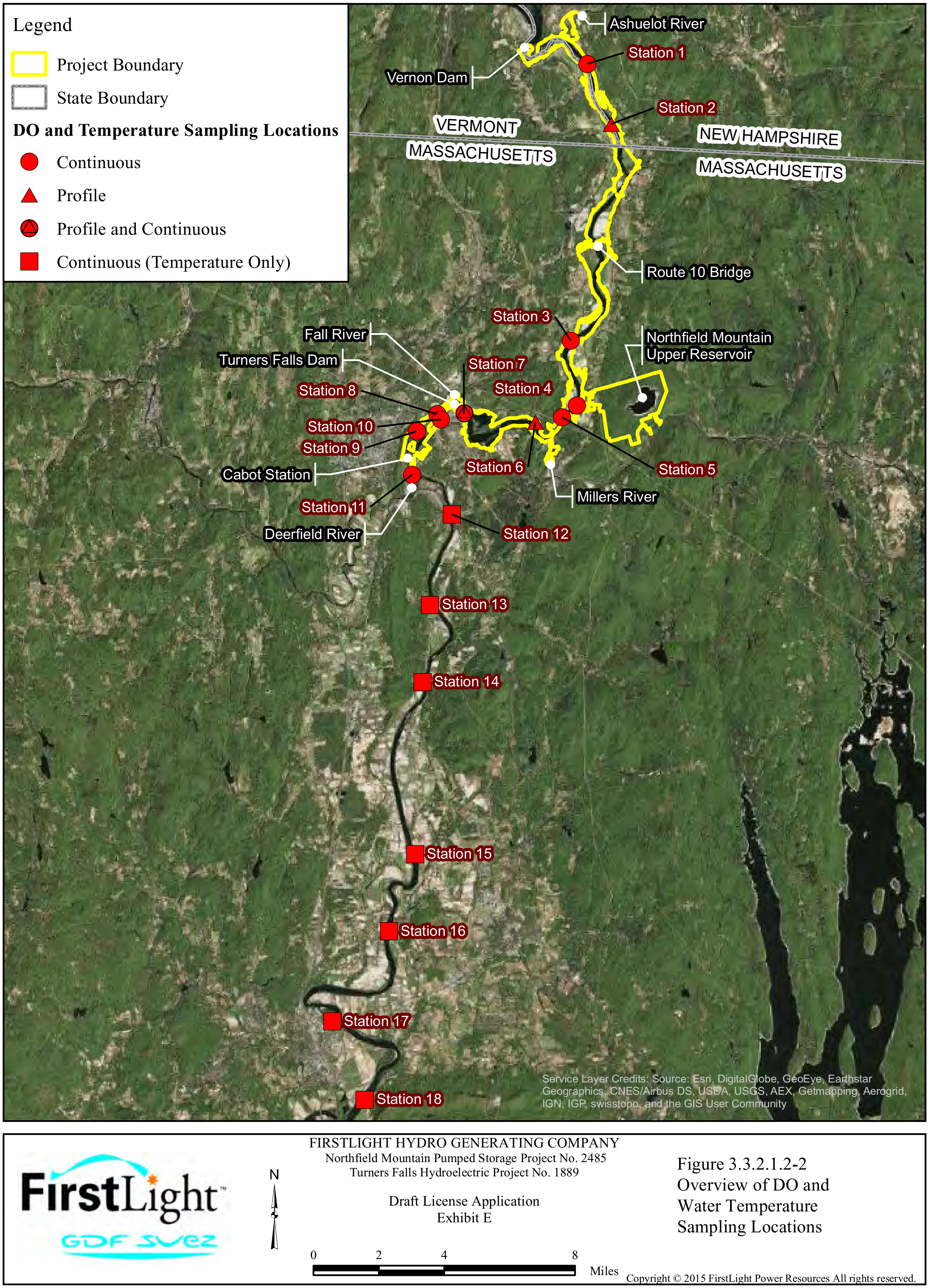

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Figure 3.3.2.1.2-2
Overview of DO and Water Temperature Sampling Locations

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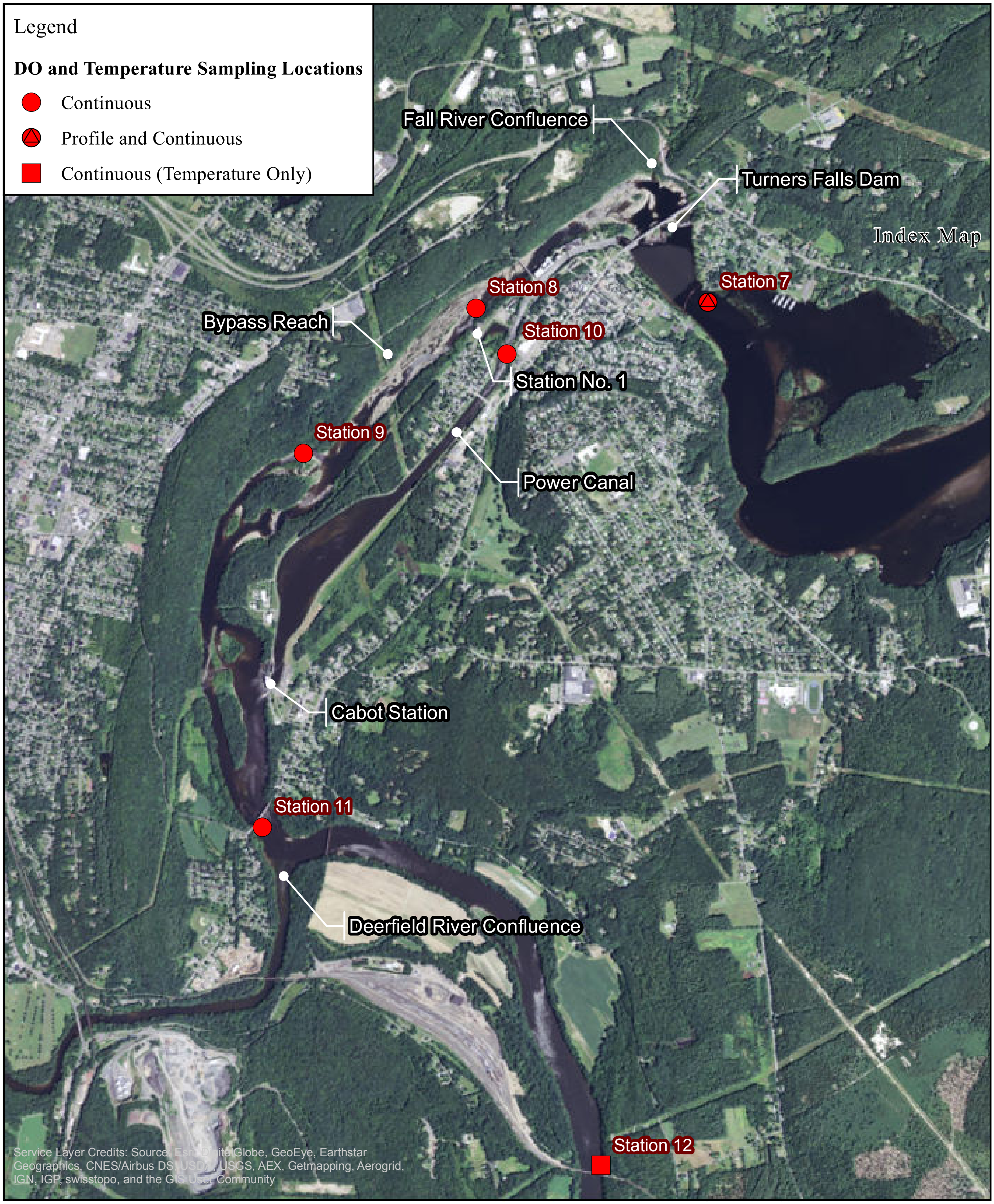

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N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-3
Water Quality Sampling Locations Near Turners Falls Dam

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Document Accession #: 20151202-5021 Filed Date: 12/02/2015

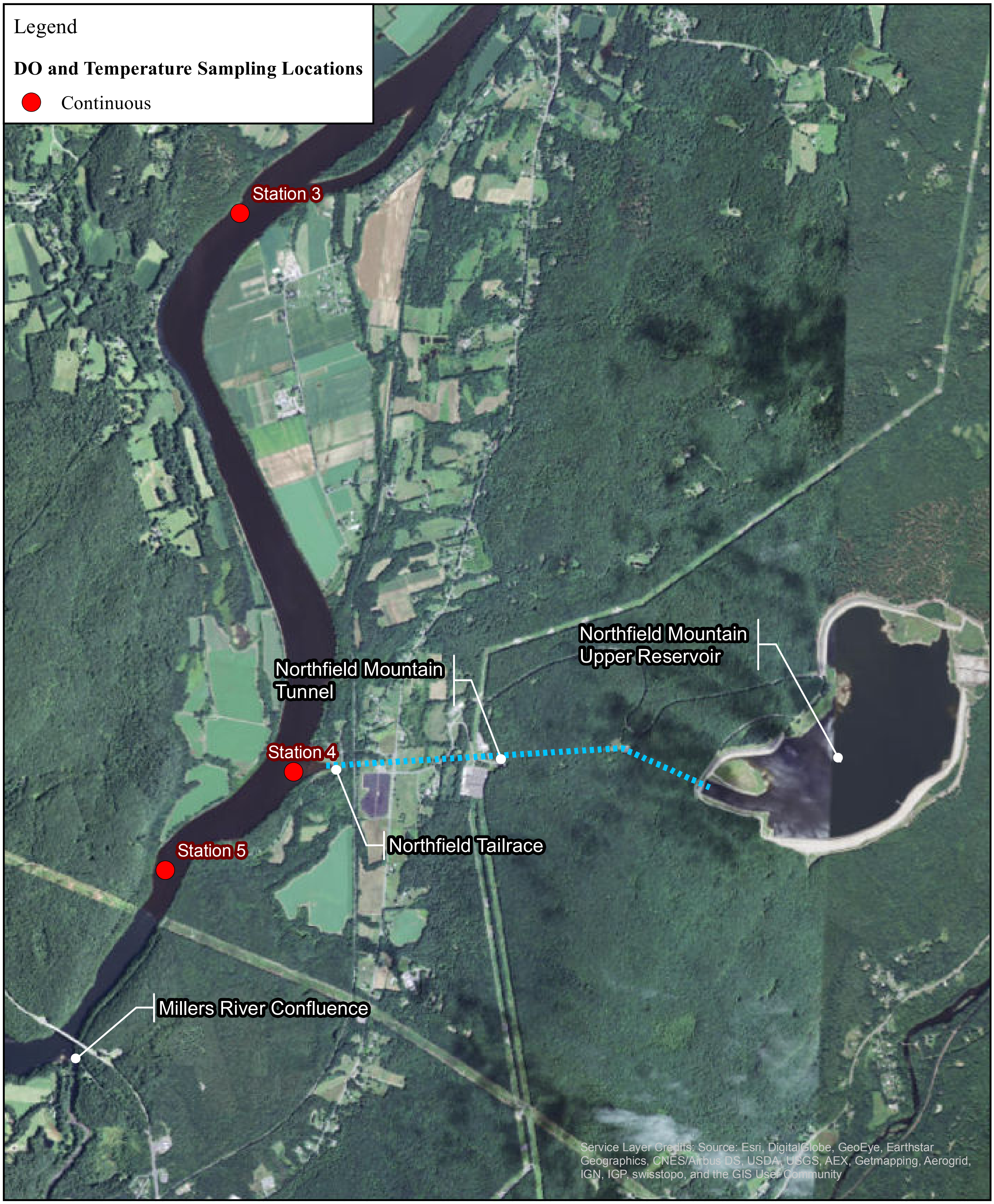

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Figure 3.3.2.1.2-4
Water Quality Sampling Locations Near the Northfield Mountain Tailrace

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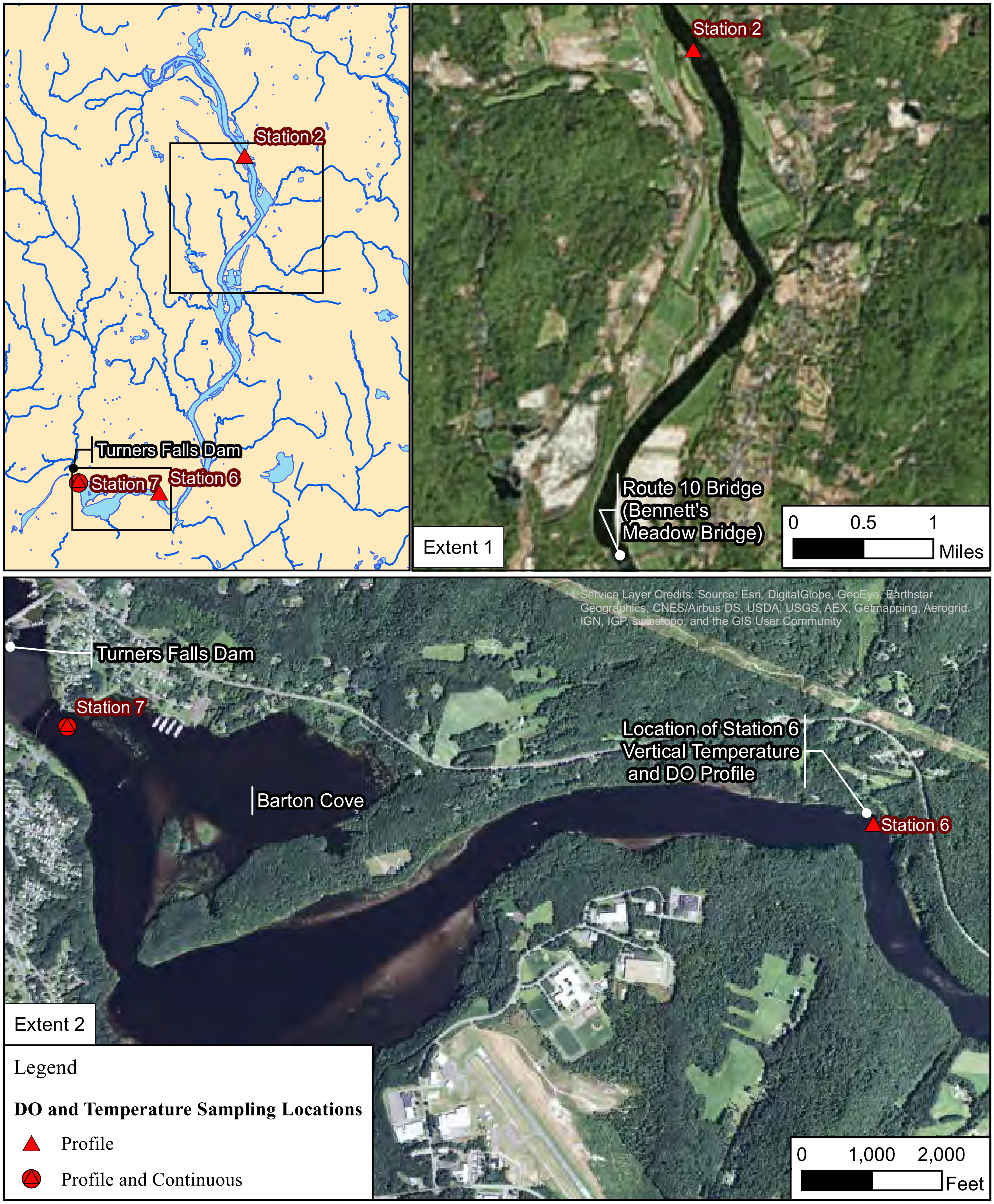

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Figure 3.3.2.1.2-5
Turners Falls Impoundment
Vertical Profile Locations

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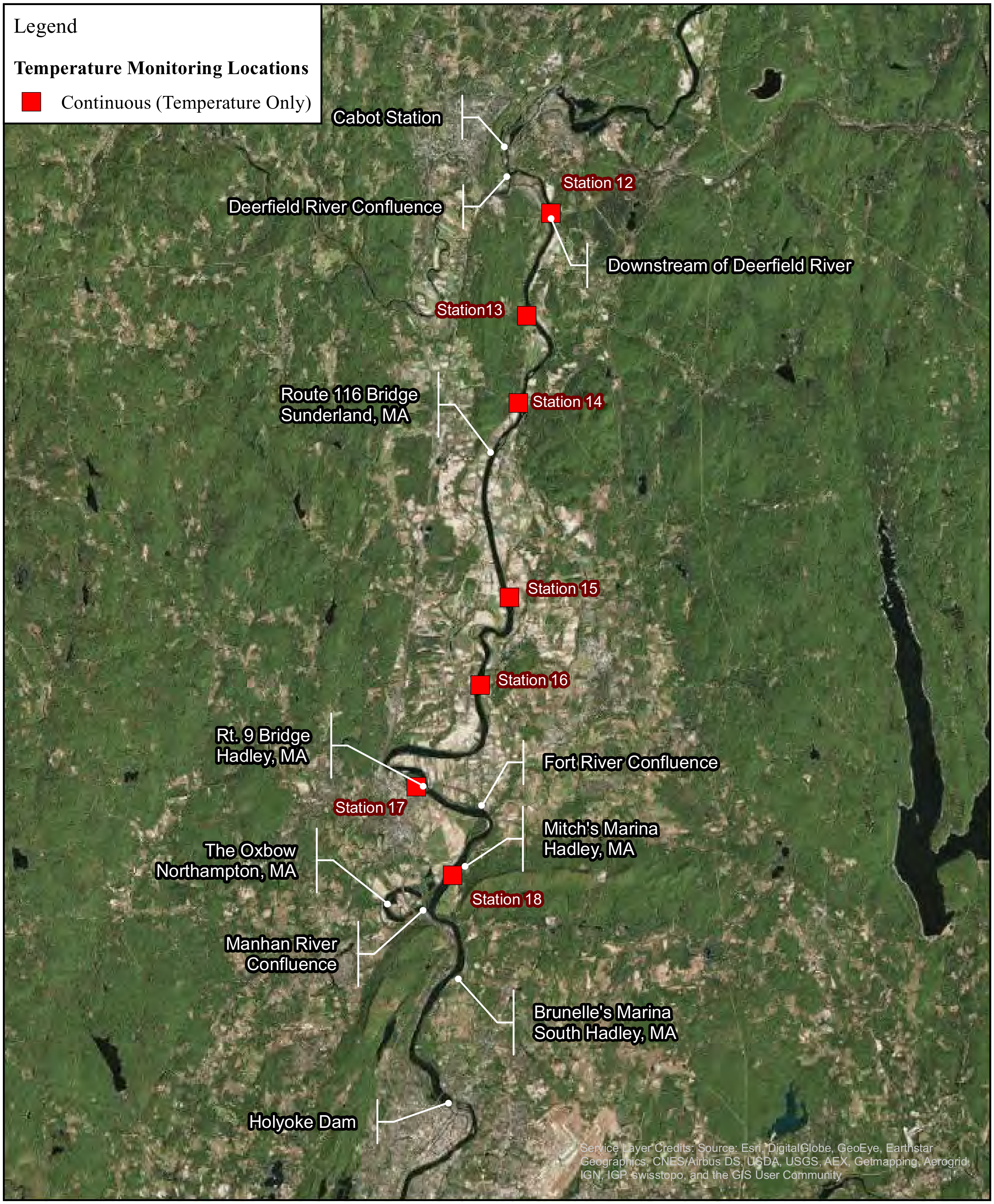

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N

0 1.25 2.5 5 Miles

Figure 3.3.2.1.2-6
Continuous Water Temperature Monitoring Locations Cabot Station to Holyoke Dam

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3.3.3 *Aquatic Resources*

The Turners Falls Development and Northfield Mountain Pumped Storage Development provide aquatic habitat for a variety of plants and animals. Studies conducted in the Project area provide information on the presence and distribution of the aquatic biota and on potential effects of Project operation on these resources.

FERC Relicensing Studies

As noted earlier (Section 1.4.3.1), closure of the Vermont Yankee Nuclear Power Plant (VY), located upstream of the Northfield Project, would change certain environmental baseline conditions during the relicensing study period. Due to the impending closure of VY, the implementation of 18 proposed or requested studies pertaining to aquatic resources were delayed for a year. Consequently, the final results of these studies are not available for inclusion in the Draft License Application.

3.3.3.1 Affected Environment

The Connecticut River in the vicinity of the Northfield Project area is generally narrow, with areas of floodplain and terraces of silt, sand and gravel. The basin is steep and makes for quick drainage to the river during mild rain events, snow melts and storms. The Northfield Project area from upstream to downstream consist of aquatic habitats associated with the TFI, bypass reach, and downstream riverine area. In addition, there is a 2.1-mile long power canal that is an important part of the passage route for migratory fish.

Turners Falls Impoundment

The TFI extends approximately 20 miles upstream from the Turner Falls Dam to the Vernon Dam (FERC No. 1904) tailrace and includes two major tributaries (Ashuelot and Miller Rivers) as well as several smaller tributaries (Figure 3.3.3.1-1). Both lentic and lotic conditions are present in the impoundment. The Licensee has undertaken a study, in accordance with the approved RSP, to determine the distribution and abundance of aquatic habitat within the TFI. The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics, were documented during field surveys in 2014 and 2015. Survey results were used to develop maps depicting the distribution of mesohabitat. Habitat maps of the TFI, bypass reach and below Cabot Station are shown in Figure 3.3.3.1-2.

The upstream reach of the TFI, extending approximately 15 miles from Vernon Dam tailrace to the Northfield Mountain Pumped Storage Development tailwater, is located within a broad flood plain and is relatively uniform and generally shallow, with gentle bends. A river channel exists with rock shorelines and lotic conditions. The substrate in this reach is variable ranging from sand to boulders.

There are a few narrow islands comprised of alluvial materials such as gravel, cobble and fines. Scour holes and shoals generally are confined to locations downstream of features such as bridge piers and there are few deep pools. Scour holes provide the most extensive cover; object cover in the littoral zone is sparse, and limited to isolated patches of submerged aquatic vegetation (SAV) and clusters of woody debris.

The downstream reach of the TFI extends from the Northfield Mountain Pumped Storage Development tailrace approximately five (5) miles to the Turners Falls Dam and is dominated by bedrock, which controls much of the stream geometry and substrate features. The geometry of the lower impoundment is complex. It is defined by both bedrock and depositional features, and includes a complex of embayment, points, coves, islands, and a wide range of substrates, and features shallow lacustrine littoral habitat with a deeply incised thalweg, in contrast to the riverine habitat found further upstream in the TFI. The lower section of the TFI has several large areas off the channel which are shallow, with SAV and muck bottom habitats characteristic of lentic conditions.

The littoral zone in the TFI is composed of varied substrates. In some locations the littoral zone is absent due to vertical bedrock cliffs, while in others there are broad horizontal shoals composed of gravel, sand or other fines, particularly in embayed sections (Figure 3.3.3.1-2). The thalweg is deeply incised. Most banks are wooded and composed of predominantly deciduous trees. Shoreline development ranges from residential (seasonal and year round homes) to urban. The least developed shorelines are those furthest upstream from Gill and Turners Falls.

Littoral zone substrates composed of fines (e.g., sand/silt, clay) and cobble collectively accounted for about 50% of all littoral substrate (Table 3.3.3.1-1). Fines comprised 29% of the study area, followed by cobble (21%), then bedrock (17%) and gravel (16%). Littoral areas where cobble substrates were combined with either fines (6%) or boulder (1 %) also occurred. However, these patches were scattered and small. Littoral areas with fines were widely distributed throughout the study area; however, cobble and gravel were most common above the French King Gorge area. Bedrock and wetland areas were most abundant in the reach from French King Gorge downstream. Riprap accounted for approximately 7% of littoral substrates and occurred in patches throughout the study area where either erosion abatement or other infrastructure such as bridges or developed shorefronts were located.

Bypass

The 2.1-mile long bypass reach runs from the base of Turners Falls Dam to the tailrace of Cabot Station. This reach has a low gradient (approximately 0.3%); contains mostly bedrock, boulder, cobble, and gravel substrates; is primarily comprised of pool mesohabitat, followed by riffle and backwater types. It has minimum flow requirements during certain times of the year as noted in Section 2.1.5. Minimum bypass flows are provided beginning May 1 and continuing until water temperatures fall below 7°C (typically November) to enhance conditions for upstream migratory species and Shortnose Sturgeon. The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics were documented during field surveys of 2012 and were utilized to develop maps depicting the distribution of mesohabitat (Figures 3.3.3.1-3, Maps 1 & 2).

Downstream Riverine Habitat

Habitat downstream of Cabot Station was mapped in 2012. This low-gradient reach forms a wide flood plain with alluvial-dominated substrates, with a meandering channel in many places. Run habitat comprises over 75% of the riverine reach by length, with pool comprising the next most abundant mesohabitat type (13%). Riffle habitat is extremely uncommon and is most concentrated in the stream reach immediately downstream from the Cabot Station discharge. The Deerfield River enters the Connecticut River just downstream of Cabot Station (Figure 3.3.3.1-1). The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics were documented during field surveys of 2012 and were utilized to develop maps depicting the distribution of mesohabitat (Figures 3.3.3.1-3, Maps 3 through 22).

3.3.3.1.1 Aquatic Vegetation

During the summer of 2014 submerged aquatic vegetation (SAV) beds within the TFI were mapped and dominant species were identified. Dominant species identified during the survey are shown in Table 3.3.3.1.1-1. Patches of SAV and wetlands, emergent aquatic vegetation (EAV) such as lily pads or cattail patches occur in areas with finer substrates. Areas with bedrock substrates have limited or no riparian vegetation. Beds of SAV vegetation, outside of the areas near Barton Cove, generally occur as narrow bands located parallel to the TFI shoreline. In some cases shallow shoals within the TFI, often associated with islands, support large beds of SAV. Native species include wild celery, various pondweeds, musk grasses, and coon tail. Wild celery occurs throughout the majority of the identified SAV beds.

Several exotic and invasive aquatic species are currently found within the Project, including variable leaf milfoil, Eurasian milfoil, curly-leaf pondweed, fanwort, and water chestnut. The majority of the exotic species occur immediately upstream of the Turners Falls Dam with fewer occurrences upstream of the

French King Bridge. In general, exotic species are not as widespread and occur at lower densities upstream of the French King Bridge.

3.3.3.1.2 Fisheries

The Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development vicinity supports a variety of cool and warm water resident fish as well as migratory species. The federally endangered Shortnose Sturgeon is also present in the reach between the Turners Falls and Holyoke Dams. These fish species are discussed in the following sections.

Resident Fish Species

The Connecticut River in the vicinity of the Northfield Project supports a variety of warm water resident fish. Dominant family groups include Centrarchidae (sunfishes), Percidae (perches) Catostomidae (suckers), and Cyprinidae (minnows). The centrarchid family includes important warmwater game fishes such as Largemouth and Smallmouth Bass, crappies and sunfish (Hartel *et al*., 2002). Among the Cyprinidae species reported in the Connecticut River are the Spottail Shiner, Fallfish and Common Shiner. Catostomids are closely related to the Cyprinids and are a highly diverse taxonomic group. Although the Longnose Sucker was historically found in the mainstem Connecticut River, recently only the White Sucker has been reported in the project area. Yellow Perch and Walleye are two common Percids, and northern pike and chain pickerel are two common Esocids found in the area (Hartel *et al*., 2002) of the Northfield Project.

Fish Assemblage Study

FirstLight conducted Study No. 3.3.11 *Fish Assemblage Study* to gather baseline information pertaining to the current population(s) within the study area. The study area includes the Connecticut River from Vernon Dam to the Cabot Station tailwater. In order to sufficiently sample representative habitat types throughout the study area, and the range of strata within these reaches, sampling methods included boat electrofishing, gill netting, and seining. Sampling was performed during the early summer in July 2015 in the TFI and again in the fall (September) in the TFI and also in the bypass reach between Turners Falls Dam and Cabot Station tailrace. Twelve (12) electrofishing stations were sampled in the TFI. Gillnets were also deployed in deep holes concurrent with electrofishing, and beach seining was conducted where feasible in the middle and lower TFI strata. In several locations where beach seining was not feasible due to snags or unwadable shorelines, supplemental boat electrofishng was conducted. Data analyses and reporting will follow completion of the fall field work. While data analysis has not yet occurred for the summer sampling, a preliminary list of species captured is provided in Table 3.3.3.1.2-1.

Littoral Zone Fish Spawning and Spawning Habitat

In accordance with the RSP, the Licensee performed a study to identify littoral zone fish spawning and spawning habitat in the mainstem, tributaries and backwater of project-affected areas to supplement information on resident species. Prior to initiating the field surveys, a desktop review was performed to determine the typical timing of spawning, spawning habitats, and spawning behaviors for resident species (Table 3.3.3.1.2-2). Field sampling was then conducted by systematically traversing the littoral zone (depth < 6 feet) of the TFI via boat and/or foot (wading) to visually identify any fish nests, egg masses/deposits, and/or spawning habitat. Identified habitats, egg deposits and nests were geo-referenced with a GPS unit, and water quality parameters, including temperature, velocity, clarity, and depth, were recorded. Other relevant information collected included sediment grain size associated with nests, presence of aquatic vegetation, occupied/abandoned nests, weather conditions, and other relevant observations or descriptive information.

The early spring survey was performed from May 4-6, 2015, after river flow had receded to safe levels. Water temperature during this period ranged from 10.1 to 11.7°C, except in the lower reaches of tributaries such as Pauchaug Brook and Millers River which were warmer (16-16.7°C). Prevailing naturally routed inflow to the impoundment during this period ranged from approximately 12,000 to 15,000 cfs, and water clarity was generally good (6-7.5 ft visibility), allowing clear view of the littoral zone bottom.

The late spring survey was initiated on June 1, 2015 but aborted due to rising river flow. The survey resumed June 11 and extended to June 13, but relatively high river flow persisted and visibility was reduced to 4-6 ft. Water temperature during late May had slowly climbed to approximately 18°C, but on June 1 was 16°C due to rains and persistent cold weather. After field work resumed on June 11 temperatures ranged from 17 to 21.5°C during the course of the survey.

A total of 18 spawning locations were surveyed during the early spawning season and 16 locations were surveyed during the late spring season. A number of spawning locations, particularly in the late spring featured multiple nests clustered in close proximity to each other. Figure 3.3.3.1.2-1 illustrates the location and distribution of spawning sites that were identified during the two surveys.

Migratory Fish Species below the Turners Falls Dam

The Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development vicinity supports a variety of migratory fish species (anadromous and catadromous), including American Shad, Blueback Herring, Striped Bass, Sea Lamprey, and American Eel[34]. Before reaching the Project Area, these migrants must successfully pass the hydroelectric facility at Holyoke (RM 87) using the fish lift or eel passage ladders at this facility. In addition, a population of Shortnose Sturgeon is known to inhabit the Connecticut River between the Turners Falls Dam and Holyoke Dam.

American Shad

American Shad migrate into the lower Connecticut River during late March or April, reaching Cabot Station in late April or early to mid- May as they move upstream to spawn. In 2015, it was reported that over 58,000 shad successfully passed upstream of the Turners Falls Dam. Shad spawning typically occurs from April into June. Young-of-Year (YOY) shad remain in southern New England freshwater rivers throughout summer before initiating seaward migration which typically occurs in September or October. Most daily movement occurs in evening hours until about 2300 hours, but movement can occur around-the-clock (Hartel *et al.*, 2002). The young migrate to areas in the North Atlantic and remain at sea for four to six years before returning to their native river to spawn. American shad are repeat spawners and can return to their natal rivers more than once.

American Shad tend to spawn in areas dominated by runs and glides, 3 to 18 feet deep, and have been observed to spawn over a variety of substrates, but prefer sand and gravel bottom (Stier & Crance, 1985). This type of habitat most closely corresponds to the runs and glides occurring downstream of Cabot Station, but is very limited in the bypass reach. Female shad broadcast their eggs, about 290,000 per individual, in open water.

Shad spawning surveys were conducted by the Licensee from May through June 2015. The surveys were generally conducted 2-3 times per week through June 22, 2015, for a total of 18 survey nights, at four general locations: 1) in the TFI (upstream of Turners Falls Dam to the tailrace of Vernon dam), 2) within the Turners Falls Power Canal, 3) in the vicinity of the Rock Dam in the bypass reach, and 4) from Cabot Station to the Route 116 Bridge in Sunderland. Shad spawning was observed in the river reach downstream of Cabot Station (Figure 3.3.3.1.2-2), in one area of the bypass reach and in one area of the lower Turners Falls power canal (Figure 3.3.3.1.2-3), as well as in the TFI, adjacent to Stebbins Island (Figure 3.3.3.1.2-4). Spawning was observed in the downstream reach (Cabot Station to Route 116 Bridge) where water

[34] At a meeting of the Connecticut River Atlantic Salmon Commisison on July 10, 2012 the USFWS announced that it will no longer culture salmon for restoration efforts in the Connecticut River Basin. Agency representatives indicated that they supported the salmon restoration for 45 years, but low return rates and the science supporting salmon restoration have caused them to refocus efforts on other anadromous fish.

temperatures ranged from 15.8 to 20.2°C, depths ranged from 3.3 to 16 ft, velocity (1 ft below the surface) velocities ranged from 0.05 to 2.84 ft/sec, and secchi depth ranged from 5.5 to 9.5 ft. The types of substrate in the observed spawning areas are being analyzed and will be incorporated into a final report. Similarly, plankton samples collected downstream from the observed spawning events in the TFI (adjacent to Stebbins Island) are being processed to validate the visual observations of spawning and the downstream drift of eggs and larvae.

Blueback Herring

Together Blueback Herring and Alewife are known as river herring. Alewife use the lower portion of the Connecticut River, but rarely pass above the Holyoke Dam. Thus Blueback Herring is the only river herring found in the Project area (Hartel *et al.*, 2002). Pre-spawning Blueback Herring enter the mouth of the Connecticut River at about the same time as American Shad. Blueback Herring broadcast spawn on hard substrate in swift-flowing tributaries to the lower Connecticut River. Presumably, some spawning also occurs in the mainstem Connecticut River, where swift-flowing habitats with hard substrate are available (Hartel *et al*., 2002). Females may produce 122,000 to 261,000 eggs; larger fish generally produce more eggs.

Blueback herring elsewhere have been reported to spawn in both swift-flowing, deeper stretches and in slower-flowing tributaries and flooded low-lying areas adjacent to the main stream; substrates may vary from coarse to fine materials (Pardue, 1983). Active spawning may occur over a wide range of water velocities. FirstLight (2012) identified that the uppermost segments of the reach below Cabot consist of riffle habitat with swift-flowing conditions, but swift-flowing runs are well distributed throughout the 30 mile reach downstream of Cabot tailrace evaluated in 2012, along with portions of the bypass reach below Turners Falls Dam. Most of the runs featuring the hard substrates (i.e. cobble gravel) can be found in the first 14 miles of river below the Cabot tailrace. Fines such as sand dominate the substrates in the remaining downstream reaches. Eggs are initially demersal, but become planktonic. Pardue (1983) reports that larvae in Chesapeake Bay remain near or slightly downstream of presumed spawning areas, and in Nova Scotia are associated with relatively shallow (<6.6 ft), sandy, warm areas in and near areas of observed spawning.

Assuming that suitable plankton and water quality exist downstream from Cabot Station, this reach should provide extensive suitable habitat for this species, especially in the transition area between cobble/gravel and finer substrates.

Juveniles remain in the river, feeding on zooplankton, until the fall of the year then emigrate to the sea (Collette & Klein-MacPhee, 2002). These characteristics of their development parallel those of American Shad and the young of the two species are difficult to distinguish. Juvenile Blueback Herring begin their seaward migration slightly earlier and at higher water temperatures (peaking at 14 to 15°C) than American Shad. Adult Blueback Herring spend three to six years at sea before returning to spawn in their natal streams. The average length of adults is less than 300 mm (Hartel *et al.,* 2002).

Blueback Herring in the Connecticut River and coast-wide experienced a decline in the mid-1990s; however, the decline of Blueback Herring was much more dramatic than American Shad. Few Blueback Herring have been recorded in the Project Area since the late 1990's. Causes for the decline were thought to be similar to those listed for American Shad with offshore bycatch and predation by Striped Bass most likely accounting for the decline in the Connecticut River.

Blueback Herring are not an important sport or commercial species in the Connecticut River, although some are captured for use as bait in coastal fisheries, and they are harvested at sea for human consumption and animal feed.

A petition to list Blueback Herring as threatened under the federal Endangered Species Act of 1973 (16 U.S.C. §1531 et seq., ESA) was submitted to the NMFS on August 5, 2011 by the Natural Resources Defense Council. In its 90-day review of the 2011 Petition, NMFS concluded that the Petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted (76

FR 67652-67656), and initiated a status review for the species. Upon completion of the status review in August 2013, NMFS determined that listing was not warranted.

Striped Bass

Striped Bass is native to Atlantic coastal waters from the St. Lawrence River in Canada to the St. Johns River in Florida, moving into freshwater to spawn or feed. Major spawning areas include the Hudson River and tributaries to Chesapeake Bay, although spawning occurs in rivers from the Maritimes to the southeastern United States. They may grow to several feet in length and are highly predatory, feeding on a variety of fishes and invertebrates. Adult and juvenile striped bass in freshwater habitats feed largely on other fish, and have been shown to feed on river herring, American Shad, and American Eel. The recent declines in Connecticut River populations of these species (herring, shad, and eel) have been linked to the resurgence of the Atlantic coast Striped Bass population (Savoy & Crecco, 2004).

During the past decade Striped Bass have become abundant in the Connecticut River; over 5,700 Striped Bass have been passed into the Holyoke impoundment below the Turners Falls Development since 2000. From 1980 to 1999, Striped Bass were rarely noted at the upstream passage facilities at the Project. Striped bass spawning has not been documented in the Connecticut River.

A three year study supported by the Connecticut Department of Energy and Environmental Protection (CTDEEP) was begun in 2005 to assess the abundance, temporal and spatial distribution, and population structure of Alewife, Blueback Herring, and Striped Bass, and to describe predator/prey interactions between these species in the Connecticut River (Davis *et al*., 2009). The study found that Striped Bass predation is a large source of mortality for migrating adult Blueback Herring and it was estimated that over 200,000 herring were consumed by Striped Bass in the Connecticut River in May 2008.

Striped Bass supports recreational fishing in the Connecticut River. Commercial fishing is not permitted.

Sea Lamprey

Sea Lamprey is an anadromous species that spawns in the Connecticut River and its tributaries. Sea Lamprey spawn during the spring in shallow areas of moderate current with gravel, and rubble substrate. Subsequent to the larval stage, Sea Lamprey mature into ammocoetes, which burrow into soft sediments and exist as filter feeders, emerging from the sediment surface to feed. This stage lasts up to seven years; the ammocoetes then undergo a transformation into the parasitic adult phase and migrate to sea. Downstream migration occurs in both the spring and fall, but primarily in the spring. Pre- spawning adults create a depression in the substrate by carrying larger rocks out of the nest area and by sweeping smaller particles out using rapid body movements. The female then deposits eggs, fertilized by the male, moving more rocks and gravel as necessary. Spawning in one nest, or redd, may continue for 16 hours to 3.5 days. During the spawning run, adults undergo considerable physiological change and deterioration; they die after spawning.

During late spring and early summer 2015 (as part of Study No. 3.3.15 *Assessment of Adult Sea Lamprey Spawning within the Project Area*), the Licensee assessed spawning activity and habitat within the Project area utilizing radio telemetry techniques and visual surveys of identified redds. Forty (40) adult Sea Lamprey were collected downstream of the Project at the Holyoke Dam fish lift and implanted with radio tags. Their movements were subsequently tracked between the Mount Hermon School and Holyoke Project from June 3 to July 7, 2015. All radio frequencies were shared with TransCanada in the event that fish move from the Turners Falls Development into the Vernon Project vicinity. Analysis of tracking data is ongoing.

The adults parasitize other fish species, using a sucking disc and rasping teeth and tongue to attach to and penetrate the tissues of prey species. The sucking disc is also used during spawning to construct 1-3 foot diameter nests in the substrate. Similar to other anadromous species, Sea Lamprey do not feed during their upstream spawning migration and thus are not parasitic while in the river (Hartel *et al*., 2002).

Areas fitting the general description of Lamprey spawning habitat were inspected to find specific locations suitable for spawning based on substrate and depth; the presence or absence of actively spawning lamprey was noted. A total of 30 redds were GPS located in five (5) distinct regions of the project area as summarized in Table 3.3.3.1.2-3.

Five (5) of the 30 redds were capped using a 4 x 4 ft, weighted PVC framed collection net (1 mm mesh) that funneled into a collection jar on the downstream end in order to capture emerging larvae. Caps were deployed only after Sea Lamprey spawning was initially observed and revisited for multiple days to ensure lamprey were no longer actively spawning on the site. Caps remained in place for 14 to 21 days, at which point samples were collected in jars, fixed with formaldehyde and transported to the lab to be further analyzed. Spawning grounds within the project area were monitored from the time of Sea Lamprey arrival until water temperatures exceeded 22°C. All 30 redds were monitored over a range of conditions: observed changes to the habitat or redd quality were recorded.

The Sea Lamprey is not of recreational or commercial value in the Connecticut River.

American Eel

The American Eel is a catadromous species whose young enter estuarine or freshwater to feed and mature, and then the adults return to the sea to spawn. After spending five (5) to 20 years in fresh or coastal waters, eels migrate to spawning grounds located in the Sargasso Sea in the South Atlantic (Collette & Klein-MacPhee, 2002). Eggs are fertilized and released in the water column. The eggs and larvae are pelagic, drifting via the Florida current and the Gulf Stream to coastal North America and Europe. The young eels ultimately leave these currents and move shoreward and either reside in estuarine coastal waters or move into fresh water, following cues that are not well understood.

Eels moving into the estuaries are called glass eels because of their transparent appearance. Once they become pigmented they are referred to as elvers until they gain the yellow cast typical of eels. Eels may reside in an estuary throughout their entire life or move upstream in freshwater during the first few years. At maturation, the species undergoes another color change to the silver eel stage and migrates downstream, usually at night during fall.

In accordance with the FERC approved RSP (Study No. 3.3.4 *Evaluate Upstream Passage of American Eel*), the Licensee conducted a study during 2014 to determine the presence of eels as well as to identify areas where eels congregated or attempted to ascend wetted Project structures. Eleven (11) nighttime surveys were performed between June 11 and October 9, 2014. Several areas within the Project, including the Cabot Station discharge area and fishway, Station No. 1 discharge area, various canal discharge areas, the Turners Falls Dam and spillway fishway, were routinely surveyed and the approximate number of eels, the date and time, eel behavior, and the environmental conditions (e.g., weather, leakage, discharge) were recorded. The Turners Falls spillway fishway accounted for 94%, of the 6,263 total eels observed during the study period.

In 2015, FirstLight conducted the second year study, installing temporary eel passes at three locations as follows: in the spillway fishway; in the Cabot fishway; and at the Cabot emergency spillway. The temporary passes were constructed of ¾-in marine plywood with ramp sections approximately 24-in wide by 5-in tall and included plywood covers to prevent avian predation. Each ramp was fitted with two sizes of milieu-type substrate mounted side-by-side to pass eels of varying sizes. Three-foot tall plastic holding tanks were placed at the upper ends of the ramps to collect eels that successfully traversed the temporary passes. Two Medusa traps were deployed at the Station No. 1 discharge in July 2015 to monitor eels in that area. These traps were designed to passively collect juvenile eels seeking refuge and consisted of submerged 5-gallon buckets containing mop heads. The ramps and Medusa traps were operated continuously through October 2015 with collections quantified every 2-3 days. Recorded data included location, trapping interval, numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period. All eels collected were transported to and released in the TFI following processing. Data analyses are ongoing; results of the analyses will be included in the final report slated for completion by March 1, 2016.

The Licensee has also conducted a study to assess downstream passage of adult outmigrating silver American Eel (Study No. 3.3.5 *Evaluate Downstream Passage of American Eel*) to better understand migration timing as it relates to environmental factors and operations at the Turners Falls Development and Northfield Mountain Pumped Storage Development.

A combination of split beam sonar and a dual frequency identification sonar (DIDSON) was used to monitor entrainment and determine the timing, duration and magnitude of the downstream run through the project area from August 1 to October 31, 2015. The sonar equipment was deployed at the Northfield intakes, within the Turners Falls Canal, and in front of the Cabot Station intake. The sonar units collected data continuously throughout the duration of their deployment.

The Licensee has also assessed downstream passage of adult American Eel using radiotelemetry techniques at the Turners Falls Development and Northfield Mountain Pumped Storage Development beginning in late October 2015. The passage route studies required a large number of adult eel to achieve an adequate sample size (n=432). Because of a concern about the feasibility of collecting this quantity of eel within the Connecticut River drainage, the Licensee proposed and received agency approval to import adult eel from a commercial fishery in Newfoundland, Canada. A permit was issued for importation into the State of Massachusetts; the permit requires that the eels be determined to be pathogen-free before use in the Connecticut River studies.

The eels were examined to confirm that they were in the silver phase, the criterion being eye diameter measurements (e.g., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater). Migration routes were assessed with the use of radiotelemetry techniques. Fixed receivers were located as indicated in Table 3.3.3.1.2-4; tagged eel were also tracked with mobile gear. Monitoring of tagged eels occurred until water temperatures reached 5 °C. Data analyses are ongoing and results will be included in the final report slated for completion in March 1, 2017 (for the second year study).

A petition to list American eel as threatened under the federal Endangered Species Act of 1973 (16 U.S.C. §1531 et seq., ESA) was submitted to the USFWS and NMFS on November 18, 2004. After initially finding that the petition presented substantial information indicating that listing the American eel may be warranted, the USFWS made a final determination in February, 2007 that listing of the eel under the ESA was not warranted. On April 30, 2010 the Council for Endangered Species Act Reliability submitted another petition to list American eels as threatened under ESA. Upon completion of this status review in October 2015, USFWS determined that listing was not warranted.

Shortnose Sturgeon

Shortnose Sturgeon is a federally listed endangered species that typically inhabits slow moving riverine waters or near shore marine waters and periodically migrates into faster moving fresh water areas to spawn. They are long-lived (30-40 years) and mature at late ages (5-10 years for males and 7-13 years for females) in the northern extent of their range (Dadswell *et al*., 1984). Shortnose Sturgeon exhibit three distinct movement patterns associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8 ºC, pre-spawning Shortnose Sturgeon move from overwintering grounds to spawning areas. Spawning occurs from April to May and may last from a few days to several weeks depending upon water temperature. Shortnose Sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS, 1998). Female Shortnose Sturgeon are thought to spawn every three to five years while males spawn every two years. Fecundity estimates range from 27,000 to 208,000 eggs/female (Dadswell *et al*., 1984).

Sturgeon eggs become adhesive after fertilization and larvae begin downstream migrations at about 20-mm total length. Laboratory studies suggest that young sturgeon move downstream in two steps; a 2 to 3-day migration by larvae followed by a residency period by YOY, then a resumption of migration by yearlings in the second summer of life (Kynard, 1997).

Adults normally depart from their spawning grounds soon after spawning and movements include rapid, directed movements to downstream feeding areas in spring followed by local meandering in summer and fall (Dadswell *et al.,* 1984; Buckley & Kynard, 1985; O'Herron *et al*. 1993). Post-spawning migrations are associated with rising spring water temperature and river discharge (Kieffer & Kynard, 1993).

Historically in the Connecticut River, Turners Falls is believed to mark the extent of the upstream range of sturgeon due to the height of the natural falls. Completion of the downstream Holyoke Dam in 1849 blocked sturgeon from migrating beyond river mile 36. The first successful fishway to pass fish upstream, an elevator, was installed at the tailrace at Holyoke in 1955. In 1976, the existing tailrace fish lift at Holyoke was improved, and a lift was installed in the bypass area at the Holyoke Dam. These improvements allowed Shortnose Sturgeon to pass above Holyoke Dam and access the Connecticut River up to their historic limit at Turners Falls. Shortnose Sturgeon have not been observed in the Turners Falls fishways, and none have been observed or captured upstream of Turners Falls Dam.

During summer, the Shortnose Sturgeon population above Holyoke Dam congregates near the confluence of the Deerfield River; this group overwinters a few miles downstream from Cabot Station. The concentration area used by adult fish in the Connecticut River is in reaches where natural or artificial features cause a decrease in river flow, possibly creating suitable substrate conditions for freshwater mussels (Kieffer & Kynard, 1993), a major prey item for adult sturgeon (Dadswell *et al*., 1984). Both adults and juveniles have been found to use the same river reaches in the Connecticut River and have ranges of about 10 km during spring, summer and fall (Savoy, 1991; Seibel, 1991). In the winter, sturgeon move less than 2 km and assemble together in deep water (Seibel, 1991). The migration of juvenile and adult Shortnose Sturgeon from the Holyoke impoundment to points downstream of the Holyoke Dam appears to be a natural event coincidental with increased river discharges (Seibel, 1991; Kynard, 1997).

Shortnose Sturgeon in the upper river population spawn from the last week of April to mid-May, after the spring freshet (Taubert, 1980; Buckley & Kynard, 1985; Kynard, 1997). The spawning period is estimated to last from five to 17 days, occurring during the same 26-day period each year (April 27 – May 22) (NMFS, 2005). Shortnose Sturgeon are believed to spawn at discrete sites within the river (Kieffer & Kynard, 1993) in channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al.,* 1984; NMFS, 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the spring freshet, water temperatures ranging from 8 - 12ºC, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell *et al.*, 1984; NMFS, 1998).

Successful spawning has been documented at two sites in Montague (Vinogradov, 1997), just downstream of Cabot Station. These sites are just downstream of the species' historical limit in the Connecticut River at Turners Falls (RM 123) (NMFS, 2005). Sturgeon eggs and larvae were captured at the sites in 1993, 1994, and 1995 (Vinogradov, 1997). These sites are within the 0.9 mi reach from the natural rock formation called Rock Dam to 656 feet downstream of Cabot Station, where all common types of river habitat are present. Much of the river bottom in the area is rock and rubble. The 0.3-mi. long reach downstream of Cabot Station contains rubble/boulder shoals that can be exposed briefly in spring during low river discharge and low Cabot Station generation (Kieffer & Kynard, 2007).

Shortnose Sturgeon spawning in this area typically occurs from April to mid-May and the egg incubation period is about two weeks when water temperatures are between 8 and 12 °C. Upon hatching, larval Shortnose Sturgeon hide for about 12 days under available cover at the spawning site while absorbing the yolk-sac, before migrating downstream to deeper water between the mouth of the Deerfield River and Holyoke.

Upstream Passage

Upstream passage facilities for Connecticut River migratory fish are provided at a number of hydroelectric projects. Migrating fish first encounter the Holyoke Project (RM 87) where they are passed upstream through a fish lift. Turners Falls Dam is the second dam on the Connecticut, 37 mi upstream of Holyoke. The Deerfield River is a major tributary that enters the Connecticut River just downstream of Turners Falls Dam. Fish passing the Turners Falls Development (RM 122) can continue upstream migrating through the TFI, passing the Northfield Mountain Pumped Storage Project (RM 127) before encountering the Vernon Project (RM 142), 20 miles upstream of Turners Falls. Fish passage facilities at the Vernon Project allow migrants to continue upstream.

Upstream fish passage facilities began operating in 1980 at the Turners Falls Development pursuant to a Settlement Agreement signed by FirstLight's predecessor, Western Massachusetts Electric Company, state and federal resource agencies, and non-government organizations. There are three fish ladders at the Turners Falls Development: the Cabot fish ladder adjacent to Cabot Station; the Spillway fish ladder at Turners Falls Dam; and the Gatehouse fish ladder at the upstream end of the power canal. The Cabot and Spillway fish ladders are modified "ice harbor" designs and the Gatehouse fish ladder is a vertical slot ladder. These fish ladders were designed in consultation with state and federal resource agencies, based on Columbia River salmon fish ladder designs.

Fish ascending the Cabot Fishway enter the power canal, then pass through the Gatehouse Fishway into the TFI. Alternatively, they can swim through the bypass reach to the base of the Turners Falls Dam, ascend the Spillway Fishway, pass through the Gatehouse collection gallery that crosses the power canal, and enter the TFI through the Gatehouse Fishway, along with the fish passed through the Cabot Fishway.

As part of relicensing, FirstLight is conducting studies at the Spillway and Cabot fish ladder entrances (Study No. 3.3.9- *Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrance and Powerhouse Forebays*). The study has not been completed as of the filing date of the Draft License Application, but will include analysis of velocities and depths in front of the fish ladder entrances under a range of flows and operating conditions. A separate CFD model and supporting report was developed for the Gatehouse fish ladder by Alden Research Laboratory in 2013 (Alden, 2013)[35], prior to initiation of the relicensing process.

Table 3.3.3.1.2-5 provides a summary of fish passage records for the Turners Falls fish passage facilities for the period of 1980 through 2014. The dates of peak passage have varied throughout the years, ranging from early to mid-May to mid to late June. American Shad and Sea Lamprey have been the dominant anadromous species observed at the passage facilities through the period of record. Substantial Blueback Herring passage was recorded for the 15-year period from 1983 to 1997, but few herring have been recorded since 1997. Use of the passage facilities by Atlantic Salmon has been low since most are collected downstream at Holyoke Dam; salmon were noted in 28 of the 31 years, but few individuals were recorded (1 – 29 annually). The 31-year period of record does not show any usage of the facilities by Shortnose Sturgeon.

Travel of adult American Shad through the TFI was studied from 1973 through 1976 (Layzer, 1976). During that time, 6,373 shad were transported to the TFI from the Holyoke Dam fish lift. Of those, 125 shad were tagged with ultrasonic transmitters and their movements were monitored. Most shad were found to exhibit one of four behavior patterns: 1) 45% of the tagged fish never migrated through the narrow turbulent area below the French King Bridge; 2) 18% remained within two miles of the Northfield Mountain Pumped Storage Development tailrace; 3) 21% migrated upstream passing the Northfield Mountain Pumped Storage Development tailrace with little or no delay; and 4) 16% exhibited greater movement up and downstream than fish in the other groups including some movement up to Vernon Dam. Layzer (1976) reported that the distance traveled in the TFI was related to water temperature. Shad that were tracked displayed a preference

[35] The Alden, 2013 report was filed with FERC as Appendix F of the Revised Study Plan.

for deeper sections of the river. The Northfield tailrace had no clear effect on shad movement through the TFI. Some shad turned back upon reaching the Northfield tailrace both during operational and non-operational periods. Others milled at the Northfield tailrace; however, similar milling behavior occurred in other portions of the TFI outside the influence of the Project.

The ratio of American Shad passage at Holyoke Dam to the number that passed upstream toTurners Falls Dam Table 3.3.3.1.2-6 is low and except for 1991 was less than 10%. The areas between Holyoke Dam aand Turners Falls is a known spawning area for shad so many may have spawn belowTurners Falls and returned downstream. The Deerfield River is also below Turners Falls and shad may have entered the Deerfield River to spawn.

The ratio of American Shad passage at Vernon Dam to the number that passed upstream of Turners Falls Dam (Table 3.3.3.1.2-7) was highly variable but often high, with a mean of 41% for all years (when counts were available) and ranging to about 100% in some years (reported counts indicate ratios > 100% as a result of counting error). As a result of analysis of count data from several years and the 2011 cooperatively supported basin wide shad study conducted by USGS, it appeared that a passage bottleneck existed at Vernon Dam. Subsequent design improvements (repairs to baffles, silt removal, automating entrance elevation, etc.) to the Vernon ladder appeared to increase effectiveness in 2012 and thereafter.

Downstream Passage

Migratory fish in the TFI or entering the TFI after passing downstream of the Vernon Project migrate downstream through the Turners Falls Development and thence to the Holyoke Project as they return to the sea. These migratory fish include post-spawning adult and juvenile American Shad, Sea Lamprey, and adult American Eel. Other possible downstream migrants include Atlantic Salmon smolts and post-spawning adults, and post-spawning adult and juvenile Blueback Herring, and post-spawning and juvenile Striped Bass, but downstream passage of these three species would be uncommon as few adults have migrated upstream of the Turners Falls Development in recent years. Shortnose Sturgeon have not been recorded as passing upstream of the Project.

Fish passing downstream leave the TFI either by passing over the spillway at Turners Falls Dam to the bypass reach or by exiting through the Gatehouse into the power canal. Migrants entering the power canal have three avenues of outmigration: 1) Station No. 1 turbines, 2) Cabot turbines or 3) a log sluice adjacent to the Cabot Station.

From the power canal there is an approximate 700-foot-long by 100-foot-wide branch canal. At the end of the branch canal is the entrance to Station No. 1, consisting of eight bays, each 15 feet wide for a total intake width of 120 feet. Trashracks are mounted across the entire entrance, totaling 114 feet wide by 20.5 feet high. With a normal canal elevation of approximately 173.5 feet, the effective trashrack opening is approximately 114 feet wide by 15.9 feet high, resulting in a gross area of 1,813 square feet (ft^2). The bar thickness is 0.375 inches and the bars are 3 inches on center, thus the clear spacing between bars is 2.625 inches. At full hydraulic capacity (2,210 cfs), the velocity in front of the racks is approximately 1.2 feet/second. After passing the trashrack, the intakes narrow down to four individual 13'-1.5" diameter penstocks feeding the original seven horizontal Francis turbines housed in the powerhouse. Only five of the turbines are operational. Due to the lack of data on downstream passage at Station No. 1, the Licensee is conducting a turbine passage mortality study with juvenile American Shad (Study No. 3.3.3 *Evaluate Downstream Passage of Juvenile American Shad*) and adult American Eel (Study No. 3.3.5 *Evaluate Downstream Passage of American Eel*) in fall 2015. FirstLight is also conducting a study to evaluate velocities in front of the Station No. 1 and Cabot racks (Study No. 3.3.8 *Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays*). The CFD modeling in front of the Station No. 1 racks will provide a better approximation of the intake velocity approximately one foot in front of the racks under a range of operating conditions. The downstream juvenile shad study report is slated for completion by September 1, 2016, and the downstream eel shad study report is slated for March 1, 2017 (second year of study).

The Cabot Station intake is 217 feet wide by 31 feet high, resulting in a gross area of 6,727 ft^2. At maximum hydraulic capacity of 13,728 cfs, the intake velocity immediately in front of the racks is approximately 2.0 feet/sec. The trashracks are angled from the vertical, and include upper and lower racks. The top 11 feet of the upper racks have clear bar spacing of 0.94 inches (15/16-inch, and the bottom 7 feet of the upper racks have clear bar spacing of 5 inches. The entire 13 feet of the lower racks have clear bar spacing of 5 inches. After passing through the trashracks, flow is conveyed through one of six penstocks to turbines housed in the powerhouse. Again, the CFD modeling will be used to refine the velocity approximation in front of the racks under a range of operating conditions. The CFD modeling report is slated for completion by December 1, 2015.

Downstream fish passage facilities at Cabot Station were designed and constructed in consultation with regulatory agencies and include reduced bar-spacing in the upper 11 feet of the intake racks; a broad-crested weir developed specifically to enhance fish passage at the log sluice; the log sluice itself, which has been resurfaced to provide a smooth passage route; above-water lighting; and a sampling facility in the sluice.

The log sluice adjacent to the Cabot Station intake racks is operated for downstream passage of Atlantic Salmon smolts, American Shad, and American Eel according to a schedule recommended by CRASC, with closures during periods of high flow to reduce erosion near the sluice discharge, and for intake rack maintenance as necessary. Under current guidelines, the sluice is operated 24 hrs/day from April 1 through November 15 annually: from April 1 through June 15 for the downstream passage of Atlantic Salmon smolts; from April 7 through July 31 for adult American Shad; from August 1 through November 15 for juvenile American Shad; and from September 1 through November 15 for adult American Eel.

Historical studies that investigated downstream passage of Atlantic Salmon smolts and juvenile Clupeids (Harza & RMC 1992a, 1992b, 1994a, 1994b; Nguyen & Hecker, 1992; NUSCO 1994, 1995, 1998a, 1998b; RMC 1994, 1995) indicated that 90% of juvenile Clupeids that entered the power canal exited through the log sluice. Similarly, 73-90% of salmon smolts utilized the downstream passage facilities at Cabot; the majority of American Eels passed through the turbines (Brown, 2005).

3.3.3.2 Environmental Effects

Several issues pertaining to fish and aquatic resources were identified in the scoping process for the Northfield Mountain Pumped Storage Development and Turners Falls Development. In SD2, the following issues were identified:

- Effects of project operations and maintenance (including fluctuations in water levels, and downstream releases) on aquatic habitat and resources in the projects' vicinity (e.g., resident and migratory fish populations; fish spawning, rearing, feeding, and overwintering habitats; mussels and habitat).
- Effects of project facilities and operations, (including reservoir fluctuations, and generation releases) on fish migration through and within project fishways, canals, bypassed reaches, reservoirs, and the downstream riverine corridors.
- Effects of entrainment on fish.

3.3.3.2.1 Effect of Project Operations

Habitat Assessment

The Connecticut River and its tributaries in the Turners Falls Development area and in downstream reaches are composed of a variety of habitats for aquatic vegetation and for game and non-game fish species, including Spottail Shiner, White Sucker, Yellow Perch, Smallmouth Bass, Bluegill, Fallfish, Rock Bass, Pumpkinseed, Tessellated Darter, Walleye, Common Shiner, American Eel, Largemouth Bass, Golden Shiner, Black Crappie, Channel Catfish, Brown Bullhead, Common Carp, Chain Pickerel, Sea Lamprey, Mimic Shiner, Northern Pike, American Shad and other important minnow and forage species.

Turners Falls Impoundment

The Licensee has undertaken a study, in accordance with the approved RSP, to determine the types of aquatic habitats present within the TFI, and the distribution and abundance of those habitats (Section 3.3.3.1), and to identify any potential effects of operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development on those habitats.

The upstream reach of the TFI, extending from Vernon Dam tailrace to the Northfield Mountain tailwater, is located within a broad flood plain and is relatively uniform and generally shallow, with gentle bends. There are a few narrow islands comprised of alluvial materials such as gravel, cobble and fines.

The downstream reach from the Northfield Mountain Pumped Storage Development tailrace approximately five miles downstream to the Turners Falls Dam is dominated by bedrock, which controls much of the stream geometry and substrate features. The lower reach impoundment geometry is complex. It is defined by both bedrock and depositional features, and includes a complex of embayment, points, coves, islands, and a wide range of substrates, and features shallow lacustrine littoral habitat with a deeply incised thalweg, in contrast to the riverine habitat in the upper reaches.

Data analyses remain ongoing to determine potential impacts of water level fluctuations on aquatic resources in the TFI; a report was previously filed with FERC on September 14, 2015; however, the impact of water level fluctuations still remains.

Bypass Reach and below Cabot Station

The Licensee has conducted instream flow studies in the following locations: a) in the bypass reach from the Turners Falls Dam to the Montague USGS Gage, and b) from the USGS Gage to the Sunderland Bridge (below Cabot Station). In addition, in the reach between the Sunderland Bridge and the Dinosaur Footprints Reservation, a habitat assessment will be conducted on state or federally listed mussels.

Aquatic habitat suitability was evaluated using techniques described in the Instream Flow Incremental Methodology (IFIM) developed by the National Ecology Research Center of the National Biological Survey (Bovee, 1982; Bovee, *et al*., 1998; Milhous *et al*. 1989). These techniques included standard field procedures and Physical Habitat Simulation (PHABSIM) modeling. The IFIM quantifies habitat for selected species over a range of flows using habitat suitability index (HSI) criteria that are based on depth, velocity and substrate

The study reaches identified in consultation with stakeholders were:

- Reach 1: Turners Falls Dam downstream to the tailrace of Station Number 1 (~0.75 miles)
- Reach 2: Tailrace of Station Number 1 downstream to Rock Dam (~1 mile)
- Reach 3: Rock Dam downstream to the confluence with the Deerfield River (including Cabot tailrace) near the Montague USGS stream flow gage (~1.5 miles)
- Reach 4: USGS Montague Gage downstream to Route 116 in Sunderland, MA (~9 miles)
- Reach 5: Sunderland Bridge downstream to Dinosaur Footprint Park (~22 miles)

Based on the results of literature reviews and consultation with stakeholders, HSI criteria were established for multiple life stages of American Shad, Shortnose Sturgeon, White Sucker, Fallfish, Longnose Dace, Tessellated Darter, benthic macroinvertebrates, and the following habitat use fish guilds: shallow-slow, shallow-fast, deep-slow, and deep-fast.

In Reach 1 and Reach 2, a one-dimensional model was developed to predict changes in depth and velocity as discharge varies. In addition, a two-dimensional model was developed to simulate hydraulics in the lowermost extreme of Reach 2, and also Reach 3 (the vicinity of the Cabot Station tailrace, from the upstream end of Rawson Island downstream to just below the Deerfield River confluence). Data collected to calibrate the model, included hydraulic data, bed profiles, substrate and cover data, and velocity/current data. Reach 4 will be modeled using the one-dimensional model approach. Field data collection for Reach

4 was completed in September 2015 and the results of the instream flow studies will be included in a final report slated for completion by September 1, 2016.

Tributary Streams

The Licensee performed systematic surveys in the spring, summer, and fall of 2014 to assess the effects of operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development on tributary and backwater area habitat and access to that habitat under a range of hydrologic conditions. The confluences of the Connecticut River with 19 tributaries located between Vernon Dam and the Route 116 Bridge in Sunderland, MA were surveyed to determine if water level fluctuations from the operation of the Turners Falls Development and Northfield Mountain Pumped Storage Developments resulted in reductions of available aquatic habitat. Potential barriers to migration/movement were observed at three of the 19 tributaries, namely Merriam Brook, Pine Meadow Brook, and Fourmile Brook; however, it appeared that the barriers were attributable to natural phenomena, such as woody debris accumulation, sediment deposition, or seasonal flow characteristics, rather than to project-related water level fluctuations. As the observed barriers appeared temporary and localized, it appears that project operations do not substantially impact access to and habitat within the tributaries. The tributary access report was filed on September 14, 2015 as part of the Updated Study Report filing.

Power Canal

While typical Project operations do not materially affect water levels in the power canal, the Licensee performs week-long annual canal drawdowns to facilitate inspections and maintenance, typically during late September or early October. As requested by stakeholders, a field survey was conducted in the lower portion of the canal during the 2014 drawdown to gain an understanding of the effects of the drawdown on aquatic species. Since the upper portion of the canal remains wetted for the duration of the outage, the aquatic species survey was performed only in the lower portion of the canal, where it begins to widen along Migratory Way. The topography of the lower portion of the canal varies with large areas of silt deposits, areas of exposed bedrock, and areas with fines and cobble.

A survey was performed in the soft sediments in the lower portion of the Turners Falls Canal during the 2014 drawdown to document the presence of ammocoetes and to determine if the annual drawdown of the canal exposés Sea Lamprey burrowing substrate. Thirty-two 1 m x 1 m quadrats were sited within soft sediments and systematically searched for the presence of lamprey ammocoetes. The quadrat sampling was performed on the day immediately following the release of water from the canal (initial survey), as well as the day prior to rewatering. Of the 64 quadrats sampled (32 during initial survey and 32 during day-prior-to-rewatering survey), only 11 ammocoetes and one transformer (individuals transitioning from ammocoete to juvenile stage) were identified, all of which were alive. The lamprey specimens were all found buried in the substrate, which likely serves to prevent desiccation and support survival until the canal is refilled.

In addition to lamprey ammocoetes, quadrat sampling identified mudpuppies and two species of mussels, Eastern Elliptio and Alewife Floaters. Almost all of the mussels found were Eastern Elliptio (n=534); only one Alewife Floater was observed. Mussels tended to be concentrated at sites proximal to the canal's thalweg. All mussels observed during the sampling events were alive, and 2 of the 3 mudpuppies observed were dead.

Twenty-two fish and one amphibian species were observed in the pools. Spottail Shiner, Tessellated Darter, and juvenile American Shad were the most abundant fish species observed. All fishes captured in the pools were alive at the time of collection, suggesting that observed mortalities at the time of sample processing were likely due to handling and temporary holding associated with sampling.

Based on results of the 2014 sampling effort, it appears that the annual drawdown has little effect on Connecticut River aquatic species. As the canal drawdown is initiated, the turbine bays at Cabot Station and Station No. 1, as well as various gates within the canal allow egress for fish. Canal geometry is such that the upper portion of the canal remains wetted for the duration of the drawdown, and Keith's Tunnel is open with substantial flow through it during the duration of the drawdown. This area provides a refuge area for fishes that remain following the release of water from the lower canal. In addition, a series of pools remain in the lower portion of the canal that provide wetted habitat for fishes and mussels that remain trapped within the canal for the week-long drawdown. Although the size of some of the pools decreased over the course of the week spanning the drawdown, some of the pools were observed to be hydraulically connected and allowed fish to progress downstream towards a larger pool that remains upstream of the Cabot intakes. In general, few stranded fish (including lamprey ammocoetes/transformers) were observed, suggesting minor impacts to fish species, and the absence of freshly dead mussels suggests that the drawdown did not adversely affect Connecticut River mussel populations.

The Canal Drawdown report (Study No. 3.3.18) was filed with in September 2014.

Migratory Fish

Several studies are being conducted to specifically examine potential effects of Project operation on migratory fish.

American Shad

A number of studies addressed American shad in Project area. These include Study 3.3.2 Evaluation of upstream and downstream passage of adults, Study 3.3.3 Evaluation of juveniles, Study 3.3.6 Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects, and Study 3.3.20 American shad ichthyoplankton entrainment assessment at Northfield. Data analysis for these studies remains ongoing and results will be included in a final reports. The report for Study 3.3.2 Evaluation of upstream and downstream passage of adults is slated for completion by September 1, 2016. Study Report 3.3.3 Evaluation of juveniles is proposed to be final September 1, 2016. The final report for Study 3.3.6 Impact of Project Operations on Shad Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects is proposed to be completed March 1, 2016. Study 3.3.20 American shad ichthyoplankton entrainment assessment at Northfield final report is slated for completion by March 1, 2016.

Sea Lamprey

The Licensee identified spawning locations within the project area and monitored redds in 2015 to assess whether operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development potentially impact these spawning areas. These data will be considered in conjunction with the hydraulic model and IFIM results to determine if project-induced flow alterations adversely affect Sea Lamprey spawning in the project area. The analysis is ongoing and results will be included in a final report slated for completion by March 1, 2016.

Shortnose Sturgeon

In support of relicensing, the Licensee committed to a study to assess the impact of sediment disturbance and excessive velocities resulting from emergency water control gate discharge and bypass flume spill events on Shortnose Sturgeon spawning and incubation habitat in the Cabot Station tailrace and downstream areas. The goal of this study is to determine the frequency of spill events during sturgeon spawning, and, if deemed necessary, determine appropriate protocols for operation of the emergency water control gates and bypass flume. The purpose of the protocols would be to protect sturgeon spawning and rearing areas below Cabot Station from excessive water velocities and exposure to transported sediments.

The Licensee is developing a two-dimensional model to define critical flow resulting in sedimentation/scour or potential adverse impacts to sturgeon spawning below Cabot. The report for Study 3.3.12 was previously filed with FERC in September 2014. In conjunction with sediment mapping (Study No. 3.3.1), the model will be used to assess the potential for sediment impacts to the sturgeon spawning areas or other areas of concern. The previously filed report will be updated to include the sediment impacts as noted and is slated to be filed by Mach 1, 2016. A draft biological assessment will be filed with FERC once the impact analysis is completed.

3.3.3.2.2 Effect on Fish Passage

The Turners Falls Development and Northfield Mountain Pumped Storage Development may have effects on migratory fish. Upstream migrants that have successfully passed the Holyoke Project encounter and attempt to pass the structures at the Turners Falls Development. Similarly, downstream migrants also encounter these structures as they return to the sea. While the Northfield Mountain Project intake structure does not physically impede migrants passing upstream in the TFI, currents and velocities resulting from pumping and generating may affect migrants.

American Shad

The Licensee conducted a study, in accordance with the approved study plan, to evaluate the upstream and downstream passage of adult American Shad at the Turners Falls Development and Northfield Mountain Pumped Storage Development. The purpose of the study was to assess effectiveness of existing fish passage facilities at Turners Falls Development, evaluate routes of upstream and downstream passage through the Turners Falls Development and Northfield Mountain Pumped Storage Development, and evaluate the effects of operation of the projects on upstream and downstream shad migrants.

A combination of active and passive telemetry techniques were employed to assess impacts of the Project on adult shad migrating upstream. In total, 793 adult American Shad were collected, tagged and released in the Project area during May and June 2015. The upstream passage of the tagged fish was monitored at fixed stations within the Project area, as well as mobile tracked from Mount Hermon School and the Holyoke Project from May through early July. The report for the adult shad passage study is slated for completion by September 1, 2016.

A study conducted from 1973 through 1976 (Layzer, 1976) indicated that the Northfield tailrace had no clear effect on shad movement through the impoundment. . During that time, 6,373 shad were transported to the TFI from the Holyoke Dam fish lift. Of those, 125 shad were tagged with ultrasonic transmitters and their movements were monitored. Most shad were found to exhibit one of four behavior patterns: 1) 45% of the tagged fish never migrated through the narrow turbulent area below the French King Bridge (RM 126); 2) 18% remained within two miles of the Northfield Mountain Pumped Storage Development tailrace; 3) 21% migrated upstream passing the Northfield Mountain Pumped Storage Development tailrace with little or no delay; and 4) 16% exhibited greater movement up and downstream than fish in the other groups including some movement up to Vernon Dam. Layzer (1976) reported that the distance traveled in the TFI was related to water temperature. Shad that were tracked displayed a preference for deeper sections of the river.

In addition to studies by the Licensee the USFWS Connecticut River Coordinator and CRASC have recently released radio tagged adult shad at various points in the river and tracked their movements from the release point to Vernon Dam. Results from that study will be available once data analysis has been completed.

To assess any effect of the Project on outmigrating juvenile American Shad, the Licensee evaluated the timing, duration, and magnitude of juvenile outmigration during fall of 2015 using hydroacoustics (split beam sonar) equipment that was installed at the Northfield Mountain intakes, Turners Falls Canal, and Cabot Station. Radio telemetry was used to evaluate route selection as juveniles migrated downstream past the Northfield Mountain intakes and Turners Falls Development. External radio transmitters (Lotek NanoTag Series model NTQ – 1) were affixed to 224 juvenile American Shad and their movements through the project area were tracked.

American Eel

Currently, there are no passage facilities for American Eel at the Turners Falls Development although some young eels apparently enter the TFI by ascending the fishways or other wetted structures associated with the Project.

In accordance with the FERC approved RSP, the Licensee conducted a study during the 2014 upstream eel migration season to identify and assess potential locations for upstream eel passage at the Turners Falls Development. The objectives of the study were to identify areas where eels congregated or attempted to ascend wetted structures, to assess whether eels could be passed in substantial numbers, and to identify sites for permanent eel passage structures. Eleven nighttime surveys were performed between June 11 and October 9, 2014. Several areas within the Project, including the Cabot Station discharge area and fishway, Station No. 1 discharge area, various canal discharge areas, and the Turners Falls Dam and spillway fishway were routinely surveyed and the approximate number of eels, the date and time, eel behavior, and the environmental conditions (e.g., weather, leakage, discharge) were recorded. Turners Falls Spillway Fishway accounted for 94%, of the 6,263 eels observed during the study period.

Temporary eel passes were installed in 2015 at the spillway fishway, Cabot fishway, and the emergency spillway at Cabot to quantify the eel passage at the project and to help select a location or locations for permanent passage structures. In addition, two Medusa traps were deployed at the Station 1 discharge in July 2015 to monitor eels attempting to migrate up through Station 1. The traps consist of mop heads contained within submerged perforated 5-gallon buckets, designed to passively collect juvenile eels seeking refuge. The temporary passes and Medusa traps are being monitored through the end of October, with data analyses and a final report to be completed.

In addition to evaluating upstream passage at the Turners Falls Development, the Licensee has conducted a study to assess downstream passage of outmigrating silver American Eels relative to environmental factors and operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development. A combination of split beam sonar and dual frequency identification sonar (DIDSON) was used to monitor eel entrainment and movement and through the project area from August 1 to October 31, 2015. The split beam sonar equipment was deployed at the Northfield intakes, within the Turners Falls Canal, and in front of the Cabot Station intake. Both the DIDSONs and the split beam sonar collected data continually throughout the duration of their deployment.

The downstream fish bypass at Cabot Station was sampled on twelve to 18 nights in September and October to ground-truth the hydroacoustic data and compare the percent of eels passing via the Cabot log sluice and Cabot StationAnalysis of these will be included in a final report.

In addition to assessing migration timing, the Licensee assessed the routes selected during downstream passage and the entrainment survival of adult American Eel using radiotelemetry techniques at the Turners Falls and NMPS Projects, beginning in October 2015. Fixed radio receivers were located as indicated in Table 3.3.3.2.2-1 and tagged individuals were mobile-tracked as well. The movements of tagged eels were monitored until water temperature had declined to 5°C.

The passage route and survival studies required a large number of adult eel to achieve an adequate sample size (n=432). There was concern that collecting this quantity of eel within the Connecticut River drainage might not be achievable. For that reason, the Licensee proposed and received agency approval to import silver eel from a commercial fishery in Newfoundland, Canada. A permit was issued for importation into the State of Massachusetts; the permit required a quarantine inspection to ensure that eels for use in the Connecticut River studies would be pathogen-free. The eye diameter and length of the study eels were measured to confirm that they were in the silver phase (i.e.., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater). Analysis of the data collected during this study will be incorporated in the final report slated for completion by March 1, 2016 (for the first year of study).

3.3.3.2.3 Entrainment

Resident and migratory fish in the TFI may be subject to entrainment and turbine passage. At the Turners Falls Development, downstream migrants may pass through the turbines at Station No. 1 or Cabot Station. At the Northfield Mountain Pumped Storage Development, fish entrained during pump-back pass through the intake/discharge tunnel and turbine(s) before being discharged to the upper reservoir. Any fish entrained in the upper reservoir intakes during hydropower generation pass through the turbine(s) and intake/discharge tunnel and then are discharged to the TFI. Features that determine the likelihood of entrainment include the velocity at the intakes, and the fish species and habitat available in the area.

As fish pass through the turbines at the two projects, mortality may occur due to collision of individual fish with blades, wicket gates, or vanes, shear forces, and/or pressure changes. Turbine passage mortality of resident fish was assessed in studies approved by FERC and by using empirically validated blade strike models to estimate potential mortality (Franke *et al.*, 1997). Field studies of adult American Eel and juvenile American Shad are being used to supplement the blade strike analyses. Both the analysis of data from the field studies and the blade-strike analyses will be incorporated in the final report.

Resident Fish

Some resident fish species in the Turners Falls Development area may be subject to entrainment at Cabot, Station Number 1, or the Northfield Mountain Pumped Storage Development (during pumpback). A qualitative scale of entrainment potential ranging from “Low” to “High” was developed for each resident fish species which were documented in the TFI during the baseline fish assemblage assessment

Migratory Fish

American Shad

An evaluation of entrainment of shad eggs and larvae at Northfield Mountain was performed by the Licensee from May 28 through July 17, 2015. During pump-back operations (including 1, 2, 3, and 4 pump operations), which typically occurs during the night, service water was diverted through an ichthyoplankton sampler equipped with a 0.5 m diameter, 0.333 mm mesh plankton net to collect eggs and larvae. The objective was to filter approximately 100 m3 of intake water per sample, which allowed two samples to be collected on the nights of sampling. Samples were preserved with a 10% formalin solution and processed in a laboratory with the aid of a dissecting scope. Once the samples are sorted, American Shad eggs and larvae will be enumerated; the number of eggs and larvae collected per volume of water sampled (sample density) will be used to estimate weekly entrainment by multiplying that ratio by the volume of water pumped during the week. The weekly estimates will be summed to approximate seasonal entrainment of shad eggs and larvae. Further, the estimated numbers of eggs and larvae entrained will be converted into the number of equivalent adults by applying published survival fractions for a given life stage. Sample densities will also be compared to the densities of shad eggs and larvae in the river. Laboratory processing of the ichthyoplankton samples and data analyses are ongoing and a final report will be completed.

Impacts to adult shad migrations were assessed by a telemetry study employing radio and passive integrated transponder (PIT) technologies to assess behavior, approach routes, passage success, survival, and delay by adult American Shad as they encounter the Turners Falls Development during downstream passage and the Northfield Mountain Pumped Storage Development during both upstream and downstream migration. Analyses of these data will be incorporated in the final report slated for completion by March 1, 2016.

Impacts to juvenile shad outmigration at the projects were evaluated using a combination of methodologies and technologies including: hydroacoustics, radio telemetry and HI-Z Turb’N tags. Analyses of these data will be incorporated in the final report slated for completion by March 1, 2016.

Atlantic Salmon

Entrainment studies have been conducted at the Northfield Mountain Pumped Storage Development to evaluate and mitigate the impacts of the operations on Atlantic Salmon smolts. The studies determined that an estimated 28.6% of Atlantic Salmon were entrained (NUSCO, 1999; LMS, 1993a; LMS 1993b).

In an effort to mitigate entrainment of Atlantic Salmon smolts, a fixed-position guide net was installed annually beginning in 1995 to reduce entrainment of Atlantic Salmon smolts at the Northfield Mountain Pumped Storage Development. After an evaluation of the net returned encouraging results, field testing of modified netting configurations was completed in 1996 and 1997. A radio telemetry study was conducted in 1999 to determine the guidance efficiency of the net (NUSCO, 1999). A limited number of 6.7% radio-tagged smolts became entrained at Northfield Mountain. Fourteen migrating smolts (not radio tagged) became entangled in the net. Results also indicated that radio-tagged smolts moved quickly along the net.

Following the 1999 testing, the fixed-position guide net to reduce Atlantic Salmon smolt entrainment has been deployed annually. The net is typically installed in mid-to-late-April after the spring freshet. Portions of the net occasionally need to be repaired or replaced because of damage due to debris. Due to cessation of the Atlantic Salmon restoration program in the Connecticut River, the Licensee plans to discontinue deploying the guide net.

American Eel

Entrainment of outmigrating adult American Eel at Northfield Mountain was estimated through radio telemetry studies. A total of 72 tagged eels were released 3km upstream of Northfield just before pumping began. In addition turbine and dam passage survival evaluations were conducted by the Licensee in the fall of 2015. HI-Z Turb'N tags were used to evaluate passage survival of 300 adult eels were injected into the turbines of Station No 1 and Cabot Station, as well as into spill over the Turners Falls Dam. Analyses will be included in a final report slated for completion by March 1, 2017 (for the second year of study).

Cumulative Effects

This section will be developed following completion of the data analyses and reporting for the ongoing studies.

3.3.3.3 Proposed Environmental Measures

The number of shad passing through the Turners Falls fishways from 1980 through 1998 did not meet agency goals. FirstLight's predecessor received a letter from USFWS in 1998 requesting discussion of potential structural and operational fishway improvements. FirstLight responded with a five-year plan written in consultation with USFWS and other members of CRASC to evaluate shad passage and develop concepts for fishway enhancements as appropriate. To that end, FirstLight and its predecessor have supported evaluation of the Cabot and gatehouse fishways conducted by researchers from the Conte Anadromous Fish Research Center (CAFRC).

Evaluation of the Cabot Fishway was conducted from 1999 through 2005. Various modifications of the weirs within sections of the Fishway were evaluated, including some that were the result of a physical hydraulic model of fishway pools constructed at CAFRC (Noreika & Haro, 2005). Although some of the modifications in selected sections of the Fishway produced marginal improvements in passage, none appeared likely to result in significant increases in overall shad passage. Evaluation was discontinued in 2005, and in consultation with representatives of CRASC designs were developed for a fish lift to replace the existing Cabot Fishway. Conceptual fish lift plans were developed and reviewed with the agencies but further design was put on hold pending relicensing evaluations.

A new Gatehouse Fishway entrance was constructed in 2007 after several years of evaluation and testing of a prototype structure (CAFRC, 2005). The new entrance includes a 70-foot-long flume built on the side of the canal opposite the original entrance. The flume joins the existing entrance gallery near the Spillway ladder exit. One of the two remaining Gatehouse Fishway entrances was closed to assure adequate flow through the new entrance and the spillway ladder. Starting in 2008, biologists from the CRASC have evaluated shad passage through the new entrance. Results of these evaluations and review of shad counts conducted by FirstLight have demonstrated that shad successfully pass through the new entrance flume, and have also led to modifications implemented since operation of the new entrance was initiated. These improvements have included the installation of flow controls within the Fishway entrance gallery, modification of canal operating protocols, relocation of water level sensors, and installation of a temporary rock ramp from the bottom of the canal to the original entrance (the ramp in no longer in place).

Currently, shad appear to pass readily through the new entrance, but not through the original entrance. Flow control changes intended to ensure adequate flow through the new entrance and to the Spillway Fishway have resulted in excessive velocity and turbulence at the original entrance that may be inhibiting shad passage.

Additional measures may be developed following completion of the data analyses and reporting for the ongoing studies.

3.3.3.4 Unavoidable Adverse Impacts

This section will be developed following completion of the data analyses and reporting for the ongoing studies.

Table 3.3.3.1-1: Relative Abundance of Littoral Zone Habitat Identified in the TFI

Habitat Type	Length (ft)	Length (miles)	% of Total
Fines	53,715	10.2	29%
Cobble	39,115	7.4	21%
Bedrock	30,850	5.8	17%
Gravel	30,555	5.8	16%
Riprap	12,945	2.5	7%
Fines / Cobble Patch	10,895	2.1	6%
Wetlands	7,045	1.3	4%
Boulder / Cobble Patch	1,260	0.2	1%

Table 3.3.3.1.1-1: Observed Submerged Aquatic Vegetation

Common Name	Scientific Name
Pondweed	*Potamogeton ssp.*
Milfoil	*Myriophylum spp.*
Coontail	*Ceratophyllum demersum*
Wild celery (Eelgrass)	*Vallisneria americana*
Clasping leaf pondweed	*Potamogeton perfoliatus*
Waterweed	*Elodea nuttallii*
Eurasian milfoil	*Myriophyllum spicatum**
Muskgrass	*Chara ssp.*
Fanwort	*Cabomba caroliniana**
Large leaf pondweed	*Potamogeton amplifolius*
Variable leaf milfoil	*Myriophylum heterophyllum**
Water chestnut	*Trapa natans**
Curly-leaved pondweed	*Potomageton crispus**

*Exotic Species

Table 3.3.3.1.2-1: Fish Species Collected in the Turners Falls Impoundment During July 2015 Effort for the Fish Assemblage Survey

Species listed in declining order of numeric abundance (provisional information).

Common Name	Scientific Name
Spottail Shiner	*Notropis hudsonius*
White Sucker	*Catostomus commersoni*
Yellow Perch	*Perca flavescens*
Smallmouth Bass	*Micropterus dolomieu*
Bluegill	*Lepomis macrochirus*
Fallfish	*Semotilus corporalis*
Rock Bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Tessellated Darter	*Etheostoma olmstedi*
Walleye	*Sander vitreus*
Common Shiner	*Luxilus cornutus*
American Eel	*Anguilla rostrata*
Largemouth Bass	*Micropterus salmoides*
Golden Shiner	*Notemigonus crysoleucas*
Black Crappie	*Pomoxis nigromaculatus*
Channel Catfish	*Ictlurus punctatus*
Brown Bullhead	*Ameiurus nebulosus*
Common Carp	*Cyprinus carpio*
Chain Pickerel	*Esox niger*
Sea Lamprey	*Petromyzon marinus*
Mimic Shiner	*Notropis volucellus*
Northern Pike	*Esox lucius*
American Shad	*Alosa sapidissima*

Table 3.3.3.1.2-2: Summary of Spawning Information for Resident Species Obtained from Desktop Literature Review

Common Name	Spawning Strategy	Notes	Spawning Period	Temperature Range
Yellow Perch	Broadcast spawn in shallow weedy areas	Eggs adhesive, no guardianship	April and May	6.7-12.2°C
Pumpkinseed	Nest scoured in sand/fines	Male adult guardianship	late spring to mid-summer	20°C
Smallmouth Bass	Sand/gravel nest near object cover	Male adult guardianship	late spring to early summer	16.1-18.3°C
Largemouth Bass	Sand/fines nest near object cover	Male adult guardianship	Mid-spring to early summer	16.7-18.3°C
Bluegill	Sand/fines nest	Male adult guardianship	Mid-May to mid-summer	17 -31°C
Spottail Shiner	Broadcast spawn on sand at mouths of streams	No guardianship	May to mid-June	
White Sucker	Gravel bars in tributary or shoals	No guardianship	Mid-April to May	10°C
Walleye	Cobble riffle or shoals	Broadcast spawn, no guardianship	April	7-11°C
Golden Shiner	Submerged vegetation in shallow water	Broadcast spawn, eggs are adhesive, no guardianship	May to August	20°C
Black Crappie	Nest scoured in sand/fines	Male adult guardianship	Mid-spring to early summer	19-20°C
White Perch	Broadcast spawn	Eggs planktonic	Mid-spring	11-15°C
Rock Bass	Sand/gravel nest near object cover	Male adult guardianship	June	15.6-21.1°C
Brown Bullhead	Sand/fines nest	Male adult guardianship	Late May through June	21.1°C
Chain Pickerel	Broadcast spawn glutinous egg strings in marshes	Eggs adhesive, no guardianship	March to May	8.3-11.1°C
Fallfish	Gravel in low velocity stream margins	Nest builder, no guardianship	Late April through May	12-16.6°C
Common Carp	Shallow vegetation	Broadcast spawn, no guardianship	Late spring to late summer	

Table 3.3.3.1.2-3: Locations of Monitored Sea Lamprey Redds in Project Area

Location	Number of redds monitored	Number of capped redds
Connecticut River mainstem within close proximity of Vernon Dam (both sides of Stebbins Island)	7	1
Ashuelot River confluence with the Connecticut River	11	1
Millers River confluence with the Connecticut River	5	1
Fall River confluence with the Connecticut River	2	1
Hatfield S curve below Rt. 116 Bridge	5	1
Total	30	5

Table 3.3.3.1.2-4: Location and Types of Telemetry Equipment Used to Evaluate Silver Eel Emigration at the Turners Falls and NMPS Projects, Turners Falls and Northfield MA

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with double yagi antennae will monitor the full width of the River
Cabot Station Tailrace	120	A Lotek SRX with yagi antenna will monitor the full river width. An Orion receiver and double yagi antennae will monitor the tailrace immediately downstream of the station.
Cabot Station Forebay	120	Two radio receivers will monitor the forebay area: 1) An Orion with double yagi and dropper antennae will monitor the full width of the forebay area 2) An Orion with dipole antenna will monitor the entrance to the Cabot downstream bypass
Station 1 Forebay	121	An Orion with yagi and dropper antenna will monitor the full width of the forebay area
Station 1 Tailrace	121	A Lotek SRX with yagi antenna will monitor the tailrace area. Detection zone will monitor the full width of the bypass reach. A detection power analysis will differentiate those test fish that are attracted to the tailwater from those that continue upstream
Below Turners Falls Dam	122	Two Lotek SRX receivers with double yagi antennae will monitor the area below the dam, one on either side of the river bank such that approach to the dam can be differentiated from either the right or left sides of the River
Upstream of Gatehouse	122	An Orion receiver with yagi and dropper antennas will be used to monitor the area immediately upstream of Gatehouse
Upstream End of the Canal	122	An Orion with a yagi antenna will monitor the full width of the canal at a location downstream of the Gatehouse in the upper canal to monitor fish entering the canal from upstream
NMPS Gill Bank	126.5	A Lotek with double yagi antennae will monitor the full width of the impoundment
NMPS Intake	127	An Orion with double yagi antenna will monitor the intake area
NMPS Upper Reservoir	127	An Orion receiver with yagi and dropper antennas will be used to monitor the upper reservoir
Shearer Farms	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment

Table 3.3.3.1.2-5: Anadromous Fish Passage Recorded at the Turners Falls Fish Passage Facilities, Connecticut River, Massachusetts, 1980 to 2014

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
1980	Cabot	687	0	11	187	0	
	Spillway	5	0	0	0	0	
	Gatehouse	298	0	1	66	1	
1981	Cabot	224	0	0	1,622	7	
	Spillway**						
	Gatehouse	200	0	0	935	8	
1982	Cabot						
	Spillway**						
	Gatehouse	11	4	0	210	0	
1983	Cabot	26,697	106	6	859	0	
	Spillway	263	1	1	649	0	
	Gatehouse	12,705	28	7	703	0	
1984	Cabot	1,831	4	0	334	1	
	Spillway	4,563	12	0	851	1	
	Gatehouse	4,333	21	0	683	1	
1985	Cabot	31,000	1,726	0	3,198	2	
	Spillway	843	243	0	3,185	3	
	Gatehouse	3,855	301	0	1,809	3	
1986	Cabot	22,144	7,091	0	1,424	5	
	Spillway	5,857	6,248	0	2,230	4	
	Gatehouse	17,858	9,578	0	1,961	10	
1987	Cabot	33,114	2,866	0	1,324	2	
	Spillway	3,679	2,841	0	2,921	3	
	Gatehouse	18,959	5,091	0	2,590	12	
1988	Cabot	28,546	349	0	335	2	
	Spillway	3,354	865	0	1,912	2	
	Gatehouse	15,787	1,079	0	1,175	7	
1989	Cabot	14,403	199	0	578	1	
	Spillway	1,494	279	0	947	0	
	Gatehouse	9,511	510	1	868	2	

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
1990	Cabot	31,056	711	0	1,304	8	1
	Spillway	5,898	768	0	1,013	2	0
	Gatehouse	27,908	1,585	0	1,301	16	13
1991	Cabot	87,168	6,433	1	2,089	2	0
	Spillway	6,282	2,718	0	3,026	2	0
	Gatehouse	54,656	7,522	3	4,090	4	1
1992	Cabot	94,046	1,765	1	1,836	9	0
	Spillway	11,760	884	0	3,275	6	0
	Gatehouse	60,089	2,157	2	2,710	14	7
1993	Cabot	21,045	243	0	711	7	0
	Spillway	898	90	0	2,082	3	0
	Gatehouse	10,221	278	0	1,637	7	0
1994	Cabot**						
	Spillway	1,507	17	0	1,740	1	0
	Gatehouse	3,729	97	0	1,702	5	0
1995	Cabot	33,938	4,234	0	1,417	2	1
	Spillway	543	31	0	1,372	0	0
	Gatehouse	18,369	2,957	0	1,813	4	4
1996	Cabot**						
	Spillway	2,293	13	0	2,651	4	0
	Gatehouse	16,192	515	0	4,556	3	3
1997	Cabot	22,518	231	0	2,374	2	4
	Spillway	3,473	15	0	2,219	1	3
	Gatehouse	9,216	128	0	2,265	2	2
1998	Cabot	14,947	2	0	8,707	6	1
	Spillway	4,721	0	0	8,642	2	2
	Gatehouse	10,527	4	0	7,579	5	2
1999	Cabot	11,501	5	0	2,014	2	543
	Spillway	4,215	0	8	1,449	2	440
	Gatehouse	6,751	2	0	916	0	275
2000	Cabot	12,289	0	0	1,455	0	9

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
	Spillway	2,240	0	0	1,962	4	358
	Gatehouse	2,590	0	0	1,350	5	199
2001	Cabot	20,933	0	0	3,678	0	0
	Spillway	2,344	0	0	5,280	0	0
	Gatehouse	1,540	0	0	2,144	0	0
2002	Cabot	7,922	0	0	14,709	0	0
	Spillway	5,372	0	0	12,367	4	7
	Gatehouse	2,870	0	0	10,160	4	2
2003**							
2004	Cabot	5,933	0	0	13,352	0	0
	Spillway	1,980	0	0	5,821	0	0
	Gatehouse	2,192	0	0	8,418	0	0
2005	Cabot	5,404	2	7	12,974	5	0
	Spillway	1,626	0	7	9,990	1	2
	Gatehouse	1,581	2	2	215,843	5	0
2006	Cabot	11,991	1	198	5,377	4	9
	Spillway	2,577	0	153	5,133	8	0
	Gatehouse	1,810	0	46	3,005	7	0
2007	Cabot	11,130	**	**	11,061	5	0
	Spillway	1,793	**	**	5,555	3	0
	Gatehouse	2,248	**	**	15,438	5	0
2008	Cabot	15,089	**	**	**	6	**
	Spillway	627	**	**	**	5	**
	Gatehouse	3,995	**	**	32,035	10	**
2009	Cabot	13,391	**	**	**	0	**
	Spillway	919	**	**	**	5	**
	Gatehouse	3,814	**	**	8,296	8	**
2010	Cabot	30,232	**	**	**	2	**
	Spillway	2,735	**	**	**	4	**
	Gatehouse	16, 768	**	**	6,352	8	**
2011	Cabot	27,077	**	**	**	2	**

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
	Spillway	1,966	**	**	**	6	**
	Gatehouse	16,798	**	**	2,032	7	**
2012	Cabot	51,901	**	**	**	2	**
	Spillway	10,608	**	**	**	3	**
	Gatehouse	26,727	**	**	4,503	2	**
2013	Cabot	46,886	**	**	**	0	**
	Spillway	10,571	**	**	**	1	**
	Gatehouse	35,494	**	**	6,016	0	**
2014	Cabot	40,666	**	**	**	3	**
	Spillway	24,262	**	**	**	8	**
	Gatehouse	39,914	**	**	5,553	11	**

* Observations of Gizzard Shad using ladders was first reported in 1990.
** not monitored

(Slater, 2011; Robert Stira, per. comm.).

Table 3.3.3.1.2-6: American Shad Passage Recorded at the Holyoke Dam Fish Passage Facilities, Connecticut River, Massachusetts, 1981 to 2014 and the Passage Ratio for the Numbers Passed at Vernon Versus Turners Falls Gatehouse.

Year	Vernon	Passage Ratio
1981	260,000	0.00
1982	380,000	0.00
1983	380,000	0.02
1984	290,000	0.01
1985	530,000	0.01
1986	500,000	0.05
1987	480,000	0.07
1988	350,000	0.05
1989	270,000	0.03
1990	290,000	0.08
1991	350,000	0.11
1992	360,000	0.08
1993	520,000	0.03
1994	720,000	0.02
1995	340,000	0.10
1996	170,000	0.06
1997	190,000	0.03
1998	280,000	0.03
1999	300,000	0.04
2000	320,000	0.01
2001	190,000	0.01
2002	225,000	0.01
2003	270,000	*
2004	370,000	0.01
2005	280,000	0.01
2006	192,000	0.01
2007	116,511	0.01
2008	155,000	0.03
2009	158,807	0.02
2010	156,492	0.10
2011	160,649	0.07
2012	164,439	0.05
2013	244,177	0.09
2014	490,431	0.11

*Passage not monitored at Turners Falls.

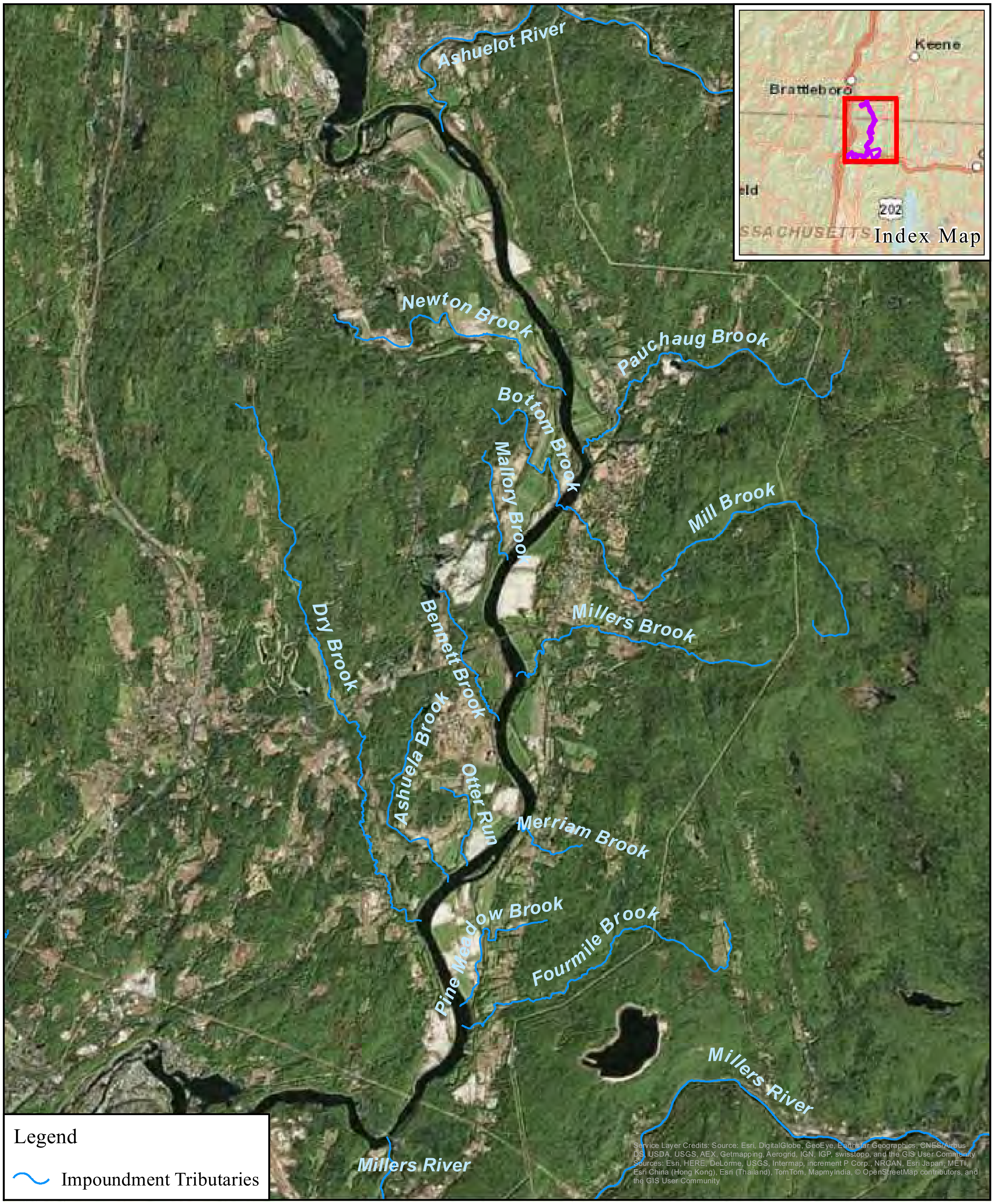
Table 3.3.3.1.2-7: American Shad Passage Recorded at the Vernon Dam Fish Passage Facilities, Connecticut River, Massachusetts, 1981 to 2014 and the Passage Ratio for the Numbers Passed at Vernon Versus Turners Falls Gatehouse.

Year	Vernon	Passage Ratio
1981	97	0.49
1982	9	0.90
1983	2,597	
1984	335	
1985	833	0.22
1986	982	0.05
1987	3,459	0.18
1988	1,370	0.09
1989	2,953	0.31
1990	10,894	0.39
1991	37,197	
1992	31,155	
1993	3,652	0.38
1994	2,681	0.81
1995	15,777	0.86
1996	18,844	1.16
1997	7,384	0.80
1998	7,289	0.69
1999	5,097	0.75
2000	1,548	0.60
2001	1,744	1.13**
2002	356	0.12
2003	268	*
2004	653	0.31
2005	167	0.11
2006	133	0.09
2007	65	0.03
2008	271	0.07
2009	16	0
2010	290	0.02
2011	46	0
2012	10,386	0.40
2013	18,220	0.51
2014	27,706	0.69

*Passage not monitored at Turners Falls.
** Counting error

Table 3.3.3.2.2-1: Location and Types of Telemetry Equipment Used to Evaluate Silver Eel Migration at the Turners Falls and Northfield Mountain Developments

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with double yagi antennae will monitor the full width of the River
Cabot Station Tailrace	120	A Lotek SRX with yagi antenna will monitor the full river width. An Orion receiver and double yagi antennae will monitor the tailrace immediately downstream of the station.
Cabot Station Forebay	120	Two radio receivers will monitor the forebay area: 1) An Orion with double yagi and dropper antennae will monitor the full width of the forebay area 2) An Orion with dipole antenna will monitor the entrance to the Cabot downstream bypass
Station 1 Forebay	121	An Orion with yagi and dropper antenna will monitor the full width of the forebay area
Station 1 Tailrace	121	A Lotek SRX with yagi antenna will monitor the tailrace area. Detection zone will monitor the full width of the bypass reach. A detection power analysis will differentiate those test fish that are attracted to the tailwater from those that continue upstream
Below Turners Falls Dam	122	Two Lotek SRX receivers with double yagi antennae will monitor the area below the dam, one on either side of the river bank such that approach to the dam can be differentiated from either the right or left sides of the River
Upstream of Gatehouse	122	An Orion receiver with yagi and dropper antennas will be used to monitor the area immediately upstream of Gatehouse
Upstream End of the Canal	122	An Orion with a yagi antenna will monitor the full width of the canal at a location downstream of the Gatehouse in the upper canal to monitor fish entering the canal from upstream
NMPS Gill Bank	126.5	A Lotek with double yagi antennae will monitor the full width of the impoundment
NMPS Intake	127	An Orion with double yagi antenna will monitor the intake area
NMPS Upper Reservoir	127	An Orion receiver with yagi and dropper antennas will be used to monitor the upper reservoir
Shearer Farms	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment



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0 0.75 1.5 3 Miles

Figure No. 3.3.3.1-1
Location of Target Tributaries in the Turners Falls Impoundment for FirstLight's Tributary and Backwater Access Study

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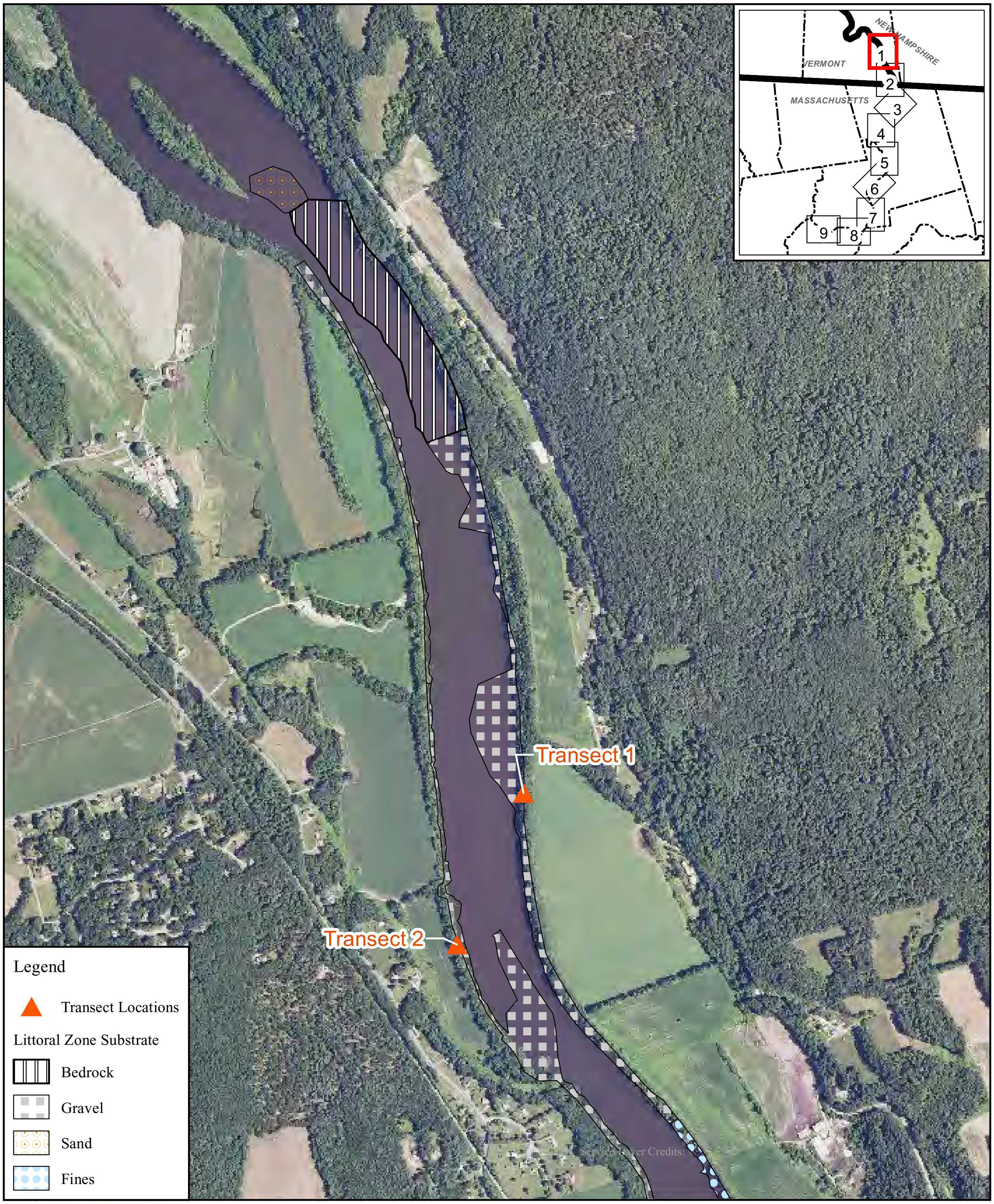

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 1

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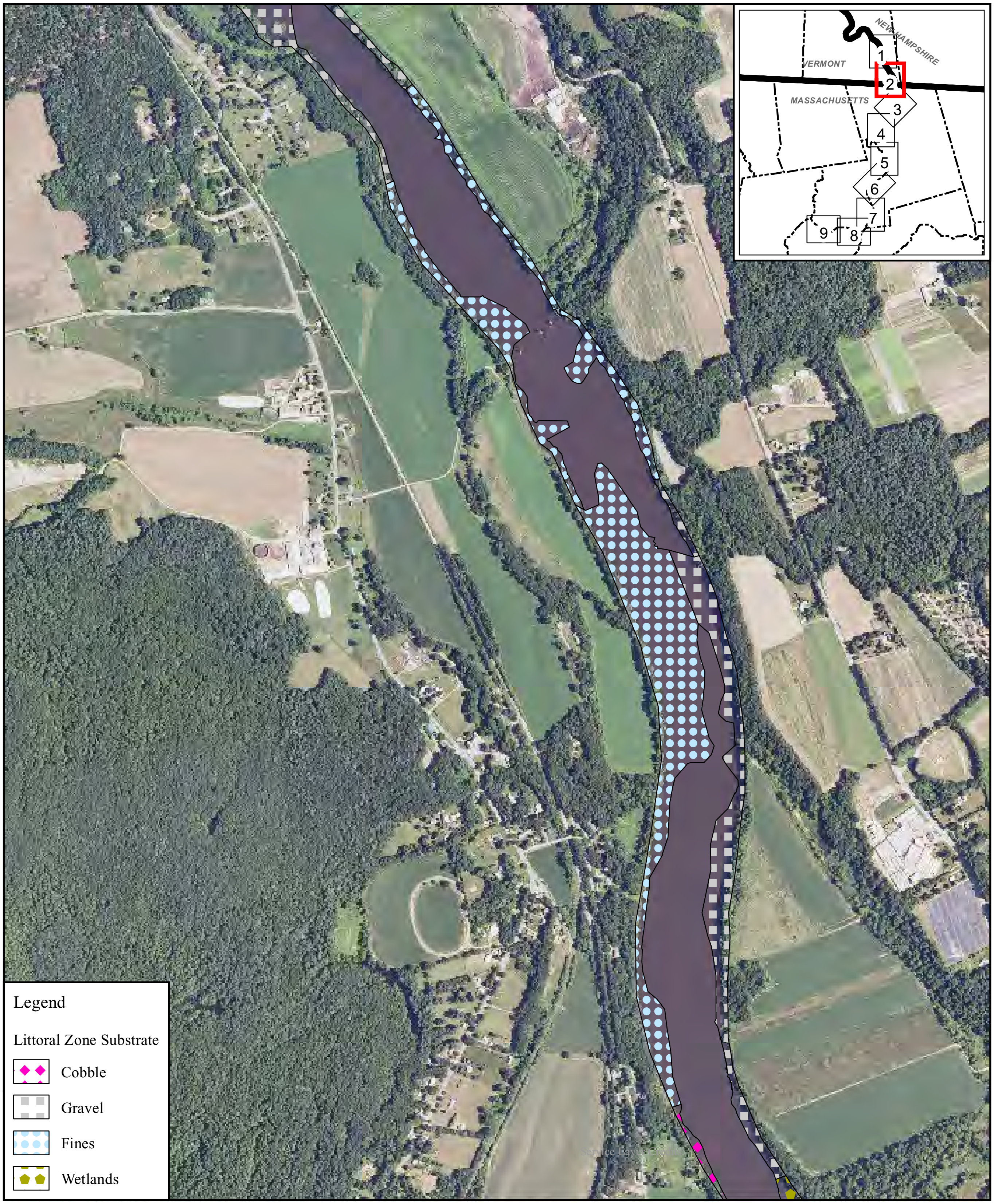

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 2

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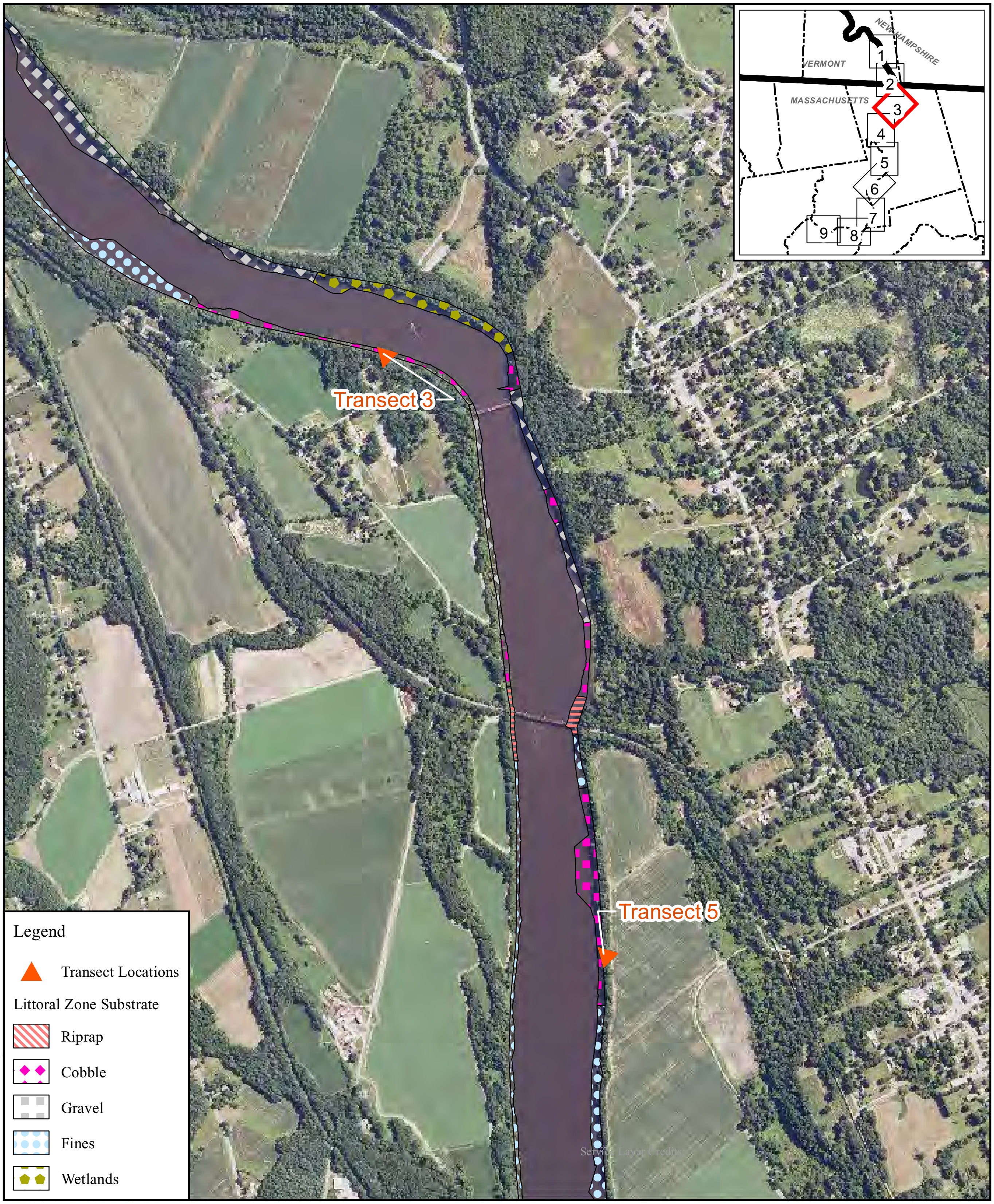

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 3

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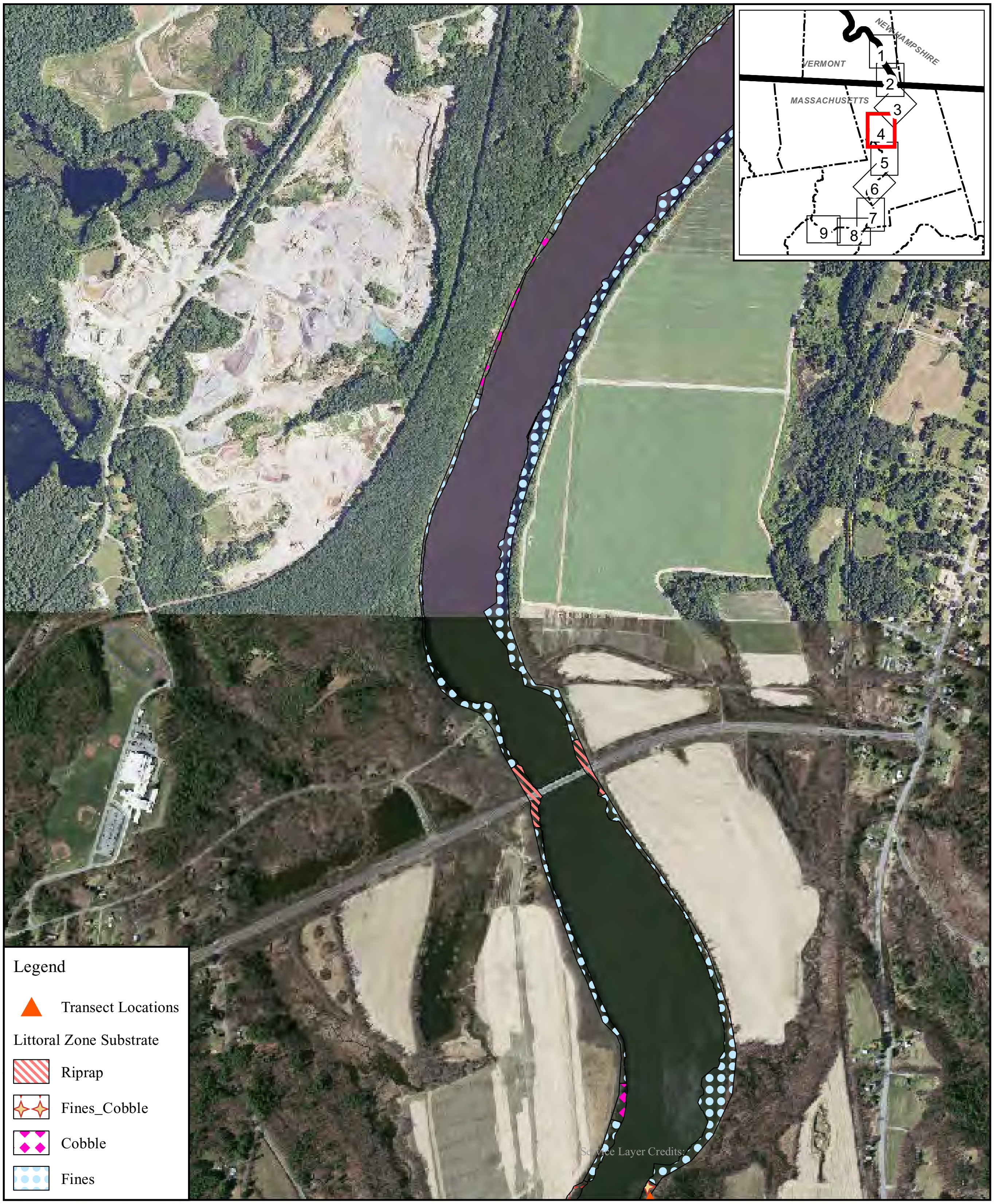

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 4

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Feet

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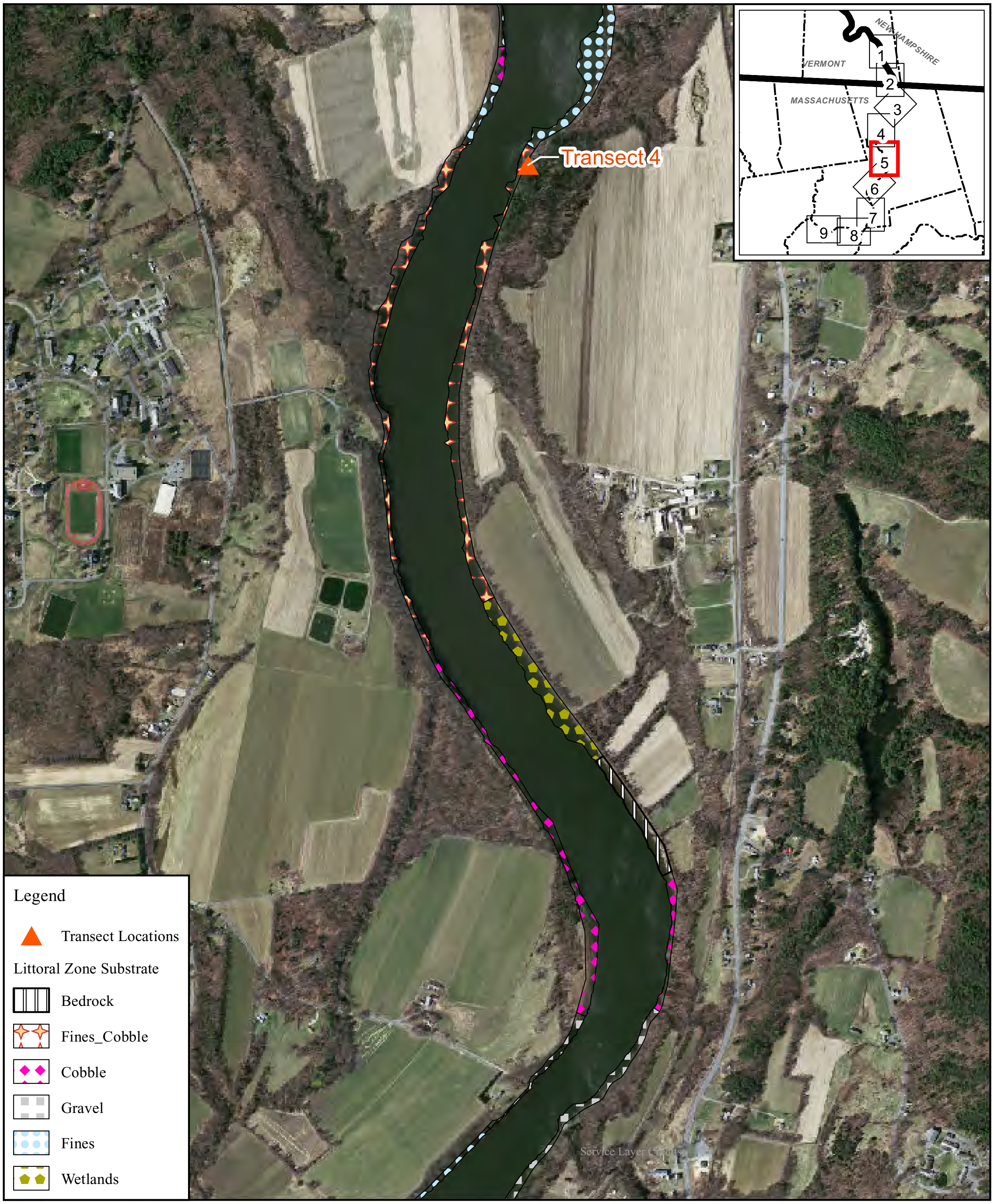

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Feet

Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 5

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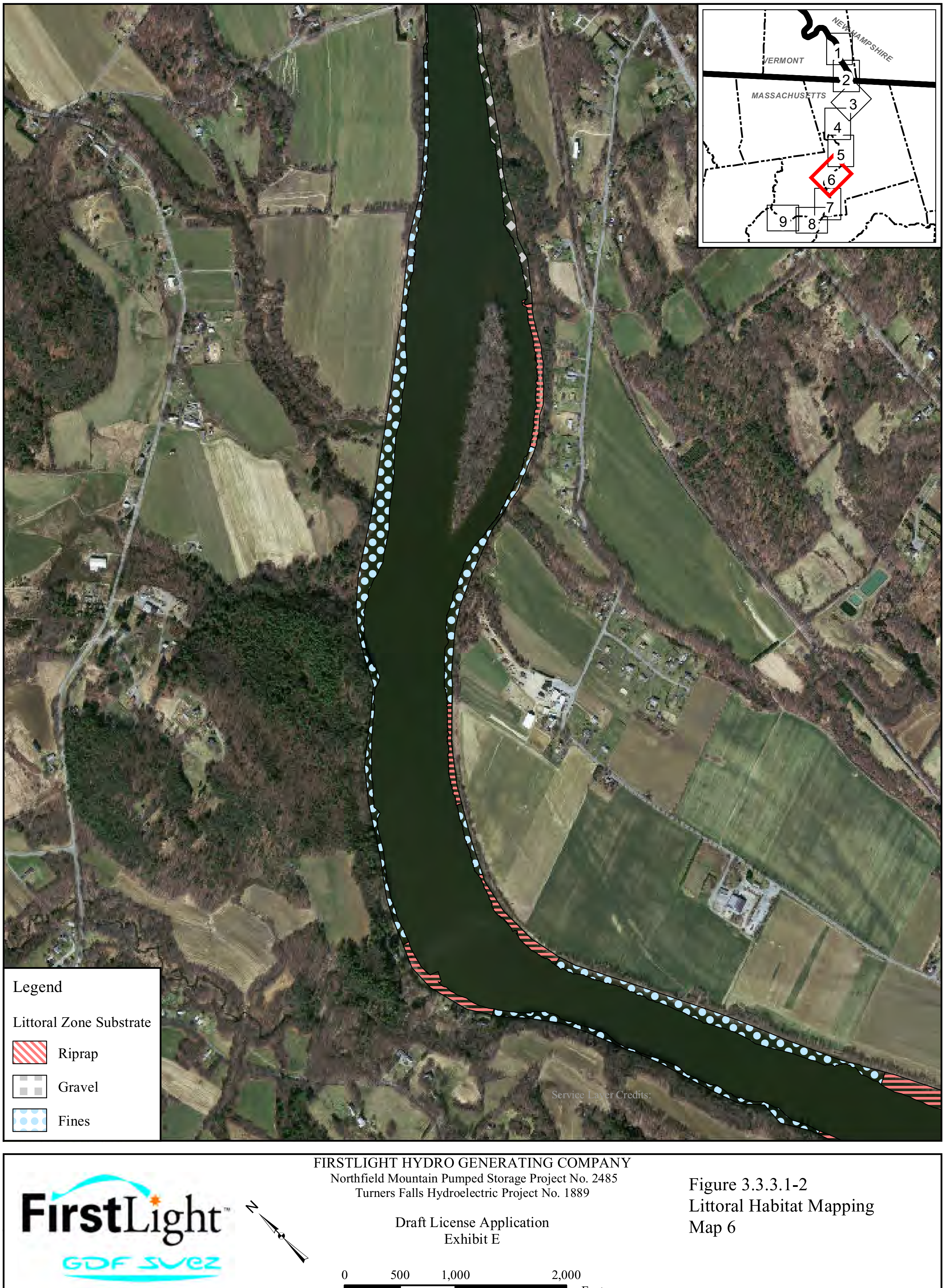

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 6

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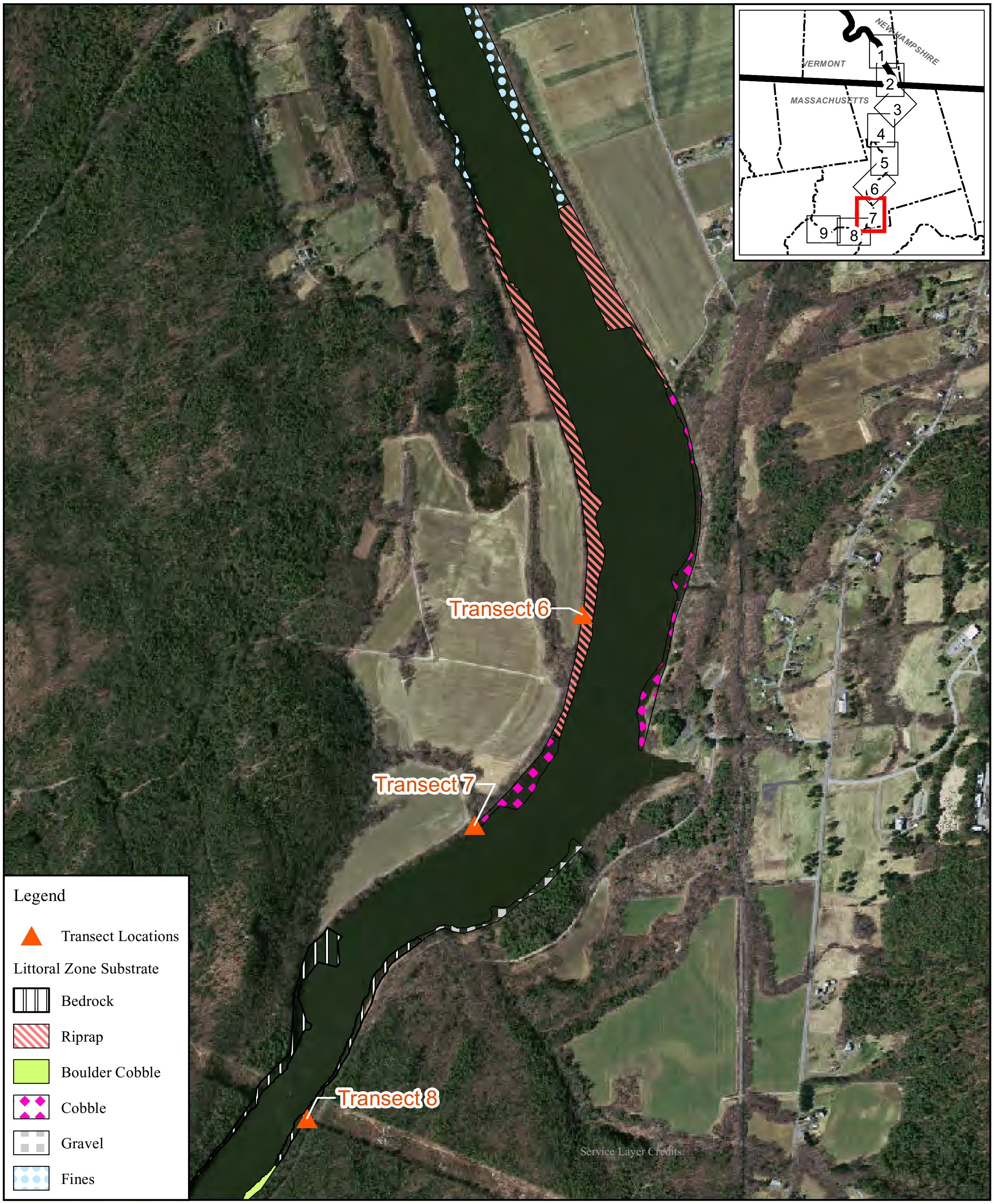

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 7

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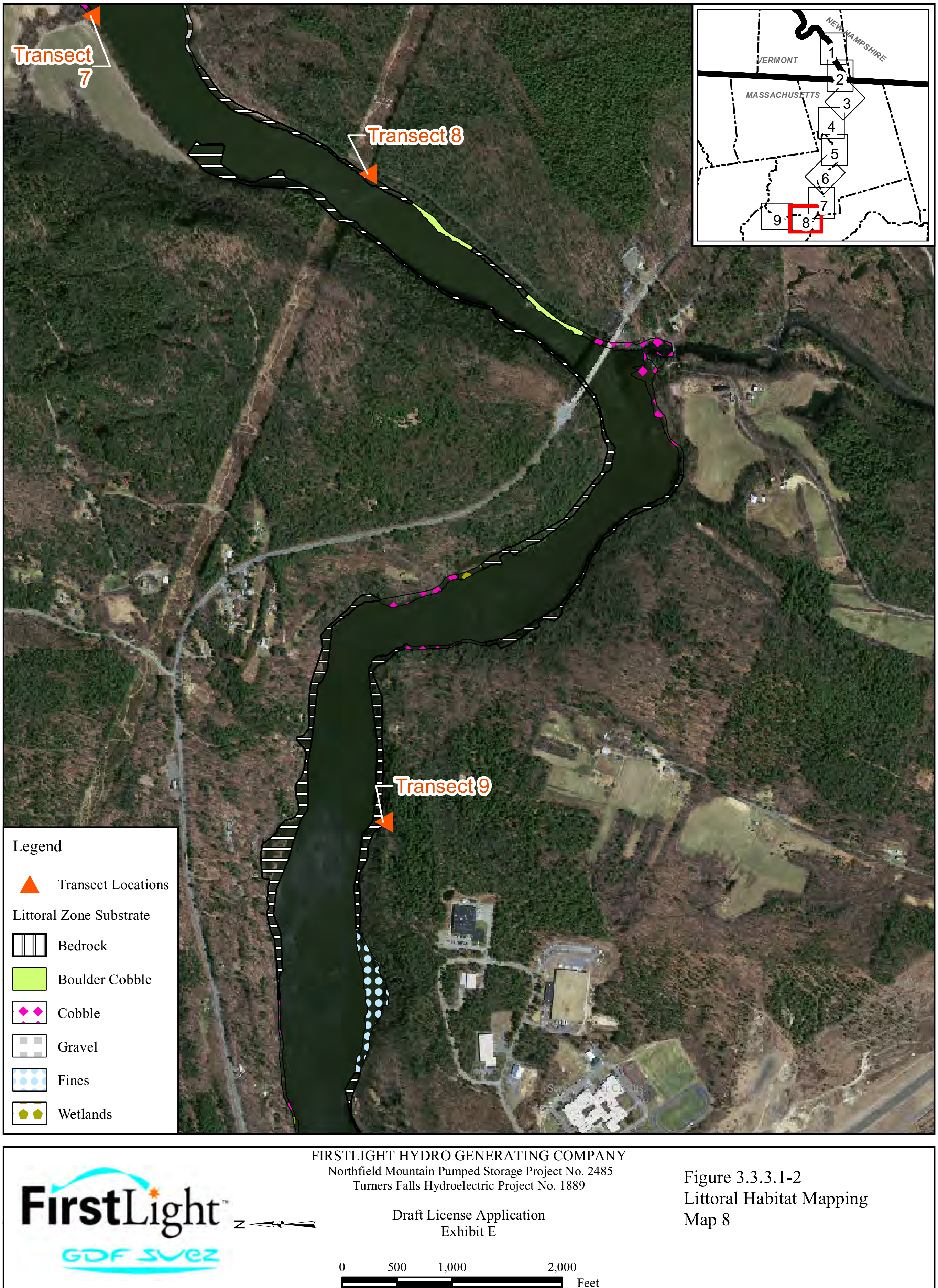

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Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 8

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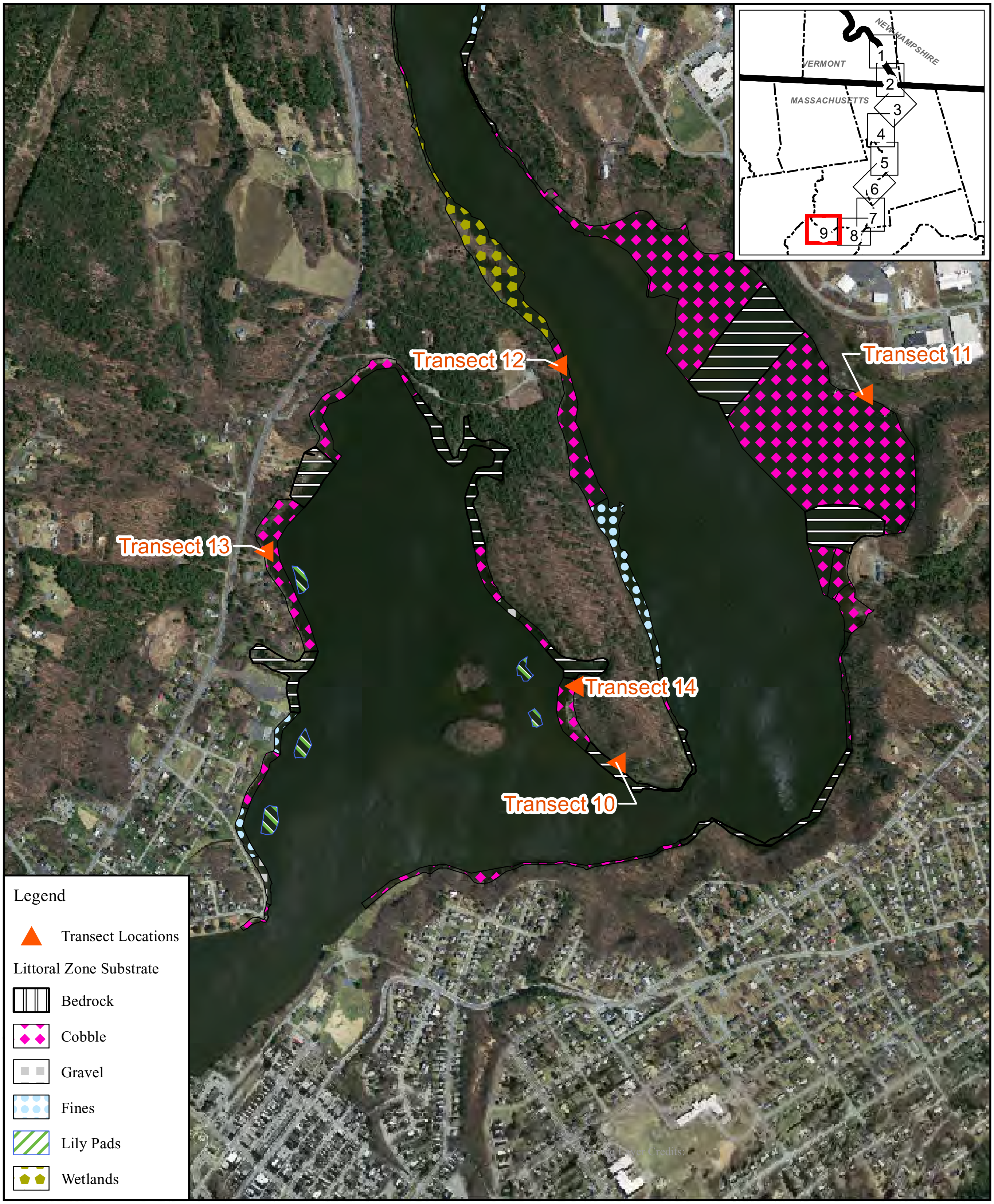

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Feet

Figure 3.3.3.1-2
Littoral Habitat Mapping
Map 9

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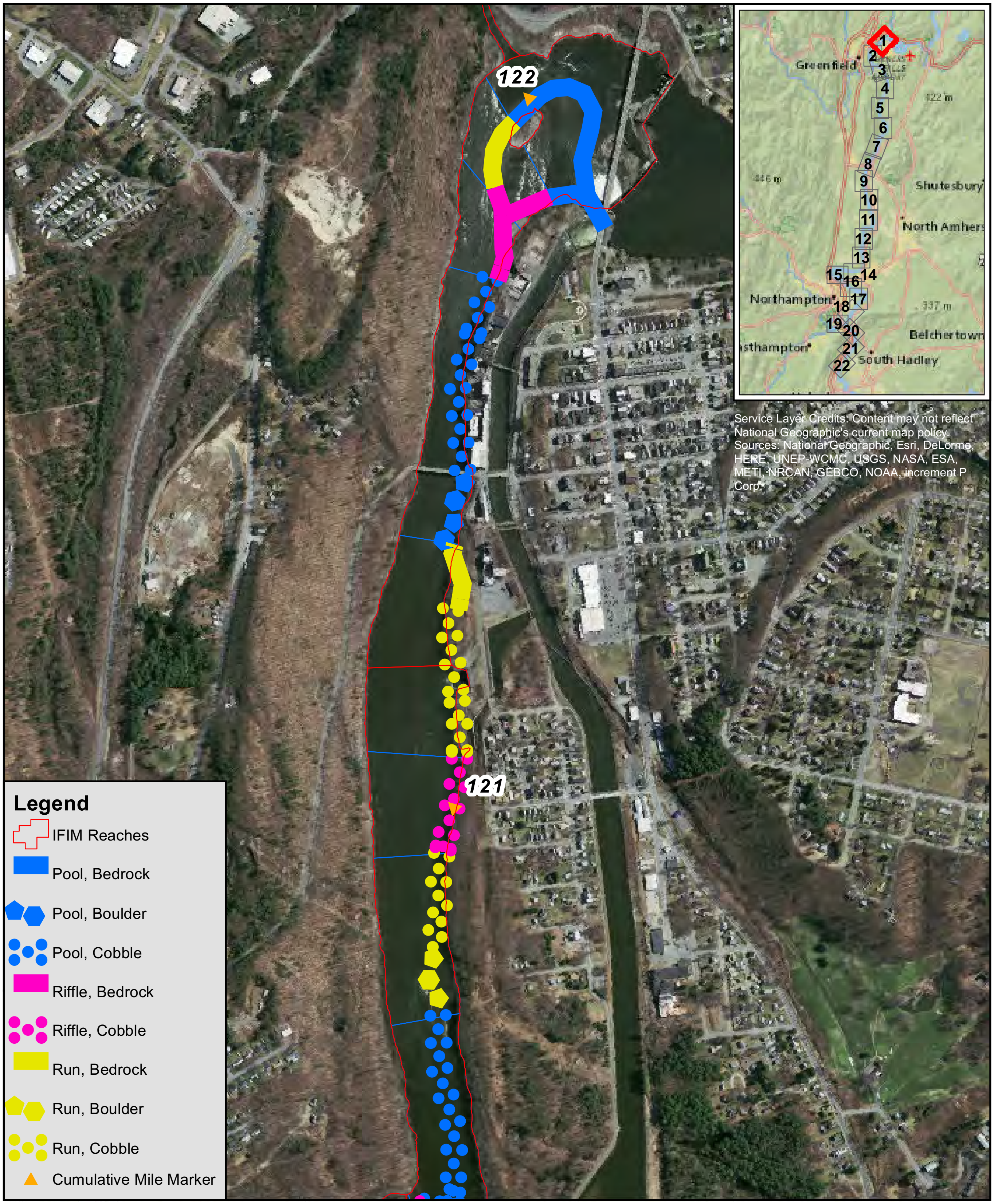

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 1

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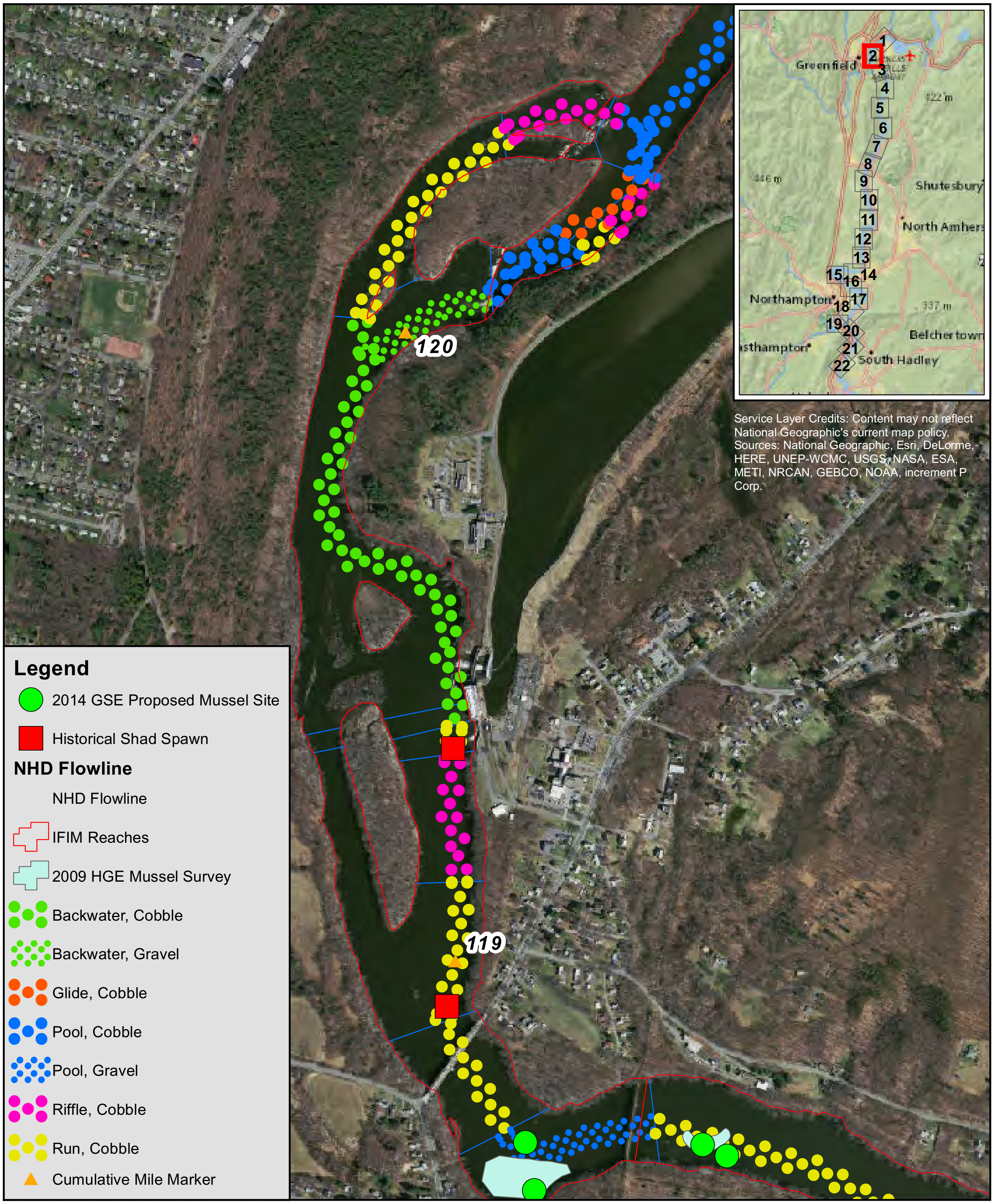

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 2

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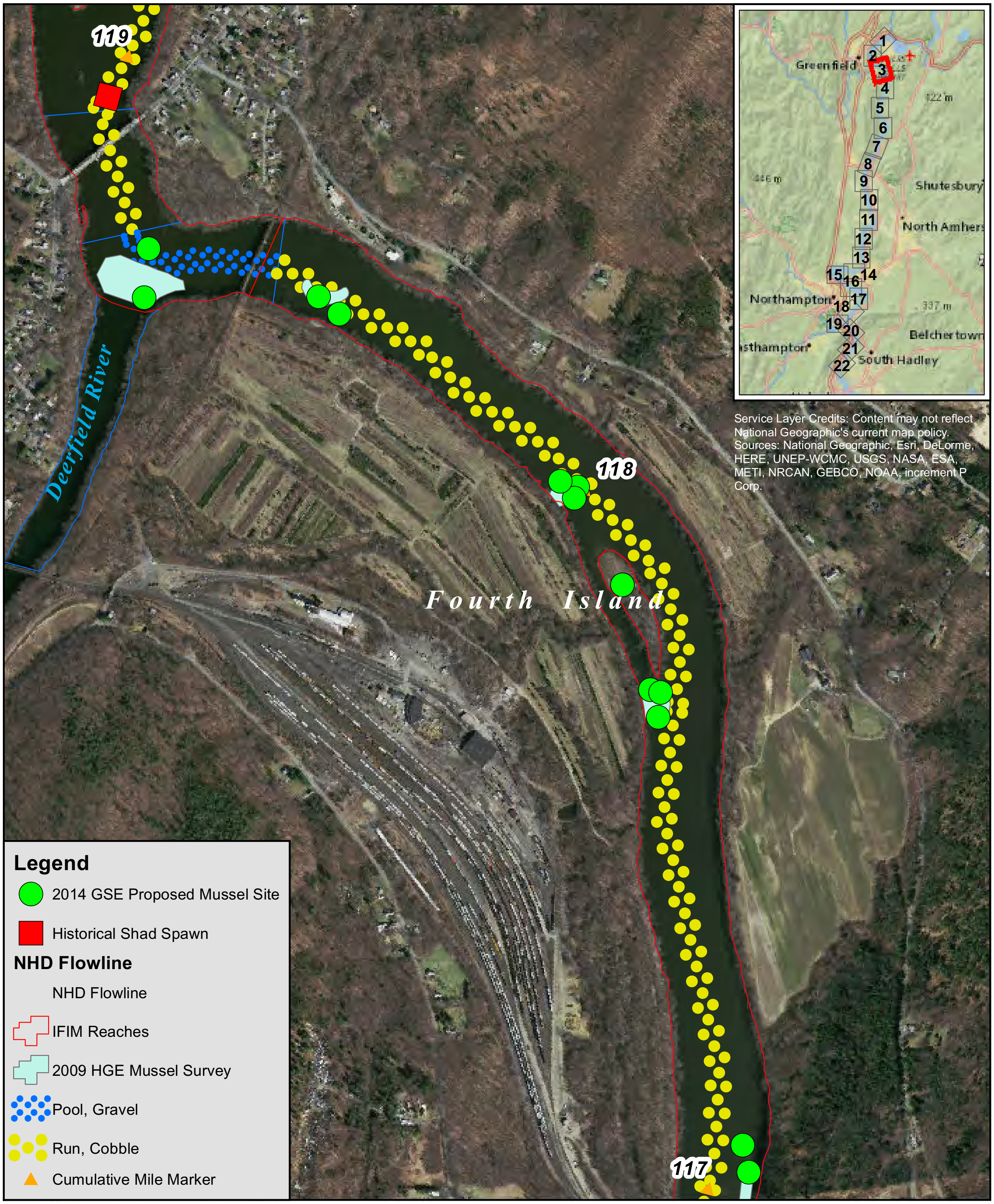

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 3

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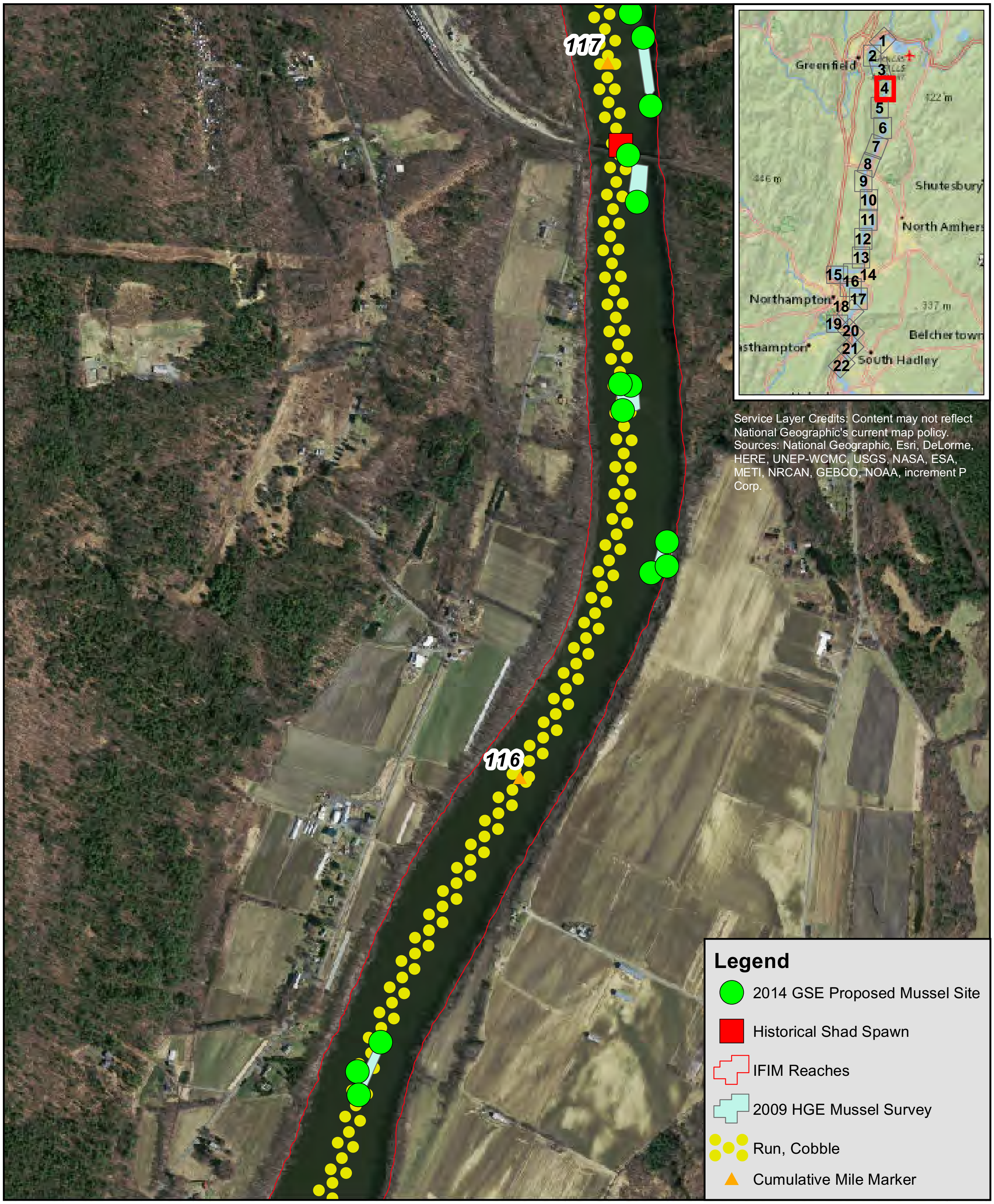

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 4

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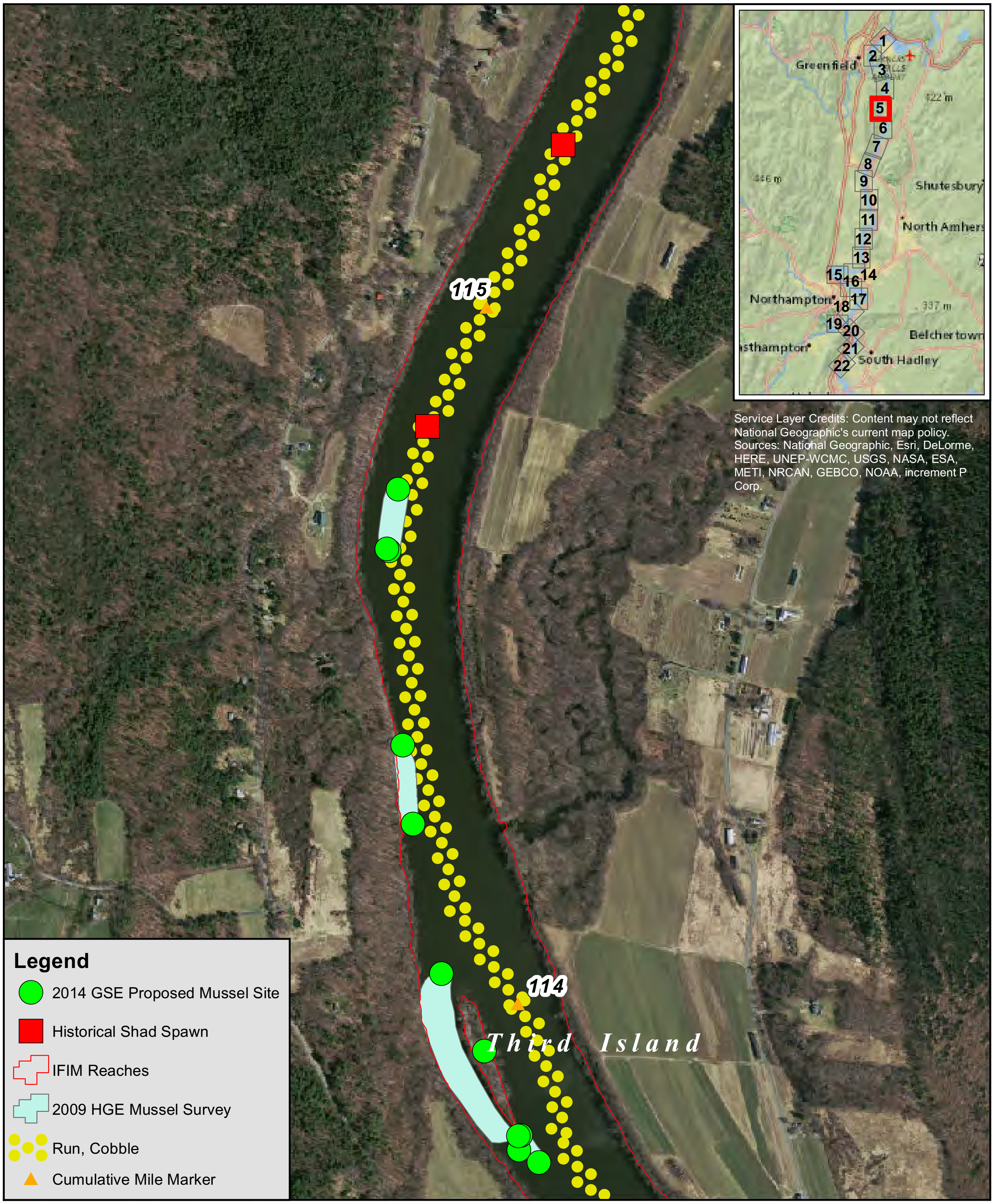

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 5

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0 500 1,000 2,000
Feet

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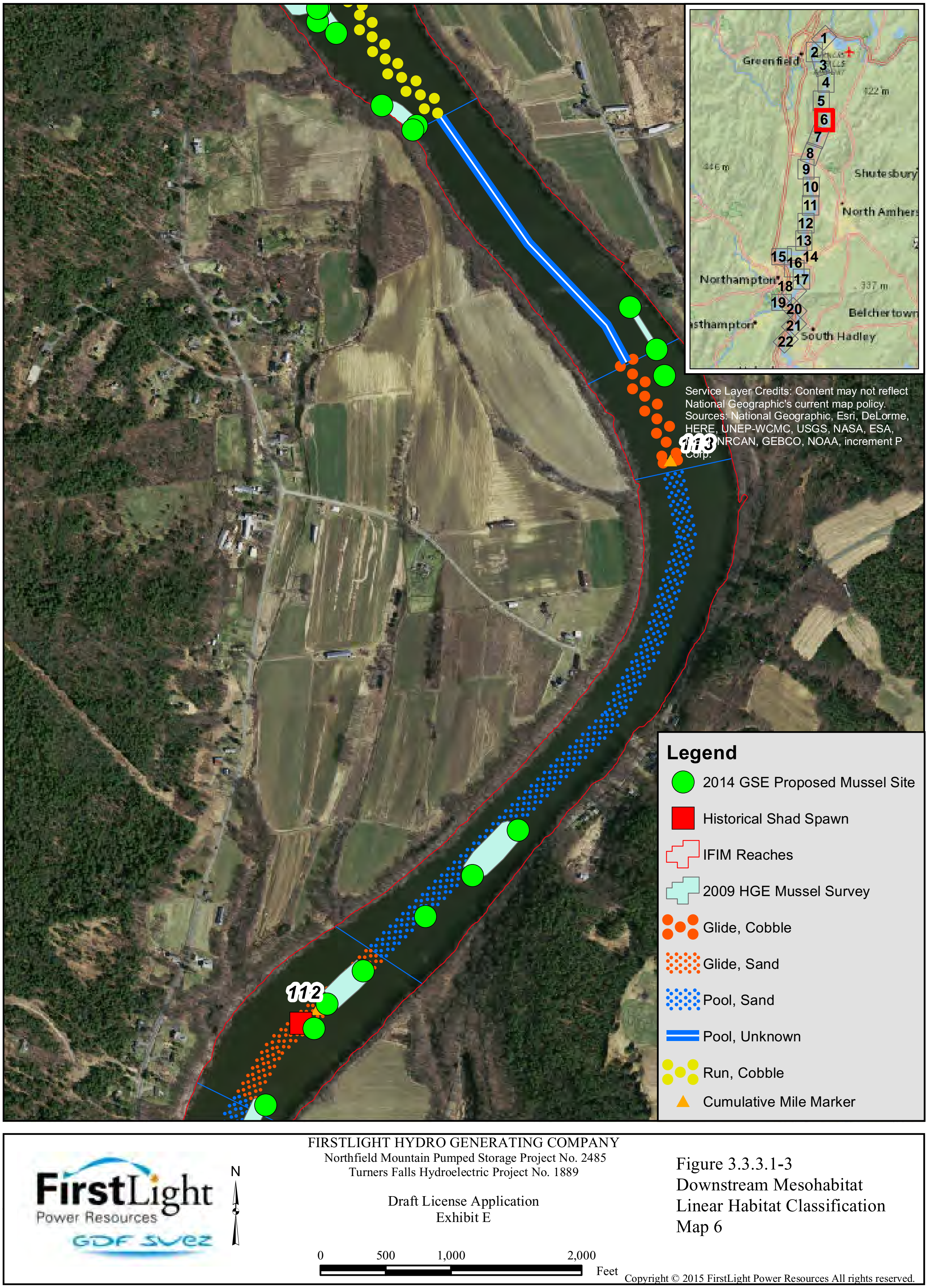

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 6

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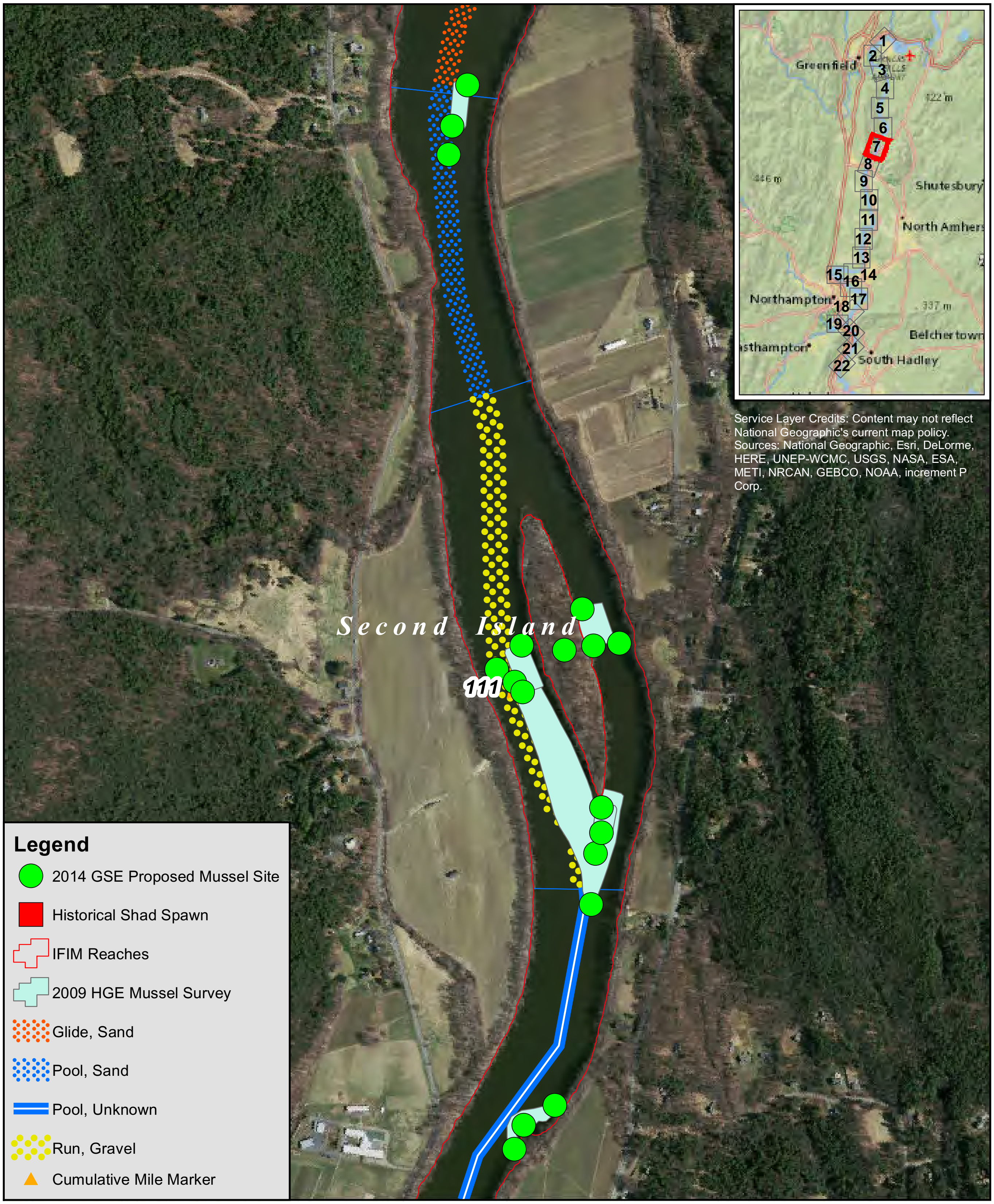

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 7

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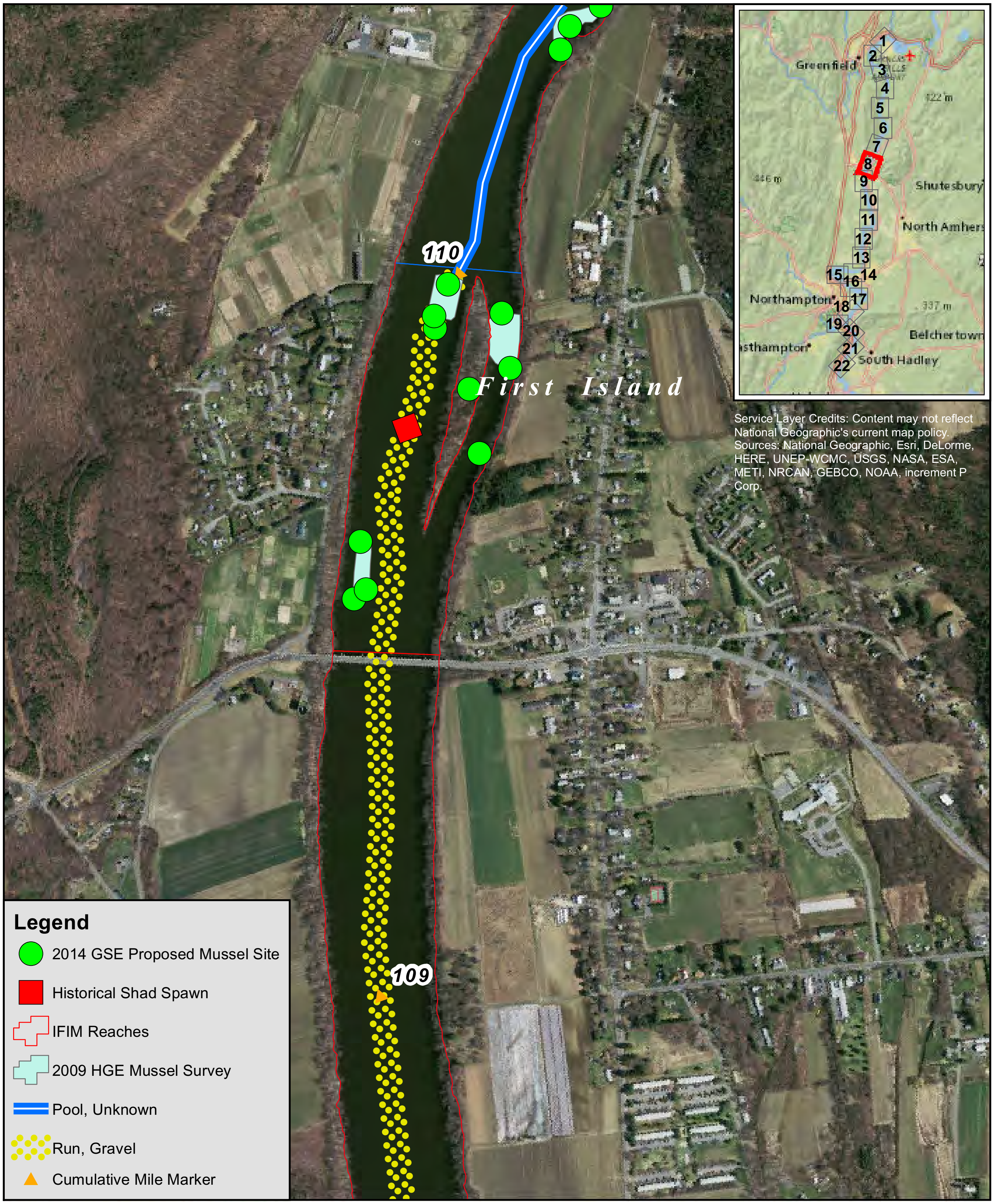

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 8

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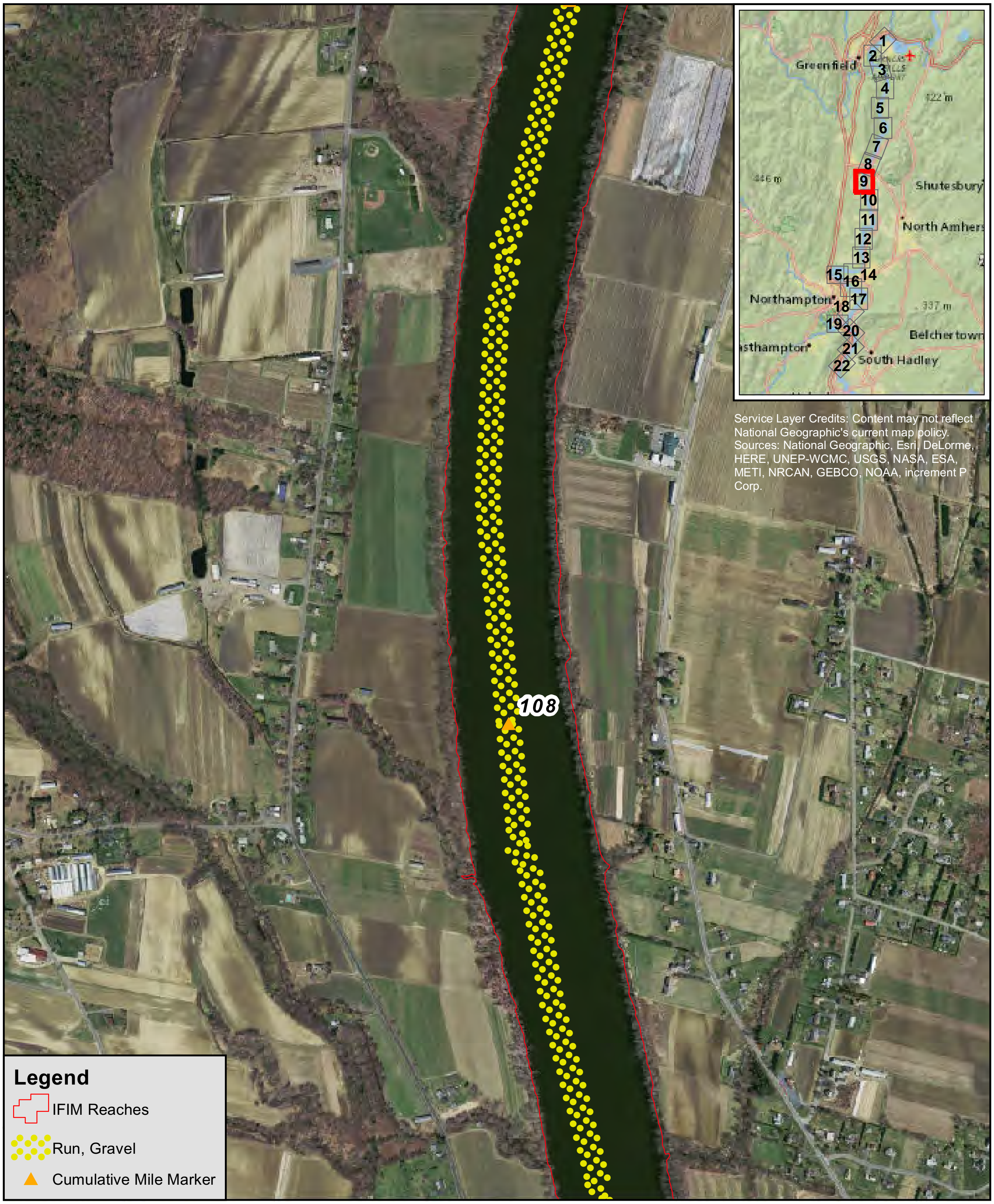

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0 500 1,000 2,000 Feet

Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 9

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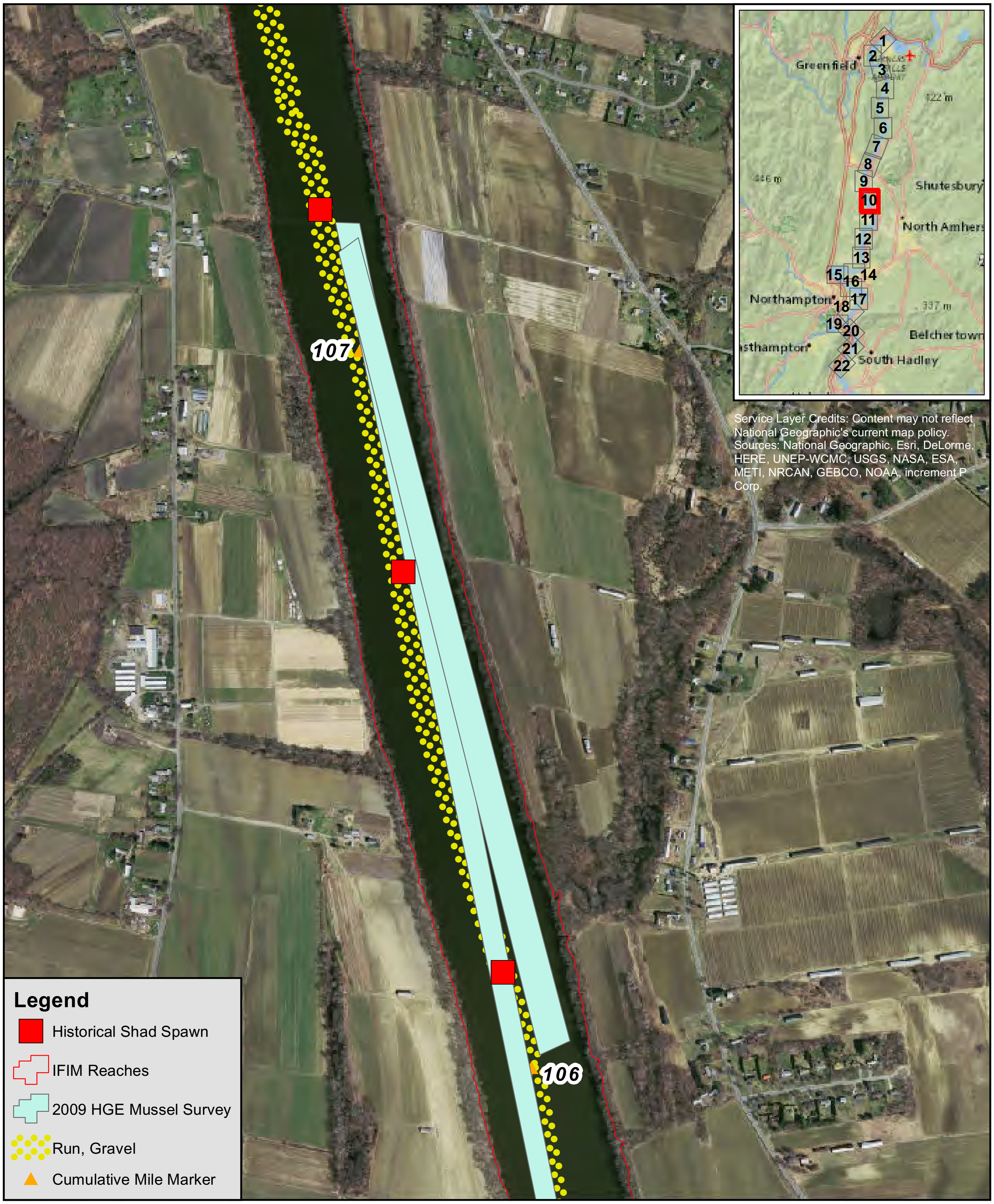

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 10

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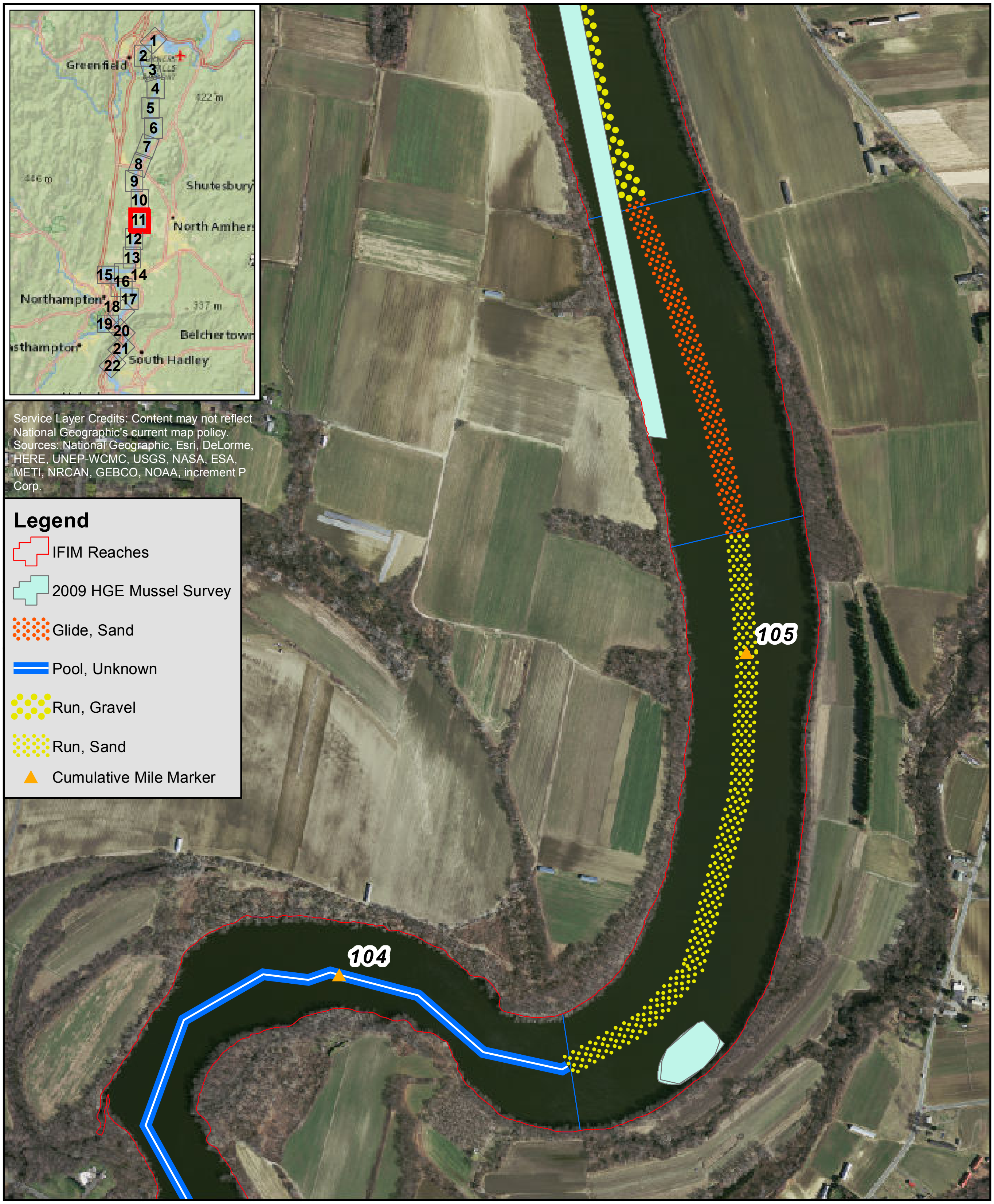

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 11

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0 500 1,000 2,000 Feet

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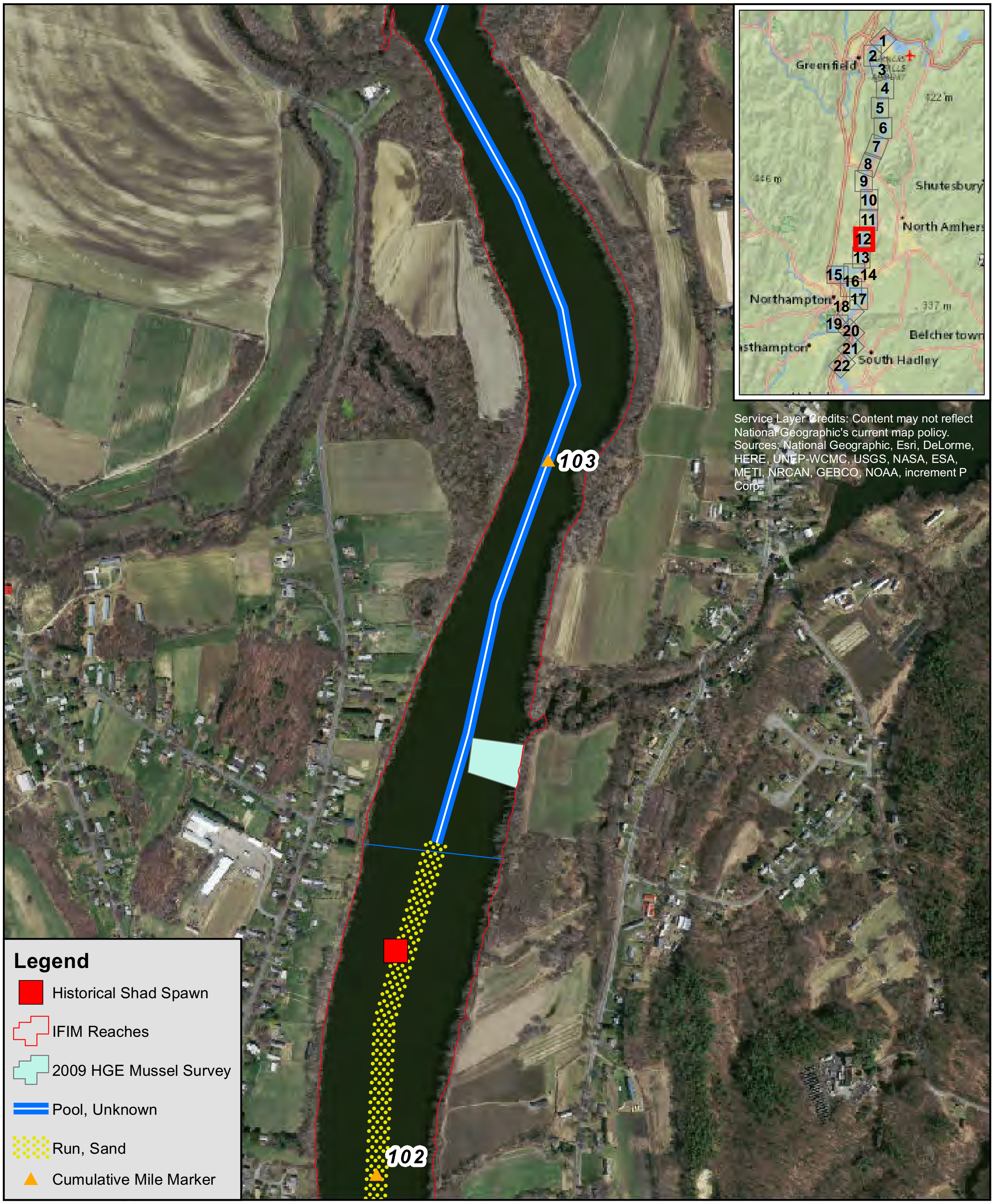

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 12

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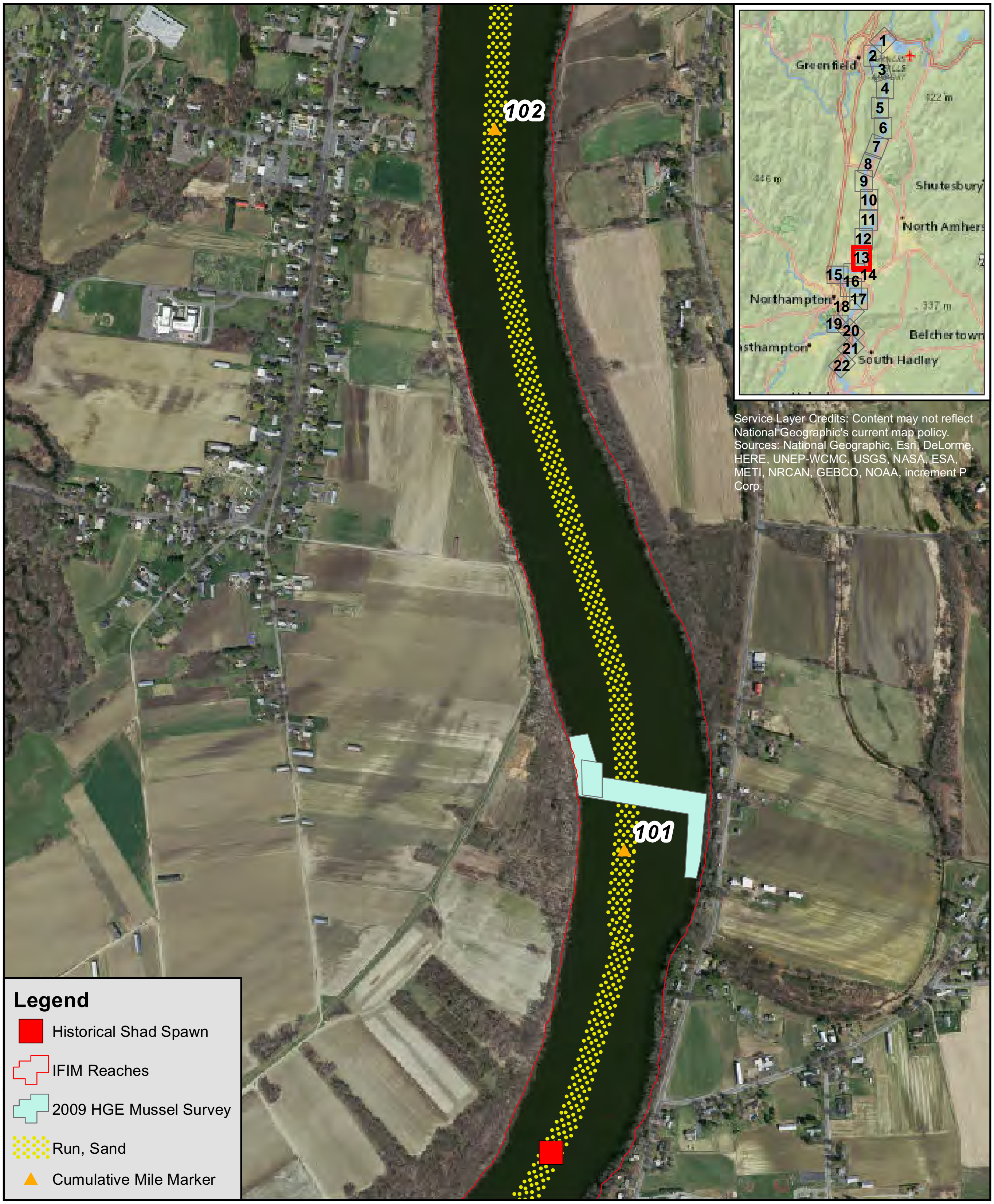

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 13

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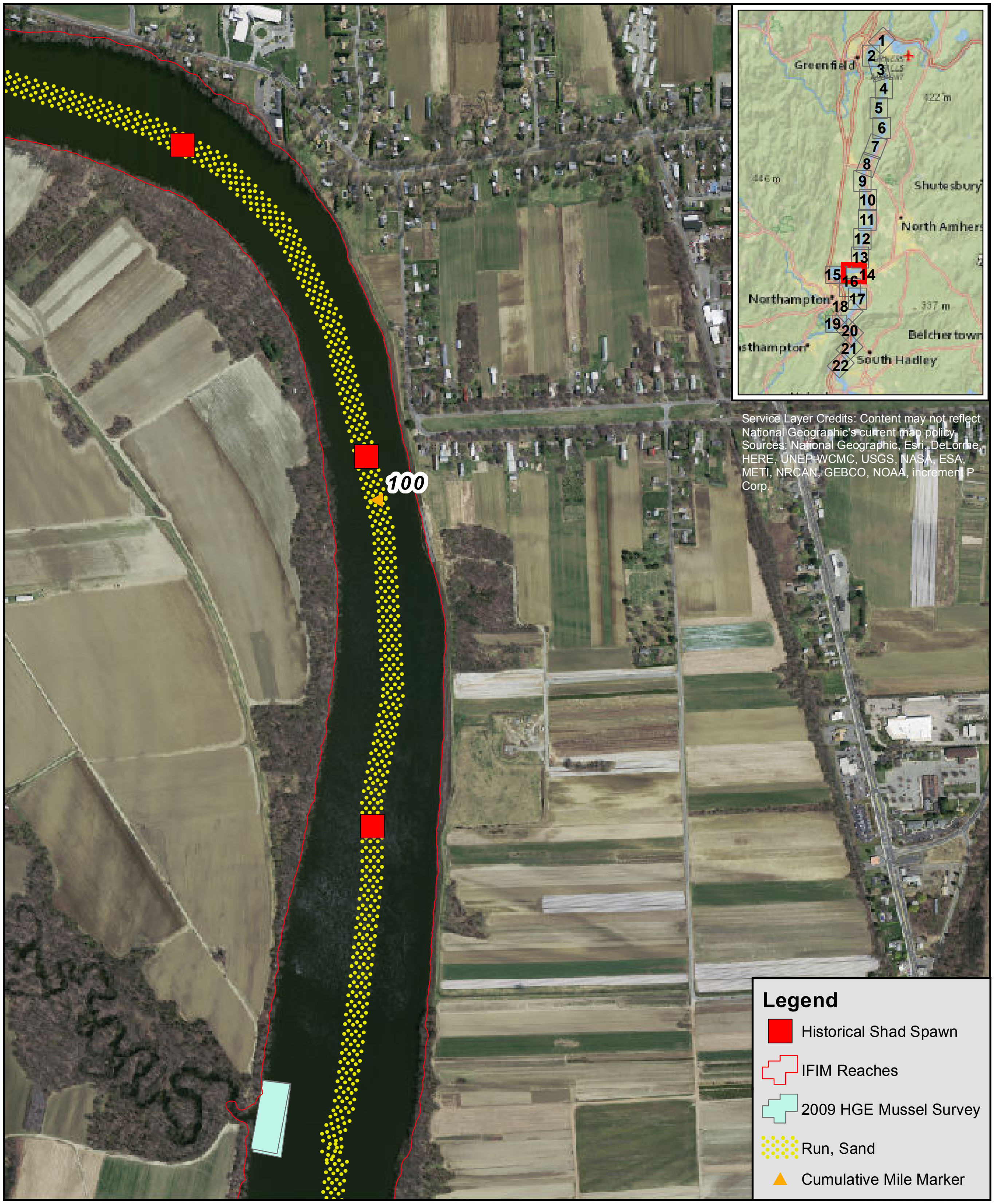

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 14

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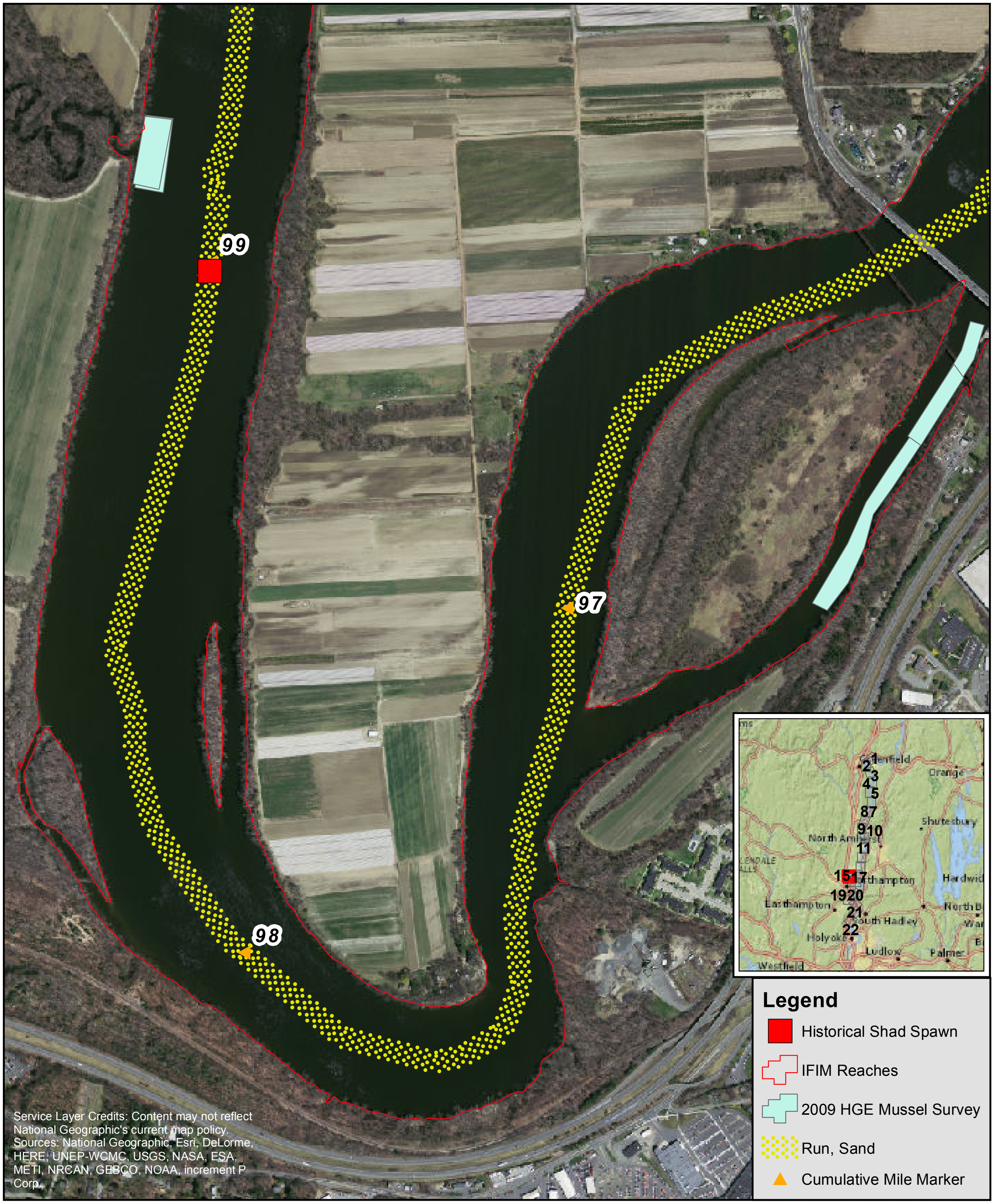

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 15

0 500 1,000 2,000 Feet

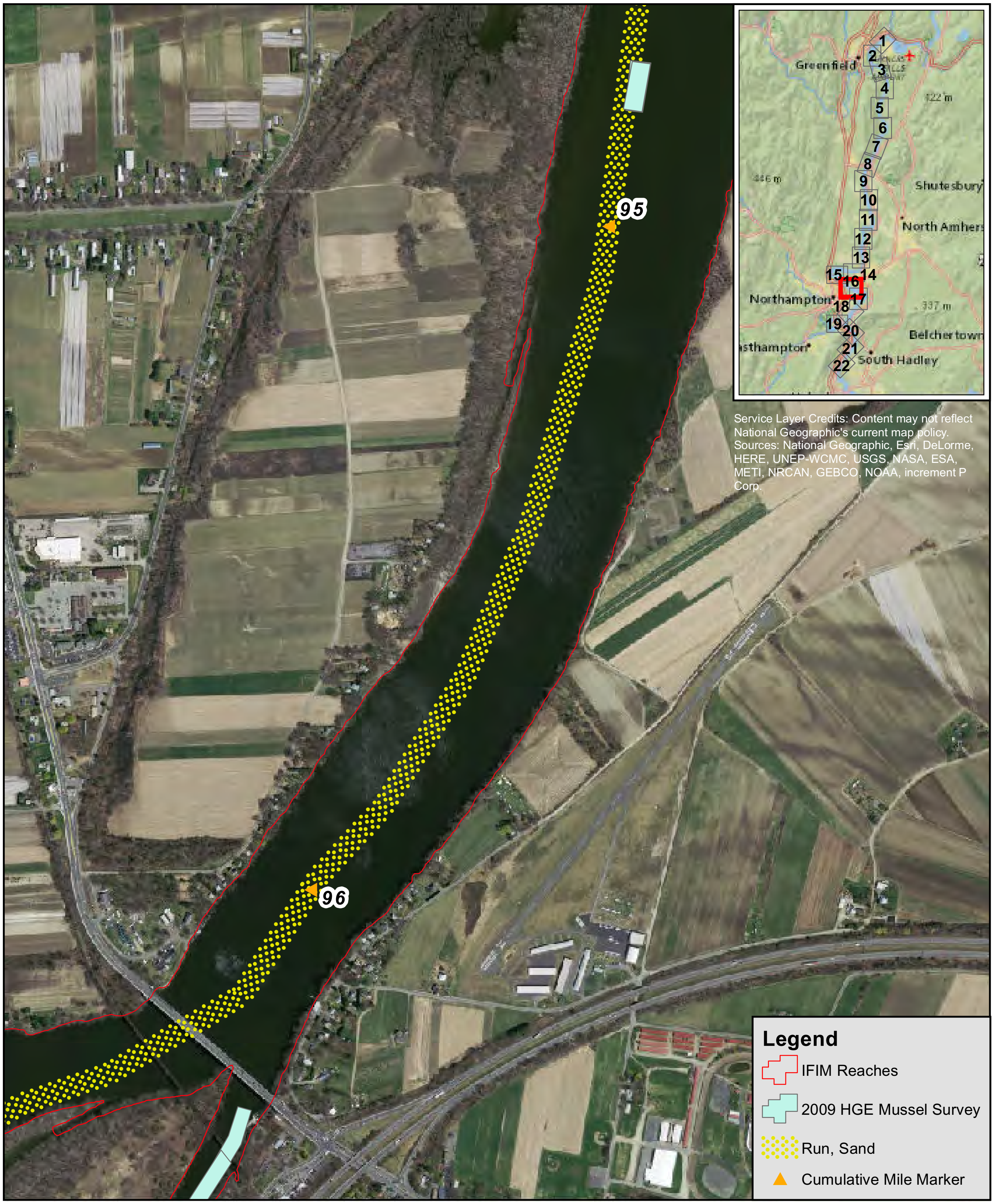

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 16

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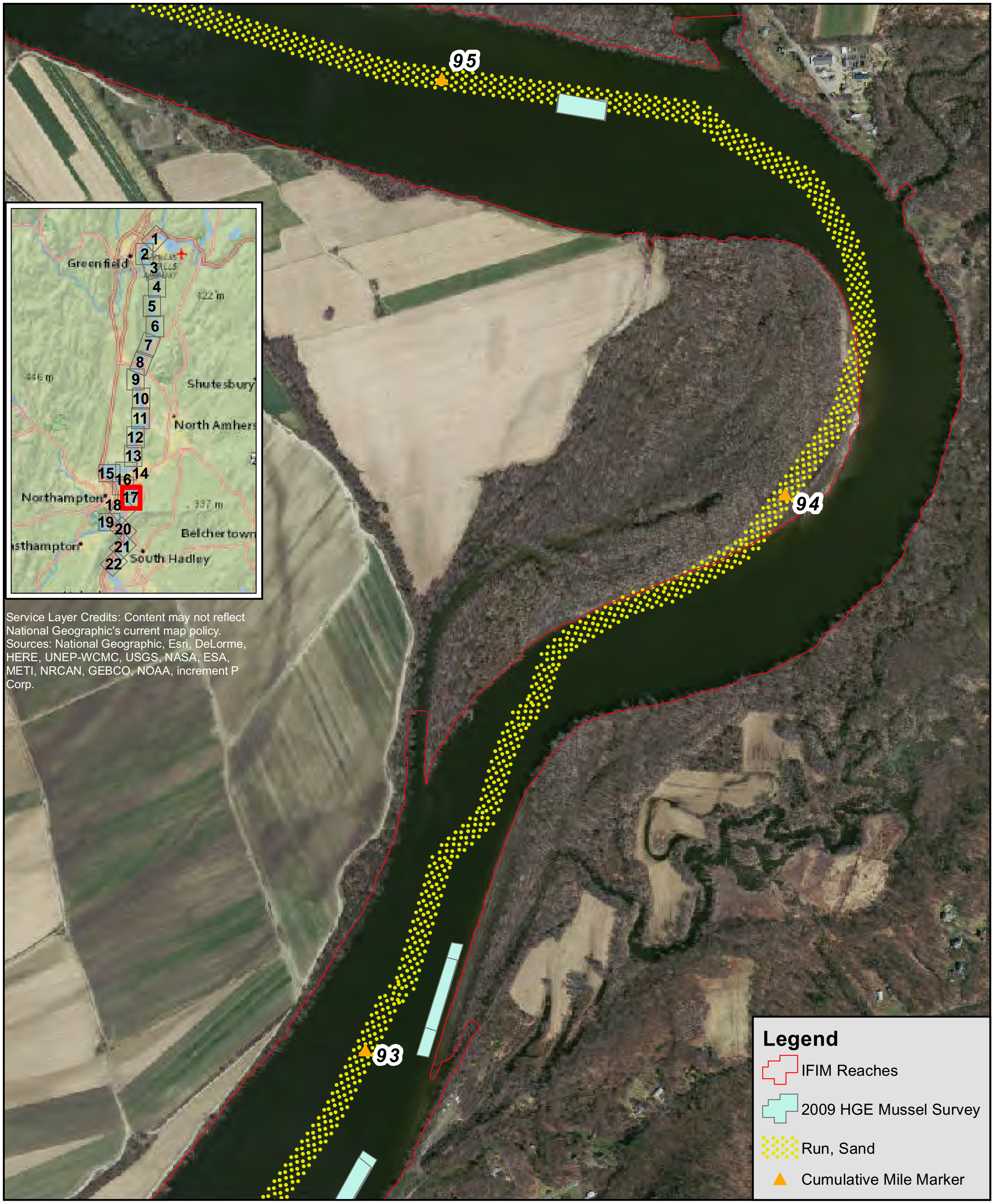

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 17

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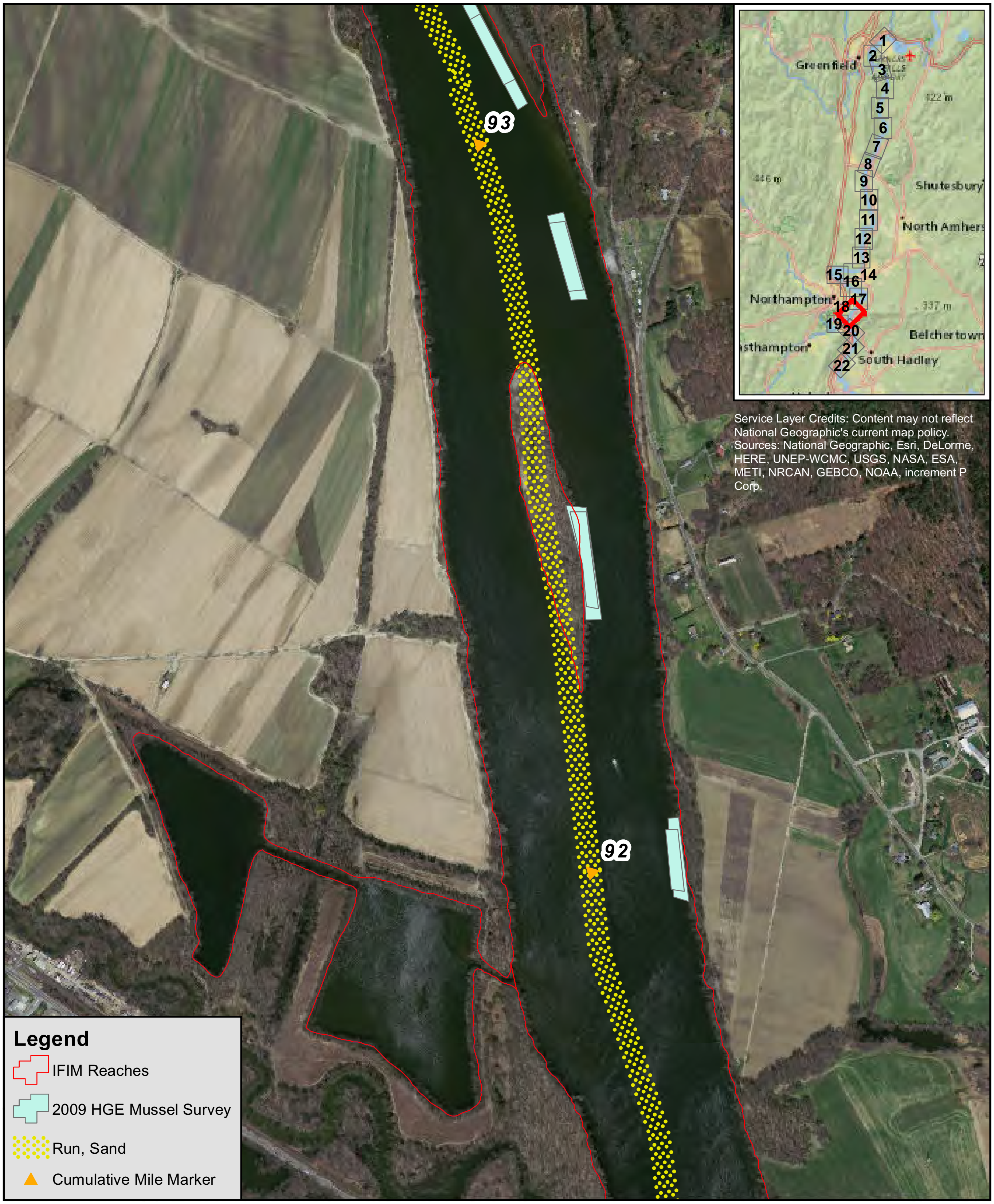

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N

0 500 1,000 2,000
Feet

Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 18

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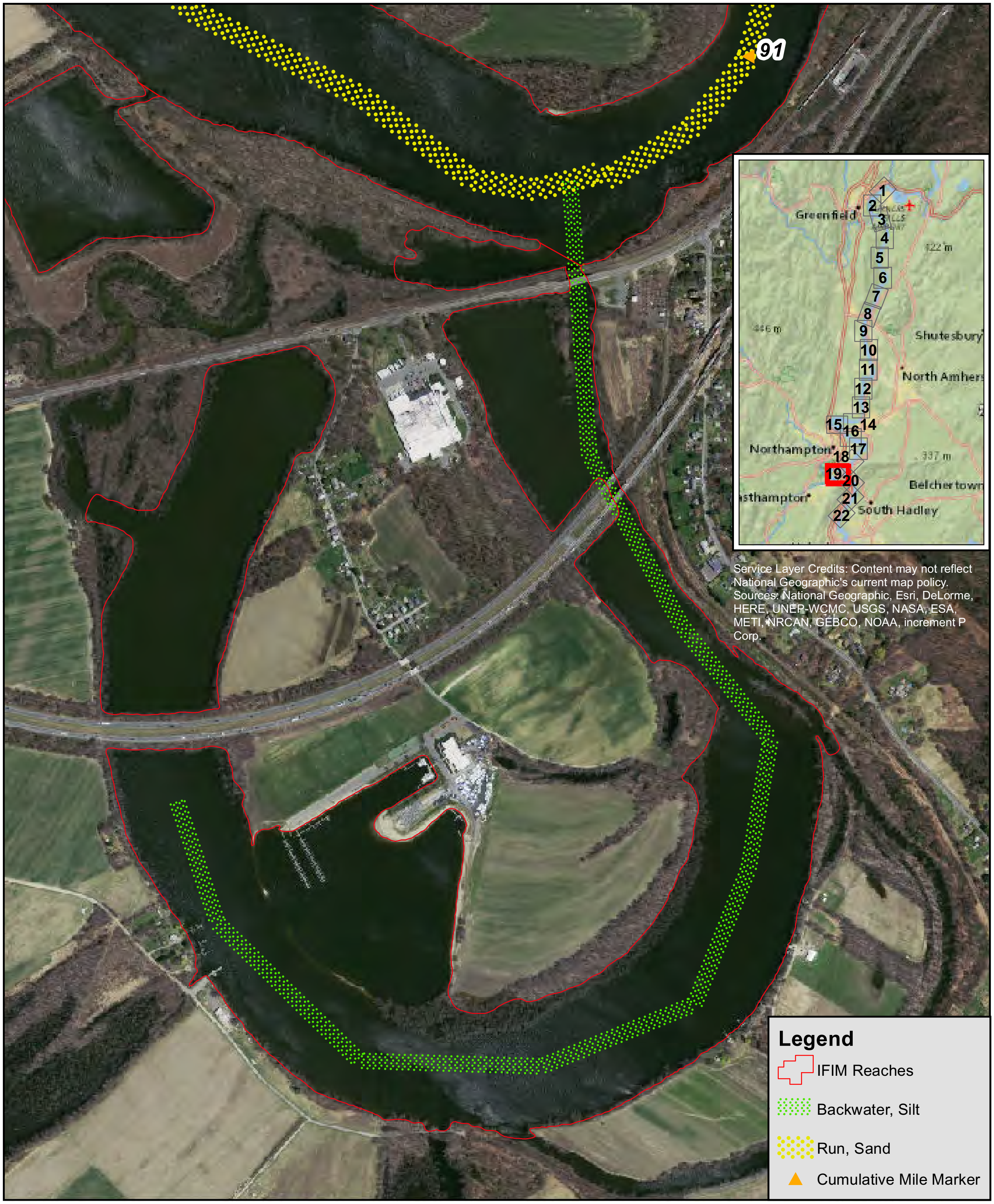

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Figure 3.3.3.1-3
Downstream Mesohabitat
Linear Habitat Classification
Map 19

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N

0 500 1,000 2,000 Feet

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